INTRODUCTORY GIS TRAINING:

REPORT AND RECOMMENDATIONS

prepared by

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in cooperation with

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INTRODUCTION

The first Malawi Environmental Monitoring Program (MEMP) introductory training course in Geographic Information Systems (GIS) was held in Blantyre, Malawi, at the Ministry of Finance's Data Processing Center from April 6 to April 15, 1994. As an introductory course, it was intended to develop a level of skills adequate for entry level GIS analysts and to provide the capacity for the trainees to continue development reasonably on their own without direct supervision through to the advanced course scheduled in August this year.

The course was conducted by Ron Eastman and James Toledano from Clark University, USA. Appendix I details the seven day course schedule including a one day field exercise conducted in the Njolomole watershed where a computer-assisted landuse mapping exercise was conducted. Appendix II shows the landuse map derived by the trainees as a result of this exercise, along with a three-dimensional satellite image of the greater Njolomole region that was created in the process of developing the map. Materials covered included fundamental concepts and analytical procedures in GIS, an introduction to Remote Sensing and Digital Image Processing, and an introduction to the use of Global Positioning Systems for field studies. This report identifies key observations and makes recommendations for future GIS activities in Malawi under MEMP.

ATTENDEES

The training was attended by 11 trainees from the Department of Forestry, Land Resources Conservation Branch, the Department of Meteorology, the Department of Surveys, the Department of Water, the Department of Research and Environmental Affairs, and the Department of Fisheries (see Appendix III).

The Department of Fisheries was not originally intended to be a part of the MEMP activities. These trainees were funded through a separate World Bank project to monitor impacts on Lake Malawi's fisheries. It was evident, however, that all parties involved could benefit from their participation. In fact, the scientists involved in the training will significantly contribute to the monitoring of Malawi's environment and it is our recommendation that they be encouraged to participate in all future activities.

OBSERVATIONS

The overall finding from our interaction with these dedicated and professional government staff trainees is the overwhelming need for a sustained and prolonged effort in GIS training in Malawi. With a few exceptions, computer skills were generally low and prior exposure to GIS was virtually non-existant. Perhaps more importantly, the analytical nature of the use of GIS to support environmental planning and monitoring seemed very new to this group. Fortunately, however, enthusiasm was high amonst the group, and we are confident that a sustained program of ground-up training will produce tangible results within a reasonable period of time.

Given this overall assessment, there was some variability within the group. For the majority, the overall skills level brought to the course was adequate, and the level of attainment within the course was encouraging. However, there were a few whose skills were marginal at best. It is our assessment that these trainees will not be able to keep pace with the main group through the prolonged effort that is needed in this research-oriented endeavor. Balancing this was another small group who performed exceptionally well. These are clearly individuals who are comfortable with computers and have a strongly analytical orientation. As a consequence, we have concluded that a better recruitment process needs to be instituted that ensures the identification of research- and analytically-oriented individuals with adequate computer skills.

Likewise, the professional level of the trainees also needs attention during the recruitment process. Although it is not uncommon for administrative personnel to be intimately involved in GIS, GIS research and analysis are demanding in time and energy at a sustained level. Thus, it is important that those recruited be of the level of GIS analysts involved in daily GIS related activities. This is not to exclude administrative personnel from the technology transfer process. However, their incorporation requires a distinctive character of training, more suited to their level of involvement.

Overall, as ascertained from the trainees, there seems to be support throughout the agencies for the development of GIS and related environmental information technologies. As a consequence, the following recommendations are offered for the long-term institutionalization of GIS.

RECOMMENDATIONS

An evolutionary training process must be at the heart of the technology transfer process. For most it was assumed that this introductory training was a one-shot affair with little follow-up. This, of course, is not the case and a continual training process will be developed that: (1) moves trained professionals to advanced levels; and (2) provides a continual flow of new personnel into the GIS research stream.

1.It is thus recommended that trainings be more frequent and varied in character than originally anticipated. This is in part to maintain the momentum created during the introductory training and to create a greater level of familiarity with the technology before the advanced course in August. In mid-May, James Toledano will conduct a two-day course on data preparation and digitizing. Furthermore, from May through August, the Clark team will send out bi-weekly exercises to be completed by the trainees and evaluated by Clark. These exercises will allow the trainees to gain more practice with the technology and expose them to a wider range of potential applications than was possible to cover within the time available for the introductory course.

It is unrealistic to hope that all trainees will be around three or even two years down the line. As such, another introductory course is planned for late July, followed by an advanced course in August. These multi-level trainings will continue throughout the remaining life of the project (Appendix IV).

2.It is recommended that those individuals identified by the Clark team as having not been able to keep up with the main stream of participants in the introductory course be asked to undertake further training in general computer use. Further, it is recommended that these individuals retake the introductory course in July along with others from their agencies.

3.It is recommended that new individuals be accepted into introductory courses through a new recruitment process. It will be required that all departments wishing to include personnel should submit *nominations* for those individuals, including a curriculum vitae with specific information on computer training. These nominations will be reviewed by Clark University and DREA. All trainees must continue to meet minimal computing standards including proficiency in DOS, word processing, and Windows (such as is provided by short courses at the Data Processing Center).

4.It is recommended that participation in advanced courses be contingent upon recommendation by DREA and the Clark team. This will prevent the main flow of the course from being interrupted by the need to review introductory materials.

5.Support materials for GIS are virtually non-existent in Malawi and are a significant component of the training process. Therefore, Clark University will provide texts for GIS and Remote Sensing to each of the agencies, as well as explore the possibility of complementary professional subscriptions to trade journals.

6.Along with training, there is an urgent need for the natural development of professional-level support outside of, and in addition to, that provided by Clark University. Communications with other GIS professionals in-country, regionally, and globally must evolve in order to share experiences, data, ideas, and develop scientific research applications. The group was advised of international networks of professionals such as GIS-L and the AFRICAGIS programme of UNITAR/UNSO/OSS. In response, the group suggested the possibility of forming a user's group of professionals in GIS. Several options for its context and mode of operation were explored, from which three persons were nominated to investigate those possibilities further. These were Sam Kainja from the Department of Forestry, Susan Machila from the Department of Surveys, and James Chuma from DREA. We feel this was an excellent example of high level of camaradarie and sense of professionalism amongst the group, and we believe that the three coordinators chosen provide an excellent cross-section of skills and professional outlook on the profession and its development. We will be monitoring this development with great interest and will provide them information as required.

7.It is strongly recommended that the Department of Fisheries be included in further training activities, and that DREA give strong consideration to their inclusion in the MEMP. The participants included in the introductory training at the request of the World Bank proved to be very strong additions to the group, and are clearly involved in monitoring activities that can benefit from GIS. The World Bank should be encouraged to support this activity further. As of yet, this department has no hardware capability for performing GIS activities.

8.A continual problem with GIS technology transfer is the upward mobility extended to each analyst. As they progress in the training process, they become highly qualified individuals worthy

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of promotion, within and outside of government. Although this is not helpful for the immediate needs of the MEMP, it is a process that shows professional growth and should not be discouraged. Instead, measures should be taken to promote the attractiveness of GIS analysts within the government. Formally setting up a GIS activity within each agency, such as a GIS Laboratory or a separate office, would give significant recognition to the to the trainees' efforts and a recognition of their talents.

9.Although most of the trainees suggested that there was strong support within each of their respective agencies, it is not realistic to assume that each agency will extend the resources needed to operate a GIS lab without proper sensitization of agency administrators.

This will not happen on its own. As part of the technology transfer process, a one day sensitization training will be given in August to administrators from each of the agencies involved. This workshop will sensitize administrators as to the opportunities afforded by the technology, explore the needs of the agencies that can be addressed, and elicit support for a broader level of involvement..

10.GIS is not a new technology, but it does require a long process of development. Since its introduction over 20 years ago, however, it has revolutionized the inventory, monitoring, analysis and planning of the natural environment. Invariably, it has led to significant efforts to covert traditional mapping technologies to computer-assisted procedures for the development of digital maps. The costs can be significant, but the payoff is equally strong -- shorter revision schedules, more precise products, and the ability to carry out monitoring and planning evaluations that would have been impossible in the past. To date, Malawi has seen no significant movement in this direction. However, it is clear that the any attempt to institutionalize the analytical capabilities offered by GIS will require such a development of digital map products.

In the National Environment Action Plan (NEAP), developed with the assistance of the World Bank, reference is made to an Environmental Information System (EIS). To some, this implies a centralized facility of on-line data, specially packaged to answer environmental queries. However, experiences from countries such as the United States, Canada, and the UK have suggested a very different concept. None of these countries has such a centralized facility. Rather, they have a decentralized program of agency-centered analysis that relies upon an archive of nationally-coordinated digital map data. It is our conviction that the development of National Environmental Mapping Program (NEMP) of coordinated digital data is essential to the further development of this technology. In addition, it is a key component of an EIS, along with mechanisms for continued education and the dissemination of data. These ideas will be sketched out in a separate document. However, it is our strong sense that the absense of any established programs offers an unusual opportunity for an extremely cost-effective development of a truely coordinated National Environmental Information System.

APPENDIX I

COURSE SCHEDULE FOR THE INTRODUCTORY TRAINING IN GIS AND IMAGE PROCESSING

Wednesday, April 6

Introduction to GIS
Introduction to IDRISI
Raster Data Structures

Thursday, April 7

Analysis in GIS
Database Query
Map Algebra
Distance / Context Operators

Friday, April 8

Vector Data Structures
Vector Analysis
Arc/Info Demonstration

Monday, April 11

Introduction to Remote Sensing
Image Exploration
Digital Image Processing I : Image Restoration
Destriping
Rubber Sheet Resampling
Digitial Image Processing II : Image Enhancement
Constrast Stretch / Compositing

Tuesday, April 12

Digital Image Processing III : Image Classification
Unsupervised
Supervised
Digital Image Processing IV : Image Transformation

Principal Components Analysis
Vegetation Index Mapping
Image Ratioing
Unsupervised Classification of Case Study Area
Introduction to Global Positioning Systems

Wednesday, April 13

Ground Truth of the Njolomole/Mlangeni Case Study using GPS/GIS

Thursday, April 14

Completion of Land Cover Mapping of Case Study Area
Accuracy Assessment
Data Entry
Data Transformation

Friday, April 15

System Design and Evaluation
Advanced Course Preview
Software Developments : ArcView and IDRISI for Windows
Open forum: GIS and MEMP
Course Evaluation

APPENDIX II

ILLUSTRATION OF PRODUCTS CREATED DURING THE COURSE

Figure 1
A three-dimensional orthographic perspective display of the satellite imagery used in the Njolomole case study. This image was produced by the participants by first registering (to the Malawi UTM Zone 36 / Arc 1950 Datum) and applying a noise removal procedure to three bands of imagery created by the SPOT satellite. These three bands (captured in the green, red and near-infrared wavelength regions) were then composited to produce a false color image that is particularly suitable for computer-assisted land cover interpretation. Finally, the image was draped over an elevation model created from digitized contours for the region.

Figure 2
A land cover map produced from a portion of the the imagery depicted in Figure 1. To create this map, the participants applied a variant of cluster analysis to the spectral reflectances in the three SPOT image bands (a process known as *unsupervised classification*). They then visited the area to identify each of the clusters. To aid in positioning, a hand-held Global Positioning device was used -- a device capable of receiving signals from a network of satellites to determine ground positions (in this case, directly in Malawi UTM Zone 36 coordinates). Identified clusters (15 in total) were then collapsed into the 8 classes indicated here. The *unclassified* category includes two clusters that could not be determined because of time constraints.

The area covered by this image includes the entire Njolomole monitoring watershed. Although the time of the imagery was not optimal (June 1992), it was still capable of yielding the major land cover types in the region. Indeed, in many cases the original clusters were able to provide reliable species differentiation, such as between sugar cane and elephant grass in the Dambo areas, and between Jacaranda and Eucalyptus in the closed canopy woodland. It is interesting to note the prevalence of bare areas in this image. In the original clusters, one of the clusters that fell into this category included a bare-earth category. We were able to determine that many of these areas were occupied by refugee camps during the time when this image was taken.

APPENDIX III

COURSE PARTICIPANTS

Land Resources and Conservation Branch
Vincent Albert Lameck Mkandawire
Senior Land Husbandry Officer

Meteorological Department
Maxwell E. Gwazantini
Hydrometeorologist

Thomas Benedicto Kamwendo
Senior Meteorological Assistant

Fisheries Department
Orton M. Kachinjika
Fisheries Research Officer

Dr. N.C. Mwanyama
Fisheries Research Officer

Forestry Department
Sam Kainja
Senior Forestry Officer

Patrick S. Jambo
Chief Documentation Officer

Water Department
Alex Miston Banda
Water Chemist

Surveys Department
Richie B. Muheya
Chief Cartographer

Susan N. Machila
Technical Officer (Photogrammetry)

Department of Research and Environmental Affairs
James B.M. Chuma
Chief Documentation Officer

APPENDIX IV

WORK SCHEDULE

	1994								1995											
	May	June	July	August	Sept.	Oct.	Nov.	Dec..	Jan.	Feb.	March	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.
Two-day Data Entry Workshop	■																			
Set-up GIS Equipment	■																			
Acquire SPOT Imagery			■								■									
GIS Practice Exercises	■	■	■		■	■	■	■		■	■	■	■	■	■	■				
Trainee Nominations/Review		■					■				■									
Introductroy Training				■					■				■							
Advanced Training				■					■				■						■	
Sensitization Workshop				■					■											
Agency Pilot Projects					■	■	■			■	■	■		■	■	■	■			
Inter-Agency Seminar									■				■						■	
Pilot Study Demonstrations									■				■						■	
Establish Users-Group				■																
Establish Agency GIS Labs					■															
EIS Planning				■					■				■						■	■
Wrap-up/Documentation																			■	■

Addendum to Malawi Trip Report: April 1994

April 28 - May 6, 1994
James Toledano

The remaining part of the trip was devoted to installing the GIS equipment that arrived from The University of Arizona on April 30. The Forestry Department was designated as the office to concentrate installation in order to prepare for the data entry training on May 2-3. Most equipment was successfully installed, with exceptions listed below. The remaining equipment at the other agencies will be installed during the week of May 9 by Kent Burger.

Equipment

In addition to the GIS and office PCs, which arrived intact, Forestry also received one each: A0 digitizer, 9-track tape, and an A0 8 pen plotter. The digitizer was made functional with Tosca 2.0. It did not, however, arrive with its stand. As a result digitizing will be very awkward until they arrive in the next shipment. (The next shipment will also include the color and laser printers.) The 9-track tape and the plotter were not left in working order before departure. Much effort was spent on bringing the 9-track on-line with faxes and phone calls to the US. In the end it was concluded by myself in consultation with Zeos that the appropriate driver was not shipped (SMARTROM.SYS). I will pursue this immediately upon return.

The 9-track tape was initially installed at Forestry in order to download Forestry's multi-temporal TM and MSS data. As a result, the TM and MSS data intended for the advanced course was not downloaded.

Although the intention was to have the plotter up and running during the data entry training for demonstration purposes, it was not possible. My initial assessment is that there may be an incompatibility with the HP command set used by Idrisi and the HP emulation used by CalComp. I will also pursue this upon return to Clark.

Training

The two day data entry training held at the Forestry Department was attended by 8 of the original 11 trainees from the introductory training: Rich Muheya and Susan Machila, Survey Department; Vincent Albert Lameck Mkandawire, Land Resources and Conservation Branch; Maxwell E.

Gwazantini and Thomas Benedicto Kamwendo, Meteorological Department; Dr. N.C. Mwanyama, Fisheries Department; Patrick S. Jambo, Forestry Department; Alex Miston Banda, Water Department (one day only). A morning of lecture was followed by hands-on digitizing. Each took their turn in digitizing line and polygonal features. Another session was given on computer hardware and maintenance as well as discussion of the Microsoft office suite of tools (given by Kent Burger) supplied with each computer.

At the end of the training the first set of GIS exercises were given to the trainees to complete in three weeks time pending equipment installation. Trainees are to complete one section in succession every two weeks. They have been instructed to write all answers in WORD in order to gain familiarity with work processing. The exercise schedule will be distributed by Kent Burger every two weeks or as trainees complete the exercises. Trainees responses to the exercises will be pouched or faxed to Clark every two weeks. The exercises are meant to reinforce key concepts acquired during the introductory training as well as maintain familiarity with GIS through to the advanced course in August.

TABLE 1: PRELIMINARY GIS EXERCISE SCHEDULE

Section 1.

> Idrisi Exercise 2: Image Display/Color
> Idrisi Exercise 3: Image Display/Contrast Stretching
> Idrisi Exercise 4: Data and File Types

Section 2.

> Idrisi Exercise 5: Database Query/Overlay Boolean Analysis
> Forestry Exercise 1: Database Query/Overlay-Extract

Section 3.

> Forestry Exercise 3: Database Query by Attribute
> Idrisi Exercise 7: Map Algebra/Suitability Mapping

Section 4.

> Forestry Exercise 4: Map Algebra/Regression Analysis
> Forestry Exercise 5: Cost Distance Analysis

Section 5.

> Forestry Exercise 6: Deforestation and Soil Loss Measurement
> Idrisi Exercise 12: Image Processing/Image Display

Section 6.

Idrisi Exercise 13: Unsupervised Classification
Idrisi Exercise 15: Supervised Classification

(Forestry exercises refer to the UNITAR Forestry Workbook)

World Bank

A meeting with the Emmanuel Aseby from the World Bank confirmed the Banks commitment to their trainees participating in the MEMP program. However, the GEF project that was to support the trainees from Fisheries will not be on-line until late summer. It is assumed that funds from the NEAP are being diverted to cover the costs of the two trainees from Fisheries Department and will continue until funding provided by the Lake Malawi GEF project comes on-line.

Save the Children

Save the Children is currently conducting research on vulnerability/hazards mapping in Malawi. They are collecting and assimilating EPA level data and correlating with ADMARC data. This is a new program which will be of interest to pursue the next trip out in July, although Kent Burger will follow-up if possible. Penny from Save and who gave a presentation at Clark regarding mapping research being carried out in Uganda will arrive in Malawi for a 6 week consultancy in June .

EPA

The report that details the reporting mechanism for agricultural development plan for Malawi, now 15 years in existence, will be forwarded to Clark. As a summary, the following is intended to give an overview of the rigorous reporting requirements at the EPA level.

Instituted in 1980, the EPA-RDP data collection is intended to monitor agricultural progress. Data is collected at the EPA level for all crops, food and cash crops including tobacco (tobacco data is not differentiated by type). Data is collected on standardized reporting forms by field assistants (FA) in each EPA who follow a systematic crop estimates methodology. Each EPA has have several FAs. Each EPA is stratified into blocks with samples taken within each block. A FA will transect these sample areas by pacing individual stratified sample fields several times to derive average hectarage and yield. Once the FA has sampled the EPA the reports are given to the development officer (DO) for the EPA. The DO will collect each FA report before filling out another standard report at the EPA level. This report is used to verify EPA data collection in regards to historical records, other FAs reporting in the EPA, and ADMARC sales of seeds, fertilizers, etc. Once the DO is satisfied, these reports are then turned over

to the project officer (PO) at the RDP. The PO further compiles a standard report for all EPAs in the RDP and verifies in the same manner as the DO. Once satisfied, and RDP report is sent to the evaluation officer at the ADD for the final report.

What this process suggests is a statistically rigorous data collection process with verification from the ground-up. For all intents and purposes, an area frame sampling scheme is already in place in Malawi. Pending the detailed report, serious consideration should be given to using this reporting system as part of the MEMP. Kent Burger will follow-up by surveying several EPAs to collect preliminary information on the accuracy of this reporting mechanism.

Follow-up for Kent Burger

Kent Burger will follow-up on trainee selection for the next introductory course currently scheduled for the first week in August. It is suggested that Rich Muheya, Thomas Benedicto Kamwendo, and Patrick S. Jambo attend an introduction DOS and computers course before the advanced course currently scheduled for the third week in August. A training site will also be finalized by the end of May.