Forestry Department
Food and Agriculture Organization of the United Nations

FRA 2000

PROCEEDINGS OF THE FAO EXPERT CONSULTATION TO REVIEW THE FRA 2000 METHODOLOGY FOR REGIONAL AND GLOBAL FOREST CHANGE ASSESSMENT

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The Forest Resources Assessment Programme

Forests are crucial for the well-being of humanity. They provide foundations for life on earth through ecological functions, by regulating the climate and water resources, and by serving as habitats for plants and animals. Forests also furnish a wide range of essential goods such as wood, food, fodder and medicines, in addition to opportunities for recreation, spiritual renewal and other services.

Today, forests are under pressure from expanding human populations, which frequently leads to the conversion or degradation of forests into unsustainable forms of land use. When forests are lost or severely degraded, their capacity to function as regulators of the environment is also lost, increasing flood and erosion hazards, reducing soil fertility, and contributing to the loss of plant and animal life. As a result, the sustainable provision of goods and services from forests is jeopardized.

FAO, at the request of the member nations and the world community, regularly monitors the world's forests through the Forest Resources Assessment Programme. The next report, the Global Forest Resources Assessment 2000 (FRA 2000), will review the forest situation by the end of the millennium. FRA 2000 will include country-level information based on existing forest inventory data, regional investigations of land-cover change processes, and a number of global studies focusing on the interaction between people and forests. The FRA 2000 report will be made public and distributed on the World Wide Web in the year 2000.

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The Governments of Finland, Japan, Sweden, Switzerland and the United Kingdom provided support for the Forest Resources Assessment 2000 Programme and this workshop in addition to the regular programme contributions of all the FAO member countries. The Governments of Denmark, Italy, Finland, France, Sweden, and the United States of America have also provided valuable in-kind contributions of goods and services to the assessment and/or the funding of Associate Professional Officers.

This report is based on daily minutes, technical discussions and working sessions of the meeting and the background document. The purpose of this report is to present a new proposal for estimating forest-cover change based on existing country information. FRA 2000 expects that the results of this meeting will contribute to an improved understanding of the world's forest resources and how they are changing over time.

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Abbreviations

AVHRR	Advanced Very High Resolution Radiometer
BEF	Biomass Expansion Factor
BV	Biomass of inventoried volume
CATIE	Centro Agronómico Tropical de Investigación y Enseñanza
CIFOR	Centre for International Forestry Research
Cirad	Centre de coopération internationale en recherche agronomique pour le développement
EDC	Eros Data Centre
EZ	Ecological Zone
FAO	Food and Agricultural Organization of the United Nations
FORIS	Forest Resources Information System
FRA	Forest Resources Assessment
GIS	Geographic Information System
LET	Laboratoire d'Ecologie Terrestre
NFI	National Forest Inventory
NGO	Non-governmental organization
SNU	Sub National Unit(s)
UN-ECE	United Nations Economic Commission for Europe
VOB	Volume Over Bark
WD	Wood Density
WCMC	World Conservation Monitoring Centre
WFS	World Forest Survey

1 Introduction

FAO organized an expert consultation from 6 to 10 March 2000 to help evaluate a range of technical options for estimating forest change for FRA 2000. Mr. El Hadji Sène, Director of the Forest Resources Division (FOR), initiated the workshop.

1.1 Opening of the session and welcome to participants

Mr. El Hadji Sène welcomed the participants to the expert consultation and expressed his gratitude for the contribution of the time and expertise of all the participants. He invited the experts to interact and candidly share their views with FRA staff members.

Mr. Sène highlighted FAO's mandate to provide worldwide information on forest resources and stressed the importance of this information in light of the need of member countries to manage and wisely use their forest resources. He stressed the need to report accurately and to fine-tune the methodologies related to data collection, processing and dissemination of this information.

1.2 Secretariat

Robert Davis, FRA Programme coordinator, invited the visiting experts and Programme staff members to introduce themselves. He noted that the experts were selected on the basis of their specialised knowledge and serve in their personal capacities and not as representatives of their governments. In this respect, FAO serves as a neutral forum to facilitate critical discussion on various aspects of food and agriculture, including forestry.

Risto Päivinen, Deputy Director, European Forest Institute, from Finland, was elected Chair of the expert consultation. Robert Davis was elected vice-Chair and Andrew Gillespie from the Forest Inventory and Analysis (FIA) Unit, U.S. Department of Agriculture, Forest Service, from the United States was elected rapporteur to the meeting.

1.3 FRA objectives

The immediate objectives for FRA 2000 are to:

1) Carry out an assessment of forest resources (including information on products and services provided by forests) on a global basis.
2) Estimate the changes in forests that have taken place since the last assessment in 1990.
3) Compare these changes with the results of all past assessments to establish trends.
4) Provide information that helps understand the reasons for and the effects of change, including the social, economic, and environmental implications.
5) Disseminate results, databases, and methodologies to interested national and international institutions, world-wide.

FRA will provide the basic source of information and knowledge on the world's forest resources. It is expected that FRA 2000 will facilitate discussion at all levels and stimulate decision-making on how to manage and protect forests at the global scale.

In collaboration with co-operating institutions and member countries, FAO is also working to compile required information and develop a comprehensive understanding of the situation regarding changes in forests at the national level during the 1990 – 2000 timeframe. The present expert meeting reflects FAO's commitment to carry out FRA 2000 through a collaborative process that engages experts from around the world to contribute their expertise and assistance. The results of the of this expert meeting will form an integral part of the FRA 2000 publication series as well as set the stage for conducting the final FRA 2000 report on forest change.

The FRA 2000 work is carried out by FAO, in the field and at its headquarters in Rome, with the assistance of donors, partners and member countries alike. One component, the compilation of country data for developed countries, is based in Geneva and is carried out jointly by FAO and UN/ECE.

1.4 Implementation of FRA 2000

FRA 2000 is implemented by FAO and UN-ECE in cooperation with many partners. The FRA programme in Rome is responsible for the overall management and coordination of the assessment. The FRA programme maintains the Forest Resource Information System (FORIS) database where basic forestry data from developing countries is archived. Other units within the Forestry Department also contribute to FRA 2000 by carrying out special studies related to non wood forest products, trees outside forests, fellings and removals, plantation surveys, etc. The FAO Regional Offices support data gathering activities in their respective regions.

All UN and FAO member countries have been formally requested to provide new data for the assessment and assist in the validation of the results. Country involvement is of particular importance for estimating forest area and change in area over time.

1.5 Expert consultation presentation, justification and objectives

Several initiatives have addressed the forest change issue over the past decade. These efforts have used a range of approaches, from assessments using remote sensing, sampling or modelling, to in-depth case studies. This has increased the knowledge about and awareness of forest changes, and FRA 2000 intends to capitalize on these findings and build on the available expertise and experiences to collect and analyse national information on forest change.

Ten outside experts[1] were invited to attend an expert consultation at FAO Headquarters, Rome. They reviewed preliminary information submitted by countries within the framework of FRA 2000 and the range of options for adjusting the existing information to a standard reference year in order to estimate the changes in forests over the past decade. Participants provided their input on the latest findings concerning forest change and reviewed the state–of –the art in measuring and estimating such changes.

[1] See list of Participants Appendix # 6

Special attention was given to:

a) identifying the parameters and variables available and necessary for predicting and adjusting national forest statistics to the common reference year 2000;
b) outlining and defining procedure(s) for predicting forest cover state and change using the identified variables ;
c) implementing a test-case scenario using the recommended procedures and variables.

2 Background information about forest cover change analysis [2]

FRA 2000 prepared and presented a background paper[3] on possible information sets that could be used for the forest-change prediction algorithm. The experts were asked to review the paper and evaluate the proposed options for the forest change estimation procedure in anticipation of the workshop. In discussing these at the meeting, the participants were asked to consider these and other approaches based on their experience and expertise. .

2.1 Type of information and collection process

Given the scope and complexity of FRA 2000, various approaches to data capture are needed to cover all aspects of the assessment. Three basic and complementary information generation mechanisms, or modules, available to FRA 2000 are a) an assessment based on existing information, b) an assessment based on newly generated information through a global remote sensing survey and c) special studies.

The collection of existing information is a continuous process. For every new assessment the data sources used in the previous assessments are consulted and new sources identified through contacts in the countries. When new sources are identified, they are compared with the older information to determine which provides the best and most reliable baseline[4].

Comparability[5] between two (or more) information sources is also evaluated, verifying their utility to serve as representative surveys in a continuous time-series. Information sources for the FAO assessments typically include:

- Tabular data derived from forest inventories and land cover surveys
- Forest and land cover maps in digital or analogue format
- Documents (inventory reports, etc.)

Frequently, many institutions contribute all the information needed for an assessment. These include forestry agencies (particularly their inventory, statistics or mensuration units), environmental and natural resources agencies, resource survey units and mapping and remote sensing institutions. Other organizations, such as regional development agencies, may also

[2] Section number 2 was taken from: Päivinen. R. and Gillespie, A. 2000**.** *Estimating Global Forest Change:1980-1990-2000***.** A background document prepared for an international panel of experts convened to review methods to be used in completing the FAO Global Forest Resource Assessment (FRA 2000), Summary Section iii. FAO, Rome.

[3] See background document, Appendix #2

[4] *Baseline* refers to the inventory or assessment used for estimating forest area according to FAO standard classification and reference year. The single most appropriate assessment is always used as the baseline. Appropriateness is a function of reliability, currency and compatibility with the FAO assessment objectives.

[5] *Comparability* between assessments requires that the techniques and protocols employed in the various surveys are sufficient to produce findings that can be compared. Few countries today, even in industrialized regions, are generating comparable multi-date information as techniques and assessment objectives frequently change from survey to survey.

provide relevant information. With this in mind, data compilers need to check with a range of national agencies and organizations to ascertain the existence of new information.
Once the new data are transmitted to FAO they are reviewed and recorded into a bibliographic reference system and archived in the FRA Programme's library.

2.2 Country data

Many countries that have forested land are interested in the status and trends of forest cover, growth, mortality and removals. Some countries have in place systems for monitoring their forests on a periodic or occasional basis. Other countries have conducted studies of subsets of their forests; for example, studies of opportunities for potential commercial operations. Many developing countries have undertaken complete or partial forest inventories sponsored by a variety of developmental organizations including FAO, the International Bank of Reconstruction and Development (World Bank) and various international donor agencies.

The result is a huge set of information regarding forest status and trends at the national and sub-national level. If all of this information was current, reliable, aggregated in a single location and collected to a standard format, it would possible to readily incorporate it into a report of forest change for FRA 2000. In reality, such information is scattered in the various countries, development agencies and donor programs across the world, and is difficult to access. Nonetheless, FRA 2000 professional staff have been working for years to make and keep current a meta-database describing what data exist, by country, throughout the tropical world, as well as archiving the actual data in the FORIS (Forest Resources Information System) database (see section 6.4). Regional specialists travel to the countries in their region, gleaning available information and assembling it for potential incorporation into FRA 2000 and future studies

2.3 Strengths, constrains and lessons learnt from previous assessments

2.3.1 Country data analysis

The strength of using data reported by countries is that results tend to be of higher precision than results from studies that only use regional data, such as the FRA 1990 remote sensing survey (see FRA 1990).

The primary weakness in the aggregation of country level inventory data is that there is tremendous inconsistency and incompleteness, both within countries over time as well as between countries. Assessments are conducted with different objectives and populations of interest, using different definitions, standards, sample designs and field methods from those used by FAO or by neighbouring countries. The results can be difficult to interpret and harmonize for comparison across countries, as FRA must do. Additionally, many countries, particularly in Africa, simply lack the resources to conduct forest assessments, so data are lacking.

2.3.2 Models used in the 1990 forest change assessment

FRA 1990 used a statistical model to generate estimates of forest change for countries. The strength of a modelling approach such as this is that it provides a platform to generate

estimates for all countries regardless of availability of country-level data. Data gaps would simply be modelled by more generalized functions. Generation of models is a useful exercise in that it forces the study of cause and effect relationships and can lead to insights regarding true mechanisms or drivers of forest cover change, which in turn could lead to better investment decisions by national governments seeking to manage their forests.

The results of existing models are probably reasonable at the global level. However, the greatest weakness of the modelling approach continues to be the inadequacy of existing models when applied to specific countries. Deforestation is such a complex process involving physical, climatological, political and socio-economic forces that are themselves very complex, that no simple generalized models of forest change have been developed that produce satisfactory results for all countries. Current models are oversimplified and yield similar predictions of forest cover change rates for countries that are known to be very different. More complex models are yet to be developed and tested.

2.3.3 The FRA 1980 forest change assessment

The FRA 1980 estimation method relied heavily on a review of existing sources, complemented by the opinions of experts experienced in the countries. These experts evaluated the reliability of the existing sources and contributed additional knowledge and information on the situation for each country in order to identify factors and processes involved in forest change. National forest cover state and change were then subjectively estimated through expert opinion and review of the information.

The strength of the FRA 1980 method lies in the large range and amount of supplementary information the experts provided through their in-depth knowledge of the countries' forests, arriving at relatively precise statements. The disadvantage of using expert opinions was the implied bias (deviation from true values) that always accompanies subjective estimates. Nevertheless, this approach represented the state of the art for global assessments at the time, and the range of qualitative information produced by the assessment is unmatched today, though much is now outdated.

2.3.4 FRA 2000 forest change assessment

FRA 2000 recognizes the importance of developing and improving methods to collect, analyse and process data from a variety of sources, including remote sensing information, to assess the change in forest cover world-wide at the national, regional and global levels. The experts were urged to provide concrete recommendations and advice about methods to improve the FRA programme.

In regard to the harmonization of FAO and country standards and definitions for such things as "forests", "forest degradation" and "deforestation", it was indicated that both local and FAO official terms and definitions will be entered into the database, which may aid in eventual harmonization.

The key end product of the FRA 2000 process for each country, its country profile web page, contains information divided into 11 subjects. It is currently under construction and available only within FAO. Data and definitions included in the web site derive from different sources, but mainly from the countries. After the information is entered it is sent to countries for feedback and validation

3 Existing data sources for change assessment

Regional presentations by the FRA staff members and consultants responsible for Asia, Anglophone Africa, Latin America and the Caribbean illustrated the parameters for estimating the utility of existing data sources for change assessment. The presentations highlighted the following key parameters: type of change information or data; coverage; periodicity of data; compatibility of time series; reliability of inventory field work; validation of remote sensing data; compatibility with FAO classifications; overall quality.

Table 1. Metadata about country-level forest inventory data available to FRA 2000.

(1) Reference with recent data

Reference contains the most recent data or the reference provides change data. In case of two independent inventories/surveys see option # 3.

(2) Reference with old data

Select the reference containing the latest data.

(3) Type of change information or data

a) Change information is derived from a series or cycle of (national) forest inventories, for example the National Forest Survey of India.
b) Change information is based on two independent inventories.
c) Basic information is available that could be used to predict change.

(4) Coverage

- National (N), or
- Partial (P), covering state(s), province(s) or otherwise.

(5) Year(s) of data

Reference years of the two data sets in the time series.

(6) Classification

- High (H): same classification has been used in the two inventories;
- Medium (M): differences in classification still allow a comparison (for instance, by aggregation, reclassification or compatibility between certain classes);
- Low (L) incomparable classification.

(7) Methodology

- High (H): same (consistent) or practically same inventory methodology has been applied;
- Medium (M): methodology differs in some aspects, for instance different remote sensing data used or different field sampling design;
- Low (L): methodologies are incompatible.

(8) Interdependent analysis

- Yes (Y): interdependent interpretation or analysis of the (remote sensing or field plot) data, meaning that analysis of the more recent data or results is done with reference to the former, preferably by the same interpreter;
- No (N): two independent inventories.

(9) Type of remote sensing data

Here the type of remote sensing data (aerial photos, Landsat TM, etc.) is listed. In general, the higher the resolution, the higher the utility/quality for change assessment.

(10) Type of field work

- Repeated measurements of permanent sample plots (P);
- One time measurement (O);
- Combination of the two (T);
- None (N).

(11) Comparability with FAO classification

Judgement on compatibility of the national definitions of forest and deforestation (applied in the time series or change study) with FAO's definitions (see FRA 2000 Working Paper 1, Terms and Definitions).

- High (H): no (basic) differences in classification schemes;
- Medium (M) comparability due to some differences in classification schemes;
- Low comparability due to significant differences in classification schemes.

(12) Overall quality

Based on all criteria a judgement can be made on the overall quality of the forest change information for estimating national forest change in FRA 2000. Three classes are distinguished:

- High (H);
- Medium (M);
- Low (L).

3.1 Data assessment report

The larger group was split into three sub-regional working groups: Asia, Africa and Latin America. An attempt was made to have a distribution of technical skills (modelling, remote sensing, statistics) in each group. FRA Country Information Coordinators (CICs) joined each group.

The FRA Country Information Coordinators made a first attempt to categorize the available information and the utility of the data for change evaluation. The regional groups revised the information sets and modified or confirmed the ranking of data availability scores within their data sets. Participants decided to categorize data availability in terms of high, medium and low. This ranking was established according the reliability of the data, information dates, periodicity and source of information. These rankings were later referred to as traffic lights,

and were used to produce a map showing the availability of FRA data (see Appendixes 1 and 2).

3.2 Summary data assessment report

Using the revised information, the regional groups constructed scenarios for generating estimates of forest state and change, including options, criteria, resources required and the rationale for their region. The groups presented their scenarios and modified the "traffic lights" in plenary session. The summary conclusion was that the Asia working group works with high-utility information from its countries, the Africa working group works with low-utility information while the Latin America working group works with medium-utility information.

3.2.1 Development of scenarios in order to generate change assessment and state in Africa

The group found no grounds to change from its assessment of low utility data. Information is poor in most countries.

Conclusions

- AVHRR will not be useful, mainly because of poor performance in dry and semidry areas.
- Intensifying the remote sensing survey seems to be a feasible approach. This is further elaborated.
- Narratives on forest change processes are useful to provide an understanding and to justify the approximations.
- Use of expert opinion when weighting the various data sets is a promising approach.

Expert approximation of forest change 1990-2000 for FRA 2000

The Africa group developed the following table to show how all available data for each country could be summarized for purposes of review and eventually weighting to arrive at a final estimate.

Utility criteria include: time period, coverage and precision/accuracy. It is important to define how deal with partial/regional observations, how to weight experts opinions to get a FAO estimate, how to weight observations outside the time period, how to establish guidelines on weighting, and how to disseminate the information and procedures (should the whole table be published).

Table 2. Assessment table.

Source	Utility info					precision/ accuracy	Weights by "experts"		
							FRA Panel	Expert opinion	Original sources of information
COUNTRY DATA									
State A-State B				C		2	0	0.5	0
State A- State C				C		1.5	1	0	0.5
FRA RSS									
Samples				P			NA	NA	NA
Country				C		3	0	0	0.5
Regional				R		2.11	NA	NA	NA
MODELS									
Model 1990				C		4.7	0	0	0
"OTHER"									
Province X				P		11	NA	NA	NA
EZ Y				R		-0.3	NA	NA	NA
Expert NN				C		0	0	0.5	0
Combination ABC				C		2	0	0	0
TOTAL							***1.5***	***1***	***2.25***
"NEW INFO"									
State A-D							NCY	NCY	NCY

-> FRA Total = 1.5 + 2.25 : 2 = 1.875

It was considered relevant the information provided by the *FRA panel* and *the Original sources of information*. The weigth gathered by the *Expert opinion* was considered with low precision/accuracy.

NA=not applicable; NCY=not considered yet

Africa scenario for intensified RSS to determine cover state and change

- Restratify using another source of information from a particular province (ecological zone) and/or groups of countries (say 3 ecological zones by 4 sub-regions) and make a new sample design;
- Poststratify existing (ca. 40) samples in the new strata;
- Add new samples (2 dates) to top up the new sample design;
- Interpret new samples;
- Derive sub-regional estimates (by ecological zone);
- Apply ecological zone statistics to countries, using known distribution of ecological zones in each country.

Resources needed:

- 120 person weeks for interpretation.
- 80 thematic mapper scenes (GOFC, Africover), estimated cost = $0-150,000.

3.2.2 Development of scenarios in order to generate state and change assessments for Asia

Scenarios should be country-specific. A scenario is defined as a combination of available information for change estimates (high, medium, low) and timeliness of information (<5 years or >5 years). This defines six possible combinations, divided into four scenarios:

Table 3. Possible scenarios for Asia.

Available Information	<5 yrs old	>5 yrs old
High	A	B
Medium	B	C
Low	C	D

Scenario A: Formal data extrapolation

- Countries with high quality data; and
- Data source not dated earlier than 1995.

Scenario B: Country's own estimations for 2000, as requested by FAO*

- Countries with medium quality data;
- Data source dated earlier than 1995.

*FAO needs to develop a decision rule to accept these estimates or to go to Scenario III.

Scenario C: Combination of estimates

- The remainder of the countries that do not adhere to the first two scenarios will be assessed based on a combination of the following "independent" estimates:
  - Country estimates.
  - Model-based estimates.
  - New remote sensing estimates.
  - Disaggregated data from regional estimates to country level expert estimates.
- An expert system must be used to define weights appropriate for each of the above estimates based on measured or expected precision of the data.

Scenario D: Combination of estimates

- With source data earlier than 1995.

3.2.3 Development of scenarios in order to generate change assessment and state in Latin America

The group revised the existing information available and alternative options for the establishment of possible methods to evaluate change. The following options were highlighted:

- Estimating change based on some weighting of existing country data;
- Deriving country level estimates by stratifying regions into areas of high, medium, and low rates of change, then using regional thematic mapper samples to obtain weighted averages.

This option may call for more field work, either in the office or through field visits to the country and would need maps by region.

Some concern was expressed about including the Brazil information in the low precision regional estimates because the country has good data available. The FRA classifications should be crosschecked with Brasil's classification of same image.

The criteria for selecting the method to carry out in-depth work in priority countries would be related to: forest area, quality of existing information, rate of change, type of forest and opportunity to work with established technical networks.

Possible process for country estimates in Latin America

Develop different estimation scenarios (expert opinion, regional thematic mapper basis):

- Identify information reporting units.
- List possible existing data inputs:
  - National or sub-national inventory reports.
  - Satellite samples (FRA and others).
  - Local sub-national inventories.
  - Old FRA modelled estimates.
  - Population growth rates by regions.
  - Policies on land use and forestry.
  - Ownership structure.
  - Land use and land productivity information by regions.
  - Forest map(s).
  - Expert opinions.
  - AVHRR map (FRA and others).
  - Thematic mapper sample unit change information for units.
  - Rutgers study.
  - Local forest change studies.
- Sort and classify data sources.
- Identify best complement of information by information unit.
- Rank information.
- Discard unreliable or unnecessary information for information unit.
- Weigh information inputs according to importance in deriving estimate.
- Processing:
  - Experts draw map of state and change and compare.
  - Experts identify where their knowledge is best.
  - Validate results from AVHRR to get broad idea of change, consult old AVHRR maps and images if available.
  - FRA expert synthesize and present conclusions.
  - FRA present cover map to validate and identify change areas receiving comments from national experts.
  - Expert delineates high change areas on small scale map.

Ratio estimates.
Build a regional state and change map (inputs are expert opinion, gradients built from remote sensing sample units).

- Remote Sensing Studies
  - FRA to request or provide new studies
  - Post stratification based on expert opinion based on estimate of change
- Tests
  - Test old model in selected areas.
  - Review the sampling procedure before you know how to apply properly.
- Experts
  - Key government agency officials.
  - International institutions and projects.
  - NGOs
- Presentation
  - Reference year estimates.
  - Estimates of change.
  - Confidence interval.

4 Data synthesis into estimates: modelling, convergence of evidence and remote sensing

The group was divided into three sub-groups to discuss how data might be synthesized into estimates. Modelling, convergence of evidence and remote sensing were three techniques reported at the end of the day.

4.1 Modelling sub-group

The sub-group agreed that a model:

- Considered external variables.
- Is used to estimate and make predictions.
- A model alternative could overlap other techniques.

The group reviewed the 1990 model:

- Used to fill gaps of information and in several countries – this situation has not changed.
- Fairly ill constructed (lack of data representativity, precision and resolution) and over-simplified.
- However, there was no ’hard’ evidence to compare results.

The use of this model in FRA estimations, could be an option as:

- Purely descriptive, no enhancement of the model (maybe integrate some new data).
- A research study (apart from the FRA report) to analyse usefulness and prepare ’hard’ evidence to validate the usefulness.

When the potential of the models was evaluated, experts agreed that:

- No more models with external factors should be used, unless independent research studies prove their fairly general usefulness.
- The focus should be on forestry information (remote sensing, field or other existing data).
- Maybe partially redefine satellite scenes.

Time series analysis could be used with a clear categorization of:

- The conditions under which they are useful – judge quality.
- Assign a quality ranking to the predictions according to the quality of input data, using time as one criterion (less or more than five years from the reference date, 2000).

4.2 Convergence sub-group: weighting procedure

A formal approach was recommended, meaning that mathematical precision should be indicated when possible, and that the final estimate should carry a precision measure when possible.

The following table illustrates the recommended approach:

Table 4. Recommended approach.

Dataset	Utility (Group 1)	Estimate ha/year	Precision (s/range/class/ rank)	Systematic errors (if available)	USE OR NOT 0/1
Country data					
A					
B					
Remote sensing					
C					
D					
Models					
E					
F					
Other					
G					

Suggested alternative uses:

a) If statistical precision measurement or range with confidence level is available for the data set(s) to be used: The weights are calculated based on precision measure and use-or-not and final estimate plus estimated error are derived.
b) If statistical precision measurement or range with confidence level is not available: Only one data set can be used and no precision will be given for the final estimate. Ranks are used to create weights according to predefined rules.

This procedure will allow several data sets to be used. The final estimate does not have any precision measure.

It was recommended that all available data sets and how they were used be published.

4.3 Remote sensing sub-group

4.3.1 First issue: sampling for Africa

In view of the recommendation that the number of sample units in Africa be increased, the remote sensing group was assigned the task of providing advice on how to best carry out the supplemental sampling, image interpretation and data analysis. It was first suggested that stratification by ecological zones (EZs) should be employed, jointly with information about population density, climate and socio-economic parameters. This additional information could help to cluster countries with similar characteristics, bearing in mind the need to make the sampling procedures as efficient as possible due to time, financial and logistic constraints.

One of the issues raised concerned the possible stratification of forest cover by high/ moderate/low rate of change to ensure that the sampling adequately covers these categories.

To identify these areas, continent-wide, several possibilities were discussed:

4.3.2 Use of AVHRR from 1980 and 1990

The remote sensing group found that due to the low correlation presented for Africa for AVHRR and thematic mapper forest cover, AVHRR should not be used for Africa, especially due to presence of dry forest.

The hot spot areas presented by the TREES Project are valuable for the humid forest. However, for TREES standards, the dry forest is not considered forest, so the expert consultation did not include identification of hot spots in that region. And such stratification would have to be done carefully as results are very sensitive to strata size for under-sampled cases.

This sampling approach, first taking into consideration the ecological zones, would allow values within the same ecological zone strata to be averaged out to provide an estimate (regional) for the entire strata.

It was proposed to first group countries with "similar" socio-economic, climatological and forest cover conditions and consider these country clusters as strata where samples would be allocated. The estimate for each stratum would be based on the actual values observed within that stratum. This approach does not eliminate the consideration of ecological zones, but employs the use of samples from countries belonging to the same ecological zones.

The use of a more systematic pattern to fit any future FRA plans was noted as an issue to consider.

The number of additional samples to supplement the existing 47 would be determined as a result of the final stratification adopted. It was recommended that a statistician be consulted to advise FAO in this respect. It must be recognized, however, that for country numbers these images will be used in a rather pragmatic fashion. The implications of the different stratification procedures should also be discussed with an expert. The remote sensing group left the issue open.

It was agreed that the sampling should not only cover those countries in the low-utility information areas of Africa, but should be distributed so as to cover the entire continent. This would ensure that a consistent methodology is applied to the entire region.

Regarding analysis of the supplemental sampling, the remote sensing group provided the following recommendations:

- The analysis should still consider the classes "closed forest" and "open forest" as distinct.
- Interpretation of the images should be carried out using digital data by analysis on the screen.
- Map change interpretation would need to be done carefully.
- Do as much as possible ground survey.
- Use Africa cover images if possible/available.

One of the tasks assigned to the remote sensing group concerned the possibility of using spatial statistics tools to generate a change gradient map based on the present 117 samples

(and possibly other information). It was generally agreed that at this point it would be premature to develop such a map or use the information for country statistics. It could be a "lab" exercise. Since Brazil has annual data on forest cover change, the lab exercise could start from these.

Regarding the use of information from the present 117 samples, the group felt that the present procedure, using the transition matrix, bar charts and division by ecological zones, is very adequate and did not recommend any immediate change. It was suggested that some examples of images, image interpretation and data analysis procedures could be included on the web site.

As to the future, the remote sensing group recommended the following:

- Promote further discussions regarding a change from visual interpretation to a semi-digital method.
- Improve "ground truth" verification through use of ground inspectors, aerial observation and aerial photography.
- Explore medium-resolution sensor data, such as MODIS and CBERS (China-Brazil Earth Resource Satellite), of appropriate spatial resolution of 250 meters.
- Further explore the possibility of developing a geo-referenced database for each region. This would considerably simplify the analysis of cover change at any time interval.
- Use a GIS map approach to area determination.
- Digitize old and new polygons and do geospatial analyses of deforestation (e.g. size, number and proximity).
- Consider using a system of permanent satellite sample plots where forest state and change are monitored for many decades to come.
- Consider adopting monitoring of change events rather than (or in addition to) overall changes in state. For example, a clearing in closed forest would be identified and documented as a "deforestation event". At present it would only contribute to area determination of deforestation (closed to open) or would be missed entirely as deforestation or missed entirely if it goes from closed to young closed in 10 years. Selected cuts could be a recorded event. This has interesting benefits and design implications.
- Country-based programs should be considered in high priority areas.

Criteria for proposed methods were discussed and several points mentioned:

- Consider compatibility with FRA 2010 or future FRA.
- FRA should determine if the programme objective is to be "the" world forest inventory or a useful source of information on inventories of the world .
- The results should stand the scrutiny of others in the field.
- The results should be defensible. Determine what weight should be put on defensibility.

5 Preliminary results: apply, test and document methods for Bolivia, Cameroon, Indonesia and Viet Nam

After the presentations, the participants divided into regional groups to continue the analysis exercise based on the process established. A fourth group was established to devise a process to arrive at a final set of weights for the different data sources in each country. A second task was to apply the methods developed to a specific country case to try to arrive at country level estimates.

Using the guidelines developed by the convergence groups, participants in the regional groups revised the documents thoroughly noting procedures, input materials, the rationale for using or not using inputs and recommendations for applying the convergence method. Participants tried to derive a best estimate for the state of forest as of 2000 and change from 1990 to 2000.

5.1 Results of Bolivia test (see Appendix 3)

a) Reviewed existing information including four country inventory reports, TM imagery for the region and for Bolivia, 1990 FRA model estimates of change and 1990 FRA report for cover.

b) Prepared spreadsheet assessing the quality of the data sources. Three of the four country inventories were completed national inventories covering the country from the late 1970s to the mid 1990s. They were deemed the most relevant information.

c) A simple linear regression was applied to the three (time, cover) pairs in order to estimate the average annual change from 1975 to 1995 (approximately 120 000 hectares per year). This estimate was then applied to the country cover (state) estimate in 1995 to project the country cover estimate in 2000.

The estimate was substantially below the change estimates provided by FRA 1990. The country data was deemed to be more reliable. The estimates were a little (but not much) below the estimates from two individual TM scenes for Bolivia.

It was decided to use 6 classes to determine relevance/quality of data inputs:

0 = not relevant,
1 = poor up to
5 = excellent.

A final weight of 100% was given to the estimate based solely on country data.

5.1.1 "More discussion needed" topics

Relevance assessment is done at two levels: relevance of individual data sets (for estimating change) as well as relevance of combinations of data sets (for trend). Some data sets may be paired better than others due to consistency of methods. Information is needed about the extrapolation procedure used to project state to 2000 in order to assess the quality of the change estimate.

Since estimating state in 2000 will always require a projection of some earlier state estimate, all cases will include change assessments as a precursor to final estimate of state as of 2000.

A general discussion of procedures for projecting to year 2000 is needed – linear extrapolation to start with, then adjusting the 2000 end point up or down based on auxiliary information.

Separation of quality assessment and weighting of state estimate versus change estimate, e.g. very consistent series of estimates over time that are biased, so the change estimate is good while state is biased.

Expert opinion data should be used if there exists no other class of data. It is important to recognise that expert opinion is always incorporated in the data evaluation and weighting phase.

There will always be remote sensing regional estimates and AVHRR cover estimates; might have remote sensing samples from the country; will have 1990 FRA model (i.e. always disregard FRA 1990/1995 model estimate). It was proposed to use the mean regional remote sensing estimate as the "worst case" scenario.

5.1.2 Results of the weighting group: A process for arriving at the final weights

Objective: To derive in a transparent way final figures (estimates) of forest cover and forest cover change. Both estimates should carry a reliability measure. The following steps were proposed:

Step 1. The group recommended that the FRA team arrive (among other descriptive measures) at reliability class and change/cover estimate using each data source from each country. FRA should also determine estimated weights, but these are kept confidential. The three columns shown in the following table are those that are used in the overall weighting procedure.

Table 5. Overall weighting procedure.

Data Source	Reliability Class (0-6)	Parameter Estimate (ha or ha/yr)	Est. Weight
Country data:			
A	X	X	X
B	X	X	X
C	X	X	X
Remote sensing sample			
Regional estimate, 1980-1990-2000	X	X	X
Country estimate, 1980-1990-2000	X	X	X
Model estimate	X	X	X
Other data sources	X	X	X

Step 2. Data (without FAO weights) is sent to countries for comments. Define deadline well before step 3. Countries may comment on the data set prepared by FAO.

Step 3. A regional workshop by region is suggested utilising experts from the region to determine final weights for each data source from each country (weights to determine final estimate of cover and change for each country), chaired by an FAO staff member (regional correspondent). The workshop would use a Delphi process to arrive at final weights and final overall estimates of cover and change by country.

Step 4. Suggested final step: sum the final estimates by country and compare to the total estimates by region determined through the remote sensing sample as a control - the sum across countries from the Delphi process should be within the confidence limit of the remote sensing sample total by region.

5.1.3 Steps to determine weights

a. FRA staff present reliability classes and change/cover estimates for each data source by country, explaining how they determined the class and giving all necessary background information.
b. Experts discuss the reliability classes and parameter estimates and perhaps adjust them based on their expert opinion. The experts may identify additional information or data sources.
c. Experts assign preliminary weights.
d. FAO staff reveals FAO weights.
e. Continued plenary discussion to review the set of weights by expert for each data source.
f. Experts assign final weights; FAO staff possibly modifies FAO weights.
g. Weights are averaged for each data source and averages are multiplied by the estimate from each data source to determine a final single estimate for each country.
h. Overall reliability is quantified by the sum of the average weighting units multiplied by the final reliability class for the data source. The result will then be on the same scale as the reliability class for the data source.

This process is considered to be open, interactive and participatory in character. It ensures as far as possible that all experts have a common level of knowledge of the particular country under discussion.

It is still necessary to define whether the process should cover all data sources (models, expert opinion) or only the ones on hand to the FRA staff (country data, remote sensing samples).

It has not been determined what part of the entire process to publish and what to only keep in internal files.

The above process should be done for the state estimates and for the change estimates. It is not clear whether or how to combine the two.

5.2 Results of Cameroon test (see Appendix 4)

A test run to make a country estimate for Cameroon using the framework assessment table was the main focus of the group's activity. The country information was reviewed and two possible new sources of information were examined. The table was completed for several cases discussed in previous sessions and several new scenarios developed. There was insufficient time to calculate the needed numbers and averages using the data from FRA. Landstat scenes for the scenarios, but evaluations and weights for each case are given.

The new sources of information generally proved of little value, but one, a very local study, indicated the need to make provision for special studies that might add useful information for an expert analysis but not of value for making actual calculations. A "special study" row was added to the table to indicate this (see attachment).

It was also found that the meaning of the various evaluation columns in the table was not clear and the group constantly had to reread and ponder their meaning.

Since there was not strong country data, work concentrated on how to use the FRA satellite plot data. Use of one scene (1501) or scene 1501 partially averaged with a similar wet zone image (1502) was considered. The group also discussed just using the regional averages for the wet, moist and dry ecozones of all of Africa in proportion to their occurrence in Cameroon. The existing sample scenes were then examined for their appropriateness to the Cameroon situation. Ecozone, socio-economic and distance were considered. The scenario that was proposed is to use scene 1501 (80% of its values) plus 20% of scene 1502 to represent the wet ecozone of Cameroon (nominally 20% of the country). Scenes 1512 and 1503 (see map of group) would be used in equal proportions for the moist zone (70% of Cameroon) and scene 1466 only for the dry zone (10%). It was felt this was correct but not overly strong and that the country data was of value. So for this scenario the final estimate would be 20% of the value of the country data and 80% of the value of the satellite-based estimate (see Appendix 5).

A scenario where new imagery can be acquired was explored. It was determined that at least seven new images would be available near enough to be considered as candidates to contribute to the Cameroon total. These were placed on the map in a reasonable pattern. The details of which scenes would be used and what weight to apply to each image was not

determined but would follow a similar logic to that described above. It was felt this scenario would give good results and, indeed, if it were available would be the only numbers used.

Scene representativeness was also discussed as a possible useful concept. Before a scene was used to represent a country it would be examined to see if it was indeed representative of the country (using expert regional knowledge and examining any images within the country and ecozone – these need not be FAO plot imagery).

The exercise of completing the table proved feasible. The evaluation of the various criteria was unclear and needs further discussion. Quite complex logic and considerations were used to determine which images to use and the weight for each. Regional expertise or guidance would be needed and local knowledge would also be useful. It would be difficult or at least too lengthy to document all the reasoning. Some guidelines and brief discussion would be the most that could be expected. The group also speculated that in areas of low-reliability data there would be only one or two dominant choices to consider as sources of information. The final weighing of source numbers may be quite easy and not require a complicated analysis. The value of additional images was considered very high.

5.3 Results of Viet Nam and Indonesia test (see Appendix 6)

5.3.1 Overall concerns

Remote sensing estimates of forest change in southeast Asia in many cases overestimates the loss figures, as plantation areas will not show up in the satellite images until approximately 10 years after planting. It is also difficult to separate home garden plantations from actual forests in remote sensing images.

5.3.2 Vietnam

For Vietnam the data set choice was easy as the group considered both state and change data to be recent and of high quality. The figures were therefore accepted and simply extrapolated to year 2000. However, there were some concerns about the change figures, as these were the sum of deforestation of natural forest on the one hand and plantation figures on the other hand. The figures were added to each other, but they might include errors of unknown size.

5.3.3 Indonesia

For Indonesia the procedure was much more difficult. The data sources were of low utility for state and change. However, there was hope that a World Bank report could be used as a source of data for state and the FRA remote sensing scenes as a data source for the change estimate. Therefore, the results of the World Bank report should be compared with the FRA 2000 remote sensing results for the seven locations for 2-3 points in time per location. One conclusion is that in the Indonesia case there may be more sources of information available in the form of reports and satellite images. One suggestion is to contact CIFOR.

There was also some confusion about the 1990 modelling approach as forest change figures were about "natural forest" while the state figures were about all "forest" areas.

5.3.4 The data sorting/weighting process

This refers mainly to the Indonesia data compiling process.

Several data sources were available but the input of regional experts was needed to determine the utility of the different sources. The results of the reviewing process would have been substantially different without the regional expertise as the available reports initially seemed comprehensive and with a number of detailed components relevant to the FRA 2000 work. More specifically this meant that:

- The National Forestry Inventory (NFI) report was evaluated as of low utility, because the methods applied in the inventory were insufficient and generated unacceptably biased results.
- The Regional Physical Planning Programme for Transmigration (RePProt) report was considered useful to some extent for state figures, but it was old (1985) and a single inventory which made it impossible to estimate change.
- The Scotland Fraser Report (1999) used a combination of the NFI and RePProt for change estimation. This report concluded that the results from this comparison were incorrect and misleading as it arrived at positive change estimates.
- A confidential document provided interesting figures regarding change but we could not consider this source of information due to its current restricted state.
- Numerous other analyses have been conducted, providing a range of results that makes us question the methods and different official sources of information (Sundferlin & Resusardmo, 1997).

6 Special presentations

During the Expert Consultation Meeting additional presentation were given by participants and FRA staff.

6.1 Brazil, RADDAM Project

This project aims to map the extension of deforestation in Brazilian Amazonia, using 1997as a base date. It mapped the additional deforestation and the regenerated areas for 1998 and characterized the fires in deforested areas. The project will built a data bank with digital maps for Amazonia.

The system looks at about 190 TM scenes out of 240 per year. Most deforestation is concentrated in about 40 scenes. They produce a preliminary estimate based on the sample of 40, then complete an analysis of about 150 more (the remaining 50 or so scenes are typically occluded by clouds). The difference between the sample estimate and the final estimate has been about 1.5% in the past two years.

The reported information is total hectares cleared each year with deforestation measured in terms of land cleared, based on cover (loss of primary forest). Brazil's approach is cumulative and does not recognise areas that ultimately stay as forest (e.g. regrow into secondary forest).

Brazil does have estimates of the rates at which the cleared land goes into agriculture, pasture and forest, so they should be able to respond to FRA requests. The FRA definition is based on hectares taken out of forest land use. In the FRA report, it was recommended that attention be paid to possible positive changes and their impact on the figures to be reported in FRA 2000.

6.2 Costa Rica, forest cover change

A short-time series of cover maps and figures from the 1940s to 1990s shows a general decline in cover from 1940 to 1990, then a sharp increase since 1990. Estimates were based on varying degrees of information: sampling, remote sensing and personal experience based on a two-week visit.

It was pointed out that the FRA global forest cover map from the EROS Data Center not very reliable at the country level in Costa Rica: it misses significant forest in the dry forest zone and the mountain forest zone; it adds significant forest in the urban central valley zone and it includes agricultural lands (e.g. banana plantations).

It was suggested that the web page should label the maps that are preliminary or under revision.

6.3 FRA 2000 global maps

FRA 2000 will present new global maps for forest cover, ecological zones and protected areas. Spatial information about the world's forests is an important prerequisite for global environmental change research, from studies on biodiversity and effective conservation to modeling sustainability of forest ecosystems.

6.3.1 Forest cover map

The forest cover map presents the first comprehensive worldwide view of forests using a consistent methodology and standard data. The map has a resolution of 1 km and is based on 1992-1993 and 1995-1996 AVHRR data. Four broad land cover categories are presented following FAO's standard classification: closed forest, open/fragmented forest, other wooded land and other land. The primary use of the map is to show the current extent of forests at a global and regional level. Other potential uses include forest change assessment and modelling, and to supplement regions lacking recent, reliable forest inventory data. Due to the coarse source data, the map cannot be used to obtain reliable country forest cover statistics. The final map has been drafted through validation with information/maps based on higher resolution data, i.e. Landsat TM and SPOT. An accuracy assessment will be carried out later this year to indicate the precision of the map.

The map was developed at the EROS Data Center (EDC) of the United States of America. The World Conservation Monitoring Center (WCMC) in the United Kingdom collaborated in the map validation.

6.3.2 Ecological zone map

Along with the core information on the state and changes in forests, FRA 2000 is reporting on various ecological aspects of forests. Forest resources information will be reported by ecological zone, which will contribute to understanding the implications of forest change on (ecosystem) biological diversity and carbon-cycling processes.

The 2000 global ecological zone map has been developed, building upon the FRA 1990 experience for the tropics and extending the coverage to include the temperate and boreal forests. A globally consistent classification has been adopted, based on the Köppen-Trewartha climate system in combination with natural vegetation characteristics. A total of 19 global ecological zones have been defined and mapped, ranging from the evergreen tropical rainforest zone to the boreal tundra woodland zone. A main principle of delineating the global ecological zones involved the aggregation or matching of available regional ecological or potential vegetation maps into the global framework.

The main uses of the map include: a) reporting purposes, to provide baseline forest statistics by ecological zone; b) analysis and modelling purposes, i.e. assessment of forest-based biological diversity, both at ecosystem and species level, and biomass modelling.

FAO's main partners in the development of the Ecological Zone map were the WCMC, EDC

and the Laboratoire d'Ecologie Terrestre (LET) of France. In addition, regional experts and scientists have been instrumental in the production of the map by providing their expertise, advice and input data. A key event was the Cambridge expert consultation (July 1999), attended by some 20 regional ecozone experts, where the proposed classification framework was presented and adopted.

6.3.3 Protected areas of the world

This map shows the location and extent of the world's protected areas as of January 2000. Along with the map data, information is provided for each country on the name, area and category (IUCN categories I – VI, International Conventions) of each protected area. A main use of the map is to show the conservation status of the world's forests.

The map was produced by WCMC, based on data/information provided by the countries.

6.4 Forest Resources Information System

The Forest Resources Information System (FORIS) provides the world with baseline information on forest resources. FORIS was developed for the production and presentation of the Global Forest Resources Assessment 2000 (FRA 2000), but with the perspective to continue to improve it beyond this event. FORIS includes both existing source information and derived information.

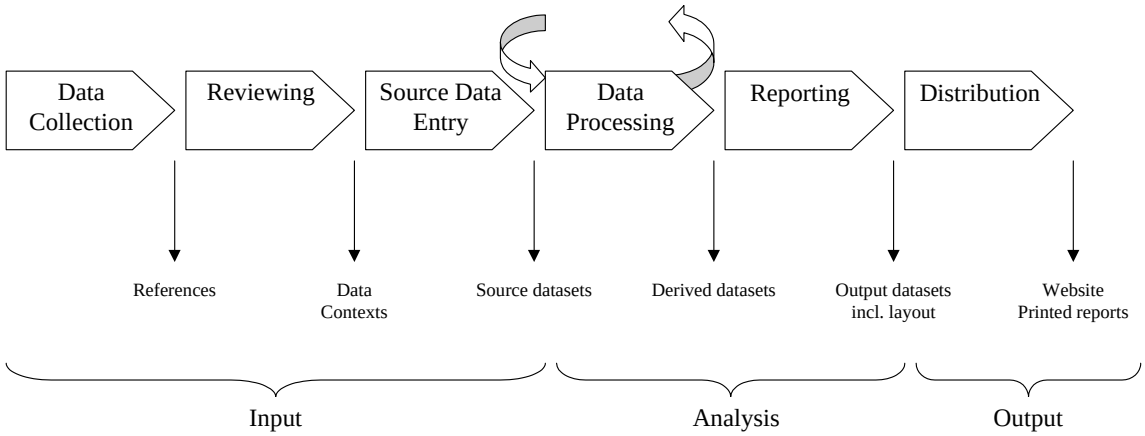
The following points have guided the system development work:

- The system includes the FORIS database, client application and web application, as well as the processes applied in the work.
- The work procedures and principles require that many users work with the system, and that data ownership is distributed among these users.
- It is a major ambition to make forest resources information accessible internally at FAO as well as externally, thus promoting a situation where data are only stored once and duplication of effort as well as risks of erroneous copies are thereby minimized.
- FORIS will cover all country information needs for FRA 2000, meaning that a variety of subjects (presently ten) are included.
- Security (user privileges, backup, documentation, dependencies on persons, defined system manager/ownership) should be tight.
- Integration with other system development efforts is essential and must be kept in mind despite the FRA 2000 rush.

Presently, ten thematic subjects have been identified. These are: country description, forest cover, plantations, volume/biomass, protected areas/conservation, forest change, ownership, non-wood goods and services, fires and wood supply. For each of these subjects a number of subject classes are identified. The subject classes essentially represent the final output of FRA 2000 (or any following presentation). For example, the forest cover subject includes the subject classes composition, disturbance and texts.

The process for incorporation of data into FORIS is shown in the next figure:

Figure 1. **Information production process**



The development of an Internet application in FORIS has not started. A mockup design of the contents of country pages has been done and will be used as a template. People to take part in the work have been identified. There will be close links to the Forestry web site.

6.5 World Forest Survey

The main issues related to a World Forest Survey (WFS) were presented:

- Data availability is poor despite international attention.
- It is not only about forest cover.
- Country capacity building is desired.
- International processes demand information.

The major forestry information requirements of a WFS, in a very general sense, are to provide supply and demand functions of products and services that are relevant (and cost efficient) for decisions and have known precision and accuracy.

There are several possible components of a world forest survey design:

- Global.
- Remote sensing (say 500 TM scenes), stratify based on change.
- Large field samples (say 500-1000, each 100 ha).
- Local and global parameters on supply and demand.
- Each field sample used for capacity building.
-

A world forest survey requires well-defined customers, a very flexible design, access to all countries and broad institutional collaboration. It is a huge task. FAO, with the experience gained through FRA 2000, could possibly serve as secretariat for this process.

Current activities and approaches:

- Pilot field work in Thailand.
- Begin work on project documents.
- View it as an extended remote sensing survey.
- Establish a technical reference group (if possible).

6.5.1 World forest survey: plenary discussion

There was a general consensus that a world forest survey is a worthy goal. One way to facilitate success would be to build as much as possible on existing *in situ* inventory and monitoring systems at the country level – e.g. national forest inventory systems (at least those that are reliable and systematic over time).

The direct involvement of countries is seen as critical to success. Countries will be sceptical about the utility/accuracy/relevance of a world forest survey at the national level if it operates independently of the country's own inventory program.

A case needs to be made as to the cost to benefit ratio of a world forest survey. It has been seen as a supplement to FRA, but in the future may evolve to simply become the future FRA. It could also be viewed as simply an elaboration of the remote sensing component of FRA. A compilation of country inventory data will still be required.

It is very relevant for places like Africa where there is a lack of consistent data for many countries in the region. Africa might be a good place to initiate a pilot project.

The world forest survey concept is very consistent with an increasing set of global accords (e.g. Kyoto, Montreal Criteria and Indicators, Helsinki accord, etc.) regarding global forest sustainability. It could provide a framework for addressing the various criteria in a consistent and meaningful fashion.

The system may require more than two levels (TM and ground). It may need a level or two in between (such as a higher resolution imagery sample) to increase efficiency. It is important to decide if the objective is a tree (cover) monitoring program or a forest (land use) monitoring program. A high proportion of trees may exist outside the forest. The expert team decided to continue as an ongoing peer review/advisory team for the FRA process, including possible evolution to a world forest survey.

7 Recommendations by the expert panel

The expert panel reviewed a draft set of recommendations prepared by the Chair and Vice-chair. The final recommendations were approved in plenary session.

With regard to completing FRA 2000 the consultation supports and recommends the following:

1. That the FRA Programme carry out a specific expert assessment for each country.

2. That the expert assessment rely on multiple sources of information, such as country data, remote sensing samples, expert opinion, etc.

3. That FRA should seek widely to gather all potentially useful data sources in each country; that they should select the most relevant information sets from the multiple sources for use in the estimation procedures; that irrelevant sources of information are not used in the estimation for FRA 2000; and that the selected information sources be weighted according to their relevance and reliability for use in generating the estimates.

4. That the estimation procedure be documented and made transparent to countries and the procedure applied be according to the information available and its utility for assessing change from 1990 to 2000 and state as of 2000.

5. That FRA will acknowledge the importance and value of the national information, and that a "country information set" containing the country contributions be published in addition to the FRA 2000 adjusted estimates.

6. FAO will carry out the assessment in a participatory manner. All countries will be given the opportunity to provide comments to FAO on the information sources used and assumptions made in the weighting, as well as the final estimate. This will be done through a formal standardised feedback mechanism and "country brief" to be sent to each country. FAO will convene workshops for validating the estimates when appropriate and practical;

7. Operational guidelines will be developed for the "convergence methods" proposed in this consultation and distributed to countries and international co-operators. FRA should continue to refine and test the methods explored in this expert meeting.

8. Estimates generated for countries and regions through different methods should be compared and analysed. FRA should evaluate the option of producing separate estimates for regions and by countries or, conversely to produce an "integrated estimate".

<u>In issues related to data, the consultation advised FAO:</u>

1. To use supplemental sampling with remote sensing in tropical Africa to bolster the information base in this region.

2. AVHRR alone is not of use in direct change assessments for FRA 2000.

3. Seek effective ways to post-stratify the regional remote sensing assessments to improve estimates in countries with low-utility data.

4. Include remote sensing samples from a given country as "information" to be evaluated and weighted for potential use in the national assessments.

5. The FRA 1990 model should not be used to generate estimates for 2000, but the estimates generated previously by FAO for reference years 1990 and 1995 may be used as a possible data source for evaluation.

6. To reassess the information utility for specific countries, noting that the consultation found in some few cases the rating to be too high or too low (it was noted that the feedback mechanism to FAO from countries should help to ensure that all relevant data has been used in the assessment).

7. Care must be taken in use of independent surveys for change assessment.

In issues related to the selection of experts, the consultation advised FAO:

1. Identify, to the extent possible, a complement of national and international experts to give feedback on country-specific estimates, emphasizing the need for national experts to participate in the assessment of their own country.

2. The participants of the expert consultation will serve as a "core advisory group" for FRA 2000 and for FRA issues in the future, including capacity building and periodic assessments.

With regard to assessments beyond FRA 2000 the consultation supports and recommends the following:

1. In co-operation with national and international organisations, continue to analyse the impact of different terms and definitions and how compatibility can best be achieved between national and global information sets. FRA should increase its outreach to ensure that global reporting needs are taken into consideration in the early stages of inventory and mapping programmes.

2. FRA should continue to improve all methods, definitions and country-capacity building activities.

3. Consider creating a global cartographic base of forests and land-cover.

4. Consider the use of medium-resolution satellite data, especially to stratify sampling.

5. That future FRAs consider using the best estimates for countries and another set of estimates at the regional level.

6. Develop mechanisms to better track projects in countries and to make full use of information from existing and ongoing programmes.

7. Use systematic sampling in future sampling programmes, noting that since strata will change according to needs, this approach will be more appropriate for post-stratification with new criteria.

8. Consider increasing the FAO remote sensing sampling intensity, possibly to ~ 25%.

9. Expand country –capacity-building programmes to enhance the information needed at the national level for forestry purposes, which may also be of utility for global assessments.

10. Consider expanding coverage of future assessments to include all trees (outside "forests").

With regard to the follow-up to the expert consultation, in issues related to the selection of experts, the consultation advised FAO:

1. A meeting report should be produced that includes: a) recommendations of the consultation; b) a summary report derived from the meeting minutes; c) the background paper as an appendix; d) relevant appendixes from the meeting materials (others to be referenced in a bibliography); and e) the regional exercises.

2. Minutes from the meeting will be circulated by email. Participants will have one week to respond with comments to the chairman, with a copy to FAO.

3. FRA is asked to construct an internal web site where expert panel documents can be posted for review and where panel members can post comments on review items.

4. Operational guidelines and other technical documents subsequently developed by FRA staff should be posted on this web site for review by expert panel members.

In issues related to the development of a world forest survey, the expert panel recommends:

1. FRA/FAO should take the lead in developing a proposal for a world forest survey (WFS) demonstrating the potential customers, costs and benefits of such a system.

2. That a first step in such a process should be to further identify potential WFS customers and their needs.

3. That the Expert Panel should take up this issue in future agendas.

4. That FRA/FAO should prepare a technical document on the WFS concept.

5. That FRA/FAO should host a future expert panel meeting to further develop the WFS idea, using the document developed in (4) above as a background document to the meeting.

8 References

FAO. FRA 2000 Working Paper 1. *Terms and definitions*. (18 pp. E/F/S/P)

FAO. FRA 2000 Working Paper 2. *Guidelines for assessments in tropical and sub-tropical countries.*(43 pp. E/F/S/P)

FAO. FRA 2000 Working Paper 7 *Forest Resources Information System (FORIS) – Concepts and status report* (20 pp. E)

FAO. FRA -2000 Working Paper 19. *Global forest cover map* (14 pp. E)

FAO. FRA -2000 Working Paper 26. *Global ecological zones mapping workshop report. Cambridge, 28-30 July 1999.*

FAO. Forestry Note 124. *Forest change assessment parameters for estimating utility of existing data sources for change assessment.*

FAO. Scotti, R. *Estimating and projecting forest area at global and local level: a step forward.*

Summary of last FRA expert consultation. Kotka, Finland, 1987.

FAO. Forestry Paper 124. *Forest Resources Assessment 1990. Global Synthesis.* Rome, Italy. FAO. 1995 (pp. 44 E/F/S)

FAO. Forestry Paper 130. *Forest Resources Assessment 1990. Survey of tropical forest cover: a study of change process*. Rome, Italy. FAO. 1996. (pp. 152 E)

Appendix 1 : Data quality information map

Appendix 2 : Forest change assessment parameters

Appendix 3 : Results of Bolivia test

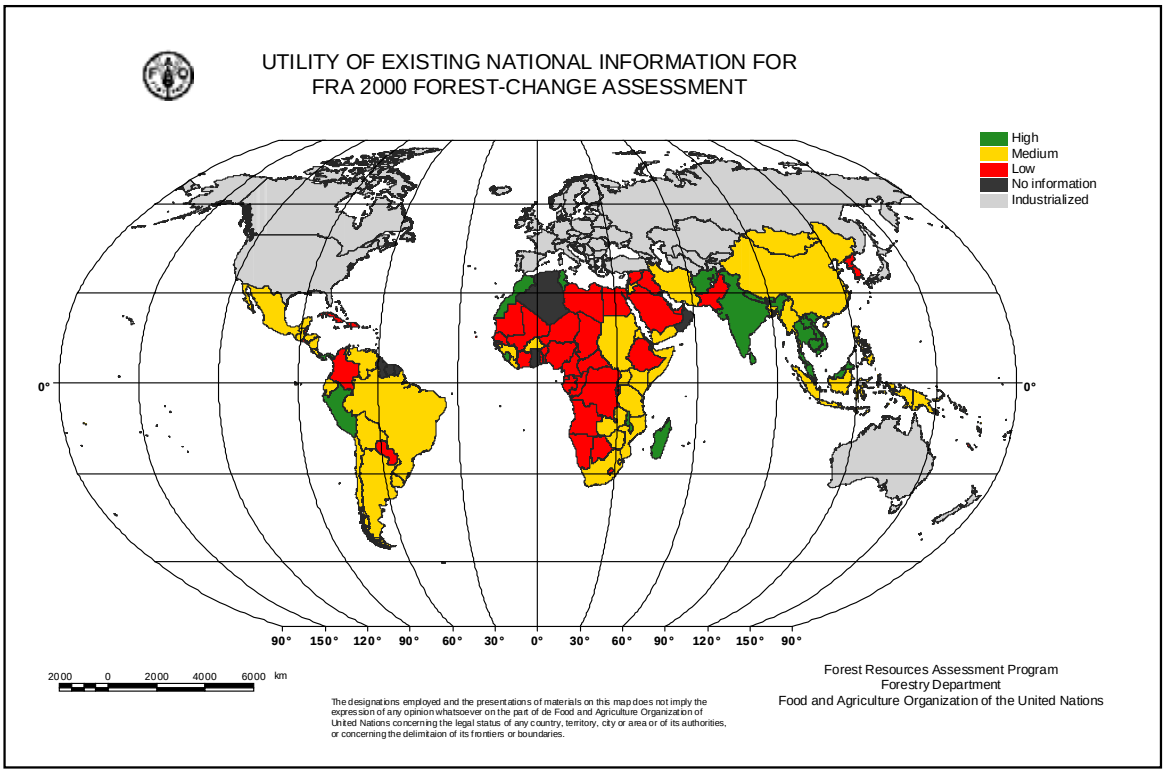
Appendix 4: Results of Cameroon test

Appendix 5 : Results from, Indonesia and Vietnam

Appendix 6 : List of participants

Appendix 7: Meeting agenda

Appendix 1: Data quality information map



Appendix 2 : Forest change assessment parameters for estimating utility of existing data sources for change assessment

Useful information for assessing forest change can be found in different reports or in only one report providing both sets of statistics. The "FRA method" has been designed to summarise and provide a first screening of the reliable and available sources for forest change. The table below provides a description of all the parameters that are taken into account during the evaluation of information to be used in a change assessment.

Type of change information/data:

This is a descriptive parameter indicating the compatibility of the sources available for estimating change. Four general categories are distinguished:

1. Change information that may be derived from a series or cycle of national or continuous forest inventories;
2. Change information based on two independent inventories;
3. Information from a single specific forest change survey/study;
4. Only state information available.

Coverage:

This parameter indicates the compatibility of the two sources in terms of their geographic coverage. For example, while two sources can be compatible technically they may relate to different areas of land within a given country. Therefore, a source can then be classified as:

1. Covering the whole country, national (N);
2. Only partially covering the country (P), e.g. covering state(s) or provinces.

Periodicity of data:

The respective dates of the two (or more) sources will provide the period for which a change assessment is possible. However, as national inventories generally take place over a long period of time, frequently two or three years (sometimes longer), it is usually necessary to indicate an "average" date for each source utilised in the time series.

Compatibility of time series:

Compatibility of data sources in a time series is defined by three distinct elements:

A: Compatibility of classification schemes used in different inventories:

A1 = High = Same classification has been used in the two inventories;

A2 = Medium = Differences in classification exist, yet still allow a comparison of the two sources (for instance by aggregation or reclassification or compatibility between certain classes);
A3 = Low =Incomparable classifications.

B: Compatibility of methods

B1 = High = Consistent for all inventories;
B2 = Medium = Methodology differs in some aspects between surveys. For example, different remote sensing data used or different field sampling design;
B3 = Low = Methodologies are incompatible and differ in most aspects.

C: Interdependence of time series

Time series is interdependent when interpretation or analysis of the new remote sensing or field plot data is done with reference to the former, specifically to ensure compatibility between inventories

Type of data:

Here the type of remote sensing data (aerial photos, Landsat TM, etc.) should be listed. In general, the higher the spatial resolution, the greater the utility for change assessment

Inventory Field Work:

It helps in evaluating the sampling methodology. The parameter takes in account four categories of fieldwork:

A) Repeated measurements on permanent sample plots
B) One time measurement
C) Combination of the above two
D) None

Remote Sensing Validation

Many countries now rely solely on remote sensing techniques to generate forest cover information. While it is widely accepted that field checks of imagery interpretations to calibrate classifications and polygon delineations improve the overall work, this is frequently not done. This parameter takes into consideration three categories:

A) Statistical field checks (H)
B) Non-statistical (windshield) surveys (M)
C) No field work (L)

Compatibility with **FAO classification**

It helps to define the compatibility of the national definitions of forest and deforestation (applied in the time series or change study) with FAO's definitions (see FRA 2000 Working Paper 1, Terms and definitions).

A) High (H): No (basic) differences;
B) Medium (M): Differences in classifications can be overcome through matching/reclassification procedures;
C) Low (L): Major differences between the classifications

Overall quality

Based on all the criteria previously defined, a judgement can be made on the overall quality of the forest change information for estimating national forest change in FRA 2000. Three classes are distinguished: high (H), medium (M) and low (L). In the overall judgement, one should put relatively high value on the compatibility of the time series.

Appendix 3: Results of Bolivia test

BOLIVIA															
Datasource	Years	Update method	Coverage	Class compatibility	Consis-tency	Method compa-tibility	Methods	Stat conf (y/n)	State (ha.) or Change (ha. /yr) Estimate	Precision measure				Use or Not (0/1)	Direct wght E=1
										s	bias	range	class 0-5		
Country Data:															
ERTSBOL	1978		100%	H	H	M	???	N	56238300	-	0	-	4	1	0.75
PROBONA	1996		<100% (highland)	H	H	M	???	N		-	0	-	3	0	
Montes de óca	1975		100%	H	H	M	???	N	56468000	-	0	-	4	1	
MDSA	1995		100%	H	H	M	???	N	54063000	-	0	-	4	1	
FRA Remote Sensing															
1990-2000 Regional Change	???		not yet available												
1990-2000 country TM scenes (2)	1990-97	avg annual rate	1 TM scene						-136532				3	0	
1980-1990 Regional Change	1980-90		>100%	H	H	H	???	Y	-326127	-4435.3	0	-	3	0	
1980-1990 country TM scenes (2)	1980-90	avg annual rate	2 TM scenes						-204498				3	0	
Models															
FRA 1990	1980-90		national	H	H	L		N	-625000				1	0	
FRA 1995 update	1990-95		national	H	H	L		N	-581000				1	0	
Expert Opinion	***	***	***	***	***	***	***	***	***	***	***	***	***	***	
FINAL ESTIMATES															
change (1975-1995)	75/76-95	regression	100%	H	H	M	???	N	-119917	-	0	-	4	1	
state (1995 projected to 2000)	1995+5	extrapolation	100%	H	H	M	???	N	53463416	-	0	-	3	1	
Plot regression change and 2 TM scenes															
Year	linear	TM3409/90	TM3413/90	TM/3413/00			Regress annual change 1975-95								
1970	57060919	57863873.89	57570267.62	57559377.56			56238300	1975							
1980	55861751	56358216.23	56167410.35	56194057.1			56468000	1978	-119917						
1990	54662584	54891736.81	54798737.54	54828736.65			54063000	1995							
2000	53,463,416	53,463,416	53,463,416	53,463,416											

Appendix 4: Results of Cameroon test

CAMEROON																		
Datasource	**Years**	**Time Period + extrapol**	**Land Coverage ha**	**Forest coverage ha**	**Forest coverag e %**	**Class compa-tibility**	**Implem entation Consist ency**	**Method compati-bility**	**Metho ds**	**Stat conf (y/n)**	**Estimate ha/year**	**Estimat e %/year**	**Precision measure**				**Use or Not (0/1)**	**Direct weight E=1**
													s	**bias**	**range**	**class 1-3**		
State 1953-1999	53-99			19598000	100	L	L	L	L	n	41717.4	0.21				1	0	
RSS sample 1501	73-83	L	1143000	1098000	6	M	M	H	H	y	-5600	-0.51				1	0	0.80
RSS sample 1502 T2-T3	*86-95*	*M*	*2032000*	*1846800*	*9*	*H*	*H*	*H*	*H*	*y*	*-32000*	*-1.73*				*1*	*0*	*0.20*
RSS sample 1502 T1-T2	*73-86*	*L*	*2032000*	*1873840*	*10*	*H*	*H*	*H*	*H*	*y*	*-46000*	*-2.45*				*1*	*0*	
FRA 1990 Model	90-95	H	46540000	19598000	100	H	n.a	n.a.	L	y	-129000	-0.66				1	0	
National report 1999	87-00	H		19598000	100		L	L	L	n	-200000	-1.02				1	0	
STATES:																		**-0.75**
National report by Njib	1999										2.6E+07							
FRA 1995	1995										2E+07							
Older FRA baseline	1975										2.2E+07							
	1953										2.3E+07							
	1956										2.4E+07							

Appendix 5: Results from, Indonesia and Vietnam

Datasource	Years	Update method	Cover-age	Compa-tibility	Consis-tency	Method compa-tibility	Methods	Stat conf (y/n)	Estimate (State) in million ha	Estimate (Change) million ha	Estimate (Change) million ha/year	Precision measure				Use or Not (0/1)
												s+comment	bias	range	class 1-3	
INDONESIA																
Country Data																
RePPProt (LS, AF. FC)	1985		100	NA	M	NA	RS	NA	119.1			NA	NA	NA	2	1
without Java for Sumatra,									118.2							
for Sumatra, Kalimantan and Sulawesi									74.6							
NFI 1996 (LS(TM), FC without Java)	1989		P(90%)	NA	M	NA	RS	NA	120.3	2.1		NA	NA	NA	3	0
World Bank																
MOF(LS(TM)) for Sumatra,	1997		P(80%)	NA	M	NA	RS	NA	??	-1.59		NA	NA	NA	3	1
Kalimantan and Sulawesi																
Scotland, Fraser	1999		100	NA	M	NA	RS	NA	57.1	-17.5	1.45	NA	NA	NA	3	0
(comparision of Reppport and NFI...)																
Internal Circulation																
(Sampled 20.3% area)	1991-1995		P	NA	M	NA	RS	NA				NA	NA	NA		
FRA RSS																
Model 1980	1990								118.299	-1.212						
model 1990									109	-0.5						
remote sensing fra										-0.58%						
									or	more						
VIETNAM																
	1990	RSS	100	H	M	H		NA	9.1756							
Country Data	1995	RSS	100	H	M	H		NA	9.3022	0.02532		NA	NA	NA	1	1
	2000	Extrap							9.4287	0.0253		NA	NA	NA	1	1
FRA RSS																
	1990								10412	-0.137						
Model 1990																

Appendix 6: List of Participants

to the Expert Consultation on Review of FRA 2000 Methodology for Regional and Global Forest Change Assessment

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Appendix 7: Meeting agenda

Expert Consultation
Review of the FRA 2000 Methodology
for Regional and Global Forest Change Assessment

Meeting Agenda

Monday 6 March 2000

9:00 Opening of the session and welcome to participants; introductions
9:30 Objectives of the Expert Consultation
10:00 Background on Forest Resources Assessment Programme
12:00 Lunch
1:00 Regional presentations: Asia, Anglophone Africa, Latin America and the Caribbean, Sweden, United States
3:00 Presentation of background paper
4:00 Discussion of background paper, plan for remainder of the meeting

Tuesday 7 March 2000

9:00 Form regional working groups:
12:00 Reconvene in plenary session: Group Chairs to report on Progress and Proposals for continued work in the Afternoon
12:30 Lunch
1:30 Reconvene in regional working groups
3:00 Plenary for Group Reports on Scenarios Proposed and
4:00 Discuss the Agenda for Wednesday

Wednesday 8 March 2000

9: 00 Review Agenda
9:15 Special Presentations: FORIS and others
9:30 Review Progress in Regional Groups and Divide into Methods Groups
12:00 Plenary -- Discuss Progress
12:30 Lunch
1:30 Continue in Methods Groups
3:30 Plenary -- Discuss Progress and Agenda for Thursday

Thursday 9 March 2000

9:00 Review Agenda
9:10 Special Presentations
9:30 Discuss Tasks in Plenary then into Regional Groups to Test Methods for Bolivia, Viet Nam, Indonesia and Cameroon
12:00 Plenary -- Discuss Progress
12:30 Lunch
1:30 Continue in Regional Groups
3:30 Plenary -- Discuss Progress and Agenda for Friday
4:30 Next Round -- A World Forest Survey

Friday 10 March 2000

9:00 Review Friday's Agenda
9:10 Review and Comment on Draft Summary Recommendations from Meeting
10:30 Firm Up and Finalise Work in Regional Groups
12:00 Plenary -- Discuss Final Recommendations from Regional Groups
12:30 Lunch
1:30 Plenary -- World Forest Survey
3:00 Plenary -- Review Final Recommendations
4:00 Closure

FRA Working Papers

0. *How to write a FRA Working Paper (10 pp. – E)*
1. *FRA 2000 Terms and Definitions (18 pp. - E/F/S/P)*
2. *FRA 2000 Guidelines for assessments in tropical and sub-tropical countries (43 pp. - E/F/S/P)*
3. *The status of the forest resources assessment in the South-Asian sub-region and the country capacity building needs. Proceedings of the GCP/RAS/162/JPN regional workshop held in Dehradun, India, 8-12 June 1998. (186 pp. - E)*
4. *Volume/Biomass Special Study: georeferenced forest volume data for Latin America (93 pp. - E)*
5. *Volume/Biomass Special Study: georeferenced forest volume data for Asia and Tropical Oceania (102 pp. - E)*
6. *Country Maps for the Forestry Department website (21 pp. - E)*
7. *Forest Resources Information System (FORIS) – Concepts and Status Report (20 pp. E)*
8. *Remote Sensing and Forest Monitoring in FRA 2000 and beyond. (22 pp. - E)*
9. *Volume/Biomass special Study: Georeferenced Forest Volume Data for Tropical Africa (97 pp. – E)*
10. *Memorias del Taller sobre el Programa de Evaluación de los Recursos Forestales en once Países Latinoamericanos (pp. 194 - S)*
11. *Non-wood forest Products study for Mexico, Cuba and South America (draft for comments) (82 pp. – E)*
12. *Annotated bibliography on Forest cover change – Nepal (59 pp. – E)*
13. *Annotated bibliography on Forest cover change – Guatemala (66 pp. – E)*
14. *Forest Resources of Bhutan - Country Report (80 pp. – E)*
15. *Forest Resources of Bangladesh – Country Report (93 pp. – E)*
16. *Forest Resources of Nepal – Country Report (78 pp. - E)*
17. *Forest Resources of Sri Lanka – Country Report (under preparation)*
18. *Forest plantation resource in developing countries (75 pp. – E)*
19. *Global forest cover map (14 pp. – E)*
20. *A concept and strategy for ecological zoning for the global FRA 2000 (23 pp. – E)*
21. *Planning and information needs assessment for forest fires component (32 pp. – E)*
22. *Evaluación de los productos forestales no madereros en América Central (102 pp. – S)*
23. *Forest resources documentation, archiving and research for the Global FRA 2000 (77 pp. –*
24. *Maintenance of Country Texts on the FAO Forestry Department Website (25 pp. – E))*
25. *Field documentation of forest cover changes for the Global FRA 2000 (40 pp. – E))*
26. *FRA 2000 Global Ecological Zones Mapping Workshop Report Cambridge, 28-30 July 1999*
27. *Tropical Deforestation Literature:Geographical and Historical Patterns in the Availability of Information and the Analysis of Causes (17 pp. – E)*
28. *World Forest Survey – Concept Paper (30 pp. - E)*
29. *Forest cover mapping and monitoring with NOAA-AVHRR and other coarse spatial resolution*
30. *Web Page Editorial Guidelines (22 pp. – E)*
31. *Assessing state & change in Global Forest Cover: 2000 and beyond (15 pp. – E)*
32. *Rationale & methodology for Global Forest Survey (60 pp. – E)*
33. *On definitions of forest and forest change (13 pp.- E)*
34. *Bibliografía comentada. Cambios en la cobertura forestal: Nicaragua (51 pp. – S)*
35. *Bibliografía comentada. Cambios en la cobertura forestal: México (35 pp. – S)*
36. *Bibliografía comentada. Cambios en la cobertura forestal: Costa Rica (55 pp. – S)*
37. *Bibliografía comentada. Cambios en la cobertura forestal: El Salvador (35 pp. – S)*
38. *Bibliografia comentada. Cambios en la cobertura forestal: Ecuador (47 pp. – S)*
39. *Bibliografia comentada. Cambios en la cobertura forestal: Venezuela (32 pp. – S)*
40. *Annotated bibliography. Forest Cover Change: Belize (36 pp. – E)*
41. *Bibliografia comentada. Cambios en la cobertura forestal: Panamà (32 pp. – S)*

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