



MAR Working Paper 36

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A review of forest information systems

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1. Introduction

1.1. Background

The MAR-SFM project, which has 26 member countries in South-East Asia and Pacific, aims to develop a harmonized Monitoring, Assessment and Reporting (MAR) system for Sustainable Forest Management (SFM) and to apply it in the Asia-Pacific region. The author of this report was assigned to the project in the beginning of 2010 in order to provide technical support regarding information system technologies.

The work included several subtask. It started with design of a brief questionnaire regarding forest information systems and databases. The questionnaire was distributed to the forest administrations in all project countries in order to create a broad picture of how they are working with these tools today. Next task was to carry out case studies in Cambodia and Lao PDR. A third subtask was to assist in preparation and implementation of a training workshop on "Effective Tools for Management of Forest Information" with participants from 20 countries. This report presents a review of current technology used in forest related information systems. The reports from the questionnaire and case study are available as a separate document (Wellving, 2010a and 2010b).

1.2. Purpose

The purpose of this study was to review general principles on *forest information systems*¹, to identify organizations involved in development of forest information systems in the Asia-Pacific region, to describe future national forest information systems and to recommend an appropriate framework for development of national forest information systems.

The main findings in this report are based on studies of literature available on the Internet. In addition a study visit was made at FAO headquarter in Rome where most of their forest information systems were discussed with responsible developers. Experiences from the above mentioned case studies and questionnaires have been included in this report.

1.3. Limitations

The review has been limited to technical aspects of forest information systems. Other aspects have been reviewed elsewhere, for instance in the Forest Sourcebook (World Bank, 2009) and the National Forest Assessments Knowledge Reference (FAO and IUFRO, 2004). Such important aspects of forest information systems are primarily: organizational issues, cost/benefit relationships, information needs, links to political decision making, etc. Another limitation to the extent of this review was the available time for the entire consultancy mission, which was five months.

2. Introduction to forest information systems

2.1 Application areas

The national forestry organizations are not organized in the same way in all countries but there are some common properties that have influenced of how forest information systems are used. The typical forestry administration is divided in three levels where the national agency is located in the capital and houses the supervising functions and some special departments, e.g. the planning and ICT departments, a Remote Sensing centre, etc. The provincial level consists of a number of offices with functions for management and support to the district offices. The district office are

¹ *Forest information system* is simply a generic term for information systems used within the forestry.

spread over the forested areas of the country and houses the staffs that work in the field with supervision, watershed protection, practical forest management and related tasks. Information systems can support the tasks at all levels from the collection of field data in the districts to the compilation of reports and all kinds of analysis at the national level.

The overall objective for enterprise-wide information systems is generally to achieve a situation with

- Timely access to consistent, accurate data
- Sharing of data for collaborative decision-making
- Improved communications across departments and levels
- Reduced duplication of tasks and efforts
- Fast, efficient service to both governmental offices and the public

A FIS can for instance facilitate the task to calculate and fill in the many forms that are required by systems that collect data from national reports and store them in a central database like the ASEAN-MAR system. Forest officers can use a FIS to, calculate areas, create new types of regions by aggregation of polygons, calculate the carbon sequestration, create buffer zones around streams and design maps.

Beside the reporting tasks there are several other activities that can be supported by a forest information system, e.g. inventories and mapping of forest compartments in the field, planning for new roads, watershed planning in order to prevent disturbances to drinking water quality, transport planning and optimization, etc. Table 1 shows a tentative classification of forest information systems based on their application areas. The first five types can be considered as "MAR systems", which means systems used for Monitoring, Assessment and Reporting activities.

Application area	Type of data	User group
Statistical and advanced analysis	Spatial and non spatial	Specialists at Analysis Units in the central administration.
Field inventory	Spatial and non spatial	Specialists at different levels
Remote sensing and mapping	Spatial	Specialists at RS/GIS units in the central administration
Reporting on forest conditions	Non spatial	Officers at all levels
Other monitoring, e.g. fires, crimes, etc	Spatial and non spatial	Officers at all levels
Forest management	Spatial and non spatial	Officers responsible for forest management, private forest owners
Watershed management	Spatial and non spatial	Specialists in the central administration and in other national agencies
Transport planning	Spatial and non spatial	Specialists on local levels
Timber market analysis	Non spatial	Specialists in the central administration
Information to the public	Spatial and non spatial	Public access via WWW
General purpose	Spatial and non spatial	All members of the staff (via Intranet)

Table 1. The most common application areas for forest information systems

2.2. Technical description

An information system is generally considered as a work tool. It is designed to help a user to perform certain recurrent tasks. A forest officer may have to keep track of a number of activities or events in his district and report them to a central office. The system provide tools to collect data about the activities, store the data in a database, edit data, search for and select relevant information to report and to design a report in a standardized format.

A (computer-assisted) information system has four basic components: *software*, *hardware*, *databases* and *user*. The user is considered a component of the system since the users background knowledge helps to create "information" from "data"². This generally means that an experienced and well educated user can get more support from a certain system than a less educated user.

software	hardware
databases	user

Figure 1. The four components of an information system

Users of forest information systems

As seen in table 1 the users of information system can be found everywhere in an organization. If the systems are web based the users can be found in other organizations or in the general public.

Hardware

The typical hardware for the ordinary user is a personal computer (PC). It is normally a desktop computer but lately laptops have become rather common. Officers that collect data in the field can be equipped with Pocket PCs (also called PDA, Personal Digital Assistant) combined with GPS's for collection of coordinates. Through the internal network the users generally have access to printers. A corporate system will also include one or several computers that act as servers for databases. Probably there will also be a web server.

Databases

A database might be one single file with many records, but a database generally contains a group of files. A metadatabase is a type of database that contains data on exist-

² In this report the terms data and information are mostly used as synonyms

ing databases. Information systems within a forest administration generally contain several different databases with both spatial and nonspatial data.

*Spatial data*³ is information about the locations and shapes of geographic features, e.g. forest compartments, and the relationships between them, usually stored as coordinates or raster cells. *Nonspatial data* are data without inherently spatial qualities, e.g. tables containing timber prices. The difference between spatial and nonspatial data is not always obvious. Data collected from sample plots in a forest inventory are for instance "spatial" if they can be linked to a location of a geographic point with stored coordinates (and presented on a map), otherwise they are "nonspatial".

Spatial data of the most common type (called *vector*), consists of a set of objects organized as thematic layers, e.g. forest stands, road net, topography, etc. The data describes both the geometry of the objects (boundaries of forest stands) and their attributes (species, age, height). A layer can be considered to be a separate database.

Software

The software in an information system is generally some kind of *data base management system* (DBMS). Such software's have a number of modules for editing, processing and querying the database. They usually also have tools for further customization of the software for certain use cases. This means that it is possible to add scripts or program modules that support special types of queries, analyses and reports. Software that can be customized in this way is often called *software platforms* or a *development environment*.

The components in an information system are generally designed according to the needs of the user or a certain group of users. Such a combination of software's, databases and hardware is called an *application*⁴ or just a *system*. A more advanced application (system) can in fact consist of several different software's as well as several databases and hardware components. Figure 2 shows a simple example of an application that has multiple components of each type.

<p>Software ArcGIS MS Excel (SQL Server)</p>	<p>Hardware Desktop PCs Data server Printer and plotter</p>
<p>Databases Compartments Planning details Map layers</p>	<p>Users Forest officers</p>

Figure 2. Example of the components of a Forest Information System

Commercial applications of forest information systems are generally built with GIS platforms, e.g. ArcGIS, since a great deal of the data used in monitoring are spatial

³ also called *geospatial*

⁴ The term *application* can also refer only to the software component

(maps of different kinds). Some applications are however built primarily on standard DBMS platforms, e.g. SQL Server. In both cases there is generally an interface to the other type of software. This means that GIS based applications have interfaces to a standard DBMS for storage of nonspatial data and that DBMS based applications have interface to a GIS or mapping software for display of maps.

Systems based on GIS software were originally introduced in most developing countries as a tool for map production. Digital ortophotos and satellite images were used for interpretation of borderlines of forest types. These were digitized by the systems and the data became the starting point for cartographic databases. The systems were also at the beginning used for digitizing paper maps.

The table below shows a number of commercial software's that are developed for creation of forest information systems. Most of them are built on a GIS platform, usually market leading *ArcGIS*, but some are built on a standard DBMS as indicated in the table.

System name	Manufacturer	Type of software platform	Running Environment
Assisi Forest	Assisi Software U.S., http://www.assisisoft.com/	DBMS	Desktop
Cypress	American Forest U.S., http://www.americanforestmanagement.com	DBMS	Web
FOREST	Oy Arbonaut Ltd. Finland, , http://www.arbonaut.co	GIS	Web
Forest Records	WoodPlan Ltd. U.K., http://www.woodplan.co.uk/	GIS	Desktop
pcSKOG	pcSKOG AB, Sweden, http://www.pcskog.se/	GIS	desktop
Woodlands	Cengea Solutions Canada http://www.cengea.com	GIS	Web
Woodstock	Remsoft Inc. Canada Woodstock, http://www.remsoft.com/	GIS	Desktop
Zenith	Savcor Group Ltd. Oy Finland http://www.savcor.com/forest/	DBMS	Desktop
Patchworks	Spatial Planning Systems Canada, http://www.spatial.ca/	GIS	Desktop

Table 2. Examples of commercial software's that can be used for design of Forest Information System

Forest information systems in larger organizations have generally *client-server* architecture. This means traditionally that the application software is installed on a desktop computer (or laptop) but at least some of the databases are located on a server accessible via network connections. Several clients can access the database server simultaneously. A more modern architecture is that the client is a web browser (*thin client*) or a simple java-based software (*thick client*). The application is in this case installed on a server and the databases can be located at this computer or another (figure 3).

Web based GIS applications are often called *WebGIS*. In later years these have been more advanced and can substitute some older desktop installations. Table 1 above shows that some of the commercial FIS software's are available as both desktop and web versions.

A simpler type of WebGIS is called *Web Map Services (WMS)*. These systems can be used as tools to present spatial data, e.g. locations for hotels, on web pages. They they can also be used by people who just need to browse maps for some information. *Google Maps* is an example of a WMS with a thin client while *Google Earth* could be used as an example of a WMS with a thick client, since you have to install a special software in order to be able to use this tool. The difference between WebGIS and WMS is however not always clear.

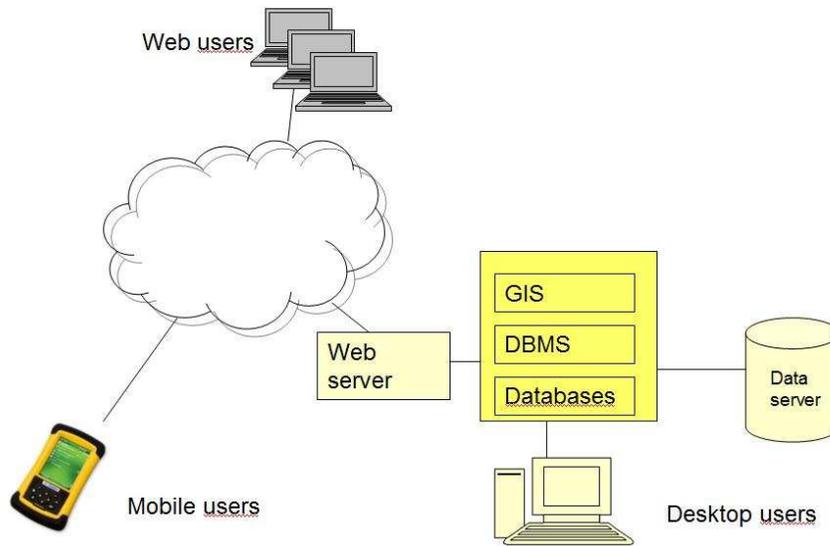


Figure 3. Description of an enterprise-wide spatial information system

Modular design

Information systems generally have several modules or subsystems. There may be one or several tools for data collection, either in the field by GPS or in the office through screen digitizing or various remote sensing technologies. There may also be separate systems for processing and storage of the data. Other software may be used for assessment and reporting, but these systems are generally integrated with the software for storage and retrieval of data.

In smaller organizations all of these subsystems can be combined in one application and installed on a single computer. In governmental agencies and larger enterprises it is more likely that the subsystems are running on several different computers connected to a common database. Sometimes the systems have an all-embracing name, for instance the *Amazonian Protection System* (which is a Brazilian system with the purpose to detect and prevent illegal logging).

There may be several separate databases in a corporate (organizational) system. One database can store data from field inventories collected at sample plots or forest stands. Another may contain satellite images and a third can be a set of data layers used as base maps, e.g. roads, rivers, etc. These databases may be managed by separate types of software and therefore perceived as separate forest information systems, but from an organizational point of view they can also be considered as subsystems of a national system. They are generally designed to function to-

gether in order to create and maintain the best possible descriptions of the national forest resources.

FMIS and FDSS

Applications used for management of production forests are often called *Forest Management Information Systems (FMIS)*. These applications support planning, analysis, reporting map design. The production forests are generally divided in management units called compartments or coupes for which several data are captured and stored. In most countries FMIS's have since long become an necessary tool for officers engaged in practical forest management. The term FMIS has also been used for such business systems that have the ambitions to integrate most of the management processes in a forest administration into a single system environment. This type of FMIS may have modules also for accounting records, human resources, etc. Most of the commercial systems listed in table 2 are in fact marketed as FMIS.

Forest information systems that have more sophisticated tools for analytical modeling could be called *Forest Decision Support Systems (FDSS)*. In forestry, they are used extensively for timber-harvest scheduling, selection of silvicultural treatments, logistic calculations, insect and disease management, etc. FDSS's are often built on GIS software. If not, they generally have functions for export of the results of the analyses to mapping software's or a GIS. The difference between FMIS's and FDSS's is not always obvious.

2.3. Development of forest information systems

Needs assessments

The reasons for implementation of enterprise-wide forest information systems is generally to achieve an situation with

- Timely access to consistent, accurate data
- Sharing of data for collaborative decision-making
- Improved communications across departments and levels
- Reduced duplication of tasks and efforts
- Fast, efficient service to both governmental offices and the public

Well designed information systems are adapted for user needs and easy to handle. The users feel that they really get good help to do their tasks and they are anxious to improve their system with extended functions. The systems may not be fully developed at the implementations in an organization but they can be improved with more functions and data gradually. Applications designed for provincial forestry officers should be based on a thorough needs assessment in order to create systems that really improve their productivity and give them possibility to answer relevant questions, for instance to monitor changes in the forest cover and calculate areas of these changes. The assessment should include needs for hardware and software as well as databases. In the last case it is important to distinguish between what data that is needed and what is available (but maybe not needed).

Experiences of support to FIS development in SE Asia

The German development agency GTZ has summarized experiences of 25 years of technical cooperation regarding natural resource management in Southeast Asia. A special report (Buchholz et al, 2005) describes a number of projects related to information and communication technology (ICT). The lessons learnt are of general interest and a few of them are cited here slightly shortened:

1. Setting up and implementing an efficient information system is not only a technical issue, but also implies demands on the organisational as well as communication culture of an institution. Therefore the managerial level needs to be integrated at all stages of development and implementation.
2. The application has to be tightly integrated in the work processes and has to facilitate the ordinary tasks of the users. They have to experience a personal gain; otherwise a resistance to the system will occur.
3. The quality of the data available for the system is often poor. As a result the outputs are disappointing, and the system is made responsible for it. Care needs to be taken to not only build an empty system shell, but to make sure that a sufficient amount of quality data forms the core of the system.
4. The project management unit needs to be aware that development of an information system is a complex task. Enough resources, financial as well as human, have to be allocated to the work team.

3. Organizations involved in development of forest information systems

3.1 National organizations

Forest Information System (FIS) is, as mentioned above, a generic term for applications used within the forest sector. Such a system can vary in design from a single user application with a small database to a enterprise-wide system with installations on many computers connected to a network with data servers and plotters.

On a national level FIS's are used by governmental organizations as well as forest enterprises, some NGOs and many private forest owners. The governmental users are found in different ministries, primarily the Ministry of Forestry or its equivalent and in the agencies responsible for management of natural resources. In forestry administration there might be an Inventory Unit and a Remote Sensing Unit which are the main users of forest information systems. In more developed countries the availability of ICT equipment is good and most of the forest officers have access to various information systems on their desks.

The forest owners, private as well as governmental, which use FIS's for planning of forest management need to have data with high resolution. For the monitoring agencies at national level the need for data with medium resolution is mostly sufficient.

FIS's can be developed by local experts that are familiar with GIS and DBMS software's. Sometimes the know-how is available within the forest administrations but more often consultants are hired for system development tasks. These generally start with assessments of user needs followed by development of pilot applications for testing. The design of the database is crucial for the benefit of the system. It is im-

portant to store data with optimal resolution and accuracy in order to keep the costs for data collection low without losing possibilities to use the system for its purposes.

Examples from LAO PDR

From a case study in Lao PDR made by the author in 2010 a few examples of forest information systems will be mentioned (Wellving, 2010a). The systems have been developed mainly by international consultants. Similar systems, more or less advanced, are available in most countries in South Asia and Pacific according to a recent questionnaire (Wellving, 2010b).

The Department of Forestry in Lao PDR have introduced a nation wide *Forestry Reporting System* which is based on internally standardised processes and activities. Annual work plans and monthly reports concerning logged volumes, etc can be entered in the system by provincial forestry officers either on-line or by submitting the data by email for later upload at the head office. The database is built on *SQL Server*. The forest officers at the head office compile the data into standardized or special reports. There are also other systems. An application called *Preharvest* is used for calculation of annual harvest plans, another system for storage and retrieval of inventory data is called *FIMP*. The software platform for these two systems is *MS Access*.

Modern GIS software is used for management of the spatial information and for design of maps at the RS/GIS center in the Department of Forestry in Lao PDR. One application, called *GIS Database*, is used to produce forest management plans. It is built on *ArcGIS*. Software development for a new web based GIS has recently started. The server is based on *PostGres* open source software. The application will make it possible for the staff members at the provincial forestry offices to get access to spatial databases through a web browser. This system has not yet got a name.

Similar systems are available in most forest administrations around the world. Some are rather simple from a technical point of view, other are contain a lot of modules and databases that work together as rather advanced systems. Some offices have staff members that can develop these systems but most of them rely on consultants. According to the result of a questionnaire (Wellving 2010b) most of the systems of this type that are used in the region are based on *Microsofts Excel* or *Access*. System that manage spatial data and can be used for map productions are most often based on *ArcGIS*.

3.2 Regional organizations

Regional organisations that use forest information systems are generally engaged in management of natural resources. They collect data for monitoring purposes and for production of maps. From the Asia-Pacific region a few examples will be mentioned.

ASEAN-MAR is a system managed by the ASEAN secretariat and is currently under construction. When operative it will contain a vast amount of data on forest resources in its ten member states. These have agreed to submit information on their forest resources using a standardized format for seven criteria's subdivided in a large number of indicators. See the link: <http://mar.aseanforest-chm.org>.

Global Forest Watch (GFW) is an initiative of the *World Resources Institute* (WRI) in Washington and it is supported partly by the World Bank. GFW has established an

office in Indonesia with the purpose to monitor the forest situation in the country. The local organization is called *Forest Watch Indonesia* and it manages a database regarding forest industry and concessions for logging. This is available on their website (<http://fwi.or.id/>). Indonesia has since 2006 with support from WRI developed and implemented a *Forest Monitoring and Assessment System (FOMAS)*. This system is built on a DBMS combined with software for map presentation.

The *Mekong River Commission (MRC)* has a head secretariat located in Vientiane. The secretariat has a technical division which is managing several information systems. Some of them can be used for monitoring of natural resources including forests. Data can be downloaded from the MRC website (<http://www.mekonginfo.org/>).

Pacific Islands Applied Geoscience Commission (SOPAC) is an inter-governmental, regional organisation promotes sustainable development in the member countries. SOPAC runs a web portal with statistical data and various downloadable documents. There is also a Web Map Service with topographic and thematic data sets, e.g. forest cover. Such interactive maps are available for most of the Pacific states.

3.3 International organizations

The main users of forest information systems at the global level are international non-profit organizations. Within United Nations there are several bodies such as FAO, UNDP, UNEP, WMO, etc. Other international users and/or producers of forest related databases are the *World Bank* and the regional international development banks like ADB.

The systems in these organizations are primarily used for inventory and monitoring, which means collection, storage, analysis and presentation of data from the whole world. Numerous databases and information systems with forestry related content have been created by these organizations throughout the years. Some of them have been abandoned due to high costs and little benefit; others have proven to be useful and further developed. In this section some of the system at FAO, one of the major actors regarding monitoring of global forest resources, will be briefly described followed by a description of some other relevant international systems.

3.3.1 Systems with connection to FAO

Food and Agriculture Organization (FAO) has among other tasks a mission to help developing countries to improve their forestry sectors. Monitoring of forests means to measure the extent, characteristics and condition of land with at least 10 % tree cover. Data are mostly collected through satellite-born sensors with relatively coarse resolutions (30 – 1000 meters pixel size). The information is compiled by FAO and falls into two areas. The first is *forest production*, which is data and statistics on the production, consumption, trade, etc. The second is *forest resources*, which includes data and statistics on the area, stocking, growth, condition and type of forest resources in countries. FAO also compiles a wide range of forestry information about biological and technical parameters, policy and institutional developments and social, economic and environmental factors. Here follows a short review of current systems and projects:

FORIS

FORIS is an information system developed within the Forestry Department of FAO. It is available from a web site where several forest related services and databases are gathered. The system is built on *Oracle*. It is an internal system and only accessible from FAO intranet.

FRA

The *Global Forest Resource Assessment* is an activity with the purpose to compile information about forest resources in the whole world every fifth year. FRA is also a name of a system for storage, processing and retrieval of the information. Data are collected from each country via questionnaires. They were digitized and edited by the staffs at the Forestry Department and stored and analysed using *FORIS*. A selection of the tables can be presented on the projects web site and the more comprehensive country reports can be downloaded as pdf-documents. <http://www.fao.org/forestry/fra/fra2005/en/>

The latest inventory, FRA2010, was extended with a sample based study using satellite images (FRA-RSS). These images are now available for download for the public via a new web portal. The locations of the sample areas, which have their centers in each longitude and latitude crossing can be shown on a web map.

<http://www.fao.org/forestry/fra/remotesensingsurvey/en/>

FAOSTAT

Two statistical information systems managed by FAO are the *Forestry country profiles* and the *FAOSTAT* system. The first of them contains mostly textual descriptions of the forestry in all countries in the world. The second has a subsystem called *foresSTAT*. It is a more advanced database system with a user friendly interface where different search criteria can be used. All data are aggregated on national level in these two systems.

<http://faostat.fao.org/site/626/default.aspx#ancor>

CountrySTAT

CountrySTAT is a technology that FAO offer to help developing countries to establish national databases of statistical data. It is built on the software PC-AXIS and data in CountrySTAT can be aggregated on sub-national level. The technology can be used to design national statistical information system with data regarding forestry as well as other sectors. <http://www.fao.org/economic/ess/countrystat/en/>

KIDS

Key Indicator Data System (KIDS) is a FAO software tool for development of Web Map Services. It has been used for visualizing data from FAOSTAT and other DBMS based applications. KIDS is an open source software and can be downloaded freely. <http://kids.fao.org/>

NFMA

This is an abbreviation for the *National Forest Monitoring and Assessment* programme within FAO. The purpose is to help developing countries to establish national forest inventories based on permanent sample plots. NFMA is also the name of the information system where the collected data are stored and analysed. This system is based on the software *MS Access*. Currently around 15 countries have implemented the NFMA methodology and several countries are in line to get support for implementation of the system. <http://www.fao.org/forestry/nfma/en/>

GeoNetwork

GeoNetwork is a web portal for primarily geospatial information. Much of the data is relevant for FIS's and the system is therefore mentioned here. It enables access to local and distributed information catalogues and makes data, graphics and documents available for download. Geospatial information can be visualized by a web map service. FAO produces a large number of GIS datasets for monitoring, assessment and analysis of environmental and socio-economic factors causing poverty and food insecurity. *FAO core spatial datasets* are special selections of downloadable data available at the GeoNetwork. They have rather coarse resolution, 30 arcsec or more (approximately 300 m) for the raster data, and a map scale between 1:1 million and 1:10 million for the vector data.

The overall functionalities of GeoNetwork include: a global library for geospatial data; an ISO standard metadata catalogue that describes the geospatial data, enabling users to assess the suitability of catalogued data for their needs; a system to search, edit and publish geospatial information from globally distributed sources; and an function that allows the integration of geospatial data from local or remote sources. <http://www.fao.org/geonetwork/>

GLCN

The *Global Land Cover Network* (GLCN) is an initiative to establish a global collaboration for developing harmonized land cover and land cover change data accessible to local, national and international initiatives. GLCN manages a website which is dedicated to the *Land Cover Classification System* (LCCS) and its applications in different parts of the world. There are links to several services, databases, free software, technical reports, etc, for those who are interested in land cover classification and mapping.

Land cover data sets from Africa can be accessed from the *Africover* site which also provides a Web Map Service for inspection of the spatial data. This site is linked to the LCCS site. The data set is intended for free public access.

http://www.glcn.org/index_en.jsp

The Africover project has made an important contribution to the science of vegetation mapping by developing a robust system for worldwide classification of land cover. This system with its 22 classes has been adopted as a ISO standard and is increasingly used for land cover mapping by different agencies.

GTOS

The *Global Terrestrial Observing System* (GTOS) is a programme for observations and analysis of terrestrial ecosystems that aims to facilitate access to such information. The secretariat is located at FAO in the Environment Assessment and Management Unit. <http://www.fao.org/gtos/>

GTOS can be seen as an umbrella organization for different agencies engaged in satellite based observations of the environment. The activities related to monitoring of forests are organized in a separate panel called *Global Observation of Forest and Land Cover Dynamics* panel (GOFD-GOLD). This panel manages a portal for data downloads divided according to three main themes

- Forest Cover Characteristics and Changes
- Forest Fire Monitoring and Mapping
- Forest Biophysical Processes

A similar database under the GTOS umbrella is TEMS, the *Terrestrial Ecosystem Monitoring Sites*. It is an international directory of sites and networks that carry out long-term, terrestrial in-situ monitoring and research activities.

<http://www.fao.org/gtos/tems/>

3.3.2 Other relevant international systems

GFIS

The Global Forest Information Service (GFIS) is a web based gateway to forest information resources from around the world. GFIS is led by the *International Union of Forest Research Organizations*, together with FAO and the *Center for International Forest Research*. GFIS provides a search tool for news, publications, other documents, events and databases. <http://www.gfis.net> . The goals are to:

- enhance access to all types of forest information for all stakeholders, including governments, researchers, forest managers, NGOs, community groups and the public
- contribute to an improved understanding of complex forest-related issues, to improve decision-making and to facilitate a more informed public engagement in forest policy and forest management at all levels.

GLCF

The Global Land Cover Facility (GLCF) provides earth science data and products to help everyone to better understand global environmental systems. In particular, the GLCF develops and distributes remotely sensed satellite data and products that explain land cover from the local to global scales. Primary data and products available at the GLCF are free to download from the site <http://www.landcover.org>.

WDCBE

The World Data Center for Biodiversity and Ecology is managed by the *National Biological Information Infrastructure*, a broad, collaborative program based at the U.S. Geological Survey. WDCBE provides increased access to data and information on the biological resources. The scope of the WDCBE is global and the website is a gateway to data and tools that address the information and research needs of scientists, resource managers, and policymakers.

http://www.nbio.gov/portal/server.pt/community/world_data_center_for_biodiversity_and_ecology/580

GLC2000

In collaboration with a network of international partners from around the world, the *Global Vegetation Monitoring (GVM)* unit of the *European Commission Joint Research Centre (JRC)* has compiled a harmonized global land cover classification for the year 2000 called *GLC2000*. The general objective was to provide a harmonized land cover database over the whole globe. Data were acquired by the *SPOT4 Vegetation Instrument*. <http://bioval.jrc.ec.europa.eu/products/glc2000/glc2000.php>

GlobCover

The *GlobCover* initiative by the *European Space Agency (ESA)* demonstrates a service for the generation of a global land cover map for the year 2005/2006. The service is designed in a way that further updates of the land cover map are possible at recurrent cost to run the developed system. GlobCover uses as its main data source the *Envisat MERIS* fine resolution (300m) mode data acquired between end 2004 and mid 2006. For maximum user benefit the thematic legend is compatible with the FAO developed Land Cover Classification System (LCCS) mentioned above.
<http://dup.esrin.esa.it/projects/summary68.asp>

LCLUC

The NASA *Land-Cover and Land-Use Change (LCLUC)* program is examining several topics including land cover conversion, land use intensification, and land degradation in arid and semi-arid environments. The project aims to define, develop, and evaluate improved remote sensing measurement techniques and data integration methods for characterizing land degradation. In the case of land cover conversion, the primary NASA interest is to identify the current distribution of land cover types, and to track their conversion to other types. The LCLUC program has a particular interest in the impacts of land cover and land use change on biogeochemical cycles and the hydrological cycle (<http://lcluc.gsfc.nasa.gov/strategy/priorities/index.asp>).

EFIDAS

European Forest Institute (EFI) is managing a number of online databases called *European Forestry Information and Data Analysis System (EFIDAS)* with data and information on different aspects of European forests, forestry and forest research. Databases may originate from projects or EFI's core activities. They represent in many cases data which are frequently used to perform EFI's research tasks. References to the original sources of the data are given. Following databases in EFIDAS can be accessed free of charge by anyone after completion of a simple registration process. Following databases are available

The *European Forest Information Scenario Database (EFISCEN)* is a forest inventory database of European countries, based on input from national inventory experts.

Long Term Forest Resources Assessment Database (LTFRA) is an interactive searchable databases on forest resources in the UNECE region. The database includes data from forest resources assessments implemented by the FAO and UNECE/FAO.

Forest Products Trade Flow Database (FPTF) uses trade data from the United Nations United Nations Commodity Trade Statistics database. These data then are processed in order to obtain precise estimates of the trade flows and stored in the FPTF Database.

Database on Forest Disturbances in Europe (DFDE) allows searching historic information about disturbances in the forests of Europe. The DFDE has been elaborated by the institutions Alterra based in Wageningen, The Netherlands and EFI.

4. Future perspectives of national forest information systems

Someone has said that "the specific objective of a national system for forest monitoring and information management is to make relevant, reliable, accurate, and up-to-date forest sector information available to decision makers and to assist them in decision and policy making based on daily use of information". The present situation is that few countries in the world have succeeded to create such systems and they are not many in the Asia-Pacific region. According to some experts the situation is in fact below standard in most countries in this region. In this section some of the problems that arise for forestry administrations in less developed countries when trying to implement forest information systems are discussed.

Poor infrastructure for ICT

First of all there is often a poor infrastructure for ICT, which primarily means that Internet is not available in the rural offices. The office conditions may be primitive and the supply of electric power for computers and air condition can be unreliable. In addition there may be considerable problems with viruses and other types of malware (malicious software) due to limited funds for acquiring firewalls and virus protections. The investments in high speed data links with fibre optics network may take long time but in later years networks based on mobile cell phone nets have provided an alternative. These mobile broadband networks seem to satisfy the need for Internet connection to most rural offices within a few years. A future perspective is that it is realistic to plan for web based FIS's even in less developed countries.

High costs for investments

Another problem is that costs for investments in software and equipment is high even if has decreased relatively by the years. Many forest administrations are for instance relying on illegal copies of software. This is not a sustainable solution for the use of forest information systems. A future solution may be to make benefit of *open source software* which is free to download and use. An increasing introduction of open source in the software's forestry administrations may be an at least partial alternative to illegal software.

There are nowadays open-source alternatives to most types of software's for professional use. *Linux* is an operative system that can substitute *Windows*. For ordinary office programs there is a well functioning alternative called *OpenOffice*. Commercial database management software can be replaced by *MySQL* or *PostgreSQL*. *Apache* is the name of open-source software for web servers. Finally there are many interesting substitutes for *ArcGIS*; the most well-known may be *Quantum GIS (QGIS)*.

Another kind of open-source software that does not need much work with installation or support is *Google Maps* and *Google Earth*. There is a growing interest for these tools as they can be useful also for professional use free of charge. There are good instructions on Google's website although some programming skills are helpful. The idea is to use these web maps and combine them with your own spatial data layers stored on a local web server. Such applications can now be seen on many business web pages.

Another emerging possibility to bring down cost for ICT is use different offers for "cloud computing". In the future organizations will not have to invest in software and data servers for information systems. Given that they have good web connections they will be able to buy time for using hardware and software located somewhere else in the world . There are an emerging number of companies that offer such services on competitive prices, for instance Amazon Web Services (<http://aws.amazon.com/ec2/>).

Serving map data over the web is an efficient, low cost solution to implementing GIS. A company in US called SEWALL has developed numerous web sites that enable customers to view, query, and publish their map and associated data with only a standard browser and Internet connection. According to their web site they offer a low-cost service that includes data review, data hosting, an introductory web page with URL address, a map viewer, navigation and query tools, and 3 gigabytes of storage space. The idea is that the customer will be able to create information systems without needing to purchase additional hardware, software, or staff resources. <http://www.sewall.com/services/geospatial/web-services.php>

A future perspective to tackle high costs for software is in conclusion to take advantage of open source software's and the growing number of cost-effective services on the Internet.

Limited access to databases

The databases are generally the most important components of information systems. Without reliable and demanded data they are useless. Data collection is usually tedious and costly and system managers therefore try to access as much data as possible from existing relevant sources. For GIS applications it is often possible to acquire useful spatial data from other local authorities. In many developing countries it is difficult to acquire good base maps with high resolution. Digital topographic databases covering the whole country are often not available. Forest information system generally demand cartographic data suitable for printed maps in scale 1:10 000.

Data accessibility has however improved for GIS users in most countries during later years thanks to various data sources that are available via Internet. Several web portals have emerged from which GIS datasets and satellite images can be downloaded freely, for instance the *GeoNetwork*. For ArcGIS users a service called *ArcGIS OnLine* was introduced recently. This service provides high quality base maps to GIS applications all over the world through a streaming dataflow. A disadvantage is that users of these base maps need a good connection to Internet.

A future perspective to acquire useful data sets and base maps is to download them from different sources on the web.

Lack of dedicated applications

As explained earlier a forest information systems application is a specific combination of computer hardware, software and databases. These components need to be customized for different user's special needs. The availability of such dedicated applications seems to be sparse in many forestry administrations in less developed countries.

Most countries in the region are now in a situation where they can extend the use of information systems to several users within their head offices and to users in regional offices. This is in line with the general development in the rest of the world where IT systems are gradually introduced for most business activities.

A challenge for forest administrations is to create corporate databases that can be used for various purposes, not only for map design. These databases will contain both spatial and non-spatial data and be connected to local networks and web servers. The next step is to develop special applications for users at both headquarters and regional offices.

Conclusions

The description above has focused on problems that obstruct the use of forest information systems in many countries. There is however a continuous technical development that will improve the situation in coming years. The infrastructure for use of Internet in rural offices will probably improve due to fast development of mobile broadband networks in most countries. Applications for forestry tend to be increasingly based on World Wide Web which means cheaper costs for investments in software and data storage.

5. A framework for development of national forest information systems

The purpose of the MAR/SFM project has the following formulation: “The project aims at developing a globally harmonized forest-related national Monitoring, Assessment and Reporting (MAR) system and applying it in the Asia-Pacific Region to directly contribute to the improvement of sustainable forest management (SFM) regimes. “ Such a “harmonized MAR system” could be a framework of

- effective tools for storage, retrieval and presentation of data
- harmonized terminology
- comprehensive databases and metadatabases
- methods for analysis and decision support
- Curriculums for training

In this section the components in the framework will be explained and some general recommendations for the future given.

Effective tools for storage, retrieval and presentation of data

Well designed information systems provide effective tools for storage, retrieval and presentation of data. In addition they give opportunities to analyze information through different models and scenarios. They can visualize information graphically through charts and maps. But information systems for the forestry do not differ very much from systems within other sectors. The same rules for successful development are valid here. This means for instance that the system must be adapted for the user's needs and their capability to understand how they should use the tools. Development and implementation of information systems can be tedious and costly but most or-

ganizations cannot function without them. Therefore it is necessary to plan for the implementation carefully and to engage experience consultants.

Harmonized terminology

Harmonization is a generic term for actions to simplify cooperation within various technical areas of practice. Within information system harmonization means efforts to agree on common definitions of concepts and classification systems in order to make data exchangeable. For spatial data this may include data models, metadata, reference systems, quality specifications, exchange formats, etc. Efforts to harmonize can be organized in national working groups contributing to create a framework called Spatial Data Infrastructure, SDI (see below). Ambitions to create better *interoperability* between systems can be included in the group of measures to improve harmonization. The idea is that certain software, for instance ArcGIS, can read data generated by other software, for instance Excel, without a need for export or import operations between systems. Developed countries have come rather far in harmonization, while developing countries in the region should speed up this process.

Comprehensive databases and metadatabases

As mentioned above lack of comprehensive databases with forest related information as well as base data is a major hinder for development of effective FIS's in many countries. Metadatabases that can help users finding relevant data are also missing or not complete. The situation can be improved in by for instance

- Better methods for data collection
- Access to international databases and metadatabases
- Cooperation between national organizations regarding the data infrastructure

Traditional systems for forest inventory in developing countries are based on sample based data collection in the field and interpretation of satellite images. Although the methods for both alternatives have improved throughout the years they are not sufficient for the needs within the forest administrations. Methods based on laser scanning as been developed during later years. These are promising but it may take some years before they are sufficient for needs in forest management. Stand wise inventories based on air photos and comprehensive field checks is still the best way to get an accurate description of the forest resources in a country.

Many non-profit international organizations collect data on forest resources and other relevant information, e.g. elevation data. The data is generally available through web sites free of charge as described above. There is a potential to use these free databases also on a national level.

All of the alternatives could be used to improve the situation but the third is probably the most effective in the long run. If the users of spatial information in a certain country decide cooperate around a national spatial data infrastructure (NSDI) the situation regarding databases will improve for all. The idea is that the responsibility for collection and storage of data is spread on several authorities and made available for each other through a web portal. The development towards national SDIs has started in many countries as a result of increasing needs for GIS applications. But the concept is not limited to national cooperation. Many SDI initiatives are regional or global. It could also be applied on a certain business area, e.g. forestry. An Asian-Pacific Forest

Data Infrastructure combined with a geoportal where other kinds of relevant information can be disseminated is a possible objective for the future.

Methods for analysis and decision support

New demands for information processing emerge continuously. Some of them are related to decision support in forest management systems. Other demands concerns methods to analyse trends or to visualize statistics. There is also a need for calculations based on environmental models. The implementation of the REDD+ mechanism (Reducing Emissions from Deforestation and Forest Degradation) demands for instance knowledge about areas of forest types and the carbon content in each type. It requires also broader information on natural resources, their uses and users, drivers of deforestation and change, governance, gender questions, indigenous rights and policy options. This kind of information is suitable to manage and analyze in a forest information system. It is important that models and methods for these types of analyses will be available for the public in the future. The Asian-Pacific Forest Data Infrastructure combined with a geoportal mentioned above could support this as well.

Curriculum's for training

A common problem connected to the introduction of forest information systems in organisations is that the staff members have to little general experience of ICT. Investments in such systems therefore generally include capacity building activities. There are three different target groups: staff members at RS/GIS units, forest officers at central departments and forest officers at provincial and district offices. The first group is the most specialized and need most qualified technical training. Users in this group should have so much knowledge that they help people in other target groups and will also be able to do some system development in order to enhance benefits of the system.

The second group consist of the growing number of ordinary forest officers that need to access data for different purposes. Probably they will get access to a corporate database with forest information through a local network or via Internet. Depending on their position they will use different applications and they need training to enter data, make queries and prepare reports.

Users in the third target group may work in offices with primitive conditions, where local networks and Internet connections are poor. If the management of forest administrations decides that they should use corporate information systems, training should be arranged with respect to actual conditions. Probably they will need a considerable amount of basic ICT-knowledge. Regardless of the magnitude of initial training arranged by donor-funded programmes, there is always a need for supplementary training. This should be an obligatory item in job descriptions for all officers in an organization using computers and information technology (which most organizations do today).

In many developing countries there is a special problem with technical courses. Since most course material is written in English many staff members cannot take part in them. In order to understand a course in database management or GIS, participants need to be fairly good in both English and basic ICT knowledge. Today there are rather few such officers in the forest administrations although the number of eligible officers is slowly increasing. Therefore, there is also a need for training in technical English.

Supplementary training in IT, GIS and database management can be organized in several ways. For those who have fairly good access to Internet there is a lot of course material available at websites. People in most of professions have learnt basic IT and geoinformatics this way. Some material can be downloaded freely, while others are necessary to pay for. ArcGIS users can benefit from a large supply of self-study courses which can be accessed from the producer ESRI's website, but some of them are combined with a fee.

6. Concluding remarks

This consultancy has contained several subtasks: a questionnaire, case studies in two countries, arrangement of a training workshop and this survey on forest information systems. A recurrent finding in all subtasks is the need for capability building in particularly the less developed countries in the region. This need has been well described in a report by a network of experts on monitoring of the environment called *Integrated Global Observing of Land* (Townshend, 2008). The authors suggest a number of actions for to build capability on monitoring systems in developing countries. Most of the recommendations are possible to apply also to forest information systems and the author of this report agrees in those statements by quoting them here:

- Training of more personnel, training of trainers in data collection, space borne imagery processing and interpretation and web mapping tools.
- Strengthening of capacities of selected universities in land observations. Provision of standardized data collection and analysis manuals, high quality teaching and promotional materials, support to the development of distance learning modules.
- Facilitating adequate dialogue, by organizing workshops and development and dissemination of outreach materials, etc., between decision-makers and technical personnel as most decision-makers are not aware of the potential benefits of such tools and technologies. Build upon the success of portals such as Google Earth.
- Improve access to data, models and tool kits.
- Disseminate information on best practices and case studies related to integration of data sets from multiple sources for solving real-life problems
- Advocate for integration of various information systems following common standards and protocols for improved interoperability.
- Improve coordination and partnerships based in as far as possible on existing regional networks. Provide a platform for interagency cooperation within each country.

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Appendix. Abbreviations

ASEAN	Association of Southeast Asian Nations
DAFO	District (or Municipal) Agricultural and Forestry Office
DBMS	Database Management System
FAO	Food and Agriculture Organization
FDSS	Forest Decision Support System
FIS	Forest Information System
FMIS	Forest Management Information System
GIS	Geographic Information System
ICT	Information and Communication Technology
IUFRO	International Union of Forest Research Organizations
MAR	Monitoring, Assessment and Reporting
NGO	Non governmental organizations
NSDI	National Spatial Data Infrastructure
PAFO	Provincial District Agricultural and Forestry Offices
SDI	Spatial Data Infrastructure
SFM	Sustainable Forest Management
REDD	United Nations Collaborative Programme on Reducing Emissions from Deforestation and Forest Degradation
RDBMS	Relational Database Management System
RS	Remote Sensing
WMS	Web Map Service

ArcGIS, ERDAS, MS Access, Oracle, SQL Server, Google Earth and Google Maps are names of proprietary software's.