Kingdom of the Netherlands
Ministry of Economic Affairs
Ministry of Foreign Affairs, Netherlands Development Assistance
Ministry of Agriculture, Nature Management and Fisheries

USER REQUIREMENTS STUDY

FOR
REMOTE SENSING BASED SPATIAL INFORMATION
FOR
THE SUSTAINABLE MANAGEMENT OF FORESTS

WORKPACKAGE REPORT

[Workpackage 2]

DESIGN OF THE USER NEEDS ASSESSMENT STUDY

November 1998

ITC	**In cooperation with**	**FAO**	**IKC N**	**NIVR**
	IBN-DLO	**WAU**	**DOFI**	**NEO**
	Fokker Space BV	**NLR**	**TNO-FEL**	**Vissers DataManagement**

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WORKPACKAGE 2

DESIGN OF THE USER NEEDS ASSESSMENT STUDY

Prepared by

International Institute for Aerospace Survey and Earth Sciences [ITC]
- E. Westinga
- W. Bijker

National Reference Centre for Nature Management [IKC N]
- K. van Dijk
- H. Savenije

DO Forestry International
- J.M. Heering

National Aerospace Laboratory [NLR]
- W. Looyen

Fokker Space BV
- E. Overbosch

November 1998

Preface

This study originates from the problems observed with information availability for sustainable forest management. It aims at addressing the following issues:

1. Identification of users of spatial information for forest management
2. Assessment of the information needs
3. Translation of these needs into functional and system requirements
4. Identification and assessment of existing and planned technology for application in forest management
5. Assessment of the extent to which information requirements are and/or can be met by existing/planned technology
6. Preliminary assessment of the need for an "end-to-end" monitoring system
7. Creation of a national and international platform to support the study

Three Netherlands Ministries have sponsored the study, i.e. the Ministry for Economic Affairs, the Ministry of Foreign Affairs (Netherlands Development Assistance – Neda), and the Ministry of Agriculture, Nature Management and Fisheries.

The study has been carried out by the International Institute for Aerospace Survey and Earth Sciences (ITC) of Enschede, the Netherlands in cooperation with:

- Food and Agriculture Organisation of the United Nations (FAO), Rome, Italy
- National Reference Centre for Nature Management (IKC N), Wageningen, the Netherlands
- Institute for Forest and Nature Research (IBN-DLO), Wageningen, the Netherlands
- Wageningen Agricultural University (WAU), Wageningen, the Netherlands
- DO Forestry International (DOFI), Bennekom, the Netherlands
- Netherlands Geomatics and Earth Observation BV (NEO), Lelystad, the Netherlands
- Netherlands Agency for Aerospace Programmes (NIVR), Delft, the Netherlands
- National Aerospace Laboratory (NLR) Amsterdam, the Netherlands
- Fokker Space BV, Leiden, the Netherlands
- TNO-Physics and Electronics Laboratory (TNO-FEL), The Hague, the Netherlands
- Vissers DataManagement, Wageningen, the Netherlands

The study results have been laid down in the following reports:

Final Report User Requirements Study

Workpackage Reports

1. International user platform
2. Design of the user needs assessment study
3. Forest functions, management principles and information systems
4. User needs assessment for spatial forest information: results and analysis
5. Country studies
6. Remote sensing applications for forest management
7. User requirements versus existing capabilities
8. Proceedings of URS Workshop
9. User Requirements Study – Administrative Report

Contents

Appendices

1. INTRODUCTION

The assessment of the need for spatial (geographically referenced) information for sustainable forest management consist of the following components:

1. Theoretical approach on: Forest functions, management principles and information requirements.

2. User inquiry.
   - direct interview at World Forest Congress 1997
   - interactive interview per fax, e-mail and WWW
   - interviews by contact persons in different countries
   - in-depths country studies

3. Inventory of existing literature, documents and initiatives

These components are separated in different work packages.

The theoretical approach was the responsibility of WP3 and the results are described in a separate report (Forest Function, Management and Information Systems).

The results of the user inquiry at global, regional (WP 4.2) and at national and local level (WP4.1) are presented in a combined report (User Needs) on user inquiry. This includes the interviews at World Forest Congress 1997, the interactive interview per fax, e-mail and WWW and the result from the contact persons. While the in-depth country studies (WP 4.3) will be described in a separate report (Country Studies).

The purpose of the user inquiry component of the URS is to assess the specific spatial information needs on forests as perceived by those involved in policy and implementation in forest management. It aims to enhance proper decision making (on sustainable forest management) in their working environment. This study was carried out worldwide and users at various levels and types of organizations were consulted. The end-users of this type of information were consulted and not the information suppliers. Although the study has a worldwide coverage the inquiry was more focussed on Latin America, Asia and Africa. Information on user needs for Europe and N. America is already available through literature and other projects.

This report deals with the description of the study approach of the user inquiry and the literature study, mentioned as the activities of WP2. First the overall user inquiry (Chapter 2) and the questionnaire used (Chapter 3) is explained. Then the target group (Chapter 4) is identified and indicated how persons and organizations were selected. Finally the results of the literature study is presented in Chapter 5.

2. APPROACH OF USER INQUIRY

A short initial questionnaire was made with open-ended questions. It was thought, that a lengthy questionnaire would consume too much time from the participants. Therefore it would be difficult for the participants to find enough time to answer all the questions. This could finally result in a low response. The questionnaire was designed with open questions in order to avoid bias by having predefined choices. This also allowed the participants to express their knowledge on the subject in full detail.

This initial questionnaire was tested at the World Forestry Congress in October 1997 held in Antalya, Turkey by interviewing different persons. Based on this experience the questionnaire was slightly adapted. Furthermore it became clear that interviewing would consume too much time. Therefore it was decided to sent the questionnaire to the participants and request them to return the completed questionnaire.

Distribution was carried out to selected persons and organizations by fax and e-mail. The selection of users is explained in chapter 4. The questionnaire was also made available on the World Wide Web (http://www.neonet.nl/forests/). This made the questionnaire available to all persons with access to the web.

For the in-depth country studies in workshops to be carried out by WP 4.3 five countries were selected. The next five countries are selected: Brazil, Cameroon, Malaysia, Costa Rica and Nepal. Selection of these countries was as follows.

Brazil will be one of the countries, for its particular interest in remote sensing based forest monitoring and for its extensive area of tropical rainforest and the associated issues of management. The other four countries should also possess a considerable amount of forest. Countries from different continents were preferred. These countries were selected according the next criteria in such a way that they would complement previous choices:

- Ecological zone (tropical/temperate, dry/wet, lowland/mountainous)
- Natural or man-made forest
- Major forest function

Cameroon was chosen as it partially covers dry areas. Malaysia as it contains many forest plantations and has special management experiences. Costa Rica was selected for its forest management with aspects on sustainable use and conservation. Nepal because of the mountainous forest, community forestry and protection forest. No country in the temperate region was selected, as information on this for Europe and N. America is already available through literature and other projects. Siberia was not possible for practical reasons.

Based on the response of the fax, e-mail and www, it was investigated if it would be necessary to focus more specifically on certain user groups, because they were not yet enough represented. It was felt that users at local level were not easy to reach by this method, particularly in Africa and Asia. Therefore countries were selected in which contact persons could undertake local interviews. The countries were selected in such a way that they were different from the in-depth country study. In total ten counties were selected. These are Kenya, Namibia, Mozambique, Senegal, and Uganda, Zimbabwe in Africa and Indonesia, Pakistan, Vietnam and Thailand in Asia.

Throughout the inquiry the same questionnaire was used for all different means of communication for a consistent approach. That means that despite the different ways contact was made with the participants the same questions were asked. Also for the different target groups the same questionnaire was used.

3. QUESTIONNAIRE

To facilitate comparability and processing of results for the interviews the same questionnaire was used for all the components of the user inquiry. As mentioned before only the questionnaires used during the test interviews were slightly different, but similar so far that the results could be used in the analysis.

In general an interactive, step-by-step, staged interview approach (in English, French and Spanish) was followed: a first round with a few, general questions and a subsequent round for more detailed specific questions.

The interviews in first round consisted of seven open-ended questions asking for information on a) the type of organisation and specific tasks of the respondent, b) the actual use and additional needs for spatial information and c) the actual supply of spatial information and how this could be improved. In appendix 1 the English version of the questionnaire is presented. It starts with an explanation of the project and purpose of the questionnaire. Then follow the seven questions and finally a part for identification of respondent and organisation.

Depending on the answers on the first round questions further questioning took place to get clarification and specification on the initial answers. The follow-up were formulated with the ultimate aim to acquire such a level of specification of information needs (in forest management terms) that an adequate translation can be made into functional and system requirements for RS-applications. For this reason these questions were elaborated in close co-operation with the members of WP5.

Justification to use this methodology

In the implementation of the User Needs Assessment by e-mail and fax was purposely opted for the staged interview approach with open-ended questions as described before, rather than an approach using one longer multiple choice questionnaire. This decision was based on the following considerations:

- Experience has learnt that long questionnaires tend to have lower responses than short ones, particularly if they are sent by mail; by this staged approach the required time to answer the questions in each round would be more acceptable to motivate respondents to answer,
- It would also allow to concentrate the efforts in later rounds on the more motivated and useful respondents identified in the first round, thus increasing the effectiveness of the study,
- A staged interview approach implies more frequent contacts and an interactive dialogue with respondents, assuming that this would muster higher participation and commitment to the study and hence contributing to networking and international platform creation for the study (which is also an objective, see WP1),
- Although open-ended questionnaires - compared to multiple choice formats - tend to invite answers that are more laborious to process and statistically more difficult to analyse, they have the advantage that they unintentionally do not influence the respondents in any specific direction in their answers. The major objective of the study was to get a good impressions and indications of the information needs situation and particularly how these are perceived by the various users as a check on the already existing literature and experiences on it. Scientific purity of analysis was considered secondary to this objective.

4. TARGET GROUP

Different criteria for classification of user groups were identified, as part of WP 3. These criteria were (see report WP 3):

a) Level of (administrative) operation:

* World-wide
* Regional,
* National,
* Local (management unit)

b) Type of body:

* Governmental
* Non-governmental:
  - Non-profit,
  - Profit

c) Type of decision-making bodies (purpose for which information is needed):

* Policy, (strategic) planning and financing bodies:
* Resource management bodies
  - Conservation management (protective area management),
  - Forest resource management (production forest),
  - Environmental protection

d) - Ecological zones:

* Tropics
  - Dry zones
  - Wet zones
* Temperate zone
* Boreal zone

On the basis of these parameters in Table 4.1 (from WP 3) the relevant bodies (at international & regional level) or categories of bodies (national & local level) to be specifically included in the study have been identified.

TABLE 4.1: MAIN CATEGORIES OF END-USERS OF SPATIAL INFORMATION FOR FOREST MANAGEMENT[1]

	WORLD WIDE		REGIONAL		NATIONAL		LOCAL	
	IGO[2]	**NGO**	**IGO**	**NGO**	**GO**	**NGO**	**GO**	**NGO**
policy development/ policy influencing	- FAO-NFP Support Unit, - UNEP, - ITTO, - Convention on Bio-diversity	- WRI, - WWF, - IUCN, - WCMC, - CIFOR, - ICRAF, - Wetlands International	- Regional NFP- Coord.-Unit - TCA, - CCAB-AP, - SADC - IGAD, - ATO, - Mekong River Commission, - Niger basin, - Helsinki/ Montreal processes, etc	- ELCI, - COICA, - Rainforest Movement, - EFI	- Ministry of Planning, - Forest Departments, - National NFAP-co-ordination units,	- Environmental & Conservation NGO's, - Rural Development NGO's - Federations of local & indigenous communities, - Consumer org. of forest products & services - media	- Regional & local govt-bodies	- farmer groups, - user groups
financing	- WORLD BANK		- ADB, - AfDB, - IRDB	- " green funds"		- national "green funds"		
forest resource management (for biodiversity conservation, environmental protection, production)		- WWF, - FSC, - IUCN			- Forest Departments, - Land Management boards, - Departments of Parks & Wildlife	- Certifying bodies, - National IUCN & WWF-bodies	- Regional & Local Forest Offices - National Park managers,	- community-based organisations (colonists, indigenc people, local (non)timber producers), - forest concessions - private forest own - non-profit manag bodies (foundations

[1] the listing of specific (categories of) organisations, particularly under "world-wide" and "regional" must be considered exemplary rather than an exhaustive enumeration.

[2] IGO: Intergovernmental organisation

Based on this a distribution list was developed from:

- the FAO address list of (heads of forest departments)
- the FAO address list of NFP
- the IAC-IKC address list
- the IBN-DLO address list
- the ITC address list

Whenever additional suitable addresses were acquired from other sources these were added.

5. LITERATURE REVIEW

A literature review was carried out with the objective to get an overview of comparable initiatives and their findings and possible additional information. A list of the studied literature is added in Appendix 2. The summaries of all these documents are presented in Appendix 3. The results of the review are summarized below.

A general overview is given of the themes on which spatial information on forests is required in Section 5.1. In the following Section 5.2 the requirements by forest related activities are compared. The differences between the levels of geographical interest, e.g. local national, international are presented in Section 5.3. The functions of forests are differentiated in Section 5.4 and the information requirements are summarized accordingly. Section 5.5 deal with the information format, preferred by most users and in Section 5.6 the major constraints in information supply are summarised. Section 5.7 gives a short overview of a number of recent initiatives that are comparable to this present study.

5.1 Requirements by information theme

The main topics of the reviewed literature deal with forest management and monitoring, discussion of forest policies and case studies. Some reports specifically discuss the results of information needs assessments.

The spatial information requirements for forest related activities that are mentioned in the literature are compared. The themes on which information is required are listed in Table 5.1. The number of reports that mentioned a required parameter is counted.

Table 5.1. Main themes, on which spatial information is required and relevant references, ranked according frequency (the number of references).

Theme	Frequency mentioned	Literature source by reference number
Forest types/classes	13	1, 6, 7, 8, 10, 12, 14, 15, 16, 19, 22, 24, 26, 28
Land use	14	9, 10, 11, 15, 16, 19, 20, 22, 23, 24, 26, 27, 28
Biodiversity	11	1, 7, 8, 9, 10, 12, 14, 15, 16, 19, 20, 24, 28
Forest cover	8	6, 8, 10, 14, 16, 19, 20, 24,26, 27, 28
Socio-economic info	7	1, 8,10, 12, 15, 19, 20, 22, 24, 28
Re- and deforestation	4	1, 6, 8, 10, 11, 21, 22, 24
Timber volume /biomass	5	7, 11, 12, 15, 16, 19, 20, 24
Forest health	6	8, 10, 14, 15, 16, 20, 22, 26
Soil condition/types	13	8, 9, 12, 14, 15, 16, 20, 26
Topography	8	7, 12, 14, 16, 20, 22, 24, 27, 28
Forest cover change	7	1, 6, 7, 9, 15, 20, 28
Fires	6	7, 8, 10, 14, 16, 22, 24
Protected areas	8	1, 7, 12, 20, 24, 27
Actual production	3	1, 6, 8, 15, 16, 26
Conservation area	10	1, 6, 7, 10, 16
Fragmentation	8	10, 11, 15, 24
Morphology	1	8, 16, 22, 24
hydrology	4	8, 15, 16, 22
tenure	4	9, 10, 15, 20
Plantation/natural	8	6,10, 14, 16
Forest structure	2	8, 10, 14
Climate	4	12, 16
CO2 fixation	4	19

This table clearly reveals that spatial information on land use, forest classes, forest cover and biodiversity are most frequently required, according to the reference sources.

In addition information is required on re- and deforestation, forest health, soils, socio-economic indicators and topography. The other parameters are mentioned only in a few reports and often related to specific activities. A comparison between the requirements by activity is made in the next paragraph.

5.2 Information requirements by type of activity

The forest related activities for which spatial information is needed can roughly be divided into four categories:

- Forest management
- Monitoring
- Survey
- Research

The literature shows that in general the information themes for each activity do not differ very much, except for the following aspects:

- Requirements for forest management and for forest survey or assessment are very similar. For both activities information is required on *the condition and status* of forest areas, e.g. protection area, conservation area, plantation area and management status. In addition information is required on the structure of forest stands, which can be defined by parameters such as: age classes, species, volume, growth and quality of the timber (10, 13, 16).

- The most important aspects of information requirements for monitoring and change detection are the *frequency and the comparability* of the supplied information. Specific parameters in this respect are re- and deforestation, and the inherent changes in the boundaries of forest areas, land use, changes in the socio-economic impact as well as the extent and impact of forest fires (6, 9,11,12, 22, 28). Less detailed information is required for monitoring than for assessment (8).

- Research usually deals with one specific aspect of forests or their management, which is studied intensively. In most cases this requires specific, detailed information on the studied theme. Researchers are not a selected user group in this study and their requirements will not be discussed extensively and/or seperately.

The scales for forest resource monitoring in many cases depend on the size of area that has to be monitored. Table 2 shows the scales, sensors and frequencies mentioned for monitoring at country level by several references.

Table 5.2. Scales and frequencies required for monitoring

Scale	**Sensor**	**Frequency**	**Ref. source**
1:250,000		Twice/year	19
1:250,000	Landsat MSS, IRS		16
1:250,000	NOAA, Landsat	Annually, twice/year	24
1:100,000		Monthly	7
1: 25,000		Annually	8

5.3 Information requirements by level of geographical interest.

The level of geographical interest (local, national, and international) determines in most cases the working scale and consequently the scale at which information is needed. These scales, as they are mentioned by the reference sources, are shown in Table 5.3.

Most references mention similar scales at national level, 1:50,000 and 1:250,000, at local level a small variation exist but the number of references that mention scales is too small to extract any conclusions.

Table 5.3. Scales required by level of interest.

Level	Scale	Ref. Source
Local	1:1,000; 1:10,000	8
	1:10,000; 1:25,000	24
National	1:50,000; 1:250,000	8
	1: 250,000	11
	1:50,000; 1:250,000	16
	1:50,000	19
	1:250,000	24
	1:50,000; 1:250,000	25
Global	1:1,000,000; 1:10,000,000	8

5.4 Information requirements by forest function

The functions of forests can be distinguished in several categories:

- Conversion : designation for other land use activities
- Production : utilization without depletion
- Conservation : maintaining naturalness, biodiversity
- Protection : soil protection in vulnerable areas.
- Scientific/social : research, and social(religious, tourist) use

Many references do not refer to any of the generally accepted functions as listed above, but apply to the concept of sustainable use in general. For this reason, Table 5.4 includes that concept together with the references.

The reference sources indicate that information requirements vary according to the function of the forest resources. Most references mention the parameter on which information is required but only few also indicate the information carrier or a suitable remote sensing instrument. Table 5.4 shows the information requirements by forest function as mentioned by the references. This is not a complete list of all information requirements by function. And most literature sources that mention forest functions in relation to information requirements do not mention the information carrier.

Table 5.4: Information requirements and spatial information carrier related to forest functions according the literature consulted. Note: The spatial information carriers (maps, RS digital files, and databases) are not linked in this table horizontally to the information requirement (Ref. sources in brachets)

Function	Information requirement/parameter	Spatial information carriers
Conversion	Land use (19) Land cover Change (9, 19) Forest inventory information (19) Tenure (9) Productivity (9)	RS deforestation (8) Vegetation map (24) Land use map (24)

	Forest classes (24) Timber roads (24) Settlements (24) Land use (24) Fragmentation (24)	
Production	Productivity (8, 15, 16) Timber volume (8,14, 19, 24) Regeneration capability (8) No. Mother trees /species /ha. (8) No. Felled trees /ha. (8, 14) Tree position (24) Stand structure (14) Tree diameter (14) Tree height (14) Timber quality (14) Species composition (14) Health (14) Canopy closure (24) Forest Inventory (19, 24) Actual forest area (14) Reforestation (24) Certification (15) Illegal activities (24) Fires (14, 24) Morphology/Erosion (16, 24) Topography (24) Hydrology (16)	Reforestation database (24) Topographic map (24) Tree position map (24) Road network map (24) Skid road plan (24) Species sampling map (8) Timber volume sampling map (8) Forest type maps (8) Plantation maps (16) Compartment maps (16) Block maps (16) Range stock maps (16)
Conservation	Gap size and frequency (8) Fragmentation (8) % pioneer species(8) Representative areas (8) Biodiversity (14, 24, 19) Habitat type (14, 24) Naturalness (14) Tenure, protection status (14,15) Buffer zones (24) Land cover (14) Forest cover change (15) Forest classes (14, 15) Inventory(19) Forest health (14, 15) Soils(15) Hydrology resource (14, 15) CO2 fixation (15) Regeneration(24) Fires (14, 24) Environmental impact (14)	Wildlife reserve maps (16) Vegetation map (10) Topography map (10) Climate map (10)
Protection	Forest cover change (9,10, 19) Forest classes (10) Land use (19) Inventory (19) % crown cover (8, 10) Deforestation (8) Soil condition and erosion (8, 10) Topography (8, 10) Morphology (8, 10)	Hydrology maps (10) Forest types maps (10) Land cover maps (10)

	Hydrology (8) Protected areas (24) Climate (10) Surface albedo (10)	
Scientific/social	Cultural relevant sites (8) Ecological relevant sites(8) Economic relevant sites(8) Geomorphology (16) Soils (16)	Survey maps(16) Topographic maps (16) Tenure maps (16)

Sustainable use	Land use (9) Land cover type (8, 9,10 ,14) Land cover density (14) Forest area (8, 10, 14) Other wooded land (14) Conversion rate (8, 9) Fragmentation (10) Illegal deforestation (8) Reforestation (15) Forest health (8, 10) Biodiversity (15) Illumination (3) Topography (14) Protection status (14) soil types (14) soil biology (3) Fires (8, 10) Productivity (15) CO2 fixation (15) Hydrology (3,15) scenic beauty (14)	Topography map (14) Soil map (14) RS canopy structure (3) RS soil disturbances (3) RS (skid)road location (3) RS water quality (3) RS forest classes(8) Forest type maps (8) Field observation land use (9)

The numbers between brackets indicate the reference sources. RS= Remote Sensing, not specified

5.5 Information format

A few references (7, 12, 25, 26, and 28) mention the information format that is currently used or preferred by most users.

Paper maps (based on interpretation of satellite images) and reports are the generally used and required format. Digital maps are increasingly being used. This indicates that information, which can be used directly in the presented format and does not need any further processing, is preferred. Most users are not interested in raw, unprocessed remote sensing data, which they will have to transform in a usable format. These unprocessed data are used only by a small group of specialist in the field of remote sensing.

5.6 Constraints in information supply

Several references mention the major constraints in information supply. The main constraints are mentioned in Table 5.6.

The need for more training in the use of spatial information is often mentioned. References also recommend that awareness of the potential of spatial information for forest management purposes be

raised amongst high level officials. Lack of data or inaccessibility of data are other frequent constraints. Several reasons for this are mentioned, such as: political (security) reasons, lack of co-operation between information providers, insufficient communication of information between and users and information providers. The high cost of remote sensing data is a constraint that is mentioned by 4 references.

Table 5.6 Constraints in information supply.

Constraints	**Ref. source**
Info deficiency, unavailability	2, 9, 23, 24, 28
Incapability to use info/need for training	2, 19, 23, 24, 25, 28
Cost of satellite data	7, 19, 23, 25
Lack of co-operation/communication	9, 23, 24, 25, 28
Political/economic	9, 23, 25
Inconsistency /incompatibility	9, 19, 23, 28
Insufficient frequency	9, 19
Inaccurate	9, 19, 24
Info not adapted to needs	9
Cloud cover	19, 24
Lack of dedicated hard/software	19, 23, 25

5.7 Recent comparable initiatives

Several reviewed reports discuss initiatives that are more or less comparable to the present initiative; i.e. they discuss information needs assessments. These initiatives are listed below.
However, this literature review does not pretend to have covered the whole area of spatial information requirements. Consequently, other initiatives on the subject may have escaped the attention.

List of recent initiatives on spatial information needs assessment:

FIRS (Forest Information from Remote Sensing) (ref. 14)
Information needs assessment to select key attributes for nomenclature project.
Geographical interest : Europe
Methodology : evaluation of existing international statistics by the projects' regional leaders, evaluation of international research programs, international forest policies
User groups : information groups on production, environmental aspects, land use

TREES (ref. 7)
Pre-feasibility study for development of new satellite remote sensing techniques for forest monitoring
Geographical interest : worldwide
Methodology : e-mail questionnaires sent to 9 user groups
User groups : global change community, international NGO, Nat forest dept., UN agencies, Intergovernmental Agencies, Nat. GO, Nat. NGO, researchers, traders.

RESPAS (ref.19)
Information needs assessment amongst information providers.
Geographical interest : worldwide
Methodology : questionnaires and interviews
User groups : mapping agencies and agencies that supply spatial information to planners.

Interest in VEGETATION (ref.26)

Survey on interest in deriving net primary production form Earth Observation techniques.

Geographical interest	:	worldwide
Methodology	:	e-mail questionnaire
User groups	:	research, National institutes, International Institutes, service providers.

Constraints in Earth observation. (Ref. 25)

Study on user and potential-user spatial information requirements in developing countries.

Geographical interest	:	developing countries
Methodology	:	interview survey and questionnaire survey, literature review, and country studies.
User groups	:	in various fields, such as cartography, fishery, forestry, health, urban planning etc.

APPENDICES

APPENDIX 1

QUESTIONNAIRE

SPATIAL[1] INFORMATION NEEDS FOR SUSTAINABLE FOREST MANAGEMENT

Invitation to participate in an interactive inquiry

Dear Colleague,

The growing need for adequate and timely information on forest resources and the increasing difficulty of
updating this information and distributing it to the right locations has been emphasised at various international meetings, including UNCED 92, IPF/IFF and the recent World Forestry Congress (at which "Monitoring and Assessment of Forest Resources" was topic number 1). So far, studies on information needs have been largely based on general assumptions rather than on facts about the specific actual and future needs obtained from the end-users, i.e. people involved in forest management policy and implementation (for conservation, production, etc.).

This study has therefore been set up to assess the specific **spatial information needs of different end-users** to optimally enhance sustainable forest management at different levels of operation - local, national, regional and international. Specifically, the study seeks to identify the **current status**, **bottle-necks** and **needs for improvement** in the supply and use of spatial information on forests. The study has been commissioned by the Dutch government and is being coordinated by the ITC[2] in collaboration with FAO and a number of Dutch organisations.

You are an important end-user and we would like to make use of your expertise on and insight into the specific needs for spatial information on forest resources in your work.

We therefore invite you to spend about half an hour completing the attached questionnaire

We propose to carry out this study through an interactive dialogue (by E-mail/fax). If you agree, we may get back to you with some more questions, after you have responded to the questionnaire.

The results of the study will be used to assess the need for and feasibility of a world-wide forest monitoring system to be set up by a group of Dutch organisations called FAME (Forest Assessment and Monitoring Environment). For more information on this study and the FAME initiative, look at the web site: **http://www.neonet.nl/forests/.**

As we believe that this inquiry and its possible follow-up will be of great interest to you, we shall keep you updated on progress; you will also receive a copy of the report.

Please be assured that all information you submit will be treated confidentially.

We highly appreciate your co-operation.

Yours sincerely,

[1] Spatial information on forests: !geographically referenced information

[2] ITC: International Institute for Aerospace Survey and Earth Science, Enschede, the Netherlands

QUESTIONNAIRE:

SPATIAL INFORMATION NEEDS FOR SUSTAINABLE FOREST MANAGEMENT

I): INQUIRY

Please answer the following questions ***(use as much space as you need):***

1. What are the main forest management objectives of your organisation?
2. Which of your tasks in the organisation require spatial information on forests?
3. What type(s) of spatial information on forests do you currently use?
4. What additional spatial information do you require for better decision-making on forest management?
5. How do you presently obtain the spatial information specified in your answer to question 3.?
6. How do you think the supply and use of spatial information could be improved?
7. Do you have any additional remarks in relation to the above questions?

II): PERSONAL DATA:

Name of your organisation:

Your name:

Your position:

Address:

Country

Fax: **Telephone:** **E-mail:**

May we contact you for more interactive discussions on the subject?: **yes/no**

Please return the completed form - **as soon as possible –** to URS@ITC.nl
or fax to +31-53-4874399

APPENDIX 2

LIST OF STUDIED LITERATURE

1) Min. van Buitenlandse zaken 1996
   Bossen en bosbouw
   Projecten van ontwikkelingssamenwerking
   Focus op ontwikkeling, 5.

2) FAO, 1996
   Basic principles and operational guidelines.
   Formulation, execution and revision of National Forest Programs.
   FAO

3) Eberhard F. Bruenig 1996
   Conservation and management of tropical rainforests. An integrated approach to sustainability.
   CAB International.

4) Canadian forest service, 1997
   The state of Canada's forests
   Learning from history, 1996-1997
   Canadian forest service

5) H. van de Veen,G. Dorren, 1997
   Tropische bossen en ontwikkelingssamenwerking
   Ministerie v. Buitenlandse Zaken

6) FAO, 1997
   State of the world's forests.
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7) TREES, 1993
   TREES II pre-feasibility study. Final report
   Earth observation sciences and world conservation monitoring center

8) J.J. van der Sanden, 1997
   Radar Remote Sensing to support tropical forest management
   Tropenbos Guyana series 5

9) CLAUDE workshop,1997
   CLAUDE, coordinating land use and cover data and analysis in Europe.
   Report on the CLAUDE workshop on the user needs for more harmonized land use information at the national and EU level.
   European Commission, DG XII.

10) Aarne Nyyssonen, 1993.
    FAO/ECE meeting of experts on global forest resources assessment.
    Kotka II.
    Finnish Forest Institute. Research papers 469

11) Forest Resources assessment 1990
    Survey of tropical forest cover and study of change processes
    FAO forestry paper, 130

12) Forest resources assessment 1990
    Tropical countries
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13) IKC, 1997
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Part 1) Information needs assessment, field doc.4
Part 2) Monitoring of forest at district level using multidate satelite data, field doc. 6
Part 3) A proposal for a new forestry planning system to replace the working plan, field doc 14
FAO

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BCRS

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BCRS

19) Paivinen, 1993
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20) INPE/IBAMA/MMA, 1997
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INPE

21) Van der Burg, Venema, Spaa, Hoekman, van der Sanden, Reichert, 1992.
Feasibility study on global operational forest cover monitoring network for FAO using satellite remote sensing.
BCRS

22) P. Romeyn et al., 1993
Applications in developing countries: a two step approach towards increased participation by user groups. Results of step 1,
NRSP (1990-2000)
BCRS

23) D.H. Hoekman. 1997
Radar monitoring for sustainable forest management in Indonesia,
MOF tropebos project
Wageningen Agricultural University Dept. of Water Resources.

24) Commission of the European Communities, 1995.
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Final report, EOS-94/ 107-RP-001
EOS/NRI/NLR/IICT.

25) F Veroustraete, J van Rensbergen, P Craamer, 1998
Surveying the interest of Earth Observation "end Users" in C-fix, a tool for the estimation of the net primary productivity of vegetation.
Study for OSTC/TELSAT program.
VITO

26) European Commission , 1998
Land cover and land use information systems for European Union policy needs.
Eurostat, program and abstracts.
European Commission.

27) World Resource Institute, 1998
Blueprint for a Global Forest Watch (DRAFT)
WRI, Forest Frontiers Initiative.

APPENDIX 3

SUMMARIES OF CONSULTED DOCUMENTS

1) Bossen en bosbouw
Projecten van ontwikkelingssamenwerking, 1996
Min. van Buitenlandse zaken

Description of interventions in forest management that are partly or completely supported and/or implemented by the Dutch Dept. of Development Cooperation, listed by country.
Distinction is made between national/regional Africa, national /regional Asia, national/regional Latin America and worldwide.

For each country the document provides information on:
- Present situation, potential and threats in forest sector: % forest, main forest types, forest reserves, reforestation, deforestation, population, BNP per capita, wood production etc.
- Projects/interventions: project name, funding, implementing organization, background info on present problems, location, main objectives, results and present state of implementation.

Spatial information requirements for interventions:
Information carriers are not mentioned.

Most interventions require info on:
- forest cover/forest cover change,
- re- and deforestation activities,
- socio economic info,
- species and biodiversity,
- conservation forest area
- protection areas,
- Productivity.

The document does not mention whether info supply is sufficient or not.
Most interventions have a training aspect but this is mostly training in institution building.
Worldwide: contributions mentioned to WRI, National remote sensing program etc. but no requirements/activities.

2) Basic principles and operational guidelines.
Formulation, execution and revision of National Forest Programs.
FAO, 1996.

Main items are:
Outline of principles, goals and main objectives of National Forest Programs (NFPs): sustainable development, national sovereignty, participation and partnership, capacity building and institutional reforms, awareness raising, national and international commitment.

Recommended main phases for implementation, execution and up-dating NFPs, c.q. Operational guidelines:

1. development of communication strategy to involve all stakeholders,
2. strategic planning aiming to follow the principles,
3. preliminary actorfield analysis (current situation),
4. in-depth sector analysis(constraints and opportunities),
5. strategic analysis (scenario development),
6. formulation of forest program,

7. implementation,
8. Revision and up dating.

Spatial information requirements not mentioned.

3) Conservation and management of tropical rainforests. An integrated approach to sustainability.1996
Eberhard F. Bruenig

Description of the main forest types and effects of climate on forest productivity/regeneration capacity.
Discussion of rain forest soils (nutrients, humidity, and texture) in relation to forest productivity.
Growth models.
Nutrient cycle, nutrient depletion and productivity estimates, based on models and studies of sample plots in several ecosystems.
Biodiversity studies in plots in several countries/climates/soils
Studies of floristic changes based on plots/field data, spatial distribution pattern of trees.
Estimations of sustainable yields based on models.
Forest use.
Discussion of forest human population and their forest uses shifting cultivation, NTFPs, customary rights.
Advantages and disadvantages of (selective) logging procedures and management systems.
Timber production/export and timber uses in developed and underdeveloped countries.
Mention of the need to improve logging methods due to increase of global consumption and regional needs, hence the need to upgrade conventional selective logging to sustainable harvesting.
Discussion of several low impact logging systems.
Principles and strategies of sustainability are discussed.
Several models of Sustainable Forest Management (SFM), growth models, and potential production in SFM are discussed.

Sustainability indicators for ecological-social functions:
- change of forest stature and canopy structure,
- change of aerodynamic roughness, (=indicator of canopy complexity, hence habitat diversity, tree species richness and diversity patterns)
- Actual evapo-transpiration.

Other key indicators for SFM (c.q. indicators of forest health):
- illumination,
- ground vegetation,
- presence of site specific species,
- soil biology
- hydrology,
- Soil humus condition.

Growth models, which are needed to guide decisions, for increment assessment and for training of fellers, require pre-harvesting mapping and post harvesting monitoring.
Management systems for different forest types are described.

New useful technologies mentioned:
- remote sensing of canopy structure and condition,
- remote sensing of soil disturbances,
- remote sensing of road and skidtrail locations and densities,
- Remote sensing of water quality.

Main obstacles:

- Information deficiencies.
- Failure to use existing knowledge efficiently.
- Economic motives in developing countries often prevail over sustainability motives.
- Forest researchers pursue their own goal at the expense of forestry progress.
- Planning and evaluation in research often inefficient and hence irrelevant to sustainable management.
- Local governments not willing to introduce changes, commercial companies have to pave the way.

Spatial information requirements are not mentioned.

4) The state of Canada's forests
Learning from history, 1996-1997
Canadian forest service

Overview of Canada's forest, forest land ownership, commercial forest types (softwood, mixed wood, hardwood)
Extract of legislation and management guidelines of the different states, including (planned) changes and achievements.
Growing number of protected areas in most states.
Renewed model forest plan: use of local level indicators to measure forest health
Fire management: now automatically monitored, predicted, and timely controlled.

Criteria for measuring forest sustainability:

- Biodiversity: species, ecosystems
- Ecosystem condition: rate of disturbances, regeneration, and biomass.
- Soil and water conservation,
- Global ecological cycles: carbon budget/ storage, hydrology, and forestland conversion.
- Multiple benefits: productive capacity (sustainable), economy, NTFPs.
- Society's responsibility: participation, fair decision making.

No mention of spatial information requirements

5) Tropische bossen en ontwikkelingssamenwerking, 1997
Ministerie v. Buitenlandse Zaken

Discussion about local level forestry activities in Vietnam, forest protection and institution building. In addition a discussion on the global situation regarding sustainable forest management and forest functions, (such as production, recreation, agro-forestry), the need for local communities to make use of forest products, their awareness of and cooperation in sustainable forest management, constraints regarding forest conservation in tropical countries, present state of affairs regarding interventions and the results of previous interventions and discussion of forest policies.

No mention of spatial information requirements or indicators for forest management.

6) State of the world's forests, 1997
FAO

Discussion of the present situation and prospects for forest conservation and development.
First part of document is mainly dealing with production, consumption and trade in past and future prospects.

The following parameters were assessed:

- distribution of forest by region
- Forest area, in ha. and in % of total land, by country
- Forest area, in ha. and in % of total land, by region and sub-region
- Natural forest (versus plantation) by country
- Natural forest, by region and sub-region
- Forest cover change (conversion) over 5 years, by country and region
- Annual forest cover change by country and region
- Land cover classes e.g. closed forest, open forest, long fallow, fragmentation, short fallow, other, plantation.
- Rate of deforestation was assessed by ecological zone.
- Production, trade and consumption of forest products by region and ecofloristic zone.

Second part, national policies, evolvement of national forest plans, international initiatives, funding etc.

Part 3: criteria and indicators for sustainable forest management.
Discussion of criteria and indicators to be used to define essential components of forest management against which sustainability may be assessed. Several international initiatives exist that define criteria, however counties may choose to develop additional indicators appropriate to their conditions: Consequently, indicators per criterion vary per region/country

The following themes are considered important indicators for monitoring sustainability of forests:

- Extent of forest resources
- Global carbon cycles
- Forest health
- Biodiversity
- Productive function
- Protective function
- Environmental function
- Socio economic function and conditions
- Legal framework
- Capacity to implement
- Sustainable forest management

In many Asian countries forest management objectives have changed from sustained yield management to sustainable ecosystem management, combined with reorientation to participatory approach. In Latin America a trend towards conservation is developing but production remains important, partial disengagement of the state is an other trend.

No specific mention of information carriers.

7) Trees II pre-feasibility study. Final report
Earth observation sciences and world conservation monitoring center

Discussion of an information requirement study, very similar to URS, mainly based on questionnaires by email.

9 User groups are differentiated: Global change community (such as WCMC, GCTE, some research institutes), International NGO, Nat. forest dept., UN agencies, Intergovt agencies (such as ODA, SIDA, GTZ, World Bank), National GO, National NGO, research, traders.
Total response rate is 21%

Variation in response rate amongst user groups: Global change groups international organizations and research had a high response, national forest dept, traders and intergovt. Agencies had a low response rate. Consequently results are somewhat biased but this is not considered to be a problem.

Results

Themes on which information is required by the user groups

The % of respondents, all user groups combined, that requested information on specific themes is shown in the table below:

Themes requested	**% of respondents**
Forest types	83%
Forest boundary change	81%
Protected area	79%
Biodiversity area	78%
Roads	53%
Timber volume	47%
Forest fires	46%
Biomass	46%

The information requests are fairly similar for each user group: Forest boundary change, protected areas and conservation areas are most required themes.
Global change community requested information on forest extent and deforestation rates for modelling purposes. NGOs requested more information on roads and topography.

Preferred format of required data:

Information format	**% users**
News letter	13
Reports	20
Paper maps	19
Online service	7
Classified sat data	10
Raw data	4
Photo prod.	10
Digital	17

Although some variation by user group exists it can be concluded that in general processed data are preferred. (Paper maps reports and in digital formats).

Resolution
There seems to be more demand for high and medium high resolution than for low, especially in national forest departments.
Mean % responses (is average of the % response per user group) shows that medium resolution is requested most.
AVHRR data are infrequently used in conservation and management and limited applied in monitoring.

Level/ scale of data requested per theme:
Mostly required is national followed by local and regional, least required is global level.
Research community showed preference for very detailed info, preferably on local and sub-national level.
Almost all users requested info on certain themes at all levels.

Frequency of up-dates required

The table below shows the required frequency of information supply for all user groups together

Requested frequency	%respondents
Yearly	40
3 yearly	23
5 yearly	22
10 years intervals	7

Priorities

The following requirements have the highest priority:
1. National level information on forest types, medium and high resolution
2. Frequent information (1 month) of forest boundary changes, roads, protected areas and forest types.
3. National and regional level information of annual changes in forest boundaries at resolution 1: 100,000 or less

Other frequently asked information:
- Forest types at all levels and medium to high resolution
- Biodiversity areas at local and regional level, high and medium resolution
- Roads, protected area, forest reserves at high and medium resolution

Additional observations and constraints:
- Cost of satellite derived data was most frequently cited as a problem
- Requirement: high level information product, not semi processed data
- Information on paper or digital
- Need for cooperation with similar activities world wide
- Users want to be kept updated of project progress

8) Radar Remote Sensing to support tropical forest management, 1997
J.J. van der Sanden
Tropenbos Guyana series 5

This is a study on the potential of radar remote sensing for tropical forest management. It discusses the use of radar in forest monitoring and in forest resource assessment, and includes two case studies. An assessment of user information requirements and indicators to be measured by geographical level was made.

The result is shown in Table 8).1.

Table 8).1: Parameters on which users required information and the indicators to be measured

Parameter	Indicators per level		
	Global level	**National level**	**Local level**
Forest cover	Forest/non -forest cover burned logged Regenerated Biomass degraded Deforestation	Forest/non-forest cover logged Sec/prim forest type	Forest/non-forest cover Burned Logged Regenerated Prim forest type Deforestation

Forest category	Potential forest veg.type Actual forest veg. type Admin/legal status Management type Plantation/natural	Admin/legal status Management type Plantation/natural	Management type Plantation/natural
Fires	Number, distribution		
Forest comp. /struct	Crown cover Tree species comp. Diameter distribution Stand height Stand architecture	Tree species comp. Timber volume	Size class distribution Tree species comp./distr Diameter distribution Timber volume Productivity
Terrain characteristics	Soil organic matter Soil texture and slope Socio economic factors	none Socio economic factors	Topography Hydrology Infrastructure
biodiversity	Canopy roughness Terrain Fragmentation road density Productivity Leaf Area Index Etc. see table 3	Canopy roughness Terrain Fragmentation road density Productivity Leaf Area Index	Sustainable management

In addition the scales and frequencies of required information were assessed. This is shown in Table 8).2.

Table 8).2: Scales and frequency of required information:

Activity	**Scale**	**Frequency**
Local level mapping	1: 1,000 1: 10,000	Annually or more
National level mapping	1: 50,000 1: 250,000	5-10 years desired every 2 years
Global assessment	1:1,000,000 1:10,000,000	5 years
Forest resource assessment (indicator)	1:10,000	5 years
Forest resource monitoring (indicator)	1:25,000	annually

Table 8).3: Indicators to be measured for sustainability and biodiversity:

Sustainability	Biodiversity
• % crown cover, type, • % affected forest(health), • extent of encroachment, rate of forest conversion, • % soils affected (erosion), • size/location of infrastructure, • encroachment in catchment area's and buffer zones, • productivity, • natural/artificial regeneration, • No./spec. of mother trees, • gap size/ frequency, • No. protected areas, • ecological infrastructure(unlogged corridors), • Presence of light demanding spec. • Protection of areas of significance for local communities.	• canopy roughness • terrain physiography • cover fragmentation • road density • net primary production • leaf chemistry actual evaporation • leaf biomass • leaf area index

5 forest functions were differentiated and the information requirements for the monitoring of each forest function were assessed, as is shown in Table 8).4.

Table 8).4: Parameters to be assessed by forest function:

Forest function	Parameter
Protection	% crown cover
	Soils and erosion
	Topography
	Morphology
	Hydrology
	Deforestation
Production	Productivity (volume)
	Regeneration
	Number/species of mother trees /ha
	Number of felled trees
Conservation	Gap size and frequency
	Representative conservation areas
	Ecological infrastructure (corridors)
	Presence light demanding, pioneer species
Social	Cultural, ecological, economic relevant sites

9) Claude, coordinating land use and cover data and analysis in Europe.
Concerted action, European Commission, DG XII.
Report on the Claude workshop on the user needs for more harmonized land use information at the national and EU level. 1997

Discussion of several European initiatives (research and project level), on land use inventory and monitoring, including a list of European agencies, initiatives, centers, their databases and networks. Mention of efforts for a joint classification system, c.q. A unified forest inventory system for Europe.

In addition the study gives a summarization of current land management and stewardship schemes, including the effects of policies at European level. A common forestry policy doesn't exist in Europe, but a Forestry Action Program was adopted in 1989, with guidelines for protection, conservation and a strategy for adaptation to climate changes.
The study expresses a need for spatial information, adapted to and depending on ongoing processes. It is remarked that national level is not a good reference data for spatial info, due to different sizes of countries.

National inventories initiated by CLAUDE showed the following **constraints** according to Dr. Barry Wyatt:

- Lack of info and documentation
- Poor quality standards
- Poor exchange of data between institutions
- Political and economic constraints
- Incomplete coverage
- Inconsistency/incompatibility
- No time series, infrequent updates.

According to de Bie, ITC, the **constraints** are:

- Classification not adjusted to user needs
- Data availability is restricted
- Poor nomenclature
- No standard data format
- Accuracy
- Users not consulted on their needs

The following information **Requirements** are mentioned**:**

Location bound needs(Chris Steenmans EEA)
Need for land cover and land use data at European level:
Land cover changes in and around agglomerations
Land cover changes in and around important national areas
Land cover changes in and upstream of catchment areas

Environment bound needs (JP Hetteling, RIVM)
Need for integrated environmental assessment:
Vegetation changes in relation to environmental problems such as: air pollution, climate change etc.
Land use change in relation to economic changes.

Need to monitor changes in four aspects of land use, e.g. types of land use changes (trends):

1. Changes in spatial distribution (land cover)
2. Changes in function and environment character (soil, species composition, land use)
3. Changes in performance (productivity, carrying capacity)
4. Changes in management (ownership, cultivation, land treatment)

Land use data needs

- Spatial : data should be georeferenced and frequently updated
- Information on land function and environment: by survey, field observation , sample sites
- Land performance/ carrying capacity information: by field study at farm level
- Management system information: by interview survey and economic analysis

Information needs aspects related to land cover changes:
Need for monitoring of the processes and variables that are influenced by land use and changes in land use type (R.H.G. Jongman, WAU).

Time and spatial scale related to vegetation type and landscape.

- Land cover change data
- Changes in intensity of land use
- Changes in related landscape structures and elements
- Changes in nutrient cycling

Land cover changes show delayed effect. Landscape structure, vegetation and species show changes that took place in earlier years. This information should be combined with farm management data and population statistics.

For more recent information one should focus on management changes, biodiversity changes. For forests aerial photographs or satellite images can do this only when trees are more then 5 to 10 years old. Consequently the aspects as shown in Table 9).1 should be considered when monitoring the results of forest policies over a period of time:

Table 9).1: Monitoring of forest policies:

Period after policy implementation	**Year 0 to 10**	**Year 5 ongoing**	**Long term**
Aspects to be monitored	Landscape structure, vegetation and species	Management changes, biodiversity changes	Land cover, intensity of land use, landscape structures
Changes detected	Immediate effects	Short term effects	Results of long ongoing process
Additional info	Farm management data and population statistics	Farm management data and population statistics	Farm management data and population statistics
Tools	Field data	Images and aerial photo's	Images and aerial photo's

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10) FAO/ECE meeting of experts on global forest resources assessment.
Kotka II, 1993.
Aarne Nyyssonen.

Reports of the meeting of experts, reports of working groups and several background papers.

Report of working group 1: general forest inventory parameters

Parameters to be measured in forest land:

- tree species composition
- Naturalness
- Management status
- Ownership
- Vegetation fragmentation
- Health, damage, fragmentation
- Age structure
- Benefit/ function(wood, water, grazing, protection, hunting, conservation, recreation)

Report of working group 4

To indicate change and vegetation degradation at global level, spatial information is required on parameters, as shown in Table 10)1, related to land cover/land use

Table 10)1: Information requirements by parameter

Essential	Desirable	Optional
Forest/non forest	Ecofloristic zones	Potential forest
Burned	Regeneration	
Logged	Management system	
Degraded	Fires	
Deforested	Crown cover	
Fragmented	Tree species composition	
Actual forest type	Stand structure	
Legal status	Physiography	
Plantation/natural		
Forest condition		
% vegetation cover		
Socio economic factors		

According to RESPAS (see also reference no. 19) for land use assessment the following parameters should be measured:

Parameter

- Land use
- Forest cover
- Forest type
- Species composition
- Wood volume
- Ecological indicators
- Socio economic indicators

An overview of required frequency and scale of information required is given below:

Activity	Monitoring	Inventory
Frequency	2 years	5 years
scale	1: 250,000	1: 50,000 or less

The main constraints and possible solutions are given in Table 10).2:

Table 10).2: Constraints and solutions

Constraints	Suggested solutions
• Cost	• Minimized data sets at reduced price
• Timeliness • acquisition/distribution	• Distribution network/ facilities
• Cloud cover	• Radar data/mosaic data of cloud free parts
• Expertise	• Formation/training
• Equipment	• Improved software with minimum hardware config. need
• Data comparability	• Standardized products

In Background paper item 8. By James T. Bones, Report for consultancy on forest definitions and classifications to be employed for Global Forest Resources Assessment, 2000 the following Parameters to assess global environmental issues are defined:

Parameter	Environmental issue				
	Biodiversity	Carboncycle	Hydrology	Forest condition	Land cover/use
Forest cover	+	+	+	+	+
Burned areas	+	+	+	+	+
Logged areas		+	+		
Regeneration	+/-	+	+		
Biomass degraded		+	+		
Potential forest	+				
Actual forest /vegetation	+	+	+		+/-
Legal status	+				
Plantation	+	+			+
Fires	+/-				
Crown cover		-	+	+	+
Species comp		+/-		+/-	
Diameter			+		
Height			-	-	
Structure		-		-	
Topography				+/-	
Soil		+			
Morphology				+	
Socio economic factors	+/-	+	+	+	+

+= *Essential, +/-: Desirable, -: optional*

11) Forest Resources assessment 1990
Survey of tropical forest cover and study of change processes
FAO forestry paper, 130

Discussion of a forest survey, covering all tropical regions (see also ref. 12). The World Reference System 2 and Landsat are used to construct a sampling frame. The results are based on 117 sampling units, with images separated by 10-year interval.
The final products are:
Forest cover change data, maps, change matrices per sample location
Forest cover state assessment

For the assessment the following categorization was used:

Natural forest:	-continuous (closed, open, and long fallow)
	-Fragmented forest
Non forest	-Other wooded land (shrubs, short fallow)
	-Non wooded areas (other land cover, water)
Man-made woody veg.	-plantations

These categories were also found in the legend of the map produced for land cover classes.

The following change categories were estimated:
- Deforestation (from forest classes to non forest classes)
- Fragmentation
- Deforestation of fragmented forest
- Degradation
- Decrease of non forest woody biomass
- Increase of biomass
- Amelioration

- Afforestation
- Partial afforestation
- Reforestation (from forest class to forest plantation)
- Conversion

These changes were used in legends of the maps for land cover changes.
Working scale: 1: 250,000 (= scale of interpreted images)

Categories of changes were classified by geographic region and by ecological zone.

12) Forest resources assessment 1990
Tropical countries
Fao forestry paper 112

Global forest assessment, by geographic region and by ecological region.

Spatial data used as input:
- Tabular data on forest resources and socio -economic information, stored in FORIS
- Map data on vegetation types, biodiversity, and national/sub national boundaries.
- Additional data were added from Landsat 4.5 World Ref. System Grid, potential biomass, climate information, topography, protected areas, vegetation map from NOAA/AVHRR, biodiversity maps.

Forest biomass state and change assessment, by geographic region and by ecological region.
Estimation of biomass density/change is based on modeling method with GIS.

Spatial data input:
- existing forest inventory data with maps,
- spatial databases including biodiversity maps,
- vegetation maps,
- Additional info like population data, climate information, soil maps, topography maps.

Deforestation and forest degradation survey at country level.
Survey based on sample survey covering all tropical countries, using World Ref system 2 for Landsat

Spatial data input:
- Maps based on interpretation of satellite images with cover classes: other land cover, water, plantations, shrubs, fragmented forest, open forest, closed forest, short fallow, long fallow, non-visible.
- Change maps produced by comparison of recent and historical images, distinction of 14 change classes (deforestation, fragmentation, … natural afforestation).

Forest fragmentation assessment.
Investigation of relationship between fragmentation and deforestation, forest degradation etc.

Spatial data input:
- Vegetation maps from NOAA-AVHRR (1 km. Resolution) in 2 study areas.

No mention of scales or constraints in obtaining data.

13) Verslag van 11e wereldbosbouwcongress
Antalya, 1997
Wageningen, IKC-N

Discussion of the topics that were dealt with at the world forestry congress in Antalya.
The paper gives an outline of current trends and policies regarding sustainable forest management in the Netherlands.
Dutch forests have multiple functions: recreation, conservation, landscape, environmental, production.

No specific mention of information requirements or constraints.

14) Definition of a system of nomenclature for mapping European forests and for compiling a pan-European forest information system. FIRS, 1996
Michael Kohl, Risto Paivinen.
Space applications institute

The main purpose of the study is to define a system of nomenclature for mapping European forest resources.
Regional leaders of the study advised that an information needs assessment should be done first and in addition a remote sensing feasibility study.
Based on information from international research programs, forest policy goals, statistics, internal comments and expected future information needs three information topics were selected, e.g. production, environmental aspects and land use. The respective key attributes to these topics were selected (see table 1). These are either frequently present in assessments or relevant information is lacking. Information needs per attribute were assessed and ranked according to priorities (scale 1 to 5)
It was found that most attributes have similar ranks, c.q. Importance, for the 5 differentiated regions, e.g. Eastern Europe, Scandinavia, Central Europe, Mediterranean, and Atlantic Europe.

Table 14).1: information needs and data sources by attribute

Attributes	**Data sources**		**Ranking of information needs**		
	Main	**Minor**	**Production**	**Environmental aspects**	**Land use**
Actual forest area	AP+F	M+Q	1	2	1
Stand structure (species composition, layers, density)	AP+F	Q	1	2	3
Diameter	F	AP	1	4	5
Height	F	AP	1	3	4
Volume	D	F+Q	1	4	4
Drain/removals	F+Q	AP	1	3	4
Timber quality	F	AP	1	4	3
Land cover	AP+F	RS+M	2	1	1
Health	ICP+F	AP	1	1	3
Damage (fire, diseases, insects, etc.)	F	AP	2	1	2
Vegetation types	F+M	AP	3	1	2
Water resources	-	F+AP+M	3	1	2
Protection status	F+M	AP+Q+D	3	1	2
Naturalness	-	F+Q+M	4	1	3
Threats to species diversity	-	M	4	1	3
Environmental impact	-	F+M+D	3	1	2
Wildlife habitats	F	M+D	4	1	3
Other wooded land	AP+RS+F	M+D	3	2	2
Topography	M+F	RS+AP+D	3	2	2
Scenic beauty	-	-	5	1	2
Soil types	F+M	AP	2	2	2

1= high need for spatial information, 5 = low need for spatial information Used data sources: AP = aerial photographs, RS = Remote sensing, F = field data, M= maps, Q= questionnaire, D= derived, ICP= Int. Coop. Program, - = not assessed.

Chapter 8 on page 77 of the book discusses the remote sensing feasibility and literature study with a number of tables (page 84 onwards) showing the feasibility of the different sensors for each attribute.

15) Bosbeleid en informatiebehoefte. 1996
H. Kusters en W Schaap
IKC Natuurbeheer

In this study information needs, spatial and non-spatial, for forest policies in Europe are described. These policies are determined by following elements:

- Quality and size of forest
- Forest functions
- Desires of community
- National or international interest

The spatial information needs for forest policy planning, as well as activities required to obtain the information are summarized in Table 15).1.

Table 15).1: Information needs for forest policy plan

Forest function	Spatial information needs	Activities
Conservation	Forest cover/change	Monitoring inventory research
	Forest classes	
	Forest health	
	Biodiversity	
	Soils	
	Hydrology	
	CO2-fixation	
	Fragmentation	
	Tenure	
Sustainable use/function	Productivity	Monitoring inventory research models
	Extension/awareness	
	Economic info	
	CO2 fixation	
	Reforestation	
	Volume	
	Hydrology	
	Soil	
	Air	
	Biodiversity	
Production	Productivity	Inventory
	Certification	
Reforestation	Forest cover	Monitoring
	Land use	
	Tenure	

16) Andhra Padesh forestry project, India, 1994
FAO
Part 1) Information needs assessment

Implementation of GIS for forest management in India

Information currently used by each of the staff members is shown in Table 16).1 below

Table 16).1: Information used by staff member

Position staff member	Working plan officer	Division forest officer	Social forestry	Economic section	Wildlife section
Info used	Range stock maps Block maps Compartment maps Revenue manual maps Hydrology Climate Forest classes Health Wildlife reserve maps Journals Literature	Deforestation Silvicultural treatments Fires Damage Regeneration Beedi map	Survey maps Topographic maps Tenure maps Morphology Soils	Plantation/land use maps Productivity Morphology Hydrology	Tenure maps Landuse maps
Source	Survey maps 1:50,000 1:250,000 field data	Not mentioned	Survey maps Field data	Not mentioned	Not mentioned

Part 2) Monitoring of forest resources at district level, using multi-date satelite data

For change detection/ forest resources monitoring in water catchment area the following information carriers are used:

- Landsat MSS, printed at scale 1:250,000
- IRS

Several land cover classes specified: closed forest, open forest, long fallow, fragmented forest, shrubs, short fallow, other land cover, water, plantations. For each class the biomass was assessed based on images over the period 1973-1995.

Reference sources currently used are:

- Forest resource maps 1:250,000 = forest area by volume classes.
- Topo map 1:50,000
- Forest vegetation maps scale 1: 250,000
- Plantation map
- Land use/land cover details from field inventory

Teak plantations are monitored, using IRS -IB data. Land cover classes (legend) measured are: closed forest, open forest, long fallow, fragmented forest, shrubs, short fallow, other land cover, water.

Part 3) A proposal on a new forestry planning system to replace the working plan.

This part discusses mainly current forest planning in Indi and gives a description of a new planning system to replace the current one.
No information requirements are mentioned in this part

17) Programs and coordination of remote sensing related research of tropical forests in the Netherlands.
P. Romeijn, 1997
BCRS

Discussion of the main programs and activities of BCRS and ROBO, the role of remote sensing in forestry and future role of ROBO
Several constraints in information supply and availability are mentioned, which are specified below:

Present general constraints	Additional constraints, specific for forestry
Availability	Insufficient resources
Accessibility	Relatively unknown
Affordability	Lack of motivation
Uniformity	Lack of information technology infrastructure
Timeliness	Poor communication
Usability	In-country regulations
	Competition between organizations
	Unwillingness to share
	Sensitivity related to illegal activities
	Sensitivity concerning marketing and ecology
	Dependence on foreign technology
	Fear to erode sovereignty over resource

No mention of spatial information requirements on themes or information carriers.

19) Consultation on user needs for RESPAS
Westinga, Looyen, Hoekman, Racaut, 1993

A study on information needs of information providers, who supply information to mapping agencies and to organizations involved in planning. De study was carried out by interviews and questionnaires. Two categories were distinguished: global and national level. The requirements by level, themes, scales and frequency when mentioned, are shown in table 19).1.

Table 19).1: Information needs by level

National level			Global level
Parameter	*Scale*	*Frequency*	*Parameter*
Land use	1:50,000	5-10 years	Sustainable use
Forest cover	1:50,000		Degradation
Forest type	1:50,000		CO2
Species composition			Biodiversity
Wood volume			Hydrology
Ecological indicators			Climate
Socio economic indicators			

For monitoring a scale 1: 250,000 with a frequency of every 2 years is preferred

Constraints:
- Timeliness
- Cost of data
- Cloud cover
- Data comparability
- Dedicated hard- and software
- Expertise
- Standardization of methodology

Forest functions

The following 4 parameters are related to the forest functions
General forest inventory needed for: production, conservation, conversion, protection
Biomass assessment needed for: production
Biodiversity information for: conservation
Land cover/land use (change) for: conversion, protection

The result of country case studies with respect to the information carrier they use and their working scale is shown in Table 19).3.

Table 19).3. Current use of satellite data at national level in 5 countries for forest monitoring

Country	Information carrier	Scale
India	Landsat	1:250,000
Thailand	Aerial photographs, Landsat, SPOT	 1:250,000, 1:125,000 1:50,000
Philippines	Landsat SPOT	 1:100,000
Indonesia	Landsat	1:250,000
Colombia (Amazone)	Radar Landsat TM SPOT	1:400,000 1:100,000
Guinea	Aerial photographs	1:700,000

Inmost countries images were used on more detailed level for special studies

20) Source: **IUFFRO guidelines. (Paivinen, 1993) in: Consultation on user needs for RESPAS**

Information needs for forest monitoring at local, national, international level according to the IUFFRO guidelines.

Table 20).2. Information needs by level

Parameter	**Level of monitoring**		
	Local	**National inventory**	**Regional monitoring**
Land use	+	+	+
Land cover	+	+	+
Degradation	+	+	+/-
Site type	+	+	+/-
Soil type	+	+	+/-
Topography	+	+/-	+/-
Tenure	+	+/-	-
Accessibility	+	+/-	-
Biomass	+	+	+
Volume	+	+	+/-
NTFPs	+	+	-
Biodiversity	+/-	+	+
Forest health	+	+	+
Wildlife	+	+/-	-
Socio economic impacts	+	+/-	+/-
Watersheds	+/-	+/-	+/-

21) Deforestation 1995-1997, Amazonia
INPE

Discussion of assessment of the Amazonian rainforest, based on Landsat images, scale 1:250,000
Identification of forest cover changes of 6.25 ha and more.
Airborne sensors were used to identify selective logging.
Main objective is control and knowledge of extents of deforestation.
No additional and more specific mention of parameters, themes or scales of information requirements.

22) Feasibility study on global operational forest cover monitoring network for FAO using satellite remote sensing, 1992
Van der Burg, Venema, Spaa, Hoekman, van der Sanden, Reichert.

Potential applications of radar remote sensing:

Activity	parameters measured
Forest survey:	- Forest types and extents
	- Biophysical parameter
	- Edaphic parameter
	- Hydrology
	- Topography
	- Morphology
	- Drainage
Management /surveillance:	- Deforestation
	- Afforestation
	- Land use
	- Erosion
	- Fires
	- Forest classes
	- Forest health
	- Socio economic impact

23) Applications in developing countries: a two step approach towards increased participation by user groups. Results of step 1, 1993
BCRS

Discussion of possibilities for development of remote sensing in developing countries; a new approach to improve communication and increase participation of user groups.
Key persons in developing countries were identified who have direct influence on incorporation of RS applications.

Perspectives:
- provision of reliable data for planning
- Radar is of relevance for monitoring clouded areas
- RS supplies actual information for monitoring of quickly changing coastal mangrove areas
- RS in forestry is relevant for monitoring land use changes

General constraints are:
- Lack of ERS-1 data
- Insufficiently adapted hard/software
- Lack of dedicated sensors (present sensors resolution often too limited)
- Weak management capacity in forest services
- Limited field experience
- High staff turn over
- Diversity of user groups

- Overlap in research and development programs
- Bad distribution of research results

Common constraints at country level:
- Lack of information, literature
- Limited availability of images
- Lack of funding to buy expensive (ERS)images
- Limitations of existing equipment, incompatibility
- Training in use of radar remote sensing
- Lack of institutional coordination at national and international level
- Political, security problems

24) Radar monitoring for sustainable forest management in Indonesia, 1997
D.H. Hoekman.
MOF tropebos project

The report deals with the use of radar, which has the advantage that it can be used even with severe cloud cover, as an observation technique for monitoring forest management activities in Indonesia

Table 24).1: Information needs by forest function and available/preferred information

Forest function/ Theme	**Info needs**	**Currently available**			**Prefered**		
		Scale	**Sensor used**	**Frequency**	**Scale**	**Sensor**	**Frequency**
Conversion/ land use	Vegetation/land use	1:250,000	Landsat tm	yearly	5*5m	SAR/ SIR-C	
	Vegetation	1:25,000	AP	5 years		SAR	Twice yearly
	Forest classes						
	Timber roads						
	Fragmentation						
	Settlements						
Sustainable management /production	Illegal activities						Actual
	Fires		NOAA/ ERS2		3*3 m	SAR	Actual
	Reforestation				1:25,000		Yearly
	Topographic						
	Tree position				1:20,000		0nce/twice yearly
	Slopes						
	Timber volume						
	Canopy closure						
	Inventory				1:25,000		
conservation	Biodiversity	1:250,000			1:50,000		
	Habitat type				1:100,000		
	Protected areas						
	Regeneration						
	Forest boundaries/ fires	1:250,000	NOAA/ Landsat		1:10,000		

Current main constraints:
- insufficient accuracy, due to small scales
- Low frequency of data, due to frequent cloud cover

Additional needs:
- Staff training
- Sufficient processing, distribution and interpretation facilities

25) Analysis of the constraints and opportunities for cost-effective implementation of earth observation techniques in developing countries
Final report, 1995.

A study is carried out to gather information on user and non-user spatial information requirements in developing countries.
Parts of the study are an interview survey and questionnaire surveys, designed to determine the key factors that control the use of remote sensing techniques. In addition a literature review and country case studies were carried out.
Scope of the study is mainly on transfer and (potential) use of remote sensing techniques with emphasis on awareness and constraints. The study does not give detailed information on thematic requirements, scales or frequency.
The study does not focus on forestry specifically; respondents are working in various fields, such as cartography, fisheries, health, meteorology, agriculture urban planning, forestry, etc.
800 Questionnaires distributed 243 returns from non-users, 173 returns from users, in 68 countries.
Main conclusions:

Non users had the following remarks:
- Difficult to obtain,
- Expensive
- Lack of access to adequate information
- National scale is preferred
- Landsat and
- Spot high resolution systems are well known
- NOAA data are less commonly known
- Respondents use computers, maps and aerial photographs
- Satellite images are considered complicated
- Training required

Users answers:
- Landsat Spot and NOAA are main data sources
- Images more often used than digital data, aerial photographs used by most respondents
- Preferred mapping scale 1:50,000 to 250,000
- Most respondents use GIS
- Information often badly communicated between departments
- National centers often function unsatisfactory, regional centers provide better services
- Military restrictions are country specific
- Low participation in international networks
- Inadequate dissemination of RS information especially in Africa and C & S America
- Inappropriate support by donors (follow-up, training, equipment, insufficient communication of data sources, too rapid)
- Assistance from international community required regarding training, equipment, data prices, infrastructure, and collaboration.

Major constraints for all participants:
- Cost of data to high
- Lack of experienced personnel at decision making level
- Lack of long term and/ or in-country education
- Better data access/dissemination
- Improved facilities/infrastructure
- Provide literature/information
- Awareness should be increased amongst policy makers
- Financial support
- Insufficient and user unfriendly equipment
- Require more feasibility studies

Constraints mentioned in country studies:

- No local receiving station, lengthy procedure to purchase elsewhere
- Cloud cover
- Use of AVHRR limted
- High cost of data
- Data are out of date
- Securirty restrictions
- Information provided is not adapted to needs (wrong themes)
- Users are not aware of information available
- Lack of training

26) Surveying the interest of Earth Observation "end Users" in C-fix, a tool for the estimation of the net primary productivity of vegetation. 1998
F Veroustraete, J van Rensbergen, P Craamer
Study for OSTC/TELSAT program.
VITO

A validated methodology has been developed for deriving net primary production from NOAA-AVHRR satellite data at country scale. (So-called c-fix method)
The VEGETATION instrument on board of SPOT 4 will allow for a daily monitoring of terrestrial vegetation cover.
A survey was set up to determine the interest of potential users with respect to the application of the c-fix method. An e-mail questionnaire was distributed amongst potential user organizations, active in forestry, active in GIS applications, UNFCCC conference participants and a few others. Return rate was 6%.
Target groups were assumed to be in academic world, national and international institutes, and service providers. Most respondents showed interest in vegetation identification and classification, as well as productivity.

Results

Respondent identification for users of Earth Observation technologies:

Level of respondents	International 78%	National 16%	regional 6%		
Respondent activities:	Applied research for environmental policy/ planning 40%	Applied research for land use planning 26%	Industrial policy 6%	Up dating National statistics 15%	Basic research 11%

Level of interest of respondents in different Earth observation applications and information themes as can be provided by c-fix:

High interest	**low interest**	**Additional requirements**
Land cover	Light absorption/reflection	High resolution
Land use	Population density	Low cost
Health	Surface temperature	More detail/specific
Evapotranspiration	Atmospheric pollution	
Vegetation classification		
Soil/vegetation humidity status		
Wood production		
photosynthesis		

The study shows that foresters and global change researchers are more interested in practical applications of earth observation techniques than in the techniques themselves. It demonstrates also that the terms used in the questions, e.g. scientific terms or practical terms, greatly influence the answers. When scientific terms are used interest is usually low, after translation into more practical applications interest increases considerably. This implies that users are not interested in the scientific or technical background but rather in practical use of applications. It also implies that users are not experienced remote sensors and are not actively involved in data processing. The majority prefers *translated 'tailor made' information*.

27) Land cover and land use information systems for European Union policy needs.
European Commission, Eurostat, 1998
Program and abstracts.

Discussion of the land use information needs for Common Agricultural Policy (CAP).
By: M. Gavira, EC

CAP needs specific data on land use such as:
- Current area for fodder production, area for annual crops, area for permanent crops.
- Agricultural area other than for arable crops
- Impacts of policy changes concerning arable land
- Information on other land uses, such as forests, urban areas, protected areas etc.

Data integration: Corine in Finland, an example
By: Y Sucksdorff, K. Valanne. EFI, A. Mikkola, NLS Finland.
Feasibility study to produce a new land cover/use database of Finland, the following classifications were recommended:
- Land use: built up area, agricultural area, forestry area, water
- Land cover: forests, sparsely forested, other vegetation, non vegetated, water
- Soil: rocks, mineral soils, thick organic soils, thin organic soils, filled in soils
- Restricted use areas: conservation, military, and ground water areas.

This study is aimed mainly at general land use requirements. No mention of information requirements for forest management.

28) World Resource Institute, 1998
Blueprint for a Global Forest Watch (DRAFT)
WRI, Forest Frontiers Initiative.

Proposal to build an independent decentralized global Early Warning Monitoring network, to monitor the results of forest policies, wood production companies and development projects. This is supposed to support on-going monitoring activities. Information collected will allow users to identify sustainable forest management and biodiversity conservation.

Information requirements mentioned:
- baseline information, including maps of forest cover, recent and sufficiently detailed, forest type, change data, biodiversity, cultural resources.
- Additional information: logging concessions, roads, resettlements, land use.
- Performance information: impact of developments, effects of policies and laws.

GFW wants to be a reliable objective source for providing free and easely accessable information.
Local forest resource centers should play a major role in monitoring and supplying information.
A data accreditation system has to be created to assure reliabiltiy of data.
Data distribution will be under responsibility of local centers. It could be done through the internet and dissemination of hard copies and synthesis reports.
Datasets can be raw data and data products such as maps, fact sheets and reports.
Additional training will have to be provided.