Draft Report
Clark University Activities
May-August 1997

Malawi Environmental Monitoring Program
Department of Environmental Affairs

submitted by: Mathilde Snel, Dr. Ron Eastman, Nicholas Haan and James Toledano
Clark University
In Collaboration with the University of Arizona
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Introduction:
Clark University's involvement in the Malawi Environmental Monitoring Programme (MEMP), a program within the Department of Environmental Affairs (previously referred to as the Ministry of Research and Environmental Affairs), continues to emphasize the development of environmental monitoring capacities within the Government of Malawi (GOM) and in its second phase MEMP II has extended its focus to include the University of Malawi (UNIMA). Clark's activities in MEMP II focuses on the initiatives to provide assistance in the development of a prototype Environmental Information System (EIS) on the Shire River valley, integrate UNIMA in MEMP activities, and build capacity in geographic technologies and environmental monitoring.

This report will review Clark's involvement in MEMP II from May to August 1997 with reference to tasks as outlined in the *Second Annual Workplan for the Components of the Malawi Environmental Monitoring Programme (MoREA, 1997)*. During this period Clark University has conducted a technical seminar on digital mapping standards with the Department of Surveys; conducted the third in a sequence of trainings in geographic technologies at Bunda College; conducted a digitizing training in ArcEdit at the Polytechnic University; worked with university staff to integrate geographic technologies and environmental monitoring into existing UNIMA courses; conducted preparatory work on the training of trainers in the next sequence of geographic technologies training to start in October, 1997; provided assistance in the development of the prototype EIS on sedimentation in the Shire; and investigated the long term acquisition and use of AVHRR data for future environmental monitoring.

Duties of the technical advisors
Four short term technical advisors were involved: Dr. Ron Eastman, Mathilde Snel, Nicholas Haan, and James Toledano. Their duties included:
1. preparing and conducting a technical seminar with the Department of Surveys on digital mapping standards to be used in the compilation of geographic data in the prototype EIS (task ID 2.4 in the *Second Annual Workplan for the Components of the Malawi Environmental Monitoring Programme*, 1997);
2. preparing and conducting an advanced training in geographic technologies (task ID 6.1) ;
3. preparing and conducting a digitizing coarse at Polytechnic (task ID 6.1 and 6.3);
4. facilitating discussions on the training of trainers in the next sequence of geographic technologies course to start in October 1997 (task ID 6.1);
5. facilitating discussions on the integration of geographic technologies in existing UNIMA courses (task ID 6.3);
6. providing assistance in the development of the prototype EIS on a situation analysis of the Shire River valley (task ID 2.1, 2.2, 2.3, and 6.3) ; and
7. investigating the long term acquisition and value of AVHRR data for future environmental monitoring activities (task ID 4.1, 4.2, and 4.3).

These duties have been described in detail in the Scope of Work for each of the four short-term technical advisors (Appendix 1).

Accomplishments of the Technical Advisors

Technical seminar on digital mapping standards at the Department of Surveys

Members of the Clark University contingent of the EIS design team met with members of the Department of Surveys in Blantyre from June 5-9, 1997 to discuss plans for the prototype EIS and its implications for the work at Surveys (task ID 2.4). Of particular concern was to establish provisional digital mapping standards to be used during the first phase of the prototype EIS. Persons present at the meeting included :

Mr. Emmanuel Likombola	Land Surveys
Mr. Thompson Sumani	Cartography
Mr. Lovemore Mazonda	Cartography
Mr. Jeff Mzembe	Photogrammetry
Mr. Muwuso Chawinga	Photogrammetry
Mr. Jackson Nakutepa	Photogrammetry
Ms. Mathilde Snel	Clark University
Dr. Ronald Eastman	Clark University

In addition, the meeting was opened by Mr. Ambuje F. Tambala, the Surveyor General, with a pledge to assist the group in formalizing its recommendations. In addition, Mr. Greshan Gunda, Chief Staff Surveyor met with the group to review their work. Recommendations for digital mapping standards were made and include coding standards (e.g. entity, representation, attribute, relationship, geometrical, and topological standards), accuracy standards (e.g. horizontal, vertical, and other attributes accuracy standards), documentation standards, and transfer standards (see Appendix 2 for a copy of the draft report). It was agreed that these standards would be reviewed by the Department of Surveys and refined in October when the members of Clark University meet again to further develop and finalize the digital mapping standards (task ID 2.4) and to develop a distribution format and medium (task ID 2.5 and 2.6).

The digital mapping standards as recommended in the draft report of the technical seminar (Surveys, 1997) are being used as provisional standards throughout the compilation of digital geographic data in the prototype EIS (task ID 2.1). The Department of Surveys is at present, for example, using a provisional data standards form as recommended by the technical seminar for all digitized files (see Appendix 3 for an example of a data standards form for a digital soils maps of Blantyre ADD) and georeferenced files (see Appendix 4 for an example of a data standards form for a 1994 georeferenced satellite image).

Advanced training in geographic technologies

The third in a series of geographic trainings was held at Bunda college from June 17 to June 21, 1997 (task ID 6.1). Seventeen participants attended and completed the full training sequence as follows:

McArd Joseph Mlotha **-** Forestry Planning and Mapping Unit, Lilongwe
Patrick Jambo **-** Forestry Planning and Mapping Unit, Lilongwe
Muwosa Kennedy Chawinga **-** Department of Surveys, Blantyre
Jakson Nakutepa **-** Department of Surveys, Blantyre
Meescheck Kapila **-** Land Husbandry Training Center, Zomba
Symon Mkwinda **-** Land Resources and Conservation Branch, Shire Valley ADD
John Mussa **-** Land Resources and Conservation Branch, Shire Valley ADD
Austwell Kayinga **-** Land Resources and Conservation Branch, Kasungu ADD
Samuel Chilombe **-** Meteorological Department, Chileka
Nicholas Mwafulirwa **-** Meteorological Department, Lilongwe
Benson Phiri **-** USAID
Joseph Jonazi **-** UNIMA, Bunda College
Kenneth Wiyo **-** UNIMA, Bunda College
Steven Taulo **-** UNIMA, Polytechnic

G. Chavula - UNIMA, Polytechic
Meya Kalindekafe - UNIMA, Chancellor
Edith Kanjo - UNIMA, Chancellor

Dr. Ron Eastman, Nicholas Haan, and Mathilde Snel conducted sessions on time series analysis to investigate landcover change and interpret socioeconomic changes; decision making techniques for environmental analysis; and modeling of soil erosion potential using additive and multiplicative models (e.g. SLEMSA). The sequence of topics covered during the advanced training has been included in Appendix 5.

In conjunction with the prototype EIS on the Shire River valley, most sessions during the training focused on analyzing areas within the Shire watershed. A time series analysis indicating variation in NDVI (Normalized Difference Vegetation Index) over a fifteen year period (1982 - 1997) was used on the watershed about the Nkulu and Tedzani hydroelectric dam. A principle components analysis was used over the fifteen year time period (1082 - 1997) to extract major trends or components. A discussion of the biophysical and socio-economic changes from 1982 to 1997 in the watershed were discussed in class to help interpret the component loadings (Appendix 6). Two primary components were identified: one indicating a 8-10 year climatic cycle (graph 1) and another indicating areas of significant vegetation change (Graph 2). Graph 2 indicates that a significant change seems to have taken place after 1993/94; it was speculated that this sudden change in the second component loading may be indicative of the significant vegetation changes that have taken place after democratization in Malawi. Figure 2 shows the corresponding image to Graph 2 where green and red/black represent significant landcover changes and yellow areas insignificant landcover changes. Areas of significant land cover change include areas about Mwanza and Neno, north of Blantyre, west of Zomba forest reserve, and west of Mount Mulanje. Similar time series analysis are presently being implemented for the entire Shire watershed in the development of the prototype EIS.

In conjunction with the prototype EIS emphasis on soil erosion hazard in the Shire, the advanced training incorporated a session on soil erosion modeling. Additive and multiplicative models were used to illustrate soil erosion potential in the Kamunde watershed. An additive model combining and weighting criteria (e.g. soils, landcover, slope, and rainfall) that affect soil erosion hazard was created . Also, a multiplicative models using a modified SLEMSA for Malawi (Paris 1990) was used to estimated soil loss in the Kamunde Watershed. As indicated in Figure 2, estimated soil loss in highly vulnerable areas within the Kamunde watershed ranges from approximately 20 to 52 tons per hectare. In approximately 60% of the catchment, however, soil loss was found to be less than 10 t/ha/yr. Throughout the SLEMSA excercise, emphasis was placed on the assumptions of the modified SLEMSA that: rainfall energy and not rainfall intensity information is incorporated; no information is included on the effect of organic matter on soil erosion; and that traditional management - v.s. improved traditional management - is assumed to lead to increased soil loss .

Digitizing course
A three day digitizing course facilitated by James Toledano, Mathilde Snel, and Nick Haan in ArcEdit was held at the Polytechic University from July 8 to July 10th, 1997 (task ID 6.1 and 6.3). Only those participants who presently have or will have access to digitizing equipment were asked to attend the course. Specific emphasis was placed on training participants from the Department of Surveys since this GOM agency has a key interest and mandate in digitizing national mapped data. To encourage institutional collaboration within the Department of Surveys, participants from both the digital mapping unit and cartographic unit of the Department of Surveys were encouraged to attend. Aside from the Department of Surveys other participants were from the Land Resources Conservation Branch (Lilongwe), Chancellor College, Bunda College, and Polytechnic college. The participants were as follows:

Jeff Mezembe - Department of Surveys, Digital Mapping Unit, Blantyre
Muwosa Kennedy Chawinga - Department of Surveys, Digital Mapping Unit, Blantyre

Jakson Nakutepa - Department of Surveys, Digital Mapping Unit, Blantyre
Thompson Sumani - Department of Surveys, Cartographic Unit, Blantyre
Lovemore Mazonda - Department of Surveys, Cartographic Unit, Blantyre
Mr. Muthali - Land Resources Conservation Branch, Lilongwe
Mr. Sengini - Air Photo Interpretation Unit, Land Resources Conservation Branch, Lilongwe
Joseph Jonazi - UNIMA, Bunda College
Kenneth Wiyo - UNIMA, Bunda College
Steven Taulo - UNIMA, Polytechnic
Geoffrey Chavula - UNIMA, Polytechic
Mrs. Faparusi - UNIMA, Polytechnic
Meya Kalindekafe - UNIMA, Chancellor
Edith Kanjo - UNIMA, Chancellor
Samuel Chilombe - Meteorological Department, Chileka

Most lectures and labs were held at Polytechnic, while hands on digitizing sessions were conducted at the Department of Surveys. This was the first training in geographic technologies conducted by MEMP where funding was obtained exclusively by participants. Furthermore, it was the first training in which MEMP was not asked to cover overhead costs, rather equipment and facilities were provided to MEMP by the Polytechnic and Department of Surveys. MEMP extents its deep gratitude to both the Polytechnic and Department of Surveys for helping organize the training and providing facilities. The turn out of fifteen participants to the technical advisors indicates the high level of interest for the trainings in geographic technology.

Training of trainers - integrating UNIMA staff as trainers in the next sequence of geographic technologies course**s**

The focus of MEMP in its second phase has been extended to include UNIMA. A large emphasis in the subsequent sequence of geographic technology trainings - to start in October 1997 - will be the training of trainers (task ID 6.1). Nicholas Haan facilitated discussions with UNIMA staff and made provisional arrangements to incorporate UNIMA staff as instructors in a number of sessions in the next geographic technology training to be held in October 1997. To place further emphasis on the training of trainers, participants in the next sequence of geographic technology course will be primarily from - although not exclusively - UNIMA. Nicholas Haan's activities relating to integrating UNIMA in the next training sequences is discussed in more detail in his trip report (Appendix 7).

Integration of geographic technologies in UNIMA courses

Nicholas Haan facilitated a number of discussions with UNIMA staff to integrate geographic technologies in existing courses (task ID 6.2). Presentations to familiarize UNIMA staff in geographic technologies were given at respectively Polytechnic, Bunda College, and Chancellor College. Discussions were held with and technical guidance given to staff at Chancellor, Bunda, Polytechnic, and Land Husbandry Training Center to integrate GIS and remote sensing in present UNIMA courses and research initiatives. Joseph Jonazi, a professor at Bunda college, for example anticipates to integrate GIS into a statistics course he will be teaching the next semester.

Furthermore, Nicholas Haan conducted a number of discussion with UNIMA on present research initiative and how these may relate to the development of the prototype EIS (task ID 6.3). With respect to these discussions it was found that UNIMA participants of the 1996/97 geographic technologies training are already actively involved in research initiatives other than the Shire (e.g. Chancellor College's research initiative on Lake Chilwe). It was determined that it would be best to encourage and assist staff on their present research interest rather than ask members to deviate. It is, however, recommended that in the next sequence of trainings similar discussions are held with other UNIMA staff to gauge their interest in participating in the Shire analysis. These activities have been discussed in more detail in Haan's report (Appendix 7).

Development of the Prototype EIS

Clark University's involvement in expanding environmental monitoring technologies in its present phase focuses on providing assistance in the development of a prototype Environmental Information System (EIS) on the Shire River valley. Guidance was given in refining the objective and technical strategy of the development of the prototype EIS, providing technical support for the collection and archiving of data (task ID 2.1), and providing technical support for GIS/Remote Sensing analysis in the prototype EIS (task 2.2).

In the absence of an EIS team leader, Mathilde Snel of Clark University and Twanga Mbale of the Department of Environmental Affairs (DEA) met informally to provide recommendations on refining the objective of and technical strategy for the development of the prototype EIS. Furthermore, Nicholas Haan, James Toledano, Mathilde Snel, and Dr. Ron Eastman of Clark University had a number of discussions relating to recommendations on refining the objective and strategy of the prototype EIS. The discussions were specially geared towards providing recommendations to the EIS team leader, analysis team, and information dissemination team once these have been formally identified.

A summary statement on the Shire situation analysis (Appendix 8) and report were drafted (Appendix 9). It was recommended that the Shire situation analysis build on Green's report (1996) and emphasize the effectivity of: 1) geographic technologies **-** such as the use of Geographic Information Systems (GIS)**-** to help situate the problem of sedimentation in the Shire and 2) the use of rural appraisals to provide explanations on the underlying causes of environmental degradation and possible mitigation scenarios. It was recommended that the Shire situation analysis concentrate on providing information on land cover change and soil erosion potential by addressing the questions: 1) where are significant landcover/use changes occurring in the Shire river valley?; 2) what is the geographic distribution of soil erosion hazard in the Shire?; 3) what are potential areas of intervention with respect to landcover/use change and soil erosion potential in the Shire?; 4) does land cover change influence soil erosion potential?; 5) what are the underlying social, economic, and political circumstances contributing to land degradation in the Shire?; 6) what are possible intervention strategies and their anticipated impacts?; and time permitting 7) to what extent does landcover/use changes influence sedimentation?. It is recommended that once the principle investigator, analysis team, and information dissemination team have been formally identified that the objective and technical strategy of the prototype EIS are further developed. It is further recommended that DEA consider allocating one staff member to work full-time on coordinating work on the development of the prototype EIS, although the technical advisors realize that this may be difficult to arrange.

In refining the objective and strategy of the prototype EIS, acknowledgment was made of the importance of social analysis to help identify the underlying causes of environmental degradation and possible mitigation scenarios. Nicholas Haan proposed to guide a group of Malawian social scientists in situating a social analysis for the Shire situation analysis (Appendix 10). It was proposed to include two additional tasks (tasks 3 and 4) under the "Assessment of Causes of Sedimentation in the Mid-Shire River" in the *Second Annual Workplan for the Components of the Malawi Environmental Monitoring Programme: Environmental Monitoring Technologies, Research, and Policy Sub-programmes* (MoREA, 1997) (Haan 1997):

> Task 3: to develop an action oriented, community based social research methodology that is replicable by GOM and linked to environmental problems identified by geographic and physical analysis
>
> > Output 1. Report on methodology with suggestions for implementation, especially as it links to geographic technologies

Task 4:, to illustrate a chain of explanation that spans from immediate to root causes of land use changes - specifically for the sedimentation problem identified in the Shire watershed - so as to advise the GOM on potential scenarios of intervention and their respective anticipated impacts.

Output 2: Research paper that illustrates chain of explanation for policy implications based on intensive study of 2 -3 communities.

Since funding for the analysis team (task force) was not secured yet, Clark University worked jointly with DEA to help facilitate the process. Discussions were held with GOM agencies to gain a better understanding of the level of commitment of staff to the Shire situation analysis and resource needs. Discussions were held with the Department of Forestry, Department of Surveys, Meteorology Department, and Land Conservation Research Branch and candidates in the respective agencies identified (Appendix 11). As a strategy to strengthen departmental capacity, discussions were held with the respective GOM agencies to determine departments interests in environmental monitoring (task 6.1). It was determined that departmental interests were as following: Department of Forestry in conducting landcover/use change analysis; Meteorological department in evaluating geographic variations in rainfall and ndvi/agricultural for drought monitoring; Ministry of Agriculture in evaluating variations in agricultural production and population; and Department of Surveys in digitizing maps (e.g. soils maps) and georeferencing images. Technical guidance was given to the Department of Forestry, Department of Surveys, Meteorology Department, and Ministry of Agriculture with respect to these departmental interest. Tasks - as proposed as deliverables in the *Second Annual Workplan for the Components of the Malawi Environmental Monitoring Programme: Environmental Monitoring Technologies, Research, and Policy Sub-programmes* (MoREA, 1997) - were allocated with respect to these departmental interests. The allocation of these tasks have been outlined in a provisional time line as indicated in Appendix 12.

Based on the draft report *Recommendations Towards Refining a Strategy for the Development of a Prototype Environmental Information System* (Snel, 1997), it was recommended that the information gathered during the initial GIS and remote sensing analyses emphasize baseline data in the Shire watershed on landcover/use changes (based off coarse 7.5 km NDVI data), slope (based off 1km data), rainfall, energy supply, agriculture, and population (Snel 1997). It is recommended that once this baseline information is collected, a workshop with information users and providers is conducted to help identify areas of intervention based on geographic analysis, anecdotal information, and existing reports (Green 1996). As proposed by Haan (1997), it is recommended that social analysis on the underlying causes and effects of sedimentation and land cover change is conducted in 2-3 such areas of intervention. Time permitting, it is additionally recommended that a more thorough biophysical assessment is conducted in these areas on land cover changes and soil erosion potential.

In addition to the compilation of baseline data, tasks were allocated and technical guidance given for land cover (1984 and 1994) and soil erosion hazard mapping of the mid-Shire as proposed in the *Second Annual Workplan for the Components of the Malawi Environmental Monitoring Programme* (MoREA, 1997). The Department of Surveys will georeference the 1984 and 1994 Landsat images (30 meter resolution) and digitize the soils maps of the Blantyre and Machinga ADDs, while the Department of Forestry will conduct unsupervised classification on the 1984 and 1994 Landsat images.

To ensure the long term investment of creating national capacity, it has been emphasized that digital geographic data sets compiled throughout the Shire analysis is created according to the provisional data standards as drafted by the Department of Surveys (Department of Surveys, 1997). The Department of Surveys is at present using the provisional data standards for all digitized and georeferenced files. The Department of Surveys has completed two data standards forms as recommended during the technical seminar - one data standards form for a Blantyre ADD digitized soils file (Appendix 3) and another for a 1994 georeferenced satellite image (Appendix 4).

To strike a balance between the short term needs of the prototype EIS situation analysis on sedimentation in the Shire and the long term investment of creating national capacity towards developing a national EIS, emphasis was additionally placed on appropriately archiving data. Mathilde Snel assisted the Department of Surveys to archive and document existing digital data (e.g. Famine Early Warning, SWEDE, and Digital Map of the World data) to be used in the Shire analysis. As specified in the technical seminar paper on data standards (Surveys 1997), existing data sets were documented using the Malawi General Purpose reference system (MalawiGP). Furthermore, the Department of Surveys archived - onto Colorado tapes - all 1994 Landsat images of the Shire to be used in the Shire situation analysis and will continue archiving the 1984 images. Mathilde Snel has contacted the University of Arizona to look into the possibility of obtaining the 1984 and 1994 Landsat images for all of Malawi on a more durable CD medium. An archiving medium and capability will need to be discussed in the follow up technical seminar with the Department of Surveys to be held in October (task ID 2.6).

Investigating the long term acquisition and value of AVHRR data for environmental monitoring
To facilitate future environmental monitoring in Malawi, the Clark team has been involved in analyzing the access and value of AVHRR data ((task ID 4.1, 4.2, and 4.3 in the *Second Annual Workplan for the Components of the Malawi Environmental Monitoring Programme*, 1997). Efforts are being facilitated to provide GOM access to 1km and 3k AVHRR for environmental monitoring- data respectively gathered by the Department of Fisheries unit in Salima and Meteorological Department Headquarters in Harare. The Meteorology department in Chileka has recently gained access to 1km NDVI AVHRR monthly data for 1996 - data that may be used for land cover change and drought monitoring. Provisions are presently being made to gain access to the separate bands of the 1km AVHRR data so that easily updated landcover/use maps may be created.

The Clark team have also been evaluating the value of different resolution data for environmental monitoring (task ID 4.3). Dr. Ron Eastman and Mathilde Snel looked into the feasibility of using 1km NDVI data - downloaded at the Department of Fisheries station in Salima - to map landcover/use and to detect fire (see report in Appendix 13 on “Evaluation of AVHRR 1.1km HRPT data”). Subsequently, Nicholas Haan conducted a special session with the Department of Forestry to analyze the use of different resolution NDVI data - 1km AVHRR, 7.6 km NDVI, and 20 meter resolution SPOT data - for monitoring vegetation changes. Discrepancies in deforestation rates between the different resolution data was identified. This will require further investigation.

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Appendix 1

Scope of Work
Mathilde Snel
In-Country Coordinator
Idrisi Project, Clark University
June-August, 1997

A major focus of MEMP II continues to be the development of environmental monitoring capacities within the Government of Malawi (GOM). During MEMP II this focus has been extended to include the University of Malawi (UNIMA). Planned activities from June to August 1997 intend to continue this development with both the GOM and UNIMA.

Specifically, three initiatives are planned during this time period: continued GIS training; development of prototype EIS; and linking UNIMA to the MEMP. An advanced GIS training is planned for June 17th to 21st, 1997 with UNIMA and GOM. Following the training, a number of follow-up activities will be conducted on integrating government agencies and university departments into the broader study on environmental monitoring of the Shire River watershed: the site for the development of the prototype EIS. The study will concentrate on assembling information on land cover change, soil erosion vulnerability, and socio-economic indicators. A meeting with the Department of Surveys is also planned in order to create initial national standards and guidelines in working with GIS and Remote Sensing data. Additional activities with UNIMA will move to create a national curriculum in environmental monitoring/GIS and related technologies. Finally, initial steps will be taken with the GOM during workshops and trainings to begin development of the prototype EIS. The role of the in country coordinator/ technical advisor will be to contribute to each of these activities as detailed below:

1. The TA will work on the one week advanced training in GIS and Image Processing. Departments that will be involved in the training include the Department of Surveys, Department of Forestry, Ministry of Agriculture, Department of Meteorology, and UNIMA (Bunda, Chancellor, and Polytechnic).

2. Prior to the one week training responsibilities will include data preparation for the training and creating training exercises.

3. The TA will work with the Department of Surveys to help create a number of national standards and guidelines in working with GIS and Remote Sensing data.

4. The TA will be involved in activities towards creating national capacity in environmental monitoring/environmental information systems including giving input to the Malawi Technical Committee on the Environment, subcommittee on the Shire situation analysis, government agencies and UNIMA.

5. During the post training period, the TA will facilitate work on analyzing land cover change, soil erosion vulnerability, and socio-economic changes in the Shire watershed - with specific concentration on the Machinga and Blantrye ADD. The TA will actively work with individuals assigned to the Shire task force as well as government agencies mandated to participate in the Shire study. The TA will also work help facilitate the involvement of UNIMA in the Shire situation analysis.

6. When appropriate, the TA will continue to facilitate with participating agencies related to continuing GIS development, either for MEMP or as required by the agency.

7. When permitting, the TA will consult on other matters related to MEMP as identified by either the in country Chief of Party or Project Manager/Clark University.

The in-country coordinator/TA will report directly to the in country Chief of Party and will submit weekly updates to both the Chief of Party and Project Manager/Clark University. The anticipated in-country stay will be 50-90 days, work permitting, and will be evaluated on a weekly basis in consultation with the Chief of Party and Project Manager/Clark University. By the conclusion of the visit data standards for working with GIS and remote sensing data will have been developed; an advanced course in GIS and Image Processing will have been conducted; a specialty training in digitizing will have been completed; satellite images about the Machinga ADD will be georeferenced; a prototype landcover map of the Machinga ADD will be created; contours and soils in the Machinga ADD will be digitized; and a prototype soil erosion model for the Machinga ADD will be created. The in country Coordinator will provide at the end of the visit a draft report of work completed, findings and recommendations: for integrating government agencies and university departments into the broader study on environmental monitoring of the Shire River watershed; on future EIS activities; on initial national standards and guidelines in working with GIS and Remote Sensing data at the Department of Surveys; on guidelines in creating a national curriculum in environmental monitoring/GIS and related technologies in UNIMA; and on future GIS/training activities.

Scope of Work
Nicholas Haan
Technical Advisor
Idrisi Project, Clark University
June-August, 1997

A major focus of MEMP II continues to be the development of environmental monitoring capacities within the Government of Malawi (GOM). During MEMP II this focus has been extended to include the University of Malawi (UNIMA). Planned activities from June to August 1997 intend to continue this development with both the GOM and UNIMA.

Specifically, three initiatives are planned during this time period: continued GIS training; development of prototype EIS; and linking UNIMA to the MEMP. An advanced GIS training is planned for June 17th to 21st, 1997 with UNIMA and GOM. Following the training, a number of follow-up activities will be conducted on integrating government agencies and university departments into the broader study on environmental monitoring of the Shire River watershed: the site for the development of the prototype EIS. The study will concentrate on assembling information on land cover change, soil erosion vulnerability, and socio-economic indicators. A meeting with the Department of Surveys is also planned in order to create initial national standards and guidelines in working with GIS and Remote Sensing data. Additional activities with UNIMA will move to create a national curriculum in environmental monitoring/GIS and related technologies. Finally, initial steps will be taken with the GOM during workshops and trainings to begin development of the prototype EIS. The role of the technical advisor will be to contribute to each of these activities as detailed below:

1. The TA will work on the one week advanced training in GIS and Image Processing. Departments that will be involved in the training include the Department of Surveys, Department of Forestry, Ministry of Agriculture, Department of Meteorology, and UNIMA (Bunda, Chancellor, and Polytechnic).

2. Prior to the one week training responsibilities will include data preparation for the training and creating training exercises.

3. During the post training period, the TA will assist in the development of a GIS/environmental monitoring curriculum within UNIMA and research initiatives amongst faculty that could utilize GIS/environmental monitoring.

4. The TA will be involved in activities towards creating national capacity in environmental monitoring/environmental information systems especially as related to UNIMA's involvement.
The TA will promote the integration of these research initiatives with the broader Malawi Environmental Information System and help facilitate the involvement of UNIMA in the Shire situation analysis.

5. When appropriate, the TA will continue to facilitate with participating agencies related to continuing GIS development, either for MEMP or as required by the agency.

6. When permitting, the TA will consult on other matters related to MEMP as identified by either the in country Chief of Party or Project Manager/Clark University.

The TA will report directly to the in country Chief of Party and will submit weekly updates to both the Chief of Party, Project Manager/Clark University, and in-country coordinator. The anticipated in-country stay will be 30-45 days, work permitting, and will be evaluated on a weekly basis in consultation with the Chief of Party, Project Manager/Clark University, and in-country Coordinator. At the conclusion of the visit, the TA will provide a draft report/log on work completed, findings and recommendations on future environmental monitoring/GIS curriculum development at UNIMA and on integrating UNIMA research initiatives in environmental monitoring/environmental information systems activities. This information will be combined in a report by the in-country Coordinator.

Scope of Work
Dr. Ronald Eastman
Principle Investigator
Idrisi Project, Clark University
June-August, 1997

A major focus of MEMP II continues to be the development of environmental monitoring capacities within the Government of Malawi (GOM). During MEMP II this focus has been extended to include the University of Malawi (UNIMA). Planned activities from June to August 1997 intend to continue this development with both the GOM and UNIMA.

Specifically, three initiatives are planned during this time period: continued GIS training; development of prototype EIS; and linking UNIMA to the MEMP. An advanced GIS training is planned for June 17th to 21st, 1997 with UNIMA and GOM. Following the training, a number of follow-up activities will be conducted on integrating government agencies and university departments into the broader study on environmental monitoring of the Shire River watershed: the site for the development of the prototype EIS. The study will concentrate on assembling information on land cove change, soil erosion vulnerability, and socio-economic indicators. A meeting with the Department of Surveys is also planned in order to create initial national standards and guidelines in working with GIS and Remote Sensing data. Additional activities with UNIMA will move to create a national curriculum in environmental monitoring/GIS and related technologies. Finally, initial steps will be taken with the GOM during workshops and trainings to begin development of the prototype EIS. The role of the principle investigator/ technical advisor will be to contribute to each of these activities as detailed below:

1. Work on the one week advanced training in GIS and Image Processing. Departments that will be involved in the training include the Department of Surveys, Department of Forestry, Ministry of Agriculture, Department of Meteorology, and UNIMA (Bunda, Chancellor, and Polytechnic).

2. Work with the Department of Surveys to help create a number of national standards and guidelines in working with GIS and Remote Sensing data.

3. Give recommendations and guidelines towards analyzing land cover changes and soil erosion modeling in the Shire situation analysis.

4. Be involved in activities towards creating national capacity in environmental monitoring/environmental information systems including giving guidance to the Malawi Technical Committee on the Environment, subcommittee on the Shire situation analysis, government agencies and UNIMA.

5. When permitting, consult on other matters related to MEMP.

The anticipated in-country stay will be 24 days, work permitting. At the conclusion of the visit, the TA will provide a log/summary of work completed, findings and recommendations for future environmental information systems/environmental monitoring activities; guidelines and standards to be used in the Department of Surveys in working with GIS and remote sensing data; recommendations on creating a national curriculum in environmental monitoring in UNIMA; and future GIS/training activities. This information will be combined in a report by the in-country Coordinator. The principle investigator/technical advisor will consult and work closely with the Chief of Party, Program Manager/Clark University and in-country Coordinator on future activities.

Scope of Work
James Toledano
Program Manager
Idrisi Project, Clark University
June-August, 1997

A major focus of MEMP II continues to be the development of environmental monitoring capacities within the Government of Malawi (GOM). During MEMP II this focus has been extended to include the University of Malawi (UNIMA). Planned activities from June to August 1997 intend to continue this development with both the GOM and UNIMA.

Specifically, three initiatives are planned during this time period: continued GIS training; development of prototype EIS; and linking UNIMA to the MEMP. An advanced GIS training is planned for June 17th to 21st, 1997 with UNIMA and GOM. Following the training, a number of follow-up activities will be conducted on integrating government agencies and university departments into the broader study on environmental monitoring of the Shire River watershed: the site for the development of the prototype EIS. The study will concentrate on assembling information on land cover change, soil erosion vulnerability, and socio-economic indicators. A meeting with the Department of Surveys is also planned in order to create initial national standards and guidelines in working with GIS and Remote Sensing data. Additional activities with UNIMA will move to create a national curriculum in environmental monitoring/GIS and related technologies. Finally, initial steps will be taken with the GOM during workshops and trainings to begin development of the prototype EIS. The role of the Program Manger/technical advisor will be to contribute to each of these activities as detailed below:

1. The TA will be involved in activities towards creating national capacity in environmental monitoring/environmental information systems including giving guidance to the Malawi Technical Committee on the Environment, subcommittee on the Shire situation analysis, government agencies and UNIMA.

2. The TA will help give recommendations and guidelines towards analyzing land cover changes and soil erosion modeling in the Shire situation analysis.

3. When appropriate, the TA will continue to facilitate with participating agencies related to continuing GIS development, either for MEMP or as required by the agency. This may include giving a specialized training in digitizing to the Department of Surveys, Ministry of Agriculture, Bunda College, and other interested agencies.

4. When permitting, the TA will consult on other matters related to MEMP as identified by the country Chief of Party.

The anticipated in-country stay will be 24 days, work permitting. The anticipated in-country stay will be 24 days, work permitting.

At the conclusion of the visit, the TA will provide a log/ summary of work completed, findings and recommendations for integrating government agencies and university departments into a national Environmental Information System; on guidelines in creating a national curriculum in environmental monitoring/GIS and related technologies in UNIMA; and on future GIS/training activities. This information will be combined in a report by the in-country Coordinator. The program manager/technical advisor will consult and work closely with the Chief of Party and in-country Coordinator on future activities.

Appendix 2

Malawi Environmental Monitoring Programme

Technical Seminar on Environmental Information Systems

Department of Surveys
Blantyre, Malawi June 5-9, 1997

Draft Report and Recommendations

June 10, 1997

Members of the Clark University contingent of the EIS Design Team met with members of the Department of Surveys in Blantyre June 5-9, 1997 to discuss plans for an EIS and its implications for the work of Surveys in the development of a Digital Mapping Standard. Of particular concern was to establish some provisional recommendations for digital data development to be used during the first phase of the EIS plan during the Shire River assessment project. Persons present at the meeting included :

Mr. Emmanuel Likombola	Land Surveys
Mr. Thompson Sumani	Cartography
Mr. Lovemore Mazonda	Cartography
Mr. Jeff Mzembe	Photogrammetry
Mr. Muwuso Chawinga	Photogrammetry (Computer)
Mr. Jackson Nakutepa	Photogrammetry
Ms. Mathilde Snel	Clark University
Dr. Ronald Eastman	Clark University

In addition, the meeting was opened by Mr. Ambuje F. Tambala, the Surveyor General, with a pledge to assist the group in formalizing its recommendations. In addition, Mr. Greshan Gunda, Chief Staff Surveyor met with the group to review their work.

The meeting began with a general overview of an EIS, considering the following components:

A. Definition of an EIS

B. Components of an EIS
   1. System Management Subsystem
   2. Data Acquisition Subsystem
   3. Information Use Subsystem
   4. Human Resources Subsystem
   5. Technical Resources Subsystem
   6. Data Archive

C. A National Mapping Programme

D. Digitial Mapping Standard
   1. Coding Standards
      - Entities
      - Representations
      - Attributes
      - Relationships

- Geometrical
- Topological

2. Accuracy Standards
   - Horizontal
   - Vertical
   - Other Attributes
3. Documentation Standards
4. Transfer Standards

E. The Malawian EIS Development Programme

Discussions were then held on a number of key elements for the formulation of a Digital Mapping Standard for Malawi, with the following recommendations:

Recommendations

A. Horizontal Datum

A datum is a location-specific reference surface to which all measurements are reduced for locational referencing. Current topographic maps of Malawi are based on what is referred to as the "New Arc 1950" datum on most sheets. It is the understanding of Surveys that this is what is now known as the Arc 1960 datum. In addition, there is the possibility that older maps might exist on the Arc 1950 datum.

1. All digital data shall be developed using the Arc 1960 datum, and should refer to it by this name rather than the older name of "New Arc 1950".

2. The ellipsoid parameters of the Arc 1960 datum shall be understood to conform to current U.S. Department of Defense[1] (USDOD) and British Military Engineering (1971)[2] figures:

ellipsoid	:	Clark 1880 (Modified)	
major semi-axis (a)	:	6378249.145	
minor semi-axis (b)	:	6356514.870	
flattening (1/f)	:	1/293.46500	(0.003407561)

   Note that Land Surveyors Handbook of Malawi rounds semi-axis figures to the nearest metre, and expresses the flattening as 1/293.465.

3. The ellipsoid parameters for the older Arc 1950 datum are the same as those for Arc 1960.

4. In transforming between datums, the following Molodensky constants should be used:

   Arc 1960 (provisional)

delta X	:	-160
delta Y	:	-6
delta Z	:	-302

1 As documented in *IDRISI for Windows Version 2 User's Guide* (1997), Appendix A.

2 *Military Engineering Volume XIII - Part XII, Cartography 1971*, Amendment No. 1, (A/GS Trg Publications/3129, Army Code No. 70650), p. 15.

Arc 1950

delta X	:	-161
delta Y	:	-73
delta Z	:	-317

The Arc 1960 constants are expressed as provisional as the constants are defined as "Mean for Kenya and Tanzania" in current USDOD tables. The EIS Design team will pursue the issue of more specific values for Malawi with USDOD as it is suspected that the use of these more general values may lead to errors in the range of 10-30 metres. This error is an estimate only, based on tests done by the group on errors attributable to using the general Southern African Arc 1950 constants versus the more specific values for Malawi for Arc 1950 (see the below).

The Arc 1950 values are specific to Malawi, as published by USDOD. Note that the more general figures for all of southern Africa should not be used as tests conducted by the group indicated that these will lead to a typical error of 30-35 metres.

5. In using GPS equipment, datum transformation parameters should be set in conformance with the setting determined above. i.e.:

Arc 1960 (provisional)

major semi-axis (a)	:	6378249.145
flattening (1/f)	:	0.003407561
delta X	:	-160
delta Y	:	-6
delta Z	:	-302

Arc 1950

major semi-axis (a)	:	6378249.145
flattening (1/f)	:	0.003407561
delta X	:	-161
delta Y	:	-73
delta Z	:	-317

In cases where there is uncertainty about the values that are used by the GPS unit, data should be collected using the WGS84 datum, and then converted using a GIS where specific parameters can be set (e.g., IDRISI). Note that WGS84 values should never be used directly as tests by the group indicate that they lead to a typical error of 200-225 metres.

B. Vertical Datum

Railways --> Trig
|--> Shire Valley
National Datum
list sheet by sheet which datum is in use and adjustment factor to be used.

C. Reference System

It is proposed that two reference systems shall be used for digital data: one for general purpose applications consistent with the UTM Zone 36 used for topographic mapping, and the second for municipal and local government applications.

1. General Purpose Reference System (MalawiGP)

The MalawiGP reference system is identical to the UTM Zone 36 system used for topographic mapping by Surveys. Its characteristics are as follows:

Projection	:	Transverse Mercator
Datum	:	Arc 1960
Central Meridian	:	33º
Scale Factor at CM33	:	0.9996
Maximum Error	:	1/2500
Longitude of True Origin	:	33º
Latitude of True Origin	:	0º
False Easting at Origin	:	500,000 m E
False Northing at Origin	:	10,000,000 m N

Because of its error characteristics, this system should not be used for municipal applications. However, it is suitable for most applications involved with environmental monitoring and resource management.

2. Municipal and Local Government Reference System (MalawiLN and MalawiLS)

The MalawiLG reference system is proposed as a new reference system, and has not been previously used for any mapping. The intention is to provide a system that will have error characteristics that do not exceed 1:10,000 for any part of the country. In addition, it is assumed that this system will be based on Class A geodetic control surveys (1:12,000). This is impossible to achieve for the whole country with a single system. Therefore a system has been designed with two zones : a northern zone to be referred to as MalawiLN and a southern zone to be referred to as MalawiLS. The division between the zones corresponds with the northern borders of Ntcheu and Mangochi districts. The characteristics of the zones are as follows:

MalawiLN

Projection	:	Transverse Mercator
Datum	:	Arc 1960
Central Meridian	:	33º 48' (33.8º)
Scale Factor at CM33-48	:	0.9999
Maximum Error	:	1/10,000
Longitude of True Origin	:	33º 48' (33.8º)
Latitude of True Origin	:	-15º
False Easting at Origin	:	150,000 m E
False Northing at Origin	:	0 m N

MalawiLS

Projection	:	Transverse Mercator
Datum	:	Arc 1960
Central Meridian	:	35º
Scale Factor at CM33-48	:	0.9999
Maximum Error	:	1/10,000
Longitude of True Origin	:	35º
Latitude of True Origin	:	-18º

False Easting at Origin	:	100,000 m E
False Northing at Origin	:	0 m N

The group conducted tests for these zones to determine the minimum, maximum and mean scale factors associated with each district. The tests were conducted with the IDRISI GIS software system for each 1' quadrangle within each district. Thus the values are geographically specific, with the mean figures being areally representative.

3. Other Reference Systems

Several older reference systems have been used and are considered obsolete for the purpose of digital mapping. These include the following systems in use prior to 1974:

Zone A 1960	:	Central Meridian at 35º, Scale Factor Unknown
Zone A 1966	:	Central Meridian at 35º, Scale Factor Unknown
Zone B	:	Central Meridian at 33º, Scale Factor Unknown

Table 1 : Scale Factors Associated with MalawiLN

District	Minimum SF	Maximum SF	Average SF
1	0.99990	1.00001	0.99992
2	0.99990	0.99999	0.99992
3	0.99990	1.00002	0.99993
4	0.99990	0.99995	0.99991
5	0.99990	1.00010	0.99994
6	1.00000	1.00001	1.00000
7	1.00002	1.00005	1.00004
8	0.99990	0.99999	0.99993
9	0.99990	1.00001	0.99993
10	0.99990	0.99992	0.99990
11	0.99990	0.99994	0.99991
12	0.99993	1.00008	0.99998
13	0.99992	1.00007	0.99998
14	0.99990	0.99994	0.99991
16	0.99990	1.00003	0.99995

Table 2 : Scale Factors Associated with MalawiLS

District	Minimum SF	Maximum SF	Average SF
15	0.99990	0.99999	0.99991
17	0.99990	0.99996	0.99992
18	0.99990	1.00002	0.99993
19	0.99990	1.00001	0.99993
20	0.99990	0.99997	0.99992
21	0.99990	0.99991	0.99991
22	0.99991	1.00001	0.99995
23	0.99990	0.99991	0.99991
24	0.99990	0.99999	0.99992
25	0.99990	0.99992	0.99990
26	0.99990	0.99991	0.99990

C. Accuracy Standards

Sources of error:

1) Photocontrol

- based on 1km traverse at a Class B accuracy standard (1:8000)
- 1000m/8000m=0.125m max. error
- upon assuming a confidence at 3 standard deviations/standard error (at 99.9%), therefore RMS=0.125/3 = 0.0417

2) Aero Triangulation

-0.2m @1:50,000
- therefore, RMS=0.2/3 = 0.0667

3) Plotting Error (Photogrammetry)

-instrument + operator + parallax characteristics

i) CP1

0.5mm=25 on ground, therefore RMS = 8.33m (needs verification, SD)

ii) Wild B8

0.35mm=17.5 m on ground, therefore RMS = 5.83m (needs verification, SD)

iii) Wild A8

0.2mm=10m on ground, therefore RMS = 3.33m (needs verification, SD)

4) Cartographic Production

i) Scribing = 0.25mm = 12.5m on ground, therefore RMS = 4.1667m

ii) Film positive = 0.1mm = 5m on ground, therefore RMS = 1.6667m (needs verification, Kieth)

iii) Paper copy = 1mm = 50m on ground, therefore RMS = 16.6667m (needs verification, Gopal and Goodchild)

5) Digitizing

i) points = 0.25mm = 12.5 on ground, therefore RMS = 4.1667m

ii) line tracing (point mode) = 0.25mm = 12.5m on ground, therefore RMS = 4.1667m

iii) line tracing (stream mode) = 1mm = 50m on ground, therefore RMS = 16.667m

Examples in calculating max. error:

a) Digitizing line tracing (stream mode) from paper print and production using the CP1 (worst scenario)

Total RMS = sqrt ((sum of RMS^2)

Total RMS = sqrt ((0.417)^2+(.0667)^2+(8.33)^2+(4.1667)^2+(16.6667)^2+(16.6667)^2)

on ground: Total RMS = 25.4m

on 1:50,000 map: Total RMS = 25.4m/50,000 = .000508 * 3se = 0.001524 max. error (ie. 1.5mm)

where se = standard error

b) Photogrametric output connected to the Wild A8 (best scenario)

Total RMS = sqrt ((0.0417)^2+(.0667)^2+(3.33)^2)

on ground: Total RMS = 3.33m

on 1:50,000 map: Total RMS = 3.33m/50,000 = .00006618 * 3se = .000199855 max. error

(ie. 2mm)

D. *Digital Map Data Tiling*

Digital map tiles are the equivalent to map sheets -- a logical segmentation of the land surface into manageable chunks. It is proposed that this tiling be made consistent with the sheet lines of the new metric sheets of the 1:50,000 topographic series. The reason for this is that the older imperial sheets are based on quadrangles bordered by meridians and parallels which do no match with the UTM reference system. By using the new metric sheet lines, it will be possible to concatenate digital map sets directly to create larger map sheets.

The tiles of this proposed system will each be 25 kilometres in extent in both the northerly and easterly directions in keeping with the dimensions of the metric sheets. Each of these tiles will constitute a separate layer for distribution purposes. Some of the paper map sheets combine more than tile where the tiles are only partially covered by the country. In cases such as this, each of the true underlying tiles should be developed in full, with the tiles being collected together for distribution. For example, if one were to order a Digital Elevation Model (DEM) for a map sheet that contains two tiles, the distribution medium (e.g., CD) will contain two data sets -- a separate one for each tile. The user can then concatenate them to produce the equivalent map sheet. The number of such irregular map sheets is small. In constructing file names for these tiles, the 1:50,000 index codes should appear in the name (e.g. X5025RDS for the roads layer for sheet X5025).

Vector layers within a tile should use the appropriate reference system in use (e.g., MalawiGP). In the case of raster layers, however, special georeferencing procedures should be used. It is vital that raster grids align exactly with tile boundaries. The reference point for each cell will be the lower-left corner (and not the center). In addition, the reference cell for each raster layer will be the lower-left cell, with the lower-left edge of the cell being coincident with the lower-left edge of the tile. Similarly, the upper-right edge of the upper-right cell must be coincident with the upper-right edge of the tile. In cases of partially filled tiles (because the border of the country intersects the tile), the tile should be fully populated with cells and padded with a flag value that should be clearly indicated in the documentation. Flag values must be unambiguous and not coincide with a valid data value. To reduce data volume with partial tiles, an approved run-length encoding scheme may be used (see the section on Data Transfer Formats below).

There are no restrictions on the resolutions of raster layers, although a preferred resolution is specified for each major scale group. For example, the following guidelines can be used for layers compatible with the 1:50,000 topographic series:

10 metre resolution (e.g., SPOT Panchromatic)	2500 cells in X and Y
20 metre resolution (e.g., SPOT Multispectral)	1250 cells in X and Y (preferred resolution)
30.012 metre resolution (approx. Landsat TM)[3]	833 cells in X and Y
79.114 metre resolution (approx. Landsat MSS)[4]	316 cells in X and Y

E. Data Transfer Formats

Archiving and distribution of data shall be according to one of the following approved formats:

Level 0 :

Provider-specific formats that do not conform to tile boundaries and approved reference systems, carefully documented with an approved metadata file. This format may seem self-defeating. However, it is intended for use only for the archiving of original data sets where it is thought that these might be of use at a later date. The primary example of this is remotely sensed imagery.

[3] TM imagery does not exactly conform to tile dimensions if it is resampled to the exact same resolution as the original (30 m). The resolution of 30.012 is derived by dividing the 25000 m tile dimension by the closest integer number of cells that will fit inside the tile (833).

[4] MSS imagery does not exactly conform to tile dimensions if it is resampled to the exact same resolution as the original (57 x 79 m). The resolution of 79.114 m is derived by dividing the 25000 m tile dimension by the closest integer number of cells that will fit inside the tile (316).

Level 1 :

Provider-specific formats that do conform to tile boundaries and approved reference systems, carefully documented with an approved metadata file. This is intended only for interim use while the level 2 Malawi Spatial Data Transfer Format is used development and testing, and for working data. Examples here would include Arc/Info coverages and IDRISI images that have been georeferenced to approved reference systems and tile boundaries.

Level 2 :

Malawi Spatial Data Transfer Format (under development)

Vector :

Raster :

Raster images should be stored as "flat raster images" -- i.e., as a data stream ordered in normal raster order from left to right and top to bottom. Thus the first cell is the upper-left cell of the tile. Supported data formats include the following structures in Intel-compatible format :

unsigned 8-bit
signed 16-bit
unsigned 16-bit
signed 32-bit
IEEE 32 bit floating point

In addition to these formats, run-length encoding may be used as a compression scheme for all integer formats. In all cases, the run-length coding scheme to be used to consist of a pair of values for each run of the same data type, with the first value indicating the run and the second indicating the attribute. Thus, for example, a run-length encoded unsigned 8-bit raster image would consist of 2 bytes for each run -- the first indicating the length of the run, and the second indicating the attribute value. Runs should be aligned with the right-hand edge of the tile.

Test Notes:

General Arc1950 to Malawi Arc 1950	24.6 m X, 23.6 m Y = 34.1 m difference
General Arc1950 to Arc 1960	80.5 m X, 02.3 m Y = 80.5 m difference
Arc1960 to WGS84	85.6 m X, 205.9 m Y = 223.0 m difference
Arc60 modified to Arc60 original	0 m in X, 0.10 m Y = 0.1 m difference

Appendix A : Metadata Format

[Version] Malawi Digital Standard Metadata Format 1.0 (provisional version: 0.1)

[Description]
e.g. Dept. of Surveys 1:50,000 Topographic
Sheet 1635 A1:Thyolo

[Status]
e.g. Provisional/Approved

[Copyright]

[File Organization]
- {File 1}
  - e.g. Roads.img, Roads.doc
- {File Description}
  - e.g. contains primary, secondary, and tertiary roads
- {File Size}
- {File Type}
  - e.g. binary, ascii

- {File Structure} (need more info.)
  - e.g. 1000(1500(I*1)
    - (I*2)
    - (I*4)
    - A (ascii)
    - P: Arc Info Export Format (provisional)

[Lineage]
- {Authors}
- {Contact Information}
- {Creation Date}
- {Source Materials}
- {Creation Devices}
- {Creation Details/Notes}

[Revision 1] 2,3,.......

[Georeferencing]
- {Reference System}
- {Horizontal Datum}
- {Vertical Datum}
- {Ellipsoid}
  - major semi-axis
  - minor semi-axis
  - flattening
- {Molodensky Constants}
  - x
  - y
  - z
- {Projection}
  - Name
  - Parameters
    - e.g. Scaling factor at Central Meridian.
    - Standard Parallels
- {True origin}
- {False Coordinates at Origin}
- {Measurement Units}
  - S.I. (System Internationale) units multiplier
- {Bounding Rectangle}
  - min. x
  - max. x
  - min. y

max. y

[Attribute Coding]
e.g.
{6} residential
{7} other urban

[Accuracy]
{positional}
{attribute}
{accuracy map} (optional)

[Precision]
{positional}
{attribute}
{precision map} (optional)

[Resampling]
{number of control points}
{control point characteritics}
column row x y z(elev.) residual(quan.) confidence(qual.)

{polynomial order}
1 2 3

{resampling type}
e.g. nearest neighbor
bilinear
cubic convolution

{overall rms}

[Completeness]
{minimum mapping unit}
e.g. 4ha

{completeness map}

[Adjoining sheets]
{N}
{S}
{E}
{W}
{NE}
{SE}
{NW}
{SW}

[User restrictions]
e.g. * The representation of Cadastral boundaries appearing on this map is not taken as evidence for the location of legal boundaries.

[Additional Information]

Appendix 3

MALAWI DIGITAL STANDARD METADATA FORMAT PROVISIONAL VERSION 0.1

Description

Map title: Land Resources Appraisal of Blantyre Agricultural
Development Division, Map 1: Soils/Physiography
Sheet/Location: Blantyre ADD
Scale: 1:250,000
Source: Land Resources Evaluation Project/MLW/85/011
Ministry of Agriculture/UNDP/FAO

Status

Provisional

Copyright

Provisional
Copyright of original source map: Ministry of Agriculture
Copyright of digitized data: Department of Surveys

File Organization

File directory name: c:\lra250\soils\blantyre\
Filename (software) (size): blantysl (ArcInfo coverage)

Export formats: blantysl.shp (ArcView)
blantysl.mdb
blantysl.vec (IDRISI)
blantysl.dvc (IDRISI)
blantysl.dxf (ACAD)
*(if a line or point coverage: incl. .gen)
Metadata file directory: c:\lra250\soils\blantyre\blantysl
c:\lra250\soils\blantyre\
Metadata file: blantysl.txt
File Description: digitized soils in Blantyre ADD
File Type: binary (blantysl ArcInfo coverage)
File Structure
Feature type: polygon
Under development
Provisional: Arc Info Export Format

Lineage

Authors: Department of Surveys
Contact Information: Department of Surveys
P.O. Box 349
Blantyre, Malawi
tel: 621475
fax: 630034
Creation Date: August 1997
Source Materials: hardcopy maps
Creation Devices: Calcomp digitizer, drawing board III

(model #34480, fccidECP33480)

Creation Details/Notes: The map was digitized according to provisional map standards. In registering the tic marks an RMS error of less than or equal to 0.003 inches was accepted. Inaccuracies of greater than 0.25mm (the thickness of one line) were not accepted (e.g. at 1:250,000, snapdistance was set to 62.5, Editdistance to 62.5, and Weed to 31.25 meters).

Revision 1,2,3,.......

Not applicable: first edition

Georeferencing

Reference System: Universal Transverse Mercator

Horizontal Datum

Ellipsoid: Clark 1880 (modified)

major semi-axis: 6378249.145

minor semi-axis: 6356514.870

flattening: 1/293.46500 (0.003407561)

Datum: new Arc1950 (Arc1960)

Molodensky Constants

x -160

y -6

z -302

Projection

Name: Transverse Mercator

Parameters

Central Meridian: 33 degrees

Scaling factor at CM33: 0.9996

Maximum error: 1/2500

Longitude of True origin: 33

Latitude of True origin: 0

Number of Standard Parallels: 2

False Eastings at origin: 500,000 m E

False Northings at origin: 10,000,000 m N

Measurement Units: S.I. units multiplier, meters

Bounding Rectangle

min. x: 650000

max. x: 800000

min. y: 8190000

max. y: 8320000

note: Information on soils in only Blantyre ADD is indicated on the map. The bounding rectangle includes those values within the map sheet.

Vertical Datum

National datum

Attribute Coding

Soils code for 1:250,000 Land Resources Appraisal Maps

A- Land with sols in Fluvial, Colluvial, and/or Lacustrine Sediments

A1a1	101
A1a2	102
A1a3	103
A1a4	104
A1a5	105
A1c1	111
A1c2	112
A1c3	113
A1e1	121
A1e2	122
A1e3	123
A1e4	124
A1e5	125
A1e6	126
A1e7	127
A1e8	128
A1f1	131
A1f2	132
A1f3	133
A1f4	134
A1f5	135
A1f6	136
A1f7	137
A1f8	138
A1f9	139
A1f10	140
A1f11	141
A1f12	142
A1f13	143
A1g1	151
A1g2	152
A1g3	153
A1g4	154
A1g5	155
A1g6	156
A1g7	157
A1g8	158
A1g9	159
A1g10	160
A1g11	161
A1g12	162
A1g13	163
A1g14	164
A1m1	171
A1m2	172
A1s1	181

A1v1	191
A1v2	192
A1v3	193
A1v4	194
A1x1	201
A1x2	202
A1x3	203
A1x4	204
A2a1	211
A2a2	212
A2a3	213
A2e1	221
A2e2	222
A2e3	223
A2f1	231
A2f2	232
A2f3	233
A2f4	234
A2f5	235
A2f6	236
A2f7	237
A2f8	238
A2v1	241
A2x1	251
A2x2	252
A2x3	253

B- Land with soils from mafic igneous or metamorphic rocks

B1c1	301
B1u1	311
B2p1	321
B2u1	331
B3e1	341
B3p1	351
B3p2	352
B3u1	361
B4e1	371
B4u1	381

D- Land with soils derived from medium to fine-grained or mixed coarse to fine-grained sedimentary rocks

D1c1	401
D1m1	411
D1p1	421
D1p2	422
D1x1	431
D2c1	441
D2e1	451
D2p1	461
D2u1	471
D2x1	481
D2x2	482
D2x3	483
D2x4	484
D3p1	491
D3u1	501
D3x1	511
D3x2	512
D3x3	513
D3x4	514
D4x1	521
D4x2	522
D4x3	523
D5x1	531

X- Land with soils derived from felsic and intermediate and metamorphic rocks

X1a1	601
X1a2	602
X1d1	611
X1e1	621
X1e2	622
X1e3	623
X1e4	624
X1e5	625
X1e6	626
X1e7	627

X1e8	628
X1e9	629
X1g1	631
X1p1	641
X1p2	642
X1p3	643
X1p4	644
X1p5	645
X1p6	646
X1r1	651
X1x1	661
X1x2	662
X1x3	663
X1x4	664
X1x5	665
X1x6	666
X2d1	671
X2e1	681
X2e2	682
X2e3	683
X2e4	684
X2e5	685
X2e6	686
X2e7	687
X2e8	688
X2e9	689
X2e10	690
X2e11	691
X2e12	692
X2p1	701
X2p2	702
X2r1	711
X2r2	712
X2r3	713
X2r4	714
X2x1	721
X2x2	722
X2x3	723
X2x4	724
X2x5	725
X2x6	726
X3a1	731
X3d1	741

X3d2	742
X3d3	743
X3e1	751
X3e2	752
X3e3	753
X3e4	754
X3e5	755
X3e6	756
X3e7	757
X3e8	758
X3e9	759
X3e10	760
X3e11	761
X3e12	762
X3p1	771
X3p2	772
X3p3	773
X3p4	774
X3p5	775
X3r1	781
X3r2	782
X3r3	783
X3r4	784
X3r5	785
X3u1	791
X3u2	792
X3x1	801
X3x2	802
X3x3	803
X3x4	804
X3x5	805
X3x6	806
X3x7	807
X3x8	808
X4d1	811
X4d2	812
X4e1	821
X4e2	822
X4e3	823
X4e4	824
X4p1	831
X4p2	832
X4p3	833
X4p4	834
X4p5	835
X4r1	841

X4r2	842
X4r3	843
X4r4	844
X4r5	845
X4u1	851
X4u2	852
X4x1	861
X4x2	862
X4x3	863
X4x4	864
X4x5	865
X4x6	866
X5d1	871
X5e1	881
X5p1	891
X5p2	892
X5p3	893
X5p4	894
X5p5	895
X5p6	896
X5r1	901
X5r2	902
X5r3	903
X5u1	911
X5u2	912
X5x1	921
X5x2	922
X5x3	923
X5x4	924
X5x5	925
S1a1	931
S2a1	941
S3u1	951
S4u1	961
Z1a1	971
Z1a2	972
Z2a1	981
Z3a1	991

E	995	(very severely eroded land)
M	996	(marshes)
R	997	(land with shallow soils)
V	998	(land with predominantly very steep slopes)
W	999	(open water)

LEGEND:
Soil parent material (1st level)

A	fluvial
B	mafic igeneous/metamorphic rock
D	medium-to fine grained or mixed coarse to fine grained sedimentary rocks
S	coarse-grained sedimentary rocks
X	felsic and intermediate igneous and metamorphic rocks
Z	soils in aeolian deposits

E	severley eroded land
M	marshes
R	land with very shallow soils
V	land with predominantly very steep slopes

Slope class (2nd level)

1	0-2 percent
2	2-6 percent
3	6-13 percent
4	13-25 percent
5	25-55 percent

Soil classes (3rd level)
a- arenic
e- eutric-fersialic
f- fluvic
g- gleyic
m- mopanic
p- paralithic
r- dystic-ferralic
u- lithic
x- eutric-ferralic

Soil units (4th level - see Land Resources appraisal legend for a detailed description)

* Detailed explanations for each soil type is found in the legend of the Land Resources source book for each respective ADD, Ministry of Agriculture, 1991 (see legend in back of pouch in source book)

Accuracy:
positional: accounts for max. error of base map (1:50,000)

and soils map (1:250,000):
photo control: 1:50,000 - not applicable (check)
1:250,000 - not applicable (check)
aero triangulation:
1:50,000 - 0.0667m (0.2m/3std- 99.9% of possible cases)
1:250,000 - not applicable (check)
plotting error:
1:50,000 - 8.33m (CP1)
1:250,000 - not applicable (no plotting)
cartographic production:
scribing
1:50,000 - 4.1667m (0.25mm)
1:250,000 - 20.8m (0.25mm)
film positive output
1:50,000 - 1.6667m (0.1mm)
1;250,000 - 8.3333m (0.1mm)
paper map output
1:50,000 - 16.6667m (1mm)
1:250,000 - 83.333m (1mm)
digitizing
RMS error of control points
1:250,000 - 1.9m (0.003"=0.00762mm)
point mode:
1:250,000 - 62.5m (.25mm)

stream mode:
1:250,000 - 125m (.5mm)
map placement on digitizing board:
1:250,000 - 12.5m (.05m)
TOTAL: 165.846 meters

(0.667+8.33+4.667+20.8+1.6667+8.3333+1.9+62.5+125+12.5)

attribute: dependent on original soils classification
total positional accuracy: 165.846 meters
accuracy map: not created

Precision
positional: precise within 0.25mm (thickness of a line - at 1:250,000 snapdistance was set to 62.5m, editdistance was set to 62.5m, and weed was set to 31.25m)
attribute: dependent on original soil map
precision map: not created

Resampling - not applicable/na
number of control points - na
control point characteristics - na
column row x y z(elev.) residual(quan.) confidence(qual.)
polynomial order - na
1 2 3
resampling type (e.g. nearest neighbor, bilinear, cubic convolution)
overall rms - na

Completeness (check)

minimum mapping unit
completeness map - not created
notes

Adjoining sheets

N - Liwonde ADD
S - Ngabu ADD
E - Liwonde ADD
W - Salima ADD
NE - Liwonde ADD
SE - Ngabu ADD
NW - Salima ADD and Lilongwe ADD
SW - none

User restrictions

The representation of Cadastral boundaries appearing on this map is not taken as
evidence for the location of legal boundaries.
evidence for the location of legal boundaries.

Additional Information

Note that the Blantyre ADD soils sheet ONLY includes information
within (not outside) of the Blantyre ADD.

Appendix 4

directory: \images\1994\167_71\
backup file: Colorado disk GIS 3

MALAWI DIGITAL STANDARD METADATA FORMAT PROVISIONAL VERSION 0.1

Description
- Map title: georeferenced image of path 167 and row 71
- Sheet/Location: path 167 and row 71
- Scale: unknown
- Source: EROS

Status
- Provisional

Copyright
- Provisional
- Copyright of original source map: CSIR (SAC), Satellite Applications Center, Pretoria, South Africa (check)
- Copyright of geoferenced images: Department of Surveys (check)

File Organization
- File directory name: c:\images\1994\167_71
- Correspondence file name: 9416771.cor
- Vector point for correspondence points: janlab.vec
- Vector labels of confidence for correspondence file: jalab.mdb
- Band names: band1, band2, band3, band4, band5, band6, band7
- Export formats: (check, .tif?, erdas)
- Metadata file directory: c:\images\1994\167_71
- Metadata file: 9416771.txt
- File Description: georeferenced images of path 167 and row 71
  - File Type: binary
  - File Structure
    - Under development
    - Provisional: IDRISI Export Format

Lineage
- Authors: georeferencing implemented by the Department of Surveys
- Contact Information: Department of Surveys
P.O. Box 349
Blantyre, Malawi
tel: 621475
fax: 630034
- Creation Date: August 1997
- Source Materials: satellite images
- Creation Devices: Gateway 2000 35-166, pentium and IDRISI software

Creation Details/Notes: The map was georeferenced according to provisional map standards. Maps were georeferenced based off 1:50,000 topo map sheets.

Revision 1,2,3,.......
- Original data: raw data from CSIR
- Revision 1: georeferencing

Georeferencing (off 1:50,000 topo sheets)
- Reference System: Universal Transverse Mercator (IDRISI: malawigp)
- Horizontal Datum
  - Ellipsoid: Clark 1880 (modified)
    - major semi-axis: 6378249.145
    - minor semi-axis: 6356514.870
    - flattening: 1/293.46500 (0.003407561)
  - Datum: new Arc1950 (Arc1960)
  - Molodensky Constants
    - x -160
    - y -6
    - z -302
- Projection
  - Name: Transverse Mercator
  - Parameters
    - Central Meridian: 33 degrees
    - Scaling factor at CM33: 0.9996
    - Maximum error: 1/2500
    - Longitude of True origin: 33
    - Latitude of True origin: 0
    - Number of Standard Parallels: 2
    - False Eastings at origin: 500,000 m E
    - False Northings at origin: 10,000,000 m N
    - Measurement Units: S.I. units multiplier, meters

- Bounding Rectangle (malawigp)
  - min. x: 600000
  - max. x: 805000
  - min. y: 8100000
  - max. y: 8400000

- Vertical Datum
  - National datum

Attribute Coding: not applicable; image not classified

Accuracy:
- positional: accounts for max. error of base map (1:50,000) and georeferencing:
  - photo control: 1:50,000 - not applicable (check)
  - aero triangulation:
    - 1:50,000 - 0.0667m (0.2m/3std- 99.9% of possible cases)
  - plotting error:
    - 1:50,000 - 8.33m (CP1)

cartographic production:

scribing

1:50,000 - 4.1667m (0.25mm)

film positive output

1:50,000 - 1.6667m (0.1mm)

paper map output

1:50,000 - 16.6667m (1mm)

georeferncing

RMS error of control points 1.965 pixels (check!!!, "output map units") =58.95 meters

Pixel resolution: 30m

TOTAL: 62.2 m

attribute: not applicable, image has not been classified

total positional accuracy:

accuracy map: not created

Precision

positional: limited within 30m (pixel resolution)??

attribute: dependent on original soil map

precision map: not created

Adjoining sheets

N - none 167 and row 70

S - path 167 and row 72

E - none

W - path 168 and row 71

NE - none

SE - none

NW - none

SW - path

User restrictions

The representation of Cadastral boundaries appearing on this map is not taken as evidence for the location of legal boundaries.

Resampling -

number of control points: 20

polynomial order: linear

resampling type: bilinear

overall rms of resampling - 1.965 pixels (check!!!) = 58.95m control point characteristics: (also see section "additional information")

id# oldx oldy newx newy residual(quan.) confidence
description of control point

1 1590.828000 4785.124000 723550.000000 8307540.000000 1.991189 very good
center of railway and river crossing, sheet 1535A3

2 1925.361000 5709.501000 737850.000000 8333250.000000 2.616581 very good
center of railway and river crossing, sheet 1535A1

3 657.603300 5526.690000 699625.000000 8333925.000000 3.152203 very good
road junction, sheet 1534B2

4 896.935200 4151.138000 699930.000000 8291690.000000 omitted very good
center of road /river crossing (at bridge) on sheet 1534B4

5 566.278700 3069.309000 685025.000000 8261620.000000 2.229343 very good
center of road /river crossing (at bridge) on sheet 1534D1

6 1031.425000 3323.710000 700090.000000 8266870.000000 1.427486 good
road junction, sheet 1534D2

7 1238.911000 3354.207000 706410.000000 8266790.000000 2.109614 very good
center of road junction, sheet 1534D2 (after Chileka airport)

8 653.952800 2712.763000 685850.000000 8250675.000000 omitted fair
river confluence, sheet 1534D3

9 1287.907000 1264.890000 697950.000000 8204470.000000 omitted very good
railway road crossing sucoma estate, sheet 1634B2

10 1128.418000 1796.343000 695600.000000 8221275.000000 2.678820 very good
railway road center crossing, sheet 1634B2

11 2145.345000 1533.366000 724480.000000 8208580.000000 1.092010 very good
road junction (center)

12 2271.336000 2047.821000 730690.000000 8223135.000000 1.861480 very good
road junction (center)

13 2330.109000 2875.999000 736525.000000 8247420.000000 omitted very good
road junction, sheet 1535C3

14 1939.360000 3117.728000 726000.000000 8256475.000000 1.793703 very good
road junction, sheet 1535C3

15 1932.860000 2489.783000 722785.000000 8237875.000000 1.125278 very good
road junction, sheet 1535C3

16 3170.271000 4640.595000 769650.000000 8295760.000000 2.987499 very good
road junction, sheet 1535B3

17 2715.804000 4619.097000 756125.000000 8297180.000000 1.347450 very good
road junction, sheet 1535A4

18 2328.332000 4313.124000 743175.000000 8290000.000000 0.179561 very good
road junction, sheet 1535A4

19 3065.779000 4286.626000 764875.000000 8285650.000000 1.280796 very good
road junction, sheet 1535A4

20 2617.811000 5403.028000 756880.000000 8320925.000000 2.314846 very good
road junction, sheet 1535A2

21 4340.249000 4262.504000 802500.000000 8278925.000000 2.228739 good
road junction, sheet 1535D2

22 3872.220000 3251.716000 783740.000000 8251125.000000 2.160111 very good
road junction, sheet 1535D3

23 3386.755000 2666.267000 766625.000000 8236170.000000 0.410348 good
road/river crossing, sheet 1535C4

24 989.428000 1468.872000 689925.000000 8212175.000000 1.237137 good
road/river crossing, sheet 1634B2

25 545.614100 1662.140000 677725.000000 8219745.000000 omitted good
road/river crossing, sheet 1634B1

26 3429.003000 2410.386000 766630.000000 8228325.000000 1.859668 good
road junction, sheet 1635A2

Completeness (check)
minimum mapping unit
completeness map - not created
notes

Additional Information

Resample : Summary of Transformation

Computed polynomial surface : Linear (based on 21 control points)

Coefficient	X	Y
b0	21900.2086218977638000	-272423.7384884789060000
b1	0.0329359005163132	0.0053234915247271
b2	-0.0053134908353941	0.0329047694245036

Note : Figures are carried internally to 20 significant figures.
Formula shown is the back transformation (new to old).

Control points used in the transformation :

Old X	Old Y	New X	New Y	Residual
1 1590.828000	4785.124000	723550.000000	8307540.000000	1.991189
1925.361000	5709.501000	737850.000000	8333250.000000	2.616581
657.603300	5526.690000	699625.000000	8333925.000000	3.152203
896.935200	4151.138000	699930.000000	8291690.000000	omitted
566.278700	3069.309000	685025.000000	8261620.000000	2.229343
1031.425000	3323.710000	700090.000000	8266870.000000	1.427486
1238.911000	3354.207000	706410.000000	8266790.000000	2.109614
653.952800	2712.763000	685850.000000	8250675.000000	omitted
1287.907000	1264.890000	697950.000000	8204470.000000	omitted
1128.418000	1796.343000	695600.000000	8221275.000000	2.678820
2145.345000	1533.366000	724480.000000	8208580.000000	1.092010
2271.336000	2047.821000	730690.000000	8223135.000000	1.861480
2330.109000	2875.999000	736525.000000	8247420.000000	omitted
1939.360000	3117.728000	726000.000000	8256475.000000	1.793703
1932.860000	2489.783000	722785.000000	8237875.000000	1.125278
3170.271000	4640.595000	769650.000000	8295760.000000	2.987499
2715.804000	4619.097000	756125.000000	8297180.000000	1.347450
2328.332000	4313.124000	743175.000000	8290000.000000	0.179561
3065.779000	4286.626000	764875.000000	8285650.000000	1.280796
2617.811000	5403.028000	756880.000000	8320925.000000	2.314846
4340.249000	4262.504000	802500.000000	8278925.000000	2.228739
3872.220000	3251.716000	783740.000000	8251125.000000	2.160111
3386.755000	2666.267000	766625.000000	8236170.000000	0.410348
989.428000	1468.872000	689925.000000	8212175.000000	1.237137
545.614100	1662.140000	677725.000000	8219745.000000	omitted
3429.003000	2410.386000	766630.000000	8228325.000000	1.859668

Overall RMS = 1.965000

Note : RMS Error is expressed in output map units.
With low RMS errors, be careful that an adequate sample exists
(eg. 2-3 times the mathematical min).

Appendix 5

Malawi Advanced Course
GIS and Image Processing

June 17 - 21, 1997
Bunda College

Welcome and Introduction

Day 1:
Time series/ land cover change analysis:
Lab: Qualitative change analysis
Lab: Quantitative change analysis
Lab: Multiple image analysis
Lab: Time series analysis

Day 2:
Relating time series trends to socioeconomic changes in the Shire
Lab: Overview of database workshop
Lab: Analyzing and interpreting socioeconomic changes in the Shire
Geodesy

Day 3:
Decision making
Lab: Concepts of decision making procedures
Lab: Case study
Discussion: Decision making in the Malawi context

Day 4:
Modeling
Lab: Modeling soil erosion potential using SLEMSA
Lab: Modeling soil erosion hazard/vulnerability in the Shire

Day 5:
Demo: Use of 1km AVHRR data to access land cover
- Unsupervised and supervised classification techniques
Lab: Map production

Appendix 7

MALAWI TRIP REPORT
(JUNE 15-JULY 18, 1997)

Nick Haan
Clark University

Continuing his role as technical assistant on behalf of Clark University, Nick Haan conducted a variety of activities during his latest visit to Malawi from June 15-July 18, 1997. The nature of these activities was guided by the project work plan, and included: cofacilitating the advanced GIS course, promoting awareness and helping to organize curriculum development within UNIMA, analysis of the usefulness of 1 km satellite data for forest monitoring, field visits to examine the link between GIS analysis and social explanation, initial training of trainers for the future GIS courses, technical assistance to UNIMA faculty, assistance in coordinating GIS professional society, and assistance with the digitizing course.

<ins>Advanced Training</ins> (ID 6.1 in workplan)

Cofacilitated with Ron Eastman and Mathilde Snel the advanced GIS training course from June 17-June 21. The broad topics included change and time series analysis of NDVI data sets, decision making, and soil erosion modeling. Further details and outputs of this training can be found in Ms. Snel's trip report. This advanced training completes a three part series for a single cohort of participants. Another series will begin in November with an introductory course. One difference will be that participants from previous courses will be mostly responsible to facilitation.

<ins>Awareness Building and Development of GIS Curriculum with UNIMA</ins> (ID 6.2 in workplan)

Conducted planning meetings with representatives from Polytechnic, Chancellor, and Bunda colleges to discuss GIS awareness promotion and curriculum development at each of the campuses. Learned of the current state of GIS instruction at each of the campuses, and planned a strategy unique for each campus as to the best way to develop a GIS curriculum. I visited each of the campuses and gave a promotional lecture to faculty and students. Each of the lectures was enthusiastically received, with an average of 50 people attending at each campus. Currently none of the campuses is teaching GIS, but there is tremendous interest on behalf of faculty, students, and administrators at each of the campuses. Given the varying states of curriculum development, available equipment, and faculty capacity, it will be difficult at this early stage to develop a GIS curriculum that will be coordinated across UNIMA. Each campus has its own unique set of circumstances that should be built upon in terms of GIS development. This is in keeping with the overall philosophy of the ecological approach that guides this technology transfer project.

After conducting meetings with each of the campuses administrators, we agreed that December would be an appropriate time to develop proposals for GIS curriculum development. This will be particularly effective because representatives from each of the campuses will have just finished facilitating the introductory GIS course in November.

Training of Trainers for November GIS Course (ID 6.1)

Coordinated representatives from each of the campuses to facilitate the upcoming introductory course in November. Each of the representatives will help select up to four participants from their campus to attend the November course. Names of these nominations should be submitted to Kent Burger no later than the end of August. Agreed upon criteria for nominations include: exposure to computers, prioritizing departments that could eventually teach GIS, commitment to attend all 3 training sessions, and willingness to eventually teach GIS.

We reviewed the future course syllabus and identified sessions that each of the future trainers will facilitate. Over 75% of the introductory course will be taught by past participants.

Analysis of 1 km Satellite Imagery (ID 4.3)

The Fisheries Dept. in Salima has access to daily satellite imagery at 1 km resolution. Given the frequency and potentially low cost nature of this data, examination of its usefulness for forest monitoring was important. In brief, Ron Eastman and I utilized the latest developments in image classification called soft classifiers to effectively conduct sub-pixel aerial assessments of vegetation cover. These results were compared with high resolution SPOT data (20 meters), and thus far seem very promising, with very similar aerial assessments of forest cover. These results require further ground truthing and investigation, and could be very important given the very high cost of high resolution data.

Initial Field Visits in the Shire Valley

Sam Chilombe and Nick Haan visited two areas within the Shire that the remote sensing analysis detected as changing rapidly within the past 10 years. The first visit was to Neno, and the second to Mulanje Mountain. Each of the visits involved local agricultural and forestry extension officers, and attempted to learn from local farmers the causes of the changes detected from satellite imagery. In each case it is quite apparent that there is a complex chain of social explanation starting from the immediate causes of change (e.g. conversion of forest to agriculture) to the more root causes (e.g. changes in land tenure, migration patterns, and rural economy). To understand the complexity of these social explanations, and ultimately lead to informing government policies, will require extended field visits and a well developed research methodology.

Technical Assistance to UNIMA Faculty (ID 6.3)

During each of the visits to UNIMA campuses, Mr. Haan advised interested faculty on the use of GIS for their particular research interests. The most intensive assistance was to Meya Kalindecafe at Chancellor College, with regards to her research on resource management of the Lake Chilwa watershed. NDVI time series and land cover change analysis was conducted for the watershed, and will be used for both her research and as examples of GIS analysis for future classes that she will teach.

Assistance Coordinating the Development of a Malawi GIS Professional Society

Held coordinating meetings with members of UNIMA to discuss the development of a Malawi GIS professional society. The participants agreed upon a strategy for the development of the society, which will include drafting a constitution, gathering information about other professional societies in Malawi, and informing interested persons throughout Malawi of our intentions. In November we will hold another planning meeting and review the draft constitution before seeking official recognition from the government of Malawi.

In addition to these activities, Mr. Haan began development of ideas for situating social analysis into the Shire Watershed Investigation. Extended field visits will begin in November in priority sites determined by the Shire Valley Task Force. The problem statement that guides the need for this type of research is as follows:

Efforts to identify causes of environmental problems often focus on the physical or immediate causes (e.g. Green, 1996) which is not adequate for government policy and intervention strategies that seek to have both short and long term effects, especially with regards to maintaining livelihoods of peasant farmers.

There are two goals of this research initiative:

1) To develop an action oriented, community based social research methodology that is replicable by the Government of Malawi and linked to environmental problems identified by geographic and physical analysis.

2) Specifically for the sedimentation problem identified in the Shire watershed, to illustrate a chain of social explanation that spans from immediate to root causes of land use changes so as to advise the GOM on potential scenarios of intervention and their respective anticipated impacts and limitations.

Nick Haan’s next visit to Malawi is planned for late October to mid December. During that time he will follow up on initiatives mentioned in this report including: conducting field research on social explanations of change in priority communities of the Shire River Valley, further organizing the GIS professional society, facilitating both a training of trainers and the introductory GIS course, further investigating the usefulness and interpretation of various scales of satellite imagery, and providing further support for UNIMA GIS curriculum.

Appendix 8

Summary Statement on the Shire River Valley Situation Analysis

submitted by: Mathilde Snel, Nicholas Haan, James Toledano, Twanga Mbale, and Dr. Ron Eastman

Increasingly it is being recognized by the Government of Malawi and Malawian public at large that sedimentation in the Shire is causing problems of national magnitude including but not limited to contributing to an instable energy supply at the Kapichila and Tedzani and Nkulu Falls hydrolectric dam, affecting the livelihoods of farmers, and affecting a regular irrigation flow at SUCOMA. It is with regards to such heightened national concern that the Malawian Environmental Monitoring Programme, a programme under the Department of Environmental Affairs formally known as the Ministry of Research and Environmental Affairs (MOREA), has embarked on a situation analysis concerning the sedimentation of the Shire River.

The situation analysis will be designed to develop a replicable methodology that may be used in future environmental analyses, monitoring, and state of the environment reporting by emphasizing the use of readily available in-country data, by building capacity within Malawian institutions in environmental analysis and state of the environment reporting, and in establishing national data collection and archiving standards to facilitate the use of similar data in future environmental analyses. This study will build on Green's report (1996) and: 1) emphasize the value of geographic technologies to help situate a problem of national concern and 2) provide explanations of the underlying causes of environmental degradation and possible mitigation strategies.

As a long term objective the situation analysis will be instrumental towards the development of national capacity for the monitoring, management, and reporting of issues on the environment and will form the basis of a prototype Environmental Information System, a "technical and institutional structure that produces and uses environmental information for environmental management and decision making" (EIS design team, 1997). The development of the prototype EIS will emphasize: the participation of agencies and individuals at all levels from the national to community; the need for institutional links between and among agencies and communities; and the need to transgress between and among different geographic and temporal scales in analyzing environmental issues.

Due to the magnitude of the sedimentation problem in the Shire, the situation analysis will specifically investigate soil erosion hazard and land cover changes in the Shire river valley. Furthermore, the situation analysis will place particular, though not exclusive, emphasis on the Blantyre and Machinga ADDs - areas considered by policy makers of importance. This situation analysis will address a number of questions pertaining to soil erosion and landcover/use change:1) where are significant landcover/use changes occurring in the Shire river valley?; 2) what is the geographic distribution of soil erosion hazard in the Shire (given coarse information on slopes, landcover, soils, and qualitative information)?; 3) what are potential areas of intervention in the Shire?; 4) does land cover change influence soil erosion potential?; 5) what are the underlying causes of landcover/use change and soil erosion?; 6) what are possible intervention strategies and their anticipated impacts?; and time permitting 7) to what extent does landcover/use changes influence sedimentation?.

Appendix 9

Draft Report
Recommendations towards Refining a Strategy for the Development of a Prototype Environmental Information System

Malawi Environmental Monitoring Programme
submitted by: Mathilde Snel
Clark University
In collaboration with University of Arizona

August, 1997

Background

In April 1997 an EIS Design Team met to discuss a strategy towards developing an Environmental Information System for Malawi (EIS Design Team, 1997). The team proposed a learning approach in the development of a functioning EIS by conducting an situation analysis of national to regional concern - the sedimentation of the Shire river. The situation analysis will be used towards the development of national capacity in environmental analysis, monitoring, and reporting where three fundamental steps were proposed: 1) an assessment of increased sedimentation in the Shire and recommendations for solutions, 2) the creation of a prototype EIS based on the experiences of the Shire assessment; and 3) the creation of a national EIS based on the experiences of the pilot EIS. The team proposed that in the initial assessment of sedimentation in the Shire three teams should be active: an information dissemination team responsible for ensuring participation throughout the EIS (e.g. by organizing workshops and outreach materials); an analysis team to collect and collate data on sedimentation in the Shire; and a technical steering team to provide guidance and expertise throughout the process. It was further proposed that the information dissemination and analysis teams would be headed by a principle investigator selected from the Government of Malawi (GOM) or University of Malawi (UNIMA).

Provisions are presently being made to select a principle investigator and to formally identify the analysis and information dissemination teams. This paper will build on the *Strategy of an Environmental Information System in Malawi* (EIS design team,1997) and the *Second Annual Workplan for the Components of the Malawi Environmental Monitoring Programme: Environmental Monitoring Technologies, Research, and Policy Sub-programmes* (MoREA, 1997) to help provide recommendations towards refining the objective of and technical strategy for the prototype EIS. In the absence of a principle investigator, Mathilde Snel of Clark University and Twanga Mbale or the Ministry of Research and Environmental Affairs (MoREA) met to review and refine the development of the prototype Environmental Information System (EIS). Furthermore, Nicholas Haan, James Toledano, and Mathilde Snel of Clark University had a number of discussions relating to recommendations on refining the strategy of the prototype EIS. The discussions were specially geared towards providing recommendations to the principle investigator, analysis team, and information dissemination team once these have been formally identified. Discussion were focused on avoiding ambiguities in the development of the prototype EIS. This paper is a draft and the recommendations within it should be discussed more formally once the principle investigator, analysis teams, and information team have been formally identified.

Introduction

Presently there is a concern within MoREA and line GOM agencies that there is insufficient capacity to conduct environment monitoring, analysis, and reporting. The main objective of the development of a prototype EIS as stated in the *Strategy of an Environmental Information System in Malawi* (EIS design team, 1997) and the *Second Annual Workplan Strategy* (MoREA, 1997) is the development of a "technical and institutional structure that produces and uses environmental information for environmental management and decision making" (EIS design team, 1997). An situation analysis into an issue of national to regional concern - the sedimentation of the Shire river - will be used in the development of national capacity in environmental analysis, monitoring, and reporting. The development of a prototype EIS will be designed to create a replicable methodology that may be used in future environmental analyses, monitoring, and state of the environment reporting by emphasizing the use of readily available in-country data, by building capacity within Malawian institutions in environmental analysis and state of the environment reporting, in establishing national data collection and archiving standards to facilitate the use of similar data in future environmental analyses, and in facilitating critical links between information providers and users. It is recommended that this situation analysis build on Prevost and Gilruth's report (1997) on *Environmental Information Systems in Sub-Saharan Africa* and recommend specific guidelines for the development of a demand driven EIS.

Addressing an issues of national to regional concern

It is critical in the development of a demand-driven EIS that a problem is addressed of concern to information users - from national policy makers to community members. Increasingly it is being recognized by the Government of Malawi and Malawi public at large that sedimentation in the Shire is causing problems of national magnitude including but not limited to contributing to an instable energy supply at the Kapichila and Tedzani and Nkula Falls hydroelectric dam, affecting the livelihoods of farmers, and affecting irrigation flows at the SUCOMA sugarcane plantations (sources...). Such concerns have contributed to a demand for information on the causes of sedimentation stemming from determining which areas are most prone to soil erosion, to which areas are experiencing significant landcover/use changes, to evaluating the influences of water flow on sedimentation.

It was in the *Second Annual Workplan Strategy* (MoREA, 1997) determined that this situation analysis will specifically investigate sedimentation of the Shire with respect to soil erosion hazard and land cover changes in the Shire river valley rather than conduct an extensive analysis on all causes of sedimentation (e.g. water flow) (MoREA, 1997). The situation analysis will build on Green's report (1996) and will emphasize the effectively of: 1) geographic technologies - such as the use of Geographic Information Systems (GIS)- to help situate a problem particularly with regard to the reporting of recent environmental changes and 2) the use of rural appraisals to provide explanations of the underlying causes of environmental change and policy intervention scenarios. It is recommended that the situation analysis will concentrate on addressing the demand for information on: 1) where are significant landcover/use changes occurring in the Shire river valley?; 2) what is the geographic distribution of soil erosion hazard in the Shire?; 3) what are potential areas of intervention with respect to landcover/use change and soil erosion potential in the Shire?; 4) does land cover change influence soil erosion potential?; 5) what are the underlying social, economic, and political circumstances contributing to land degradation in the Shire?; 6) what are possible intervention strategies and their anticipated impacts?; and time permitting 7) to what extent does landcover/use changes influence sedimentation?. As indicated in the *Second Annual Workplan for the Components of the Malawi Environmental Monitoring Programme: Environmental Monitoring Technologies, Research, and Policy Sub-programmes* (MoREA, April 1997) the situation analysis will place an emphasis, though not exclusive, on the mid-Shire - the Blantyre and Machinga ADDs - areas considered to be of importance (MoREA, 1997). The problem statement and objective of the situation analysis on sedimentation in the Shire then is recommended to be as follows:

Problem statement of the situation analysis of the prototype EIS on sedimentation the Shire

Heightened national and regional concern on the effects of sedimentation from contributing to an instable energy supply at the Kapira, Tedzani, and Nkula Falls hydroelectric dam, affecting the livelihoods of farmers, to affecting the irrigation flow at SUCOMA sugarcane plantation.

Emphasis of the situation analysis into sedimentation in the Shire

This situation analysis will report on sedimentation of the Shire river valley with respect to soil erosion hazard and land cover changes in the Shire river valley rather than conduct and extensive analysis on all causes of sedimentation. Furthermore, this situation analysis will place particular, though not exclusive, emphasis on the Blantyre and Machinga ADDs - areas considered by policy makers to be of importance (MoREA, 1997).

Objective of the situation analysis of the prototype EIS on sedimentation in the Shire

The objective of the Shire situation analysis is to provide information- needed by information users - relating to sedimentation in the Shire. Due to a significant demand for information on sedimentation in the Shire with regard to landcover/use change and soil erosion potential, the situation analysis will address the following questions: 1) where are significant landcover/use changes occurring in the Shire river valley?; 2) what is the geographic distribution of soil erosion hazard in the Shire (given coarse information on slopes, landcover, soils, and qualitative information)?; 3) what are potential areas of intervention in the Shire?; 4) does land cover change influence soil erosion potential?; 5) what are the underlying causes of landcover/use change and soil erosion?; 6) what are possible intervention strategies and their anticipated impacts?; and time permitting 7) to what extent does landcover/use changes influence sedimentation?.

Building national capacity for environmental analysis and monitoring

An emphasis in the development of the prototype EIS will be to provide a replicable methodology that may be used in future environmental analyses, monitoring, and state of the environment reporting. The methodology will focus on using readily available in-country data, building capacity within Malawian institutions in environmental analysis and state of the environment reporting, establishing national data collection and archiving standards to facilitate the use of similar data in future environmental analyses, and facilitating critical links between information providers and users. The methodology will seek to strike a balance between the short term needs of the prototype EIS situation analysis on sedimentation of the Shire and the long term goal in creating capacity towards developing a national EIS. Upon building on the *Strategy for an Environmental Information System* (EIS design team, 1997) and the *Second Annual Workplan for the Components of the Malawi Environmental Monitoring Programme: Environmental Monitoring Technologies, Research, and Policy Sub-programmes* (MoREA, April 1997) it is recommended that the Shire assessment continue to refine its situation analysis on: 1) identifying information providers and users; 2) linking information users and providers; 3)creating continued awareness of the Shire situation analysis; 4) conducting an inventory of existing data; 5) using geographic technologies to help situate the issue of landcover/use change and soil erosion potential in the Shire; 6) identifying technical expertise and setup to conduct geographic analysis and allocating tasks 7) using community based assessment to identify the underlying social, economic, and political circumstances contributing to environmental degradation in the Shire; 8) providing information to information users; and 9) time permitting, conducting an biophysical assessment on the relationship between landcover/use change and sedimentation.

Identifying information providers and information users

Upon building on the *Strategy for an Environmental Information System* (EIS design team, 1997) and the *Second Annual Workplan for the Components of the Malawi Environmental Monitoring Programme: Environmental Monitoring Technologies, Research, and Policy Sub-programmes* (MoREA, April 1997) information providers should be from the major resource management agencies (e.g. Forestry, Agriculture, Water, Fisheries, Surveys, MoREA), private agencies (e.g. ESCOM, SUCOMA), non-government agencies (e.g CURE), communities (e.g. farmers), and UNIMA. Major resource management agencies would be instrumental in providing information on, for example, land cover change and soil erosion potential in the mid-Shire; private agencies such as ESCOM may provide information on, for example, energy use; non-government agencies may provide information on helping identify areas of intervention; communities may provide information on the underlying social, economic, and political circumstances leading to environmental degradation (Haan 1997); while UNIMA may supply information on references relating to environmental degradation in the Shire. Information users may include GOM, donors, non-government agencies, private agencies (e.g. ESCOM and SUCOMA), community members, and other stakeholders interested in and/or affected by sedimentation in the Shire. The information users may, for example, use the prototype EIS information to help direct their work on soil conservation and help allocate afforestation and soil conservation funds.

Linking information users and providers

It is recommended that once the principle investigator, analysis team, and information dissemination team have been formally identified that a workshop with information users and providers is organized. It is recommended that the workshop is held to refine the strategy of the Shire situation analysis and to show preliminary information relating to sedimentation in the Shire. It is recommended that the presentation of the preliminary baseline information is used to further direct the prototype EIS towards more specific information requests (e.g. to direct analysis to specific areas of intervention of interest to information users).

Creating continued awareness of the Shire situation analysis

As indicated in the *Strategy for an Environmental Information System in Malawi* (April 1997) the information dissemination team will be involved in creating a series of outreach materials, radio broadcasts, press releases, and workshops in anticipation of both informing known information users and targeting potential information users on the Shire situation analysis. It is further recommended that the coordinating agency (MoREA) and principle investigator conduct interviews with potential information users throughout the Shire situation analysis. In a recent interview (Khaguza and Metoseni, 1997), for example, it was realized that the Shire situation analysis would help agricultural extension officers identify Extension Planning Areas (EPAs) in need of soil conservation (presently there was concern among agricultural extension officers that the Famine Early Warning vulnerability index - that they are proposing to use to select EPAs in need of soil conservation - too heavily emphasizes indicators on famine and not on soil erosion potential). Such efforts are critical so that the EIS goals stay fully connected to the community of information users.

Conducting an inventory of existing data

As indicated in the *Strategy for an environmental information system in Malawi*, an inventory and collection of information on the biophysical (e.g. siltation, landcover, soil erosion), socio-economic (e.g. energy use) and political (e.g. land tenure and legal documents) references relating to sedimentation in the Shire will need to be gathered. MoREA is in the process of evaluating reports, projects, and other data that might be of use to the Shire situation analysis. Reports such as Green's report on the *Study to Identify Sources of Siltation in the Middle Shire River Catchment Area* (Green 1996) and other references regarding siltation of the hydroelectric dam, soil erosion affects on the livelihoods of farmers, and land use laws and practices will need to be compiled. MoREA with the assistance of Clark University and University of Arizona are also in the process of compiling geographic information of relevance to the Shire situation analysis - satellite images and existing digital files on rivers, roads, district boundaries and elevation model have been gathered for the Shire.

To strike a balance between the short term needs of the prototype EIS on sedimentation in the Shire and the long term investment of creating national capacity towards developing a national EIS, emphasis will need to be placed throughout the situation analysis on appropriately archiving existing data. Furthermore, attention will need to be placed on establishing links with the information providers of updated environmental data (e.g. 1km, 3km, and 11km AVHRR data). Already efforts are being facilitated for the access of 3km and 1km AVHRR data to GOM - data respectively gathered by the Meteorological Department Headquarters in Harare and Department of Fisheries unit in Salima (Snel et al, 1997).

Creating data standards in the use of geographic information

Since the development of the prototype EIS will require the extensive collection and use of geographic data, it is important that data standards for digital mapping are established. Dr. Ron Eastman and Mathilde Snel met with members of the Department of Surveys in Blantyre from June 5-9, 1997 to discuss the development of digital mapping standards. Recommendations for digital mapping standards were made and include standards on georeferencing (e.g. geodetic, projection, entity, representation, attribute, relationship, geometrical, and topological), map accuracy, and meta-data/documentation. Discussions were held on creating a digital map data storage and distribution format and medium. The digital mapping standards as recommended in the draft report (Department of Surveys, 1997) is being used as the provisional data standard throughout the compilation of digital geographic data in this prototype EIS.

The use of geographic technologies to provide information on soil erosion potential and landuse/cover change in the Shire watershed

Due to the demand for baseline information on landcover/use change and soil erosion potential for the entire Shire, it was determined in the *Strategy for an Envionmental Information System* (EIS design team, 1997) and the *Second Annual Workplan for the Components of the Malawi Environmental Monitoring Programme: Environmental Monitoring Technologies, Research, and Policy Sub-programmes* (MoREA, April 1997) that information initially gathered during the GIS and remote sensing analyses will emphasize: 1) landcover/use changes in the Shire (although, with an emphasis on the mid-Shire valley - the Blantyre and Machinga ADDs), 2) soil erosion potential in the mid-Shire (based on coarse slope, rainfall, landcover, and soil data); and 3) selected socio-economic indicators (e.g. population and agricultural change of select crops). The following outputs were identified:

a. Land cover change with respect to AVHRR ndvi data, based off 7.6 AVHRR data
b. Land cover based off the Landsat 1994 image (Blantyre and Machinga ADDs)
c. Land cover based off Landsat 1984 image (Blantyre and Machinga ADDs)
d. Land cover change based on 1994 and 1984 (Blantyre and Machinga ADDs)
* e. Land cover of the Shire watershed based off 7 km data
* f. Slope map for the Shire watershed (based off 1km data)
* g. Rainfall map for the Shire watershed
h. Soil map (Blantyre and Machinga ADDs)
i. Soil erosion hazard map of the mid-Shire (based on 1km data on landcover/use, slope, soil, and rainfall)
*j. watershed boundaries map (based off 1km data)
*k. Agricultural data (based off FEWs data) by EPA
*l. NDVI change data by district, EPA, and micro watersheds in the Shire .
*m. Population data (based off FEWs) by EPA.
*n. Energy supply data (based off FEWs) by EPA

It is further recommended that once selected baseline information is collected (e.g. as indicated by outputs with asterixes), that a workshop between information users and providers is conducted to help further identify information needs within specified areas of intervention. The workshop would focus on using a combination of geographic, anecdotal information, and existing reports (e.g. Green 1996) to help identify specific areas of intervention. It is recommended, time permitting, that GIS and remote sensing analyzes are conducted in 1 to 2 selected areas of intervention towards providing more detailed information on soil erosion potential and landcover/use change. Outputs may include:

n. Contour map in 1 to 2 areas of intervention (based off 1:50,000)
o. More detailed landcover/use map in 1 to 2 areas of intervention
p. Soil erosion hazard map of 1 to 2 areas of intervention

To ensure the long term investment of creating national capacity in developing an EIS, digital geographic data sets compiled throughout the situation analysis will be created with respect to the provisional data standards as drafted by the Department of Surveys (Department of Surveys, 1997).

Identifying technical expertise and setup to conduct geographic analysis and the allocation of tasks

An important part of using geographic technologies in the development of any EIS is to provide the appropriate technical expertise and setup. Clark University has been involved in providing such technical expertise and setup over the past four years under the first phase of the Malawi Environmental Monitoring Programme. After three sequences of trainings (each sequence consisting of an introductory, intermediate, and advanced course) and after the allocation of hardware and software to participating GOM and UNIMA departments, a pool of skilled individuals and a facilitating setup is available in country towards conducting such geographic analyzes.

In conducting geographic analysis in the Shire it is important to identify which Ministry will benefit most from the capacity built during the Shire situation analysis. It was determined that the Department of Forestry and Ministry of Agriculture would benefit most from conducting landcover/use change analysis, that the Meteorological department would benefit most from evaluating geographic variations in rainfall and ndvi/agricultural (to help on their future work in drought analysis), and that the Department of Surveys would benefit from the digitizing of required base maps (e.g. soils maps) and georeferencing of satellite images according to map standard. Furthermore, it was identified that all participants and the coordinating body, MoREA, should be involved in the integration of data (e.g. in creating a soil erosion potential model for the mid-Shire) after data has been gathering data in the respective ministries. A time line and allocation of tasks was proposed as indicated in Appendix 1.

The use of community based assessments to gain a better understanding of the underlying causes of soil erosion and land cover change and potential policy intervention strategies.

In making recommendation towards refining the purpose and methodology of the situation analysis of the Shire, acknowledgment was made of the importance of a social analysis to help identify the underlying causes of land cover change and soil erosion to provide policy recommendations towards mitigating environmental degradation (Haan, 1997). As proposed by Haan (1997) it is recommended that guidance is given to a group of Malawian social scientists in situating a social analysis for the Shire situation analysis (Appendix 2). The social analysis will be conducted in a number of areas of interventions identified by the information providers and users using a combination of information from the geographic analysis, existing reports (Green 1996), and anecdotal information. By incorporating an analysis in the Shire situation analysis on the social, economic, and political circumstances contributing to land degradation and by providing mitigation strategies, the prototype EIS will emphasize the need to stay fully connected with the demands of the community of information users ranging from national decision makers to community members.

Analysis on the relationship between landcover/use change and sedimentation

Time permitting, it is hoped that soil erosion models specific to regional conditions may be created in 1 to 2 areas of intervention. Such soil erosion models would indicate the actual tons per hectares of estimated annual soil loss. The soil erosion model may be based off a new model specific to Malawi regional concerns or be modified with respect to an existing model such as the Soil Loss Equation for Southern Africa (SLEMSA). Furthermore, time permitting it is hoped that information on landcover change's influence on sedimentation may be obtained. This will require obtaining information on sedimentation. Due to under staffing at the Department of Waters the lack of useable information on sedimentation is evident. MoREA has proposed to help assist the DOW and is looking into the possibility of obtaining a sediment sampler such that this information may be incorporated into the Shire situation analysis.

Providing information to information users on the Shire

Once information has been compiled, a workshop will need to be organized where information will need to be presented in a usable format to policy makers, donors, farmers, and other stakeholders interested in and/or affected by sedimentation in the Shire. By encouraging the participation of both information providers and users throughout the Shire situation analysis, the information may be used towards mitigating further environmental degradation. Furthermore, the workshop may additionally provide a forum to funnel information demand for similar investigations in watersheds other than Shire. In such a manner, capacity may be build towards the development of a national EIS.

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Appendix 11

Candidates proposed for the Analysis Team of the Shire River Valley Situation Analysis:

Department of Forestry, Ministry of Forestry, Fisheries, and Environmental Affairs
Mr. J. Mlotha
Mr. P. Jambo

Department of Surveys, Ministry of Lands, Housing, Physical Planning, and Surveys
Mr. G. Mzembe
Mr. J. Nakutepa
Mr. M. Chawinga

Meterology Department
Mr. S. Chilombe

Land Resources Training Center and Land Resources Conservation Branch, Ministry of Agriculture
Mr. M. Kapila (Zomba)

Department of Environmental Affairs, Ministry of Forestry, Fisheries, and Environmental Affairs
Ms. T. Mbale (coordinating role)

Appendix 12

Provisional allocation of tasks:

Meteorology department and Ministry of Agriculture:

* Rainfall in the 1984-85 growing season
  1994-95 growing season
  1996-97 growing season

* Agricultural production for:
  12 of the major crops (in Shire and Malawi)
  hybrid maize 1991 - 1995
  local maize 1991 - 1995

* Energy use:
  % livelihood depending on sale of charcoal
  % livelihood depending on sale of firewood

* Digitizing
  roads off 1:250,000
  rivers off 1:250,000

Department of Forestry:

*NDVI profiles by EPA, district, and micro watershed

* Unsupervised classification (1984 and 1994 images)

Department of Surveys:

* Georeferencing of 1984 and 1994 images
* Digitizing
  soils (Blantyre and Machinga)