FAO/GOVERNMENT COOPERATIVE PROGRAMME

GCP/INT/723/FIN
"Forest Resources Assessment 2000: Country Capacity Building"

Finnish Support to FRA 2000: Update on Deforestation Trends and Special Studies

PROJECT EVALUATION REPORT

by
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1 Executive summary

Since its start in 1940's the Global Forest Resources Assessment activity has gradually evolved to a multi-source forest information service. In the beginning, the information was collected by questionnaires only, but since 1990, multi-temporal satellite data has been utilised in the Tropics. In FRA2000, major steps in increasing the volume and improving quality of the information have been taken.

In this report, three components of the project, financed by Government of Finland, have been reviewed and suggestions made for finalising and following up the work.

Out of FRA2000 financial resources, slightly more than 10 % (US$ 963 390) was covered by Government of Finland. The duration of Finnish support to FRA 2000: was 24 months at the very end of the FRA period, starting in January 1999.

The 'Finnish' component had three sub-components:

a) Deforestation trends;
b) Ecological map; and
c) Information system

A review was conducted by Risto Päivinen, on behalf of the Forest Resources Assessment Programme. The main objectives of the evaluation were to assess the effectiveness in meeting planned goals, and to provide feedback for the development of new projects and guidance for the future.

The evaluation process between consultant and FRA staff has been interactive. Reporting of the project achievements was accomplished in early February 2001.

1.1 Conclusions

Regarding the objectives of the three sub-projects and achievements, the following can be concluded:

a) Deforestation trends

The Remote Sensing method used in 1990 was applied also in 2000, and the same locations of samples were used (113 Landsat images). The changes from/to nine land use classes were shown, the main result being that the rate of deforestation was found to be slowing down.

The method allows a cost-effective change assessment at regional level, but for country estimates the sample of 113 images is not intensive enough. The time data on time series 1980-1990-2000 will gain more and more value over the time, and should be carefully reported and stored.

The quality of the information is of high importance whenever the results of the study will be used. It is necessary to analyse all sources of error in the final report, and discuss their possible impact on the results. The field check material also plays an important role in error analysis.

In the methodology development, the use of a semi-automatic classification method in harmonising and speeding up the work of many consultants, should be investigated.

b) Ecological map

The map has been a necessary component in assisting Remote Sensing study, and it should be developed according to the needs deriving from the FRA methodology in the future.

c) Information system

The information system developed for FRA has successfully met its goal to make it possible to store the data and to follow the information flow from received documents to figures in the final tables. The system has been upgraded to serve the whole Forestry Department. Due to the raise of the ambition level of the work, some delays related to the original time schedule have occurred.

FORIS will certainly play the key role as tool for dissemination of the information within FRA and FAO staff and between data providers and users of information. It is necessary to continue the development of it by taking into account the changing technology and needs of the users.

The testing and documentation of the system is not yet completed, which will be an urgent task for early 2001.

d) General

To summarise the achievements: The objectives of the project GCP/INT/723/FIN have been in general achieved, as can be seen from the working reports and information system at the moment. Only in few details, have the objectives have been adjusted during the work, or left aside as not important ones.

The work of FRA has been carried out subject to tight time constraints, which has led to some problems in time sequencing of the elements. The Finnish funding has played a major role in helping to achieve the overall goals of FRA.

1.2 Recommendations

The following general level recommendations for finalising the FRA2000 and planning the new FRA programme are given. More detailed conclusions and recommendations can be found in the report itself.

Forest Resources Assessment Programme (FRA)

The FRA should:

1) Maximise the utilisation of FRA results, for instance by special reports and articles on issues of interest especially for international policy-making processes.
2) Using the potential of the information system, systematically analyse the use and the users of the data provided.
3) Seek partners in working on studies made of the collected data, for instance by senior and junior researchers at the Universities, Research Institutes and other relevant organisations. These studies will also contribute to the methodology development.
4) Review the new methodologies which could be used in the next FRA, and continue the brainstorming on Global Forest Survey
5) Establish an advisory group as a link to experts in the field, and invite the group members for a certain period of years.
6) Carry out an information needs assessment study, utilising the components mentioned above.

FAO

It is recommended that the overall working framework for next round of GFRA will be set up within 12-18 months, and the negotiations with partners and donors will be started.

Donors

It is recommended that the donors consider their possible interest in supporting FRA and signal in detail the kind of resources that may be able to make available (cash, secondments, support for partners in the countries, etc.).

2 Introduction

2.1 Background

The FAO Global Forest Resources Assessments are the most comprehensive summaries of the state of forests around. In this report, there's no need to repeat the importance of the work and the mandate of FAO to carry it out. Simply, the demand of

- more reliable information on many;
- more forest characteristics for;
- various geographic reporting units; and
- more often,

has been increasing in the international community.

FAO has responded to these needs since 1946, starting to collect forest resources information by questionnaires, and publishing them at 5-year intervals in the period 1948-63, and in 1970.

The next global survey [1] included 1) country visits and research to collect existing information; 2) interpretation of satellite imagery where existing information was weak; 3) re-appraisal and re-classification carried out by a team of specialists; and 4) adjustment to the common reference date (end of 1980) by empirical methods.

The Forest Resources Assessment 1990 applied two parallel methods to estimate the state and change of the forest cover. As before, country-level information was gathered through country visits and by correspondence. A deforestation model was developed, based on population growth, to take care of the adjustments to the common reference dates 1980 and 1990. Results for the tropical countries were published in 1993[2].

The second "branch" of FRA 1990 was to apply a stratified random sampling scheme to obtain statistically sound estimates of forest cover at regional and global levels[3]. The sampling units consisted of multi-temporal Landsat images, one from a date close to 1980 and the other from a date close to 1990. The systematic use of satellite imagery covering the whole tropical region allowed considerable improvements of change estimates.

Since the publication of the FRA 1990 results, FAO has made bi-annual reports called "State of the World´s Forests[4]" (SOFO). The reports contain updated country information and regional summaries, and can be seen as a first step towards a continuous reporting system. Efforts were made to obtain new information for SOFO by focusing on large countries where new forest surveys had been carried out.[5]

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[1] FAO, 1982. Tropical Forest Resources. Forestry Paper no. 30.
[2] FAO, 1993. Forest Resources Assessment 1990 - Tropical countries. Forestry Paper no. 112.
[3] FAO, 1995. Forest Resources Assessment 1990 - Survey of tropical forest cover and study of change processess. Forestry Paper no. 130.
[4] FAO, 1997. State of the World´s Forests 1997.
[5] Celander, T. Lindgren, O. 1999. Sidas support capacity building for the formyulation of National Firestry Prtogrammes. FAO Evaluation report. December 1999.

The Global Forest Resources Assessment activity has gradually evolved to a multi-source forest information service. The main challenge in compiling global forest statistics from many sources is to harmonise all sources to a single – as much as possible – comparable product. This is not always even possible, and the only way to produce value added information is to report every source and every turn in data derivation in a transparent way. Another solution is to utilise similar method all over the world. Using Remote Sensing a global picture can be drawn but only for large areas and for few forest characteristics.

In FRA2000, major steps in improving of the quality of the information on global forest resources have been taken. In the following, three components of the project have been reviewed and suggestions made for finalising and following up the work.

2.2 FRA2000 programme and Finnish funding component

Out of FRA2000 financial resources, slightly more than 10% (US$ 963,390) was covered by Government of Finland. The duration of Finnish support to FRA2000: was 24 months, starting date in January 1999.

The 'Finnish' component had three sub-components with the following objectives:

1. DEFORESTATION TRENDS. Provide reliable updated estimates of forest cover state and change, including current trends, and detailed descriptions of the change processes affecting the tropical forest resources (deforestation, degradation, and biomass flux) by geographical (global, regional) and ecological reporting units;

2. ECOLOGICAL MAP. Contribute to the development of an improved ecological map for tropical countries;

3. INFORMATION SYSTEM. Contribute to the development of a state-of-the-art electronic information system for forest resources assessment information (FORIS).

2.3 Evaluation

In the project document, it has been agreed to carry out the evaluation of the project:

> "Representatives of FAO and the Donor Government nine months prior to its completion will jointly evaluate the Project. The terms of reference, exact timing and place will be decided in consultation among the concerned parties and in conjunction with other modules of the FRA 2000 Programme".

The terms of reference (Annex 1) define the tasks of the evaluation mission as follows:

> Under the overall supervision of the FRA Programme Coordinator, and in cooperation with all FRA staff members, the Consultant will be responsible for the following:

a) conduct a review of the project GCP/INT/723/FIN on behalf of the Forest Resources Assessment Programme. (The review should cover the thematic responsibilities of the project and assess its effectiveness in meeting planned goals. The same document should also provide feedback for the development of new projects and guidance for the future, so that FAO may improve its periodic assessments). FAO will provide the framework for the assessment of the project, interviews with staff and relevant documentation.

b) produce a review document based on the assessment of the GCP/INT/723/FIN project and incorporate all the findings of the same.

2.4 Modus operandi

The evaluation work has been carried our mainly during a mission to FAO headquarters 28.11.-6.12.2000, and email correspondence after that. For the evaluation report, the sub-task managers (Branthomme, Davis, Grylle) have been interviewed, and they have also provided basic material on achieved outputs and activities carried out, which has been edited then by the consultant. The self evaluation of a staff member is written fully by the sub-task managers.

The process between consultant and FRA staff has been interactive. In this context I would like to thank the whole FRA and other FAO staff for the open-minded approach to report what has happened and why, and how the whole process can be improved next time.

2.5 Overall goals and design of Forest Resources Assessment 2000

Objectives, outputs and activities as they are written in the original project document, are attached below in *italics.*

Overall goals

In the 723/FIN project document the 'Problem statement' reads as follows:

Information is needed to

- *formulate global/regional policies addressing environmental and development issues, and implement coordinated international actions and*
- *support strategic planning and monitor/evaluate national/international level development programs.*

To address these issues on an informed basis, it is vital that global and national level policy makers, scientists, and resource managers be provided with reliable information on the state of the world's forest resources and, most importantly on its rate of depletion and associated change processes. It is essential that the information on change go beyond the pure estimation of deforestation rates, which is a catchy piece of information but also a rather simplistic

resultant of diverse and composite dynamics, whose differentiation and understanding is essential for effective policy formulation.

The information on change must describe land cover change processes, highlight regional/sub-regional/ecological characters, and thereby provide new consistent evidence on cause-effect mechanisms. Similarly, it must be suitable to multi-disciplinary studies by adopting a land cover classification, inclusive of forest as well as non-forest classes, rather than a simple forest/non-forest dichotomy.

Consistent and reliable information on trends in forest cover change, defined as acceleration/deceleration of deforestation and degradation rates, plantation establishment, etc., is also very important for the evaluation of medium terms effects of large scale policies and for the development of future scenarios. Finally, information must be accurate and objective, as well as comparable on a global scale. It must cover the entire tropical region in order to represent all tropical forest types, from wet to dry conditions. It must also be current and timely in order to address dynamic issues effectively.

2.6 Programme implementation

The FRA2000 collects information using two main strategies:

1. Data on forest variables, collected from national forest statistic of the countries. In many tropical countries, however, a number of other sources have been used.

2. Data on 9 variables and their change, utilising a sample of 113 satellite imageries.

To successfully carry out the work within both areas, FRA2000 has produced a number of ancillary products for stratification etc. purposes.

Finland funded 3 elements:

1. Information system, which is used to organise and handle the data and other materials collected from countries, and the Remote Sensing data as well.

2. The main part of Remote Sensing work.

3. Ecological map, which is used to stratify the RS results to 3 ecological zones, and for other reporting.

In order to maximise the utility of funding from various sources, and due to the time constraints, and the availability of the skilled staff, the 'Finnish' components were sometimes funded by other sources, and vice versa.

Table 1. Funding sources of thematic elements and their sub components.

Finland: Remote sensing survey, information systems, global maps	1 M US$
FAO Regular Programme: some contributions in all sectors,	2,7 M
Sweden: 2 APOs Information systems and remote sensing, and GIS, Country information, capacity building, some special studies	2, 5 M
France: APO, remote sensing	
EROS Data Center: Cost sharing for global forest cover map	
NASA: Satellite Imagery,	0,2 M
UNEP: Africa Data Collection and forest map of Africa	
UK: Protected Areas and Biological Diversity	0,5M
Switzerland: volume and biomass studies,	0,35 M
Japan: Southeast Asia Regional Project	
US Forest Service: In-kind contributions to data collection in Caribbean, facilities for meetings, technique development	
Denmark: APO (Thailand, data in Asia)	
Finland: APO (Geneva, Data in Industrialized Countries)	
Italy: APO (Cairo, Data in Middle East)	
Swedish National Board of Forestry: Web and information system, and data collection in Africa	

The total budget of FRA2000 during period 1998-200 was **US$ 8,7 Million,** one third from FAO Regular Programme, two thirds from donors, largest contributions coming from Sweden and Finland.

The Finnish contribution was US$ 963 000, which is approximately US$ 0,5 mill./year for 2 years. At the same time, FAO Regular Programme allocated US$ 430 000/year for FRA2000, and as much as staff time other donors almost US$ 5 Million. The US$ 430 000 is 20 % of the Forest Resources Division budget, 5 % of the Forestry Department budget, and 0,25 % of the total FAO Regular Programme budget.

Approximately 30 persons were regularly involved with FRA2000, including five APO's. The FRA2000 is co-managed by Robert Davis (Regular programme component), and Peter Holmgren (externally financed component). In December 2000, 92 % of the Finnish funding have been used, and for the rest, plans have been made to spend it by March 2001.

2.7 Programme design

Table 2. WORKPLAN. Activities shown by quarters for duration of project

	YEAR ONE				YEAR TWO			
	1	2	3	4	1	2	3	4
ACTIVITIES								
DEFORESTATION TRENDS								
Imagery Selection/Procurement								
Technical Guidelines								
Interpret Imagery								
Field Verification								
Review and Evaluation								
Map Production								
Reference System								
Update Methods								
Analysis								
Reporting								
ECOLOGICAL MAP								
Analysis								
Consultation and Testing								
Data Preparation								
Expert Review								
Final Compilation								
Evaluation								
INFORMATION SYSTEM								
Requirement Study								
Links to Existing Systems								
Acquire Hardware/Software								
Training								
Updating/Debugging								

The project implementation was somehow delayed from the planned timetable above. Final compilation and evaluation of ecological map was delayed for half a year. Information System work included elements like ‘development and implementation’ which does not show up in the timetable attached in the project document. Probably that is one reason why referring to the timetable above, the work was delayed almost by one year.

2.8 Conclusions on overall objectives and achievements

1. 'Reliable information on the state of the world's forest resources' will be available as the results have been published in the internet.

2. The 'reliability' of the results based on information provided by the countries is difficult to evaluate. The origin of the information, and the different phases of the derivation of the results, have been made possible to follow trough 'transparent' information system [6] developed in the project.

3. The information on change from the Remote Sensing Study [7] describes land cover change from nine land use classes to nine classes in 113 locations, each 34 000 square kilometers. 3 regions and 3 ecological zones present the results[8]. The statistical errors and other error sources will be described in the final report.

4. Land use changes were studied in the same locations for the periods 1980-1990 and 1990-2000 using the same classification and the same methodology the 'trend' was identified.

5. The comparability of results on a global scale can be considered good in the remote sensing survey and global maps, but probably only satisfactory in the information based from country reports (which component was not part of project 723/FIN).

6. To summarize, the overall goals have been achieved, but are not yet fully available as written reports.

7. It is striking that the timing of the whole FRA has been a bit problematic. Even if it was obvious after FRA1990, that there will be FRA2000, and two planning meetings in Kotka (1993, 1996) were held, there was no clear plan (umbrella project document) on the implementation of the work before 1997. The time pressure has caused difficulties and may have affected to the quality of the findings.

8. In the problem statement it was correctly stated that Information is needed to *…formulate global/regional policies… and …support strategic planning and monitor/evaluate national/international level development programs.* These needs reflected in portfolio of variables collected and studies concerning topics such as[9] volume and biomass, status of protected forests, bio-diversity, wood supply / fellings and removals, non-wood forest products and forest fires. How this working program has been obtained, and what kind of choices have been made (for instance in the Kotka meetings), should be visible in the final reports.

[6] Sub-project 1c, information system' has contributed to this goal
[7] Remote Sensing Study, sub-project 1a
[8] Ecological map, sub-project 1b
[9] FAO, 1998. FRA 2000 - Guidelines for assessments in tropical and sub-tropical countries. FRA Programme, Working Paper 2.

2.9 Recommendations

1. Reliability of the results should be emphasised in the final reporting phase, including all sources of error (statistical, interpretation, coding, etc.).

2. A plan should be presented to maximise the ulitisation of FRA2000 results, based on the FAO staff time, partnerships between FAO and various institutes.

3. For the next assessment, a strategy discussion should be continued, including the systematic collection of FRA2000 feedback, overall goal setting, methodological aspects, work distribution between FAO staff, consultants and partners, and funding arrangements between FAO regular program, secondments and donors.

As the division of countries between developing and industrialised countries is somewhat arbitrary, it is important that these two processes continue to integrate to ensure comparability of the results.

3 Project internal achievements vs. objectives of the sub-components

3.1 Deforestation Trends

Objectives, outputs and activities as they are written in the original project document, are attached below *in italics*.

Objective 1a: DEFORESTATION TRENDS. Provide reliable updated estimates of forest cover state and change, including current trends, and detailed descriptions of the change processes affecting the tropical forest resources (deforestation, degradation, and biomass flux) by geographical (global, regional) and ecological reporting units

Outputs 1a:

- ***Reliable forest cover state and change estimates for the periods 1990-2000; biomass flux estimates for the same period, detailed descriptions of the change processes affecting the tropical forest resources by geographical (global, regional) and ecological reporting units; in relation with the pre-existing 1980-1990 data, analysis of deforestation/afforestation trends (increase or decrease of change rates).***

Description of change process has been done at four geographical reporting units:
at pan-tropical level, at regional level, at ecological zone level and at sampling unit level. For each level, change process is described by sequential class-to-class transition matrices 1980-1990-2000, composed of 81 cells (9*9 classes).

- **Reliability of the estimates**

The same sampling units as in FRA1990 have been used, so the sampling error can be derived in a similar way and is expected to be close to the previous one. During the FRA1990, two sampling units over the 117 hadn't been analyzed due to the lack of suitable data available. Two more have been excluded from the FRA2000 analysis also because of the lack of cloudless images. As a consequence the study relies on 113 sampling units.
The method used is the same than for the FRA1990: visual interpretation by local consultants. The third date (T_3) is not only used for the estimation of the changes between T_2 and T_3, but also to improve the reliability and consistency of the entire T_1-T_2-T_3 series. The other error sources than sampling (interpretation, coding etc) will be analysed.

- ***A catalogued archive of all the interpretation films and computer generated maps (or copies thereof) of all dates produced in the course of area and change assessment, with the corresponding computerized catalogue, the latter including an index of all the satellite scenes used and their archive location.***

Two archives are available:
- An Excel workbook, accessible to the project staff, regularly updated by the remote sensing group.
- In tables located in the FORIS table space on the FAO ORACLE server (database server), available through FORACLE system which can be used within the FAO HQ LAN. Back up of all data present in the database is carried out frequently.

- ***A spatial database describing, for each sampling unit, the classes resulting from image interpretation and the resulting change maps. This information will be compatible to most common Geographic Information Systems to allow multi-layers spatial analysis***

Georeferenced sampling units are accessible by RS/GIS staff in the FAO FRA drive Z. The files are ARC/INFO files compatible with most of the GIS software.

- ***Area transition matrices of land cover classes for each sampling unit (matrix 1990-2000 and matrix 1980-2000, in addition to the available matrix 1980-1990) and, derived from these, the annual and periodic probability transition matrices. The latter being essential for the aggregation of the individual sampling units at stratum, geographical and ecological levels to produce 'mean' transition matrices.***

- The description of change processes is done at four levels: pan-tropical level, at regional level, at ecological zone level and at sampling unit level.
- The regional level includes 3 regions: Asia, Africa, and Latin America.
- The description at ecological zone level divides the pan-tropical zone into 3 different ecological zones: 1) Tropical rainforest ("moist and very moist); 2) Tropical deciduous forest and woodland ("moist with short and long dry season"); 3) Tropical semi-desert and desert ("sub-dry to very dry").

For each level, change processes are described by sequential class-to-class transition matrices 1980-1990-2000, composed of 81 cells (9*9 classes). From these matrices are derived deforestation rates, calculated using 3 definitions of forest, and afforestation/deforestation trends by comparison of the deforestation rate between the first and the second period.
At sampling unit level, raster maps (state and change) are produced to describe spatial distribution of the changes.

Activities 1a:

- ***Screen, select, procure and process all imagery needed***

The data procurement focused on the acquisition of T3 images (closed to 2000) since the imagery for the dates T1 and T2, used for the FRA 1990, was already available at FAO. However for some of the sampling units the imagery, left to the countries, couldn't been retrieved and had to be re-ordered/acquired.
Selection of the imagery was mainly done using on-line catalogues (internet) and quick looks, when available. Criteria for the selection were: acquisition dates (latest possible, same period and season than the T2 image), quality (cloud cover, visibility) and cost.

The procurement of the imagery took longer time than expected: some of the imagery had to be returned due to their poor quality (bad stretch, cloud cover above what was mentioned in the catalogues, wrong path/row).

- **Latin America**

- Images were ordered at EDC for the sampling units located in Central America and South America excluded Brazil. Some (4) images were below acceptable standard (extremely poor processing or cloud coverage in contradiction of catalogue description) and a request was sent to EDC for alternative data. The cost was US$ 600 for digital data/films/photo products. Time: order placed in December 1998, last images were received in June 1999.

- INPE for Brazil.
  INPE order suffered some delay at FAOR Brasilia and the order to INPE was actually placed only at the end of February. Positive Films were received from INPE and sent to EDC for printing. Last images arrived in June 1999.

- **Africa**

- All recent acquisitions available at EDC, all located in Central Africa sub-region, were ordered in December 1998. This order (14 scenes) was delivered on February 5th, 1999.
- All elements for ordering the remaining 33 images were ready since March (image selection made from South Africa quick looks and Eurimage catalogues).
  Arrangements for NASA free image contribution continued until June (thus delaying the procurement of Africa images of some three months). Digital data from NASA was ordered in August 1999, last images arrived in September 2000.
  Processing and image production were carried out by Eurimage (Italy) and EarthSat.
  Before the launch of LANDSAT 7 (summer 1999), there were very few recent data available: thus for Central Africa, most of the data are acquired in 1994 and 1995.For two locations quite cloudy (South Cameroon and Equatorial Guinea), no suitable data were acquired by the LANDSAT program. Search for other kind of data was unsuccessful.

- **Asia**

- The order of data for Asia depended on the availability of data from FSI, India, RFD, Thailand and FIPI, Vietnam, which provided the images used during FRA1990. Field missions to all these countries allowed to ascertain the availability of recent and historical data and to arrange for the procurement of the required data.
  All images required for subregions 45 and 46 (Continental and Insular South East Asia) were procured through National Forest Inventory Unit of Indonesia and through the Royal Forest Department of Thailand.
  Digital data for India (subregion 44) were provided through the NASA donation (ordered in August 1999). Michigan University made prints. All the prints were given back and replaced since they had a wrong scale and projection. Last prints were received in March 2000.

When the imagery was available in digital format, it has been processed at FAO HQ, after the acquisition of an ERDAS license (Sept. 1999), and given to the photo-interpreters as a reference under a ".tif" format that can be easily displayed without any image processing software.
Reference: FRA2000 Excel archives**.**

- ***Develop technical guidelines for interpreters***

A document written for the FRA1990 was used as a starting point. Two other documents have been produced to complete and update it.
Most of the photo-interpreters have been trained during at least one week.

➢ **References**
- Monitoring methodology. Procedure for interpretation and compilation of high-resolution satellite data for assessment of forest cover state and change. FRA1990 Project document.
- Interpretation process FRA 2000. Step by step. 2000 update. Internal document.
- Interpretation process FRA 2000. Step by step. Entire time series. Internal document.
- FRA 2000 Remote Sensing Component - 2000 Update- data compilation system- Customized Excel File for the entry and analysis at sampling unit level. Internal document.
- Training material (transparencies in French, Spanish and English). Internal document.

- ***Interpret, interdependently, the new image and the "1990" image produce sequential matrices 1980-1990 and 1990-2000 for all sample locations.***

The interpretation process started in July 1999, the last interpretation is still on going, but most of the interpretations were completed in August 2000 (110 Sampling units).
Interpretation was done through individual contracts or letters of agreement with national institutions (CATIE, FSI, IBAMA). The letter of Agreement with the Forest Survey of India (FSI) failed**.**
Number of interpreters involved: Twenty-nine[10], many of them (13) the same persons than in 1990.

The time for the analysis of one sampling unit is estimated to 2 weeks for the update of the previous interpretation (interpretation of the T3 image), and the corrections of the T1 and T2 images (102 sampling units, so 204 weeks); to 3 weeks-1 month for the interpretation and data entry of the entire time series (15 sampling units, so 75 weeks). Total: approximately 280 weeks.

- ***Carry out field verification for selected, critical samples.***

➢ **Field knowledge**
Most of the interpretations relies on the field knowledge of the persons who carried out the interpretation during the FRA1990 (and national interpreters involved during the FRA2000), mainly national foresters, or experienced interpreters of satellite images, or responsible for national vegetation mapping programmes. The interpretation was always carried out with the support of descriptive reports, existing cartographic information such as vegetation, land use

[10] Ambrosini I., Bernard C., Branthomme A., CATIE (5 interpreters), Dell'Agnello A., Dibari C., Drigo R., FSI (8 interpreters), IBAMA (2 interpreters), Jacobs T., Jewell N., Kokou K., Leonardi U., Maggi M., Monjane M., Robiglio V., Saket M.

maps, when available. Recent maps or reports have been used during the FRA 2000 in order to complement/verify the information, and improve the interpretation.

- **Field check**

During the FRA1990, 17 samples were ground checked. In FRA2000, 5 samples were checked in Brazil and one in Thailand.

During the FRA2000, field verifications were mainly carried out in Brazil (5 samples, 5 weeks). The samples were selected according to their locations and to the fact that they hadn't been checked during the FRA 1990. Most of the Brazilian sampling units have been checked during the FRA 1990 or 2000, except the sampling unit in the middle of Amazon (3501) - not easily accessible and completely covered with forest - as well as the sampling units geographically closed to another sampling unit that had been already surveyed and with similar vegetation.

In that case field visit was carried out after a preliminary interpretation. It consisted in an aerial survey of the zone and /or ground visit. The plans for the flights/ground visits were prepared according to the vegetation specifications and after identification of the areas with doubts, in order to cover the highest diversity possible and to survey the areas for which there were some classification problems.
A report was prepared containing:
- identification of the objectives of the field verification;
- choice of the type of field verification according to the objectives;
- a description of the region (land cover) and the route taken;
- list of the material used (satellite images, maps, GPS, etc.);
- observations : corrections to be brought to the interpretation according to the field visit;
- annexes: map of the area with the itinerary; photographs with brief comments and location.

A transparency overlay reporting the location of the photographs at the scale of the satellite imagery (1:250,000) was also produced.

Persons involved: the principal photo-interpreter involved, Débora Campos Jansen, and other IBAMA technician Marcos Andrey Hermogenes, Elizabethe l. Veras Micheletti, Cirineu Jorge Lorensi, Maristela Félix de Lima, and Anne Branthomme.

Another field-work was made in **Thailand** (2 weeks), combined with the pilot work for the World Forest Survey. It focused on three areas where some changes had been identified on the preliminary interpretation of the sampling unit (4505). The field survey documented the three studied areas, with an objective to confirm and explain the changes observed in through the interdependent interpretation of the satellite imagery. Two of them were confirmed and the last one was considered as incorrect. The classification code for this last studied area was modified, but the arguments for the absence of change reported by the surveyors wasn't suitable comparing to what was visible on the imagery. This survey brought a better understanding of the changes at the scale of each plot studied, but not at the image/interpretation scale (1:1250,000) and had a limited value in term of field verification for the remote sensing work.

Field checks took altogether 6 weeks. The main constraint was time, the high costs involved for field verification and the accessibility of the sample locations.

Persons involved: Alice M. Ennals, Ingemar Eriksson and Sören Dalsgaard.
Reference: FRA 2000 Working Paper 25, *Field documentation of forest cover changes for the Global FRA 2000* (40 pp. – E).

- ***Review and evaluate all interpretation results.***

Most of the interpreters came to Rome at the beginning, at half and at the end of their contract. During the first visit, classification problems were identified and discussed with the FAO responsible in order to find a better solution. A bibliographic search (new maps and reports) was then carried out to document the sample and bring better information on the area. At the middle of the period, the interpretation was evaluated and given back to the interpreters for adding of corrections.
The final evaluation was generally done at arrival of the interpretation overlays.

The screening process was:
- Check of the transition matrices to see if the results are realistic for the area (deforestation rate, positive changes) and if matrices from both periods (T1-T2 and T2-T3) are consistent.
- Check of the change raster maps produced in Excel to see if changes are relevant, consistent between both periods, and to locate where could be possible errors (regeneration in a deciduous forest...).
- Check of the classification used on the interpretation overlay, and see if there is a consistent use of each class within each interpretation and within the entire time series, if the corrections done in the T2 overlay are reported on the T1 overlay.
- Check of the changes written on the interpretation overlay with a particular attention to the changes between T2 and T3 (the changes between T1 and T2 are supposed to have been controlled during the FRA 90), to see if the reported changes are real (not due to a different contrast of the imagery, to the season...) and if they have all been drawn.
- Check of the state raster maps in Excel to see if they correspond to the interpretation overlay and to identify some data entry mistakes.

All these steps allow detecting possible errors or approximations in the interpretation work in a systematic way. The quality of the interpretation and the need of corrections is reported in the remote sensing archive, and reviewed straight away or when time is available. Corrections are done only where there are obvious misinterpretation, and give priority to the sample where the biggest errors were detected.
The first version of the interpretation is saved in the directory created for each interpreters, a revised Excel workbook is then created to insert the correction (with a suffix: “rev”), and save in the final results directory. The reviewed file is then imported into the ORACLE tables, removing the previous version.

Three persons have been recently contracted for quality control and review of the interpretation. While the corrections are entered the person verify a sample of points, randomly selected, to assess the accuracy of the data entry.
Persons involved: Anne Branthomme, Paola De Salvo, Rudi Drigo (till September 1999), Dan Altrell, Angela dell’Agnello, Federica Urbani (data entry).

The main limit of this process is the time constraint. A lot of errors have been identified, also in the work carried out during the FRA 1990, and the actual interpretation was quite conservative related to the previous interpretation.
The absence of the interpreters to explain to the reviewer how and with which arguments they interpreted a zone is also a limit. Some reports by the interpreters, explaining their difficulties/doubts, have been produced during the FRA 1990 and the FRA 2000 to avoid this loss of the experience, but unfortunately not in a systematic way.

- ***Produce digital maps for each sampling unit as derived from image interpretation for state assessment (historical and recent images) and change assessment (change maps).***

Digital raster maps for T1-T2-T3 maps and change maps produced directly in Excel or in FORIS. T1 and T2 already geo-referenced and in the GIS. Digitizing of 10 sampling units located in Latin America made; scanning traces for 10 other sampling units done.
2 people contracted: 2 months.

- ***Select and maintain a suitable reference and retrieval system; label all remote sensing data used and all final interpretation films, computerized spatial data, transition matrices and other relevant documents produced; progressively produce a computerized catalogue indicating the location of all items.***

All data are labeled according to the sampling unit codes - which contains indication on the location (Sub-region/regions) - and to the observed time studied (T1, T2, T3).

- ***Update methodologies and guidelines according to relevant developments in satellite remote sensing (use of radar data over permanently cloudy areas).***

Nothing done in a deep way, for matter of time since LANDSAT (IRS for India) data were found for all the sampling units except two. For the two remaining locations, very cloudy, the use of radar data has been tried without success on the visual identification of all 9 vegetation classes used. It was also rather difficult to compare the T2 data with the radar image to identify the changes.

- ***Produce periodic and final reports on the activities carried out, difficulties and progress in relation to the achievement of Project's objectives.***

Status reports were produced periodically. The Excel worksheet "archive" contained all the steps of the process and allowed to see the status of the work. The final report has been started.

- ***Analyze sampling results to produce:***

i. Statistical estimates (means, sampling errors) of forest area, deforestation rates by region, ecological zone and at pan-tropical level.

ii. Statistical estimates of current deforestation trends by comparing the two decades 1980-90 and 1990-2000.

iii. Area and probability transition matrices by geographical and ecological reporting units to describe at the highest detail (change matrix level) the dynamic class to class changes observed for the periods 1980-1990 and 1990-2000.

(i) (ii) (iii) Made in collaboration with a statistician. Different programs have been created in FORTRAN, to adjust the observed matrices to the reference years 1980-1990-2000. All the ten-year adjusted matrices have been verified one by one, to see if they are realistic, if they don't have too many/high negative values, and integrated into the ORACLE tables through FORIS.

- The process for the adjustment of observed matrices is made using the following steps :
  - Two programs have been run on all the observed transition matrices. The statistician takes care of the difficult cases. 4 different kind of adjusted matrices result from this process: "Exact matrices", "positive matrices", "constant matrices", and "constant after modification of observed matrices" (class appears or disappears).
  - Control of the adjusted matrices done into FORIS, one by one, following a systematic process in order to identify: which type of matrices to be used, if the resulting matrices are realistic.
  - Comparison of the exact and positive probability matrices with attention to the negative values (number and value).
  - Comparison of the exact and positive area matrices with attention to the negative values (number and value).
  - Identification of very high negative values in adjusted matrices and states.
  - Observation and comparison of the diagrams for all classes.
  - Record in the result table of the chosen matrices.
  - Several problematic cases: results not realistic and program failed. Given to the statistician for further analysis.
  - Remaining negative values manually removed from the matrices.

- The aggregation process and the calculation of errors, standard deviation at the different reporting levels of analysis have been done using the adjusted matrices and programming in ORACLE. Trend analysis, calculation of forest estimates and deforestation rates, are made using the standardized aggregated matrices.

- Persons involved: Anne Branthomme, Ingemar Eriksson (system development, programming in ORACLE), Sören Holm (statistical concepts, formulae, programming).

(iv) Contributions to modeling and simulation studies; the observed changes will be analysed in combination with FRA global forest databases (FORIS) and auxiliary data (population density and growth rate, ecological settings, socio-economic parameters, etc.) to produce prediction models.

Nothing was done in that perspective since the model approach has been abandoned during the FRA 2000.

Links to other thematic elements? The breakdown by ecological zones of the sampling units has been carried out thanks to the new ecological map.

3.1.1 Self-evaluation of responsible staff member (Anne Branthomme)

- **Relevance of objectives – were they refined or changed during the work?**

None of the initial main objectives (cf. 1) have been changed during the study. The modeling approach in change assessment was abandoned, but it had only minor impacts on the RS component.

- **Were all the objectives met?**

All the main objectives are to be met although they have not been finalized yet, except the implementation of a spatial database.

The following problems during the work have been found:

- Interpretation: because of a lack of suitable data two sampling units couldn't be analysed. Few images have a very poor quality creating probably uncertainties in the interpretation. A lot of T3 images for East Africa are not very recent (1994-1995) due to the absence of more recent LANDSAT images available, although they have at least 6 years of difference with the T2 images. Due to the lack of records from the FRA 1990, it was often difficult to estimate the quality (field knowledge integrated) of the T1 and T2 interpretations, used as reference.

- Timing: the time for finalizing the study time was longer than expected, due to the delays in data procurement, and the reviewing of some results which came late (India).
  The small number of persons involved at the FAO HQ (one after September 2000) did not make the problem easier.

Other achievements, not included in the initial objectives are the development of tools that facilitate the data entry, the verification process, and the archiving of the data. These are the customized Excel workbook, with a set of macros, and the Remote sensing module of the database FORIS, which allows to store the data, update them and calculate/update automatically most of the statistics at all reporting levels.
Then the statistical methods and programs used also for standardization to a three date time series is also quite new and powerful.

- **Lessons learned for further assessments**

  - **Sampling design**

A higher sampling intensity would decrease the sampling error, increase the reliability and improve the estimate. Possibilities to have more efficient stratification criteria (using new maps, deforestation hot-spots), should be studied.

- **Interpretation**

- Training should be longer than 1 week and a closed supervision is usually needed at the beginning to ensure a good understanding of the methodology, a good consistency in the classification at global level.
- It is preferably to have less but well trained people contracted for longer periods. It would in particular allow to identify where would be needed collateral material or information and field visits, and to have time to take appropriate actions. This would also reduce training/contracting efforts and ensure a better continuity in the work.
- Persons with a good field knowledge or remote sensing skills are not always the best photo-interpreters, but it is important to have people with a knowledge of the type of forests, the dynamics in the area and familiarized with remote sensing data.
- A report on the analysis of any sampling unit should be written in order to keep record on each step of the analysis process by the photo-interpreter.
- More field work and the use of other information for validation (very high resolution satellite data) would be needed

- **Techniques**

Manual interpretation is quite powerful especially for change detection since the person can synthesize and integrate different sources of information that would be difficult to program in automatic classification. The high diversity encountered worldwide is also a limit to automatic methods unless an intensive fieldwork is carried out.
However, utilisation of automatic digital techniques could improve the results, depending on the approach undertaken:

- Manual interpretation on hard copies:
  Looking on screen at the digital data as a reference, to clear doubts.
  Image processing to get images with a good contrast for discriminating vegetation types and ensure a geometric and radiometric uniformity within the time series.
  Digitizing of the overlays, to ensure the permanence of the information (transparency overlays are very unstable), avoid the use of the dot-grid and allow multi-layer spatial analysis.
  Change detection algorithm.
- On screen interpretation using software that could be used in developing countries; experience of other projects may be used (JRC...).

➢ **Conclusions**

1. The methodology used was justified by using the same method as last time in 1990. In principle, if new methods would have been available, they could also have been applied to the 'old' data of 1980/1990. In the time of 2-3 years available, and the unsecure funding situation before starting the 'Finnish' project, the chosen way has been safest.
2. Cost effectiveness can be considered good: total cost of the RS component was US$ 0.5 million, which means US$ 4 300 per image (including 2 weeks interpretation), 13 cents per square kilometer or 50 cents per sample 'plot'. There are not many possibilities for savings, rather more should be invested in field checks and improving the quality of interpretation.

3. Field check: original interpretation in Brazil not filed, probably should have been made for transparency and training purposes in the next round. The field check should be given more emphasis in the future assessments.
4. Office check: logical checks by task manager, after which images were checked again by 3 assistants. If mistakes were found, they were corrected. T1-T2 80-90 checked as well. The experiences of this checking should be reported and used in reliability assessment and training.
5. Even if in principle the image interpretation will produce comparable results, this will not be the case unless it can be ensured that interpreters do their work in a consistent way. As learned in India; 10 consultants, who should have been experienced since they were employed in 1990 already, provided as average too positive results, as training and supervision was not sufficient. There seem to be a trade-off between country involvement/capacity building and the cost-efficient image interpretation.

- **Recommendations**

1. Field checking should be more intensive, systematic and transparent.
2. Visual interpretation is easily subject to personal bias, the joint training courses should be emphasised to guarantee consistent results.
3. FRA should consider semi–automatic classification systems to help the consultants both to make the work more consistent and quicker.
4. The RS data and interpretation results are a valuable basis for long-term time series. All data and descriptions of the work process should be documented well.
5. All sources of error are to be analysed and reported. At this stage of the project, quality can be improved only by making all sources of errors as transparent as possible. The following elements should be discussed:
   - Sampling errors – based on sampling design.
   - Measurement errors/interpretation errors, which may cause personal bias but may balance out with many interpreters and can be minimised by good training. The random errors, bias, and accuracy should be analysed.
   - Modeling errors.
   - 'Other' errors include coding errors etc. How they have been checked and corrected, should be described. It would also be necessary to explain how it has been secured that the information does not change inside the system.

3.2 Ecological map

Objectives, outputs and activities as they are written in the original project document, are attached below *in italics.*

Objective 1b: ECOLOGICAL MAP. Contribute to the development of an improved ecological map for tropical countries

Outputs 1b:

- ***Improved ecological map for the interpolation of forest statistics by ecological units in tropical countries.***
- ***Dissemination of methodology, guidelines and result maps/reports of improved ecological map.***

This was done by the same institute – LET of France. The new FRA2000 ecological map based on considerations presented in a background paper (FRA Working Paper 20), thorough discussion in Cambridge (FRA Working paper 26) and review meeting in Salt Lake City. The map used in 1990 was improved both by more completed coverage (Mexico, Caribbean) and improved accuracy in the thematic contents. New and more updated references were used to re-delineate the polygons originally used in 1990 map. The map covers the whole would, but Finnish trust fund was used for the tropical areas only.

A final report is in production. The maps are still being edge matched at this time, with another 1 week to go before we can release for the remaining tiles. However, about 75% of the world is ready now and already on the internet but not released to the public. All thematic work is complete.

Activities 1b:

- ***Improving an ecological map for the tropics will require the overlay and analysis of several different thematic layers, principally climatic, vegetation and topographical data. The input data sets are available from the US National Climatic Data Centre (NCDC), the ICIV in France and the US EROS Data Centre, among others. The mapping/modification process will consist of:***
  - ***analysis of modifications/improvements needed;***
  - ***consultation and testing;***
  - ***data preparation;***
  - ***expert review process;***
  - ***final compilation;***
  - ***evaluation.***

The collaborators and their share of the budget in producing the map were as follows:

1. LET (formerly ICIV): New better delineations for tropical ecological zones and new global zones produced but for tropics only. US$ 50,000
2. EDC: Coordinate work for North America and make global mosaic. US$ 50,000
3. National University of Mexico: Mexican FRA 2000 Map: Through EDC
4. Canadian Forest Service: Canadian FRA 2000 Map
5. Tropical Science Center: FRA 2000 Central America: US$ 2,000
6. IIASA and Moscow State University: FRA 2000 Map of Russia: Transportation
7. Chinese Academy of Sciences (IRSA): FRA 2000 Map of China: US$ 10,000
8. Bundesamt für Naturschutz (Federal Agency for Nature Conservation)
9. (Bonn): FRA 2000 Map of Europe
10. Bureau of Rural Sciences: FRA 2000 Map: US$ 400
11. University of Damascus: FRA 2000: US$ 1,500
12. USFS: FRA 2000 Map of USA (free)
13. WCMC: Workshop for strategy/conceptualization of EZ map US$ 40,000

The Ecological map was or will be used for three purposes:

1. Post-stratification of Remote Sensing results by Ecological Zones.
2. Reporting the RS results by Ecological Zones for statistical information.
3. Overlay with Forest Map for display of Forests by Ecological Zones.

3.2.1 Self-evaluation of responsible staff member (Robert Davis)

- **Relevance of objectives: were they refined or changed during the work?**

Work was highly relevant, and this was an incredibly difficult work to coordinate the many inputs of the multiple contributors. Also there is much controversy in the area of ecological zoning with many specialists that are real experts and cannot agree on how to do the work. Consensus was achieved in the WCMC meeting but the debate was heavy.

- **Were all the objectives met?**

Objectives are met. We also expanded the reporting to include thematic descriptions of vegetation for specific Ecological Zones, with contributors from around the world. Draft report available to the evaluator.

- **Lessons learned for further development of the methods for future FRAs**

Start earlier. Have staff in place and funding secured before making a commitment for the work. However, the next round will be easier since much work was done in the documentation of the map and making it compatible with the DCW basemap.

- **Other comments**

Some shortcomings in the map were noted in the final meeting (Salt Lake City, August 2000) which relate to the need to incorporate more edaphic factors in the zones. It was agreed it was important but could not be achieved for FRA 2000. It would be good to have some funds dedicated to map improvement now and for the next 2-3 years, so that we can continue to improve the map.

- **Conclusions**

1. For the present purpose, it has been necessary to produce the ecological map.

2. As learned during the process, there may be no single ‘best’. Different maps weigh ecological characteristics differently. One solution could be to produce a number of maps and various combinations, and use them according to the purpose. The improvement of the map should therefore go hand in hand with other methodological development of FRA.

3.3 Information system

<u>Objective 1c: INFORMATION SYSTEM</u>. Contribute to the development of a state-of-the-art electronic information system for forest resources assessment information (FORIS).

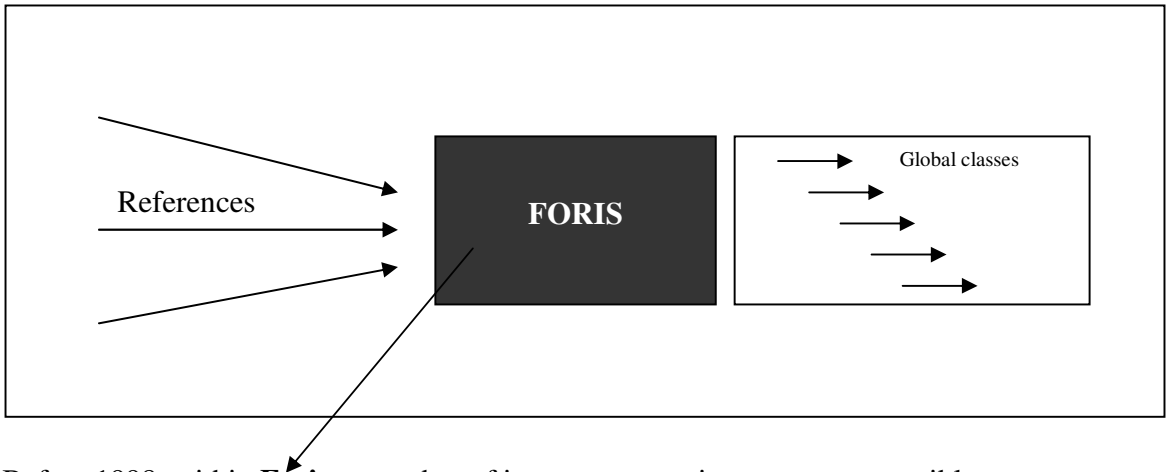
History

Computers were introduced in the FRA work in small scale already when working with the 1980 assessment. At that time computers were mainly used for computing/calculating results based on large homogeneous data sets.

Ten years later, when working with the 1990 assessment the situation was much different. Attempts where made to put in source information and produce output through a computerised system already then called Foris[11]. Although much better, the computer capabilities at the time were still not enough to carry Foris from idea to running system. An additional problem was that the orientation of expertise among the staff working with the assessment, was towards assessment itself, not towards database management.

After the 1990 assessment was done, a loose collection of DBASE-files was all what remained as Foris. The embryo was there, but both the idea and its implementation was far from a working system. The system also suffered from the conceptual misunderstandings. It was not transparent. It did not allow users to follow the production line of information.

Table 3. This was how it was viewed



Before 1998, within **Foris**, a number of important questions were not possible to answer, including:

1. Which references has been *used* versus *considered*?
2. Exactly which data from a given report are used (often a report contains several, and at times inconsistent tables).
3. How was the re-classification done?
4. How was the matching to official FAO area statistics done?

In the following, improvements in the system during period 1999-2000 have been reported.

[11] Foris - Forestry Resources Information System

Output 1c:

- ***Documented methodologies and processes for the production of systematic forest resources information***

FRA covers a number of variables. Among the classical, 'basic', variables are forest cover, plantation area, stem volume and biomass, and a few others. Due to the different traditions of forest use in different countries, even the basic variables are lacking form a common assessment methodology or harmonised definitions. This drawback underlines the importance of clear documentation of the process starting from available inventory reports and ending at statistics published by FRA.

Forest cover, as the most needed subject, was chosen as pioneer subject. The initial steps in the production line construction was outlined[12] and system development followed. The whole chain was not clearly seen until recently, when forest cover information finally was published on the web. There is an immense number of variants of publishing inventory reports. A new terminology had to be developed in order to describe the production chain properly.

Emphasis has been put on identifying and applying transparent methods, which reference to use, how to apply a re-classification, etc.

Much of the initial work carried out for Forest Cover can be drawn upon when settling how work is done for other subjects as well. This is however still to be done. Regarding forest cover only, it is exactly documented how the numbers in output tables have been derived.

The documentation is essential for the further use of the FRA results, and both the users and producers have to pay more attention to it in the future.

- ***Computerized electronic information system for the archiving, analysis, presentation and publishing of forest resources information***

Foris is a large system based on a data base implemented in Oracle 8i.

It has two interfaces:

1. A largely public interface letting literally everyone accessing it over the World Wide Web.
2. A more restricted back-office end. This is designed mainly for data entry, data-processing and more qualified type of analysis not publicly available. This is implemented as a normal Windows application.

All data in the system can be retrieved and easily exported to popular common file formats such as Microsoft Word and Excel. Among the data stored in the system is references, (at present there are some 1800 in the system), the definitions used in the references, data identified as relevant, our re-classification of source data, and finally how we have compiled the states.

[12] Field Document No 7. Forest Resources Information System (FORIS), Concepts and Status Report.

A large part of the system consists of a totally dynamic web-site manager. Pages are created on-the fly without having to have any particular HTML-knowledge. They are managed through a user-friendly interface, and can be turned off and on at wish. Pages are updateable wherever there is a Internet browser connected to the internet. At present FRA has people working on the system at such diverse places as Auckland, Freiburg, and Bangkok.
All references and a large amount of knowledge is stored in the database, at present some 450 MB of data. The main presentation interface is at present the Internet, at the FAO forestry country web-site. There are some 10 000 pages ready (3000 + pages times 3 languages). At present most of the information is presented in a country-by-country manner, but a subject-wise presentation is planned as well, showing traditional FRA-tables. A great advantage is that the database now makes it possible to combine data in any manner and still have consistent totals and sub-totals.

The system has grown since the development started. It has now been recognised as the Forestry Department (FO) information system, an achievement which is extremely important. Foris is the overall name of the system, although the abbreviation now is interpreted differently. It was **Fo**restry **R**esources **I**nformation **S**ystem, but has now changed into **For**estry **I**nformation **S**ystem. It now compromises more than resources information, such as contacts, images, links, duty-travel reports, genetics, etc. There are some already finalised sub-components of Foris such as:
- **Ectis**, the FO contacts database.
- **Reforgen**, the Forest genetics research database.
- **Foracle**, the Windows interface to resources information.

- **Established user group of the system, including routines for external exchange of data and information.**

The system has grown since development started. Initially it was meant only for FRA use although its potential was known. Due to this, certain design decisions were taken at early stages in its development that would not have been there if the system had been aimed at a small user-group only. Once considered and originally implemented, these decisions did not slow down further development work. As we moved along the potential and actual group of users grew.

FRA
Almost all FRA-staff members have been using the system. (There are a few exceptions like dedicated GIS-staff). The FRA-team user group amounts to some ten to fifteen persons[13].

Forestry Department
Once the system advanced to the stage were it was accepted as the Forestry Department information system, the number of potential users made a jump. There are some 70 professionals at FO. All of them could potentially benefit from having access to the system. The more limited web-interface is ready to be used without any further considerations, while it will

[13] Amsallem, DelLungo, Ortiz, Saket, Malleaux, Garsuglia, De Salvo, Simons, Vuorinen, Holmgren, Lehtonen, Cedergren, Hirai, Dahlsgaard, Space, etc.

take some time to get the advanced Windows application installed since this has to be done on a machine by machine basis.

Country-correspondents
A third group of existing and potential users are country-correspondents. They will have access to *all subjects for a certain country*. Initially, they will reach the system over the web using their normal Internet browser. An easily downloadable Java-based version of the Foracle application is a future scenario, also attractive for decentralised FAO staff. Country correspondents adds another 200 users to the system. Some of those have already started inter-acting with FAO. South Africa and Belgium have both added comments and even new sources of information.

Partners
Already today have a few letter of agreements been written, or is in a process of being written, with partners outside FAO. One example is UNEP (WCMC). The idea is that they will work on the subject protected areas, covering all countries. The system can manage this. The UNEP users will have access to one subject only, but for all countries.

Future
The system is already prepared for a large(r) number of users. It is possible to define user-groups and define permissions to individuals and user groups. Permissions can be set on either individual table, or by country or by subject.

Use is monitored through the application. The number of visits on our web-site (on individual page-basis) is monitored. Each time a user logs onto the system using the Windows interface it is logged.

The system is prepared for active user interaction. All web-pages facilitates user inter-action. It is possible to add a comment on each. Reply can be posted as well. This could develop to a user forum, or an on-line discussion group, if found useful.

Activities 1c:
- ***Perform a system requirement study and implementation plan for the system development***

The system development work has been carried out by two persons, Zoltan Fazakas and Magnus Grylle. (In addition, Ingemar Eriksson has been working on the Remote Sensing component). Conceptual work such as design and routine-development has been done by Peter Holmgren and Magnus Grylle. The work started by using Microsoft Access as the data base, but changed to Oracle halfway through the project. The reason behind this was a decision to follow corporate standards as far as possible, coupled to sheer capacity. Oracle is much more capable.

Interfaces are built using Inprise (former Borland) Delphi. The entire process of system development has been highly interactive and iterative. Some time was spent on preparing an environment so regular updates of the software could be done often and without any time lost due to configuration and downloading.

In principle, a prototype was built and tested live on our users. If it proved to do the work, the prototype was further developed and tested. The transition from prototype to operational module was in practise seamless. The are advantages and disadvantages with this modus operandi. Thorough testing may not be done, since the prototype "is working" hiding potential bugs for long before they are finally found and weeded out. Documentation is a related matter often suffering from lack of time. When "everybody" already is using the module, documentation is easily regarded as second or even third priority.
The system requirement study was done piece-by-piece, and a from *a* to *z* system development plan was never done, mainly due to the very tight time schedule.

- ***Establish links to other FAO and external information systems***

The decision of using Oracle made it possible to establish good working relationships between FRA and WAICENT, (**W**orld **A**griculture **I**nformation **Cent**re) the group responsible for FAOSTAT. Official FAO-country names are used, retrieving these from the official FAO-source, ensuring consistency. Country areas given by FAOSTAT are cross-checked in the same manner. Reasons for discrepancies have been analysed.

Linkages has also been established with other parts of the organisation. A legal database FAOLEX at FAO contains original documents, (legal texts), covering the agricultural sector, organised by country and theme. These have been linked in into Foris, and are appearing in the system as an integrated part of Foris, although not being maintained by Forestry Department staff. The maps generated by FRA shall be uploaded to the corporate MAP repository FAOMAP.

- ***Acquire needed hardware and software***

Hardware and software have been acquired as needed. The computers are standard machines with a few exceptions for those that have been used for heavy system development work. Still they are not extreme. They are all FAO-standard equipment. The only feature striking a passer-by is the presence of large monitors. This is prioritised since so much time has been spent in front of the computers. The only software bought is the tools have been used for the system development. (Inprise Delphi and Jbuilder). The database and all work dealing with its configuration, tuning and disk procurement etc. are all done by WAICENT.

- ***Develop and implement system according to plan and in interaction with users***
- ***Train users***

As mentioned above, system development, testing, and re-fining has been done in close co-operation with our users. Users have been trained regularly by having "mini-workshops" whereby users have been briefed and trained.

- ***Establish routines for continuous improvements of the system, including debugging***

Since all users up to now have been sitting in the same corridor, bug-reports have been either verbal or over e-mail and informal. However, there is a routine in the system under the main

menu ***Help*** that read "Bugs and Suggestions" clicking on this bring up an empty e-mail, with address filled in. It is here possible to send in comments and bug-reports without prior knowledge about who takes care of issues like this.

3.3.3 Self-evaluation of responsible staff member (Magnus Grylle)

- **Relevance of objectives – were they refined or changed during the work?**

The objectives for the system development work are not only relevant, but fundamental. Establishing the routines and methodologies used is of course essential. Assessment is something that should be a part of Forestry Department normative and *normal* work. All officers should have this as an integrated part of their terms of reference. Up to now, there has been no tools and no routines for this. Spending time on how to collect information is something that most officers regard as outside their terms of reference, and maybe it is. Now, there is a central group (FODA) that both have the competence of doing it, and also the mandate for doing it. Still, it will be up to the thematic officer to take care of the information content, once the frame is ready.

The objective were widened during the work, from being a FRA only, to become a Forestry Department wide information system. This is not only a mere change, but also a major achievement. It will most likely change the way FAO-forestry department is working with information for many years to come.

- **Were all the objectives met?**

All objectives are about to be met. We have accommodated most of the information we need for the FRA, although to what extent always can be discussed. There is no definite end on this work. Information can always be improved. Still, we may not have reached as far as we would like when it comes to conceptual development of some FRA subjects. For some subjects, we have data, but how we arrived at those, are not always very clear. In addition, the spatial resolution is uneven. Forest cover and volume and bio-mass are both dealt with on sub-national unit level, while for many other subjects we have only country estimates. This is something that is being discussed. We push for a more detailed reporting. There are a number of countries that are so huge that country estimates are not useful for any subsequent analysis, such as outlook studies or policy work. Severe regional imbalances may be hidden in a country average. Imagine for instance Sweden and Finland as being lumped together with the rest of Europe. Some funny average statistics would most likely come out, not making any sense what so ever in the Nordic context. A special case is the countries being taken care of by ECE-Geneva. The methodologies are not the same and the objectives always are in danger of drifting apart. Furthermore, all their reporting is done only on country level with all the disadvantages this bring along. It makes for instance quite some difference if the Russian forest is located in the western part of the country or in Siberia. At present we don't know how much is where. Another difference is that they do not report the national statistics "as is", but only (some) FAO classes. It makes it difficult to interpret the information given. In short, ECE-data still suffers from the problems FAO data used to have, problems that we have spent two years on getting rid of!

Apart from obvious and measurable data as *on-time, on-budget*, the main achievement is that we have brought the assessment closer to Forestry Department. Still, there is much work to be done in this field. The information system is only one part of this. Re-direct the minds of a large number of staff to become responsible for their field, rather than back-stopping project which was previously much of the work done, is long and thorny. It is to a large extent back to basics.

- **Lessons learned for further development of the system**

For the next round of FRA, the work of bringing in the assessment as an integrated part of the department work must be further emphasised. Having only two or three representatives from FAO (FRA) attending the Kotka meeting is a mistake. In this way it never becomes the responsibility of Forestry Department. Visibility is important. Either another attendance, say ten officers, one from each service being involved + the FRA-core group, or instead, or another, meeting in Rome.

Methodology development for how collect information must be further elaborated. This is something that is well suited for external funding. It is a typical project, and it should be done well in advance of the next assessment.

The information system is up and running but there is still much work to be done. As already said, documentation and system tuning are two extremely important tasks for the future. Bringing in all other subject in a truly organised manner is another part of the work ahead. Staff and funding must be made available for this. Promotional work inside and outside FAO showing the usefulness and the wealth of information available is also needed. Further linking the system to others is also an important task.

There is a lot still to be done.

- **Conclusions**

1. The main achievement of the component 'c' is that the system works as transparent documentation of data flow in FRA. However, it still has problems which need continuous support by the system developer. The other achievement is that the system has grown from FRA information system to the backbone of the FAO Forestry Department Forestry Information System.
2. Methodology applied seems to be justified. (But I must admit that this issue would require a more professional computer scientist to give a final statement.)
3. Co-operation with other FAO systems seems to work well so far. A continuous mutual follow-up by FRA and FAO-WAICENT is necessary also in the future. FRA should also consider the links with other information services – like IUFRO-GFIS.
4. The development of the system has been carried out within tight time constraints, which have caused problems in testing the system and training its in-house users. The applied development – even if defendable in this situation- has led to complaints by users on wasted work, which had to be repeated.
5. Documentation of FORIS has been postponed to 2001 which has caused the risk regarding availability of the expert who has all knowledge, mainly only in his own head. There are 10

unfinished technical documents, altogether 129 written pages (Annex 3). The actual situation is, however, going to improve, as the system developer has been hired by the Forestry Department regular programme as Forest Information Officer starting in January 2001.

6. It is hard to evaluate the cost-efficiency at the moment. The cost has been necessary to get the system up and running at its present level. The efficiency depends on the ability of the system to serve its users, within FAO and outside it. However, it is obvious that the project has succeeded to bring the collected information closer to the users in a transparent manner.

- **Recommendations**

1. The most urgent need is to finalise the tests and the documentation of the information system, and then collecting the systematic feedback from users, both in-house and outside FAO.

2. The FRA has facilities and plans to follow up the use of the system, which should produce 'a users' profile' to be utilised in designing the further services and next assessment

3. The system needs continuous development based on frequent review of information needs, technical development and development of other relevant information services in the same field.

4. FAO should aim to have the Foris system ready to absorb data whenever new relevant information would be available.

4 Risks evaluation

Risks as they are written in the original project document, are attached below *in italics.*

Description of the Risk *(Estimated Likelihood)*

(i) *In certain moist and mountainous areas of the world, such as Indonesia, it may be difficult to obtain the high resolution multi-date satellite imagery needed to assess the current state of forest cover, and the rates of change since 1980. This risk is being mitigated in the Project through the availability of alternative data sources such as microwave data, or lower resolution NOAA AVHRR Satellite Data, or existing national level forest inventories.*

(low to medium likelihood)

Instead of 117 images, only 113 were obtained, and in the rest, there was often problems in finding totally cloud free data. Alternative data sources were not utilised.

(ii) *The cooperation and participation of national level institutions in developing countries is important to the overall success of the Project. The level of commitment which some of the institutions will be able to make is an uncertainty. However, since the present Project deals with the re-visit of study areas for which the "local knowledge" was already provided through FRA 1990 institutional network, this risk is less serious than for new sample locations. In addition, the Project intends to mitigate this risk by providing financial and technical support for national and regional level activities.*

(low to medium likelihood)

Some of the work which was carried out by national institutes, included serious quality problems and had to be redone (India). In some other cases, administrative difficulties were met in contracting the local expertise (Brazil), and in some cases (Central Africa) national contribution was not possible to organise.

(iii) *The requisite technical expertise to implement the Project is not largely available in many developing countries. The Project is attempting to overcome this by providing technical support through the regional field units, arranging for training, and by facilitating cooperative working agreements between developed and developing countries.*

(low to medium likelihood)

See above.

The following are factors, which over time could cause major delays or prevent achievement of the Project's outputs and objectives.

Description of the Risk *(Estimated Likelihood)*

(i) *The continuing cooperation and participation of national level institutions in developing countries is important to the overall success of the Project. The level of sustained commitment which some of the institutions will be able to make is uncertain. The Project intends to mitigate this risk by providing support for national and regional level activities leading to the long term strengthening of national institutions in developing countries.*

(low to medium likelihood)

See above.

(ii) *The ability to effectively integrate global and national level assessments will depend on the continued use of agreed upon standards for classifying global level forest resources information. A forest resources and land use information classification scheme has already been developed for the Project. Continual maintenance and refinement will be needed to assure the long-term integrity of global continuous forest monitoring information.*

(low likelihood)

The different nomenclature of classification will continue causing problems in comparability of the results. Encouraging observation is that the deforestation rate in two independent sources Remote Sensing Survey (8 mill ha/a) and Country Statistics (11,5 mill ha/a) is sufficiently close to each other.

Annex 1 – Terms of Reference

Consultant
Evaluation of the project GCP/INT/723/FIN
FRA 2000

Background

The mission of FAO's global forest resources assessment programme is to *provide the world community reliable information to describe and understand the situation of the world's forests and related resources and how they change over time*. To carry out this mission, FAO's Forest Resources Assessment Programme:

1) Supports capacity building by providing technical assistance to developing countries in the conduct of national forestry assessments;
2) Co-ordinates forest resources assessments for both developing and industrialised countries; and
3) Produces global forest resources assessment data bases and periodic reports.

The immediate objectives for the Global Forest Resources Assessment 2000 will be to:

1) Carry out an assessment of forest resources (including information on the goods and services provided by forests) on a global basis referenced to the year 2000;
2) Estimate the changes in forests that have taken place during the decade 1990-2000;
3) Compare to the changes during the decade 1980-1990;
4) Provide information that helps understand the reasons for and the effects of change, including the social, economic, and environmental implications;
5) Disseminate results, data bases, and methodologies to interested national and international institutions, world-wide.

Technical work to be performed

Under the overall supervision of the FRA Programme Coordinator, and in cooperation with all FRA staff members, the Consultant will be responsible for the following:

a) conduct a review of the project GCP/INT/723/FIN on behalf of the Forest Resources Assessment Programme. (The review should cover the thematic responsibilities of the project and assess its effectiveness in meeting planned goals. The same document should also provide feedback for the development of new projects and guidance for the future, so that FAO may improve its periodic assessments.) FAO will provide the framework for the assessment of the project, interviews with staff and relevant documentation.

b) produce a review document based on the assessment of the GCP/INT/723/FIN project and incorporate all the findings of the same.

Annex 2 - FRA Working Papers

1. FRA 2000 Terms and definitions (English)
   FRA 2000 Termes et définitions (Français)
   FRA 2000 Términos y definiciones (Español)
   FRA 2000 Termos e definições (Português)

2. FRA 2000 Guidelines for assessments in tropical and sub-tropical countries (English)
   FRA 2000 Directives pour les evaluations dans les pays tropicaux et sub-tropicaux (Français)
   FRA 2000 Directrices para la evaluación en los países tropicales y subtropicales (Español)
   FRA 2000 Diretrices para a avaliação nos paises tropicais e subtropicais (Português)

3. The status of the forest resources assessment in the south-Asian sub-region and the country capacity building needs (English)
4. FRA 2000 Volume/Biomass special study: Georeferenced forest volume data for Latin America (English)
5. FRA 2000 Volume/Biomass special study: Georeferenced forest volume data for Asia and tropical Oceania (English)
6. Country maps for the Forestry Department website (English)
7. Forest resources information system (Foris) Concepts and status report (English)
8. Remote sensing and forest monitoring in FRA 2000 and beyond (English)
9. FRA 2000 Volume/Biomass special study: Georeferenced forest volume data for tropical Africa (English)
10. Memoria Del Taller Sobre El Programa De Evaluación De Los Recursos Forestales En Once Países Latinoamericanos (Español)
11. FRA 2000 Non-wood forest products study for Mexico, Cuba and South America (English)
12. Annotated Bibliography Forest Cover Change - Nepal (English)
13. Annotated Bibliography Forest Cover Change - Guatemala (English)
14. Forest Resources of Bhutan - Country report (English)
15. Forest Resources of Bangladesh - Country report (English)
16. Forest Resources of Nepal - Country report (English)
17. Forest Resources of Sri Lanka - Country report (English)
18. Forest plantation resources in developing countries (English)
19. Global forest cover map (English)
20. A concept and strategy for ecological zoning for the global forest resources assessment 2000 (English)
21. FRA 2000 Planning and information needs assessment for forest fires component (English)
22. Evaluación de los productos forestales no madereros en América Central (Spanish)
23. Forest resources documentation, archiving and research for the global forest resources assessment 2000 (English)
24. Maintenance of country texts on the FAO forestry department website (English)

25. Field Documentation Of Forest Cover Changes For The Global Forest Resources Assessment 2000 (English)
26. Global Ecological Zones Mapping - Workshop Report Cambridge, 28-30 July 1999 (English)
27. Tropical Deforestation Literature: Geographical and Historical Patterns in the Availability of Information and the Analysis of Causes (English)
28. Global Forest Survey - Concept paper (English)
29. Forest cover mapping & monitoring with NOAA-AVHRR & other coarser spatial resolution sensors (English)
30. WebPage Editorial Guidelines (English)
31. Assessing state and change in Global Forest Cover: 2000 and beyond (English)
32. Rationale and Methodology for Global Forest Survey (English)
33. On definitions of Forest and Forest change (English)
34. Bibliografía comentada - Cambios en la cobertura forestal: Nicaragua (Español)
35. Bibliografía comentada - Cambios en la cobertura forestal: México (Español)
36. Bibliografía comentada - Cambios en la cobertura forestal: Costa Rica (Español)
37. Bibliografía comentada - Cambios en la cobertura forestal: El Salvador (Español)
38. Bibliografía comentada - Cambios en la cobertura forestal: Ecuador (Español)
39. Bibliografía comentada - Cambios en la cobertura forestal: Venezuela (Español)
40. Annotated bibliography - Forest cover change: Belize (English)
41. Bibliografía comentada - Cambios en la cobertura forestal: Panamà (Español)
42. Proceedings of the FAO Expert consultation to review the FRA 2000 methodology for Regional and Global Forest Change Assessment (English)
43. Bibliografía comentada. Cambios en la cobertura forestal: Colombia (Español)
44. Bibliografía comentada. Cambios en la cobertura forestal: Honduras (Español)
45. Proceedings of the South-Asian Regional Workshop on Planning, Database and Networking for Sustainable Forest Management (English)

Annex 3 - An assortment of reports on Information Systems

1. DBStruct.doc: Very technical. Lists all tables in the system. Each table should be described more in detail. It is done for a few. See the table of content.
2. Web.doc: Start on the documentation of the web-module.
3. TVGeo.Doc: An example of technical documentation that should go with all modules of Foris.
4. Text Management in Foracle.doc: Describes the thinking behind. Not ready.
5. State.doc: A user documentation of the state module.
6. Permissions.doc: User documentation of permissions module. By subject and by country permission has been added since this document last was updated.
7. Old structure.doc: A dump of file structure from the old, old DBASE structure (1994).
8. Foris thoughts.doc: An old document showing some of my thought some time back.
9. ModGeoDM.doc: A chart showing one piece of the application. Should be done for the remaining 40 or so tables as well.
10. Measurement units.doc module description.
11. ModGeo.doc: Module description

Annex 4 - Staff interviewed during the mission

Senior Forestry Officer (Forest Resources Appraisal & Monitoring)	Davis, Robert
Senior Forestry Officer (Project Director, FRA)	Holmgren, Peter
Forestry Officer (FRA)	Grylle, Magnus
Consultant (FRA)	Ennals, Alice
Associate Professional Officer	Eriksson, Ingemar
Consultant (FRA)	Branthomme, Anne
Consultant (FRA)	Paola De Salvo
Associate Professional Officer	Altrell Dan
Consultant (FRA)	Federica Urbani
Consultant (FRA)	Amsallem, Isabelle
Consultant	Del Lungo, Alberto
Consultant (FRA)	Lehtonen, Aleksi
Consultant (FRA)	Vuorinen, Petteri
Director (Forest Resources Division)	Sène, El-Hadji
Chief (Forest Resources Development Service)	Palmberg-Lerche, Christel
Senior Evaluation Officer, Office of Programme, Budget and Evaluation	Robert E. Moore