

## Chapter 8

# Progress towards sustainable forest management

Chapters 2–7 of this report focus on the results for individual thematic elements of sustainable forest management. As indicated in those chapters and as illustrated in Figure 8.1 below, forests are managed for a variety of uses and values. But how well are they managed? What does the information provided in FRA 2005 tell us about the overall progress towards sustainable forest management since 1990 on the global, regional and subregional scale?

The analysis presented in this chapter illustrates aggregated findings from FRA 2005. For the first time, an attempt has been made to present trends more broadly, covering six of the seven thematic elements of sustainable forest management.

The purpose is to shed more light on some of the complexities of sustainable forest management and stimulate additional analyses and debate, thus promoting decision-making and action for further progress towards sustainable forest management. Details of the data and analyses applied in this chapter are provided in FAO (2006b).

### METHODOLOGY

#### Variable selection

For each of the six thematic elements, variables from the FRA 2005 reporting tables were selected based on relevance to the theme and on information availability for the variable. No relative weighting of variables was applied. An implicit weighting is, however, present, because one criteria in selecting the variables was that each thematic element should be represented by two to five variables.

Twenty-one variables were selected from 12 of the 15 reporting tables (Table 8.1). Some are derivations of the variables reported by countries: for example, carbon stock per hectare is derived from total carbon stock and forest area.

An increase in the value of a variable is generally interpreted as making a positive contribution to the thematic element (with the exception of area of forest affected by fire, insects and diseases or other disturbances) and thereby to sustainable forest management.

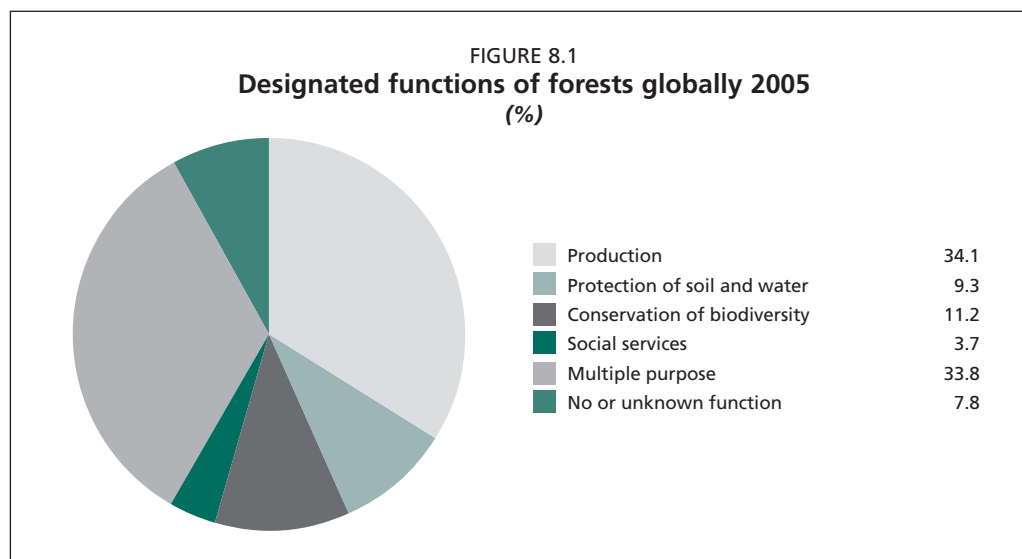


TABLE 8.1  
List of variables selected for synthesis assessment by thematic area

Thematic element	FRA 2005 variables or derivatives	Unit
Extent of forest resources	Area of forest	ha
	Area of other wooded land	ha
	Growing stock of forests	m <sup>3</sup>
	Carbon stock per hectare in forest biomass	tonnes/ha
Biological diversity	Area of primary forest	ha
	Area of forest designated primarily for conservation of biological diversity	ha
	Total forest area excluding area of productive forest plantations	ha
Forest health and vitality	Area of forest affected by fire	ha/year
	Area of forest affected by insects, diseases and other disturbances	ha/year
Productive functions of forest resources	Area of forest designated primarily for production	ha
	Area of productive forest plantations	ha
	Commercial growing stock	m <sup>3</sup>
	Total wood removals	m <sup>3</sup> /year
	Total NWFP removals	tonnes/year
Protective functions of forest resources	Area of forest designated primarily for protection	ha
	Area of protective forest plantations	ha
Socio-economic functions	Value of total wood removals	US\$/year
	Value of total NWFP removals	US\$/year
	Total employment	person years
	Area of forest under private ownership	ha
	Area of forest designated primarily for social services	ha

The extent to which this assumption holds depends on local or national circumstances. For example, an increase in forest area is likely to be seen as a positive development in most countries, but where it is a result of abandonment of agricultural land and declining rural populations, it may not be seen as positive by policy-makers or society.

Four variables were selected for analysis of the extent of forest resources: area of forest, area of other wooded land, total growing stock and carbon stock in forest biomass (per hectare).

The biological diversity theme is represented by the variables of area of primary forest, areas designated for conservation of biological diversity and total area of forest excluding productive forest plantations. While it is recognized that productive forest plantations may provide some biological diversity conservation values compared with other types of land cover, this is not the primary management purpose and these values are often limited. Primary forests are usually associated with high levels of biological diversity, particularly in tropical regions, but in temperate and boreal ecosystems, primary forests can present a limited number of species and may not be a good indicator of biological diversity *per se*. Yet area of primary forest is an important indicator of the status of the forest ecosystem as a whole.

Forest health and vitality is described by two variables indicating the area affected by fire, insects, diseases and other disturbances. Within this theme, stable or decreasing values are seen as a positive contribution to sustainable forest management. It is recognized that a number of forest ecosystems are dependant on fire to maintain their vitality and regenerative capacity (particularly in boreal zones). However, fires

frequently run wild and destroy large areas of forest, resulting in soil erosion and desertification – a serious threat to sustainable use of resources.

For the productive functions theme, these variables are taken into account: area of forest designated for productive purposes, area of productive forest plantations, commercial growing stock, total wood removals and NWFP removals for the four categories of products for which information availability is highest (see Chapter 5). It seeks to address the need to maintain an ample and valuable supply of primary forest products, while at the same time ensuring that production and harvesting are sustainable and do not compromise the management options of future generations. Thus an increase in wood removals may not be positive in all cases, as the level of removals may not be sustainable.

The protective functions theme is depicted by two variables indicating the total area of forest used primarily for protective functions and the area of forest plantations managed for protective purposes.

Socio-economic functions cover a wide range of forest benefits to mankind. The variables selected for this analysis are: level of private ownership, area of forest designated for recreation, education and other social services, total employment in forests and total value of removals. The level of private ownership is a somewhat ambiguous variable. In some situations, an increase in this variable may be seen as a benefit for sustainable forest management, indicating devolution of management responsibility and control to individuals or communities. In other cases, it may mean that forest property rights are being transferred from state or communal ownership and concentrated in the hands of relatively few within the community.

### Information availability

Many countries have not been able to provide complete data for all variables or for each point in time. The extent to which countries can report on this limited set of variables also provides an indication of data availability and reporting capacity for the wider range of uses and values that societies expect of forests. However, presenting data as regional aggregations overcomes some of the limitations in data availability on regional and subregional scales. Poor quality, outdated or missing data are common problems in natural resource or environmental management. Effective analysis and synthesis can be used to expose weaknesses in data and identify those areas in which information collection efforts can be targeted to improve decision-making.

Rules were created for handling gaps in data in the regions and subregions as follows. Information availability was determined as the sum of the area of forest of those countries reporting on a given variable, expressed as a percentage of total forest area in the region or subregion. It is rated high if the reporting countries together represent 75–100 percent of the total forest area, medium if the countries represent 50–74 percent and low if the percentage is 25–49 percent. If the reporting countries together account for less than 25 percent of the total forest area in the region, no findings are presented owing to insufficient data.

### Data analysis and presentation of results

The country data included in the calculations are those for which countries have reported a complete time series for the variable for all reporting years.

The change rate for variables on the subregional scale is expressed as the compound change rate in percent *per annum* for the period 1990–2005 (1990–2000 for area of forest affected by fire; area of forest affected by insects, diseases and other disturbances; total employment; and area of forest under private ownership). Thus the rate is based on two different estimates – the accuracy of which is unknown. An arbitrary threshold of  $\pm 0.50$  percent per year was selected for all variables in order to highlight large changes and to distinguish cases in which a difference between the two estimates may indicate an actual change from those in which the difference may not be statistically significant.

Simple, three-coloured ‘traffic light’ matrices were prepared to visualize change rates in the variables listed under each thematic area for a particular region. These indicate trends in the selected variables over time and the progress they reflect towards sustainable forest management. Trends can thus be positive, negative or with no major change (+/-0.50 percent per year) for each of the 21 variables.

Results are presented at global, regional and subregional levels and related to key statistics for each theme. For the subregional level, the number of positive and negative trends in each subregion was also related to two parameters – forest area and rural poor population – with the aim of illustrating progress towards sustainable forest management from different perspectives.

## RESULTS

### Global level

Table 8.2 summarizes trends in the selected variables at the global level.

*Extent of forest resources.* The area of forest has decreased by an average of 8.4 million hectares per year since 1990, or 0.21 percent per year. The other variables under this theme also show a decrease over time, but none of the change rates exceed the threshold of 0.50 percent annually.

TABLE 8.2  
Trends towards sustainable forest management at the global level

Thematic element	Trends in FRA 2005 variables or derivatives	Data availability	1990–2005 Annual change rate (%)	1990–2005 Annual change	Unit
Extent of forest resources	● Area of forest	H	-0.21	-8 351	1 000 ha
	● Area of other wooded land	M	-0.35	-3 299	1 000 ha
	● Growing stock of forests	H	-0.15	-570	million m <sup>3</sup>
	● Carbon stock per hectare in forest biomass	H	-0.02	-0.15	tonnes/ha
Biological diversity	● Area of primary forest	H	-0.52	-5 848	1 000 ha
	● Area of forest designated primarily for conservation of biological diversity	H	1.87	6 391	1 000 ha
	● Total forest area excluding area of productive forest plantations	H	-0.26	-9 397	1 000 ha
Forest health and vitality	● Area of forest affected by fire	M	-0.49	-125	1 000 ha
	● Area of forest affected by insects, diseases and other disturbances	M	1.84	1 101	1 000 ha
Productive functions of forest resources	● Area of forest designated primarily for production	H	-0.35	-4 552	1 000 ha
	● Area of productive forest plantations	H	2.38	2 165	1 000 ha
	● Commercial growing stock	H	-0.19	-321	million m <sup>3</sup>
	● Total wood removals	H	-0.11	-3 199	1 000 m <sup>3</sup>
	● Total NWFP removals	M	2.47	143 460	tonnes
Protective functions of forest resources	● Area of forest designated primarily for protection	H	1.06	3 375	1 000 ha
	● Area of protective forest plantations	H	1.41	380	1 000 ha
Socio-economic functions	● Value of total wood removals	L	0.67	377	million US\$
	● Value of total NWFP removals	M	0.80	33	million US\$
	● Total employment	M	-0.97	-102	1 000 pers. yrs
	● Area of forest under private ownership	M	0.76	2 737	1 000 ha
	● Area of forest designated primarily for social services	H	8.63	6 646	1 000 ha

H = High (reporting countries represent 75–100% of total forest area)  
M = Medium (reporting countries represent 50–75% of total forest area)  
L = Low (reporting countries represent 25–50% of total forest area)

● = Positive change (greater than 0.50%)  
● = No major change (between -0.50 and 0.50%)  
● = Negative change (less than -0.50%)  
– = Insufficient data to determine trend

**Biological diversity.** The area of primary forest decreased by an average of 5.8 million hectares per year (excluding the Russian Federation, where large differences in the values for 1990 and 2005 were due to the introduction of a new classification system). On a positive note, the area of forest designated for conservation of biological diversity increased by about 6.4 million hectares per year during the same period – or a total of 96 million hectares.

**Forest health and vitality.** The area of forest adversely affected by insects, diseases and other disturbances shows an increase equivalent to 1.1 million hectares per year, while the area adversely affected by forest fires shows a small decrease. However, information was missing from many countries, particularly from Africa.

**Productive functions of forest resources.** The most prominent changes over time are a decrease in the area of forest designated primarily for productive purposes – an average of 4.6 million hectares per year – and an increase in area of productive forest plantations of 2.2 million hectares per year. This shift indicates that substantial areas of natural forests previously allocated for productive purposes are now designated for other uses, while the proportion of wood removals coming from forest plantations is likely to significantly increase in the future.

**Protective functions of forests.** Both variables under this theme show an increase since 1990. The area of forest designated primarily for protective purposes has thus increased by close to 3.4 million hectares per year or more than 50 million hectares during the last 15 years.

**Socio-economic functions.** The nominal values of removals of wood and non-wood forest products have increased, but less than the average rate of inflation. Employment in forest conservation and management has decreased by about 1 percent per year. The area of privately owned forests has increased by an average of 2.7 million hectares per year in the period 1990–2000 (2005 data not requested from countries). Area of forest designated for the provision of recreation, education and other social services has increased by more than 6.6 million hectares per year – or a total of 100 million hectares since 1990 – primarily due to a large increase in Brazil, which is partly offset by a much smaller decrease in the Russian Federation caused by a reclassification of forests.

**Conclusions.** Overall, the situation at the global level has remained relatively stable. Negative trends include decreases in area of primary forest and employment and an increase in area of forest adversely affected by insects, diseases and other disturbances. Positive trends were reported in the area of forest designated for biological diversity and social services, as well as for area of productive and protective forest plantations, value of wood removals and amount and value of NWFP removals, and area of forests under private ownership.

## Africa

Table 8.3 summarizes trends in the selected variables for Africa.

**Extent of forest resources.** The region of Africa consists of three subregions (Eastern and Southern Africa, Northern Africa and Western and Central Africa). Area of forest decreased at an alarming rate during the period. There are indications, however, that the net loss of forests is slowing down. In the period 1990–2000, the net area change was about -4.4 million hectares per year, whereas in the period 2000–2005, it averaged -4.0 million hectares per year. The decrease in other wooded land was about half that of forest area (2.2 million hectares per year). The decrease in growing stock was below the threshold of 0.50 percent per year; however annual reductions in growing stock for the period were about 275 million m<sup>3</sup>. Carbon stock per hectare did not change, but this probably reflects the fact that few countries have more than one estimate of growing stock over time. The overall trend for this theme is thus negative.

**Biological diversity.** The area of primary forest in Africa decreased by some 270 000 ha annually during 1990–2005. However, information for this variable was

TABLE 8.3  
Trends towards sustainable forest management in Africa

Thematic element	Trends in FRA 2005 variables or derivatives	Data availability	1990–2005 Annual change rate (%)	1990–2005 Annual change	Unit
Extent of forest resources	● Area of forest	H	-0.64	-4 263	1 000 ha
	● Area of other wooded land	M	-0.52	-2 193	1 000 ha
	● Growing stock of forests	H	-0.41	-275	million m <sup>3</sup>
	● Carbon stock per hectare in forest biomass	H	0.01	0.1	tonnes/ha
Biological diversity	● Area of primary forest	M	-0.68	-270	1 000 ha
	● Area of forest designated primarily for conservation of biological diversity	M	0.27	182	1 000 ha
	● Total forest area excluding area of productive forest plantations	M	-0.75	-3 361	1 000 ha
Forest health and vitality	– Area of forest affected by fire				1 000 ha
	– Area of forest affected by insects, diseases and other disturbances				1 000 ha
Productive functions of forest resources	● Area of forest designated primarily for production	M	-0.64	-911	1 000 ha
	● Area of productive forest plantations	M	0.41	42	1 000 ha
	● Commercial growing stock	M	-0.39	-22	million m <sup>3</sup>
	● Total wood removals	H	1.89	10 767	1 000 m <sup>3</sup>
	– Total NWFP removals				tonnes
Protective functions of forest resources	● Area of forest designated primarily for protection	M	-0.25	-52	1 000 ha
	● Area of protective forest plantations	M	1.22	26	1 000 ha
Socio-economic functions	– Value of total wood removals				million US\$
	– Value of total NWFP removals				million US\$
	● Total employment	L	3.44	12	1 000 pers. yrs
	● Area of forest under private ownership	H	-0.48	-49	1 000 ha
	● Area of forest designated primarily for social services	M	-0.04	-0.2	1 000 ha

H = High (reporting countries represent 75–100% of total forest area)  
M = Medium (reporting countries represent 50–75% of total forest area)  
L = Low (reporting countries represent 25–50% of total forest area)

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based on 46 countries that together account for 67 percent of the forest area, with information missing from most of the countries in the Congo Basin (which represents the second largest area of tropical primary forest after the Amazon Basin). Some of this decrease was caused by deforestation, some by alteration of forests through selective logging and other human interventions. This ‘altered’ forest area was subsequently classified as modified natural forest. On a positive note, there has been an increase in the area of forest designated primarily for conservation of biological diversity of close to 3 million hectares since 1990.

*Forest health and vitality.* Data availability was insufficient for trend analysis.

*Productive functions of forest resources.* There was a steady increase in wood removals from 500 million m<sup>3</sup> in 1990 to 661 million m<sup>3</sup> in 2005, or an annual increase of almost 11 million m<sup>3</sup>. Yet the area designated for production of wood and non-wood forest products decreased by nearly a million hectares per year. Most of the increase in wood removals stemmed from increased production of fuelwood – on average, an increase of more than 9 million m<sup>3</sup>/year – particularly in Western and Central Africa. A large part of this may have been collected from areas outside forests (other wooded land and trees outside forests). Some may have come from forests designated for multiple

purposes – including community forests – rather than from forests designated primarily for productive purposes.

**Protective functions of forest resources.** The area of forest designated for protective functions shows a slight decrease, while the area of protective forest plantations shows an increase.

**Socio-economic functions.** The status of the information is generally quite weak and data availability is low for most of the variables under this theme. Employment in forest management and conservation seemed to have increased, while the area under private ownership declined.

**Conclusions.** On the whole, progress towards sustainable forest management in Africa appears to have been limited during the last 15 years. There are some indications that the net loss of forest area has slowed down and that the area of forest designated for conservation of biological diversity increased slightly. However, the continued, rapid loss of forest area (the largest of any region during this 15-year period) is particularly disconcerting. A summary of information by subregion can be found in Table 8.9.

## Asia

Table 8.4 summarizes trends in the selected variables for Asia.

**Extent of forest resources.** The region of Asia consists of three subregions showing great variation (East Asia, South and Southeast Asia and Western and Central Asia). In the period 1990–2005, area of forest was virtually stable, with an annual decrease of 191 000 ha or -0.03 percent. However, it should be noted that, within this period, a net loss of forests of about 792 000 ha per year in the 1990s was reversed into an annual net gain of 1 million hectares in the period 2000–2005, largely due to increased plantation activity in the region, particularly in China. The annual net loss of forests in South and Southeast Asia averaged about 2.7 million hectares per year. In the period 1990–2005, the regional net annual decrease in growing stock was about 290 million m<sup>3</sup>/year. There was, however, a large variation among the three subregions, with an annual net increase of 260 million m<sup>3</sup> in East Asia and 13 million m<sup>3</sup> in Western and Central Asia. In South and Southeast Asia the annual net decrease was 559 million m<sup>3</sup>. Carbon stock per hectare was largely unchanged – reflecting the fact that few countries had more than one estimate of growing stock per hectare over time. Over the last 15 years, the regional trend for this theme was largely stable or slightly negative, with some recent positive trends in a number of countries.

**Biological diversity.** The area of primary forest decreased at the alarming rate of 1.5 million hectares per year during the last 15 years – entirely explained by large losses in the subregion of South and Southeast Asia, particularly in Indonesia. The cause of the decrease was not only deforestation but also alteration of forests through selective logging and other human interventions, which resulted in a subsequent classification of such forests as modified natural forest. About 13 percent of the forest area is currently designated primarily for conservation of biological diversity, representing an average annual increase of some 850 000 ha or about 1.3 percent since 1990.

**Forest health and vitality.** The area affected by fire and other disturbances increased slightly, but data for the area of forest affected by insects, diseases and other disturbances were generally quite weak.

**Productive functions of forest resources.** The forest area designated primarily for the production of wood and non-wood forest products decreased by an average of 774 000 ha per year, while the area of productive forest plantations increased by an average of about 1 million hectares per year or 2.9 percent. In the last five years, the area of productive forest plantations increased by 1.6 million hectares per year, which is the highest increase of any region. This rapid expansion took place primarily in China, where the area of productive forest plantations increased by about 460 000 ha/year in the 1990s and 1.35 million hectares per year in the period 2000–2005 – an increase of

TABLE 8.4  
Trends towards sustainable forest management in Asia

Thematic element	Trends in FRA 2005 variables or derivatives	Data availability	1990–2005 Annual change rate (%)	1990–2005 Annual change	Unit
Extent of forest resources	● Area of forest	H	-0.03	-194	1 000 ha
	● Area of other wooded land	M	-0.36	-697	1 000 ha
	● Growing stock of forests	H	-0.58	-286	million m <sup>3</sup>
	● Carbon stock per hectare in forest biomass	H	-0.15	-1	tonnes/ha
Biological diversity	● Area of primary forest	H	-1.52	-1 510	1 000 ha
	● Area of forest designated primarily for conservation of biological diversity	H	1.31	848	1 000 ha
	● Total forest area excluding area of productive forest plantations	H	-0.23	-1 224	1 000 ha
Forest health and vitality	● Area of forest affected by fire	H	1.15	127	1 000 ha
	● Area of forest affected by insects, diseases and other disturbances	M	0.30	35	1 000 ha
Productive functions of forest resources	● Area of forest designated primarily for production	H	-0.30	-774	1 000 ha
	● Area of productive forest plantations	H	2.90	1 033	1 000 ha
	● Commercial growing stock	M	0.51	95	million m <sup>3</sup>
	● Total wood removals	H	-1.49	-6 116	1 000 m <sup>3</sup>
	● Total NWFP removals	M	3.71	160 796	tonnes
Protective functions of forest resources	● Area of forest designated primarily for protection	H	1.94	2 325	1 000 ha
	● Area of protective forest plantations	H	0.99	187	1 000 ha
Socio-economic functions	● Value of total wood removals	H	-2.27	-452	million US\$
	● Value of total NWFP removals	L	1.40	191	million US\$
	● Total employment	H	-1.15	-100	1 000 pers. yrs
	● Area of forest under private ownership	H	0.66	179	1 000 ha
	● Area of forest designated primarily for social services	H	1.18	39	1 000 ha

H = High (reporting countries represent 75–100% of total forest area)  
M = Medium (reporting countries represent 50–75% of total forest area)  
L = Low (reporting countries represent 25–50% of total forest area)  
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193 percent compared with the previous decade. Total wood removals have decreased significantly during this period – also partly because of China, where a logging ban was in effect for a large part of the forest area and wood is now being imported – including from outside the region. Several countries noted that the figures for wood removals submitted do not take into account illegal removals or informal collection of fuelwood, so actual removals may be underestimated.

**Protective functions of forest resources.** Both the area of forest designated for protective purposes and the area of forest plantations managed for this purpose show an increase, reflecting a greater attention to the role forests play in the conservation of soil and water and other protective functions.

**Socio-economic functions.** The value of wood removals decreased, over and above the decrease in the amount of wood removed, while the value of NWFPs increased during the last 15 years. Employment also shows a reduction, while the area of forest under private ownership and the areas designated for recreation, education and other social services increased.

**Conclusions.** Overall, forest area was almost the same in 2005 as in 1990 (572 million hectares versus 574 – or a decrease of 0.03 percent per year), owing to large-scale afforestation



efforts during the last 7-8 years, particularly in China. Forest health deteriorated, but forest fires, pests and diseases were still affecting a relatively small proportion of the total forest area in Asia (2.2, 2.6 and 2.4 percent respectively). The rapid decrease in area of primary forest is cause for concern, while the increase in area designated for conservation of biological diversity and for protective functions is commendable. In short, there has been mixed progress over the last 15 years. A summary of information by subregion can be found in Table 8.9.

## Europe

Table 8.5 summarizes trends in the selected variables for Europe.

**Extent of forest resources.** Forest area in Europe increased by an average of 805 000 ha per year or 0.08 percent of total forest area. Over the last 15 years, total growing stock increased by nearly 340 million m<sup>3</sup> per year and forests in Europe became more densely stocked. Average volume per hectare increased from 103 to 107 m<sup>3</sup>/ha (124 to 141m<sup>3</sup>/ha excluding the Russian Federation – an annual increase of 1.2 m<sup>3</sup> per hectare per year), which also means that forests were sequestering more carbon. The area of other wooded land, on the other hand, diminished at a rate of 0.28 percent – or 286 000 ha – per year.

TABLE 8.5  
Trends towards sustainable forest management in Europe

Thematic element	Trends in FRA 2005 variables or derivatives	Data availability	1990–2005 Annual change rate (%)	1990–2005 Annual change	Unit
Extent of forest resources	● Area of forest	H	0.08	805	1 000 ha
	● Area of other wooded land	H	-0.28	-286	1 000 ha
	● Growing stock of forests	H	0.33	340	million m <sup>3</sup>
	● Carbon stock per hectare in forest biomass	H	0.02	0.1	tonne/ha
Biological diversity	● Area of primary forest	H	0.37	956	1 000 ha
	● Area of forest designated primarily for conservation of biological diversity	H	4.72	1 224	1 000 ha
	● Total forest area excluding area of productive forest plantations	H	0.03	332	1 000 ha
Forest health and vitality	● Area of forest affected by fire	H	4.27	54	1 000 ha
	● Area of forest affected by insects, diseases and other disturbances	H	6.27	729	1 000 ha
Productive functions of forest resources	● Area of forest designated primarily for production	H	-0.44	-3 277	1 000 ha
	● Area of productive forest plantations	H	1.71	322	1 000 ha
	● Commercial growing stock	H	-0.52	-322	million m <sup>3</sup>
	● Total wood removals	H	-0.67	-4 783	1 000 m <sup>3</sup>
	● Total NWFP removals	H	-0.49	-1 872	tonnes
Protective functions of forest resources	● Area of forest designated primarily for protection	H	0.99	826	1 000 ha
	● Area of protective forest plantations	H	1.86	97	1 000 ha
Socio-economic functions	– Value of total wood removals				million US\$
	● Value of total NWFP removals	H	1.46	22	million US\$
	● Total employment	H	-2.61	-23	1 000 pers. yrs
	● Area of forest under private ownership	H	1.36	1 257	1 000 ha
	● Area of forest designated primarily for social services	H	-1.89	-496	1 000 ha

H = High (reporting countries represent 75–100% of total forest area)  
M = Medium (reporting countries represent 50–75% of total forest area)  
L = Low (reporting countries represent 25–50% of total forest area)

● = Positive change (greater than 0.50%)  
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**Biological diversity.** Four percent of forest area is currently designated primarily for conservation of biological diversity. If the Russian Federation is excluded, the share is about 12 percent. There was a large increase in this area since 1990 (1.2 million hectares per year). The figures on primary forest include the Russian Federation, in which large changes were primarily owing to the introduction of a new classification system. Excluding the Federation, there was still a slight increase, which is explained by the fact that areas of natural forest have been set aside and protected from human intervention. With time, these areas evolve into forests in which there are no clearly visible indications of human activity and ecological processes are not significantly disturbed, which is the definition of primary forests used in FRA 2005.

**Forest health and vitality.** An increase in the average area of forest affected by other disturbances was evident when comparing the 1988–1992 period with that of 1998–2002. The storms that hit Europe in December 1999 may have resulted in an increase in areas affected by insects and diseases as well. The area affected by forest fires also increased during this period in relative or percentage terms, but was still a very small proportion (0.2 percent) of the total forest area.

**Productive functions of forest resources.** The total volume of wood removals and commercial growing stock decreased in the last 15 years. There was a large increase in area of productive forest plantations, almost 5 million hectares during 1990–2005 or an annual increase of about 1.7 percent. The area of forest used primarily for wood production decreased and forest plantations now account for a larger proportion of forest area available for wood supply. The change in area of forest designated primarily for production was less than 0.5 percent per year. However, this area has decreased by close to 50 million hectares since 1990, with corresponding gains in the areas of forest designated for multiple-purpose, conservation and protective functions.

**Protective functions of forest resources.** The area of forest designated primarily for protection increased by more than 800 000 ha per year for the period 1990–2005.

**Socio-economic functions.** The area of forest under private ownership increased by more than 1 million hectares per year. To a large extent this is owing to the ongoing privatization process in central and eastern European countries. The level of employment in forest conservation and management decreased – probably due to an increase in mechanization and streamlining in organizations, as well as to a decrease in the amount of wood removals. The area of forest designated primarily for the provision of recreation, education and other social services decreased since 1990, mainly as a result of the reclassification of forests in the Russian Federation during this period. The total area of forest in Europe providing such services (as either primary or secondary function) is the highest in the world (72 percent of total forest area).

**Conclusions.** Data availability was high and the status of forest resources in Europe was essentially stable, although forests in Europe suffered from occasional storms. The severe storms of 1999 were the main reason for the negative trend in the health and vitality of forests. The focus of forest management in Europe has clearly shifted away from productive functions towards conservation of biological diversity, protection and multiple uses.

## North and Central America

Table 8.6 summarizes trends in the selected variables for North and Central America.

**Extent of forest resources.** The region of North and Central America consists of three subregions (the Caribbean, Central America and North America). Forest area for the region as a whole is virtually the same as in 1990, as is the area of other wooded land. There was a decrease in forest area in Central America of about 350 000 ha per year for the period 1990–2005. In North America, forest area decreased by about 100 000 ha annually from 2000 to 2005 – down from a net increase of 17 000 ha per year in 1990–2000. This current net loss of forests was primarily due to a decrease in

TABLE 8.6  
Trends towards sustainable forest management in North and Central America

Thematic element	Trends in FRA 2005 variables or derivatives	Data availability	1990–2005 Annual change rate (%)	1990–2005 Annual change	Unit
Extent of forest resources	● Area of forest	H	-0.05	-329	1 000 ha
	● Area of other wooded land	M	0.01	16	1 000 ha
	● Growing stock of forests	H	0.23	159	million m <sup>3</sup>
	● Carbon stock per hectare in forest biomass	L	0.05	0.3	tonnes/ha
Biological diversity	● Area of primary forest	H	-0.17	-545	1 000 ha
	● Area of forest designated primarily for conservation of biological diversity	H	0.86	712	1 000 ha
	● Total forest area excluding area of productive forest plantations	H	-0.12	-800	1 000 ha
Forest health and vitality	● Area of forest affected by fire	H	-0.14	-6	1 000 ha
	● Area of forest affected by insects, diseases and other disturbances	H	0.88	307	1 000 ha
Productive functions of forest resources	● Area of forest designated primarily for production	H	-0.05	-21	1 000 ha
	● Area of productive forest plantations	H	3.46	471	1 000 ha
	● Commercial growing stock	H	0.27	160	million m <sup>3</sup>
	● Total wood removals	H	-0.14	-1 201	1 000 m <sup>3</sup>
	– Total NWFP removals				tonnes
Protective functions of forest resources	● Area of forest designated primarily for protection	H	2.85	77	1 000 ha
	● Area of protective forest plantations	H	13.14	67	1 000 ha
Socio-economic functions	● Value of total wood removals	M	4.19	617	million US\$
	● Value of total NWFP removals	M	2.66	1.6	million US\$
	● Total employment	H	0.98	4.8	1 000 pers. yrs
	● Area of forest under private ownership	H	0.06	129	1 000 ha
	● Area of forest designated primarily for social services	H	0	0	1 000 ha

H = High (reporting countries represent 75–100% of total forest area)  
M = Medium (reporting countries represent 50–75% of total forest area)  
L = Low (reporting countries represent 25–50% of total forest area)

● = Positive change (greater than 0.50%)  
● = No major change (between -0.50 and 0.50%)  
● = Negative change (less than -0.50%)  
– = Insufficient data to determine trend

the forest plantation establishment rate in the United States (down from an average of 596 900 ha/year in 1990–2000 to an average of 157 400 ha/year in the period 2000–2005) and the continued, albeit decreasing, net loss of forests in Mexico. In contrast, there was an annual increase in forest area of about 40 000 ha in the Caribbean subregion, mainly due to natural expansion onto abandoned agricultural land. There is limited information on carbon stock in forests, due to lack of information from Canada and an incomplete dataset from the United States.

**Biological diversity.** There were decreases in the areas of primary forest and of total forest excluding productive forest plantations, but the change rates were below 0.2 percent per year. The area of forest designated for conservation of biological diversity increased by 712 000 ha per year since 1990, or more than 10 million hectares in total.

**Forest health and vitality.** The area adversely affected by forest fires shows only limited changes over time, while the area affected by insects, diseases and other disturbances increased.

**Productive functions of forest resources.** The most prominent change over time was the increase in area of productive forest plantations – from 3.3 percent of total forest area in 1990 to 5.1 percent in 2000 and 5.4 percent in 2005. The area of forest designated

primarily for productive purposes remained fairly stable, while total wood removals decreased slightly, by 1.2 million m<sup>3</sup> per year – or 0.14 percent.

*Protective functions of forest resources.* Both of the variables related to protective functions showed an increase in relative (percentage) terms during the last 15 years. However, the increases in absolute terms were fairly small compared with other variables.

*Socio-economic functions.* The value of both wood and non-wood forest products increased since 1990, despite a slight decrease in the amount of wood removals. The level of employment in forest conservation and management also shows an increase.

*Conclusions.* Progress towards sustainable forest management was generally positive in North and Central America as a whole during the period 1990–2005, with none of the annual rates of negative trends being more than 0.20 percent – except for the area adversely affected by insects, diseases and other disturbances. There was, however, considerable variation among subregions, as can be seen in Table 8.9.

## Oceania

Table 8.7 summarizes trends in the selected variables for Oceania.

*Extent of forest resources.* Area of forest was essentially stable over the period 1990–2005. The reported annual change was -417 000 ha per year or -0.2 percent per year. Information availability was insufficient to determine trends in the remaining variables under this theme.

*Biological diversity.* There was a slight increase in area of primary forest. Information availability was insufficient on area of forest designated for biological diversity conservation (1990 data were missing for Australia). Total forest area, excluding area of productive forest plantations, decreased slightly, following the trend for forest area as a whole.

*Forest health and vitality.* Data availability was insufficient for trend analysis.

*Productive functions of forest resources.* Information availability was insufficient on area of forest designated for productive purposes (1990 data were missing for Australia) and on commercial growing stock. The area of productive forest plantations increased, as did the amount of wood removals.

*Protective functions of forest resources.* Information availability was insufficient on area of forest designated for protective purposes (1990 data were missing for Australia). However, the area of protective forest plantations increased at the very high rate of 28 percent per year, from 500 ha in 1990 to 3 100 ha in 2000 and 21 100 in 2005.

*Socio-economic functions.* The number of persons employed in the primary production of forest goods and services and related activities increased from 1990 to 2000 (data not requested for 2005). Information availability was insufficient for an analysis of the other variables.

*Conclusions.* The status of the information for Oceania was generally very weak, and low data availability was a serious issue in the region. Data were insufficient for determining regional trends for two-thirds of the variables. Thus it is difficult to assess progress towards sustainable forest management.

## South America

Table 8.8 summarizes trends in the selected variables for South America.

*Extent of forest resources.* Forest area in South America decreased at an alarming rate and continues to do so. The annual net loss during the period 1990–2000 was 3.8 million hectares, and in the period 2000–2005 the annual net loss increased to 4.3 million hectares, which was the highest annual net loss of any region during this five-year period and corresponds to almost 60 percent of the total annual net loss. However, it should be noted that the figures for Brazil referred to areas of forest cleared, without taking into account the part of clear-cut areas that may have regenerated and returned to forest. Net loss for the region as a whole may thus be overestimated and was below the threshold of 0.50 percent per year for the period 1990–2005 as a whole. Growing stock

TABLE 8.7  
Trends towards sustainable forest management in Oceania

Thematic element	Trends in FRA 2005 variables or derivatives	Data availability	1990–2005 Annual change rate (%)	1990–2005 Annual change	Unit
Extent of forest resources	● Area of forest	H	-0.20	-417	1 000 ha
	– Area of other wooded land				1 000 ha
	– Growing stock of forests				million m <sup>3</sup>
	– Carbon stock per hectare in forest biomass				tonnes/ha
Biological diversity	● Area of primary forest	H	0.24	82	1 000 ha
	– Area of forest designated primarily for conservation of biological diversity				1 000 ha
	● Total forest area excluding area of productive forest plantations	H	-0.23	-471	1 000 ha
Forest health and vitality	– Area of forest affected by fire				1 000 ha
	– Area of forest affected by insects, diseases and other disturbances				1 000 ha
Productive functions of forest resources	– Area of forest designated primarily for production				1 000 ha
	● Area of productive forest plantations	H	3.00	91	1 000 ha
	– Commercial growing stock				million m <sup>3</sup>
	● Total wood removals	H	2.56	1 348	1 000 m <sup>3</sup>
	– Total NWFP removals				tonnes
Protective functions of forest resources	– Area of forest designated primarily for protection				1 000 ha
	● Area of protective forest plantations	H	28.34	1.4	1 000 ha
Socio-economic functions	– Value of total wood removals				million US\$
	– Value of total NWFP removals				million US\$
	● Total employment	H	0.79	0.3	1 000 pers. yrs
	– Area of forest under private ownership				1 000 ha
	– Area of forest designated primarily for social services				1 000 ha

H = High (reporting countries represent 75–100% of total forest area)  
M = Medium (reporting countries represent 50–75% of total forest area)  
L = Low (reporting countries represent 25–50% of total forest area)  
● = Positive change (greater than 0.50%)  
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● = Negative change (less than -0.50%)  
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followed the trend of total forest area, while carbon stock per hectare reportedly did not change – probably reflecting the fact that few countries had more than one estimate of growing stock over time.

**Biological diversity.** Primary forests currently account for 77 percent of total forest area in the region but continue to decrease rapidly. The net loss of primary forest increased from 3.0 million hectares per year in the period 1990–2000 to almost 3.9 million hectares in the period 2000–2005. Apart from deforestation, the decrease was caused by alteration of forests through selective logging and other human interventions, which resulted in a subsequent classification of such forests as modified natural forests. On a positive note, the area of forest designated primarily for conservation of biological diversity increased by about 3.3 million hectares per year in the last 15 years, or a total of 50 million hectares – equivalent in size to the area of primary forest lost during this period.

**Forest health and vitality.** The area of forest adversely affected by fire and other disturbances increased, but was still relatively small (less than 1 percent combined). However, some countries presented incomplete information on this topic, so the figures should be considered underestimates.

TABLE 8.8  
Trends towards sustainable forest management in South America

Thematic element	Trends in FRA 2005 variables or derivatives	Data availability	1990–2005 Annual change rate (%)	1990–2005 Annual change	Unit
Extent of forest resources	● Area of forest	H	-0.46	-3 952	1 000 ha
	● Area of other wooded land	L	-0.13	-138	1 000 ha
	● Growing stock of forests	M	-0.51	-503	million m <sup>3</sup>
	● Carbon stock per hectare in forest biomass	H	0	0	tonnes/ha
Biological diversity	● Area of primary forest	H	-0.53	-3 297	1 000 ha
	● Area of forest designated primarily for conservation of biological diversity	H	3.69	3 342	1 000 ha
	● Total forest area excluding area of productive forest plantations	H	-0.49	-3 872	1 000 ha
Forest health and vitality	● Area of forest affected by fire	H	1.00	1	1 000 ha
	● Area of forest affected by insects, diseases and other disturbances	M	4.13	46	1 000 ha
Productive functions of forest resources	● Area of forest designated primarily for production	H	0.21	190	1 000 ha
	● Area of productive forest plantations	H	2.16	207	1 000 ha
	● Commercial growing stock	M	-0.97	-229	million m <sup>3</sup>
	● Total wood removals	H	-0.76	-3 214	1 000 m <sup>3</sup>
	● Total NWFP removals	M	-2.14	-16 800	tonnes
Protective functions of forest resources	● Area of forest designated primarily for protection	H	0.21	195	1 000 ha
	● Area of protective forest plantations	H	7.48	1	1 000 ha
Socio-economic functions	● Value of total wood removals	H	-1.23	-760	million US\$
	● Value of total NWFP removals	M	-5.10	-15	million US\$
	– Total employment				1 000 pers. yrs
	– Area of forest under private ownership				1 000 ha
	● Area of forest designated primarily for social services	H	20.33	7 102	1 000 ha

H = High (reporting countries represent 75–100% of total forest area)  
M = Medium (reporting countries represent 50–75% of total forest area)  
L = Low (reporting countries represent 25–50% of total forest area)  
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– = Insufficient data to determine trend

**Productive functions of forest resources.** The area designated for productive functions was essentially stable, while the area of productive forest plantations increased. Total wood removals decreased by about 3.2 million m<sup>3</sup> per year. This was caused by a decrease in the amount of fuelwood removals of 8.6 million m<sup>3</sup> per year, partly offset by an increase in the amount of removals of industrial wood of 5.3 million m<sup>3</sup> per year. Commercial growing stock and NWFP removals decreased during the period.

**Protective functions of forest resources.** Both variables showed an increase since 1990. Protective forest plantations increased by 7.5 percent per year, but the area is still relatively small (31 000 ha in 2005 – or 0.004 percent of total forest area).

**Socio-economic functions.** The area designated for social services increased by more than 7 million hectares per year since 1990. This mainly reflected the allocation of large areas in Brazil as ‘indigenous lands’ and ‘sustainable development reserves’, where both of these categories were classified as designated for social services.

**Conclusions.** Overall, progress towards sustainable forest management was mixed in South America. The increasing trend in the area of net forest loss is cause for concern, as is the rate of loss of primary forest. Yet there were also positive signs in the increased areas of forest designated for conservation of biological diversity and for social services.

The decrease in removals of fuelwood may reflect a reduced demand for this product in the region, but was partly offset by an increase in removals of industrial wood. The area of productive forest plantations increased and may meet a larger proportion of the demand for wood in the future.

### Subregional level

Three regions (Africa, Asia and North and Central America) having significant intraregional differences were divided into three subregions each and subregional trends were determined using the same method used for the regions. No subdivisions were made of Europe, Oceania and South America, which can be considered relatively homogeneous with respect to the variables studied. The possible exception is Europe, where the Russian Federation dominates owing to its size, but the preference in this study was not to single out any individual country in the presentation. The resulting set of 12 subregions and regions constituted the basis for the analysis in this section, and as a set is referred to as the 'subregions'. Table 8.9 summarizes the results for each subregion and illustrates some important intraregional differences.

In Africa, Western and Central Africa had more positive trends than negative ones, while Eastern and Southern Africa had predominantly negative trends. However, it is also noteworthy that information availability for Western and Central Africa was generally poorer than for the other subregions (except for the extent of forest resources), which may have affected the results. North America and the Caribbean also had a majority of positive trends, whereas Central America had a preponderance of negative ones. The most significant difference occurs in Asia, where East Asia had a strong set of positive trends, while the South and Southeast Asia subregion was dominated by negative trends. Clearly, the division into subregions reveals trend patterns that are not prominent on a regional scale, just as the regional breakdown highlighted variations masked on the global scale. As is also clear from Table 8.9, there is a mix of positive and negative trends in all subregions.

In considering progress towards sustainable forest management, the very large differences among the subregions in size and population structure must be taken into consideration. Two parameters – forest area (Table 1 in Chapter 2) and the number of rural poor people (Table 3 in Chapter 1) – were selected and applied as arbitrary weights to indicate the relative significance of the observed trends (Figure 8.2).

When weighting by forest area, Europe, North America and South America dominate the picture. It is also clear that Europe and North America contribute considerably to the positive and stable trends and less to the negative ones, whereas the trends for South America are mostly negative. Overall, there seems to be a balance between positive and negative trends, assuming that the selected variables are valid, that they are all weighted equally and that a weighting by forest area of each subregion is relevant.

When weighting by rural poor population, the picture becomes dramatically different. Some of the African subregions are more prominent, and the subregion of South and Southeast Asia dominates. Obviously, the developed regions become less significant, as there are relatively few rural poor in these areas. Compared with the weighting by forest area, there is a higher proportion of negative trends from this poverty perspective.

## DISCUSSION

### Approach and limitations

Several disclaimers must be advanced regarding the methodology and findings presented in this chapter:

- As stated in Chapter 1, the variables in FRA 2005 do not address all aspects of sustainable forest management.
- Information availability is not satisfactory for all variables, which leaves a number of gaps in the analysis.
- Selection of variables is subjective and may not be valid in other contexts or scales.

TABLE 8.9  
Trends towards sustainable forest management by subregion

Themes and variables	Africa			Asia		
	Eastern and Southern	Northern	Western and Central	East	South and Southeast	Western and Central
<b>Extent of forest resources</b>						
Area of forest	● H	● H	● H	● H	● H	● H
Area of other wooded land	● M	● L	● H	● H	● M	● H
Growing stock of forests	● H	● H	● H	● H	● H	● H
Carbon stock per hectare in forest biomass	● H	● H	● H	● H	● H	● H
<b>Biological diversity</b>						
Area of primary forest	● H	● H	● L	● H	● H	● H
Area of forest designated primarily for conservation of biological diversity	● H	● H	● L	● H	● H	● H
Total forest area excluding area of productive forest plantations	● H	● H	● L	● H	● H	● H
<b>Forest health and vitality</b>						
Area of forest affected by fire	–	–	–	● H	● H	● H
Area of forest affected by insects, diseases and other disturbances	–	–	–	● H	● L	● M
<b>Productive functions of forest resources</b>						
Area of forest designated primarily for production	● H	● H	● L	● H	● H	● H
Area of productive forest plantations	● H	● H	● L	● H	● H	● H
Commercial growing stock	● H	● L	● L	● H	● M	● H
Total wood removals	● H	● H	● H	● H	● H	● H
Total NWFP removals	–	–	–	● H	● L	● M
<b>Protective functions of forest resources</b>						
Area of forest designated primarily for protection	● H	● H	● L	● H	● H	● H
Area of protective forest plantations	● H	● H	● L	● H	● H	● H
<b>Socio-economic functions</b>						
Value of total wood removals	–	● L	–	● H	● H	● H
Value of total NWFP removals	–	● M	–	–	● L	● M
Total employment	● L	● M	● L	● H	● M	● H
Area of forest under private ownership	● H	● H	● H	● H	● H	● H
Area of forest designated primarily for social services	● H	● H	● L	● H	● H	● H

H = High (reporting countries represent 75–100% of total forest area)  
M = Medium (reporting countries represent 50–75% of total forest area)  
L = Low (reporting countries represent 25–50% of total forest area)

● = Positive change (greater than 0.50%)  
● = No major change (between -0.50 and 0.50%)  
● = Negative change (less than -0.50%)  
– = Insufficient data to determine trend

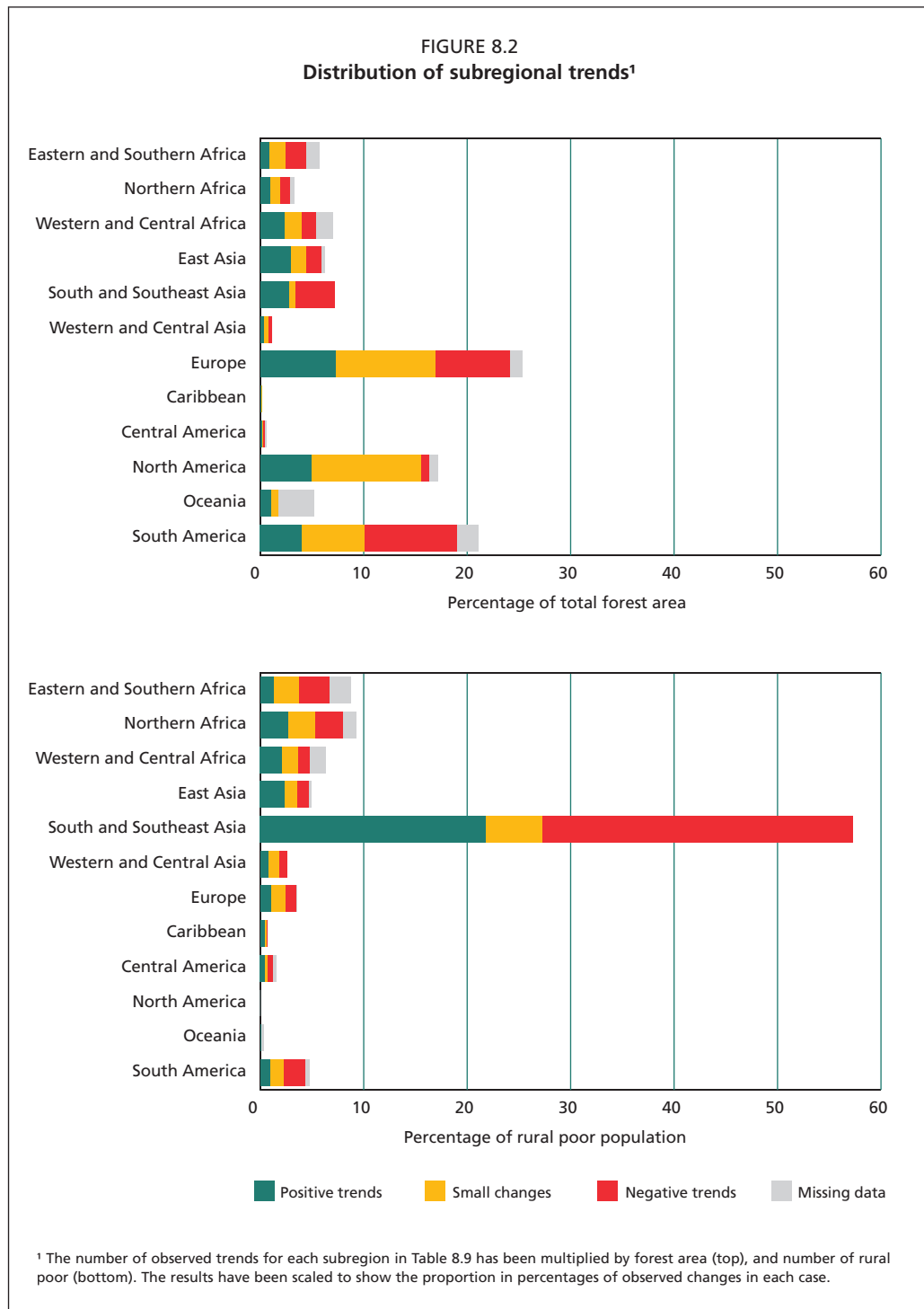
- Indications of positive or negative values for trends can be argued in several cases, particularly if the trend is seen in a bigger policy perspective. For example, the loss of forest area can be positive if agricultural development and efforts to improve food security and self-sufficiency are national priorities.
- Indications of positive or negative trends are not presented in relation to the current status of forests and their management.
- Although no weights are explicitly applied in the analyses, the selection of certain variables is in itself a weighting.
- Aggregation of trends by region and subregion obscures positive or negative trends in individual countries. Results cannot therefore be seen as applicable to individual countries in any region.



Europe	North and Central America			Oceania	South America	Themes and variables
	Caribbean	Central	North			
<b>Extent of forest resources</b>						
● H	● H	● H	● H	● H	● H	Area of forest
● H	● H	● H	● M	–	● L	Area of other wooded land
● H	● H	● H	● H	–	● M	Growing stock of forests
● H	● L	–	–	–	● M	Carbon stock per hectare in forest biomass
<b>Biological diversity</b>						
● H	● M	● H	● H	● H	● H	Area of primary forest
● H	● M	● H	● H	–	● H	Area of forest designated primarily for conservation of biological diversity
● H	● M	● H	● H	● H	● H	Total forest area excluding area of productive forest plantations
<b>Forest health and vitality</b>						
● H	● M	–	● H	–	● H	Area of forest affected by fire
● H	–	–	● H	–	● M	Area of forest affected by insects, diseases and other disturbances
<b>Productive functions of forest resources</b>						
● H	● M	● H	● H	–	● H	Area of forest designated primarily for production
● H	● M	● H	● H	● H	● H	Area of productive forest plantations
● H	● M	● M	● H	–	● M	Commercial growing stock
● H	● H	● H	● H	● H	● H	Total wood removals
● H	● L	–	–	–	● M	Total NWFP removals
<b>Protective functions of forest resources</b>						
● H	● M	● H	● H	–	● H	Area of forest designated primarily for protection
● H	● M	● H	● H	● H	● H	Area of protective forest plantations
<b>Socio-economic functions</b>						
–	● L	● H	● M	–	● H	Value of total wood removals
● H	● L	–	● M	–	● M	Value of total NWFP removals
● H	● H	● M	● H	● H	–	Total employment
● H	● M	● M	● H	–	–	Area of forest under private ownership
● H	● M	● H	● H	–	● H	Area of forest designated primarily for social services

The analysis is clearly sensitive to the selection of variables. The options for variables were limited by the set of FRA 2005 reporting tables and further reduced by the information availability for several of these. In addition, there is a high covariation between some variables, which must be considered before drawing far-reaching conclusions from the findings.

The methodology used to illustrate these key trends does not take into account value judgments or variations in stakeholder perceptions of forest benefits and the relative importance of different variables. While such evaluation methodologies exist, e.g. Delphi approaches, which were tested in the FRA 2005 process (FAO, 2003c), the objectives of this study were to provide an example of how existing information, collected as part of FRA 2005, can be used in an initial analysis of progress towards sustainable forest management and to stimulate further discussion and more detailed analyses.



In conclusion, the analyses and presentations in this chapter are limited by the variables and data available in the FRA 2005 reporting tables. Many relevant parameters are not included owing to lack of information at the global level, and a more detailed analysis must take into consideration the varying conditions between regions and countries. It should also be noted that the analyses do not cover all aspects of sustainable forest management: the thematic element of the legal, institutional and policy framework as well as forest benefits generated in secondary production and trade were explicitly excluded from FRA 2005. Nevertheless, the results provide a global picture of key trends with respect to the management and use of forest resources. It should be seen as one illustration of progress, or lack of progress, towards sustainable forest management.

**Forest or poverty perspective?**

The illustration of trends in relation to both forest area and rural poor population provides an additional example for discussion and further analyses. It is an attempt to combine subregional trends for all studied thematic elements of sustainable forest management and to relate them to the relative proportion of the global forest area and the number of rural poor people in each subregion. The number of observed positive and negative trends should be seen as an illustration rather than an absolute result. Still, the presentation provides some insight into the very different conclusions that may be reached. Forest resources assessments have often had a relatively restricted approach, emphasizing results related to measures of forest area. However, the broad objective of sustainable forest management, addressing also sustainable development, would suggest that a variety of analytical perspectives be included that encompass socio-cultural, economic and environmental dimensions of forest resources, their management and uses.

**Is there progress towards sustainable forest management?**

Given the complexity of this question, the answer cannot be a definitive one. There are many good signs and positive trends, but many negative trends remain. While intensive forest plantation and conservation efforts are on the rise, primary forests continue to become degraded or converted to agriculture at alarming rates. As the analyses above illustrate, the answer also depends on the scale and perspective applied.

