

Chapter 9

Discussion

As with all analyses, the reliability of the results depends on the quality of the input. This chapter provides information on overall data availability and quality, describing specific issues in the determination of the most recent reliable estimates and of trends. Lack of comprehensive information and changes in methodologies and, to a lesser extent, definitions from one assessment to another represented the most serious difficulties faced in comparing national estimates and analysing trends. Political boundaries of a few countries have changed over the years and/or additional mangrove areas have been discovered only recently, making trend analyses very challenging.

DEFINITIONS USED

In the present study, mangrove areas were broadly defined as areas containing one or more true mangrove species (based on Tomlinson, 1986, and Saenger, Hegerl and Davie, 1983²). No attempt was made to reclassify areas defined as mangrove forests in the original sources. All definitions used in the original sources have been entered into the global database. Where possible, waterways and other vegetation types existing within the larger mangrove forest and areas of freshwater swamp were subtracted from the total area. Mangroves are a relatively distinct and, in most cases, easily demarcated forest type, and consequently the problem of different definitions over time is deemed to be less significant than the problems caused by the use over time of varying methodologies and sampling intensities and potential interpretation errors.

OVERALL DATA AVAILABILITY

Quantitative or qualitative information on the current status and extent of mangroves has been found for all 124 countries and areas in which these coastal ecosystems are known to exist. More than 2 900 national and subnational data sets were collected, with the earliest estimates dating from 1888. Of the countries included in this assessment, 90 were reporting through national experts and focal points during the initial phases of the study, providing FAO with essential information for a reliable evaluation.

The database of mangrove area estimates currently includes 2 969 data sets for the countries and areas included in the study. The total number of references is 630; of these, 43 provide global or regional information on mangrove areas, while the remaining 587 are country specific. A total of 1 153 data sets provide national estimates (including those with breakdowns to subnational units), while 1 816 data sets provide only subnational figures, covering provinces or key mangrove areas within a given country. Some of the data sets are secondary sources that repeat past estimates. The total number of different national estimates is therefore 899 – an average of seven different estimates over time per country or area. The information availability per region (i.e. the number of national estimates and their reliability) is illustrated in Figure 15.

Despite concerted efforts, no quantitative data were identified on the extent of mangroves in seven countries/territories (Table 15); only qualitative information was obtained indicating the presence of mangroves on their coasts. Even though the total mangrove extent in these countries is assumed to be low and does not greatly influence the world total, an assessment should be undertaken soon in order to fill in gaps in current knowledge. This information will also aid in the preparation of sustainable use plans and the management of these resources.

² See 'Definition of true mangrove species', page 8.

For six other countries/territories (corresponding to 0.1 percent of the 2005 world mangrove area), only a single estimate was identified (Table 15). Efforts should be made to increase the knowledge of mangrove resources in these 13 countries and territories.

Conversely, ten or more national estimates over time were identified for 37 countries, which represent more than 80 percent of the current extent of world mangrove area. Among these, some have more than 15 different estimates over time (Table 16).

DATA QUALITY

The methodology used in the studies and assessments reviewed to generate national mangrove area estimates (Table 17) provides an indication of the quality of data collected during the present study.

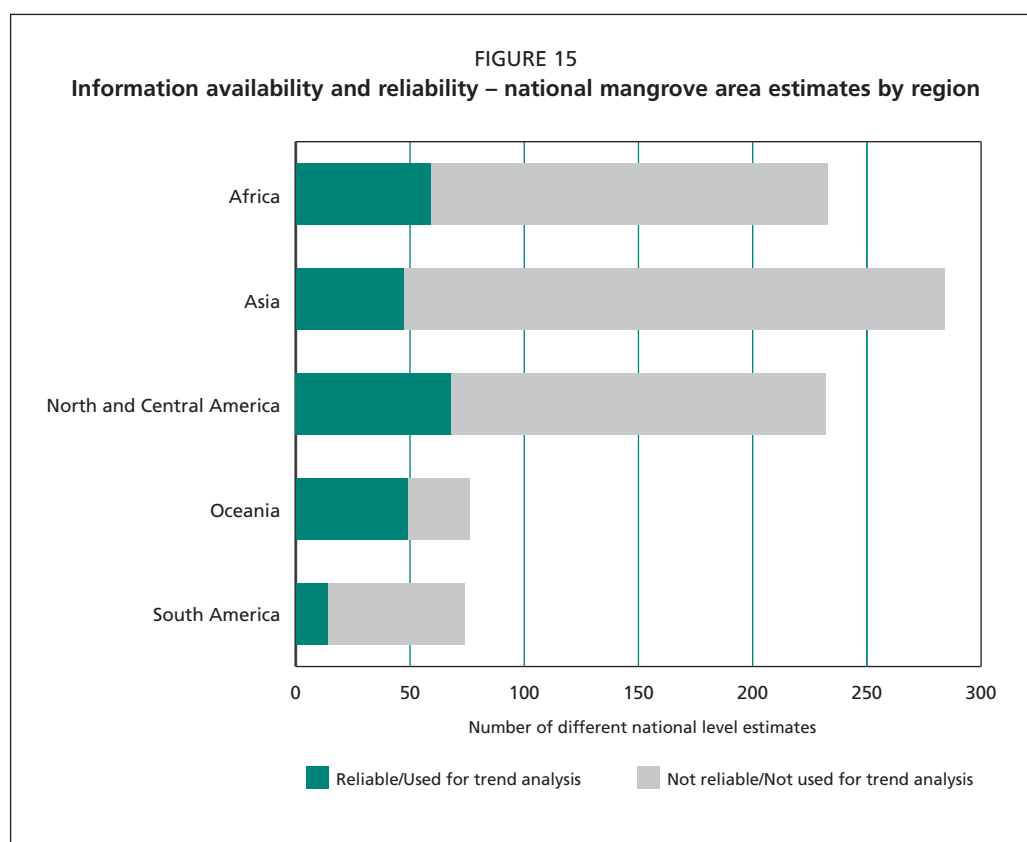


TABLE 15
Countries and areas with poor or no national data

Country/area	No. of estimates
Djibouti	1
Micronesia (Fed. States of)	1
Niue	1
Northern Mariana Islands	1
Seychelles	1
Wallis and Futuna Islands	1
British Indian Ocean Territory	no data
Christmas Island	no data
French Polynesia	no data
Maldives	no data
Marshall Islands	no data
Sao Tome and Principe	no data
Tokelau	no data

TABLE 16
Countries with good national data

Country	No. of estimates
Philippines	49
Thailand	34
Indonesia	26
India	24
Ecuador	21
Bangladesh	17
Viet Nam	16
Malaysia	16
Mexico	16
Costa Rica	16
Guinea	16
Madagascar	16

TABLE 17
Data quality

Region	All national estimates									Most recent reliable estimate							
	Total no.	Ground survey		Remote sensing/mapping		Expert estimate		Not known		Ground survey		Remote sensing/mapping		Expert estimate		Not known	
		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Africa	233	5	2	99	42	31	13	98	42	2	6	25	78	4	13	1	3
Asia	284	6	8	75	144	52	34	151	53	2	8	11	46	4	17	7	29
North and Central America	232	15	6	82	35	55	24	80	34	10	29	13	38	8	24	3	9
Oceania	76	3	4	29	38	12	16	32	42	2	11	11	58	3	16	3	16
South America	74	0	0	31	42	16	22	27	36	0	0	6	75	0	0	2	25
World	899	29	3	316	35	166	18	388	43	16	14	66	56	19	16	16	14

Note: The percentages given for the various methodologies refer to the number of national estimates using the related methods and not to mangrove area coverage.

About 38 percent of all national estimates were based on ground surveys (3 percent) or remote-sensing imagery interpretation and/or mapping (35 percent). Ground surveys were carried out in all regions, but only to a very limited extent and at a lower percentage than with other methodologies, probably due to the costs involved in conducting large-scale inventories with this methodology and the additional logistic difficulties that have to be faced when undertaking such inventories in these ecosystems. No such inventories were reported for South America. Tidal changes and the complexities of undertaking a classic field survey in mangrove forests make their assessment difficult and time consuming. Consequently, more institutes and governments are making use of remote sensing imageries coupled with Geographic Information System (GIS) technology for their inventories. The new digital technologies used in India, for example, improved the minimum mapping area to one hectare, allowing the preparation of accurate estimates.

Unfortunately, the methodology used in assessments was often not reported (43 percent); where this is due to reliance on secondary sources, further attempts will be made to obtain copies of the original inventories.

In the framework of this study, only the most reliable estimates were taken into account for the trend analysis. Despite efforts to find as many reliable estimates as possible, for 40 countries and areas (mainly from Africa and the Caribbean) only one estimate was considered reliable. Even though more estimates were available, discrepancies among them (e.g. differences in methodologies, exclusion of some mangrove sites in the country, low resolution of the mapping scale, etc.) did not allow a proper comparison and analysis of area changes. For a few of these countries and areas (e.g. Anguilla, Aruba, French Guiana and Qatar), qualitative information indicated no major changes over the last 20 years, while for others the estimates for 1980, 1990, 2000 or 2005 were produced by applying the annual change rates for forests calculated for the global forest resources assessments (FAO, 1995b, 2001a, 2006). The total area of mangroves estimated to be currently growing along the coasts of these 40 countries and areas is just 2.5 percent of the global mangrove area and thus does not greatly influence the world total. However, this study recommends focusing future attention on these countries in order to increase the availability of reliable data.

On the other hand, the analysis of changes in area for 39 countries/territories (61.6 percent of worldwide mangrove area) was based on three or more reliable data sets over time, and for eight of these on more than five data sets (Table 18).

TABLE 18
Countries with five or more reliable estimates used for the trend analysis

Country	No. of reliable estimates	Time range analysed
Viet Nam	7	1943–2000
Cuba	6	1972–2003
Malaysia	6	1995–2005
Peru	6	1976–1995
Ecuador	5	1984–1999
El Salvador	5	1981–2004
Pakistan	5	1980–2001
Philippines	5	1918–2003

MOST RECENT RELIABLE ESTIMATE

The majority of estimates selected as the most recent reliable national estimate are based on detailed ground surveys (14 percent) and/or accurate remote sensing imagery interpretation (56 percent) (Table 17). The weighted average year for the world total (15 704 958 ha) is 2000, which makes this study the most up-to-date and comprehensive assessment ever undertaken on this subject at the global level.

Recent reliable estimates by country dating from 2000 or later were identified for 45 countries (or 64 percent of the total current mangrove area), while such estimates dating from 1995 to 2000 were found for an additional 30 countries. These two sets of countries together account for 87 percent of the global mangrove area.

For 25 countries and areas, the most recent reliable estimate dated from 1990 to 1995; 36 percent of these were Caribbean islands, often dating back to 1991 (Bacon, 1993). For 17 countries and areas the most up-to-date estimate dated from before 1990. Half of these are arid-zone countries or small island developing states (SIDS). Mangroves here, with a few exceptions (e.g. the Bolivarian Republic of Venezuela, French Guiana and Kenya), cover a relatively small area totalling less than 3 percent of the world extent.

Estimates for Indonesia, Australia and Mexico (among the five countries with the largest mangrove cover worldwide) covered a wide range of time, with a weighted average reference year of 2001. Brazil and Nigeria (the other two countries among the top five) have most recent information dating only from 1991 and 1995 respectively.

TRENDS OVER TIME AND IMPEDIMENTS TO THE ASSESSMENT

The abundant feedback received from the countries, coupled with an intensive literature search, provided estimates covering more than 100 years, with the earliest assessments dating from 1888 (Australia) and 1918 (Philippines), and the most recent ones dating from 2005 (Australia, Japan, Malaysia and the Wallis and Futuna Islands).

At the global level, trend analyses were hampered by three main difficulties: lack of comprehensive data over time, differences in definitions used and differences in methodologies over time, which represented the most serious problem. When selecting the estimates to be used for trend analysis, preference was given to estimates based on field inventories and/or remote sensing. However, in some instances it was not possible to exclude estimates for which the methodology was unknown. The apparently large mangrove loss in Indonesia, for example, may in part be due to the use of different methodologies over time. Some over- or underestimation of area changes may also be caused by the different scales and sampling intensities. In some cases, the 'no significant area changes over time' reported by some countries may be only apparent – the result of a lack of reliable estimates, not allowing proper trend analysis and imposing the use of only qualitative information to assess the current extent of mangroves.

A list of national estimates by country – including full references and information on methodology, reliability and use for trend analysis – and the results of the individual

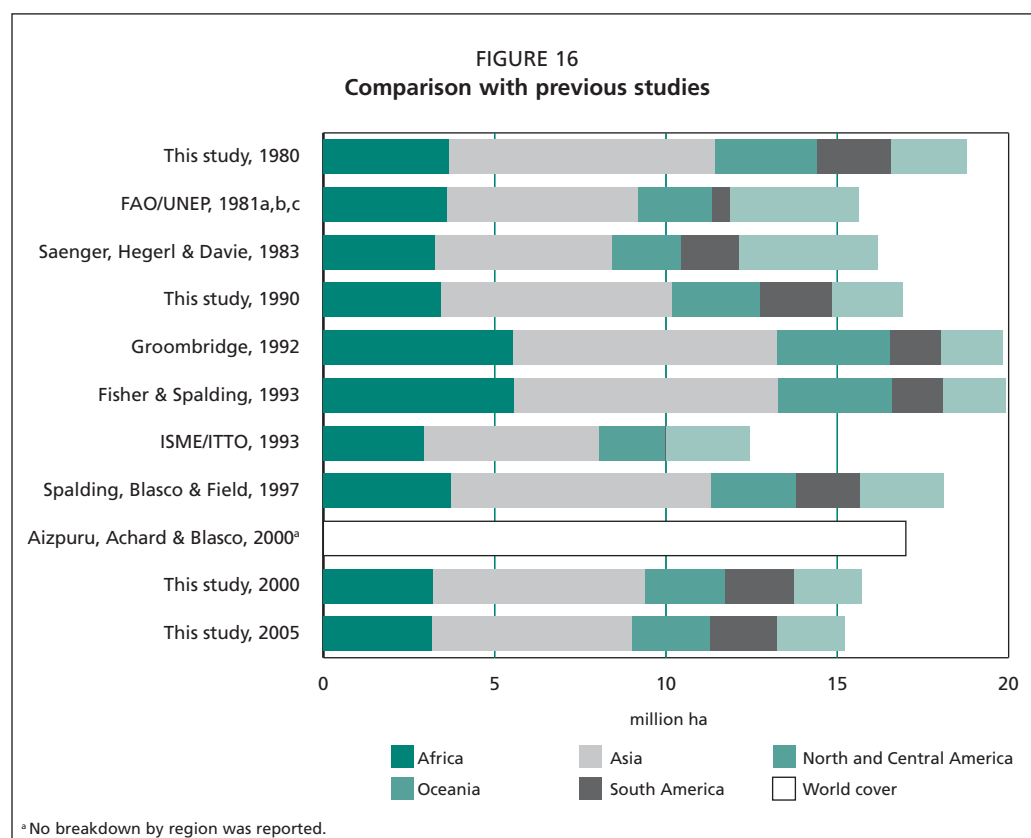
trend analyses for each country and area are provided in the five regional working papers complementary to the main study listed in Annex 2.

COMPARISON WITH PREVIOUS STUDIES

Figure 16 compares the results of the present study with previous global estimates. Keeping the cited caveats in mind, the results indicate that the 1980s estimates of total mangrove area were too low (primarily due to the limited number of countries included), whereas those made in the 1990s and 2000 were too high, with the exception of ISME/ITTO in 1993, which included fewer countries.

TABLE 19
Countries and areas with most recent reliable estimate predating 1990

Country/area	Reference year
Benin	1989
Mayotte	1989
Haiti	1988
Turks and Caicos Islands	1988
Aruba	1986
Venezuela (Bolivarian Rep. of)	1986
Djibouti	1985
Palau	1985
Saudi Arabia	1985
Micronesia (Fed. States of)	1983
Kenya	1982
Niue	1981
French Guiana	1980
Netherlands Antilles	1980
Northern Mariana Islands	1976
Somalia	1975
Seychelles	1960



The new estimates provided by the present study for 1980, 1990 and 2000, as well as those presented as the most recent reliable estimates, are presumed to be the best available. The extrapolation to 2005 is, by definition, less reliable – particularly where few or no recent assessment results were available. This estimate is thus only indicative and is likely to change as and when results from ongoing and future assessments become available.