A DIGITAL ELEVATION MODEL (DEM) FOR LAKE ST LUCIA AND SURROUNDING AREAS

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COMMON ABBREVIATIONS USED

DEM	Digital elevation model
GPW	Geoprocessing Wizard (an ArcView extension)
CD	Compact disc
WGS 84	World Geodetic System 1984 (a geographic datum)
TM	Transverse Mercator (a geographic projection)
CM33° E	Central Meridian of 33° East
DD	Decimal degrees

INTRODUCTION

St Lucia is one of the study-sites for the Norwegian funded Norwegian Council for Higher Education's Programme for Development Research and Education (NUFU) programme entitled: UNIVERSITY CO-OPERATION ON NATURE CONSERVATION AND MANAGEMENT: Biodiversity in coastal Maputaland (northern KwaZulu-Natal and southern part of Mozambique): links between geology and ecology. This programme has attracted a number of researchers who are currently engaged in geological and ecological studies in the area.

All these studies need good maps, and one map which is fundamental to many of the studies is topography. With this in mind, NUFU funding was used to collate existing information and interpolate the data to produce the 200 m and 50 m cell size Digital Elevation Models (DEM). A DEM is a raster model with square (in this case) cells (or pixels). Each cell gives the averaged elevation of the land surface for the area covered. It is a method of storing topographical data that can be used in a very computer-efficient manner when using topography in spatial calculations

These DEMs are freely available to all *bona fide* scientists and managers who require them for non-commercial purposes. The compact disc (CD) containing the DEM and data files may be freely copied and distributed to encourage the sharing of data. However, due acknowledgement must be given to the authors of the model and report. If it is desired to use the DEM for commercial gain (eg. use by consultants), please contact Ricky Taylor to discuss this).

TYPICAL USES OF DEMS

To provide elevation and other topographical information for groundwater modelling;
To generate aspect and slope analyses for vegetation studies, and for sighting of new roads, trails and other developments;
The generation of viewsheds to aid sighting of developments, and conversely, to show what visibility impacts a development will have;
The generation of maps showing effects of sea level rise, and graphs to show area or volume relationships for changing water levels;
To predict the spatial effects of various magnitudes of floods;
To provide hillshading of landorms that can be draped over other maps;
For generating spectral correction factors for analysing satellite imagery – to counter the effects of aspect;
To use as a component in potential habitat models – for land and lake;
To use as an input in fire modelling (when combined with wind directions and aspects and slope steepness);
To do calculations of actual surface areas (rather than horizontal plane surfaces as is the usual case when mapping); and,
To identify areas susceptible to erosion (based on steepness).

DEVELOPMENT OF THE ST LUCIA DEMS.

SOFTWARE USED

ESRI ArcView 3.2 and Spatial Analyst 2.0 were used throughout for data editing and manipulation. Surfer® 6.0 was used to interpolate data points. The Surfer file was converted to an ArcView grid format using a TurboPascal program developed by Frank Sokolic of the Geography Department of the University of Natal Durban (UND).

DATA SOURCES

The four data sources for the DEM were:

1) Contours derived from orthophotos taken in 1996 (Surveyor General job number 985), were compiled by the Air Survey Company of South Africa in 1999. Eighty-nine contour themes were provided, each corresponding to a 1:10 000 orthophoto from the St Lucia region (Fig. 1). The projection the data was provided in was Transverse Mercator (TM) using the Clarke 1880 spheroid and a central meridian of 33° East (abbreviated as C33 in file names). The contours were at 5m intervals, with grid intervals of 1000 m. Point and line files in Microstation format were provided with each orthophoto, supplying information on spotheights and contours respectively. Heidi Snyman of KZN Wildlife converted the Microstation line files (contours) into an ArcView theme format

2) Spotheights derived from orthophotos taken in 1996, were compiled by the Air Survey Company of South Africa in 1999. Eighty-nine spotheight Microstation point files were provided, each corresponding to a 1:10 000 orthophoto from the St Lucia region (Fig. 2). The projection the data was in Transverse Mercator (TM) using the Clarke 1880 spheroid and a central meridian of 33° East

3) Borehole elevation data were provided as an Microsoft Excel spreadsheet, with co-ordinates in World Geodetic System 1984 (WGS 84) decimal degrees (Fig. 2). Borehole elevations for the Ezemvelo KZN Wildlife (EKZNW) boreholes (A-G lines) were surveyed by the Reclamation Unit surveyor using a theodolite to obtain latitude, longitude and elevation. There is some confusion about which survey base was used (elevation accuracy probably within 25 cm –Taylor), but it was likely to have been the local survey grid - based on the "Estuary Mean Lake Level". Data for the borehole levels were obtained from Brian Rawlins at the University of Zululand. The date of the survey is not known.

   The other boreholes were put in for Richards Bay Minerals (RBM) by Davis, Lynn & Partners as part of the environmental impact assessment (EIA) work for their proposal to mine the area. The work was undertaken in about 1993. All the data are recorded in the EIA document Vol. 4 part 1. The elevations were recorded by a surveyor and the base is likely to be the national survey grid (i.e. relative to geodetic mean sea level). Elevation accuracy is likely to be within 10 cm (Taylor).

4) The lake bathymetry was sourced from a map entitled "Bathymetry of Lake St Lucia", compiled by C.J. Sydow & I.L. van Heerden (Fig. 3). The lake was surveyed by the Marine Geoscience Division, NRIO (National Research Institute for Oceanography: CSIR) in December 1985. The map was at a scale of 1: 50 000, with contours at 20 cm intervals relative to Mean Sea Level. The map was derived from surveys of cross-sections of the lake using an echo-sounder and positioning equipment lined up with land-based transponders, at 1 km intervals in an east-west direction. The baseline elevation was that of the water-level recorder at Charters Creek (operated by the Department of Water Affairs) which has been surveyed in to the national survey network. Ricky Taylor digitally scanned the main basins of the lake from a printed bathymetry map. In some shallow areas data were not collected, and the missing data were depicted by a spike in the contour line. The boundaries of the lake were fitted to a digital image of the shoreline (1996 orthophotos) by Ricky Taylor using ArcView Image Analysis. From this, the contours were digitised on-screen as ArcView polygon themes (Fig. 1)

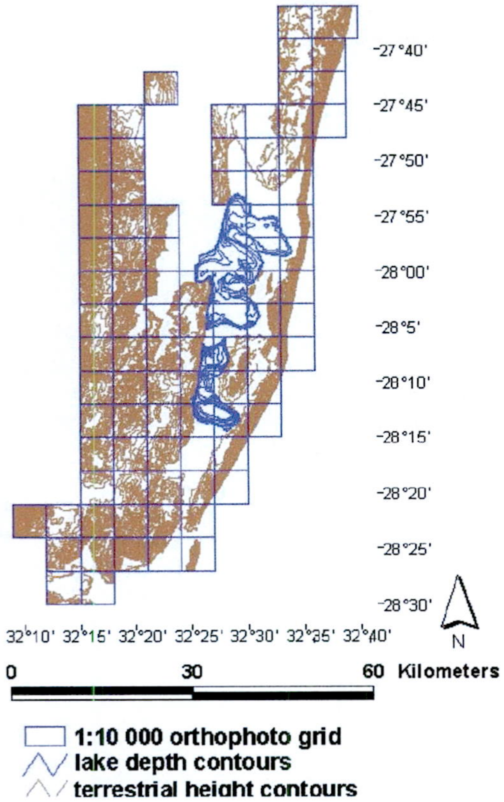

Figure 1. Terrestrial and lake contour data used to generate the DEM. Projection is in TM WGS 84 CM33° E.

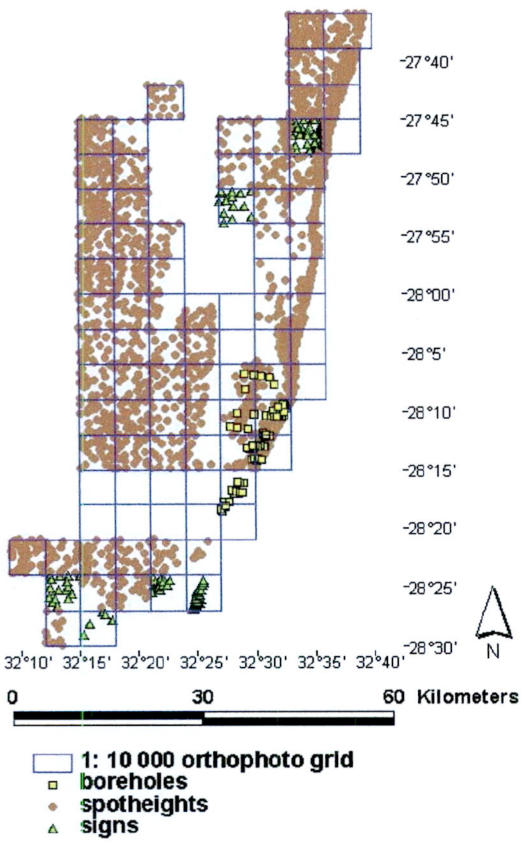

Figure 2. Terrestrial spotheight data used to generate the DEM. Projection is in TM WGS 84 CM33° E.

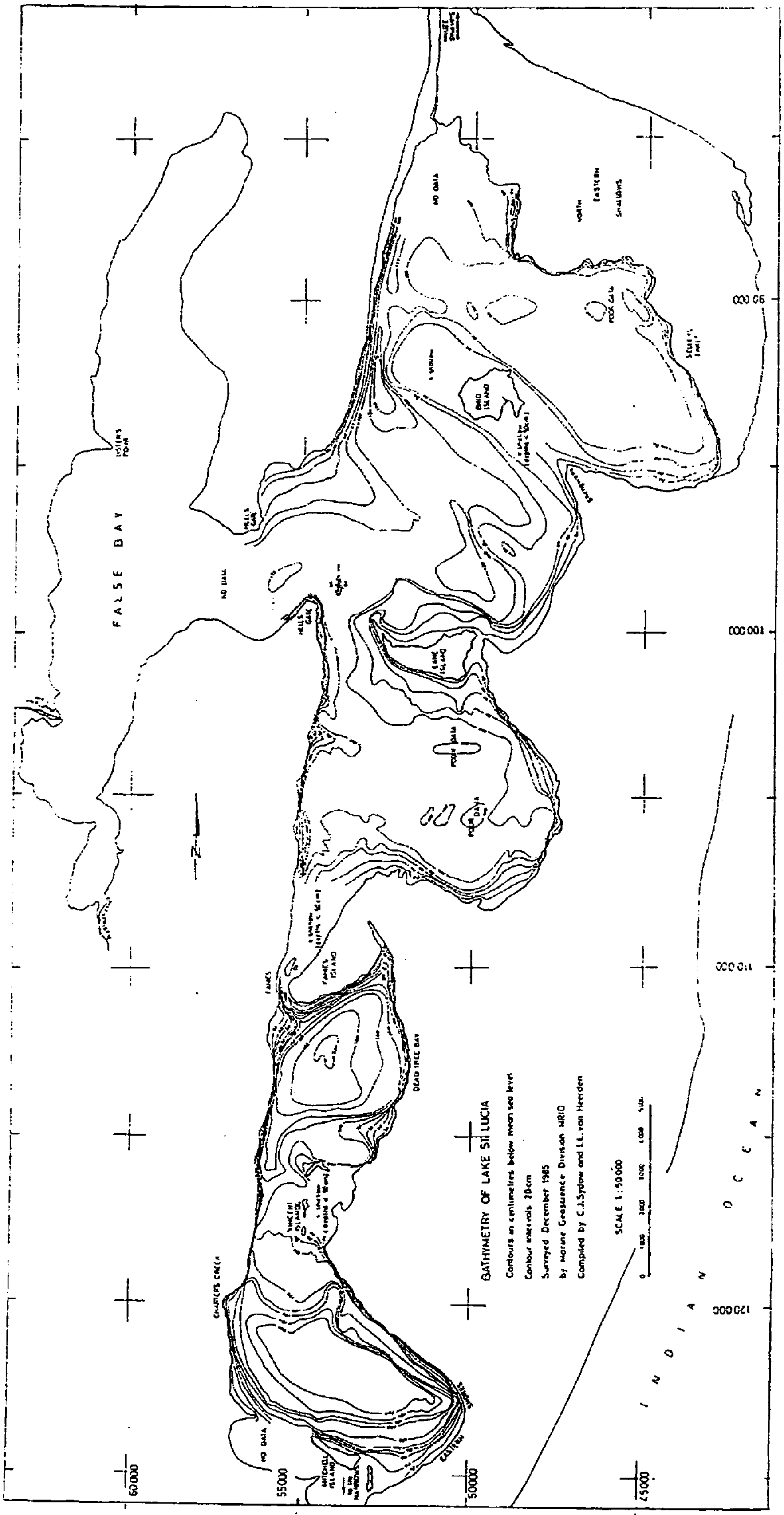

Figure 3. The lake contour data from the NRIO, which was incorporated into the DEM.

DATA MANIPULATION

1) The terrestrial contour lines were in the form of multipart polylines. The contour themes were cleaned of extraneous data, and the following fields were deleted from each file: entity, level, length, and colour. In addition, the following records were deleted from the attribute tables: records with layer attributes of lacustrine, boundaries, scratch[2] and pavements. The contour files also had several polyline records that represented spotheights with an elevation value of zero. These represented the surface layer of waterbodies, namely Lake St Lucia and the Indian Ocean. Those that fell within the area for which lake bathymetry was available, were deleted. A new field with the name of the source orthophoto was added to each file, and all 89 files were then merged using the ArcView extension Geoprocessing Wizard (GPW). The DATUM and PROJECTOR extensions were used to convert the projection of the merged contour theme from TM Clarke 1880 CM33° E to WGS 84 CM33° E.

   The polylines were then converted to points (nearly 900 000 records) using X-Tools "Transfer/convert selected features". To assign the original attribute data to the new point theme, GPW "Assign data by location" was used.

2) The Microstation spotheight files were converted in ArcView to themes, and an ESRI script was run to convert the theme from 3D to a 2D format (included in the submitted ArcView project). A new field with the name of the source orthophoto was added to each file, and all 89 spotheight files were then merged using X-Tools (this had to be done in 5 steps and the data then merged, as X-Tools could not process all the files at once). The DATUM and PROJECTOR extensions were used to convert the projection from TM Clarke 1880 CM33° E to WGS 84 CM33° E.

   The merged spotheight file was edited to remove extraneous points. The following records were deleted from the attribute table: records with layer attributes of cell, labels, roads, scratch[2] and contoursINTER. Additional records with a layer value of "signs" were saved as a separate theme, as their source was unknown. They represent points with varying elevations and may be useful data. (These were incorporated in the final DEM but are also provided as separate themes in the submitted ArcView project, should a user wish to exclude them at a later stage).

3) The borehole elevation data was converted to an ArcView theme format. The PROJECTOR extension was used to change the projection of the borehole point data from Geographic WGS 84 to TM WGS 84 CM 33° E.

4) The lake bathymetry data was provided as Arcview polygons in separate themes, and these were converted to contour lines using X-Tools. The contour line themes were merged into a single theme using

GPW. The PROJECTOR extension was used to change the projection from Geographic WGS 84 to TM WGS 84 CM33° E. Although the scanned lake image containing the bathymetry had been manipulated by Taylor to fit the lake shoreline according to the 1996 orthophotos, some of the bathymetry contours significantly overlapped the terrestrial contours. Since the terrestrial contours were regarded as more accurate, the lake bathymetry was clipped to the terrestrial 5m contour (the lowest terrestrial contour provided for the lake edge). The contour lines were then converted to points using X-Tools "Transfer/convert selected features". To assign the original attribute data to the new point theme, GPW "Assign data by location" was used. Missing data that had been denoted by a spike in the original polygon outlines were removed, except for those that were intuitively estimated (by Taylor from existing data and local knowledge). A comparison of the original contour lines with the final point elevations used will provide the user with more detailed information on each point.

CREATION OF THE DEM

Using all the available data, DEMs at both 50m and 200m cell size (Fig. 4) were generated. In addition, a separate DEM of the Eastern shores area (50m cell size) was created (Fig. 5). The DEM with a 50m cell size was generated in two parts (Eastern and Western shores), and then later merged, as the data set was too large for Surfer to interpolate all the points in a single run. The merging was accomplished by running an ESRI script (Pig Grid version 2.3), which averaged the overlapping data points.

All the elevation data (all converted to point data) were merged using GPW into a single ArcView theme. The database (dbf) file of the point theme was converted to an ASCII format in Microsoft Excel, the data columns arranged in XYZ format (x co-ordinate, y co-ordinate, elevation; all in metres), and then imported into Surfer® v6.0. A regular grid was generated using the Kriging algorithm for interpolation (see below for options selected). The Surfer output ASCII grid was converted to an ArcView ASCII grid file using a Turbo Pascal program developed by Frank Sokolic of the Geography Department of UND.

The ASCII grid file was imported into ArcView, with the Spatial Analyst extension loaded, and an output grid (the DEM) was created. The DEM grids produced by Surfer cover a rectangular area defined by the following parameters:

- The **minimum** and **maximum X- and Y-coordinates**
- The **Cell Size**
- The number of **Rows** and **Columns**

The input data, however, did not cover a rectangular area and contained a number of large gaps. This meant that large parts of the DEM were generated from no data and could not be considered to be accurate. These areas were removed from the DEM by creating a masking polygon layer in ArcView. A new polygon theme was created by digitising around the image of the data points that were used to generate the DEM. The polygon thus defined the areas for which data were available. The masking polygon was converted to a grid using the same specifications (cell size and output extent) as the DEM. The resulting grid was used as the analysis mask for the DEM. After applying the analysis mask (thus excluding areas of "no data"), the ArcView grid was exported and saved as an ASCII grid file (both these file types are provided on the CD).

Reasons for choosing the Kriging method of interpolation

Kriging is a flexible gridding method and can be used for gridding almost any type of data set. The Surfer® help manual recommends using Kriging as it generates the best overall interpretation of most data sets. There are a number of options that can be selected when using Kriging to generate grids.

- Ensure that Kriging acts as an Exact Interpolator. This can be done by **not specifying a nugget effect**. An Exact Interpolator incorporates data points into the grid file when they coincide with the grid node being interpolated. The Nugget Effect is only used when there are potential errors in input data. As the input data for this exercise was assumed to be correct, there was no need to use a Nugget Effect and Kriging was thus set to act as an Exact Interpolater.
- A Variogram Model can be selected to specify the spatial variability of the input data set. Selecting the Variogram Model is a complicated process and it requires detailed knowledge of geostatistics. Surfer recommends using a **Linear Variogram Model** when there is uncertainty over which one to use.
- A Drift Type can be specified when interpolating across large holes in the data distribution pattern, and when extrapolating beyond the limits of the data. Selecting an appropriate Drift Type requires knowledge of an underlying linear or quadratic trend in the input data. Since the input data is elevation data, no trends are assumed to be present and the **No Drift** option was selected.

DATA AND DEM CONSTRAINTS/LIMITATIONS

Terrestrial contours

The original contours provided by KZN Wildlife were presumably interpolated from spot heights and traced contours from the orthophotos. Errors may have arisen from the accuracy of the surveying equipment, and human errors of accurately tracing the contours, and interpreting the heights of the vegetation above ground level in different parts of the orthophotos. The contours were then converted into points and a regular grid was interpolated using the Kriging algorithm to generate data between points – as these are estimates, errors would have arisen from this method.

There are inaccuracies around the edge of the lake, as the shallowest bathymetry contour provided was –0.02 m, which was estimated, as the shallowest data recorded was *ca.* -0.05m. The lowest terrestrial contour provided was 5m, thus the actual boundary of the lake (at ca. 0.0m) was not provided and was interpolated by the Kriging method.

Inaccuracies were also noted in the vicinity of the Umfolozi flats and Western Shores, where negative elevations arose from Kriging interpolation. Data were very sparse in this region due to the uniform flatness of the topography. It should be noted that the greatest depth for which data existed was –3.0 m (in Lake St Lucia), while no elevations below 0 m were recorded in the surrounding terrestrial areas. Thus, elevations below these values arose from interpolation and should be treated as anomalies. For both the DEMs of the entire region at 200m cell size and the Eastern shores at 50m cell size, depths of up to –17m were generated by the Kriging algorithm. For the DEM of the entire region at 50m cell size, depths of up to –53m were generated. Based on local knowledge, these are incorrect.

<u>Spotheight data</u>
Errors may have arisen from the accuracy of the surveying equipment, and human errors of accurately interpreting the data. A regular grid of points was interpolated using the Kriging method of generating data – errors would have arisen from this method.

<u>Borehole elevations</u>
Care should be taken to ensure that the survey data is corrected to the same baseline system. In the past much of the St Lucia survey work was recorded relative to the local "Estuary Mean Sea Level" base line. This is several centimetres different to Geodetic Mean Sea Level on which the national system is based. This in turn does not correlate exactly with actual Mean Sea Level (which is continually changing).

Details of the method of data collection and the accuracy of the borehole elevation data need to be investigated and recorded in the metadata for the DEMs.

<u>Lake bathymetry</u>
During the survey period the weather was calm and the water surface of the lake was assumed to be level. As the equipment was boat-based, depths of less than about 50 cm were not measured. The contours for areas of shallower water were thus extrapolations. In some shallow areas data were not collected, however in some cases local knowledge was used to estimate the missing bathymetry.

Spatial errors included in the data include:

- The assumption that the lake is level may have been violated if there was a wind blowing, as the water would then tend to accumulate at one end of the lake. As the survey was done over several days, this is likely.
- The accuracy of the echo sounder in shallow water is dependent on the wavelength of the pulse, which should be as short as possible relative

to the depth of the water. The data may not be sound where the water was too shallow relative to the wavelength.

- The definition of the water-substratum layer in soft mud was indistinct.
- The extrapolation of depths between cross-sections is difficult as these distances were large
- The sediments in the lake would shift over time, being deposited in some places and eroded in others. Thus the bathymetry will change over time (but this is not regarded as being significant - Taylor).
- The lake image was scanned from a printed version – any stretching and distortion of the paper would have altered the accuracy of the scanned image.
- The fitting of the map to the shoreline was not exact, and may be out by 50m to 100 m in places
- Digitising the contours would have introduced further errors of accuracy and resolution
- The extrapolations in shallow water may be incorrect, as depth does not always change constantly.

Taylor believes that even taking into account all the above errors, the lake bathymetry is nonetheless valuable. It provides a generalised pattern of the bathymetry, but should be used with care when trying to estimate the depth of any particular point. (With 20 cm intervals, it is of a much higher resolution than the terrestrial 5 m contours – the accuracy is thus well within that of the terrestrial areas)

<u>Digital Elevation Modelling</u>
The DEM is a mathematically generated representation of elevations at regular intervals. When assessing the accuracy of the DEM, cognisance has to be taken of the accuracy and distribution of the input data. For example, parts of the DEM show fairly large depths in Lake St Lucia. These depths aren't accurate but are a reflection of the quality of the input data used to generate these parts of the DEM. The parts of the DEM over the coastal dunes, in contrast, are likely to be much more accurate because of the denseness of the elevation contours used as input data.

The resolution of the DEM (i.e. 50m or 200m) is set as one of the options of the Surfer gridding routines. The accuracy of the DEM that is generated depends on the accuracy and distribution pattern of the input data. As the distribution of the input data is both patchy and variable, the accuracy of the DEM is not homogeneous. For example, the dunes along the coast show large variations in elevation over relatively small horizontal distances. Elevation contours in these areas are thus relatively densely packed. In contrast, the areas over Lake St Lucia and the Umfolozi flats have relatively few contours which are spaced far apart. These differences, along with the gaps in the input data, cause variations in the accuracy of the DEM.

The limitations in the data need to be recognised by the user. Most of the data are derived from the 5m interval contours generated on 1:10 000 orthophotos using photogrammetry and computing techniques. These are based on stereoscopic elevation detection and often are based on the surface of the vegetation. The resolution of the data has possibly been pushed to its limits by generating a 50 m cell-size DEM. Also, as the spatial distribution of the data is variable, there are anomalies generated during the process of interpolation.

The input elevation data is provided in addition to the final DEM, so the user can overlay the data points on the grid to assess the accuracy of the DEM at any location, and identify areas where there is a paucity of data.

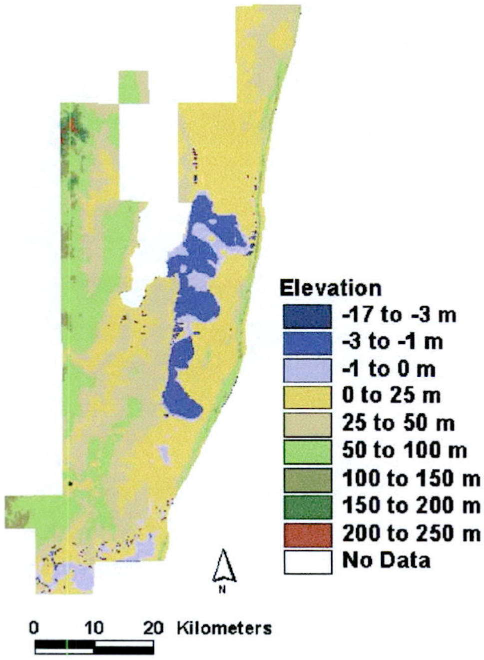

Figure 4. Full DEM of the St Lucia area, available at 200m or 50m cell size. Projection is TM WGS 84 CM 33° E

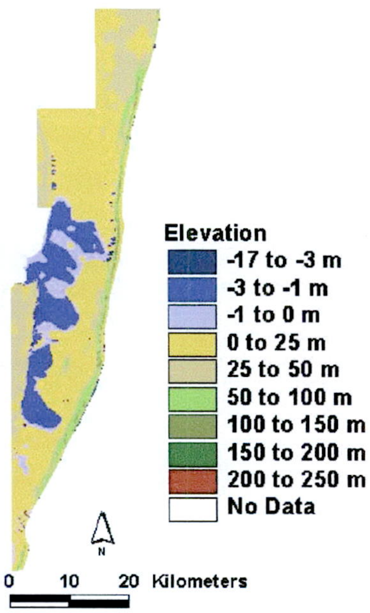

Figure 5. Full DEM of the St Lucia Eastern Shores area, at 50m cell size. Projection is TM WGS 84 CM 33° E

FUTURE DEVELOPMENT

The construction of this DEM has shown up some weaknesses and gaps in data. Hopefully these can be filled in the future.

There are anomolies that show up in the DEM – these require "cleaning" – possibly by using a high quality differential GPS to saturate problem areas with new elevation points to provide accurate data.

We need to expand the coverage to include all of the lake and surrounding areas. This should include bathymetry for False Bay, contours for the Mzinene valley, full coverage of the Mkhuze Swamp and of the Umfolozi Flats, and marine bathymetry to show offshore topography.

Some of the gaps can be filled by obtaining and using the following data sources:
SA Navy offshore bathymetry;
Council for Geoscience (Marine Geoscience) offshore data (especially of Leadmans Shoal);
The NRIO bathymetry data for the Leven Canyon and for the St Lucia/Umfolozi Mouth areas;
DWAF bathymetry survey lines for Lake St Lucia;
KZN Roads Department surveys of the Narrows done for the CSIR;
Mkhuze Swamps data extracted from Orthophotos by Prof Ellery;
Lake Bhangazi bathymetry done by Reid;
Mouth to Bridge bathymetry which is measured as part of the dredger monitoring programme;
Surveys done of the Umfolozi Flats by the Sugar Co-op;
Surveys done by Loudon & Partners for reclamation work done in the Mkhuze Swamp;
Mapping done by the NPA Roads Department for the excavation of the Umfolozi Link Canal;
Local surveys – e.g. for the construction of the St Lucia – Cape Vidal road;
Contours can be digitised from orthophotos for the missing areas;
Measurement of bathymetry for False Bay using a GPS and probe to obtain spot depths;
Bathymetric mapping of the southern part of St Lucia by Houart – the surveyor of the Reclamation Unit; and,
The height control network established by survey students of the Survey Department of the University of Natal.

APPENDIX

Digital information provided

The digital project file is titled STLUCIADEM.APR. Double-clicking on this file will open the entire project into Arcview 3.2. Note that Spatial Analyst must be loaded to view the DEM.

The postscripts to the view and theme (file) names indicate the geographic datum of the theme (all projections are Transverse Mercator). C33 indicates the datum of Clarke 1880 CM33° E, while W33 indicates the datum of WGS 84 CM33° E

VIEW: CONTOURS EDITED C33 contains edited contours (as described under "Data Manipulation" derived from all 89 orthophotos in Clarke 1880 CM33° E.
It contains 89 themes, one for each orthophoto. The themes are all given the orthophoto sheet name followed by _C33 to indicate the projection used.

VIEW: LAKE DEPTH W33 contains the themes used to derive the final lake contours, following editing
STLCONT5M_W33.SHP is the terrestrial 5m contour, derived from the orthophotos (the lowest terrestrial elevation provided). This was used to clip the lake depth data where it overlapped with terrestrial data.
STLCONTLAKEORIG_W33.SHP is the original lake depth data provided by Taylor, converted to contour lines
STLCONTLAKE_W33.SHP is the above theme, clipped to the terrestrial 5m contour.
STLLAKEPT_W33.SHP is the final lake depth data (in point format) used for the DEM. It is clipped to the terrestrial 5m contour, and the missing data (spikes) have been removed. The latter was undertaken after the depth data was converted to point form.

VIEW: ALL DEM DATA W33 contains all the themes used for generating the final DEM (before interpolation) in WGS 84 CM 33° E. All data were converted to points for this exercise.
DEMALLPT_W33.SHP contains all the data (derived from all the other themes in this view, merged into one file), converted to points, used to generate the DEM. X and Y co-ordinates (in metres) are provided for each point.

STLCONTTPT_W33.SHP is comprised of all the terrestrial contours, derived from the orthophotos, converted to point data
STLLAKEPT_W33.SHP is comprised of the edited lake contour data, converted to point data
STLBORE_W33.SHP is comprised of the borehole elevation data
STLSPOT_W33.SHP is comprised of the spotheights extracted from the orthophoto elevation data
STLSIGN_W33.SHP is comprised of the spotheights labelled as "signs" which were extracted from the orthophoto elevation data

VIEW: DEM 200M W33 contains the DEM at 200m cell size (after Kriging interpolation) in WGS 84 CM 33° E.
DEM200M is the grid theme generated from ASCII raster data.

VIEW: DEM 50M contains the DEM at 50m cell size (after Kriging interpolation) in WGS 84 CM 33° E.
DEM50M is the grid theme generated from ASCII raster data.
DEMMASK_50M is the grid theme which was used as the analysis mask to blank out areas of the DEM for which no data was available
MASK_50M.SHP is the polygon theme which was digitised to create the analysis mask (this was converted to the grid theme DEMMASK_50M).

VIEW: DEM east 50m contains the DEM of the Eastern shores and Lake St Lucia at 50m cell size (after Kriging interpolation) in WGS 84 CM 33° E.
DEMEAST50M is the grid theme generated from ASCII raster data.

Table 1. Orthophoto names and sheet numbers used to generate the DEMs.

NAME	SHEET NUMBER
	2732DA13
VINCENT ISLANDS	2832AB19
THE NARROWS	2832AD03
DUKUDUKU PLANTATION	2832AD06
DUKUDUKU STATE FOREST	2832AD11
SUNNYMEAD	2832AC25
	2732DA12
KWA MBILA	2732DA17
BHANGAZI	2732DA18
RONALD SHAY	2732CB23
OCHRE HILL	2732DA23
EKHOHLO	2732DA22
LO MA RO	2732CD02
EZIMBONDWENI	2732CD05
MKUZE SWAMP	2732DC03
MKUZE SWAMP	2732DC01
MKUZE SWAMP	2732DC02
FENDA	2732CD01
BANGISWA	2732CD10
ZUKA	2732CD06
INSLEEP	2732CD07
MKUZE SWAMP	2732DC06
BUKWINI	2732DC07
IZWEHELIA	2732CD12
NTABANDLOVU	2732DC11
TIMAVO TRIESTE	2732DC12
KWA NIBELA	2732CD15
NTABANKOSI	2732CD11
KULENI	2732CD18
NORTH ISLAND	2732DC16
ST. MARYS HILL	2732DC17
BIGNOUX	2732CD17
NGWENI	2732CD16
LISTERS GATE	2732CD23
GLEN GWENI	2732CD21
SHENGWANE	2732DC21
	2732DC22
PINE DENE	2732CD22
LANE ISLAND	2832AB05
MBOTSHENI	2832BA01
	2832AB01
TWEE DENNE	2832AB02
	2832BA02
PICNIC POINT	2832AB03
	2832AB04

NCEMANE	2832AB06
LAKE ST.LUCIA	2832AB10
KWA-DLEMBE	2832BA06
BUNDU	2832AB07
FANIES	2832AB09
NKUNDUSI	2832AB08
	2832BA07
BUSHLANDS	2832AB11
DOEN-DIT-NOU	2832AB12
FANIES	2832AB14
DEAD TREE BAY	2832AB15
BHANGAZI	2832BA11
	2832BA12
FANIES PLANTATION	2832AB13
NDOMBENI	2832AB16
SIBOMVINI	2832AB20
MFEKAYI	2832AB17
FANIES PLANTATION	2832AB18
	2832BA16
THE NARROWS PLANTATION	2832AB23
CHARTERS CREEK	2832AB24
	2832BA21
MITCHELL ISLAND	2832AB25
BOOMERANG	2832AB21
NYALAZI RIVER	2832AB22
	2832AD05
BALLYGAMBLE	2832AD01
THE FORKS	2832AD04
FERNWOOD	2832AD02
MEHLOWEMAMBA	2832AD07
NDODA	2832AD09
	2832AD10
MPATE	2832AD08
MPATHE PLANTATION	2832AD12
DUKUDUKU STATE FOREST	2832AD13
	2832AD14
DUKUDUKU	2832AC15
KANGELA	2832AC14
LAWMERE	2832AC20
MFUTULULU	2832AD16
MONZI	2832AD17
ST.LUCIA PARK	2832AD18
MAPELANA	2832AD19
MAURANN	2832AD21

Table 2. List of files contained on the CD, including information used to generate the DEMs. It is assumed that the CD drive is assigned to drive D. Note that only the ArcView shape files (*.shp) files are listed here, but 2-4 additional ArcView files with the same name but different extensions are required to load the themes. All the necessary files are included on the CD.

TEXT FILES

Name	Location	Description
St Lucia DEM report.doc	D:\ StLuciaDEM	MS Word 2000 document describing the concept, and the metadata used to generate the DEM

ARCVIEW FILES

Name	Location	Source/Description	Projection	Date of data collected
DEMallpt_W33.shp	D:\StLuciaDEM\DEMfinal	All elevation data points, merged	WGS 84, CM33° E	See source data files
StLspot_W33.shp	D:\StLuciaDEM\DEMfinal\ spotheight	Orthophoto terrestrial elevation data from QEP, converted from Clarke 1880 DD	WGS 84, CM33° E	1996
StLsign_W33.shp	D:\StLuciaDEM\DEMfinal\ spotheight	Orthophoto terrestrial elevation data from QEP, converted from Clarke 1880 DD	WGS 84, CM33° E	1996
StLbore_W33.shp	D:\StLuciaDEM\DEMfinal\ spotheight	EKZNW and UniZul, converted from WGS 84 DD	WGS 84, CM33° E	*Ca*. 1993

StLconttpt_W33.shp	D:\StLuciaDEM\DEMfinal\ contours	Orthophoto terrestrial contour data from QEP, converted from Clarke 1880 DD. Converted to point data	WGS 84, CM33° E	1996
StLuciaDEM.apr	D:\StLuciaDEM	ArcView project file, created for this DEM	Various	See source data files
Eg. 2732DA13_C33 (89 files in this format, of the orthophoto sheet number folowed by _C33)	D:\StLuciaDEM\contours	Orthophoto terrestrial contour data from QEP, converted from Clarke 1880 DD. Edited to exclude non-elevation data.	Clarke 1880, CM 33° E	1996
StLcontTpt_w33.shp	D:\StLuciaDEM\contours	Elevation contours from orthophotos, terrestrial, converted to point data. Converted from Clarke 1880 DD	WGS 84, CM33° E	1996
StLcont5m_W33.shp	D:\StLuciaDEM\DEMfinal\ lake	5m contour from orthophoto terrestrial contour data from QEP, converted from Clarke 1880 DD.	WGS 84, CM33° E	1996

StLlakept_W33.shp	D:\StLuciaDEM\DEMfinal\ lake	NRIO and R. Taylor (EKZNW). Lake depth point data (from contours), edited to remove missing data and clipped to 5m terrestrial contour. Converted from WGS 84, DD	WGS 84, CM33° E	1985, stretched to 1996 lake boundaries
StLcontlake_w33.shp	D:\StLuciaDEM\DEMfinal\ lake	NRIO and R. Taylor (EKZNW). Lake depth contours, edited to remove missing data and clipped to 5m terrestrial contour. Converted from WGS 84, DD	WGS 84, CM33° E	1985, stretched to 1996 lake boundaries
StLcontlakeorig_w33. shp	D:\StLuciaDEM\DEMfinal\ lake	NRIO and R. Taylor (EKZNW). Lake depth contours, including mising data "spikes". Converted from WGS 84, DD	WGS 84, CM33° E	1985, stretched to 1996 lake boundaries
DEM_200m_clip.asc	D:\StLuciaDEM\DEMfinal\ DEMgrid	All elevation data used for full DEM, with Kriging interpolation at 200m cell size. ASCII format	WGS 84, CM33° E	See source data files

DEM_50m_east_clip.asc	D:\StLuciaDEM\DEMfinal\DEMgrid	All elevation data used for DEM of Eastern Shores (including lake), with Kriging interpolation at 50m cell size. ASCII format	WGS 84, CM33° E	See source data files
DEM_50m_clip.asc	D:\StLuciaDEM\DEMfinal\DEMgrid	All elevation data used for full DEM, with Kriging interpolation at 50m cell size. ASCII format	WGS 84, CM33° E	See source data files
Mask_50m.shp	D:\StLuciaDEM\DEMfinal\DEMgrid	Digitised by Sokolic in Arcview to create an analysis mask	WGS 84, CM33° E	See source data files
Mask_50m.asc	D:\StLuciaDEM\DEMfinal\DEMgrid	Mask_50m.shp converted in Arcview to a grid. ASCII format	WGS 84, CM33° E	See source data files
DEM50m	D:\StLuciaDEM\DEMfinal\DEMgrid	Directory containing Arcview files needed to load the full DEM at 50m cell size.	WGS 84, CM33° E	See source data files
DEM200m	D:\StLuciaDEM\DEMfinal\DEMgrid	Directory containing Arcview files needed to load the full DEM at 200m cell size.	WGS 84, CM33° E	See source data files

DEMEast50m	D:\StLuciaDEM\DEMfinal\DEMgrid	Directory containing Arcview files needed to load the DEM of Eastern Shores at 50m cell size.	WGS 84, CM33° E	See source data files
DEMmask_50m	D:\StLuciaDEM\DEMfinal\DEMgrid	Digitised by Sokolic in Arcview and converted to a grid	WGS 84, CM33° E	See source data files
Info	D:\StLuciaDEM\DEMfinal\DEMgrid	Directory containing Arcview files needed to load the different DEMs	WGS 84, CM33° E	See source data files