Forestry Department
Food and Agriculture Organization of the United Nations

GLOBAL FOREST RESOURCES ASSESSMENT 2005

THEMATIC STUDY ON MANGROVES

INDONESIA

COUNTRY PROFILE

DRAFT, JUNE 2005

Forest Resources Development Service
Forest Resources Division

Forestry Department
FAO, Rome (Italy)

DISCLAIMER

The designation employed and the presentation of materials in this information product do not imply the expression of any opinion or whatsoever on the part of the Food and Agriculture Organization of the United Nations concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries.

This paper does not reflect any official position of FAO. Please refer to the FAO website (www.fao.org/fo) for official information.

The purpose of this paper is to provide early information on on-going activities and programmes, to facilitate dialogue, and to stimulate discussion.

Contact person:

Mette Løyche Wilkie, Senior Forestry Officer
Global Forest Resources Assessment
Forest Resources Division
Forestry Department
FAO
Viale delle Terme di Caracalla
Rome 00100 (Italy)
E-mail:Mette.LoycheWilkie@fao.org

INTRODUCTION

Mangroves are found along sheltered coastlines in the tropics and sub-tropics where they fulfil important functions in terms of providing wood and non-wood forest products, coastal protection, conservation of biological diversity and provision of habitat, spawning grounds and nutrients for a variety of fish and shellfish. High population pressure in coastal areas has led to the conversion of many mangrove areas to other uses and numerous case studies describe mangrove losses over time. However, information on status and trends at the global level is scarce. The first attempt at estimating the total mangrove area in the world was undertaken as part of the FAO/UNEP Tropical Forest Resources Assessment in 1980, where the world total was estimated as 15.6 million hectares. More recent estimates range from 12 to 20 million ha. For many of these studies, countries with small areas of mangroves were excluded due to lack of information and because their combined area of mangroves would not significantly affect the world total.

A recent initiative by FAO aimed at facilitating access to comprehensive information on the current and past extent of mangroves in 121 countries and areas (FAO. 2003). This built on the earlier FAO/UNEP assessment and on the recent FAO Global Forest Resources Assessment 2000 (FRA 2000). An extensive literature search yielded additional information. More than 2800 national and sub-national datasets were collected, with the earliest estimates dating back to 1918. One of the results was an updated list of the most reliable, recent estimate for each country, mostly based on inventories or analysis of remote sensing imagery. Regression analyses based on earlier data provided estimates for 1990 and 1980 and an extrapolated estimate for 2000 for each country.

The preliminary results of this initiative showed that mangrove deforestation continues, albeit on a slightly lower rate in the 1990s than in the 1980s. The relatively large mangrove deforestation rates in Asia, the Caribbean and Latin America in the 1980s reflect large-scale conversion of mangroves for aquaculture and tourism infrastructure. Most countries have now banned the conversion of mangroves for aquaculture purposes and require environmental impact assessments prior to large-scale conversion of mangroves areas for other uses.

In order to provide the most accurate and comprehensive evaluation of current mangrove status, FAO is presently updating the above cited preliminary results, which have been sent out to all countries and areas in which they exist (124) for information and validation. Additional literature search, active collaboration with national and international mangrove experts and the use of remote sensing imagery interpretation, have further supported the preparation of the final report, which will be published in 2005.

Readers are strongly encouraged to provide feedback and additional information to help update and improve this database for the benefit of all those who may have an interest in mangroves.

Indonesia

Vegetation description

Indonesia is a vast archipelago consisting of some 17 000 islands. It has the largest area of mangroves of any country, a large part of which is concentrated in Irian Jaya. Mangroves are found throughout the country, although they are scarce in west Sumatra. Other very large areas are found along the east coast of Kalimantan and the east coast of Sumatra. The diversity of mangrove species found in Indonesia is very high. Five major mangrove types or 'consociations' are recognised, based on dominant species of *Avicennia, Rhizophora, Sonneratia, Bruguiera* and *Nypa*. The relative occurrence of each of these can be related to ecological factors such as tidal regime, soils and salinity. While more mixed associations also occur in some areas, closer inspection of these often reveals a zonation or succession of some of the consociations already mentioned. Typically mangroves show a high degree of structural development, with trees reaching 50 m in height in many areas such as on the south and east coasts of Sumatra and Kalimantan. It is very difficult to make generalisations about the climate or physical conditions in a country of this size; however most coastal regions have humid tropical or equatorial climates, with high humidity, seasonal wind and precipitation, a high annual rainfall and high temperatures. Where conditions of rainfall or coastal topography are less favourable, mangroves may only form shrubby communities or be virtually absent, such as in the East Nusa Tenggara (Lesser Sunda Islands) and western Sumatra. Tidal fluctuations vary enormously over relatively short distances due, in part, to the complexity of the coastal configuration.

Uses and threats

Losses of mangrove areas in Indonesia can mostly be attributed to the development of shrimp ponds and logging activities. Conversion to shrimp ponds is especially prevalent in East Java, Sulawesi and Sumatra. Local use of mangrove products includes timber for construction, considerable usage for fuelwood, the use of *Nypa* for sugar production and *Nypa* leaves for roofing. Commercial uses include charcoal production and large areas of logging concessions. Production of woodchips and pulp is increasing. Chip mills have been built in Sumatra and Kalimantan, while a major mill has been built to process mangroves from a 137 000 ha lease in Bintuni Bay, Irian Jaya, formerly one of the largest and most pristine mangrove areas in the world. Mangrove associated fisheries are important, including finfish, bivalves and crabs. Brackish water fishponds have been used in Indonesia since the fifteenth century and in the 1970s they began to be used for shrimp farming. Extensive methods are used, relying on natural stocking as well as intensive methods, the fry being obtained from hatcheries, with feeding and predator controls applied. Smaller areas of mangroves have been lost or threatened by conversion to agriculture, salt pans (Java and Sulawesi), oil extraction (East Kalimantan) and pollution. Recognising the importance of mangroves for fisheries, forestry, coastal protection and wildlife, a number of protected areas and mangrove greenbelts have been designated. Continuing cutting has given rise to thickets of the fern *Acrostichum aureum* and *Acanthus* spp., by which natural regeneration is greatly impaired. On the other hand it is also important to notice that mangrove awareness is increasing in the country and some areas have been reforested / planted in few localities. In order to further protect the ecosystem, the government designated mangrove land use in different classes: nature conservation and national park; protection forest; production forest; agriculture fishery and other purposes.

Besides human threats, mangroves in Indonesia have to face many different natural hazards, such as cyclones, wind and tsunamis; studies are currently on-going in order to assess the damage caused to mangrove forest by the 26th December 2004 tsunami, at the same time their role in protecting the coast and smoothening the strength of the waves is also being evaluated.

Kusumawardhani, L. 2004. Information provided for the Global Forest Resources Assessment (GFRA) 2005 thematic study on mangroves. Unpublished**.**

Spalding, M.D., Blasco, F. & Field, C.D., eds. 1997. *World Mangrove Atlas*. The International Society for Mangrove Ecosystems, Okinawa, Japan. 178 pp.

Wiroatmodjo, P. 2004. Status and challenges on the management of mangroves in Indonesia. *In*: Bhandari, B.B., Kashio, M. and Nakamura, R. *Mangroves in Southeast Asia. Status, Issues and Challenges.* pp: 135-150. Ramsar Center Japan. Institute for Global Environmental Strategies (IGES)., Tokyo.

National level mangrove estimates

In order to provide the whole range of the information currently available on mangrove area extent for this country, all the national level mangrove area estimates collected so far have been reported in the following table.

Differences in methodologies, classifications, mapping scales etc. may have led to discrepancies in figures, thus only the estimates considered as the most accurate and reliable (marked in the Trend column in this table) have been used for the analysis of the area changes over time.

Year	Area (ha)	Source	Trend	Methodology/Comments
1950	2 501 825	**Martosubroto, P., Naamin, N. 1977. Relationship between tidal forests (mangroves) and commercial shrimp production in Indonesia.** *Marine Resources Indonesia* 18: 81-86.		Map analysis. This figure excludes Bali and Nusa Tenggara and provides a low estimate for Irian Jaya. This figure has not been represented in the chart since it is too old for the purposes of this study.
1973	3 807 100	**Directorate of forestry Planning.** 1981. *Report on the Forest of Indonesia.* Publication No. 18, 1981		Cited in: **Sutter, H., Ministry of Forestry, Government of Indonesia**, **FAO.** 1989. *Forest Resources and Land Use in Indonesia*. This figure excludes Nusa Tenggara.
1978	1 000 000	**Directorate of Forest Planning.** 1979. *Forestry in Indonesia 1978.* Bogor		Cited in: **FAO, UNEP.** 1981. *Tropical Forest Resources Assessment Project, Forest Resources of Tropical Asia.* FAO, UNEP, 475 pp. According to the authors this figure has to be considered as on the higher side.
1978	3 600 000	**Soemodihardjo, S.** 1978. *Utilization and management of mangrove resources in Indonesia.*		Cited in: **Snedaker, S.C.** 1984. The Mangroves of Asia and Oceania: Status and Research Planning. *In: proceedings of the Asian Symposium on Mangrove Environment Research and Management*, p 5-15 Kuala Lumpur, August 25-29, 1980. Edited by E. Soepadmo, A.N. Rao and D.J. MacIntosh. 1984

Year	Area (ha)	Source	Trend	Methodology/Comments
1978	3 627 119	**Wiroatmodjo, P. and Judi, D.M.** 1978. *Pengelolaan hutan payau di Indonesia / Management of brakish-water forests in Indonesia.* Presented at Seminar on Mangrove Ecosystem, 27 February - 1 March 1978, Jakarta.		Cited in: **FAO.** 1982. *Management and utilization of mangroves in Asia and the Pacific.* FAO environment paper 3. 160 pp. This figure does not include Bali.
1978	3 707 119	**Knox, G., Miyabara, T.** 1984. *Coastal Zone Resource Development and Conservation in Southeast Asia with special reference to Indonesia.* UNESCO East-West Centre, Jakarta Pusat, Indonesia, 182 pp.		Based on: **Burbridge, P. R., Koesoebiono.** 1980. *Management of Mangrove exploitation in Indonesia*; **Wiroatmodjo, P. and Judi, D.M.** 1978. *Pengelolaan hutan payau di Indonesia / Management of brakish-water forests in Indonesia.* Presented at Seminar on Mangrove Ecosystem, 27 February - 1 March 1978, Jakarta
1980	2 171 300	**Sutter, H., Ministry of Forestry, Government of Indonesia, FAO.** 1989. *Forest Resources and Land Use in Indonesia*. Forestry studies: I-1. MOF - FAO.		Vegetation map of Outer Islands at the scale of 2 750 000, source date 1972; Jawa and Bali at scale 1: 1 000 000.
1982	3 177 200	**Sutter, H., Ministry of Forestry, Government of Indonesia, FAO.** 1989. *Forest Resources and Land Use in Indonesia*. Forestry studies: I-1. MOF - FAO.		Bina Programme 1982 & FAO 1981 and 1982 edited from Asian Wetland Bureau, quoted in article in The Jakarta Post of 27 March 1989 by Information Officer at AKEPHI, the Network for forest Conservation in Indonesia.
1982	4 251 011	**FAO.** 1985. *Mangrove management in Thailand, Malaysia, and Indonesia.* FAO Environment Paper (FAO), no. 4. FAO, Rome, 62 pp.		BINA program - Directorate of Forest Planning
1982	4 254 312	**Forestry Department.** 1982	X	Cited in: **Soemodihardjo, S., Wiroatmodjo, P., Abdullah, A. Tantra, I.G.M. and Soegiarto, A.** 1993. Condition, socio-economic values and environmental significance of mangrove areas. *In:* Clough, B.F. 1993. *The Economic and environmental values of mangrove forests and their present state of conservation in the South-East Asia/Pacific Region.* p. 17-38 Mangrove Ecosystems Technical Reports vol.3 ITTO/ISME/JIAM Project PD71/89. Rev. 1(F) Okinawa, Japan, ISME. 202 pp.
1983	2 176 300	**Saenger, P., Hegerl E.J. and J.D.S., Davie.** 1983. *Global status of mangrove ecosystems.* Commission on ecology Papers No.3. IUCN. Gland, Switzerland. 88 pp.		Secondary reference, no primary source provided. The "Year" is the publication year. The figure is very similar to the one cited in Sutter, et al. 1989 (see above) It could refer to the same source, the difference in the figure could be due to a different conversion factor used.

Year	Area (ha)	Source	Trend	Methodology/Comments
1984	4 250 000	**Darsidi, A.** 1984. Mangrove forest management in Indonesia. *In:* Soemodihardjo, S. et al (eds) *Proceedings of the Seminar on the mangrove ecosystem II*, Baturaden, 1982. LIPI : 19-26		Cited in: **Soegiarto, A.** 2000. Research and conservation of Mangrove ecosystem in Indonesia. *In: Proceedings of the International Workshop* 26-30 March, 2000, Okinawa, Japan - Asia-Pacific cooperation on Research for conservation of Mangroves. This figure could refer to Soemodihardjo, S. et al., 1993. (see above)
1984	4 345 116	**Soegiarto and Sukardjo**. 1984.		Cited in: **Cholik, F. and A. Poernomo**. 1986. Development of aquaculture in mangrove areas and its relationship to the mangrove ecosystem. *In:* Mepham, R.H. 1986. *Papers contributed to the workshop on strategies for the management of fisheries and aquaculture in mangrove ecosystems.* p. 93-104. Bangkok, Thailand, 23 June 1986. The "Year" is the publication year.
1985	3 790 500	Regional Physical Planning Programme for Transmigration (RePPProT mid 1980's, 1985-89)		Cited in: **The World Bank.** 2001. *Indonesia: environment and natural resource management in a time of transition.* Washington DC. World Bank. 147 pp.
1985	3 737 340	**National Forest – Inventory.** 1993. *INTAGM Dep. Kehutanan using Landsat data from early and mid - 1980's*	X	Remote sensing.
1988	3 493 110	**Ibid**	X	Combined National Level Mangrove Estimate based on remote sensing studies. Bali: **Forestry Department.** 1982 (cited in Soemodihardjo, S., Wiroatmodjo, P., Abdullah, A. Tantra, I.G.M. and Soegiarto, A., 1993). (Ref. Year: 1982). Irian Jaya: **National Forest - Inventory, INTAGM Dep.** 1993. (by Hatari, H. pers comm 2002). (Ref. Year: 1985). Java: Regional Physical Planning Programme for Transmigration (RePPProT mid 1980's (1985-89) (cited in The World Bank, 2001). (Ref Year: 1985). Kalimantan: **National Forest - Inventory, INTAGM Dep.**, 1993. (by Hatari, H. pers comm 2002). (Ref. Year: 1985) Maluku: **National Forest - Inventory, INTAGM Dep.** 1993 (by Hatari, H. pers comm 2002) (Ref Year: 1985) Nusa Tenggara, Sulawesi: **FAO, Directorate General of Forest Inventory and Land Use Planning.** 1995. (Ref Year 1989). Sumatera: **Aizpuru, M., Blasco, F.** 2000 Reference Year: 2000

Year	Area (ha)	Source	Trend	Methodology/Comments
1988	4 542 100	**Spalding, M.D., Blasco, F. and Field, C.D.**, eds. 1997. *World Mangrove Atlas*. The International Society for Mangrove Ecosystems, Okinawa, Japan. 178 pp.		Map analysis, scale 1:2 500 000. Map references provided at the end of the table.
1989	3 743 500	**FAO, Directorate General of Forest Inventory and Land Use Planning.** 1995. *Second Interim Forest Resources Statistics Indonesia.* UTF/INS/066/INS		Remote sensing. Same figures as in Nat. For. Inv., 1985 (see above) except for Sulawesi.
1992	3 515 471	**Selamat Datang di Situs-Departemen Kehutan Republik Indonesia.** n.d. *Peta Fungsi Kawasan Hutan* (Peta Tata Guna Hutan Kesepakatan).		Remote sensing imagery (Landsat)
1993	2 490 185	**Giesen, W.** 1993. *Indonesia's mangroves: an update on remaining area and main management issues.* Presented at the international seminar on coastal zone management of small island ecosystems. Ambon 7 - 10 April 1993. AWB Indonesia. 10 pp		Calculation on remaining mangrove areas based on RePPProT's (1985-1989) series and Land-system maps plus remote sensing information for some of the islands.
1996	3 533 600	**Kitamura, S., Anwar, C., Chaniago, A., Baba, S.** 1997. *Handbook of mangroves in Indonesia* - Bali & Lombok - JICA, ISME, Japan, p.119.		The extent is representing the remaining mangroves in Indonesia in 1996. Secondary reference, no primary source is provided.
2000	4 000 000	**Aizpuru, M., Achard, F., and Blasco, F.** 2000. Global Assessment of Cover Change of the Mangrove Forests using satellite imagery at medium to high resolution. *In EEC Research project n 15017-1999-05 FIED ISP FR* – Joint Research center, Ispra.		National level estimate extrapolated from the remote case study on Java and literature review.
2000	2 423 700	**World Resources Institute**. 2000. *World resources 2000-2001: people and ecosystem—the fraying web of life*. Washington, DC. UNDP. 400 pp.		Secondary reference, no primary source provided. "Year" is the publication year.
2003	3 062 300	**Rekalkulasi Penutupan Lahan Indonesia,** 2003. *Indonesia Forest Coverage Reassessment, 2003.* Unpublished. www.dephut.go.id	X	Cited in: **Kusumawardhani, L**. 2004. Information provided for the Global Forest Resources Assessment (GFRA) 2005 thematic study on mangroves. Unpublished.

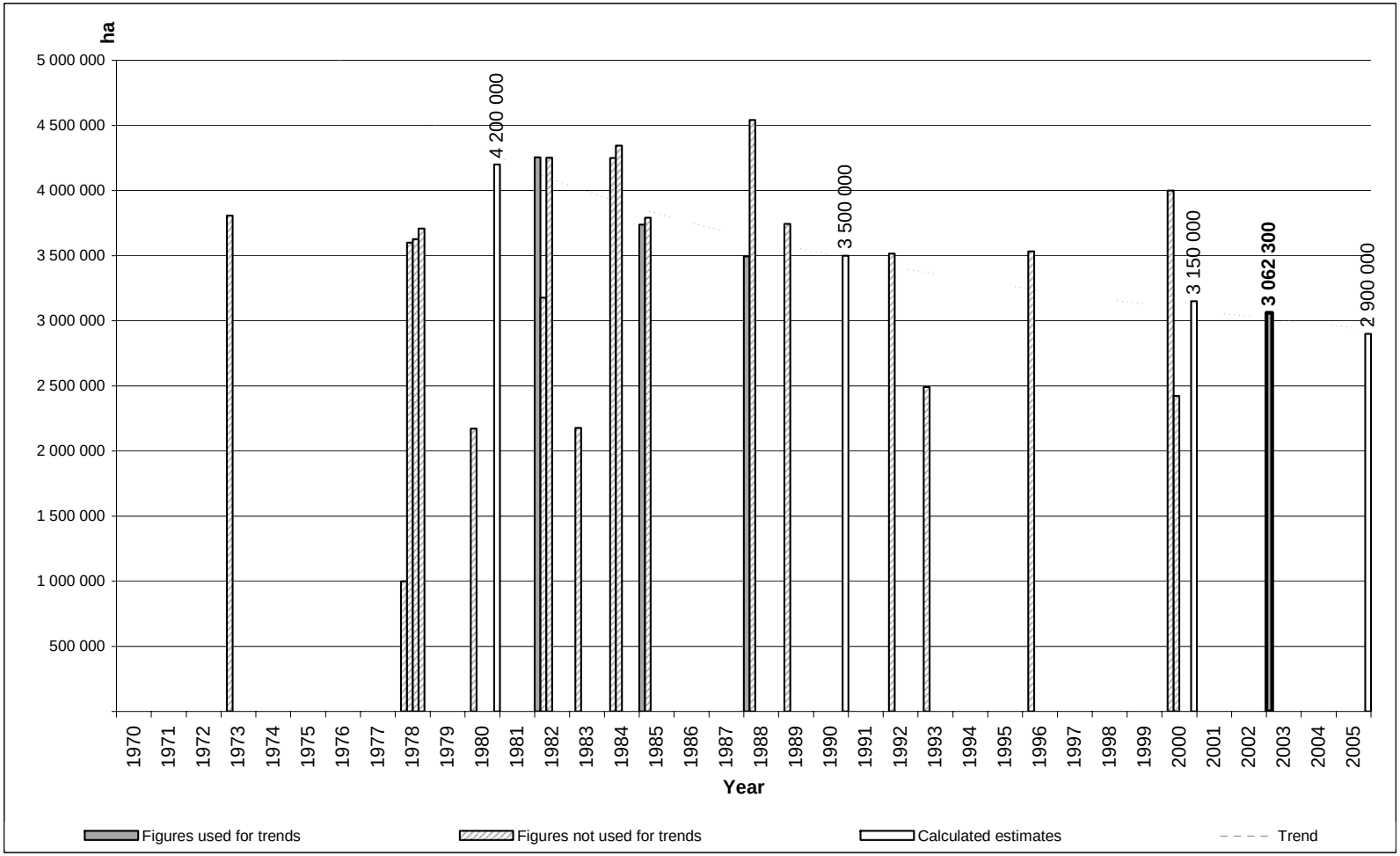
Mangrove species checklist

Following Tomlinson 1987 classification, mangroves may be divided into three groups according to their features: major elements (strict or true mangroves), minor elements and mangrove associates. Tomlinson list of true mangrove species have been here modified by adding some species commonly found as exclusive mangrove species (Saenger et al. 1983)

In the context of this assessment, only true mangrove species will be reported:

Acanthus ebracteatus
Acanthus ilicifolius
Acrostichum aureum
Acrostichum speciosum
Aegialitis annulata
Aegiceras corniculatum
Aegiceras floridum
Avicennia alba
Avicennia marina
Avicennia officinalis
Avicennia rumphiana
Bruguiera cylindrica
Bruguiera exaristata
Bruguiera gymnorrhiza
Bruguiera hainesii
Bruguiera parviflora
Bruguiera sexangula
Camptostemon philippinensis
Camptostemon schultzii
Ceriops decandra
Ceriops tagal
Excoecaria agallocha
Excoecaria indica
Heritiera globosa
Heritiera littoralis
Kandelia candel
Lumnitzera littorea
Lumnitzera racemosa
Nypa fruticans
Osbornia octodonta
Pemphis acidula
Rhizophora apiculata
Rhizophora mucronata
Rhizophora stylosa
Scyphiphora hydrophyllacea
Sonneratia alba
Sonneratia caseolaris
Sonneratia ovata
Sonneratia x gulngai
Sonneratia x urama
Xylocarpus granatum
Xylocarpus mekongensis
Xylocarpus rumphii

Trends in mangrove area extent over time



The estimates for 1980, 1990, 2000 and 2005 are based on the trend analysis, rounded according to the original data collected.

Summary status of mangrove area extent over time

	Most reliable, recent mangrove area estimate		Mangrove area estimate 1980	Mangrove area estimate 1990	Mangrove area estimate 2000	Mangrove area estimate 2005
	ha	**year**	**ha**	**ha**	**ha**	**ha**
Indonesia	3 062 300	2003	4 200 000	3 500 000	3 150 000	2 900 000

References

FAO. 1995. *Forest Resources assessment 1990: Global synthesis.* FAO Forestry Paper No. 124. Rome, 46pp.

FAO. 2001. *Global Forest Resources Assessment 2000: main report.* FAO Forestry Paper No. 140. Rome. www.fao.org/forestry/fo/fra/main/index.jsp

FAO. 2003. *Status and trends in mangrove area extent worldwide.* By Wilkie, M.L. and Fortuna, S. Forest Resources Assessment Working Paper No. 63. Forest Resources Division. FAO, Rome. *(Unpublished)* http://www.fao.org/documents/

Saenger, P., Hegerl, E.J. & Davie, J.D.S. 1983. *Global status of mangrove ecosystems*. Commission on ecology papers No. 3. Gland, Switzerland, IUCN.

Tomlinson, P.B. 1986. *The botany of mangroves.* Cambridge Tropical Biology Series, Cambridge, 419 pp.

Explanatory notes

Figures used for trends

The estimates used for the trend analysis has been marked with an “X” in the “Trend” column in the country specific table; it has been coloured in green - with no patterns - in the chart.

Most recent reliable figures

The figure chosen as the most recent reliable is underlined in the country specific table; in the chart it has been bolded.

Formulas used for the trend analysis

Power:
$y=cx^b$ where c and b are constants.