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Methodological Guide for developing Environmental and Sustainable Development Indicators in Latin American and Caribbean countries

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This document was prepared by Rayén Quiroga Martínez, Regional Advisor on Environmental Statistics in the Statistics and Economic Projections Division of the Economic Commission for Latin America and the Caribbean (ECLAC), with the collaboration of Pauline Stockins, Matías Holloway, Kristina Taboulchanas, Alynn Sanchez, Luisa LaFleur and Paulina Pizarro.

Preliminary versions of this methodology have been used in a variety of courses and workshops offered by the Statistics and Economic Projections Division of ECLAC.

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Summary

This methodological guide is intended as a practical tool for the design and implementation of systems of national indicators to evaluate the success of environmental and sustainable development initiatives, and to define policymaking priorities. The methodology derives from work carried out in Latin American and Caribbean (LAC) countries keeping in mind that the manner in which indicators are constructed and updated has an impact on their overall quality and possible uses.

This guide is based on an intra- and inter-institutional collaborative approach and on the statistical principles and best practices that have been established in the region. The guide discusses the various possibilities that arise at each stage of intra- and inter-institutional statistical work, organizing the content into a methodological road map with systematized stages and steps based on actual experience. The methodology presented herein has been tested in various countries and used to build or expand a set of official environmental or sustainable development indicators.

The heterogeneity of environmental processes, their connection to economic activity, and the limited availability of suitable statistical series means that country teams must be prepared to produce and maintain environmental or sustainable development indicators by drawing upon accumulated regional knowledge and experience. They must then adapt these indicators to meet their country's particular circumstances. Thus, this is not a manual with a canned method; it is a methodological guide that enables users to find their way depending on their own objectives.

Introduction

For decades, the Economic Commission for Latin America and the Caribbean (ECLAC) through its Statistics and Economic Projections Division has helped develop economic, social and demographic statistics in the region. As national awareness of the environment and natural resources and the demand for related information has grown, ECLAC has gradually amassed a comprehensive collection of environmental statistics. Moreover, it has provided capacity-building and technical assistance to the region to support the ongoing development of their environmental statistics systems. ECLAC promotes a step-by-step and integrative approach that incorporates basic statistical series, indicators and environmental accounts.[1]

Over the last decade, experience working with LAC countries has revealed that one of the main challenges to developing environmental statistics is the need to build methodological and statistical capacity[2] and to strengthen inter-institutional coordination.

[1] The literature uses different terms to refer to integrated environmental accounts, including integrated environmental accounts, integrated accounting, environmental accounts, integrated accounts or integrated environmental economic accounts. All of these terms are based on the System of Integrated Environmental and Economic Accounting (SEEA, 2003), which was developed by the relevant international organizations for the purpose of producing comprehensive economic and environmental information on the basis of the core framework of National Accounts. The tables and results of this system allow the interrelationships between economic output and environmental dynamics to be measured in terms of stocks and flows, both in the economy as a whole and by sector. The SEEA enables indicators and statistics to be derived for strategic planning and the analysis of public policy that aid in identifying more sustainable development trajectories. (See http://unstats.un.org/unsd/envaccounting/seea.asp).

[2] Details of these environmental statistical activities and supplementary training in statistics, indicators and environmental accounts can be found at: www.cepal.org/deype/statambiental.

This methodological guide addresses this challenge by presenting the technical elements necessary to build and maintain a system of national indicators. Emphasis is placed on the basic principles of statistics, informed by actual experience in developing environmental and sustainable development indicators. The methodology can be used to build and maintain indicators of any degree of complexity, especially those derived from administrative records or from a combination of different sources.

Building indicators of any sort requires statistical knowledge and an understanding of the issue to be addressed with the information produced. In this context, developing environmental and sustainable development indicators is extremely complex, since the team must be made up of statisticians, as well as an interdisciplinary group of specialists who normally work in diverse public agencies that produce and use meaningful environmental information. It is therefore essential that certain institutions be invited to participate in a joint undertaking at both the executive and technical levels, and that an important part of the training process and of the work programme itself should involve the development of intra- and inter-institutional capacities and work methods for the various team members.

Most of the recommendations in this guide were developed during innumerable initiatives, courses and workshops involving technical experts from all the Spanish-speaking LAC countries. In this regard, the methodology presented draws upon the conceptual and methodological contributions of a group of LAC experts who pioneered[3] environmental statistical efforts in their own countries before becoming involved with other countries in the region. They have generously shared their experience, supported by ECLAC[4] and the regional United Nations Environmental Programme (UNEP).[5]

This methodology was intentionally not published earlier so that at least a decade of practical experience could be gained. As a result, it is solidly grounded in the skills and experiences acquired, and is geared to the current statistical, environmental and institutional dynamics in LAC. In addition, the contents of this guide have been used and refined in other thematic initiatives, such as the development of Systems of Agricultural and Rural Life Indicators, LAC indicators for the Millennium Development Goals, and regional indicators for sectors such as tourism.

The guide presents the advantages and disadvantages of the various approaches at each stage of a methodological design. In this way, the technical teams can adapt the design according to the priorities of their specific country or territory. The course this adaptation takes will depend on the opportunities for coordinating the information with the cycle of public policymaking.

This guide is intended primarily for the statistical and environmental agencies of LAC governments seeking to design and implement and/or improve a given set of official environmental or sustainable development indicators. This methodological guide is divided into two main parts:

The first part is a compilation of basic definitions in the fields of statistics and the environment which, as a whole, provide a common language to facilitate the development and design of environmental indicators (EI). It also addresses the complexity of environmental, social and economic dynamics, explaining how the official environmental statistics systems are organized and why inter-institutional cooperation must be established and strengthened. In addition, the ten fundamental principles underlying the methodological process of building indicators are presented. The second part provides a detailed methodological path for building and maintaining EI, which is based on a core methodological process encompassing three major stages: preparation, design and development, and institutionalization and updating of indicators. At each step, and with each tool, the user is offered a broad range of possibilities within the methodological path being analysed, and given an explanation of

[3] It is appropriate to acknowledge the contributions made by the following regional experts over the past 10 years: Yosu Rodríguez (Mexico), Armando Yañez (Mexico), Guido Gelli (Brazil), Wadih Scandar (Brazil), Dharmo Rojas (Chile) and Francisco Canal (Colombia). The collaboration of these experts in the various countries and with ECLAC and UNEP has led to valuable lessons that have enabled us to systematize and publish this Methodological Guide.

[4] It is important to underscore the valuable conceptual contributions made by Gilberto Gallopin (Argentina), who was one of the world's pioneers in developing the concepts of sustainability indicators (nearly two decades ago now), as well as his work on scenarios and syndromes, and the systemic conception of sustainability of development that he devised for the region under the auspices of ECLAC.

[5] Among the UNEP projects on the Latin American and Caribbean Initiative for Sustainable Development (ILAC) Indicators and GEO reports, the region has for many years benefited from the valuable contributions of regional expert Edgar Gutiérrez (Costa Rica).

the advantages and disadvantages of the various options at each step. Thus, the team devising the indicators will have enough information to make choices and implement designs that are consistent with their needs and resources.

Finally, the annexes contain a series of sample Methodological Sheets, selected links, and the main publications resulting from initiatives for building environmental and sustainable development indicators.

I. Concepts and fundamentals for building indicators

1. A basic review of concepts

The problems and challenges to sustainability facing Latin American and Caribbean (LAC) countries are immense. It is clear that the formulation and monitoring of policies must be evidence-based. Central to this is the need for a set of indicators that are designed to display the vital signs of environmental components and their interrelationships with social and production dynamics.

Better official data on the environment and sustainable development are essential for improving decision-making and the formulation of policies in a manner that responds decisively and effectively to thegrowing demands of the general public. Readily available official data can also help better target the limited resources available in the region for regulating and managing the environment, in both public and private sectors.

Environmental and sustainable development indicators, hereinafter referred to as Environmental Indicators or EI,6 should ideally consist of a system of clear and timely signals about a given environmental process or component. Formulated specifically for the user, these indicators make up a system of select information that enables stakeholders to evaluate their progress in terms of certain goals (if they exist) or simply over time. EI, along with economic and social indicators, allow the various users to share a common stock of evidence and quantitative, select, processed, described and contextualized information. In other words, these indicators are tools for objectivizing environmental and sustainable development processes.

Given the magnitude and diversity of the environmental and sustainable development challenges facing the region, and the limited availability of economic and technical resources, EI are a good investment. They generate finely tuned data that provide a platform of shared content, which can serve as a basis for better communication and decision-making on specific interventions and public policies in the places where the problems are the most critical and urgent.

The power of these indicators has been leveraged effectively in a variety of fields over a long period of time. For example, they have been used in the management of private businesses, the macroeconomic management of countries, and in the sphere of social programmes and policies. It is a well-known fact that timely information is essential for decision-making. Just as businesses need financial statements and strategic information to manage operations, the success of public policies and environmental management, depends on the use of reliable and systematic information. A nation's Ministry of Health could not improve public health without indicators to prioritize and target scarce resources.

Although the environment has been moving up on public and civic agendas, its links to economic and social processes and the development of EI only began to be addressed about 15 years ago. These developments date back to the publication of the report "Our common future", better known as the Brundtland report,7 and the Conference on Environment and Development, which yielded Agenda 21.8

Brundtland popularized the concept of sustainable development (see figure 1), which envisions development as the integration of the economic, social and environmental fields. The Brundtland report emphasized that development processes should balance progress on all three fronts simultaneously and equitably. Since Agenda 21, it has been explicitly acknowledged that EI are necessary to monitor countries' progress, even though at the time the region as a whole lacked the capacity to produce them.

Thus, these indicators were developed ad-hoc and in an uncoordinated way, with National Statistical Offices (NSOs) or Environmental Ministries taking the lead until it gradually became apparent that the complementary competencies of these institutions needed to be coordinated along with those of other institutions9 so that official national systems could be established.

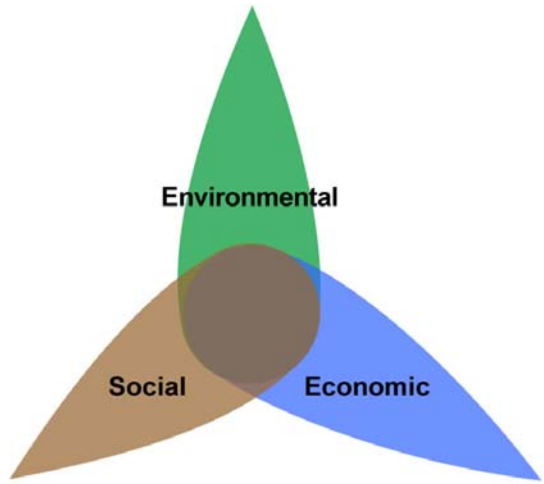
[6] Throughout this methodological guide, for purposes of simplicity, environmental indicators and sustainable development indicators will both be referred to using the term "Environmental Indicators" (EI). For more detailed definitions, see the Glossary section.

[7] In 1987, the World Commission on Environment and Development presented its report, "Our common future", better known as the Brundtland report, in which the concept of sustainable development was popularized. See http://daccessdds.un.org/doc/UNDOC/GEN/N87/184/67/IMG/N8718467.pdf?OpenElement

[8] Agenda 21 arose out of the United Nations Conference on Environment and Development. Chapter 40 of that document emphasizes the need to produce environmental information and calls for the construction of sustainable development indicators. See http://www.un.org/esa/sustdev/documents/agenda21/spanish/agenda21spchapter40.htm

[9] See Quiroga Martínez, Rayén (2007).

FIGURE 1
SUSTAINABLE DEVELOPMENT: INTERRELATIONSHIP OF SOCIAL, ECONOMIC AND ENVIRONMENTAL FIELDS



Source: Prepared by the author based on the concept of Sustainable Development.

Environmental information systems (databases, statistics, indicators, maps, images, and so on), which are relatively uncoordinated, depending on the progress each country has made, are gradually taking shape. In turn, institutions are becoming more aware of the importance of such systems and of the need for inter-institutional cooperation. However, the paucity of basic environmental statistics, in comparison with the economic and social information that has been compiled routinely on an official basis for decades, is evident. Any progress made on collecting statistics and producing EI will depend more on whether the political will exists to allocate sufficient resources, than on conceptual and methodological advances that make it possible to address the complex issues involved.

It is obvious that this process can be catalyzed through public pressure, and it should be noted that international demand for environmental information can bear fruit. In time the State will have to undertake the official production of statistics, indicators and integrated environmental accounts through its specialized agencies.

In this regard, the countries of Latin America and the Caribbean have made a significant effort to measure the EI contained in the Seventh Millennium Development Goal10 in drawing up their national reports on progress towards achieving these internationally agreed goals.

Shedding light on what is happening to the environment and its link to economic and social development requires the strengthening of institutions, inter-institutional coordination and the creation of new forms of collaborative work. However, these innovative steps may draw resistance. While institutions and individuals tend to treasure and monopolize their knowledge as vital capital, the complexity and interrelatedness of environmental processes means that they must use cooperative and inclusive approaches, and that is not an easy task. In LAC, official data are produced more slowly than the public or the urgency of the situation demand. The official culture is such that the transparency of information is still not at the level required for all citizens to be on an equal footing in decision-making. Thus, the production and dissemination of environmental information that by nature is potentially conflictive, poses a formidable challenge.

Although significant progress has been made in the past decade, the environmental information available in LAC is inadequately described, disparate, scattered and sporadically produced. In addition,

[10] http://www.cepal.org/mdg

this scant environmental information is not being systematically incorporated into central and regional decision-making. Individuals, civil society organizations and key government agencies are not provided with sufficient EI to help them make better and more informed decisions on environmental and sustainable development issues.

In the next section, some key concepts that must be addressed to implement the proposed methodology for building a System of Environmental Indicators are presented and discussed.

1.1 Information, knowledge and decisions

Profound and increasingly rapid changes are taking place, both in the world and in LAC, with respect to the way things are done. We are witnessing a major shift in methods of production and lifestyles, spearheaded by technology, information management and communications. There is no doubt that information management is a driving force in just about every aspect of work. The spectacular growth and popularization of information and communication technologies is the platform for this third industrial revolution. The change does not lie in the use of tangible gadgets, such as microprocessors, computers, and wireless devices, but rather the real transformation is taking place in the way people organize their work and their lives. At the same time, expanded access to knowledge and information means that every individual and group of citizens can demand better quality and greater security from providers of goods and services, be they public or private. However, despite recent advances, vast segments of the population remain excluded or have very limited access to information and communication technologies (ICTs). Unfortunately, ICTs are not equitably distributed among the regions and countries of the world.

Although there is still a considerable shortfall in the production of systematic official information on environmental issues, the demand for environmental information in most countries is rising. Moreover, there is an increasing awareness that information management in general is an extraordinary tool for doing things better, insofar as information can be processed rapidly and there is enough creativity to adapt and design systems to provide timely and accurate information for making decisions, intervening and optimizing processes.

Despite the fact that access to these opportunities is not universal or equally distributed, there is no question that knowledge, creativity and innovation can be important catalysts to development, given that the demand for these services increases apace with the rise in per capita income. Thus, before discussing environmental information in general and, more specifically the role of indicators in decision-making, it is important to consider two basic concepts:

Information: At its simplest, information consists of facts and data that do not necessarily have a clear and immediate meaning to all audiences. Examples of specialized information include the number of endangered species, the number of hectares of deforested land, and air pollution levels. In a broader sense, information means data processed in a meaningful way so that they can be used in current and future decision-making. The defining characteristic is that information makes it possible to reduce uncertainty.

Knowledge: Most of the literature refers broadly to knowledge as the ability to understand and function in a given domain. To know something means understanding it enough to evaluate and therefore make decisions. In this sense, general knowledge is recognized as a step above raw information. It is through knowledge that data and background information are processed according to previously established needs and criteria.

In simple terms, it can be said that information, once contextualized and assigned meaning in a relevant situation, is understood by one or more persons and thereby becomes knowledge. By the same token, it can be argued that EI are tools that turn information into social knowledge.

Although studies and publications do not always make the distinction, knowledge is generally referred to as organized, classified and contextualized information, insofar as value has been added to basic information to transform it into useful knowledge. In particular, it has been used to judge or evaluate a situation with a view to making a decision. In essence, applying strict statistical principles, this is what indicators do with statistical series, turning the information they contain into real knowledge for the users.

Therefore, although it may seem obvious, it must be made explicit that substantial organizational and cultural change must be brought about as a necessary precondition to managing knowledge and improving the value and quality of services or the benefits of public policies. EI are no exception. In management literature, it has been established that decision-making should be carried out as rationally and objectively as possible, albeit recognizing that factors such as uncertainty, attitudes (risk-aversion and conservatism, for instance) and the cultural framework may influence the process.

In this regard, information and, more specifically, knowledge are decisive and critical ingredients in decision-making for any modern institution. The availability of timely, balanced, contextualized and good-quality information is very helpful for making strong, objective decisions, thereby increasing the likelihood that decisions will be appropriate and effective.

Public policy decision-making is complex, controversial and critical, and it has major implications. For this reason, information and knowledge are more important and vital than in other areas where decisions are made in narrower or more limited contexts. It is at this point that EI become necessary.

The implications and complexities associated with each level of decision-making vary considerably. In particular, their consequences and duration are different over time, hence the need to make the process as objective as possible. Information must be produced, used and, above all, processed in a manner that generates knowledge. This is even more critical when public policies are formulated for large political-administrative entities (communities, municipalities, provinces, regions, nations, federations).

Not every piece of information or report makes a valuable contribution to objective decision-making, however. An isolated fact or one that is of doubtful provenance is almost as useless as no information at all. In general, the basic characteristics that define the quality of information useful in decision-making are:

1. Reliability
2. Accuracy
3. Relevance, suitability and pertinence
4. Comprehensiveness
5. Current validity
6. Contextualization
7. Organization and classification
8. Presentation (clear and appealing)
9. Appropriateness for users' needs

In indicator-building workshops in various fields, different positions often emerge with respect to the availability of statistical information. On the one hand, experts consider that available statistics are insufficient (or unusable) for building certain indicators while, on the other hand, some participants contend that there are enough data or information to build the desired indicators.

This apparent contradiction arises out of the fact that the two sides do not have the same notion of statistical information and the minimum qualities necessary for building evidence or indicators. Experts will have considered the abovementioned criteria, whereas those without training in statistics will believe information exists without taking into consideration these criteria. For indicators to constitute a robust, credible, usable and sustainable system of signals, they must meet a number of technical prerequisites. Perhaps the most important of these is the quality of the information that went into the calculation of these indicators. Later on, these criteria will be explained by applying them to the case of EI, and their scope in the methodological road map will be discussed (see the methodological road map below).

1.2 Variable, data, statistic, indicator

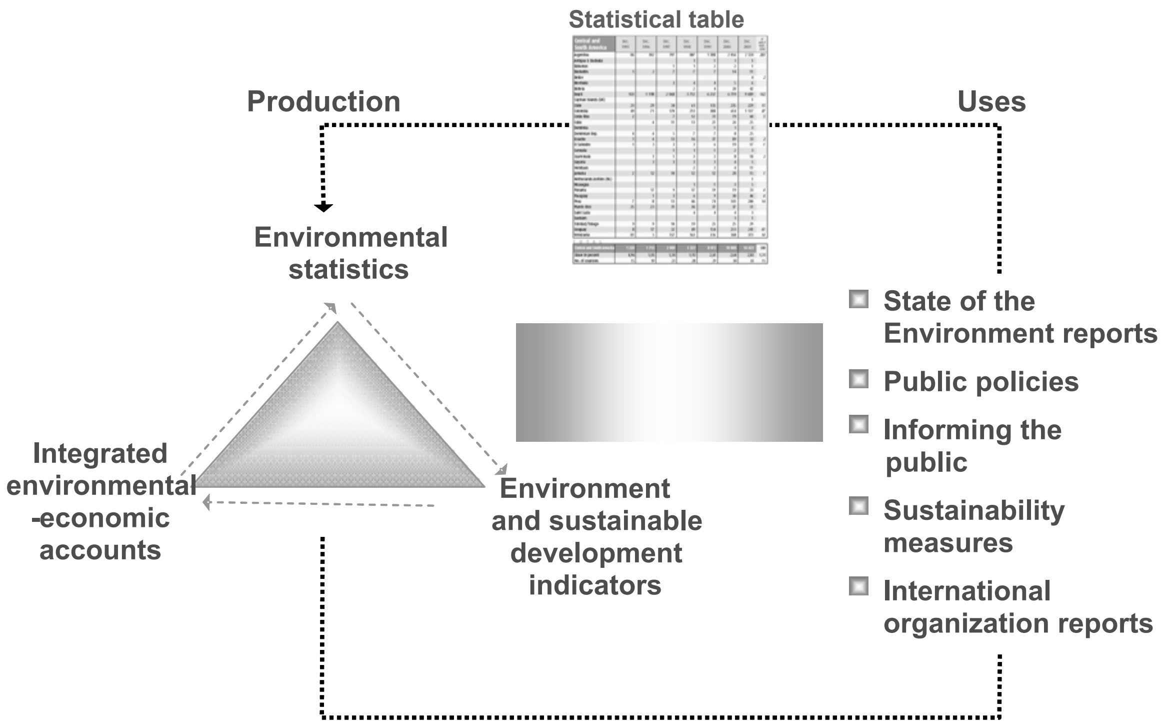
The following basic concepts are associated with the task of building environmental or sustainable development indicators and are aimed at simplifying the interpretation of EI.

Basic environmental statistics are statistical series related to the principal environmental components in time and space: water, air, weather, biota (biodiversity), soil, land use, forests, coasts, marine ecosystems, pollution (sources), solid waste, access to water and sanitation, and so on. They are collected from fragmented, scattered and diverse sources such as administrative records, surveys and censuses, monitoring stations, remote sensing and geospace applications, estimates and models.

Formulating EIs requires a sustained effort to build an integrated system consisting of a continuous flow of information that is periodically replenished and updated and that provides feedback for the process over time. According to the approach taken by the Statistical Division of ECLAC in working with environmental statistics, Environmental Statistics (also known as ES) are understood to encompass the following statistical products:

- basic environmental statistical series;
- environment and sustainable development indicators; and
- integrated environmental-economic accounts.

FIGURE 2
COMPREHENSIVE SCHEME OF ENVIRONMENTAL STATISTICS



Source: Prepared by the author

As figure 2 shows, ES are based on a comprehensive and systemic scheme that includes the design and use of statistical series, selected EIs and integrated environmental accounts. It is recommended that these three products be developed in a coordinated, progressive and synergistic manner.

Several different national institutions can collaborate to produce basic statistical series, indicators and accounts under the leadership of an appointed institution (the NSO or the Ministry of the Environment),11 but all participating institutions should fully cooperate. Furthermore, the work must be based on international statistical standards and specialized environmental knowledge to ensure the consistency and coherence needed for the production of EI and accounts.

Certain environmental economic indicators that can be of particular relevance to public policies can be generated on the basis of the integrated accounts. That is why this integrated approach is recommended for every Latin American or Caribbean country and for the region as a whole. Ongoing feedback among the different components (and the organizations guiding them) will contribute to the modular construction of a national, official, inter-institutional Environmental Statistics System that is tailored to suit each nation's needs.

[11] It is not possible to define *a priori* which institution should be in charge of developing the environmental statistical products mentioned here, because it will depend on the situation in each country, on the institutional strengths of the official Statistical Agency, the Ministry of the Environment and other data-producing entities, and on the availability of technical and financial resources for developing these products and maintaining them over time. Nevertheless, the experiences of developed countries and of some countries in the Latin American and Caribbean region suggests that the first essential step is the commitment of the official Statistical Agency and the environmental authority. In practice, there has been a growing tendency for National Statistical Offices to assume responsibility for producing at least the statistics and Environmental Indicators, even though the initiatives frequently originate in the environmental ministries or as inter-institutional projects.

This approach ensures the efficient use of limited resources for the development of environmental statistical products (basic statistical series, EI, integrated accounts) in a coordinated and consistent manner. In turn, these products will feed both environmental and sustainability diagnoses and public policies, and strengthen public engagement.

Some general definitions are presented below, with a view to defining and clarifying the conceptual differences between the principal elements of information (data, statistical series, variables and indicators).

1.2.1 Some definitions

Variable

The phenomenon being studied, the value of which varies in time and/or space. The most common environmental variables are: air quality in a city, the amount of annual rainfall in a province, the weight of pollutant X that a surface watercourse (a river, for example) carries, or the quality of soils in a given territory. Being variables, their value varies over time and from one territory to another. This allows information about their condition, development and trends to be obtained.

A variable is an operational representation of an attribute (quality, characteristic, property) of a system. It is the image of an attribute defined from the viewpoint of a specific measurement or observation. Every variable is associated with a particular set of entities through which it manifests itself. These entities are usually called states (or values) of the variable. The set of possible states is called a set of states (or values). The pragmatic interpretation of a particular variable as an indicator is usually based on the fact that the variable carries information about the condition and/or tendency of an attribute of the system under consideration.

In general, any variable may show some attribute that is worth observing and monitoring. This depends on the objectives established by the specialized teams that have included it within a set of key variables to be examined.

Data

Data are a set of numerical values that are observed, recorded or estimated for a given variable at some point in space and time. They are usually the result of the application of some kind of statistical survey (such as an opinion poll or the use of an administrative registry), on-site measurement, or some other form of measurement or observation, such as one using remote sensing instruments (satellite imaging, for example).

Data and microdata are the raw material of statistical work, in that they have not yet been described, validated or structured.

Statistic

A statistic is a measurement, value or specific result that a variable has at a given point in time and space, and that has been validated, structured and described statistically.

Statistical processes, because they are oriented towards generating sets of statistics about certain variables in a systematic manner, are generally referred to as statistical series or basic statistical series (to differentiate them from indicators) rather than as a single statistic.

Basic statistics are developed from data using a pre-defined, standardized set of statistical procedures derived from national statistical standards and international statistical recommendations. A basic statistical series, then, is a collection of data that has undergone an exhaustive statistical validation process, has been structured according to an appropriate classification, and is organized and presented to users in an appropriate framework. A key component of statistics is that they must be thoroughly described and supported by metadata.

Statistics are often presented as time series or geographic distributions, disaggregated or broken down into the components that might be of interest to users. In general, statistical series are published in the form of statistical tables, statistical databases and statistical yearbooks or compendiums.

The main users of basic statistical series are researchers, policy analysts, experts and research centres that have the time and knowledge necessary to process them and generate reports that suit their professional needs.

Metadata

In order to ensure that statistics are comparable regardless of when and where they were produced, and that users can apply and interpret them appropriately, each statistical series must have its metadata. Usually, metadata consist of a data sheet or methodological sheet containing detailed information about the concept, its origin, the specific source, the method of calculation, and what each statistical series does and does not include.

Indicator

Indicators are statistics selected for their ability to depict an important phenomenon. Indicators are often produced by processing statistical series as aggregations, proportions, growth rates or other forms, in order to show the current state of a phenomenon, its development over time, or trends that can be identified. Indicators are designed and produced for the purpose of tracking and monitoring certain phenomena or dynamics that require intervention or the development of a programme. Therefore, indicators are developed with a specific purpose in mind, and must be carefully calibrated on the basis of criteria such as the availability and quality of information, the relevance of the indicator and the indicator's contribution to the System of Indicators.

Indicators are often presented in a contextualized form, meaning that the user is given an explanation of what the indicator shows and its importance and implications, in a clear, user-friendly format with computer graphics, charts and maps. They are generally published as Systems of Indicators on the topic in question, in digital form on websites, and on paper to facilitate the access of laypersons to their content.

Like statistics, indicators must be supported by metadata, commonly known as sheets or data sheets (see Annex 2).

The term indicator generally denotes an empirical observation or statistical estimate that synthesizes different aspects of one or more phenomena that are important for purposes of analysis and monitoring over time. Although the term can refer to any observable characteristic of a phenomenon, it usually applies to characteristics that can be expressed numerically and that are of public interest.

The main users of indicators are decision-makers and authorities, the public and opinion leaders who do not have the time or the extensive specialized knowledge necessary to make direct use of statistical series. Collections of indicators are usually assembled explicitly for these users.

1.2.2 Statistical information processing: data, statistics, indicators

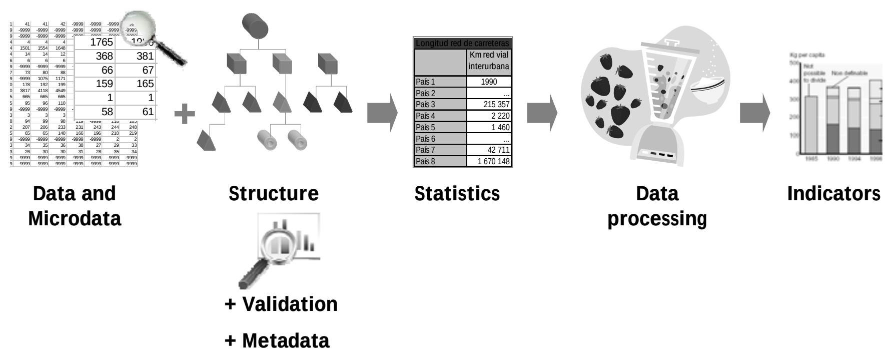
The processing of statistical information involves a number of indispensable steps, as shown in figure 3. Data from a survey gathered from a variety of available sources (monitoring stations, administrative records, censuses and polls) are, depending on the nature of the data, organized and described in time series. These statistical series can be used to calculate indicators and as inputs for environmental accounting. In addition, some statistics may be indicators themselves.

An example of this is the growth rate of the number of automobiles in a polluted and congested city. In addition to being a statistic, it is also an indicator that refers, not only to the number of vehicles added to the total each year but also (if it is positive), to the possibility that automobile emissions will become a greater problem and traffic congestion will worsen, thereby increasing travel times and reducing quality of life.

Indicators and integrated environmental accounts are statistical products that are built using basic statistics and using more complex forms of processing and publication. Consequently, all indicators are also statistics (or are made up of them), but not all statistics are indicators. However, the users of these statistical products do not usually know that an indicator is also a statistic, nor do they know the difference between the two. This should be clarified by differentiating between them, to the extent that each type of ES product (statistic, indicator, accounts) is intended for a different type of user. Thus, as has been stated previously, in most countries, environmental statistical series are usually published in the form of online databases and/or voluminous yearbooks or compendiums of ES. This is because the main users are researchers, consultants, experts and research centres that use them as the basis for building various indicators and reports on aspects that need to be studied.

In contrast, the typical users of indicators are decision-makers, political and civic leaders who are short of time and need to receive processed, selected, contextualized information that indicates the main trends and challenges derived from it, the task of analysis being the responsibility of their own experts and advisors.

FIGURE 3
PROCESSING OF STATISTICAL INFORMATION



Variable:	Attribute or part of a phenomenon that changes its value over time and across space.
Data:	Numbers derived from information surveys.
Statistics:	Structured, systematic, described data.
Indicator:	Refined, selected statistics for decision-making, communicated in a context.
Metadata:	Description of information about definition, sources, methods of calculation, periodicity, etc.

Source: Prepared by the author

1.3 Processed and select information: Indicators

Sets of indicators are important instruments for supporting countries' efforts towards achieving sustainable development.

1.3.1 What is an indicator?

An indicator refers to a combination of one or more variables. It acquires different values in time and space, and sends signals to the public and to decision-makers about basic or priority aspects of the development process.

The variations in indicator values yield important information about a particular phenomenon or problem. Therefore, to achieve their full potential as signals, indicators require more than one point of observation in time or space. Thus, just one indicator with a single value for the year 1990 or for one location in the territory, will not be as useful as one tracked over time or compared to how it varies from place to place.

As has been noted above, an indicator is a variable which, depending on its value at a given moment and in a given place, holds meanings that are not immediately apparent and must be decoded by the users, looking beyond what is directly shown and associating the indicator with its corresponding cultural construct and social significance. Not all statistics can be considered indicators. To be categorized as such, the statistic must communicate clearly a relevant story—it must send a message about what is occurring with respect to a phenomenon, problem, challenge or target that has been agreed upon, and it must provide robust, clear and contextualized information that leaves no room for doubt or contradictory interpretations. Indicators are variables, and not values, as is sometimes asserted.

As Gallopín12 (1997) demonstrates, the most desirable indicators are variables that add or somehow simplify relevant information, make the phenomena of interest visible or perceptible, and quantify, measure and communicate relevant information. Since indicators can acquire different values or states, particular significance can be attributed to certain states based on certain value judgments: thus, these specific states become thresholds, standards, norms, targets or reference values.

1.3.2 Definitions of Environmental Indicator and sustainable development indicator

The study of the sustainability of development has yielded major contributions and debates in the last 15 years. However, for practical purposes EI and sustainable development indicators should be defined.[13]

Simply put, EI are those that describe and demonstrate the principal environmental components and their states. In other words, they reflect the status and tendencies of, for example, biota and biodiversity, the quantity and quality of water, the quality of breathable air, pollutant load and the supply of renewable energy, the availability and extraction of natural resources (such as forests, fisheries, agriculture), urban pollution, the production of solid waste, the use of agrochemicals, or the frequency and intensity of natural disasters.

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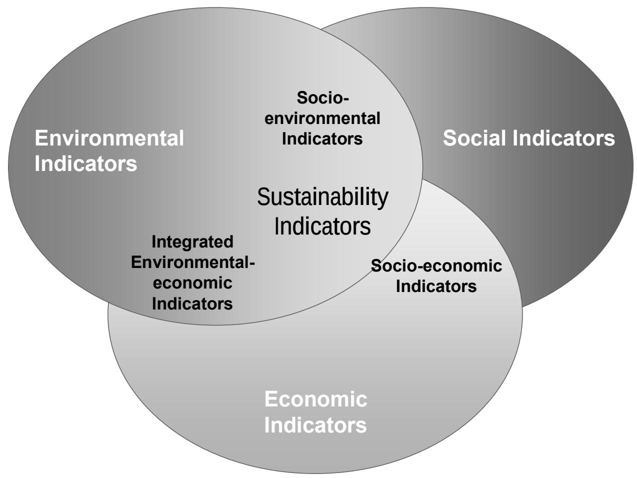
[12] Gallopin, Gilberto (1997), *Indicators and their Use: Information for Decision-making. Sustainability Indicators*. Moldan & Billharz, (Eds.).

[13] The theoretical discussion of what is understood by sustainability, sustainable development and the respective indicators is as extensive as it is passionate, and there are various summaries of it (see Quiroga, 2007). However, as far as statistical praxis is concerned, beyond the fertile discussion and progress on conceptualization, and mainly because environmental data and statistics are actually somewhat scarce in the countries of Latin America and the Caribbean (and to a lesser extent in developed countries), two kinds of indicator collections are actually constructed in today's world: environmental indicators and sustainable development indicators. They tend to take the form of official national systems of indicators. Analysis of the indicators contained in nearly every national or agency initiative reveals, with few exceptions, that the indicators that are published and updated are either environmental or sustainable development indicators (either first or second generation, as conceived by Quiroga, 2007). In some cases, however, there are countries and organizations that give their indicator initiatives more complex and ambitious names.

Sustainable development indicators attempt to show economic, social and environmental dynamics and their interrelationship. To date, however, sustainable development indicators for the region have essentially been produced by assembling groups of variables incorporating the main economic, social and environmental indicators, without integrating them or describing their interrelationships adequately.14

FIGURE 4
INTEGRATION OF SOCIAL, ECONOMIC AND ENVIRONMENTAL INDICATORS



Union EnI+EcI+SI = Sustainable Development Indicators
Intersection EnI ∩ EcI ∩ SI = Sustainability Indicators

Source: Prepared by the author

Some organizations, such as the Commission on Sustainable Development of the United Nations, include the institutional framework among these elements in their proposed Indicators of Sustainable Development. See (online) http://www.un.org/esa/sustdev/natlinfo/indicators/isd.htm

The relationship among EI and sustainable development and sustainability indicators is shown in figure 4 above.

EI reflect the principal issues and components of the environment in a given territory. They can be presented on their own or as part of sustainable development indicators, in which case they correspond to the environmental dimension of those indicators.

Sustainable development indicators can be understood as the union of sets that incorporate economic, social and environmental indicators, without necessarily integrating or merging these dimensions into one or more indicators. Sustainability indicators correspond to a higher dimension that can be illustrated using the analogy of the intersection of sets comprising economic, social and environmental indicators. To create this intersection, at least two of the three components must be merged or integrated in each of the resulting sustainability indicators. The outcome is a set or System of Sustainability Indicators that are cross-cutting and capture the interrelationships among economic, social and environmental factors to the best possible degree and detail.

An example of the sustainability indicators that can be compiled comes from the field of integrated environmental and economic accounting (System of Integrated Environmental and Economic

[14] The sustainable development indicators system of the Commission on Sustainable Development programme within the United Nations is currently under review. See Quiroga, M., Rayén (2007), "Environmental and sustainable development indicators: progress and perspectives for Latin America and the Caribbean" (Spanish), Manuals Series No. 55 (LC/L.2771-P/E), ECLAC, Santiago, Chile.

Accounting, 200315), which can produce indicators showing the interrelation of economic and environmental processes (Quiroga, Ortúzar and Isa, 2005) (in both hybrid and integrated forms, by assigning monetary value to environmental flows and assets). In LAC, only Mexico systematically calculates these indicators over time.

1.3.3 What purpose do environmental and sustainable development indicators serve?

The existence of environmental and sustainability problems in the development process requires interventions and public policies based on evidence and clear, transparent information.

Two elements combine to further complicate the issue of EI in LAC: the cross-cutting, complex nature of environmental phenomena implicit in the vast territorial expanse of each country and, concomitantly, the cost of compiling and updating official environmental statistics. Hence the importance of focusing efforts and resources on the production of select information, and giving priority to what is most essential for improving the efficacy of decision-making. Once a robust set of indicators has been produced and becomes known and valued, its scope can be amplified and deepened over time.

EI are a good tool for this task. They allow for the synthesis of information on a complex and changing reality. Indicators are themselves selected and processed information whose usefulness has been pre-defined. With the appropriate indicators, those who monitor processes can predict trends and intervene before undesirable or irreversible situations result. Those who implement policies can objectivize and measure their effectiveness, calibrate instruments and programmes, and focus efforts in a timely manner. The public in general can also share the same objective compilation of select information so that they can hold informed discussions with the government and the private sector.

Thus, the investment in producing, maintaining and disseminating environmental and sustainable development indicators in LAC is highly justifiable, just as work on developing economic, health, and social indicators, and statistics in general, was justified in its time.

1.4 Complexity of environmental information

Due to its very nature, environmental information has characteristics and complexities that pose formidable challenges for national statistical systems. EI and statistics come from disperse sources, and consist of components that know no political or administrative borders and, with a few exceptions, are difficult to capture from polls and censuses.

1.4.1 The dynamics and spatial dimensions of environmental phenomena

Ever-changing environmental phenomena occur throughout the planet, and even in the exchange of energy with outer space. In this context, human beings, their economies and activities make up a subsystem within the larger biotic and physical ecosystem.

When environmental dynamics are viewed in their true magnitude and complexity, their intrinsic nature reveals the tremendous challenge involved not only in understanding their principal processes, but also in approaching the enormous task of demarcating and measuring them, especially given that this must be done periodically. The first step in developing environmental statistics is to select a few key variables and, in each case, to make meticulous decisions on the source, frequency, aggregation and itemization of these variables. Careful decisions help ensure that scarce human and financial resources may be utilized efficiently.

Selecting variables is not an easy task, since the main environmental and ecosystemic variables cannot be measured by means of the surveys or censuses normally used to gather primary demographic information. Environmental variables are by nature dynamic, and are distributed territorially without

[15] United Nations, European Commission, International Monetary Fund, Organisation for Economic Co-operation and Development, World Bank (2003), *Handbook of National Accounting. Integrated Environmental and Economic Accounting 2003. Final draft circulated for information prior to official editing*, United Nations.

regard for political-administrative borders. They defy human technical and economic capacity to demarcate and objectivize environmental phenomena at the time and place of their occurrence with a minimally acceptable periodicity.

In addition, the values attained by the different environmental variables are heterogeneous and tend to fluctuate. Certain features of natural growth of the biomass – for example, in a natural slow-growing forest that is not subject to logging – do not justify or require assiduous monitoring of their status, since the most relevant changes can be observed on a yearly basis or less frequently. Other elements, however, change so quickly that in some urban centres they are monitored as frequently as every hour of the day. One example is air quality, which depends on emissions or concentrations of fine and coarse particulate matter (PM10, PM2.5) or of sulphur dioxide (SO2). The sustainability of renewable resources requires economic and environmental analysis to determine the ideal frequency of updating. Moreover, some variables are markedly seasonal, such as fluctuations in fish biomass and the incidence of fires. In such cases, monitoring needs to be focused more during some months than others.

Other variables fluctuate considerably as a function of their geographic location, which in turn is associated with different climatic, ecosystemic and anthropic conditions. Consequently, specialized indicators, or those that are specific to each territory, are more useful than indicators that are national aggregates or averages. This is true for the quality of surface water intended for human consumption, since water pollution – the biochemical oxygen demand (BOD)16 indicator – may be less important in the flow downriver from a city than in the intake for the public water supply.17

In such cases, it is more important to know the maximum rather than the average pollution levels, in order to determine whether the standard for that location, or that country, has been met. Obviously, the average would be influenced by the number of observations and the pollution levels for the entire length of the river. The same logic applies to toxic or hazardous residue pollution variables; it is probably not worth investigating averages or national weighted averages: instead, efforts should be made to gather data at critical locations in order to guide public policy interventions.

Given these circumstances, the survey criteria, and the criteria for prioritizing the monitoring, measurement and recording of the principal phenomena and states of environmental components, should be chosen carefully. It is essential to provide an adequate description of the coverage, nature and limitations of the variables and EI by using metadata, and to explain in detail the assumptions, methodologies and forms involved in collecting and structuring a data series. This information must be made available both to producers and to users.

1.4.2 Complexity of interrelationship among environmental, economic and social dynamics

If the above description shows the tremendous complexity of ecosystem phenomena and dynamics, the challenge becomes even greater when the relationship between ecological variables and human activities is taken into consideration. In this regard, the sustainability of natural resources is of great interest. This implies considering the stocks and flows of natural resources, and the economic extraction and rate of natural restoration of marine species, vegetation, and other similar resources. This makes it possible to get a more precise idea of the situation and the trends of the phenomena under study.

The theoretical and referential frameworks that attempt to deal with the increasing diversity of these society-nature phenomena should always be borne in mind. The extreme complexity of these dynamics will have a profound impact on the statistical work, and the resulting knowledge will yield criteria and approaches that will make the creation of a national EI system feasible and manageable for the personnel tasked to carry it out.

1.4.3 Difficulty and costs of measurement

[16] Corresponds to a parameter that is usually used as a proxy for the biological pollutant load of surface waters.
[17] Provided that it is for human consumption.

The discussion above reveals the technical barriers to the systematic demarcation and measurement of the principal environmental and sustainability dynamics. Territorial dispersion, the multiplicity of recurring phenomena and the constant interaction among the different components of ecosystems — especially the interaction between society and nature — all make the task of monitoring, measuring, recording and calculating the behaviour of these variables a true challenge. Furthermore, LAC countries also face serious budgetary constraints and the government funds allocated to statistics are subject to strong competition from other areas. In general, environmental issues are given a lower priority. Although the cost of monitoring and measuring is falling consistently, some of these activities require the purchase, calibration and use of somewhat costly instruments, not to mention the work of interpreting data (such as satellite images). This means that scientists and highly specialized experts must be paid for their time, thereby increasing the cost of producing environmental statistics relative to the cost of statistics derived from questionnaires, for example.

Thus, developed and LAC countries alike have had to decide which environmental or sustainability components, or elements, are the most critical or strategic, in order to begin working sequentially and progressively on the production of environmental statistics.

1.4.4 Organizing the Environmental Statistical System and strengthening inter-institutional cooperation

At present, environmental data in most countries of the region are scattered, unstructured and lacking in descriptions. In this regard, as often becomes apparent in discussions among experts, the most significant and urgent task is to organize and structure national Environmental Statistical Systems to make them permanent repositories into which data can flow, and from which environmental statistical series, indicators and, eventually, integrated accounts can be created and disseminated in accordance with the information needs of all users.

Therefore, it is very important to bear in mind that most countries, including those furthest behind in the official production of environmental statistics, have large amounts of environmental data that can be fed into such a system. Although most environmental data may be partial and uncoordinated, it is still essential raw material that can be used in an orderly sequence of steps. Gradually, processes can be put in place, networks and devices developed and, finally, results and products obtained, so that public policies can be adopted, and producers and citizens can make decisions.

1.5 Sources of information for building Environmental Indicators

One of the key elements in building any statistical product, including any type of indicator, is the careful selection of the type of statistical source and, within each type, of the specific instrument or procedure used to build the official statistical series.

In general, the environmental variables that are currently being measured or estimated in the region come from different types of sources. Therefore, this diversity must always be taken into account when validating and calibrating procedures to ensure the reliability of results. This will depend on how the factors that make it possible to gauge the quality and robustness of the data vary, in turn depending on how well each country has developed the ability to collect statistics from different sources, and on the way the different kinds of environmental variables behave.

Here are the principal sources for Environmental Statistics:

i. Administrative records (of government agencies in charge of natural resources and other ministries.)

ii. Censuses (of population, housing, livestock, businesses)

iii Surveys (of households, employment, the environment)

iv. Monitoring systems (of water quality, air pollution, climate, soils, and so on)

v. Remote sensing (satellite imaging to inventory forests)

vi. Estimates (using different models, such as regressions, simulation, extrapolation and interpolation)

vii. Combinations of sources (such as soil degradation from land monitoring systems, remote sensing or expert estimates)

Analysing potential sources is important and can enhance the quality and statistical robustness of the EI System's final product. Every source and instrument or primary information-gathering method has essential advantages, disadvantages and challenges that can affect the quality of the calculated indicators. Selecting the best possible source, given the limited availability of primary environmental information, requires careful study of the alternative sources available, all of which is described and analysed in the methodological road map (see section II).

2. Fundamentals for building indicators

Before addressing each methodological stage it is important to consider a number of principles that underscore the methodological process for building indicators. These can guide and strengthen the quality and sustainability of the statistical product that is under construction.

These fundamentals are based on the experiences of Latin American and European countries, and New Zealand and Canada. They are presented here so that teams tasked with building and maintaining EI can study them with a view to improving the process and results of their work and reducing the time required to achieve their objectives.

The principles are generic and referential, and teams may choose to adopt or adapt them, depending on their particular needs.

2.1 Teamwork

Putting together and sustaining an interdisciplinary and inter-institutional EI team that is led by a single institution is very important for the success of the process and the durability of the results. The team must be made up of individuals whose abilities and expertise are complementary, both from the institutional point of view and in terms of their academic training and work experience.

According to the methodological road map, a team tasked to develop EIs and put them into practice is essential for the start of a national EI initiative. This team includes a leader who, together with the central and specialist teams, will be responsible for developing the System of Indicators. The teams must communicate and coordinate with public officials, as well as receiving support from experts and scientists, and also the opinions of future users.

The team must have clear leadership and personnel to ensure objectives are met. This leadership will likely fall under the responsibility of the institution mandated to develop the EIs in each country, such as the national statistical office (NSO) or the Ministry of the Environment.

The working team will be set up in an ad hoc manner to carry out tasks as efficiently as possible. During the design phase when methodological sheets are being filled in, the team must be divided into sub-groups specializing in particular subject areas. Subsequently, it will hold plenary meetings at which progress is reported and the EIs are corrected and validated.

It is essential that at least part of this team, the collective architect of the first set of national EIs, be incorporated as a specialized unit within the lead institution's organizational structure so that the EIs can be updated and utilized permanently.

2.2. Adequate organization

As mentioned in the preceding section, it is essential that this (these) heterogeneous working team(s) be organized in such a way as to perform tasks adequately. A working plan that includes a clear schedule for achieving goals, and assigns responsibilities at each stage for each team and sub-team, should be drawn up and disseminated.

A clearly-defined executive mechanism (i.e., high level inter-institutional committee or commission) is equally important to the team effort, to convene meetings, organize work, make timely decisions, and ensure both compliance with the working plans and high-quality results. Depending on the institutional arrangements of the country in question, this leadership and coordination should come from the institution best equipped to guide the process and persuade other institutions to collaborate: the NSO or the Ministry of the Environment.

Ongoing and effective coordination depends on continuous communication with the high level inter-institutional committee or commission, with all working groups, and with national and regional experts who contribute to the process.

2.3 Cooperation

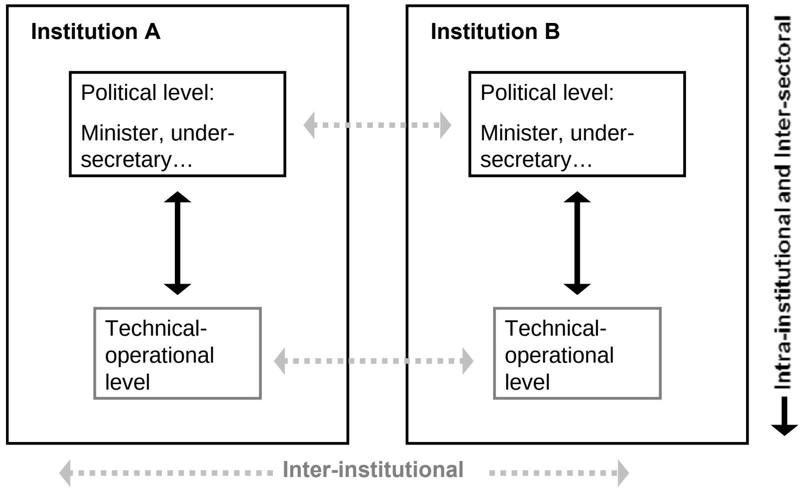
Establishing and maintaining collaborative relations among the various members of the working team will vastly improve the quality and pace of work. The various institutions that make up the teams, the different areas or levels of government (politicians, technical experts, administrators) across all the regions of the country, and other countries and technical cooperation agencies in the region, must cooperate with each other to create inter-institutional and intra-institutional ties (see figure 5).

There may be obstacles to cooperation, given that institutions and individuals may be reluctant to share resources, information, data and expertise if there are no assurances regarding the use to which the products of the collaboration will be put. This is especially true if there are institutional or collective cultures that encourage the withholding of information rather than sharing and collective management. In LAC, there is a general tendency to appropriate information within institutions, and even within different departments of the same institution, in keeping with the maxim that "information is power."

As a result, it is necessary to sensitize the political class, one of the main users of the product being built, to the benefits of the process under way. The unlimited support of this user is essential to encourage the sharing of information and expertise and, at the same time, to explain the benefits that will be enjoyed by all participants at the end of the process.

A powerful and proven argument for stimulating collaboration and the sharing of information, human and technical resources and initiatives, is to assure the participants that all actors will have benefited by the end of the process by gaining access to quantitative data, to the data sheets and to the human resource network that will have been formed. It should also be emphasized that these benefits are only possible if everyone works together, commits to the project and contributes energy, labour, data, expertise, and so on. This is a collective effort, and the participants must be confident that the products and results will also be available collectively and freely without any limits to access.

FIGURE 5
ORGANIZATIONAL CHART OF INDICATOR-BUILDING TEAM AND CONTRIBUTORS



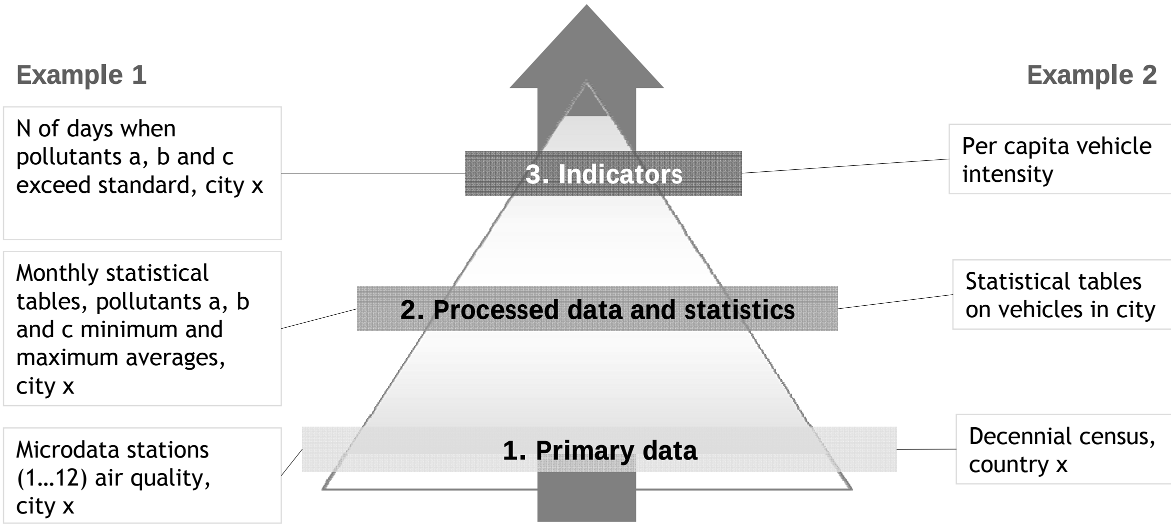
Source: Prepared by the author

2.4 Selection of information and coordination of processes

As mentioned in the first part of this methodological guide, in order for indicators to fulfil their purpose, they must be able to capture the largest number of phenomena possible in a synthesized and cross-cutting form. The teams that produce indicators must check constantly to ensure that each of the indicators has been processed and refined to the greatest extent possible.

Figure 6 illustrates a simplified scheme for statistical information processing, using two examples of actual EI. As can be seen, statistical processing begins with primary data and/or microdata, that is then transformed into systematic statistical series and combined to generate a small number of powerful, select indicators.

FIGURE 6
STATISTICAL INFORMATION PROCESSING



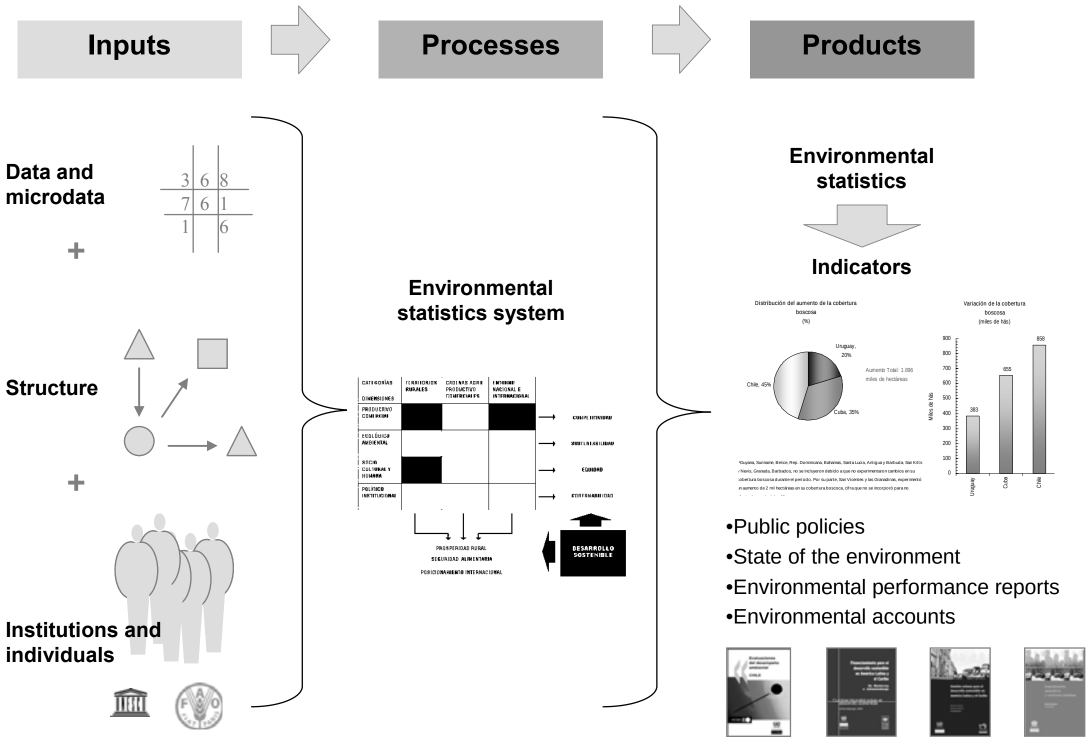
Source: Prepared by the author

Ideally, the production of EI should be appropriately coordinated with the general process of building statistics and with the national statistical system. In turn, the production of EI can serve as a basis for the creation of other periodic information products, thus ensuring the efficient use of existing resources and synergies.

The first step in establishing a national Environmental Statistics System is to gather the data per se, followed by the compilation, structuring, validation, description, tabulation and systematic publication of the data. The end result is the environmental statistical series. This part of the process (which, ideally, should be carried out in a steady, professional manner, even though the first time may be an ad hoc, one-off effort) is, of course, a sine qua non for the process of building EI or development sustainability indicators.

Environmental information products can draw upon statistical series as well as environmental accounts and indicators, and generally correspond to reports on the state of the environment, either in the country as a whole or in certain subdivisions of it (cities, regions, provinces and, to a lesser extent, watersheds or bioregions). These environmental statistical products help decision-makers design, monitor and improve public environmental, sectoral and/or sustainability policies, insofar as they are valid and useful tools in the process of selecting and targeting interventions.

FIGURE 7
INTEGRATION OF PROCESSES AND RESULTS



Source: Prepared by the author

Figure 7 depicts the process starting with the inputs and the individuals involved. The mechanism itself is the statistical system designed to process the information required to meet pre-defined objectives. The production of the information must be supported by criteria, tools and methodologies that ensure the rigour and quality of the resulting products.

One of the main products to emerge from this process is a validated, organized and structured environmental statistical series. Various uses can be made of this series and different products can be derived from it, such as the production of indicators. In turn, the resultant indicators can contribute to the development of public policies, the preparation of reports on the state of the environment, environmental performance assessments, environmental accounts, and other instruments.

Although these products tend to be created during the initial phases of national environmental statistical development, they should not be viewed as separate from environmental statistical work. Often, one institution is responsible for formulating and maintaining indicators, another has the task of generating statistics, and a third has the task of producing integrated economic environmental accounts. Should this arrangement be necessary, it is highly recommended that an inter-institutional group be set up to carry out the production, processing and use of statistics, indicators and environmental accounts.

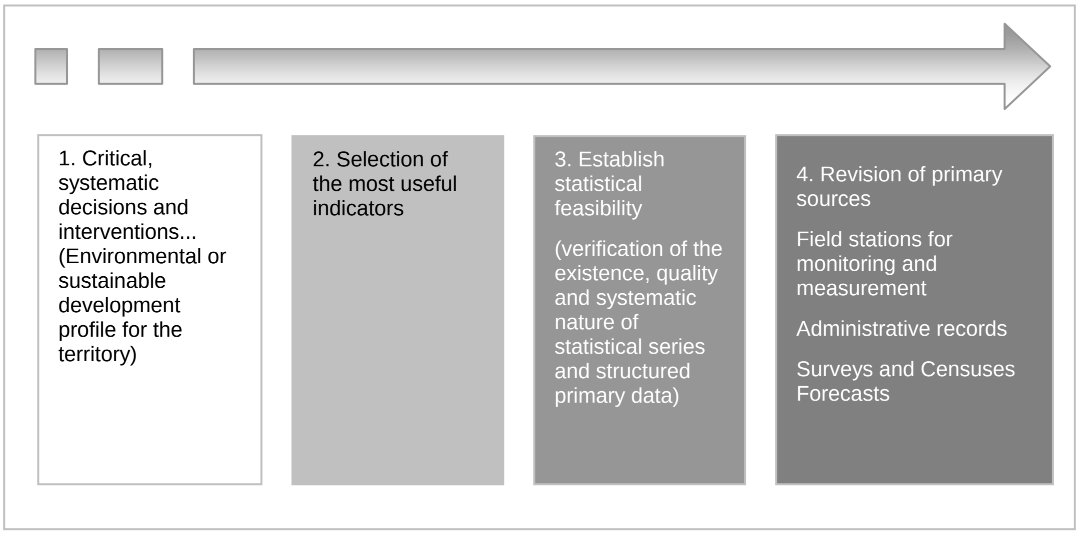
2.5 Demand-driven design

Unlike environmental statistical series, which are based on existing data series or on new statistical series that are produced from different sources, indicators work according to an inverse logic.

Indicators are not built by processing everything that already exists. Rather, they are designed based on the information that is needed. The decisions and interventions that must be made, and which indicators may help shape these decisions and interventions, is determined from the outset. It is imperative that the principal users be consulted in order to gain an understanding of their information needs so that the most appropriate indicator can be chosen. This is a demand-driven effort rather than a supply-driven effort.

Indicators involve considerable production and maintenance costs; initially it is recommended that a limited number of indicators be produced that can be immediately useful to the user. In marketing terms, the first indicators that are produced must be aimed directly at a client need.

FIGURE 8
CONSTRUCTION OF INDICATORS BASED ON USER DEMAND FOR INFORMATION



Source: Prepared by the author

As shown in figure 8, it is important to build indicators and compile or gather the data based on the needs of the decision-makers. Once decisions and interventions that need to be supported by the indicator tool are known, a preliminary list of the most useful or comprehensive indicators that address the users' interests can be drawn up. Only then should the search be initiated into the availability of statistical series and structured primary data, and the list of indicators with the potential to be produced and sustained over time be further refined.

Finally, if these environmental statistical series do not already exist, it is important to verify primary sources (as will be explained later on: see methodological road map 2.2), monitoring stations, administrative records, censuses and surveys, remote sensing and forecasts.

2.6 Manageable number of indicators

Each indicator requires a certain investment of time, energy and dedication. Therefore, each indicator that is part of a collection of EI for a country or territory, must be justified according to several eligibility criteria. Among them are relevance to the subject areas defined as critical in the indicator-building process, the quality of the basic statistics used to calculate the value of the indicator, and contribution to the system as a whole.

When building indicators, it is important to bear in mind that the fewer the indicators, the more influential their input, and the greater their impact on the quality of the system as a whole. When resources are limited, the technical quality of each indicator, and therefore of all the indicators combined, will be directly proportional to the energy, time, dedication, and subject area and statistical expertise invested in it.

Every indicator counts and should add value to the set. Teams should not feel pressured to limit the number of indicators in the first collection to a dozen or twenty. It is difficult to establish a recommended number, especially because it will depend on the resources and time available to the inter-institutional teams and the lead institution. It is worth remembering that the pioneers of these initiatives in the developed world, countries such as Canada, New Zealand, and some European nations, began with (and in some cases still have) a very limited (15 to 30) number of excellent Environmental and Sustainable Development Indicators. Furthermore, these countries have far more technical and financial resources than most Latin American and Caribbean countries. Countries such as Argentina, Brazil, Chile, Colombia, the Dominican Republic, Mexico and Panama have gone the same route.18

To ensure that the entire set of indicators is robust and sustainable over time, the initial set must be limited in number and manageable with available resources. Due consideration should be given to the need to research statistical availability, which often means visiting locations or other institutions and holding periodic meetings to coordinate and monitor the progress of the subject-area teams.

Teams will engage in interactive exchanges to choose the right number of indicators to start with, from which they will draw up an initial, usually lengthy, list. Then, they will assign specialized subject-area sub-groups to investigate the statistical viability of each proposed indicator. Usually, this process yields a smaller number of national EI that are pertinent and statistically viable (see section 2.1 of the methodological road map).

It is important to take into account experience in the region. Although countries tend to start with a limited number of EIs, over time and with the growing capacity of the teams within the NSOs or the Ministries of the Environment to update the EI (every two or three years in LAC), the number of EIs is usually increased and new subject areas or sub-categories are included.

2.7 Strict compliance with procedures

It is important to emphasize quality throughout the production process in order to ensure the best possible final product. This requires a critical and constructive working attitude, frequent evaluations, presenting the indicators along with metadata to statistics experts, and improving content and format as much as possible.

It is essential to protect the quality of the primary data, which is associated with the quality of its source or record, although sometimes it is not possible to discover the origin of the series and its statistical robustness because the corresponding metadata are not present. In information systems, the expression “garbage in – garbage out” is commonly used to mean that if the initial data are worthless, the final result will be worthless as well. This expression emphasizes the fact that information processing cannot whitewash poor quality information. Therefore, in keeping with the concept of total quality assurance, it is imperative that the quality of the data be guaranteed from the outset so that good statistical products can be generated.

The indicators must be described and calibrated completely. For this purpose, the Methodological sheet or data sheet is a key tool that must be used throughout the production chain. This description makes it possible to provide a common language, not only when analysing progress in the construction of the indicator or evaluating its quality but also when the user interprets the indicator’s trendline.

In addition, the Methodological sheet prevents staff turnover from affecting the continuity of the work, since all the plans and technical details for each indicator and its component variables are made explicit by means of a written record.

[18] See Quiroga Martínez (2007)

To ensure the reliability of each indicator produced, it is recommended that intensive consultations be carried out with agencies and scientific experts to understand and then to explain the value of the indicator and what its main implications are. It will be necessary to differentiate between the consultations that occur when the data show unexpected or atypical tendencies, and those that occur when the values of the indicators appear untrustworthy or cannot be relied on for use in a first set of national indicators.

The quality of the system will only be as good as that of the weakest of the component indicators. Therefore, it is preferable to eliminate an indicator that does not appear to have the statistical strength or the substance to sustain the credibility of the overall System of Indicators.

2.8 User-friendly indicator format

In addition to being statistically robust and substantively pertinent, indicators must be displayed in a manner that is attractive and easily understood by the user. This does not mean that good quality and properly presented indicators will always be used because experience has shown that targeted actions (such as workshops, seminars, forums) are necessary to stimulate use. It is undeniable, however, that to encourage people to use and provide feedback on indicators, the indicators must be properly constructed and attractively presented.

The working teams should allot sufficient time and trained staff to the design phase of the components and communication platform of the indicators, so that the format, medium and graphic design of each indicator is as clear, attractive and powerful as possible from the communication standpoint. Often, reference is made to the importance of graphs in communicating indicators. Creating graphs with various ways of presenting (and therefore, of processing) the variables of the indicator is time well spent.

Similarly, it is important to carefully select the language used to present the indicator, and the overall design of the pages on which each indicator is presented. The components (such as name, tendency, graphic or cartographic representation, limitations, scope, and challenges) must be chosen in a way that provides neither too much, nor too little, information to the user.

Another key element that must be taken into consideration for the subsequent use of indicators is the proper selection of the publication media, whether on a Web page, on compact disks (CDs), or in printed publications with different levels of detail. It is also very important to plan and spend time on the launching of the indicators, complete with media coverage and institutional backing, in keeping with the resources of each country.

2.9 Flexibility

Throughout the process of designing and building indicators, a flexible attitude is necessary to deal with the changes that will inevitably occur. These changes may affect the personnel involved in the process, the list of indicators, the availability of statistics, or the priority and support that the indicator construction process receives from the policymakers supervising the team and the institution in charge.

Experience in the region shows that flexibility is needed most in situations where the presented indicators do not meet the technical criteria for quality and must be removed from the list to be published. The most common reasons for discarding indicators or setting them aside for later use are the paucity of available statistics, the fact that data quality has been compromised, or the working team's lack of confidence in the data. Publishing a dubious indicator compromises the statistical quality of the entire set. Postponing publication of an indicator, or eliminating it, is always unfortunate, especially for the institution or individual that has invested time and effort in it. That is why it is important to note that the first set of indicators is an initial step, and new indicators can always be incorporated later as the institution matures and statistical series become more available.

Flexibility is also essential in the creative process itself, because there is always room to envisage and modify indicators. Furthermore, the teams must have the capacity to develop new potential indicators at any time during their work. No rigidities of any sort should stand in the way of these contributions.

2.10 Perseverance

As any team that has worked on designing and maintaining EI can attest, there are always methodological, institutional, financial, capacity and primary information challenges to face during the work, especially when EI are being constructed for the first time. It is important to continue the construction efforts until a finished product emerges that can be appreciated by users. This will serve to build support within the framework of public policies.

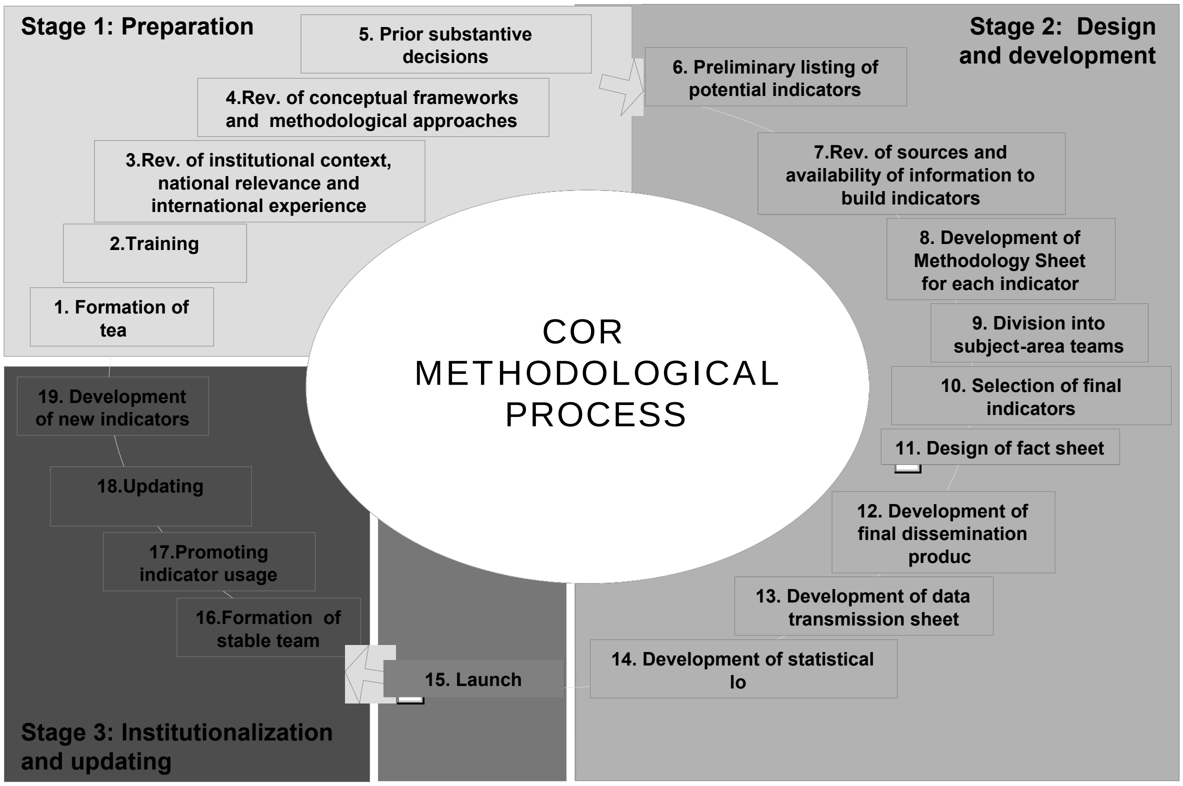
Team members may feel that too much effort is needed to overcome the lack of understanding or support, yet it is crucial that they remember that their efforts and perseverance will be rewarded when the first collection of indicators is published. This is especially true when the set of indicators becomes more widely known and used, and the country or territory can base decisions on a larger body of evidence.

II. Methodological road map for building and maintaining Environmental Indicators

The methodological road map presented in this section is based on a core methodological process comprising three stages: (1) Preparation, (2) Design and development, and (3) Institutionalization and updating. The road map is circular, reflecting the constant feedback, improvement, review and updating of the EI that make up the System.

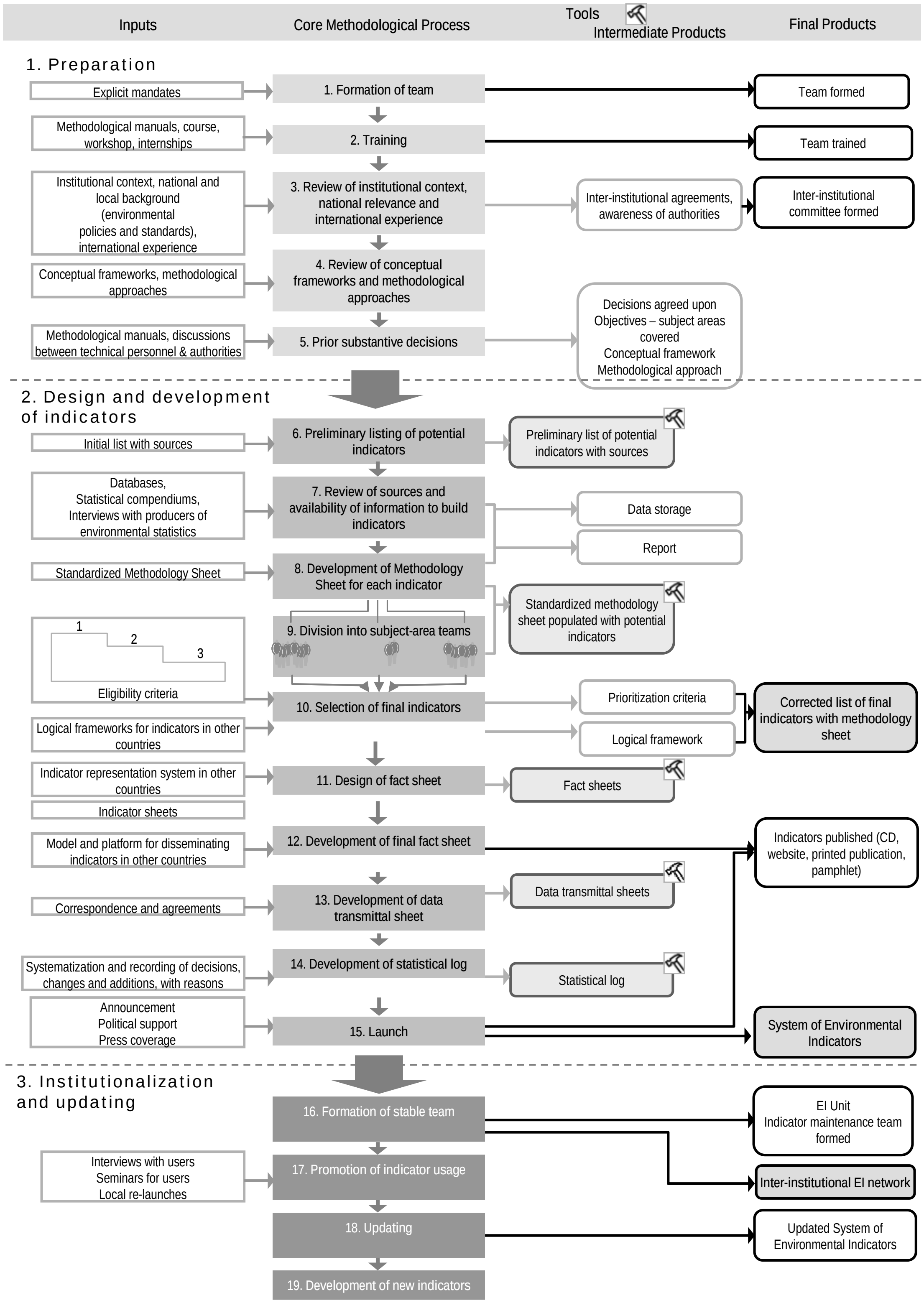
Figure 9 depicts the methodological road map as a flow chart, whereas figure 10 shows the inputs, tools and products that emerge from this process. Following this, the various phases, stages and tasks the make up this process are described, and details are provided on the respective inputs, products and tools related to each stage.

FIGURE 9
STANDARDIZED METHODOLOGICAL ROAD MAP



Source: Prepared by the author

FIGURE 10
FLOW CHART OF THE PROCESS



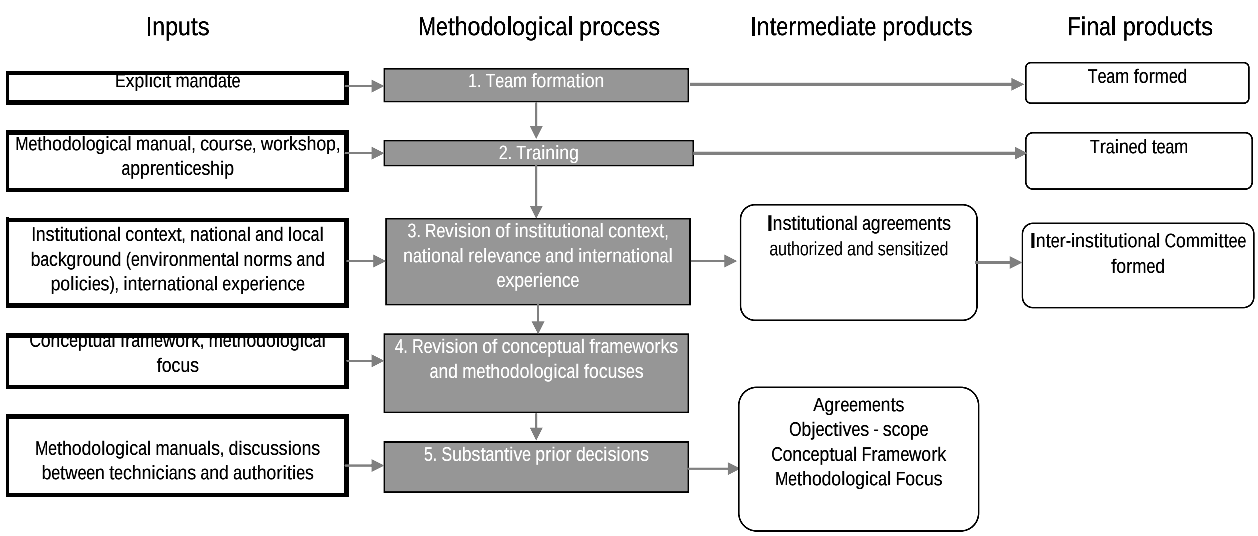
Source: Prepared by the author

1. Stage 1: Preparation

This first stage of the methodological process lays the foundation for the construction of the EI system. The working team is formed and organized, and training and capacity-building activities are carried out. This helps strengthen the capabilities of team members, enables them to form bonds with other members of the team and establishes a common language for effective team work. At this stage, critical inputs such as international experience are reviewed and decisions are made on substantive aspects related to the conceptual framework and the methodological approach, to name a few.

During this period, the Inter-Institutional Committee is formed. It will continue to operate throughout the entire process of building the EI system.

FIGURE 11
FLOW CHART FOR STAGE 1: PREPARATION



Source: Prepared by the author

1.1 Team-building

The process of building EI must be a team effort, especially given the complex, cross-disciplinary and cross-cutting nature of environmental and sustainable development issues mentioned previously. In order for the working team to have the correct composition, the contributions of three different, clearly defined groups need to be combined efficiently, as shown in figure 12 and described below:

Core Team

The first group is the core team, responsible for the entire EI building process. This group will be responsible for exercising appropriate leadership and follow-up during the processes. It must be made up of technical experts from at least two fields and institutions.

1.From the Ministry of the Environment: environmental experts or experts in the relationship between development and sustainability, depending on the technical focus of the indicators to be produced.

2. From the NSO: statisticians or methodologists with expertise in statistics and indicators, ideally in the environmental field, since the statistical work and the surveying, compilation, validation, description, structuring, representation and dissemination of the indicators requires specialized contributions from this community.

Subject-specific consultants

The second group comprises experts who provide support in a specific area. They may advise the core team during the development and updating of the indicators relevant to their field of expertise. Their work may be intermittent, depending on the core team's needs.

3. From universities and research centres: specialist scientists for support in specific subject areas. Since it is sometimes not possible to have access to specialized expertise over a long period of time, it is recommended that an advisory group be established, consisting of scientists specializing in different aspects of the environment and sustainability. These experts will have the up-to-date knowledge necessary to help create the data sheets for the indicators, and they can participate in the validation and interpretation of the values and trends that the indicators show once these are calculated. Furthermore, they can contribute to the updating process.

4. Experts in indicators from other countries or territories:[19] regional experience shows that it is of fundamental importance to maintain constant contact with other teams and experts responsible for developing and maintaining EI. Exchanges of expertise and information among peers, both within the region and with industrialized countries, have proven to be essential for the initial phase of producing and maintaining indicators, as well as in the final process of institutionalization.

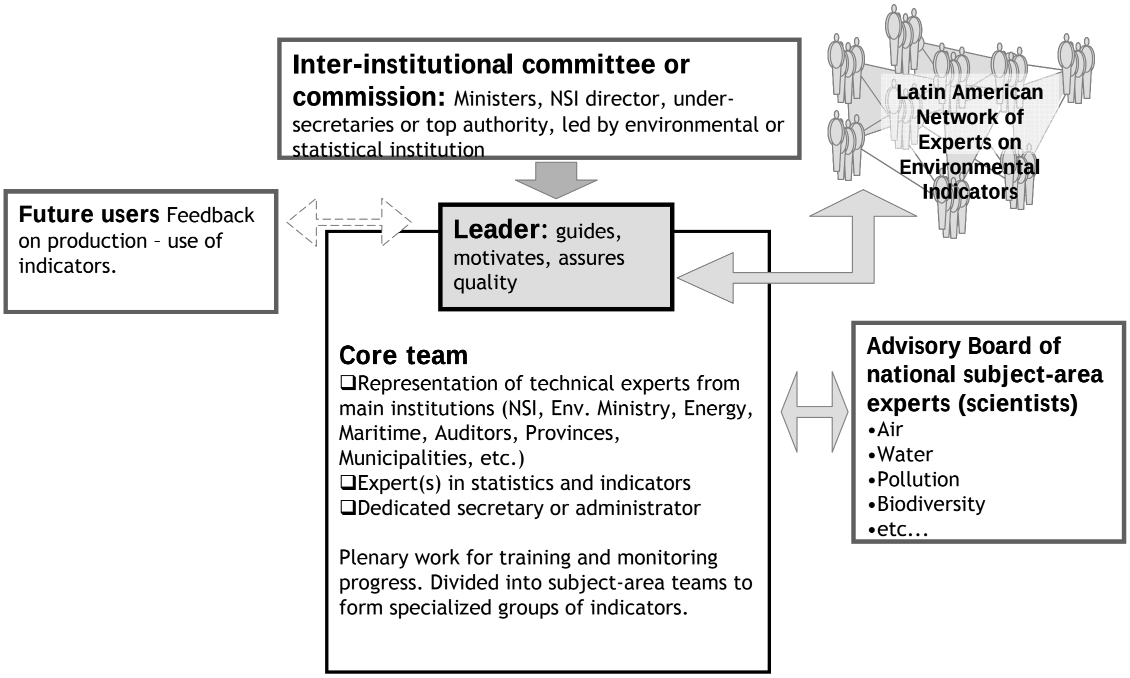
Future Users

It is important that future users contribute to determining the information that needs to be produced. In fact, users, or a carefully selected sample of them, should be involved from the beginning of the process, primarily to help define the objective and the type of indicators to be built (about which more will be said in the next chapter). Workshops can be held to discuss progress and present the indicators, and users can make observations and suggestions and express doubts about the work under way.

This early participation not only produces better quality indicators, but also sensitizes the users and makes them more committed to actually using the indicators and providing feedback once they have been published.

[19] One experience worth highlighting is the exchanges and collaboration on Environmental Statistics among the organizations within a country, and between the latter and their regional counterparts and international agencies, based on the work of the ECLAC Statistics Division, which has resulted in the formation and maintenance of a Network of Institutions and Experts on Social and Environmental Statistics (REDESA). Through this network some 140 individuals and 30 institutions work directly on the development of statistics, indicators and environmental accounts in the Latin America and Caribbean region. In addition, a small cadre (eight in all) of regional experts on statistics and Environmental Indicators continues to provide technical assistance and training. Besides creating and strengthening technical and inter-institutional capacities, ECLAC provides a website where methodological resources and environmental statistical publications can be obtained (methodological guides, reports based on indicators, and studies on national and regional progress) [www.cepal.org/mdg] and has worked with countries in the region to develop a Database of Environmental Statistics and Indicators for Latin America and the Caribbean (BADEIMA) [http://www.eclac.cl/estadisticas/bases/].

FIGURE 12
ORGANIZATIONAL CHART OF THE INDICATOR-BUILDING TEAM AND ITS CONTRIBUTORS



Source: prepared by the author.

1.2 Training

Participation in training and capacity-building activities is critical for the team in charge of building the EI to master the necessary concepts and tools. The objective is to enhance their professional capacity in statistics and indicators, and to introduce subjects that will help them work effectively as a group.

In order to work well together, the team must have shared knowledge and language in the area of indicators. It is highly recommended that one or more capacity-building activities be carried out at the beginning of the project. This practice has yielded very good results in LAC. The activities consist of a formal course in which conceptual and methodological elements are taught and a workshop (in which participants learn by doing) presented by regional experts. There is great emphasis on methodology and exercise dynamics so that team members can put into practice the knowledge they have acquired. The team can then rely on a collective language, methodology and expertise that will facilitate their efforts to build and maintain the indicators properly.

It is also advisable to be familiar with and analyse the experience of countries at a similar or more advanced stage in this process, and of organizations that work on the development of support tools for this kind of initiative. This information can be gleaned from methodology manuals and from the systematization of experiences. Visits to countries that have implemented a similar system are important and highly recommended, to learn first-hand from their experiences and establish ties of mutual cooperation (see Annex 4).

In addition, consideration should be given to the training required by those who are frequently called upon to participate in inter-institutional statistical platforms or working groups in the various countries. Statistical training in general is seen as a collaborative educational process that imparts information about statistical concepts and instruments to technical working teams outside the NSO, such as those in the sectoral ministries. These individuals learn to form intra-institutional and inter-institutional teams that will work together to produce basic statistical series, indicators and, eventually, integrated environmental accounts, in accordance with national statistical standards, international statistical recommendations and statistical best practices in the region. In order to complement this effort, the NSO technical teams will need to undergo formal and collaborative training on environmental topics. These training programmes can be presented periodically with technical support from regional commissions, organizations and specialized agencies of the United Nations, such as ECLAC and UNEP.

1.3 Review of institutional context, relevance to national situation and international experience

1.3.1 Review of the international context and the national experience

Once the team that will be responsible for designing the System of Indicators has been formed and the training activities have taken place, the next step will be a collective review of the institutional framework and the national context. This includes an examination of existing policies in the country and research on the users and their needs. Thus, it will be necessary to find out which institutions, if any, have statistical and environmental mandates, which inter-institutional committees on environmental indicators or at least producing environmental information have been set up, and so on.

At the same time, an exhaustive review can be made of international experiences in this regard, so that the team can review what has been done and how. It is important to note that each national System of Indicators will most likely respond to the environmental policy and sustainability priorities of that particular country, and to the institutional design of each territory involved. This review should also include an analysis of what the specialized agencies of the United Nations system are doing, particularly the UNEP Regional Office for Latin America and the Caribbean and ECLAC. A synthesized and updated description of the international experience and the work of agencies providing cooperation on environmental indicators can be found in Quiroga (2001), and a recent diagnosis of Environmental Statistics can be found in Taboulchanas and Fernández (2009).

The team should review these critical national and international inputs together, so that the work of developing indicators does not begin from square one. At a minimum, the following should be reviewed:

Internationally:

- EI experiences and products, throughout the world as well as in similar countries and agencies (particularly regional ones).

Nationally:

- Objectives for the construction of EI, why they are sought and for what purpose they will be maintained over time
- Scale of the indicators, as related to the administrative and political context of each country, given that indicators must be helpful to the users
- Expectations of users and technical teams, identifying, demarcating and prioritizing the demand for environmental information that the EI are intended to meet, and the frequency of such information
- National and local precedents in building EI and Environmental Statistics and any publications, or prior teams that may exist
- Institutional context: agencies with competencies, mandates and experience in the field, in terms of both producing and using EI and information

- Environmental standards, environmental policies and sustainability objectives at different governance levels (such as national, regional or provincial) so that the indicators produced can also be used to monitor emerging environmental policies.

1.3.2 Capturing national (territorial) characteristics, versus international comparability

Once the above-mentioned issues have been investigated, the next step is to agree on the degree to which the System of Indicators captures the main environmental and sustainability challenges in the specific country or territory under study. The indicators must be sufficiently geared to the environmental and development dynamics of each country. However, it is also important that the System of Indicators be relatively comparable from regional or international perspectives and internationally recommended nomenclatures and methodologies should be adopted.

Judging by the experience in LAC, a certain degree of friction exists between these two objectives. Naturally, the ideal would be to integrate both perspectives, but doing so is a methodological challenge.

Building indicators autonomously and tailored to the specific needs of the direct user is a valid approach. Indicators should be pertinent and relevant to each country's policymaking, planning and administrative processes, within the limits of the institutional framework and using the nomenclature that national laws and standards have produced. However, it is also useful to have at least some internationally comparable indicators, particularly for the progress reports required by international environmental conventions.

It is highly recommended that the team discuss and clarify from the beginning how much importance will be given to the two objectives, individually and jointly. In some cases it may be possible to include indicators of national relevance alongside those that are already being calculated using internationally accepted methodologies.

Some countries built their indicators in an essentially autonomous way, in response to the demands of their users (the legislature, central or regional governments, or ministries of the environment). Some countries have also managed to produce rigorous indicators as well as excellent communicational platforms for the indicators (Quiroga, 2007). These custom-made experiences are worth analysing.

The cooperative experiences garnered worldwide are equally important. Of particular note is the test programme sponsored by the United Nations Commission on Sustainable Development, which produced a shortlist of pilot sustainable development indicators. The Millennium Development Goals and the Latin American and Caribbean Initiative for Sustainable Development (ILAC) have also produced indicators.

Regardless of which System of Indicators is chosen, the use of internationally agreed concepts, such as definitions, variables and classifications, will be especially relevant. It is also essential to use established methods of calculation. At this juncture in the development of global environmental protection, there are already conventions and agreements covering all the main environmental issues, as well as international or inter-governmental agencies specializing in these areas. The documents they have produced contain implicit or explicit definitions of the principal environmental variables, and in some cases metadata have even been developed for the classic indicators in each category.20

[20] In order to consult metadata on variables and Environmental Indicators constructed by ECLAC along with the countries of Latin America and the Caribbean, see BADEIMA [online] http://websie.eclac.cl/sisgen/ConsultaIntegrada.asp. In this database, metadata for each statistic or indicator can be consulted by theme, subject area (for example, atmospheric air), by variable or indicator (for example, consumption of chlorofluorocarbons) and, finally, a digital version of the information can be requested. In addition, the indicators of the seventh Millennium Development Goal regarding the environmental sustainability of development can be consulted in detail, in definitions of the corresponding international agencies, and in the metadata in the updated version of the Millennium Development Goals indicators database (http://mdgs.un.org).

For reconciliation purposes, whenever a country needs to use a numerator or denominator definition that is different from the international standard or recommendation, this should be explained in the metadata for each of the indicators constructed. For example, in measuring forest cover, if a country uses a forest surface area with a definition other than the international standard stipulated by the Food and Agriculture Organization of the United Nations (FAO), or a national territory other than the one defined by FAO (for example, one that includes water surfaces), this must be clearly explained.

It is likely that there will be unique indicators that will apply to a specific country or small group of countries. In such cases, prior experiences may not exist, so teams should try to adhere to international classifications and nomenclatures, provided the matter is covered in international agreements or conventions to which the country is a party. Examples of this type of locally relevant indicator designed by the countries or subregions for which the phenomena in question are important include: Hydrocarbon Discharges into the Panama Canal Basin, Ultraviolet Radiation (as a consequence of the thinning of the ozone layer in Chile), Andean Glacier Retreat (Andean countries), and Swimmability of Beaches in Rio de Janeiro.

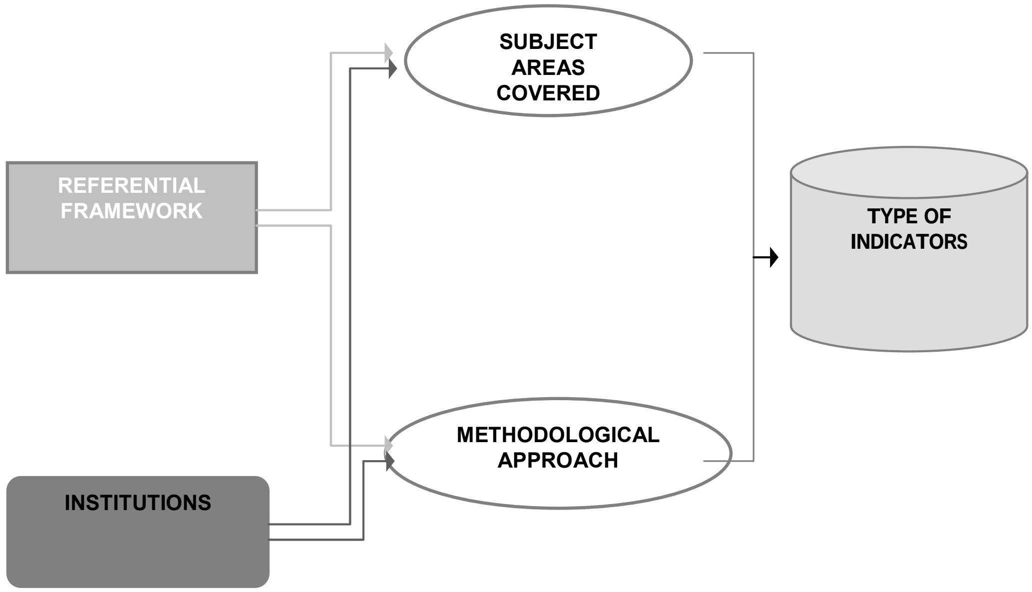
Finally, the experience in LAC suggests that the most advisable approach is for each country to develop a national collection of EIs systematically through inter-institutional collaboration. Among these should be the principal regional and international EIs that are usually reported as part of the seventh Millennium Development Goal, ILAC, the Environmental Indicators and Statistics Database (BADEIMA) and international environmental conventions, provided that these indicators are relevant to the country or territory. Additionally, the country will likely develop other indicators that are pertinent and perhaps unique, to address its own problems, public policy goals or citizen demands.

A good System of Indicators will be capable of capturing the most essential and important phenomena to be monitored for each country or territory. More importantly, the System will establish a stock of consistent, systematic, and official inter-institutional indicators, and serve as the basis for reports submitted for national policy purposes (Reports on the State of the Environment, for example), for regional initiatives, and other global demands.

1.4 Review of conceptual frameworks and methodological approaches

Next, the indicator-building team should review the principal conceptual frameworks that will form the basis of its proposed indicators, and the two methodological approaches most commonly used today. As shown in figure 13, the indicators ultimately produced will depend on the referential framework, the country's institutional system, the thematic scope and the methodological approach chosen.

FIGURE 13
PRELIMINARY DECISIONS AND RESULTING INDICATOR TYPES



Source: prepared by the author.

1.4.1 Conceptual or referential frameworks and their possible indicators

The first step should be to look at the institutional context, the environmental or sustainable development policies and objectives that currently exist in the country or region, and the team's mandate. The purpose of this analysis is to define the subject areas to be addressed by the team (for example, EI or sustainable development indicators). Careful study of the context in which the indicators will be developed will help target scarce resources appropriately, save time, and avoid institutional headaches later on.

The framework will most likely be dictated by the environmental or sustainability or sustainable development policy that the country or territory has adopted. It is also important to ask which conceptual framework will allow the most room for the development of indicators, given that the more complex and wide-ranging the framework, the greater the complexity of indicator construction can be. The chosen referential or conceptual framework should not be too broad however, given that there may not be enough environmental statistical series to feed into such a rich analytical milieu.

Along the same lines, it is possible to develop collections of indicators that cover a given field: some countries are developing indicators of the state of the environment, while others are taking the sustainable development approach, incorporating (but not necessarily linking) the economic, social, environmental and institutional dimensions of development. In very few cases, progress is being made on the construction of some integral sustainability indicators.

It is also advisable to analyse and decide upon the methodological approach that will be taken, based on the purposes for which the indicators are being developed. This will depend on whether several different indicators are to be built to form a collection or system, or if the goal is to homogenize different variables in a single index or group. This is a critical decision that has major implications for the statistical quality and communicational potential of the resulting indicators.

Since there are usually limitations on the time available for designing and implementing indicators, a minimum consensus must be reached on the most significant variables. Inter-institutional and multidisciplinary teams working on indicators should take care to group variables and avoid constructing a long list of disjointed indicators, each focusing on the expertise of individual team members. This exercise is very important, as it will form the basis for the work, since building a framework of interrelationships based on the specialized knowledge of the participants is often a Herculean task.

A proven and more manageable approach for the region is to begin with a previously created conceptual framework that covers enough variables that are relevant to the country, but that does not have an excessive number of variables and interrelationships. The team can then adapt, modify and simplify the framework so that it broadly reflects the way social and economic processes take place within the area under study, or the way the components of the environment interreact among themselves. When the team reaches a consensus that is reasonably consistent with the institutional context of the area in question, it should proceed to design the indicators. The team can always revisit the conceptual framework once it has gotten feedback from an initial group of indicators. It is also important to note that which indicators can be produced immediately will depend more on the availability of existing information than on the conceptual framework that has been chosen. The conceptual framework can, however, reveal significant information deficits in the calculation of indicators, and the team can then inform the relevant agencies that they should make the information available in the medium term.

The conceptual or referential framework makes explicit the relationship between society and nature, specifying what is understood by environmental conservation, sustainability or sustainable development. This is implicit in the construction of indicators.

No matter which alternative is chosen, the team responsible for actually applying the framework to the construction of indicators should constantly test the indicators it is proposing, to make sure they are consistent with the theoretical referent being used (and ultimately with the availability of existing information).

Frequently, groups spend too much time trying to achieve the optimum scientific and conceptual solution, sacrificing time that could be devoted to the indicators themselves. In this regard, it is advisable to stay with an agreed conceptual framework that satisfies local needs and that is good enough to begin working with, as the indicator itself may lead the group to refine its conceptual framework later on.

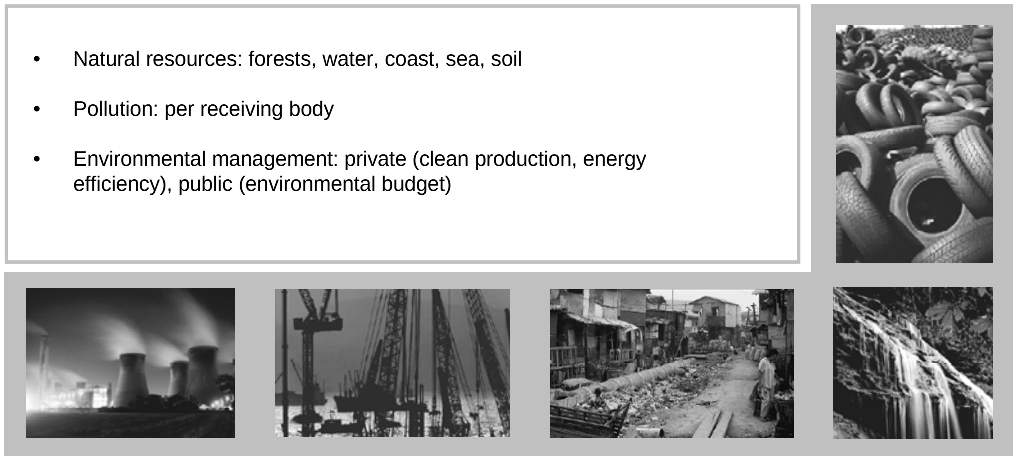
Similarly, the conceptual framework should adapt to national or local conditions in the geographic area covered by the System of Indicators being developed. This will avoid including elements inconsistent with the local situation. The latter point is very important when conceptual frameworks are imported from developed to developing countries.

The countries studied here have begun with either EI or sustainable development indicators, depending on the origin of the decision to carry out the work, the institutional context and the resources available. Either option has advantages and disadvantages that should be taken into consideration, in keeping with the objectives that a country or region is pursuing when the project is launched.

Option A: Conceptual framework based on components of the environment and Environmental Indicators

EI are specifically built to provide a view of the general state of the different components of the environment (figure 14) and the phenomena that affect the environment.

FIGURE 14
COMPONENTS OF THE ENVIRONMENT



Source: Prepared by the author

These components are less developed than their economic or social counterparts, since the availability and quality of basic environmental information is limited, particularly in LAC countries. It is often possible in these countries to calculate levels of water pollution, sewage treatment, air pollutant concentration, vegetation coverage, mineral reserves and extraction, marine biomass capture and protected areas, to cite a few examples. Other, more refined indicators associated with the environment are very difficult to measure in the short term because of the lack of information.

However, there are two basic advantages to beginning with this type of indicator. The first is that beginning with ecological dynamics focuses on elements that are relatively less developed in terms of information. Therefore, the scant resources available will almost certainly be concentrated on this task, enhancing the overall effectiveness of the effort. The emphasis will be on producing, organizing and processing EI, which are so necessary and so lacking in the countries of the region.

The second advantage is that EI require a less complex institutional design than that needed for sustainable development indicators. In the second case, an agreement would have to be reached so that the individuals in charge of the production and processing of environmental data can work under the official mandate of either the Ministry of the Environment or the NSO, as the case may be. In addition to these two entities, it will normally be necessary to involve the regional environmental authorities, the research institutes that produce and process environmental data, and official local agencies responsible for managing the environment, water, forests, soils, agriculture, energy, and so on. While this is already a complex and lengthy undertaking, a decision to work with sustainable development indicators will require a broader, more complicated design and organic effort.

Examples of countries that have opted to begin with EI include Canada and New Zealand, which concentrated their efforts on producing collections of Environmental Sustainability Indicators. These indicators are of excellent quality and have gained credibility and explicit recognition among users relatively quickly. In Latin America, the experiences of Mexico and Panama can be cited in this regard.

Examples of Environmental Indicators:

- Changes in forest cover
- Protected marine areas
- Proportion of degradated soil
- Trends in CO_2 emissions

- Air pollution
- Pollution (by source)

Option B: Conceptual framework based on sustainable development and its indicators

Other countries, inspired to a certain extent by the United Nations Commission on Sustainable Development, and largely as an official part of the trial involving the first list of indicators, have proceeded to incorporate sustainable development indicators which include EI and social, economic and institutional indicators.

This option has the advantage that an initial set of refined indicators with methodological sheets has already been systematized and made available, as a result of a voluntary national trial in which a large number of countries have participated. At the same time, these indicators are backed by the international community of experts and the corresponding government agencies, which can be very useful for countries that need this platform to begin the process or to advance more quickly in it. Another advantage is that although it does not really link the indicators of the different dimensions (see figure 15), it at least presents them simultaneously, which allows the user to visualize some related variables. This could result in a future demand for the construction of indicators in this direction. Finally, provided that the indicators are built according to the Methodological sheets that the Sustainable Development Commission makes available, international comparability will be possible using the indicators chosen by the country in question.

Two countries that have developed this option with noteworthy results are Sweden and the United Kingdom. In Latin America, Brazil and Argentina have chosen this alternative.

FIGURE 15
EXAMPLE OF SUSTAINABLE DEVELOPMENT INDICATORS: FOUR DIMENSIONS

Sustainable development indicators

- Per capita economic production
- Foreign debt
- Income distribution

- Level of education
- Access to health care
- Availability and quality of water

- Forest surface area (deforestation)
- Waste production and management
- CFC and greenhouse gas emissions
- National environmental budget

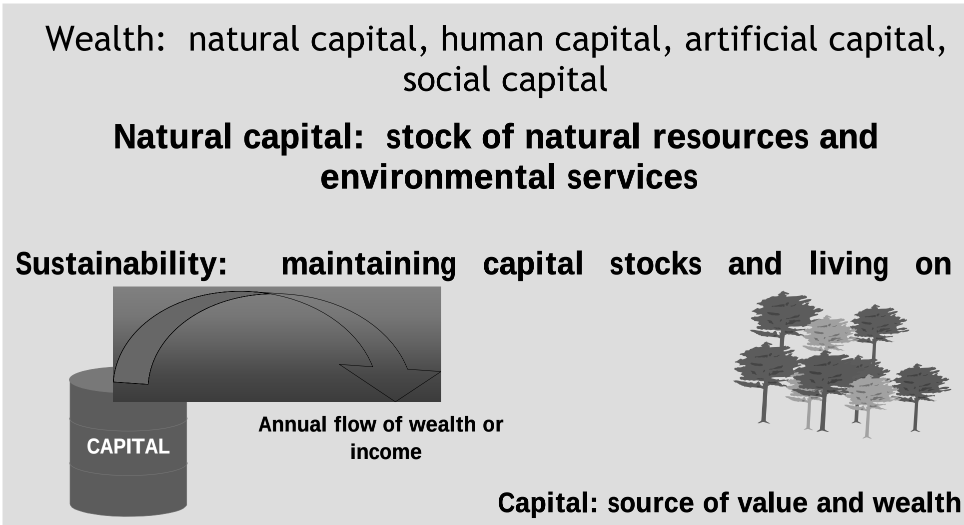
- Internet access

Source: Prepared by the author

Option C: Conceptual framework based on natural capital and monetized indicators

The World Bank, taking a global view, proposes two main indicators using the conceptual framework of natural capital: true wealth (stock) and genuine savings (flow). Total or true wealth includes produced, natural, human and institutional capital. Measuring changes in total wealth and in natural wealth can contribute to the analysis of the road to development and determine whether or not it is sustainable (see figure 16).

FIGURE 16
NATURAL CAPITAL

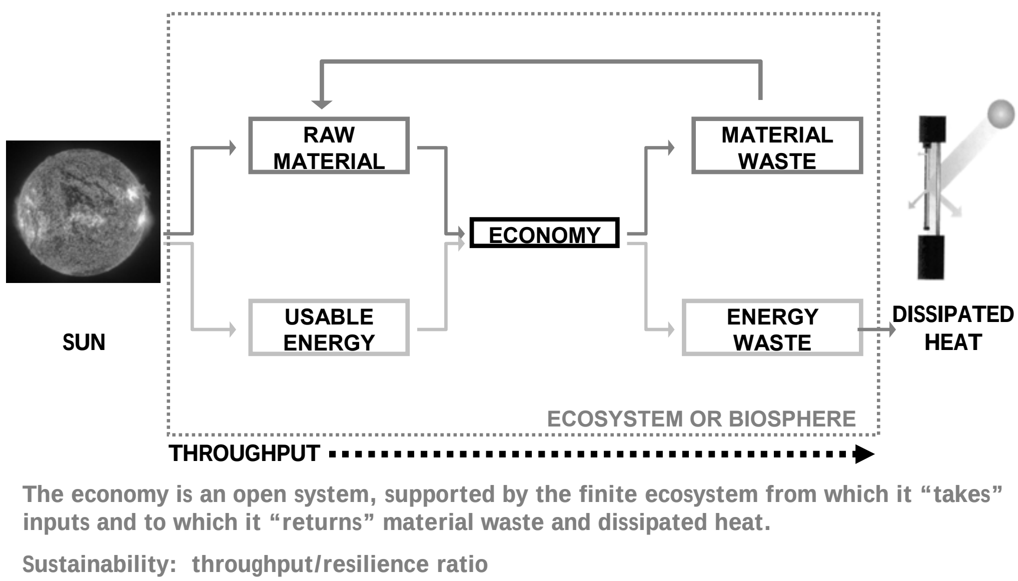


Source: Prepared by the author

Option D: Systemic conceptual framework (Economy-Ecology) and integral sustainability indicators

Very few countries have been able to develop the kind of indicator that is all-encompassing, inter-dimensional, cross-cutting and concise. Such indicators must be capable of covering more than just environmental, economic or social issues; they must bring two or more dimensions together in a single indicator. This complex economic-social-ecological conceptual framework should be considered (as would any other) as a reference when Sustainability Indicators are designed and fine-tuned.

FIGURE 17
EXAMPLE OF A SYSTEMIC CONCEPTUAL FRAMEWORK, ECOSYSTEMS AND ECONOMIC SUB-SYSTEM



Source: Prepared by the author based on the concept of Ecological Economics.

The most substantial contribution this cross-cutting approach has made is to explain the economy as a sub-system completely contained within a finite and fragile ecological system. It views the economy as a sub-system open to very simplified material exchanges drawn from the natural resource base, in relation to what the economy yields and the material and energy residuals that it returns to the ecosystem. If the goal is sustainability, the human economy should consume only renewable elements of the natural resource base so that it can be preserved as a source of wealth for future generations.

As Herman Daly (1996) sums it up, the economy is an open sub-system sustained by the finite ecosystem, with which it exchanges material and energy. The biosphere (like any ecosystem) receives a given amount of energy (directly or indirectly from the sun) and sustains the biotic and non-biotic cycles on our planet. From this continuous flow, what humans channel for their economic activities is called throughput. The economy constantly receives energy from the ecosystem in the form of raw materials and useful energy (fossil fuels, hydroelectricity and so on), makes the necessary conversions to produce goods and services to meet human needs, and subsequently returns two types of residual to the ecosystem: heat (under the second law of thermodynamics) and various kinds of material waste that are partially, or potentially, recyclable.

Throughput[21] can be understood as a low-entropy energy flow from the natural world (originally the sun) that is channelled by humans in their daily socio-economic activity. This flow, which we see as resources and inputs, is converted by the human economy for production and consumption and is then returned to the biosphere (in the form of waste, emissions, by-products, or trash) for biodegradation and reuse, in a continuous cycle. However, this cycle is subject to certain limitations and conditions.

From this perspective, trying to capture these dynamics and ever-changing processes in order to build consistent indicators is rather complex. However, the procedures described below could be followed:

1. Design indicators for the different boxes or variables in the diagram, that is, some indicators related to the biophysical support system (for example, the ratio of renewable energy to total energy, mineral reserves, forestry stocks), other indicators corresponding to the socio-economic dynamic (for example, production, employment, poverty), and others focusing on waste (solid, liquid, industrial, emissions, household).

2. In addition, indicators can be developed to show what happens in the arrows that represent the dynamics between boxes. These indicators, which represent linkages or synergies, are more powerful but more difficult to build (efficiency of energy use, change in the biomass, deterioration of health resulting from toxic substances, and so on).

A cost-effective combination of the indicators exemplified in steps 1 and 2 would comprise a very appropriate initial group for the framework presented.

In short, although this is a very complex approach, some countries such as Spain, Sweden and the United Kingdom have provided this kind of indicator on a partial basis within their collections of Environmental or Sustainable Development Indicators.

Potential integral sustainability indicators:

- Energy efficiency of production
- Proportion of renewable and clean energy (within total energy supply)
- Pollution intensity of production (waste/production)
- Material intensity of production
- Distributional equity (income, gender, territorial, and so on)
- Territorial sustainability of production

[21] Concept developed by Herman Daly, as translated by Schatan, Jacob (1991), "Growth or development: A debate on the sustainability of economic models: Ecological economics and sustainable development", Friedrich Ebert Foundation, Santiago, p. 24.

- Territorial sufficiency of waste absorption/management
- Ecological footprint, carbon footprint, water footprint

Table 1 synthesizes the different frameworks and the possible indicators derived from each.

TABLE 1
EXAMPLES OF CONCEPTUAL FRAMEWORKS AND THE INDICATORS DERIVED FROM THEM

Conceptual framework	Indicators
Environmental components	Environmental Indicators: Natural resources: state of forests, water, coastline, seas, soils, etc. Pollution: air, water, soil, etc. Environmental management: private (clean production, energy efficiency), public (environmental budget, environmental impact assessment, etc.)
Sustainable development	Sustainable Development Indicators: Economic dimension Per capita economic production Foreign debt Distribution of income
	Environmental dimension Water availability and quality Forest cover (deforestation) Waste production and management Greenhouse gas and CFC transmissors
	Social dimension Education level Access to health care
	Institutional dimension National environmental budget Internet access
Natural capital	Monetized Indicators: Total wealth (stock): natural capital, human capital, artificial and institutional capital Genuine savings (flow) Sustainability status: constant or growing capital stock (living off the harvest or yields)
Systemic (Economic-Ecological)	Integral Sustainability Indicators Energy efficiency of production Proportion of renewable and clean energy Pollution intensity of production (waste/production) Material intensity of production Distributional Equity (income, gender, territorial, etc.) Territorial sustainability of production Territorial sufficiency of waste absorption/management

Source: Prepared by the author

1.4.2 Methodological approaches

There are two basic methodological approaches that have been used to develop indicators: the commensurable approach and the systemic approach.

The commensurable approach

The commensurable approach involves aggregating a number of different variables into a single indicator or group, forcing different processes (with different units of measurement) to coexist within a single basket, as shown in figure 18. This approach presupposes that different dynamics and processes can be quantified using the same standard of measurement (commensurability), such as money, hectares or indexed coefficients created specifically for the purpose. Hence, this school can be termed commensurable. Its most widely-known results are the following:

- Indexes (Environmental Sustainability Index, Human Development Index, Living Planet Index, Index of Sustainable Economic Welfare).
- Monetized (Green GDP, Total Wealth, Genuine Savings).
- Basket-type (Ecological Footprint, Environmental Space, and material input per unit service or MIP).

The different elements are aggregated into a single scale of value in three steps:

(a) determine which processes are going to be considered;

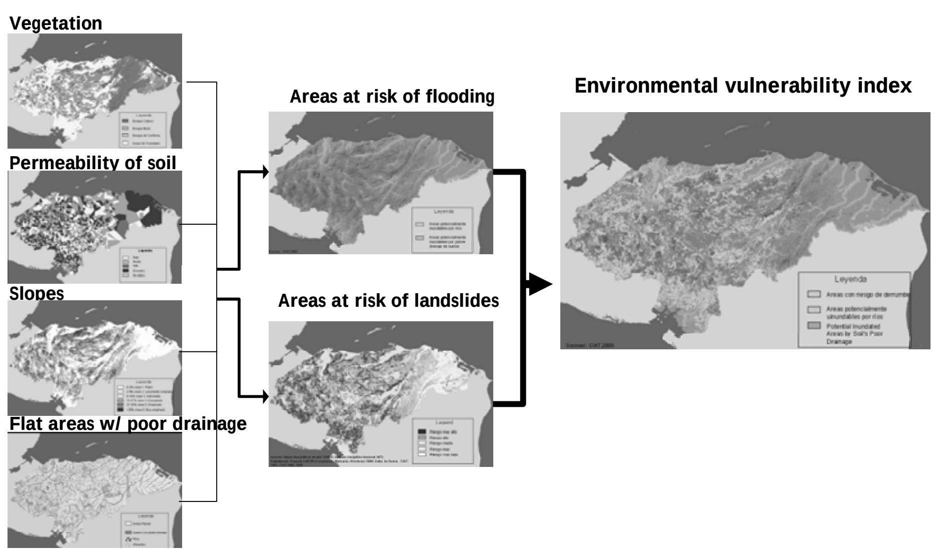
(b) stipulate the relative weight to be assigned to each phenomenon within the total, known as relative weighting; and

(c) find the procedure for assigning or transferring the measurement of a dimension to a common scale (assigning monetary value, producing coefficients, converting to energy units, and so on).

The main problem with this approach is that its results are debatable in methodological terms, which ultimately weakens the indicators by putting into question their validity. The main advantage is that it lends itself to communication, as a single figure can reflect a large number of processes. The public and those who need to make decisions without being experts in the field appreciate this feature.

FIGURE 18
EXAMPLE OF THE COMMENSURABLE APPROACH

VULNERABILITY TO NATURAL DISASTERS IN HONDURAS [a]



Source: International Centre for Tropical Agriculture [online] http://gisweb.ciat.cgiar.org/Vulnerabilidad/index.htm

[a] Note: Study to determine the municipalities and areas most vulnerable to natural disasters in Honduras.

The systemic approach

The systemic approach involves a group of indicators (whether environmental or sustainable development) that together reflect the principal processes that need to be understood so that better decisions can be made. The linkage of different individual indicators will depend on the conceptual framework and the organizational framework that is designed ad hoc, so it is a rather flexible approach that does not entail a lot of methodological complications. The relative disadvantage of this approach is that it has limited communicational potential, since the information is contained in a collection of indicators. Countries that have chosen this alternative (the vast majority) will always have an advanced base of primary, processed information in case they decide in the future to create indices or other mega-groups.

The idea is to build a collection of indicators that shows associative and/or synergetic tendencies or, in other words, that reveals the main trends, tensions and underlying causes of sustainability problems. In addition, the systemic approach enables the team to recognize methodological and axiological problems of incompatibility, and to resist the temptation to build mega-indicators through aggregation.

FIGURE 19
EXAMPLE OF A SYSTEMIC APPROACH
BASIC ENVIRONMENTAL PERFORMANCE INDICATORS IN MEXICO, 2005

INDICATORS – FORESTRY RESOURCES
7-1 Change in soil usage in forested areas
7-2 Production of timber and other forestry products
7-3 Forest fires and surface area affected
7-4 Surface area affected by forest pests
7.5 Timber confiscated upon inspection
7-6 Surface area of forests and jungles
7-7 Harvestable stock in forests and jungles
7-8 Surface area of commercial timber planted, verified and paid for
7-9 Surface area covered by sustainable forestry management
7-10 Surface area treated for pests
7-11 Reforested surface area
7-12 Forestry inspections, operations and resolutions

INDICATORS – HAZARDOUS WASTE
5-1 Physical volume of manufacturing and mining production
5-2 Intensity and volume of hazardous waste production
5-3 Locations polluted with hazardous waste
5-4 Installed capacity for handling hazardous waste
5-5 Hazarous waste locations cleaned up or being cleaned up
5-6 Compliance with hazardous waste regulations
5-7 Environmental audits

Source: Secretariat of the Environment and Natural Resources of Mexico [online] http://portal.semarnat.gob.mx/semarnat/portal

In general, it could be said that international agencies and some civil society institutions tend to favour commensurable indicators, but for different reasons. International agencies appreciate that because they are internationally comparable, they can be calculated for many countries and world rankings can be established. Civil society institutions prefer homogenist indicators because they are cost-effective.

Central and regional governments are more likely to choose the systemic indicators approach. They are willing to undertake the investment involved in maintaining a collection of indicators over time without excluding the possibility of complementing these sets with an index they may find valuable.

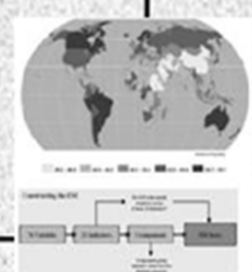
FIGURE 20
COMPARISON OF THE TWO METHODOLOGICAL APPROACHES

(a) EI of the Republic of Panama, systemic approach

Forests and Biodiversity
Forest cover of the territory
Surface area reforested
Protected areas
Index of Biological Integrity (IBI) in the Transystemic Corridor of the Panama Canal Basin
Water
Waste water disposal
Extraction of water from the Chinqui River Basin

(b) Davos Environmental Sustainability Index, commensurable approach

Variables	Indicators	Components
Concentration of Nitrogen Dioxide Concentration of particles Concentration of Sulphur Dioxide Quality of internal air	Air quality	Environmental Systems
Ecological regions at risk Amphibians threatened Birdlife threatened National Biodiversity index Mammals threatened	Biodiversity	
Wilderness areas Developed areas	Soil	
Dissolved oxygen Solids in suspension Electrical conductivity Phosphorus concentration	Water quality	
Availability of surface water Availability of groundwater	Water quantity	



Source: Prepared by the author on the basis of: Indicadores Ambientales Nacionales de la República de Panamá [National Environmental Indicators for the Republic of Panama] [online]: http://www.anam.gob.pa/indicadores/index.htm, and Yale Center for Environmental Law and Policy (2005), Environmental Sustainability Index. Benchmarking National Environmental Stewardship. Yale University, Center for International Earth Science Information Network Columbia University. http://www.yale.edu/esi/ESI2005_Main_Report.pdf

[a] annexes __ to see the complete list of Environmental Indicators of the Republic of Panama

[b] annexes __ to see the 2005 Environmental Sustainability Index (ESI)

Figure 20 shows a comparison of the two methodological approaches, using the example of EI and the Environmental Sustainability Index (ESI)[22] for Panama. The top section contains some subject areas and EI for the Republic of Panama presented as a systemic methodological approach. The lower section shows the process of aggregation of several variables and components to build the DAVOS 2005 Environmental Sustainability Index with a commensurable methodological approach.

Table 2 compares the advantages and disadvantages of the two methodological approaches. For a detailed review of these indicators, see Quiroga (2001).

TABLE 2
METHODOLOGICAL APPROACHES

1. COMMENSURABLE APPROACH: **1.1 MONETIZED (PIN, Green GDP, true wealth, weak and strong sustainability, Net Forest Product)** **1.2 INDEXES (IBES, IDH, LPI, ESI)** **1.3 PHYSICAL-TERRITORIAL (AE, EE, ME)**	**Advantages:** A powerful synthesis of many different environmental aspects **Disadvantages**: Persistent criticism of methodology for valuing or assigning weights to different variables. Components cannot be identified, since it consists of many variables that disappear once they are aggregated.
2. SYSTEMIC APPROACH **2.1 ENVIRONMENTAL (biophysical)** **2.2 SUSTAINABLE DEVELOPMENT (biophysical and socio-economic)**	**Advantages**: International experts agree they are more advisable. Do not require homogeneity or valuation. Reflect diversity of phenomena. **Disadvantages**: Do not reveal trends as readily as other approaches.

Source: Prepared by the author

1.5 Preliminary substantive decisions

Before developing the necessary indicators, there are several substantive and methodological decisions that must be made, such as determining the objective of the indicators, developing or adopting a conceptual framework, deciding on the subject areas to be covered by the indicators, and choosing a methodology and scale that the indicators will encompass.

In general, these preliminary decisions should be policy decisions, and should not be made by the technical experts. It is extremely important that all team members have a clear understanding of certain elements and accept the decisions that have been taken, in order to save time during the development process. These are the steps to be taken:

1. Decide and make explicit what the indicators are to be built for (such as to establish a permanent system, to contribute to State of the Environment Reports, or to fulfill a legal obligation to generate environmental information).
2. Obtain and make explicit the mandate of the lead institution and the core inter-institutional team (to ensure that the corresponding time and resources are allocated).
3. Organize the ad hoc human resource team and inter-institutional system.

[22] The ESI stems from an initiative of the Global Leader for Tomorrow Environmental Task Force of the World Economic Forum, which began in Davos, Switzerland. The ESI was developed by Yale University during the World Economic Forum at Davos in early 2001.

4. Build or adapt the conceptual or referential framework to the local situation and institutional context. Clarify how the components of the environment function, or explain the relationship between nature and society.
5. Decide and make explicit what subject areas the indicators will cover:
   (a) Environmental
   (b) Sustainable development
6. Decide upon and make explicit the methodological approach:
   (a) Commensurable
   (b) Systemic
7. Decide upon (combine) the coverage or scale:
   (a) Basin
   (b) Province
   (c) Country
   (d) Subregion
   (e) Multi-scale (for example, national-provincial)
8. Decide to what extent the indicators will reflect the uniqueness of the country (and its territories and dynamics) and to what extent or which indicators will be regionally and internationally comparable.

2. Stage 2: Design and construction of Environmental Indicators

The indicator design and development stage consists of ten phases, from the creation of a preliminary list of indicators to the establishment of the final System of Environmental Indicators. The key tools required for this stage are described and exemplified, as shown in figure 21.

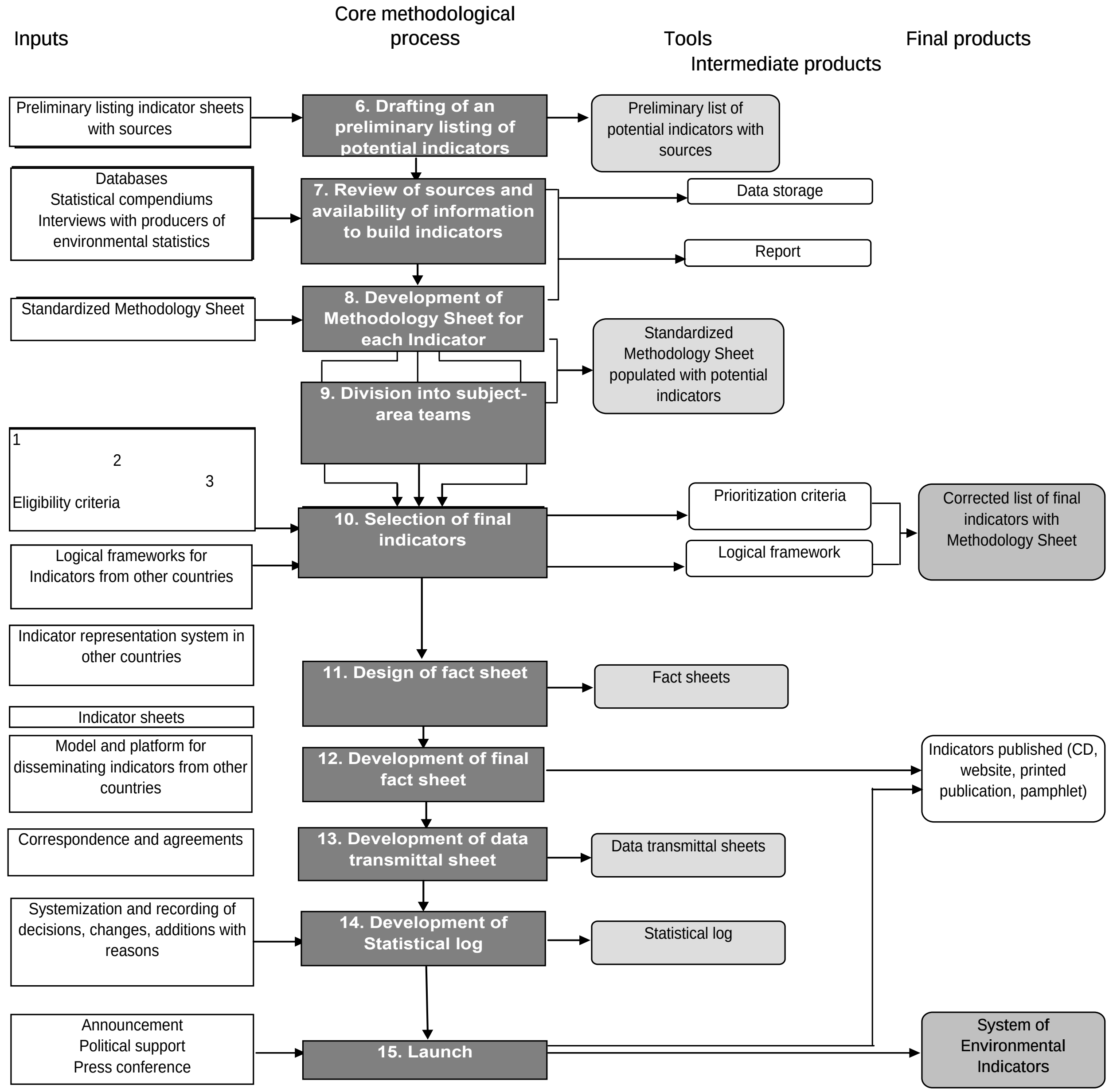
The tools consist of the basic or Preliminary List of Indicators, the Methodological Sheet that contains the metadata for each indicator, and the Public Information Sheet, which includes only the fields that will help the user interpret the indicator.

The Data Sharing Sheet, another useful tool for this process, is also described. This document details the origin and application of the data and statistical series that are needed to calculate and update the value of each EI for each specific country or territory.

Finally, the Statistical Log for the indicator-building process is an essential source of information about the decisions, sources and criteria used in the initial construction of the EI. This Log should be created each time the indicators are updated and perhaps expanded, so that future teams will have a systematic record of the details and can continue building and updating indicators in a statistically consistent manner.

The tools presented here can be used and adapted for the construction and maintenance of any official indicator, since such indicators generally require information and contributions from various individuals and institutions, depending on the nature of the particular indicator-building initiative.

FIGURE 21
STAGE 2 PROCESS: DESIGN AND DEVELOPMENT



Source: Prepared by the author

2.1. Preliminary list of potential indicators

Begin with a list of potential indicators that reflects the information needed to make decisions in the chosen area, be it the environment or sustainable development. Participants should undertake this task early on in the process to prioritize and focus their search for the appropriate statistical information.

In drawing up the preliminary list of potential indicators, the working team should have a common perspective on the main environmental or sustainability issues. These problems can be identified and agreed upon using different methodologies and varying levels of participation. Often these lists are compiled during a consultation process involving stakeholders in the public spheres (environmental, statistical, sectoral and utilities such as water and power) and in academia. The private sector and environmental non-governmental organizations (NGOs) may also be included in the process so that they can detail which indicators they need. The scope of the consultation on indicator-building is a political rather than a technical decision. It depends on the objectives and methodology established by the lead institution in the indicator-building process on the advice of the technical experts involved.

Almost without exception, when a team sets out to build a collection of indicators to monitor environmental progress, it draws up too long a list of prospective indicators. This extensive inventory is often ironically called a wish list23 because the issues are so complex and the institutions and mandates so diverse, that the list represents the team's wishes for what should be contained in an ideal System of Indicators. During the ensuing effort to determine the statistical viability of the desired indicators, the list can be narrowed down to a reasonable size. In practice, the scarcity of statistics, which is the emerging issue for the environment and environmental sustainability of development, becomes the central criterion for determining the eligibility of an indicator.

It is important that the initial list of potential indicators follow a specific format from the outset, so that the minimum required information can be captured (see the standardized form in box 1). Such information should include the name, proponent, source, periodicity and available time series.

[23] Also called a shopping list.

BOX 1
TOOL 1. PRELIMINARY LIST OF POTENTIAL INDICATORS

The preliminary list is the first tool to be developed in the exploratory phase of the design exercise. Often this wishlist reflects the creative spirit of the team, and it is important to encourage contributions to the list.

The format for the list should include the fields shown here in order to provide a minimum template for the teams or the subject-area specialist groups to begin filling out the Methodological sheet.

Standardized form for a basic list

Number (correlative)	Proposed indicator name	Person or institution proposing the indicator	Possible source of data	Periodicity of data production	Time series available
1	Change in forest cover	Juan Pérez, Ministry of Agriculture	Vegetation inventory	Every 5 years	1990,1995 2000
2	Annual variation in energy consumption	Ana Rodríguez, Ministry of Energy	Energy Report, Ministry of Energy	Annually	1975 to 2006
3	Air pollution (Particulate Matter) in Green City	Manuel Hernández and Gloria Martínez, Ministry of the Environment	Green City pollution control centre	Monthly	1998 to 2006
4	Solid waste collection	Claudia Aravena, Ministry of the Environment	Solid Waste Secretariat	Annually	1994 to ?

The list must have at least these columns

It is unlikely that all the information necessary to complete the form will be obtained immediately, but it is important to make the effort in order to give the proposed indicators the significance and the minimum statistical backing required to begin the work.

This preliminary list will give individuals a tool to enable them to consolidate and disseminate the progress made by the group. The list can be modified continuously by the individuals responsible for investigating and finding the necessary environmental statistical series to calculate the indicators, as they make further headway in their work.

Source: Prepared by the author

This list should be distributed among all the team members so that all can participate in the next phase with a full picture of the potential indicators.

2.2 Review of sources and availability of information for building indicators

Environmental statistics in LAC tend to be scattered among different sources, and most of these sources do not consider producing environmental data for statistical purposes to be their main objective. Among the usual sources of environmental statistics are administrative records, records of pollution levels and environmental quality from monitoring processes and stations, exploiting new questions added to surveys and censuses, and the results of estimation and modelling processes. Environmental dynamics are complex and cross-cutting; their measurable effects cannot be captured by a single type of survey or systematic records over time. Thus, countries have come to realize that building national Environmental Statistical Systems is a necessity, and they have undertaken the task within the limits of their resources and their capacity to marshal technical assistance from the regional networks and agencies that have emerged to deal with this issue.

It should be noted that all countries face major challenges in the primary production of environmental data and statistics based on existing monitoring and record-keeping efforts, the interpretation of remote sensor data, structuring variables from polls and censuses, and the creation of specific environmental data collection instruments such as environmental surveys. However, the existence of a significant stock of primary environmental data and statistics in many countries is already an achievement in itself. Hence, the challenge is to channel what is already being produced by a wide variety of sources and presented in diverse formats, into a centralized national system, in order to build a permanent environmental statistical process in which all stakeholders may become involved. The process should be organized according to the criteria of quality, transparency and timeliness in the dissemination of environmental statistical products in the countries of the region.

2.2.1 Types of environmental statistical sources

In demographic, economic and social statistical work, the usual sources of information for statistical series and specific indicators are Censuses and Surveys, which have their own established and time-validated data collection processes and instruments. These sources by far surpass the few administrative records on which statistical information is based in areas where adequate surveys have not yet been developed. However, sources of relevant statistics have a much shorter history and their own complexities. This statistical milieu differs substantially from others in types of sources, suitability, robustness and timeliness.

There are different types of environmental data sources, all of which are still evolving. Each has its own characteristics, strengths and weaknesses that must be taken into consideration when choosing the source for calculating a specific indicator.

The different sources of environmental information in LAC and in statistically and environmentally developed countries are listed here, with due consideration for the spatial or territorial nature of environmental phenomena and the fact that they are constantly changing. Table 3 shows the principal types of sources, with examples of the instruments or process from which environmental statistics series are usually derived. Some examples of these series are also given.

TABLE 3
TYPES OF ENVIRONMENTAL STATISTICAL SOURCES

Type of source	Example of source type	Example of statistical series
1. Administrative records	Statistical collation of records maintained in different government agencies for administrative purposes, at various levels (national, regional, provincial, municipal, and so on) such as: Customs records (imports), sectoral ministry records, public finance and budget records, tax return records, environmental authority records.	Apparent consumption of agrochemicals Chlorofluorocarbon consumption Number of motor vehicles Environmental impact or licensing assessments Enforcement of Protected Area regulations Environmental education efforts Reforestation surface area Public spending on environmental matters
2. Monitoring systems	Includes various natural resource quality and pollution monitoring stations and systems, such as: Urban air pollution monitoring stations, surface water quality monitoring systems (principal rivers), glacier monitoring systems, seawater or coastal water quality monitoring systems, and so on.	Quality of potable water (various parameters) Urban clean air quality Coastal pollution Level or height of principal glaciers
3. Censuses	Although these are general purpose instruments, censuses may often include environmental aspects of areas inhabited by the population.	Potable water Basic sanitation Housing quality Establishments with systems
4. Surveys	Includes general purpose instruments (which may undoubtedly cover environmental issues) such as Household Surveys and business surveys; also includes emerging surveys specifically designed to gather environmental information, such as environmental management surveys for business establishments (industry, tourism, agriculture, and so on), municipal environmental management surveys and public opinion polls on the environment, among others.	Potable water Basic sanitation Housing quality Establishments with environmental management systems Production and handling of solid waste Opinion barometers on environmental policies and management
5. Remote sensing	All kinds of remote sensing and atmospheric measuring tools that produce images and their interpretation: such as satellite imaging, aerial photography, geodata, geodesy and geomatics.	Satellite imaging to inventory forests Remote imaging of urban sprawl (city core) Soil use (types)
6. Estimates	Estimates made using different methods such as regression, modelling, simulation, scenarios, extrapolation and interpolation.	CO_2 emissions Degradation of natural resources
7. Combinations of sources	Combinations of various types of sources, according to requirements.	Soil degradation (for example, integrating land monitoring systems, remote sensing and expert estimates)

Source: Prepared by the author

As noted earlier, the different types of sources have various strengths and weaknesses that need to be taken into consideration when building basic statistical series and EI. In most cases, the emerging nature of environmental statistics means that for each environmental variable, it may be possible to find a measurement or estimate from a single source. However, it is also true that various institutions in the region estimate or calculate the indicator with information drawn from different sources, which obviously results in disparate values for the indicator.

It is not a good idea to combine different sources in a historical or spatial series for a single statistical variable within an indicator, much less to combine different types of sources. This is because, almost without exception, each source will produce a statistical series based on a specific definition and methodology; and the periodicity, coverage, scope and limitations of that series will probably render it impossible to make a statistical comparison with a second source or instrument.

For example, potable water and sanitation coverage indicators generally come from two of the main sources in the region, Censuses and Household Surveys. The same is true of indicators on soil use, frequently drawn from alternative sources such as agricultural censuses and information derived from remote sensing systems. Thus, it is worth analysing the scope and limitations of each source in the specific context of the institutions responsible for producing the microdata or gathering the information, the mechanisms for statistical validation – in short, the quality, frequency of updating and timeliness of the information itself.

It may also be possible for all existing sources for a single indicator to come from sources of the same typology, such as administrative records (records of the central Ministry of the Environment versus records of a local oversight agency). In this case, in choosing a particular instrument or data collection process, it is always advisable to conduct a thorough analysis of the quality, timeliness, relevance, continuity, description and robustness of the data. Similarly, should it be necessary to select a source from one of two periodic surveys, the sample design, the manner in which environmental variables are sought, and the periodicity of each survey are important considerations in choosing the best alternative.

The decision is relatively complex, given that the statistical potency of the indicator will depend on the source that is ultimately selected to feed it (or its numerator or denominator). If public policy decisions are based on evidence provided by the indicator, the importance of selecting the best source in each case becomes even greater.

Each of the possible sources of environmental information has its advantages, disadvantages and benefits (see table 4), with the usual trade-offs among the various options, hence the need to conduct expert cost-benefit and cost-effectiveness analyses on the basis of multiple criteria.

TABLE 4
PRINCIPAL STRENGTHS AND WEAKNESSES OF ENVIRONMENTAL STATISTICS SOURCES

Type of source	Strengths	Weaknesses	Challenges for Latin America and the Caribbean
1. Administrative records	High periodicity of production (annual, quarterly and even monthly) and thus high updating frecuency	Quality of records is questionable because of discontinuity, and insufficient metadata to ensure compatibility of series	Building statistical capacities in sectoral ministries and public services Requires stable national inter-institutional coordination
2. Monitoring systems	Better quality and more accurate data and microdata	High costs of installing and maintaining monitoring systems and thus of producing microdata	Need to coordinate the flow of data in terms of periodicity, aggregation and format required for feeding into statistical production (series, indicators)
3. Censuses	More representative and accurate data	Periodicity every decade	Improving sections of the census to capture more and better environmental information
4. Surveys	Greater periodicity and therefore more frequent updating of series	Sampling and representativity of sample	Improving sections of recurrent surveys to capture more and better environmental information Developing and maintaining specialized environmental surveys of different sectors and on different scales
5. Remote sensing	Very accurate, but still under-utilized in the region	Cost of interpreting images remains high	Requires geo-spatial literacy among officials responsible for environmental statistics
	Costs of imaging have declined considerably	Many national statistical offices and Ministries of the Environment do not have specialists in geomatics	Requires sufficient resources to interpret images and build geospatial representations of data
6. Estimation	Can be used when it is not possible to monitor or gather information directly	Results may be questionable, depending on methodologies used	

Source: Prepared by the author

It is extremely important to address the issue of sources and their strengths and weaknesses in building the capacities of teams working on indicators. This is because when indicators are proposed and questions are asked about sources, the lack of expertise among participants in indicator-building workshops may lead to two, three or even more potential sources of information being mentioned spontaneously for a single possible indicator.

Thus, establishing minimum criteria for acceptable sources of statistical information such as reliability, rigour and timeliness is essential to enable everyone to select and collectively optimize their statistical work by using the same concepts.

2.2.2 Identification and compilation of existing statistics

At the beginning of the indicator-building exercise, a number of important activities must be carried out to identify all the data and statistics related directly or indirectly to the country's environment. These activities include, but are not limited to, the following:

- Visits to institutions where data gathering, record-keeping, processing, validation and storage can be observed.
- Interviews with technical experts in public agencies and research centres.

- Interviews with environmental subject-matter experts.
- Consultations with technical experts in various government agencies and research institutes to determine the availability of environmental statistics suitable for use. Often environmental and statistical experts are unaware of the array of data series produced in the various offices or departments. Therefore, it is recommended that a list of all relevant institutions be drawn up, based on the previously identified subject-area priorities, so that the entire spectrum can be covered.
- Consultations with experts in specialist fields of the environment or of sustainability (such as water, toxic waste, energy, soil, forestry, coastlines and seas, and atmospheric pollutants). These experts know exactly what is available —in terms of isolated data and specific studies, administrative records, monitoring centres, estimation efforts and surveys in their area of expertise— that is worth considering and has the potential to be used for building EI.

This task can be carried out by subdividing the indicator-building team into subgroups that will investigate sources in specific subject areas, thereby speeding up the identification process and ensuring the robustness and longevity of the data series identified.

During these activities, it will be necessary to keep a record of the consultations and findings so that, after the information identification effort is completed, a technical document can be prepared to systematize the search process and the results. This will ensure that there is a valid written record that may serve as a basis for subsequent searches and enrich the first collection of indicators. In this way, the process will not be negatively affected by any changes in personnel assigned to the teams working on the indicators.

Finally, the environmental data and statistics used to calculate indicators will need to be compiled. This will reveal whether the data series identified in this phase of the work are actually available. These series will be essential for building the methodological sheets explained below.

2.3 Development or completion of the Methodological Sheet for each indicator

The Methodological Sheet, the main working tool for building indicators in any field, makes it possible to objectivize the content, significance, scope, limitations, methodologies and availability of the indicators that are being built.

In this way, all participants will have a shared understanding throughout all stages of the work (table 4 shows examples of the fields in the Methodological Sheet). Filling out the Methodological Sheets will enable the team to distinguish the indicators with adequate technical characteristics and statistical validation for inclusion in the first collection of EI from those that must wait for later phases of the work.

There is a well-known tendency for individuals to become so committed to the indicators they are developing, either because they pertain to their field of expertise or because the indicator yields interesting information for the individual's institution of origin, that it is difficult for them to accept that "their" indicator is not statistically or scientifically viable. In this context, a more objective decision can be made if the Methodological Sheet is filled out and analysed dispassionately for the statistical quality of the data, the certainty of the indicator's directionality, and so on. In particular, the candidate indicators should be placed side by side and the most robust, valid and indicative ones should be selected.

The Methodological Sheets should be filled out sequentially, generally by the specialized subgroups, with unambiguous leadership. There should also be several opportunities for plenary socialization of the results so that the entire team can participate in the analysis and refinement of the indicators as they are being developed. For this reason, it is advisable to maintain an Intranet where all the progress and tools and, above all, the successive versions of the Methodological Sheet for each indicator can be made available to all participants.

It is also a good idea to maintain a list of Methodological Sheets with a column where progress can be tracked (in percentage terms). The coordinator of all the teams can make a note of delays and decide on the necessary changes in good time rather than waiting until an indicator has so many problems and is so far behind schedule that control has been lost and it is not viable enough to be included in the indicators to be published (Annex 1 contains examples of Methodological Sheets).

BOX 2
TOOL 2: METHODOLOGICAL SHEET

The Methodological Sheet or data sheet for each indicator is the second tool required for building a System of Indicators. Once completed, it is like the construction plans for a building. It has all the technical specifications necessary for proper construction, updating and interpretation of the indicator, even if the author or technical expert in charge is no longer participating in the project.

The Methodological Sheet begins to take shape as a sketch that is gradually filled in and refined. It may undergo many drastic changes as information becomes available and the process of refining the indicator achieves its maximum potential and quality, thereby allowing its completion.

The Methodological Sheet is an internal technical document that should not be published as such, since the idea of disseminating an indicator is to simplify its content and facilitate immediate comprehension by the user. However, some of the fields of the Methodological Sheet will serve as a basis for some sections of the final presentation or publication of the indicator (for example, the name, trend line, relevance, limitations, the graphic depiction, and the challenges).

The fields of the standardized Methodological Sheet presented in box 3 are an entirely generic proposal and should be tailored to the objectives of each working team, the subject matter and the territory or institution involved in each case. In its current form, it has proven its basic usefulness and has been enriched by the indicator-building experiences of Argentina, Brazil, Chile, Colombia, the Dominican Republic, Nicaragua and Panama. The standard Methodological Sheet has also been improved through regional and national training courses and other areas in which the Statistics and Economic Projections Division of ECLAC has worked: the indicators of the AGRO Plan of the Forum of Ministers of the Environment of Latin America and the Caribbean, the development of the Economic Impact of Tourism Indicators and the seventh Millennium Development Goal Indicators for Latin America and the Caribbean.

Source: Prepared by the author

TABLE 5
DESCRIPTION OF FIELDS IN THE METHODOLOGICAL SHEET

Name of indicator	Give the indicator a name that is as clear, concise and user-friendly (“Energy Intensity of Production”) and that defines exactly what the indicator shows.
Short description of indicator	Provide a short description of what the indicator shows, especially if it has a scientific or technical name, using clear and simple language that gives the user guidance regarding the indicator in question.
Relevance of the indicator	Explain the importance of the proposed indicator for evaluating the environment or sustainability. Define the variables that make up the indicator, associating them with environmental or sustainable development problems that the user can easily- understand.
Graphic or image, with trend-line descriptor	Provide an image of the indicator, ideally a graphic one. Often unforeseen errors and strengths can be detected by analysing graphs (more so than with tables). Try different formats or types of graphs to display the indicator’s optimum results. Devise a descriptor of the trend line shown in the graph, which can be used as a title.
Trends and challenges	Include a brief paragraph beneath the graph to inform the user of the implications and challenges revealed by the indicator’s trend line.
Directionality	Give a clear explanation of how changes in the indicator are to be interpreted. Interpret the indicator in the context of environmental sustainability or development.
Scope	Specify exactly what the indicator measures.
Limitations	Explain what the indicator does not measure and clarify which dimensions and dynamics cannot be captured with the indicator.
Formula for calculating the indicator	Specify the operations that are necessary to obtain the value of the indicator at each point of observation (territorial, historical, and so on). Clearly define the indicator’s unit of measurement.
Definition of variables that make up the indicator	Specify each of the variables that make up the indicator. If possible, adopt the definition used by the institution producing the data, for example: “The concept of fragmentation of ecosystems used by the Conservation of Biodiversity Institute of Ministry X has been adopted.”
Scope or scale of the indicator	The indicator may encompass or combine different levels. This should be clearly specified, as should the scope of the component variables. Examples include the community, provincial, departmental, ecoregional, river basin and national scales.
Source of data	Specify in detail the source of the data for each variable: the institution, the department or office, and/or the physical or electronic publication where this is available (if applicable) and the name and e-mail address of the person in charge.
Method of collecting or capturing data	Describe the method through which the basic data are captured or generated. In general, this includes surveys, censuses, administrative records and monitoring stations.
Availability of data (qualitative)	The availability of data refers to the ease or difficulty in gaining systematic access to the data. For example, state “Fully available in hard copy or electronic form,” “Availability restricted to public agencies," "Primary data available in Household Survey but subsequent processing required to generate the required information," or “Confidential information.”
Periodicity of data	Specify the period of time for each variable in the indicator. For example, “every four years,” “annually,” “bimonthly,” and so on. Where appropriate, specify the periodicity of the collection, recording and publication of the data.
Period of currently available time series	Specify the period of time covered by the currently available series, for example, “Period: 1987 to 2000.”
Periodicity of indicator updates	Indicate the group’s recommendation on how often it is possible to update the indicator.
Relationship of the indicator to environmental or	Explain whether there are policies, targets, quality standards or even baselines relevant to the indicator that can be used to evaluate progress over time or in different territories.

sustainable development policy objectives in Latin American and Caribbean countries	
Link with regional or worldwide initiatives	State whether the indicator in question (or a very similar one) is part of regional or worldwide indicator initiatives, is reported to specialized agencies or to the various International Environmental Conventions. Specify the code or number corresponding to the indicator for each initiative, for example, "corresponds to Indicator 7.1 of the seventh Millennium Development Goal."
Data table	Statistical data that are the basis for calculating the indicator allow for a more thorough analysis and make it possible to find the best graphic representation. Include an Excel spreadsheet with the historical time series required to calculate each indicator.

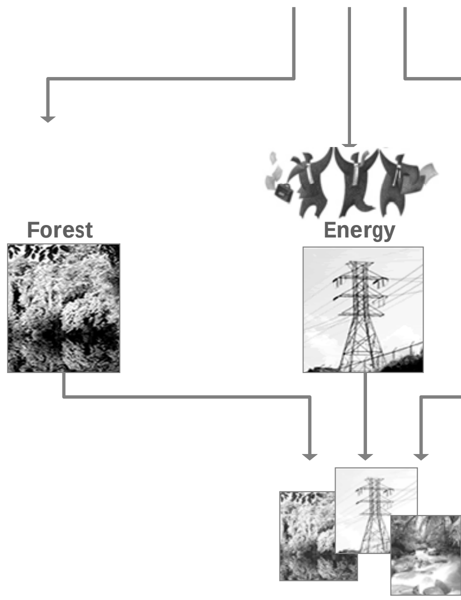
Source: Prepared by the author
Note: See annex 4 for more Environmental Indicator initiatives.

2.4 Formation of subject-area subgroups for elaborating Methodological Sheets

After the initial list of indicators and the corresponding Methodological Sheets have been developed and the availability of statistics analysed, the working groups must be established by subject area to discuss, analyse and decide on each indicator based on the prioritization criteria mentioned in the previous section.

Figure 22 below shows an example of how the groups can be established by subject area, with one group working on forestry, another on energy issues, and a third on water. The indicator-building process will be carried out by these specialized sub-groups, which will be responsible for completing all the fields on the Methodological Sheet. The sub-group will then present the Sheet with comments to a plenary meeting of the core team. At this critical point, the indicators that have been developed can be evaluated according to specific eligibility criteria. In this manner, indicators will either be selected to go into the first set of EIs, or relegated for later development.

FIGURE 22
DIVISION INTO THEMATIC TEAMS



Source: Prepared by the author

2.5 Selection of final indicators

After a set of indicators has been identified with Methodological Sheets that have been completed and checked thoroughly, a rigorous final selection will be made of the indicators that merit inclusion in the first collection of Environmental or Sustainable Development Indicators for the country or territory in question.

2.5.1 Eligibility criteria for indicators

When re-evaluating the relevance (to public policymaking, informing the public, and so on) and the technical quality of the indicators being built, the teams must agree on the criteria for deciding whether the indicators should form part of the first collection to be published and used, or whether they should be put aside for future consideration, or even discarded. Table 6 shows some criteria that can be used.

TABLE 6
ELIGIBLITY CRITERIA FOR INDICATORS

Criteria	
Relevance criteria	Pertinence to problems or decisions for which indicators will be used
	Relationship to the specific goals, objectives or standards in place in the country or territory under consideration.
Statistical viability criteria	Availability of statistical information necessary for calculating the indicator
	Quality of statistical information necessary for calculating the indicator
	Existence and quality of the indicator description derived from underlying statistics
	Strength of the indicator in terms of international or local acceptance, based the information quality and the scientific validity of the phenomena to be reflected
	Simplicity, in the sense that the best indicators are those that provide information simply and directly
	Precision and clarity
	Reliability of directionality
Formal criteria	Internal consistency of the Methodological Sheet, which means that all of the fields (for example, name, formula, trend-line descriptor, graph and policy challenges) are aligned in the same direction
	Optimization of graph, cartography or diagram chosen

Source: Prepared by the author

It is recommended that an exhaustive check be made to ensure that all the agreed-upon criteria have been adhered to for each of the prospective indicators. Taking a multi-criteria approach means that all criteria are equally important, and that indicators cannot be rejected, postponed or accepted based on only one of them, except for the criterion referring to the existence of statistical information for calculation.

At this point, the concept of reliable directionality bears further clarification. An indicator is said to be directionally reliable when the value it assumes over time or across territories is unequivocal and clear, with no room for erroneous or vague interpretations. In this regard, a directionally reliable indicator leaves no room for doubt that when it increases (or decreases) in value, the variation can be understood as a positive or negative movement with respect to environmental sustainability. For example, if the value of an indicator or the variation in that value leads to conflicting or contradictory interpretations by different people, it is most likely a directionally unreliable indicator, rendering it unacceptable. Directionally unreliable indicators should not be included in the initial EI collection of any country.

In short, indicators that are unsuitable for immediate incorporation into the collection to be published due to one of these criteria will be left for future development, a task for the teams responsible for maintaining and updating the EI system over time. It is often useful to keep a record of the lists that were revised and prioritized during the design process, dividing them into three sub-groups:

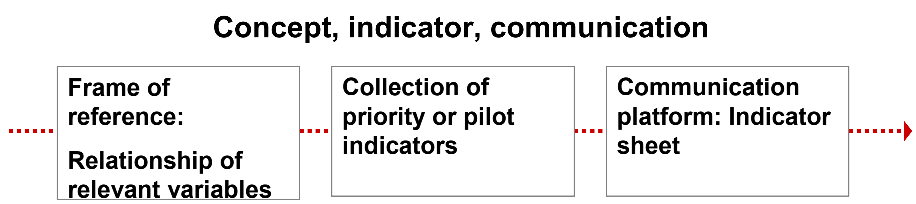
- List A: indicators that will be statistically viable in the short term
- List B: indicators that will be statistically viable in the medium term
- List C: indicators that will be statistically viable in the long term.

2.5.2 Definition of a logical framework

Defining the logical framework is a necessary step in that it enables the indicators to be organized and presented in a way that makes sense to the users. Logical frameworks are important instruments in the process of communicating to users the content revealed by indicators.

Several different logical frameworks have been proposed or used to organize and present EI. This guide will mention only the most widely known: the Pressure- State- Response (PSR) framework developed and recommended by the Organisation for Economic Co-operation and Development (OECD), and its different derivations: Driving- Force- State- Response (DSR), Driving-Force, Pressure-State- Impact- Response (DPSIR), and the logical framework organized thematically or by subject area, used by Canada and the Sustainable Development Commission of the United Nations. In general, the countries of Latin America and the Caribbean use the thematic and sub-thematic logical framework, adapted to national or local priorities, as needed.

FIGURE 23
DEFINITION OF A LOGICAL FRAMEWORK



Source: Prepared by the author

Pressure- State- Response (PSR) logical framework

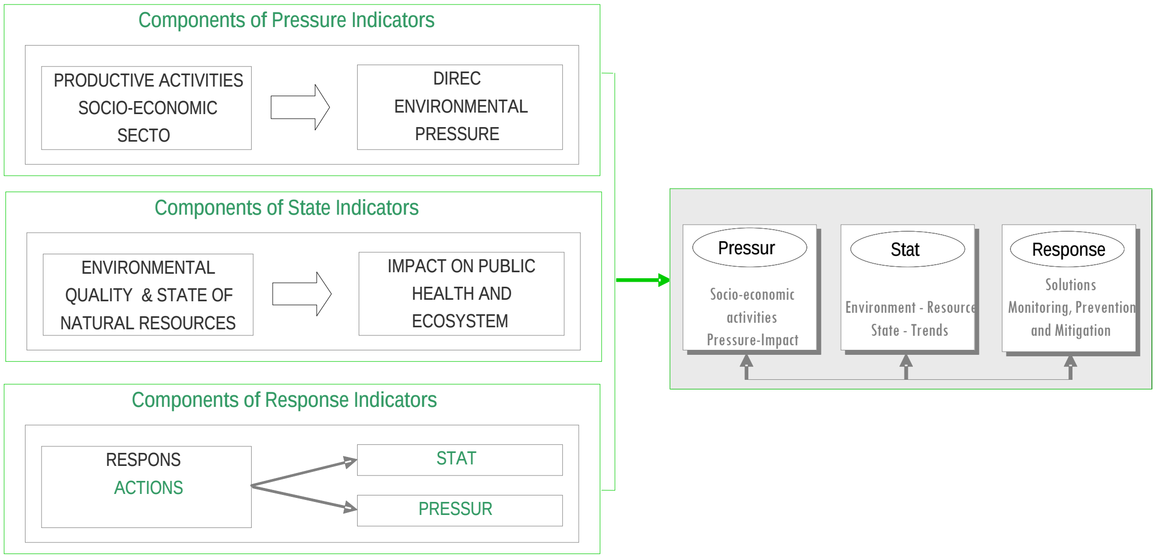
This framework was originally developed and recommended by the OECD (1993), SCOPE (Ghent Report) (UNEP, 1995) - UNSTAT or EUROSTAT. It organizes the indicators into three categories:

- Indicators of pressure – causes of the problem (emissions and waste accumulation)
- Indicators of state – state of the environment (quality of urban air, quality of underground waters, changes in temperature, concentrations of toxic substances, or the number of endangered species)
- Indicators of response – what is being done to solve the problem (international commitments, rates of recycling or energy efficiency).

FIGURE 24

EXAMPLE OF A PSR LOGICAL FRAMEWORK

NATIONAL ENVIRONMENTAL INFORMATION SYSTEM OF NICARAGUA



Source: National Environmental Information System of Nicaragua.

Logical framework organized thematically or by environmental components

Figure 25 is a schematic example of a thematically organized logical framework. This framework is widely used because it is simple and user-friendly. It is recommended and used by the Sustainable Development Commission of the United Nations, by Canada and by experts on the subject.

The Indicators are organized by theme and sub-theme, although more disaggregations or breakdowns may be necessary, for example:

Theme A Indicator A1

Indicator A2

Indicator A3

Theme B Indicator B1

FIGURE 25
EXAMPLE OF A THEMATICALLY-ORGANIZED LOGICAL FRAMEWORK

ENVIRONMENTAL INDICATORS SYSTEM OF CANADA, 2003

Ecological Life-Support System
- Biodiversity and protected areas
- Toxic substances
- Acid rain
- Climate change
- Stratospheric ozone

Human Health and Well-being
- Municipal water usage
- Municipal waste water treatment
- Urban air quality

Natural Resources Sustainability
- Forestry sector
- Agricultural soils

Human Activities
- Energy consumption
- Passenger transportation
- Municipal solid waste

Source: Environment Canada. Canada's National Environmental Indicators Series. www.ec.gc.ca/soer-ree/English/Indicators/default.cfm. Canada began to develop Environmental Sustainability Indicators in 2004.

2.6 Fact Sheet Design

The format, medium and graphics of the System of Indicators are of the utmost importance to optimize comprehension and usage. Thus, the indicator-building teams should devote part of their time to performing this task or to supervising it closely if it has been assigned to specialized individuals or units.

The Methodological Sheet used in developing EI for each country should serve as the basis for designing the Fact Sheet on the indicators, which is what the users will ultimately see. In no case should the indicators be published in the technical format of the Methodological Sheet, which includes all the metadata, since that was not its intended purpose.

BOX 3
TOOL 3: FACT SHEET

The Fact Sheet should be designed for optimum presentation of the indicators, making the information as attractive as possible to users in order to have the greatest impact. The Fact Sheet that emerges from this design process is the final information that users will see.

The Fact Sheet should include the following fields from the Methodological Sheet:

- Name of indicator
- Trend-line descriptor
- Graph and/or map
- Relevance of the indicator
- Challenges
- Sources
- Metadata (optional), allowing access (on another sheet or another digital layer) to additional fields such as the method of calculation, scope and limitations.

Each country requires a specific format and content for this instrument. However, it is important that the Fact Sheet have the following characteristics:

- Shows the indicator and its trend line
- Provides information about minimum technical specifications
- Presents the context of the indicator
- Interprets the results
- Is user-friendly
- Shows different levels of technical depth, depending on the nature of the indicator and the presentation format.

Source: Prepared by the author

FIGURE 26
EXAMPLE OF A FACT SHEET

BASIC ENVIRONMENTAL PERFORMANCE INDICATORS OF MEXICO, 2005

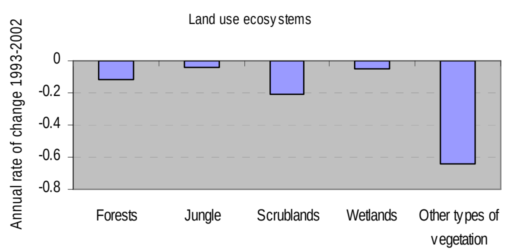
CHANGES IN SOIL USE

Justification

The pressure exerted by the production of goods and services has intensified the loss and deterioriation of earth ecosystems through changes in land use. The change in land use is perhaps the most important factor threatening the integrity and durability of land ecosystems and their biodiversity. The activites that produce the greatest changes in soil use are agriculture and livestock production, followed by urban sprawl and communications and other service infrastructure.

Situation / Tendency

During the period from 1993 to 2002, the forest cover was reduced by almost 3 590 square kilometres, an annual rate of change of 0.12%; the forests lost 1 100 square kilometres (0.04% annually), shrublands lost close to 9858 square kilometres (0.21% annually), wetlands 92 square kilometres (0.05% annually) and other types of vegetation (including natural grazing, halophilic and gypsophilic vegetation, riverain, thicket and submontane scrub vegetation, amongst others) were reduced by close to 13 330 square kilonetres, at an annual rate of 0.64%.



Comments on the Indicator

This indicator is included on the list of United Nations Sustainable Development Indicators and the environmental integration intiative of the Statistical Office of the European Union (Eurostat) and the Organisation for Economic Co-operation and Development (OECD), the Ministry of the Environment of Spain and the International Union of Geological Sciences.

Metadata of the Indicator 6.1-1

Complementary Information

- Land under cultivation, 1980 to 2003 IC 6.1 - 1A)
- State lands used for rearing livestock, 1999 (IC 6.1 - 1B)

Table of Indicator 6.1-1

METADATA	
Name	Change in land use
Brief definition	Change in land use in some of the main national land ecosystems
Unit of measurement	Percentage
Objectives and goals	Not defined
Definitions and concepts	Change in land use: total or partial removal of the vegetation in forested areas to engage in non-forestry activities (SARH, 1994)

Method of measurement:	The annual rate of change was calculated using the formula r+ $(((s_2/s_i)^{(1/t)})*100)-100$, where r is the rate, s_2 and s_i are the surface areas for the final and initial times respectively, and t is the time elapsed between the dates.The change in land use is evaluated by means of geographical and remote sensing information systems and by multitemporal analysis of land use by forestry, agriculture, grazing and urban activites.
Periodicity:	Variable
Limitations of the Indicator:	Not applicable
Data sources:	Calculations by the author with data from: INEGI,Mapping of land use and vegetation cover, series II 1993, Mexico.INEGI,Mapping of land use and vegetation cover, series III 2002, Mexico, 2003.
References:	SARH, Periodic National Forestry Inventory 1992-1994, Mexico, 1994

Source: Secretariat of the Environment and Natural Resources of Mexico [online] http://portal.semarnat.gob.mx/semarnat/portal

2.6.1 Selection of graphic representation: types of graphs and maps

Graphs

In the EI workshops conducted in various countries, the choice of graphic representation is often based on the explicit recognition of its critical importance. The optimal graphic or cartographic representation adds value to the indicator and becomes much more than a mere vehicle for displaying the indicator.

The graph or map (of a combination of the two) that has been carefully selected after a series of trials, using pilots examined and interpreted by volunteers who are not experts, will be one of the most significant elements in the communicational power of the indicators.

There are different types of graph, each with advantages and disadvantages that the core indicator-building team must assess and evaluate so that it can create the best possible representation for each case and situation. Annex 3 provides examples of various graphs, ranging from simple (one variable) to complex.

Formal elements a graph should contain

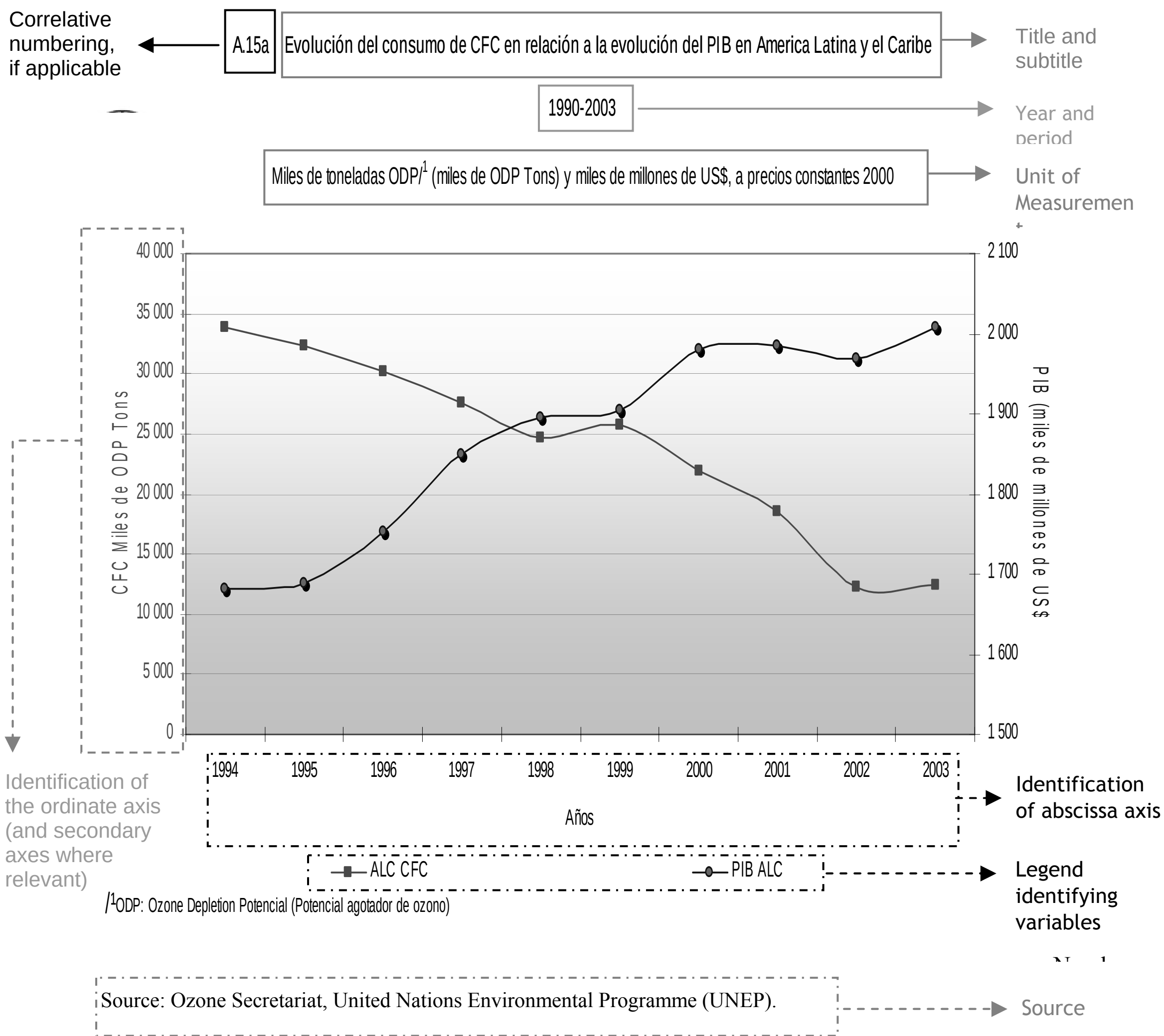
Graphs are subject to a number of minimum conditions for statistical rigour that should be met so that they can be considered technically valid and complete. These elements are described below, followed by an example to illustrate the conditions.

From the standpoint of statistical rigour, graphs must be self-contained, meaning that they must have all the information necessary for their correct reading and interpretation, even though the information may also be presented in the accompanying text analysing the graph. Accordingly, the graph should always have a title, preceded by a correlative number where applicable. The title must describe what the graph shows (whether it is a progression, a composition or a ratio) and the geographic or territorial scale covered (whether it corresponds to a region, a country or a particular geographical area). The title should also indicate the period covered by the data series and the unit of measurement.

Within the graph, the axes must be clearly identified, especially if a graph with a secondary axis is used. In that case, it is very helpful to use different colours so that the elements of the graph can be associated with the corresponding axis. The units of measurement and scale of each axis should be provided, especially if these are multiples of the unit of measurement specified in the title. All graphs should have legends showing the variable(s) depicted, and finally, the source of the information should be indicated. In general, it is recommended that acronyms be avoided, and that footnotes or reference marks always be shown.

A good graph should meet all of these requirements, even if some of these elements are repeated in the narrative that precedes or follows the graph in a document. This is because users tend to cut and paste graphs without including the analytical text from the original context. In fact, the basic test used by teams to determine whether the requirements have been met is to show the graph without the other fields of the Methodological Sheet. The core team can then analyse it and determine whether it provides all of the essential information necessary for correct understanding, description and interpretation.

FIGURE 27
EXAMPLE OF MINIMUM FORMAL REQUIREMENTS OF A GRAPH



Maps

Maps are also excellent tools for presenting statistical information, especially when working with EI directly linked to the territory. When a map is used to present information, it must contain the same elements as a conventional graph (title, geographical areas, units of measurement, and so on), in addition to providing the geographic scale of the representation.

If the boundaries and names on the map are not supported or accepted by the institution responsible for publication, an explanatory note must be inserted. It is also advisable to insert a disclaimer stating that the geographical boundaries depicted on the map do not represent any judgment on the part of the institution concerning the legal status of countries, territories or cities.

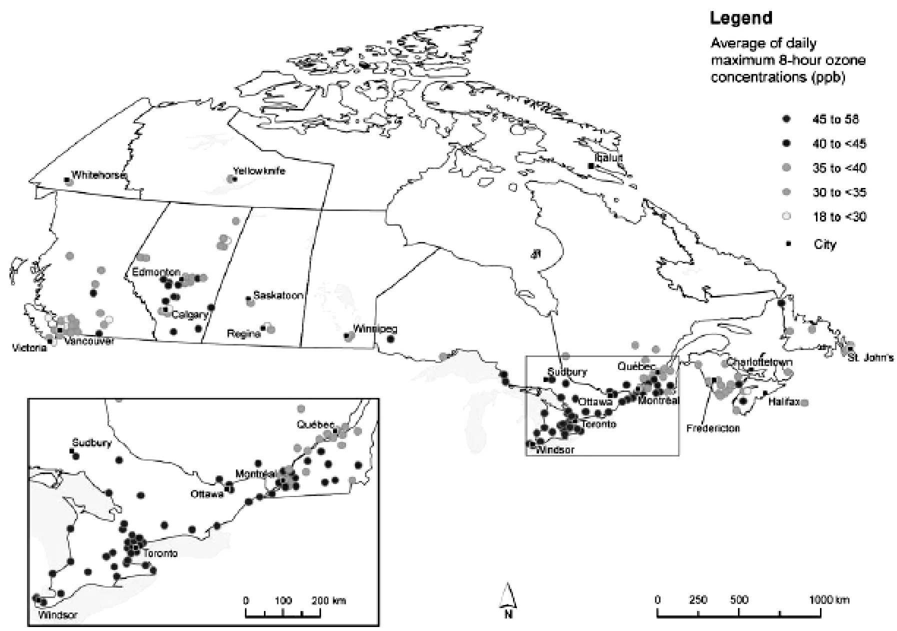
Examples of map types

Below are samples of different options for representing various indicators.

The map in figure 28 depicts the maximum concentrations of tropospheric ozone at different monitoring stations in Canada in 2005, using different coloured symbols. The colours represent intervals that are explained in the legend and that are located on the map at the various monitoring stations throughout the country.

FIGURE 28
CARTOGRAPHIC REPRESENTATION OF A VARIABLE BY VALUE RANGES ACCORDING TO LOCATION

MAP 1: GROUND-LEVEL OZONE CONCENTRATIONS AT MONITORING STATIONS, CANADA, 2005

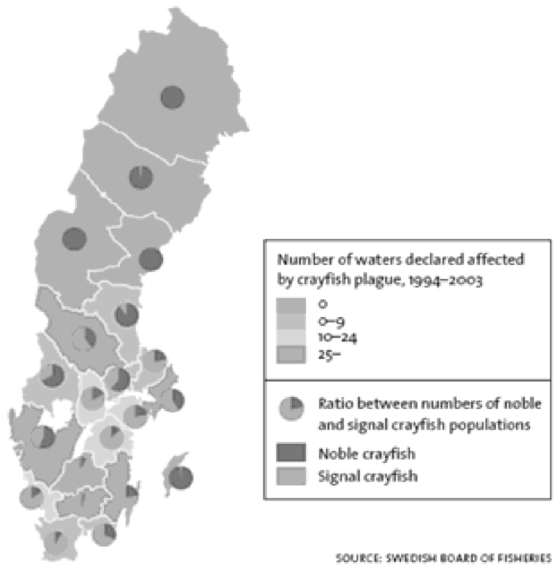


Note: Ambient data collected from 175 monitoring stations. Concentrations are not weighted by population.
Sources: National Air Pollution Surveillance (NAPS) Network and the Canadian Air and Precipitation Monitoring Network (CAPMoN).

Source: Canadian Environmental Sustainability indicators 2007 Report. http://www.ec.gc.ca/indicateurs-indicators/2102636F-9078-409F-8133-8775E51400BE/featureweb_e.pdf

The map in figure 29 shows the extent to which waters in different regions have been affected by crayfish plague using different shades of colour. Along with the map, pie charts display each region with supplementary information indicating the ratio between the two types of crayfish populations (noble and signal) affecting the waters.

FIGURE 29
CARTOGRAPHIC REPRESENTATION BY VALUE RANGES COMBINED WITH GRAPHIC REPRESENTATION OF PERCENTAGE IMPORTANCE OF A VARIABLE



Source: Sweden's Environmental Objectives. A progress report from the Swedish Environmental Objectives Council, 2007.

2.7 Development of final publication

2.7.1 Selection of dissemination platform

Disseminating indicators is a critical task. Both the future use of the indicators and the budget assigned to sustain them over time will depend to a certain extent on the distribution strategy that is employed. Experience has proven that there will be only one occasion to launch or publicize the indicators and this opportunity should be exploited to the utmost. The indicator must be seen as a tool both by the mass media and by the authorities and decision-makers who will be the main users.

An appropriate system for disseminating the indicators is almost as important as their technical quality. The publication strategy should include a global dissemination scheme for the indicators which covers the process, outcomes and specific products that have been created. The communication strategy and graphic design should be of professional quality so that the indicators are attractive, clear, and user-friendly in all the media in which they are published, thereby encouraging their use and sustainability over time.

It is highly advantageous to publicize the results of the laborious task of building EI by using as many methods as possible. A printed document in an attractive format is an asset to the publication of the EI and has historically been the most effective. But with the growth and popularization of new technologies, publishing the information on a website is perhaps the most efficient distribution method. Web publication has the advantage that it can be updated regularly and quickly and provides an avenue for periodic reports to be made available to the public. In addition, the site can also allow access to databases and enable the construction of graphs.

Another alternative for publishing information is to put it on a compact disk (CD-ROM), which is easy to navigate and can be distributed more rapidly and economically than a printed publication.

Taking into consideration the cost of each medium of communication, it is recommended that at least those shown in table 7 be employed.

TABLE 7
COMMUNICATION MEDIA FOR ENVIRONMENTAL INDICATORS

Type of medium	Description	Advantage	Example
1. Book	Of limited length to facilitate use	A complete printed document in an attractive format	Sweden, Panama and Argentina
2. Website	User-friendly, attractive design that can be accessed through SINIA and national statistical offices or located on the web page of the institution hosting the system of indicators, or both, itself a political decision	Broad distribution, low cost, easy and immediate access	Panama and Mexico
3. CD-ROM	A user-friendly system based on the web design that allows access to information to different degrees of detail.	Cost-effective, does not require internet connection	Panama Brazil 2008 Sustainable Development Indicators (IBGE-MMA, 2008)
4. Publicity brochure or pamphlet	Synthesizes the main trends revealed by the indicators in few pages	Allows public information to be provided at low cost to different environmental authorities and national statistical offices	Panama

Source: Prepared by the author

Production of the publication

The production process is critical for achieving the objectives of the dissemination strategy. It is important to define the content, format and communicational design of the publication, including language and graphic design.

All the components of the publication, including maps and graphs, should be chosen based on the criteria of being clear, simple and attractive in design to the user. The commissioned maps will become an important resource in indicator publication. This resource must be exploited to the maximum, especially if the institution developing the EI also has the capacity to produce the maps.

Structure of the Environmental Indicator publication

In general, the content shown in table 8 should be included in the publication introducing the System of Indicators, regardless of the medium or form of dissemination.

TABLE 8
STRUCTURE OF ENVIRONMENTAL INDICATORS PUBLICATION

Element	Definition
1. Foreword	(formal introduction by the authority)
2. Table of contents	
3. Introduction	This section can explain the process, the intended audience, the importance of having a National System of EI, and so on.
4. Methodology for building the indicators	The intra- and inter-institutional agreements and the process for building and maintaining the indicators over time should be presented very succinctly.
5. Content	This section should present the indicators. 5.1 The structure of the indicators by subject area 5.2 The thematically organized indicators, with specific introductions In general, each of the indicators should be presented in a user-friendly format, using as much space as necessary (two to six pages for a complete double-page display). For each indicator, depending on the design of the fact sheet made up of selected fields from the Methodological Sheet, the following minimum information is suggested: – Number of the indicator in the series – Name of indicator – Short description – Graph, map or both – Description of the graph and map, trend line – Relevance – Relationship to policy challenges or existing standards or goals Graphic design should employ the following: – photographs – supplementary graphs – maps, where appropriate – wide array of colours
6. Acknowledgement	It is very important to give the appropriate credit to each of the teams and institutions participating in the process, in order to encourage them to continue contributing to the maintenance and development of the System of Environmental Indicators.

Source: Prepared by the author

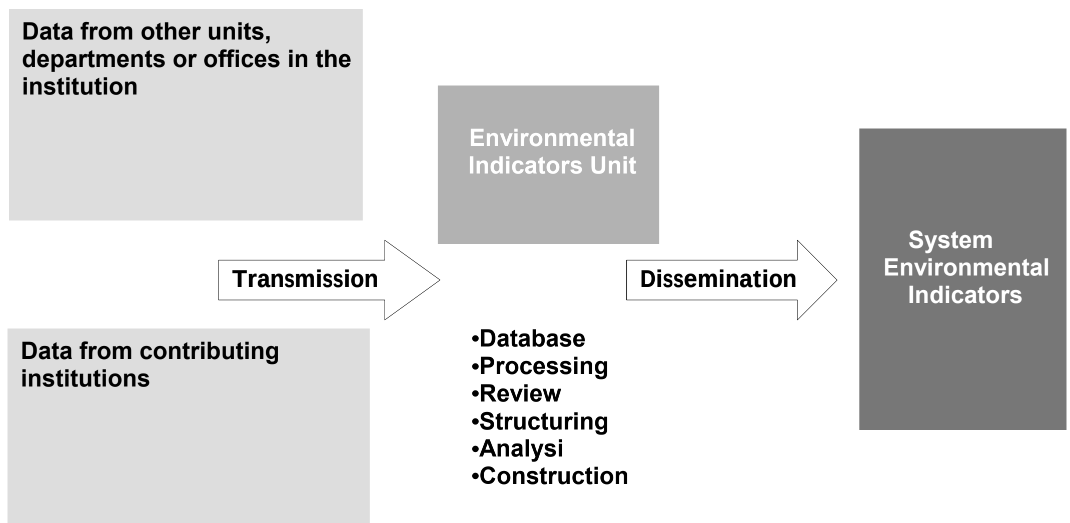
2.8 Development of Data Sharing Sheet

The Data Sharing Sheet is the result of the systematization of the processes and protocols for coordinating and exchanging statistics among the various institutions or intra-institutional departments responsible for producing or compiling data on issues relevant to the System of Indicators. The purpose of this sheet is to record parameters and contact data to ensure the flow of data from these institutions to the EI Unit in the format and with the frequency required by the EI System.

Inter-institutional data flow

Figure 30 shows an initial schematic conception of how data should flow to the team responsible for managing indicators in the lead institution. Like any preliminary design, it should be tested and refined during implementation so that its functioning can be adjusted if necessary. Features which may need to be adjusted are the fields and formats of the sheet and the periodicity with which data are transmitted and EI recalculated.

FIGURE 30
GENERAL FLOW OF DATA SHARING



Source: Prepared by the author

The EI System is an information system and, as such, entails entering and then processing data, and finally generating outputs in different formats suited to the needs of the users. The flowchart illustrates in general terms how the data move from different sources (by means of the Sharing Sheet tool within and between institutions, as the case may be) and are processed and validated by a central EI Unit in the lead institution. After this processing, the EI is generated (and later updated) in supporting documents, CD-ROM and/or a web page. Through the dissemination of these products, users will receive the most up-to-date information available for a given period of time, depending on the availability of information and the technical and financial resources necessary to exploit them.

2.8.1 Individualized inter- and intra-institutional data flow sheets for indicators

The exhaustive systematization process results in the design of a sheet for recording the data transfer process. This allows for continuity in the flow of information despite staff turnover within the different offices and institutions.

The sheet, which shows the specific source of data for each variable in the indicator, also systematizes the details on those responsible for the information, the periodicity (of recording, sharing, recalculation and dissemination) of the data and the indicator. The sheet's schematic form is intended to track the flow of data from the sources to the points where the data are fed into indicators, the indicators produced, and their values updated (see box 4).

BOX 4
TOOL 4: DATA SHARING SHEET

Another exceptional tool for building a System of Indicators is the Data Sharing Sheet. This document details the origin and application of the data and statistical series that are needed to calculate and update the value of each EI for the country or territory in question. A separate Sheet will be created for each indicator, and the teams in charge of developing and updating the indicators should keep it current and available.

It is generally a good idea to have two types of sheet, one for recording the systematic sharing of data within the institution in charge of the indicators (intra-institutional sheet) and one for recording the specifications of the data originating from, or collected with the cooperation of, other ministries and official agencies (inter-institutional sheet) responsible for producing the Environmental or Sustainable Development Indicators.

Both types of sheet should provide details on the core elements of data sharing, such as the form, periodicity and content of the statistical information that must flow between the institutions and departments (and the corresponding individuals), so that the indicators can be calculated and updated.

Inter-institutional Data Sharing Sheet

This sheet captures the form, periodicity and content of the statistical information that must flow among different institutions (and the corresponding individuals) so that the indicators can be calculated and updated.

Inter-institutional Data Sharing Sheets are like maps, enabling anyone new to the indicator-building team to follow the same path as his/her predecessors and giving continuity to the task, using the same sources so that the values provided by the indicators can be compared over time. At the same time, the sheets enable staff turnover and institutional changes to be recorded so that these changes can be referred to subsequently by the teams. The data sharing sheet records pathways for the calculation of the indicators, avoiding loss of momentum in the event of staff turnover and/or institutional changes in organizations that produce and use basic statistics or indicators.

Ideally, maintaining these sheets should be one of the tasks of the indicator-building team leader, but the members of the working teams should also maintain duplicate sheets. Redundancy will be useful precisely because of the high turnover that may affect the coordination of the process.

Intra-institutional Data Sharing Sheet

The purpose of the sheet used within an institution is to provide the same detailed record of information specifications that are required within a single ministry or national statistical office for calculating and updating national indicators in a systematic manner.

The Intra-institutional Data Sharing Sheet can be adapted from the sheet described above so that it can accommodate data that are usually in the form of administrative records (such as the environmental management indicators in the Ministry of the Environment) or a survey or census (in the case of a national statistical office).

Source: Prepared by the author

Below are two hypothetical sharing sheets. Table 9 shows an Inter-Institutional Data Sharing Sheet with its fields filled in, for an imaginary Vehicular Flow Intensity Indicator. Table 10 shows an Intra-Institutional Data Sharing Sheet for an imaginary indicator reflecting environmental impact evaluations.

TABLE 9
SAMPLE INTER-INSTITUTIONAL DATA SHARING SHEET

Indicator [write indicator number] 8

Name: [write indicator name] Vehicular Flow Intensity (VFI)

Formula: [write formula for calculating indicator]

VFI = Number of vehicles (number)/Length of highway grid (km) * 100

Name of variable 1: [write name of variable 1]

Number of vehicles (NV)

Institution and contact:
[write name of institution (unit) and the person providing the data]
Ministry of Transportation Statistical Section
Ernesto Castro
Telephone: 456-0333, ext. 7361
e-mail: Ernesto.castro@mintransporte.gob

Collection periodicity (CP): [monthly, yearly …]

Annual

Transmission medium: [paper, Excel, etc.]

Paper

Name of variable 2: [write name of variable 2]

Length of highway grid (LHG)

Institution and contact:
[write name of institution and the person providing the data]
Ministry of Public Works Roads and Highways Unit
Teresa Martínez
Telephone: 996-3000, ext. 4628
e-mail: Teresamartinez@obraspublicas.gob

Collection periodicity (CP): [monthly, yearly …]

Annual

Transmission medium:
[paper, Excel, etc.]

Electronic, Excel

Periodicity of transmission (PT) to Environmental Indicators Unit: Annual
[periodicity with which data are transmitted to the Environmental Indicators Unit]

Spreadsheets: tabulated
[contains data series, may be attached as an Excel file]

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
NV													
LHG													
VFI													

UPDATED VALUE OF INDICATOR

Dissemination periodicity (DP): Annual
[periodicity of dissemination of indicator]

Source: Prepared by the author

TABLE 10
SAMPLE INTRA-INSTITUTIONAL DATA SHARING SHEET

Indicator [write indicator number] **7.4**

Name: [write name of indicator] Environmental Impact Evaluations

Formula: [write formula for calculating indicator]

XXXXXXX

Name of variable 1: [write name of variable 1]	Name of variable 2: [write name of variable 2]
XXXXX	XXXX
Department and contact: [write name of institution (unit) and the person providing the data] Ministry of the Environment Department of Environmental Statistics and Indicators Ernesto Castro Telephone: 456-0333, ext. 7361 e-mail: Ernesto.castro@ambiente.gob	Department and contact: [write name of institution and the person providing the data] Ministry of the Environment Planning Unit Teresa Martínez Telephone: 996-3000, ext. 4628 e-mail: Teresamartinez@obraspublicas.gob
Periodicity of record P: [monthly, yearly …]	Periodicity of record PL: [monthly, yearly …]
Monthly	Monthly
Transmission medium: [paper, Excel, etc.]	Transmission medium:
Form 7.4a	Form 7.4b
Excel	Excel

Periodicity of transmission to Environmental Indicators Unit: Monthly

[periodicity with which data are transmitted to the Environmental Indicators Unit]

Spreadsheets: tabulated

[contains data series, may be attached as an Excel file]

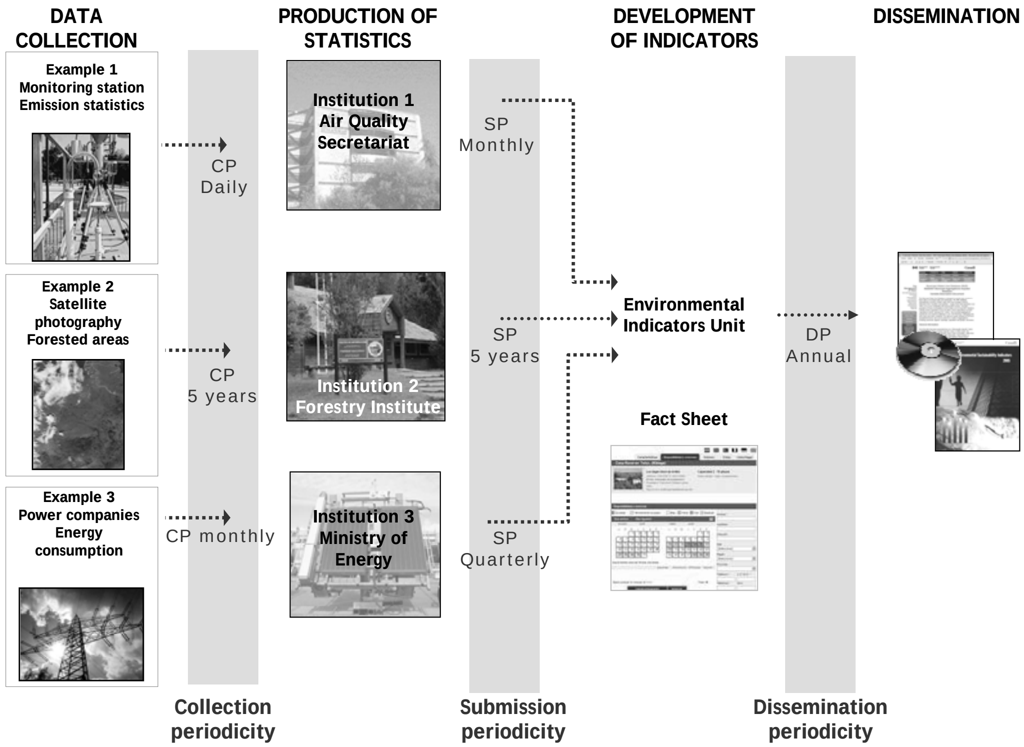
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
NV													
LHG													
VFI													

Source: Prepared by the author

Periodicity

As can be seen in figure 31, the periodicity with which data should be transmitted or delivered depends on the type of data or statistic. Therefore, three different periodicities (for collection, delivery to the EI Unit and dissemination) have been defined, since the distinctions are critical when it comes to determining the frequency and manner in which the data should flow and the indicators be updated.

FIGURE 31
FLOW OF DATA IN AN ENVIRONMENTAL INDICATORS SYSTEM



Source: Prepared by the author

2.9 Development of the Statistical Log

After the teams have finished building the first set of indicators, and on finishing each update, it is very important that they systematize and record every decision, change and addition, along with the reasons for each. In this way, the information will be available to those running or updating the system in the future (see table 11). The rotation of personnel makes it essential to have a permanent record of developments and progress in statistical systems of any sort, especially in the case of these indicators, which are intra- and inter-institutional products.

BOX 5
TOOL 5: STATISTICAL LOG

The final tool for the indicator-building process is the Statistical Log, in which every decision, change and addition is recorded, along with the reasons for it. The log should be organized by indicator, with a list of the variables, sources of information, steps for obtaining the information, units of measurement, updates, modifications and changes, in addition to other pertinent observations.

This Log should be filled out on a yearly basis, every time the System of Indicators is updated. There should be a column for modifications where any decisions made to change the variables, units of measurement or sources can be recorded, along with the reasons justifying them. That way, the process can be reviewed in the future and the work can be carried on with proper statistical consistency.

Source: Prepared by the author

TABLE 11
SAMPLE INDICATOR DEVELOPMENT LOG

Indicator	Variable	Source	Steps for obtaining information	Unit of Measure ment	Observations (updates, revisions, calculations …)	Differences from international official definition
Indicator 1 **Protected Areas (PA)**	1.1 Surface area of PAs	Protected Areas Directorate of Ministry of the Environment	Exploit official administrative records of PA Directorate	Hectares	Updated yearly	Includes all different categories of protection under national legislation
	1.2 Surface area of protected marine areas	Marine Authority	Exploit official administrative records of Marine Authority	Hectares	Updated yearly	Includes all different categories of protection under national legislation
	1.3 Total territorial area of country	Geographic Authority of the Territory	Fully available in digital format	Hectares	Updated yearly	Water surfaces have not been excluded from total surface area
Indicator 2 **Forest Cover**	2.1 Forested surface area	Ministry of Agriculture Directorate of Forestry	Satellite data must be processed every 5 years	Hectares	This variable will be updated every 5 years	Forests of scrub less than 1.5 m tall have not been excluded
	2.2 Natural forest surface area	Ministry of Agriculture, Biodiversity Protection Directorate	Satellite data must be processed every 5 years	Hectares	This variable will be updated every 5 years	_______

Source: Prepared by the author

2.10 Launch

Launch event, drafting of the guest list and announcement

A launch event must be held, and invitations extended to the principal authorities of the country, including but not limited to NSO and the environmental sector, ministries, regulatory bodies, the legislature, business organizations, non-governmental organizations, universities, and so on. Good press coverage (newspapers, radio, web and television) is essential to ensure that the whole nation is made aware of what is being published and of its importance and utility.

The announcement of the event should come from the head of the organization leading the development of the indicators. The event may later be co-sponsored by all the other contributing institutions, to give the event the political standing needed to attract the highest level authorities. It is important to try and gain the political support of fellow cabinet members, legislators and leaders of public opinion.

Obtaining political support at the highest level would also contribute to achieving a good level of attendance. Lastly, it is suggested that two or three people of ministerial rank be asked to say a few words about the importance of the indicators, after the formal presentation by chief executive of the lead institution.

Subsequently, seminars and workshops can be organized to raise awareness among users and give them the basic tools they need to make proper use of the EI over time. Whenever the institution responsible for the Environmental or Sustainable Development Indicators participates in an event, it is recommended that the Director of the NSO or the Minister of the Environment display the publication and emphasize that it is also available on the Internet. The heads of the other institutions involved in the indicator-building process can do the same.

Press coverage

It is worth noting that the broadest media coverage received by a similar initiative in the region was in Brazil. Brazil's Sustainable Development Indicators were given abundant press coverage, including two or more full pages devoted to analysis. What drew media attention was not the launching of the indicators, but the information they revealed, for example, about Amazon deforestation, solid waste, air pollution in Sao Paulo, or the swimmability of Rio's beaches.

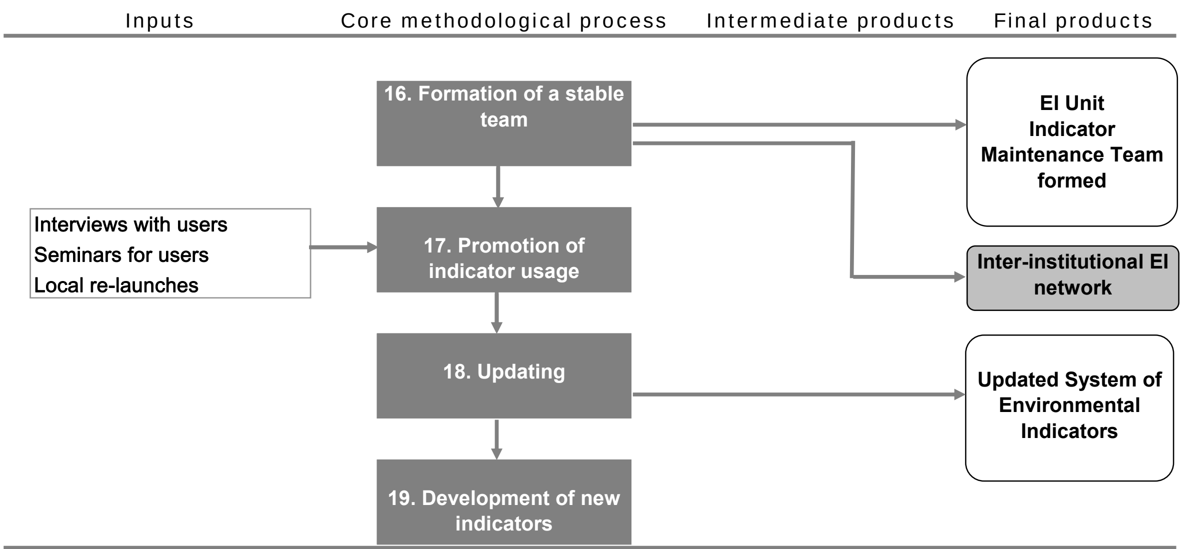
Press kits should be assembled, presenting the technical material in as clear and straightforward a manner as possible, to ensure that the information is assimilated by the media and circulated to the general public.

3. Stage 3: Institutionalization and updating of the System of Indicators

The purpose of this chapter is to present, in a concise and practical way, a method for a country to institutionalize a System of Environmental Indicators on a national scale. The method presented here is simplified in order to facilitate its application to country working programmes and activities.

The chapter discusses the fundamentals and mechanisms necessary to ensure the flow of data within and between institutions so that national EI can be developed and kept up to date. Ensuring a systematic flow of high quality data and environmental statistics is indispensable for calculating indicators and maintaining the system over time.

FIGURE 32
STAGE 3 PROCESS: INSTITUTIONALIZATION AND UPDATING



Source: Prepared by the author

The importance of institutionalizing the System of Environmental Indicators

The environment is such a complex, dynamic, multi-institutional and multidisciplinary field that building indicators to reflect the state of a country's environment and its trends is a tremendous collaborative challenge.

Forming human resource networks and formal institutional alliances to develop EI is one of the key elements to achieving the objectives in a shorter period of time. These networks can also be decisive to sustaining the System of Indicators over time, judging by the experience of some Latin American countries and of developed countries in general.

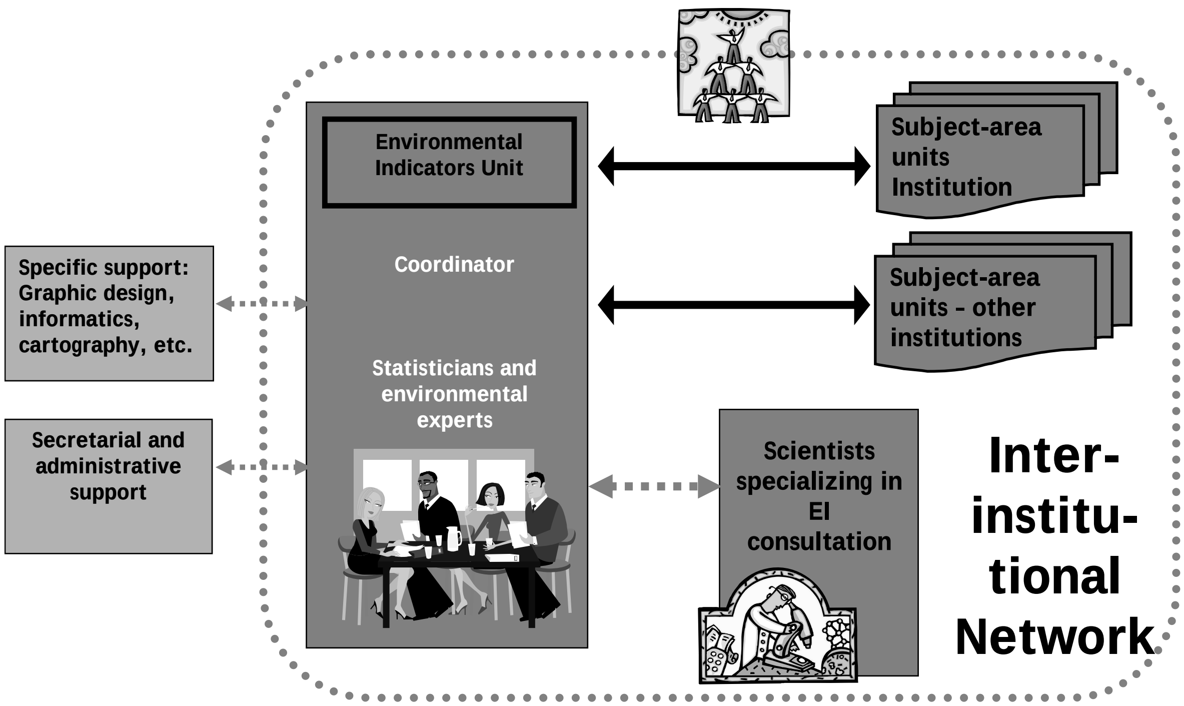
The proposal presented here has been developed on the basis of experience working with experts supporting various countries in the region, and of technical assistance provided by the Statistics and Economic Projections Division of ECLAC. These experiences have yielded important lessons about the most functional ways to work, which have been systematized below so that the teams responsible for maintaining the indicators can benefit from the lessons learned.

3.1 The formation of the Core Team

3.1.1 Organizational proposal for a Unit to implement and provide continuity to the system of Environmental Indicators

In order to carry out the task of implementing and progressively developing the priority EI that have been built, it is essential to have a Core Team. The Core Team should uphold the highest standards and thus validate the system's credibility with stakeholders. This Core Team will coordinate the National System of Environmental Indicators, maintaining constant contact and working in collaboration with personnel from other institutions.

FIGURE 33
ORGANIZATION OF ENVIRONMENTAL INDICATORS UNIT



Source: Prepared by the author
Note: In other similar institutions in Latin America and the Caribbean, a single unit is responsible for developing environmental statistics and indicators, which means that the functions of statistical work and producing indicators are carried out by the same entity.

Environmental Indicators Unit: Members

The EI Unit should have at least the following:

- A unit leader or coordinator that has the professional capacity to lead the task, to discover new opportunities for the development of indicators, to correct and refine the first indicators, and to engage in dialogue with and uphold the network of technical peers. Rather than a statistics specialist, this individual should be an environmental information specialist with proven managerial capabilities and the ability to lead a team as well as inter-institutional cooperation.
- Under the direction of the unit leader, professional statisticians provide support by processing tabulated data and graphs, and building and maintaining metadata. The team of statisticians can be made up of professionals or experts with training in statistics, geography, research, quantitative methods and related subjects. They must be well organized, diligent, rigorous and

motivated to work with data, graphs, maps and indicators. As the volume of work increases with time and with a growing number of indicators, it will be necessary to bring in new experts and form specialized groups according to subject areas or functions. It will also be necessary to rely on professional environmental specialists or specialists in environmental information with general training, who can generate the content for the indicator fact sheets, interpret trends, and consult with scientists specializing in each of the environmental components of the indicators.

- Specialized scientific advisers, who will collaborate specifically on the interpretation of indicators in each of the thematic fields covered by the indicators. These advisers usually work at universities and research centres, and it is recommended that experts in areas such as pollution, toxicology, soils, water, forestry, fishing, climate change, ozone, clean production, energy, and marine biology be included.
- Secretarial support to provide administrative assistance and enable the technical and professional personnel to dedicate time to their substantive tasks.

3.2 Promoting the use of the indicators

A strategy must be devised to promote the continued use of the indicators and to build on the effort put forth during the launch phase. In addition to keeping the human resource networks active, and constantly updating and disseminating the indicators, training activities, workshops and information seminars should be held:

- on the use of the indicators;
- to raise awareness of their usefulness;
- to teach users how to manipulate metadata at different levels of detail;
- to target groups (such as ministries, legislators or researchers) whenever possible; and
- to add new users at the highest levels, particularly those who can influence both the allocation of resources and political support.

3.3 Updating

Strategic elements to forge intra- and inter-institutional partnerships to facilitate the flow of data into the System of Environmental Indicators

EI are instruments that support public policies and are very useful tools for decision-makers in the various national institutions, in the executive branch (ministries, the administration, municipal governments, sectoral agencies), in the legislative branch, and among civil society leaders.

As has been noted previously however, the effort to produce a high quality, reliable result that can be sustained over time requires the active and genuine participation of individuals from different entities and institutions. This formalization and institutionalization process should begin during the indicator-building phase and should grow stronger over time so that it can lend adequate support to the System of Indicators. The country’s chief environmental and/or statistical authority should formalize the content and format of each institution’s involvement, by entering into agreements and maintaining ongoing written communication with counterparts in other ministries and political peers. Along the same lines, technical personnel should enlist and remain in constant contact with their peers in related institutions.

The methodological framework for the EI design and construction phase uses an inter-institutional collaboration approach. Likewise, the recommended strategies for forging inter-institutional alliances to guarantee the flow of data to the System of Indicators are based on the same approach of working in teams drawn from different units and institutions and from different disciplines. By working together in a systematic and organized fashion, teams can sustain the System of Indicators over the long term.

3.4 Fostering the network: general principles

1. Raising awareness at all levels in participating institutions: executive, technical and administrative

All levels of personnel participating in the effort must have a clear idea of the objectives, results and benefits of working together to build and maintain the System of Indicators, so that an effective ongoing commitment can be achieved. This implies sending appropriate messages and reminding groups and individuals of the importance of timely and systematic contributions, which in turn requires strong leadership in the unit or team in charge of the EI.

2. Communicating by telephone and e-mail, with written backup of all communications

Since time is one of the scarcest commodities in the participating institutions, it is very important to make use of the available electronic media to keep a record of the messages and data that are sent and received. These records should be filed appropriately, in digital form or hard copy. That will make it easier to keep track of processes, speed up the achievement of objectives that may be behind schedule, and facilitate continuity of the work when new personnel take over or are incorporated into the process.

Actual experience has shown that, although it is always a good idea to hold conversations by telephone and in person, it is also of vital importance that the communications be formalized and recorded. This is also true of data that are transmitted and tools that are in the process of being developed.

3. Developing methodological and orientation material for new participants who join the process

It is critical that the tools and methodological and instrumental materials of the System of Indicators be systematized and made available for the training of new participants joining the initiative. This will make it easier for newcomers to find their bearings.

4. Persevering during technical and executive personnel turnover

Personnel turnover is a common feature of institutional operations, and should not become a stress factor. On the contrary, remaining personnel should persevere with their collective efforts to build and refine the EI System, expressing appreciation for the contributions of newcomers and facilitating their work, particularly by revising the training process.

5. Permanent human resource networks and acknowledging inter-institutional collaboration and teamwork

No information system or process can work without human resource networks. For this reason, it is very important to capitalize on the organization and commitment of all participants. Great care should be taken to ensure transparency and explicit acknowledgement of every contribution. Immediate supervisors should be informed of staff contributions, which will keep the human resource network infused with enthusiasm and energy.

Although it may seem like a difficult task, motivating and recognizing one's co-workers ensures that the human resource network will continue supporting the collaborative process now and in the future. Any investment of time and effort given to nurturing and protecting this network will be extremely beneficial. Often it is possible to identify potential data and subject-matter expertise because of the technical and executive contacts made while participating in the human resource network engaged in maintaining the EI of each country.

6. Distributing the intermediate and final products and making them available to all participants so they benefit from the joint effort

All participants in the effort should have access to both intermediate and final products in a timely and transparent manner. However, the public and general users should only be given access to final products that have been reviewed and validated. In this way, those involved in the process can feel that they are partners in the effort and that the benefits are collective. Access to the information will reward them for all their work in the joint project. The team responsible for maintaining the indicators can certainly refine these principles over time to guide their daily decisions.

3.4.1 Intra-institutional coordination for internal data flow

Internal indicators are those whose constituent environmental statistics are to be found in the offices of the institution in charge, in a different format, and that must be structured and systematized ad hoc to feed into the process of generating national EI:

a. Indicators whose constituent variables originate from the lead institution's primary sources, that is, whose data are produced directly by that institution.

b. Cases where the institution in charge has compiled the data for other purposes and, in consequence, the data have already been recorded, independent of the existence of EI, such as indicators of PM_{10} contamination of the air in the capital city.

In both cases, a continuous process of intra-institutional coordination is required, based on the principles already outlined above, to ensure that the data flow, in the format and with the frequency required, to the office or team in charge of the maintenance and updating of the national EI.

At this point, the intra-institutional coordination to facilitate the flow of data to the EI Unit of the institution in charge of data management requires a combination of the following elements:

A. A constant effort to raise awareness of the institutional and cross-disciplinary importance of the System of Environmental Indicators, with the directors of the institution, and with repeated and explicit backing from the executive authority of the institution in charge of the indicators.

B. Continuous technical discussions with the technical teams in each subject-area unit responsible for developing and updating the indicator or indicators in question.

C. Since the full institutionalization of the System of Indicators requires the lead institution (and the contributing agencies) to establish an ongoing process, it is recommended that all verbal communication, both formal and informal, be backed up with written documentation sent to executive and technical personnel. These documents will describe and acknowledge the value of the specific contributions made by each subject-area unit in the institution, including the identification of variables, the frequency of sharing, the identification of the EI in question and its subject area. The recommendation to formalize communications in writing is a way of strengthening the institutionalization of the System of Indicators to provide formal support for recording the history of the process and lending it continuity. This will minimize the cost of personnel turnover and structural changes that are innate to any organization.

D. The above cannot be carried out if the work is not institutionalized, and a Unit given the exclusive responsibility for producing the EI must be seen by its peers and by the executive as a working area of the institution and not as a transitory project. In this regard, it also becomes part of the organizational structure.

3.4.2 Inter-institutional coordination for the flow of external data or data originating from other organizations collaborating with the institution in charge

External indicators are defined as those whose constituent data are produced, compiled and/or stored in the offices of institutions separate from the institution in charge. These indicators have been identified and transmitted to the System of Indicators, initiating and strengthening a process of inter-institutional cooperation in the field of environmental statistical data.

As these data are usually found in any format, they need to be structured and systematized ad hoc in order to guarantee their flow to the EI Unit. Thus, the EI Unit must develop a form or sheet (which could be an Excel worksheet) to continue the periodic collating of these data, and to send the time series held in the database to update the data from the source.

There are two types of data originating from sources external to the institution in charge:

1. Data originating from primary sources in other institutions, data directly produced by these institutions which can be found in their archives as microdata, databases from polls and censuses, administrative records, monitoring reports and unstructured and unpublished data. This raw material needs to be systematized and structured if it is to be used as an EI input. To do so, the data must be classified and validated and there should be a pre-established format and periodicity for the transfer of such data to the EI Unit.

2. Data produced by other institutions, which are accessible to the public, and which contribute to the System of Indicators. Such data must flow from these institutions to the EI Unit in a pre-established format and periodicity, ideally via a previously formatted, digital medium. For example, data on energy production and consumption, and data on GDP, the former produced by the Ministry of Finance and the latter by the system of national accounts, are both eventually compiled and published by the national statistical office, and are used to calculate an Indicator of Energy Intensity of GDP.

At this point, inter-institutional coordination to ensure the flow of data from other institutions contributing to the System of Indicators requires a combination of the following elements:

A. A constant effort to raise awareness of the importance of the System of Indicators as information of national significance for decision-making and public knowledge. These awareness-raising activities, which could ideally extend to user training, should include the political leaders or directors of the various institutions participating (or potentially participating) in the System. They should also receive the explicit continuous support of the country's top statistical or environmental authority.

B. Ongoing discussions with the technical teams in each subject-area unit of the collaborating institutions. Without the decisive collaboration of these teams, continuous maintenance of the System of Indicators would be impossible. In this regard, it is of the utmost importance that these contributions to the maintenance of the System of Indicators be explicitly acknowledged and, where possible, recognition and credit for technical experts' work be made public. This will make it possible for them to identify with and remain committed to the System of Indicators for the long term.

C. This strategy requires the full institutionalization of the System of Indicators as a permanent function of the lead institution. A Unit within the lead institution should be given exclusive responsibility for this matter so that it will be recognized by participants in other institutions and by its own leaders as a permanent task of the institution, not a temporary project. In this regard, it also becomes part of the organizational structure

D. In this case, it is even more important to back up all verbal communication, both formal and informal, with notes sent to executive as well as technical personnel. This written backup should include a description and recognition of the specific contributions made by each subject-area unit in the participating institutions.

E. Keeping formal written records is documented in the processes of institutional strengthening for the System of Indicators to minimize the cost of staff turnover and organizational change that are endemic to all organizations.

3.5 Products resulting from the indicator-building process

The final list of indicators, with their respective Methodological Sheets fully developed is the heart of the System of Indicators.

FIGURE 34
LIST OF FINAL INDICATORS WITH METHODOLOGICAL SHEET

INDICATORS – FORESTRY RESOURCES
7-1 Change in soil usage in forested areas
7-2 Production of timber and other forestry products
7-3 Forest fires and surface area affected
7-4 Surface area affected by forest pests
7.5 Timber confiscated upon inspection
7-6 Surface area of forests and jungles
7-7 Harvestable stock in forests and jungles
7-8 Surface area of commercial timber planted, verified and paid for
7-9 Surface area covered by sustainable forestry management
7-10 Surface area treated for pests
7-11 Reforested surface area
7-12 Forestry inspections, operations and resolutions

INDICATORS – HAZARDOUS WASTE
5-1 Physical volume of manufacturing and mining production
5-2 Intensity and volume of hazardous waste production
5-3 Locations polluted with hazardous waste
5-4 Installed capacity for handling hazardous waste
5-5 Hazarous waste locations cleaned up or being cleaned up
5-6 Compliance with hazardous waste regulations
5-7 Environmental audits
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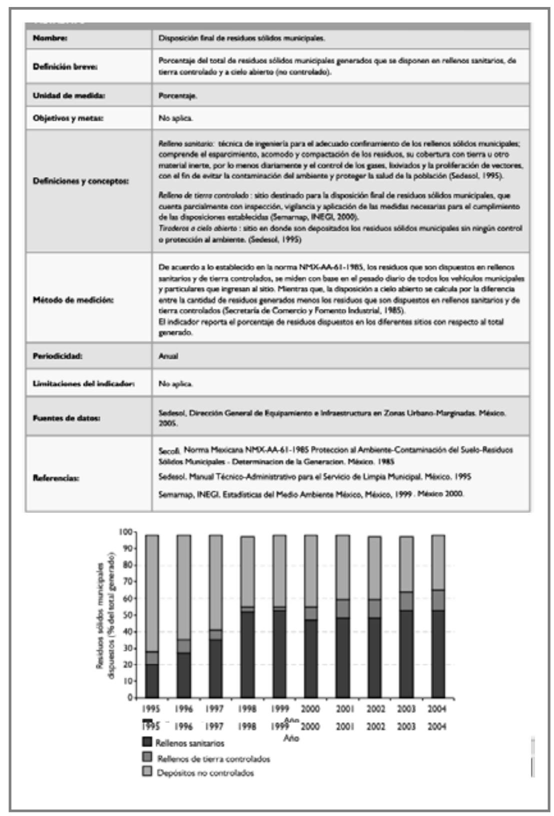
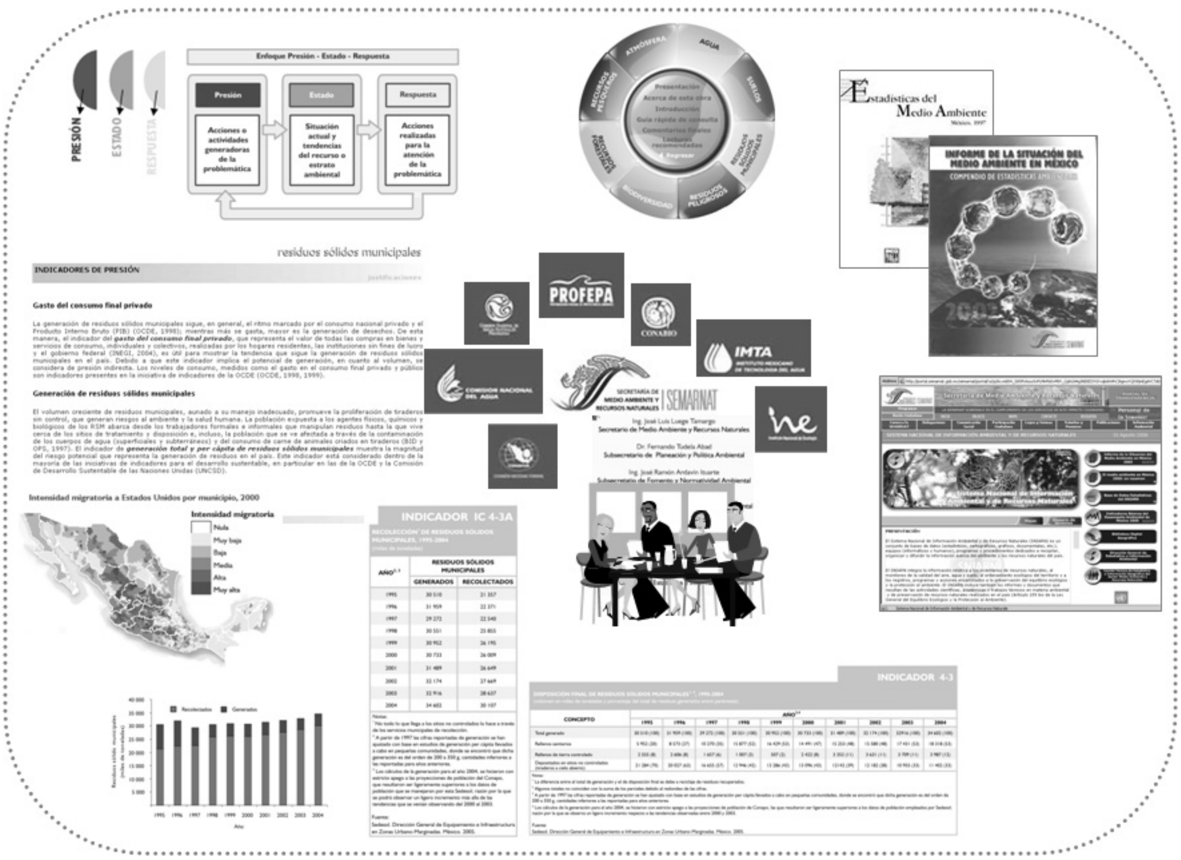


Nombre:	Disposición final de residuos sólidos municipales.
Definición breve:	Porcentaje del total de residuos sólidos municipales generados que se disponen en rellenos sanitarios, de tierra controlado y a cielo abierto (no controlado).
Unidad de medida:	Porcentaje.
Objetivos y metas:	No aplica.
Definiciones y conceptos:	*Relleno sanitario:* técnica de ingeniería para el adecuado confinamiento de los rellenos sólidos municipales; comprende el esparcimiento, acomodo y compactación de los residuos, su cobertura con tierra u otro material inerte, por lo menos diariamente y el control de los gases, lixiviados y la proliferación de vectores, con el fin de evitar la contaminación del ambiente y proteger la salud de la población (Sedesol, 1995). *Relleno de tierra controlado* : sitio destinado para la disposición final de residuos sólidos municipales, que cuenta parcialmente con inspección, vigilancia y aplicación de las medidas necesarias para el cumplimiento de las disposiciones establecidas (Semarnap, INEGI, 2000). *Tiraderos a cielo abierto* : sitio en donde son depositados los residuos sólidos municipales sin ningún control o protección al ambiente. (Sedesol, 1995)
Método de medición:	De acuerdo a lo establecido en la norma NMX-AA-61-1985, los residuos que son dispuestos en rellenos sanitarios y de tierra controlados, se miden con base en el pesado diario de todos los vehículos municipales y particulares que ingresan al sitio. Mientras que, la disposición a cielo abierto se calcula por la diferencia entre la cantidad de residuos generados menos los residuos que son dispuestos en rellenos sanitarios y de tierra controlados (Secretaría de Comercio y Fomento Industrial, 1985). El indicador reporta el porcentaje de residuos dispuestos en los diferentes sitios con respecto al total generado.
Periodicidad:	Anual
Limitaciones del indicador:	No aplica.
Fuentes de datos:	Sedesol, Dirección General de Equipamiento e Infraestructura en Zonas Urbano-Marginadas. México. 2005.
Referencias:	Secofi. Norma Mexicana NMX-AA-61-1985 Proteccion al Ambiente-Contaminación del Suelo-Residuos Sólidos Municipales - Determinacion de la Generacion. México. 1985 Sedesol. Manual Técnico-Administrativo para el Servicio de Limpia Municipal. México. 1995 Semarnap, INEGI. Estadísticas del Medio Ambiente México, México, 1999 . México 2000.

Source: Prepared by the author

An additional product of the process described above is the construction of a true System of Environmental or Sustainable Development Indicators. Ideally, this System should be strengthened institutionally and inter-institutionally on a periodic basis, in keeping with each country's circumstances and capacities. The System of Indicators is a formal, routine process involving institutions, individuals and social and inter-institutional networks. It also includes transfer processes, the validation and development of statistics and indicators, and processes for the analytical and systematic development of products over time.

FIGURE 35
SYSTEM OF ENVIRONMENTAL INDICATORS



Source: Prepared by the author

The development of environmental statistical products through a system such as the one described here is still a tremendous challenge for LAC countries. Mexico, which has made the most progress in this area in the region, exemplifies the process. In fact, as described in the region's specialized literature, moving from the ad hoc production of environmental statistical products (such as statistical compendiums, indicators, accounts, and so on) to their systematic and habitual production has now become the driving force in the urgent task of producing quality environmental information.

Another equally important product is the creation of social and inter-institutional linkages which must continue to collaborate on future updates and expansions of the System of Indicators. This network must be formally institutionalized and adapted to the characteristics of each country and continually motivated and invited to undertake other projects subsequent to the development of the first collection of national EI. In this way, the resulting human and institutional capital can be maintained and, ultimately, strengthened.

Glossary

Carbon Intensity or Footprint: is a "measure of carbon the impact that human activities have on the environment in terms of the amount of greenhouse gases produced, measured in units of carbon dioxide". These gases are produced by the burning of fossil fuels for our everyday living. (Source:UNEP, Climate Neutral Network www.unep.org/climateneutral).

Census: a survey conducted on the full set of observation objects belonging to a given population. It addresses demographic, economic and social issues.

Data: information, usually numerical that are observed, recorded or estimated for a given variable at a certain point in space and time. Data may be collected or measured on-site or may be produced from some other form of monitoring or observation.

Ecological footprint: the Ecological Footprint measures the amount of biologically productive land and sea area an individual, a region, all of humanity, or a human activity requires to produce the resources it consumes and absorb the waste it generates, and compares this measurement to how much land and sea area is available.

Biologically productive land and sea includes area that 1) supports human demand for food, fiber, timber, energy and space for infrastructure and 2) absorbs the waste products from the human economy. Biologically productive areas include cropland, forest and fishing grounds, and do not include deserts, glaciers and the open ocean. Source: Global Footprint Network www.footprintnetwork.org

Environmental accounts: The System of Integrated Environmental and Economic Accounting is a satellite system of the System of National Accounts. It brings together economic and environmental information in a common framework to measure the contribution of the environment to the economy and the impact of the economy on the environment. It provides policy-makers with indicators and descriptive statistics to monitor these interactions as well as a database for strategic planning and policy analysis to identify more sustainable paths of development.

Environmental indicators: parameter, or a value derived from parameters, that points to, provides information about and/or describes the state of the environment, and has a significance extending beyond that directly associated with any given parametric value. The term may encompass indicators of environmental pressures, conditions and responses. (UN, 1997)

Environmental statistics: describe the state and trends of the environment, covering the media of the natural environment (air/climate, water, land/soil), the biota within the media, and human settlements. Environment statistics are integrative in nature, measuring human activities and natural events that affect the environment, the impacts of these activities and events, social responses to environmental impacts, and the quality and availability of natural assest. Broad definitions include environmental indicators, indices and accounting (UN, 1997).

Index: A ratio or other number derived from a series of observations and used as comparative indicator (UNECE, 2000)

Composite statistical indicator: A set of elementary statistical indicators related to a given phenomenon or process or one of their aspects, described by one and only one category of statistical methodology. At least one of the attributes of a composite indicator has more than one occurrence (set, vector, matrix) (UNECE, 2000)

Index of Sustainable Economic Welfare (ISEW): It is an index developed by Daly and Cobb (¨For The Common Good¨, 1989). Measure of broadly defined economic welfare. It applies a number of adjustments to personal consumption adding desirable services such as household production and subtracting regrettable expenditures, for example, for commuting, automobile accidents, and water, air soil, and noise pollution and other welfare losses, for example, from unemployment (UN, 1997)

Statistical Indicator: A data element that represents statistical data for a specified time, place, and other characteristics (OECD Glossary). Every indicator is a statistic, but it is a special kind of statistic in that it clarifies meaning and presents selected, contextualized information so that users can quickly grasp the information it contains. Indicators are often produced by processing statistical series as aggregations, proportions, growth rates or other forms in order to show the current state of a phenomenon that is being monitored, its development over time, or trends that can be identified. Indicators are developed for a purpose, and must be carefully calibrated on the basis of criteria such as the availability and quality of information, the relevance of the indicator, and the indicator's contribution to the System of Indicators.

Information: data processed in a meaningful way so that it can be used in current and future decision-making, and makes it possible to reduce uncertainty and strengthen decisions.

Knowledge: the final step leading to raw information, through which data and background information are processed according to previously established needs and criteria. Knowledge adds structure and context to information.

Metadata: description of statistical information, including definition, sources, methods of calculation, and periodicity. Are presented on Methodological Sheets or Data Sheets.

Microdata: set of observations compiled into a statistical unit as information is being collected. Microdata are the minimum statistical unit and make up the raw material with which statistical series will be built. Users generally do not have access to microdata.

Monitoring systems: measurement processes in different locations or facilities, by means of instruments calibrated for the measurement of the quality and quantity of different environmental variables (concentration pollutants in water, air, and so on).

Natural capital: an extension of the economic notion of capital (manufactured means of production) to environmental 'goods and services'. It refers to natural assets in their role of providing resources inputs and environmental services for economic production for example a stock (e.g., a forest) which produces a flow of goods (e.g., new trees) and services (e.g., carbon sequestration, erosion control, habitat). (EEA Glossary, and UN 1997).

Remote sensing: the process of producing information about an object from a distance This usually refers to images from satellite sensors or aerial photographs.

Statistic: the measure, value or specific result of a variable at a given point in time and space. Statistics are the result of the collection of data and the validation, structuring and description of the data in accordance with the country's official statistical procedures.

Strong sustainability: all forms of capital must be maintained intact independent of one another. The implicit assumption is that different forms of capital are mainly complementary; that is, all forms are generally necessary for any form to be of value. Produced capital used in harvesting and processing timber, for example, is of no value in the absence of stocks of timber to harvest. Only by maintaining both natural and produced capital stocks intact can non-declining income be assured. (OECD, Glossary.)

Survey: investigation about the characteristics of a given population by means of collecting data from a sample of that population and estimating their characteristics through the systematic use of statistical methodology (OECD, Glossary).

Sustainable development: development that meets the needs of the present without compromising the ability of future generations to meet their own needs. (UNEP, Glossary Term). Sustainable Development usually involves the simultaneous consideration of four component dimensions of the development process: environmental, economic, social and institutional.

Sustainable development indicators: attempt to show economic, social and environmental dynamics and their interrelationships. To date, however, Sustainable Development Indicators produced around the world and in the region assemble collections of the main economic, social and environmental indicators, and do not integrate them or describe their interrelationships adequately.

Weak sustainability: all forms of capital are more or less substitutes for one another; no regard has to be given to the composition of the stock of capital. Weak sustainability allows for the depletion or degradation of natural resources, so long as such depletion is offset by increases in the stocks of other forms of capital (for example, by investing royalties from depleting mineral reserves in factories). OCDE, Glossary

Variable: Attribute or part of a phenomenon that changes its value over time or across space.

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Glossary on line:

Environmental European Agency (EEA), Glossary, http://glossary.eea.europa.eu/

Global Footprint Network, www.footprintnetwork.org

United Nations Environment Programme (UNEP),Glossary term.
www.unep.org/dec/onlinemanual/Resources/Glossary/Tabid/69Default.aspx

United Nations Environment Programme (UNEP), Climate Neutral Network
www.unep.org/climateneutral

Organisations for Economic Co-operation and Development (OECD), Glossary of Statistical Terms, http://stats.oecd.org/glossary/

Annexes

Annex 1

Methodological Sheet with description of fields

Name of Indicator	Select a clear, concise and user-friendly name ("Energy intensity of production") that explains exactly what the Indicator shows.
Brief description of Indicator	Provide a brief description of what the Indicator shows, especially when the Indicator has a highly scientific or technical name. Use clear, simple language that informs the user about the Indicator in question.
Relevance or pertinence of the Indicator	Specify the importance of the proposed Indicator in evaluating the environment or sustainability. Essentially, try to connect the Indicator with the challenges and issues of sustainability in the specific area to be covered. This implies defining the variable or variables that make up the Indicator, linking them to environmental or sustainable development issues that the user can understand.
Graph or diagram with trend phrase	Provide a visual representation of the Indicator, ideally in the form of a graph. Frequently, unforeseen errors and strengths are identified from the analysis of graphs (more so than from tables). Try different types or layouts of graphs until the optimal result is achieved for what the Indicator is attempting to demonstrate. Develop a trend phrase that describes the Indicator and/or the graph.
Tendencies and challenges	Beneath the graph, summarize briefly the implications and challenges arising from the behaviour of the Indicator.
Trends	Interpret the changes (increases or decreases) in the value of the Indicator in the context of environmental sustainability or sustainable development.
Scope (what the Indicator measures)	Specify the dynamics that the Indicator captures or measures.
Limitations (what the Indicator does not measure)	Clarify what dimensions and dynamics cannot be captured or visualised by the Indicator.
Formula for calculating the Indicator	Specify the operations and procedures for the variables that are required to obtain the value of the Indicator at each point of capture (territorial, historical, and so on). The unit of measurement in which the Indicator is expressed must be clearly stipulated.
Definition of the variables that conform the Indicator	Define in detail each of the variables that conform the Indicator. One common practice is to adopt the definition used by the institution producing the data, for example, "The concept of fragmentation of the ecosystem of the Institute of Biodiversity Conservation of the Ministry X has been used."
Coverage or scale of the Indicator	The coverage of the Indicator can encompass or combine different scales; this must be clearly specified and, at the same time, the coverage of the constituent variables taken into consideration. Examples include: community, province, district, ecoregion, river basin, national territory.
Source of the data	Stipulate the data source for each of the variables in detail: indicate not only the institution but also the department and office, and/or the publication where the data are available (if appropriate) and the name and contact information for the person in charge.
Method of collection or capture of data	Describe the method by which the basic data are captured or generated. In general, these include surveys, censuses, administrative records, monitoring stations and so on.
Availability of the data	Refer to the availability of data in terms of the ease or difficulty of systematic access to

(qualitative)	the data, beyond that which is formally produced. For example, this may mean, "Easily available in hard copy or electronic format," or "Restricted availability to public institutions," or "Primary data available in Household Surveys, but requires subsequent processing to generate the required information," or "Restricted information."
Periodicity of the data	Specify the frequency of update for each of the component variables of the Indicator. This is understood to be the period of time between successive updates of the data. For example, "Every four years," "Annually", "Bi-monthly" and so on. Specify where appropriate the frequency of collection, recording and publication of the data.
Period of the time series currently available	Specify the time period for which the time series is currently available, for example, "Period from 1987 to 2000."
Frequency of update of the Indicator	Provide a recommendation by the group on how often it is possible to recalculate the Indicator to update its value.
Relationship to regional initiatives such as: BDEIMA, ILAC, ODM7 and others (specify).	Indicate the relationship existing with reports or requests for information from regional or global initiatives such as the Environmental Indicators and Statistics Database (BADEIMA) (ECLAC), the Latin American and Caribbean Initiative for Sustainable Development (ILAC) (United Nations Environment Programme), ODM7, DENU and others (specify).
Relationship of the Indicator to political objectives, norms, or environmental or sustainable development goals in Latin America and the Caribbean	Specify if there are policies, goals, quality norms or base lines relevant to the Indicator, with respect to which progress through time or in different areas may be assessed.
Data table	The statistical data on which the Indicator is calculated enable a deeper analysis of the Indicator, and an exploration of the optimal visual representation. Include an Excel spreadsheet with the time series required to calculate the Indicator.

Source: Prepared by the author

Annex 2

Examples of completed Methodological Sheets

ENVIRONMENTAL INDICATORS OF PANAMA

1. FORESTS AND BIODIVERSITY

Indicator 1.1.

Name	Forest cover of the territory
Brief definition	This Indicator shows the proportion of national territory that is coverd by forest, by province and district.
Unit of measurement	Percentage
Method of calculation	In order to calculate the above Indicator, data are required on the total surface area under forest cover in square kilometres for each province and district. Once this data has been obtained, the total surface area under forest cover in the provinces and shires is divided by the total national territory. The result is the proportion of forest cover in the country for a specific year. TSAF=Total surface area under forest cover TSAN=Total surface area of national territory n=Number of province or district then Sum (TSAFi /TSAN) *100% (for values of i from i=1 to i=n)
Frequency	Every five years
Limitations of the Indicator	Does not show specific activites related to changes in land use that affect forest cover, such as: seasonal agriculture, aquaculture, fisheries. Does not include the causes and efffects of changes in forest cover. Primary data (satellite images) require updating to calculate the Indicator
Data sources	National Environmental Authority. Project on "Institutional Strengthening of the System of Geographic Information of the ANAM for the evaluation and monitoring of Forestry Resources in Panama in the context of Sustainable Management,"OIMT/ANAM Project, Panama, 2003.

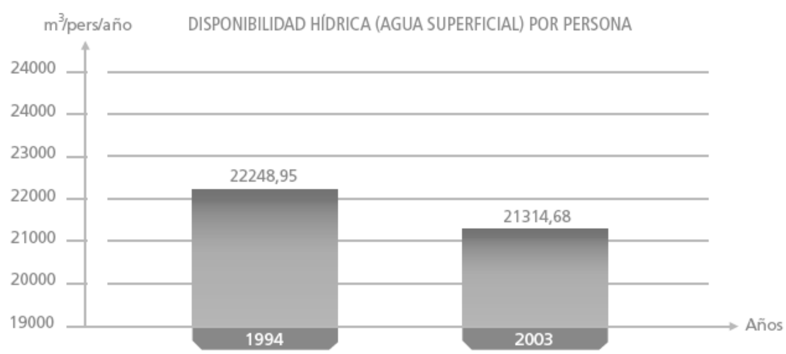
METADATA

Source: National Environmental Authority (2006). “Indicadores Ambientales de la República de Panamá, 2006”. Republic of Panama.

SYSTEM OF SUSTAINABLE DEVELOPMENT INDICATORS OF ARGENTINA, 2005

DISPONIBILIDAD HÍDRICA (AGUA SUPERFICIAL) POR PERSONA

Descripción Corta del Indicador	Mide la disponibilidad de agua superficial por persona en un período de tiempo determinado.
Pertinencia del Indicador para el Desarrollo Sostenible	El indicador mide la disponibilidad de agua por persona e indica el nivel de sustentabilidad del recurso para un país. Valores debajo de 1000 indican "stress hídrico", entre 1000 y 2000 situación crítica y mayores de 2000 indican un umbral para el desarrollo sustentable. Se conoce como el Indicador de Falkenmark.
Relevancia para la Toma de Decisiones	Establece la disponibilidad del recurso con objeto de sustentar políticas de manejo y gestión, depende de la cantidad del recurso hídrico, pero también de la tasa de crecimiento poblacional.



Fuente: Estadística Hidrológica de la República Argentina (Edición 2004) de la Subsecretaría de Recursos Hídricos.

Descripción

El agua es un elemento clave para la vida y el desarrollo del país. Uno de los principales problemas que enfrenta la Argentina es su desigual distribución espacial y temporal, así como la degradación de las fuentes de agua dulce como consecuencia de la actividad humana y los conflictos que se generan entre las zonas urbanas, industriales y agrícolas. El desafío para la gestión integrada de los recursos hídricos es establecer políticas de manejo sustentadas en una legislación apropiada para el uso sostenible del recurso.
Las variaciones que muestran los gráficos anteriores corresponden a las fluctuaciones de las precipitaciones entre los años 1994 y 2003, así como al crecimiento de la población.

Source: Secretariat of the Environment and Sustainable Development, Ministry of Health and Environment of the Nation (2005). "Sistema de Indicadores sobre Desarrollo Sostenible República de Argentina", Argentina.

SUSTAINABLE DEVELOPMENT INDICATORS OF BRAZIL, 2004

7 Desflorestamento na Amazônia Legal

Expressa a perda estimada de cobertura florestal no território compreendido pela Amazônia Legal e as relações entre o desmatamento e as áreas florestais remanescentes.

Descrição

As variáveis utilizadas são a área total desflorestada, compreendida na categoria desflorestamento bruto, computada no mês de agosto de cada ano, e as áreas florestadas remanescentes.

O indicador é composto por dois valores distintos, que devem ser considerados de forma associada. O primeiro valor é a área total desflorestada acumulada, chamada de desflorestamento bruto acumulado, expresso em km². O segundo valor é a taxa de desflorestamento bruto anual, constituída pela razão, em percentual, entre a área desflorestada anualmente (km²/ano) e a área florestal remanescente. A área desflorestada anualmente foi obtida pela diferença entre o desflorestamento bruto acumulado em dois períodos consecutivos.

A fonte utilizada para este indicador é o Instituto Nacional de Pesquisas Espaciais – INPE, a partir de informações oriundas do Programa de Avaliação do Desflorestamento na Amazônia – PRODES.

Justificativa

A Floresta Amazônica é um dos principais biomas predominantemente florestais do território brasileiro. Em termos mundiais, é a maior floresta tropical existente, correspondendo a 1/3 das reservas de florestas tropicais úmidas. Abriga grande número de espécies vegetais e animais, muitas delas endêmicas. Com um patrimônio mineral ainda em parte desconhecido, estima-se que a Floresta Amazônica detém a mais elevada biodiversidade, o maior banco genético do mundo e 1/5 da disponibilidade mundial de água potável.

Quatro milhões de km² da Amazônia brasileira estão associados a uma cobertura com fisionomia florestal primária. A área total desflorestada na Amazônia é da ordem de 15% da área total. O processo de desflorestamento acentuou-se nas últimas quatro décadas, concentrado nas bordas sul e leste da Amazônia Legal (Arco do Desflorestamento). Algumas formações vegetais características desta região já estão sob risco de desaparecimento. O desflorestamento é realizado, majoritariamente, para a formação de pastos e áreas agrícolas, decorrendo também da extração predatória de madeira.

Este indicador é útil para a avaliação do avanço das atividades agrosilvipastoris, e da ocupação antrópica em geral, nas áreas recobertas por florestas no norte do Brasil.

Comentários

As áreas desflorestadas foram obtidas a partir da análise comparativa de imagens de satélite (LandSat TM) tomadas em dois períodos consecutivos. Esta metodologia de análise detecta as áreas que foram completamente desflorestadas, excluídas aquelas submetidas à extração seletiva de madeiras – que não estão computadas, portanto, nos valores apresentados pelo indicador.

O projeto utiliza imagens LandSat em composição colorida na escala 1:250.000, que permite a identificação de desflorestamentos maiores que 6,25 ha.

A utilização da categoria de desflorestamento bruto traz implicações tanto no cômputo da área total desflorestada, quanto no cálculo das taxas de desflorestamento, pois considera o desflorestamento de florestas primárias e secundárias. As florestas secundárias são o resultado da recomposição natural de uma área anteriormente desflorestada. Seu desflorestamento representa, no mínimo, uma segunda derrubada da floresta numa mesma área.

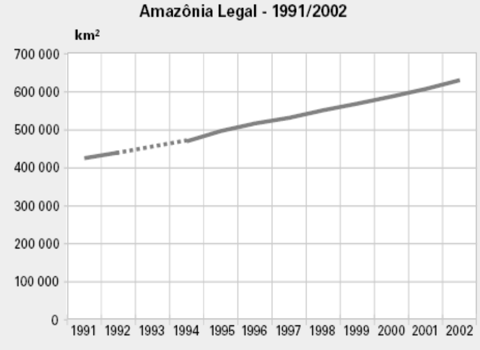
As taxas de desflorestamento bruto aqui apresentadas, quando comparadas com aquelas anteriormente divulgadas na publicação *Indicadores de desenvolvimento sustentável: Brasil 2002*, são diferentes, pois os valores foram recalculados pelo INPE. O objetivo foi corrigir as imprecisões acumuladas ao longo dos anos devido a arredondamentos numéricos. No processo de revisão dos cálculos, foi detectado que, no caso específico do Estado do Maranhão, as taxas percentuais do desflorestamento bruto para os períodos 1994-1995 e 1995-1996 haviam sido erroneamente calculadas. Essas taxas, para esses anos, foram alteradas para assegurar a consistência da série histórica.

Também foi modificada a metodologia de análise das imagens de satélite, com a substituição da interpretação visual das mesmas pelo processamento digital.

Indicadores relacionados

03 - Uso de fertilizantes
04 - Uso de agrotóxicos
05 - Terras em uso agrossilvipastoril
06 - Queimadas e incêndios florestais
14 - Espécies extintas e ameaçadas de extinção
15 - Áreas protegidas
17 - Espécies invasoras
35 - Doenças relacionadas ao saneamento ambiental inadequado
42 - Produto interno bruto *per capita*
54 - Ratificação de acordos globais
56 - Gastos com pesquisa e desenvolvimento
57 - Gasto público com proteção ao meio ambiente

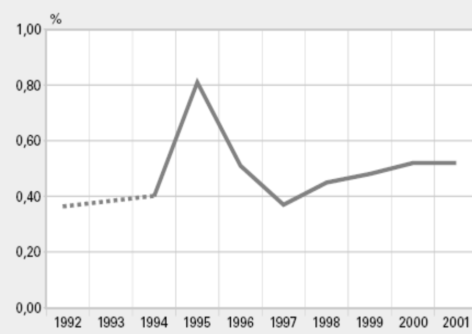
Gráfico 11 - Desflorestamento bruto acumulado na Amazônia Legal - 1991/2002



Fonte: Ministério da Ciência e Tecnologia, Instituto Nacional de Pesquisas Espaciais - INPE, Programa de Avaliação do Desflorestamento da Amazônia Legal - PRODES.

Nota: Para os anos de 1992 a 1994, o incremento anual da área desflorestada foi calculado como a média simples do desflorestamento total do período.

Gráfico 12- Taxa de desflorestamento bruto anual em relação à área de floresta remanescente na Amazônia Legal - 1992/2001



Fonte: Ministério da Ciência e Tecnologia, Instituto Nacional de Pesquisas Espaciais - INPE, Programa de Avaliação do Desflorestamento da Amazônia Legal - PRODES.

Nota: Para o período 1992-1994 o valor corresponde à taxa média.

SUSTAINABLE DEVELOPMENT INDICATORS OF BRAZIL, 2004 (CONTINUED)

Tabela 14 - Desflorestamento bruto acumulado na Amazônia Legal, segundo as Unidades da Federação - 1992/2002

Unidades da Federação	Desflorestamento bruto acumulado na Amazônia Legal (km²)									
	1992	1994	1995	1996	1997	1998	1999	2000	2001	2002
Total	**440 186**	**469 978**	**497 055**	**517 069**	**532 086**	**551 782**	**569 269**	**587 727**	**607 957**	**631 223**
Rondônia	36 865	42 055	46 152	48 648	50 529	53 275	55 274	58 143	60 696	64 301
Acre	11 100	12 064	13 306	13 742	14 203	14 714	15 136	15 767	16 200	16 927
Amazonas	23 999	24 739	26 629	27 434	28 140	28 866	29 616	30 322	31 250	32 266
Roraima	4 481	4 961	5 124	5 361	5 563	5 791	6 112	6 386	7 266	7 320
Pará	151 787	160 355	169 007	176 138	181 225	188 372	194 619	200 118	207 041	215 738
Amapá	1 736	1 736	1 782	1 782	1 846	1 962	1 963	1 963	2 318	2 318
Tocantins	23 809	24 475	25 142	25 483	25 768	26 404	26 613	26 842	26 996	27 255
Maranhão	95 235	95 979	97 761	99 338	99 789	100 590	102 326	104 256	105 581	106 911
Mato Grosso	91 174	103 614	112 150	119 141	125 023	131 808	137 610	143 930	150 609	158 187

Fonte: Ministério da Ciência e Tecnologia, Instituto Nacional de Pesquisas Espaciais - INPE, Programa de Avaliação do Desflorestamento da Amazônia Legal - PRODES.

Notas: 1. Dados referentes a 1° de agosto de cada ano.
2. Para o ano de 2003 as estimativas preliminares, baseadas nas 80 imagens LANDSAT que historicamente concentram 90% do desmatamento na Amazônia Legal, indicam uma área de desflorestamento bruto anual de 23 750 km². No total, 223 imagens LANDSAT cobrem a Amazônia Legal.

Tabela 15 - Taxas estimadas de desflorestamento bruto anual em relação à área de floresta remanescente da Amazônia Legal, segundo as Unidades da Federação - 1991/2001

Unidades da Federação	Taxas estimadas de desflorestamento bruto anual em relação à area de floresta remanescente da Amazônia Legal (%)								
	1991/1992	1992/1994 (1)	1994/1995	1995/1996	1996/1997	1997/1998	1998/1999	1999/2000	2000/2001
Total	**0,38**	**0,41**	**0,80**	**0,51**	**0,37**	**0,51**	**0,49**	**0,52**	**0,52**
Rondônia	1,25	1,43	2,62	1,38	1,14	1,65	1,39	1,47	1,62
Acre	0,28	0,34	0,86	0,31	0,26	0,39	0,32	0,40	0,31
Amazonas	0,05	0,03	0,14	0,07	0,04	0,05	0,05	0,04	0,04
Roraima	0,17	0,15	0,13	0,13	0,11	0,14	0,13	0,15	0,22
Pará	0,38	0,43	0,80	0,63	0,43	0,60	0,53	0,70	0,55
Amapá	0,03	-	0,01	-	0,02	0,03	-	-	0,01
Tocantins	1,15	0,95	2,31	0,95	0,82	1,75	0,67	0,76	0,59
Maranhão	1,07	0,36	1,68	1,05	0,41	1,03	1,26	1,11	1,89
Mato Grosso	1,06	1,42	2,42	1,55	1,27	1,59	1,74	1,61	1,96

Fonte: Ministério da Ciência e Tecnologia, Instituto Nacional de Pesquisas Espaciais - INPE, Programa de Avaliação do Desflorestamento da Amazônia Legal - PRODES.

Nota: Para os períodos de 2001-2002 e de 2002-2003 ainda não foram calculadas as taxas de desflorestamento bruto anual percentual.

(1) Para o período 1992-1994 o valor corresponde à taxa média.

Source: Brazil 2004 Sustainable Development Indicators (IBGE-MMA, 2004)

ENVIRONMENTAL INDICATORS OF CHILE, NATIONAL ENVIRONMENT COMMISSION (CONAMA)

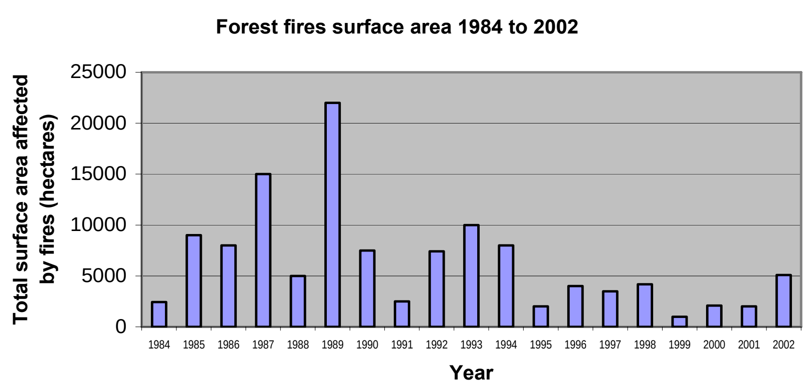
[illegible]	[illegible]
PES (Priority environmental situation)	Loss of forestry resources and ecosystems
Type	Specific Regional
Regions	V^{th} Region
Environmental category	Ecological Support
Category of information	Impact
Description	Surface area burned annually due to the incidence of forest fires
Interest	Forest fires are a relevant cause of loss of forest cover, the permanence of which is linked to an important part of the natural resources of the region. The indicator is frequently questioned for two basic reasons. The first objection is that fires do not always produce loss of natural resources and, in fact, may constitute a natural mechanism for the rejuvenation of ecosystems. Secondly, fires are not always anthropic in origin. However, these habitual objections seem more suited to its use as an indicator of loss of biodiversity (the first objection) and of environmental pressure anthropic in origin (the second objection). According to national statistics, almost all forest fires are anthropic in origin, so this indicator is directly related to the pressure of society on this natural resource. At the same time, it demonstrates the regional efforts to control forest fires.

Scope	**Limitations**
In Chile, unlike in other places, most forest fires are anthropic in origin, therefore this indicator is directly associated with the pressure of human activity on forestry resources.	While surface area is a good indicator of the extent of the damage, it does not capture the degree of damage caused by the forest fire, which is of significance if the goal is to assure the availability of forestry resources.

Method of calculation	The information supplied by CONAF relates to monthly forest fires during the season from October to May, and the necessary summation must be carried out to estimate the surface area burned in the year.
Statistical source	National Forestry Corporation (CONAF)

Series	**Frequency**
1984 to 2001	Annual

Observations



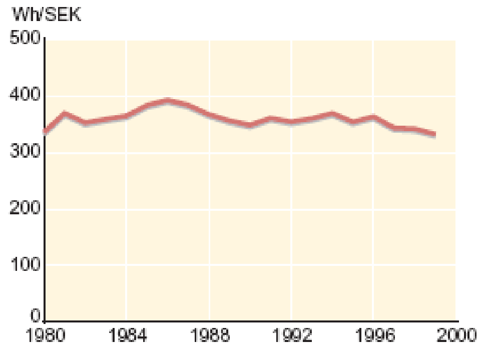
Source: Rayén Quiroga. "Indicadores regionales de desarrollo CONAMA", Documento de Trabajo No. 7, Economía Ambiental series", Santiago, Chile. National Environment Commission (CONAMA).

SUSTAINABLE DEVELOPMENT INDICATORS OF SWEDEN, 2001

Energy intensity in Sweden is falling slowly

GDP has grown faster than the energy supply over the last two decades. The change in energy intensity in Sweden during the period is a result of change in economic structure, energy use and energy conversion.

1. Total energy supply in relation to GDP, 1995 prices



Source: Statistics Sweden; Swedish National Energy Administration

Energy intensity: Total primary energy supply in relation to GDP.

Energy efficiency: The specific use of energy in industry, i.e. kWh/SEK of production value.

Relevance

Energy intensity, as measured by total primary energy supply per unit of GDP in constant prices, mainly indicates changes in energy efficiency and economic structure. Falling energy intensity generally indicates increased production at less energy per unit produced, which also means less impact on the environment and increased overall welfare.

This indicator is connected to the Swedish environmental objectives: A limited influence on climate, Natural acidification only, A good urban environment and Clean air.

Trends

Energy intensity has fallen slowly, during the 1990s.

Influence

Energy intensity has fallen slowly but energy efficiency has improved substantially over the years. The total amount of energy used in the residential and service sectors has remained steady during the last 30 years, although the size of heated areas has grown by 45 per cent.

The specific use of energy in industry, i.e. kWh/SEK of production value, has also decreased substantially over the years. Between 1992 and 1999, the specific use of energy fell by 26 per cent, the specific use of oil by 21 per cent and the specific use of electricity by 29 per cent. These changes were mainly due to the sharply higher production in less energy-intensive engineering industries combined with almost unchanged electricity use.

Future

Scenarios from the Government Commission of Measures against Climate Change indicate that energy use will grow more slowly than GDP during the next decade, i.e. energy intensity will continue to fall.

See also indicators: 2, 15, 24, 30.

Source: Statistics Sweden, (2002), “Sustainable Development Indicators for Sweden”.

PROPOSED COMPLEMENTARY INDICATORS FOR MILLENNIUM GOAL 7

FOR LATIN AMERICA AND THE CARIBBEAN, ECLAC

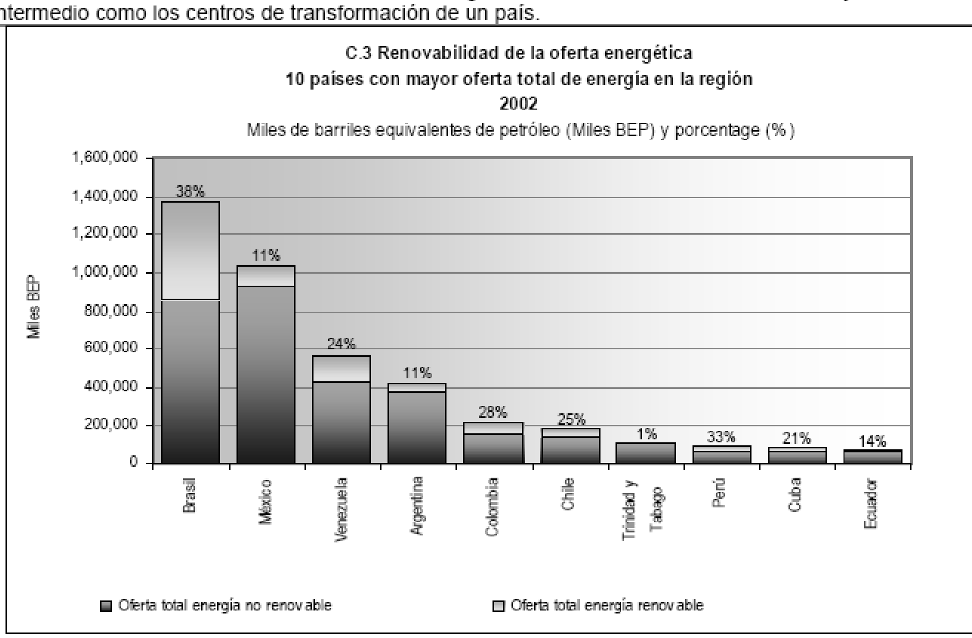
Indicator	C.3	*Renewability of the energy supply*
Energy		***Methodological Sheet***

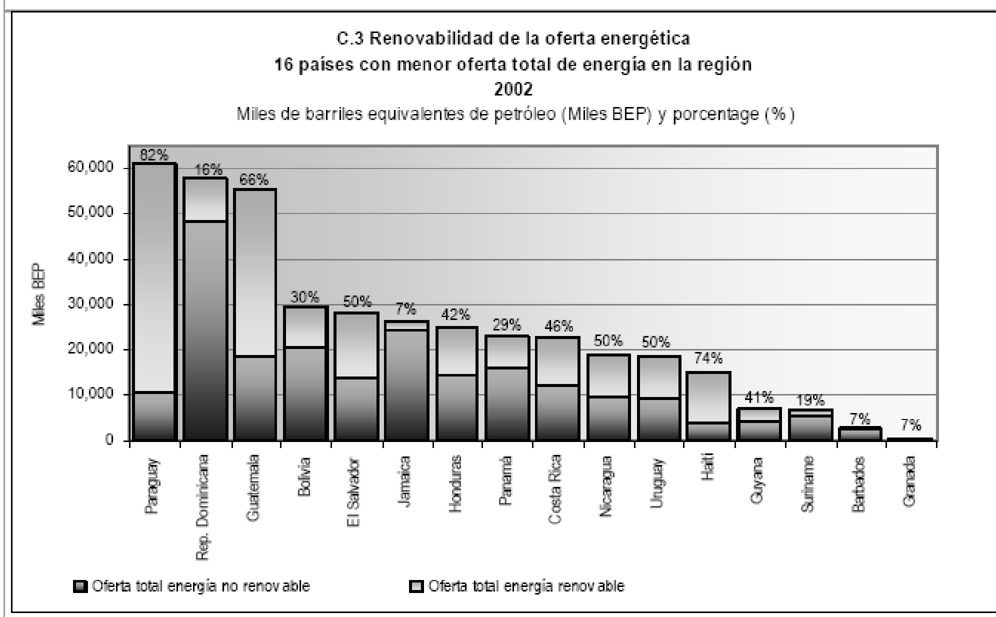
Definition	It is the relationship between the total supply of combined renewable energy sources and total energy supply. It considers, in relative terms, the level of participation of sources of renewable energy in the internal storage of energy in the intermediate and final consumption sectors and in the transformation centres of a given country. Considered among renewable sources are: hydro-energy, geothermal energy, sustainable bio-energy unrelated to wood and other sources such as eolithic and photovoltaic energy. Total energy supply: refers to primary energy supply plus secondary energy supply less secondary energy production. This last variable is subtracted to avoid double accounting.	
Scale	National	
Unit of measurement	Percentage (%)	Thousands of equivalent barrels of oil (thousands of OEB)
Method of calculation	The following equation is used to calculate the indicator: C.3 Renewability of energy supply = $\left(\frac{RES_i}{TES_i}\right)$ *100 where RES_i = Renewable energy supply of country i TES_i = Total energy supply of country i	

PROPOSED COMPLEMENTARY INDICATORS FOR MILLENNIUM GOAL 7 FOR LAC, ECLAC (CONTINUED)

Indicador	C.3	*Renovabilidad de la oferta energética*	
Energía			***Nacional***

Este indicador da cuenta, en términos relativos, respecto del nivel de participación de las fuentes renovables en el abastecimiento interno de energía en los sectores de consumo final y de consumo intermedio como los centros de transformación de un país.





Fuente: División de Recursos Naturales e Infraestructura, CEPAL, en base a información de la Organización Latinoamericana de Energía –OLADE

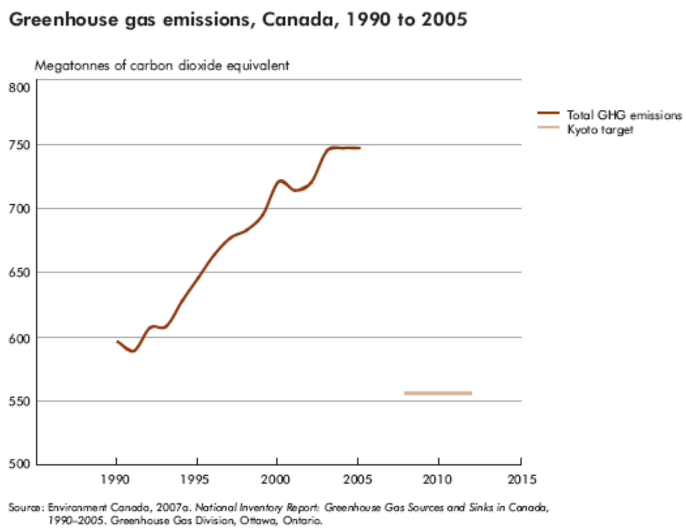
Source: R. Quiroga Martínez. « Propuesta regional de indicadores complementarios al objetivo de desarrollo del Milenio 7: Garantizar la sostenibilidad del medio ambiente", *Estudios estadísticos y prospectivos series,* No. 50, Santiago Chile, Economic Commission for Latin America and the Caribbean (ECLAC), 2007.

Annex 3

Types of graph

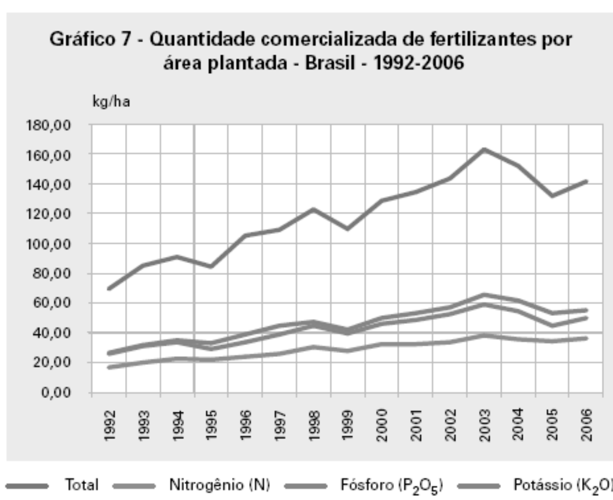
GRAPH 1

GRAPHIC REPRESENTATION OF ABSOLUTE TREND



Source: Canadian Environmental Sustainability indicators 2007 Report. http://www.ec.gc.ca/indicateurs-indicators/2102636F-9078-409F-8133-8775E51400BE/featureweb_e.pdf

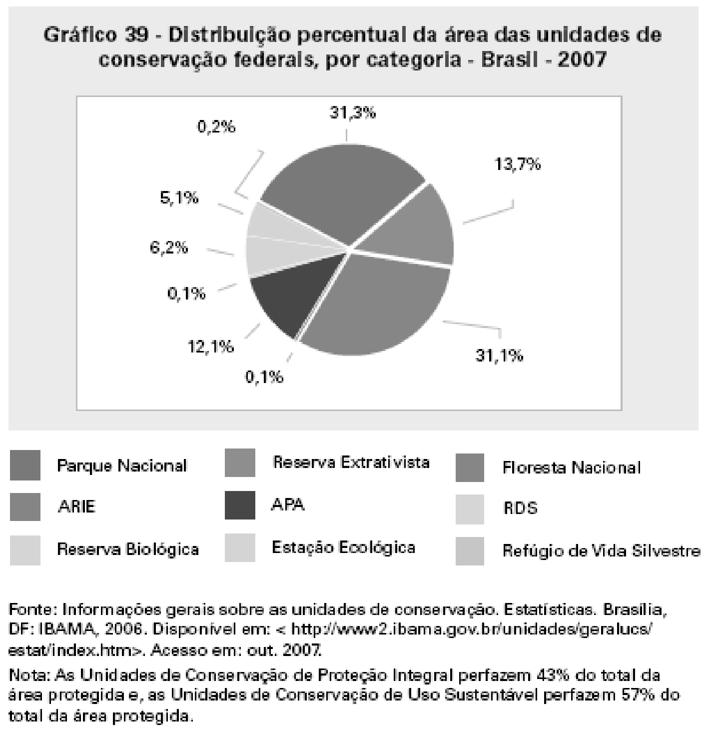
GRAPH 2
GRAPHIC REPRESENTATION OF RELATIONAL MAGNITUDE TRENDS



Fontes: Anuário estatístico do setor de fertilizantes 1992-2006. São Paulo: Associação Nacional para Difusão de Adubos, 1993-2007; Levantamento sistemático da produção agrícola: pesquisa mensal de previsão e acompanhamento das safras agrícolas no ano civil 1992-1999. Rio de Janeiro: IBGE, v. 4-11, 1992-2000; Levantamento sistemático da produção agrícola: pesquisa mensal de previsão e acompanhamento das safras agrícolas no ano civil 2000-2006. Rio de Janeiro: IBGE, v. 12-18, 2001-2007. Disponível em: <ftp://ftp.ibge.gov.br/Producao_Agricola/Levantamento_Sistematico_da_Producao_Agricola_%5Bmensal%5D/Fasciculo>. Acesso em: ago. 2007.

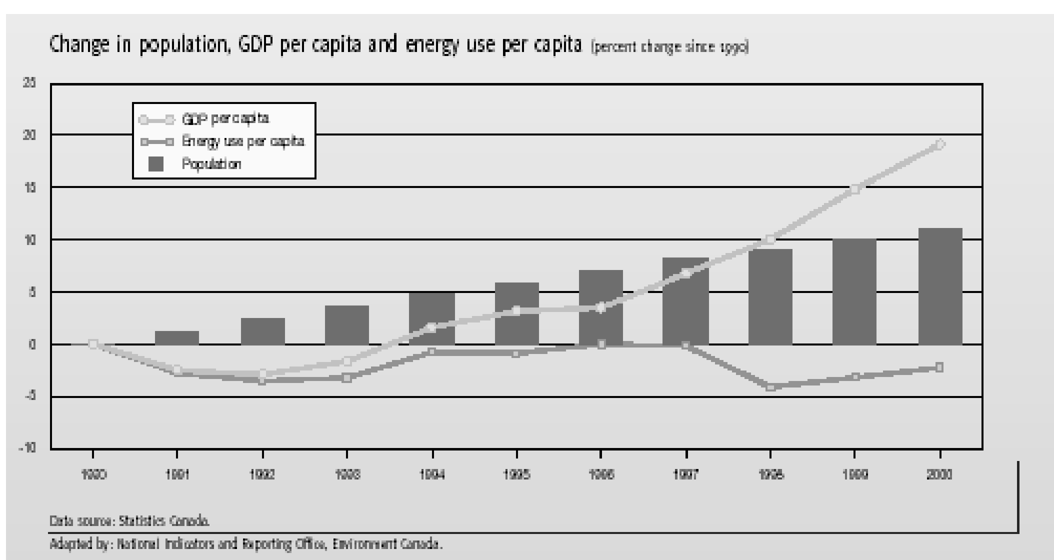
Source: Brazil 2008 Sustainable Development Indicators.

GRAPH 3
GRAPHIC REPRESENTATION OF A VARIABLE,
PERCENTAGE WEIGHT



Source: Brazil 2008 Sustainable Development Indicators.

GRAPH 4
GRAPHIC REPRESENTATION OF THREE VARIABLES, RATES OF INCREASE

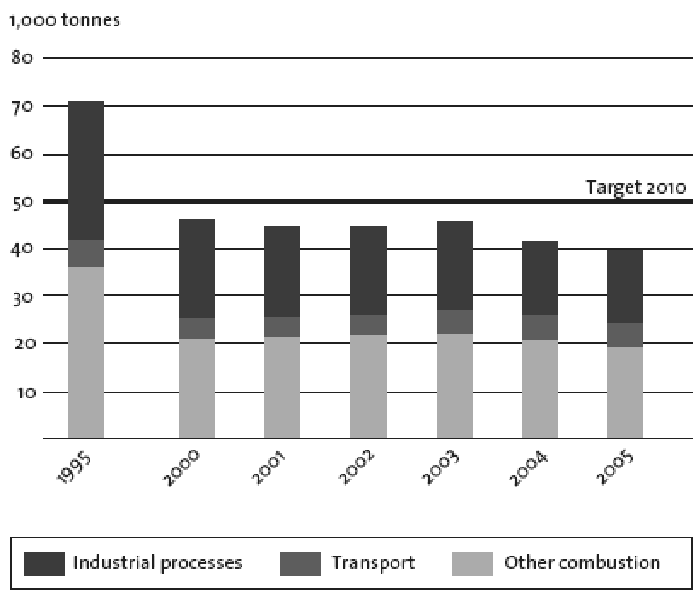


Source: Environment Signals, (2003). "Canada's National Environmental Indicator Series 2003".

GRAPH 5

GRAPHIC REPRESENTATION OF TRENDS IN COMPOSITION

FIG. 3.4 Swedish emissions of sulphur dioxide to air, 1995–2005 (excluding emissions from international shipping and aviation)



SOURCE: SWEDISH ENVIRONMENTAL PROTECTION AGENCY, SWEDISH REPORTING UNDER UNFCCC

Source: Sweden's Environmental Objectives. A progress report from the Swedish Environmental Objectives Council, 2007.

Annex 4

Conceptual frameworks and selected Indicators

a. Collections or systems of multiple Indicators

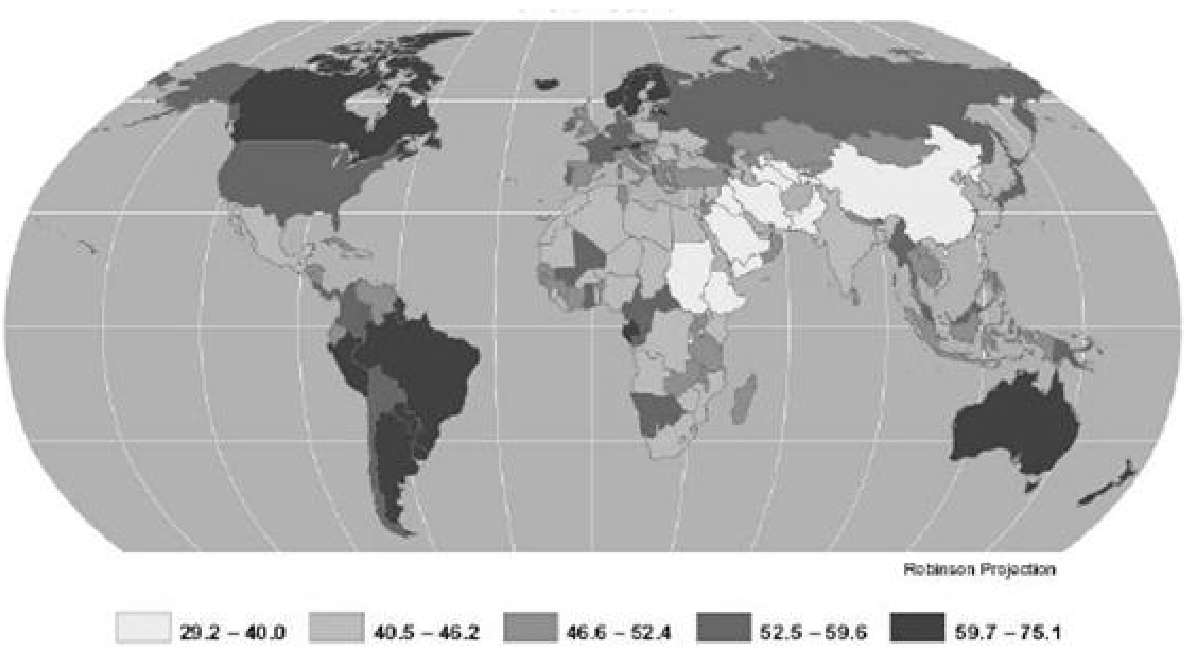
ENVIRONMENTAL INDICATORS OF THE REPUBLIC OF PANAMA
SUBJECT AREAS AND ENVIRONMENTAL INDICATORS, 2005

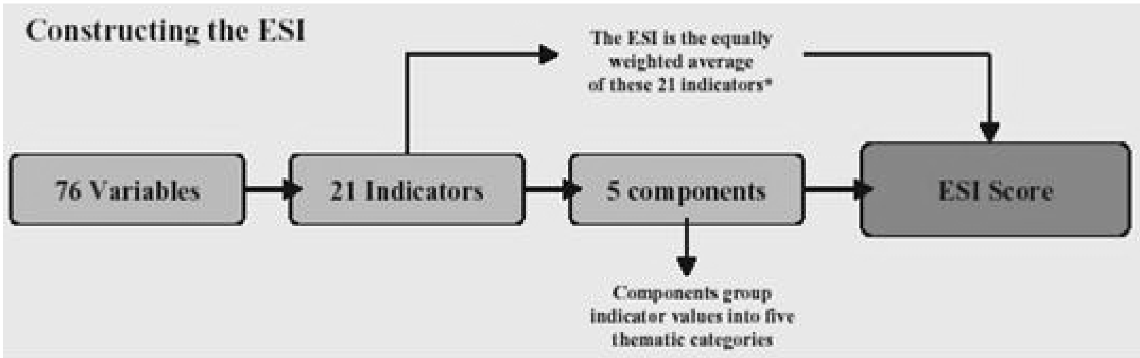
1	Forest and biodiversity
1.1	Forest cover in the territory
1.2	Reforestation surface area
1.3	Protected areas
1.4	Index of Biological Integrity (IBI) in the Trans-Isthmian Corridor of the Panama Canal Basin
2	Use of Soil
2.1	Changes in use of soil
3	Coastal marine resources
3.1	Regulation of fishing***
3.2	National shrimp production
4	Energy and transportation
4.1	Energy intensity of Gross Domestic Product
4.2	Proportion of renewable energy resources in total energy supply
4.3	Vehicular flow intensity
5	Natural disasters
5.1	Incidence of flooding and mudslides
6	Water
6.1	Waste water discharge
6.2	Extraction of water from the Chiriqui River basin
7	Air
7.1	Concentration of particulate matter at two stations in Panama City
7.2	Concentration of Nitrogen Dioxide at two stations in Panama City
8	Sanitation and waste
8.1	Drinking water supply systems
8.2	Faecal waste elimination systems
8.3	Volume of solid waste dumped in the Cerro Patacón sanitary landfill
9	Environmental management
9.1	Environmental impact evaluation
9.2	Environmental territorial organization

Source: National Environmental Authority of Panama. http://www.anam.gob.pa/indicadores/index.htm

b. Davos Environmental Sustainability Index

DAVOS ENVIRONMENTAL SUSTAINABILITY INDEX, COUNTRY RANKING, 2005





Source: Yale Center for Environmental Law and Policy (2005), Environmental Sustainability Index. Benchmarking National Environmental Stewardship. Yale University, Center for International Earth Science Information Network Columbia University. http://www.yale.edu/esi/ESI2005_Main_Report.pdf

VARIABLES, INDICATORS AND COMPONENTS OF THE DAVOS ENVIRONMENTAL SUSTAINABILITY INDEX, 2005

76 Variables		21 Indicators	5 Components
•Nitrogen dioxide concentration •Sulfur dioxide concentration	•Particulates concentration •Indoor air quality	Air Quality	Environmental Systems
•Ecoregions at risk •Threatened birds •Threatened mammals	•Threatened amphibians •National Biodiversity Index	Biodiversity	
•Wilderness area	•Developed area	Land	
•Dissolved oxygen •Electrical conductivity	•Suspended solids •Phosphorus concentration	Water Quality	
•Surface water availability	•Groundwater availability	Water Quantity	
•Coal consumption •Nitrogen oxide emissions •Sulfur dioxide emissions	•VOC emissions •Vehicles in use	Reducing Air Pollution	Reducing Stresses
•Forest cover change	•Acidification	Reducing Ecosystem Stress	
•Population growth	•Total Fertility Rate	Reducing Population Pressures	
•Ecological Footprint •Waste recycling rates	•Hazardous waste	Reducing Waste & Consumption Pressures	
•Industrial organic effluents •Fertilizer consumption	•Pesticide consumption •Water stress	Reducing Water Stress	
•Overfishing •Sustainably managed forests •Market distortions	•Salinization due to irrigation •Agricultural subsidies	Natural Resource Management	
•Deaths from waterborne diseases •Child mortality rate	•Deaths from respiratory infections in children	Environmental Health	Reducing Human Vulnerability
•Malnutrition	•Safe drinking water supply	Basic Human Sustenance	
•Deaths from environmental disaster vulnerability	•Natural hazard exposure	Environment-related natural disaster exposure	
•Gasoline price •Corruption •Government effectiveness •Protected area •Environmental governance •Strength of rule of law •Local Agenda 21 initiatives	•Civil and political liberties •Sustainable development data gaps •International environmental engagement •Environmental knowledge creation •Democratic institutions	Environmental Governance	Social and Institutional Capacity
•Energy consumption/ GDP	•Renewable energy production	Eco-efficiency	
•Corporate sustainability (Dow Jones) •Corporate sustainability (Innovest) •ISO 14001 certified companies	•ISO 14001 certified companies •Private sector environmental innovation •Responsible Care participation	Private Sector Responsiveness	
•Innovation capacity •Digital Access •Female primary education	•University enrollments •Research scientists	Science and Technology	
•Intergovernmental environmental activities •Role in international environmental aid	•Participation in international environmental agreements	Participation in International Collaborative Efforts	Global Stewardship
•Greenhouse gas emissions / GDP	•Greenhouse gas emissions / capita	Greenhouse Gas Emissions	
•Transboundary sulfur dioxide spillovers	•Polluting-goods imports	Reducing Transboundary Environmental Pressures	

Source: Yale Center for Environmental Law and Policy (2005), Environmental Sustainability Index. Benchmarking National Environmental Stewardship. Yale University, Center for International Earth Science Information Network Columbia University. http://www.yale.edu/esi/ESI2005_Main_Report.pdf. More recently, the Environmental Performance Index (EPI) has been developed. See Quiroga (2007), op.cit.

Annex 5
Principal Environmental Indicator initiatives

COUNTRIES OF LATIN AMERICA AND THE CARIBBEAN

Country	System of Indicators	Internet address	Main participants	Publications
ARGENTINA	System of Sustainable Development Indicators of the Republic of Argentina (SIDSA)	http://www.medioambiente.gov.ar	Secretariat of the Environment and Sustainable Development Ministry of Health and Environment of the Nation National Network of Sustainable Development Indicators	• Secretariat of the Environment and Sustainable Development, Ministry of Health and Environment of the Nation (2005). "Sistema de Indicadores sobre Desarrollo Sostenible República de Argentina", Argentina.
	ILAC Indicators	http://www.medioambiente.gov.ar	UNEP Secretariat of the Environment and Sustainable Development Ministry of Health and Environment of the Nation	• Argentina 2006, Latin American and Caribbean Initiative for Sustainable Development (ILAC) follow-up indicators UNEP
BOLIVIA (Plurinational State of)	*National System of Information for Sustainable Development (SNIDS)*	http://www.planificacion.gov.bo	Ministry of Development Planning	
BRAZIL	Sustainable Development Indicators	http://www.ibge.gov.br/home/geociencias/recursosnaturais/ids/default.shtm?c=1	Brazilian Institute of Geography and Statistics (IBGE) (Ministry of Planning, Budget and Management)	• Brazil 2004 Sustainable Development Indicators (IBGE-MMA, 2004) • Brazil 2002 Sustainable Development Indicators (IBGE-MMA, 2002)
CHILE	CONAMA Regional Development Indicators *National Environmental Information System (SINIA).*	www.sinia.cl	National Environment Commission (CONAMA)	• Rayén Quiroga. "Indicadores regionales de desarrollo CONAMA", Documento de Trabajo No. 7, Economía Ambiental series", Santiago, Chile. National Environment Commission (CONAMA).
COSTA RICA	System of Sustainable Development Indicators (SIDES)	www.mideplan.go.cr/sides/index.html	Ministry of National Planning and Economic Policy	
COLOMBIA	System of Environmental Sustainability Indicators (SISA)	www.minambiente.gov.co/sisa/	Ministry of the Environment, Housing and Territorial Development	• Ministry of the Environment, Housing and Territorial Development – UNDP. "Sistema de Indicadores de Sostenibilidad Ambiental en el ámbito Nacional – Avances y Perspectivas". Colombia (digital version only)

Country	System of Indicators	Internet address	Main participants	Publications
MEXICO	Basic Environmental Performance Indicators of Mexico 2005 National System of Information on the Environment and Natural Resources (SNIARM)	http://portal.semarnat.gob.mx/semarnat/portal/ http://app1.semarnat.gob.mx/dgeia/indicadores04/index.htm	Secretaría del Medio Ambiente y Recursos Naturales (SEMARNAT).	• Secretariat of the Environment and Natural Resources (2005), "Indicadores Básicos de Desempeño Ambiental de México", Mexico. • Secretariat of the Environment and Natural Resources – UNDP (2005), "Informe de la Situación del Ambiente en México. Compendio de Estadísticas Ambientales 2005", Mexico. • Secretariat of the Environment and Natural Resources (2002), "Informe de la Situación del Ambiente en México 2002", Mexico • Secretariat of the Environment and Natural Resources (1999), "Estadísticas del Medio Ambiente, México 1999", Mexico • Secretariat of the Environment and Natural Resources (1997), "Estadísticas del Medio Ambiente, México 1997", Mexico.
	Sustainable Development Indicators	http://www.ine.gob.mx/	National Institute of Statistics, Geography and Informatics (INEGI) National Institute of Ecology (INE).	• National Institute of Statistics, Geography and Informatics (INEGI), National Institute of Ecology (INE), (2000), "Indicadores de Desarrollo Sustentable", Mexico.
	System of Indicators for Evaluation of the Environmental Performance of Mexico	http://www.ine.gob.mx/	National Institute of Statistics, Geography and Informatics (INEGI) National Institute of Ecology (INE).	• National Institute of Ecology (INE), (1998). "Avances en el Sistema de Indicadores para la Evaluación del Desempeño Ambiental en México 1997" • National Institute of Ecology (INE), (2000). "Indicadores para la Evaluación del Desempeño Ambiental en México. Reporte 2000".
NICARAGUA	Environmental Indicators of Nicaragua *National Environmental Information System (SINIA).*	www.sinia.net.ni/indicadores/intro.htm	Ministry of the Environment and Natural Resources	• Ministry of the Environment and Natural Resources (2004), "Indicadores Ambientales de Nicaragua, volumen 1", Nicaragua.
REPUBLIC OF PANAMA	Environmental Indicators of the Republic of Panama	http://www.anam.gob.pa/indicadores/index.htm	National Environmental Authority	• National Environmental Authority (2006). "Indicadores Ambientales de la República de Panamá, 2006". Republic of Panama.
DOMINICAN REPUBLIC	Environmental Sustainability Indicators for Water Resources	http://www.medioambiente.gov.do/cms/	Secretariat of the Environment and Natural Resources of the Dominican Republic National Statistical Office (ONE)	• Secretariat of the Environment and Natural Resources of the Dominican Republic (2007), Indicadores de Sostenibilidad Ambiental del Recurso Hídrico en la República Dominicana 2000 - 2005. Sectoral Office of Planning and Programming.

DEVELOPED COUNTRIES

Country	System of Indicators	Internet Address	Main participants	Publications
AUSTRALIA AND NEW ZEALAND	Core Environmental Indicators for Reporting on the State of the Environment	*http://www.deh.gov.au/soe/publications/pubs/coreindicators.pdf* http://www.deh.gov.au/about/environment-reports/index.html	Australian and New Zealand Environment and Conservation Council –Anzecc	• Australian and New Zealand Environment and Conservation Council, State of the Environment Reporting Task Force (2000). “Core Environmental Indicators for Reporting on the State of the Environment”. Environment Australia, Canberra.
CANADA	National Environmental Indicators Series.	http://www.ecoinfo.ec.gc.ca/env_ind/indicators_e.cfm	Environment Canada - Knowledge Integration Strategies Division Statistics Canada Health Canada	• Environment Signals, (2003). “Canada’s National Environmental Indicator Series 2003”. • Bond, W., D. O'Farrell, G. Ironside, B. Buckland, and R. Smith. (2005). “Environmental Indicators and State of the Environment Reporting: An Overview for Canada”. Background paper to an Environmental Indicators and State of the Environment Reporting Strategy, 2004–2009, Environment Canada, Gatineau, Quebec • Canadian Environmental Sustainability Indicators 2005. Environment Canada, Statistics Canada, Health Canada. Government of Canada.
SPAIN	Environmental Indicators	http://www.mma.es/portal/secciones/info_estadistica_ambiental/estadisticas_info/	Ministry of the Environment	• Ministry of the Environment (2005), Perfil Ambiental de España 2005. Informe basado en indicadores.” • Ministry of the Environment (2004), “Perfil Ambiental de España 2004. Informe basado en indicadores.”
	Sustainability Indicators *Observatory of Sustainability in Spain*	http://www.sostenibilidad-es.org/Observatorio+Sostenibilidad	University of Alcalá	• Observatory of Sustainability Spain, (2005). “Informe de Sostenibilidad en España 2005”. Spring report. University of Alcalá, Madrid.

Country	System of Indicators	Internet Address	Main participants	Publications
UNITED STATES OF AMERICA	Sustainable Development Indicators	http://www.sdi.gov/	United States Interagency Working Group on Sustainable Development Indicators	• United States. Interagency Working Group on Sustainable Development Indicators (2001), " Sustainable Development in the United States: An Experimental Set of Indicators." Washington DC.
	Environmental Indicators	http://www.epa.gov/ebtpages/envienvironmentalindicators.html	Environmental Protection Agency (EPA)	• United States Environmental Protection Agency (2003), "Draft Report on the Environment (ROE)." Washington DC. • United States Environmental Protection Agency (2003), "Draft Report on the Environment Technical Document." Washington DC.
NEW ZEALAND	Environmental Indicators	http://www.mfe.govt.nz/state/monitoring/epi/index.html	Ministry for the Environment	• Taylor, Rowan (1997), "The State of New Zealand Environment." The Ministry for the Environment, Wellington, New Zealand. • Ministry for the Environment (1998), "Environmental Performance Indicators: Summary of Proposed Indicators of Terrestrial and Freshwater Diversity." Ministry for the Environment, Wellington, New Zealand. • Ministry for the Environment (1996), "National Environmental Indicators: Building a Framework for a Core Set." Ministry for the Environment, Wellington, New Zealand. • Ministry for the Environment (1997), "Environmental Performance Indicators: Proposal for Air, Fresh Water and land." Ministry for the Environment, Wellington, New Zealand. • Ministry for the Environment (1997), "Environmental Performance Indicators: Summary of Proposed Indicators of Terrestrial and Freshwater Diversity." Ministry for the Environment, Wellington, New Zealand. • Patterson, Murray (2006), "Headline Indicators for tracking progress to sustainability in New Zealand." (Signposts for sustainability) Ministry for the Environment, Wellington, New Zealand. • The Ministry for the Environment (2006), "Gentle Footprints. Boots 'N' All." Wellington, New Zealand.

Country	System of Indicators	Internet Address	Main participants	Publications
UNITED KINGDOM	Headline Indicators of sustainable development *Sustainable Development, UK.*	http://www.sustainable-development.gov.uk/index.asp	Department of Environment, Food and Rural Affairs –Defra-, Sustainable Development Unit.	• Sustainable Development Unit UK (2002). "Achieving a better quality of life: review of progress towards sustainable development." Government annual report 2002. DEFRA - Sustainable Development Unit. • Sustainable Development Unit UK (2003), "Achieving a better quality of life: review of progress towards sustainable development." Government annual report 2002. DEFRA - Sustainable Development Unit. • Sustainable Development Unit UK (2004), "Quality of Life Counts. Indicators for a strategy for sustainable development for the United Kingdom. 2004 Update." Updating the baseline assessments made in 1999. DEFRA - Sustainable Development Unit. • Sustainable Development Unit UK (2003). "Regional quality of Life Counts, 2003." Regional versions of the national headline Indicators of sustainable development. DEFRA - Sustainable Development Unit. • Sustainable Development Unit UK (2004). "Sustainable development indicators in your pocket 2006." Department of Environment, Food and Rural Affairs - Sustainable Development Unit, UK. • Sustainable Development Unit UK (2005). "Sustainable development indicators in your pocket 2006." Department of Environment, Food and Rural Affairs - Sustainable Development Unit, UK. • Sustainable Development Unit UK (2006). "Sustainable development indicators in your pocket 2006." Department of Environment, Food and Rural Affairs - Sustainable Development Unit, UK.
Sweden	Sustainable Development Indicators for Sweden	http://www.scb.se/templates/Amnesomrade____12460.asp	Statistics Sweden The National Board Of Housing, Building And Planning - Swedish Council On Sustainable Development	• Statistics Sweden (2002), "Sustainable Development Indicators for Sweden."

Country	System of Indicators	Internet Address	Main participants	Publications
	Environmental Indicators	http://www.naturvardsverket.se/bokhandeln/dse/620-1240-1 http://www.miljomal.nu/english/english.php	Swedish Environmental Protection Agency (EPA) Environmental Objectives Council Swedish Environmental Advisory Council (EAC)	• Swedish Environmental Objectives Council (2006), "Sweden's environmental objectives- buying into a better future" - deFacto 2006. A progress report from the Swedish Environmental Objectives Council." EPA. • Swedish Environmental Objectives Council (2005), "Sweden's environmental objectives- for the sake of our children" - deFacto 2005. A progress report from the Swedish Environmental Objectives Council." EPA. • Swedish Environmental Objectives Council, (2004), "Sweden's environmental objectives- are we getting there?" - deFacto 2004. A progress report from the Swedish Environmental Objectives Council. EPA.

INTERNATIONAL AGENCIES, MULTILATERAL AND REGIONAL ORGANIZATIONS

Lead institution, international organization	Indicators document	Link
United Nations Department of Economic and Social Affairs. Division for Sustainable Development. Commission on Sustainable Development. (CSD)	Indicators of Sustainable Development 1997 to 2003	www.un.org/esa/sustdev/natlinfo/indicators/isd.htm
	Indicators of Sustainable Development: Guidelines and Methodologies	www.un.org/esa/sustdev/natlinfo/indicators/indisd/indisd-mg2001.pdf
	CSD Working List of Indicators of Sustainable Development, September 1996	www.un.org/esa/sustdev/natlinfo/indicators/worklist.htm
	Framework Sustainable Development Indicators and Methodologies	www.un.org/esa/sustdev/natlinfo/indicators/indisd/spanish/espanol.htm
Statistics and Economic Projections Division of ECLAC.	Environmental Indicators and Statistics (CEPALSTAT)	www.eclac.org/estadisticas/
	Documentary base, directory of environmental experts and institutions Information on activities, projects, technical assistance and courses	www.cepal.org/deype/statambiental
Sustainable Development and Human Settlements Division of ECLAC.	Sustainability Assessment in Latin America and the Caribbean (ESALC). Database of Sustainability Indicators in Latin America and the Caribbean	http://www.cepal.org/esalc
Forum of Ministers of the Environment of Latin America and the Caribbean UNEP	Latin American and Caribbean Initiative for Sustainable Development (ILAC)	www.pnuma.org
Organisation for Economic Co-operation and Development - OECD	Environment at a Glance: OECD Environmental Indicators. 2005 (Complete Edition - ISBN 9264012184)	www.sourceoecd.org/environment/9264012184
	OECD Environmental Indicators. Development, Measurement and Use. Paris, 2003	www.oecd.org/dataoecd/7/47/24993546.pdf
	OECD Environmental Indicators. Environment at a Glance. Paris, 2006	www.oecdbookshop.org/oecd/display.asp?sf1=identifiers&lang=EN&st1=972005081p1
European Environmental Agency.	European Environmental Indicators (Core set of indicators CSI and other published indicators	http://themes.eea.eu.int/indicators/all_indicators_box
	Environmental signals 2002 - Benchmarking the millennium.	reports.eea.eu.int/environmental_assessment_report_2002_9/en
	Environmental signals 2004 – A European Environment Agency update on selected issues.	http://reports.eea.europa.eu/signals-2004/en
The World Bank	Environmental Economics and Indicators The Little Green Data Book (2001, 2002, 2003, 2004, 2005, 2006), Country Data, Documents	http://go.worldbank.org/8E6DWNZPY0
Global Footprint Network. Advising the science of sustainability.	Ecological Footprint	www.footprintnetwork.org/gfn_sub.php?content=ef_essay
International Institute for Sustainable Development – Reporting Services Division.	IISD Linkages. A multimedia resource for environment and development policy makers.	isd1.iisd.ca/measure/compendium/searchinitiatives.aspx
World Wildlife Fund	Living Planet Index	www.panda.org/news_facts/publications/living_planet_report/living_planet_index/index.cfm

International Centre for Tropical Agriculture (CIAT)	Environmental and Sustainability Indicators	www.ciat.cgiar.org/indicators/indicadores/index.htm
SEDAC Socioeconomic Data and Applications Center	Environmental Sustainability Index Yale Center for Environmental Law and Policy (YCELP), Center for International Earth Science Information Network (CIESIN) of Columbia University, in collaboration with the World Economic Forum and the Joint Research Centre of the European Commission	www.ciesin.columbia.edu/indicators/ESI/

Series

Manuals

Published issues

A complete list of publications and the .pdf files are available at

www.eclac.cl/publicaciones

61. Guía metodológica para desarrollar indicadores ambientales y de desarrollo sostenible en países de América Latina y el Caribe (LC/L.3021-P), Nº de venta S.09.II. G.45, (US$ 15.00), 2009
60. Directrices para la elaboración de módulos sobre envejecimiento en las encuestas de hogares, CELADE (LC/L.2969-P), Nº de venta: S.08.II.G.81, (US$ 15.00), 2008.
59. Técnicas de análisis regional, Luís Lira, Bolívar Quiroga (LC/L.2884-P), No de venta: S.08.II.G.21(US$ 15.00), 2009.
58. Manual metodológico de evaluación multicriterio para programas y proyectos, Juan Francisco Pacheco, Eduardo Contreras (LC/L.2957-P), No de venta: S.08.II.G.71, (US$ 15.00), 2008.
57. Manual de presupuesto plurianual, Roberto Martirene (LC/L.2829-P), No de venta: S.07.II.G.153 (US$ 15.00), 2007.
56. Indicadores ambientales y de desarrollo sostenible: avances para América Latina y el Caribe, Rayén Quiroga Martínez (LC/L.2771-P), No de venta: S.07.II.G.108 (US$ 20.00), 2007.
55. Indicadores ambientales y de desarrollo sostenible: avances para América Latina y el Caribe, Rayén Quiroga Martínez, LC/L.2771-P, S.07.II.G.108, 2007.
54. Las cuentas nacionales: lineamientos conceptuales, metodológicos y prácticos, Michael Séruzier (LC/L.2765-P), Nº de venta: S.07.II.G.101, (US$ 15.00), 2007.
53. El modelo GTAP y las preferencias arancelarias en América Latina y el Caribe: reconciliando su año base con la evolución reciente de la agenda de liberación regional, Andrés R. Schuschny, José E. Durán y Carlos J. de Miguel (LC/L.2679-P), N° de venta: S.07.II.G.29, (US$ 15.00), 2007
52. Modelo de análisis del impacto social y económico de la desnutrición infantil en América Latina (LC/L.2650-P), N° de venta: S.06.II.G.175, (US$ 15.00), 2006.
51. Manual de prospectiva y decisión estratégica: bases teóricas e instrumentos para América Latina y el Caribe, Javier Medina Vásquez y Edgar Ortegón, (LC/L.2503-P), N° de venta: S.06.II.G.37, (US$ 20.00), 2006
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