FAO/ECE Meeting of Experts on Global Forest Resources Assessment



Kotka II

METSÄNTUTKIMUSLAITOS
Kirjasto

Proceedings of FAO/ECE Meeting of Experts on Global Forest Resources Assessment in cooperation with UNEP and with the support of FINNIDA (Kotka II)

Kotka, Finland, 3–7 May 1993

Edited by Aarne Nyyssönen

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Preface

FAO/ECE meeting of experts on Global Forest Resources Assessment in cooperation with UNEP and with the support of FINNIDA was held at the Kotka College of Forestry and Wood Industry from 3 to 7 May 1993. This was the second meeting on the same topic in Kotka; the first meeting there had taken place in October 1987.

The meeting was attended by 53 participants from 30 countries, including the experts of the satellite meeting on a "Remote Sensing Processing and Archiving System" (RESPAS).

The main content of these proceedings is formed by the report of the meeting with its annexes, the background papers for various agenda items, and the summaries of 9 voluntary papers.

The proceedings are intended to inform the decision-makers and inventory specialists about the views of the experts attending the meeting. Institutions receiving the proceedings are requested to forward these to the persons concerned in the country for reference purposes.

Agenda and Timetable

FAO/ECE Meeting of Experts on Global Forest Resources Assessment in Cooperation with UNEP and with the Support of FINNIDA ("KOTKA II")

Kotka, Finland, 3–7 May 1993
(starting Monday morning 3 May
and ending early afternoon Friday 7 May)

Provisional Agenda

Revised 1 April 1993

1. Opening, introduction of participants

Representatives of FINNIDA, FAO, ECE, UNEP welcome participants and explain briefly background and objective of meeting

Participants introduce themselves briefly with indication of function.

2. Adoption of the agenda

3. Election of officers

Chairman and two vice chairmen for the meeting (chairmen and rapporteurs for working groups will be elected later)

4. Report on the status of forest inventory worldwide

For information. The report will be based on concise forest inventory situation reports received from countries.

5. Presentation of the 1990 Global Forest Resources Assessment

For information.

(a) Overview
(b) Tropical countries
(c) Non-tropical developing countries
(d) Industrialized countries
(e) Aspects related to the coordination of the assessments.

6. Developments related to future forest resources assessment and related activities of other organizations

(a) An ECE/FAO enquiry into future forest resources information needs covering the industrialized countries.
(b) Progress in planning of assessment for developing countries. Includes a study on the need of remote sensing based information executed in tropical countries under the FAO/ITC project "Remote Sensing Processing and Archiving System" (RESPAS).
(c) Relevant activities of other organizations and scope and need for cooperation.

For information and problem identification

7. Results of the UNEP/FAO expert meeting on environmental parameters for future global forest assessments

For information. Report from the meeting will be presented by UNEP

8. Review of parameters and classifications

(a) Parameters

Item for discussion and group work. Background material:

(i) the parameters used in the 1990 assessment for the industrialized and in the developing countries and
(ii) for parameters related to biomass, biodiversity and land cover change and vegetation degradation the outcome of the FAO/UNEP expert consultation held in Nairobi in December 1992.

(b) Classifications and definitions

Item for discussion and group work. Background material:

(i) the report of a consultant (deals only with the top level categories),
(ii) the previous sets of classification used in the industrialized and in the developing countries and
(iii) the FAO publication Toward a Common Framework.

9. Review of other major methodological features of global forest resources assessments

Item for discussion and group work. Some of the subitems, e.g. 9 (b) and (c) have quite different and specific implications for industrialized and for developing countries.

In the context of this item a satellite meeting is proposed to present methods used in the Finnish National Forest Inventory.

(a) Aspects of up-dating the Forest Resources Data Base on a continuing or other regular basis.
(b) Application of remote sensing and GIS for regular monitoring of the forest resource, in particular of change over time.
(c) Possibilities of strengthening/building up a network of country contacts for global assessment. Possibilities of twinning arrangements and lead centres.
(d) Design and implementation of future assessments for the industrialized and for the developing countries.

Practical questions related to data collection, analysis, validation procedures, periodicity in data collection and in reporting, type of output and dissemination of results have to be resolved.

10. Conclusions and recommendations

11. Any other business

12. Adoption of the report of the meeting

Notes on the agenda and timetable

The meeting will begin in Kotka on 3 May 1993, at 0900 hours and end in Kotka on 7 May at 1400 hours. Sessions will take place from 0830–1200 and from 1330–1730. On Tuesday and Thursday there will be evening sessions from 1900 hours.

Monday 3 May, am

Item 1–5:

Monday, pm

Item 5 – continued
Item 6–7

Monday evening: Reception given by Finnish hosts

Tuesday 4 May, am

Item 8: Plenary meeting to introduce the matter and to arrange working groups. It is proposed that five groups work in parallel and that each of them deal with subitems (a) as well as (b) as follows:

Group 1: General forest inventory parameters, industrialized countries
Group 2: General forest inventory parameters, developing countries
Group 3: Parameters related to biomass
Group 4: Parameters related to biodiversity
Group 5: Parameters related to land cover change and vegetation degradation

Global common aspects should be covered by groups 3, 4 and 5

Item 8: Group work

Tuesday pm

Item 8: Group work, continued, followed at the end of the day by a brief plenary meeting to check the situation

Tuesday 19 hours

Presentation of the Finnish National Forest Inventory, aided by personal computers. About 30 minutes. Possibility for self-

studies on the PCs until Thursday.
Time for presentation of voluntary papers.

Wednesday 5 May, am

Item 8: Plenary meeting to report on group work and draw conclusions.
Items 9: Plenary meeting to deal with subitem (a). Subitems (b), (c) and (d) will be introduced and working groups arranged. Two working groups are proposed, one for industrialized and one for developing countries, and each of them dealing with all the three subitems.
Subitems 9 (b). (c) and (d): Group work. Global common aspects particularly to be observed under subitem (d)
Item 8: Remaining group work on item 8 can be done simultaneously.

Wednesday pm

Field excursion to see inventory, planning and development work in the ENSO Timber Company.

Thursday 6 May, am

Item 9: Plenary meeting to report on group work and draw conclusions.

Thursday pm

Reserve time
Item 10: In plenary. Group work as required

Thursday 19 hours

Time for presentation of voluntary papers.

Friday 7 May, am

Reserve time
Item 11

Friday 14 hours: End of the meeting.

Satellite meeting on RESPAS

A satellite meeting will be held during the week of the Kotka II meeting on "Remote Sensing Processing and Archiving System" (RESPAS). This is a cooperative project between the International Institute for Aerospace Surveys and Earth Sciences (ITC) of the Netherlands, the Dutch Aerospace Laboratory (NLR), the Agricultural University of Wageningen, and FAO. RESPAS will consist of a dedicated hardware and software system for optimized processing and analysis of remote sensing data for forestry applications. To date a feasibility study and a user needs assessment have been carried out. The Kotka II meeting will be informed about RESPAS and invited to advise on user requirements and on a programme for RESPAS that will lead to full coordination with the forest resources assessment programme of FAO.

The satellite meeting on RESPAS consists essentially of participants who are specifically invited for this purpose. It takes advantage of the presence in the Kotka meeting of top level experts on forest inventory. It will cooperate with the Kotka II meeting in a number of common plenary meetings and some of the group work and it will hold separate meetings as follows: Participation in most of the plenary meetings with a prepared presentation under item 6 (about 30 minutes) by Mr. E. Westinga of a user needs study carried out within the RESPAS project. Participation in working groups 2–5 under item 8 and in the working group for developing countries on subitems 9 (b), (c) and (d). Separate work mainly on Wednesday pm and on Thursday.

Opening

Opening Statement

by
Eljas Pohtila
Director General
Finnish Forest Research Institute

Ladies and Gentlemen!

On the behalf of the host country, Finland, it is my great pleasure to bid you most heartily welcome to Kotka Forestry and Wood Technology College, the venue of your important meeting. This is the second time that the world's forest resource inventory experts have come together here in Kotka. The previous occasion was in 1987.

We Finns probably attach more value to the work that you do than is the case in many other countries. The reason for this attachment is in the immense significance that forests have for our national economy and our society as a whole. As you well know, Finland has traditions in the sector of forest resource surveys. The world's first national forest inventory was conducted in Finland during the years 1921–1924. Yrjö Ilvessalo, the leader of that historic survey, is one of our national figures. Some of you will have participated in the symposium held last August in commemoration of the 100 years that had passed since his birth.

In other ways, too, Finland has striven to show initiative in raising global forestry issues as subjects of international policy. This coming June will see Europe's forestry ministers gathering in Helsinki for their conference. The theme of the conference will be protection of forests and their sustainable use. European Forest Institute, a scientific organisation established for the purpose of monitoring and predicting developments in European forestry, is based in Finland. Two years from now and it will be time for the IUFRO World Congress to be held in Finland. Without any hesitation, Finland signed all the agreements formulated in connection with the United Nations Conference on Environment and Development held in Rio de Janeiro last year; we understand that these agreements will have a number of impacts all the way to practical forest management. Finland has also striven to promote the formulation of a global forest agreement.

It is against this background that I wish to assure that this country is definitely the most appropriate one for your meeting. With the per-

mission of my most respected mentor and predecessor, professor Aarne Nyyssönen, the leading organiser of this meeting, and also in my personal capacity as a forester with a major in forest mensuration, I shall present you with my understanding of the task ahead of you.

Thanks to your work and your predecessors' efforts, we know with reasonable accuracy what the Earth's forest area is and what this means in terms of timber resources. We have about four billion hectares of forest and other wooded land - may be a little less than half of what we started off with. Central Europe has perhaps a quarter of the initial area still under forest cover. The tropical forests are disappearing at the rate of fifteen million hectares a year, whereas in most of the industrialised countries of the northern hemisphere the forest area is actually increasing. Man-made forests amount to a total of 150 million hectares and they are increasing at an annual rate of ten million hectares.

The North-South confrontation has many aspects and will probably influence international forest policy far into the future. The fundamental reason behind the devastation of tropical forests is in that they are being cleared for cultivation purposes. This is accelerated by high population growth and land ownership structures. In Latin America, five per cent of the farmers own seventy per cent of the arable land. Or to put in another way: seventy per cent of the farmers have to get by on five per cent of the arable land. The world's population is estimated to increase by three billion people during the next forty years – and most of these people will be born in the tropical countries. What is needed is six hundred million new forest-saving jobs during the next twenty years in order that tropical forests might be protected.

There is no doubt that industrialised countries can influence developments in the tropical forests. And yet the justification for such action has been questioned. The argument put forward is "Why can't developing countries do the same as the industrialised countries of the North have done" (that is to say, use their natural resources as they please and grow rich by doing so)?

The fundamental teachings of classical conservation are more valid in the tropics than in the northern coniferous forest zone. The living Nature of the tropics is ancient in comparison to that of the North. An area the size of Finland in the tropics can easily have hundreds of endemic species while we have none. It is believed that perhaps as much as ninety per cent of the world's entire fauna and flora are to be found in tropical forests. When seen from this perspective, even the severest conservation measures focusing on tropical forests begin to be justified. It is also becoming apparent that a new deal must be reached between the world's rich and poor countries in order to achieve meaningful results.

The agreements on biodiversity and climate signed at the Rio Conference on Environment and Development provide new challenges for forest resource inventory specialists. It is quite likely that we shall have to review our concepts and define a host of new ones.

In all honesty, I think we shall have to admit that the terminology we use is excessively wood-resource oriented and industrial-utilisation oriented.

For the present, the new policy of "sustainable development" has made itself felt in the form of listing of endangered species and of preparations made for associated conservation programmes. We, at least we in Finland, lack a scientifically based depiction of what the state of forest biodiversity is at the present. Time and regional dimensions are essential in the interpretation. In practice, the only means available to practical forestry personnel for depicting ecosystems is to use plant communities in the manner of traditional forest site type classification. These people cannot be expected to be familiar with hundred and even thousands of organisms - that is a task for specialists who have devoted themselves to certain groups of organisms. The question of how this might be implemented in practice is probably on your agenda for this week.

The climate agreement signed in Rio underscored the role that forests have in the carbon cycle and as a factor in maintaining the carbon balance. Someone might even see the makings of new global forest policy in this observation. However, before we can go that far we need increasingly accurate forest resource data from all over the world. And that, my friends, calls for even greater efforts from you and your colleagues.

Dear participants!

New, increasingly challenging tasks await you. I wish you all the best in your important work!

Introductory Remarks

by
J.P. Lanly, Director
Forest Resources Division FAO

Dear Colleagues,

As Doctor Pohtila just recalled, we had, in October 1987 in this very same place and again at the kind invitation of the Finnish government, the *first FAO/ECE meeting of experts on global forest resources assessment*. The main purpose of this first meeting was to provide guidance to FAO and ECE on the methodology for the *1990 forest resources assessment*, which ECE was to carry out for the industrialized world and FAO for the developing countries.

Less than six years have elapsed and many things happened during this period. As one of our colleague stated yesterday with regret and disappointment, large areas of tropical forests have disappeared during this period, and also large areas of forests in the whole world, in the North as well as in the South have been degraded mostly as a direct or indirect consequence of human activity. This is the sad truth and the negative face of the coin. But let us also look at the positive developments which took place during the same period and which are of direct concern to us today.

First, and this is not a small achievement, the 1990 global forest assessment is practically completed. At the last session of the FAO Committee on Forestry (COFO) held two months ago, a summary of the final results were presented for the industrialized countries by ECE, for the tropical countries by FAO. Copies of various reports of these two major parts of the global assessment will be made available. Work is progressing on the last part of the assessment, that is the non-tropical developing world. It is hoped to have it completed by the end of this year as well as the global synthesis.

Member countries assembled in the Committee on Forestry requested that FAO in cooperation with all competent and concerned national and international institutions to make this global assessment a continuous programme of high priority. FAO has taken steps in this direction both technically and in programmatic and financial terms.

Our meeting this week is part of this process. Another step was the organization last December in Nairobi, jointly with UNEP, of an expert consultation on environmental parameters in future global forest assessments.

Another positive development has been the considerable progress made during this period with regard both to the information available in the countries and the methods used to compile it at the regional and global levels, be it by FAO, by ECE or by the other actors involved such as the World Conservation Monitoring Centre.

A third positive development has been the high priority given to forest resources assessment and monitoring by the United Nations Conference on Environment and Development (UNCED), the so-called "Earth summit" held in Rio last June. This unique gathering in human history devoted a significant part of its long preparation process and of its decisions to matters related to the conservation and sustainable development of the world's forests.

One of the four areas of the forestry chapter of UNCED's action programme, the so-called "Agenda 21", is devoted mostly to the subject of our meeting. It is entitled "Establishing and/or strengthening capacities for the planning, assessment and systematic observations of forests and related programmes, projects and activities". All of us gathered here today, who are forest assessment and monitoring specialists, should feel pleased to have had their role and responsibilities highlighted to that degree in a document signed by more than one hundred heads of state and ministers from all countries of the world.

However, this is not just an honor for us. It is also a considerable challenge we have to face now and for many years to go. Member countries, and the international community at large – including the important segment of the scientific community dealing with global change issues – have high expectations with regard to the knowledge on the status and dynamics of the world's forests. We must not disappoint them. And those intergovernmental organizations like FAO, UNEP and ECE, which have a clear mandate in this field have to live up to their responsibilities with the support and understanding of their member countries. I can assure you that, as far as FAO is concerned, we will do all what is possible to honour our duties and commitments in this field.

Within this general context, what is the precise objective of our meeting? We could define it in the following way: on the basis of the accumulated experience of past regional and global assessment exercises, and particularly the 1990 one, and following the path laid out by the general recommendations of our governing bodies – which the Secretariat of the meeting will clarify as we proceed – the purpose of our gathering is to propose methodological approaches to some of the most important aspects of forest assessment and monitoring at global level, such as:

– a revision of the top level definitions and classifications for a better consistency of the information at regional and global levels;

– the incorporation of additional environmental parameters in global

assessments, on the basis of the work achieved and of the conclusions of the UNEP/FAO expert consultation held last December in Nairobi;
– the technical modalities for building the capabilities of national institutions of developing countries in order for them to contribute increasingly to the building up of knowledge at world level and to strengthen the "bottom-up" component of the global exercise.

ECE, FAO and UNEP expect from you clear technical recommendations on how they should proceed with their global forest resource assessment programme. The focus is on group work and not on prepared interventions. The agenda is tight. Secretariat introductions will be restricted to the necessary minimum. A large number of voluntary contributions have been announced. We understand that they all have relevance for the topic of this meeting and are of interest to the participants. However, it has not been possible to accommodate them in the agenda as full presentations. There are several other ways to make use of them: there will be evening sessions on Tuesday and Thursday for presentations. Furthermore the ideas contained in the contributions may be brought in under the relevant agenda items in some way. Finally there is a possibility to expose posters and similar material in the lobby.

Before closing, I would like to briefly present another important dimension of our gathering, which is the satellite meeting on a "Remote Sensing Processing and Archiving System (RESPAS)". What is RESPAS all about?

In the tropical part of the 1990 forest resources assessment programme, the compilation of existing reliable information on forest resources complemented by the analysis of high resolution satellite data. 120 samples of the size of a Landsat scene have been selected following a stratified sampling approach. For each of these samples, imagery from around 1980 and 1990 was selected to assess the present state of the forest resources, as well as to quantify changes they have undergone since 1980.

When assessing the quality of the standard false colour composites provided by the various distributors, however, the need for an application specific enhancement and for higher quality standards for the satellite imagery became evident. To achieve this, a careful processing of the original digital data is required.

In a cooperative effort of FAO, the Dutch National Aerospace Laboratory and the Agricultural University of Wageningen, a feasibility study on a "Global operational forest cover monitoring network for FAO using satellite remote sensing", was undertaken and completed in 1992. Based on the results of this study, a project proposal for the development of a pilot Remote Sensing Processing and Archiving System (RESPAS) is now being discussed between FAO and the Dutch authorities.

The high quality data expected from RESPAS are not only required for FAO's global forest assessment programme, but would also assist in assessing the impact of activities implemented in the framework of TFAP.

A first step towards the development of RESPAS was the in-depth analysis of user needs which has started earlier this year by the International Training Centre of Enschede in the Netherlands with the cooperation of Thailand, the Philippines, Guinea, Kenya and Colombia. A first report on these user needs is expected to be discussed and completed during the RESPAS satellite meeting. I would therefore like to extend a warm welcome to our colleagues from these countries and from the Netherlands. I am sure that both the main meeting and this satellite meeting will benefit each other and that this cross fertilization process will ensure in particular that the global forest resources information needs will be properly assessed with regard to the possibilities and limitations of remote sensing technology.

It is time now for me to stop and conclude in thanking again our Finnish hosts and wishing all of us a most successful meeting.

Opening Remarks

by
A. Korotkov
the representative of the
ECE/FAO Agriculture and Timber Division,
Geneva

Mr. Chairman,
Ladies and Gentlemen,
Dear Colleagues,

It is a great pleasure and privilege for me to address the meeting and to welcome you on behalf of the ECE/FAO secretariat and all our colleagues in Geneva.

We have been experiencing here nowadays an important event. I would say, in a certain sense a historical event in the scale of the forest inventory and monitoring, the *starting point* of the next Global Forest Resource Assessment 2000. Remarkable, and certainly not by chance, that the previous Assessment 1990 was initiated here, in Kotka, on the hospitable land of Finland. And, as professor Aarne Nyyssönen told me yesterday, exactly in this lovely place.

International Forest Resource Assessments have been carried out in collaboration with FAO since the middle of the century, at approximately 10-year intervals. In several recent Global Forest Resource Assessments, responsibility for their temperate zone parts (industrialized countries) was with the United Nation's Economic Commission for Europe or, more precisely, with the Joint ECE/FAO Working Party on Forest Economics and Statistics, a subsidiary body of the ECE Timber Committee and the FAO European Forestry Commission.

Now, when the 1990 Assessment is being finalized (the temperate zone part of it has already been totally completed), we meet to summarize the results of the Assessment, elaborate recommendations for follow-up activities and initiate actions for the next Assessment 2000.

We have to be prepared to meet challenges of the 21st century and a proper assessment of real values of forest resources all over the Globe would serve to this noble purpose.

The Global Forest Resource Assessment 2000, will not be, by any means, an easy task.

To a great extent, the success of this Assessment depends on national forest inventory activities, which, at present, are one of the most reliable *sources* of information for (at least) the boreal and temperate zone parts of the international assessments.

Forest inventories are expected to provide today an increasingly wide range of information about forest resources for many different spheres of human activities, including legislators, policy-makers, researches, managers, ecologists and others concerned with forestry and environment as well as the general public. These new demands are being placed now both on national and regional inventories and on global assessments.

The UNCED-Rio Conference, which achieved the first global consensus in the history on principles for sustainable management of the forest worldwide (boreal, temperate, tropical), emphasized these expectations.

I am firmly convinced if we are to reach a harmonize world or, at least, regional systems of International Forest Resource Assessments, developments of national forest inventories by countries should be not only internationally oriented but, also, internationally coordinated. The elaboration of the IUFRO "International Guidelines for Forest Monitoring" is just one example of such coordination. The application of these Guides would be another important step in the right direction. Our meeting will also serve this global task.

The principles of collecting forest resource data and their dissemination at the international level should be agreed and formulated by countries. It should be kept in mind that the types of information needed at the international level may differ from that found in a national inventory, while the degree of detail must necessarily be lower. Coordination must also be given to the majority of participating countries being able to provide the information. Replies to some of the most important questions on the subject we should find in the process of this meeting.

In implementation of this task, discussing definitions and classifications, remote sensing and sampling plots, advanced technologies and methodologies of forest inventories, we must not fall into a position when somebody could say: "They can not see the wood for the trees". I mean that we should be realistic in formulating strategy for the forthcoming Assessment. One difficult point will be, in my opinion, the coordination of our ambitious wishes and advanced technologies available at present in the world with the real needs and possibilities of nations to respond to demands.

The findings and recommendations of this meeting will be presented to the next session of the Joint ECE/FAO Working Party on Forest Economics and Statistics, which will decide next month on the developments, in particular, the Assessment 2000.

Once again, on behalf of the ECE/FAO Agriculture and Timber Division and all our colleagues in Geneva, I take this opportunity to

thank the Government of Finland for its offer to host the meeting. I express sincere thanks to organizers, and first of all to Professor A. Nyyssönen, for having prepared this meeting, which constitutes an important contribution to the whole process of Global Forest Resource Assessment.

I have to thank all of you for your willingness to contribute to the good start of the long way to the desirable results.

Thank you very much for your attention.

Report with Annexes

Report as Approved by the Meeting

Introduction

1. The meeting took place at Kotka (Finland) from 3 to 7 May 1993 at the kind invitation of the Government of Finland. Forty–six participants attended from the following 30 countries: Austria, Bulgaria, Canada, Chile, China, Colombia, Estonia, Finland, France, Germany, Guinea, Hungary, India, Indonesia, Kenya, Lithuania, Malaysia, Morocco, Netherlands, Nigeria, Norway, Peru, Philippines, Russian Federation, Senegal, Sweden, Thailand, United Kingdom, United States of America and Zimbabwe. The World Conservation Monitoring Centre and IUFRO were also represented in addition to the FAO, FAO/ECE and UNEP secretariats.

2. Mr. E. Pohtila, Director of the Finnish Forest Research Institute welcomed participants on behalf of the host country authorities. He stressed the importance of meeting the new challenges for international forest inventory, notably the need to review concepts and definitions to meet new demands, notably those generated by UNCED, concerning biodiversity, climate change (the carbon cycle) and sustainable development.

3. Mr. J–P. Lanly, Director of the FAO Forest Resources Division, Mr. A.V. Korotkov of the FAO/ECE Agriculture and Timber Division and Mr. A. Singh of UNEP/GRID also welcomed participants.

4. Mr. Lanly defined the objectives of the meeting as follows:
- a revision of the top level definitions and classifications for a better consistency of the information at regional and global levels;
- the incorporation of additional environmental parameters in global assessments, on the basis of the work achieved and of the conclusions of the UNEP/FAO expert consultation held last December in Nairobi;
- the technical modalities for building the capabilities of national institutions of developing countries in order for them to contribute increasingly to the building up of knowledge at world level and to strengthen the "bottom-up" component of the global exercise.

He hoped the meeting would generate clear technical recommendations on how the assessment should proceed.

Adoption of the agendas

5. The provisional agenda was adopted.

Election of officers

6. Mr. A. Nyyssönen (Finland) was elected Chairman and Messrs. J. Lowe (Canada) and H.C. Thang (Malaysia) Vice-Chairmen. Mr. J.O. Abayomi (Nigeria) was elected General Rapporteur.

Report on the status of forest inventory word wide

7. The meeting was informed of the results of an enquiry circulated to temperate and tropical countries asking for a concise description of the forest inventory situation, particularly as to how information is obtained (e.g. continuous monitoring, one estimate, expert opinion, no data), the scope of the national forest inventory and the availability of statements of reliability.

Presentation of the 1990 global forest resource assessment (FRA 90)

8. The meeting was also informed of the status of FRA 90. An overview had been presented to the FAO Committee on Forestry (COFO) in March 1993, and the country reports for the tropical countries would be issued shortly. The temperate zone assessment had been issued (document ECE/TIM/62 in two volumes). Work with the non-tropical developing countries was in hand.

Developments related to future forest resources assessment and related activities of other organizations

9. Sixty-one replies had been received from 22 industrialized and developing countries and one international organization to an enquiry into future forest resource information needs and the possibility of supplying them. The enquiry had identified the following areas where it was desirable and realistic to collect additional information:

- site quality
- health/damage status, including changes
- indicators of the supply of non-wood goods and services
- stand density
- changes over time
- forest ecosystem types

10. The meeting was also informed of plans to collect and store remote sensing data in a standardized and cost effective way in a system called RESPAS (= Remote Sensing Processing and Archiving System) as well as of other activities including the CEC TREES project and the IUFRO guidelines for forest resource monitoring.

Results of the UNEP/FAO expert consultation on environmental parameters for future global forest assessment

11. The meeting was informed of the results of the above meeting, held in Nairobi in December 1993. It agreed to take the detailed recommendations of the Nairobi meeting as the basis for its own work on incorporating environmental parameters into the FRA.

Review of parameters and classifications

12. Under this item, the meeting split into four working groups:

Group 1: General forest inventory parameters (developing and industrialized countries)
Group 2: Parameters related to biomass
Group 3: Parameters related to biodiversity
Group 4: Parameters related to land cover change and vegetation degradation.

The task of these groups was to generate recommendations on which parameters should be collected and how. The groups based their work on the methods used for the FRA 90, and other agreed international classifications, as well as the report of the Nairobi meeting and suggestions by a consultant (Mr. J. Bones, USA) on the top level categories. The reports of the groups, which take into account also comments made by the plenary session, are reproduced in the annexes.

Review of other methodological features of global forest resources assessments

13. Under this item, the meeting considered the following subjects:
- updating on a continual or regular basis;
- application of remote sensing and GIS;
- use of country contacts;
- design and implementation.

14. It noted that a system for receiving and updating forest resource information in tropical countries (FORIS) was already operational,

but that for the temperate zone, updating had been by periodic (at roughly 10-year intervals) assessments.

15. Remote sensing had been a major part of FRA 90 for the tropical regions, but the main method for the temperate zone had been questionnaires filled in by national correspondents. The challenge for the meeting was to develop methods for global forest resource assessment which incorporated the advantages of the new technologies (e.g. comparability, speed, independence of national infrastructure weaknesses), while not losing the advantages of the more traditional methods (e.g. wider range of parameters, including those which could not be measured by remote sensing, partnership with countries). The meeting noted the distinction to be drawn between remote sensing (a method of collecting data) and the collection of geo-referenced data. In this context, it was noted that the adoption of either remote sensing methods or geo-referenced data for the temperate zone assessment would be a major departure from previous practice, with significant resource implications for the secretariat and for member countries.

Other business

16. A field excursion was organised for participants to the Imatra region to see forestry development work, and the paper mill of ENSO Company. Participants thanked the company for the interesting excursion and the generous hospitality.

17. Participants warmly thanked the Finnish Government, the Finnish Forest Research Institute, the Forestry Training Programme, the Department of Forest Resource Management of the University of Helsinki and Professor Nyyssönen for the excellent organisation of the meeting and the kind hospitality extended to participants.

Recommendations

1. It is essential that national and international organisations engaged in forest resource assessment coordinate their activities and cooperate with each other to avoid any duplication and keep to the minimum the burden on national correspondents and institutions. The meeting requested the Joint FAO/ECE Working Party on Forest Economics and Statistics to review activities on forest resource assessment and collection of data on forest resources in the ECE region to ensure there was no duplication of activities.

2. Because of the importance of changes in forest biomass in the carbon budget and climate change, FAO and UNEP were encouraged to prepare jointly a project proposal for global forest biomass monitoring as part of the FRA process. The Global Environment Facility might be considered as the funding source.

3. Aware of the decisions on biodiversity agreed at UNCED and the importance of forest ecosystems in global biodiversity conservation and sustainable utilization, the FAO and FAO/ECE should increase their efforts to compile at regional and global levels forest-related data collected by national institutions in the temperate, tropical and boreal forests of the world. In addition, national capacity and ability to gather forest-related biodiversity data through traditional forest inventory practices should be strengthened (see proposals in annex III).

4. Consideration should be given to separating boreal from temperate forests in the assessment.

5. In order to put the presentation of information for the temperate and tropical assessments in parallel, future temperate zone assessments should also incorporate the information on forest fires and forest health at present issued separately.

6. Recognising the need for timely and reliable information on forest resources, the initiative to develop and maintain a global network of remote sensing processing and archiving systems was supported. These systems would provide optimized remote sensing data to strengthen the capacity of countries to assess and monitor their own forest resources as well as assist the FAO's Forest Resource Assessment and Tropical Forests Action Programme (TFAP) activities (see annex V). The need for a remote sensing satellite dedicated to global forest monitoring should be examined.

7. Particular attention should be paid, at all stages, to national capacity building in developing countries, notably as regards construction of national data bases, training of staff (lack of trained staff was often the major constraint at the national level) and the necessary equipment.

8. FAO should urgently compile a Directory of institutions, national and international, and contact persons engaged in forest resource assessment, including a brief description of their activities and the methodology and equipment used (e.g. for remote sensing).

9. It was pointed out that countries in transition had specific problems, which needed urgent resolution. FAO/ECE and FAO should continue to attach priority to their programmes to assist countries in transition, mostly through exchange of information and experience, but also as advisers to funding agencies.

10. The UNCED preparatory process demonstrated that problems of a political nature arose from the lack of consistency and comparability of data on the status of forests in the North and the South. It is essential that in future the core information be entirely comparable and that the format of the enquiry and the methods of work be agreed in advance at the intergovernmental level. To that end, the meeting suggested that FAO, ECE/FAO and UNEP study the feasibility of establishing an

intergovernmental panel of experts in forest resource assessment and monitoring to advise these organisations in carrying out the work. Its members should be senior people, at the interface between political and technical issues. To ensure effectiveness, the panel should not be too large (say about 15). The three secretariats should participate in the preparation of its meetings. As such a panel could probably not be established immediately, the opportunity should be taken to stimulate reflection and comments by the FAO regional forestry commissions. To this end, the meeting suggested that the Joint FAO/ECE Working Party transmit the Kotka meeting's suggestions, with the Working Party's comments, to the European Forestry Commission and that FAO transmit them to the other regional commissions. In this way, the final proposal could take into account the comments made by these policy bodies.

11. An analysis should be carried out of the extent to which the results of the global forest assessments are used at the national and international levels. Constraints on the full use of this information should be identified and methods for improvement proposed.

12. Care should be taken when introducing observations on new definitions and parameters in existing data bases so that time series were disturbed as little as possible.

13. The system of national correspondents had proved useful for the FRA-90 (temperate zone). The Joint Working Party should consider re-establishing the correspondent network (identifying institutions as well as individuals), and FAO might consider using this system, with appropriate modifications in developing countries, including twinning, lead centres and Technical Cooperation among Developing Countries (TCDC) arrangements.

14. As regards the continual updating of the forest resource data base, the meeting felt it was desirable to have a unique global data base to incorporate data from tropical, industrialized and non-tropical developing countries, to provide a single world-wide source of data on the forest resource, which could be regularly updated. Before this recommendation could be implemented, it was necessary to explore a number of questions, notably the form of input required, the classifications to be applied, the adjustments necessary to convert national information to a harmonized format, the updating procedure and references to source materials. The meeting requested the FAO and FAO/ECE secretariats to explore these questions and present a detailed proposal to the Joint FAO/ECE Working Party on Forest Economics and Statistics at its twentieth session, probably in 1995. Consideration should be given to combining the data base developed by EFI on the basis of the FRA (temperate zones) with FORIS. It would be helpful to supply an example of the output of FORIS as a demonstration of the system's potential.

15. To the extent possible, information in forest resource data bases should be published and disseminated as widely as possible, in hard copy, in machine readable form and through interactive access.

16. The relevant UN organizations should make sure that all land cover types, including grassland, shrubland, wetlands and arid land are adequately covered in international reporting on natural resources. These lands like forest lands, are very important in the context of biodiversity, as sources of food, fibre and fuel, and as components of the carbon cycle.

17. The meeting endorsed the set of recommendations and general conclusions of the working groups reports (annexes I to V), but noted that insufficient time had been available to review them in detail or to check them for consistency. It asked the secretariats to do this on the basis of the meeting's comments and to prepare unified and consistent proposals.

Annex I

General Forest Inventory Parameters (Developing and Industrialized Countries)

Report of working group 1
Chairman: J. Bones (USA)
Rapporteur: C. Prins (ECE/FAO)

Introduction

1. The group considered that the global Forest Resource Assessment (FRA) should aim, in the first instance, at providing an authoritative answer to the question of how much land on the planet is covered by forest and other woody vegetation at the time of assessment. To reach this figure, a single simple unambiguous definition is necessary. Within this framework, answers should be sought to the wide range of questions posed by the likely users of the data. Probably the best way of achieving this objective was to use as the main criterion, the concept of existing tree cover, as definitions using criteria of present or potential use or potential cover were not applicable at this broad level.

2. To the extent possible, there should be:
- comparability and continuity in concepts, definitions and terminology, in order to assess trends over time;
- immediate understanding by a wide range of users of the results;
- responsiveness to the new demands of a wider audience.

3. It was pointed out that FRA was concerned with trees and forests, and should include all relevant areas, even when they are classified elsewhere in land-use classifications (e.g. as agricultural land with tree crops). It is necessary to separate out these areas to retain comparability with existing classifications.

Proposed area classification

4. On the basis of suggestions by Mr. J. Bones (USA), a broad classification by area was proposed. The main headings are "Total area", "Inland water" and "Land area". Under "Land area" there should be the following:

- Forest land (tree land)
- Shrubland, including maquis, etc.,
- Herbs, (grassland)
- Other vegetation, in particular agricultural land
- Barren land including non vascular
- Urban, infrastructure, etc.

Proposed major definitions

5. *Forest (tree land)*: all land with tree cover of more than 10 % (or equivalent stocking level), or formerly having such tree cover and that is being naturally or artificially regenerated or that is being afforested. Land used for agricultural purposes but with 10 % or more tree cover is included.

It includes coniferous and non-coniferous trees, bamboos and palms. Linear formations and planting over about 20 metres wide are also included [1].

Tree: an erect woody perennial having generally one well developed main stem (except in coppice management systems) and of a species which is usually capable of reaching a height of 5 metres at maturity in most of its distribution area.

The concept of "other wooded land" will be reconstituted, mostly out of shrubs.

Possible breakdowns of forest land

6. Within the total of forest, several different breakdowns were possible, including the following (in brackets are listed data already collected in temperate (TE) or tropical (TR) assessments):

- by tree species composition (coniferous/non-coniferous/mixed in TE and TR)
- by "naturalness" (natural/plantations in TR)
- by management status in TE
- by ownership (in TE)
- by vegetation fragmentation (in TR)
- by health/damage/degradation (degradation in TR, fires and forest damage published separately for temperate countries)
- by age structure (TE)
- by benefit/function (see below)

7. For "benefits/functions", it would be useful to have for each major type of benefit supplied by the forest, indications on productivity classes by area, area where supply of that benefit is restricted, and accessibility. The types of benefit/function proposed are those used in

[1] This definition does not at present include the idea of an ecological community, principally because it was difficult to write such a definition which would also include the more intensive and artificial forest types which are nevertheless generally considered forest.

the FRA 90, volume II (TE), namely:
- wood
- water
- grazing/range
- protection (against erosion, avalanches, etc.)
- hunting (wildlife)
- nature conservation
- recreation (amenity)

Considerable work would be necessary to develop this concept in practice for benefits other than wood.

8. It would also be desirable to collect data on growing stock (all zones) and net annual increment (temperate only) [2].

9. Problems and drawbacks with the above included:
- loss of the term forest fallow, useful in areas of shifting cultivation;
- desirability, but difficulty in practice, of separating closed and open forest;
- it was suggested a matrix be drawn up of forest cover v. use (forest land protection, agriculture, unused);
- some of the land falling in the category of forest, as defined above, is on agricultural land (agroforestry systems, tree crops) and had not been included in earlier assessments;
- in many countries, "forest land" or "forest" is legally defined, using concepts different to those above (indeed much "forest", as legally defined, has no tree cover at all);
- definition of minimum area to classify as forest (TE: 0,5 ha, TR 100 ha!);
- possible breakdown of "other wooded land";
- classification of concept of "naturalness" (possible criteria are degree disturbance, method of regeneration, genetics-domestic/exotic species or provenances, silviculture methods, etc.).

Recommendation

10. It is necessary to bring the above proposals regarding general forest inventory parameters to the attention of the relevant official and technical bodies in order to develop a consensus, based on these proposals, on the main parameters to be used in FRA, and to propose solutions to the undersolved issues identified in para. 9 of this report.

[2] It might be possible, indeed desirable, to collect data on increment in tropical non-natural forests, notably plantations.

Annex II

Parameters Related to Biomass

Report of working group 2
Chairman: K. Schwenke (Germany)
Rapporteur: K. Janz (FAO)

Basic consideration

1. The report of the UNEP/FAO Expert Consultation on Environmental Parameters in Future Global Forest Assessments, held in Nairobi, 1–3 December 1992, was taken as a basis. The work of this group concentrated on additional aspects and did not repeat the findings of the Nairobi report. It was noted that biomass assessment here should be seen in the context of the global carbon cycle. This implies that state and change of the total biomass should be considered. There was also a general agreement with the findings of the Nairobi report, including its view on who the users and which the uses were. It was agreed that methods need to be specified for two different situations:

- Local biomass studies – this is the 'primer' recommended by the Nairobi meeting;
- Global Forest Resources Assessment – how to make the best use of existing information.

Components of total biomass

2. The components of total biomass were identified as follows:

Above ground

1 stems, including non-inventoried trees
2 branches, foliage and fruits
3 stumps
4 dead trees, standing and lying
5 shrubs
6 ground vegetation
7 litter

Below ground

8 tree roots
9 other roots
10 organic material of mineral soils
11 peat

3. The biomass of components 1–3 (and 8) can be assessed with known and well established forest inventory techniques after the addition of biomass functions or conversion factors. The same is often true for component 4, but not always, especially not in the case of lying trees (coarse debris). For components 5–7 and 9–11 special additional studies are needed.

Approaches currently in use

4. The following will only deal with above ground tree biomass (components 1–3). This makes up a very large proportion of the total biomass and can be assessed with moderate additional costs, compared with the costs for classical forest inventories. It is in this field that further assessment activities can bring the greatest additional knowledge and it is here further methodological development should have its focus.

5. Local biomass studies consist of two elements:
- biomass per tree within size classes and species (species groups); and
- number of trees per ha within these classes.

6. The first element is based either on special biomass functions which use tree variables commonly measured in forest inventories or on conversion factors applied to some tree volume estimate. The development of precise biomass functions or conversion factors with wide applicability is costly. The Nairobi report describes another common approach which derives biomass per ha from stand tables and mean tree height. Such an approach is less precise and less costly. A further widely used approach is the application of a conversion factor to aggregated 'inventoried' volumes assessed anyway for other purposes. Such conversion factors are as a rule derived from other populations and lead to rough estimates only. The above mentioned 'primer' should describe alternative options and their implications. If more widely applied to existing forest inventory information rough methods can produce much additional state information quickly and cheaply.

7. Global assessments will estimate the distribution of forests into cover types and combine them with local biomass studies conducted within these cover types. Therefore it is important that local biomass studies are well spread and geo-referenced. This makes it possible to follow the changes in spatial distribution of the biomass.

8. With regard to the availability of information it is noted that industrialized countries often have tree volume information as a minimum. This can serve as a basis for biomass estimations. In developing countries such information is missing almost completely. Regarding change information, the FAO Forest Resources Assessment 1990 for tropical countries has developed some and studied other promising approaches to deal with biomass change.

Major knowledge gaps

9. Substantial improvements of the global information on biomass can be achieved if primarily the following knowledge gaps are filled:
- biomass functions for single trees;
- conversion factors from aggregated volume information to biomass for specified inventory situations;
- local biomass studies, well distributed and geo-referenced;
- for change information: results from repeated local studies;
- methodology for deriving biomass state and change estimates with a given budget in a given area.

Recommendations

10. FAO should encourage and its Field Programme promote the filling of the identified knowledge gaps (see above).

11. Change assessment in developing countries: the approaches developed or studied in the FAO Forest Resources Assessment 1990 Project should be further developed.

12. Change assessment in industrialized countries: no operational procedures and mechanisms exist at present to assess this. Yet it is a basic input to the understanding of fluxes of the carbon cycle which is one of the primary areas of global concern. Countries are committed under Agenda 21, problem area D of chapter 11 to "strengthen or establish systems for the assessment and systematic observations of forests and forest lands with a view to assessing the impacts of programmes ...". In view of this, new approaches should be sought, in which existing information on standing volume and biomass is used to estimate biomass changes for large regions.

13. For all change assessment the use of permanent plots is recommendable.

14. The "primer": FAO should initiate the production of a guide for local biomass studies, including change assessment studies. Such a guide should be designed so that it can be applied in a wide range of inventory situations. The range should include specialized biomass studies with the development of biomass functions for single trees as well as the case of simple approximations, based on existing area information for cover types and general experience on biomass per hectare values for these cover types.

15. In all cases the procedures should be well documented for later use and control. In particular it is essential that local biomass studies specify exactly which of the biomass elements are included. For above ground tree biomass it must be specified which diameter classes, species, etc. are included. This is a condition for the use of such studies in global assessments of total biomass, since estimates for the missing elements have to be added.

Annex III Parameters Related to Biodiversity

Report of working group 3
Chairman: H. C. Thang (Malaysia)
Rapporteur: M. Collins (WCMC)

Background

1. The Group reviewed the report of the UNEP/FAO Expert Consultation on Environmental Parameters in Future Global Forest Assessments (Nairobi, 1–3 December 1992) and on the basis of this confirmed the desirability of extending the conclusions to embrace temperate and boreal forests.

2. The Group was aware that the conclusions of UNCED (particularly Agenda 21 – Conservation of Biological Diversity, the Forest Principles and the Convention on Biological Diversity) called for country capacity-building, and in the gathering and application of environmental data to assist national sustainable development. In this context it was recognised that the Forest Resources Assessment (FRA) undertaken by countries could contribute substantially.

3. With this in mind, the Group began work on a global framework for gathering forest biodiversity data, using the experience of the participants from both tropical and temperate regions.

Definitions, scope and objective

4. Biodiversity is the variety of life at the ecosystem, species and genetic levels, and must be viewed in a temporal and spatial framework.

5. The FRA methodology could contribute substantially to our knowledge of forest-related biodiversity at the national and ecosystem levels, to some extent at the species level, but would not focus on the genetic level at this stage.

6. The objective of the Working Group was to maximise the contribu-

tion of the FRA to knowledge of biodiversity by designing methodologies in harmony with the practices of national forest inventories, and by compiling this information into a global framework.

Global framework – forest ecosystems

7. Ecofloristic zones have already been defined for the tropical regions, based upon national potential floristic classifications nested together into high level categories and combined with ecological parameters (climate, soils) to provide the global framework. This concept should be extended to temperate and boreal regions, drawing upon existing national classifications, where appropriate.

8. Actual vegetation cover and condition should be compiled and classified to give basic information on the condition of forest ecosystems globally, and to demonstrate the extent to which they have been converted or modified. Data from national maps based on high resolution imagery, aerial photographs and ground survey should, where available and necessary, be combined with recent satellite data for updating, monitoring and harmonisation of information. Imagery will allow for assessment of vegetation fragmentation and its impact on species diversity based on species/area models.

9. Legal status and management information should be gathered in order to assess the level of protection afforded to biodiversity at the ecosystem level.

10. Other indicators of biodiversity are needed and should be developed. This will require collaboration between forest inventory specialists, botanists, zoologists, ecologists and taxonomists.

11. In the medium term, given adequate resources, the global framework could be made available, delivering reports on ecosystem status and protection at both ecosystem and country level as a contribution to biodiversity conservation planning and its sustainable utilisation.

National assessment of forest-related biodiversity

12. Additional data should be gathered and analysed at national and sub-national levels with the view to:

- prepare national reports on biodiversity with special reference to forest ecosystems;
- contribute to global/regional reports on forest-related biodiversity status and trends by sub-region and ecological zone.

13. Forest inventory methods should be strengthened by the introduction of new skills, developed from pilot studies, focussing on the need

for fully integrating biodiversity data with traditional forest inventory practices. The main requirements are as follows:

- geo-referenced data on micro-types of vegetation surrounding forests under survey. This work should be done at a scale of 1:50,000–1:250,000, and is essential because of the influence it has on the forests;
- statistical data on biodiversity indicators (e.g. richness/abundance/distribution of species/species groups by age/diameter classes).This should be geo-referenced and set in a large area framework. In addition to surveys of tree species/species groups by foresters, plant taxonomists should be included in inventory crews to survey shrubs and herbs. Studies of faunistic diversity are more difficult but might be included following pilot studies and modelling exercises;
- models to estimate species biodiversity at sub-national/national levels using sample survey data.

Recommendations and plan of action

14. PHASE 1 – Preparatory Activities

The recommended activities to be undertaken are as follows:

- review existing ecological and floristic schemes at global level with a view to adopt a common framework for forest related biodiversity reporting. If necessary a new scheme should be developed;
- undertake studies to identify and establish global indicators based on ecological and floristic information;
- implement pilot studies with the view to develop indicators and assessment techniques for forest-related biodiversity at national and sub-national levels and changes over time as follows:
  (a) research and development to elaborate global and regional indicators of biodiversity. This work must be undertaken in cooperation with specialists in different disciplines and countries, and should be completed before 1995;
  (b) methodologies for assessment of the indicators should be harmonised with national and international forest inventory systems;
  (c) compilation of relevant national and sub-national biodiversity data should be promoted and supported.

15. *PHASE 2* – Compilation and Analysis of Existing Information for the Global Framework.

In this phase the following activities are recommended:

- preparation of ecofloristic zones (or equivalent) at the global level;
- compilation of updated national vegetation maps at appropriate scales, taking into account the capability of remote sensing and existing/formulated vegetation schemes;
- development of appropriate data bases, if necessary, for the protection, conservation and production forest areas, expanded to include particularly forest reserves in tropical, temperate and boreal countries;
- extension of these data bases to include information on actual manage-

ment, the vegetation content and the condition of these protection, conservation and production forest areas, particularly the reserve areas.

16. PHASE 3 – National Capacity-Building and Support for Collection of Additional Information

Strengthening of the national capacity and ability should be undertaken with a view to:

- collect and collate information on species inventories for forest areas, particularly reserves and protected areas, at two levels:
  (a) metadata on the existence of inventories;
  (b) actual data on selected groups wherever possible.
- document information on tree floras at national and sub-national levels to ensure sufficient information is available for sustainable management and utilisation of biodiversity;
- gather and collate information on the distribution of tree species at national and sub-national levels to allow analysis of their location and extent in relation to forest cover and the reserve system;
- ensure regular and timely dissemination of forest-related biodiversity information to the world community.

Conclusion

17. The recommendations and plan of action proposed above will provide an excellent basis for decisions and priority actions needed in order to ensure the sustainable management, conservation and utilisation of biological diversity of the world's forest ecosystems.

Annex IV

Parameters Related to Land Cover/Land Use: Change and Vegetation Degradation

Report of working group 4
Chairman: L. Isavwa (RCSSMRS)
Rapporteur: A. Singh (UNEP/GRID)

Background

1. The group reviewed the recommendations of the working group on "Land Cover/Land use and Land degradation" constituted during the UNEP/FAO Expert Consultation on Environmental Parameters in Future Global Forest Assessments, 1–3 December 1992, Nairobi (Kenya), and made necessary suggestions for parameters and methodology to be adopted in the future global forest assessment.

Justification

2. Information on land cover/land use change is being sought by local and national planners, scientists involved in global change studies, international agencies and by the general public. Also in the UNCED Agenda -21, numerous references have been made for better and standardized information on land use and land cover: Chapter 10 (Land resources), 11 (Deforestation), 12 (Desertification), 14 (Agriculture and Rural Development), 18 (Water Resources) all referred to the need for better land cover/use information. Changes in land cover/use have also significant implications in the three conventions i.e. Climatic change, Biodiversity and the declarations of the Non-legally binding authoritative statement of principles for global consensus on the management, conservation and sustainable development of all types of forests agreed upon during the UNCED.

Parameters

3. The parameters needed to assess major global environmental issues, discussed in the UNEP/FAO Expert Consultation on Environmental Parameters in Future Global Forest Assessments were examined and have been presented in Table 1. in accordance with their order of importance. Those which are essential or indispensable are scored with three asterisks, those parameters which are desirable or

accessory are scored with two asterisks, and finally those parameters which are optional have one asterisk in the table. The parameters for vegetation changes have been considered on the same basis as those for land cover/land use and have not been mentioned separately. A detailed examination of parameters should be made in response to requirements by users.

4. Transformation in land cover/land use occurs due to various factors such as diversion of forest areas to agriculture, settlements etc. and natural calamities, hence details of such changes in land cover/land use should be accounted for.

Table 1
Land use / Land cover: State and change

Parameters	State and change
Ecofloristic zones	**
Forest cover	
– forest / non forest	***
– burned areas	***
– logged areas	***
– regeneration	**
– degraded areas	***
– deforested areas	***
– fragmented areas	***
Forest categories	
– potential forest	*
– actual forest type	***
– administrative / legal status	***
– management system	**
– plantation / natural	***
Forest condition	***
Fires (distribution)	**
% vegetation cover	***
Crown cover	**
Tree species composition	**
Stand structure	**
Physiography	**
Sosioecomomic factors	***

*** Essential, indispensable
** Desirable, accessory
* Optional

Methods

5. The methods involved in the assessment and monitoring of the parameters suggested should be able to meet the following criteria:
– Cope with dynamic situations that are of interest in land cover/land use.

- Consider socio-economic characteristics.
- Produce results which are useful for development models.
- Use available resources.
- Comparable and repeatable in diverse conditions.
- The frequency of assessment should be determined. A period of five years is suggested.

6. Changes in land cover/land use can be measured using the following approaches:
- Change matrices. These are needed in order to measure the transition from one class of land use to another. They are very useful in comparative studies.
- Change detection methods.
- Quantitative changes in the parameters such as biomass, percentage ground cover, species composition etc.
- Use of models.

7. There are various sources of data which could be used for the assessment of monitoring of land cover/land use:
- remote sensing data of varying resolutions.
- available maps.
- auxiliary statistical data.

8. All data sets are to be geo-referenced in a common framework to facilitate further analysis.

Recommendations

9. Considering that land cover/land use changes can only be evaluated on the basis of continuity, it is essential to maintain a common and stable system of land classification and definitions related with tropical resources where dynamics of change are very strong.

10. Lead centers, fully equipped with the state of art and equipments, should be established for continuous monitoring of the changes, specially in the tropical countries.

11. In order to get a continuous information about changes, a minimum sampling intensity should be defined and permanent sample sites should be fixed.

12. FAO should compile data pertaining to the state and change of parameters listed in Table 1.

13. FAO and UNEP should encourage the development, in cooperation with other relevant agencies, of geo-referenced data sets in digital format on land cover/land use using available sources including remote sensing methods.

Annex V

Information of the Satellite Working Group on "Remote Sensing Processing and Archiving Systems" (RESPAS)

1. The result of the discussion of the satellite working group on user needs for forest resources assessment and monitoring at national level is presented. This national information can be aggregated up to global level.

2. Forest resources assessment includes forest resources inventory based on collection of data. Proper forest inventories consist of exhaustive data collection, which is time consuming and therefore cannot be realised too frequently at national scale.

3. Forest changes can take place on a shorter timescale than inventories are carried out. In order to take necessary action, up-to-date information is needed in a cost effective way on a regular basis. Forest cover change detection, so called monitoring, can be done more frequently and is less costly than forest inventories.

4. Forest inventory consists of the collection of locational data of the following general parameters:
- land use
- forest cover
- forest type
- species composition
- wood volume
- ecological indicators
- socio-economic indicators.

5. Depending on the specific parameters, different precision of mapping is needed. According to the participating country representatives, information on land use, forest cover and forest type are optimally needed at scales of 1':'5O'OOO and even at more detailed level, if possible. For selected areas information is needed on species composition and wood volume at detailed level.

6. As a recommended cycle, a national forest inventory should be carried out every five years.

7. Regarding monitoring the national forest cover, the frequency should be preferably two years. And minimal information is needed at scale 1':'250'000.

8. In forest inventories and monitoring, remote sensing is already used worldwide. The participating country representatives expressed a need for improved flow of remote sensing data, better adapted to forestry uses. Present constraints are:

- cost of satellite data
- acquisition, distribution in time
- cloud cover
- expertise
- equipment
- data comparability

9. Suggested short-term and partial solutions to overcome these problems could be:

- bulk order of satellite data on a regular basis, minimised data sets to reduce price;
- furnisher agreements, distribution network and facilities of an international organization;
- use of radar data, mosaic of cloud-free parts;
- formation and on-site training;
- software to produce satellite imagery optimized for forest applications, with minimum hardware configuration required;
- standardized products.

10. A long-term solution to the mentioned problems could be an end-to-end system comprising a dedicated satellite system and associate ground facilities.

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Background Papers

Agenda Item 4

Report on the Status of Forest Inventory Worldwide

Industrialized countries

Background

In the course of the preparation for the "Kotka-II" meeting the Checklist enquiry asking for a concise description of the national forest inventory situations (Annex I) was circulated to the tropical and industrialized countries with the purpose of specifying the information on the present day inventory systems in the countries and to look at possibilities of countries to respond to forest resource information needs at international level.

As far as the industrialized countries are concerned, the Checklist was sent to the national correspondents to the Forest Resource Assessment 1990 and other contact persons, including experts invited to participate in the "Kotka-II" meeting.

By the time this note was prepared, replies had been received from correspondents in 25 industrialized countries of the boreal and temperate zones, which constitute more than half of the ECE member countries, including the United States of America and the Russian Federation. Unfortunately, replies have not been yet received from Italy, Spain, and some other countries which are significant from the forest resources point of view. Some countries (United Kingdom, Switzerland) provided additional information on the forest inventory situations in their countries.

The results of the Checklist enquiry were summarized by the secretariat in 3 tables:

Summary Table I on sources of information and how the information is obtained (for each type of information examined);
Summary Table II on scope of the national forest inventories;
Summary Table III on availability of statements of reliability.

The tables are presented in this note and accompanied by comments and explanations received in the replies to the Checklist.

Sources of information (Summary Table I)

The replies to the Checklist show, in particular, *sources of information* on the forest resources available in the countries for different categories: *area, growing stock, biomass, species, volume increment, fellings/removals and change assessment.*

Area. All reporting countries have data on area. The overwhelming majority of the countries which replied to the Checklist (except Canada, Estonia and Germany) indicated monitoring as the source of information on *area.* Generally, monitoring was shown as the only most important source of all examined types of information in the industrialized countries. Six countries (Albania, Canada, Estonia, Germany, Switzerland and the United Kingdom) use "*one estimate*" as the source of information on area.

"*Expert opinion*" is not used in the industrialized countries as a source of information on area, growing stock, species and fellings/removals, according to the replies. Poland and the Netherlands apply "expert opinion" as the source of information on *biomass*; Poland and Switzerland on *volume increment*; Poland, Luxembourg and Portugal for *change assessment*; and Portugal for fellings/removals.

Several countries indicated "*no data*", mostly on *biomass* (Albania, Austria, Estonia, Germany, Lithuania, Luxembourg, Russian Federation, Switzerland and Slovak Republic), and also on species (Albania), on *volume increment* (Germany), on *fellings/removals* (United Kingdom) and *change assessment* (Bulgaria, Estonia, Germany, Norway, Slovak Republic).

Growing stock. All reporting countries have data on "*growing stock*". The main source for this type of information is *monitoring*, which is not used only by Canada, Estonia, Germany and Switzerland. Five countries use a "*one estimate*" approach: Albania, Canada Estonia, Germany and Switzerland and no countries apply "expert opinion".

Biomass is the most difficult type of information to obtain for the countries which replied to the Checklist. Nine countries out of twenty five have no data on "biomass". The Netherlands and Poland use "expert opinion"; Canada, Czech Republic, Poland and the United Kingdom "one estimate"; and only nine countries out of twenty five apply monitoring.

Species. Practically all reporting countries, except Albania, have the information on "species". None use "expert opinion"; five countries (Canada, Estonia, Germany, Switzerland and the United Kingdom) apply "one estimate" and the others monitoring.

Volume increment. Twenty one countries out of twenty five use monitoring to obtain data on "volume increment" (except Canada, Estonia, Germany and Switzerland). Albania, Canada and Estonia use "one estimate"; Poland and Switzerland "expert opinion" and Germany has no data on *volume increment.*

Fellings/removals. Practically all countries, except the United Kingdom, informed that they had this type of information. Portugal

uses "expert opinion"; tree countries (Albania, Estonia and Portugal) apply "one estimate" and all others (22 countries) use monitoring as a source of information for *fellings/removals*.

Change assessment. After biomass, this is the second most difficult type of information to obtain, according to the replies to the enquiry. Five countries (20 %) have no data on "change". Luxembourg, Poland and Portugal use "expert opinion" and Poland "one estimate"; 14 countries informed that they used monitoring of "change".

How is the information obtained (Summary Table I)

For the information on *area* 12 countries (about 50 %) use an *aggregation of local data* and 19 countries (76 %) use *sampling over large areas* (some countries use both methods to obtain information). The same is reported for *growing stock*. For *biomass* figures are: 8 and 16 countries; for change assessment, 9 and 16; for *species*, 11 and 18 countries; for *volume increment* and *fellings/removals* 12 and 18 countries. One could conclude from these figures that "sampling" is the preferred method to obtain the information on forest resources in the industrialized countries.

Scope of the national forest inventories (Summary Table II)

Land categories. *Forest* is covered by the inventory in all reporting countries. National inventories in 16 countries of 25 cover the *other wooded* land category; and only 12 of 25 the *other lands* category.

Ownership classes. Practically all reporting countries (except Albania, Portugal and Slovak Republic) indicated that their national inventories cover the category "*public*" ownership. The category "*other*" ownership is not covered in Albania, Bulgaria, Israel, Portugal and Slovak Republic. The reasons are obviously different and need to be explained.

Geographical coverage. Only 3 countries (France, Germany and Norway) of 25 indicated that certain regions are not covered by their national inventories. The reasons are different and explained by the correspondents (Annex II).

Availability of statements of reliability (Summary Table III)

Practically all countries, except Albania, Lithuania, Portugal and Ukraine provided information for which types of information statements of reliability exist. Details on a country by country basis are presented in the Summary Table.

The "Kotka-II" meeting is invited to draw conclusions and recommendations based on the information presented in this note, information to be provided by participants in the course of the meeting and on discussions on the subject.

Summary Table I of National Forest Inventory Situations 1993

Type of information: Area

Countries	Source of information				How is the information obtained	
	Monitoring [1]	One estimate	Expert opinion	No data	Agregation of local data	Sampling over large areas
Albania	+	+		–	Yes	Yes
Belarus	+			–	Yes	Yes
Bulgaria	+			–	Yes	Yes
Czech Republic	+			–	Yes *	Yes *
Estonia		+		–	Yes	...
Finland	+			–	No	Yes
France	+			–	No	Yes
Germany *		+		–	No	Yes *
Hungary	+			–	Yes *	... *
Israel	+			–	Yes	Yes
Lithuania	+			–	...	...
Netherlands	+			–	No	Yes
Norway	+			–	No	Yes
Poland	+			–	Yes	Yes
Russian Federation	+			–	Yes	...
Slovak Republic	+			–	Yes	No
Switzerland	+	+		–	No	Yes
Ukraine	+			–	No	Yes
United Kingdom	+	+ *		–	No	Yes
United States	+			–	No	Yes *

Footnotes:
*/ see comments and explanations on separate pages.
1/ Monitoring here means that comparable information from more than one time and covering the same area is available.
.../ information is not available
(+) confirmation
(–) no confirmation

Summary Table I of National Forest Inventory Situations 1993

Type of information: Growing stock

Countries	Source of information				How is the information obtained	
	Monitoring [1]	One estimate	Expert opinion	No data	Agregation of local data	Sampling over large areas
Albania	+	+		–	Yes	Yes
Belarus	+			–	Yes	Yes
Bulgaria	+			–	Yes	Yes
Czech Republic	+			–	Yes *	Yes *
Estonia		+		–	Yes	...
Finland	+			–	No	Yes
France	+			–	No	Yes
Germany *		+		–	No	Yes
Hungary	+			–	Yes *	... *
Israel	+			–	Yes	Yes
Lithuania	+			–	...	...
Netherlands	+			–	No	Yes
Norway	+			–	No	Yes
Poland	+			–	Yes	Yes
Russian Federation	+			–	Yes	...
Slovak Republic	+			–	Yes	No
Switzerland		+		–	No	Yes
Ukraine	+			–	No	Yes
United Kingdom	+			–	No	Yes
United States	+			–	No	Yes *

Footnotes: */ see comments and explanations on separate pages.
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.../ information is not available
(+) confirmation
(–) no confirmation

Summary Table I of National Forest Inventory Situations 1993

Type of information: Biomass

Countries	Source of information				How is the information obtained	
	Monitoring [1]	One estimate	Expert opinion	No data	Agregation of local data	Sampling over large areas
Albania				+	...	...
Belarus	+	...	...	–	Yes	Yes
Bulgaria	+			–	Yes	Yes
Czech Republic		+		–	Yes *	Yes *
Estonia				+	...	...
Finland	+			–	No	Yes
France	+ *			–	No	Yes
Germany *				+	...	...
Hungary	+			–	Yes *	... *
Israel	+			–	Yes	Yes
Lithuania				+	...	...
Netherlands			+	–	No	Yes
Norway	... *			–	No	...
Poland		+	+	–	Yes	Yes
Russian Federation				+	...	...
Slovak Republic				+	...	No
Switzerland				+	...	Yes
Ukraine	+			–	No	Yes
United Kingdom		+ *		–	No	Yes
United States	+			–	No	Yes *

Footnotes: */ see comments and explanations on separate pages.
1/ Monitoring here means that comparable information from more than one time and covering the same area is available.
.../ information is not available
(+) confirmation
(–) no confirmation

Summary Table I of National Forest Inventory Situations 1993

Type of information: Species

Countries	Source of information				How is the information obtained	
	Monitoring [1]	One estimate	Expert opinion	No data	Agregation of local data	Sampling over large areas
Albania	*	*	*	+ *	...	...
Belarus	+			–	Yes	Yes
Bulgaria	+			–	Yes	Yes
Czech Republic	+			–	Yes *	Yes *
Estonia		+		–	Yes	...
Finland	+			–	No	Yes
France	+			–	No	Yes
Germany *		+		–	No	Yes
Hungary	+			–	Yes *	... *
Israel	+			–	Yes	Yes
Lithuania	+			–	...	...
Netherlands	+			–	No	Yes
Norway	+			–	No	Yes
Poland	+			–	Yes	Yes
Russian Federation	+ *			–	Yes	...
Slovak Republic	+			–	Yes	No
Switzerland				–	No	Yes
Ukraine	+			–	No	Yes
United Kingdom	+			–	No	Yes
United States	+			–	No	Yes *

Footnotes: */ see comments and explanations on separate pages.
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.../ information is not available
(+) confirmation
(–) no confirmation

Summary Table I of National Forest Inventory Situations 1993

Type of information: Volume increment

Countries	Source of information				How is the information obtained	
	Monitoring [1]	One estimate	Expert opinion	No data	Agregation of local data	Sampling over large areas
Albania	+	+		–	Yes	Yes
Belarus	+			–	Yes	Yes
Bulgaria	+			–	Yes	Yes
Czech Republic	+			–	Yes *	Yes *
Estonia		+ *		–	Yes	...
Finland	+			–	No	Yes
France	+			–	No	Yes
Germany *				+	...	...
Hungary	+			–	Yes *	... *
Israel	+			–	Yes	Yes
Lithuania	+			–	...	...
Netherlands	+			–	No	Yes
Norway	+			–	No	Yes
Poland	+		+	–	Yes	Yes
Russian Federation	+			–	Yes	...
Slovak Republic	+			–	Yes	No
Switzerland			+	–	No	Yes
Ukraine	+			–	No	Yes
United Kingdom	+			–	No	Yes
United States	+			–	No	Yes *

Footnotes: */ see comments and explanations on separate pages.
1/ Monitoring here means that comparable information from more than one time and covering the same area is available.
.../ information is not available
(+) confirmation
(–) no confirmation

Summary Table I of National Forest Inventory Situations 1993

Type of information: Fellings / Removals

Countries	Source of information				How is the information obtained	
	Monitoring [1]	One estimate	Expert opinion	No data	Agregation of local data	Sampling over large areas
Albania	+	+		–	Yes	Yes
Belarus	+			–	Yes	Yes
Bulgaria	+			–	Yes	Yes
Czech Republic	+			–	Yes *	Yes *
Estonia		+ *		–	Yes	...
Finland	+			–	No	Yes
France	+ *			–	No	Yes
Germany *	+			–	No	Yes
Hungary	+			–	Yes *	... *
Israel	+			–	Yes	Yes
Lithuania	+			–	...	...
Netherlands	+			–	No	Yes
Norway	+			–	No	Yes
Poland	+			–	Yes	Yes
Russian Federation	+ *			–	Yes	...
Slovak Republic	+			–	Yes	No
Switzerland	+			–	No	Yes
Ukraine	+			–	No	Yes
United Kingdom				+	No	...
United States	+			–	No	Yes *

Footnotes: */ see comments and explanations on separate pages.
1/ Monitoring here means that comparable information from more than one time and covering the same area is available.
.../ information is not available
(+) confirmation
(–) no confirmation

Summary Table I of National Forest Inventory Situations 1993

Type of information: Change assessment

Countries	Source of information				How is the information obtained	
	Monitoring [1]	One estimate	Expert opinion	No data	Agregation of local data	Sampling over large areas
Albania	+			–	Yes	Yes
Belarus	+			–	Yes	Yes
Bulgaria				+	...	...
Czech Republic	+			–	Yes *	Yes *
Estonia				+	...	...
Finland	+			–	No	Yes
France	...	...	...	...	...	...
Germany *				+	...	...
Hungary	+			–	Yes *	... *
Israel	+			–	Yes	Yes
Lithuania	+			–	...	...
Netherlands	+			–	No	Yes
Norway				+ *	No	Yes *
Poland	+	+	+	–	Yes	Yes
Russian Federsation	+			–	Yes	...
Slovak Republic				+	...	No
Switzerland	+			–	No	Yes
Ukraine	+			–	No	Yes
United Kingdom	+ *			–	No	Yes
United States	+			–	No	Yes *

Footnotes:
*/ see comments and explanations on separate pages.
1/ Monitoring here means that comparable information from more than one time and covering the same area is available.
.../ information is not available
(+) confirmation
(–) no confirmation

Summary Table II on scope of the National Forest Inventory

Countries	Land categories			Ownership classes		Geographical coverage		
	Forest	Other wooded land	Other lands	Public	Other	Whole country is covered	Certain regions are excluded	Which regions are excluded
Albania	Yes	No	No	No	No	...	...	...
Belarus	Yes	Yes	Yes	Yes	Yes	+ *	No	No
Bulgaria	Yes	Yes	No	Yes	No	+	No	No
Czech Republic	Yes	No	No	Yes	Yes	+ *	No	No
Estonia	Yes	Yes	Yes	Yes	Yes	+	No	No
Finland	Yes	Yes	Yes	Yes	Yes	+	No	No
France	Yes *	Yes	Yes	Yes	Yes	No *	Yes	See comments
Germany	Yes	No	No	Yes	Yes	No	Yes	See comments
Hungary	Yes	No *	Yes *	Yes	Yes	+	No	No
Israel	Yes	No	No	Yes	No	+ *	No *	See comments
Netherlands	Yes *	No *	No	Yes *	Yes *	+	No	No
Norway	Yes	Yes	Yes *	Yes	Yes	No *	Yes	See comments
Poland	Yes	...	...	Yes	Yes	+	No	No
Russian Federration	Yes	Yes	Yes	Yes	Yes	+ *	No	No
Slovak Republic	Yes	Yes	No	No	No	+	No	No
Switzerland	Yes *	Yes *	Yes *	Yes *	Yes *	+	No	No
Ukraine	Yes	Yes	Yes	Yes	Yes	+	No	No
United Kingdom	Yes	Yes	No	Yes	Yes	+ *	No	No
United States	Yes	Yes	No	Yes *	Yes *	+ *	No	No

Footnotes: */ see comments and explanations on separate pages.
.../ information is not available
(+) confirmation

Summary Table III on availability of statements of reliability

Countries	Types of information 1/	Comments
Albania	...	...
Austria	Information obtained by sampling	...
Belarus	All types	...
Bulgaria	For all types of information mentioned in the reply to the Checklist	None
Canada	None	None (at the national level)
Czech Republic	Growing stock..... Increment..... Forest stand's species composition.....	... (+ –) 10 % error allowed ... (+ –) 20 % – " – ... (+ –) 0.5 % – " –
Estonia	All presented information is reliable	None
Finland	Area, Growing stock, Species, Volume increment, Removals, Change	None
France	All variables are subject to mathematical errors except: – species – removals	On removals – detailed enquiry with loggers
Germany	Area, Age classes, Dendrometrical data, Growing stock, Damage assessment	None
Hungary	Growing stock	See comments to the table
Israel	None	None
Lithuania	...	...
Luxembourg	None	None
Netherlands	Area census, Removals	Area census =0 % Growing stock + Volume increment : no
Norway	Productive forest area, Mean volume, Total volume	The standard error of productive forest area, mean volume and total volume are estimated for each county

Summary Table III on availability of statements of reliability (continued)

Countries	Types of information 1/	Comments
Poland	Area, Growing stock, Fellings/removals	None
Portugal	...	...
Russian Federation	For all types	None
Slovak Republic	Forest area, Land area, Total timber supply, Timber increment, Species composition, Actual annual cut, Planned annual cut, Incidental fellings, Tree species damage	Statement of reliability also exists for "timber supply per ha"
Sweden	Sampling error on all types of information in table of the Checklist. Some information on systematic, mainly measurement, errors	...
Switzerland	All information collected by the Swiss National Forest Inventory	Sources of information: – Swiss Nat. Forest Inventory – Land Use Inventory – Swiss Forest Statistic
Ukraine	...	None
United Kingdom	*Area* by Forest Type, *Growing stock* of productive forest and trees outside the forest by species groups, with error estimates on the volume in largest timber size categories (diameter categories), *Number of trees* outside the forest by coniferous and broadleaved types	No error limits are given for State forests as these are based on 100% survey. These data are combined with the data for other ownerships and an estimate of the standard error for the combined data is given for counties, regions and countries as indicated in the left column
United States	All forest land	None

1/ Types of information for which statements of reliability exist
.../ Information is not available

Annex I

Concise description of the forest inventory situation 1993

Checklist

Please provide for your country a concise description of the situation with regard to such forest resources information that is covering the whole country or larger parts of it. If needed, please fill in separate forms e.g. for different geographic regions or different ownership categories. The completed description should be returned not later than 31 March 1993 to:

Economic Commission for Europe
ECE/FAO Agriculture and Timber Division
Palais des Nations
CH-1211 GENEVE 10 Fax: + 41 22 917 0041
Switzerland Tel: + 41 22 917 2879

Country:.....
Date:.....

1) Types of information and their sources

Source of information

Types of information	Monitoring (1)	One Estimate	Expert opinions	No data
Area				
Growing stock				
Biomass				
Species				
Volume increment				
Fellings/ /Removals				
Change assessment				

Note (1) – Monitoring here means that comparable information from more than one time and covering the same area is available.

2) How is the national forest resources information obtained?

– Aggregation of information collected from local inventory sources yes/no
– Sampling over large areas (e.g. country or province level) yes/no

Please give concise information on important details not covered by this checklist (use separate sheets, if needed)

3) Scope (which land categories, ownership classes and geographical regions are covered by the inventory)?

– Forest	yes/no
– Other wooded land	yes/no
– Other lands	yes/no
– Public	yes/no
– Other	yes/no

– Geographical coverage: is the whole country covered or are certain regions excluded ? Which?

4) For which types of information do statements of reliability exist (sampling and other errors) ?

Annex II

Comments and explanations by national correspondents in replies to the Checklist

Summary Tables I, II, III

Albania

Species: Beech, Fir, Black Pine, different varieties of Oak, Chestnut, Walnut, Poplar, etc.

The collection of information has up to now been done by the 26 forest enterprises but now, this collection will be realised by the 36 Forest Service Directorates (one Directorate for each district).

The collection in each district is done in accordance with the inventory and management plan for each forest stand and various measurements, referring the annual changes that occurred with these forest stands, and based on separated parcels.

Pastures occupy 403 thousand ha.

The inventory, management plans and monitoring of forest resources are carried out using methods determined by the Forest and Pasture Research Institute.

Belarus
Annually 1/10 of the forest area is covered by the forest inventory, i.e. national reevaluations every 10 years.

Bulgaria
Productivity of stands, density and wood species are not covered by this Checklist.

Canada
Source of information on area, growing stock and species: best available data aggregated every 5 years, but results not comparable in a monitoring sense.

Information on volume increment is mean annual increment of mature growing stock; on *change assessment:* partial reporting.

Scope of information: on other lands – within the areas of forest inventory; on ownership classes – with some omissions.

Geographical coverage: all the forested regions.

Czech Republic
Important details of the national forest inventory:

a) Forest management plans are elaborated every 10 years (i.e. annually approximately 10% of country's forest area)

b) Pollution damage assessment

The whole country is covered by the inventory. Two sources of information:

a) civil forests – Lesproject, Forest Management Institute, Brandys n.L.

b) military forests – Ustav pro hospodarskou upravu vojenskych lesu a statku, Susice.

Estonia
Data on fellings compared to increment are small as only 6 % of forest are mature stands and fellings cannot be increased.

During the last 50 years the area of forest has increased 2.2 times; half that area was not forest land before. Middle aged and young stands form 83 % of the total forest area.

Germany
Data cover only the western part of Germany. For the area of the former GDR interim data will be available in 1994

France
French Forest Inventory covers 10 % of the French National territory each year.

Monitoring of biomass is provided by using standing volume coefficients.

Monitoring is provided for "removals", not for "fellings".

Information on "change assessment" is not given in the reply.

Overseas Departments and territories are excluded from this inventory.

Hungary

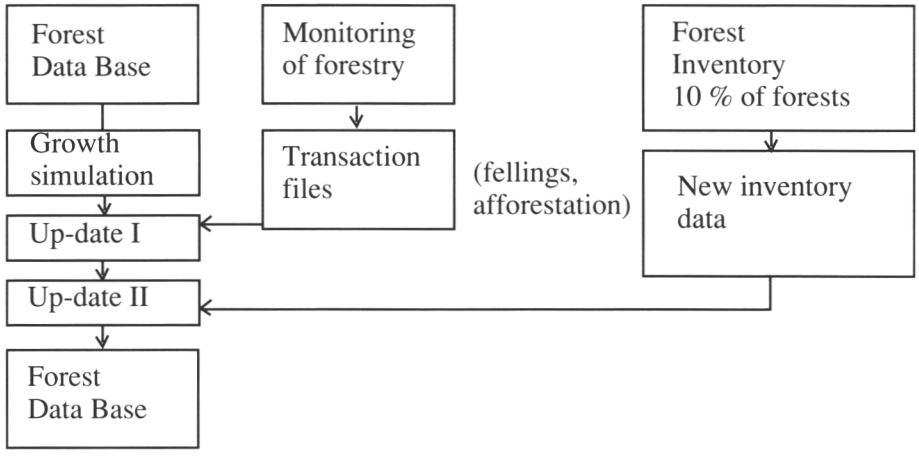
1. *Biomass* as such is not covered by the forest inventory in Hungary. However, there are no diameter limits when measuring growing stock and the yield tables were constructed so that all branches, twigs and even needles are included in the case of conifers (above-ground dendromass for broadleaved and above-ground tree biomass for coniferous).

So, the answer to question 1 of the Checklist could either be "Monitoring" or "No data", because these figures are not being considered as biomass values.

In the basic report to FRA-90, the same values were used for growing stock and for the above ground tree biomass.

2. The national forest inventory is in close connection with management planning producers. Since the validity of plans is 10 years, the inventory on each area is being repeated every tenth year. So 10% of the forested area is surveyed annually.

The steps of generating the forest inventory data are as follows:



The inventory is the task of an institute with country-wide responsibility (Forest Management Planning Service). This institute manages the forest data base.

All inventory data are collected on subcompartment level, using terrestrial methods and areal photos.

The activities of forest owners are monitored by the forest inspectorates, and their annual records are used for updating the data-base between two inventories.

The data of the Forest Data Base always relate to 01 January of the year and are updated once a year.

As a consequence of the above procedure, the system can rather be described as aggregation of information collected from local sources, although the inventory itself is country-wide and is being carried out by one institute.

3. Country wide sampling is used for monitoring forest health. The sample plots are organized in a 4x4 km systematic grid. In 1993 a modified version of this grid will be used for a country-wide forest inventory applying sampling techniques.

The method is a tailored version of the Austrian forest inventory. First results are expected in late 1993 or early 1994. This method will serve as a basis for long-term increment monitoring on the one hand, and reference for qualifying the Forest Data Base – on the other hand.

Israel

All planted forest more than 10 years old is covered by the inventory.

Netherlands

Two sources of information are indicated in the reply :

a) Forest area: complete census the Netherlands on species, year of germination, diameter class;

b) Growing stock, volume increment, removals: 3000 sample plots over the country

Scope: 30 forest types; no other wooded land; 6 classes of public ownership; 2 classes of other types of ownership.

Norway

The national inventory does not emphasize the estimation of *biomass*, but rough estimates have occasionally been calculated.

Permanent sample plots for "Change assessment" have been established during the period 1986–1993, but have not been remeasured yet.

The national forest resource information is obtained by systematic plot sampling. The survey has so far been organized on a per county basis. (Data on fellings are based on reports collected by forest administration).

Scope: for "other lands", only the land type is recorded.

Finnmark, the northernmost county, is excluded due to insignificant forestry importance. Areas above the coniferous forest limit are also excluded.

Russian Federation

The national forest resources information is obtained by the aggregation of information collected from local inventory sources.

Species: Larix, Pine, Spruce, Fir, Oak, Beech, Aspen, Birch and others.

Data on removals are not available.

Geographical coverage: the whole country is covered: 70 % by terrestrial inventory methods, 30 % by remote sensing methods.

Sweden

The whole country is covered by the inventory. National Forest Inventory has been carried out since 1923. As from 1953 the NFI is annually covering the whole country.

Switzerland

The source of information on *area, fellings(removals)* and *change assessment* is "Swiss Forest Statistics".

The source of information on *area, growing stock, species* is "Swiss National Forest Inventory" (1982–1985).

The brochure "Swiss National Forest Inventory" was attached to the reply on the Checklist and available on request in the ECE/FAO secretariat.

United Kingdom

Monitoring of *area, growing stock and species* is based on inventory at 15 years intervals plus annual records. This is also the main source for *change assessment* (as well as some land use change studies).

Monitoring of *volume increment* is based on yield models.

Information on *area* by "one estimate" is also being obtained from two sources:

– Great Britain Land Cover by Remote Sensing (Landsat) 1990. Results due 1993, and

– Land Cover of Scotland by Air Photo Interpretation at 1:25000 scale (Scotland only).

State Forest (Forestry Commission) *data* is collected on a stand by stand basis and updated annually. *Other ownerships* are sampled on a 15 year cycle on a country or regional basis and the summary data updated annually from fellings and planting statistics of each region.

Five pages of additional information on national forest inventory were attached to the reply on the Checklist and available on request in the ECE/FAO secretariat.

United States

"National reevaluations every decade" was indicated in the reply to the Checklist

Summary tables

1

Global Summary table of the National Forest Inventory situation 1993

REGIONS	No of countries under assessment	Area				How is the information obtained		Whole country cover	Land categories covered			Ownership classes	
		Monitoring	One estimate	Expert opinion	No data	Aggregation of local data	Sampling over large areas		Forest	Other wooded land	Other lands	Public	Other
AFRICA	11	3	3	5	-	9	9	2	8	6	1	6	5
ASIA	6	2	4	-	-	3	6	5	6	4	2	5	2
LATIN AMERICA	3	-	2	1	-	3	3	3	3	2	2	3	1
NEAR EAST	2	-	2	-	-	-	2	1	2	2	2	2	1

Summary table I of national forest inventory Situations 1993

Type of information :Area

Countries	SOURCE OF INFORMATION				How is the information obtained		
	Monitoring[1]	One estimate	Expert opinion	No data	Aggregation of local data	Sampling over large areas	Comments
AFRICA							
Angola			+		Yes	No	
Kenya	+				Yes	Yes	Sampling over large ares (country or province level) was done once in 1969 by the canadian sponsored inventory. In 1991, FAO sponsored an inventory on the exotic plantations only which covered 80% of the plantations that forms the industrial forest base.
Morocco			+		Yes	Yes	A national forest inventory has just started, and information over the whole country is not yet available. Presently only partial data exists, mainly for productive forests where inventory has been conducted for management purposes. Prior to actual survey, an inventory was executed in 1979 but concerned one province only.
Niger		+			No	Yes	Data issued from a cartography based on satellite imagery.
Nigeria		+			No	Yes	
Senegal			+		Yes	Yes	
Swaziland	+				Yes	Yes	
Tanzania	+				Yes	Yes	
Togo			+		Yes	No	
Uganda			+		Yes[1]	Yes[2]	1/Forest Department inventories 2/ National Biomass Studies Information is also obtained from field reported by district forest officers and from permanent plot.
Zaire		+			Yes	Yes	

Countries	Source of information				How is the information obtained		
ASIA	Monitoring	One estimate	Expert opinion	No data	Aggregation of local data	Sampling over large areas	Comments
India	+				Yes	Yes	
Indonesia		+			Yes	Yes	Some of information is collected from local inventory source on various level of accuracy, while sampling over large areas are under implementation through NFI Project.
Malaysia (Peninsular)	+				No	Yes	
Malaysia (Sabah)		+			No	Yes	
Mongolia		+			No	Yes	
Sri Lanka		+			Yes[1]	Yes[2]	1/ For plantation inventory; 2/for indicate inventory of natural forests.
LATIN AMERICA							
Chile			+		Yes	Yes	Some regions have been inventoried for area information about 30 years ago. Plantations covering 1.5 million ha have been partly inventoried for area and volume recently.
Colombia		+			Yes	Yes	
Peru		+			Yes	Yes	
NEAR EAST							
Lebanon		+			No	Yes	National forest map, 1966 (UNDP). Land use map, 1990 (FAO).
Yemen		+			No	Yes	

Footnotes: 1/Monitoring here means that comparable information from more than one time and covering the same area is available.

Summary table I of national forest inventory Situations 1993

Type of information :Growing stock

Countries	SOURCE OF INFORMATION			
	Monitoring[1]	One estimate	Expert opinion	No data
AFRICA				
Angola			+	
Kenya	+			
Morocco			+	
Niger			+	
Nigeria		+		
Senegal				+
Swaziland		+		
Tanzania		+		
Togo			+	
Uganda		+		
Zaire		+		
ASIA				
India		+		
Indonesia		+		
Malaysia (Peninsular)	+			
Malaysia (Sabah)		+		
Mongolia		+		
Sri Lanka		+		
LATIN AMERICA				
Chile			+	
Colombia		+		
Peru		+		
NEAR EAST				
Lebanon			+	
Yemen			+	

Footnotes:1/Monitoring here means that comparable information from more than one time and covering the same area is available.

Summary table I of national forest inventory Situations 1993

Type of information :Biomass

Countries	SOURCE OF INFORMATION			
	Monitoring[1]	One estimate	Expert opinion	No data
AFRICA				
Angola			+	
Kenya	+			
Morocco				+
Niger				+
Nigeria				+
Senegal				+
Swaziland		+		
Tanzania				+
Togo				+
Uganda		+		
Zaire				+
ASIA				
India				+
Indonesia				+
Malaysia (Peninsular)				+
Malaysia (Sabah)				+
Mongolia		+		
Sri Lanka				+
LATIN AMERICA				
Chile				+
Colombia		+		
Peru		+		
NEAR EAST				
Lebanon				+
Yemen		+		

Footnotes:1/Monitoring here means that comparable information from more than one time and covering the same area is available.

Summary table I of national forest inventory Situations 1993

Type of information :Species

Countries	SOURCE OF INFORMATION			
	Monitoring[1]	One estimate	Expert opinion	No data
AFRICA				
Angola			+	
Kenya	+			
Morocco			+	
Niger			+	
Nigeria		+		
Senegal		+		
Swaziland		+		
Tanzania			+	
Togo		+		
Uganda		+		
Zaire			+	
ASIA				
India		+		
Indonesia			+	
Malaysia (Peninsular)	+			
Malaysia (Sabah)		+		
Mongolia		+		
Sri Lanka		+		
LATIN AMERICA				
Chile			+	
Colombia		+		
Peru		+		
NEAR EAST				
Lebanon		+		
Yemen		+		

Footnotes:1/Monitoring here means that comparable information from more than one time and covering the same area is available.

Summary table I of national forest inventory Situations 1993

Type of information :Volume increment

Countries	SOURCE OF INFORMATION			
	Monitoring[1]	One estimate	Expert opinion	No data
AFRICA				
Angola			+	
Kenya		+		
Morocco				+
Niger				+
Nigeria		+		
Senegal			+	
Swaziland		+		
Tanzania			+	
Togo				+
Uganda		+		
Zaire				+
ASIA				
India				+
Indonesia			+	
Malaysia (Peninsular)				+
Malaysia (Sabah)				+
Mongolia			+	
Sri Lanka				+
LATIN AMERICA				
Chile			+	
Colombia		+		
Peru		+		
NEAR EAST				
Lebanon			+	
Yemen				+

Footnotes: 1/Monitoring here means that comparable information from more than one time and covering the same area is available.

Summary table I of national forest inventory Situations 1993

Type of information :Fellings/Removals

Countries	SOURCE OF INFORMATION			
	Monitoring[1]	One estimate	Expert opinion	No data
AFRICA				
Angola			+	
Kenya	+			
Morocco				+
Niger				+
Nigeria				+
Senegal				+
Swaziland			+	
Tanzania		+		
Togo			+	
Uganda			+	
Zaire			+	
ASIA				
India			+	
Indonesia			+	
Malaysia (Peninsular)				+
Malaysia (Sabah)				+
Mongolia	+			
Sri Lanka		+		
LATIN AMERICA				
Chile			+	
Colombia		+		
Peru		+		
NEAR EAST				
Lebanon			+	
Yemen				+

Footnotes:1/Monitoring here means that comparable information from more than one time and covering the same area is available.

Summary table I of national forest inventory Situations 1993

Type of information :Change assessment

Countries	SOURCE OF INFORMATION			
	Monitoring[1]	One estimate	Expert opinion	No data
AFRICA				
Angola				+
Kenya	+			
Morocco				+
Niger				+
Nigeria				+
Senegal				+
Swaziland			+	
Tanzania	+			
Togo			+	
Uganda			+	
Zaire				+
ASIA				
India	+			
Indonesia			+	
Malaysia (Peninsular)	+			
Malaysia (Sabah)				+
Mongolia		+		
Sri Lanka		+		
LATIN AMERICA				
Chile			+	
Colombia				+
Peru		+		
NEAR EAST				
Lebanon				+
Yemen				+

Footnotes:1/Monitoring here means that comparable information from more than one time and covering the same area is available.

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Summary table II on scope of the national Forest Inventory

Countries	Land categories			Ownership classes		Geographical coverage	
	Forest	Other wooded land	Other lands	Public	Other	Whole country coverage	Comments
AFRICA							
Angola	-	-	-	-	-	Yes	
Kenya	Yes	Yes	No	-	-	No	Some areas are not covered like Mt. Elgon Region and the Coast Province. Indigenous forests have not been covered although how its being done forest land outside gazetted forests are covered elsewhere.
Morocco	Yes	Yes	No	Yes	Yes	Yes	
Niger	Yes	No	No	Yes	Yes	No	
Nigeria	Yes	No	No	Yes	No	No	Southern part of the country covering selected high forest reserves.
Senegal	-	-	-	-	-	No	Only the southern part of the country (ZEG of Casamance) is covered with reliable data. In the others ZEG, the information of local inventory are available (Zones des Niayes et du Centre-est).
Swaziland	Yes	Yes	No	No	Yes	No	Whole country covered except Public areas.
Tanzania	Yes	Yes	No	Yes	No	No	Regions excluded: Mara, Ruvuma, Kigoma and Shinyanga.
Togo	Yes	Yes	No	Yes	Yes	No	No reliable whole country cover.
Uganda	Yes	Yes	Yes	Yes	Yes	No	The National Biomass Study covered only peri-urban areas.
Zaire						No	Forest inventories are done just for commercial needs. Actually about 20% of accessible rain forests are covered by the inventory.

	Land categories			Ownership classes		Geographic coverage	
	Forest	Other wooded land	Other lands	Public	Other	Whole country cover	Comments
ASIA							
India	Yes	Yes	Yes	Yes	No	Yes	The inventory work is done in selected areas of the country. So far as monitoring of vegetation cover is concerned, it is done for the whole country on a two year cycle.
Indonesia	Yes	Yes	Yes	-	-	No	Except Java Island, which is maintained by a state enterprise.
Malaysia (Peninsular)	Yes	No	No	Yes	Yes	Yes	The whole of Peninsular Malaysia was covered and currently the Forestry Department is developing a continuous forest monitoring system using satellite imageries and geographical information system.
Malaysia (Sabah)	Yes	No	No	Yes	Yes	Yes*	*The 1969-72 forest inventory was carried out for all forested areas, while the 1986-87 forest inventory only involved the logged-over inland forests areas only.
Mongolia	Yes	Yes	-	Yes	-	No	Excluded are coniferous forests and forests of Zaisan Saxaul.
Sri Lanka	Yes	Yes	No	Yes	No	No	The North-East Province is excluded for security reasons. Conservation areas and Wild Life Reserves are also excluded for field sampling.
LATIN AMERICA							
Chile	Yes	Yes	No	Yes	No	No	For extreme northern and southern regions only information from local inventories is available.
Colombia	Yes	Yes	Yes	Yes	No	Yes	
Peru	Yes	Yes	Yes	Yes	Yes	No	The Selva Central Region is not covered.
NEAR EAST							
Lebanon	Yes	Yes	Yes	Yes	Yes	Yes	
Yemen	Yes	Yes	Yes	Yes	No	No	The survey by the Hunting Company covers the whole mainland. It excludes all the islands.

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Summary table III on availability of statements of reliability

Countries	Type of information[1]	Comments
AFRICA		
Angola	None	
Kenya	Volume, growing stock, fellings and removals (commercial exotic plantations)	Since no exploitation occurs in indigenous plantations, they are merely preserved although at the moment an indigenous forest conservation project is working on this, sponsored by ODA.
Morocco	area, growing stock	The method of the national survey presently taking place, is based on stratified sampling techniques.
Niger	None	
Nigeria	Growing stock, volume increment.	
Senegal	See comments.	The information from inventory of the ZEG of Casamance and Niayes are first-rate. The other information used in the national forest inventory came from sampling over some large areas.
Swaziland	Field sampling and standard error of volume.	
Tanzania	Area, Growing stock, Species, Removal, Geographic coverage.	
Togo	None	No reliable data issued from recent forest inventories.
Uganda	See comments	Forest inventory of softwood plantations/Forest inventory of natural forest/Standing stock inventory of woody biomass per 11 vegetation types.
Zaire		The systematic sampling is used with a rate of 0.2%. The estimation error of gross volume do not pass over 15% at level 95%.

ASIA	Type of information[1]	COMMENTS
India		Results of inventory survey are at the precision level of 10% at 95% probability level.
Indonesia	area, species, volume, number of trees, forest types, forest status.	expected reliability of 15% sampling errors. Other errors may still exist due to human and uncalibrated equipments.
Malaysia (Peninsular)		For the 1971-72 and 1981-82 forest inventories, the estimates of gross volume for all species with a diameter above 45 cm, would be within an accuracy limit of 10% at 95% probability level. For the 1991-93 forest inventory, the estimates of gross volume for all species with diam. > 30 cm for the virgin and logged-over forests would be within an accuracy limit of 15% and 10% respectively at 95% probability level.
Malaysia (Sabah)		For the 1969-72 forest inventory, sampling error below 10% at 95% probability level. For the 1986-87 forest inventory, the standard error at 95% probability level for the estimates of gross volume of trees having diam. above 40 cm for the inland forests were found to vary from 6 to 12%.
Mongolia	Timber harvesting, afforestation, Forest and woodland, stumpage income.	
Sri Lanka	do not exist for forest plantation inventory data.	It is foreseen to calculate sampling errors for the indicative inventory of natural forests which is currently being undertaken.
LATIN AMERICA		
Chile	None	
Colombia		No answer on this topic.
Peru		Sampling errors
NEAR EAST		
Lebanon	None	Passable reliability as based on estimation.
Yemen	Wood resources	90% reliability

Footnotes: 1/Types of information for which do statements of reliability exist.

Agenda Item 5

Presentation of the 1990 Forest Resource Assessment (Temperate zone) and Plans for Follow-up

Background

Forest resource assessments of temperate-zone regions have been carried out in accordance with the programme of work of the Joint FAO/ECE Working Party on Forest Economics and Statistics. Two programme elements are involved:

02 (B).2.3 – *Forest Resource Assessment; and*
02 (B).1.5 – *Quantification and evaluation of the environmental and other non-wood benefits of forests.*

The 1990 Forest Resource Assessment (Temperate-zone) constitutes a part of the Global Forest Resource Assessment which has been carried out jointly by FAO and UN-ECE/FAO.

Development of the Assessment

Plans for the 1990 Global Forest Resource Assessment were initiated at the FAO/ECE/FINNIDA *ad hoc* meeting of experts held in Kotka, Finland in October 1987. It was agreed to implement the temperate-zone part of the Assessment by means of a detailed enquiry, covering the most important forest inventory information.

At its *sixteenth session* (24–26 February 1988, Geneva) the Working Party considered the proposals of the first *ad hoc* meeting of experts held in Kotka with regard to the scope, contents and layout of the enquiry for the temperate part of the 1990 Assessment. The member countries' correspondents were invited to comment on the draft enquiry and the secretariat was asked to submit a new version, revised in the light of the Working Party's and the correspondents' comments to the second *ad hoc* meeting.

The second *ad hoc* meeting, which was held in conjunction with the IUFRO Conference on Natural Resource Monitoring and Assess-

ment: Preparing for the 21st Century (Venice, Italy, September 1989), proposed further modifications to the enquiry. These proposals were transmitted to the seventeenth session of the Joint Working Party (6–8 December 1989).

After the final revision, the enquiry as a whole, including terms, definitions and the questionnaire with explanatory notes, was approved by the *seventeenth session* of the Working Party and circulated in spring 1990 to the member countries of the ECE region (Europe, the former USSR and North America) as well as to three other temperate-zone industrialized countries (Australia, Japan and New Zealand).

Replies from national correspondents to both parts of the enquiry: Part I – "General Inventory Information", and Part II –"The role of forests in supplying environment and other non-wood goods and services" were received by the secretariat during 1990 and 1991. On the basis of replies received by mid-1991, the secretariat prepared preliminary results of the assessment (TIM/EFC/WP.2/AC.2/R.21, R.22 and WP.2/AC.2/9) which were examined during the third *ad hoc* meeting of experts held in August 1991 in Geneva. The report of the meeting, including the recommendations for the follow-up was approved by the *eighteenth session* of the Joint FAO/ECE Working Party (28–30 August 1991) (TIM/EFC/WP.2/21).

Following the recommendations of the Joint Working Party the secretariat asked countries to check and complete their data and related information to the extent possible. The national correspondents also contributed by completing the "Table of essential data" for their country files in the publication. In case where official data were not available, estimates were made by the secretariat in cooperation with the correspondents.

The principal results of the Assessment: "The Forest Resources of the Temperate Zones: Main findings of the UN-ECE/FAO 1990 Forest Resource Assessment" (ECE/TIM/60) were issued in advance of the main two volumes, after a preliminary version had been approved in April 1992 by the joint meeting of the ECE Timber Committee office-holders and the Executive Committee of the FAO European Forestry Commission, just before the UNCED Conference (Rio de Janeiro, June 1992).

The 1990 Forest Resource Assessment(Temperate zone) was finalized and published by spring 1993 in two volumes (ECE/TIM/62): Volume I – "General Forest Resource Information" and Volume II – "Benefits and Functions of the Forest". The joint meeting of the ECE Timber Committee office holders and the Executive Committee of the FAO European Forestry Commission (Geneva, January 1993) noted the importance of the results of the Assessment. The meeting was informed that arrangements were being undertaken to prepare a computer readable data retrieval system for the statistical database of the 1990 Assessment.

The results of the Forest Resource Assessment 1990 (Temperate zone) were also presented at the 11th session of the FAO Committee on Forestry (COFO) in March 1993, together with the results of the

tropical zone Assessment. The Committee welcomed the report on the Forest Resources Assessment 1990 and the final results for the industrialized and tropical countries. It looked forward to the early completion of the whole assessment with the inclusion of the non-tropical developing countries (COFO-93/REP, para 7).

Results and main findings of the Assessment

The UN-ECE/FAO Forest Resource Assessment (Temperate zones) 1990 has resulted in a more complete, better founded set of data than was possible in previous surveys, thanks to the effective support of member countries and of the correspondents responsible for collecting and providing data to the secretariat. The survey may be considered as valuable reference material for policy-makers, managers and others concerned with forestry, ecology, nature conservation, wood production, trade and socio-economic development.

The main findings of the assessment are:

The combined *area of forest and other wooded land* for the industrialized countries concerned is 2.06 billion hectares or nearly 39% of land area. However, the share of forest and other wooded land varies considerably at the country level, ranging from 68% in Japan and 77% in Finland down to 20% in Belgium and less than 10% in the United Kingdom.

On a *per caput* basis (assuming the population in the industrialized countries is of 1.27 billion), there is an average of about 1.6 ha of forest and other wooded land per inhabitant.

Differences in land classification and definitions, in particular the definitions of "*Forest*" between those used in tropical and temperate-zone parts of the Assessment (e.g., "*Forest*" is the "*Land with tree crown cover (stand density) of more than about 20 % of the area...*" – for the temperate-zone, and "*...with a minimum of 10 per cent crown coverage...*" – for the tropical part), prevent reliable and precise comparison of this and other categories worldwide.

The *area of forest* (i.e. without other wooded land) in the industrialized temperate zone countries is about 1.43 billion hectares (following the above definition). It constitutes nearly 27 % of land area or 1.12 ha per inhabitant on a *per caput* basis. (According to the final results for the tropical part of the 1990 Assessment, the forest cover of the tropical world accounts in the forest ecological zone for 42 %). The share of forest varies considerably at the country level, ranging from 66 % in Finland and Japan down to about 5% in Ireland and Israel.

The total volume of *growing stock* on exploitable forests in the industrialized countries is estimated at 112 billion m^3 o.b. Averages of growing stock per ha of exploitable forest at the sub-regional level have wide differences (204 m^3 o.b./ha in the countries of central-

eastern Europe, 121 m^3 o.b./ha in the former USSR, excluding Belarus and Ukraine, and only 70 m^3 o.b./ha in the Iberian peninsula.

Ownership structure varies from country to country according to historical, social, political and other factors. For Europe, as a whole, almost exactly half the area of forest and other wooded land is privately owned and the other half publicly owned.

Species distribution can better be indicated by the growing stock data than by area, because of difficulties of finding common area based definitions of "coniferous forests" and "broadleaved forests". Of a total growing stock of 112 billion m^3 o.b. on exploitable forest in the temperate zones, 75.5 billion, or almost exactly two-thirds are coniferous and 36.5 billion or one-third are broadleaved.

The total *net annual increment* (NAI) on exploitable forest in Europe amounted to 577 million m^3 o.b., in the former USSR countries to 700 million m^3 o.b., and for the United States and Canada is estimated around 640 and 210 million m^3 respectively. Total fellings in the industrialized countries around 1990 are estimated at 1.86 billion m^3 o.b.

The *relationship* between *fellings* and *net annual increment* gives a good indication of the evolution of the forest resources. The 1990 Assessment has clearly indicated that in almost all temperate-zone industrialized countries net annual increment has been higher than fellings over many years, and consequently there has been a rise in *growing stock* even though many countries have reported an increasing trend in fellings.

Public attitudes towards the forest and forestry have been changing over the past decade, with increasing concern being expressed in many countries for the protection of the environment, conservation of forests, bio-diversity and meeting society's demands for non-wood benefits (goods and services). The majority of countries expect increasing emphasis in policy and planning to be given to the non-wood functions of the forest, in particular protection, water regulation and quality, nature conservation and recreation. The prevailing importance of wood production will be maintained, while the importance of hunting, grazing and specified non-wood products will also remain about the same as before.

Some countries have made good progress in quantifying the production and harvest of different *non-wood products* and even in putting a value on them. It should be noted, however, that we are still far from being able to apply methodologies, allowing valuation, whether in monetary terms or any other units, of the relative importance of different functions or products of the forest.

One parameter for which quite a number of countries found difficulty in providing reliable information was *changes over time* in area of forest and other wooded lands. The United States and Japan were the only temperate-zone countries to report reductions in the area of forest and other wooded land. In Japan there was a small net loss of 48 thousand ha between 1980 and 1990; in the USA, the net loss amounted to nearly 3.2 million ha between 1977 and 1988. In the case of Europe and the former USSR, the 1990 Assessment categorically

stated that the area of forest and other wooded land increased between 1980 and 1990, confirming the total *positive balance* in changes over time for the temperate-zone industrialized region as a whole.

Conflicts between forest functions cover a wide area and may vary considerably from country to country. Generally speaking, however, the problem is between wood production and another function, notably environmental protection, hunting, nature conservation or recreation. Other conflicts arise between nature conservation or environmental protection on the one hand and recreation on the other. Methods have been or are being developed in some countries to reconcile the different functions, so that an improved combination of uses can be achieved.

Of the main findings, two stand out as being common to most of the industrialized countries in the temperate regions, so far as their significance for the long term and likely implications for policy are concerned. They are the *continuing expansion of the temperate forest resource* and the *increasing relative and absolute importance of the non-wood functions of the forest.*

Problems to be solved and aspects to be investigated

The results of the 1990 Assessment (temperate zone) revealed a number of problems to be solved in the course of implementation of the next Global Forest Resource Assessment, discovered some new ideas to follow up and raised some aspects to be investigated.

The global framework of definitions and classifications used in the assessment 1990 does not respond sufficiently to the recent developments in the forest policies at national and international levels and needs to be revised (e.g. there is by no means universal acceptance of the concept and meaning of "exploitable" forest). To respond to the present day requirements and developments, the *new set of definitions* and classifications should be elaborated and agreed by nations. For the purpose of international assessments it (or at least the most aggregated levels of it) should be applicable both in questionnaire enquiries as well as in surveys based on remote sensing and other increasingly sophisticated forest inventory techniques.

The problem of the real integration of the tropical, temperate zone and boreal parts into a single whole global assessment is still open, mainly for reasons of *comparability* of classifications and definitions. This problem is particularly acute in connection with the necessity to improve estimates on *changes in area* and *status* (i.e. consistent use of terms like "degraded", "logged over", etc.) of forests in the industrialized countries and to obtain a clear idea of the changes occurred globally.

Interest in the way and extent to which the boreal and temperate zone forest resource has been changing has increased considerably in recent years and particularly after the UNCED Conference, partly as a reaction to the evidence of serious deforestation in the tropical zones. Among the difficulties encountered in providing data on changes in area for the temperate zone part of the 1990 Assessment appear to

have been:

– making a distinction between afforestation (establishment of a forest or woodland on previously non-forest land) and reforestation (re-establishment of forest cover on temporarily unstocked forest or other wooded land, e.g. after clear cutting, forest fire or storm damage);
– interpretation of data on "Loss to other uses" sometimes as the transfer of forest land to other categories (e.g. wilderness areas), without necessarily involving the loss of tree cover;
– changes (improvements) in survey methods.

Specific approaches have to be found and dealt with to assess the changes over time in the forest areas of the industrialized countries in the course of the Assessment 2000.

The 1990 Assessment does not consider specifically the state of *health* of the forest resource, problems related to *forest damage* (e.g. forest fires and storm damage) and other threats to forest ecosystems of temperate zones as well as *quality* of forest resources. The forests of the industrialized countries are expanding in physical terms, but in many areas they are under stress on various reasons. The forest decline can be observed in many areas of the industrialized countries. Further analysis will be necessary in order to determine what could be the most appropriate policy responses to the information received, especially they may be different from one country to another. Findings of the Assessment should be merged with data available from other sources on the above mentioned aspects, when analysis of its results is undertaken.

There is a strongly increasing need for the information on *environmental and social* benefits and functions of the forest. This type of information contained in the temperate zone part of the 1990 Assessment is of a much more qualitative kind, more difficult and costly to collect and often, up to now, requiring subjective judgements on the part of the inventory manager, in the absence of quantitative or monetary assessment methods. These aspects should be considered in details when preparing for the next Global Forest Resource Assessment.

Since the time when the enquiry was circulated in early 1990, far-reaching political changes have taken place in some of the countries covered by this survey. Replies were received from a number of countries which no longer exist under their old names. At present, the UN-ECE membership has risen from 34 to 44 countries, including 17 with economies in transition to a market economy. The political changes in the transition countries are likely to lead to significant alterations in the years ahead in, for example, ownership structures, as well as in the way in which the forest resource is managed and used. One of implications of this historica change is possible reorganization, or (in some cases) building up the forest inventory capacities *of the newly constituted countries*. Monitoring of developments in the forest resources of these countries will therefore become more important than ever. The existing network of national correspondents on the forest resource assessment aspects in this context should also be

revised and reestablished.

The quality and coverage of the temperate zone part of the Assessment 1990 need to be significantly improved, even if we state that this assessment has been an important step ahead in comparison with the previous one. Some countries could not reply to the enquiry in full, at least not with what they consider to be adequately reliable, scientifically collected and officially approved information. Difficulties in reconciling national classifications and definitions with the accepted "Common Framework for World Forest Resource Assessment" sometimes made it impossible for national correspondence to provide all of the more important figures. Strong efforts still have to be made by many countries to improve the quality of the information to be submitted in connection with international assessments.

The lack of data for some countries created the problem of making regional totals, and the secretariat was obliged to provide, in some cases, its own estimates of regional totals or even to leave them blank. In other cases, the regional totals should be considered as the sum of the country data shown. This has sometimes led to apparent inconsistencies, which demand explanations in footnotes. Countries should consider how they want to see this problem be solved. There could be different solutions ranging from more heavy use of secretariat estimates to executing a sampling survey over the whole area of the industrialized countries.

A major obstacle to proper data quality (particularly on non-wood goods and services of forests) is the influence national correspondents may have on the replies because of personal or institutional attitudes, or because of misinterpretation of definitions. For the next assessment, consideration should be given to using a multi-disciplinary group of correspondents in each country, or to maintaining the same person or institution as correspondent.

Drawing up plans for the next global assessment and considering how to improve quality and coverage of future surveys, countries should also take into consideration the fact that *more resources* will have to be committed for this challenging task, both at the national and at the international level.

Follow-up activities to the 1990 Assessment

The ECE Timber Committee at its 50th session held in Geneva in October 1992 endorsed a number of follow-up activities to the temperate zone part of the Forest Resource Assessment 1990. The work accomplished and to be undertaken should be carried out in close cooperation with the FAO European Forestry Commission.

The FAO Committee on Forestry (COFO) at its 11th session held in Rome in March 1993 emphasized the fundamental importance of continuous forest resources assessment to provide the information needed for the formulation, implementation and review of the effects of plans and strategies for forest conservation and development at national and international levels as highlighted in chapter 11 of

UNCED's Agenda 21. The Committee recognized the increasing amount and complexity of information required on forest resources and the difficulty of compiling it at national, regional and global levels and assessing the changes over time.

The Committee (COFO-93) considered that continuous forest resource assessment at global level was, and continued to be, a fundamental task of FAO and stressed the need for the Organization to give it higher priority in its Regular Programme.

Policy implications of the results

Further analysis will be necessary in order to determine what could be the most appropriate policy responses to this latest information on the temperate-zone forest resource, especially since they may well differ from one region to another or even between different countries of the region.

The Timber Committee at its 50th session in October 1992 warmly welcomed publications of the 1990 Assessment (ECE/TIM/60 and 62) and confirmed that the joint session with the FAO European Forestry Commission to be held in October 1993 should include as a main topic on its agenda the policy implications of the results and findings of the temperate-zone part of the Global Forest Resource Assessment 1990.

A study on policy implications based on the results of the temperate-zone part of the Assessment is being undertaken by the European Forest Institute (EFI) at the request of the ECE/FAO secretariat and it will be presented together with a background paper on the subject for consideration to the forthcoming joint session of the UN-ECE Timber Committee and the FAO European Forestry Commission. A brief note by the secretariat will also be prepared on this topic for the Joint session to be held in October.

A study on the outlook for the non-wood goods and services

In accordance with the decision of the eighteenth session of the Joint ECE/FAO Working Party on Forest Economics and Statistics and as a follow-up to the 1990 Forest Resource Assessment, the *ad hoc* meeting to examine the feasibility of carrying out a study on the outlook for non-wood goods and services of forests was held in February 1993 in Geneva. The outcome and proposals of this meeting will be considered at the next Joint ECE/FAO Working Party session to be held in June 1993.

FAO/ECE meeting of expert on Global Forest Resource Assessment 2000 (Kotka, Finland, 3–7 May 1993)

The Joint ECE/FAO Working Party on Forest Economics and Statistics at its eighteenth session in August 1991 had agreed to convene a new FAO/ECE meeting of experts to review future information needs and to draw up recommendations and proposals for the scope and

contents of the next 2000 Assessment. The Timber Committee, at its 50th session, held in October 1992, approved this proposal and welcomed the offer of Finland to organize the meeting (ECE/TIM/62). At the kind invitation of Finland the meeting was scheduled to be held from 3 to 7 May 1993 in Kotka.

Among the key issues on the Provisional Agenda of the meeting are:

- the status of forest inventory worldwide
- presentation of the 1990 Forest Resource Assessment
- future forest resources information needs
- environmental parameters for future global forest assessments
- definitions and classifications
- major methodological features of global forest resource assessment.

The outcome and recommendations of the "Kotka-II" meeting, which has been taking place shortly before the 19th Working Party session, will be presented by the secretariat under item 2 (b) of the Provisional Agenda of this session on the basis of the meeting's report.

Study of long-term historical changes of the forest resource

The Joint ECE/FAO Working Party on Forest Economics and Statistics at its eighteenth session in August 1991 (TIM/ECE/WP.2/21) agreed that a project should be undertaken to investigate the long-term historical changes to the forest resources and the factors involved, in the industrialised temperate zone countries. To initiate work, the secretariat has engaged a consultant from France to draw up proposals for carrying it out and, more specifically, the preparation of a number of country case studies which could be brought together in a report that could be submitted to the joint ECE Timber Committee and the FAO European Forestry Commission in October 1993. It was presumed that this report could provide a useful complement to the discussion on policy implications of the forest resource assessment.

The development of the project will be discussed under item 2 (c) of the Provisional Agenda of the 19th session of the Joint ECE/FAO Working Party.

Forest resources of newly constituted countries

At its 50th session in October 1992 the ECE Timber Committee noted the need to collect and disseminate forest resource data of the newly constituted countries of central and eastern Europe in transition. It requested the secretariat to send out to these countries a simple questionnaire to collect essential forest resource data from these ECE countries.

The concise one-page enquiry in the form of the "Table of essential data" was sent out by the secretariat in January 1993 to 10 newly constituted ECE countries, considered to be in a position to respond to this shortened enquiry. The countries were asked to complete and return the enquiry to the secretariat by 31 March 1993. By the time of

writing this note there had been received replies from 3 countries. The session will be informed on the development of the project and on a possibility to issue forest resource data on the newly constituted countries as a supplement to the 1990 Assessment.

Proposals for future activities on Forest Resource Assessments

A number of proposals have been generated in the course of internal discussions. They are set out below for the comments of the 19th session of the Working Party, which should agree on recommendations for future work, based on this document and on the results of the "Kotka-II" meeting.

A team of specialists should be established with the task of formulating proposals and recommendations for the possible methodologies and ways of the practical implementation of the boreal and temperate zones' parts (industrialized countries) of the Forest Resource Assessment 2000. The team of specialists should also prepare in good time (by 1995 at the latest) recommendations to the national authorities responsible for forest inventories for the scope and contents of the 2000 Assessment. The proposals should be based on the results of the 1990 Assessment, findings of the "Kotka-II" meeting and proposals and recommendations of the 19th session of the Joint Working Party.

A network of national correspondents and experts of the industrialised countries of the ECE region should officially be re-established by the mid-1994 and maintained with the purpose of close cooperation with the team of specialists in the implementation of the next Forest Resource Assessment 2000.

To meet the need for on-going monitoring of changes, including bio-diversity, biomass, land cover and land use aspects, consideration should be given to the establishment of a system for the regular collection and dissemination of statistics on planting, replanting, fellings, disease (forest health), fires, other types of forest damage and forest decline (forest quality).

Possibilities for the collection of forest resource statistics of the industrialized boreal and temperate zone' countries on a continuing basis and the establishment of a computerized data base should be considered as well as setting up a system to feed in the results of new national (inventories) assessments as they become available. Statistics in this data base should be easily accessible to member countries in a computer readable form or through print-out of revisions.

An Overview of Forest Resources Assessment 1990: Tropical Countries

1. Introduction

The status and condition of the world's forests have become a source of increasing concern to the international community. In keeping with its mandate, FAO launched the present assessment for the reference year 1990 to provide current and objective information about the existing conditions of the world's forest resources. The work of the global assessment for 1990 comprises two main components: the survey of forest resources of the developed countries, coordinated by the FAO/ECE Agriculture and Timber Division in Geneva; and assessment of the forest resources of the developing world, carried out by the Forest Resources Assessment 1990 Project (further referred to as the Project) at FAO Headquarters[1]. The assessment work for the developing world has been implemented in two parts: the first for the tropical zone and the second for the non-tropical zone.

This paper presents an overview of the methodology and findings of the tropical forest resource assessment.

The objectives of the tropical forest resources assessment were to:

(i) make an assessment of the forest resources of the tropical countries for the reference year 1990, and estimate changes that have taken place during 1981–1990;

(ii) prepare vegetation and eco-floristic zone maps, and integrate these with socio-economic data, the FAO soil map and the protected area map of IUCN/WCMC in the form of a Geographic Information System (GIS);

[1] The Forest Resources Assessment 1990 Project was supported by the Governments of Finland, France, Italy, the Netherlands, Sweden and Switzerland through a multi-donor trust fund. Major in-kind contributions were made by the Swedish University of Agricultural Sciences, the United States Forest Service and the World Conservation Monitoring Centre (Cambridge, U.K.) Personnel assistance was given trough the Associate Professional Officers scheme of the Governments of Belgium, Germany, the Netherlands, Sweden and the United States of America.

(iii) study the environmental impact of deforestation and forest degradation in the tropics;
(iv) disseminate the database and the methodology of assessment to the national and international institutions.

Objectives (i) and (ii) concern the building of an *information base*; objective (iii) concerns the building of a *knowledge base* on deforestation; and objective (iv) to the building of a national *institution base* for present and future forest resource assessment.

2. Methodology

The tropical forest resources assessment includes two complementary elements in its methodology. The first is based on existing survey data and the other based on remote sensing.

2.1 Assessment based on existing information

The methodology consists of the following three steps: (i) establishment of a database system; (ii) development of a deforestation model (or an adjustment function); and (iii) computation of results for the standard reference dates.

2.1.1 Establishment of a database

The data compiled by the Project consists of two categories:
(i) *Tabular (statistical) data at the sub-national level (province, state) including*:
- forest resources data
- population data
- socio-economic data

The Project prepared the *"Guidelines for assessment based on existing data"* in the three official FAO languages to compile the country statistics and bring them to a common concept and classification system. Using the guidelines, the country reports were reviewed and reliable information extracted, edited and stored as part of the Project database with the acronym FORIS which stands for Forest Resources Information System.

FORIS is a database as well as a database management system. It can be run in a PC environment using dBASE IV™. The data entering facility is designed to be user-friendly and builds on an easily applied menu-driven procedure. Only minimum computer knowledge is required in order to enter, correct and print the data. FORIS is a useful database and database management system for studies at national, regional and global levels.

(ii) *Map (geo-referenced) data, including:*
- vegetation types

– eco-floristic zones
– country and sub-national boundaries

Realising that deforestation is a location-specific process driven by, among other things, population pressure and environmental conditions (particularly the population carrying capacity of the area), demographic and ecological parameters were included in the database and integrated with the statistical data in the form of a geographic information system (GIS). From the beginning it was realised that a GIS was essential to handle statistical and spatial data from a variety of sources, in a variety of formats and in different projections. Moreover, the GIS was expected to serve as a major tool for processing location-specific information and to support studies on deforestation.

In the course of time, more spatial data were added in addition to those mentioned earlier including LANDSAT 4.5 World Reference System Grid, potential global and forest biomass, mean annual precipitation and bio-temperature, topography, protected areas, and vegetation map from NOAA/AVHRR satellite imagery (for some regions). These found use in various ways, to be discussed later.

2.1.2 Deforestation model

The forest cover data contained in FORIS refer to different periods and need to be brought for reporting purposes to the standard years, namely 1980 and 1990. This was done with the help of a deforestation

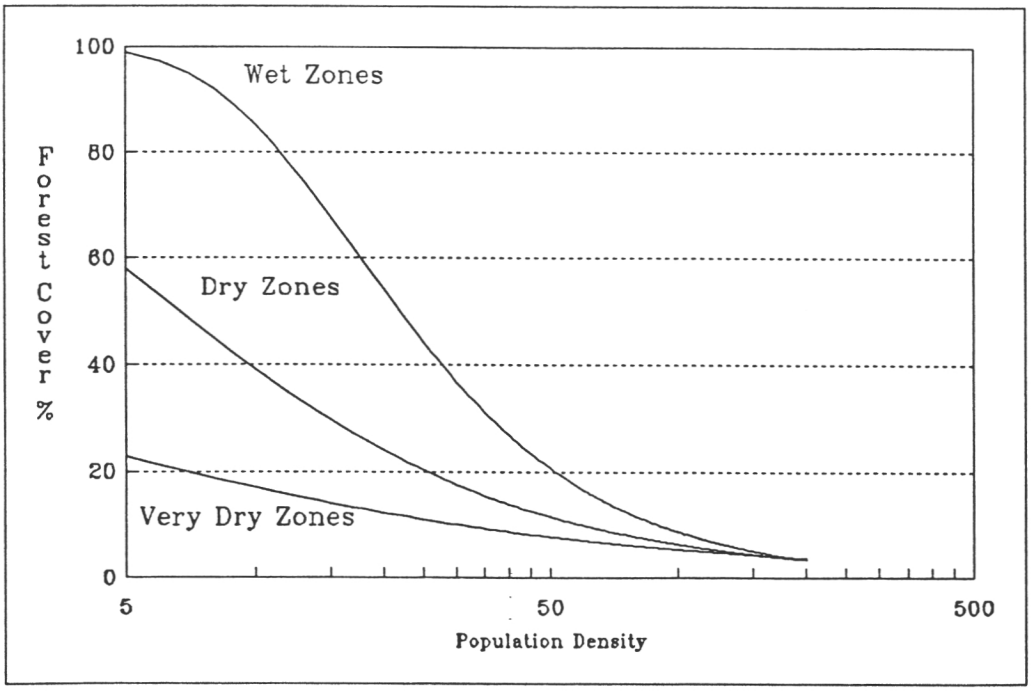

Figure 1
Illustration of model curves for different ecological zones

model (or a forest area adjustment function) which correlates forest cover change in time with other variables including population density and population growth for the corresponding period, initial forest cover area and the ecological zone under consideration. For developing the model only multi-date data at the sub-national units are used and the function is computed in the form of a differential equation. Figure 1 provides an idea of the shape of the function.

2.1.3 Estimation procedure

The FORIS database combined with the model can be used for (i) adjusting forest cover area of countries to the standard reference year 1990; and (ii) producing estimates of the forest cover change over the period 1981–90.

The estimation is performed at the lowest level (sub-national units in most cases). Appropriate procedures have been established for integrating the FORIS and GIS data to compute the model parameters for each unit and to provide forest cover in 1980 and 1990 as standardised output.

The model has proved to be a valid and flexible tool to estimate deforestation at a global level and to relate forest cover changes with demographic and ecological variables, the more so as existing reliable multi-date observations are still scarce.

2.2 Forest cover change assessment based on remote sensing

The Project has developed and operationalised a design for a continuous assessment of tropical forests using high resolution satellite data with the aim of achieving the highest level of consistency and precision in the assessment of forest cover changes through a simple and robust technique.

The Sample Survey Design for the Remote Sensing Component

The surveys is based on a sampling desingn covering all tropical countries. The World Reference System 2 (WRS2) for the LANSAT satellites is used as the sampling frame. LANSAT scenes covering approximately 3.4 million ha as the sampling unit.
A two stage stratified random sample is carried out. In the first stage the survey area is divided into sub-regions on a geographic basis. In the second stage the sub-regions are divided into forest cover strata. The allocation of samples to the sub-regions is made proportional to estimated deforestation. Within a sub-region, sampling units are selected with equal probability.

Inter-dependent Procedure of Interpretation of Remote Sensing Imagery

1. Image characteristics

- LANDSAT MSS (20% of recent images will be TM) and IRS *(Indian Remote Sensing Satellite)* satellite data
- Two dates, one close to 1990, one close to 1980, at least 5 years apart, same season (preferably beginning of dry season)
- Standard enhancement for vegetation assessment
- Common cloud-free overlay of one million ha minimum

2. Interpretation procedure

- Interdependent interpretation, viz. visual interpretation of both images by the same interpreter (coming from the region and familiar with the location) at same time
- Standard and globally compatible land use classification

3. Image Interpretation recording

- User-friendly data recording from dot grid using customized LOTUS 1-2-3® spreadsheet software
- Generation of change matrices showing land use changes

4. Field verification of selected samples in cooperation with National Forest Services and Remote Sensing Agencies

The survey design has been carried out with a sampling intensity of 10%. This will allow to coverage of the entire tropical zone on a ten year cycle. 117 samples were selected for the first survey round. At each sample location, two satellite images of the best quality and appropriate season, separated by a time interval of approximately ten years, were chosen for interpretation. The image close to 1990 enables state assessment; whereas the area in common between the 1990 and the 1980 images enables the change assessment.

The image interpretation has been done following standard procedures developed by the Project which assure conceptual, spatial and temporal consistency. A distinctive feature of the methodology lies in the fact that it provides not only annual estimates, but also change maps and matrices for each sample location. This allows the assessment of class to class changes of land use and forest categories between the two dates of interpretation which is essential for understanding the process of deforestation and forest degradation.

Satellite images were interpreted using the help of a number of regional and national remote sensing institutions. With the dual objectives of strengthening national capacities for forest cover monitor-

ing and improving the quality of image interpretation, the Project has organised three regional training workshops on the subject, benefitting 27 countries. The final results and quality of the output were centrally analysed and evaluated.

3. Findings

3.1 State of tropical forest inventories

Table 1
State of forest inventory in the tropics at end 1990

The country data, available in the form of statistical tables or maps, are one of the main sources of information for the global forest resources assessment and the direct determinant of its quality and content. Therefore, a review of the current state of the country forest inventories (see Table 1) is an appropriate starting point for discussion of the Project results.

Region	Number of countries under assessment	Number of countries with forest resources data at national level							
		Forest area information (number of assessments and reference years)				Other topics covered			
		No assessment	One assessment		More than one assessment	Forest conservation and management	Forest plantations	Volume and biomass	Forest harvesting and utilisation
			before 1981	1981-90					
Africa	40	3	23	12	2	4	8	2	4
Asia & Pacific	17	0	1	6	10	10	8	7	7
L. America & Caribbean	33	0	15	9	9	11	8	9	4
Total	**90**	**3**	**39**	**27**	**21**	**25**	**24**	**18**	**15**

Source: FORIS database of the Project

The findings of the Project on the current state of the country forest inventories can be summarised as follows:

- there is a wide variation among regions with respect to completeness and quality of the information with the Asia and Pacific region situation being better than the Latin America and Caribbean, and the latter better than the Africa region;
- there is also a wide variation in the timeliness of the information: the data is about ten years old, on average;
- even though some countries have carried out more than one assessment, these countries have not used appropriate techniques, such as Continuous Forest Inventory (CFI) design, for change assessment (repeating single shot inventories means more cost and less precision for the assessment of changes);
- no country has carried out a national forest inventory containing information that can be used to generate reliable estimates of the total woody

biomass volume and change. Only a few countries have reliable estimates of actual plantations, harvest and utilisation although such estimates are essential for national forestry planning and policy making.

The above findings confirm that forest resource assessment is a most neglected aspect of forest conservation and development in tropical countries and that considerable efforts in international cooperation are needed to enhance national capacities in this field, as called for in Agenda 21 of UNCED.

3.2 State of tropical forest resources

3.2.1 Terminology

Forests are defined as ecosystems with a minimum of 10% crown cover of trees and/or bamboos, generally associated with wild flora, fauna and natural soil conditions, and not subject to agricultural practices.

Deforestation refers to change of land use with depletion of tree crown cover to less than 10%. Changes within the forest class (from closed to open forest), which negatively affect the stand or site and, in particular, lower the production capacity, are termed *forest degradation*. Degradation is not reflected in the estimates.

The basis of ecological zoning are *eco-floristic zone* (EFZ) maps

Table 2
Estimates of forest cover area and rate of deforestation by geographical subregion

Geographic sub-region / region	Number of countries	Land area	Forest Cover		Annual Deforestation 1981-'91	
		million ha	1980 million ha	1990 million ha	million ha	% per annum
Africa	**40**	**2,236.1**	**568.6**	**527.6**	**4.1**	**0.7**
West Sahelian Africa	6	528.0	43.7	40.8	0.3	0.7
East Sahelian Africa	9	489.7	71.4	65.5	0.6	0.9
West Africa	8	203.8	61.5	55.6	0.6	1.0
Central Africa	6	398.3	215.5	204.1	1.1	0.5
Trop. Southern Africa	10	558.1	159.3	145.9	1.3	0.9
Insular Africa	1	58.2	17.1	15.8	0.1	0.8
Asia & Pacific	**17**	**892.1**	**349.6**	**310.6**	**3.9**	**1.2**
South Asia	6	412.2	69.4	63.9	0.6	0.8
Continental S.E. Asia	5	190.2	88.4	75.2	1.3	1.6
Insular S.E. Asia	5	244.4	154.7	135.4	1.9	1.3
Pacific	1	45.3	37.1	36.0	0.1	0.3
Latin America & Caribbean	**33**	**1,650.1**	**992.2**	**918.1**	**7.4**	**0.8**
C. America & Mexico	7	239.6	79.2	68.1	1.1	1.5
Caribbean	19	69.0	48.3	47.1	0.1	0.3
Tropical S. America	7	1,341.6	864.6	802.9	6.2	0.7
Total	90	4,778.3	1,910.4	1,756.3	15.4	0.8

Source: FORIS database

for South America, Africa and Asia and Pacific that were produced in the 1980s by FAO in cooperation with the French Institute for the International Vegetation Map. Both ecological parameters (such as climatic, physiographic and edaphic factors) and floristic parameters (dominant or characteristic forest species of indigenous flora) have been used for mapping of the eco-floristic zones. For each region approximately 50–60 classes have been delimited.

For presentation of the overall results, the Project has grouped the above eco-floristic zones into six broad ecological zones (one upland and five lowland).

3.2.2 Main results

Table 2 provides figures by geographic sub-region. The *pan-tropical forest cover* at end 1990 was 1756 million ha and 1910 million ha at end 1980 (this latter figure replaces the earlier estimate of 1935 million ha provided by the 1980 FAO/UNEP Tropical Forest Resources Assessment project). Thus, average annual deforestation during the past decade amounts to 15.4 million ha (0.8% in compound annual rate of deforestation). The largest extent of forest cover was in Latin America and Caribbean (918 million ha: 52% of the total tropical forest area), followed by Africa (528 million ha: 30%), and Asia and Pacific (311 million ha: 18%). The annual loss of forest cover by region was: Latin America and Caribbean 7.4 million ha (0.8%), Asia and Pacific 3.9 million ha (1.2%) and Africa 4.1 million ha (0.7%).

Table 3 provides results by ecological zone. At end 1990 lowland formations were 1544 million ha (88% of the total tropical forest area) and upland (hill and montane) formations 204 million ha (12%). Among the lowland formations, the tropical rainforests constituted the biggest portion, viz. 718 million ha (or 41%), the moist deciduous forests 587 million ha (33%) and the dry and very dry zone forests 238 million ha (14%). The rest of the forests, nearly 8 million ha, were scattered in the non-forest zone. The annual loss of forest cover by ecological zone were: the tropical rainforests 4.6 million ha (0.6%), the moist deciduous forests 6.1 million ha (1.0%), the dry and very dry zone forests 2.2 million ha (0.9%) and the upland formations 2.5 million ha (1.1%).

Among the ecological zones the moist and upland forest formations had higher than the average deforestation rate.

Comparing the forest area to land area ratio for each ecological zone it appears that 76% of the tropical rainforest zone is still covered with forest. As can be expected, the percentage of forest cover declines with drier conditions and differences are quite obvious: 46% are forested in the moist deciduous, 30% in the dry deciduous and 19% for the dry and very dry zones together. One can assume that in the very dry zone the original forest area was considerably less than 100% of the total land area. This is in contrast to the rainforest and moist zones where the original forest area was close to 100%.

Ecological zone	Land area	Population density 1990	Annual pop. growth 1981-90[1]	Forest cover 1990		Annual deforestation 1981-90[1]	
	million ha	inh / km^2	% per annum	million ha	% land area	million ha	% per annum
FOREST FORMATIONS	**4,186.4**	**57**	**2.4**	**1,748.2**	**42**	**15.3**	**0.8**
Lowland formations	**3,485.6**	**57**	**2.3**	**1,543.9**	**44**	**12.8**	**0.8**
Rainforest	947.2	41	2.2	718.3	76	4.6	0.6
Moist deciduous	1,289.2	55	2.4	587.3	46	6.1	1.0
Dry and very dry	1,249.2	70	2.3	238.3	19	2.2	0.9
Upland formations (hill and mountain forest)	**700.9**	**56**	**2.6**	**204.3**	**29**	**2.5**	**1.1**
NON-FOREST ZONE (Alpine areas, deserts)	**591.9**	**15**	**3.1**	**8.1**	**1**	**0.1**	**1.0**
TOTAL TROPICS [2]	**4,778.3**	**52**	**2.4**	**1,756.3**	**37**	**15.4**	**0.8**

Notes:
1/ Compound interest formulae were used for population growth and deforestation rate calculations.
2/ Totals may not tally due to rounding.
Source: FORIS database

Table 3
Estimates of forest cover area and rate of deforestation by main ecological zone

3.3 The state of tropical forest management

3.3.1 Forest management mainly for wood production

Forest management can be said to have begun when a forest area is demarcated and set aside to be managed for future production of forestry goods and services. Further progressive steps include: inventory of site and stand, preparation of a management plan and control, application of logging operations and silvicultural treatments. Activities involving the development of the needed institutional infrastructure and capacities also form a part of it.

Since 1980 a number of studies on the status of forest management in the tropics have been carried out by FAO and the International Tropical Timber Organization (ITTO). According to an ITTO report published in 1988: "The area of tropical moist forests outside South Asia, which is demonstrably under sustained yield management, amounted, at the very most, to about 1 million ha and has now been reduced by about one fifth on environmental grounds. In the South Asia sub-region 59 million ha were reported to be covered by regular working plans, but under slow degradation due to heavy pressure of grazing and fuelwood removals by the local population. The reports of ITTO and FAO present on the whole a bleak picture of the overall state of natural forest management during the decade 1981 to 1990.

Timber harvesting from tropical (broadleaved) forests

Figure 2 illustrates the trends in annual production of non-coniferous industrial roundwood (sawlogs and veneerlogs) in the three tropical

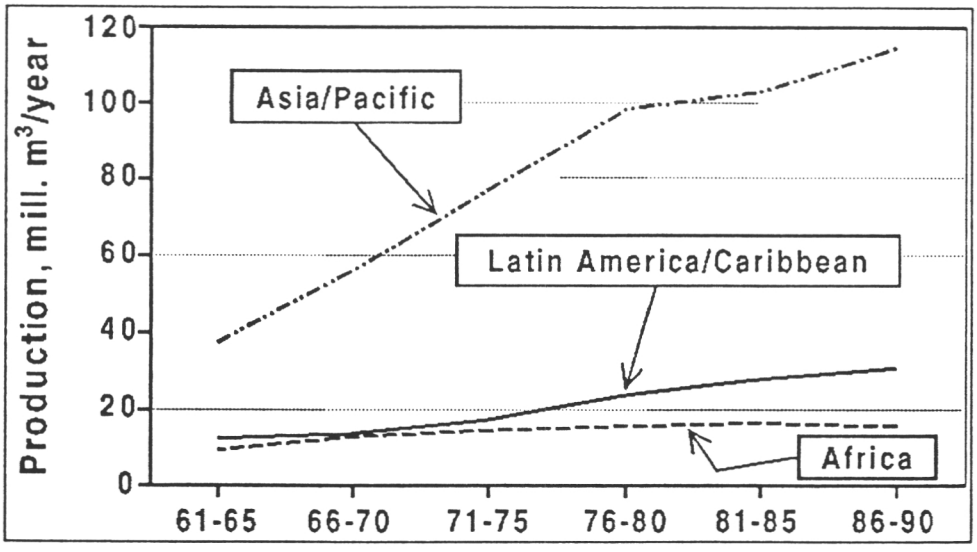

Figure 2
Trends in average annual production of non-coniferous industrial roundwood (sawlogs and veneer logs only) in the three major regions of the tropics, 1961–90

regions from 1961 to 1990, levelling off in Africa, slight but steady increase in Latin America and Caribbean and steep and steady increase in Asia and Pacific.

Table 4 provides information on harvesting intensity and harvested areas by region. The statistics presented by five year period starting from 1961 indicate the trend in the area of broadleaved forest on which industrial timber harvesting operations take place annually in the three major regions of the tropics. In addition to the total area harvested, information is presented on the estimated areas of previously unlogged and previously logged forests. All three regions exhibit a slow but steady increase in the share of harvesting operations that occur in secondary forest. This effect is due partly to the fact that less primary forest remains each year, but it also results partly from the fact that changing markets increasingly improve the economic feasibility of re-logging areas that were harvested two or more decades previously. This is especially true with respect to the increase in market acceptability of "lesser known" tree species. Although the increase is seldom dramatic, it is relatively steady and over a period of decades the effect is significant.

Table 4 and Figure 2 read together, illustrate regional differences in the annual area harvested and the stocking density of commercial species. As an example, even though the *volume* of non-coniferous sawlogs and veneerlogs produced annually in the Asia and Pacific region during 1986–90 was 3.7 times the comparable volume produced in the Latin America and Caribbean region, the estimated *total area harvested* in tropical Asia is only 89% of that in tropical America. This is due to the fact that the average commercial timber harvest volume per unit area in the Asia and Pacific region during 1986–90 is estimated to be about 33 m^3/ha compared to an average of only about 8 m^3/ha in the Latin America and Caribbean region.

Period	Africa			Asia and the Pacific			Latin America and the Caribbean			All tropical countries		
	Average harvest intensity (m^3/ha)	Area of forest harvested annually ('000 ha)		Average harvest intensity (m^3/ha)	Area of forest harvested annually ('000 ha)		Average harvest intensity (m^3/ha)	Area of forest harvested annually ('000 ha)		Average harvest intensity (m^3/ha)	Area of forest harvested annually ('000 ha)	
		Primary forest	Secondary forest		Primary forest	Secondary forest		Primary forest	Secondary forest		Primary forest	Secondary forest
61-65	14	394	91	42	510	78	7	1,247	57	17	2,152	226
66-70	14	506	137	43	750	135	8	1,260	76	20	2,516	348
71-75	14	593	166	35	1,343	221	8	1,485	119	20	3,422	505
76-80	14	612	215	33	1,732	319	8	2,011	183	19	4,356	717
81-85	14	634	239	32	1,718	369	8	2,297	251	18	4,648	859
86-90	13	723	248	33	1,861	453	8	2,287	320	19	4,871	1,020

Table 4
Estimated harvesting intensities and areas of broad-leaved forest harvested annually in the three major regions of the tropics, 1961–90

3.3.2 Forest management mainly for conservation

The term "*conservation area*" has been used instead of "*protected area*" and is defined as "an area of land managed through legal or customary regimes so as to protect and maintain biological diversity and natural and associated cultural resources" (this definition was agreed at the IV World Congress on National Parks and Protected Areas, Caracas, 10–12 February 1992.

The World Conservation Monitoring Centre (WCMC) carried out a survey of conservation areas in the tropics within the framework of the Project. Table 5 summarises the findings of this assessment at regional and global levels.

The table provides also a breakdown by types of managing institutions, e.g. national forest administrations, national wildlife administrations and other institutions.

The data in this assessment suggest that a significant proportion of the tropics is under management for conservation or protection. The quantitative information must be tempered, however, by a realistic appraisal of on-the-ground management effectiveness and the threats to existing sites. Throughout the tropics there tends to be inadequate legislation and ineffective application of the legal measures that do exist. Weak institutional support, management that is frequently deficient or even non-existent and inadequate funding are also ubiquitous. Consequently, there is a strong tendency towards 'paper parks' whose existence is largely theoretical and is not reflected by substantive and durable conservation reserves on the ground. Furthermore, those sites that do exist are under increasing pressure from competing land uses.

Despite the seemingly encouraging picture that emerges from the data, it is often impossible to know whether or not a conservation area network is representative, particularly in terms of biodiversity. A special survey conducted by WCMC shows that out of 8,715 conservation areas only 5% are known to have been inventoried for one or more taxonomic groups. Conservation areas have frequently been

Region	Conservation areas in forestry, wildlife and additional sectors				
	Forestry	Wildlife	Others	All	
	Area million ha.	Area million ha.	Area million ha.	Area million ha.	Land proportion %
Africa	25.9	197.7	0.6	224.2	10.0
Asia & Pacific	70.5	55.6	0.8	126.9	14.2
L. America & Caribbean	116.5	118.4	120.7	355.6	21.5
Total	**212.9**	**371.7**	**122.1**	**706.7**	**14.8**

Source:Assessing the Conservation Status of the World's Tropical Forest; WCMC, a contribution to the FAO FRA 1990 Project

Table 5
Number and extent of conservation areas in the forestry, wildlife and other sectors

established with little or no regard to ecological criteria for their selection. Continuing and growing pressure on land throughout the tropics, particularly in densely populated Asian nations, has forced the selection of conservation areas to be made on pragmatic and not necessarily scientific grounds.

Conservation areas have become increasingly isolated, and they should be theoretically as large as possible to maximise the degree to which their contents retain their integrity. Thus, the effectiveness of a conservation area network in maintaining biological diversity will partly be a function of the size of its constituent units. For example, conservation areas need to be large enough to support minimum viable populations of key species. These should contain, accordingly to WCMC, at least 500 genetically effective individuals, including juveniles and non-breeders. The optimal size of a conservation area will vary with respect to the key species under protection, but conservation areas for ungulates or carnivores at the top of their food chain generally require that areas extend over several tens or hundreds of thousands of hectares.

3.4 Forest plantations

A detailed review of plantation area was conducted by the Project in cooperation with the Swedish Royal College of Forestry. According to this study the total plantation area reported in 90 countries of the tropical zone amounts to a total of 43.9 million ha as at end of 1990 (see table 6). Tropical Asia and Pacific has the largest share with 73% and the remainder is distributed between tropical America (20%) and tropical Africa (7%). The five countries having the largest reported area under plantation, constituting about 85% of the tropical plantations, are India (18.9 million ha), Indonesia (8.8 million ha), Brazil (7.0 million ha), Vietnam (2.1 million ha) and Thailand (0.8 million ha).

Region	No. of countries under assessment	Reported plantation area at 1990			Estimated net plantation area	Area planted annually	
		Industrial plantations	Non-industrial plantations	Total reported area		Reported	Estimated net
Africa	40	1,400	1,600	3,000	2,100	130	90
Asia & Pacific	17	9,100	23,100	32,200	22,600	2,100	1,470
Latin America & Caribbean	33	5,100	3,500	8,600	6,000	370	260
Total	**90**	**15,600**	**28,200**	**43,800**	**30,700**	**2,610**	**1,820**

Source FORIS database

Table 6
Reported and net forest plantation areas in the tropics at 1990 (in '000 ha.)

During 1981–90 there has been considerable development in non-industrial plantations in the form of tree planting and by agroforestry. Cultivating trees with agricultural crops and growing woodlots outside gazetted forests has gained momentum in the last decade. In order to estimate the planted area outside the traditional forests, many countries have fixed national criteria to convert seedlings raised in the nurseries and distributed or planted, into area. No entirely consistent estimates can be made at global level for these forms of tree planting.

Survival rates calculated from 56 plantation inventories in 18 tropical countries have been used to determine the same rate at global level which is just about 70%. Applying this latter factor to the reported plantation area gives a *net* total plantation area in the tropics of *30.7 million ha* as at end 1990.

About 60% of the reported plantations have been established during 1981–90, in other words the increase in plantation area during the ten years over the estimate of 1980 is about 150%. The average annual plantation area in the tropics reported during the decade 1981–90 was about 2.61 million ha, corresponding to a net plantation area of 1.80 million ha.

The main species planted are eucalyptus, pines, teak and acacias. While pines and teak are planted mostly for industrial purposes, eucalyptus are planted for both industrial and non-industrial purposes and acacias mainly serve for fuelwood and gum arabic production.

3.5 Non-forest plantations

Non-forest plantations have become a potential source of wood due to increasing demand and improved technology. Area information about non-forest plantations is available essentially for tropical Asia (Indonesia, Malaysia and Thailand) which contains most of the non-forest plantations of the tropical world (as is confirmed by the fact that about 85% of the world's production of rubber, coconut oil and palm oil comes from this region – FAO Production Yearbook 1991). Of the total area of 14 million ha, rubber occupies 7.2 million ha and the rest are coconut (4.2 million ha) and oil palm (2.7 million ha).

Summary of Results for the Temperate Zones

Eleventh Session of the Committee on Forestry (Rome, 8–12 March 1993)

Forest Resources Assessment 1990

The Forest Resource Assessment *temperate zones* constitutes an integral part of the Global Forest Resource Assessment 1990. It was carried out jointly by FAO and UN-ECE by means of a detailed enquiry. The geographic coverage of the 1990 temperate-zone Assessment includes the member countries of the ECE region (Europe, former USSR, USA and Canada) as well as three other developed temperate-zone countries (Australia, Japan and New Zealand).

The *results of the Assessment 1990* are being published 1992/93 in two separate volumes (ECE/TIM/62): I General Forest Resource Information and II Benefits and Functions of the Forest. The "main findings of the UN-ECE/FAO 1990 Forest Resource Assessment" had already been published earlier (ECE/TIM/60), just before the UNCED Conference (Rio, June 1992). This Forest Resource Assessment (Temperate zones) 1990 has resulted in a more complete, better founded set of data than was possible in previous surveys. The main findings of the assessment are:

The *area of forest* for the industrialized countries concerned is 1.43 billion hectares or nearly 27% of land area. However, the *share of forest* varies considerably at the country level, ranging from 66% in Finland and Japan down to about 5% in Ireland and Israel.

The total *net annual increment* (NAI) on *exploitable forest* in Europe amounted to 577 million o.b., in the former USSR countries to 700 million m3 o.b., and for the United States and Canada is estimated around 640 and 210 million m^3 respectively. Total *fellings* in the industrialized countries around 1990 are estimated at 1.86 billion m^3 o.b.

The *relationship* between *fellings* and *net annual increment* gives a good indication of the evolution of the forest resources. The 1990 Assessment has clearly indicated that in almost all temperate-zone industrialized countries net annual increment has been higher than fellings over many years, and consequently there has been a *rise in growing stock* even though many countries have reported an increas-

ing trend in fellings.

Of the main findings, two stand out as being common to most of the countries in the temperate regions, so far as their significance for the long term and likely implications for policy are concerned. They are the *continuing expansion of the temperate forest resource* and the *increasing relative and absolute importance of the non-wood functions of the forest.*

Further analysis will be *necessary* in order to determine what could be the most appropriate policy responses to this latest information on the temperate forest resource, especially since they may well differ from one country to another. A study on policy implications based on the results of the temperate-zone Forest Resource Assessment is being undertaken and a paper will be presented for consideration to the forthcoming joint session of the FAO European Forestry Commission and the UN-ECE Timber Committee in October 1993.

Forest damage and threats to the forest ecosystem of temperate-zones (as well as the state of *health* of the forest resource and its *quality*) have not been dealt with specifically in the 1990 Assessment. Consequently, date available from other sources on, for example, forest decline, forest fires and storm damage, need to be taken into account when analysis of the results of the 1990 Forest Resource Assessment (temperate-zones) is undertaken.

[1] The Forest Resources Assessment 1990 Project was supported by the Governments of Finland, France, Italy, the Netherlands, Sweden and Switzerland through a multi-donor trust fund. Major in-kind contributions were made by the Swedish University of Agricultural Sciences, the United States Forest Service and the World Conservation Monitoring Centre (Cambridge, U.K.). Personnel assistance was given through the Associate Professional Officers scheme of the Governments of Belgium, Germany, the Netherlands, Sweden and the United States of America.

Summary table
Population and land classification

Countries	Year(s) covered	Population	Land area (excluding inland waters)	Forest		Forest and other wooded land
				Total	of which: privately owned	
		(thousand)	(thousand hectares)			
Albania	1990	3 250	2 775	1 046	-	& 1 449
Austria	1986 - 1990	7 710	8 254	3 877	3 174	3 877
Belgium	1980	9 840	3 025	620	347	620
Bulgaria	1990	9 010	11 019	3 386	..	3 683
Cyprus	1990	700	916	140	c/ 13	280
CSFR	1988	15 660	12 540	4 491	482	4 491
Denmark	1979	5 140	& 4 253	466	339	& 466
Finland	1980 - 1989	4 990	30 462	20 112	14 837	23 373
France	1976 - 1988	56 440	54 325	13 110	9 544	14 155
Germany, of which	1987 - 1989	a/ 79 880	a/ 34 934	a/ 10 490	..	a/ 10 735
former German Dem. Rep.	1988 - 1989	16 650	10 522	& 2 938	& 894	& 2 981
former Germany, Fed. Rep.	1987 - 1989	63 230	24 412	7 552	3 460	7 754
Greece	1964	10 050	12 926	2 512	567	6 032
Hungary	1990	10 550	9 213	1 675	9	1 675
Iceland	1970 - 1985	250	8 844	b/ 11	..	134
Ireland	1989	3 500	6 890	396	62	429
Israel	1989 - 1990	4 660	2 031	102	2	124
Italy	1988	57 660	30 128	6 750	4 052	8 550
Luxembourg	1989	370	257	85	46	87
Netherlands	1982 - 1985	14 940	3 392	& 334	175	& 334
Norway	1980 - 1986	4 240	30 688	8 697	7 305	9 565
Poland	1989	38 180	30 445	8 672	1 471	8 672
Portugal	1980 - 1986	10 530	8 655	2 755	2 491	3 102
Romania	1990	23 200	22 954	6 190	-	6 265
Spain	1990	38 960	49 937	8 388	5 138	25 622
Sweden	1985 - 1989	8 560	40 823	24 437	17 399	28 015
Switzerland	1983 - 1985	6 710	3 976	1 130	364	& 1 186
Turkey	1990	58 690	77 079	8 856	44	20 199
United Kingdom	1988 - 1989	57 410	24 086	2 207	1 261	2 380
Yugoslavia	1987 - 1988	23 810	25 540	8 370	a/ 2 626	9 453
Total: Europe		**564 890**	**550 367**	**149 305**	a/ **76 102**	**194 953**
former USSR, of which	1988	288 590	2 138 999	754 958	-	941 530
Belarus	1988	a/ 10 200	a/ 20 700	6 016	-	6 256
Ukraine	1988	a/ 51 700	57 955	9 213	-	& 9 239
Canada	1986	26 520	921 500	247 164	23 007	453 300
United States of America	1987	249 970	& 913 658	& 209 573	150 448	295 989
Total: North America		**276 490**	**1 835 158**	**456 737**	**173 455**	**749 289**
Japan	1985	⊙ 123 540	36 460	& 24 158	13 964	& 24 718
Australia	1990	17 090	754 402	39 837	11 445	a/ 145 613
New Zealand, of which	1987 - 1989	3 350	26 784	7 472	a/ 1 924	7 472
plantations	1989			1 244	601	1 244
natural forest	1987			6 228	1 323	6 228
Total: Other		**143 980**	**817 646**	**71 467**	**27 333**	a/ **177 803**
GRAND TOTAL:		**1 273 950**	**5 342 170**	**1 432 467**	a/ **276 890**	a **2 063 575**

Summary table
Population and
land classification

a/ – Secretariat estimates
b/ – Natural forest area only
c/ – Abandoned agricultural land colonized by forest (trees)
&/– See notes in the country files in ECE/TIM/62, Vol.I, rart II

Summary of Final Results for the Tropical World

Eleventh Session of the Committee on Forestry (Rome, 8–12 March 1993)

Forest Resources Assessment 1990

FAO started the assessment work in March 1989 with the support of a multi-donor trust fund to provide reliable and globally consistent information on the state of the tropical forests at end 1990, rates of change during 1981–90 and to undertake studies on the process of deforestation and forest degradation.

The assessment covering 90 countries was carried out in two phases. The available statistical information on forest cover area, growing stock, management, conservation and utilisation of forests was first compiled and incorporated into a database. The spatial information on vegetation cover, ecological zones and administrative boundaries at sub-national level was scanned, edited and integrated with the statistical data in the form of a geographic information system. The collected data were used to build a deforestation model, to estimate forest cover area at end 1990 and rates of change during 1981–90.

In addition, a remote sensing based survey of the tropical forests using high resolution satellite data of two dates, one close to 1980 and the other dose to 1990, was implemented at 117 sample locations. State and change information was interpreted and stored in the form of change matrices following the standard procedure developed. These data were analysed to obtain in-depth knowledge of the process of deforestation and forest degradation on the sample locations, by geographic sub-region and ecological zone.

Table 1 provides figures by geographic sub-region. The pan-tropical forest cover at end 1990 was 1756 million ha and 1910 million ha at end 1980 (this latter figure replaces the earlier estimate of 1935 million ha provided by the 1980 FAO/UNEP Tropical Forest Resources Assessment project). Thus, average annual deforestation during the past decade amounts to 15.4 million ha (0.8% in compound annual rate of deforestation). The largest extent of forest cover was in Latin America and Caribbean (918 million ha: 52% of the total tropical forest area), followed by Africa (528 million ha: 30%), and Asia and Pacific (311 million ha: 18%). The annual loss of forest cover by region was: Latin America and Caribbean 7.4 million ha

(0.8%), Asia and Pacific 3.9 million ha (1.2%) and Africa 4.1 million ha (0.7%).

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Thus, among the ecological zones, deforestation rates were higher than the average in the moist and upland forest formations; and among the geographic sub-regions in Central America and Mexico, Continental South East Asia and West Africa.

The reported area of forest plantations in the tropics at end 1990 was 43.9 million ha and the net area 30.7 million ha (viz. 70%). During 1981 to 1990 the reported forest plantations area increased annually on average by 2.6 million ha and the net area by 1.8 million ha. Thus, the deforested area was about 8.5 times the net planted area.

The work has clearly revealed that a great majority of the tropical countries have insufficient institutional capacity to collect and analyse data on a continuous basis. Assessment and monitoring is a neglected component of forest resource management, conservation and development It rightly deserved to be included as a full-fledged programme area in Agenda 21 of UNCED.

Table 1. Estimates of forest cover area and deforestation by geographical sub-region

Geographic subregion / region	Number of countries	Land area	Forest cover		Annual deforestation 1981-90	
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South Asia	6	412.2	69.4	63.9	0.6	0.8
Continental S.E. Asia	5	190.2	88.4	75.2	1.3	1.6
Insular S.E. Asia	5	244.4	154.7	135.4	1.9	1.3
Pacific	1	45.3	37.1	36.0	0.1	0.3
Latin America & Caribbean	**33**	**1,650.1**	**992.2**	**918.1**	**7.4**	**0.8**
C. America & Mexico	7	239.6	79.2	68.1	1.1	1.5
Caribbean	19	69.0	48.3	47.1	0.1	0.3
Trop. South America	7	1,341.6	864.6	802.9	6.2	0.7
Total	90	4,778.3	1,910.4	1,756.3	15.4	0.8

Ecological zone	Land Area	Population Density 1990	Ann. Pop. Growth 1981-'90	Forest Cover 1990		Annual Deforestation 1981-'90	
	million ha	inh / km²	% per annum	million ha	% land area	million ha	% per annum
FOREST ZONE	**4,186.4**	**57**	**2.4**	**1,748.2**	**42**	**15.3**	**0.8**
Lowland Formations	3,485.6	57	2.3	1,543.9	44	12.8	0.8
Rainforest	947.2	41	2.2	718.3	76	4.6	0.6
Moist deciduous	1,289.2	55	2.4	587.3	46	6.1	1.0
Dry and very dry	1,249.2	70	2.3	238.3	19	2.2	0.9
Upland Formations (hill and mountain forest)	700.9	56	2.6	204.3	29	2.5	1.1
NON-FOREST ZONE (Alpine areas, deserts)	**591.9**	**15**	**3.1**	**8.1**	**1**	**0.1**	**1.0**
TOTAL TROPICS	**4,778.3**	**52**	**2.4**	**1,756.3**	**37**	**15.4**	**0.8**

– Totals may not tally due to rounding
– Compound interest formulae used for population growth and deforestation rate calculations

Table 2.
Estimates of forest cover area and deforestation by ecological zone

Agenda Item 6

Developments Related to Future Forest Resources Assessment and Related Activities of Other Organizations

ECE/FAO enquiry into future forest resources information needs covering the industrialized countries [1]

Background

At its 17th session in December 1989, the Joint FAO/ECE Working Party on Forest Economics and Statistics discussed the results of the second *ad hoc* meeting of experts on global forest resource assessment, which had been held as a satellite meeting to the IUFRO Conference on Global Natural Resource Monitoring and Assessment: Preparing for the 21st century (Venice, Italy, September 1989). The *ad hoc* meeting had considered the sort of information that will be needed in future international assessments, more specifically of the temperate zone forest resource. The ECE/FAO secretariat was asked to prepare a paper as a basis of discussions on the subject.

The paper "*How should we develop the 1990 FAO/ECE Temperate-zone assessment to meet user needs in the 2000 Assessment*" was prepared by *Mr. T.J. Peck*, the former Director of the ECE/FAO Agriculture and Timber Division, and presented to the Working Party (document TIM/ECE/WP.2/R.104/Add.1).

In this paper there were formulated, in particular, the following "*principles underlying the choice of data to be included*":

(1) The additional data should be of value to users at the international level, and not just at the national level;

(2) The large majority of countries should be willing and able to supply the data;

(3) There should be a positive benefit: cost ratio, i.e. the value of the collected information should be greater than the costs involved in its collection;

(4) The introduction of new items should not result in a break in the statistical continuity with previous enquiries.

[1] - The ECE/FAO secretariat would like to express its thanks to the former Director of the ECE/FAO Agriculture and Timber Division, *Mr. T. J. Peck* for his work on this document.

The following categories were proposed in *Mr. Peck's* paper as a basis for discussion (without any particular order of priority) :

- (1) Site quality,
- (2) Stand density,
- (3) Economic accessibility,
- (4) Wood quality of growing stock,
- (5) Forest health and forest damage,
- (6) Statistics on change,
- (7) Quantification of the environmental and other non-wood benefits,
- (8) Evaluation of the forest resource.

It was noted that each of categories should be evaluated on the basis of the principals for collecting information at the international level, either those set out above (para 3) or others that may be agreed upon.

Some thoughts were given in the paper to possible methods of data collection and presentation. It was noted, in particular, that "consideration of the type of data that could and should be added to future international forest resource assessments should also take into account the latest technological developments that would improve the quality of the results, the way in which they are presented and the costs of producing them".

Some additional view points with respect to the forest resource assessment 2000 in the temperate zone were presented to the Joint ECE/FAO Working party by *Mr. Klaus Janz*. He noted in particular that "specific emphasis should be given to promoting the use of international forest resource data".

Possible promotional activities could be:

- Demonstrate examples of policy applications, e.g. analyze the consequences of alternative policies with respect to rotation ages, given the present age structure of forest area and growing stock;
- Communicate with users. A dialogue will produce knowledge about the information needs of users and will make users aware of the information available. It may also improve the flow of statistical information from countries to the secretariat;
- Members from the secretariat should visit countries in order to introduce the matter, collect views and ensure cooperation.
- Country correspondents should be encouraged to establish a net of well selected contacts within their countries. Reports from meetings and status reports, for example, on ongoing resource assessment should be distributed to the contact persons and the views of the contact person on various matters should be requested. After such a procedure the final publication of the final publication of assessment results will be an expected or even eagerly-awaited product.

Mr. *K. Janz* stressed the preferability of quality of international forest resource assessments to quantity. It was noted that "the possibilities for the secretariat to produce more accurate results are limited, since the information available in countries is limited. What can be done in the international context is :

– in collaboration with country correspondents, find the best available information;
– undertake consistency checks and cross-checks with other available information in order to detect and eliminate errors".

The Joint ECE/FAO Working Party "agreed that consideration should be given at as early a stage as possible to plans for the next forest resource assessment, which would probably be for the year 2000". It noted with interest the ideas in this regard presented by the secretariat. The Working Party supported the suggestion that *the enquiry on additional needs and collection possibilities* for the temperate-zone part of the global forest resource assessment 2000 (see *Annex I*) should be circulated to inventory managers and users and others concerned. The results of that enquiry should be reported to the 18th session of the Working Party which should decide on further steps to be taken in preparation for the 2000 Assessment

Results of the enquiry

The enquiry was circulated, in accordance with the Working Party's request, in November 1990. By June 1991, sixty-one replies had been received from correspondents in twenty-two countries (including four from regions other than the "ECE region") and one international organization. In several cases the replies were the combined reactions from a group of specialists. Thus the total number of specialists involved was appreciably greater than sixty-one, and the extent of the response to the enquiry may be considered as gratifyingly high.

The results of the enquiry were presented by *Mr. T. J. Peck* at the *ad hoc* meeting on the forest resource assessment (temperate-zone) 1990, held in Geneva in August 1991. The results are summarized in Tables 1 to 5 of this paper.

Table 1 shows that replies were received from countries generally representative of the ECE region as a whole from the forestry point of view, although some important forestry countries, including Canada, France and Spain are missing. It would be helpful for this meeting to have also the views of experts in countries that have not replied to the enquiry.

Many correspondents provided replies based on their experience both as experts concerned with the *collection* of forest resource data and with the *use* of such data (44 out of 61 and 51 out of 61 replies, respectively). It may be concluded that the results reflect rather well the views of the users of inventory information as well as of the inventory managers in the countries concerned.

Table 2 summarizes the replies on *how useful* it would be to have available at the international level certain information not covered in the 1990 forest resource assessment (temperate-zone): *very useful*, *quite useful* or *not useful*. Of the eight types of information listed by the secretariat, the three to attract the strongest support (67 % to 70 % – "very useful") were:

(1) Site quality (area, growing stock and increment by main forest types, species or species groups and site quality;
(5) Forest health and forest damage (by area, growing stock, species or species group, age- or diameter class, extent and type of damage);
(7) Quantification of the environmental and other non-wood benefits of the forest.

It is worth noting the remarkable fact that these results were received in the period of the preparation for the UNCED Conference, quite long before the Conference itself.

Two other types of information had moderately strong support (53 % to 55 % "very useful"):
(3) Economic accessibility for wood harvesting;
(6) More detailed (than in the 1990 assessment) statistics on change over time (changes between classes of forest and other wooded land, forest types).

While between 44 % and 48 % of correspondents considered that information on the remaining three categories would be "very useful", this percentage was lower than for the five categories mentioned above. The three are:
(2) Stand density (growing stock by main forest types, species or species groups, age- or diameter classes and stand density);
(4) Wood quality of growing stock in relation to commercial acceptability;
(8) Monetary evaluation of the forest resource (including land, standing crop and components of the forest ecosystem without a market value).

Table 3 shows correspondents' replies on the extent to which countries are already collecting information on the various types listed by the secretariat. Quite a number of countries (10 to 16 out of 22) apparently do so for categories (1) to (6) – site quality, forest health/damage, and more details on forest change, respectively. Presumably, these countries could provide information for a future international assessment without having to change significantly their existing national inventories. They would also be able to share their experience with other countries that would need to adapt or develop their inventory coverage. For the quantification of environmental and other non-wood benefits and the monetary evaluation of the forest resource, on the other hand, few countries are at present collecting information, and the problems of introducing these questions into future international assessments will obviously be greater.

Table 4 shows replies indicating that it would be difficult to collect such data. Confirming the point made in the previous paragraph, most difficulty would be expected with the quantification of environmental and other non-wood benefits and with monetary evaluation, and quite a number of countries would have problems also with economic accessibility, wood quality and more detailed change data. An interesting aspect, when comparing tables 3 and 4, is that in several cases

countries appear in both. That is to say, one correspondent reports that data are already being collected, while another from the same country considers that those data would be difficult to collect. This seeming anomaly would obviously need to be looked into more closely. One explanation could be that there are differences in understanding of precise type of data in question or of the definition used.

Table 5 lists suggestions by correspondents of types of information, in addition to the eight set down by the secretariat, that they consider would be useful to collect at the international level. In same cases the suggestions are in fact already covered in the 1990 assessment (e.g. nature reserves, age-class composition, production of non-wood forest products). A number of others might be combined (e.g. terrain description, climatic conditions and area by ecosystem). The meeting is invited to consider these suggestions when drawing up its recommendations for further steps to be undertaken in the Assessment 2000.

Many correspondents to the enquiry gave considerable thought to their replies and raised some interesting points related to the subject:

(a) In some countries much of the information suggested for the assessment 2000 is already being collected for the plantation areas, but it would be very difficult to obtain it for the natural forest (Chile).

(b) The usefulness of information collected at the international level depends on its comparability between countries (Hungary).

(c) It is considered to be extremely difficult to find uniform standards for the quantification (assessment) of environmental, and especially of non-wood, benefits. If this topic is dealt with, it is recommended to ask the member countries for indicators (Norway).

(d) Generally, very detailed information is not considered to be essential at the international level. All types of information listed on the form are considered to be quite useful, but the collection should be kept at the level of the general view for international purposes (Norway).

(e) The idea of combining tabular statistical data with thematic forest maps (at national, regional and international levels) was supported. If it could be done, it (this combined information) would be in demand from all types of forest inventory users (former USSR).

(f) The necessity for improving the collection and reporting of detailed change or trend statistics as well as for expanding the collection of data that will include enough components of forest ecosystems to evaluate species diversity and wildlife habitat was stressed (USA).

(g) The current effort was fully supported and the willingness to assist in its implementation was expressed (USA).

(h) Site, stand density, economic accessibility and wood quality should be very useful to forest industries interested in locating new sources of row material. However, the author of the reply was not sure how useful it would be to others. This information is very detailed and site specific and consequently quite costly to collect (USA).

(i) A very important part of an International Forest Resource Assessment should be to monitor and detect change in the forested land base and in forest health. Ideally we should be inventorying and monitoring forest ecosystems (USA).

(j) Decisions should be made quickly and information requirements be made available to participating nations soon, so that we can adjust our inventories accordingly (USA).
(k) FAO/ECE is commended on taking a survey for the outlook for the year 2000. Is FAO conducting such a survey of the tropical nations ? If so, how does the information proposed differ from what FAO/ECE is asking for and why ? (USA). [1]
(l) Globally, we need to know the area of forest land, the change since the last assessment (and reasons for that change) and projections for the future. We need the same information regarding volume, biodiversity, environmental health, and other resources associated with forest lands. This kind of information can be collected in any nation, and if it is not being collected, it should be for the nation's well-being. Recommendations for collecting and tracking most of these things may be found in the proceedings from our various IUFRO S 4.02 meetings over the past ten years (IUFRO).

Conclusions

The enquiry carried out by the secretariat and reported on in this document should be helpful in respect to provide guidance to the ECE/FAO Working Party about possible changes to the coverage of the 1990 forest resource assessment (temperate-zone) to meet the expected information needs by the time of the next Assessment 2000. Participants of the present meeting should draw on their own expertise in determining (a) *what are most likely to be the principal information needs at the international level,* and (b) *what countries can realistically be asked to furnish with that necessary information.* It may not be possible to reach consensus immediately on these questions, but the meeting should be asked to make recommendations at least on the following:

(1) The types of information that are not covered in the 1990 assessment but appear the most likely to become of major importance by the year 2000;
(2) Of the above, those that need to be collected and disseminated *at the international level.* As a basis for discussion, the secretariat puts forward the following suggestions based on the results of the enquiry:
   – area of forest and other wooded land by site quality,
   – area of forest and other wooded land according to health and damage status, including changes over time,
   – indicators of the supply of environmental and other non- wood goods and services of the forest,
   – stand density of forest and other wooded land,
   – changes over time between different categories of forest and other

[1] – Note by the secretariat: It appears that the "Kotka-II" meeting constitutes a reply to this question.

wooded land (by area),
– area of forest and other wooded land according to type of forest ecosystem;

(3) Work to be undertaken on determining the information to be collected (bearing in mind the need to avoid too much detail in internationally collected data), agreement on definitions, etc.;
(4) Possibility to prepare maps showing distribution of different categories of forest and other wooded land at sub-national, national and regional levels to complement information presented in tabular form;
(5) The steps to be taken to forewarn countries that this information will be collected in the next international assessment, so that they can make the necessary adaptations to their national inventories in good time. One action may be to obtain details from countries already collecting the information on their methodologies and circulate them to other countries;
(6) A suitable means of carrying out these activities could be with a team of specialists. IUFRO should be invited to collaborate with the team. Besides looking into the need for and possibilities of introducing *new elements* in future assessments of the boreal and temperate zone forest resource, the team should also review the results of the 1990 assessment with a view to advising on *improvements to the data already being collected.* This might include steps to raise the quality of the data collected and possibly to reduce the degree of detail in order to concentrate on the information considered to be essential for international data series. The FAO/ECE Working Party session in June 1993 should lay down the timetable for team's activities.

The FAO/ECE Working Party on Forest Economics and Statistics at its 18th session held in August 1991 noted that the results of the secretariat's enquiry, presented in this paper, should be taken into account when formulating proposals for the scope of the temperate zone part of the Forest Resource Assessment 2000. The Working Party indicated also that recommendations for the scope and contents of the 2000 Assessment should "be drawn to the national authorities responsible for forest inventories by 1995 at the latest".

Annex 1

Enquiry on additional needs and collection possibilities for the global forest resource assessment (temperate zone) 2000

Name:..... Address: .....
.....
.....
Tel:..... Telefax:.....

Are you (1) concerned with the collection of inventory data? YES/NO
(2) a user (e.g. for management, planning, analysis) YES/NO
(3) neither? In which case, please specify:.....

Having read the paper "How should we develop the 1990 FAO/ECE temperate-zone assessment to meet user needs in the 2000 assessment?" (TIM/EFC/WP.2/R.104/Add.1), please complete the following table.

(Please tick appropriate boxes)

	How useful would it be to have such information at the international level?			How practical would it be to collect such information in your country?		
Type of information	Very useful	Quite useful	Not useful collected	Already being means for collection	Possible to develop	Difficult to collect
(1) Site quality (area, growing stock and increment by main forest types, species or species groups and site quality)						
(2) Stand density (growing stock by main forest types, species or species groups, age- or diameter-classes and stand density						
(3) Economic accessibility for wood harvesting						
(4) Wood quality of growing stock in relation to commercial acceptability						
(5) Forest health and forest damage (by area, growing stock, species or species group, age- or diameter class, extent and type of damage)						
(6) More detailed statistics on change over time (change between classes and other wooded land, forest types)						
(7) Qualification of the environmental and other non-wood benefits						
(8) Evaluation of the forest resource (including land, standing grop and components of the forest ecosystem without a market value)						
(9)						
(10)						
(11)						

(9), (10), (11). Please add your own suggestions for information that it would be very useful to collect. Please provide any further ideas on a separate sheet.

Please return to: ECE/FAO Agriculture &,Timber Division, Palais des Nations, CH-1211 Geneva 10 Switzerland, Fax: (22) 734 9825

Not later than: 31 March 1991

Table 1
Number of replies to the enquiry

Countries	No. of replies	Correspondent is concerned with collection of forest resource data	Correspondent is user of data (e.g. for management, planning, analysis)
Austria	6	3	6
Chile	1	1	1
China	1	1	1
Cyprus	1	1	1
former CSFR	2	2	2
Finland	7	2	5
Germany	2	2	2
Hungary	1	1	1
Italy	1	1	1
Morocco	1	1	1
Netherlands	2	1	2
Norway	3	3	3
Poland	2	1	2
Portugal	1	1	1
Sweden	4	3	3
Switzerland	2	1	2
Tanzania	1	–	1
Turkey	1	–	1
former USSR	13	11	12
United Kingdom	2	2	1
USA	5	5	1
former Yugoslavia	1	–	1
UNEP-GRID	1	1	–
TOTAL	61	44	51

Table 2
Replies on how useful it would be to have information available at the international level

	Type of information	Very useful	Quite useful	Not useful
		(percent of total replies)		
(1)	Site quality (area, growing stock & increment by main forest types, species or species groups & site quality)	68	28	4
(2)	Stand density (growing stock by main forest types, species or species groups, age- or diameter classes & stand density)	48	45	7
(3)	Economic accessibility for wood harvesting	53	40	7
(4)	Wood quality of growing stock in relation to commercial acceptability	44	51	5
(5)	Forest health & forest damage (by area, growing stock, species or species group, age- or diameter class, extent and type of damage)	70	28	2
(6)	More detailed statistics on change over time (changes between classes of forest & other wooded land, forest types)	55	36	9
(7)	Quantification of the environmental & other non-wood benefits	67	31	2
(8)	(Monetary) evaluation of the forest resource (including land, standing crop, & components of the forest ecosystem without a market value)	47	42	11

Table 3
Countries where data in question are reported as being already collected

Type of information (abbreviated)		Countries
(1)	Site quality	Austria, China, Finland, Germany Hungary, Italy, Netherlands, Norway, Poland, Portugal, Sweden, Switzerland, Turkey, USSR, UK, USA (16)
(2)	Stand density	Austria, China, Cyprus, Finland, Germany, Hungary, Netherlands, Nor way,Portugal, Sweden, Switzerland, USSR, UK, USA, Yugoslavia (15)
(3)	Economic accessibility	Austria, China, Finland, Hungary, Netherlands, Poland, Sweden, Switz-erland, USSR, USA, Yugoslavia (11)
(4)	Wood quality	Austria, China, CSFR, Finland, Hungary, Sweden, Switzerland, USSR, UK, USA, (10)
(5)	Forest health/damage	Austria, Finland, Germany, Hungary, Italy, Netherlands, Norway, Poland, Sweden, Switzerland, USA (11)
(6)	More details on change	Austria, China, Cyprus, CSFR, Finland, Hungary, Poland, Sweden, Switzerland, USSR, UK, USA, Yugoslavia (13)
(7)	Quantification of environmental/other non-wood benefits	Finland, USSR (2)
(8)	Monetary evaluation of forest resource	Finland, USSR, USA (3)

*/ Replies to the enquiry were received before the disintegration of the USSR, CSFR and Yugoslavia.

Table 4
Countries where it is considered that data in question would be difficult to collect

Type of information (abbreviated)	Country
1) Site quality	Germany, (Italy) [1], USSR, Yugoslavia (4)
(2) Stand density	Germany, (Italy), Turkey, USSR, UK (5)
(3) Economic accessibility	Chile, Cyprus, CSFR, Finland, Germany, Poland, Tanzania, Turkey, USSR (9)
(4) Wood quality	Austria, Germany, Italy, Morocco, Netherlands, Poland, Switzerland, Tanzania, Turkey, USSR, UK Yugoslavia (12)
(5) Forest health/damage	Austria, Chile, Tanzania, USSR (4)
(6) More details on change	Germany, Italy, Netherlands, Portugal, Tanzania, Turkey, USSR (7)
(7) Quantification of environmental/other non-wood benefits	Austria, Cyprus, CSFR, Finland, Germany, Italy, Morocco, Netherlands, Norway, Portugal, USSR, UK Yugoslavia (13)
(8) Monetary evaluation of forest resource	Austria, Cyprus, CSFR, Finland, Germany, Italy, Morocco, Netherlands, Norway, Poland, Portugal, Sweden, Switzerland, Turkey, USSR, UK (16)

[1]/ Brackets denote that only some of the data in question would be difficult to collect.

*/ Replies to the enquiry were received before the disintegration of the USSR, CSFR and Yugoslavia.

Table 5
Suggestions for other information considered to be very useful to collect at international level

Type of information	Country & present collection status [1]/
1. Nature reserves (number, area, etc.)	China (a)
2. Rare species of trees (area, standing volume, etc.)	China (b)
3. Silvicultural systems (by area, species, forest type, etc.)	Cyprus (?)
4. Age-class composition	CSFR (a)
5. Stand quality	Finland (a)
6. Classification based on different types of forest ownership (major statistics for state, private and community forests)	Hungary (?)
7. Production of non-wood products of the forest	Italy (a)
8. Detailed statistics on existing wood quality & its effective use possibilities	Morocco (b)
9. Structure of small (forest) holdings	Netherlands (b)
10. Terrain description	Norway (?)
11. Climatic conditions (over the year)	Norway (?)
12. Comparison of forest damaged areas in the 1990 and 2000 FAO/ECE assessments	Poland (?)
13. General description of the land use system in each country (including potential uses of unutilized land)	Sweden (?)
14. Protective role of forests	Switzerland (?)
15. Status of forest management	Switzerland (?)
16. Status of protected areas & reasons for status	Switzerland (?)
17. Gross increment, total cut & intermediate cut (? thinnings) by species & site quality	USSR (?)
18. Economic evaluation of forests	USSR (?)
19. Normative forest cover on different zones	USSR (?)
20. Losses of growing stock	USSR (?)
21. Value of final products of the forest	USSR (?)
22. Share of the value of the final products of the forest in Gross National Product	USSR (?)
	USSR (?)
23. Change in soil capital (e.g. trough erosion)	UK (?)
24. Changes in water table level & soil water content	UK (?)
25. Change detection/monitoring	USA (?)
26. Area by forest ecosystem	USA (?)
27. Monitoring of changes in forested wetlands	USA (?)

[1]/ (a) = already being collected
(b) = possible to develop means for collection
(c) = difficult to collect
(?) = not indicated by correspondent

*/ Replies to the enquiry were received before the disintegration of the USSR, CSFR and Yugoslavia.

The WCMC Tropical Managed Areas Assessment

Summary Report
World Conservation Monitoring Centre
Cambridge, UK

Summary

The *FAO Tropical Forest Resources Assessment 1980* concluded that human population growth and agricultural expansion are the main causes of deforestation in the tropics. Subsequently, FAO carried out the *1990 Forest Resources Assessment* to improve and update the information on the state of tropical forest resources. It was generally recognised more emphasis should be given to the service functions of forest, including environmental protection and nature conservation. This requirement was addressed by the *WCMC Tropical Managed Areas Assessment 1990* (TMAA).

The overall objective of the TMAA was to complement the *FAO Forest Resources Assessment 1990* by quantifying the contribution of forestry, wildlife and other sectors to nature conservation in 106 tropical countries. This helps identify gaps in existing managed and conservation area networks and, particularly with respect to the forestry sector, highlight the need for increased allocation of tropical forests for protection and conservation purposes.

The key, global finding of the TMAA was that managed areas within the forestry sector cover at least 10.9% of the tropical region, assigned to production (6.5%), protection (3.0%) and conservation (1.5%). Combined with the 7.8% protected in the wildlife sector, and the 2.6% in other sectors, some 21.3% of the tropical region is contained within managed areas.

Acknowledgements

The WCMC Tropical Managed Areas Assessment is the distillation of many people's efforts, both within and outside WCMC. This report on the Assessment was compiled by James R. Paine, Donald M. Gordon, Jeremy D. Harrison and N. Mark Collins. Express thanks go to the agencies and individuals throughout the tropics who provided

information, and to the UK Overseas Development Administration who provided funding *via* Research Scheme No. 4544. A comprehensive acknowledgement is given in the full report of the project (WCMC, 1992).

1. Background

The clearance of tropical forests, both rain forests and dry forests, is an issue at the top of the environmental agenda. Most tropical forest occurs within developing nations where pressures to exploit this resource for products and to convert forest land to agriculture are greatest. Meanwhile, developed nations are concerned that such forests contain half the world's species, and play an important role in maintaining global climatic stability.

1.1.2 FAO Forest Resources Assessment 1990

The 1987 *ad hoc* FAO/ECE/FINNIDA Meeting of Experts on Forest Resource Assessment ('Kotka I') recommended that the 1990 Assessment "should give more explicit emphasis to the service functions of forest, including environmental protection and nature conservation." To accomplish this goal, the group recommended that the project seek supplementary information on legally established protected areas, including forest reserves, and that environmental and protected areas data be entered on a Geographical Information System (GIS) to allow further analysis. It was on this basis that the WCMC *Tropical Managed Areas Assessment 1990* (WCMC, 1992) was initiated.

1.1.3 WCMC Tropical Managed Areas Assessment 1990

The *WCMC Tropical Managed Areas Assessment 1990* (TMAA) was a three-year project (July 1989-June 1992) funded by the UK Overseas Development Administration. It was carried out in collaboration with IUCN - The World Conservation Union, in particular its Forest Conservation Programme and Commission on National Parks and Protected Areas, and in close cooperation with the Food and Agriculture Organization of the United Nations (FAO).

The overall objective was to complement the *FAO Forest Resources Assessment 1990* by quantifying the contribution of forestry, wildlife and other sectors to nature conservation in the tropics. In so doing it helped to identify gaps in existing managed and conservation area networks and, particularly with respect to the forestry sector, highlight the need for increased allocation of tropical forests for protection and conservation purposes.

1.2 Methods

1.2.1 Scope

The TMAA covers 106 tropical geopolitical units. These are split into 12 subregions and three tropical regions, namely Latin America, Africa and Asia & Pacific. The number of countries included in the FAO Forest Resources Assessment however, was reduced to 90, and the data presented in this report has been recalculated on the basis of this reduced number in order to allow direct comparisons between the two sets of results.

The study is focused on *managed areas*, particularly those having a protection or conservation role which are referred to as *conservation areas* in this report. These terms are defined in the Glossary. It is directed primarily at the forestry and wildlife sectors, within which occur the majority of managed areas. Additional sectors, such as the indigenous people's reserves of Central and South America, are covered where appropriate.

1.2.2 Data collection

Forestry sector For the purpose of this study, it was necessary for WCMC to contact forest administrations in every tropical country, often for the first time. Administrations were asked for statistics and maps of the forest estate, information relating to its management and copies of relevant legislation. Additional information was obtained from the FAO Forest Department, Rome and the Oxford Forestry Institute. Copies of much of the forest legislation relevant to managed areas were obtained from the FAO Forest Resources Division.

Wildlife sector WCMC already holds an extensive body of information on conservation areas within the wildlife sector. This information has been gathered over many years as a result of contact with management agencies It is successively being updated as existing areas are upgraded in status or enlarged, and as new ones are created.

Relevant agencies within all tropical countries were contacted at some stage during the WCMC Assessment for their latest lists and maps of conservation areas, or asked to check and update such material generated from the WCMC Protected Areas Database and Biodiversity Map Library.

1.2.3 Maps

Where possible, maps of managed areas were obtained in order to digitise their boundaries using a Geographic Information System. In addition, the map libraries of the University of Cambridge and Oxford Forestry Institute were searched for maps of managed areas. Maps were also obtained from the Natural Resources Institute of the Overseas Development Administration (ODNRI) and Hunting Technical Services, UK.

Over the past two years WCMC has collated, analysed and mapped cartographic data for managed areas in the tropical countries covered by the *Tropical Managed Areas Assessment*. For some countries all managed areas have been mapped; for others coverage is partial, depending on data availability.

To enhance the WCMC's data handling and exchange capabilities, the GIS data are compiled in a central map library - the *Biodiversity Map Library (BML)*. This provides a method for maintaining the data in a structured and easily accessible manner. By so doing, WCMC is better equipped to answer enquiries.

2. Outputs

The TMAA project resulted in the production of *Subregional Reviews*, covering *Tropical Asia & Pacific*, *Tropical Africa* and *Tropical Latin America* (Part I); a *Regional and Global Review* (Part II) and a set of maps generated from the GIS under the heading *Mapping Tropical Managed Areas* (Part III). The following is a summary of information collected for each part of the TMAA report.

2.1 Subregional Reviews (TMAA Part I)

Each subregional review includes an historical perspective, providing information on nature conservation policy and legislation, and administration, within forest, wildlife and additional sectors. Information is also provided on managed areas status, with a review of coverage, representativeness, integrity and effectiveness. Finally, future prospects, international conventions and programmes, and priorities for action, are discussed.

2.2 Regional and Global Review (TMAA Part II)

The analyses in Part II are essentially similar to those described above for Part I, but carried out at the regional and global level, rather than the subregional level. Part II is intended to summarise the major trends across each of the three continental regions, and at a global level.

2.3 Mapping Tropical Managed Areas (TMAA Part III)

A significant part of the project was the collection of maps and the digitization of managed areas boundaries for incorporation within a computer Geographic Information System. The immediate aims of this were twofold: to generate hard copy maps; and to facilitate analysis of the coverage of managed areas. Part III of the TMAA comprises more than 100 maps in A3 format depicting the location of managed areas throughout the tropics.

2.4 Additional outputs

2.4.1 Ecofloristic Zone Analysis

It has not been possible to examine coverage of the different vegetation/bioclimatic types by managed and conservation areas within the available time. It was WCMC's intention to base this analysis on the ecofloristic zone maps of the tropics produced for FAO by the Institut de la Carte Internationale de la Végétation, Université Paul Sabatier, Toulouse. Such maps have been available for tropical Asia (Sharma, 1986a) and Africa (Sharma, 1986b) for some time, but those for parts of Latin America have still to be completed. WCMC did not acquire the digital datasets of ecofloristic zones for Asia, Africa and Latin America (excluding Central America and Mexico) from FAO until the penultimate month of the project. Subsequent technical problems with the geo-referencing of the digital ecofloristic zone data sets precluded an analysis based on protected areas data sets.

It is still planned to assess the representativeness of the managed and conservation area networks with respect to ecofloristic zones. This study will be carried out in close cooperation with FAO and the results presented in a separate report.

2.4.2 Species inventories

In the course of WCMC collaboration with the FAO, the absence of baseline inventory data for many tropical conservation areas was identified as meriting further investigation. This lead to the compilation of the report *Status of Plant and Animal Inventories for Protected Areas in the Tropics* (Murray *et al.*, 1992), in collaboration with the Oxford Forestry Institute. The results are discussed below.

3. Contribution to other WCMC initiatives

The TMAA has contributed to a number of other activities at WCMC.

The four-volume series *Protected Areas of the World: A review of national systems* (IUCN, 1992), compiled by WCMC, was developed in conjunction with the TMAA. This country-by country review of the world's conservation areas was produced for the IV World Parks Congress and comprises descriptions, lists and maps of national conservation area networks.

Data collection for TMAA also contributed to the preparation of the three volume series the *IUCN Conservation Atlas of Tropical Forests*(Collins *et al.*, 1991; Sayer *et al.* 1992, Sayer and Harcourt, *in prep.*). This series covers *Asia/Pacific*, *Africa* and *Latin America* (in preparation) provides information on the distribution of tropical forests, and presents an overview of forest degradation and loss.

TMAA datasets are currently supporting the *Tropical Ecosystem Environment Observations by Satellite* (TREES) project of the Com-

mission of the European Communities (CEC) and the European Space Agency (ESA). TREES is a research project of the EC Joint Research Centre, under which a pan-tropical forest map is being compiled from AVHRR satellite imagery, and mechanisms to monitor changes in the forests on a regular basis are being developed. To support the satellite-derived data, other relevant information is being integrated into a Tropical Forest Information System (TFIS). These ancillary data include the location and extent of managed areas, provided by WCMC, giving a more complete picture of the conservation status of tropical forests.

The *Forest Resource Accounting* project (FRA) offers a model to assist ITTO producer countries to monitor progress towards sustainable forest management and pilot studies have been carried out in Indonesia, Ecuador and Cameroon. WCMC datasets, developed through the TMAA, and the experience gained in the handling of forest data in a GIS, are likely to make a significant contribution to the forest inventory and monitoring aspects of this project.

Other initiatives which the TMAA supports include the IUCN/EEC *Environmental Profiles* (1988-present), a World Bank (1993) supported study entitled *Ecologically Sensitive Sites in Africa,* and an initiative about to commence under the heading *Monitoring the State of Tropical Forests*. The objective of the latter is to provide a systematic overview on the extent, condition, and vulnerability of the world's tropical forests.

4. Access to information

All of the material compiled as a part of the TMAA is available through WCMC. Original reports and correspondence are on file, and the extracted information is included within various databases. In particular, basic information on all protected areas sites is incorporated within the WCMC Protected Areas Database, and maps are incorporated within the WCMC Biodiversity Map Library. Spatial datasets are available on request as plots or as digital ARC/INFO export files. Further information on WCMC databases and services is available from the Centre.

5. Summary and analysis

The following section provides a summary of the results of the WCMC Tropical Managed Areas Assessment.

5.1 Managed Areas within the Forestry Sector (Table 1)

Managed areas within the forestry sector cover at least 10.9% of the tropical region. This comprises 6.5% assigned to production compared to 2.9% assigned to protection and 1.5% to conservation.

In absolute terms, managed areas in the forest sector are the most extensive in Tropical Latin America, followed by Tropical Asia & Pacific. By comparison, there is relatively poor coverage in Tropical Africa. In relative terms, Tropical Asia & Pacific has the most extensive forest sector, (24.9%), followed by Tropical Latin America (13.1%), whilst Tropical Africa has only 3.8% within notified forests.

5.1.1 Regional highlights

Tropical Asia & Pacific Production forest reserves are the principal component of the forest sector, covering 15.9% of the region, compared to 4.7% assigned to protection and 2.8% to conservation functions.

Tropical Africa There is an approximate equivalence between protection (0.3%) and conservation (0.8%), whilst production forests cover 2.5% of the region. Madagascar is noteworthy in that conservation forests are more than twice as extensive as production forests.

Tropical Latin America In proportional terms the forest sector is most extensive in the Central America subregion, with 35.9% coverage, the great bulk of which (29.5% of the subregion) being assigned to a protection function. Much of this comprises the more than 200 protection forest zones in Mexico, covering some 68,000 sq.km.

5.2 Managed Areas within Forestry, Wildlife and Additional sectors (Table 2)

In total, managed areas in the forest, wildlife and additional sectors cover 21.3% of the tropical region, a very significant proportion, although this does include 6.5% assigned to production.

The wildlife sector is responsible for areas covering 7.8% of the tropics, whilst additional sectors cover 2.6%. Significantly, the forest sector contributes another 4.5% of the tropical region in protection and conservation areas.

The greatest contribution to the global total comes from Tropical Latin America. The additional sector (mainly indigenous people's reserves) contribute more than one-third of the managed areas network in this subregion, and more than 10% of the entire tropical conservation areas network.

There is rough equivalence in the extent of the forest and wildlife sectors at the regional level, with the exception of Tropical Africa. Here, the wildlife sector is some eight times larger than the forest sector.

There are opportunities to extend the forest sector contribution to nature conservation, especially in those sub-regions that retain a high percentage of forest cover. Where forest reserves predominate over wildlife conservation areas, there is a clear need to review their role. In Sri Lanka, for example, much of its biological diversity in terms of species richness is found in the rain forests of the south-west wet zone which fall mostly within the jurisdiction of the Forest Department. These rain forests have become increasingly fragmented and isolated

due to population pressures, with the result that logging has now been banned in the wet zone until the conservation importance of these forests has been assessed. Already, the largest rain forest, Sinharaja, has been strictly protected under new conservation legislation introduced within the forestry sector and designated a World Heritage site, while 14 other forests have been earmarked for conservation.

5.3 Distribution of managed areas (Figure 1)

In order to adequately protect the full range of biodiversity, conservation areas must be properly distributed. A good example of where this is **not** the case is the wildlife sector in Benin, which covers 12% of the country. Although this exceeds the widely recognised minimum 10% extent, it is found exclusively in the savanna/arid lands in the north of the country; tropical forest areas are not included (Figure 1). On the other hand, the forest sector, which covers 12.2% of the country, has a more even distribution.

The wildlife sector in Costa Rica is relatively smaller (10%), but better distributed than that in Benin. Conservation and protection areas in the forest sector (11.5%), and additional sector areas (11.3%) are also well distributed. In total, 19 out of 20 Holdridge life zones and transition zones found in Costa Rica are included within the conservation areas system.

This comparison shows that rudimentary statistics do not provide the full picture. Managed areas must be systematically mapped for even cursory systems analyses to be carried out.

5.4 Distribution of forests and managed areas in Panama (Figure 2)

This is not a direct output of TMAA as such, but is an analysis that can be carried out as a result of TMAA, if funds are available. Overlaying data sets of natural forest cover and the distribution of managed areas, it is possible to calculate the percentage of protected habitat. An analysis of the data for Panama shows that nearly 40% of remaining forest cover in the country is included within conservation areas of either the forest sector or wildlife sector.

A prerequisite for this type of analysis is improved habitat mapping, at national, regional and global levels.

5.5 Species inventories (Table 3)

It became evident during the TMAA that there was a paucity of baseline inventory data on conservation areas. Consequently, WCMC files were scanned for species inventories carried out within such areas. Of the 8,715 tropical conservation areas recorded in the WCMC Protected Areas Database, only 5% appear to have been the subject of floral or faunal inventories. The best recorded taxonomic groups were birds (3.72%) and mammals (3.11%), followed by higher plants (1.82%), reptiles (1.14%), trees (1.01%), amphibians (0.70%), fresh-

water fish (0.47%) and butterflies (0.40%). WCMC data holdings are most extensive for the Asia and Pacific region, and least comprehensive for Latin America. These results highlight a serious 'knowledge gap' in current attempts to conserve biodiversity in a network of conservation areas.

6. Conclusions

The information collected for the TMAA project complemented the FAO Tropical Forest Resources Assessment 1990 and has been used by a number of organisations in support of conservation activities.

The TMAA resulted in the significant expansion and development of the WCMC Protected Areas Database and the GIS system within the context of the Biodiversity Map Library at WCMC. Information held by WCMC is readily available and accessible to institutions and individuals who have need for it.

The major findings of the TMAA project are that managed areas in the forest, wildlife and additional sectors cover 20.9% of the tropical region, comprising 6.5% assigned to production, 2.9% to protection and 1.5% for conservation in the forest sector, 7.8% in wildlife sector areas and 2.6% in the additional sectors. The greatest contribution to the global total comes from Tropical Latin America. The additional sector (mainly indigenous reserves) contribute a little more than one-third of managed areas network in this subregion, and more than 10% of the entire tropical conservation areas network.

Conservation areas are not always evenly distributed. The wildlife sector in Benin is found exclusively in the savanna/arid lands in the north of the country whilst the forest sector has a more even distribution. This indicates an opportunity for the conservation potential of the forest sector to be further developed. Statistics alone do not provide the full picture: habitats and managed areas must be systematically mapped for such analyses to be carried out.

Of the 8,715 tropical protected areas recorded in the WCMC Protected Areas Database, only 5 % appear to have been the subject of floral or faunal inventories, highlighting a serious 'knowledge gap'.

7. Recommendations for future assessments

7.1 Ongoing activities

The main phase of the TMAA is complete, although a number of concluding activities are still in progress:

– Drafting of an *executive summary* for wider circulation, to include regional tables and sample national material. This will serve two purposes: reporting on the project to those who contributed; and advertising the available information for those who might need it.

Dissemination of the full report to specific individuals and organizations; completion of the *ecofloristic zone analysis* in collaboration with – FAO, and publication of the results; soliciting further feedback on national sections of the report, and incorporating review comments, and corrections and additions to lists, tables and maps within the WCMC database; and preparing *articles and scientific papers* for submission to appropriate meetings and journals.

Additionally, a *summary of actions* to draw the attention of IUCN and other organizations to the priorities identified in preparation of the report should be prepared.

7.2 Future assessments

The project has drawn together a valuable body of information and it is essential that this is used to best effect, and that the database continues to develop. The following should form part of a continuing review.

– *Regular review and update* of the information, which would involve routine contact with wildlife and forestry departments, and the update of maps, files and databases.

– *Extension of the coverage* to developing countries not included in the Forest Resources Assessment 1990 Project (for example Chile and Argentina are the only countries not covered in South America).

– *Regular analysis* of the available information, and dissemination of the results.

In the future it will be necessary to extend the work on status and distribution of managed areas, to a review of the actual protection on the ground and the effectiveness of management. In particular WCMC will need to address the following:

– *Assessment of forest type and cover* within protected areas in selected countries, to assess how well the information reflects actual forest protection.

– *Assessment of management effectiveness* within protected areas, and assessment of threats to their integrity, to better assess the implementation of designated protected areas; and

– *Assessment of the resources available* for managing areas, looking in particular at staff resources and available funding.

7.3 New projects

The TMAA results not only provides important baseline information but also suggests further study and analysis; these include:

– *Analysis of forest cover in the tropics*, using the managed area maps, and maps of forest distribution compiled for other projects, to produce an initial assessment of the coverage of remaining forest areas by managed areas;

– *Review of protected area species inventories* in order to build a better

body of information on what inventories are available. This will make species lists more accessible, facilitate analysis of species numbers and protected areas, and species distribution within protected areas;

– *Conservation in temperate forests.* An extension of the concept to cover the temperate regions, in order to assess the conservation status of temperate forests; and

– *Mapping production forests.* An extension of the TMAA project to more systematically incorporate information on production forests. This would promote global and regional forestry analyses, supporting the activities of both FAO and ITTO.

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9. Glossary

Additional sector Those parts of government responsible for legally designated areas with a conservation function but are outside the wildlife sector or forest sector; examples include indigenous reserves.

Conservation forest Areas within the forestry sector designated for conservation by law or other regulations (FAO, 1990).

Conservation area Defined as for protected area. [The term conservation area is used instead of protected area with which it is synonymous.]

Forest land An area of land proclaimed to be forest under a Forest Act or Ordinance (FAO, 1990).

Forest reserve Generally well-defined, surveyed, demarcated and legally constituted forest under the control of a forest department. All acts of felling, collection of forest produce, grazing and even trespassing are usually prohibited unless expressly permitted by law (FAO, 1981).

Forestry sector That part of government responsible for the protection and management of forest land.

Managed area A legally designated natural area managed for production on a sustainable basis or for conservation purposes. The term includes conservation area and is frequently used generically when referring to reserves within the forestry sector that may have a production and/or conservation function.

Natural forest Forest composed of tree species known to be indigenous to the area. Included in this definition are primary forest (undisturbed), disturbed primary forest associated with various intensities of selective logging, secondary forest resulting from logging of primary forest, logged over forest with under-planting of exotic species, and managed forest regenerated artificially or naturally so long as this involves the renewal of essentially the same crop as before (FAO, 1990).

Production forest Forest having terrain and soil conditions suitable for the production of wood and other products on a sustainable basis. The distance to consumption or export centres is not taken into account, which means that economically inaccessible forests are included in this class (FAO, 1990).

Protected area An area of land and/or sea managed through legal or customary regimes so as to protect and maintain biological diversity and natural and associated cultural resources. [This definition was agreed at the IV World Parks Congress on National Parks and Protected areas, Caracas, 10–12 February 1992. The term protected area is not used in this report, 'conservation area' being preferred.]

Protection forest Areas within the forestry sector located on terrain that is too steep or rough, or subject to periodic or permanent inundation, which makes forest management impractical due to physical non-productivity (FAO, 1990).

Wildlife sector That part of government responsible for nature conservation.

Table 1 Extent of notified natural forests (eg forest reserves), classified by forest function.

Areas are given in thousands of sq.km, followed by percentage total area.

REGION Subregion		Production		Protection		Conservation		Total	
	Area	Area	(%)	Area	(%)	Area	(%)	Area	(%)
TROPICAL ASIA & PACIFIC									
South Asia	4,122	594	14.4	10	0.2	3	0.1	607	14.7
Continental SE Asia	1,902	201	10.6	97	5.1	198	10.4	496	26.1
Insular SE Asia	2,444	717	29.3	331	13.5	67	2.7	1,115	45.6
Oceania	453	0	0.0	0	0.0	0	0.0	0	0.0
Regional Total	8,921	1,512	16.9	438	4.9	268	3.0	2,218	24.9
TROPICAL AFRICA									
West Sahelian Africa	5,280	169	3.2	51	1.0	13	0.2	233	4.4
East Sahelian Africa	4,897	16	0.3	1	0.0	23	0.5	40	0.8
West Africa	2,038	130	6.4	15	0.7	50	2.5	195	9.6
Central Africa	3,983	30	0.8	4	0.1	12	0.3	46	1.2
Tropical Southern Africa (*)	6,163	238	3.9	7	0.1	83	1.3	328	5.3
Regional Total	22,361	583	2.6	78	0.3	181	0.8	842	3.8
TROPICAL LATIN AMERICA									
Central America & Mexico	2,396	120	5.0	732	30.6	8	0.3	860	35.9
Caribbean	690	9	1.3	8	1.2	8	1.2	25	3.6
South America	13,416	870	6.5	161	1.2	248	1.8	1,279	9.5
Regional Total	16,502	999	6.1	901	5.5	264	1.6	2,164	13.1
GRAND TOTAL	47,784	3,094	6.5	1,417	3.0	713	1.5	5,224	10.9

* NB Includes Madagascar

Table 2 Extent of conservation areas in the forestry (conservation and protection), wildlife and additonal sectors.

Areas are given in units of thousands sq.km

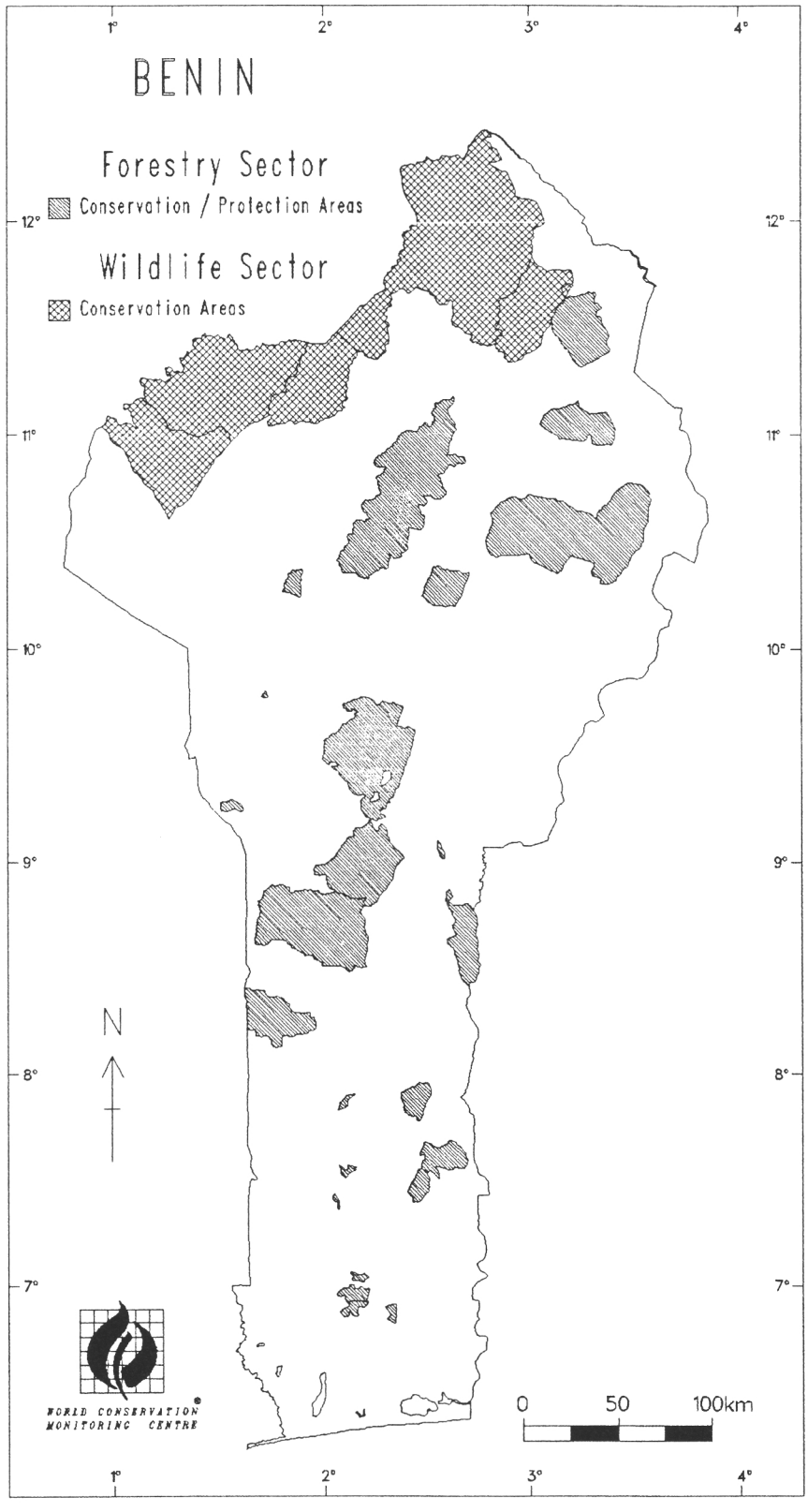
REGION Subregion		Forest Sector		Wildlife Sector		Additonal Sectors		Totals	
	Area	Area	(%)	Area	(%)	Area	(%)	Area	(%)
TROPICAL ASIA & PACIFIC									
South Asia	4,122	13	0.3	248	6.0	0	0.0	261	6.3
Continental SE Asia	1,902	295	15.5	70	3.7	8	0.4	373	19.6
Insular SE Asia	2,444	397	16.2	228	9.3	0	0.0	625	25.6
Oceania	453	0	0.0	10	2.2	0	0.0	10	2.2
Regional Total	8,921	705	7.9	556	6.2	8	0.1	1,269	14.2
TROPICAL AFRICA									
West Sahelian Africa	5,280	64	1.2	334	6.3	0	0.0	398	7.5
East Sahelian Africa	4,897	24	0.5	409	8.4	0	0.0	433	8.8
West Africa	2,038	65	3.2	75	3.7	0	0.0	140	6.9
Central Africa	3,983	15	0.4	252	6.3	6	0.2	273	6.9
Tropical Southern Africa (*)	6,163	91	1.5	907	14.7	0	0.0	998	16.2
Regional Total	22,361	259	1.2	1,977	8.8	6	0.0	2,242	10.0
TROPICAL LATIN AMERICA									
Central America & Mexico	2,396	740	30.9	151	6.3	14	0.6	905	37.8
Caribbean	690	16	2.3	31	4.5	2	0.3	49	7.0
South America	13,416	409	3.0	1,002	7.5	1,191	8.9	2,602	19.4
Regional Total	16,502	1,165	7.1	1,184	7.2	1,207	7.3	3,556	21.5
GRAND TOTAL	47,784	2,129	4.5	3,717	7.8	1,221	2.6	7,067	14.8

* NB Includes Madagascar

Table 3 Number of conservation areas species inventories

Region	Africa		Asia		Latin America		Pacific		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%
Higher plants	40	1.57	78	2.17	26	1.08	15	9.38	159	1.82
Trees	31	1.22	48	1.33	7	0.29	2	1.25	88	1.01
Mammals	109	4.29	119	3.31	33	1.37	10	6.25	271	3.11
Birds	96	3.78	171	4.75	42	1.74	15	9.38	324	3.72
Reptiles	30	1.18	35	0.97	26	1.08	8	5.00	99	1.14
Amphibians	18	0.71	25	0.69	18	0.75	0	0.00	61	0.70
Freshwater fish	13	0.51	21	0.58	7	0.29	0	0.00	41	0.47
Butterflies	20	0.79	12	0.33	3	0.12	0	0.00	35	0.40
No. of conservation areas	2,543		3,599		2,413		160		8,715	

NB. Data based on all tropical countries, and therefore not exactly comparable with the 90 country subset used in the FAO Forest Resources Assessment 1990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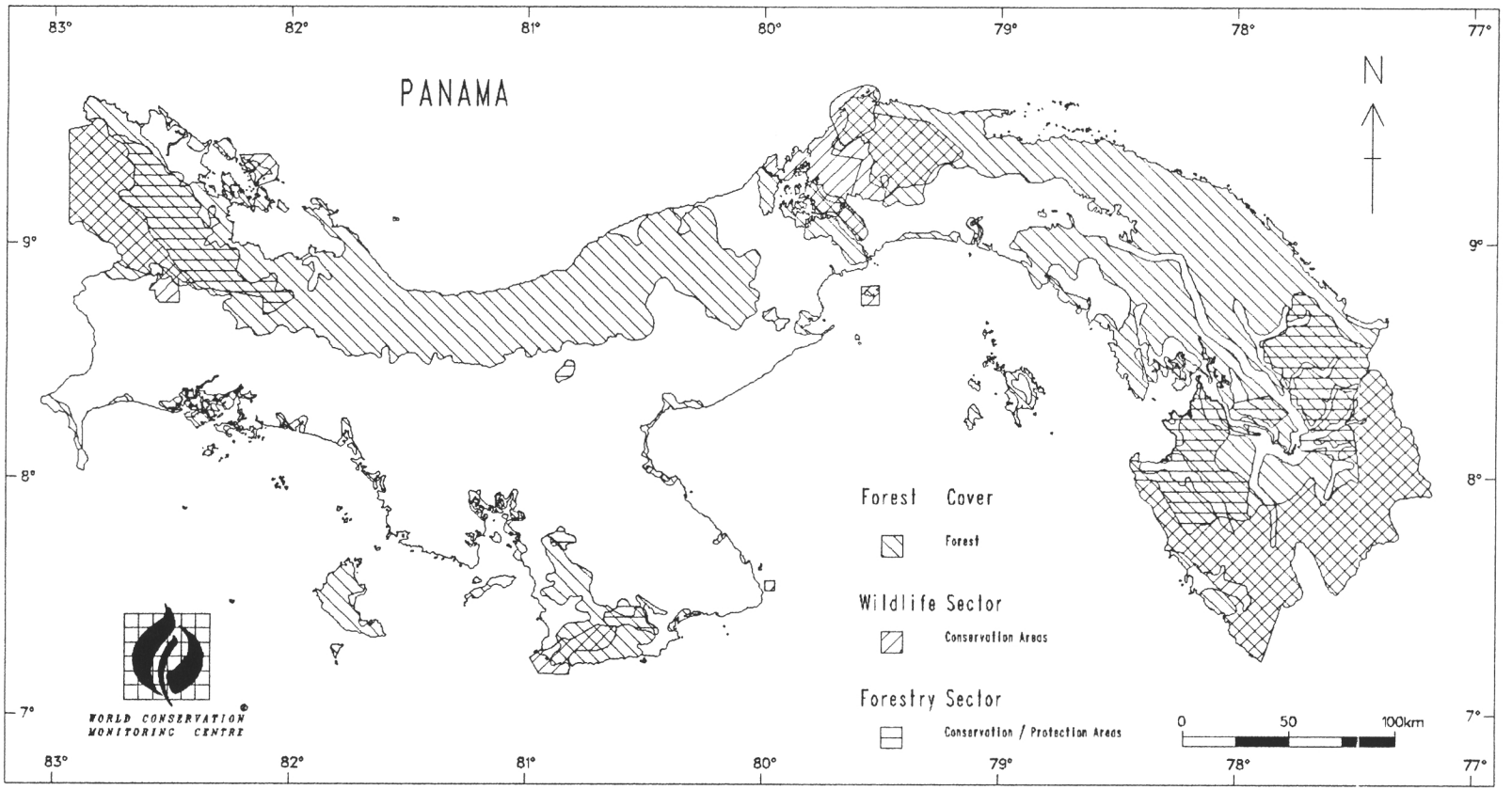
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RESPAS: User Need Information at the Global Level

There is a growing need for timely and reliable information on forest cover and the extent and rate of forest degradation in tropical and temperate regions. This need for assessment and systematic observations of forest cover has been strongly expressed in Agenda 21 of the UNCED Conference in Rio 1992, where it states that assessment and systematic observations of forest cover are essential components of long-term planning and that in many cases, even the basic information related to the area and type of forests is lacking.

In line with Agenda 21, the UNEP/FAO expert consultation on environmental parameters in future global forest assessments, held in Nairobi, 1–3 December 1992, identified various parameters to be assessed in future forest assessments related to: loss of biodiversity, climate change, green house gases's sources and sinks, hydrological cycle, land degradation, and sustainable use of forests.

The Kotka meeting reviewed the content-and methodologies for future global assessment including the results of the UNEP/FAO expert consultation on environmental parameters, and gave the following recommendations regarding remote sensing information needs.

Land cover/land use

Land cover/land use assessments are oriented toward the identification and measurement of changes. Remote sensing is the main source of information to assess land cover/land use changes on an operational and sustainable basis. It allows for repetitive coverage of areas at selected intervals to update information on forest resources and to assess changes in forest cover. It also allows comprehensive wall to wall assessment and monitoring of land cover/use situations required at different levels of interest (global, regional, national, ...) for forest policy and decision making purposes.

FAO and UNEP should develop, in cooperation with other relevant agencies, georeferenced data sets in digital format on land cover/land

use using available sources including remote sensing methods.

Lead centres, fully equipped with state of the art tools should be established for continuous monitoring of changes, specially in the tropical countries.

Biomass

The role of forests in biogeochemical cycles, especially the carbon cycle and its relation to the green house effect, has increased the interest in estimating the biomass of forests. Moreover loss of biomass is often an indicator of forest degradation. Therefore the monitoring of biomass changes should be an element of forest assessments which seek information on degradation.

To better understand the relationship between all these factors, there is a need to develop spatial digital representations (in GIS) of forest biomass, and combine these data with other spatial data bases such as bio-climatic factors, land use patterns, road networks, and demographic and socio-economic data in order to better understand some of the mechanisms leading to forest biomass change. For a number of these factors, remote sensing is an important source of information.

Biodiversity

Biodiversity is the variety of life at the ecosystem, species and genetic levels, and must be viewed in a temporal and spatial framework. The methodology of the Forest Resources Assessment could contribute substantially to our knowledge of forest related biodiversity at the national an ecosystems levels and to some extent at the species level.

Within this context the need was identified to describe actual vegetation cover and condition to give basic information on the condition of forest ecosystems globally, and to demonstrate the extent to which they have been converted or modified. Data from national maps based on high resolution imagery, aerial photographs and ground survey should, where available and necessary, be combined with recent satellite data for updating, monitoring and harmonisation of information. Imagery will allow for assessment of vegetation fragmentation and its impact on species diversity based on species/area models.

Conclusion

Recognizing the need for timely and reliable information on forest resources the initiative to develop and maintain a global network of remote sensing processing and archiving systems was supported.

These systems would provide optimized remote sensing data to strengthen the capacity of the countries to assess and monitor their own forest resources as well as assist FRA and TFAP activities.

The need for a remote sensing satellite dedicated to global forest monitoring should be examined.

Based on a detailed analysis of the information requirements, of a number of representative tropical countries and global organizations, a pilot Remote Sensing Processing and Archiving System (RESPAS) will be developed to produce standardized imagery optimized for forestry applications on an operational basis. At a global level, RESPAS will be used to support FAO's forest resources assessment and monitoring programme. The information requirements on the extent, state and distribution of forest resources will be aggregated from the information derived at a national level.

Towards the end of this project, RESPAS facilities will be operational in the participating countries and will form the basis for a global forest assessment and monitoring environment.

Great Expectations and the Year 2000 Global Assessment

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What is an assessment?

An assessment is the act of officially estimating the value or character of property. It is the process of estimating or determining the significance, importance or value of something.

Assessments are for people. We conduct assessments to present factual information on state and condition of resources. We hope that someone in authority will do something with the resulting information. Ultimately the assessment should lead to programs and plans concerning future allocation of resources to meet the needs of a growing human population.

The International Union of Forestry Research Organizations (IUFRO) Subject Group S 4.02 fully supports the role of the United Nations and the Economic Community of Europe (ECE) in developing future assessments.

Current efforts

Current global assessments focus on single sectors such as forested lands. They tell what resources we have, but not where they are located and where opportunities for expansion exist. Because current assessments focus on single sectors, we run into the possibility of different groups or decision-makers planning different uses for the same area.

For the most part they focus on the current status and on the economic aspects of the resources. The social and environmental aspects are overlooked. More recently, however, there have been regional assessments driven primarily by research to measure the impact of various environmental issues.

Great expectations

The Year 2000 will be a landmark year marking the official start of the third millennium. Because of this historic event, which all of us have only the chance of participating once in our life, it will be a cause for great celebration, reminiscing, and looking forward.

Even though the Year 2000 is an artificial point in the history of humankind, it will be a benchmark against which our past activities will be judged and a baseline against future accomplishments will be measured. Therefore, it is imperative that the Year 2000 assessment be as complete and as accurate as possible.

Based upon recommendations made at the 1989 IUFRO Conference on *Global natural resource monitoring and assessments: preparing for the 21st century* (Lund and Preto 1990), the World Forest Watch meeting held in Brazil in 1992 (Malingreau et al. 1992), the UNEP/FAO expert consultants meeting held in December 1992 (UNEP/FAO 1993) and the World Resources Institute meeting on future global assessments also held this past December (World Resources Institute 1993), we can reach some conclusions about our future assessments.

The Year 2000 Global Assessment should:

1. Include everything that is in the 1990 Global Forest Assessment plus be all encompassing – include integrated and continuous estimates of grasslands, forests, agricultural lands, wetlands etc. (UNEP/FAO 1993, World Resources Institute 1993).
2. Provide estimates on food, fuel, shelter, employment, environment.
3. Include environmental and social considerations in addition to economic factors (as noted above).
4. Trace human impact on the Earth's resources
5. Reflect latest technology in data acquisition and display (Malingreau et al 1992)
6. Present facts so people can understand and authorities make rational policy decisions including maps showing:
   - distribution of the Earth's resources.
   - distribution of people, agricultural lands, forest lands, etc. in the years "0", "1000", and "2000" (an expansion of a recommendation from Tim Peck at the IUFRO World Congress in 1990, Montreal)
   - current land cover of the earth. Including agricultural, forest, urban, grasslands, water bodies, and wetlands.
   - where pressures exists and predictions of where they will occur in the future.
   - where opportunities are for meeting needs.

Our future assessments must include multiple resource and multiple location information spatially registered and to predetermined standards so the data may be aggregated to the global level and changes tracked over time.

Many groups will be doing assessments or studies at the end of this century. To be competitive, our work, through the United Nations, must be complete and authoritative.

How to get there from here

Through the United Nations Earthwatch Program, we should:

1. Plan on making the year 2000 assessment a benchmark and make a commitment to bringing it about on paper and in actions.
2. Bring in other sectors into the assessment process and plan data acquisition and outputs accordingly.
3. Work with remote sensing organizations as partners to develop the needed remote sensing data bases.
4. Work with historical/archaeological groups to develop maps of the past.
5. Work with modelers, socio-economists to develop maps of the future.

My preference is to do multi-sector assessments, but I realize that this may not be possible in the limited time we have between now and the year 2000.

If future assessments are to be done by single sectors, then the sectors have to mutually exclusive, but all sectors must be included and all lands covered.

In addition, the sectorial assessments must be done in such a manner that we can share each others data to see where opportunities for expanding our resource base exist.

Summary

The Year 2000 Assessment should be a landmark document. The assessment should account for all lands and resources. It should provide resource estimates (and statements of reliability of such estimates) at the local and global levels. It should display estimates spatially. Methods to collect the required data should make maximum use of existing information and new technology.

It will provide a baseline for monitoring changes in the extent and distribution of the Earth's resources. We should strive to end redundant data collection and promote data sharing through the use of corporate data bases. Lastly, the future assessment should provide up-to-date information bases using continuous inventories and accounting and modelling procedures.

Whatever is decided for the Year 2000 Assessment, the International Union of Forestry Research Organizations Subject Group S 4.02 pledges its support to the UN/ECE effort.

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29 April 1993

Agenda Item 7

UNEP/FAO Expert Consultation on Environmental Parameters in Future Global Forest Assessment

Nairobi, 1–3 December 1992

Report

1. Introduction

The FAO and UNEP jointly carried out a first 'Global Tropical Forest Resources Assessment Project' in 1980. Subsequently, FAO and FAO/ECE initiate the current global forest resources assessment. An indepth review of the current assessment was organized by FAO in which UNEP participated. One of the recommendations of the review team was to include the environmental dimensions of forests into future assessments.

In recent years, there has been a perceptible change with respect to the role and functions of forests. There is a growing consensus that all aspects of goods and services offered by the forests, be it for boreal, temperate, or tropical forests, should be considered in a holistic manner.

In order to assist national and international agencies to formulate their policies and strategies, methodologies need to be developed to assess and monitor the relevant environmental parameters.

To address these and related issues, FAO and UNEP held a joint expert consultation 1–3 December 1992, in Nairobi, Kenya to:

a. Identify various parameters to be assessed in future global forest assessments related to: loss of biodiversity, climate change, greenhouse gases' sources and sinks, hydrological cycle, land degradation, and sustainable use of forests.

b. Recommend suitable methods which could be used and the scale and level of reliability which should be attainable for a comprehensive assessment.

c. Recommend an operational plan of action for future assessments.

2. Process

Detailed background papers, prepared prior to the meeting, described environmental information needs and methods of data collection for boreal, temperate, and tropical forests (see annex 2). These and other sources of information (annex 3) served the consultations as material for preparation of working group papers. Three working groups were formed to cover: (1) biodiversity, (2) biomass and its importance to the carbon cycle and global change, and (3) land cover/land use and land degradation. Each working group prepared a paper that included sections on identification of users, user needs, pertinent parameters, methods of measurement, and a strategy for future assessments of these topics. The participants, in plenary sessions, developed a synthesis of parameters to be measured some general recommendations for future assessments.

3. Results

Discussions over the three days resulted in a statement of a series of general recommendations.

3.1. General Recommendations

a. Future resource assessments should take into account the conclusions of the UNCED conference, particularly Agenda 21, The Non-Legally Binding Authoritative Statement of Principles on the Management, Conservation and Sustainable Development of All Types of Forests, and the Biodiversity and Climate Change Conventions. This means the gathering, dissemination, and utilization of environmental data as a contribution to the process of national sustainable development.

b. The expert group endorses the concepts that the Global Forest Assessment should in future include more parameters to support environmental activities (See table 1 in Section 3.2 below).

c. Given the growing importance of environmental issues and the growing levels of activity in many agencies both within and outside of the UN System, it is important that all groups work together in developing mutually supporting plans.

i) Every effort should be made to incorporate information and data from related activities, especially those being performed by various environmental science groups, such as NASA's Pathfinder activity, the EC TREES project, the World Conservation Monitoring Centre and others.

ii) These efforts should be directed towards forging stronger links between the UN and these research groups. A periodic review and forum should be organized possibly in conjunction with key players (such as World Forest Watch, IUFRO, IGBP, and others) and funding sources to assess what work is being carried out in order to identify areas for cooperation. All these activities should be coordinated within the frame-

work of the UN System-wide Earthwatch.
iii) Development of future forest assessments should be linked to other global activities concerned with terrestrial vegetation, such as IGBP's core project on Global Change and Terrestrial Ecosystems and the proposed Global Terrestrial Observing System.

d. The FAO, in cooperation with UNEP should review future forest assessments with respect to their objectives, the methods to be applied and the balance of efforts by the agencies in various components of the work, including its role in remote sensing.
e. Future forest assessments need to take account of scientific and technological advances and the changing requirements of nations and the global scientific community (e.g., IGBP, IPCC) notably those associated with improvements in remote sensing technology, data processing, and spatial data base (GIS) developments.
f. All agencies must continue to develop capacity building in developing countries, recognizing the need for objective and timely global assessments.
g. The FAO, in cooperation with UNEP, should develop plans for improved dissemination of the results of current and future forest assessments, taking advantage, as appropriate, of existing experience and mechanisms for dissemination of environmental data both within and outside of the agency.

i) During the project preparation, there should be an open process for wide publicity to ensure the full support and participation of concerned groups.
ii) Results from the current forest assessment have considerable potential interest for the broader scientific community and effort's should be directed towards publication of the results and underlying methods in the open scientific literature.
iii) Results of all FRA activities should be made available as soon as possible.

3.2 Parameters

A summary of parameters needed in future assessments to address these environmental concerns is given in Table 1.

The list is long, but not all parameters are required for each environmental concern. Furthermore, information about these parameters is either already available, is being collected, or is in the stages of being collected by many national and international organizations. A key role for UNEP/FAO is to insure that the information is amenable for use in the global context and to coordinate the various activities.

Table 1 Identification of parameters needed to assess major global environmental issues. The Parameters are ranked according to importance [1] to the assessment.

PARAMETERS	Bio-diversity (Ecosystem & levels)	Carbon Cycle	Hydro-logical	Forest Condition Cycle distur-bances)	Land Cover Land use (health,	Key Players
Ecofloristic zones					*	FRA ICTV
Forest cover						Remote
– forest/nonforest	***	***	***	***	***	sensing
– burned areas	***	***	***	***	***	community
– logged areas		***	***			
– regeneration	**	***	***			
– biomass degraded areas		***	***			
– deforested	***	***	***	***	***	
Forest categories:						
– potential forest vegetation	***				**	
type	***	***	***			
– actual forest vegetation	***					WCMC
type	**	**				FAO/FRA
– administrative/legal status	***	***			***	
– management type						
– plantation/natural						
Fires (numbers, distribution)	**					Rem.S.Comm.
X of vegetation cover					***	Rem.S.Comm.
Crown cover/ leaf index	*	***	***		**	Rem.S.Comm.
Tree species composition	**		**			Nat.Forinv
Diameter distribution		***				–"–
Stand Height						–"–
Stand structure	*		*			–"–
Soil characteristics / UNESCO				**		FAO/
topography		***				Nat. Soil
– soil organic matter			***			Surveys
– texture 8 slope						
Socioeconomic factors (pop. density, infrastructure. a.o.)	**	***	***	***	***	UNSO/FRA

[1] *** : essential, indispensable, ** : desirable, accessory, * : optional

3.3 Work Group Reports

3.3.1 Work Group Report on Biomass

Of importance to the global carbon cycle is the total amount of carbon, as organic matter, in forests undergoing change. This includes the biomass of the trees, understory, vines, palms, roots, fine and coarse litter, and soil organic matter. For the aboveground component, the biomass in the trees is by far the most important quantity, and one that is at present the most straightforward and feasible to measure. Further discussion on the other components of forest biomass is given in the background papers in Annex 2.

3.3.1.1 Background

Biomass of forests is very relevant for issues related to global change. The role of forests in global biogeochemical cycles, especially the carbon cycle and its relation to the greenhouse effect, has heightened interest in estimating the biomass of forests. The biomass of forests provides estimates of the carbon pools in vegetation (about 50% of biomass is carbon) and consequently the potential amount of carbon dioxide that can be added to the atmosphere when the forest is cleared and/or burned. Biomass estimates also provide the means for estimating the amount of carbon dioxide that can be removed from the atmosphere due to recovering forests because it establishes the upper bounds for carbon sequestering. Because the amount of other nutrient elements in forests is also related to the quantity of biomass present, biomass estimates of forests are extremely relevant for studying other global biogeochemical cycles.

Forests have traditional been used for many products, including timber, fuel, and fodder. Determining the biomass of forests is clearly a useful way of providing estimates of the quantity of these components. Typically, the quantity of sawtimber has been assessed by making volume estimations, but this ignores the other useful components such as smaller size wood for fuel use, particularly in the tropics Furthermore, very few assessments have been made of the quantity of wood that appears to have no potential for sawtimber production. Assessing the total aboveground biomass of forests (per unit area and for whole forested regions) is a useful way of quantifying the amount of resource available for all these traditional uses. It can give the quantity of total biomass directly or the quantity by each component because their biomass tends to vary systematically with the total quantity.

The quantity of biomass in a forest is a result of production (photosynthesis) and consumption (respiration and harvest) processes, thus it is a useful measure for assessing changes in forest structure due to human (e.g., management and degradation) and natural impacts (e.g., climate change). Change in biomass can therefore be used to monitor and measure forest degradation if the rate of removal is greater than the rate of production.

Past assessments of forests have generally not directly estimated biomass. The 1980 assessment of tropical forests by FAO concentrated on reporting the quantity of timber available (as volume overbark [VOB] to a minimum tree diameter of 10 cm), which does not give total biomass, but only a partial measure. This attempt to quantify the amount of timber volume in the FAO 1980 assessment was a positive step forward, but it was not without its errors. Very few national or subnational inventories in the tropics measure or report VOB and the 1980 assessment required much educated guesswork to produce VOB estimates on a tropic-wide basis. It is obvious that greater effort is needed to develop more reliable estimates of the biomass of tropical forests. In the temperate zone, biomass estimates have been made as more developed countries are interested in estimating the role in forest resources in the carbon cycle.

Several other issues related to forest biomass and tropical forests have emerged since the 1980s. In addition to loss of forest area, forest degradation, resulting in biomass loss (in addition to that accounted for by logging), is also occurring. Much of this biomass degradation appears to be unrecorded. Clearly, this process of biomass reduction has implications for the global carbon cycle and biodiversity. Biomass degradation is due to many factors related to both the biophysical characteristics of an area as well as to social/economic/political factors. To better understand the relationship between all these factors, there is a need to develop spatial digital representations (in GIS) of forest biomass, and combine these data with other spatial data bases such as bio-climatic factors, land use patterns, road networks, and demographic and socio-economic data in order to better understand some of the mechanisms leading to forest biomass change. Not only will this approach be useful for addressing the availability of forest biomass resources within a given country, but it will also be extremely useful for dealing with the other global issues such as climate change and biodiversity.

We define the most practical measure of biomass of forests to be the amount of standing stock of living matter of all trees to a minimum diameter to 10 cm or less (less, for example, in dry forests, young forests, etc), expressed as dry tons/ha.

Where resources are available, every effort should be made in future assessments to include the other organic matter components of forests, particularly roots (can be up to 50% or more of the aboveground biomass) and coarse woody debris -dead standing and lying wood- (up to 50% or more of the living biomass). Methods for measuring these components are well established, though they can be time consuming (refer to background papers (Annex 2) for more details).

3.3.1.2 Users and user Needs of Forest Biomass Information

The primary users of information on forest biomass are:

a. The scientific community concerned with global climate change: The needs of this group are in relation to the carbon cycle, other

biogeochemical cycles, biomass burning and trace gas emissions, and the hydrological cycle. Data on forest biomass would also be useful for validating models of forest biomass (amount and dynamics), as well as validating interpretation of remote sensing imagery.

b. National policy makers and planners: This group of users would require information, at national level, on net changes in biomass at regular intervals (5 yr interval) and information on timber and fuel quantity and production rate.

c. International organizations (e.g., ITTO): The interest of this group of users would be similar to those of group (2).

3.3.1.3 Parameters

We define the most practical measure of biomass of forests to be the amount of standing stock of living matter of all trees to a minimum diameter to 10 cm or less (less, for example, in dry forests, young forests, etc.), expressed as dry tons/ha.

Where resources are available, every effort should be made in future assessments to include the other organic matter components of forests, particularly roots (can be up to 50% or more of the above-ground biomass) and coarse woody debris -dead standing and lying wood- (up to 50% or more of the living biomass). Methods for measuring these components are well established, though they can be time consuming (refer to background papers (Annex 2) for more details).

– All parameters on biomass must be georeferenced

– Forest lands defined as lands with >10 % tree cover (UNESCO and FAO have provided more detailed definitions in which canopy height is also used to separate forest from shrubland).

– Areas of broad forest types need to be distinguished as biomass can change substantially from one type to another. However, for purposes of global estimates, only broad types can be recognized keeping in view the limitations of current technology. These broad types are: broadleaf vs conifer; wetland forests- freshwater vs mangroves; monospecific types such as bamboo, palms etc.

– Change in area of forest cover types, i.e., a forest-cover change matrix, including such classes as conversion to permanent non-forest use, logging, shifting cultivation cycle (long and short rotation), other unmanaged transformations (e.g., log poaching, fires, etc), degradation, amelioration, etc. Many of these cover types are mosaics which need to be characterized.

– Non forest woody plants such as line plantings, living fences, home gardens, etc need to be included as they can account for substantial quantities of biomass.

– Number of trees by diameter classes, or diameter distributions (in some applications report by species), by general broad forest types and forest cover types (see above).

3.3.1.4 Methods

The basis for biomass estimation is a diameter distribution of the stand. Measurement are to be taken at breast height (or above buttress when present) for temperate and tropical forests, and at 50 cm above ground for dry forests or brushlands. The diameters are recorded by species in 10 cm classes or smaller depending on stand structure, i.e. in dry forests or young stands smaller classes are used, as in standard forest inventories. All trees should be assigned to a class and no grouping of larger classes are to be used.

The measurements are taken on standard inventory plots, as used in national or regional inventories, the size depending on the stand structure. If complex designs of plot location are used the appropriate statistical evaluation procedures for deriving biomass estimates are to be applied. The diameter distributions should be stratified by forest types and forest cover change classes described earlier.

In addition to measurements of diameter, height estimates have to be derived. As height measurements for all trees on a plot are too time consuming and costly, a double sampling approach can be used where a small number of heights are measured, and the relation between height and diameter is derived by regression analysis. This regression equation is then applied to all trees measured and the height is estimated. The measured diameter and estimated height will be used in the regression equations for estimating biomass of the trees.

Based on the diameter distribution (and height/diameter regression) estimates for both total biomass and timber volume can be derived by applying biomass/volume regression equations:

$$F(d)$$
$$\text{Volume} = F(d,h) \text{ or } F(d)$$

These biomass and volume regression equation are assumed to exists for most applications, otherwise they have to be derived by subsampling a small number of trees for biomass and volume respectively. Refer to background papers for further discussion of availability of regression equations for temperate and tropical regions. Standard errors and confidence limits should be provided, if possible, considering both the sampling error and the error of the biomass/ volume regression.

For interpreting state and changes in biomass or volume the past history of the forests, by strata, should be noted from historical records, direct field observations, and other standard monitoring systems for disturbance. Of importance are such issues as whether the forest has been cleared, logged, burned, etc.

In traditional timber inventories only live trees are considered. The estimation of the mass of dead trees and coarse woody debris should be recorded as well because it represents a significant portion of the total biomass which is important for (1) estimating the total carbon pool, (2) estimating fuel loads, and (3) assessing ecological factors (effect on biodiversity, etc.).

The estimation of total biomass is dependent on three components:

a. Forest area estimation
b. Estimation of forest cover types by sampling
c. Biomass function

In a total error analysis the first component will be most important on a global scale. This issue is addressed by the FRA 90 project. It is recommended to use this approach, or a similar one, in assessing total biomass, supplemented by ground sampling. In the temperate region, where more precise area information exist, information from national or regional forest inventories can be used to assess the area of forest cover types. Remote sensing imagery should be used to stratify the forest cover into classes for further analysis.

For the ground samples, existing information should be used as much as possible, e.g., inventory plots from past inventories, provided they are not outdated (which in general means not older than 5 years). For future inventories it is recommended the measurements of dead material be included, in addition to the standard inventory variables. Supplementary studies on the derivation or validation of generic biomass and/or volume equations should be planned in cooperation with national institutions.

For the appropriate interpretation of biomass changes, data on socio-economic factors are crucial. Therefore, information of population density, accessibility of the forest, illicit fellings, non-timber uses of the forests should be included in the assessment, in addition to the parameters described above. This information can be included in the plot information collected during standard inventories or derived from GIS overlays.

3.3.1.5 Recommendations for Biomass Assessment

– For providing compatibility between biomass studies, common guidelines should be developed, i.e., a primer on biomass estimation techniques should be produced. This would include biomass regression equations for temperate and tropical regions, general diameter-height relationships, methodology, measurement requirements, etc.

–The data base used to develop the general biomass regression equations for tropical forests needs to be increased, particularly with respect to the number of large diameter trees (>70 cm). A systematic collection of such data from a variety of forest types, and geographic and ecological zones should be undertaken to remedy this situation and to improve the regression equations.

– All future forest inventories (national to subnational) supported by international donor agencies should ensure that the methods for collecting field measurements outlined in this report be used, and that the data be made available to all interested groups.

3.3.1.6 Work Group Participants

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D. Pelz
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A. Singh

3.3.2 Work Group Report on Biodiversity

3.3.2.1 Background

The 1987 meeting of experts at Kotka, Finland, agreed that future assessments should gather data on the services provided by forests. These include protection of soils and watersheds and conservation of biological diversity. As a first step it was agreed to study the system of protected areas and forest reserves. WCMC, in full collaboration with FAO and with funding from ODA (UK) completed a study in the tropics, but the temperate proposal was not funded. The results for the tropics have been incorporated by FAO into the 1990 assessment.

The objective of the Biodiversity Group was to define activities that would lead to greater precision in assessment of the biodiversity function of forests. The group focussed down on what will be practicable to achieve in the next assessment.

a. The Group recognized the importance of the recommendations and achievements of the UNCED conference, including Agenda 21, the Non-legally Binding Authoritative Statement of Principles on the Management, Conservation and Sustainable Development of all Types of Forests, and the Biodiversity Convention.
b. Other fora actively gathering data on biodiversity include, but are by no means restricted to:
- Parties to Convention on Biological Diversity
- Parties to ITTA
- UNEP Country Studies Programme and National Biodiversity Units
- The IUBS/UNESCO/SCOPE Diversitas programme linked to the Man-and-Biosphere Programme of UNESCO
- The IGBP/GCTE Project

Care should be taken to complement and not to duplicate these efforts.

3.3.2.2 Users of Biodiversity Data

A study should be made of the user groups of the Forest Resource Assessment. The UN agencies should make greater efforts to proactively disseminate data in a wide variety of formats. Existing organizations (such as WCMC) and mechanisms should be used wherever possible. Users of biodiversity data include:

– National and global agencies involved in planning, policy development and decision-making;
– Communicators, media, educators and the general public.

3.3.2.3 Parameters

Biological diversity can be measured and monitored at a number of different levels: a) ecosystem, b) species, and c) genetic. The Forest Resources Assessment should contribute substantially to a), selectively to b) and not at all (at the moment) to c).

In the context of biodiversity, the information to be derived includes:

a) Ecosystems:	Ecofloristic zones
	Vegetation types
	Protected and reserved areas
	Management information
b) Species:	Tree species and their distribution

Future assessments should include information on the processes leading to reduction in biological diversity, i.e.:

– assessment of forest extent
– deforestation processes and rates
– forest fragmentation
– forest degradation and utilization

3.3.2.4 Methods

Biodiversity assessments should be made in both the tropical and temperate zones. There exists a substantial body of information on methodology and this should be developed as a background paper to the Kotka II meeting.

The data gathered on biodiversity must be georeferenced. The methods for mapping and spatial analysis are more easily accessible now than in the past, and these should be utilized in the assessment.

Phase one – collection and analysis of existing information.

a. Ecofloristic zones (or equivalent). A global bioclimatic/edaphic classification system is a very valuable analytical tool. Ecofloristic zones may be used, but the work needs peer review. Other systems (e.g. Holdridge's system, Bailey's ecoregions) should be considered.
b. Vegetation types. Baseline data will rely on national vegetation maps (say 1:1 million scale). National agencies should be asked to harmonize their legends with a global vegetation classification system at a scale of approximately 1:5 million: This global system should be a hierarchical system newly developed but taking into account a) the contribution and needs of the remote sensing and

vegetation modeling communities, and b) existing vegetation schemes (e.g. UNESCO).

c. Protected areas and forest reserves. The database built by WCMC with support from ODA must be maintained and expanded to include maps of forest reserves in the tropics and maps of all protected areas and reserves in the temperate and boreal latitudes. The UN agencies should help to facilitate this work through collaborative agreements and exchange of data.

d. The information on protected areas and reserves should be extended to include data on actual management on the ground, and the vegetation content and condition of reserves.

e. Species inventories for reserves or protected areas. Information on species inventories for reserves should be gathered and collated at two levels: a) metadata on the existence of inventories, b) actual data on selected groups should be compiled wherever possible.

f. Tree floras. Information on tree floras should be gathered and collated, to identify gaps in knowledge.

g. Information on the distribution of tree species at national and subnational levels should be gathered and collated using museum and herbaria data and GIS technology, allowing analysis of likely coverage by reserve systems and remaining forest cover.

Phase two – preparation of databases, guidelines, and analysis.

h. Databases must be built in support of the activities 1–7 above. They should be designed with a view to their dissemination and establishment in-country or in-region as appropriate, using standard database methodologies and accessible technology.

i. Identification of data gaps, and support of national applications. Establish cookbook or primer methodology for assessing plot diversity and regional diversity of forest organisms, especially indicator species (as defined by established criteria).

j. Identification of gaps. Analysis of protected area systems, species inventories and management regimes will permit identification of new needs in terms of coverage of ecosystems and species.

Phase three – ground surveys and national capacity-building.

k. Ground surveys. Basic data on tree species and their gross distribution should be supplemented by inventory data in selected reserves or protected areas in each ecofloristic zone, so as to derive species/area curves that might be applied to data on forest fragment size and number obtained from GIS analysis. This work will require taxonomists, parataxonomists and foresters/botanists aware of the need for biodiversity data as opposed to timber production variables.

l. Extension to analysis of diversity and endemism of forest organisms (i.e. above and beyond trees) by obtaining distribution data from herbaria, museums and other sources.

m. National capacity-building, enabling the gathering of biodiversity data for sustainable development (in the context of the Biodiversity Convention, Country Studies and National Biodiversity Units).

The ideas described above, if followed through, will provide an excellent baseline for decisions on the priority actions needed in order to ensure the perpetuation of the biological diversity of the world's forest ecosystems and trees.

– Analysis of ecofloristic zones, vegetation types, forest cover, deforestation rates and levels of management and gazettement of reserved areas will suggest to analysts where new areas should be established and where management of reserves needs to be adjusted.

– Analysis of tree species distribution maps in relation to remaining forests and reserves, coupled with more detailed inventory data, will lead to establishment of criteria for species in danger. Priority species will require recovery plans that may involve a range of activities including research, protection in reserves, controlled exploitation and even ex situ conservation.

It is important to bear in mind that this is a very selective approach to biodiversity conservation. An important concern of zoologists is that many species of animals are hunted out from forests, and this may affect forest structure and phenology. Forest Departments should be encouraged to extend their work to cover groups other than trees, and invited to report any observations that may seem relevant to the subject of biological diversity conservation.

The recommendations on parameters and activities have been focused on the requirements for the tropical region and amendments or adjustments may be needed for application in the temperate and boreal zones. This issue should be taken up in a special study.

3.3.2.5 Work Group Participants

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3.3.3 Work Group Report on Land Cover/Land Use and Degradation.

Issues covered under the broad heading of land cover/land use have now acquired sufficient environmental significance that the topic warrants further examination at the international level. It is recognized by the working group that a global land cover/land use assessment with a strong environmental dimension should be envisaged.

The detail of such undertaking could not be reviewed in the time but it is strongly suggested that attention be given to the matter by international organizations and the scientific community. A blueprint for such global land cover/land use assessment system should be prepared for discussion.

Unlike in the past, environmental data are required with urgency for a wide variety of scientific, policy making and planning purposes. The land cover/land use aspect of such assessments must now receive serious consideration.

a. Land Cover/Land Use

3.3.3.1 Background

Land cover/land use issues are inextricably linked to forest resource utilization and conservation. Furthermore, the non-forest categories are usually not covered in classical forest assessment exercises. Yet, there are various reasons why non-forested area should be considered in environment assessments

- land cover/land use changes are the main indicators of land degradation, such as in the areas of clear cut, logging, agricultural expansion etc.
- land cover/land use analyses is usually a point of entry in the determination of degradation or rehabilitation trends.
- non forest land cover categories are to be taken into consideration in carbon cycling studies. The importance of vegetation regrow after deforestation is often cited in this respect.
- large biomass is found in non forest cover categories such as the forest gardens, plantations, tree rows etc. Their accounting must be taken into account through overall land cover assessments.
- the success of sustainable forestry practices depends heavily upon land use policies in the non-forestry sector (i.e. the role of agroforestry in buffer zones etc).
- non forest ecosystems contribute to biodiversity in a significant way.

It thus seems entirely justified and even necessary to enlarge forest resource assessments to an examination of broader issues which can be studied in the context of land cover/land use analyses.

3.3.3.2 Uses and users of land cover/land use information

This category of environmental information encompasses a wide range of parameters and can answer a broad spectrum of needs.

Major uses of land cover land use information are foreseen in the following sectors:

- assessments of the productive base and changes therein in the field of timber, fuel wood and food production. Such assessments can be extended to other benefits such as recreation, aesthetic, non wood resources etc.
- design of strategies for ecosystem conservation, management etc.
- monitoring of the impact of policies, development programmes using

changes in land use as an indicator of the success or failure of existing polices.
– planning tool in agriculture, forestry, national conservation areas selection, transportation, etc.
– assessment of degradation.

Users can be identified at all levels of interest and decision making
– national and local planning agencies
– scientists involved into the study and modelling of climate, geochemical cycles, hydrological cycles etc.
– international agencies in need of regional and global environmental assessments.
– education sector involved in raising the awareness of the general public in potentially damageable trends. Use of indicators of probable transformation of land resources.

3.3.3.3 Parameters

There are many land cover/use classifications currently utilized and the working group did not engage into a discussion of their respective merits. A series of characteristics of such classification schemes can, however, be cited. A classification
– must reflect the nature of surface features (vegetation cover, soils etc) and it single/multiple use.
– must be consistent whenever possible with characteristics observable by remote sensing.
– must contain categories in response to requirements by a wide spectrum of users (see following section).
– must be applicable to scales ranging from global to local at various levels of hierarchy (nested classifications).

Specific parameters have been identified with respect to the a few intended uses of the land cover/use assessments:
– Biomass studies: the description of the classes must include an evaluation of the relative tree, shrub and grass or crop cover (%).
– Biodiversity studies: the assessment must include an enumeration of dominant species, a characterization of land cover in terms of spatial patterns and an indication of the uniqueness of the habitat.
– Degradation/rehabilitation studies: the land cover/use assessment must provide an indication of the degree of modification (positive or negative, to be assessed) with respect to the original cover and utilization. This can be expressed in terms of possible impact upon the landform, the hydrology, the local climate. These trends have then to be interpreted in terms of degradation or rehabilitation.

The relevance of ecofloristic stratification in land cover land use analyses is to be investigated. The importance of having physiographic (landform) georeferenced information is stressed.

Socio-economic characteristics of the classes should be included in the assessment; among those the identification of the basic manage-

ment unit which operates the change has priority (individual farmer, settlement schemes, plantations etc).

3.3.3.4 Methods

Land cover/land use assessments are oriented toward the identification and measurement of changes. These can be identified and measured using a series of approaches

- change matrix are to be produced for measuring the transitions form one class of land cover/use to another. All other changes are then derived from overall values associated with the classes (i.e. productivity, biomass etc).
- physical parameters are directly quantified: e.g. changes in biomass, cover percentage, soil surface characteristics such as albedo, or roughness etc).

The methodology must be able to cope with a spectrum of dynamic situations from drastic changes (for example in deforestation) to more gradual transformation such as those associated with regrow, selective log extraction, fuel wood collection. Gradual changes are sometimes best represented by maps showing fields of values of a selected parameter.

Whenever possible, the physical processes of change must be identified such as fire, landscaping, clearing of vegetation, succession, regrowth, building up etc, extreme weather events, and pollution.

The data base must be such that it can be evaluated in terms of degradation, rehabilitation, land amelioration etc as desirable or undesirable trends. This will often require that the land cover/land use data are combined with other data sets (see following section).

Driving forces behind the changes must be identified with respect, especially, to population trends (growth, migration, etc) and socioeconomic conditions.

Comprehensive wall to wall assessments of land cover/use situations are usually required at the level of interest (global, regional, local etc). Such data base provides the material for sampling schemes addressed to the examination of more detailed issues (i.e change valuation etc).

The resolution of the observation must be consistent with area units of change at the subnational level.

The source of data for land cover/use assessment are

- a combination of remote sensing data providing adequate temporal and spatial resolution (AVHRR for low spatial high temporal res. and SPOT/LANDSAT for high spatial/low temporal resolution.
- a Georeferenced collection of ancillary map data (i.e. topography, vegetation, climatic etc)
- georeferenced point observation such as those produced by field verification, inclusion of local knowledge, statistical analyses etc).

As a rule, the methodology should be mainly oriented toward change assessment and provide the necessary material for the development of models.

b. Degradation of Forest lands

Two main inter-related components are land degradation and vegetation degradation.

3.3.3.5 Land degradation

The group defined land degradation as some significant reduction in the capacity of the land (may refer to inherent productivity, or impacts such as those down-catchment of an area, factors leading to reductions in biodiversity such as those caused by habitat fragmentation. Hence there is no simple measurable parameter which represents all aspects of land degradation.

3.3.3.6 Users of Information on Land Degradation.

There are many users of information of land degradation especially at a local scale amongst decision-makers and planners. However much of the information can only be derived by very local observations and analyses. Hence global assessments would not normally provide useful information for local users. There is a strategic need for global land degradation information by international agencies, though its magnitude is difficult to gauge.

3.3.3.7 Parameters

Among the important required parameters are the following:
– poorer soil surface structure
– subsoil compaction
– loss of soil organic matter
– acidification
– nutrient depletion
– erosion
– loss of regularity of ground water flow

3.3.3.8 Methods

These mostly depend on ground sampling and a global scheme of data collection will of necessity be of a rather qualitative and general nature, although of value to awareness purposes and this is demonstrated in the recent GLASOD project sponsored by UNEP. It is difficult to see how a program of intensive ground data measurement of the above parameters could be incorporated into the current Global Forest Assessment procedures.

Recent discussions as part of the proposed GTOS and the IGBP's Global Change and Terrestrial Ecosystems core project suggest the

setting up a limited number of monitoring sites where ground observations linked to satellite and other spatially referenced data sets would be made. These efforts and others could assist the quantitative assessment and validation of global land degradation.

The subsequent development of deforested land may give important indicators whether productivity has progressively declined. For example, secondary forest successions may display reductions in biomass and diversity compared with the original forest.

Monitoring the fate of deforested lands should be feasible using remotely sensed data assuming that data from high spatial resolution systems are regularly available. This would require a wall to wall approach to land cover monitoring if the information are to be useful at a national scale. In some areas data from existing continuously monitored sampled sites could assist in assessing degradation.

c. Vegetation Degradation

Vegetation transformation is estimated to represent a degradation process if it negatively affects the value of the ecosystem or negatively impact upon the environment. Value may be related to biodiversity, productivity, land and water conservation etc)

Degradation assessment requires that a departure from an original or desired state of vegetation is identified and measured.

3.3.3.9 Parameters and Methods

Degradation must be evaluated with respect to productivity, biodiversity, hydrological conditions. Among the indicators of degradation the following assume a special significance in the context of forest resources

- change in land cover/use category
- changes in fragmentation intensity and/or characteristics
- changes in the relative components of the mosaics
- changes in biomass
- changes in percentage ground cover

Perspectives, operational aspects, data distribution

3.3.3.10 Work Group Participants

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d. Hydrological Cycle

3.3.3.11 Background

Much of the world's utilisable fresh water resources originate in forested lands. The increasing pressures on forests and the rapid current rate of deforestation has, over recent decades, raised concerns about the influence of forest changes on water resources and other related aspects such as flooding and sedimentation. More recently the concern has expanded to include the influence of global changes such as climate change on water resources and flooding. A sizable body of knowledge has been accumulated on the influence of forests and forest changes on the hydrological cycle and stream ecosystems. Generally, widespread disturbance or removal of forests causes a decline in the quality of surface waters and in stream, river and lake ecosystems although the change in quality may be short-lived. Forest changes, particularly deforestation, can also modify the quantities and timing of runoff. The biota associated with fresh water ecosystems are usually very susceptible to such hydrological changes.

The hydrological cycle can be represented by the following water balance equation:

$$R + P - (I + T) - G$$

where R = runoff	mm/yr
P = precipitation	mm/yr
I = interception loss	mm/yr
T = transpiration loss	mm/yr
G = loss to groundwater	mm/yr

Changes in forest cover influences I, T and sometimes G. Studies have shown that a change from forest cover to bare ground or vegetation cover with small statue compared to forest, usually results in increased runoff through a reduction in I and T (Bosch and Hewlett 1982, Bruijnzeel 1990). The variable in the water balance equation are measured by making point observations, usually on small instrumented experimental catchments. Modelling approaches which require information on precipitation, vegetation cover and soil/terrain characteristics have also been used to estimate runoff. Models to predict evapotranspiration (I + T) using information on climate and vegetation parameters have also been developed.

3.3.12 User and user needs for hydrological information

The important users of hydrological information are:

– The scientific community concerned with landuse hydrology, freshwater ecosystems and erosion/sedimentation and flood hazard prediction.

– National policy formulators and planners concerned with water re-

source development and supply who need information on the changes in the quality and quantity of water accompanying changes in forest cover.
– National policy formulators and planners concerned with floodplain landuse and flood protection who need information on changes in flood hazards associated with forest landuse changes.

3.3.3.13 Parameters

The important parameters required for the broadscale assessment of the hydrological cycle are:

– Climate parameters particularly precipitation and temperature which are usually available as point observations but for some regions, are available in spatial format such as maps of mean annual precipitation.
– Surface albedo which is an important parameter for estimating available energy for evapotranspiration.
– Area of forest cover needs to be defined as precisely as possible because the hydrological balances for forest and non forest cover can vary markedly.
– Areas of broad forest types such as broadleaf vs conifer, evergreen vs deciduous, tall statue mature forest vs short stature immature forest or other forest types such as mangrove forests. The water balance differences between different forest types can be substantial.
– Crown cover/leaf index is important because of the influence these parameters have on evapotranspiration.
– Terrain/topography characteristics particularly relief, steepness and degree of dissection and drainage density are important particularly for estimating flood hazard.
– Soil characteristics particularly soil permeability, surface condition and soil depth are important because of their influence on G in the water balance equation and on the amount of water storage in the ecosystem.

3.3.3.14 Methods

Assessment of the water balance for forest and non forest areas has depended on small catchment studies of the hydrological cycle, intensive measurements of evapotranspiration or estimates of evapotranspiration using semi empirical models and on broader scale estimates of precipitation and runoff for larger catchment areas. Such studies have provided a reasonable understanding of the waterbalance for most of the major broad forest types in temperate regions but in the tropical regions there remains a dearth of information owing to be lack of reliable forest hydrological studies. The hydrological effects of deforestation have mainly been assessed in small catchment studies. Information for a range of forest types and methods of forest removal for temperate and subtropical regions is available but information for tropical regions is scarce.

Water Balance

At the global scale GIS databases of long term mean annual rainfall and runoff will need to be generated for major forest regions or for

broad forest types. Broad estimates of evapotranspiration for forest regions or forest types will be more difficult to obtain but could be accomplished by modelling approaches. A reasonably precise estimation of the areas of broad forest types using high resolution remote sensing will be required. The fate of deforested areas will also be important and will require repeated land cover monitoring using high resolution remote sensing imagery.

Flood hazard

At the national level estimating and mapping the areas that are susceptible to inundation by flood waters is important. Such information is useful for compiling flood plain models which identify permitted areas of landuse and location of floodways. High resolution remotely sensed data obtained during or shortly after flood events will be required for broad scale assessments.

3.3.3.15

Compile GIS databases of mean annual rainfall, mean annual runoff and mean annual evapotranspiration for broad forest types and broad deforested land types. FAO or UNEP should probably accept the responsibility for coordinating the work but the basic information required will need to be obtained from national databases and from organizations such as WMO.

- Define forest and non forest areas using combinations of low spatial resolution (AVHRR) and high spatial resolution (LANDSAT/SPOT) remote sensing. Repeated appraisals at 5 to 10 year intervals will be required to determine changes in forest/non forest cover. Again FAO/UNEP should coordinate this work.
- Define areas of broad forest types and non forest categories such as grassland, horticultural crops and pasture using high resolution remote sensing.
- Undertake an appraisal of additional information needs and design and achievable research programme to obtain key hydrological data where there are gaps. The most likely serious existing information gaps are water balance data for humid tropical forests and soil permeability data for a wide range of forested terrain in temperature and tropical environments. It may also be necessary to develop and apply modelling techniques to determine evapotranspiration for forest and not forest areas. FAO/UNEP should coordinate this work but will need to coopt trained hydrologists to undertake this work.

Agenda Item 8

Report for Consultancy on Forest Definitions and Classifications to be Employed for Global Forest Resources Assessment, 2000

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Compiled for Forest Resources Division Food and Agriculture Organization of the United Nations

Background

Responsibility for the World Forest Resources Assessment 2000 is currently being shared by FAO-Rome and FAO/ECE-Geneve. Even with the drafting of the working paper on "A Common Framework", there are still significant differences in the systems of forest classifications and definitions and data gathering that are being employed. This was partly due to the vast physical differences between the regions and the limited availability of reliable statistics in the past. In recent years, however, the adoption of new technologies for gathering data and the increasing need of multinational planners for new types of forest resources data, has begged for a reevaluation of the types of information that are needed and the methodology of collecting it.

Planning for the World Forest Assessment 2000 will begin with a meeting that will take place in Finland in May 1993. In preparation for this meeting, an agreement has been made between FAO-Rome and the United States Forest Service regarding a consultancy to work on forest definitions and classifications. The Forest Service has been asked to:

1) Identify objectives and criteria for definitions and classifications
2) Examine to what extent existing definitions and classifications within the subject area can meet the identified objectives and criteria.
3) To the extent necessary, propose new definitions and classifications.
4) Summarize the proposals made in a report which can be submitted by FAO to the May meeting in Kotka, Finland.

The overall objective of the work is to provide a common basis (A new global framework) for the activity that is being done in many countries with forests of widely diverse types and conditions, so that a consistent and comprehensive world assessment can be completed in the year 2000.

World forests perform many functions that are important for sustainable use which involves both economic production and the maintenance and protection of the global environment. New concerns are being expressed about decreasing biodiversity, forest fragmentation, the buildup of greenhouse gases, and changes in the general health and quality of the world's forests. Comprehensive statistics are needed to determine the extent of these phenomena and to monitor their rates of change. A new "Global Common Framework 2000" should facilitate achieving this goal and will respond to the needs of the UNCED-Rio Conference (Global Forest Principles-Agenda 21) and UNEP/FAO Conference in Nairobi.

Criteria for developing international standard forest definitions and classifications

1 Base system on current vegetative cover, not climax or potential.
2. Classification should be universally applicable.
3. Optimize to the extent possible compatibility with other regional or national land cover/land use systems.
4. Classification should be hierarchically designed (i.e., aggregatable, disaggregatable).
5. System should be organized from the general to the specific (top-down).
6. Should be designed to take advantage of emerging technologies (i.e., digital satellite classification) using a vertical projection downward.
7. All categories and life forms (i.e., grass, shrubs, trees) must be accurately defined.
8. Classification must be repeatable from place to place (spatial) and from time to time (temporal).
9. Categories must be mutually exclusive and additive to 100% of area.
10. Sets minimum standards for percent cover (based on vegetation structure, not species).
11. When possible, use standard (not scientific) terminology (i.e., make terms understandable, simple, and unbiased in meaning).
12. Should correspond to identified use and needs.

Current and future global information requirements

Two recent assessments have been conducted to identify global information that is needed in addressing current international concerns. IUFRO has released a draft of international guidelines for monitoring global forest resources and identified three levels of monitoring; one of which applied to the regional/global level. At this level, they stressed the following factors and types of monitoring as being highly important to determine: (1) land use/land cover-for land

management, 2) biomass-for energy use or carbon balances, (3) biodiversity/environmental quality-for ecosystem management, (4) forest resources- for timber production, (5) Forest Health. Data needed for the first four of these types of monitoring are presented in the table 1.

A report containing Environmental Parameters in Future Forest Assessments was presented at a UNREP/FAO Conference in Nairobi on December 1–3, 1992. It presented parameters needed to assess major global environmental issues. A summary of the issues and parameters are presented in table 2.

The following forest health factors were deemed important to quantify by LaBau in his presentation to the IUFRO Congress in Berlin in 1992.

Monitoring for tree and stand changes:

- vegetation composition, diversity and structure
- leaf indices
- changes in tree crown density, transparency, and die-back
- wood and foliar chemistry
- changes in tree seed viability

General forest health indicators include:

- foliar damage from ozone, acid rain, or atmospheric impacts
- increased incidence of insect and disease activity -increased incidence of root disease

Tree mensurational aspects to monitor include:

- radial growth rate
- periodic height growth
- mortality rate

Soil science characteristics to monitor include:

- soil physics
- soil chemistry and nutrients
- soil biota

Ancillary data includes:

- climate
- socio-economic factors
- dendrocronological data
- normalized differential vegetation indices

No country in either the tropical or temperate zone is currently collecting data on all of the elements and parameters mentioned above. These lists, however, help focus upon those attributes that could be used for multiple purpose analyses or are essential for different types of monitoring. It is apparent that the accurate classification of existing vegetative cover can be a powerful analytical element for many resource purposes.

Table 1
Data needed for Land cover, Forest, Biomass, and Environmental quality monitoring.

(An X means the element is needed)

	Land C.	Forest	Biomass	Environ.Q.
Plot Identification				
Location Coordinates	X	X	X	X
Elevation	X	X	X	X
Aspect	X	X	X	X
Terrain Position	X	X	X	X
Year Observed	X	X	X	X
Area Classification				
Land Use Class	X	X	X	X
Land Cover Class	X	X	X	X
Vegetation Type	X	X	X	X
Crown Closure	X	X	X	X
Stand History		X	X	
Tree/Plant Ratings				
Species		X	X	X
Height		X	X	X
DBH/DRC		X	X	X
Age		X		
Stem Ratings				
Log Size		X		
Timber quality		X		
Crown Rating				
Crown Diameter			X	X
Crown Length			X	X
Leaf area			X	
Defoliation		X		X
Bioindicators				X
Damage Assessment		X		X
Dendrochronology				X
Understory Vegetation		X	X	X
Foliar Chemistry				X
Soil Productivity Indicators	X	X		X

Source: IUFRO International Guidelines for Forest Monitoring, Nov. 15, 1992.

Table 2. Identification of parameters needed to assess major global environmental issues. The Parameters are ranked according to importance to the assessment.

PARAMETERS	Bio diversity (Ecosystem & levels)	Carbon Cycle	Hydro-logical Cycle	Forest condition (health, distur-bances)	Land Cover Land use	Key Player
Ecofloristic zones					*	FRA ICTV
Forest cover						Remote
– forest/nonforest	***	***	***	***	***	sensing
– burned areas	***	***	***	***	***	community
– logged areas		***	***			
– regeneration	**	***	***			
– biomass degraded areas		***	***			
– forested						
Forest categories:						
– potential forest; vegetation type	***					
– actual forest vegetation type	***	***	***		**	
– administrative/legal status	***					WCMC FAO/FRA
– management type	**	**				
– plantation/natural	***	***			***	
Fires (numbers, distribution)	**					Rem.S.Comm.
% of vegetation cover					***	Rem.S.Comm.
Crown cover/ leaf index		*	***	***	**	Rem.S.Comm.
Tree species composition		**		**		Nat.Florlnv
Diameter distribution			***			– n –
Stand Height			*	*		– n –
Stand structure		*		*		– n –
Soil characteristics/ topography				**		FAO/UNESCO Nat. Soil
soil organic matter		***				Surveys
texture & slope				***		
Socioeconomic factors (pop, density, infrast-ructure. a.o.)	**	***	***	***	***	UNSO/FRA

[1] ***: essential, indispensable, **: desirable, accessory, *: optional

Source: GEMS Report Series No. 17, Nairobi, Feb. 1993.

Existing global classification system-common framework 1990

The existing system contained in the FAO Working Paper *"Toward a Common Framework for World Resource Assessment"* meets many of the twelve evaluation criteria. It is universally applicable, compatible with many existing classification systems, and is based on current vegetative cover. The system, however, uses terms that have no universally accepted definition, has terms linked to land-use, and is not designed to take advantage of emerging technologies. One level (Forest and Tree Resources) does not fit into the hierarchical design. Presumably, it is included for tree volume aggregation purposes.

While the initial separation between Land and Inland Water is distinct and repeatable, the second level separation of land into Agricultural Land, Forest and Other Wooded Land, and Other Land might be difficult to accomplish using remotely-sensed products (see Technical Specifications for Pilot Studies, Forest Resource Assessment 1990 Project) . Arable and Permanent Cropland should be easily classified, but Meadows and Pastures may be difficult to distinguish from Forest Fallows and Shrublands.

One strength of the system is that it relates well to the systems in use for decades. However, it does not relate well to recently introduced ecologically-based classification systems. Another strength is that the definitions not only tell what categories are included, but also those that are excluded.

Minimum tree crown cover to qualify for "Forest" varies between the temperate zone (ECE/FAO-Geneve) and the tropical zone (FAO-Rome). A footnote explains that developing countries use 10 percent to conform to the UNESCO classification, while temperate countries ask data contributors to state the minimum percentage in use. The Forest category in the common framework states "more than 20-percent". A common standard should be developed. The level will significantly effect the extent of the forest resource. Recently, when developing a forest type map for the United States employing AVHRR and TM digital data, researchers learned that the minimum forest density required to define the boundary of major forest type groups varied from 10- to 50-percent. Table 3 presents these results:

Terminology should be reviewed for acceptance by the general public. Terms like Exploitable and Unexploitable should be replaced by terms with neutral or positive application histories. Terms like Closed Forests and Other Wooded Land should be replaced with crown cover class ranges; they are not used by analysts in North America.

Forest fallows represent the edge of shifting land use; usually the border between forests and agriculture. At present fallows are considered to be a nonforest category, however, in many cases they support considerable vegetation, and in some cases, are forested (tree land cover). Because of the heterogeneity, they are difficult to classify. In many instances, ground-based observations are necessary to

properly classify the cover. Forest fallows should be accurately classified as they relate directly to the measurement of change in the extent of forest cover.

Table 3
Forest density for defining forest boundary in major forest type groups of the United States

FOREST DENSITY[1]	FOREST TYPE GROUP
50-percent	Western white pine
40-percent	White-red-jack pine
	Spruce-fir
	Loblolly-shortleaf pine
	Maple-beech-birch
	Aspen-birch
	Hemlock-Sitka spruce
	Lodgepine
	Western larch
	Fir-spruce
30-percent	Longleaf-slash pine
	Oak-pine
	Oak-hickory
	Douglas fir (patch cutting)
	Redwood
	Aspen-birch
20-percent	Oak-gum-cypress
	Elm-ash-cottonwood
10-percent	Chaparrel
	Pinyon-juniper
	Western hardwoods

[1] Crown coverage per unit area.

Analysis of classification terminology

Most vegetative classification systems contain terms that relate to vegetative density or cover, or land use, or on a combination. Experience has proved that, when developing a system for broad geographic application, less difficulty is experienced if the terminology relates to earth cover than land use. The term *"forest"* has long been used in vegetative classification and is accepted widely. However, it also reflects a land use that is sometimes limited by law and management practices. For example, the Swedish Parliament defines forest land as suitable for the production of timber and not currently used for other purposes, and land were the presence of forest is desirable to protect against erosion. If one takes a broad view of designing a global

system for classifying vegetative cover, then a more generic term like "*tree land*" should be considered.

Before forest or forest land can be defined, a basic problem is: how to define a tree. Most classifiers agree that a tree is (1) an erect woody perennial,(2) having generally one well-developed main stem, (3) and usually capable of reaching a height of 5 meters at maturity. The first two requirements are more or less universally accepted, however, the height requirement varies widely from region to region. The northern limits of the boreal forest region presents a major exception. Height/age relationships are difficult to determine remotely. Ground verification is necessary. Another element that could be used in classification of a tree is species, but some species have both a tree and shrub form.

In addition to defining a tree, there are quantitative criteria that are employed in most forest inventories which relate to the minimum crown cover, minimum area, and minimum widths that are required to be classified as forest land. Kleinn assembled the following table as an illustration of these differences for 15 countries in Europe.

Table 4
Principle quantitative criteria used in forest definitions of some European National Forest Inventories (from Hoeren, 1990).

(Numbers in brackets indicate where the data were not clear or derived from other criteria)

COUNTRY	FOR. cover [%]	Invent. period (ref.)	Type of survey F=Field A=Areial ph.	Min. crown cover	Min. width [m]	Min. area [ha]	Prod.
Austria	45.5	1981–85	F	0.3	10	0.05	–
Denmark	11.4	1990	A	–	20	1.0	–
Finland	76.0	1977–84	F	–	–	–	$1M^3/a/ha$
France	27.8	from 1960	A	0.1	25	0.5(0.05)	–
Germany	29.6	1986–89	F	–	10	0.1	–
Greece	44.6	1976–80	A/F	0.1	30	0.5	–
Ireland	5.5	1983–85	F	0.2	–	0.5	–
Italy	26.8	1983–86	F	0.2	20	0.2	–
Netherlands	10.5	1980–87	A	0.2	30	0.5	–
Norway	28.3	1986–93	F	–	–	0.1	$1M^3/a/ha$
Portugal	34.8	1979	A/F	0.1	30	0.2	–
Spain	25.0	1985–94	A	0.1	–	(4.0)	–
Sweden	67.7	1983–92	F	–	–	–	$1M^3/a/ha$
Switzerland	28.3	1982–86	A	0.2	25	(0.06)	–
U.K.	9.0	1979–82	A/F	0.2	20	0.25	–

SOURCE: Kleinn, On the compatibility of forest inventory results. IUFRO Conference, Canberra, Australia, January, 1992.

Once the term forest or tree land has been selected, a variety of definitions are possible. Some examples are:

1. Land at least 10 percent stocked with forest trees of any size, including land that formerly had such tree cover and that will be naturally or artificially regenerated.
2. An ecological system with minimum 10 percent coverage of trees of land surface.
3. All land with a "forest cover", i.e., with trees whose crowns cover more than about 20 percent of the area (or with a stand density of more than 20 percent) and used primarily for forestry.

The first definition is based on tree stocking (number of trees/hectare) not crown cover. For correct classification, stocking tables must be available and field verification is preferred. The second and third definitions depend upon estimating crown cover which is best estimated remotely from above. It is difficult, however, to identify regenerating forests by remote sensing.

A recommended alternative might be a combination:

Tree land is all land with tree crown-cover (stand density) of more than 20 percent as determined from remotely-sensed classification, or at least 10 percent stocked with trees of any size as determined by field measurements, or formerly having such tree cover and that is being naturally or artificially regenerated.

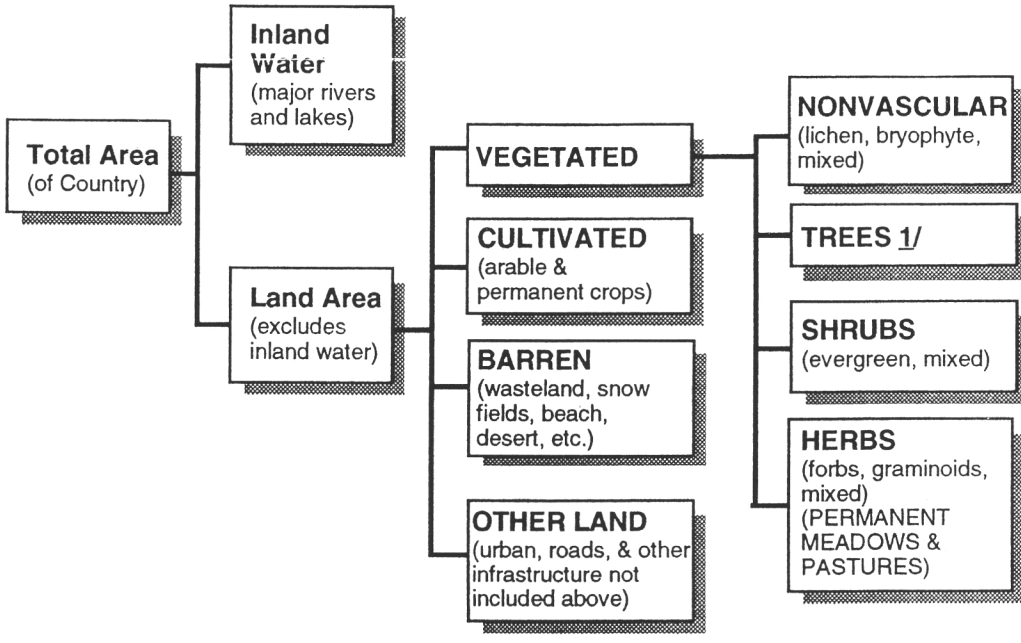
Proposed system for 2000 global vegetation classification

The new system should be able to link with past statistics while providing enough new information to address current and future global concerns. The same tree and stand information that was needed for commodity planning purposes in the past will still be valuable input to analyses concerning environmental and forest health issues. In addition, more information is needed about vegetation other than trees and the sustainability and resilience of forest ecosystems. At the global level, few major changes are recommended, however, a crosswalk should be provided between the current forest and woodland level structure and the major vegetation categories. In future years, as individual countries begin to collect information on tree land and its relationship to the other vegetated categories (Nonvascular, shrub lands, and herbaceous lands), the structure will be in place.

Those categories of land that can be accurately and consistently separated from vegetated land, by employing either field measurements or remotely-sensed data, should be delineated at level 3 (see figure for proposed system). Within the tree land category, the previous open and closed forest separation should be replaced by a table containing stocking classes sufficient to recover those categories for regional analysis purposes. Shrubs, a category in other wooded land

in the 1990 classification, would become a separate vegetative category in the proposed system. Fallow, in the 1990 classification, should be assigned to one of the vegetated subcategories. The forest/other wooded lands separation should be replaced with a table containing tree land by productivity classes. Most Scandinavian reviewers place the separation at more than/less than 1 cubic meter/hectare/year.

Proposed system for Global Vegetation Classification



1/ Trees may be further segregated by productivity classes, by stocking classes, by species or species groups, by legal status or requirements, and by ownership.

Global 2000 analysis and reporting

For analysis purposes, there would be advantages in tying the proposed vegetative classification to an existing ecologically-based classification system; such as Bailey's Ecoregions of the World. This would allow remotely-sensed satellite data to be stratified within unique domains, divisions, and provences; and also, allow a direct comparison between the current and potential natural vegetation condition which might be supported on the site in the absence of disturbance. Field-measurement based inventories could also be easily assigned to an ecoregion, since the mapped location of the plot would be recorded. This practice would provide another unifying connection between the two types of inventory information and aid the analysis.

Thought might be given to identifying regional resource analysts

(or teams) that would be involved in the reporting. The Global 2000 Resource Report should feature an introductory section for the world (general area and volume statistics), but should be followed by strong, more-detailed regional analyses. These regional analyses would be based on an aggregation of statistics based on similar inventories, using compatible methodologies. This technique would strengthen the overall credibility of the final global product, since it would be based upon strong regional analyses.

Definitions for terms of proposed 2000 classification

Total Area – total area (hectares) of the country, including area under Inland Water bodies *(Same as Common Framework, 1990).*
Inland Water – includes major rivers and lakes *(Same as Common Framework, 1990).*
Land Area – total area (hectares), excluding area under Inland Water bodies *(Same as Common Framework, 1990).*

Barren – mostly permanently devoid of vegetation (vegetation accounts for less than 5 percent of the total surface cover). Examples include beaches, dry salt flats, waste land, bare rock, and snow and ice fields. Excludes Other Land.

Cultivated – includes Arable and Permanent Crops *as defined in the Common Framework.* Excludes Permanent Meadows and Pastures.

Arable – land culivated under temporary crops (double-cropped areas are counted only once), tempory meadows for mowing or pasture, land under market and kitchen gardens (including cultivation under glass), and such land temporarily lying idle. *(Same as Common Framework, 1990).*

Permanent Crops – land cultivated with crops that occupy the land for long periods and need not be replanted after each harvest, such as cocoa, coffee, and rubber; it includes land under shrubs, fruit trees, nut trees, and vines, but excludes land under trees grown for wood or timber. *(Same as Common Framework, 1990).*

Other Land – Includes unused but potentially productive land, Man-made and built -on surfaces, parks, ornamental gardens, roads, lanes, and structures. Excludes Barren, Cultivated, and Vegetated Lands.
Vegetated – a condition in which vegetation makesup more than 5 percent of the total surface cover. Includes Herbs, Shrubs, Trees, and Nonvascular plants. Excludes Barren, Cultivated, and Other Land.

Nonvascular – a condition in which vegetation makesup more than 5 percent of the surface cover, and Lichens or Bryophytes, or the two in combination, makeup more than 50 percent of the total surface cover; or when the two makeup 5- to 50-percent of the cover and the vegetative condition does not qualify as Trees, Shrubs, or Herbs.

Herbs – a condition in which vegetation makesup more than 5 percent of the surface cover, and Forbs or Graminoids, or the two in combination, makeup more than 50 percent of the total surface cover; or when the two makeup 5- to 50-percent of the cover and the vegetative

condition does not qualify as Trees, Shrubs, or Nonvascular. Includes permanent meadows and pastures *as defined in the Common Framework.*

Shrubs – a condition in which vegetation makesup more than 5 percent of the surface cover, and Evergreen or mixed shrubs makeup more than 50 percent of the total surface cover; or when the two makeup 5- to 50-percent of the cover and the vegetative condition does not qualify as Trees, herbs, or Nonvascular. Includes Shrubs under Permanent Crops *as defined in the Common Framework.*

Trees – a condition in which vegetation makesup more than 5 percent of the surface cover, and Coniferous, Broadleaved, or Bamboos and Palms, or a combination of the three, makeup more than 50 percent of the total surface cover; or when the three makeup 20- to 50-percent of the cover and the vegetative condition does not qualify as Shrubs, Herbs, or Nonvascular. Defined as forest land in previous assessments.

Coniferous – trees classified botanically as Gymnospermae, i.e. fir (Abies), pine (Pinus), parana pine (Araucaria). These are sometimes referred to as softwood. *(Same as Common Framework, 1990).*

Broadleaved – trees classified botanically as Angiospermae and in the sub-class Dicotyledonea, i.e. oaks (Quercus), poplar (Populus), teak (Tectona), okoume (Aukoumea). These are sometimes referred to as hardwoods or non-coniferous. *(Same as Common Framework, 1990).*

Bamboos and Palms – trees classified botanically as Angiospermae and in the sub-class Monocotyledonae, Bamboos (eg., Bambusa), Palms (eg., Cocos). *(Same as Common Framework, 1990).*

Common framework, 1990 – definition terms

Area

Total Area – Total area (as measured in the survey map projection) of the country, including area under Inland Water bodies.

Inland Water – Includes major rivers, lakes, and reservoirs.

Land Area – Total area, excluding area under Inland Water bodies.

Agricultural Land – Includes Arable land, land under Permanent Crops and Permanent Meadows and Pastures.

Arable – Land cultivated under temporary crops (double-cropped areas are counted only once), temporary meadows for mowing or pasture, land under market and kitchen gardens (including cultivation under glass), and such land temporarily lying idle.

Permanent Crops – Land cultivated with crops that occupy the land for long periods and need not be replanted after each harvest, such as cocoa, coffee, and rubber; it includes land under shrubs, fruit trees, nut trees, and vines, but excludes land under trees grown for wood or timber.

Permanent Meadows and Pastures – Land used permanently (five year or more) for herbaceous forage crops, either cultivated or growing wild (wild prairie or grazing land).

Forest and Other wooded Land – Land under natural or planted stands of trees, whether productive or not and exceeding 0.5 ha in extent. It includes areas occupied by roads, small cleared tracts and other small open areas within the forest which constitute an integral part of the forest.

Forest – All land with tree crown cover (stand density) more than 20% of the area [1]. Continuous cover with trees usually growing to more than about 7m in height. This includes both closed formations where trees of various stories and undergrowth cover a high proportion of the ground and open formations with a continuous grass layer in which tree synusia cover at least 10% of the ground.

Includes:

(a) All plantations, including one-rotation plantations, primarily used for forestry [2] purposes;

(b) Small areas normally forming part of the forest area which are unstocked as a result of human intervention or natural causes expected to revert to forest;

(c) Young natural stands and all plantations established for forestry purposes which have not yet reached a tree crown cover of more than 20%; [1]

(d) Forest roads, cleared tracts, firebreaks and other small open areas, as well as forest nurseries, that constitute an integral part of the forest;

(e) Forests in national parks and other protected areas;

(f) Areas of windbreaks or shelterbelts larger than 0.5 ha in extent.

Excludes:

(a) Trees Outside the Forest as defined above;

(b) Areas not meeting the conditions of forests as described above, even if administered by a Forest Authority.

Production:

Forest predominantly used or available for the production of wood. This may be subdivided between accessible (exploitable) and inaccessible for wood production (unexploitable).

Protection:

Forest with predominant function of environmental protection, where wood harvesting should be excluded or strictly controlled.

[1] In the assessment of temperate forest resources, 1990, countries which use another percentage (greater or smaller) were asked to indicate this very clearly in all tables related to area of Forest and Other Wooded Land. In the assessment of forest resources of developing countries, the minimum crown cover percentage used is 10% to match the UNESCO vegetation classification and the FAO/UNEP Tropical Forest Resources Assessment of 1980.

[2] 'Forestry' may be broadly defined as activities related to the production of wood and other goods and services of the forest.

Environmental protection includes: the protection of soil against erosion in watersheds, water flow control, air purification, wind shelter, noise abatement, etc., the preservation of habitats, the protection of fauna and flora species, the preservation of wildlife forage grounds and other biological use, recreation and amenity. It includes forest in national parks and other protect areas (unexploitable for legal reasons).

Other Wooded Land – Land which has some forestry characteristics but is not Forest as defined above.

Includes:
(a) Open woodland: Land with tree crown cover (stand density) of 5-20% of the area: see footnote 1, previous page.
(b) Scrub, shrub and brushland: Land with shrubs or stunted trees where the main woody elements are shrubs (usually more than 50 cm and less than 7 m in height), covering usually more than 20% and in any case more than 5%.

Excludes: Trees Outside the Forest.

Production:
Other Wooded Land predominantly used or available for the production of wood. This may be subdivided between currently accessible (exploitable) and inaccessible for wood production (unexploitable).

Protection:
Other Wooded Land with predominant function of environmental protection where wood harvesting should be excluded or strictly controlled. Environmental protection includes: the protection of soil against erosion in watersheds, water flow control, air purification, wind shelter, noise abatement, etc., the preservation of habitats, the protection of fauna and flora species, the preservation of wildlife forage grounds and other biological use, recreation and amenity. It includes Other Wooded Land in national parks and nature reserves.

Forest Fallows:
(Shifting cultivation) This includes all complexes of woody vegetation deriving from the clearing of Forest for shifting agriculture. It consists of a mosaic of various reconstitution phases and includes patches of uncleared forests and agriculture fields which cannot be realistically segregated and accounted separately for area-wise, especially from satellite imagery.

Other Land – Includes unused but potentially productive land, built-on areas, wasteland, parks, ornamental gardens, roads, lanes, barren land, and any other land not specifically listed under: arable land,

permanent meadows and pastures, land under permanent crops, forest and other wooded land.

Area Change

Gross increase – Average annual gross addition to the category, eg., area of Forest may be increased by afforestation or natural regeneration on Other Wooded Land, Agricultural Land or Other Land. Other wooded Land may be increased by colonization by scrub of Agricultural Land or Other Land (hectares).
Gross reduction – Average annual gross reduction from the category, eg., reduction of Forest may be by clearance for permanent or shifting agriculture or other use. Reduction of Forest may be by degradation to character of Other Wooded Land. Reduction of Other Wooded Land may be by natural regeneration or afforestation - upgrading to character of Forest (hectares).
Net change – 'Gross increase' minus 'Gross reduction' (hectares).
Plantation – Average annual area of plantation established [3] (hectares)

Includes:
(a)Forest stands established artificially by planting or artificial seeding on land which previously did not carry forest (afforestation).
(b) Forest stands established artificially by planting or artificial seeding on land which recently carried forest (at most within the previous 50 years or within living memory) and involving the replacement of a previous crop by a new crop (reforestation).

Excludes:
(a)Areas that are naturally regenerated or colonized.
(b) Areas thatcarry Trees Outside the Forest.

Ownership

Public – Forest and Other Wooded Land belonging to State and other public bodies[3] (hectares).
State – Forest and Other wooded Land owned by national, state, and regional governments or by government-owned corporations (hectares).
Other Public – Forest and Other wooded Land area belonging to towns, villages and communes, including any other publicly owned forest (hectares).
Private – Forest and Other wooded Land (hectares) which is:
(a) owned by private forest (wood-processing) industries;
(b) farm forest: owned by individuals, families or corporations engaged

[3] In many countries it is not possible to determine areas of plantations. It is, however,very valuable to get an indication of the importance of afforestation and reforestation which may include changes in species and genetic stock.

in agriculture as well as forestry;
(c) other privately owned forest including forest owned by private institutions (religious, educational, etc.).

Species

Coniferous – trees classified botanically as Gymnospermae, i.e. fir (Abies), pine (Pinus), parana pine (Araucaria). These are sometimes referred to as softwood. (Same as Common Framework, 1990).
Broadleaved – trees classified botanically as Angiospermae and in the sub-class Dicotyledonea, i.e. oaks (Quercus), poplar (Populus), teak (Tectona), okoume (Aukoumea). These are sometimes referred to as hardwoods or non-coniferous. (Same as Common Framework, 1990).
Bamboos and Palms – trees classified botanically as Angiospermae and in the sub-class Monocotyledonae, Bamboos (eg., Bambusa), Palms (eg., Cocos). (Same as Common Framework, 1990).

Volume

Growing stock – Inventoried volume of growing stock over bark, measured to a minimum diameter **(cum o.b.)**.
Biomass of inventoried volume – The biomass of inventoried growing stock volume over bark (mt o.d.w.).
Total above-ground tree biomass – Sum of 'Biomass of inventoried volume' and 'Other above-ground woody biomass' measured in units of oven dried weight (mt o.d.w.).
Other above-ground woody biomass – The biomass of inventoried growing stock volume over bark of above-ground tree components not covered in the inventoried material: stems and branches below the minimum inventory diameter, tops and other (e.g. twigs and foliage). It excludes stumps and roots (mt o.d.w.).

Recommendations

1. Review current terms and their definitions used by the World Forest Resources Assessment. Accept the term and its definition if the following criteria are met:

a) The term is neutral or positive in acceptance by both resource use and the environmental protection communities.
b) The definition is currently valid and needed for current and future reporting and analysis purposes.

Several terms that should be considered for revision or elimination include: High forest, coppice, and coppice with standards (too specific for World Assessment analyses), exploitable/unexploitable (nega-

tive to the environmental community), closed/open forests and scrubland (best portrayed by stand density classes), and forest fallows (difficult to disaggregate).

2) Review crown cover (stand density) concept of classifying tree land (forest land) in light of emerging technology as to the appropriate minimum density required to delineate the extent of the forest resource. A provisional worldwide standard should be developed based on remotely sensed data for major forested regions.
3) Review "stocking-level" concepts for determining the extent of tree land (forest land) based on field measurements. How should relate to (2) above.
4) Consider introducing the measurement of key vegetative attributes that relate to defining biodiversity, forest health, site protection, climate change, and bio-productivity.

Suggested table formats for global 2000 assessment

Global Table Formats-Area

Table 1.– Land and water areas for countries of the ECE by region and country, 2000

Region and Country	Total land and water area	Land					Total water area
		Total land	Tree land			Other land	
			Total	Available tree land	Reserved tree land		
	(thousand hectares)						

Table 2.– Land area for countries of the ECE by country and land class, 2000.

Region and country	All Land	Tree land				Nontree land
		Total	Timberland	Timberland reserved	Other tree land	
	(thousand hectares)					

Table 3.– Area of tree land for countries of the ECE by country and ownership class, 2000.

Region and country	All Ownerships	Public		Private		
		State	Other	Industry	Farmer	Other private
	(thousand hectares)					

Table 4.–Area of tree land for countries of the ECE by country and forest type, 2000.

Region and country	Total	Coniferous			Broadleaved		
		Spruce	Fir	Pine	Birch	Poplar	Maple
	(thousand hectares)						

Table 5.– Area of tree land for countries of the ECE by country and stand-size class, 2000.

Region and country	All Class	Stand-size class			Nonstocked Areas
		Mature	Immature	Seedlings and Saplings	
	(thousand hectares)				

Table 6.– Area of tree land for countries of the ECE by country and site, 2000.

Region and Country	All Class	Site class (cubic meters/hectare/year)				
		> 8.5	6.0–8.4	3.5–5.9	1.0–3.4	<1.0
	(thousand hectares)					

Table 7.– Area of tree land for countries of the ECE by country and stocking class, 2000.

Region and Country	All Classes	Stocking class (Percent)				
		>70	50–69	40–49	10–39	<10
	(thousand hectares)					

Regional Table Formats-Area

Table 8.– Area of tree land by forest type and ownership class, Eastern Asia, 2000.

Forest Type	All Ownerships	Public		Private		
		State	Other public	Forest industry	Farmer	other private
	(thousand hectares)					

Table 9.– Area of tree land by ownership class and stocking classes of trees, North America, 2000.

Ownership class	All Class	Stocking class (percent)				
		> 70	40–69	20–39	10–19	<10
	(thousand hectares)					

Table 10.–Area of tree land by forest type and stand-size class, Central America, 2000.

Forest type	All Classes	Stand-size class			Nonstocked areas
		Mature	Immature	Saplings-Seedings	
	(thousand hectares)				

Other Tabular Formats–Global and Regional

Table 11.–Number of live trees on tree land by species and diameter class, Western Europe, 2000.

Species	All Classes	Diameter class (Centimeter at breast height)							
		2.5–12.6	12.7–22.7	22.8–27.8	27.9–32.9	33.0–43.0	43.1–53.2	53.3–73.6	73.7 Larger
	(thousand trees)								

Table 12.–Number of growing stock on tree land by species and diameter class, Eastern Europe, 2000.

Species	All Classes	Diameter class (Centimeters at breast height)							
		2.5–12.6	12.7–22.7	22.8–27.8	27.9–32.9	33.0–43.0	43.7–53.2	53.3–73.6	73.7 and Larger
	(thousand trees)								

Table 13.–Volume of growing stock on tree land by species and diameter class, East Africa, 2000.

Species	All Classes	Diameter class (centimeters at breast Height)							
		2.5–12.6	12.7–22.7	22.8–27.8	27.9–32.9	30.0–43.0	43.7–53.2	53.3–73.6	73.7 and Larger
	(million cubic meters)								

Table 14.–Volume of growing stock and mass on tree land for countries of the ECE by country and species group, 2000.

Region and country	All Species	Growing stock		All Species	Mass	
		Coniferous	Broadleaved		Coniferous	Broadleaved
		(million cubic meters)			(million metric tons)	

1/Includes growing stock (mature and immature), rough trees, rotten trees, and saluable dead.

Table 15.–Volume of timber on tree land by class of timber and species group, Andean Region, 2000.

Class of timber	All Species	Species group	
		Coniferous	Broadleaved
	(million cubic meters)		

Table 16.–Volume of live trees and growing stock on tree land by ownership class and species group, Oceania developed, 2000.

Ownership Class	Live trees			Growing stock		
	All Species	Coniferous	Broadleaved	All Species	Coniferous	Broadleaved
	(Million cubic meters)					

Table 17.–Average net annual growth of growing stock on tree land for countries of the ECE, by country and species group, 2000.

Region and Country	All Species	Coniferous	Broadleaved
	(Million cubic meters)		

Table 18.–Average annual removals of growing stock on tree land for countries of the ECE, by country and species group, 2000.

Region and country	All Species	Coniferous	Broadleaved
	(million cubic meters)		

Table 19.–Average net annual growth and average annual removals of growing stock on tree land by species, West Asia, 2000.

Species	Growth	Removals
	(million cubic meters)	

Table 20.–Average annual mortality of growing stock on tree land by species, Caribbean, 2000.

Species	Growing Stock
	(million cubic meters)

Summaries of Voluntary Papers

Future Forest Resource Assessments in Nigeria: Problems and Prospects

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This paper reviews the historical development of forest resource assessment in Nigeria. Forest inventory in Nigeria dates as far back as the 1930's with early efforts being localised inventories by State Forestry Departments. In the 1970's however two large scale studies were carried out by the Federal Department of Forestry (FDF), namely the indicative high forest inventory (IHFI) of Southern Nigeria and the national vegetation/land use survey with the aid of the Side Looking Air-borne Radar.

FDF has already embarked on a programme of continuous Forest Inventory involving a network of permanent sample plots established within the IHFI sample area, and has planned the first National forest inventory, which is yet to take off due largely to financial constraints. Problems facing the proposed NFI are discussed, and some recommendations made for its successful execution.

Keywords: Forest inventory, inventory design, land use.

Assessment of Non-forestry Plantations – World Rubberwood Supply

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The main results of the resource assessment on world rubberwood supply are presented, including plantation area, wood production potential, utilisation, socio-economic aspects and environmental issues. In 1991 the total rubber plantation area in the world was 9 million hectares, mostly in Asia, with an average growing stock of 95 m^3/ha. The annual production potential of rubberwood is currently 39 million m^3 of which 11 million m^3 is suitable for saw and veneer logs. It is estimated that the potential production will grow up to 50 million m^3 by 2010. At present about 8 million m^3 of rubberwood logs would be economically available, but only 4.5 milllion m^3 are utilised, mostly by sawmills. Rubberwood can significantly improve the profitability of rubber plantations, of which 75% are managed by smallholders. The world rubber plantations employ directly about 5.4 million people. Rubber plantations have generally a positive impact on environment and rubberwood production reduce the pressure on natural tropical forests.

Keywords: rubberwood, resource assessment, production, utilisation, economics.

The French Forest Inventory: An Unsuspected Approach to Some Non-Wood Benefits of Forests

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The "historical" mission of the French national forest inventory (NFI) was, and still is, to describe the forest resource. Using aerial photographs for that aim, NFI has now two full covers of France and third cover being constituted; it, therefore, has an unique opportunity to monitor land use. Some environmental parameters are already collected through photo-interpretation: land use, actual vegetation type (forest, other wooded lands), and through field measurements: tree species composition, biomass estimate, topography, forest soil and herbaceous vegetation characteristics. NFI also conducts special natural resources inventory and ecological studies.

After drawing maps at a 1/200 000 scale and building a cartographic data base, NFI is now going towards an ecological data base. During the 80's, new parameters were being observed for site classification purpose. In 1992 the setting of a data logic model has been conducted so that in 1994 an ecological data base will be available. All that may lead to geographically referenced data with analysis possibility, and make environmental data available widely. Next phase is an ecological layer of a GIS, with a 25 meters precision, compatible with satellite image processing.

The main limit encountered by the method is that environmental data is not yet considered worthy: those who could pay for it do not feel concerned, those who feel concerned cannot pay for it. The major benefit obtained is a better knowledge of local natural resource, and, in fine, a possible evaluation of forest management sustainability.

In conclusion, environmental parameters are more than just a "by-product" of the French NFI, they are one of the keys to sustainability monitoring.

Forest Resource Accounting

A joint project of the
World Conservation Monitoring Centre
and the
International Institute for Environment and Development

Presented by Mark Collins

Forest Resources Accounting (FRA) is a joint project of the World Conservation Monitoring Centre and the International Institute for Environment and Development, and is funded by the UK Overseas Development Administration as a contribution to the International Tropical Timber Organisation.

The objective is to establish a mechanism for integrated quantitative and qualitative monitoring of forest changes including area, location, legal status, management, forest type and condition. It is designed to report these changes in ways which help to improve forest valuation, policy, planning and management. FRA offers both a tool for setting national strategy for sustainable management of forests and a cost-effective way of demonstrating progress in achieving strategic objectives.

Brief feasibility studies for developing national FRA systems have been conducted in Cameroon, Ecuador and Indonesia. They conclude that FRA is appropriate to countries at different stages. Discussions outside these three countries also suggest that FRA is just as appropriate for temperate and boreal countries and these countries may be more immediately able to realise its full potential. In fact, FRA would be feasible in all countries in at least a rudimentary form, since a broad range of information and monitoring of forest dynamics is now crucial to any forest strategy. FRA must be a continuous process, not just a one-off information-collecting exercise. Countries already have many parts of the process in place although there will be a significant need for capacity-building to accompany FRA.

A strong distinction can be made between FRA for national purposes and FRA for international purposes. FRA at national level will complement independent forest certification at the forest/concession level and labelling at the product level. International reporting and information-sharing can be a by-product of national reporting.

Concise Description of the Senegal Forest Inventory Situation

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The purpose of the paper was to give an answer to such questions as:
- how is the national forest resources information obtained;
- what is covered; and
- for which types of information do statements of reliability exist?

The following conclusions were drawn:

In developing countries, it is very hard for the technicians and politicians to have the same priority in the development of the national resources.

For the technicians, a national forest (or natural resources) inventory is very important in view of the better forest management. For the politicians, again, the high cost of this operation is the main constraint which can reduce its priority.

The services and structures involved in the rural development have to be coordinated. All tools and opportunities available have to be utilized to increase knowledge of each zone.

For the development of the country, the Ecological Monitoring Centre (CSE), with its modern equipment and qualified human resources, can offer within this framework an appreciable and useful support to all the departments of Rural Development.

Forest Resources Inventory and Monitoring in China – Past Developments, Present Situation and Future Trends

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For almost half a century, the forest inventory in China, started from the very simple polygonometry survey, has developed into an integrate system which employs the statistical methodology and the modern technology. This paper is to give a general review of past technological developments of forest resources inventory in China. It will also give a brief introduction to the situation of current national forest inventory. With highlights of "the Establishment of a National Forest Resources Monitoring System", a project jointly supported by FAO/UNDP and the Chinese Government, it is to discuss the future trends of forest resources monitoring and/or assessment in China.

Keywords: China, forest resources inventory, forest resources monitoring.

Economical Assessment of Tropical Forest Using Forest Inventory Data

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The simple presentation of timber volume data per species and per hectare is not enough in many circumstances for an assessment of the true potential use of tropical forest. Several factors as accessibility, timber value at the market or timber volume by valuable groups of the present species must be taken into account to obtain a more accurate assessment of forest value. These factors, based on data of low cost forest inventory, may offer enough information to investors for their decision on the need of more detailed studies and forest management plans.

The "a priori" forest assessment is calculated through the weighted average of the *value indexes,* which are obtained through the following four factors:

- Weighted index of the valuable species group price
- Proportional area of each layer or forest type
- Exploitability index
- Compensation factor Price-Cost

The major problem found for using the method is the obtention of real and updated values of the timber prices in the local market. These prices vary very much in relation to time and locality, and the local tropical timber market is still far from being organized. In spite of this problem, the method demonstrates to be practical and greatly useful in the decision making process for investment.

For an economically viable logging and management (and therefore, an economically viable investment decision) of an average tropical forest, representing the Peruvian Amazon, a minimum of about 30 m^3/ha of commercial timber is required, combining the values of three valuable group species. In case of specific logging of species of very high commercial value, the availability of about 4 m^3/ha should be required. Normally, the real average volume is less than 1 m^3/ha and, therefore, a combination with greater volumes of other group species is necessary in order to justify any investment. Consequently, the economically viable alternative is the integral management of the tropical forest, which needs the resolution of the market problem.

Planning Forest Management and the Role of Measurement of Non-Wood Services in the Forest

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Head of Statistics Section
Wageningen, Netherlands

In the Netherlands many government plans have been made during the last decades to meet the needs of society. Not only a National Environmental Plan, adjusted almost every year, but also plans on nature and forestry. One of these plans is the Long-term Forestry Plan. In it 82% of the Dutch forest is mentioned as "multi-functional forest" and 18% as forest with accent on nature development.

Based on the discussion of forestry planning the following conclusions were drawn:

1. With the development in thinking the functions of the forest more interest is to be expected for non-wood services.
2. Assessment of non-wood services will be highly connected with the goals in a certain forest area. If we want to know the qualities over a larger area or over the whole country, a special inventory will be necessary.
3. Adding of non-wood services in the Global Forest Resources Assessment should be on a not too detailed level, so that results can be obtained by extrapolation of existing sources.
4. Adding of non-wood services will nevertheless be important to facilitate the comparison between countries and regions and to assist the responsible use of our forest.

National Forest Inventory of Finland

Erkki Tomppo
Professor of Forest Inventory
The Finnish Forest Research Institute Helsinki, Finland

The total land area of FinIand is 30.5 million hectares and the forestry land area 26.4 million hectares, of which 23 million hectares are suitable for wood production. The total growing stock is 1900 million m^3 and the annual increment 80 million m^3 while the annual removal, cuttings and natural losses, was 54 million m^3 at the end of eighties. The annual value of exports of forest industries products was at the end of 1980's 40 billions FIM, corresponding to about 50 percentages of the net income from foreign trade. Forestry and the forest industries thus form the most important single industrial sector in Finland.

The Finnish National Forest Inventory has produced unbiased, reliable large-area forest resource information for over 70 years. The information has been utilized in large area forest management planning, such as determining the level of cuttings and other treatments needed, as the information basis of the official forest policy, in the strategic planning of the forest industries, as the basis for forest income taxation, and, more recently, for calibrating the level of estimates of standwise inventories. Data which can be used in assessing biodiversity have from the beginning been included in the inventories, and variables related to forest health from the seventh inventory (1977–1984). Their role have been emphasized in the recent changes.

The Finnish Forest Research Institute began to develop a new inventory system in 1989 in connection with the eighth inventory, in order to obtain geographically localized, up-to-date information and for areas smaller than before.

The method exploits satellite images (Landsat TM) and digital map data in addition to the ground measurements. The system is now operative and the inventory has been applied to an area of about 10 million hectares, producing thematic maps and statistics for large and small areas (even single stands).

The new inventory system makes it possible to estimate all the variables of the national forest survey for each point of the country. The variables include the properties of site type, soil, growing stock,

mortality, cutting, and damages and diseases. The geographically localized information can be stored in digital form and be transferred easily into the users' databases for further processing. Tree and stand models and simulation between two image acquisition dates will be applied for updating of estimates.

The inventory method is thus changing from the repeated temporary field inventories to an up-to-date, multi-source forest resource monitoring and forest management planning system. In addition to the traditional publications, the inventory results will be supplied as thematic maps and in digital form for further processing. The utilization of the inventory results is creating new co-operation between practical forestry and forest research.

Field Excursion to Imatra

Enso-Gutzeit Oy
Enso Forest Development Oy Ltd

Wednesday 5 May 1993

12:00 – 14:00	Kotka – Imatra by bus. Description of inventories for forest management planning in Finland by Prof. K. Kuusela
14:00	Introduction to forest inventories in Enso-Gutzeit Oy
	Early inventories of Enso-Gutzeit Co: Professor A. Nyyssönen
	Demonstration of present inventories and management planning: Chief Forester J. Pekkarinen
	Coffee in the forest
15:30	Kaukopää pulp and paper mills
	The raw material supply of Enso-Gutzeit Co: Managi ing Director Y. Schildt
	Kaukopää mills: Director M. Savolainen
	Visit to papermill and to wood handling department
17:00	Enso guest house
	Forest development activities in Enso Forest Development Oy Ltd: Managing Director Y. Schildt
17:30	Discussions and dinner
19:00 – 21:00	Imatra – Kotka by bus

Photographs



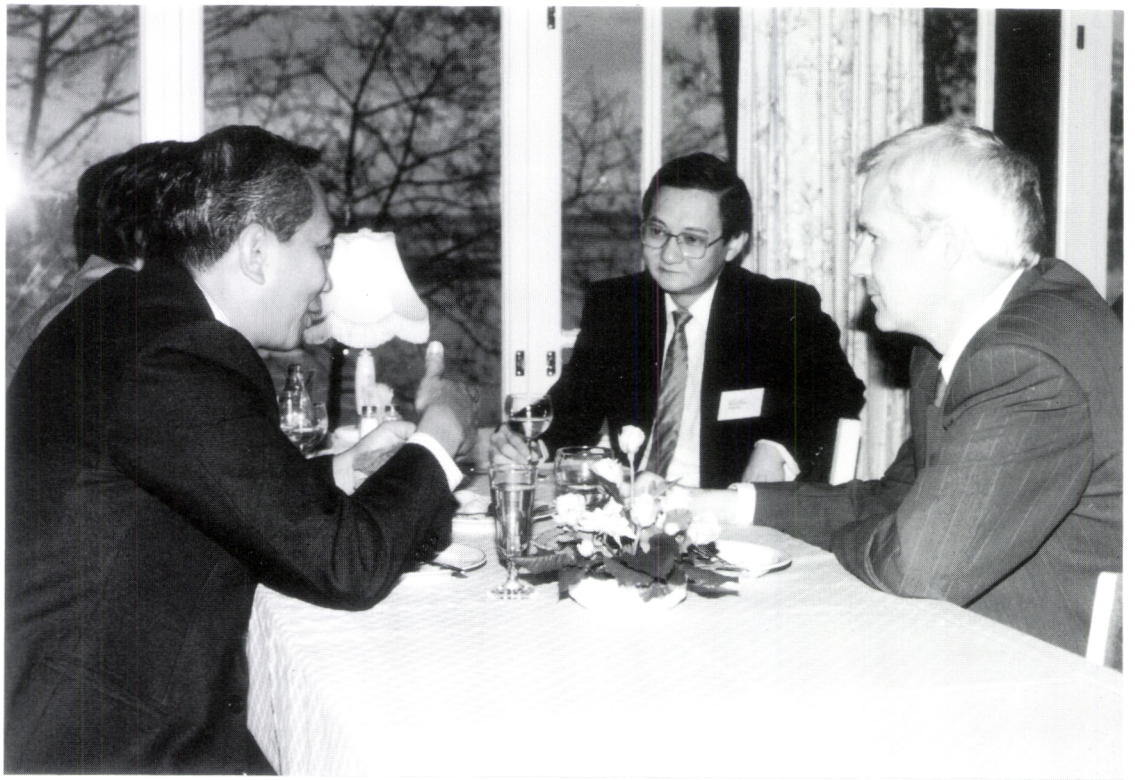




Reception









Excursion



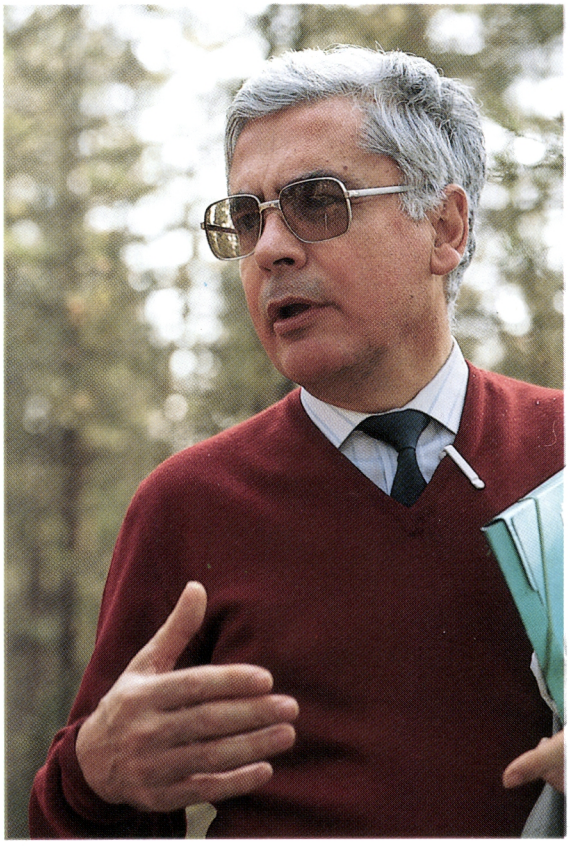






Meet the Press





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