Trip Report
October – December, 1998
Clark University Activities
Malawi Environmental Monitoring Programme

submitted by Mathilde Snel, James Toledano, and Neil Manspeizer
Clark University
In collaboration with the University of Arizona
December, 1998

I. INTRODUCTION

This trip report will review activities conducted by Clark University under the Malawi Environmental Monitoring Programme (MEMP) from October to December, 1998. This report will describe the technical assistance provided by Mathilde Snel, James Toledano, and Neil Manspeizer and will primarily focus on the following four main activities for which Clark University provided technical assistance during this period:

1. Development of digital spatial data standards;
2. Development of an EIS in Malawi;
3. Assessment of MEMP's capacity building efforts; and
4. Intermediate training in GIS and remote sensing.

II. DEVELOPMENT OF DIGITAL SPATIAL DATA STANDARDS

Continued technical assistance was provided by Mathilde Snel to the Department of Surveys (DOS) on the development of national digital spatial data standards. More specifically, technical assistance was given to: 1) development digital spatial data for 1:50,000 (Machinga) and 1:250,000 (Liwonde) map sheet samples; 2) identifing geographic naming and coding standard conventions; 3) determining attribute coding standards; and 4) preparing for technical and senior sessions on digital spatial data standards.

II.a. Digital 1:50,000 and 1:250,000 map samples

Technical assistance was provided to the DOS for the completion of 1:50,000 and 1:250,000 digital spatial data samples. The DOS has been in the process of compiling spatial digital data and metadata for two map samples: a 1:50,000 map sample for the Machinga area and a 1:250,000 map sample for Liwonde. These digital map samples will be pressed on CD and will consist of the following digital features:

Digital features of the 1:50,000 map sample – Machinga

i. roads (to consist of digital spatial file, export formats, and metadata)
ii. rivers (")
iii. forest reserves (")
iv. villages (")
v. land cover (")
vi. georeferenced Landsat TM imagery (bands 1 – 7) for 1984 and 1994 (")

** Note: digital files for the 1:50,000 digital map sample were digitized at DOS, export formats were created at DOS, and metadata was completed at DOS.*

Digital features of the 1:250,000 map sample – Liwonde

i. roads (to consist of digital spatial files, export formats (ArcInfo Export, IDRISI, DXF)
ii. rivers (")
iii. districts (")
iv. national boundary (")

** Note: digital files for the 1:250,000 digital map sample were digitized at the Arizona Remote Sensing Center (ARSC), export formats were created at DOS, and metadata was completed at DOS*

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Metadata files for the digital vector data and digital raster data were created (see 1:50,000 metadata samples in Appendices 1 and 2). Also, a readme file for the 1:50,000 and 1:250,000 digital samples was developed (see Appendices 3 and 4).

Discussions were held with DOS on the provisional mapping standards document (DOS, 1998) and small revisions were suggested. These revisions include:

i. adding a note on scanning error in the "estimating digital map accuracy" section;
ii. appending information on provisional geographic naming and attribute coding standards conventions in the "MDSDS Department of Surveys Coding Standard" section (for more detail see section II.b. and II.c. of this report);
iii. revising the metadata for vector files to include only one metadata file for all vector export formats (e.g., for ArcInfo export, IDRISI, and DXF formats); and
iv. adding a section on Quality Assessment/Qualtiy Control (QA/QC) procedures[1].

Discussions were further held with DOS regarding the format of the metadata for spatial data – whether Text or Access files should be used[2]. DOS staff voiced that due to software constraints in Malawi, a simple ASCII text format would be preferable for distribution purposes. During another session at DOS, discussions were further held regarding the value and format of an Access database[3]. The group was in agreement that: 1) an Access format at DOS would greatly help manage spatial data as DOS embarks on developing national digital spatial coverage; 2) that it would be preferable for the Access format to mimic as best as possible the provisional national data as described in the *Malawi Digital Spatial Data Standard* report (DOS, 1998); 3) that the Access database should allow for the creation of ASCII text files for distribution purposes; and 4) that a metadata format for agencies other than DOS who compile spatial data (e.g., Department of Forestry, Ministry of Agriculture, and Meteorology Department) will be determined at a later date after the DOS has had an opportunity to discuss and get feedback on DOS provisional spatial data standards. The Surveyor General, Mr. Gunda, and Ron Eastman – both of whom have been actively involved in the development of digital spatial standards – will be debriefed and asked to give additional input to the above noted issues. Upon their consent, ARSC will be asked to create an Access database that DOS may use in the future to manage their spatial data. Training in Access – as already proposed by the EIS task force funded through the World Bank – will be critical so that DOS may easily revise this database in the future as new needs arise.

II.b. Provisional geographic naming standards conventions

To ensure interoperable spatial environmental data, technical assistance was given on the development of geographic name and coding standards[4]. Existing geographic names and coding conventions as used by other institutions - such as the National Statistics Office (NSO) and the Famine Early Warning System (FEWS) – were used and adhered to in developing the provisional geographic naming standards. A draft of the geographic name standards has been included in Appendix 5. It is proposed that this document be appended to the provisional *Malawi Spatial Data Standards* report (DOS, 1998).

II.c. Provisional attribute coding standards

Technical assistance was provided to the DOS to develop provisional geographic feature attribute coding standards[5]. As indicated in Appendix 6, the provisional geographic features coding standards includes information on the geographic features entity definition and symbology[6]. It is recommended that this provisional document be appended to the provisional *Malawi Spatial Data Standards* document (DOS, 1998).

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[1] It is recommended that spatial data QA/QC procedures as developed by ARSC are refered to. It may be necessary to develop specific QA/QC for digitizing procedures conducted in Cartalinx if QA/QC procedures continue to be software specific.

[2] Individuals present were: Geoffrey Mzembe, Jackson Nakutepa, Thomson Sumani, Emmanuel Likombola, Lovemore Mazonda, Muwuso Chawinga, Richard Muheya, Susan Nyerende, and Alice Gwedeza.

[3] Individuals present were: Geoffrey Mzembe, Thomson Sumani, Muwuso Chawinga, Susan Nyerende, and Alice Gwedeza. (Other individuals typically involved in the digital mapping standards were in Zambia at an ITC workshop).

[4] Individuals particularly involved in developing these provisional geographic naming standards conventions were those from the DOS's cartography section – Thomson Sumani and Lovemore Mazonda.

[5] Again, individuals particularly involved in developing these provisional attribute coding conventions were those from DOS's cartography section – Thomson Sumani and Lovemore Mazonda.

[6] Note that symbology specifications for most geographic features is as yet incomplete. These will be completed in the future once DOS has the opportunity to test various digital symbologies in producing digital maps.

II.d. Conducting Sessions on Digital Spatial Data Standards with other line agencies

Discussions were held at DOS with regards to conducting digital spatial standards/National Mapping Standards sessions with other line agencies compiling spatial data. A concern of DOS staff was the need for two types of spatial data standards sessions: 1) one session to focus on building awareness and gaining feedback on the digital mapping standards from ***technical*** staff at line agencies other than DOS that also gather spatial data and 2) a session to build awareness and recognition towards approving the national mapping standards with ***senior*** staff from line agencies other than DOS that gather spatial data.

It is envisioned that the former session – with ***technical*** staff - would be a forum in which the DOS would present the DOS's provision spatial data standards in order to build awareness and gain input on the spatial data standards. It was proposed by DOS that this technical session should include technical staff from other agencies that compile spatial data – namely the Department of Forestry, Ministry of Agriculture, Meteorology, Environmental Affairs Department, National Statistics Office, and FEWS. It was proposed that ideally this session should be approximately 3-5 days. Local currency funds will need to be available to conduct this technical session.

As for the latter spatial data standards session – with ***senior*** staff - it is envisioned that this session would be an opportunity for the DOS to present its provisional national mapping standards to senior level staff in order to encourage broader recognition. It was proposed that this session would be approximately three days with the first day and a half filled with presentations on the provisional standards to land surveyors and the second and third day with presentations made to senior staff of other agencies that compile spatial data. The surveyor general, Mr. Gunda, mentioned that these senior level discussions may include the possibility of incorporating the digital spatial standards as a part of the Land Surveying Act. Local currency funds will also need to be available to support this activity.

III. DEVELOPMENT OF A NATIONAL EIS

Technical assistance was given by Mathilde Snel and James Toledano on the development of a national EIS in Malawi. Two presentations were given to senior level staff: the first presentation was given to members of the National Committee on the Environment (NCE) and select senior staff and the second presentation was given to the Technical Committee on the Environment (TCE). In accordance with the EIS Design Team strategy paper (1997), presentations focused on building awareness of data and information products compiled to date in the Prototype EIS on the Middle Shire. A pamphlet on results of the Middle Shire investigation was developed and distributed during the presentations (see Appendix 7). During both presentations concern was voiced on the sustainabilty of the collection of environmental information such as compiled for the Middle Shire. To accommodate this concern a section on a national EIS was included in the pamphlet (see last section on EIS on p. 5 – Appendix 7). Clark University started drafting a document to specifically help address institutional issues in developing a sustainable national EIS (see Appendix 8). However, concern was raised by the EIS Team Leader and the COP that the EIS institutional assessment focus initially on securing the development of the EIS task force and further exploitation of the Mid-Shire Analysis. Also, it was recommended by the EIS Team Leader that UA play a larger role in the development of the NEIS initiative. Consequently, it was agreed that UA will now take the lead in this development and that recommendation contained in Appendix 8 be considered at a much later date by the GOM and the EIS Task Force.

IV. ASSESSMENT OF MEMP'S ENVIRONMENTAL MONITORING CAPACITY BUILDING EFFORTS

Upon the request of Wayne McDonald, an assessment was compiled of MEMP's capacity building efforts throughout the GOM over the past five years. Clark University hopes to present these results during their wrap-up presentation in March/April, 1999. Respondents were asked about the number of individuals trained by MEMP vs. other initiatives, the environmental monitoring hardware obtained through MEMP vs. other initiatives, the applications for which environmental monitoring technologies have to date been used, and opportunities and concerns to continue providing environmental monitoring services. To date, preliminary institutional assessments have been conducted for DOS, Department of Forestry and Chancellor College. During the next trip assessments of MEMP's capacity building efforts will also be conducted for the Ministry of Agriculture, Meteorology Department, Environmental Affairs Department, Polytechnic, and Bunda College.

An assessment of MEMP capacity building efforts that have had direct or indirect impacts on participating GOM departments to conduct ongoing work includes:

Department of Surveys (DOS)

1. Health facility siting in the Central region: The DOS is presently compiling spatial digital data on roads, rivers, districts and traditional authority boundaries, and government institution locations for nine districts in the Central region to help site health facilities. The project is being facilitated from the Ministry of Health with funding from JICA .
2. Development of District Planning initiatives: The DOS is presently compiling spatial digital data on existing infrastructure for six districts across the entire country under a contract with the local government District Development project. DOS is compiling a GIS database on roads, water, boreholes, postal services, telecommunications, relief, primary schools, and health facilities locations within these six districts. Local governments will be using the information for district development and planning.
3. Irrigation and dam siting: The DOS worked collaboratively with the Ministry of Agriculture last year to prepare a digital national map on irrigation and dam sitings. The map was used by the Ministry of Agriculture to help further help site and plan for other irrigation and dam sites.
4. City planning: The DOS developed a 1:10,000 city map of the Blantyre area using aerial photography, image processing, and GIS. The map is being used extensively for Blantyre city planning purposes.
5. National boundary verification: GIS and GPS technology was used by the DOS and the Zambian government to help delineate boundary areas of contention between Malawi and Zambia.
6. Land cover change and soil erosion mapping: DOS provided core digital data sets on roads, rivers, topography (elevation and slope), villages, and forest reserve locations in the Middle Shire investigation.
7. National Malaria mapping: The Ministry of Health has expressed an interest to DOS for the provision of spatial digital information to help site areas prone to Malaria in Malawi (e.g., mapping of marsh areas). A contract is being drafted.
8. Project siting for the Save the Children Fund: The Save the Children Fund has expressed an interest to DOS to have a digital spatial database developed on their project sites.
9. Development of a national spatial digital archive: DOS is in the process of developing a national spatial digital archive so that a national spatial data set exists to continue supporting the applications as indicated above.

Department of Forestry (DOF)

1. Monitoring of encroachment in forest reserves: DOF is presently using GIS, image processing, and GPS technologies to help monitor encroachment in the Namizimu forest reserve in the Mangochi district.
2. Forest management in the Kammwamba area: the DOF is presently compiling a digital spatial data set at a 1:5,000 scale for a project about the Kammwamba area (within the Lisungwe catchment) funded through the GTZ. GIS and image processing are being used to compile spatial data on land cover, land cover change, facilities (hospitals, schools, and churches), and geographic features (roads, rivers, villages, and village forest areas) in this area. The information will be used for forest management in this area.
3. Village forest area mapping/social forestry: The DOF used GPS technology to locate village forest areas within the Lilongwe area. This data was used to help site borehole locations under the Lilongwe social forestry project.
4. Land cover and land cover change mapping in the Middle Shire: The DOF provided information on land cover and land cover change in the Middle Shire investigation.

Chancellor College (UNIMA)

1. Assessment of biodiversity of Mangochi palm forest reserve: Image processing technologies was used by faculty at Chancellor collage to access biodiversity at the Mangochi palm forest reserve.

Land cover change analysis was conducted to help delineate the decline of palm and forest cover in the area.

2. GIS course requirement: The newly developed Masters of Environmental Sciences curriculum program requires that students complete a GIS course. Furthermore, discussions have been held on allowing master students to specialize in environmental monitoring and GIS.
3. Incorporation of Introduction to GIS in an undergraduate geographic techniques course: An undergraduate course in Geographic Techniques presently has a section covering an Introduction to GIS.

V. TRAINING IN GIS AND REMOTE SENSING

An intermediate training in GIS and remote sensing was conducted at Bunda College from December 9 – 19. The initial three days of the training focused on ArcView GIS – coordinated by Sam Drake of the University of Arizona - while the subsequent six days of the training focussed on IDRISI GIS and Cartalinx – coordinated by Mathilde Snel and Neil Manspeizer of Clark University. The intermediate training was the continuation of the "training of trainers" in which primarily UNIMA staff instructed sessions throughout the training. The Malawian trainers were as follows:

1. Mescheck Kapila – Land Husbandry Training Center, EIS task force leader;
2. Meya Kalidekafe – Chancellor College, UNIMA;
3. Steven Taulo – The Polytechnic, UNIMA;
4. Joseph Jonazi – Bunda College, UNIMA; and
5. Sam Chilombe – Meteorology Department.

During the IDRISI/Cartalinx section of the training – coordinated by Clark University – approximately 80% of the sessions were instructed by Malawian trainers. Furthermore, in accordance to the "training of trainers" ten of the twenty-two participants were UNIMA staff or trainers elsewhere (e.g., Dedza School of Forestry and Wildlife and Land Husbandry Training Center - see participants list in Appendix 9). The six day IDRISI/Cartalinx training focused on digitizing and database development, image processing, and environmental modeling (see training schedule in Appendix 10). Participants were asked to evaluate the course. Evaluations were very favorable. Participants indicated that the course had met their expectations and complemented the teaching styles of various instructors. As UNIMA plans to continue this effort – possibly through the World Bank EIS initiative – two constructive observations were made from the evaluations: 1) extending the training may be considered and 2) fewer trainers may be preferable. At the end of the course, participants were given two certificates – one for the three day ArcView course and another for the six day IDRISI GIS course.

BIBLIOGRAPHY

Department of Surveys (DOS), 1998. Malawi Digital Spatial Data Standard, Version 0.2. Draft Provisional Version, Revision 2. March, 1998.

EIS Design Team, 1997. Strategy for an Environmental Information System in Malawi. April, 1997.

Malawi Environmental Monitoring Programme, 1998. Workplan for University of Arizona and Clark University activitites.

APPENDIX 1: SAMPLE METADATA FOR A VECTOR DIGITAL SPATIAL FILE (1:50,000, ROADS)

[VERSION]
MALAWI DIGITAL STANDARD METADATA FORMAT PROVISIONAL VERSION 1.0
[DESCRIPTION]
Roads, Machinga, YU2500 (TD) Malawi 1:50,000 Metric Edition tile.
[STATUS]
Provisional
[COPYRIGHT]
(C) of original digitised data: Department of Surveys, 1998 Government of Malawi
[FILE ORGANISATION]
[File Structure]
[transfer level]
Level 1
[format]
Arc/Info Export (.EOO) File
IDRISI Vector (.VEC, .DVC) File
DXF (.DXF) File
[version]
Arc/Info 3.1
IDRISI 2.0
[Number of Files]
4
[File Name / Size / Date / Purpose]
TDRD98.EOO 45,450 04/11/98 Arc/Info export format
TDRD98.VEC 18,208 22/03/98 IDRISI vector data file
TDRD98.DVC 315 16/12/98 IDRISI vector documentation file
TDRD98.DXF 64548 07/12/98 DXF file
[ATTRIBUTION]
[Authors]
digitised by G. C. Mzembe, M.K. Chawinga, L.K. Mazonda and T. G. Sumani
[Contact Information]
Surveys Department, P. O. Box 349, Blantyre, Malawi. Tel.: 623 722 Fax: 634 034
[Original Creation Date]
digitised on 01/07/98
[LINEAGE]
[Source Materials]
1:50,000 non-metric topographic maps (digital file windowed about metric tile parameters). First Edition published by the Directorate of Overseas Surveys, D.O.S. 1950. Second Edition reconstructured by the Federal Department of Trigonometrical and Topographical Surveys, 1959. Third Edition revised by the Directorate of Overseas Surveys, 1967 (D.O.S. 425). Fourth Edition reconstructed, drawn, photographed and printed by the Department of Surveys, Blantyre, 1977 period. Air Photography by Meridian Air maps LTD., September 1974.
[Creation Devices]
Zeos 80486 DX4 computer and CalComp 34480 (A0) digitising board
[Creation Details / Notes]
The map was digitised according to provisional map standards. Map were digitised off 1:50,000 topo map sheets.
[REVISIONS]
[GEOREFERENCING]
[Reference System]
MalawiGP
[Horizontal Datum]
Arc 1960 (new Arc 1950)
[Vertical Datum]

Trig Datum
[Ellipsoid]
[name]
Clark 1880 (modified)
[major semi-axis]
6378249.145
[minor semi-axis]
6356514.870
[flattening]
1/293.465000
[Molodensky Constants]
[delta x]
-179 (provisionally for ARC 1960)
[delta y]
-87 (provisionally for ARC 1960)
[delta z]
-314 (provisionally for ARC 1960)
[Projection]
[name]
Transverse Mercator
[scale factor at true origin]
0.9996
[True Origin: Lat./Long.]
0 33
[False Coordinates at Origin: X/Y]
500000 m E 10000000 m N
[Measurement Units]
metres (conformed to S.I. standards)
[Bounding Rectangle]
[minimum x]
725000
[maximum x]
750000
[minimum y]
8300000
[maximum y]
8325000
[ATTRIBUTE CODING]
110 main road
120 secondary road
130 district and other roads
[ACCURACY]
[Positional Error]
22.43 metres = (sqrt((0.04)^2+(0.07)^2+(8.5)^2+(4)^2+(1.5)^2+(10)^2+(12.5)^2+(12.5)^2)
(Based on error associated with: photo control at 0.04 m; aerotriangulation at 0.07 m; plotting error at 8.5 m;scribing at 4 m; reprographic materials at 1.5 m; paper map production at 10 m; map storage at 12.5 m; and stream mode digitizing at 12.5 m.)
TOTAL RMS = 22.43 m
[Attribute Error]
0
[PRECISION]
[Positional Precision]
6.25 metres ((.25mm width of the scribing pen *50 to convert into metres off 1:50,000 scale)/2 sides of a line)
[Attribute Precision]
constrained within three classes/types of roads (i.e., main, secondary, and district & other)

[COMPLETENESS]

Roads as represented in 1977. Roads are precise within 6.25 metres and is constrained to three classes.

{ADJOINING SHEETS}

{North}
T9(YU2525)

{South}
W1(YT2575)

{East}
TE(YU5000)

{West}
TC(YU0000)

{Northeast}
TA(YU5025)

{Southeast}
W2(YT5075)

{Northwest}
T8(YU0025)

{Southwest}
W0(YT0075)

[RESTRICTIONS]

The representations of cadastral boundaries appearing on this map is not taken as evidence for location of legal boundaries. User assumes all responsibility for determining the applicability of this product for any purpose.

APPENDIX 2: SAMPLE METADATA FOR A RASTER DIGITAL SPATIAL FILE (1:50,000, IMAGERY)

[VERSION]
MALAWI DIGITAL STANDARD METADATA FORMAT PROVISIONAL VERSION
[DESCRIPTION]
Machinga, YU2500(TD)Malawi 1:50,000 Metric Edition tile, Landsat TM, 17/09/94, 7 bands, true colour and false colour
[STATUS]
Provisional
[COPYRIGHT]
(c) of original source image: CSIR (SAC), Satellite Applications Center, Pretoria, South Africa. (C) of georeferenced images: Department of Surveys,1998 Government of Malawi"
[FILE ORGANIZATION]
[File Structure]
[transfer level]
Level 1
[format]
IDRISI Raster Image
[version]
IDRISI 2.0
{rows}
833
{columns}
833
{resolution}
30 meters
[Number of Fies]
19
[File List]
TDIM94T1.img 693889 17/09/94 raster data file
TDIM94T1.doc 2750 17/09/94 raster documentation file
TDIM94T2.img 693889 17/09/94 raster data file
TDIM94T2.doc 2750 17/09/94 raster documentation file
TDIM94T3.img 693889 17/09/94 raster data file
TDIM94T3.doc 2750 17/09/94 raster documentation file
TDIM94T4.img 693889 17/09/94 raster data file
TDIM94T4.doc 2750 17/09/94 raster documentation file
TDIM94T5.img 693889 17/09/94 raster data file
TDIM94T5.doc 2766 17/09/94 raster documentation file
TDIM94T6.img 693889 17/09/94 raster data file
TDIM94T6.doc 2766 17/09/94 raster documentation file
TDIM94T7.img 693889 17/09/94 raster data file
TDIM94T7.doc 2766 17/09/94 raster documentation file
TDIM94TT.img 693889 17/09/94 raster data file
TDIM94TT.doc 2766 17/09/94 raster documentation file
TDIM94TF.img 693889 17/09/94 raster data file
TDIM94TF.doc 2766 17/09/94 raster documentation file
TDIM94.cor 710 28/10/98 raster image correspondence file
[ATTRIBUTION]
[Authors]
Georeferencing and tiling done by: J.A. Nakutepa.
[Contact Information]
Contact address: Department of Surveys, P.O.Box349, Blantyre, Malawi. tel:621475 fax:634034
[Original Creation Date]

Original image obtained on: 17/09/94
Georeferenced image created on: 30/10/97

[LINEAGE]

[Source Material]

Landsat TM satellite images and 1:50,000 non-metric topographic maps(for georeferencing). First Edition published by the Directorate of Overseas Surveys, D.O.S. 1950. Second Edition reconstructed by the Federal Department of Trigonometrical and Topographical Surveys, 1959. Third Edition revised by the Directorate of Overseas Surveys, 1967 (D.O.S. 425). Fourth Edition reconstructed, drawn, photographed and printed by the Department of Surveys, Blantyre, 1977 period. Air Photography by Meridian Air maps LTD., September 1974.

[Creation Devices]

Gateway 2000 35 - 166 Pentium computer and IDRISI 2.0 software

[Creation Details/Notes]

The map was georeferenced according to provisional map standards. Maps were georeferenced off 1:50000 topo map sheets.

[REVISIONS]

[GEOREFERENCING]

[Reference System]

MalawiGP

[Horizontal Datum]

Arc 1960 (new Arc 1950)

[Vertical Datum)

Trigonometric Datum

[Ellipsoid]

[name]

Clark 1880 (modified)

[major semi-axis]

6378249.145

[minor semi-axis]

6356514.870

[flattening]

1/293.465000 (0.003407561)

[Molodensky Constants]

[delta x]

-160 (provisionally for ARC 1960)

[delta y]

-6 (provisionally for ARC 1960)

[delta z]

-73 (provisionally for ARC 1960)

[Projection]

[name]

Transverse Mercator

[scale factor at true origin]

0.9996

[True Origin: Lat/Long]

0 33

[False Coordinates at Origin: X/Y]

500000 m E 10000000 m N

[Measurement Units]

meters (conformed to S.I. standards)

[Bounding Rectangle]

[minimum X]

725000

[maximum X]

750000

[minimum Y]

8300000
[maximum Y]
8325000
[ATTRIBUTE CODING]
DN (digital numbers) represent spectral reflectance
[ACCURACY]
[Positional]
55.32 meters(=sqrt((0.04)^2+ (0.07)^2+(8.5)^2+(4)^2+(1.5)^2+(5)^2+(10)^2+(12.5)^2+(52)^2)
(Based on error associated with: photo control at 0.04m; aerotriangulation at 0.07m; plotting on A CP1 at 8.5m; scribing at 4m; reprographic at 1.5m; paper map production at 10m; map storage at 12.5m; georeferencing at 52m (see {Resampling} below)
TOTAL RMS = 55.32 m.
{Resampling}
Computed polynomial surface : Quadratic (based on 21 control points)

Coefficient	X	Y
b0	40890.4326844215393000	-276726.9090753770000000
b1	0.0275847734609500	0.0099660799466257
b2	-0.0094350422227762	0.0335375536128595
b3	0.0000000000847360	-0.0000000002839633
b4	0.0000000006326624	-0.0000000005109743
b5	0.0000000002213119	-0.0000000000158277

Old X	Old Y	New X	New Y	Residual
1590.828000	4785.124000	723550.000000	8307540.000000	2.518382
1925.361000	5709.501000	737850.000000	8333250.000000	2.122570
657.603300	5526.690000	699625.000000	8333925.000000	2.379595
566.278700	3069.309000	685025.000000	8261620.000000	2.555030
1031.425000	3323.710000	700090.000000	8266870.000000	1.089089
1238.911000	3354.207000	706410.000000	8266790.000000	1.504927
1128.418000	1796.343000	695600.000000	8221275.000000	1.499282
2145.345000	1533.366000	724480.000000	8208580.000000	1.449355
2271.336000	2047.821000	730690.000000	8223135.000000	1.428673
1939.360000	3117.728000	726000.000000	8256475.000000	1.614134
1932.860000	2489.783000	722785.000000	8237875.000000	0.811124
3170.271000	4640.595000	769650.000000	8295760.000000	2.438972
2715.804000	4619.097000	756125.000000	8297180.000000	1.639189
2328.332000	4313.124000	743175.000000	8290000.000000	0.178188
3065.779000	4286.626000	764875.000000	8285650.000000	1.482895
2617.811000	5403.028000	756880.000000	8320925.000000	1.133384
4340.249000	4262.504000	802500.000000	8278925.000000	1.827611
3872.220000	3251.716000	783740.000000	8251125.000000	2.365955
3386.755000	2666.267000	766625.000000	8236170.000000	1.384712
989.428000	1468.872000	689925.000000	8212175.000000	1.364893
3429.003000	2410.386000	766630.000000	8228325.000000	1.467136

Overall RMS = 1.734299

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 mean)
[Attribute Error]
n/a
[PRECISION]
[Positional Precision]
30m
[Attribute Precision]
contained within a byte range (from 0 to 255)

{RESAMPLING}
{Number of Control Points}
21
{Control Points Characteristics}

id#	oldx	oldy	newx	newy	sidual(quan.)	confidence
1	1590.828000	4785.124000	723550.000000	8307540.000000	1.991189	very good
2	1925.361000	5709.501000	737850.000000	8333250.000000	2.616581	very good
3	657.603300	5526.690000	699625.000000	8333925.000000	3.152203	very good
4	896.935200	4151.138000	699930.000000	8291690.000000	omitted	very good
5	566.278700	3069.309000	685025.000000	8261620.000000	2.229343	very good
6	1031.425000	3323.710000	700090.000000	8266870.000000	1.427486	good
7	1238.911000	3354.207000	706410.000000	8266790.000000	2.109614	very good
8	653.952800	2712.763000	685850.000000	8250675.000000	omitted	fair
9	1287.907000	1264.890000	697950.000000	8204470.000000	omitted	very good
10	1128.418000	1796.343000	695600.000000	8221275.000000	2.678820	very good
11	2145.345000	1533.366000	724480.000000	8208580.000000	1.092010	very good
12	2271.336000	2047.821000	730690.000000	8223135.000000	1.861480	very good
13	2330.109000	2875.999000	736525.000000	8247420.000000	omitted	very good
14	1939.360000	3117.728000	726000.000000	8256475.000000	1.793703	very good
15	1932.860000	2489.783000	722785.000000	8237875.000000	1.125278	very good
16	3170.271000	4640.595000	769650.000000	8295760.000000	2.987499	very good
17	2715.804000	4619.097000	756125.000000	8297180.000000	1.347450	very good
18	2328.332000	4313.124000	743175.000000	8290000.000000	0.179561	very good
19	3065.779000	4286.626000	764875.000000	8285650.000000	1.280796	very good
20	2617.811000	5403.028000	756880.000000	8320925.000000	2.314846	very good
21	4340.249000	4262.504000	802500.000000	8278925.000000	2.228739	good
22	3872.220000	3251.716000	783740.000000	8251125.000000	2.160111	very good
23	3386.755000	2666.267000	766625.000000	8236170.000000	0.410348	good
24	989.428000	1468.872000	689925.000000	8212175.000000	1.237137	good
25	545.614100	1662.140000	677725.000000	8219745.000000	omitted	good
26	3429.003000	2410.386000	766630.000000	8228325.000000	1.859668	good

{Control Point Descriptions}
{point id/description}
1 center of railway and river crossing, sheet 1535A3
2 center of railway and river crossing, sheet 1535A1
3 road junction, sheet 1534B2
4 center of road /river crossing (at bridge) on sheet 1534B4
5 center of road /river crossing (at bridge) on sheet 1534D1
6 road junction, sheet 1534D2
7 center of road junction, sheet 1534D2 (after Chileka airport)
8 river confluence, sheet 1534D3
9 railway road crossing sucoma estate, sheet 1634B2
10 railway road center crossing, sheet 1634B2
11 road junction (center)
12 road junction (center)
13 road junction, sheet 1535C3
14 road junction, sheet 1535C3
15 road junction, sheet 1535C3
16 road junction, sheet 1535B3
17 road junction, sheet 1535A4
18 road junction, sheet 1535A4
19 road junction, sheet 1535A4
20 road junction, sheet 1535A2
21 road junction, sheet 1535D2
22 road junction, sheet 1535D3
23 road/river crossing, sheet 1535C4

24 road/river crossing, sheet 1634B2
25 road/river crossing, sheet 1634B1
26 road junction, sheet 1635A2
{Polynomial Order}
2(quadratic)
{Resampling procedure}
nearest neighbor
{Overall RMS}
52.028970 meters (=1.734299pixels*30 meters}
[COMPLETENESS]
{Minimum Mapping Unit}
30 meters
[ADJOINING SHEETS]
{NORTH}
T9(YU2525)
{SOUTH}
W1(YU2575)
{EAST}
TE(YU5000)
{WEST}
TC(YU0000)
{NE}
TA(YU5025)
{SE}
W2(YU5075)
{NW}
T8(YU0025)
{SW}
W0(YU0075)
[RESTRICTIONS]
The representations of cadastral boundaries appearing on this map is not taken as evidence for the location of legal boundaries. User assumes all responsibility for determining the applicability of this product for any purpose.

APPENDIX 3: README FILE FOR 1:50,000 DIGITAL SPATIAL FILES

README FIRST file:

This CD contains digital data adhering to the 1:50,000 metric map sheets of Malawi.

File organization:
First Level Subdirectories:
The first level subdirectory consists of the metric edition sheet number, e.g. YU2500. The first two values of the map sheet code consists of two characters indicating a location based on a global UTM code (e.g. YU includes sixteen 1:50,000 mapsheets). The maps sheet code is followed by four numbers in which the first two values indicate the UTM eastings (note the first significant value is disregarded- e.g. YU2500 indicates an easting of 725000) followed by the UTM northing (note the first two significant values are disregarded- e.g. YU2500 indicates a northing of 8300000)

Second Level Subdirectories:
The second level subdirectory indicates the layer type. Layer types include:

\RIVERS\	(Rivers)
\ROADS\	(Roads)
\CONTOURS\	(Contours)
\FORRES\	(Forest reserves)
\SOILS\	(Soils)
\LANDUSE\	(Land use / Land Cover)
\VILLAGES\	(Villages)
\AGROCLIM\	(Agro-Climatic Zones)
\DEM\	(Digital Elevation Models, either as raster elevation models or as vector TIN models)
\TRADAUTH\	(Traditional Authorities)
\ENUMAREA|	(Enumeration Areas)
\IMAGERY\	(Georeferenced Imagery)

Third Level Subdirectories:
The final level subdirectory indicates the basic data type and approved date of the layer. Data type codes include:

VC	Vector
RS	Raster
TM	Landsat TM
MS	Landsat MSS
SX	Spot XS Multispectral
SP	Spot Panchromatic
AV	AVHRR HRPT

For example, a Landsat TM image from June 16, 1992 would be stored in a subdirectory named TM160692, while a vector DEM (ie.g. TIN format) approved for release on March 20, 2001 would be stored in a subdirectory named VC200301.

EXAMPLES:
The full directory path for a vectors roads layer for YU2500 released on April 29, 1999 is as follows:
yu2500\roads\VC290499

Data file naming conventions:

The names of the files reflect the specific software format in which they are stored. Note that vector files are available in three formats: Arc/Info export (.e00), IDRISI vector (.vec, .dvc), and DXF (.dxf) formats, while raster data is available as IDRISI raster band sequential files (.img and .doc) Also note that respectively vector and raster files have an associated text file on geodetic parameters(.mmt). Filenames include:

.e00	Arc/Info Export Format
.dxf	DXF Format
.vec	IDRISI Vector Data Files
.dvc	IDRISI Vector Documentation Files
.img	IDRISI Raster Images
.doc	IDRISI Raster Documentation Files
.mmt	Malawi Metadata Text Format
.msd	Malawi Spatial Data Transfer Format (followed by the version number - i.e. 1.0)

The first two characters of a file name refer to the sheet location identifier using the following codes for the metric tile as indicated below.

The first letter of the file names refers to the 100km metric tile block using the following codes transformation between the digital tile code (left) and the metric tile code (right):

A	VE
B	WE
C	XE
D	WD
E	XD
F	WC
G	XC
H	WB
I	XB
J	VA
K	WA
L	XA
M	YA
N	VV
O	WV
P	XV
Q	YV
R	WU
S	XU
T	YU
U	ZU
V	XT
W	YT
X	ZT
Y	XS
Z	YS

The second letter of the file names refers to a 25km block within each metric tile (16 sheets in one 100km metric tile) using the following transformation between the digital tile code (left) and the metric tile code (right):

0	0075
1	2575
2	5075
3	7575
4	0050
5	2550

6	5050
7	7550
8	0025
9	2525
A	5025
B	7525
C	0000
D	2500
E	5000
F	7500

EXAMPLE: The YU2500 map sheet would be referred to as TD ("T" for YU and "D" for 2500).

The next two characters (the third and fourth character of the filename) refers to the layer type using the following codes:

RV	Rivers
LK	Lakes
RD	Roads
CN	Contours
FR	Forest Reserves
SL	Soils
LU	Land Use/Cover
VG	Villages
AC	Agro Climatic Zones
TA	Traditional Authorities
EA	Enumeration Areas
DM	Digital Elevation Model
IM	Georeferenced Imagery

The fifth and sixth character of the file name are used to specify the year in which the data was approved (note that for satellite imagery this will be the year in which the satellite image was obatained while for digitized data this will be the year in which the digital data was created).

The seventh character of the file name may, in the case of imagery, refer to the type of receiver using the codes:

S	SPOT data
T	Landsat TM data
M	Landsat MSS data
A	AVHRR data

The eighth character of the file name may, in the case of imagery, refer to the band number, composite type (i.e., true colour), or additional information using the following codes:

1 Band 1
2 Band 2
3 Band 3
etc.

T	True Colour Composite
F	False Colour Composite
X	for SPOT Multispectral
P	for SPOT Panchromatic

EXAMPLES:

The full path and files defining a vector roads layer for YU2500 released on April 16, 1999 in vector format is as follows (note this includes ArcInfo export, IDRISI, and DXF formats and a metadata file):
\YU2500\ROADS\VC160499\T8RD99.e00
\YU2500\ROADS\VC160499\T8RD99.vec
\YU2500\ROADS\VC160499\T8RD99.dvc
\YU2500\ROADS\VC160499\T8RD99.dxf
\YU2500\ROADS\VC160499\T8RD99.mmt

The full path and files defining a raster digital elevation model for YU2500 released October 12, 2001 in IDRISI format is as follows (note this includes IDRISI raster band sequential format and a metadata file):
\YU2500\DEM\RS121001\T8DM99.img
\YU2500\DEM\RS121001\T8DM99.doc
\YU2500\DEM\RS121001\T8DM99.mmt

The full path defining bands 1,2,3, and a true colour composite of March 14, 1994 SPOT data for the YU2500 map sheet is as follows:
\YU2500\IMAGERY\SX140394\T8IM94S1.img
\YU2500\IMAGERY\SX140394\T8IM94S1.doc
\YU2500\IMAGERY\SX140394\T8IM94S2.img
\YU2500\IMAGERY\SX140394\T8IM94S2.doc
\YU2500\IMAGERY\SX140394\T8IM94S3.img
\YU2500\IMAGERY\SX140394\T8IM94S3.doc
\YU2500\IMAGERY\SX140394\T8IM94ST.img
\YU2500\IMAGERY\SX140394\T8IM94ST.doc
\YU2500\IMAGERY\SX140394\T8IM94S1.mmt

APPENDIX 4: README FILE FOR 1:250,000 DIGITAL SPATIAL FILES

README FIRST file:

This CD contains digital data adhering to the 1:250,000 topographic map series of Malawi.

File organization:
First Level Subdirectories:
The first level subdirectory consists of map sheet location. The following are used for the 1:250,000 topographic map series:

\KARONGA\
\NYIKA\
\MZUZU\
\MZIMBA\
\KASUNGU\
\LILONGWE\
\MONKEYBY\
\LIWONDE\
\BLANTYRE\
\NSANJE\

Second Level Subdirectories:
The second level subdirectory indicates the layer type. Layer types include:

\RIVERS\	(Rivers)
\ROADS\	(Roads)
\LAKES\	(Lakes)
\CONTOURS\	(Contours)
\DEM\	(Digital Elevation Models, either as raster elevation models or as vector TIN models)

Third Level Subdirectories:
The final level subdirectory indicates the basic data type and approved date of the layer. Data type codes include:

VC	Vector
RS	Raster
TM	Landsat TM
MS	Landsat MSS
SX	Spot XS Multispectral
SP	Spot Panchromatic
AV	AVHRR HRPT

For example, a Landsat TM image from June 16, 1992 would be stored in a subdirectory named TM160692, while a vector DEM (ie.g. TIN format) approved for release on March 20, 2001 would be stored in a subdirectory named VC200301.

EXAMPLES:
The full directory path for a vectors roads layer for the 1:250,000 Liwonde map sheet released on April 29, 1999 is as follows:
LIWONDE\roads\VC290499

Data file naming conventions:
The names of the files reflect the specific software format in which they are stored. Note that vector files are available in three formats: Arc/Info export (.e00), IDRISI vector (.vec, .dvc), and DXF (.dxf) formats, while

raster data is available as IDRISI raster band sequential files (.img and .doc) Also note that respectively vector and raster files have an associated text file on geodetic parameters(.mmt). Filenames include:

.e00	Arc/Info Export Format
.dxf	DXF Format
.vec	IDRISI Vector Data Files
.dvc	IDRISI Vector Documentation Files
.img	IDRISI Raster Images
.doc	IDRISI Raster Documentation Files
.mmt	Malawi Metadata Text Format
.msd	Malawi Spatial Data Transfer Format (followed by the version number - i.e. 1.0)

The first two characters of a file name refer to the sheet location identifier using the conventional codes for the 1:250,000 map sheets as indicated below.

1	Karonga
2	Nyika Plateau
3	Mzuzu
4	Mzimba
5	Kasungu
6	Lilongwe
7	Monkey Bay
8	Liwonde
9	Blantyre
10	Nsanje

The next two characters (the third and fourth character of the filename) refers to the layer type using the following codes:

RV	Rivers
LK	Lakes
RD	Roads
CN	Contours
DM	Digital Elevation Model

The fourth and fifth character of the file name are used to specify the year in which the data was approved (note that for satellite imagery this will be the year in which the satellite image was obtained while for digitized data this will be the year in which the digital data was created).

The sixth character of the file name may, in the case of imagery, refer to the type of receiver using the codes:

S	SPOT data
T	Landsat TM data
M	Landsat MSS data
A	AVHRR data

The seventh character of the file name may, in the case of imagery, refer to the band number, composite type (i.e., true colour), or additional information using the following codes:

1 Band 1
2 Band 2
3 Band 3
etc.

T	True Colour Composite
F	False Colour Composite

X for SPOT Multispectral
P for SPOT Panchromatic

EXAMPLES:

The full path and files defining a vector roads layer for the 1:250,000 Liwonde map series released on April 16, 1999 in vector format is as follows (note this includes ArcInfo export, IDRISI, and DXF formats and a metadata file):
\LIWONDE\ROADS\VC160499\8RD99.e00
\LIWONDE\ROADS\VC160499\8RD99.vec
\LIWONDE\ROADS\VC160499\8RD99.dvc
\LIWONDE\ROADS\VC160499\8RD99.dxf
\LIWONDE\ROADS\VC160499\8RD99.mmt

The full path and files defining a raster digital elevation model for the 1:250,000 Liwonde map series released October 12, 2001 in IDRISI format is as follows (note this includes IDRISI raster band sequential format and a metadata file):
\LIWONDE\DEM\RS121001\8DM99.img
\LIWONDE\DEM\RS121001\8DM99.doc
\LIWONDE\DEM\RS121001\8DM99.mmt

APPENDIX 5: PRELIMINARY GEOGRAPHIC NAMING CONVENTIONS/STANDARDS

The following spelling conventions (including upper and lower case conventions) and numeric codes are recommended for the following geographic locations in developing digital database:

Code	Geographic Location
Regions	
10000	Northern Region
20000	Central Region
30000	Southern Region
Districts	
10100	Chitipa District
10200	Karonga District
10300	Nkhata Bay District
10400	Rumphi District
10500	Mzimba District
20100	Kasungu District
20200	Nkhota kota District
20300	Ntchisi District
20400	Dowa District
20500	Salima District
20600	Lilongwe District
20700	Mchinji District
20800	Dedza District
20900	Ntcheu District
30100	Mangochi District
30200	Machinga District
30300	Zomba District
30400	Chiradzulu District
30500	Blantyre District
30600	Mwanza District
30700	Thyolo District
30800	Mulanje District
30900	Phalombe District
31000	Chikwawa District
31100	Nsanje District
31200	Balaka District
Townships, Bomas, and Town Planning Units	
10120	Chitipa Boma
10220	Karonga Town
10320	Nkhata Bay Boma
10420	Rumphi Boma
10520	Mzimba Boma
20120	Kasungu Township
20320	Ntchisi Boma
20420	Dowa Boma
20520	Salima Township

20720 Mchinji Boma
20820 Dedza Township
20920 Ntcheu Boma
30120 Mangochi Boma
30220 Machinga Boma
30221 Liwonde Township
30420 Chiradzulu Boma
30620 Mwanza Boma
30720 Thyolo Boma
30721 Luchenza Township
30820 Mulanje Boma
31020 Chikwawa Boma
31120 Nsanje Boma
31220 Balaka Town

Cities
10530 Mzuzu City
20630 Lilongwe City
30331 Zomba Municipality
30530 Blantyre City

Wards and Areas
Mzuzu City
10531 Nkhorongo Ward
10532 Lupaso Ward
10533 Zolozolo Ward
10534 Chiputula Ward
10535 Chibanja Ward
10536 Mchengautuwa Ward
10537 Katoto Ward
10538 Jombo Ward
10539 Muzilawayingwe Ward
10540 Chasefu Ward
10541 Katawa Ward
10542 Masasa Ward
10543 Kaning'ina Ward
10544 Viphya Ward
10545 Msongwe Ward
10546 New Airport Site Ward
Lilongwe City
20631 Area 1
20632 Area 2
20633 Area 3
20634 Area 4
20635 Area 5
20636 Area 6
20637 Area 7
20638 Area 8
20639 Area 9
20640 Area 10
20641 Area 11
20642 Area 12
20643 Area 13
20644 Area 14
20645 Area 15

20646 Area 16
20647 Area 17
20648 Area 18
20649 Area 19
20650 Area 20
20651 Area 21
20652 Area 22
20653 Area 23
20654 Area 24
20655 Area 25
20657 Area 27
20658 Area 28
20659 Area 29
20660 Area 30
20661 Area 31
20662 Area 32
20663 Area 33
20664 Area 34
20665 Area 35
20666 Area 36
20667 Area 37
20668 Area 38
20669 Area 39
20670 Area 40
20671 Area 41
20672 Area 42
20673 Area 43
20674 Area 44
20675 Area 45
20676 Area 46
20677 Area 47
20678 Area 48
20679 Area 49
20680 Area 50
20681 Area 51
20682 Area 52
20683 Area 53
20684 Area 54
20685 Area 55
20686 Area 56
20687 Area 57
20688 Area 58

Zomba Municipality

30331 Mbedza Ward
30332 Mtiya Ward
30333 Masongola Ward
30334 Chikamveka Ward
30335 Chikamveka North ward
30336 Chirunga East Ward
30337 Chirunga ward
30338 Likangala North Ward
30339 Zakazaka Ward
30340 Zomba Central Ward
30341 Chambo Ward
30342 Sadzi Ward
30343 Likangala Central Ward

30344 Likangala South Ward

Blantyre City

30531 Michiru Ward
30532 South Lunzu Ward
30533 Mapanga Ward
30534 Nkolokoti Ward
30535 Ndirande North Ward
30536 Ndirande South Ward
30537 Ndirande West Ward
30538 Nyambadwe Ward
30539 Likhubula Ward
30540 Chilomoni Ward
30541 Blantyre West Ward
30542 Blantyre Central Ward
30543 Blantyre East Ward
30544 Chichiri Ward
30545 Mzedi Ward
30546 Bangwe Ward
30547 Namiyango Ward
30548 Limbe East Ward
30549 Limbe Central Ward
30550 Limbe West Ward
30551 Soche East Ward
30552 Soche West Ward
30553 Nancholi Ward
30554 Misesa Ward
30555 Chigumula Ward
30556 Msamba Ward

Traditional Authorities and Sub-Traditional Authorities

Chitipa District
10101 Mwabulambya TA
10102 Mwenemisuku TA
10103 Mwenewenya TA
10104 Nthalire TA
10105 Kameme TA

Karonga District
10201 Kilupula TA
10202 Mwakaboko STA
10203 Kyungu TA
10204 Wasambo TA
10205 Mwirang'ombe STA

Nkhata Bay District
10301 Kabunduli TA
10302 Fukamapiri TA
10303 Malenga Mzoma TA
10304 Malanda STA
10305 Zilakoma STA
10306 Mankhambira TA
10307 Fukamalaza STA
10308 Mkumbira STA
10309 Musisya TA
10310 Nyaluwanga STA
10311 Mkondowe STA
10312 Timbiri TA
10313 Mkumpha TA
10314 Boghoyo TA

Rumphi District
10401 Chikulamayembe TA
10402 Mwamlowe TA
10403 Mwahenga STA
10404 Mwalweni STA
10405 Kachulu STA
10406 Chapinduka STA
10407 Mwankhunikira STA
10408 Katumbi TA
10409 Zolokere STA

Mzimba District
10501 M'mbelwa TA
10502 Mtwalo TA
10503 Kampingo Sibande STA
10504 Jaravikuba Munthali STA
10505 Chindi TA
10506 Mzikubola TA
10507 Mabulabo TA
10508 Khosolo Gwaza Jere STA
10509 Mpherembe TA
10510 Mzukuzuku TA

Kasungu District
20101 Kaluluma TA
20102 Simlemba STA
20103 M'nyanja STA
20104 Chisikwa STA
20105 Kaomba TA
20106 Lukwa STA

20107 Kawamba STA
20108 Njombwa STA
20109 Chilowamatambe STA
20110 Chulu TA
20111 Santhe TA
20112 Wimbe TA
20113 Kapelula TA
20114 Mwase TA

Nkhota kota District

20201 Kanyenda TA
20202 Kafuzila STA
20203 Malenga Chanzi STA
20204 Mphonde STA
20205 Mwadzama TA
20206 Mwansambo STA

Ntchisi District

20301 Kasakula TA
20302 Chikho TA
20303 Kalumo TA
20304 Nthondo STA
20305 Chilooko STA

Dowa District

20401 Dzoole TA
20402 Chakhaza STA
20403 Kayembe STA
20404 Chiwere TA
20405 Mkukula STA
20406 Msakambewa TA
20407 Mponela STA

Salima District

20501 Maganga TA
20502 Karonga TA
20503 Pemba TA
20504 Kambwiri STA
20505 Ndindi TA
20506 Kambalame STA
20507 Khombedza TA
20508 Mwanza STA
20509 Kuluunda TA
20510 Msosa STA

Lilongwe District

20601 Chadza TA
20602 Kalolo TA
20603 Chiseka TA
20604 Mazengera TA
20605 Chitekwele STA
20606 Khongoni TA
20607 Chimutu TA
20608 Chitukula TA
20609 Mtema STA
20610 Kalumbu TA
20611 Tsabango TA
20612 Kalumba TA
20613 Njewa STA
20614 Malili TA
20615 Kabudula TA

Mchinji District
20701 Mlonyeni TA
20702 Mavwere STA
20703 Zulu TA
20704 Mduwa STA
20705 Mkanda TA
20706 Dambe STA
Dedza District
20801 Pemba TA
20802 Chilikumwendo STA
20803 Kaphuka TA
20804 Tambala TA
20805 Chauma STA
20806 Kasumbu TA
20807 Kachindamoto TA
20808 Kamenya Gwaza STA
Ntcheu District
20901 Phambala TA
20902 Mpando TA
20903 Kwataine TA
20904 Makwangwala STA
20905 Champiti STA
20906 Njolomole TA
20907 Chakhumbira TA
20908 Goodson Ganya STA
20909 Masasa TA
Mangochi District
30101 Mponda TA
30102 Chimwala TA
30103 Nankumba TA
30104 Jalasi TA
30105 Mbwana Nyambi STA
30106 Chowe TA
30107 Katuli TA
30108 Makanjila TA
30109 Namabvi STA
Machinga District
30201 Liwonde TA
30202 Sitola STA
30203 Kawinga TA
30204 Chamba TA
30205 Mposa STA
30206 Mlomba STA
30207 Chikweo STA
30208 Ngokwe STA
30209 Chiwalo STA
30210 Nyambi TA
Zomba District
30301 Kuntumanji TA
30302 Mwambo TA
30303 Mkumbira STa
30304 Chikowi TA
30305 Mbiza STA
30306 Mlumbe TA
30307 Malemia TA
Chiradzulu District

30401 Mpama TA
30402 Likoswe TA
30403 Kadewere TA
30404 Nkalo TA
30405 Chitera TA
30406 Nchema TA

Blantyre District

30501 Kapeni TA
30502 Lundu TA
30503 Chigaru TA
30504 Kunthembwe TA
30505 Makata TA
30506 Kuntaja TA
30507 Machinjili TA
30508 Somba TA

Mwanza District

30601 Dambe TA
30602 Mlauli TA
30603 Kanduku TA
30604 Nthache TA
30605 Symon TA
30606 Ngozi TA

Thyolo District

30701 Nsabwe TA
30702 Thukuta STA
30703 Mbawela STA
30704 Changata TA
30705 Mphuka STA
30706 Kwethemule STA
30707 Kapichi TA
30708 Nchilamwela TA
30709 Chimaliro TA
30710 Bvumbwe TA
30711 Thomas TA

Mulanje District

30801 Mabuka TA
30802 Laston Njema TA
30803 Chikumbu TA
30804 Nthiramanja TA
30805 Nkanda TA
30806 Juma TA

Phalombe District

30901 Mkhumba TA
30902 Nazombe TA

Chikwawa District

31001 Ngabu TA
31002 Lundu TA
31003 Chapananga TA
31004 Maseya TA
31005 Katunga TA
31006 Kasisi TA
31007 Mankhwira TA

Nsanje District

31101 Ndamera TA
31102 Chimombo TA
31103 Nyachikadza TA

31104 Mlolo TA
31105 Tengani TA
31106 Mbenje STA
31107 Malemia TA
31108 Ngabu TA
31109 Makoko STA

Balaka District

31201 Msamala TA
31202 Kalembo TA

Extension Planning Areas (EPAs)

1 Bazale
2 Bembeke
3 Bilira
4 Bolero
5 Bowe
6 Bulala
7 Bwengu
8 Chafumba
9 Chamama
10 Champhira
11 Chigonthi
12 Chikweo
13 Chikwina_SCA
14 Chilaza
15 Chilipa
16 Chingale
17 Chinguluwe
18 Chintheche
19 Chioshya
20 Chipoka
21 Chipuka
22 Chisenga
23 Chisepo
24 Chitekwele
25 Chitheka
26 Chitsime
27 Chivala
28 Chiwamba
29 Chulu
30 Demela
31 Dolo
32 Dzaone
33 Emfeni
34 Eswazini
35 Euthini
36 Golomoti
37 Kabwazi
38 Kalambo

39 Kalira
40 Kalulu
41 Kaluluma
42 Kambanizithe
43 Kandeu
44 Kanyama
45 Kaphuka
46 Kaporo North
47 Kaporo South
48 Karonga Central
49 Karonga South
50 Kasongo
51 Kasungu Chipala
52 Katuli
53 Kavukuku
54 Khombedza
55 Khosolo_SCA
56 Linga
57 Linthipe
58 Lirangwe
59 Lisasadzi
60 Lisungwi
61 Livunzu
62 Lobi
63 Lufita
64 Lungwena
65 M'ngwangwa
66 Madisi
67 Magoti
68 Maiwa
69 Makhanga
70 Malomo
71 Malosa
72 Manjawira
73 Manyamula
74 Masambanjati
75 Masuku
76 Matapwata
77 Mayani
78 Mbawa
79 Mbewe
80 Mbonechera
81 Mbwadzulu
82 Mikalango
83 Mikundi
84 Ming'ongo
85 Misuku_SCA
86 Mitole
87 Mjinge

88	Mkanda
89	Mlomba
90	Mlonyeni
91	Mndolera
92	Mombezi
93	Mpamba
94	Mpatsa
95	Mpenu
96	Mpherembe
97	Mphompha_SCA
98	Mpilipili
99	Mpilisi
100	Mpinda
101	Mpingu
102	Mpokwe
103	Mponela
104	Msitu
105	Msondole
106	Mtakataka
107	Mthiramanja
108	Muhuju
109	Mulanje South
110	Mulanje West
111	Mvera
112	Mwamkumbwa
113	Mwansambo
114	Mwanza
115	Nachisaka
116	Nakachoka
117	Naminjiwa
118	Namkumba
119	Nampeya
120	Nanyumbu
121	Nasenga
122	Neno
123	Ngwerero
124	Njolomole
125	Nkhatabay Boma
126	Nkhulambe
127	Nkhunga
128	Nsanama
129	Nsanje
130	Nsipe
131	Ntchenachena_SCA
132	Ntchisi Boma
133	Nthondo
134	Ntiya
135	Ntonda
136	Ntubwi

137 Nyachilenda
138 Nyambi
139 Nyanja
140 Phalula
141 Santhe
142 Sharpevale
143 Sinyala
144 Tamani
145 Tembwe
146 Thondwe
147 Thumbwe
148 Thyolo Boma
149 Tsangano
150 Ukwe
151 Ulongwe
152 Waruma
153 Zidyana
154 Zombwe

AGRICUTLURAL DEVELOPMENT DIVISIONS

201 Blantyre
202 Karonga
203 Kasungu
204 Lilongwe
205 Machinga
206 Mzuzu
207 Ngabu
208 Salima

Lakes

701 Lake_Chilwa
702 Lake_Chiuta
703 Lake_Kazuni
704 Lake_Malawi
705 Lake_Malombe
706 Lake_Mdila

Mountains

801 Dedza
802 Mulanje
803 Zomba
804 Marangwe
805 Kirk
806 Dzalanyama
807 Nyika
808 Vipya
809 Kandoli
810 Ntchisi

Rivers

1100 Bua
1200 Diampwe
1300 Dwangwa
1400 Lilongwe
1500 Linthipe
1600 Mwanza
1700 North_Rukuru
1800 Rivi-Rivi
1900 Ruo
2000 Shire
2100 Songwe
2200 South_Rukuru

APPENDIX 6: PRELIMINARY ATTRIBUTE CODING STANDARDS FOR THE 1:50,000 TOPOGRAPHIC MAP SERIES

ATTRIBUTES LINGUISTIC VARIATION	ATTRIBUTE CODE	ENTITY DEFINITION (DIGITAL REPRESENTATION)
Roads and miscellaneous transport	100	
Main road	110	
tarred	111	line: double black line, line width___, width between lines___ fill: red between double line (Cyan__%,Magenta__%, Yellow__%) 1abel: red (e.g.) "M1", ___pt., ____font
gravel	112	line: double black line, line width___, width between lines___ fill: pink between double line (C__%,M__%,Y__%) 1abel: red (e.g.)"M1", ___pt., ____font
planned/UC[7]	113	line: double black line, line width___, width between lines___ fill: red pecked between double line (C__%,M__%,Y__%)
Secondary	120	
tarred	121	line: double black line, line width___, width between lines___ fill: orange between double line (Cyan__%,Magenta__%, Yellow__%) 1abel: orange (e.g.)"S1", ___pt., ____font
gravel	122	line: double black line, line width___, width between lines___ fill: light orange between double line (C__%,M__%,Y__%) 1abel: orange (e.g.)"S1", ___pt., ____font
planned/UC	123	line: double black line, line width___, width between lines___ fill: orange pecked between double line (C__%,M__%,Y__%)
Tertiary	130	
Gravel	131	line: double black line, line width___, width between lines___ fill: red between double line (Cyan__%,Magenta__%, Yellow__%) 1abel: red (e.g.)"T20", ___pt., ____font
planned/UC	132	line: double black line, line width___, width between lines___ fill: red pecked between double line (C__%,M__%,Y__%)
District	140	
gravel	141	line: double black line, line width___, width between lines___ fill: light orange between double line (C__%,M__%,Y__%) 1abel: orange (e.g.)"D40", ___pt., ____font
planned/UC	142	line: orange pecked, line width___ (C__%,M__%,Y__%)
Tracks and footpaths	150	line: black pecked, line width___
Lake transport	160	
Misc. transport	170	
bridge/culvert	171	symbol: black, bridge symbol (____#)
railway	172	line: black line with cross hatches, line width___, spacing between cross hatches
light railway	173	line: black line, line width____
railway station	174	symbol: black, railway station symbol (____#) label: black "Sta", ___pt., ____font

[7] UC: Under Construction

level crossing	175		symbol: black, level crossing symbol (____#)
airport	176		symbol: red, airport symbol (____#)
aerodrome/ landing area	177		symbol: pink, aerodrome (____#)

ATTRIBUTES	ATTRIBUTE CODE	LINGUISTIC VARIATION	ENTITY DEFINITION (DIGITAL REPRESENTATION)
Boundary	200		
International	201		symbol: orange cross hatch, spacing between cross hatches___
Regional	202		symbol: orange pecked line (line width__) with one orange dot separating lines (C__%,M__%,Y__%)
District	203		symbol: orange pecked line (line width__) with two orange dots separating lines
Traditional authority	204		symbol: orange pecked line (line width__)
Township	205		symbol: black pecked line (line width__)
National park	207		symbol: national park/game reserve symbol (____#)
Game reserve	208		"
Forest reserve/ controlled area	210		symbol: green forest reserve/controlled area symbol (____#) (C__%,M__%,Y__%)
Cadastral plan	211		line: green pecked line (line width___) (C__%,M__%,Y__%) label: green (e.g.)"SD/1000 or SP43/75", ___pt., ____font
Estates	212		label: black, italic, ____pt., ____font
Plantations	213		label: black, italic, ____pt., ____font
EPAs	214		symbol: EPA symbol (____#)
ADDs	215		symbol: ADD symbol (____#)
Ward	216		symbol: ward symbol (____#)

ATTRIBUTES	ATTRIBUTE CODE	LINGUISTIC VARIATION	ENTITY DEFINITION (DIGITAL REPRESENTATION)
Watercourse	300		
Lake	310		line: blue, ___ pt. fill: light blue (C__%,M__%,Y__%) label: blue, italic, __pt., ____font
River	320		line: blue, ___pt. fill: light blue (C__%,M__%,Y__%) label: blue, italic, ___pt., ____font
Seasonal Gully	330		line: blue pecked label: blue, italic, __pt., ____font
Canal	340		
pipeline	341		line: blue, ___pt. label: blue "P", __pt., ___font
water	342		line: blue, ___pt. label: blue "W", __pt., ___font
Waterfall	350		
single river	351		symbol: blue, waterfall symbol (____#) label: blue, italic "Waterfall", __pt., ___font
double river	352		symbol: blue, waterfall symbol (____#) label: blue, italic "Waterfall", ___pt., ___font
Miscellaneous	360		
rapids	361		symbol: blue, rapid symbol (____#) label: blue, italic "Rapid", ___pt., ___font

dams	362	symbol: blue, dam symbol (____#) label: blue, italic “Dam”, ___pt., ___font
reservoir	363	point: blue, ___size label: blue italic “R”, ___pt., ___font
pond	364	polygon: solid blue
spring	365	point: blue, ___size label: blue italic “S”, ___pt., ___font

ATTRIBUTES	ATTRIBUTE CODE	ENTITY DEFINITION
LINGUISTIC VARIATION		(DIGITAL REPRESENTATION)
Landmarks	400	
International boundary pillar	401	symbol: black international boundary pillar symbol (____#)
Bench mark (with number)	402	symbol: black bench mark symbol (____#)
Air photo principle point	403	symbol: black air photo principle point symbol (____#)
Radio telephone mast	404	symbol: black radio telephone mast symbol (____#)
Lighthouse, harbour	405	symbol: black lighthouse, harbour symbol (____#)
Site of historic Interest	406	symbol: black site of historic interest symbol (____#)

ATTRIBUTES	ATTRIBUTE CODE	ENTITY DEFINITION
LINGUISTIC VARIATION		(DIGITAL REPRESENTATION)
Human settlements	500	
Towns or areas with permanent buildings (cities)	501	symbol: towns/areas with permanent buildings symbol (___#)
Other population areas	502	symbol: other population areas symbol (____#)
Villages	503	symbol: villages symbol (____#)
Estate housing (compounds)	504	symbol: estate housing (compounds) symbol (____#)

ATTRIBUTES	ATTRIBUTE CODE	ENTITY DEFINITION
LINGUISTIC VARIATION		(DIGITAL REPRESENTATION)
Relief	600	
Contours	ft./m.	line: brown line, line width____ (C__%,M__%,Y__%)
Trigonometric station	610	symbol: black trigonometric station symbol (____#)
Spot heights in metres	620	point: black point, ___pt. label: black (e.g.)“1200” (contour value)

ATTRIBUTES	ATTRIBUTE CODE	ENTITY DEFINITION
LINGUISTIC VARIATION		(DIGITAL REPRESENTATION)
Miscellaneous	700	
Borehole	701	symbol: borehole symbol (____#), colour: ____
Power line	702	symbol: power line symbol (____#), colour: ____
Telephone line	703	symbol: telephone line symbol (____#), colour: ____
Well	704	symbol: well symbol (____#), colour: ____
Dip tank	705	symbol: dip tank symbol (____#), colour: ____
Water tank	706	symbol: water tank symbol (____#), colour: ____
Outcrop rock	707	symbol: outcrop rock symbol (____#), colour: ____
Quarry	708	symbol: quarry symbol (____#), colour: ____
Sand or mud	709	symbol: sand or mud symbol (____#), colour: ____
Inland	710	symbol: inland symbol (____#), colour: ____
Coastal	711	symbol: coastal symbol (____#), colour: ____

ATTRIBUTES	ATTRIBUTE CODE	ENTITY DEFINITION
LINGUISTIC VARIATION		(DIGITAL REPRESENTATION)
Vegetation	10000	
Forest	11000	symbol: forest symbol (____#), colour: ____
light forest	11100	symbol: light forest symbol (____#), colour: ____
planted forest	11200	symbol: planted forest symbol (____#), colour: ____
Agriculture	12000	symbol: agriculture symbol (____#), colour: ____
rice	12100	symbol: rice symbol (____#), colour: ____
palms	12200	symbol: palms symbol (____#), colour: ____
Dambo	13000	symbol: dambo symbol (____#), colour: ____
Grass and scrub	14000	symbol: grass and scrub symbol (____#), colour: ____
grassland	14100	symbol: grassland symbol (____#), colour: ____
scrub	14200	symbol: scrub symbol (____#), colour: ____
Marsh	15000	symbol: marsh symbol (____#), colour: ____
seasonal marsh	15100	symbol: seaonal marsh symbol (____#), colour: ____

POSSIBLE CODES FOR A MORE EXTENSIVE VEGETATION MAP:

ATTRIBUTES LINGUISTIC VARIATION	ATTRIBUTE CODE	ENTITY DEFINITION (DIGITAL REPRESENTATION)
Vegetation	10000	
Forest	11000	symbol: forest symbol (____#), colour: ____
light forest	11100	symbol: light forest symbol (____#), colour: ____
planted forest	11200	symbol: planted forest symbol (____#), colour: ____
deciduous	11300	symbol: deciduous symbol (____#), colour: ____
Bracastegia	11301	symbol: bracastegia symbol (____#), colour: ____
Miombo	11302	symbol: miombo symbol (____#), colour: ____
coniferous	11400	symbol: coniferous symbol (____#), colour: ____
tropical	11500	symbol: tropical symbol (____#), colour: ____
Agriculture	12000	symbol: agriculture symbol (____#), colour: ____
rice	12100	symbol: rice symbol (____#), colour: ____
palms	12200	symbol: palms symbol (____#), colour: ____
maize	12300	symbol: maize symbol (____#), colour: ____
cassava	12400	symbol: cassava symbol (____#), colour: ____
tobacco	12500	symbol: tobacco symbol (____#), colour: ____
millet	12600	symbol: millet symbol (____#), colour: ____
groundnuts	12700	symbol: groundnuts symbol (____#), colour: ____
banana	12800	symbol: banana symbol (____#), colour: ____
mango	12900	symbol: mango symbol (____#), colour: ____
Dambo	13000	symbol: dambo symbol (____#), colour: ____
Grass and scrub	14000	symbol: grass and scrub symbol (____#), colour: ____
grassland	14100	symbol: grassland symbol (____#), colour: ____
scrub	14200	symbol: scrub symbol (____#), colour: ____
bush	14300	symbol: bush symbol (____#), colour: ____
dense bush	14400	symbol: dense bush symbol (____#), colour: ____
scattered bush	14500	symbol: scattered bush symbol (____#), colour: ____
Marsh	15000	symbol: marsh symbol (____#), colour: ____
seasonal marsh	15100	symbol: seaonal marsh symbol (____#), colour: ____

APPENDIX 8: PRELIMINARY MALAWI NATIONAL EIS STRATEGY

Malawi Environmental Information System (EIS)

DEVELOPING A NATIONAL EIS STRATEGY

What is an Environmental Information System (EIS)

Given the significant pressures on natural resources in Malawi, the dynamic state of the environment demands information that is both timely and accurate. The proliferation of information technologies has allowed for greater access and dissemination of environmental information. A sustainable EIS is used to describe the institutional and technical infrastructure that routinely produces and uses environmental information to improve environmental and natural resource management. Geographic Information Systems (GIS) and Remote Sensing are information technologies that can be viewed as a driving forces behind this process.

As shown in the Middle Shire Report, such routine environmental monitoring and the use of information technologies can focus on obtaining information on environmental "hot spots" in which more intensive investigation may be carried out (Snel et. al., 1998 and Haan, 1998). As will be described in more detail below, a sustainable NEIS includes in-country capacity to address four components : 1) to develop an environmental data infrastructure, 2) conduct routine environmental analysis, 3) establish an environmental decision support network, and 4) provide for EIS oversight (Figure 1).

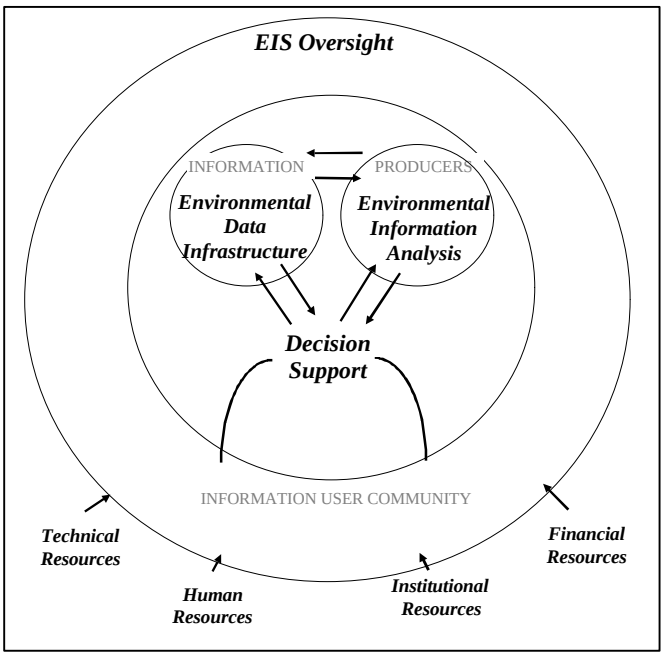

Figure 1: Components of an Environmental Information System (EIS).

Effective decision making and the development of environmental management strategies must be demand-driven and participatory in nature in order to include the many local to national environmental decision makers and stakeholders. As a consequence, environmental information development must be distributed ensuring that capacities are developed at many different levels. In the end, success of an environmental information system will be judged according to the type and quality of environmental decisions that result.

Key Issues for Developing a NEIS

In order to replicate the analyses found in the Middle Shire Report and to develop a sustainable National Environmental Information System (NEIS) strategy, four areas need to be developed by the Government of Malawi: 1) environmental data infrastructure, 2) environmental data analysis, 3) environmental decision support network, and 4) EIS oversight. To develop each of these areas and the questions they pose, institutional, human resource, technical, and financial issues must be addressed and resolved.

1. Developing a National Environmental Data Infrastructure

The development of an in-country environmental data infrastructure entails the routine collection of core environmental data sets. It is important that such environmental data sets are managed adequately to ensure that they are easily retrievable and interoperable as environmental concerns arise. The ability to supply environmental data from a variety of sources is facilitated through the development of data standards and an environmental data infrastructure that allows for proper archiving and regulated accessibility. This ensures that environmental data used for environmental decision making is of the highest accuracy and integrity.

Objective: Identify environmental data needs how they should it be compiled to ensure good quality and routine collection.

Key *Institutional* Issues to Resolve

- Identify departments to be involved in routine collection of environmental data.
- Encourage routine environmental data collection.
- Identify mechanism for coordinating the collection of environmental data catalogues.
- Establish national environmental data standards
- Identify coordinating department for coordinating national standards.

Key *Human Resource* Issues to Resolve

- Acquire skilled staff to routinely collect environmental data.
- Develop mechanism to retain skilled staff.

Key *Technical* Issues to Resolve

- Identify technical capacities to routinely environmental data.

Key *Financial* Issues to Resolve

- Identify financial resources to support routine collection of national environmental data.

2. Conducting National Level Environmental Data Analysis

Multidisciplinary environmental analysis is required to routinely address environmental concerns as they arise. Such environmental analysis may be conducted to help identify environmental "hot spots" (e.g., as done in the Middle Shire assessment) or to carry out elaborate analyses within specific areas of environmental concern. Highly trained technical staff are required to conduct routine multidisciplinary environmental analysis. Such multidisciplinary analysis may span biophysical and social explanations of environmental change and result in recommendations on mitigation strategies as needed by environmental decision makers.

Objective: Build capacity and infrastructure to conduct routine environmental analysis.

Key *Institutional* Issues to Resolve

- Identify institution and individuals to conduct routine environmental analysis.

Key *Human* Resource Issues to Resolve

- Acquire skilled staff to analyze environmental data.
- Develop mechanism to retain technically skilled staff.

Key *Technical* Issues to Resolve

- Identify technical analyses required.

Key *Financial* Issues to Resolve

- Identify required financial resources to support routine national environmental analysis.

3. Establishing a National Level Environmental Decision Support Network

An EIS is intended solely for the support of environmental decision making and to improve environmental conditions and management. It is critical that national to local environmental information users and providers are adequately linked such that: 1) environmental information is collected with respect to user demands; 2) environmental information is adequately disseminated to all relevant environmental decision makers and stakeholders; and 3) adequate support is given for environmental information usage. An EIS needs to accomplish these tasks on a routine basis.

Objective: Identify infrastructure to ensure that national to local environmental information users and producers are adequately linked.

Key *Institutional* Issues to Resolve

- Identify individuals and institutions to coordinate routine environmental information forums to routinely assess environmental information needs and disseminate environmental information.
- Identify frequency of environmental information forums.

Key *Human Resource* Issues to Resolve

- Develop capacity to conduct environmental information forums.

Key *Technical* Issues to Resolve

- Develop technical resources to link environmental information producers and stakeholders.

Key *Financial* Issues to Resolve

- Identify financial resources needed to conduct effective environmental information forums.
- Identify financial resources needed to support environmental information usage to improve natural resource management.

4. Developing EIS Oversight

This is the most important component of an EIS. An effective EIS implies that all activities are coordinated and integrated. EIS oversight requires that a committee, forum, or institution is mandated to oversee and coordinate that: 1) environmental data are routinely collected according to standards and user demand within respective institutions; 2) environmental analysis draws from multidisciplinary expertise and is routinely conducted to satisfy user demands; 3) environmental information needs are routinely assessed and information routinely disseminated, and 4) environmental support are routinely reviewed to encourage environmental information usage (e.g., review of extension, environmental support funds, and policy).

Question : Develop infrastructure to oversee the development and implementation of a National EIS.

Key *Institutional* Issues to Resolve

- Identify activities required oversee and coordinate the development of the EIS.
- Identify institution to coordinate national EIS activities.

Key *Human Resource* Issues to Resolve

- Identify capacities needed to develop an effective EIS oversight.

Key *Technical* Issues to Resolve

- Identify technical resources needed to ensure EIS oversight.

Key *Financial* Issues to Resolve

- Identify financial resources required to support the oversight of the national EIS.

EIS-Related Activities in Malawi

The following capacity presently exists in Malawi to routinely monitor the environment towards improving its management.

Development of an environmental data infrastructure in Malawi

The development of an environmental data infrastructure in Malawi has to date focused specifically on building technical capacity in the following institutions (where technical assistance has been provided by Clark University and the University of Arizona[8]): the Department of Forestry to routinely monitor land cover change; the Ministry of Agriculture to routinely monitor agricultural yields and soil loss; the Meteorology Department to routinely monitor rainfall and rainfall energy, and the Department of Surveys to provide core mapped environmental data sets. Furthermore, to ensure the future management and interoperability of in-country environmental data, technical assistance was provided to the Department of Surveys in developing environmental data standards (Figure 2). Many other in-country efforts exist contributing to an in-country environmental data infrastructure but have not yet been coordinated. These include, for example, data collection efforts at the National Statistical Office, Famine Early Warning System (FEWS) project, Department of Fisheries, and National Parks and Wildlife Department.

[VERSION]
MALAWI DIGITAL STANDARD METADATA FORMAT PROVISIONAL VERSION 1.0
[DESCRIPTION]
Machinga, YU2500 (TD) Malawi 1:50,000 Metric Edition tile.
[STATUS]
Provisional
[COPYRIGHT]
(C) of original digitised data: Department of Surveys, 1998 Government of Malawi
[FILE ORGANISATION]
[File Structure]
[transfer level]
Level 1
[format]
Arc/Info Export (.EOO) File
IDRISI Vector (.VEC, .DVC) File
DXF (.DXF) File
[version]
Arc/Info 3.1
IDRISI 2.0
[Number of Files]
4

Figure 2: Partial listing of the proposed environmental data standards

Conducting environmental data analysis

The development of in-country environmental data analysis capacity has included: 1) four annual training cycles (including an introductory, intermediate, and advanced course) in environmental monitoring using Geographic Information Systems, Remote Sensing, and Global Positioning System (GPS) - to date approximately seventy individuals have been trained; 2) specialized courses in environmental monitoring including ground truthing and participatory rural assessment within various GOM agencies; 3) development of a University curriculum in the Environmental Studies program; and 4) completion of select environmental analysis case studies such as the Middle Shire and Public Land Utilization Study (PLUS). Other in-country environmental analysis capacities exist, for example, training in social analysis in the National Statistical Office, the Center for Social Research, Agricultural Policy Research Unit, and various NGO's and training in natural resource management in Natural Resources College, Malawi College of Forestry and Mpwepwe College for respectively agriculture, forestry, and fisheries extension staff.

Development of in-country Decision Support

The development of in-country decision support includes the development of environmental legislation/policy initiative (e.g., the Environmental Management Act, National Environmental Policy, NEAP, Fisheries Conservation and Management Act, Forestry Act, and Biodiversity Act); in-country environmental support funds (e.g., Environmental Support Fund and Malawi Social Action Fund); in-country extension services (e.g., agricultural extension, forestry extension, NGO project, various other environmental related initiatives); and environmental awareness programs.

Development of in-country EIS Oversight

Technical assistance has been provided on the development of a national EIS. This has included Eastman, Toledano, and Hutchinson (1994) initial proposal on the development of a national EIS and technical assistance

[8] Technical assistance by Clark University and the University of Arizona was provided under the Malawi Environmental Monitoring Program (MEMP) activity. The MEMP activity has been funded by the United States Agency for International Development (USAID) since 1993 to the present. Local currency funds for EIS related activities in Malawi have since 1998 been provided by the World Bank.

to the EIS Design team (1997), USAID's Strategic Objective assessment (Eastman, Snel, and Haan, 1998), and EIS task force (1998).

Requirements for the Continued Development of a National EIS in Malawi

The development of a National EIS in Malawi has to date focused on primarily technical capacity building. The next phase in developing a National EIS will require focusing on institutional capacity building ranging from addressing and reviewing institutional mandates and job descriptions with respect to environmental data, collection, analysis, dissemination, and usage to legislating and regulating environmental data collection, analysis, dissemination, and usage. It is recommended that a National EIS Policy is developed to address and regulate these institutional issues.

Requirements for the Development of an Environmental Data Infrastructure in Malawi

A national environmental data standard policy – such as presently being developed by the Department of Surveys - needs to be legislated and regulated. In addition, as part of the National EIS Policy (see section below on "EIS Oversight"), institutional mandates need to be reviewed with specific regard to routine environmental data collection. This will include addressing such institutional issues as the development of specific job descriptions in routine environmental data collection, development of strategies to acquire and retain skilled staff, and development of environmental data sharing and pricing strategies (e.g., cost-sharing environment for data providers).

Requirements for the Development of In-Country Environmental Analysis in Malawi

As a part of the National EIS Policy (see section below on "EIS Oversight) a section that specifically addresses institutional issues related to routine environmental analysis will need to be developed and regulated. This will focus on such institutional issues as: who will routinely coordinate environmental analysis forums; how often will these forums will be coordinated; who will be involved in routine multidisciplinary environmental analysis; how may such skilled environmental analysts be retained; how will these forums be funded; and who will coordinate capacity building initiatives to strengthen in-country environmental analysis (e.g., development of university and extension environmental curricula).

Requirements for the Development of In-Country Environmental Decision Support Network

As a part of the National EIS Policy (see section below on "EIS Oversight") a section specifically addressing the institutionalization of an environmental decision support network will need to be addressed. This will include institutionalizing: who will be responsible to coordinate environmental information needs and dissemination forums; who will funds these environmental information forums; and who will review existing environmental decision support structures and make recommendations towards strengthening these structures (e.g. routine review environmental support funds and extension).

Requirements for the Development of In-Country EIS Oversight

A National EIS Policy needs to be developed and regulated. A National EIS Policy should specifically focus on institution building for the development of an in-country environmental data infrastructure, environmental analysis, and environmental decision support network. Furthermore, the National EIS Policy will need to address who will be responsible for overseeing and coordinating all national EIS activities spanning environmental data infrastructure, information analysis, and decision support.

The Way Forward to Implementing a Sustainable National EIS

A number of sessions with senior staff and the technical level EIS task force are being conducted in November/December, 1998 and will culminate in a draft on: 1) the state of EIS in Malawi (including accomplishments and constraints) and 2) recommendations towards its further development. The draft report will be distributed during a session in March/April to a senior level EIS think tank. The March session will focus on discussing alternative strategies in developing a National EIS. It is envisioned this session will result in a draft report on recommendations to further develop a National EIS Policy that will help pave the way forward to develop a sustainable Malawian EIS that routinely and collaboratively produces and uses environmental information to improve the management of Malawi's natural resources and environment.

Bibliography

Eastman, Snel, and Haan, 1998. *The Clark University Component.* A report produced at the request of the SO2 assessment team, March, 1998.

Eastman, R., J. Toledano, and C. Hutchinson, 1994. *The Malawi National Environmental Information System*. Submitted to USAID, Lilongwe.

EIS Design Team, 1997. *Strategy for an Environmental Information System in Malawi.* Lilongwe: Ministry of Research and Environmental Affairs.

EIS Task Force, 1998. *Minutes from EIS task force meeting on Shire assessment and national EIS strategy*. November 16th – 19th, 1998. Capital City Motel, Lilongwe.

Haan N., O. Kabambe, and P. Jambo. (1998) *An Interim Report on linking macro and micro analysis for a National Environmental Information System.*

Snel M, N. Haan, R. Eastman, K. Burger, P. Jambo, J. Mlotha, S. Chilombe, J. Mzembe, J. Nakutepa, M. Chawinga, V.A.L Mkandawire, P.E Mbiriyawaka-Munthali, J.G Munthali and H. Gausi.(1998) *Preliminary Report on the Middle Shire Investigation*. Malawi Environmental Monitoring Programme, Department of Environmental Affairs, Malawi.

APPENDIX 9: PARTICIPANTS LIST FOR THE GIS/REMOTE SENSING IDRISI INTERMEDIATE TRAINING

1. Flyson Bonda	The Polytechnic (UNIMA), Blantyre
2. Adams Chavula	Meteorology Department, Chileka
3. Richmond Chinula	National Statistics Office, Zomba
4. Stella Gama	RFO, Lilongwe
5. Alice Gwedeza	Department of Surveys, Blantyre
6. Charles Jumbe	Agricultural Policy Research Unit, Bunda College (UNIMA), Lilongwe
7. Fabian Kalua	The Polytechnic (UNIMA), Blantyre
8. Lucy Chipeta	Chancellor College (UNIMA), Zomba
9. Amos Madhlopa	The Polytechnic (UNIMA), Blantyre
10. G. Mamba	Ministry of Water, Lilongwe
11. Laurence Matias	Department of Lands and Valuation, Lilongwe
12. Francis Mkanda	SADC/GEF, Salima
13. Luke Malembo	FRIM, Zomba
14. John Mlava	Bunda College (UNIMA), Lilongwe
15. Jimmy Mkumbira	The Polytechnic (UNIMA), Blantyre
16. Ladislas Mpando	National Statistics Office, Zomba
17. Joel Munthali	Land Resources Conservation Branch, Ministry of Agriculture, Lil.
18. Priska Munthali	Land Husbandry Training Center, Zomba
19. Susan Nyirenda	Department of Surveys, Blantyre
20. Amadeus Nyondo	Malawi College of Forestry and Wildlife and FRIM, Dedza
21. Thomson Sumani	Department of Surveys, Blantyre
22. Richard Watts	Chancellor College (UNIMA), Zomba

APPENDIX 10: IDRISI INTERMEDIATE TRAINING SCHEDULE

GIS/Remote Sensing IDRISI Intermediate Training

December 14 - 19

Digitizing and Database development in Cartalinx and IDRISI (Joseph Jonazi)

Dec. 14: Database Development and Data Integration
- Review of Vector data structures and Vector topology
- Digitizing Overview
- On-screen digitizing of Aerial Photo
- Database Manipulation (queries, filters)

Dec. 15: Digitizing from tablet
- Demonstration
- Group A: digitizing
- Group B: digitizing
- Exporting CataLinx to ArcView
- Rasterizing vector coverages in IDRISI

Image processing/Remote Sensing in IDRISI (Mescheck Kapila and Chipo Kanjo)

Dec. 16: Overview of IDRISI (Menu, Environment, Display, Analysis, Reformat, Data Entry)
- Importing satellite images (Lisanjali case example)
- Georegistering images (Resample)
- Unsupervised classification (CLUSTER)
- Supervised Classification (MAKESIG, MINDIST, MAXLIKE)
- Map production

Dec. 17: Land cover change analysis
- Introduction to Ratios and Vegetation Indices
- Change Detection and Time Series Analysis
- Image Differencing and Thresholding
- Image Regression
- Image Ratioing
- Pairwise Qualitative Change

Environmental modeling and spatial Data Analysis/GIS in IDRISI (Steven Taulo, Sam Chilombe, and Mescheck Kapila)

Dec. 18: Environmental Modeling Day 1: the use of GIS for soil erosion potential modeling in Lisanjali
- Overview of Soil Loss Equation Model for Southern Africa
- Cartographic modeling for topographic ratio (X)
- Modeling topographic ratio (X) (EDIT, ASSIGN, SURFACE, Image Calculator)
- Cartographic modeling for crop ratio (C)
- Modeling crop ratio (C) (EDIT, ASSIGN,Image Calculator)
- Cartographic modeling for soil loss factor (K)(incl. Rainfall Energy E and Soil Erodibility F)
- Modeling soil loss factor (K) (RECLASS, CROSSTAB, EDIT, ASSIGN)

Dec. 19: Environmental Modeling Day 2:
- Cartographic modeling for SLEMSA
- Modeling SLEMSA (Image Calculator)
- Map production (RECLASS, AREA, Map composition)