

# **Report on a consultancy to the EC Natural Forest Management and Conservation Project**

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## **Summary**

This report describes further work and training related to the ISSMI Integrated Stock Survey and Management Inventory technique for conservation and management of natural forest in Uganda. It also discusses progress on tree volume sampling, permanent sample plot work, and exploratory inventory.

During this assignment, the ISSMI software has been strengthened in a number of ways. It has been split into an application program and separate database, improving network performance and facilitating future upgrades. The GIS linkages have been fully developed, including geo-referencing of blocks and trees, and output of a block polygon file and tree attribute table. Tree selection for harvesting and protection has been simplified and improved to take into account spatial patterns. A new report has been added for polyblock summaries. The Excel block mapping program has been improved to show selected trees with colours and symbols, and to list statistics. A standardised 3-letter species mnemonic has been added to the species list that is used in the Excel mapper and exported to the GIS tree attribute table. The quick mapper used for spatial data checking has been reconfigured to avoid earlier installation problems. More extensive training in ISSMI was given than hitherto, and two project professional staff are now fully acquainted with ISSMI and with the GIS linkages.

Two keynote presentations were given at a workshop held at Masindi from 6-7<sup>th</sup> December 2000 which covered yield regulation concepts in natural forestry, and the ISSMI system. This workshop served to establish ISSMI as a formal technique for natural forest management in Uganda. The consultant also led a field training exercise in ISSMI at the workshop.

Progress in tree volume sampling was reviewed and found to be minimal. It is clear that the existing volume equations based on Relascope sampling are inaccurate and urgently need to be replaced. A high priority should be given to tree volume sampling over the next two to three months to get this work underway. PSP work was likewise reviewed; it was found that the EPHRU software developed earlier by the consultant was being used to enter data, but only 10 plots were in the system. Generally the data processing section (TSS, or Technical Services Section) appears to be under-resourced in terms of personnel, space and equipment; the problem is exacerbated by deficiencies in work control methods. The consultant suggests that this needs to be reviewed and addressed with some urgency.

The exploratory inventory methods were discussed, a field form designed, and an Excel program prepared which produces random transects in a format that can be imported into the GIS system for mapping. However, no EI database development was possible within the current assignment, and this will be a priority requirement if the EI data is to be entered and analysed.

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### Background

The assignment described in this report continues work under the EC Forest Conservation and Management Project (FCMP) to improve some aspects of quantitative forest management in the natural tropical forests of Uganda. The earlier visits have been concerned with the development of an integrated stock survey and inventory technique known as ISSMI, the improvement of tree volume equations, permanent sample plot work in the natural forests, and exploratory inventory techniques. The main contribution by the consultant in these areas has been in suggesting suitable and efficient techniques, designing field forms, developing appropriate software, and staff training relative to both the field aspects and data processing. These technical issues have also been linked to the central objective of improved sustainability of forest management through proper planning, monitoring and control.

### Terms of Reference

For the present visit of about 25 working days, the terms of reference (TORs) covered the following aspects:

- Improvements and modifications to the ISSMI software, development of linkages with the GIS system, training in ISSMI, and review of progress;
- Review of progress with PSP and tree volume studies;
- Participation in a workshop on ISSMI held in Masindi from 6-7 December;
- Software development and design work for Exploratory Inventory (EI).

These TORs have been substantially completed, as will be detailed in the report. In particular, ISSMI has been greatly improved as a software package and in its tree selection method for forest management. Much more training than hitherto has been given, focussing especially on the GIS linkages with ISSMI, but also covering all aspects of the package. There are now two key staff trained in ISSMI, rather than one as formerly. The Masindi workshop has established ISSMI nationally as the primary technique for natural forest management.

The progress on PSPs and volume studies has been reviewed and will be detailed in the report, but can basically be summarised as slight. As will be discussed, data processing activities are under-resourced and under-managed, and this is an area which will need to be addressed in future.

Time did not permit as much work on the exploratory inventory as originally hoped. At least two further weeks are required for software development, and there should preferably also be time allocated for field supervision and training in inventory planning and analysis, as well as for actual analysis of a preliminary data set both to check the software and as part of the training process. However, the consultant was able to confirm design concepts, and prepare a GIS-compatible program to generate random inventory transects, as well as to design the field form to be used.

## The ISSMI concept

ISSMI is an acronym for Integrated Stock Survey and Management Inventory. It can be seen as having three layers:

- A field procedure for stock survey and management inventory,
- A data processing package which translates the field results into stock maps and inventory tables,
- A sustainable forest management system, based on the detailed information, monitoring and control capability of the field and data processing aspects.

During the present visit, the consultant has made a number of improvements to the ISSMI computer package, which are described in the following sections, to improve performance and ease of use, and provide some additional tables and linkages to the Forestry Department's GIS system. The field procedures have remained unchanged, and now can be regarded as a stable and well established operation. The management layer is the area which now requires to be developed further, through application of the system.

## Field procedures

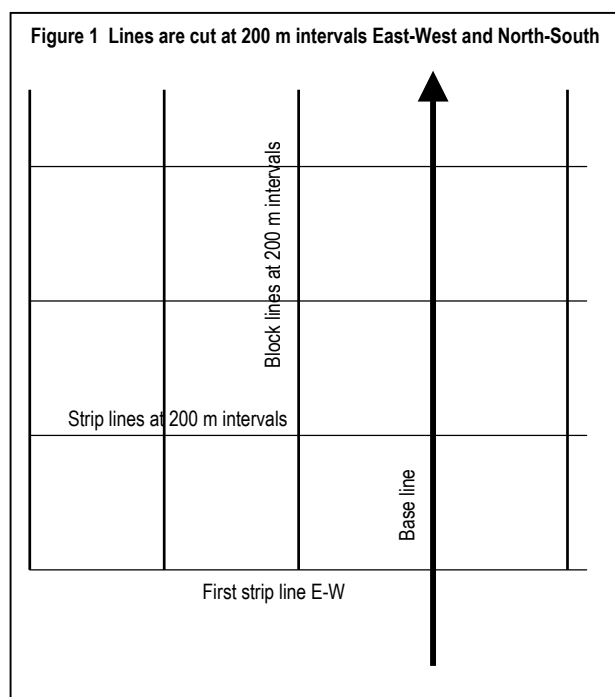
The ISSMI field procedures are now well-established and have not been modified as a result of this consultancy visit. They are described here briefly for reference purposes.

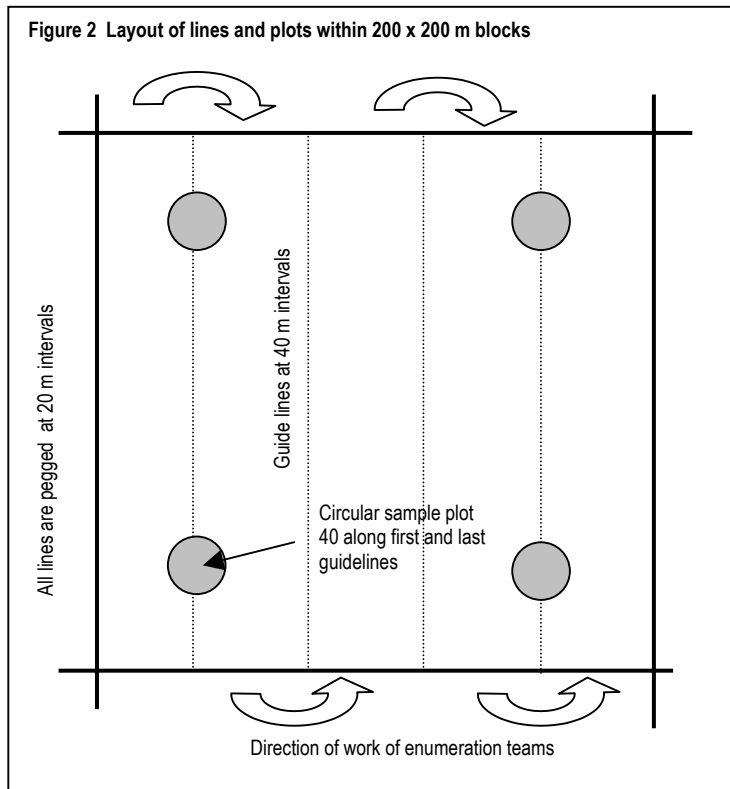
ISSMI combines stock survey and management inventory into a single operation. The operation is usually carried out at compartment level, on areas of around 500-600 ha, and should be done about a year before harvesting.

A base line is established in a NS orientation at a convenient access point (see Figure 1). It may be located relative to a pre-planned grid using a GPS. From this primary base line, an initial strip line is cut in an EW direction.

Further NS block lines are then cut at 200 m intervals from the first strip line. Additional strip lines are cut every 200 m along the NS baseline. This subdivides the forest into a series of 200 x 200 m blocks.

Once this demarcation has been done over a sufficient area, a team then cuts guide lines at 40 m intervals in a NS direction in each block (see Figure 2). These guide lines divide the block into 5 NS sweeps.





Stock survey is carried out usually by two teams each with blue paint, a diameter tape, and a skilled tree spotter. They move up each sweep with a single booker, who stays in the guide line to the west of the sweep. For each tree over the specified minimum diameter, the position north from the block's southernmost boundary is recorded (0 to 199 m), and the distance east within the sweep is estimated (0-39 m). These, together with the sweep number, record the tree's position within the block. Each stock tree has a number painted on its buttress or bole, as close to the ground as possible so that it will remain visible if the tree is felled. The number is painted on the due north side of the tree if buttressing permits, or as near thereto as possible. The

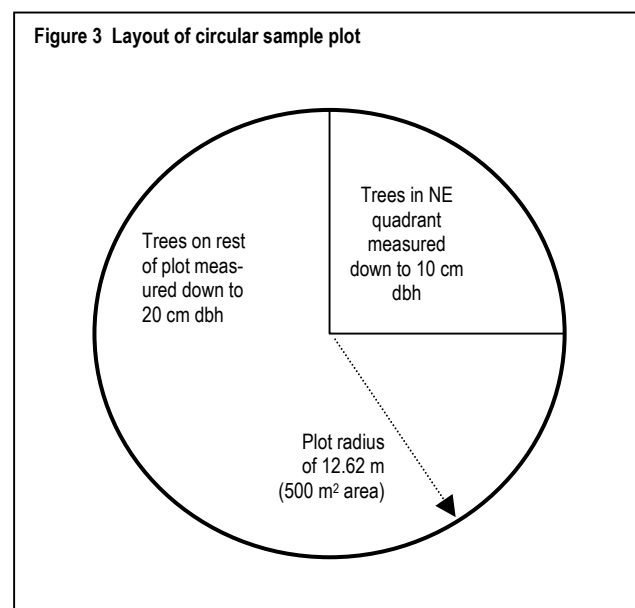
trees within a block are numbered sequentially.

The sweeps are surveyed in a zig-zag fashion (Figure 2), moving north on the first sweep, turning and going south on the second, and so on. The sequence of stock numbers follows this pattern.

On the first and last guidelines, at 40 and 160 m, a temporary sample plot is established. This is a circular plot of 12.62 m radius (500 m<sup>2</sup>) on which all trees down to 20 cm are measured. On the NE quadrant of this plot, trees down to 10 cm are measured (see Figure 3).

For the stock survey, the standard procedure prescribes that all trees down to 50 cm are recorded. This has been varied to record *Funtumia elastica* down to 40 cm, as it is normally only common as a smaller tree.

The data recorded for each species comprise species identification, diameter at breast height or above buttress, a stem quality code ranging from 5 for a perfect bole to 1 for a tree with no possible timber use - severely



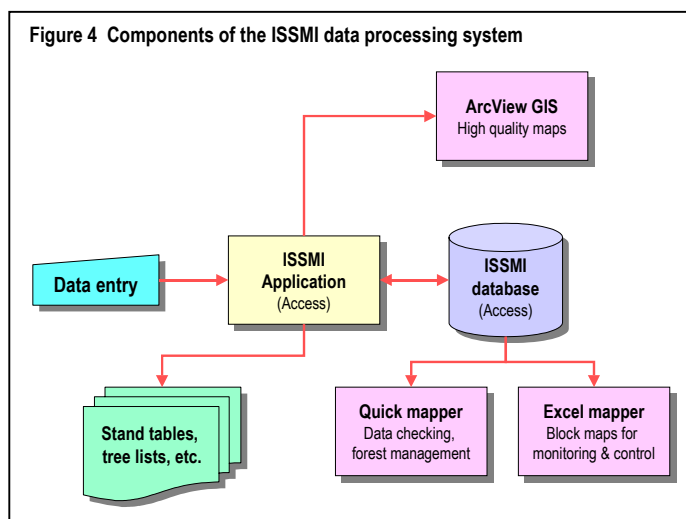
misshapen, rotten or otherwise unusable. A series of coded notes are provided to record observations about the tree – broken top, decay, damage, climbers, deformation, and so on. The same system of measurement is used for stock trees and smaller trees measured on the TSPs.

The trees over 50 cm (or 40 cm for *Funtumia elastica*) are measured on 100% of the forest area. Trees from 20 to 49 cm are measured on 5% of the area by a systematic sample. Pole sized trees, from 10-19 cm, are sampled on 1.25% of the area.

## Data processing

A software application had been developed using *Microsoft Access 97* during earlier consultancy work related to ISSMI. This provides for entry of stock survey and sample plot data, and some reporting and mapping facilities. In addition, a program in *Microsoft Excel 97* was written for drawing tree maps of single blocks which has proved to be very useful for control and monitoring on the ground.

During the present visit a number of improvements have been made to the software, which are described in detail in the following sections. ISSMI now includes the software shown in Figure 4. The main ISSMI application is an MS Access program. This has been split from the database, which is also an Access file, but contains only the data tables for block headers, plot headers, stock trees, plot trees, the species list, and some related tables. The ISSMI application has various reports and tables, which are unchanged from previous versions, and an additional management report which is described further in the relevant section below.



The Quick Mapper, written in MS Visual Basic, has been causing problems due to installation difficulties. It has now been revised and works properly. The Excel mapper has been one of the more successful parts of the system. It has been slightly modified in this version to provide greater ease of use.

### **Re-organisation of processing programs and database**

Originally, ISSMI was a single Access file that contained both the database and the various forms, reports and programs that form part of the system. This involves difficulties when any part of the program is updated, since all the data must be carefully synchronised between the current version of the database and the updated version before an upgrade can be released for service.

Microsoft recommend splitting applications of this type into two parts, called in their jargon a front-end (FE) application and back-end (BE) database. This works faster and more efficiently on a network and is also easy to update, since the database does not need to be touched when a new version of the application is released. This has now been done with

ISSMI and thoroughly tested under network conditions, with multiple access to the same form or data table simultaneously. The new version performs well and has already saved much time in terms of ease of maintenance and support.

It has also been found as part of this process that different versions of MS Access can be used without difficulty, provided some basic rules are respected. The BE database on the file server must be kept in the earlier version, Access 97, without using the 'convert database' option. The FE applications can, if they are running on a machine that uses Access 2000, be converted using the automatic Wizard that pops up as soon as an Access 97 file is opened. The mixed application will run without difficulty.

However, the master database should not be converted to Access 2000 as it will otherwise become inaccessible to all users who only have Access 97. Once Access 97 is no longer in use, then the conversion can be carried out. If the file is inadvertently converted, then it can be saved again in Access 97 format under an option on the Access 2000 menu.

### **Upgrades to the quick mapping program**

The ISSMI mapping application, which is a separate *Microsoft Visual Basic* program has been changed from an OLE<sup>1</sup> server to a stand-alone EXE application called from the ISSMI menu. There are installation problems with OLE servers which had inhibited the use of this facility. The amended system avoids these problems and is simple to install. The mapper has been revised, and recompiled using version 6 of MS Visual Basic, which also has improved robustness and ease of use compared to the earlier VB4 version.

The functions of the quick mapping program have not been changed, but they are now set from a menu, whose facilities are described in the table below.

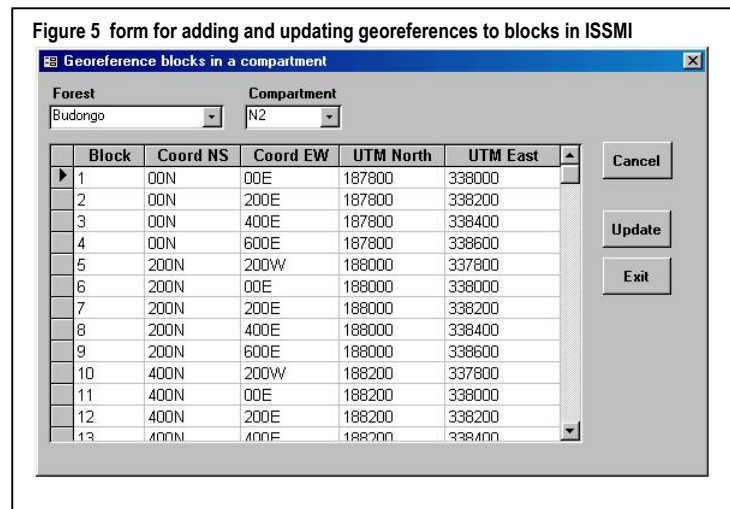
Menu	Description
<b>File ► Database</b>	Opens a dialog box to search for the ISSMI database. When started from ISSMI, this is not needed, as the database name is passed automatically.
<b>Location</b>	Produces a list of compartments in the database as a popup menu. Selecting one will result in it being mapped.
<b>Refresh</b>	When the mapper is used in tandem with ISSMI, corrections can be made on the data, such as block or plot coordinate changes. The effect of these will not be seen on the maps until the 'refresh' function is run.
<b>Map ► Zoom</b>	Zooms in on selected blocks. If no blocks are selected, draws the whole compartment.
<b>Full</b>	Draws the whole compartment.
<b>Colours ► Species groups</b>	Trees are coloured according to the group colours selected in the ISSMI species groups form. In addition tree symbols show circles with an X through for harvest trees, or solid circles for seed trees. Reserve trees are empty circles.
<b>Tree Selection</b>	Trees are coloured according to selection: Blue for harvest trees, red for seed trees, and green for reserve or unselected trees.
<b>Stock No.</b>	If checked, stock numbers will be shown against each tree when the map is zoomed.
<b>Inv. Plots</b>	If checked, inventory plot locations are drawn as yellow circles.
<b>Copy</b>	Copies the current map image to the clipboard. From there it may be pasted into another application such as Word, Paintbrush or Powerpoint. Images are copied as bitmaps (.BMP).

<sup>1</sup> OLE: Object linking and embedding. Such programs are contained in .DLL library files and require to be properly registered in the Windows Registry. The registration process was found to be non-automatic and involve several obscure steps, making it difficult to use the mapper when ISSMI was moved to a new machine or directory.

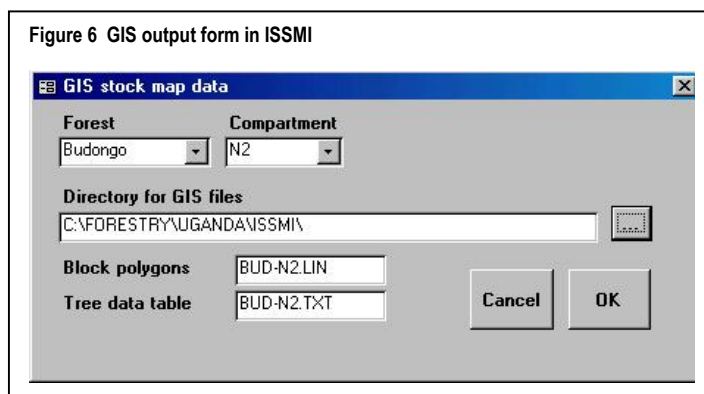
The main uses of the mapper are to view tree selection and species distribution, and to check on plot and block co-ordinates. If the latter are not correct, then the plot or block will appear displaced. The images produced by the mapper are of low resolution, and are suitable mainly for inclusion in word-processor reports and for on-screen presentations. For high-resolution maps, together with overlays of compartment boundaries, roads, rivers, etc., the data must be exported to the ArcView GIS system.

### Geo-referencing and GIS linkages

The database has been modified to add extra fields to the Blocks table called [UTM North] and [UTM East]. These store the UTM co-ordinates for each block. A form has been created which allows the user to enter UTM co-ordinates from GPS readings taken at the SW corner of selected blocks, as shown in Figure 5. On this form, the UTM co-ordinates for a compartment will be initially blank. A single GPS reading is entered for any block, and the **Update** button clicked. The UTM co-ordinates for the rest of the compartment will then be filled in, based on their local co-ordinates relative to the block where the reading was taken.



This procedure is imperfect, as some survey errors and deviations will always occur in the real world. A better method would be to take 4-8 GPS readings at widely spaced locations over the compartment, and apply a scaled transformation to get best approximations for other points, based on the distortions between the theoretical and actual locations of the control points. However, the consultant had neither the time nor the necessary reference books to design an algorithm based on the latter method. For the moment, the method is adequate provided survey standards are high.



Once a compartment has been geo-referenced, then the GIS output files can be generated, using the form shown in Figure 6. The compartment is selected, and when the **OK** button is clicked, two files are generated. These are given default names with extensions .LIN and .TXT respectively. These default names and output directory can be amended by the user before creating the output files.

The .LIN file contains the line information in a format that can be processed in ArcInfo using the GENERATE, CLEAN and BUILD commands. The former will import the file and create an ArcInfo coverage. The latter builds the block line information into polygon topology, which is more useful than simple lines in the GIS system. The coverage, once created, can be added to an ArcView map.

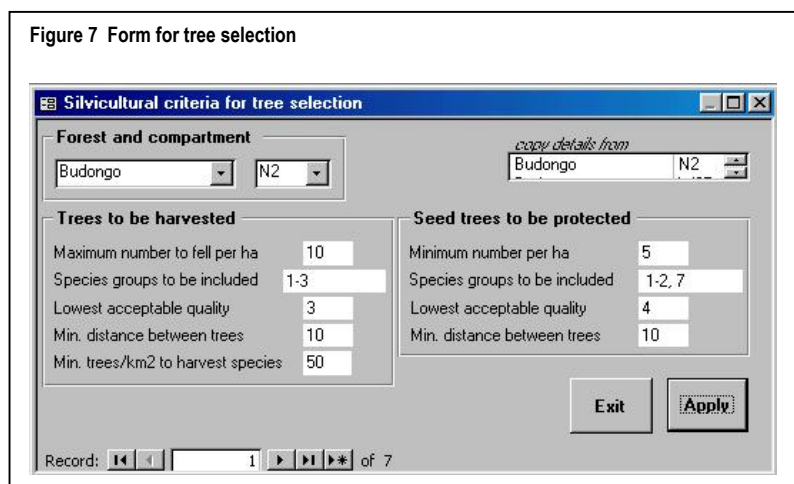
The .TXT file is a table of tree data in text format, in which each tree has its individual UTM co-ordinates. This file can be imported directly into ArcView and overlaid on compartment boundary and other information as a high quality stock map. The various fields in the file can be used within ArcView to label, colour or size points or to select distinctive symbols. The columns which are exported from ISSMI include:

ISSMI field	Description
<b>BlkId</b>	Block ID, such as Bud-N1, based on first three letters of the forest name and the compartment ID.
<b>StockNo</b>	Tree stock number
<b>Y</b>	UTM coordinate north (negative values are south of the equator)
<b>X</b>	UTM coordinate east
<b>Spp</b>	Species numeric code
<b>Spg</b>	Species group number
<b>Code</b>	A three-letter species mnemonic
<b>Diam</b>	Tree diameter in cm at dbh or above buttress
<b>Quality</b>	Tree quality, from 1-5
<b>Status</b>	A code indicating selection status. 0 means not selected or a Reserve tree, +1 is a Seed tree, -1 is a Harvest tree

### Tree selection

The tree selection process introduced during the last consultancy has been simplified. The earlier scheme of using various weights to balance the relative importance of tree size, species group and quality was too opaque and complicated, and did not take into account spatial relationships among trees. The new scheme is simple and can be explained by reference to the tree selection screen, which appears under the ISSMI menu **Forms** ► **Silviculture**, and is shown in Figure 7.

This form allows a different treatment to be applied to each compartment. The specifications for both harvest and seed trees are similar. The number of trees to per ha to be selected is set, together with the applicable species group, the lowest acceptable quality standard, and the minimum spacing





in metres between selected trees. For harvest trees, species which have less than a specified stocking per km<sup>2</sup> can be excluded. Once these criteria have been given, clicking the **Apply** button will update the *Status* field in the *StockTrees* table of the database for that compartment to reflect selections made. Subsequent reports and maps for that compartment will show the selection made.

In logic, trees within the specified species groups and quality band are regarded as of equal value, but are sorted by size from largest to smallest, so that larger trees that satisfy the criteria are picked first. Only species which exceed the specified minimum stocking per km<sup>2</sup> are included on this list. Once a candidate tree is picked, the current and adjacent blocks are scanned for other trees in the same category that may already have been picked and which are closer than the designated minimum distance. If there are other selections within that distance, the tree is not chosen, and another one is tried.

The *Status* field in the *StockTrees* can be set to one of three numerical values. Harvest trees are coded -1, seed trees as +1, and reserve trees as 0. In the quick mapper, these are illustrated by the colours blue, red and green respectively. In the revised version of the Excel block mapper, the same colour scheme is also used, as well as the symbols X for harvest tree or ST for seed tree.

The analysis of tree spatial arrangements fails if, due to errors in block co-ordinates, two blocks are superimposed. In this case, an error message appears which gives the relative block numbers involved. Co-ordinate errors must therefore be eliminated before the tree selection can be completed successfully.

### ***Revisions to management report***

The report menus have been re-organised and a new report added which summarises species numbers and volumes for harvest, and tree numbers for reserve trees, and seed trees. This should prove useful as an additional forest management tool. Appendix A details the revised menu structure for ISSMI and lists the various reports available from the menu.

### ***Installation***

The current version of ISSMI requires the installation files shown in the table overleaf. At first installation, these files should be copied into appropriate directories, and the SETUP.EXE program run by clicking on it from the Windows Explorer. This installs Visual Basic 6 resource files onto the local workstation WINDOWS\SYSTEM directory as required. Installation also assumes that the system is properly configured with MS Office 97 or MS Office 2000, otherwise the Access and Excel files will not work.

ISSMI is started by clicking on the ISMI2-07.MDB file from the Windows Explorer, or by creating a shortcut to it on the desktop. The first time this is done after installation, the **Data-base►Open** menu selection must be chosen to set up the links to the data file, ISSMI DATA.MDB. This does not need to be repeated unless the data file is renamed or moved to another directory.

File	Installed location and description
ISSMI2-07.MDB	The ISSMI Access application. It can be installed in a suitable directory (the <i>ISSMI directory</i> ) on each workstation on a network using the database. When used for the first time after installation, the <b>Database► Open</b> command must be used to set up the database links (see Appendix A).
ISSMI DATA.MDB	The central database, located on a network file server. The name of this file can be modified as desired, but to avoid confusion and loss or duplication of data, there should be only one working copy. Backup copies should be made from time to time on a different disk drive (in case of drive failure). This file contains only data tables, and has no code, queries, reports, or forms that are part of ISSMI.
ISSMIMAP.EXE	The quick mapper application. This should be copied from the <i>setup directory</i> (see below) into the <i>ISSMI directory</i> on the workstation.
ISSMIMAP.CAB	This should be located in a convenient <i>setup directory</i> – which could also be the <i>ISSMI directory</i> , but not necessarily. It contains installation files for ISSMIMAP.EXE.
SETUP.EXE	Located in the <i>setup directory</i> , this is run to install ISSMIMAP.EXE
SETUP.LST	This file is required by the SETUP program, and must be in the <i>setup directory</i> .
ISSMI-TM.XLS	The Excel block mapping program. This should be located in the <i>ISSMI directory</i> .

## Forest management and block selection

As has been discussed in earlier reports and elsewhere, ISSMI as a forest management system is premised around the selection of 4-ha blocks for harvesting or other treatments on a 15-year cycle that is adaptive to forest growth or other dynamic changes. Every 15-years, compartments will be re-surveyed and their condition re-assessed. The blocks allocated for harvesting in any one 15-year cycle should be those which satisfy certain criteria. The precise nature of these criteria will need to be refined with experience, but as a first approximation, the consultant suggests the following benchmarks:

- ❑ The number of harvestable trees over 50 cm should be between 5-10 per ha. This is equivalent to around 15-30 m<sup>3</sup>/ha. No more than 10 trees per ha over 50 cm should be harvested under any circumstances.
- ❑ The number of reserved trees over 50 cm should at least equal to the harvest trees. In other words, no more than 50% of stock trees over 50 cm should be harvested under any circumstances.
- ❑ A species should not be harvested if it is locally rare, even though it may be classified in an exploitable group. The consultant suggests that average stockings on a compartment should exceed 50 trees/km<sup>2</sup> before a species is exploited.
- ❑ The advance growth in the size classes 30-50 cm should be at least double the stock (including reserve and seed trees) over 50 cm for exploitable species. This indicates healthy regeneration, and a balanced diameter distribution.

These various points need to be justified in some depth, which time does not permit in this context. It has been agreed with the project management that the consultant should write a scientific paper describing the ISSMI system. This paper would include a justification and explanation for the harvesting and protection criteria, and a comparative review of similar forest management systems.

ISSMI in its present form does not provide explicit selection of blocks either in map or list form, using the above criteria. An add-on Excel program that will provide this facility is in

preparation, and should be available for field testing within a few weeks. The ISSMI menu has already been configured to allow this, as indicated in Appendix A under **Reports ► Block summary**.

ISSMI stock maps and tree selection lists are already being used to control felling on the ground. However, prior to the present assignment, ISSMI did not select trees well, and there has been a tendency to fell more heavily than the 5-10 tree/ha guidelines given above. The latest version will give good selections provided the parameters under the **Forms ► Silviculture** dialog (see Figure 7 and Appendix A) are set to reasonable values. Of importance here, relative to the above criteria, are:

- *Maximum number to fell per ha* should not exceed 10.
- *Minimum distance between trees* to be harvested should be at least 10 m.
- *Minimum trees/km<sup>2</sup> to harvest species* should be at least 50.

Respecting these criteria will ensure that harvest trees are well distributed and not clumped together, that felling is not excessively heavy, and that locally rare species are not harvested.

When the block selection facility becomes available, this will provide an additional layer of control and protection, by indicating through a list and thematic map which blocks should be included in a harvesting operation, and which should be left.

ISSMI will certainly evolve as a management system as knowledge improves and the data system itself is widely and routinely applied in the forest districts. However, the basic concepts of strong monitoring and control on the ground, complete transparency in yield selection and control, and silvicultural adaptability, permit this evolution whilst encouraging better forest management practice.

### Objectives

A clear distinction needs to be made between exploratory inventory (EI) and the management inventory incorporated within ISSMI. The EI is a one-off procedure undertaken when a reserve is first being brought under management or, as in the case with many reserves in Uganda, when management is being reintroduced after a lapse of many years. Its intention is to provide a basis for compartmentation, and an idea of annual allowable cut and major commercial species for the reserve as a whole. It is not intended or able to provide management information at or below the compartment level.

ISSMI is a system of continuous forest inventory (CFI), with a 15-year remeasurement cycle, and if instituted and established, further use of the EI procedure in a reserve should not be necessary.

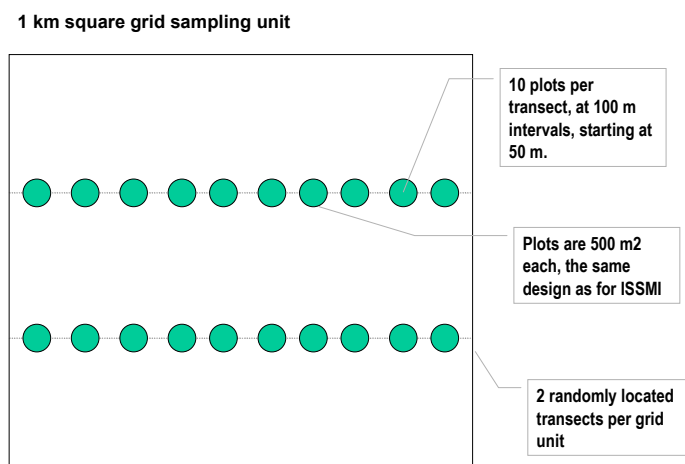
### Design

The EI design that the consultant has proposed is a partially randomised stratified design. The sample plots use the same design as for ISSMI (see Figure 3) and have an area of 500 m<sup>2</sup>. They are laid systematically at 100 m intervals along a randomly located line of 1 km length. Two random lines are placed within a stratum, which comprises a 1 km<sup>2</sup> block.

This design has been adopted so that the block lines, which demarcate the strata, can be retained as the basis for subsequent ISSMI operations.

This design has numerous historical precedents. H.C. Dawkins, in his 1958 work *The Management of Natural Tropical High-Forest with special reference to Uganda* discussed the advantages of a similar design, and it was adopted for several inventories conducted in Belize. In these earlier designs, the random strips were measured as continuous lines, broken into record units. The use of circular plots in inventories in the tropics also has many precedents, and the combination of both methods combines the advantages of an effective randomisation method with a compact and rapidly demarcated sample unit. The compatibility of the sample unit with ISSMI is also designed to reduce costs and re-use skills and software from the latter operation. Personnel experienced in measuring ISSMI plots can rapidly adapt to the EI procedure.

Figure 8 Exploratory inventory design



It should be noted that the block of 1 km<sup>2</sup> is a statistical stratum with two random sampling units, the transects. A within-transect variance estimate can be made using systematic sampling formulae applied to the plot data, using methods such as those described in M.S. Phillips's *Measuring Trees and Forests* or the *FAO Manual of Forest Inventory*. Although it is useful if a statistical strata corresponds to a forest type, it is not necessary, and may not always be possible where there is no prior information on species distribution.

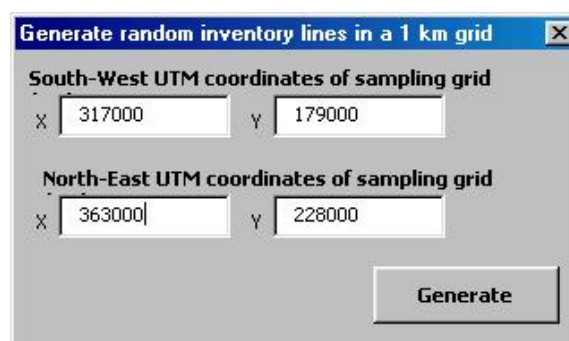
The design described above provides a sampling intensity of 1% for trees down to 20 cm dbh, and of 0.25% for trees from 10-19 cm dbh. This is a relatively high intensity for exploratory inventory, and should provide strong indicative information for preliminary forest reserve management planning.

### Software for sample frame generation

An Excel program called *inventory lines.xls* has been written that generates random transects in a format that can be incorporated into an ArcInfo or ArcView map.

When this program is started, the dialog shown in Figure 9 appears. The UTM coordinates for the SW and NE corners of the total inventory area should be entered and the **Generate** button clicked.

Figure 9 Dialog for inventory transect generator



The output file name will be reported when it is written, and should be noted down. The name will be similar to INVTR1.LIN. In ArcInfo, the GENERATE, CLEAN and BUILD instructions can be used to convert this file into a coverage that can be then be incorporated into a map in ArcView.

### Field forms

A field form has been designed that can be used for early training exercises, and is attached as Appendix B. This is similar to the ISSMI inventory plot form, except that location information for the inventory block, the transect position, the survey direct (East or West) and the plot number need to be entered.

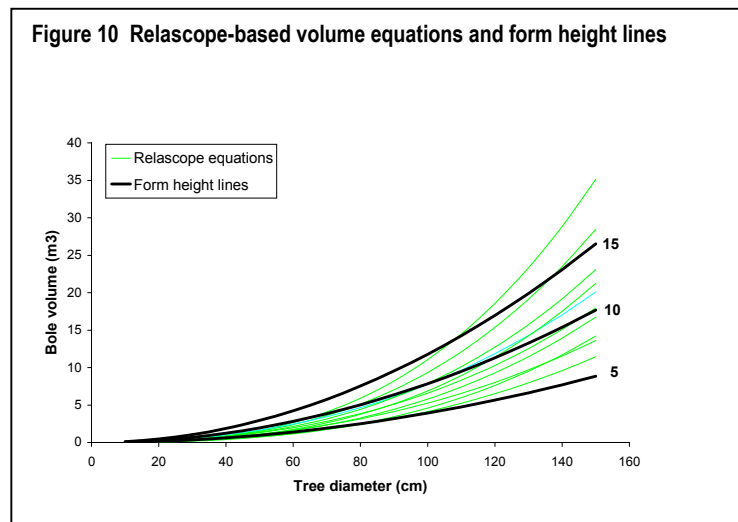
### Data processing software

No software has yet been written for the EI data entry or analysis. It is considered that a minimum of two weeks is required for this task, and it should clearly be prioritised if the EI work is to go forward without delay.

## Tree volume sampling

Since the consultant provided training in tree volume sampling in June 1999, little has been done on this work, and only about six trees have been measured. Project staff have made some efforts at designing a data input format, but without any great success.

It is evident that the existing tree volume equations underestimate tree volumes substantially. The various models correspond roughly to form heights<sup>1</sup> between 5 and 10 m, whereas for tropical forests generally, the range that would be expected would be between 10 and 15 m or perhaps higher. Figure 10 shows the existing relascope-based equations overlaid with the form height lines for 5, 10 and 15 m.



There is therefore some urgency about developing at least a general equation that can be used to estimate volumes more reliably. It should not be difficult to undertake the field measurements proposed in conjunction with ongoing exploitation, and to rapidly measure 200-300 trees that would be sufficient for a set of preliminary equations. The consultant is concerned however, that because some 18 months have elapsed since the training exercise, many of the points made at that time may have been forgotten. Nonetheless, whatever imperfections may exist in the procedure can be corrected later; it is more important now that field work should go ahead as rapidly as possible.

A simple data entry format is being prepared which can be used to enter and check the data. The consultant will provide a copy of this as soon as it is completed.

The log volume tables in the Departmental Standing Orders (1997 revision) were also reviewed. These tend to overestimate log volumes calculated directly by Huber's formula, although they are themselves based on the same formula. This is because they show volumes against class mid-points, based on linear measure, whereas the volumetric class mid-point should be at the square root of the class interval. This problem could be resolved by making more detailed tables, with smaller intervals, and using a correctly weighted class mid-point to eliminate bias.

<sup>1</sup> Form height is the ratio of volume to tree basal area. It is the height of a cylinder with the same volume as the tree bole.

## Permanent sample plots

The PSP data entry system EPHRU now contains measurements for 10 PSPs. If possible, more data should be entered to avoid too large a backlog developing.

However, in the next phase of the project, PSP data processing issues will need to be addressed more seriously if the current field work is not to go to waste. PSP data needs to be rigorously and carefully checked if they are to be useful, and some processing programs prepared. Although measurements over periods of less than 3 years do not give good increment estimates, they are useful for testing procedures and methods, and for developing software. All of this will require technical inputs of 3-4 months duration, preferably combined with a training fellowship for a specialist who may take over these duties.

## Data processing management

Data processing and management in the project still has a somewhat *laissez faire* and *ad hoc* quality, although record keeping is somewhat improved from the last visit 18 months ago. However, the situation is clearly inadequate with regard to the demands of the proposed Uganda Forest Authority. Office space is a very serious constraint, and some of the computers are now verging on obsolescence and will need to be upgraded or replaced within the next 12 months. There is a need for a thorough study of data processing requirements in terms of staff, facilities, equipment and space, and training. This study should review all the data processing tasks that the UFA will be expected to undertake on a routine basis, and map out a 5-year plan for ensuring adequacy of human resources, training, equipment and support in these areas.

The present *ad hoc* approach means that the ambitious undertakings in terms of ISSMI, exploratory inventory, PSPs, and GIS services are being channelled into a unit which is inadequate in almost every respect to support these services. Unless this situation is addressed with a fair degree of urgency, much of the field work being undertaken at great expense and effort will prove to be wasted.

In the short run, thought needs to be given to making the best use of existing resources. Space needs to be organised to remove bulky, broken or unused furniture to storage. The foyer of the herbarium can be cleaned out and used for shelving to store data records. This will create more space in the two rooms used for data work. These rooms, and the equipment, need to be cleaned thoroughly and routinely.

There is a need for more proactive, skilful and positive management of the TSS unit. At the moment, there is little clarity about any sense of schedules and tasks on a weekly or monthly basis, or any tracking of data input, checking and output reports. The consultant considers that this should be discussed in the project and the TSS required to produce a weekly list of data entered, and reports produced or tasks completed in summary format. This will help to focus effort on organisational matters and avoid waste of the admittedly inadequate resources. It will also provide statistical information on data processing activities that will help in longer term planning.

### ISSMI software improvements

During this visit, the ISSMI data processing system has been considerably strengthened and improved in a number of respects. All the linkages to the ArcView GIS system have been fully programmed and tested. ISSMI can now output compartment tree attribute tables that include UTM geo-referencing of each tree, with tree diameter, species code, species mnemonic, stem quality and selection status. These can be used to produce high quality compartment or polyblock maps with various symbols and colouring schemes based on this attribute data.

The ISSMI quick mapping program has been re-configured to avoid earlier installation problems. This will make ISSMI more portable, and will assist the task of decentralising its use and providing copies to forestry teaching institutions. The Excel block mapping program has been revised to use standard species mnemonics, a standard colouring and symbol scheme for selected trees, and for more convenient operation.

The main ISSMI package has also been reconfigured for optimum operation by splitting the data tables from the program and related forms, reports, and queries. This allows for more efficient network operation and for easier upgrading of the ISSMI program. Network access has been tested, and multiple data entry operators can add or edit data on a single master file without difficulty.

The tree selection method has been re-designed and re-programmed for greater transparency and for spatial sensitivity to avoid clumps of harvestable or seed trees. Selection now treats all trees within a designated set of groups and quality grades as equal, but picks the largest trees first, and considers a spatial constraint to avoid picking neighbours within a designated distance. Tree selections are now reflected in the Excel block mapping program, as well as other output tables and reports. The former term *Residuals* for trees not selected as either harvestable or seed trees has been changed in all reports, maps and in this report to *Reserved trees*.

In the consultant's view, the only remaining improvement required for the ISSMI software to be complete will be the thematic mapping program for block selection. He is committed to providing this without further consultancy costs, as the programming involved is relatively simple.

### Training in ISSMI

This visit has seen a major workshop on ISSMI, which took place in Masindi from 6-7 December. The consultant provided two key sessions in this workshop and led a field training exercise undertaken in compartment W37 of Budongo FR. This workshop has formally established ISSMI as a standard stock mapping and inventory technique, replacing earlier methods used by the Forestry Department.



In the office, extensive training has been given to two professional staff on all aspects of ISSMI, including geo-referencing, error checking of block co-ordinates, amending species list and species group data, GIS outputs and linkages, and tree selection.

### **Exploratory inventory**

Data forms and a program to select random sampling transects for the exploratory inventory (EI) have been prepared, but much more needs to be done. In the consultants view, it will require a minimum of two weeks dedicated time to prepare EI software for data entry and report generation. Further time should be added on top of that for training in EI analysis. The consultant has suggested that the Kilembe Sawmill Project, presently postponed due to security concerns, should be re-thought and re-designed to provide a basis for this to be done. This does require some adjustment of the consultant's TORs in that project as currently agreed.

### **Permanent Sample Plots**

Some use has been made of PSP software EPHRU provided by the consultant on an earlier visit, and data for ten plots are in the system. However, data entry is lagging well behind field work. As the consultant has said earlier, it will not be possible to manage this task at the data processing level unless there are two dedicated personnel assigned to it: A professional officer, and a data entry assistant. The professional officer should be responsible for managing, following up and checking all aspects of the PSP work, and should, if efficient in their duties, be assigned overseas training opportunities on relevant short courses. In addition, further consultancy work is required in at least three phases, to cover immediate data processing upgrades and training, a field training and data entry design phases relative to PSP re-measurement, and a final and longer consultancy associated with PSP data analysis software.

### **Tree volume sampling**

In June 1999 the consultant spent several days providing field training in tree volume sampling. In the ensuing 18 months, only some 6 trees appear to have been measured, and the work appears to have lapsed. It remains on the critical path, as existing volume equations derived from earlier Relascope studies are clearly too low, perhaps by a factor of 30-50%. The project should now give a high priority to this issue, and try to measure at least 200 trees over the next two months, and maintain this momentum continuously over a further 18 months.

### **Conclusion**

At the moment, developments in forest biometry under the EC project have been pursued in an *ad hoc* and adaptive fashion. This has led to many useful results, such as the ISSMI method and software, but is also inefficient, as short-term consultancy has a high overhead of travel and report writing, and it is difficult to achieve many kinds of software preparation and training in very short periods. It is to be hoped that in preparing the next phase of EC support for forestry, that this type of work is being planned on a more coherent and long term basis, linked with an appropriate strategy for human resources development in this field.

## Appendix A: ISSMI Quick Reference Card

### ISSMI Menus and usage

Menu			Description and usage
<b>Database▶</b>	<b>Open</b>		Brings up an open database dialog box. ISSMI will 'remember' the last database used, so this option is required only when the configuration of the system changes, eg if the data file is moved to a new directory, or ISSMI is installed on a new machine.
	<b>Exit</b>		Closes ISSMI. The same effect is achieved by closing the ISSMI dialog box.
<b>Edit▶</b>	<b>Undo</b>		Reverses the last operation if possible.
	<b>Copy</b>		Copies a selection to the clipboard.
	<b>Cut</b>		Copies a selection to the clipboard and deletes it.
	<b>Paste</b>		Pastes the clipboard at the current position, replacing a selection if made.
	<b>Delete Record</b>		Deletes the current record.
	<b>Find</b>		Finds text in a table or form.
	<b>Find Next</b>		Finds next instance of the same text.
	<b>Replace</b>		Finds and replaces text in a table or form
<b>Forms▶</b>	<b>Stock Survey</b>		Opens list of blocks to select one for editing. The <b>Tools&gt;Form View</b> will display the selected block as a data entry form for stock tree data.
	<b>Inventory Plot</b>		Opens inventory plot form for data entry and editing.
	<b>GeoReference</b>		Form to allow UTM coordinates to be entered for a specified block, and then applied to the whole compartment via the <b>Apply</b> button.
	<b>Silviculture</b>		Form to set the tree selection criteria for harvesting and seed trees, and apply them to a specified compartment.
	<b>Species groups</b>		Form to set species group names, minimum diameter limits, and colours for the quick mapping module.
	<b>Species List</b>		Displays the species list, and allows new entries, editing of names, species group or volume equation to be applied.
<b>Reports▶</b>	<b>Mapping▶</b>	<b>Quick Map</b>	Starts the quick mapping module. This is used to review block and plot co-ordinates and progress, and to check on species distribution or tree selection.
		<b>Block Map</b>	Starts the Excel block mapping application. Draws detailed maps of single blocks with lists of trees by harvesting category, for harvesting control and monitoring.
	<b>Selected yield▶</b>	<b>Species summary</b>	Produces a report for a selected compartment of species tree numbers by harvest, seed tree and reserve categories, with harvest volumes. It also gives a stand table by 20-cm classes to assess recruitment and sustainability.
		<b>Group summary</b>	Summarises harvest, seed and reserve tree numbers and volumes by species groups.
		<b>Tree List</b>	Lists for each block the harvest, reserve and seed trees with individual stock numbers, for monitoring and control.
	<b>Stand Tables</b>		A general stand table for a compartment, with user-definable size classes, summarisation of tree numbers, basal area or volume, and cumulative or class values, per ha or for the whole area.
	<b>Block Summary</b>		This function is not yet working. It is designed to call the Block thematic mapper.
	<b>Data check▶</b>	<b>Block</b>	Lists the stock tree data for a given block, with all details, in a format similar to the field data sheet, for checking purposes.
		<b>Plot</b>	Lists the data for an inventory plot, with all details, in a format similar to the field data sheet, for checking purposes.
	<b>Work summary</b>		Summarises numbers of blocks, plots and trees in the database by compartment.
	<b>GIS output files</b>		Generates ArcInfo-compatible files of block outlines, and a data table of tree attributes for a compartment including geo-referenced locations which can be imported by ArcView.

(Continued/...)

Menu	Description and usage
<b>Tools ►</b>	
<b>Datasheet view</b>	Toggles the current form into datasheet view, if allowed.
<b>Form view</b>	Restores normal form view for a datasheet.
<b>Sort ascending</b>	Sorts the datasheet on the selected columns in ascending order.
<b>Sort descending</b>	Sorts the datasheet on the selected columns in descending order.
<b>Print</b>	Prints the current form or datasheet.
<b>Print preview</b>	Previews the printed format of the current form or datasheet.
<b>Page setup</b>	Sets printer information such as paper size, margins, orientation, etc.
<b>ISSMI design</b>	Opens the Access database window for ISSMI and restores the standard menu.

## Appendix B : Exploratory inventory plot form

<b>Exploratory inventory sample plot enumeration form</b>		OIC enumeration team		Date		sheet	of
		Forest	Cpt.	Inv. Block UTM East	Inv. Block UTM North	Transect N	Direction
Site codes				Observations			
(1) Tree No.	(2) Species	(2) Spp Code	(3) Diam	(4) Quality	(5) Coded notes		