



**Strengthening Monitoring, Assessment, and Reporting  
on Sustainable Forest Management in Asia  
(GCP/INT/988/JPN)**



**MAR Working Paper 38**

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**Information systems for monitoring, assessment and reporting of forest resources - a case study in Cambodia and Lao PDR<sup>1</sup>**

**Content**

1. Introduction .....	1
2. Purpose .....	2
3. Performed work .....	2
4. Forest information systems in Cambodia .....	3
5. Forest information systems in Lao PDR .....	6
6. Discussion .....	13
7. Recommendations .....	24
8. References .....	27
9. Terminology .....	29
Appendix 1. Explanation of relevant terminology .....	30
Appendix 2. Listing of agencies involved in RS/GIS in Lao PDR .....	31
Appendix 3. Cambodian authorities engaged in spatial data base management .....	32
Appendix 4. Selected projects with GIS and spatial databases in Cambodia .....	33

**1. Introduction**

The MAR/SFM project, with 26 member countries in Asia and the Pacific, aims to develop a harmonized Monitoring, Assessment and Reporting (MAR) system for sustainable forest management for application in the Asia-Pacific Region. Such a "system" could be a framework of:

- databases and metadatabases
- systems and tools for storage and processing of data
- methods for analysis and reporting

<sup>1</sup> The designations employed and the presentation of the material in this document do not imply the expression of any opinion whatsoever on the part of the Food and Agriculture Organization of the United Nations concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries.

- decision support functions
- curricula for training in relevant technologies

The author of this report was assigned to the project as a resource person during the first half of 2010. A questionnaire was first distributed to forest administrations in all project countries in order to create a broad picture of how they are working with forest databases and information systems today. Two countries were selected for study visits in order to create deeper knowledge. This report describes results of case studies concerning the use of forest information systems in Cambodia and Lao PDR.

## 2. Purpose

The purpose of this case study is to "analyze national forest information systems in order to comprehend countries' achievements and weaknesses and to formulate recommendations on further development of national forest information systems" (Terms of References).

*Forest Information System (FIS)*<sup>2</sup> is simply a generic term for applications of information systems used within the forestry. Although these kinds of systems are designed for use within forest administrations, they may also be available in other organizations engaged in management of natural resources. In order to assess the status of activities in a country, it is therefore necessary to consult not only with the national forest administration but also with other authorities who are users or producers of forest-related information.

There are two types of FIS's. A forest *geographic* information system (forest GIS) can manage both spatial and non spatial data and is often used for MAR activities. A forest *database* system (forest DBMS) is normally used only for management of non spatial data (tables of data). Other concepts related to forest information systems are further explained in appendix 1.

## 3. Performed work

A number of governmental organisations that use forest related information in Cambodia and Lao PDR were visited during two weeks in April 2010. Discussions were held regarding available databases related to natural resources management, work procedures, available GIS and database management software and general needs for information on forests and other natural resources. Collected material was analyzed afterwards and compared with information in available literature and Internet.

The following organizations were visited during 9 working days. Names of contact persons are listed under the paragraph: "7. References."

### Cambodia

- The Department of Forestry and Community Forestry, Forestry Administration.
- The Department of Geography, General Department of Cadastre and Geography
- The Ministry of Water Resources and Meteorology

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<sup>2</sup> It can also be called "Forestry Information System."

## **Lao PDR**

- Department of Forestry, Ministry of Agriculture and Forestry
- Center for Statistics and Information at the Department of Planning, Ministry of Agriculture and Forestry
- Remote Sensing Center, Water Resources and Environment Administration
- Land and Natural Resources Research Information Center, National Land Management Authority
- Mekong River Commission Secretariat

The time consumed for preparations, field study, additional literature studies and report writing was about 5 weeks. This time was too short to make a comprehensive assessment of all activities regarding forest information systems in the two countries. Conclusions and recommendations in this report must therefore be considered preliminary.

## **4. Forest information systems in Cambodia**

Following authorities are according to governmental web pages responsible for monitoring of forest resources in Cambodia:

Ministry of Agriculture, Forestry and Fisheries

- Forestry Administration

Ministry of Environment

- Department of Nature Conservation and Protection
- Department of Natural Resources Assessment and Environmental Data Management

### **4.1 Forestry Administration**

#### **Organization**

The Forestry Administration (FA) of Cambodia belongs to the Ministry of Agriculture, Forestry and Fisheries (MAFF). The Department of Forestry and Community Forestry is responsible for MAR activities (monitoring, assessment and reporting) and has three divisions: Forest Management Office, Community Forest Office and Watersheds and Forest Land Management Office. There is also a remote sensing and GIS (RS/GIS) unit, which probably will be upgraded to a separate division later this year. The Forestry Administration has also a regional organization. The country is divided in 4 *inspectories*, 15 *cantonments*, 55 *divisions* and approximately 170 *trriages*, which is the name of the lowest regional unit.

Forestland in Cambodia is classified into three groups: permanent forest reserves, private forests, and protected areas. The permanent forest reserve is state public property and falls under the jurisdiction of the Forestry Administration. It is divided into protected forests (8% of the total land area), former forest concessions (19%) and community forestry (4 %). All forest concessions, which earlier were leased for 25-year periods, are now suspended and logging rights are only valid for one year and for smaller areas called *coupes*.

## The Organization Chart of Forestry Administration

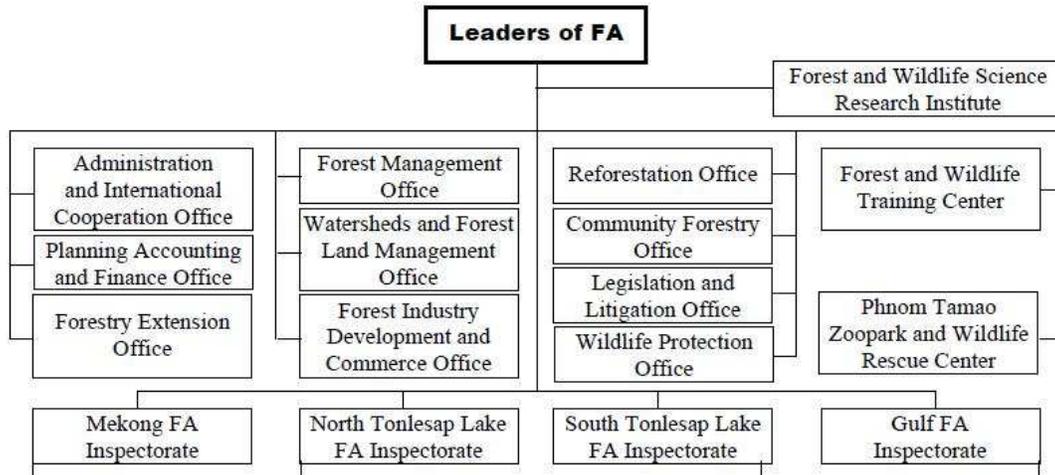


Fig.1. Organizational chart for the Forestry Administration in Cambodia. The picture shows the names of the central offices located in Phnom Penh and the names of the superior regional offices called inspectorate. Under each inspectorate there are 3-5 cantonments. The forest management office and the community forestry office have merged into a new unit called the Department of Forestry and Community Forestry under leadership of Mr Meas Makara. Source: FA website.

### Forest inventories

The RS/GIS unit was created in 1995 with support from German development agency GTZ and FAO. The unit is a resource for the whole Forestry Administration. Its main task is to design maps of all kinds that are needed within the administration, e.g. for management plans. The staff seem to be well trained and the maps they produce have generally good quality.

The RS/GIS unit has been engaged in three remote sensing inventories of the permanent forest reserve in recent years

- 1997 (with support from Germany)
- 2002 (with support from the World Bank)
- 2006 (with support from Denmark)

A new inventory is planned for this year 2010, but supporting agency is not yet determined. The 1997 inventory was made through manual interpretation of analogue satellite images. In the second inventory digital images were used and the forest boundaries were manually digitized from screen with GIS software. This means that a first database of forest boundaries was created. The third inventory was based on Landsat ETM+ images and the software ERDAS was used for classification and segmentation of forested areas. Different classification schemes and different inventory methods were used in each inventory which makes it difficult to compare estimations of the forest cover from time to time. Consequently, the question on whether the forested area has decreased or not in recent years cannot be answered in a reliable way.

The smallest mappable unit was 1 km<sup>2</sup> in the first two inventories and 0.5 km<sup>2</sup> in the third (7x7 mm in scale 1:100,000).

The equipment at the RS/GIS unit is rather old (installed more than 3 years ago) and it was indicated that the Japan International Cooperation Agency (JICA) would sponsor new equipment and software. This support for technical improvements is urgent.

### **Community Forestry Division**

At the Community Forestry Division a fairly new DBMS which stores data for all community forests in the country has been implemented. The system, which is built on MS Access, can also store maps as jpg-files. As the number of community forests will increase in the future this is a necessary tool for keeping track of all data. The Forest Administration strives to transfer 20% of the production forests to community forestry agreements before 2020.

### **Training**

Donors have provided funds for computer support and training of forest officers at most of the cantonment offices. The purpose with the training was to improve their skills to report the status of the forests using Internet and to access the central database server. There is however a number of practical problems due to insufficient power and internet connections at provincial offices. There is also a lack of antivirus software.

Planned establishment of Community Forestry training services in 15 cantonments during the period 2008-2010 will enable the Forestry Administration to meet the growing demand for training in ICT in the regional offices (Forestry Administration, 2008).

Short-term training courses have been organized within the FA on use of new equipment such as GIS and GPS. The purpose was to help forest officers locate illegal actions and to do forest areas demarcation (Forest Administration, 2008).

The JICA has given a grant aid for a project called Capacity Building for the Forest Sector. Training is located at a training center north of the capital and there are three different themes: forest management planning, silviculture and community forestry.

### **TWG/FE**

The development of the forestry sector in Cambodia is managed by the Forest Administration but a special working group coordinates contributions from development partners, NGOs and stakeholders. The working group is called Technical Working Group for Forest and Environment (TWG/FE) and is chaired by the chief of the Forest Administration.

## ***4.2 The Ministry of Water Resources and Meteorology***

In this ministry a French consultant has recently developed a rather advanced GIS application that can be used to analyze and map areas that fulfil the requirements for reforestation according to rules in the REDD mechanism (see below). The data comes from Forestry Administration and the resolution of the data is 1x1 km. (Brun, 2009)

#### **4.3 Department of Geography at the Ministry of Land Management, Urban Planning and Construction**

The Ministry of Land Management, Urban Planning and Construction is the principal authority for generation of spatial information such as topographic maps, cadastral maps, geodetic networks, administrative base maps, aerial photo capture and production, state land mapping, systematic land registration, etc. The Department of Geography, which was visited by the author, is one of the four sub-departments within the department of Cadastre and Geography. It is responsible for the topographic mapping of Cambodia and as such seems to be extremely undeveloped.

Map users in Cambodia now have to stick to quite old and small scale (1:100,000) topographic maps created by USA in the 60's and JICA in the 90's. Aerial photographs from 2001-2005 are available at a scale of 1:40,000 for smaller areas. There is no official digital topographic database in Cambodia. Such a product would be much appreciated by GIS users. South Korea has however recently agreed to sponsor modern digital database and topographic map series at a scale of 1:50,000 for parts of the country.

The Department of Geography has recently completed the geodetic network for Cambodia. Conversion of the national reference system (datum) from *Indian-1960* to *WGS-84* has also been performed.

The director of the department is active in working groups regarding cooperation in GIS and geographic information on a national level. Several meetings have been held in order to mobilize national engagement in the creation of a Cambodian Spatial Data Infrastructure (SDI). A list of potential authorities in this cooperation as well as a selection of projects with GIS components in Cambodia is found in appendix 4.

#### **5. Forest information systems in Lao PDR**

The following organizations are considered responsible for monitoring of forest resources in Lao PDR:

- Department of Forestry, Ministry of Agriculture and Forestry
- National Agriculture and Forestry Research Institute, Ministry of Agriculture and Forestry
- Remote Sensing Center, Water Resources and Environment Administration
- Land and Natural Resources Research Information Center, National Land Management Authority

Two of these organizations belong to the Ministry of Agriculture and Forestry which is organized according to the following chart:

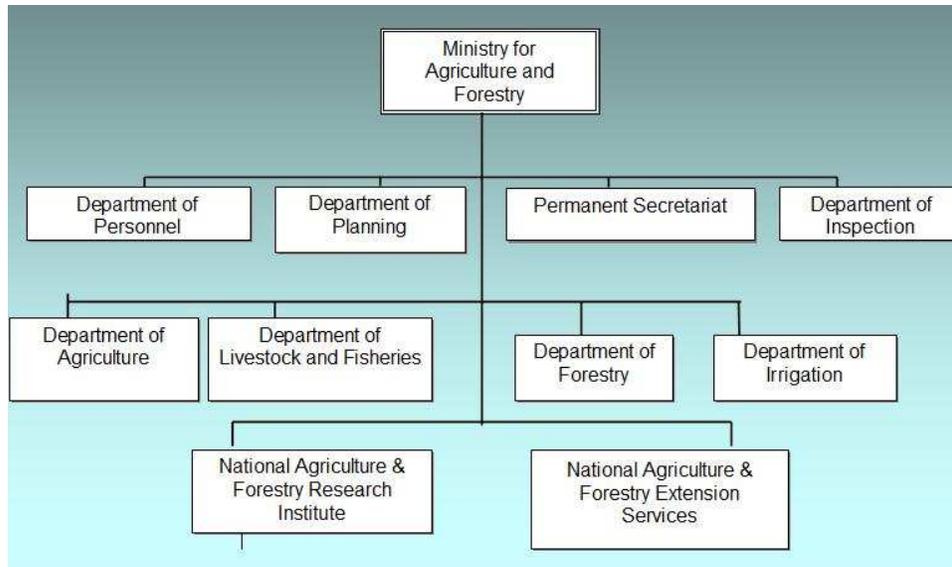


Figure 2. Organizational chart for the Ministry of Agriculture and Forestry (May 2007)

Organizations that are responsible for management of natural resources generally use GIS for planning and mapping purposes. In Lao PDR there are more than 30 agencies that use GIS to store spatial data and produce maps (see the list in Appendix 2).

### **5.1 Department of Forestry (DoF)**

The Department of Forestry (DoF) is the main authority for monitoring and management of forest resources in Lao PDR. DoF has several divisions. The Forest Inventory and Planning Division, FIPD, is responsible for inventories of forest resources. Other divisions are the Division of Production Forest and Forestry Business Management, PFBMD, which is responsible for management of the production forest land, the Division of Forest Protection responsible for protection forest land, the Division of Forest Conservation responsible for National Biodiversity Conservation areas and the Planning Division.

#### **The Forest Inventory and Planning Division (FIPD)**

Forest land is classified into three types: conservation forests, protection forests and production forests. Detailed inventory and management plans are made only for production forests (covering 3.1 M hectares) due to limited resources. Synoptic inventories of the entire forest area are compiled every ten years (1990, 2000 and 2010). The methods are different for production forests, protection forests and conservation forests. The production forests are surveyed by remote sensing techniques in combination with a network of sample points for field checks. Some boundaries are registered in the field by GPS-devices. The other two types of forests are surveyed only by satellite based remote sensing.

FIPD is located in Vientiane a building relatively far from the rest of DoF. The division has a Remote Sensing and GIS Center with technical equipment funded by the World Bank, SIDA and JICA. The imagery used for mapping comes mostly from ALOS and SPOT satellites. The RS/GIS center possesses at the moment a handful of personal

computers. Important tasks for the staff are classification and digitization of boundaries of forest areas from satellite images and design of map for the management plans.

Modern GIS software (ArcGIS 9.3) is used for management of spatial information (map layers) and for design of maps. For non-spatial information there are two applications available: FIMP is a database management system for storage and retrieval of inventory data and PREHARVEST is used to calculate annual harvest plans. Both systems have been developed by consultants connected to the Suford project (Suford, 2009).

Several interlinking databases are maintained at FIPD. One is called "GIS database" and the content is layers of topography and elevation for base maps. Another database contains the forest management plans. Other data are related to the forest cover mapping, the national forest inventory and to the FAO-sponsored Forest Resource Assessment. There are also data on roads, hydrological networks, contours, planned hydropower dams, villages, district cities and UXO locations (unexploded ordnance).



Fig 3. The office building of the Forest Inventory and Planning Division (FIPD) in Vientiane.

Software development for a new Web Map Server has started. The server will be based on PostGRES/PostGIS (open source) software. This will make it possible for staffs at provincial offices to get access to FIPD's spatial databases (i.e. maps) through Internet.

Preparations have recently begun for the establishment of a "Forest Resource Management Information Center". This is a major investment in current geoinformation technology (funded primarily by JICA). This center will replace the existing RS/GIS center. It will be hosted in a new building under construction 2010. Capacity building will also be organized by JICA focusing on remote sensing, GIS, database training, field surveys and REDD. This center is meant to put both the human and technical capability for data collection and data base management at FIPD to the frontline.

### **The reporting system**

The FIPD is responsible for planning, monitoring and evaluation in all three forest categories. Reports on the forest status are sent to the DoF from district and provincial offices for analysis and compilation. Reports on forest conditions can be prepared at all local levels within DoF. Reports from lower levels are often summarized at higher levels before they are submitted to the ministry.

Reports are also delivered to various external or international organizations, e.g. FAO. These reports require a lot of time for preparing at the provincial and district offices since there are weekly, monthly, quarterly and annual reports. A consultant at DoF has calculated that the average number of working days per year that are spent in preparing reports at provincial offices was 730. The corresponding number at district offices was 35. Today most of this work is manually done, but there is a big potential for simplification of the work if the reports could be entered in computer forms and distributed via mail or if rural offices could update the information in a central database via Internet directly.

The DoF recently introduced a nation wide forestry reporting system which is based on agreed and standardised processes and activities. The processes are defined to match as far as possible with the ASEAN MAR reporting requirements (see below), and the National 5-year Programme reporting needs. Annual work plans and monthly reports can be entered by provincial forestry sections either on-line or by submitting the data by email or fax to be uploaded at DoF afterwards. The database is built on the software SQL Server. The management at DoF can generate standard reports or if required the administrators can create special reports from the system.

### **ASEAN-MAR**

ASEAN-MAR is a regional database that is hosted by the regional organization ASEAN Secretariat (ASEC) and contains a vast amount of data on forest resources within its ten member states. These countries have agreed to submit information using a standardized format. Data are compiled on Forest Management Units for seven different *criteria* subdivided in a large number of *indicators*. Such a unit is in Lao PDR equal to a province although districts should be more appropriate according to the instructions.

Most of this information can be compiled by provincial forest officers, but values of some indicators must be collected from other authorities in Lao PDR, for instance the National Land Management Authority. Information will be uploaded to the ASEAN-MAR database by officers at the DoF for the first time to this database in 2010.

### **Training on information systems within DoF**

The Sustainable Forestry and Rural Development Project (Suford) mentioned above is a multilateral project between the government of Lao PDR, the World Bank and the Government of Finland. The focus of the project is sustainable forest management in a pilot area covering nine provinces. It aims to contribute to rural development, poverty reduction of rural people, bio-diversity conservation, forestry development and national socio-economic development.

In 2007 four provincial offices and six district offices were visited by an ICT expert and the need for ICT support at these offices was investigated. The result of the investigation was that a considerable amount of training regarding technical issues would be necessary. In the future also the district offices should be able to do their reporting tasks via Internet. A general conclusion drawn by the Suford expert regarding spatial data bases was that at least provincial offices would be able work with state-of-the-art information systems including GIS. He also developed a plan for “training of trainers” in ICT use. The courses have now been implemented in all target provinces. The training will probably continue and also be disseminated to the offices in the remaining provinces. This capacity building effort has helped the provincial offices to perform tasks with Word, Excel and to some extent even MS Access and GIS software (Suford, 2009 and 2010).

### **5.2 Department of Forest Inspection**

This department is one of the organizations within the Ministry of Agriculture and Forestry (Figure 1) and has a role as a direct secretariat for the ministerial forestry inspection, forestry land investigation, offenders of the forestry law, etc. The department uses a DBMS application called "Intelligence Information Management System" (based on SQL Server) in order to store and retrieve all forest law enforcement data. There is also a case tracking module in this system.

### **5.3 National Agriculture and Forestry Research Institute (NAFRI)**

NAFRI was established in 1999 by combining several existing research centers with the tasks of coordinating and implementing all agriculture and forestry research in Lao PDR. From its strategic plan for 2007-2012 the following text on geographic information and land based information systems is cited:

"NAFRI is considered one of the leading agencies on spatial and land-based information. The GIS unit has a range of datasets related to land, soil, forest, fisheries and agricultural production and works closely with Ministry of Agriculture and Forestry and with provincial and district authorities to carry out land capability analysis and zoning. Activities include: data management, GIS-based research such as agro-ecological analysis and land capability zoning and services including mapping and training support as well as production of information packages for different actors."

### **A GIS project for Natural Resource Management**

Asia Development Bank has recently decided to support a project called “Sustainable Natural Resource Management and Productivity Enhancement” with the total cost estimated at US\$35 million.

The project aims at capacity building in land suitability assessment, land-use classification and zoning, and digital mapping in participating provincial agriculture and forestry offices (PAFO) and requires:

- provision of geographic information system (GIS) equipment;

- training of PAFO and district staff in land suitability and participatory land-use mapping and social analysis of land rights and GIS and information management techniques;
- procurement of digital data sets to facilitate the preparation of land suitability and land-use maps at a district level, i.e. kumbans and villages; and
- funds to operate a resource mapping facility including “ground truth” of interpreted data sets. This will provide the basic information and equipment to enable staff to present technical recommendations prior to the award of land concessions.

(Source: Asian Development Bank )

#### **5.4 Center for Statistics and Information, Department of Planning, Ministry of Agriculture and Forestry**

An important task for this center is to produce a statistical yearbook for agriculture and forestry. The center has also a GIS unit which produces maps and reports in order to support spatial planning at provincial planning offices. There are three regional levels under the Ministry of Agriculture and Forestry:

- Provincial Agricultural and Forestry Offices, called PAFO (17)
- District or Municipal Agricultural and Forestry Offices, called DAFO (141)
- Kumban offices (cluster of villages)

The GIS-unit has adopted a method for spatial planning called Integrated Watershed Planning (Ministry of Agriculture and Forestry, 2003). Separate GIS databases will be created for each of the 64 watersheds in Lao PDR. The material will be distributed to the PAFOs as printed copies, because only few of them have enough capability to work with GIS. Up till April 2010 eight watersheds were completed. The center is equipped with modern computers and software.

#### **5.5 Remote Sensing Center (RSC), Water Resources and Environment Administration**

The Remote Sensing Center is one of the sections within the Water Resources and Environment Research Institute. This institute belongs to the Water Resources and Environmental Administration (WREA) which is an agency directly under the Lao government. There are around ten employees in the RSC and here follows a list of recent projects performed at the center related to forest information systems:

- Forest cover monitoring by remote sensing
- Collection of ground truth for forest covers monitoring by the ALOS satellite.
- Flood monitoring
- Forest fire monitoring
- Utilization of satellite images in disaster management

The center has produced a comprehensive catalogue of environmental databases available from different sources within Lao PDR and also a list of 31 organizations in

the country working with GIS and their points of contact. This list is included in Appendix 2.



Figure 4. The Remote Sensing Center at Water Resources and Environmental Administration (WREA)

### ***5.6 Land and Natural Resources Research Information Center, National Land Management Authority (NLMA)***

This center was established in 2004 and is working with land titling and registration together with land use zoning and management. The center has four divisions; one of them is called the Division of Land and Natural Resource Information where the GIS unit is located. The main task for this unit is to produce maps for spatial planning. Another division is the Research Division which recently has implemented a system for aerial photography and ortophoto production in order to facilitate cadastral mapping.

The chief of the center is active in different contexts aiming at building a modern organization for land-use planning in Lao PDR.

### ***5.7 Mekong River Commission Secretariat***

Each country belonging to the Mekong river basin has a National Mekong Committee. There is also a common secretariat for all countries located in Vientiane called MRC. The secretariat has a technical division containing a GIS unit which is equipped with modern hardware and software.

MRC's activities are organized in several programmes. The Information and Knowledge Management Programme is a cross-cutting programme providing data services to other MRC programmes and member countries. It helps to manage data and

display it to the public and others in the organisation. A current activity is to make spatial data from the Mekong river basin available on Internet via FAO-supported GeoNetwork. Old topographic maps have been scanned and georeferenced. In the future, it will be possible to download them via Internet as KML-files and use them with Google Earth.

The GIS unit at the MRC has provided databases to a socio-economic Atlas of the Lao PDR. This is a fairly new product funded by the Swiss government. It contains a comprehensive set of maps showing a wide range of socio-economic aspects of the population of the Lao PDR. The majority of the maps presented in the Atlas are at the village level. There is also some forest-related information in the Atlas. It is available for the public as a printed book but there is probably also a database with a large number of datasets covering Lao PDR available for GIS users. Documents can be downloaded as pdf-files (<http://www.laoatlas.net/>).

### **5.8 National Geographic Department (NGD)**

The National Geographic Department is the authority in charge of land surveys, mapping, and geodetic control networks. In 2007 the department compiled a country wide topographic map at a scale of 1:100,000. NGD is currently working on updating topographic maps in a digital format with the main interest of GIS users who demand high-quality digital maps equivalent to 1:50,000 paper maps.

The Government of Finland has recently signed an agreement to provide a grant aid of 9 million USD which will enable NGD to create a new national topographic map. The project will start at the end of 2010 and finish 2013. It will take advantage of new technologies in aerial and digital mapping. The new map will cover a total area of 71,000 km<sup>2</sup> in the middle and south of Lao. Urban areas in each of the provinces will also be mapped using a larger scale to support future urban development plans, land management, infrastructure construction and environmental management.

## **6. Discussion**

The situation concerning forest information systems in Cambodia is in many ways comparable to the situation in Lao PDR. Both countries have similar natural conditions for forestry and similar organizational structure for the forest administration. Both countries have introduced remote sensing, database management and GIS technology rather late and with support from several foreign donor agencies. Both countries have undeveloped infrastructure for telecommunications, which means that Internet is not available in most rural areas. There is also a shortage of human capacity in both countries, especially staff that have knowledge in both ICT and English language.

These shortages seem to be discouraging, but on the other hand, there are high ambitions in both countries to use their current systems and know-how in the best way and to catch up with more developed countries regarding the use of forest information systems but there are also differences between the countries. The forest administration in Lao PDR seems to be stronger and better organized than the one in Cambodia. The introduction of ICT and database management in the forestry therefore appears to have come further regarding use of ICT and database management in Lao PDR.

### **6.1 Additional applications of FIS**

As explained earlier a Forest Information Systems application is a specific combination of computer hardware, software and databases. Applications for MAR activities (monitoring, assessment and reporting) are generally based on GIS software. In RS/GIS centers GIS software is used for data collection through screen digitizing and for design and printing of maps. Applications for map design in most RS/GIS centers in Cambodia and Lao PDR are based on a standard PC as hardware, ArcGIS as software and various databases with topographic and forest-related data. Applications for management of non-spatial data are normally based on DBMS software. Examples of such applications are systems for storage and retrieval of data from forest inventories. Forest information systems can thus be based on both GIS and DBMS types of software.

Most commercial GIS software's provides many tools and extensions that can be used for analytical purposes. These tools are apparently not much utilized by the forestry administrations in both countries. There are for instance tools that can be used to create well structured databases that store data in a format that can be updated by several users at the same time in a safe way (geodatabases). There are also a number of specific tools for processing raster or vector data that can be used for planning and decision support.

The forest administrations in both Lao and Cambodia 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. The application development should however be based on careful needs assessments.

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. In Lao PDR this work has already been started. A Web Map Server (WMS) is as mentioned before under development that will make it possible for all staff members with Internet access to study forest maps and related data with only a web browser.

### **6.2 Technology**

Although the basic principles for design of information systems are the same today as ten years ago, fundamental improvements have occurred regarding performances of such systems. Now it has become easier to develop applications that can improve business productivity because of:

- Internet
- Availability to databases
- Harmonization
- Open source software

## **Internet**

Internet can be viewed as a huge information system; an infinite number of databases that users easily can access and explore. In this enormous system there are a number of subsystems designed for professional and other uses. An increasing number of system developers use Internet as a development environment in order to make their systems easy to access from remote places and to trim down costs for the client software.

Examples of Forest Information Systems with Web interfaces.

There is also a growing number of useful "web services" available on the Internet. Examples of web services are tools that can translate texts from one language to another (e.g. Google Translate). Web Map Services (WMS) are services that can show spatial information overlaid on a base map. This technology is used in some types of forest information systems for users that just need to look at a map with relevant information. WMS-services can be a service provided through *geoportals*, sites that provide data dictionaries, metadata, link libraries and news feeds, etc. Examples of geoportals are GeoNetwork (<http://geonetwork-opensource.org/>) and EuroForest Portal (<http://forestportal.efi.int>).

Users of web-based services need to have good connections to Internet which is a problem in many developing countries, especially at provincial offices. Infrastructure for data communications is not very developed up till now but it is rapidly improved in Cambodia and Lao PDR as well as in most other parts of the world. Both fibre optical and wireless broadband networks are constructed. This means that web based information systems probably will be available also at provincial offices in a few years.

## **Access to databases**

The databases are generally the most important components of information systems. Without reliable 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 usually possible to acquire useful spatial data from other authorities. In many developing countries it is difficult to acquire good base maps with high resolution. This is the case in Cambodia and to some extent in Lao PDR. Both countries lack digital topographic databases covering the whole country. Thanks to the earlier mentioned mapping projects the situation will improve in coming years.

Data accessibility has otherwise been improved for GIS users in most countries during later years thanks to various data sources that are available via Internet. Several portals have emerged from which GIS datasets and satellite images can be downloaded freely, for instance the GeoNetwork mentioned above. 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. They will therefore not be available in rural areas of Lao PDR and Cambodia.

## **Harmonization**

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) . Developed countries have come rather far in harmonization, while developing countries like Lao PDR and Cambodia are at the beginning of the progress.

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.

### **Open-source software**

Software's with "open" source codes are normally free to download and use. To some extent they can be further developed by the users, but in that case they are not allowed to be sold to other as proprietary (protected) products. The increasing number of open source software's is of great benefit for users with small budgets. Although it is rather easy to find sites where you can download commercial products like ArcGIS, everybody knows that it is illegal and this is not a sustainable solution for a governmental organization. Therefore, exploration of open-source alternatives to illegal software is recommended. A sustainable solution would be to invest in a limited number of legal licenses and use open source as a complement.

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).

A disadvantage with open-source alternatives is that they often demand more technical knowledge within a user organization than the proprietary alternatives. Documentation is usually poor and the number of consultants that can support the users may be few. The decision to use open-source software must therefore be combined with an evaluation of available technical know-how within the organization (as with all other decisions regarding software investments).

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.

### **6.3 Capacity building**

Introduction of new information systems normally aims to increase the productivity and will therefore have influence on the existing work procedures. Some staff members must change they way they have worked before and some jobs will be redundant. This

often creates resistance among staff towards new systems and it is important that the systems live up to the expectations. Many failures have been made in the history of information systems. In some cases the management have tried to implement systems that create more problems than help for the staff. Such systems will cause frustration and complaints and a decreasing number of users. Finally they may be abandoned.

To avoid such failures donor-supported investments in forest information systems should include capacity building activities directed to the management of the organization as well as to individual users. In the latter case 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 IT-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 both Cambodia and Lao PDR 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 IT 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.

Some leading people in the forest administrations have reported that advanced IT training of the staff will make them attractive for other employers. This may be a risk for the organization, but such job rotation is normally good for the country as a whole in the long run.

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.

Training can also be organized as "training of trainers" meaning that a few staff members at each office are gathered at workshops where they get training in new information systems. They will also get instructions for how to train their colleagues.

The Suford project in Lao PDR has recently developed a course package for this purpose which consists of the following modules (Suford, 2010):

- Training of trainers
- General training in work with computers
- Forest management planning tools
- Common office programmes and applications
- Advanced Excel and MS Access
- Advanced training for information managers
- GIS for foresters

#### **6.4 Spatial Data Infrastructures**

Several agencies in both countries collect and store forest related information. This is especially the case in Lao PDR where a number of governmental authorities have a mandate for land use planning and therefore feel responsible for monitoring the state of forests.

In Lao PDR the *Forest Inventory and Planning Division* within Department of Forestry (DoF) is the most obvious user of forest information systems, because they need them in forest management planning. The *Center for Statistics and Information*, also within DoF, use forest related information and GIS for integrated watershed planning. This activity is intended to support strategic planning for socio-economic development in provinces. The *Remote Sensing Center* within *Water Resources and Environmental Administration* (WREA) develop methods for monitoring most kinds of environmental resources and has also done some work on deforestation. Finally the *Land and Natural Resources Research Information Center* at *National Land Management Authority* is an organisation with ambitions to store forest related information for planning purposes.

In all of these agencies, as well as in some additional of organizations like the *Mekong River Commission* and the *National Geographic Department*, there are users of forest information systems in a wide meaning. Most of them have entered the field of geoinformatics through the use of satellite images for mapping. With the advent of cheap and user friendly image processing systems at the beginning of this century and an increasing access to useful satellite scenes, the organizations could start to build and maintain spatial databases with forest information. A need for digital topographic data, e.g. roads and borders, emerged in order to produce good maps. Considering that there was no official database with such information the authorities started to exchange data with each other or, more commonly, created their own topographic databases by various methods. This development followed the same pattern as in most countries that have introduced computer assisted methods for spatial planning, management of natural resources and map production.

It is obviously a waste of time that many organizations in one country do the same data collection. Therefore a demand for a National Spatial Data Infrastructure emerges. This means that responsible organizations for all critical datasets of common interest is

defined and that data they collect can be exchanged by GIS users in a well organized manner.

This situation is achieved neither in Lao PDR nor in Cambodia at the moment, but there are people in both countries that strive in that direction by arranging workshops and meetings. A reasonable job allocation would be that the forest administration in each country would be responsible for all dataset related to forest resources, while the road administrations should be responsible for road networks, etc.

Other case studies that discuss this situation of "competing" authorities in Lao are composed by Burgess et al (2009), Grant (2006) and Wada (2006).

### **6.5 Opportunities linked to REDD+**

During 2009-10 international organizations have been preparing for the implementation of the REDD+ mechanism (Reducing Emissions from Deforestation and Forest Degradation) in a number of developing countries. The idea is that international funds can finance arrangements to reduce emissions of greenhouse gases. In order to calculate the payment to the participant countries it is necessary to create procedures for measurement of the reductions achieved in each country, or in other words: the increase of timber volumes. This will bring opportunities for further development of the forest information systems in both Cambodia and Lao.

It will be necessary to develop special MRV-systems (measurement, reporting and verification) for monitoring the changes in the carbon volumes stored in the trees. These systems must be able to

- Provide high accuracy mapping of forest types and their changes over time
- Calculate the amount of carbon per area unit in each forest type

The implementation of the REDD+ mechanism requires 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 information is to a large extent spatial and is therefore suitable to manage and analyze in a GIS environment.

Assessment of the existing technical capabilities for high accuracy mapping in a number of tropical countries has recently been made by a group of experts (Herold, 2009). The study found that the facilities for RS/GIS operations within both Cambodia and Lao PDR (in 2009) were insufficient for the REDD mechanism. The equipment at the Forestry Administration will as mentioned probably be upgraded soon. Similar investments in the RS/GIS unit in Lao PDR have already started.

### **6.6 Considerations regarding foreign support**

Both Cambodia and Lao PDR belong to the 50 least developed countries in the world according to a list compiled every year by the United Nations. Conditions for rapid adaptation of computer based work procedures are therefore not ideal and expectations of progresses must be seen in relation to that. The willingness to introduce ICT

methods is high and many foreign donors are interested to support the two countries in their efforts to modernize their information systems.

Introduction of advanced information systems in the forest administrations started more than ten years ago with the establishment of national forest inventories based on interpretation of satellite images combined with collection of ground truth from sample plots in the field. This resulted in the creation of spatial databases for forest cover information as well as non spatial databases for inventory data. These databases have since then mainly been used for design and printing of maps.

Generous grants have kept the RS/GIS centers in Cambodia and Lao PDR at a technically fairly advanced level throughout the years. The REDD initiative seem to bring more technical equipment and support to both countries in the near future. The disadvantage of foreign support is however the discontinuity that most donor funded projects have. At the beginning of support programmes, equipment and training is top modern and the staffs are motivated and enthusiastic. The possibility to maintain this level decreases when the project funds are consumed after 3-5 years. The number of qualified tasks may also be too few to keep the staffs busy. This may result in less enthusiasm and loss of human capacity due to resigning employees. Some donor funded GIS projects collapse entirely when the funds are finished, two such examples are the FAO funded ASIACOVER and the UNEP-funded SEMIS, which both aimed at creating comprehensive geodatabases covering countries in Southeast Asia with purpose to support spatial planning.

Another consideration is that donor funded projects often are linked to special tasks which are conditions for grants, e.g. the ASEAN MAR reporting system. These tasks may not be urgent for ordinary work and they may take a lot of time as described earlier. They may also have a disturbing influence on the development of the overall infrastructure for management of information. The ongoing investments in modern equipment in FIPD are naturally of great value for them, but a general impression is that both FA and DoF have become too much dependent on donor funds and technical assistance for their forest information systems. The recommendation is that both organizations should strive to gradually substitute this need for support by governmental funds and dedicated human capacity building in order to become less dependent on donors ideas.

## **7. SWOT evaluation**

Here follows a tentative evaluation of the current use of forest information systems within the two countries based on the authors study visit in April 2010 and complementary literature studies. The method for evaluation is called "SWOT Analysis". It is a brief analysis of four different aspects which are summarized in a table followed by comments.

### **7.1 Achievements and weaknesses regarding FIS's in Cambodia**

<b>Strengths</b>	<p>There is good understanding and support for usage of ICT from the management</p> <p>The staff in the RS/GIS unit have good skills in their current tasks</p> <p>Current community forest projects and other donor supported projects are improving the capabilities among the staffs in database management</p>	<p>Poor capacity in ICT and database management among staffs outside the RS/GIS units.</p> <p>The knowledge in English is weak for most of the staffs which is a hinder for capacity building</p> <p>Availability of Internet connections is very low in offices in the cantonments and district offices.</p> <p>The availability and quality of forest data is partly poor. There is also a shortage of detailed base maps.</p> <p>Extensive use of unlicensed copies of some crucial software.</p>	<b>Weaknesses</b>
<b>Opportunities</b>	<p>There is a potential to improve the productivity by using customized DBMS and GIS applications for several tasks</p> <p>Improved know-how in information systems can give assignments and incomes from customers outside the forest administration</p> <p>Further developed cooperation with other authorities should give better access to data and experiences.</p>	<p>Skilled people may leave the administrations for jobs in other organizations.</p> <p>High dependency of technical and economic support from donors.</p> <p>Available technical support to maintain the forest information systems in a good order may suffer from a lack of competent local consultants.</p>	<b>Threats</b>

Figure 5. SWOT evaluation of the use of Forest Information Systems in Cambodia.

**Strengths**

It seems to be good internal support for the work at the RS/GIS unit. The executive management seems to be convinced that the forest administration should adapt modern principles for data collection and information management in the entire organization as soon as possible.

The staff members at the RS/GIS unit have rather long experience in working with modern GIS and DBMS software. The skills are well developed in collecting digital data via satellite images by remote sensing and design of maps.

The technical support from foreign donors and funds for purchase of modern hardware and software is a sort of strength in a shorter perspective. This support has however also a negative consequence as indicated before and can also be regarded as a threat.

**Weaknesses**

Skills to use computers and other ICT are insufficient among forest officers outside the RS/GIS centers. This is a result of limited access to personal computers and Internet. The IT provided training has generally not yet met the demand.

Knowledge of English language is weak among most of the staff members. This makes it difficult to introduce software with English menus and manuals.

Introduction of forest information systems on provincial and district levels is obstructed by poor office conditions. There are several technical problems that make

the use of computers less effective than it should be, for instance lack of air conditioning, unreliable power supply, poor Internet connections, uncontrolled situations regarding viruses and malicious software, lack of local networks, etc.

Due to limited resources for data collection the information on forest conditions in Cambodia has variable quality and coverage. Different classification systems have been used throughout the years and the method for sample based inventory is old fashioned. There is also a lack of official base maps in high resolution covering Cambodia which is a significant disadvantage for the creation of accurate maps and various GIS applications.

Service agreements and updates for crucial software are missing because they are often unlicensed.

### ***Opportunities***

There is a large potential to use DBMS and GIS applications for many more tasks than today in order to simplify work processes (on condition that more databases of good quality will be available)

Improved know-how in forest (geographic) information systems within the forest administrations can generate assignments and incomes from customers outside their own organizations.

A further developed cooperation with other governmental GIS users in order to create a National Spatial Data Infrastructure should give better access to more useful GIS data, applications and experiences. This would increase benefits of the systems.

### ***Threats***

A main threat is shortage of forestry officers having knowledge in both information technology and English. This may be a hinder for the further development of useful forest information systems. There is also a risk that key people will leave the organization because better work conditions in private companies.

The dependency on financial support and know-how from foreign donors regarding database management is obvious. This situation may lead to that particular projects or applications has to be abandoned when the funds of the programs finish.

The market for local consultancy in information systems will not grow to a sufficient level to provide necessary technical support for the users. This may lead to problems to maintain crucial systems in good working conditions.

## ***7.2 Achievements and weaknesses regarding FIS's in Lao PDR***

<b>Strengths</b>	<p>There is good support for usage of ICT from the management of DoF</p> <p>The staff in the RS/GIS unit is motivated and have good skills in their current tasks</p> <p>The Department of Forestry have a substantial technical and economical support from several international donors</p> <p>The capabilities to use ICT in the province and district offices have improved lately.</p>	<p>The knowledge in English is weak for most of the staff which is a hinder for capacity building</p> <p>The physical conditions for computer supported tasks is poor at most local offices</p> <p>The availability and quality of forest data is partly poor. There is also a shortage of detailed base maps</p> <p>Frequent use of unlicensed copies of crucial software's</p>	<b>Weaknesses</b>
<b>Opportunities</b>	<p>There is a potential to improve the productivity by using customized DBMS and GIS applications for several tasks</p> <p>Improved know-how in information systems will give assignments and incomes from customers outside the forest administration</p> <p>Further developed cooperation with other national authorities should give better access to complementary data for assessments.</p>	<p>Skilled people may leave the administrations for jobs in other organizations.</p> <p>The current dependency on funds and technical support from foreign donors may be a disadvantage in a longer perspective.</p> <p>Available technical support to maintain the forest information systems may suffer from a lack of competent local consultants</p>	<b>Threats</b>

Figure 6. SWOT evaluation of the situation on the use of Forest Information Systems in Lao PDR.

### **Strengths**

It seems to be good internal support for the work at the RS/GIS unit. The management seems to be convinced that the forest administrations should adapt modern principles for data collection and information management in the entire organization as soon as possible.

The staff members at the RS/GIS unit have rather long experience in working with modern GIS and DBMS software. The skills are well developed in collecting digital data via satellite images by remote sensing and designing maps.

The technical support from foreign donors and funds for purchase of modern hardware and software is a sort of strength in a shorter perspective. This support has however also a negative consequence as indicated before and can also be regarded as a threat.

The officers at regional offices have acquired a relatively good knowledge in ICT use thanks to initiatives for instance within the Suford project.

### **Weaknesses**

Knowledge of English language is generally low among most of the staff members. This makes it difficult to introduce software with English menus and manuals.

Introduction of forest information systems on provincial and district levels is obstructed by poor office conditions. There are several technical problems that make the use of computers less effective than it should be, for instance lack of air conditioning, unreliable power supply, poor internet connections, uncontrolled situations regarding viruses and malicious software, lack of local networks, etc.

Due to limited resources for data collection the information on forest conditions the databases of forest resources does not cover the whole country and may partly have poor quality. There is also a lack of official base maps with high resolution covering the country, which is a significant disadvantage for the design of forest maps and GIS applications.

Service agreements and updates for crucial software are missing because they are often unlicensed.

### ***Opportunities***

There is a large potential to use DBMS and GIS applications for several more tasks than today in order to simplify work processes and increase productivity.

A further developed cooperation with other governmental GIS users should give better access to more useful GIS data, applications and experiences. This would increase benefits of the systems.

Improved know-how in forest information systems within the forest administrations can generate assignments and incomes from customers outside their own organizations. Such assignments are already performed at FIPD.

### ***Threats***

A main threat is shortage of forestry officers having knowledge in both information technology and English. This may be a hinder for the further development of urgent forest information systems. There is also a risk that key people will leave the organization for better work conditions in private companies.

The dependency on financial support and know-how in from foreign donors regarding database management is significant. This situation may lead to that urgent donor supported projects or applications has to be abandoned when the funds of the programs finish after 3-5 years.

The market for local consultancy in information systems will not grow to a sufficient level to provide necessary technical support for the users. This may lead to problems to maintain systems in good working conditions.

## **7. Recommendations**

Both Cambodia and Lao PDR are developing countries with limited budgets for ICT investments in all governmental authorities. Within the forest sector the situation is not so bad thanks to long-running support from international donors. There is still much to do in both countries before the forest information can be managed in a modern way so that the full potential of ICT can be achieved. Some recommendations for actions in order to do this are given below. The advices are directed to both the Forestry Administration in Cambodia and the Department of Forestry in Lao PDR.

### **New applications**

The use of forest information systems, especially forest GIS's, can be increased to more users and more applications within the organizations. The management should explore

the possibilities to create applications for use both at head offices and local organizations. Careful needs assessments are however necessary to do.

The quality of the output from the systems is dependent on the acquired data. A well structured central database for all forest related information is a basis for future application development. Much concern should be given to the design of the databases and to collect and store demanded data with good quality.

The management should be aware that introduction of information systems will change the work procedures and that this will cause stress and some resistance among the staff.

### **Resources on Internet**

Internet is not yet available at most rural offices. Despite that, the IT strategy of the administrations should be planned for systems that use Internet to access central servers. The strategy should be to install Internet and Web browsers at all local offices as soon as possible.

The forest administrations in Lao PDR and Cambodia are recommended consider the use of especially Google Earth for certain types of tasks, e.g. digitizing of the boundaries of new cuttings and other objects etc that may be detected in recent satellite images with high resolution.

The use of ArcGIS Online and other sources for spatial data on Internet should be explored. There are also several web portals where forest related data of potential interest can be downloaded.

The forestry administrations should prepare for communication with other authorities and the public regarding the status of national forest resources by providing different kinds of services on their web sites.

### **Open software**

There are many useful open source alternatives for professional software. These should be considered as alternatives for illegal copies of proprietary software's when the number of users is increasing. Combinations of licensed and open source software are a more sustainable solution.

### **Training**

The management should take every possible opportunity to train the staff to work with computers since this certainly is a must in the future. An old truth regarding IT education is that the time people spend in training generally is gained tenfold in later tasks. Training is a good investment in other words.

Course packages in ArcGIS can be bought for a limited sum of money. They can be downloaded from the Internet and made available for self studies for staff members who are willing to develop their skills on their own.

Special GIS and database management courses in local language should be developed for those staff members that are supposed to use the systems. Efforts should be made to translate English menus into local languages in that software where possible.

### **Strategic considerations**

Both FA and DoF should strive to gradually substitute financial support from international donors by governmental funds in order to avoid unhealthy dependence. Due to the rapid technology development in the science of geoinformatics, however, the need for technical assistance from international consultants will persist for several years.

The forest administrations should engage in efforts to cooperate with other national authorities in order to create national spatial data infrastructures. In a longer perspective this should facilitate the use of forest information systems and development of applications.

Regional international cooperation in this field should be considered, for instance the Asean Forest Clearinghouse Mechanism (see the references paragraph).

### **Self evaluation**

A preliminary SWOT evaluation of the situations at the forest administrations was presented in paragraph 7. The concerned staff in FA and DoF may not agree with all of these findings. The recommendation is therefore that a deeper evaluation is arranged by the local chiefs for FA and DoF in cooperation with the staff members. When the analysis of the four aspects on the performance is compiled in a SWOT analysis it should be followed up in some way. A working group could be appointed in order to elaborate suggestions for how the following questions should be responded to:

- How should we keep and improve our *strengths*?
- How should we minimize our *weaknesses*?
- How can we take advantage of our *opportunities*?
- What can we do to eliminate the *threats*?
- Which of these questions should we prioritize?

## **8. References**

### ***Personal meetings in Phnom Penh, Cambodia***

*Mr. Meas Makara*, Director at the Department of Forestry and Community Forestry, Forestry Administration, Ministry of Agriculture, Forestry and Fisheries

*Mr. Khorn Saret*, Forest Management Unit, Forestry Administration

*Mr. Samreth Vanna*, Forest Inventory Unit, Forestry Administration

*Mr. Pak Chealy*, Remote Sensing Unit, Forestry Administration

*Mr. Long Ratanakoma*, Community Forest Unit, Forestry Administration

*Mr. So Vanna*, Director at the Department of Geography, Ministry of Land Management, Urban Planning and Construction's (MLMUPC).

*Dr. Stephane Brun*, consultant at the Ministry of Water Resources and Meteorology.

### ***Personal meetings in Vientiane, Lao PDR***

*Mr. Khamphay Manivong*, Deputy DG for the Forest Administration.

*Mr. Somchay Sanontry*, Director for Forest Inventory and Planning Department.

*Mr. Tapani Ruotsalainen*, consultant at Indufor Oy and technical advisor at the Department of Forestry/SUFORD.

*Mr. Nori Kitamura*, Chief advisor, Forestry strategy 2020 implementation Promotion project (FSIP) at Forest Administration.

*Dr. Thatheva Saphangthong*, Director at the Center for Statistics and Information, Ministry of Agriculture and Forestry.

*Mr. Sangkhane Thiangthammwong*, Deputy DG at Water Resources and Environment Administration (WREA) and Director *Ms. Virany Sengtianthr* the Remote Sensing Center.

*Dr. Chanthaviphone Inthavong*, director for Land and Natural Resources Research Information Center (LNRRIC), National Land Management Authority (NLMA)

*Mr. Huon Rath*, Mekong River Commission Secretariat. Vientiane.

*Mr. Carl Mossberg*, consultant at Ramboll Group and technical advisor for the Upland Research and Capacity Development Program at National Agriculture and Forestry Research Institute.

### ***Literature***

Annual Review of REDD+ in Lao PDR 2009 - Report prepared for the National REDD Task Force of Lao PDR. Department of Forestry, MAF.

Brun, 2009: Elaboration of cartographic tools for reforestation CDM and REDD project activities in Cambodia. Final Report. ONF International.

Buchholz et al, 2005: Information and Knowledge Management (IKM) Systems within the context of Natural Resource Management in Southeast Asia. Experiences from 25 Years of German Technical Cooperation. GTZ, Germany. The report can be downloaded from the link <http://www2.gtz.de/dokumente/bib/05-0440.pdf>.

Burgess et al, 2009: An assessment of Integrated Spatial Planning (ISP) capacity in Lao PDR. Final Draft Report for Gov. of Lao review: October 2009

Forestry Administration, 2008: Country paper on Forestry Outlook 2020. Forestry Administration.

Global Witness, 2007: Cambodia's Family Trees Illegal logging and the stripping of public assets by Cambodia's elite.

Grant, 2006: Lao land titling project II. Land Information Coordination Strategy. National Land Management Authority.

Herold M, 2009: An assessment of national forest monitoring capabilities in tropical non-Annex I countries: Recommendations for capacity building. GOF-C-GOLD Land Cover Project Office, Friedrich Schiller University, Jena.

Kao et al, 2010: Analyzing the forest structure in Northern Cambodia. In Eredics (editor), Mapping Forestry. ESRI Press.

Ministry of Agriculture and Forestry, 2003: Strategic vision. Integrated Watershed Management. Approach for Sustainable Upland Development and Poverty Alleviation in Lao PDR.

Poffenberger et al, 2009: Designing collaborative REDD projects: A case study from Oddar Meanchey Province. Community Forestry International.

SUFORD, 2009: Survey regarding capacities in forest information processing and reporting. Findings and Recommendations. Ministry of Agriculture and Forestry. Department of Forestry. Lao PDR.

SUFORD, 2010: IT Training Program for Provincial and District Staff 2009 – 2010. Step-by-Step Learning & Development. Ministry of Agriculture and Forestry. Department of Forestry. Lao PDR.

Pravongviengkham et al, 2003: Integrated Watershed Management For Sustainable Upland Development And Poverty Alleviation In Lao People's Democratic Republic. Proceedings of the Asian Regional Workshop on Watershed Management. 2003.

Wada, 2006: Final Report for GIS database. Sector plan for sustainable development of the mining sector in the Lao PDR. The World Bank.

### **Web sites**

The Technical Working Group on Forestry and Environment (TWG-F&E)  
<http://www.twgfe.org/Aboutus.php>

Mekong River Commission.  
[http://www.mrcmekong.org/contact\\_us.htm](http://www.mrcmekong.org/contact_us.htm)

Department of Forestry, Lao PDR  
<http://www.dof.maf.gov.la/>

Forestry Administration.  
[http://www.forestry.gov.kh/AboutFA/VisionMision\\_Eng.html](http://www.forestry.gov.kh/AboutFA/VisionMision_Eng.html)

Global Witness  
[http://www.illegal-logging.info/item\\_single.php?it\\_id=482&it=document](http://www.illegal-logging.info/item_single.php?it_id=482&it=document)

GeoNetwork  
<http://geonetwork-opensource.org/>

EuroForest Portal  
<http://forestportal.efi.int>

Socio-economic Atlas of the Lao PDR.  
<http://www.laoatlas.net/>

## 9. Terminology

ASEAN	Association of Southeast Asian Nations
DAFO	District (or Municipal) Agricultural and Forestry Office
DBMS	Database Management System
FIS	Forest Information System
FMIS	Forest Management Information System
GIS	Geographic Information System
ICT	Information and Communication Technology
IT	Information Technology
MAR	Monitoring, Assessment and Reporting
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
SUFORD	Sustainable Forestry and Rural Development Project
WMS	Web Map Server

ArcGIS, ERDAS, MS Access, Oracle, SQL Server, Google Earth and Google Maps are names of proprietary (protected trade-mark) software.

## Appendix 1. Explanation of relevant terminology

*Forest information system*<sup>3</sup> (FIS) is simply a generic term for systems used within forestry. In order to explain concepts that are used several times in this report it is necessary to start with some definitions, most of which are cited from ESRI's GIS dictionary.

A *database* is an integrated collection of logically-related records or files consolidated into a common pool that provides data for one or more multiple uses. A simple database might be a single file with many records but a database generally contains a group of files. *Metadatabases* contain data (descriptions) on existing databases.

*Spatial data* is information about the locations and shapes of geographic features, e.g. forest compartments, and the relationship between them, usually stored as coordinates and topology. *Non-spatial data* are data without inherently spatial qualities, e.g. tables containing timber prices. The difference between spatial and non-spatial data is not always clear. Data collected from sample plots in a forest inventory is for instance "spatial" if they can be linked to a location of a geographic feature with stored coordinates (and presented on a map), otherwise they are "non-spatial".

An *information system* (IS) is technically an integrated combination of computer hardware, software and databases used to view and manage information. Another common term for information system is *database management system* (DBMS). The abbreviation RDBMS refers to *relational* database management systems.

A *geographic information system* (GIS) is an integrated combination of computer hardware, software and databases used to view and manage spatial<sup>4</sup> data. A geographic information system is a special type of information systems.

An (*information system*) *application* is a certain combination of computer hardware, software and databases designed to manage information for a special purpose.

Applications used for management of forest compartments (including planning, analysis, reporting, map design, etc) can be called *Forest Management (Information) Systems*. If these systems have more sophisticated tools for analytical modelling they could as well be called (*Forest*) *Decision Support Systems* (FDSS). In forestry, they have been used extensively for timber-harvest scheduling, selection of silviculture treatments, insect and disease management, etc. FDSS's are often built on a GIS software, if not they generally have functions for export of the results of the analysis of mapping software or GIS.

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<sup>3</sup> It can also be called Forestry Information Systems

<sup>4</sup> It can also be called *geospatial* or *geographic*

## Appendix 2. Listing of agencies involved in RS/GIS in Lao PDR

Source: Remote Sensing Centre, Water Resources and Environment Administration, 2010

Agency	Contact person	Email
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### Appendix 3. Cambodian authorities engaged in spatial data base management

<b>Authority</b>	<b>Data bases</b>
Ministry of Land Management, Urban Planning and Construction	topography, cadastral data, geodetic network, administrative boundaries, aerial photo capture and production, land registration data, etc.
Ministry of Agriculture, Fisheries and Forestry	land cover, forest cover, soils, etc
Ministry of Environment	protected area boundaries, environmental data of various kinds
Ministry of Public Work and Transportation	road network and topography
Ministry of Industrial, Mine and Energy	mine resources
Cambodian Mine Action Center	land mine and unexploded ordnance
Ministry of Water and Meteorology	meteorological and hydrological data
National Institute of Statistics, Ministry of planning	socio-economic data

#### Appendix 4. Selected projects with GIS and spatial databases in Cambodia

Project name	Purpose, etc
Land Management and Administration Project, 2002-2007	Extensively used GIS/RS technology for cadastral mapping, land management and administration. Aerial photographs and satellite images of the Cambodian territory were used for preparation of a land-classification map. Funded by the World Bank with technical assistance from Germany and Finland.
Reconnaissance Survey Project, 1996-2003	Produced 1:100,000 topographic maps, land use map and 1:500,000 geology map that covered the whole country. Funded by JICA.
Tonle Sap Environmental Management Project	Developed GIS Environmental Information Database. Interpretation and mapping of the landuse/land cover of Tonle Sap Lake areas from aerial photos. Asian Development Bank.
National Atlas of Landmine & UXO Contamination	Funded by government of Canada. Covered the whole country and made publicly available
GIS for identification poverty areas	Performed by World Food Program in cooperation with Ministry of Rural Development.
Forest Cover Assessment and Monitoring	Performed by the RS/GIS Office at the Forest Administration. Extensively used RS/GIS technology for forest cover assessment, planning, and monitoring. Funded by various donor such as GTZ, JICA, FAO, etc.
The ATLAS of Cambodia	The atlas was developed and distributed as a book 2006. Supported by Denmark.
Health mapping and database	Created by Ministry of Health in cooperation with National Institute of Statistics.