Forest Sector Indicators

An Approach for Central America

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With an Annex on water indicators
Conceptual Framework for the Development and Use of Water Indicators
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Cover: Forest cover map for Central America. Dark areas are deciduous forests and lighter are coniferous forests. *Source*: CIAT-WB-UNEP 1999.

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Abbreviations and Acronyms

CCAB-AP	Central American Council on Forests and Protected Areas
CCAD	Central American Commission on Environment and Development
CIAT	International Center for Tropical Agriculture
COHDEFOR	The national forest agency in Honduras
CUM	Cubic meters
FAO	United Nations Food and Agriculture Organization
FMU	Forest Management Unit
ITTO	International Tropical Timber Organization
n.a.	Not available
NAI	Net annual increment
NGO	Non-Governmental Organization
SFM	Sustainable Forest Management
UNEP	United Nations Environmental Programme

Chapter 1

Introduction

The exploitation of natural resources, and changes in the services provided by the rural environment, in Central America and other developing regions have important impacts on the livelihood of rural communities. Uncontrolled development of forest resources may result in growing poverty and loss of welfare due to environmental degradation and depletion of social values and opportunities. If, on the other hand, the possible trade-offs with environmental services and rural livelihood are taken into consideration when natural resources are exploited, it may be possible to mitigate adverse impacts on the environment and rural poverty.

Environmental indicators are a set of tools that can enable decisionmakers to link policy decisions and regulation of natural resource exploitation with possible adverse impacts and capability to monitor those impacts. Access to this relatively unbiased information can also become a crucial part of consensus building and conflict resolution.

This paper presents an outline and discussion for developing national indicators for the forest sector in Central America, focusing on Honduras as a country case study. It is intended to present an example of how indicators in a sector can be developed on available data. Rather than a comprehensive analysis of the forest sector in Central America based on empirical data, the paper is primarily aimed at demonstrating an approach for a selected sector as an input to a larger project on rural sustainability indicators in the region.

Objective

Countries commonly take a sectoral approach to natural resources, such as water, forests, coasts, and agriculture. One reason is that this is how the public administration is structured, and most sector-oriented policies offer few incentives to look at the cross-linkages between sectors, ecosystems, natural resources, and human welfare. A sector-based approach thus speaks to a specific public institutional setting. It may be an efficient way to reach the level of policy-making, but poses a risk of focusing on partial policy issues. The challenge therefore, is to make the best of the sector-based approach while ensuring that indicators can capture inter-sectoral linkages reaching beyond the sectors and their self-interest.

The *objective* of this forest sector example is to demonstrate how policy-relevant issues can be addressed at the regional and national level through the use of *available* forest sector information derived from *existing* data sources.[1] The sector example does not attempt to reach the local level where the key sector issues are related to management. Moreover, it is not an attempt to develop indicators where information is not available or relatively easy to retrieve.[2]

The Rural Sustainability Indicators Project in Central America

This paper represents one component of a collaborative effort between the International Center for Tropical Agriculture (CIAT), the United Nations

Environment Programme, and the Environment Department of the World Bank.[3] The project—rural sustainability indicators project in Central America—aims at developing and testing a framework of environmental indicators for rural development in Central America. More specifically, the objectives of the project are to:

- Develop, test, and refine environmental, land quality, and other related indicators and information tools in a user-friendly geographic information system interface, for the integration of rural sustainability considerations into policy-making and planning
- Improve environmental management at the regional, national, and local levels in Central American countries.

These objectives are achieved by:

- Identifying information needs among stakeholders in the region, which are translated into a need for indicators according to issues (forests, land use, natural disasters, and social dynamics
- Collecting existing data from the region in collaboration with about 50 regional, national, and local institutions
- Preparing and compiling data on a CD-ROM, thus converting available data into feasible indicators and accessible information.

The rural sustainability indicators project aims at developing indicators with policy relevance at different tiers of decisionmaking. For this purpose, indicators at the regional level (including six Central American countries: Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua, and Panama) have been further developed at the national and even at the local level in some case studies.

The design of indicators to monitor sectoral sustainable development requires a systemic approach, but management and policymaking remain predominantly organized by sector. For this reason, the CIAT-World Bank-UNEP rural sustainability indicators project includes sector-level indicators, in addition to developing environmental and sustainability indicators at different analytical levels and for different dimensions (political/administrative and ecological/environmental). This paper is one of the sectoral case studies in the larger study; a second study is the conceptual water-sector case study presented in Annex B.

Outline

The forest sector paper is organized in five main chapters:

1. Introduction, including objectives and a brief description of the rural sustainability indicator project for Central America
2. Key conceptual issues in the development and application of forest indicators
3. The regional view for Central America
4. The national level, with examples based on geo-referenced and tabulated indicators from the forest sector in Honduras
5. Further examples of possible developments of advanced forest indicators.

Chapter two provides an overview of selected conceptual issues relevant for forest sector indicators. The chapter outlines a number of selection criteria, as well as examining the considerations necessary for forest indicators from the perspective of what information could be demanded and how it could be organized, barring limitations in available information.

Chapter three shifts to a discussion on indicators based on available data. The purpose is to present national level indicators for all six countries in the region. It is based on data compiled by CIAT and additional contributions from other sources, and does not include desired indicators for which no data are available.

Chapter four is an example of forest sector indicators at the national level in Honduras. This chapter is also based on available data; if important topics are neglected it is due to lack of data and not a lack of importance or demand. The purpose is not to provide a complete description of the Honduran forest sector. Instead this chapter aims to show that even in a decision- and policymaking environment with limited available information, developing sector indicators can improve the information level and assist policymakers in outlining the current state and development of the sector. The development of sector indicator can also facilitate the process of setting development goals and identifying information gaps.

A national sector overview study demonstrates how different types of information can be processed and applied (such as tabulated data, trends, indicators, or geo-referenced data). Indicators are not only a way of converting existing data into useful information, but through the identification of information needs and gaps, the indicator approach can also provide policymakers and institutions with a framework to organize learning systems, harmonize methods, and improve the use of information.

Chapter 2

Forest Indicators — Conceptual Issues

Perceptions differ as to what constitutes a forest sector indicator. In this chapter a brief introduction is given to selection criteria and indicators relevant to the forest sector in Central America. These are compromises made between many different interests, so a common denominator is difficult to apply. Box 1 presents some characteristics of the forest sector that need to be taken into consideration when selecting indicators.

Selecting Forest Indicators

Indicators are a way of dealing with complex decisions in a decisionmaking environment characterized by both lack of, and unstructured, information. They also offer a low-cost approach to dealing with incomplete information in a decision context with many possible impacts. Rural and environmental indicators can be instrumental in flagging *when* and *where* a policy regulation or other means of intervention is urgent. Another function of environmental indicators is to monitor the impact of existing policies and determine whether they are in line with policy objectives or whether adjustments are needed; for example, improved coordination with other sectors.

No consensus exists on exactly what an indicator is or what properties it has. There is a tendency to use any available environmental data as environmental indicators, but this ignores the need to be selective, to make information out of data, and to prioritize. A smaller set of indicators is preferable, since decisionmakers are more capable of dealing with a few well-defined and tested indicators than an incomplete and changing set of data on rural development or the environment. Although many potential defini-

Box 1. Forest sector characteristics and indicators

Some of the characteristics of the forest sector call for indicators that capture the dynamics and diversity of the resources and their use. The implications of these characteristics (which are not always exclusively for forests) include:

- The need for forest sector indicators to be representative; they need to consider the diversity of forest resources (including timber resources, food products, global services, species, and soil management).
- The large number of different goods and services produced by forests makes it difficult to monitor them all.
- The use of forest resources by multiple stakeholders, and within different jurisdictions, exacerbates the apparent need for lot of information. However, rather than including everything, priorities must be set.
- The dynamics of forest resources call for the monitoring of selected indicators consistently over a longer period of time.
- Since natural resources are not confined to administrative boundaries, monitoring is also required across jurisdictions, such as national boundaries.

tions exist for the format and function of environmental indicators, a useful point of departure is to delineate some of the desirable characteristics of indicators to be considered when selecting a set of indicators:

- *Agreement.* Definitions (such as "accuracy of forest cover") and method of data collection (such as sampling rate) should be agreed on among stakeholders.
- *Consistency*. The data should be of a quality that makes it possible to compare it both temporally (when changes in the natural resource base occur) and spatially (where the natural resources are and the changes in these resources). Special care should be taken with data and time series that are derived (for example, a per hectare stock of timber from a certain area that is used to estimate the total stock) and not measured.
- *Policy relevance*. The indicators should be related to the objectives of sustainable development at the forest management and policy level (if these have been defined and agreed upon). This also implies that the indicators should be policy relevant, and that the different needs at the regional, national, and local levels (due to different concerns, geographical scales, data availability, and users) are recognized.
- *Clarity*. It should be possible for outsiders to understand an indicator (for example, terms such as "forest fragmentation" or "accessibility"). It should also be clear how the changes and pressures on natural resources can be explained in both temporal and spatial dimensions.
- *Representativity*. The indicators should represent wider and scarce environmental information because of correlation. As such they become an alternative to collecting additional, costly new information.
- *Feasibility*. An indicator should consist of either available data or data that can be collected in a cost-efficient manner.

Failure to identify and apply indicators often occurs because they are selected on the basis of what different stakeholders and sectors consider relevant, without consideration of data availability and monitoring costs of the underlying data or the overall relevance for decisionmaking. If *everyone* is asked what indicators may be important, the answer will be that *everything* is important. This offers no grounds to prioritize what information is the most needed. Because the identification and development of environmental indicators is based merely on stakeholders' narrow interest, the indicators become a reflection of narrowly defined policy objectives, rather than appropriate decisionmaking tools serving broader needs.

Applying these criteria to the process of selecting indicators results in sets of environmental and rural indicators that provide information to decisionmakers, the public and private sector, and other stakeholders. For decisionmakers the development and use of indicators includes three key questions:

- *What kind of information is required?* Information needs span from the determination of a baseline to the monitoring of progress.
- *How to make best use of existing information?* While not all existing information is relevant or available at once, the challenge is to have access to and process information to address most pertinent needs. (There are drops of information in the ocean of data).
- *What are the gaps in the available information?* Demand for and availability of information are balanced to identify the most important improvements. Additional information is not always relevant if costs are considered.

These three questions demonstrate the common problem of demand for and supply of indicators and data. The next chapter discusses these aspects in more detail.

Demand and Supply of Indicators

Who or what decides which indicators are relevant to monitor a sector? On the one hand, there is *demand* from decisionmakers and others for information relevant to decisionmaking about the forest sector. On the other hand, there are limitations to the available information (*supply*), and therefore also to the extent that it is possible to develop indicators. Is the need for information or the availability of information deciding which indicators to include in monitoring?

Figure 1 illustrates this discrepancy between the demand and the supply side of environmental indicators. The supply side describes the steps, from the selection of available data to describing the relevant information. The point is that not all available data is relevant, and the quest is to distill what is reliable and relevant information. A discussion about filling possible information gaps is also necessary. The concern is about data quality, the relevance to policymakers, and the costs of monitoring the data, as well as other selection criteria introduced in chapter two. From the available data it is possible to advance to the feasible indicators by applying additional criteria, such as the possibility of collecting data over time. Finally, information is created on the basis of which decisionmaking is possible.

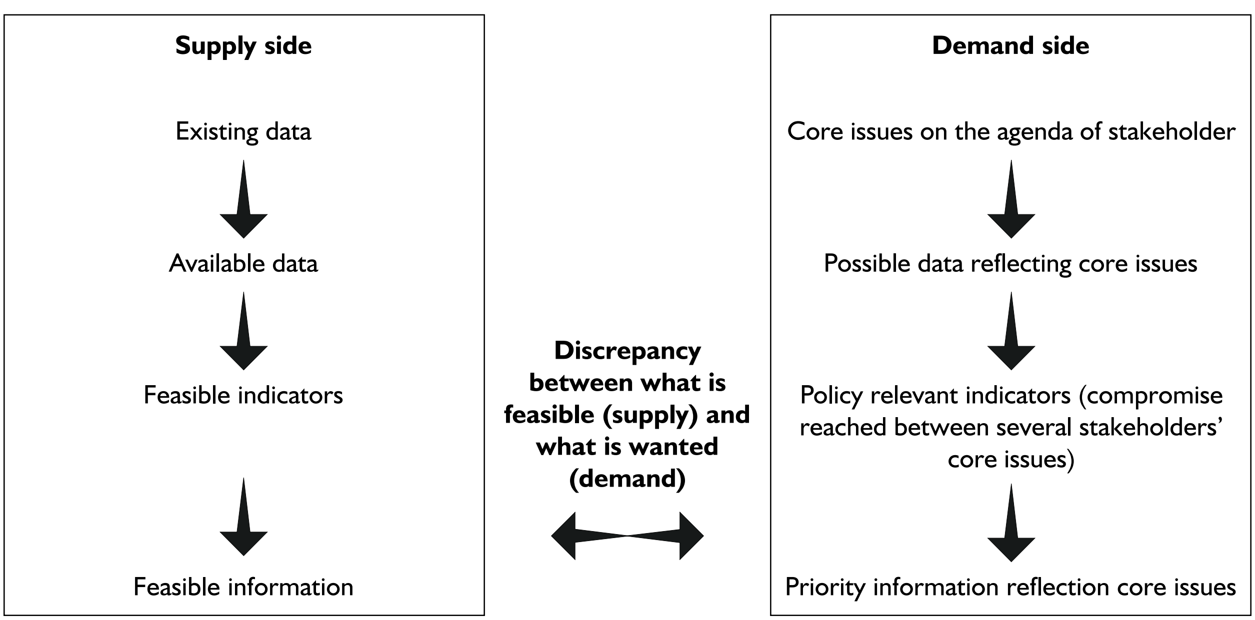
The demand side pulls in another direction. It is determined by the stakeholder and sector interests, and the need for information reflects what may be policy relevant. However, stakeholders and sector interests tend to move beyond what is necessary, because the demand for information also reflects the perception that more information is the path to more influence (as long as the costs of information are not considered). The selection of policy-relevant indicators should therefore narrow the wider expressed need for data by addressing key information needs (setting priorities) and balancing these with feasible indicators.

Many examples of the discrepancy between demand for and supply of information can be found in the real world, including biodiversity and environmental services provided by forests, which currently attract great interest. This increased interest is reflected in the demand for indicators on these topics. However, the lack of available data makes the supply of indicators almost infeasible (in the Central America case). The information can be collected (such as species monitoring) but at a high cost. In addition the resources may be more efficiently used to prevent biodiversity loss that has already been established rather than to continue to measure its decline.

A first step toward solving the dilemma of the mismatch between supply and demand can be to develop policy-relevant indicators from the available information, and then to cover identified information gaps. There are, however, some issues to be considered regarding an approach that only uses available data:

- Available information is never complete. Indicators are representative of a much larger set of data than has been used for the development of the indicator. The indicators are proxies for different types of impacts. For example, the reduction in the area of natural forests is an indicator of possible reduction in biodiversity. Indicators are a way of structuring existing sources of information in order to monitor the main impacts of complex policy decisions.
- Data collection and processing has a cost. Even existing data may not be available without a cost, and the development of indicators should include the costs of making both existing and new information available.

Figure 1. Demand and supply side of environmental indicators



- Data sources are not always reliable or comparable. Every source of environmental data is in itself an indicator, because data is sampled. For example, a forest inventory or bird population count is seldom made on the basis of a complete assessment. The quality of different sources of data is variable, which places a constraint on validity.
- The spatial and temporal distribution of data derived for indicators are dimensions to be addressed in order to monitor changes and pressure on natural resources in both the local, national, and regional context.

If an approach is selected that focuses on indicators with existing data, another common dilemma for the forest sector becomes apparent: timber production tends to dominate the feasible indicators, since most available data are on economic timber production. In contrast, fewer data are available on non-timber functions (biodiversity or carbon sequestration). Since the purpose of a decisionmaking process based on forest sector indicators is to achieve a *sustainable development*, goods and services of the forest sector other than timber production need to be included. Indicators are not an end in themselves, and the development of indicators for other forest functions is not crucial for sustainable development, but indicators can support sustainable forest development when relevant data are available.

It is possible to widen the scope of the forest indicators to include non-timber functions, but it requires efforts in both collecting data and developing methods for data collection. The principle behind using indicators in decisionmaking is to economize on data collection. Data on a few species that can represent impacts on forest resources may therefore be sufficient. It should be noted that existing data on forests (for example forest cover, forest types, and timber stocks), unlike data for most other sectors, also are quasi-indicators for areas such as biodiversity or carbon storage. The question is how much misinformation on the sustainable development of forests is generated by relying largely on existing information on forest area and timber production?

Given the various demands on any given set of indicators — criteria for relevance, the supply and demand for indicators and the information that they contain, problems of missing data and weak institutions — it is important to clearly identify a core set of indicators. These indicators should have the following characteristics: policy relevance, appropriate geographical-level focus, and implementation feasibility. The following section presents a set of candidate indicators for the forest sector.

Candidate Indicators for the Forest Sector

Indicators in the forest sector have been the subject of extensive work in many parts of the world. The aim has been to introduce a verifiable standard to ensure that criteria for sustainable forest management can be monitored, and eventually also certified. The organization is commonly based on a two-tier hierarchy:

- Policy level: *Forest principles and guidelines*
- Management level: *Forest criteria and performance indicators.*

Although there are some similarities between indicator sets to monitor sustainability at the forest management level and the development of a system of forest sector indicators that captures the development of key policy factors at the national or regional level, there are also fundamental differences. The monitoring and certification of *sustainable forest management* (SFM) and the forest management level is a potential source of existing data, but not all of this will converge at the policy level.

Performance indicators are used to measure compliance of a defined set of criteria for SFM within the overarching forest principles. While this approach has been generally applied, it is a weakness that the principles and criteria are formulated in broad terms that can make development of indicators cumbersome and reduce its applicability. The indicators reflect good intentions and common sense, but offer few opportunities to measure concrete performance or impact. The challenge is how to delineate sustainability through the agreed criteria and its application; that is, how to make the indicators measurable and operational.

In sum, stakeholders in the forest sector have different objectives and different needs. The forest industry and part of the public administration may be concerned with the availability of raw material, while others may be concerned with the extent and protection of the remaining natural forest resources. The differences in policy objectives could be resolved with a core set of indicators that is not targeted at supporting special interests only. Indicators may serve different policy objectives, but the indicators cannot themselves be policy objectives. Finally, there are also differences due the absence of a framework to develop and apply indicators.

A set of indicators have been put forward for Central America for *forest management* level, including five criteria and 50 indicators.[4] These are the "forest principles" developed in the same spirit as other forest indicators at a number of regional meetings (such as the Helsinki and Montreal processes).

The indicators developed in the criteria and indicators framework can be difficult to apply in practice. One reason is that they are developed in a context where the indicators reflect policy or stakeholder objectives rather than a tool to monitor the development or performance of a higher level of objectives. It is, however, possible to identify a typology of the different types of possible indicators; a generic list of types of indicators might include:

- *Basic data* (forest area or the annual extraction of logs)
- *Trend data* (rate of deforestation) and other data reflecting temporal changes
- *Impact data* (change in the area of forest affected by forest fires) where changes are recorded in a spatial setting
- *Check lists* (existence of forest legislation)
- *Qualitative information* (identification of stake holders)
- *Economic impact data* (improvement in economic profitability or forest products trade)
- *Social impact data* (accessibility, both physical and legal, to forest resources).

A simpler, indicator-type framework could be created consisting of basic data, derived indicators, and combined indicators. It is suitable to make a distinction between different classes of indicators (derived and combined indicators), and to start out with the basic data that are being collected in the field for the purpose of monitoring the forest sector or for other reasons (Table 1).

Table 1. Types of forest indicators

Type of data	*Basic data (absolute)*	*Derived indicators (relative)*	*Combined indicators (absolute)*
Explanation	Primary data collected	Change in basic data over a time period	Combination of two sets of basic data
Example	Forest area	Change in forest area	Average volume per hectare *or* Production per hectare

A forest inventory at the national level is the core of the forest resource basic data. A forest inventory is produced at high cost. Most countries with an inventory prepare it at intervals of at least one decade, but several countries lack a forest inventory. Moreover, there is a large degree of sampling when an inventory is made, and the standard deviations on the inventory estimates provide an indication of the reliability of data. A question therefore arises as to what extent changes over the years represent significant trends or sampling uncertainty. The data on forests are in general estimates, with a proportion of uncertainty especially for non-commercial stands. However, once established, a forest is likely to be in place for a number of years, and it is possible to acquire relatively accurate information on an annual basis by prolonging information from the previous inventory.

To make environmental indicators applicable to the forest sector (as well as other sectors of both rural and urban origin) a set of indicators could be defined following these indicator types. The indicators in this set could be monitored on a regular basis, even if the frequency differs. The forest area and timber stock may, for example, only be assessed every decade, while assessments of removals may be annually and prices quarterly. Examples of possible indicators are listed in Table 2. Hardly any of this information is readily available in Central America, and the cost of obtaining it should be carefully weighed against the benefit for decisionmaking. Collecting information for indicators has no impact unless the data is absorbed in policymaking.

Table 2. Some candidates of forest indicators

	Baseline data *(the state at a given location or point in time)*	***Derived indicators*** *(reflecting spatial distribution and temporal change in baseline data)*	***Combined indicators*** *(customized from baseline indicators)*
1. Forest resource availability (subdivided to species, age- and site-classes)	Forest area Productive forest area (e.g. NAI > 1 m^3 p.a.). Area of primary forest Area of legally protected forest conservation areas.	Area of deforestation Area of reforestation and afforestation	% rate of change in forest area Forest fragmentation Extent of forest frontier Forest area per cap.
2. Volume and production	Forest inventory Production of industrial roundwood and fuelwood Inventory of non-timber forest resources.	Annual growth Trends in the annual removal of timber Extraction of non-timber forest products	Net annual increment. Removal per ha of productive forest. Balance between growth and removal (potential misleading) Forest fragmentation
3. Consumption and trade	Consumption of industrial roundwood and fuelwood Volume of trade Value of trade	Change in consumption pattern Change in trade patterns Change in trade value	Wood products mass balance Deficit in trade balance ($) of wood products
4. Ownership	Forest area in public, private and common ownership.	Change in ownership structure.	% of area in public ownership
5. Economic impacts	Timber prices Cost of timber production Public sector revenue from forest sector	Change in timber prices Change in public sector revenue	
6. Social impacts	Number of people depending on forest resources	Conversion of forest areas through encroachment	
7. Biodiversity	Species inventory (e.g. number and spread of endangered species).	Changes in species diversity and density.	Indices of biodiversity richness
8. Environmental services	Stock of carbon Forest areas in riparian zones and catchments Number of forest recreational visitors	Change in carbon stock Location of forests protection water sheds	
9. Forest fires	Fire incidents and area burned	Change in forest fires incidents and area burned	Loss of timber and release of carbon due to fires

Chapter 3

Regional Forest Indicators

At a regional level, indicators for the forest sector are supposed to provide a general overview of the state and development of the forest sector in each country through a comparison of key information. A core set of indicators should be limited, and although any topic could be considered important by someone, it does not imply it deserves its own indicator. A set of a few standardized indicators furthermore focus and makes inter-country comparisons feasible.

Another argument for focusing on a few, rather than a large set, of regional indicators on forests is that there is no super-national decision making for the forest sector at the regional level. Policy making occurs at the national or local level while at the super-national level negotiations and collaboration occur that may result in national policy making. There are some efforts to produce standardized environmental data in order to respond to international environmental agreements or organizations collecting such information. There are also collaborative efforts in the region to compile regional data that makes it possible to compare the state of the forest sector and development across national borders. The scope for decision making, however, remains national but regional collaboration and information sharing provides new dimensions for developing and using these indicators.

A set of core indicators at the regional level commonly consists of national indicators from each country. One of the basic data at the country level and for a regional comparison, that a possible core indicator can be based on, is the *forest area* (Table 3).

From the basic data the *relative forest cover* can be estimated. The data from Table 3 are compared with a set of data compiled by FAO and similar data made available from national

Table 3. Forest area in Central America (*hectares*)

	Land area	*Primary forest*	*Secondary forest*	*Plantations*	*Total forest area*
Guatemala	10,889,000	3,030,200	360,000	89,900	3,480,100
El Salvador	2,097,000	34,298	275,989	6,593	316,880
Honduras	11,249,000	5,989,000	n.a.	8,647	5,998,247
Nicaragua	12,142,800	3,700,000	n.a.	64,172	3,764,172
Costa Rica	5,113,300	1,305,980	388,000	151,707	1,845,687
Panama	7,551,700	2,396,000	n.a.	26,724	2,422,724

n.a. : data not available

Source: CCAD 1998: "Estado del ambiente y los recursos naturales en Centroamerica 1998", Central American Commission of Environment and Development (p.94).

forest authorities (Table 4). Neither of the data sets can be proven to be wrong (or correct) and the differences merely illustrates uncertainty of data sampling and different definitions, e.g., of forest cover. The difference in the particular case can be a result of the definitions used, but since the difference is not one-sided there are probably also differences in methods applied within countries. The point is that even when asking the same question there are several answers that can be derived.

The inclusion of changes in the forest area over time, i.e., basic data on the forest area in different years, can provide some indication of the *net change in the forest area*. A decline in forest area is interpreted as deforestation (Table 5), although reforestation and afforestation may actually cover some liquidation of mature timber reserves in natural forests.

In the data from CCAD a somewhat different approach has been used based on the assumed area of annual forest loss rather than single year estimates of forest cover (Table 6). These data may be uncertain but they do provide an indication (as any indicator only will do) of the rates of national forest losses in Central America.

Table 4. Different sources of relative forest cover

	CCAD data %	*FAO data* %	*National Sources* %
Guatemala	32.0	35.4	34.4
El Salvador	15.1	5.1	n.a
Honduras	53.3	36.8	53.2
Nicaragua	31.0	45.8	35.41
Costa Rica	36.1	24.4	34.7
Panama	32.1	37.6	44.47

Source: Data from CCAD and FAO are adapted from CCAD 1998: "Estado ambiente y los recursos naturales en Centroamerica 1998", Central American Commission for Sustainable Development (p.94-95); Guatemala: PAFG, 1996; Honduras: COHDEFOR, 1994; Nicaragua: PAF-NIC, 1992; Costa Rica: MAG-IMN, 1992; Panamá: INRENARE, 1992. (National sources from CIAT).

Table 5. Rate of deforestation — FAO data

	Deforestation 1980-1985 (area ha) / (rate %)	*Deforestation 1981-1990 (area ha) / (rate %)*
Guatemala	72,000 / 1.6	81,300 / 1.9
El Salvador	4,000 / 2.8	3,100 / 2.5
Honduras	48,000 / 1.3	111,600 / 2.4
Nicaragua	105,000 / 2.3	124,000 / 2.0
Costa Rica*	65,000 / 4.0	49,600 / 3.5
Panama	36,000 / 0.9	64,400 / 2.0

Source: FAO,1985, Forest Resources 1980, FAO, Rome and FAO,1995, Evaluacion de los recursos forestales 1990, FAO, Rome.

Table 6. Rate of deforestation — CCAD data (Data from mid 1990s)

	Forest Area (ha)	*Deforestation (ha)*	*Rate of deforestation (%)*
Guatemala	3,480,100	90,000	2.59
El Salvador	385,087	11,653	3.03
Honduras	4,536,700	108,000	2.38
Nicaragua	3,764,172	100,000	2.66
Costa Rica	1,845,687	18,000	0.98
Panama	2,422,724	51,000	2.11

Source: Adapted from CCAD 1998: "Estado ambiente y los recursos naturales en Centroamerica 1998", Central American Commission for Sustainable Development (p.98).

The uncertainty of the forest area data is increased when moving towards indicators of *change in the type of deforestation*. A loss in forest area in any one period can occur as a loss of natural and secondary forests less the increment in forest cover from reforestation of former forest land and afforestation of other types of land. The matrix for changes in forest land area (Table 7) includes not only the loss of forest through deforestation but also the conversion between different forest types and of mature to young forest.

The matrix provides additional information than just the net deforestation rate, which is crucial in understanding the impacts of forest change. The deforestation rate does not capture whether there is a liquidation of the forest resource towards clearing forest for replanting or natural succession. It provides more of an overview of the dynamic changes in the area of different forest types. The matrix, however, does not reveal how large the parts of a forest that are under influence of logging and possible degradation. The downside of the matrix approach is that these data are not readily available, but this approach can be used to validate data on the area of deforestation, reforestation and afforestation. To monitor these trends over a longer period is ambitious and none of the countries in Central America appear yet to have such detailed level of information.

A further level of detail of forest indicators beyond the forest area concerns the *forest resource* in terms of timber stock, growth and removals. Basic data on the standing volume as well as the current net annual increment (NAI)

Table 7. Matrix for changes in forest areas

Converted to ------------------- *Converted From*	*Primary natural forest*	*Secondary forest*	*Plantation (reforestation)*	*Plantation (afforestation)*	*Forest converted to non-forest land*	*Forest area and non-forest land converted*
Primary natural forest		Primary natural forest logged and natural succession	Logged and replanted		Conversion of natural forests to non-forest uses	= Conversion of natural primary forest areas
Secondary forest (natural regrowth)		Logged and natural regrowth	Logged and replanted or "improvement" of degraded forest land		Conversion of secondary forest to non-forest use	= Secondary forest area converted
Plantations (reforestation/ afforestation)		Failed plantations taken over by natural regrowth.	Replanting after completed rotation.		Conversion of plantations to non-forest use	= Plantations converted
Non-forest area		Natural forest growth on abandoned land		Plantations on non-forest land		= Non-forest area converted to forest
Increment of area with young forest.	= None (Increment in area of primary natural forest not possible)	= New secondary forest	= Reforestation	= Afforestation	= Conversion of forest to non-forest area	*Net forest area under some conversion (impacts)*

Notes:

1. Net deforestation is the "conversion of forest to non-forest area" minus "non-forest area converted to forest."
2. The conversion from forest area with high stock (older forest) to low stock (young forest) is revealed in the matrix. The young stock may have a higher annual growth than the older forest, but the capital stock is reduced.
3. The matrix does not include impacts like low-impact logging in primary natural forests or commercial thinnings in plantations which do not result in a conversion to another forest type. The matrix does not take forest degradation or high grading into account.

are costly to obtain, and even at the forest management level a comprehensive inventory is expensive. Only when the stands approach economic maturity are there incentives for forest managers to intensify the level of inventory. The reality at country level is that only few countries have good inventories of even the commercial volume of standing timber resources, and for almost any assessment of the total increment in volume this is estimated by a fixed factor derived from experience and permanent measurement plots on the production of m^3 per hectare. While the total timber stock and its increment may be indicators in demand it is one example where the cost of the efforts to obtain such information may exceed the benefits of more accurate information.

A feasible approach to the assessment of the use of forest resources is through *basic data of removals*. This is a pressure indicator that can be more readily available than the state indicators of stock and increment. The removal of industrial roundwood in public forests will mostly be known, e.g., from taxation of concessionaires. The removals, however, are basic data that does not reveal whether the resource is sustainably used (e.g., whether the timber stock is non-declining). For the Central American countries estimates of the removal of wood is available on a regional level including the rate of fuelwood production compared to total wood consumption (Table 8).

Table 8 reveals that the major extraction of wood in the Central American region is for fuelwood. The share of industrial wood production is rather small in both absolute and relative terms. These figures do not reveal whether there is a sufficient and sustainable supply of fuelwood or whether a reduced fuelwood production could enhance the supply of industrial roundwood and processing of industrial wood leading to further development of a wood based industry.

FAO data are available from 1980 and 1990 on the consumption, production and trade in industrial roundwood and forest products for the six Central Americans countries.[5] This type of data makes it possible to develop national wood balances (a topic further explored in chapter 5). It can reveal to what extent there is a balance in wood consumption and production or whether a nation relies on imports. Dependency on wood and forest products imports does not have to be a negative impact in neither an economic nor an environmental sense, because trade may assist countries in utilizing their comparative advantages with regard to the costs of production, resource availability, environmental protection, and land-use for other production.

In a regional setting trade is a crucial indicator since this is what is linking forest sectors in different countries under the given conditions of market access and level of protective measures or other market interventions. One indicator for the development in markets is the market price on industrial roundwood but also on various other forest products (Table 9).

With a low level of the resource base for industrial roundwood the forest industry in Central America is not very developed, and these topics may not be exactly where there is a large need for further of information on the forest sector.

Table 8. Production of fuelwood and industrial roundwood (reference year is mid-1990s)

	Fuelwood (million m^3)	*Industrial wood (million m^3)*	*Share of fuelwood of total wood (%)*
Guatemala	7.11	0.31	96
El Salvador	5.30	0.32	94
Honduras	7.50	0.70	91
Nicaragua	3.70	0.27	93
Costa Rica	1.69	0.68	71
Panama	0.93	0.05	95

Source: Adapted from CCAD 1998: "Estado ambiente y los recursos naturales en Centroamerica 1998", Central American Commission for Sustainable Development (p.99).

Table 9. Trade in wood based forest products (1993)

	Exports (US $)	Imports (US $)	Trade deficit (US $)
Guatemala	3,634	66,913	63,279
El Salvador	104	45,121	45,017
Honduras	29,306	39,913	10,607
Nicaragua	523	6,115	5,592
Costa Rica	2,454	111,408	108,954
Panama	3,658	37,514	33,856

Source: FAO Forest Products Yearbook (1993).

Having discussed some of the most common, and important, indicators of the forest sector as well as the data availability for these indicators, it is now time to focus on the set of regional core indicators for the sector.

A Regional Core Set of Indicators

One proposition is that the core set of environmental data is a selection of basic data. These are the building blocks for indicators and with an excellent core set of basic data available in time series and spatially, it is possible: (i) to develop customized indicators to meet the needs of a given decision process, and (ii) to define and improve the input to a set of more advanced forest sector indicators which, for example, can be used for inter-country comparisons and as a consistent reporting mechanism to international agencies and environmental agreements.

Occasionally, the available forest sector data used as indicators are in a form where the basic data cannot easily be assessed. This is for example the case with data on percentage rate of deforestation or trade in forest products. It becomes a problem for the quality assurance and the merger of different data sources to build time series, and without information about the basic data a comparison across countries and time is deceptive.

However, considering that indicators are supposed to give a first indication of the condition of a sector, creating a core set based on indicators, rather than basic data, can provide more information with less indicators. A core set of regional forest sector indicators can still be

Table 10. Suggested set of feasible regional core indicators

	Forest area[1] (1,000 ha)	Rate of deforestation[2] (%)	Annual wood removal[3] (million m^3)	Fuelwood share of removals[4] (%)	Trade deficit[5] (USD)
Costa Rica	3,480	2.59	7.4	96	63,279
El Salvador	385	3.03	5.6	94	45,017
Guatemala	4,537	2.38	8.2	91	10,607
Honduras	3,764	2.66	4.0	93	5,592
Nicaragua	1,846	0.98	2.4	78	108,954
Panama	2,423	2.11	1.0	95	33,856

Notes: All data are from the mid 1990s.
1. One of the basic indicators from the forest inventory. The relative forest area can be derived by comparing forest area and total land area.
2. The rate of deforestation can be derived from net changes in the forest area.
3. The annual wood removal is an indicator of the use of the forest resource (pressure) as well as economic availability and demand.
4. Fuelwood share is a derived indicator that reflects to the policy makers the relative importance of fuel wood production.
5. The trade deficit in forest products is derived from the export and import values which are derived data from trade statistics.

based on the available information. Table 10 presents a feasible but not necessarily the only possible set of core indicators for the forest sector at the regional level in Central America. Rather than including every single indicator possible at the regional level the selection of a core set of indicators reflects a prioritization of the important indicators. The importance of an indicator is here both determined by the availability of data (supply side) and policy relevance (demand side).

The core set presented in Table 10 is a pragmatic set of indicators aiming at feasible indicators that provide a first impression of the forest sector. There is some scope for customizing indicators by a comparison with other basic data, e.g., relative forest cover, forest area per capita, and wood consumption per capita. There is a bias towards wood production and commercial use but this is a result of the available data and not the importance of "soft" issues such as ecological, social and institutional issues. The explanation is that it is difficult to derive indicators on these topics. In the short-term, the decision makers therefore have to: 1) identify trade-offs and not use indicators as the only basis for decisions, and 2) recognize that due to joint production in forestry, a production oriented indicator may also comprise "soft" information. In the long-term, however, a strategy for including and monitoring "soft" issues should be discussed and implemented.

To be able to discuss forest indicators in more detail, including indicators that are geo-referenced, the next chapter focuses on Honduras and its available data on the forest sector.

Chapter 4

The Forest Sector in Honduras

Key Information on the Forest Sector in Honduras

Honduras has one of the most developed forest sectors of the countries in Central America in terms of economic development and industrialization. One explanation is that unlike other countries in the region a large share of the forest resource in Honduras consists of native pine forests (softwood). These pine forests are located particularly in the high-lands in the center of the country while the hardwood forests are predominantly located on the Northeastern part.

The total forest area in Honduras according to the ITTO data is 6,112,000 ha with 53 percent in production forest and 47 percent in protection forest, and these are almost equally divided between the hardwood and conifer forest area (Table 11). The official 1997 statistics from COHDEFOR, the national forest agency in Honduras, has a total forest area of 5,989,600 ha. It is a 2 percent reduction equal to the approximate deforestation rate.

The standing volume of the forests is always an uncertain estimation. Figures from COHDEFOR suggest that the total volume is 603 million m^3 and this is probably commercial stock only (about 100 m^3 per ha on average). Of this 36 percent is in conifer stands, 58 percent is in hardwood stands, and the remaining 6 percent in other stands like mangroves. However, more than 90 percent of the timber production (removals) is from the pine forests which reflects a likely higher production capacity of this forest type (lower average stock but higher average annual increment). The uncertainty and technical difficulties in estimating these figures imply that time series on the development of the timber stock are not likely to be available.

The only data that are available as a time series cover a relative short period and only the removal of industrial roundwood (Table 12). No data on fuelwood extraction are available. Note from the previous chapter that the industrial roundwood production is estimated to be only about 10 percent of the total wood extraction. Thus the removals of industrial roundwood is only a small share of the total production of wood. The largest share is fuelwood with an estimated volume of 6–7.5 million m^3 harvested annually.

Table 11. Forests areas in Honduras, 1996

	Production forests (ha)	*Protection forest (ha)*
Hardwood	1,932,000	1,357,000
Conifers (softwood)	1,308,000	1,515,000
Total	3,240,000	2,872,000

Source: ITTO country profile of Honduras (www.itto.or.jp/forest_update/v8n2/22.html).

The estimation of an exact figure of fuelwood harvests is highly uncertain because the amount of fuelwood is not monitored to the same extent as industrial roundwood removals. The

Table 12. Removals of industrial roundwood in Honduras (1993-97)

	Conifers (softwood) (1,000 m^3)	*Hardwoods (1,000 m^3)*	*Total industrial roundwood removal (1,000 m^3)*
1997	663.8	41.2	705.0
1996	613.0	32.2	645.2
1995	469.8	4.8	474.6
1994	693.0	3.8	698.9
1993	584.5	5.6	590.1

Source: Data from COHDEFOR 1997: "Annuario estadistico forestal 1997" as compiled by CIAT.

removal of industrial roundwood is easier to monitor because some accounts are kept of these volumes, e.g., for taxation purposes. The removal of hardwood, as it appears in the statistics in Honduras, is insignificant but increasing in terms of volume extracted, and the bulk of the industrial wood removal is pine. Annual variations in the production may indicate resource availability. However, there is no clear indication whether a declining or increasing trend in removals indicates resource depletion. The linkage between the level of removals and sustainable timber production is not straightforward even if harvest is compared to increment. Variations in removals also reflect changes in market prices, industrial capacity and institutional arrangements, e.g., incentives and disincentives in the forest legislation.

A general conclusion is that the availability of data that may qualify as core indicators for the forest sector are scarce. There are few data available that for example enables the construction of reliable time series. The challenge is to be able to move beyond data extracted from scattered sources of information towards a more strategic approach where the collection of data for core indicators is balanced with the information needs of the policy makers in the forest sector. One remarkable observation from Honduras, in particular, is the extensive data collection presented in annual reporting performed by the national forest agency (COHDEFOR). A valuable assistance to COHDEFOR would be to convert the collected *data* into *a core set of forest indicators* that are manageable and have policy relevance.

Developing Geo-referenced Forest Indicators for Honduras

Forest data from Honduras are also available at a sub-national level from different provinces. Moreover, some geo-referenced information is already available which can be linked to existing basic data. In this paper, three examples of base maps are discussed that provide an overview of the forest area development in Honduras over a decade and give some indication of the forest frontiers. These types of indicators are *ex post* and do not yield direct up-front information for decision making in the future. In addition, three thematic maps are introduced which depict issues related to forests such as forest fires, floods, and accessibility.[6]

The spatial presentation of forest indicators adds a new dimension to the identification of national forest planning compared to other formats like tables and charts since maps provide an opportunity to present geo-referenced information in a superior way, e.g., overlaying of indicators. Maps are thus a strong form of presenting spatial relation and in particular the correlation of more than one set of basic indicators. However, the major advantages of a presentation of forest indicators on maps can also be counted among their major drawbacks. One drawback is that maps can make it difficult to assess the quality of the underlying data sources and basic data used, and colorful maps can be deceptive and confirm unreliable data. A critical factor is therefore the validity of data and the risk that mapping becomes an implicit validation of data sources because a quality assessment is not feasible from the maps and the comparability of different sources of information and definitions is not disclosed. There are, for example, forest locations in the 1994 map that are shown as deforested in the 1985 map that cannot only be a result of afforestation (for the maps, see Annex A). The example is a case of conifers and mixed forests in the Central and Western part of the country, and it reveals some of the limitations of maps to describe impacts, if the primary data are not consistent with the objective.

One of the main purposes with the base maps shown in Annex A is to provide an analytical background for the assessment of more specific issues depicted in thematic maps. An example of a thematic map is *forest area and accessibility to markets,* which combines several layers of information in one map to address the issue of accessibility and pressure on the forest resource (Annex A). Accessibility is defined as a geo-referenced indicator of the time it takes to get from a given location to any smaller or larger urban community. The accessibility takes into account road access and topography and to a lesser extent mode of transportation. The indicator of access *to* a market or smaller urban community *from* a given site is also an indicator of access *from* a market or smaller urban community *to* a given site. In economic terms, access is of importance when determining the land value of alternative land uses. Hence, access risks exerting pressure on natural forest resources in two ways: (1) through an economic pressure to exploit the resource, and (2) by augmenting the value of land for alternatives uses such as agricultural crop production. A substantial share of global natural forests is protected because exploitation is not economically profitable.

The map reveals (not surprisingly) that no forest cover results in a higher accessibility. It also shows how access increases along the forest frontier. What cannot be deducted explicitly from the maps is whether, for example, access results in deforestation, deforestation improves the condition for access or deforestation increases the population density and thus the demand for infrastructure? But it is the experience that improved access also increases the pressure on natural resources. What is often happening with indicators is that they are used for deductive arguments, however, in most cases there are no causal relationships from the environmental data.

The second thematic map shows forests and floods in Honduras. The floods resulting from hurricane Mitch (in 1998) are here presented together with the forest area. Floods did not occur in forested areas, but this is no surprise since forests remain on higher elevations while floods occur at a lower. The spatial overview does not lead to clear conclusions on the importance of forest cover to protect against floods. But it does show where there is a possible interaction between forests and mitigation of flood impacts worth a further assessment. It would also be expected that in extreme situations like with hurricane Mitch, the forest cover has only small impacts on floods, but may play a protective role in the case of the more significant problem of mudslides.

The incidence of forest fires in 1993, if depicted in a map (Map 6 in Annex A), reveals two interesting observations. Firstly, the fire incidences are scattered equally over a large proportion of the country except in the forest areas and this could indicate a strong human influence. Secondly, there is a strong concentration on the same Western part of the broadleaved forest core, where the forest area maps revealed fragmentation. Thus from a policy perspective is seems that action could be focused on the fire incidences along this forest frontier.

In the development of forest sector indicators the proposed procedure is to extract information from available data, and from there decide on a core set of indicators. The selection of core indicators is balanced by data availability, stakeholders' interests, and policy relevance. It is not possible to monitor and collect data on everything, so the development of indicators should be pragmatic in order to be applicable.

Once a core set of indicators for the forest sector is established it will be available as a tool which may be developed to more advanced forest sector indicators. The following chapter introduces three different options of advanced forest sector indicators.

Chapter 5

Possible Developments of Advanced Forest Sector Indicators

Although not feasible at the moment, an objective may be a more strategic approach to the development and use of indicators in the forest sector in Central America. A large challenge is therefore to develop indicators that reflect a wider range of forest goods and services including those where few data are available, like social and environmental impacts. As a first step towards this more strategic approach, this chapter is discussing some prospects for advanced forest sector indicators.

With the availability of basic data from primary data collection on forests it is possible to develop more advanced and complex indicators. Three different types of indicators are considered which can be further developed:

- A *wood utilization balance* to determine the domestic consumption and the sources to meet this demand. This could give an indication of domestic production compared to domestic supply and the vulnerability there could be from a dependence on trade in regional or global forest products markets.
- A *carbon account* for the forest sector monitoring the trend in the net sequestration of carbon. This could be of relevance if the national government wish to link the forest sector in the national policies to eliminate the net emission of gasses contributing to climate change.
- An *asset valuation* of the forest resource which is an economic assessment of the capital value of forest resources. This could be included in an expanded version of the national accounts that takes into account natural capital and its depreciation.

There is at present neither sufficient data nor national capacity to develop these indicators for the countries in Central America. But if the collection of basic data is systematized and carried out on a regular basis, there will be a possibility to use this information to develop more advanced forest indicators. This chapter serves as an illustration of such prospects.

A Wood Utilization Balance

Much concern arises around the topic of self-sufficiency of wood and forest products. One issue is the maintenance of a sustainable supply of fuelwood, fiber and logs from the forest sector, and another is the reliance on supply of forest products through trade. An indicator, such as the wood utilization balance, is related to the consumption pattern of wood and forest products where the supply of roundwood to domestic processing and final consumption plus trade is balanced with the net import of wood and forest products.

Production, consumption and trade data for the six Central American countries for all main categories of roundwood and forest products are available from FAO. These data form the basis for a wood utilization balance. For each forest product commodity the consumption is calculated by adding imports to production minus exports (consumption = production + imports – exports). One example is for sawnwood in Honduras for which data are presented in Table 13.

The sawnwood data show that the production in Honduras has dropped by one third. Furthermore, due to this drop in production, reduced exports or structural changes in the sawnwood industry have occurred. (There may be an explanation, e.g., a trade regulation of sawnwood). The domestic consumption has increased by 6 percent from 1980 to 1994.

The main categories of final consumption of forest products are listed in Table 14. Industrial roundwood or different types of wood pulp are not listed to avoid double counting, because these are intermediary products, i.e., roundwood is used for sawnwood and panels, and pulp is used for paper and paperboard.

With an assumption of conversion factors to produce forest products it is possible to estimate the total consumption of wood. If it, for example, is crudely assumed that the average conversion factor is 50 percent for all forest products, the total consumption of wood in forest products is 688,000 CUM in 1980 and 830,000 CUM in 1994. The consumption of industrial roundwood in Honduras was 1,082,000 CUM in 1980 and 540,000 CUM in 1994. However, this is not a relevant comparison, because the Central American countries import most of the paper and paperboard consumption. The reason for this is that the forest sector in any of the countries is not sufficiently large to supply a pulp and paper industry. The total consumption of wood could be in the order of 6.5 million CUM in 1994. With a population of around 5.8 million this is about 1.13 CUM per capita, with almost 90 percent consumed as fuelwood.

The preparation of an index for wood consumption is feasible but rely on various data sources, the technical conversion rates, and the production and net trade. In the estimation there is a risk of double counting, e.g., residues from sawmills are used as fuel or as an input to paper or fiber board production and it is a challenge to factor these out. As a control, the wood balance can also be addressed from the supply side.

Carbon Accounts

One of the most direct examples of joint production is that between timber and carbon sequestration. A distinction can be made between the rate of carbon accumulation and the storage capacity of the forests, where the important is the latter, which is a functional relationship between the rate of sequestration and the time lag before release and possibly replacement through regrowth. The time lags and the overlapping uptakes are what in the end results in a net sequestration of carbon in a plantation.

Estimating the carbon storage in forests is not interesting because carbon provides direct benefits in itself to the forest owner, local communities or the country. The reason is the suggested mechanisms of the Kyoto protocol in the Framework Convention for Climate Change (FCCC) where there may be a possibility of a

Table 13. Sawnwood production and consumption in Honduras

Year	*1980*	*1994*
Production	560	362
+ Imports	0	0
- Exports	269	53
= Consumption	291	309

Table 14. Final consumption of forest products in Honduras

	1980	*1994*
Fuelwood (1,000 CUM)	3,704	5,701
Sawnwood (1,000 CUM)	291	309
Wood based panels (1,000 CUM)	10	17
Paper and paperboard (1,000 MT)	43	89

future market for carbon sequestration or reduced reduction in commitments to net reductions.

In the forest sector carbon accounts are made by linking them with the forest inventory. If there was a general interest in the amount of carbon in the forest sector the standing volume would be an important indicator, although there are differences in carbon content among different tree species and among different forest ecosystems when litter and subsoil organic matter are included. The assessment of the current carbon stock is commonly assessed by multiplying the following factors:

- The volume of commercial timber stock according to national forest inventory.
- The carbon content per CUM (dry-matter weight, which varies among tree species, times 0.5, the carbon content of dry-matter).
- The "expansion" factor, which takes into account non-commercial above ground non-commercial wood biomass, debris, litter and below ground biomass in roots.

The carbon content will thus be estimated based on the inventory and technical coefficients. A full measurement of the carbon content is unlikely, although some trials could be made to establish a more concise basis for the content of carbon in wood biomass of different tree species and the relation between commercial timber in the inventory and total biomass in forests including soils.

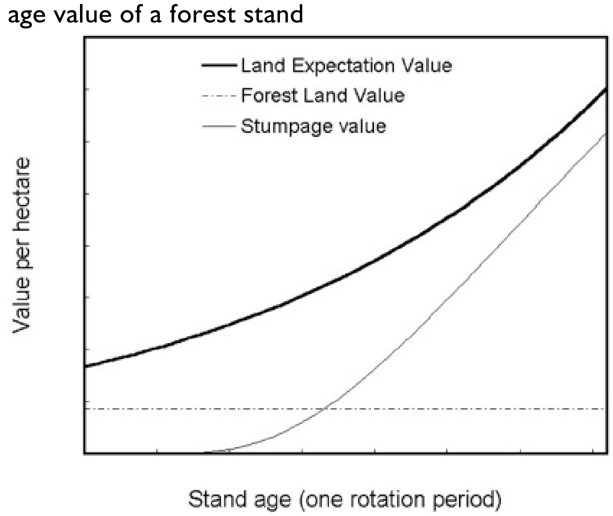
The change in the carbon stock can thereafter be monitored by comparing stocks in various years. The bottleneck is the lack of a sampled inventory of commercial timber stocks. Although data exists on the forest stock these are in the case of Honduras not derived through sampled data collection but through the application of fixed coefficients to the forest area of different forest types. The carbon account will then vary only by the variation in the forest area, which would make it a quasi-indicator.

Asset Values of Forests

Forests are a natural capital asset. As a renewable natural resource, they also offer an opportunity to invest in natural capital through afforestation of non-forest land, reforestation of former forest land, and rehabilitation of degraded forest land. The natural capital of forests can be included, for example, in the asset balance of the national accounts, and the asset value can be an indicator of the development of the forest capital in a measure of national wealth. It is not a rule that forest capital shall be non-declining. The point is that excessive extraction results in a declining asset value, which in turn becomes a loss of welfare. This loss in welfare can be monitored, and preferably counterbalanced by an increase in welfare somewhere else.

The valuation of a forest is unfortunately not straightforward even if only the marketed (price) products are considered. One simple approach has been to multiply the standing volume with a unit stumpage value, i.e., the difference between the market price and costs of extraction. Although this approach seems straightforward it is not recommended because the value of a non-mature forest stand exceeds the current realization value, i.e., the stumpage value (Figure 2). The asset value (land expectation value) is the net present value of all future returns from the forest and this requires in addition to information on prices also information on harvesting schedules and logging volumes, future prices and the discount rate. Furthermore, in addition to the value of timber, the forest land also has a value due to the economic return of growing trees and an opportunity cost from excluding other uses.

Figure 2. The land expectation-, land-, and stumpage value of a forest stand



The asset value of the timber stock and forest land is an economic approach to sustainability, but it does offer some useful approaches to the assessment of the development of forest resources which is not considered in a physical account of hectares and cubic meters. This is, for example, the ability to consider a forest as natural capital taking into consideration the location and quality of the resource. It is a high-end indicator that combines basic and derived indicators of both physical and economic dimensions. An example of a possible application is for the inclusion of natural resources in the expanded system of national accounts. Few, if any, countries have made it all the way to an asset valuation of forest resources for this purpose.

The World Bank has estimated natural capital, including forest assets, for the measure of national wealth. Table 15 provides an example of country level data for Central America. These are indicators at the higher end of more advanced indicators, composed by basic information together with technical and economic assumptions. The final product can be useful information for decision makers at the national level. The downside is that these indicators can not easily be verified or reproduced by the national level users, who may therefore not have the same trust in these figures compared to indicators developed by the users.

Table 15. Country level natural capital estimates in Central America

	Natural capital	*Pasture land*	*Crop land*	*Timber resources*	*Non-timber forest benefits*	*Protected areas*	*Sub-soil assets*
	$ per capita	*Per cent of natural capital*					
Costa Rica	7,860	19	72	2	1	5	..
El Salvador	1,150	22	77	1	0	0	..
Guatemala	1,720	18	54	10	6	9	4
Honduras	3,380	12	47	24	6	7	3
Nicaragua	3,690	15	57	16	10	2	0
Panama	6,300	15	63	4	5	13	..

Source: World Bank, 1997: "Expanding the measure of wealth - indicators of environmentally sustainable development", Environmentally Sustainable Development Studies and Monographs No. 17.

Chapter 6

Concluding Remarks

This paper is an attempt to derive a core set of indicators that would inspire the use of indicators in the forest sector in Central America. The approach used in the paper makes it clear that by working with feasible information it is possible to make a first leap without loosing touch with neither the users' needs nor the reality of the data. A major drawback is that existing data reflect economic uses and there is little information available to meet the needs for indicators on the environmental and social functions of the forests.

A fundamental approach towards the development and use of indicators is suggested in the paper. It consists of the following steps:

- Identify available data
- Prioritize the data by selecting the feasible set of core indicators
- Develop composite use of indicators by using the core set of indicators to develop policy oriented indicators.
- Apply both the core set of indicators and the composite indicators to monitor the resource, to develop forest policy, and for a dialogue with stakeholders.
- Extract the policy relevant information from the results of the monitoring.

Not all available data should be considered as indicators for the forest sector, and not all desirable indicators can be supported by sufficient data (within reasonable costs). The discrepancy between desired and feasible indicators imply that there is insufficient possibility (technically and economically) to support a wide range of indicators. There is a need to prioritize and develop indicators within the scope of forest sector policy, existing learning systems, and technical skills among the users.

Traditionally, there has been a narrow focus on the timber production side in discussions of the forest sector. It should be stressed that there are other forest resources and services than timber production, and some of these can also be inventoried and included as forest indicators. One example is the monitoring of key species of both plants and animals, which reflects the disturbance and development of the diversity of the forest ecosystem. In the case of the Central American countries this may be desirable from the policy point of view but not yet feasible from the data point of view.

Non-timber forest indicators are another branch of forest indicators that can be developed later, but just because these resources are not currently being as closely monitored or mentioned does not imply they lack importance. The purpose of this paper has been to use what is feasible from available data. There are some good reasons why the monitoring of the timber resources is an applicable point of departure:

- The information on the timber resource is more readily available due to the commercial importance although data quality may vary. A national forest inventory is the outset for a core set of indicators for the forest sector.

- The joint production in forests indicates that if an area is covered with forests (and in particular also if this forest maintains some structure and biomass) this is an indicator of a wider existence of other forest resources than timber. There are modifications to this assertion, e.g., when a natural forest is replaced by a plantation.

It is a finding that the ability of a country to develop the core set of indicators can be judged on the quality and frequency of the national forest inventory.

The lesson for decision makers and other stakeholders in the forest sector is that the sector indicators are only one part of the available information for decision support and communication. Indicators can be developed where this is feasible but their outcome needs to be combined with more soft approaches to topics that are difficult to monitor:

- Social issues and impacts
- Ecological services and biodiversity
- Institutional capacity and changes in policy objectives.

These may at some stage also be reflected through indicators but that stage has not yet been reached for the forest sector in the Central American countries. The development and use of indicators is complementary to gaining further insight and understanding of social, ecological and institutional processes.

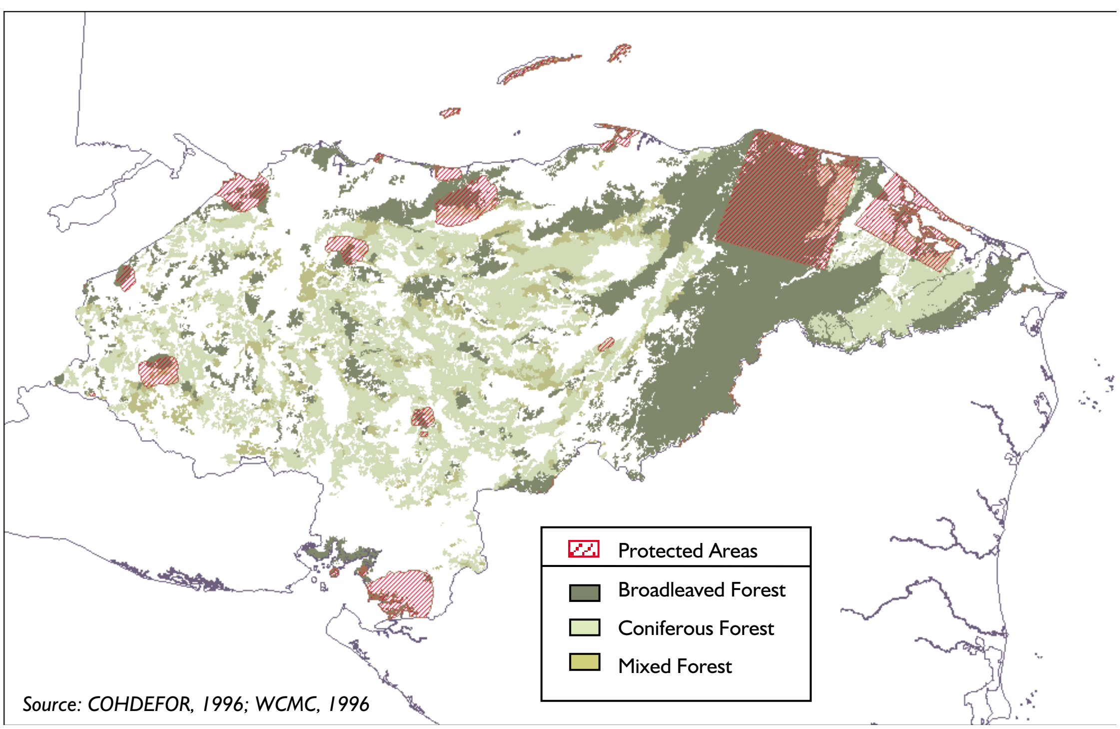
It should not be neglected that information (objective or manipulated) in the form of indicators can be powerful in providing access to the policy agenda. If there is sufficient information to raise an issue in the forest sector it can, through public attention, open the policy agenda for forest policy changes. Finally, indicators are not to be ready-made by technical experts for any predictable occasion. Indicator development can have more impact if an agency (or stakeholder) based on sector knowledge and the building blocks from a core set of indicators can develop their own customized set of indicators describing a particular policy problem. Indicators should not drive the policy agenda but they should be instrumental in assisting stakeholders including decision makers in defining policy problems and solutions in the forest sector and how to monitor their impacts.

Annex A

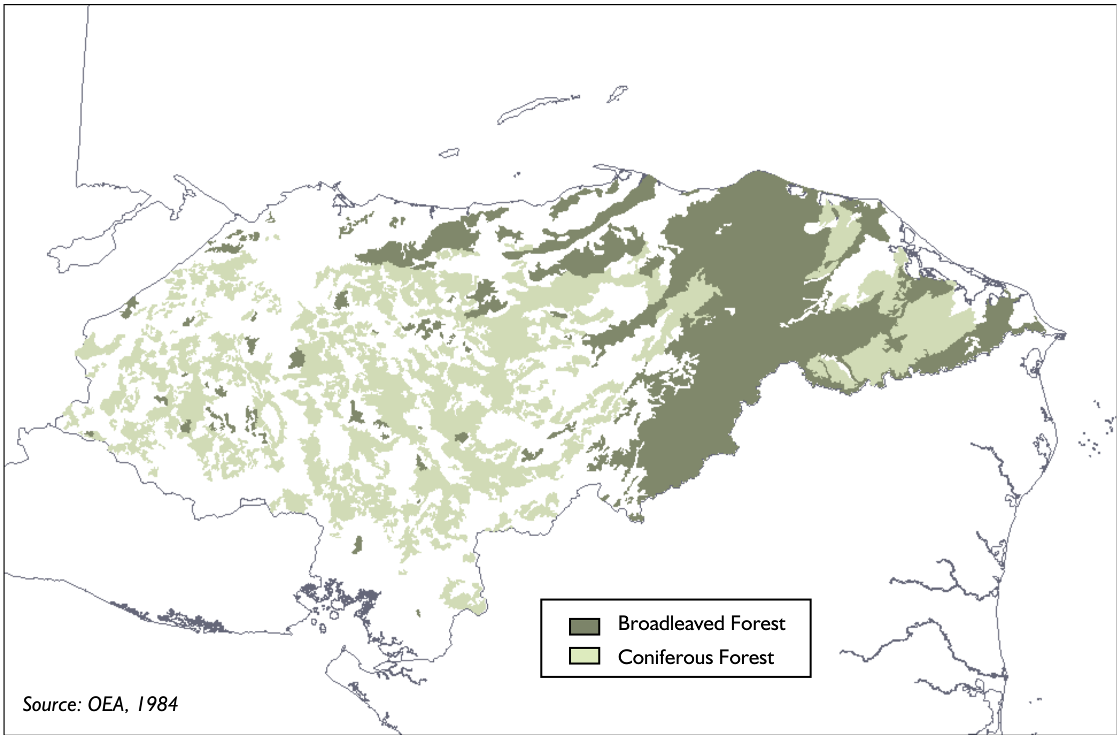
Maps of Forest Area and Related Issues in Honduras[7]

Base maps: Forest resource maps of the forest area

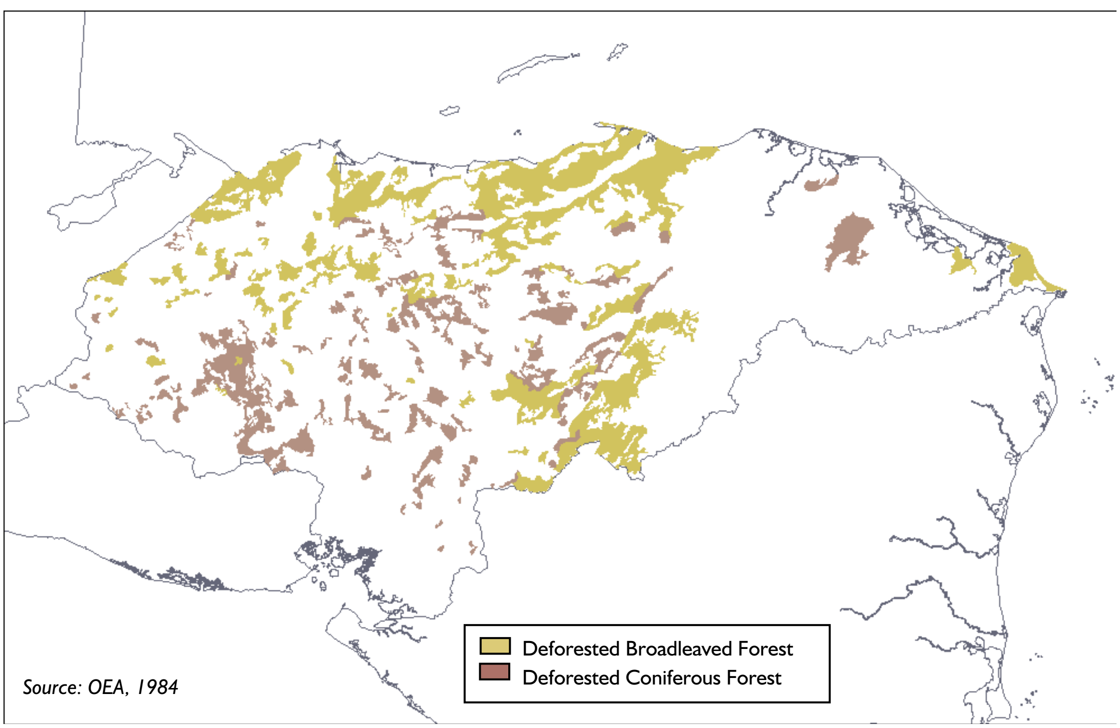
Map 1. Forest area in 1994 (including protected areas), Honduras



Map 2. Forest area in 1985, Honduras

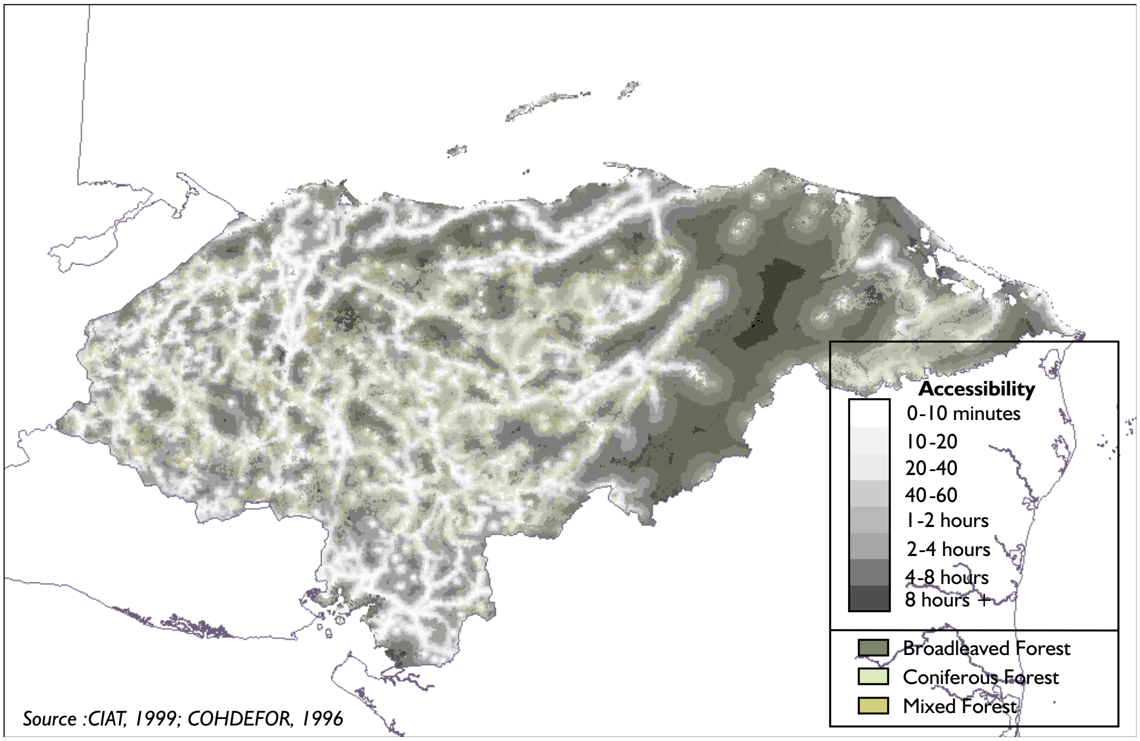


Map 3. Forest area that was already lost in 1985, Honduras

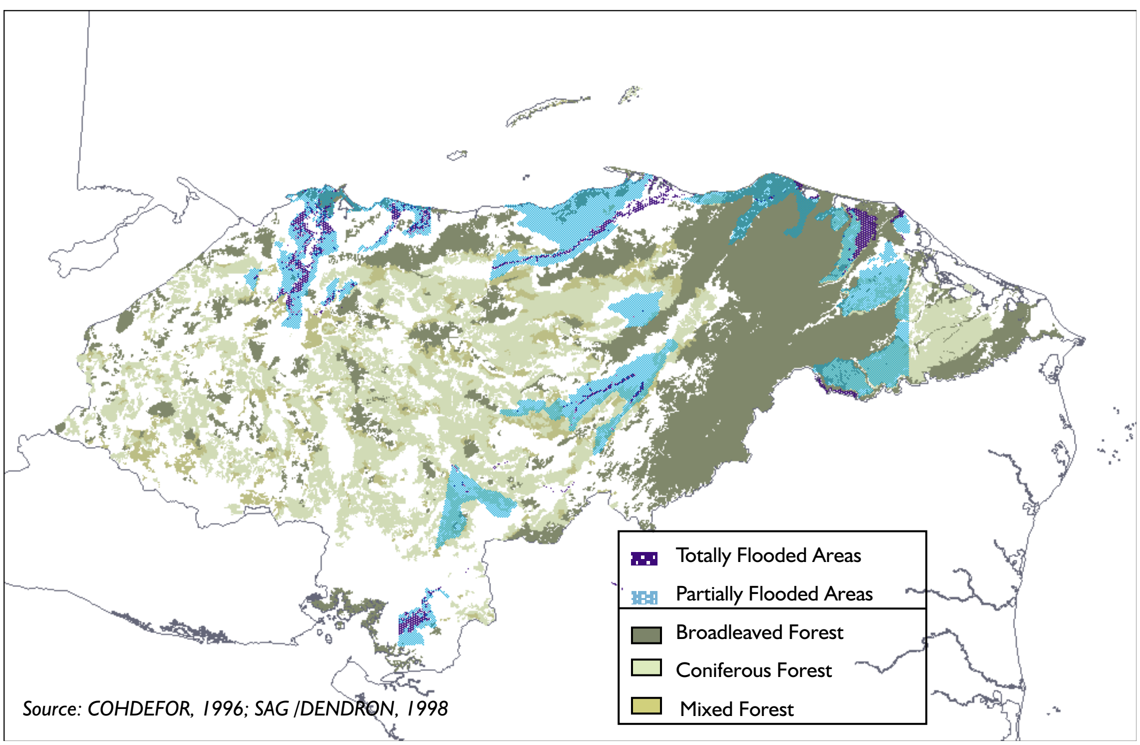


Thematic maps: accessibility, floods and fires

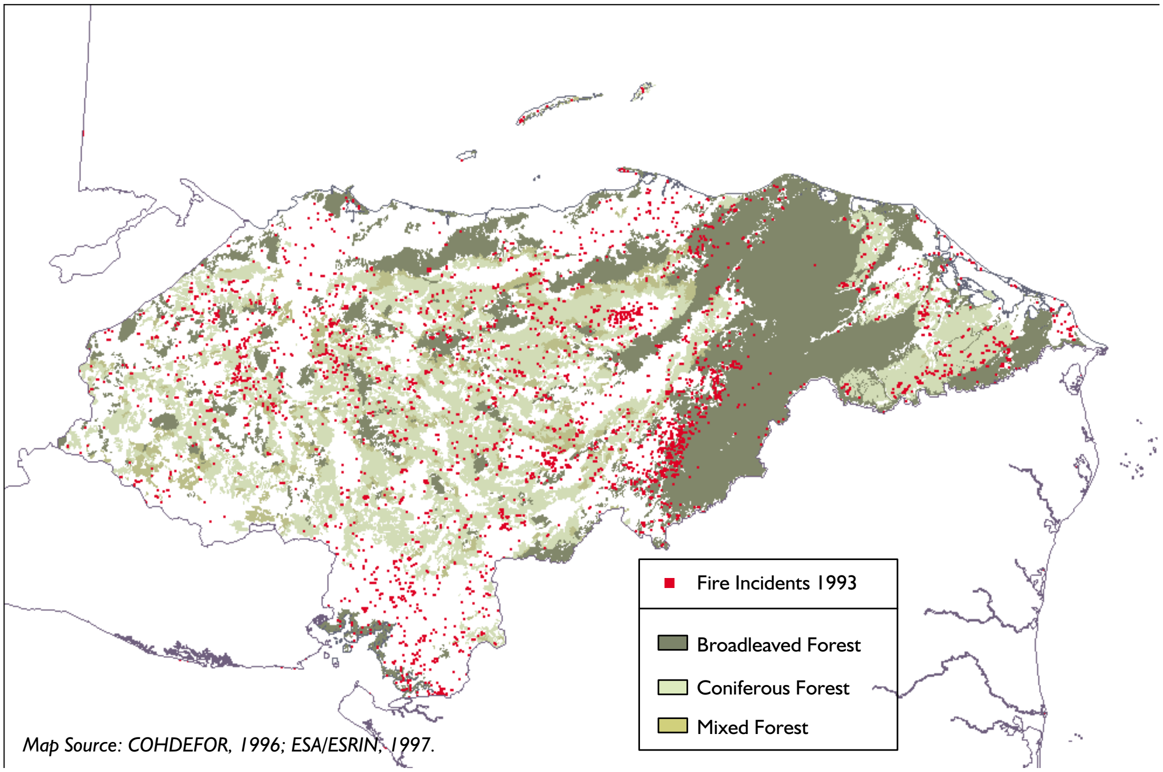
Map 4. Forest accessibility, Honduras



Map 5. Forest and floods, Honduras



Map 6. Forest fires, Honduras



Annex B

Conceptual Framework for the Development and Use of Water Indicators

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Introduction

Sustainable development, and indicators to monitor it, implies a systemic approach. Nevertheless the management and policies for some resources are still organized at the sectoral level. For this reason, in the context of the CIAT/World Bank/UNEP rural sustainability indicators project —besides the development of environmental and sustainability indicators at different scales and levels—a goal is to develop *sectoral indicators*.

Water is one case where the management of a resource is still sectoral. Water resources play a vital role in the lives of all people and in the functions of ecosystems. At the same time, they may appear as one of the most endangered natural resources in the world. The present document is a technical note that introduces a framework that can be used in the development and use of water indicators. Two different indicator approaches are presented—a project-based approach and the Pressure-State-Impact-Response approach.

First steps

The two first steps for any indicator developer are i) problem identification and ii) establishment of objectives. The phase of *problem identification* is necessary to focus the selection of indicators. Even if the choice to study water as a sector is a way to narrow down the selection, an identification of the specific issues – aspects of water quality or water quantity – is usually helpful. The problem identification can be achieved in two ways. One is public consultations. Key stakeholders that should be consulted include those who cause or are affected by environmental problems (e.g., industry and population in the project area), those who have relevant information and expertise (e.g., the scientific community, international and local NGOs, and the media), and those who control implementation instruments (governments). The other way is through literature reviews. Usually a combination of the two is the most efficient.

Both the problem identification and the *establishment of objectives* benefit from being as detailed as possible since that will enable the indicator selection and policy formulation to be specific. Vague or overly broad objectives, such as "improving water quality", are of little use in selecting indicators (and may well indicate that the project or component itself is not very well thought out). The *establishment* of objectives is, however, only the first step—they are not of much use if the advances of the project are not measured against them. This implies a need to measure the environmental problem at three points in time: before the project begins (to obtain baseline values), during project implementation (to enable changes in the project design if deviations from the objectives are noticeable), and after the project has ended (to compare baseline values to targets). Hence, to identify and establish appropriate and reachable objectives, causal links must be clearly identified.

Selection Criteria[8]

There is no universal set of indicators that is equally applicable in all cases. However, the following criteria are appropriate to most indicator selections:

Direct relevance to project objectives. The indicator selection must be closely linked to project objectives and the environmental problems being addressed. Where the environmental impact is not the primary objective, an Environmental Assessment process can outline the potential impacts and hence help select indicators.

Limitation in number. A small set of well-chosen indicators tends to be the most effective approach.

Clarity in design. It is important that the selected indicators are defined clearly in order to avoid confusion in their development or interpretation.

Realistic collection or development costs. Indicators must be practical and realistic, and their cost of collection and development therefore need to be considered. This may lead to trade-offs between the information content of various indicators and the cost of collecting them.

High quality and reliability. Indicators, and the information they provide, are only as good as the data from which they are derived. If the "ideal" indicator to measure a problem is based on unreliable data, it is common to depart from the "ideal" indicator and use proxies instead.

Appropriate spatial and temporal scale. Careful thought should be given to the appropriate spatial and temporal scale of indicators. Since the environmental impact of project activities seldom coincides with administrative boundaries, indicators often need to be measured on different scales. There might also be lags in time before project effects are felt.

The interpretation of the indicators selected based on the above criteria, is further facilitated if they are structured according to a framework. The following section introduces two possible approaches to such frameworks.

Indicator Approaches

A project based approach

One approach is depicted in Figure 3. In this, the focus is on a project—a water project has both overall *project objectives* it is designed to meet and *components* by which the implementation of the project proceeds. The implementation of these components, combined in complex ways, leads to the desired project outcomes and impacts. Even though it is common to distinguish between outcome indicators—which measure the immediate, or short-term, results of project implementation—and impact indicators—which monitor the longer term or more pervasive results of the project—the distinction is sometimes ambiguous. For this reason, the approach presented in this note bundles the two together.

Indicators are then developed for both the overall project objectives and the components: *impact indicators* relate to the stated objectives of the project; *output indicators* relate to the components. In the same way that the project components are closely linked to the overall objectives of the project, the output and impact indicators should be related. The framework also includes *baseline indicators*, which monitor aspects viewed as the context of the project. Table 16 presents examples of water indicators to be used in a project which is structured according to the framework.

The P-S-I-R Approach

Another possible approach to use in the structuring of indicators is the Pressure-State-Impact-Response approach. This approach is depicted in Figure 4, and differs a bit from the project based approach presented earlier in that it can, with advantage, be used for activities that focus on a relatively large area (e.g., a whole watershed). The difference would be that for a larger area, project-sized objectives and specific components may not be easily identified. Instead, this framework distinguishes between four different aspects of *environmental problems*:

1) The *pressure* variable describes the underlying cause of the problem. It can be an existing

Figure 3. A project based approach

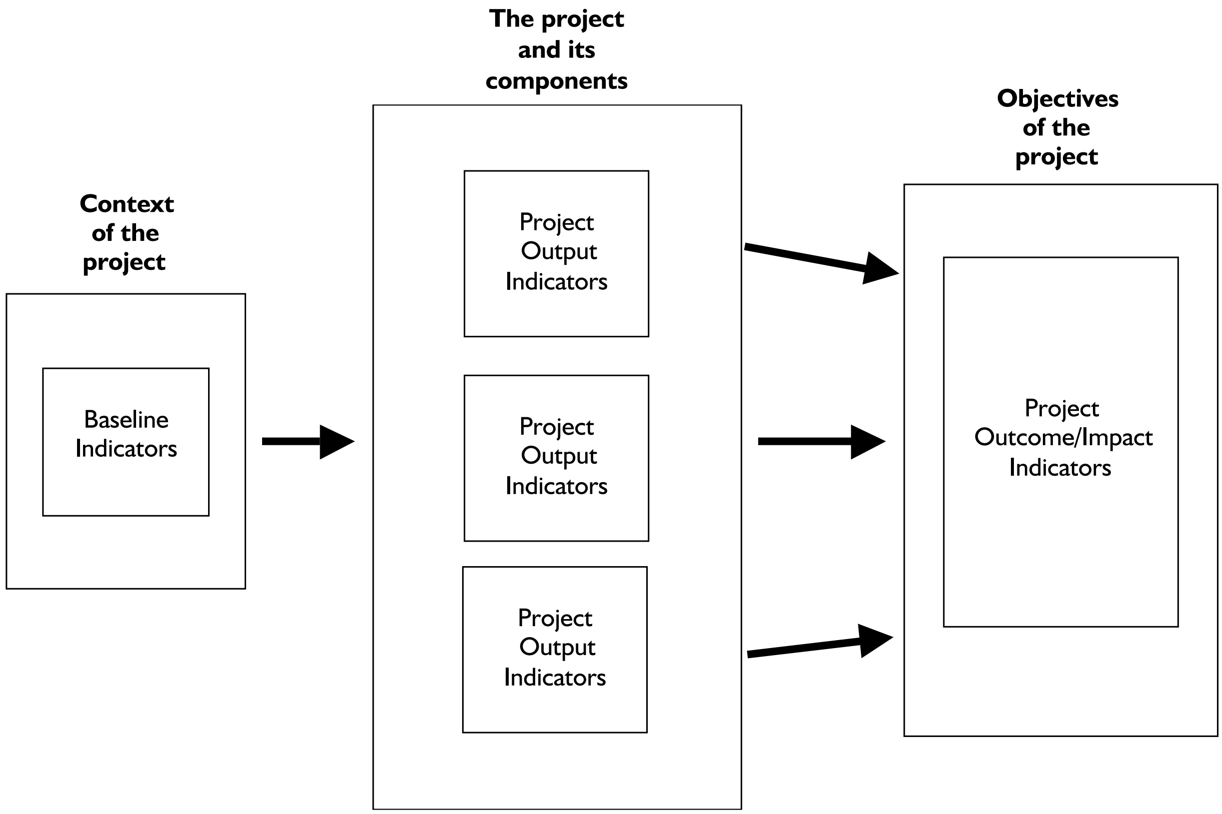


Table 16. Examples of water indicators for a project-based approach

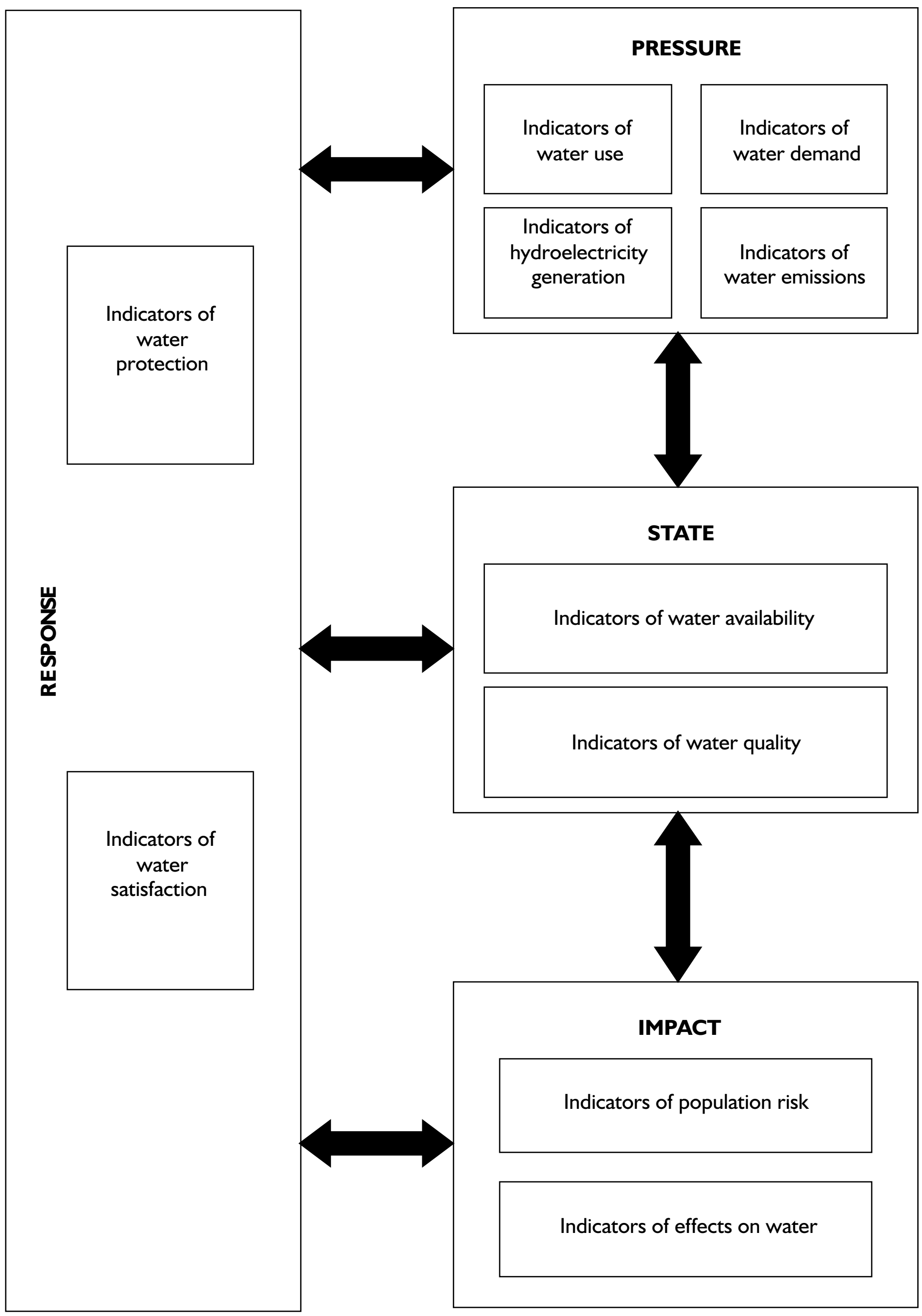
Baseline/output indicators	*Outcome/impact indicators*
Water use/demand	
Water recycling potential (%)	Use efficiency (%)
Water: annual extraction per capita (m^3)	Population with access to potable water (%)
Water: annual extraction by sector (%)	Number of aqueducts (#)
Water: total demand (m^3)	Water price (US/m^3)
Hydroelectricity generation	
Dams (#, location)	Kilowatts per hectare inundated (kW)
Hydroelectricity production (mw)	
Water emissions/quality	
N emissions (kg)	Biological oxygen demand (mg L^{-1})
Other emissions (kg)	Chemical oxygen demand (mg L^{-1})
Eutrophication	Treatment of used waters (%)
Acidification	Access to drains (%)
Toxicity/Heavy metal concentration	People affected by diarrheic diseases (#)
Colibacilli (m L^{-1})	
Water availability	
Water reserves (m^3)	Water annual extraction as % of total (%)
Rate of recharge ($m^3 yr^{-1}$)	
Annual rainfall (mm)	

(*continued*)

Table 16. Examples of water indicators for a project based approach (*continued*)

Baseline/output indicators	*Outcome/impact indicators*
Population risk	
Population risking inundation (#)	Population affected by inundation (#)
Capital risking inundation ($)	
Water protection	
Watershed land use (ha)	Watershed protected area (ha)

Figure 4. The Pressure-State-Impact-Response approach



problem or it may be the result of a new project or investment.

2) The *state* variable usually describes some physical, measurable characteristic of the environment that results from the pressure.
3) The *impact* variable is the same as the impact indicators mentioned above – they monitor the long-term, or more pervasive, results of a project or investment.
4) The *response* variables are those policies, actions or investments that are introduced to solve the problem. As responses to environmental problems they can affect the state either directly or indirectly, by acting at the pressures at work.

When indicators are structured according to the Pressure-State-Impact-Response approach, they become sorted in a somewhat different way than in the project-based approach. Table 17 shows how indicators of use, demand, generation, and emissions are categorized as pressure indicators; indicators of availability and quality as state

Table 17. Examples of water indicators for Pressure-State-Impact-Response approach

		Detailed information	*Aggregated information*
PRESSURE	Indicators of use	Annual extraction per capita (m^3) Annual extraction by sector (%)	Water vulnerability index
	Indicators of demand	Total demand (m^3) Use efficiency (%) Recycling potential (%)	
	Indicators of generation	Number of dams (no) Kilowatts per hectare inundated (kW) Hydroelectricity production (mW)	
	Indicators of emissions	N emissions (kg) Other emissions (kg)	
STATE	Indicators of availability	Reserves (m^3) Rate of recharge ($m^3 yr^{-1}$) Annual rainfall (mm) Annual extraction as % of total (%)	Water quality index
	Indicators of quality	Biological oxygen demand(mg L^{-1}) Chemical oxygen demand (mg L^{-1}) Eutrophication Acidification Colibacilli (m L^{-1})	
IMPACT	Indicators of effects	People affected by diarrheic diseases (#) Population affected by inundation (#) Toxicity/ Heavy metal concentration	Climatic risk index
	Indicators of risk	Population risking inundations (no) Capital risking inundations ($)	
RESPONSES	Indicators of protection	Watershed land use Watershed protected area	Safe water index
	Indicators of satisfaction	Access to potable water (%) Access to drains (%) Aqueducts (#) Treatment of used waters (%) Water price (US/m3)	

indicators; indicators of effects and risk as impact indicators; and indicators of protection and satisfaction as response indicators. Structured in this way, the indicators in each category can also be aggregated into four indices (see Table 17).

Conclusions

This note has presented a conceptual framework to the development and use of water indicators, as well as two different approaches to the structuring of the indicator work—the project-based approach, and the Pressure-State-Impact-Response approach. While there are several similarities to the two, such as the criteria to use in the selection of indicators, the need to identify problems as well as establish the appropriate objectives, and the importance of public consultation, there are clearly times and situations when one of the frameworks would be preferable to the other.

The first approach presented—*the project-based approach*—is most useful for a well-defined area, or project, where the specification of some project-level objectives and components is feasible. An example could be a water purification project—improved access to safe drinking water would be the project objective, and the installation of water monitoring stations one of the components. *The P-S-I-R approach*, on the other hand, is preferable in a situation that has taken a broader perspective, for example that of a nation, or region. The four categories forces the indicator developer and user to consider the various aspects of an environmental problem, which is usually important when several people from various stakeholder groups, are involved in the process.

Another similarity between the two approaches worth pointing out explicitly, is the need for interpretation of the indicators and for integration in the decision-making process. No indicator —irrespective of the approach used—is the end, but rather the means to an end. That is to say, the integration of the results from the monitoring into the decision-making processes, is what really makes the difference.

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Notes

1. Collected by CIAT in the rural indicators project and supplemented with data from other sources.
2. There has been considerable development of concepts for criteria and indicators at the forest management level, e.g., for forest certification. A general problem is that these indicators reflect good intentions (a perception of what is relevant) rather than feasibility (measurability).
3. For more information about the rural sustainability project visit its home page: http://www.ciat.cgiar.org/indicators/index.htm
4. Source: FAO, CCAD and CCAB-AP 1997: "Sustainable forest management in Central America. Proposal of criteria and indicators at the forest management unit (FMU)." Food and Agriculture Organization of the United Nations (FAO), Central American Commission on Environment and Development (CCAD), Central American Council on Forests and Protected Areas (CCAB-AP) (http://www.iucn.org/places/orma/bosques/bosques.html)
5. Zhu, Shushuai , David Tomberlin, and Joseph Buongiorno. 1998. "Global forest products consumption, production, trade and prices: global forest products model projections to 2010." Paper prepared for the 1999 Global Forest Products Outlook Study, FAO, Rome (Working paper: GFPOS/WP/01), viii + 37 pp and appendix.
6. The six maps are presented in Annex A.
7. Maps are in color and are best viewed on-screen or in color print. Black and white prints will result in the loss of some information.
8. For a more detailed discussion about selection criteria, see Segnestam (1999), *Environmental Performance Indicators — A Second Edition Note*, The World Bank, Washington, D.C., USA.

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