Supervising Scientist

Jabiru Field Station

internal report **327**

Application of geographic information systems to the assessment and management of mining impact

Progress report 1 – initial GIS development

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December 1999

supervising scientist

Environmental Research Institute of the

Supervising Scientist

(*eriss*)

Internal Report 327

Application of GIS to the Assessment and Management of Mining Impact: Progress Report 1 - GIS Establishment

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Relevant Files – JR – 05 – 327

JR – 05 – 298

Jh – 03 – 340

CONTENTS

Appendices

Figures

LIST OF ACRONYMS

COTS – Commercial off the Shelf

eriss – Environmental Research Institute of the Supervising Scientist

GIS – Geographic Information System(s)

GPS – Global Positioning System

GUI – Graphical User Interface

NTU – Northern Territory University

ODBC – Open Database Connection

RDBMS – Relational Database Management System

RMS – Rehabilitation of Mining

UTM – Universal Transverse Mercator

WGS – World Geodetic System

ACKNOWLEDGEMENTS

We are grateful to Mr Mike Saynor and Dr Ann Bull for their advice on the stream sampling program and the *eriss* GIS respectively. Thank you to Dr C.M. Finlayson and Mr D.R. Moliere, Environment Australia, for their comments on the draft.

NOTE

This report is the second report prepared for the collaborative research project entitled 'Application of Geographic Information Systems to the Assessment and Management of Mining Impact'. Previous reports relating to this project are:

Internal Report 320 – Application of Geographic Information Systems to the Assessment and Management of Mining Impact: A Project Outline

MANAGEMENT SUMMARY

- This report describes the establishment of a geographic information system (GIS) that provides a central focus point for the storage, manipulation and retrieval of spatial and related information generated by an investigation into the geomorphological impacts of the Environmental Resources of Australia (ERA) Jabiluka Mine located within the Swift Creek catchment of the Northern Territory, Australia.

- A collaborative project has been put in place between ***eriss*** and the Northern Territory University (NTU) to help achieve the integration of GIS and geomorphological modelling and impact assessment in the most effective way.

- The following aims of this phase of the project were to:

  1. develop a GIS with an appropriate database framework, geoprocessing functionality, and interface
  2. populate the database with currently available data,
  3. demonstrate the current capability of the system, and
  4. discuss how this development provides for future development of the project.

- The establishment of the GIS was approached in a conventional manner in order to achieve a robust foundation for the future needs of the project. This included a needs assessment, a conceptual design, and a survey of available hardware, software, data, and skills within ***eriss***. This was followed by database planning, design and construction together with software application development to provide the functionality required.

- Software application tools have been developed specifically for accessing Swift Creek attribute data including a general 'database access dialog box' and a more rigid 'geormorphology tool box'. The database access dialog box allows the user to access the Swift Creek database and either import, chart or export the data, whilst the geomorphology tool box is composed of a number of tools that import and chart data for a specific variable and study site.

- Data produced by the Jabiluka impact project and stored/used within the RMS group GIS include; (1) High Temporal Resolution Spreadsheet Data (eg garnet automatic water sampling data); (2) Low Temporal Resolution Spreadsheet Data (eg cross sectional surveys); (3) Raster Data (eg Digital Elevation Models); (4) Vector Data (eg dGPS data) and; (5) Model Data (eg Siberia rst2 files).

- The RMS group GIS has been developed to such a point that it is now available for use by the RMS group members and wider ***eriss*** community. All data with a spatial component stemming from the Jabiluka impact project can now be accessed, analysed and prepared for final presentation within the RMS group GIS.

- Future development of the RMS group GIS will focus on the integration of the GIS with erosion, hydrological and geomorphological modelling techniques utilised by the group in the assessment of geomorphologic impact.

1. BACKGROUND

This paper describes the establishment of a geographic information system (GIS) that provides a central focus point for the storage, manipulation and retrieval of spatial and related information generated by an investigation into the geomorphological impacts of the Environmental Resources of Australia (ERA) Jabiluka Mine located within the Swift Creek catchment of the Northern Territory in Australia. The catchment is located partly within the World Heritage Kakadu National Park (KNP), and partly within the Jabiluka Mineral Lease (JML) that has been excised from KNP (Figure 1). Construction of the portal, retention pond and other headworks for the Jabiluka Mine commenced in June 1998. Swift Creek, a major right-bank tributary of the RAMSAR listed Magela Creek wetlands, will be the first catchment to be affected should any impact occur as a result of mining operations at Jabiluka. The Environmental Research Institute of the Supervising Scientist (***eriss***) carries out independent research into the environmental effects of uranium mining. The Rehabilitation of Mine Sites (RMS) group at ***eriss*** has established a project to assess the geomorphological impacts of the Jabiluka mining operations through (1) the collection of data on catchment geomorphology, channel stability, sediment movement and hydrology of the Swift Creek catchment and (2) the use of these data to calibrate landform evolution modelling technology for the assessment and management of impact on the catchment.

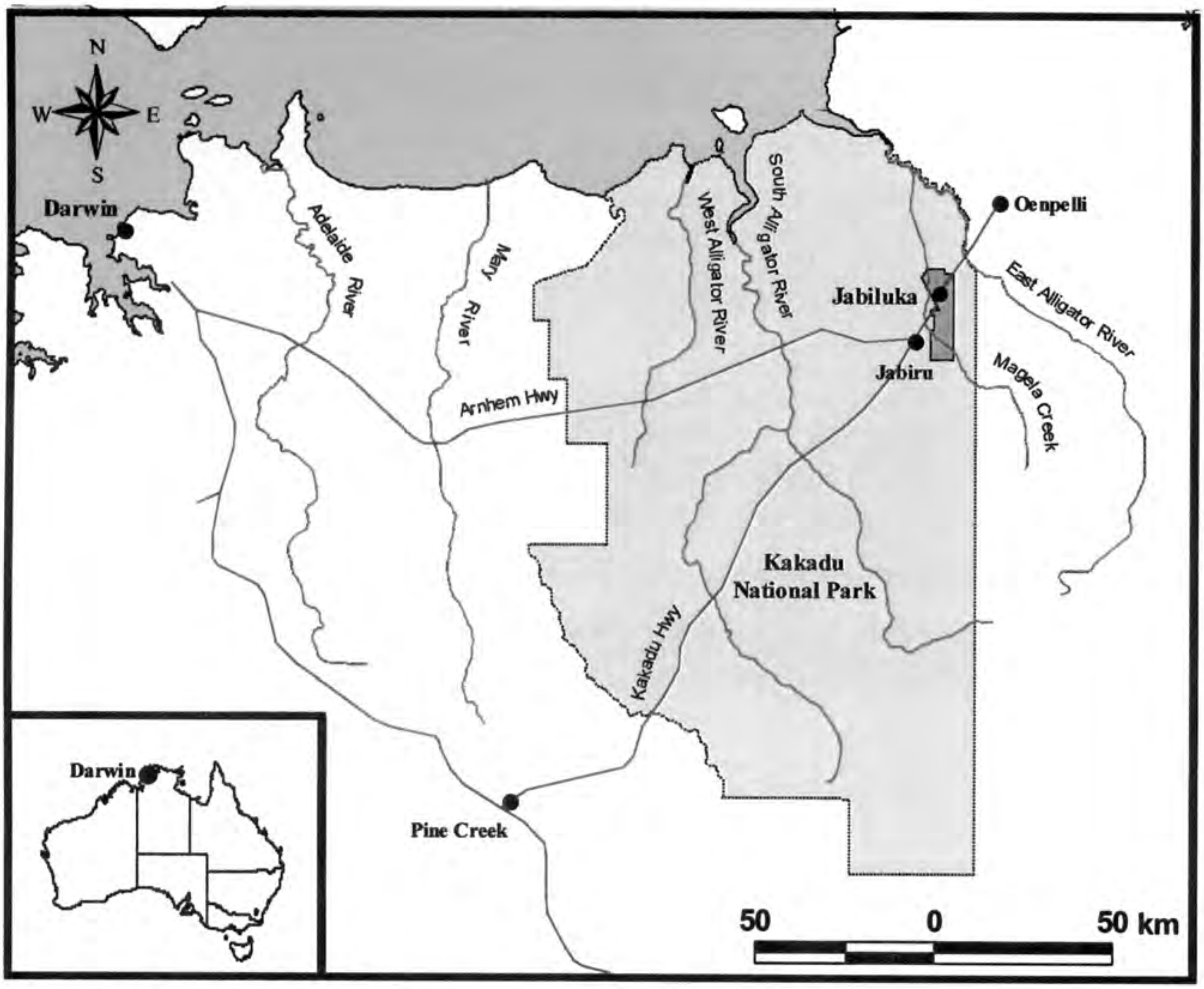

Figure 1: The Jabiluka Mine Site, located, 225 km east of Darwin, Northern Territory, is situated on the Jabiluka Mineral Lease, which has been excised from the surrounding World Heritage Kakadu National Park.

With the commencement of construction of the head works for the ERA Jabiluka Mine, there was a need to develop techniques to assess and manage any possible changes caused by Jabiluka mining operations (Erskine, Saynor and Evans *pers comm.*, 1998). Initial studies have focussed on establishing and monitoring the characteristics of streams and sub-catchments in the Swift Creek catchment. These studies have been varied, including the geomorphic mapping of the catchment using differential global positioning system technology (dGPS) and interpretation of aerial photography, channel cross-section surveying, total stream sediment load sampling, velocity-area gauging and water parameter sample collection. Erosion, hydrology and landform evolution modelling techniques (Willgoose et al., 1998; Evans et al, 1998), using data from the field sampling program, a digital elevation model (DEM) and remotely sensed imagery, are also being employed to enable the assessment and management of possible short and long term geomorphologic impacts of the mine.

Gauging the impact of mining on catchment geomorphologic processes and landform evolution is recognised as a significant factor in the environmental impact assessment (EIA) process. However, extracting the geomorphologic components, processes and assets required to insert geomorphologic considerations into environmental research and EIA requires the collection, storage and analysis of a substantial range of spatial and other information (Panizza et al., 1995). GIS provide powerful tools for the collation, storage, retrieval, transformation and display of spatial data from the real world (Burrough and McDonnell, 1998) and offer several different methods for interacting with other applications (eg. inter-application communication (IAC) protocols, Dynamic Link Library (DLL) functionality etc.). GIS have been linked with a number of erosion and hydrology models (De Roo, 1998; Hann and Storm, 1996) and used in a limited number of geomorphological impact assessment studies (Patrono et al., 1995; Verstappen, 1995). This study differs from previous studies in its attempt to adopt a GIS centred approach to the management and manipulation of data generated by a geomorphological impact assessment investigation. GIS currently provide a powerful environment for the development of an intelligent system able to integrate databases, models, expert systems, documents, statistics and other components important in the geomorphologic assessment of mining impact (Lam and Swayne, 1993).

A collaborative project has been put in place between ***eriss*** and the Northern Territory University (NTU) to help achieve this integration of GIS and geomorphological modelling in the most effective way (Boggs et al, 1999). While the RMS group at ***eriss*** has extensive experience in the geosciences it does not have expertise in the area of spatial information systems. NTU brings to the project specialised expertise in GIS and remote sensing coupled with extensive practical experience and knowledge of potential pitfalls in GIS in the northern Australian environment. NTU staff also have a long standing relationship with ***eriss*** which dates back over ten years of collaborative work in the Alligator Rivers Region (eg. Devonport and Waggitt, 1994; Devonport and Bull, 1999) including work on earlier prototype GIS systems associated with minesite rehabilitation and risk/hazard assessment (eg. Devonport 1992 & 1993). The collaboration will enable a short term, quick response to the current issues while at the same time enabling the development of inhouse knowledge and skills in a cost-effective manner. This report is the second in a series of reports planned under the collaboration (see Boggs et al, 1999) and covers the establishment of a spatial database outlined in the proposal.

2. AIMS

The aims of this phase of the project were to:

1. develop a GIS with an appropriate database framework, geoprocessing functionality, and interface
2. populate the database with currently available data,
3. demonstrate the current capability of the system, and
4. discuss how this development provides for future development of the project.

Each of these aims is expanded on and addressed in subsequent sections of this report. In addition a number of ancillary objectives were identified at the start of the project and these were used to help shape the specifics of each aspect of the development.

A significant goal set within the RMS group is to make the best use of current spatial technology. Real and absolute costs of computing have continued to decline dramatically over recent years and together with improvements in software interfaces and functionality are providing an environment not previously available for putting GIS principles into practice. This increase in capability is being accompanied by an ever-wider uptake of spatial technology across a wide spectrum of disciplines in both science and business. In this project the aim is to explore the potential of GIS in the context of impact of mining and geomorphology which is a new development. These hardware and software developments have also driven improvements in networking capabilities that facilitate the sharing of data and information by users that means that an appropriate GIS can be utilised by multiple users within a work group. Improved useability, functionality, and access to spatial and temporal data are key aims of this project.

Data useful to the project are disparate in terms of location, format, and the original context in which it was collected (Figure 2). GIS provides a framework to house both spatial and aspatial data in a secure central database thereby providing an environment that eliminates problems such as absence of metadata and multiple copies of the same datasets spread through the organisation. Benefits of this approach include the simplification of data maintenance, revision, and update as well as facilitating availability and access for users. In addition, the goal has been to simplify data analysis and presentation, to increase individual and group productivity and effectiveness, and to provide an information system that could be integrated with other specialist environments in use within the group.

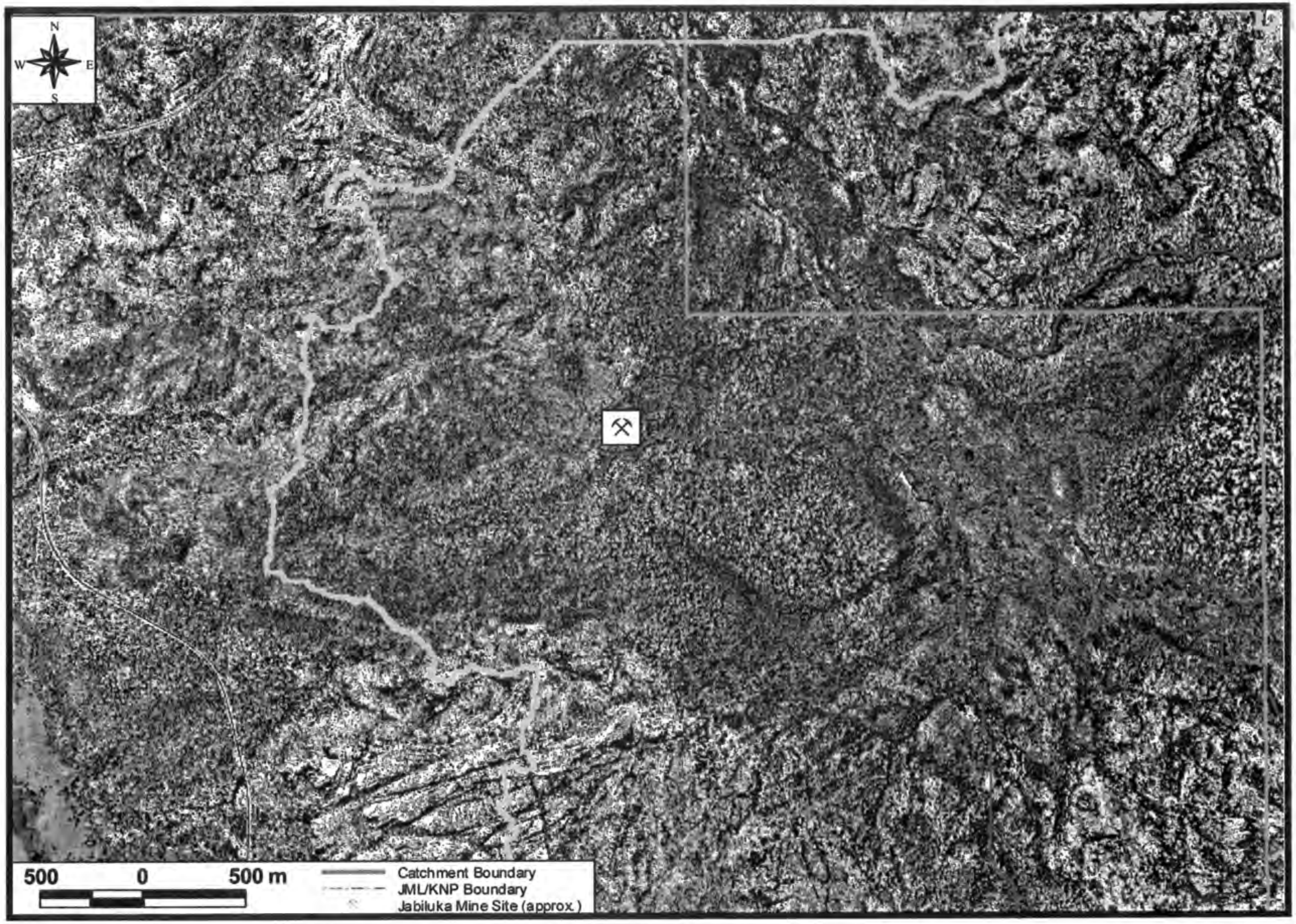

Figure 2: An aerial photograph of the area surrounding the Jabiluka Mine, with the main Swift Creek tributaries, catchment boundary and Jabiluka Mineral Lease/Kakadu National Park boundary overlayed onto the photo

3. GIS DEVELOPMENT

The establishment of the GIS was approached in a conventional manner in order to achieve a robust foundation for the future needs of the project. In the first instance, this included a needs assessment, a conceptual design, and a survey of available hardware, software, data, and skills within ***eriss***. This was followed by database planning, design and construction together with software application development to provide the functionality required.

3.1 Needs assessment

The GIS needs assessment was designed to produce two critical pieces of information required to achieve the aims of the project:

- the GIS functions required
- a master list of geographic data needed

The principal author collected this information in conjunction with staff in the RMS group during 1999. His assessment was based on an understanding of the overall aims of the project as well as the geomorphologic aspects of the work within the RMS group through personal communications, fieldwork, and literature review. The GIS functions needed over and above those provided by the commercial-off-the-shelf (COTS) software already in use (see below) at ***eriss*** are discussed in section 3.52 below. The master data list is included at Appendix 3 and identifies data already available and currently being collected. The data contained within the master data list currently falls into four primary categories including;

- AUSLIG data clipped to the Northern Territory or Top End extent (eg roads, towns, hydrology, tenure etc)
- Swift Creek scale data generated from dGPS mapping, Aerial Photograph interpretation and other clipped data sources (eg sampling sites, Jabiluka Mine Site, cross section surveying sites etc)
- Swift Creek DEM derived data sets (eg escarpment regions, streams, sub-catchments, flow direction etc)
- Attribute data stored within the Swift Creek database (including data on rainfall, discharge, bedload sediment transport etc)

3.2 Hardware and software survey

A brief survey of hardware and software was carried out to establish the existing resources available for this project, identify any related constraints, and flag any future requirements for the achievement of the project goals. While UNIX workstations and servers are present at ***eriss*** these are not widely used and the RMS group indicated a preference for the Microsoft Windows NT environment that was in line with hardware availability and their other tasks. COTS software available and used elsewhere at ***eriss*** was ArcView from ESRI (with ARC/INFO also available in the organisation if need be). The ArcView environment is user friendly and comes with a comprehensive scripting language (Avenue) that allows for the development of extensions to the standard software interface and functionality. It is widely used in government throughout Australia and was consequently adopted as the primary GIS software for this project.

3.3 Conceptual design

The conceptual design of a GIS is based on a now widely accepted three-tier architecture (Figure 3). The main advantages of this approach are that it allows for the development of different aspects of the GIS independently and also provides a mechanism for delivering different views of the data or functionality to different users in a manner that is transparent and appropriate to their needs and skill levels.

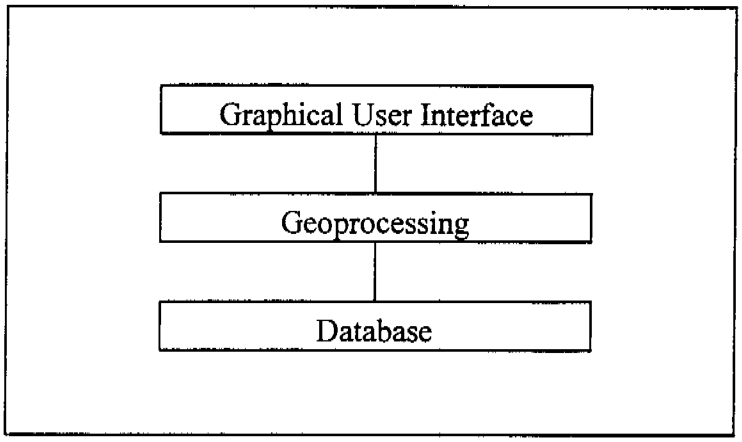

Figure 3: The three-tier GIS architecture which provides maximum flexibility within the system by separating out the core technologies that can then be worked on independent of each other without major disruption.

The graphical user interface (GUI) has been kept consistent with the look and feel of the COTS software ArcView and the additions to the standard interface (buttons, dialog boxes, tools, etc.) are available to users without any specific effort on their part. This has been achieved by using the ArcView scripting language Avenue that provides access to the same suite of objects as used in the standard interface.

The standard ArcView functionality (data input, geoprocessing, and output) has been extended with several tools (see Appendix 1) that provide users with specialised data analysis and presentation specific to the tasks and interests of the RMS group. These functions underlie the GUI and provide the means to retrieve and manipulate data from the database in a user-friendly manner.

The database has been designed to accommodate both baseline and specific data for the project in a variety of formats. ArcView handles vector, grid, and image data and each of these data types is present in the master data list (Appendix 3). In addition, the directory structures (Appendix 6) have been designed and backup procedures put in place.

An important aspect of the system is the support for users. This takes three forms (i) documentation and help files, (ii) procedures for demonstrating and training users, and (iii) mechanisms for the reporting of problems and their solution. These aspects are still being developed at the time of writing this report.

3.4 Database

3.41 Data

The GIS database design and development process utilised by this project was based on (1) the existing ***eriss*** GIS database design for the spatial datasets (both raster and vector) and; (2) the type and amount of data emanating from the Jabiluka impact project for the attribute information. The existing ***eriss*** spatial database in Jabiru contains approximately 12Gbytes of data, including thematic coverages, aerial photography, satellite imagery and DEM data. The base GIS contains the topographic 1:250000 digital data produced by AUSLIG (which includes layers of drainage, waterbodies, roads, etc.) with some of the data available at 100K scale. Additional data layers are related to individual projects and have been obtained in the field or from aerial photography or other imagery (Bull, 1999).

The design of the ***eriss*** database organises data through consideration of the projection (Geographic or Universal Transverse Mercator (UTM)), datum (AGD66 or WGS84) and spatial extent (Continental, Top End or Alligator Rivers Region GIS (ARRGIS)) of each dataset. The design of the RMS group GIS mimics this design, organising the spatial data using these three levels of classification. This allows the general ***eriss*** GIS user to move seamlessly between the base ***eriss*** GIS spatial database and the RMS group GIS spatial database, providing an efficient and effective method of disseminating information to the end user. A more detailed description of this directory structure can be found in Appendix 6, with a description and reference location for all Jabiluka impact project spatial data sets given in Appendix 4.

The RMS group's investigation into the impact of the ERA Jabiluka Mine on the Swift Creek catchment has involved the production of a number of different data sets, with two primary forms of attribute information; (1) high temporal resolution spreadsheet data and (2) low temporal resolution spreadsheet data. Although their association with the GIS differs, the method for storing the high and low temporal resolution spreadsheet datasets is very similar. A relational database management system (RDBMS) represents an efficient method for storing large amounts of data. Using RDBMS for data storage provides an overall reduction in required storage space, as data are stored more efficiently and only one copy is required. RDBMS also maintain a high level of data integrity and quality, reduce software engineering cost, increase security control and provide a conceptual, external view of the data (as opposed to the more common physical, internal view of data) (Delaney pers. comm., 1996).

The data from both the high and low temporal resolution spreadsheet datasets have been entered into a common Swift Creek relational database ('SwiftCreek.mdb'). The high temporal resolution section of the database consists of a series of separate tables, containing the base data emanating from the field-sampling program. A spatial component is provided for these tables by linking them to a site description table containing the geographic coordinates, name and description of the sampling site (providing a central, spatial attribute table reduces the amount of redundant information associated with these low spatial resolution datasets) (Figure 4). The low temporal resolution data section of the database currently contains a number of tables with the spatial component provided within each table. The base spreadsheet datasets from which this database has been compiled are stored within the Jabiluka sub-directory of R: \31 and are managed by Mr Michael Saynor.

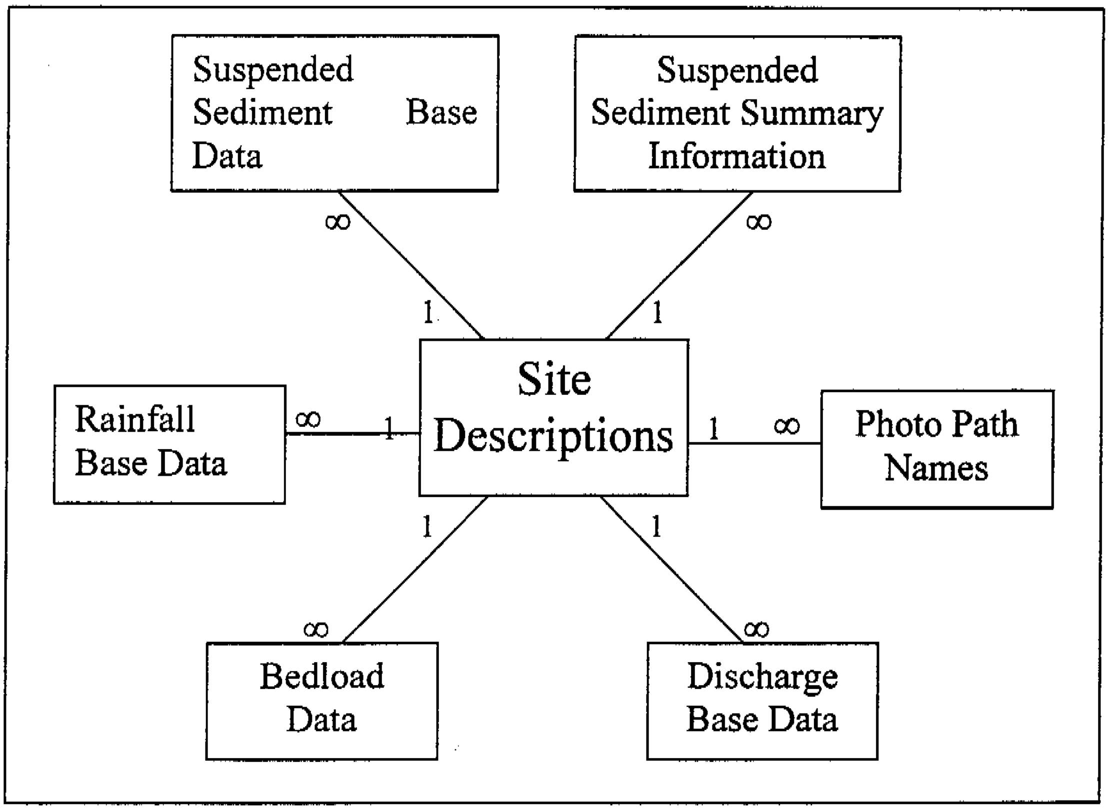

Figure 4: The site names and descriptions table is related by one (1) to many (∞) links to the high temporal resolution spreadsheet data tables.

3.42 Metadata

Metadata, commonly defined as being 'data about data', describe the content, quality, condition and other characteristics of data and help a person to locate and understand data (USGS, 1994). The presence of accurate metadata is especially important with regard to GIS and related data sets due to the large amounts of original and derived data commonly involved with such projects. The metadata database compiled for this project, adapted from Schweitzer (1998), has been devised as a simple, user-friendly database to encourage all users to maintain an accurate and up to date metadata. This database is designed to work with the more detailed ***eriss*** database that is based on the ANZLIC metadata standards (Bull, 1999). Metadata standards documents, such as these ANZLIC metadata guidelines, tend to emphasise many of the fine details of geospatial data. However, whilst these serve a useful purpose for government departments and large organisations they can be overwhelming, or even irrelevant, at the small project level where metadata is still very important but rigid adherence to standards may not be practical. The questions associated with the final project metadata database therefore do not necessarily cover all the metadata fields in the various standards but convey in plain language the basic information needed at the outset about each dataset to be used in a given project (Devonport pers. comm., 1999). The exact questions asked in the Metadata Database can be found in Appendix 5. The Jabiluka impact project metadata database is stored within the metadata directory of the ***eriss*** base GIS database (Appendix 6).

3.5 Interface and Functionality

3.51 Development Environment

The ArcView GIS package provides two primary methods for customising and developing the GIS environment. The first involves customisation of the ArcView graphical user interface (GUI), with the user being able to manipulate ArcView's menus, button bars, tool bars and popup menus. That is, the user is able to add controls that are used most frequently and remove those that aren't required. Within the ArcView environment, the graphical interface for each document type (including Views, Tables, Charts, Layouts, Scripts, Projects and Applications) can be customised separately, providing a wide spectrum of possibilities for customising the total ArcView interface.

The second path of GIS customisation involves direct programming by the user in ArcView's object-oriented scripting language, 'Avenue'. There exist many uses for Avenue including customising the way the user interacts with ArcView, directing ArcView to perform a specific task or even developing a complete application that works along with ArcView's graphical user interface.

A new method for customisation within ArcView combines these two facets of the GIS development environment. The 'Dialog Designer' addition to the ArcView suite of tools provides Avenue developers with a new tool, a dialog, to customise ArcView's interface. A dialog allows the user to organise a single task or set of related tasks onto a separate window, much like the organisation of related tasks under a particular menu item or on the button bar.

3.52 Software Development Requirements

The graphical user interface of the commercial off the shelf (COTS) software ArcView has been modified to suit the requirements of the ***eriss*** RMS group. The number and type of tools and buttons available on the View GUI of the COTS ArcView package were found to be excessive for the requirements of the RMS group. As such a number of buttons and tools have been removed, providing a simpler, more user-friendly form of View GUI whilst retaining the functionality needed by the group. The buttons and tools removed from the View GUI are listed and described in Appendix 1. These buttons and tools can be added back to the View GUI of the RMS group GIS if or when the requirements of the group expand or change.

The primary requirement of the GIS identified by the RMS group was to provide direct, spatial access to data generated by the group's Jabiluka impact project. The large amount of data generated by this project has been collated and stored in a single Microsoft Access database. By linking this database with the GIS, a more clearly organised and user friendly approach can be made to retrieving data. That is, data can be extracted from the database for a specific location simply by clicking on the location within a View. Two dialog boxes have been designed to provide this functionality for the RMS group GIS; the 'Database Access Dialog Box' and the 'Geomorphology Tool Box'. In order to function, both dialog boxes rely on an Open Database Connection (ODBC) having been established for the database.

3.53 Database Access Dialog Box

The database access dialog box is a dialog box constructed in ArcView to allow the user to access the Swift Creek database and either import, chart or export the data (Figure 5). The dialog box is accessed both via a tool and button on the ArcView 'View' GUI. When selected, the tool allows the user to select a site on the view for which the information is to be imported, charted or exported, before displaying the dialog box. The button simply displays the dialog box and imports, charts or exports information for all sampling sites. The dialog box consists of five buttons labelled 'delete', 'cancel', 'done', 'create chart' and 'export to excel', as well as four data selection/entry boxes (available tables, available fields, selected fields and output table name). The 'done' button will import the data from the selected fields into an ArcView table, and will link the new table with the sampling sites theme's attribute table. That is, although data may have been imported for all sites, the user will be able to select information in the imported table by site, through the interactive selection of the sampling site within the view. Selecting the 'create chart' button allows the user to create a chart with the label field and variable field selected from the list of selected fields to import. The corresponding table is also imported into the project. Finally, the 'export to excel' button allows the user to export the data to a new Microsoft Excel spreadsheet through the use of dynamic data exchange (DDE) functions. A description of the exact functionality and Avenue script(s) associated with each control on the dialog box is provided in Appendix 1. The header information for the scripts that run behind these buttons are contained in Appendix 2.

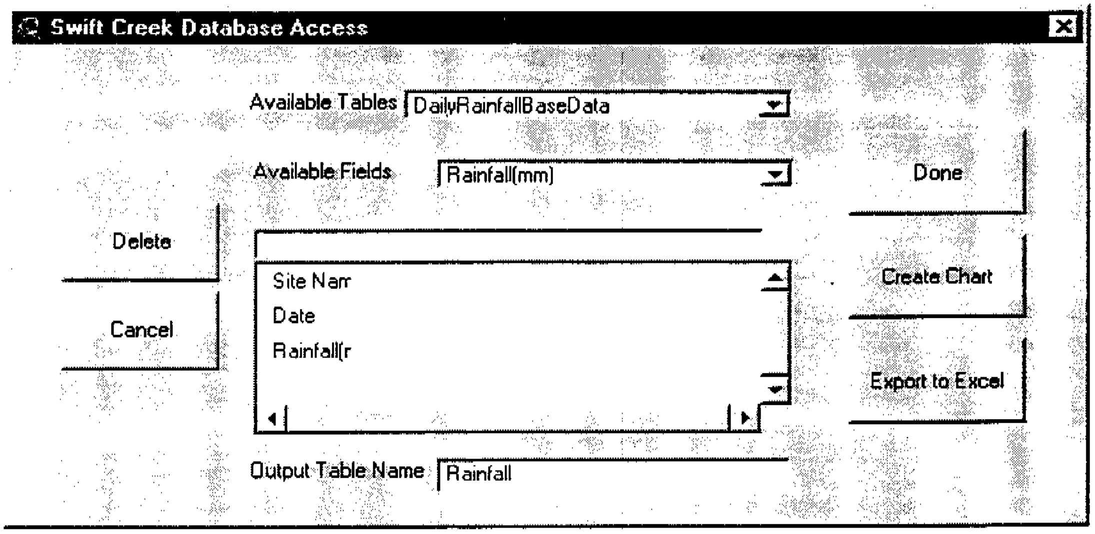

Figure 5: The database access dialog box allows the GIS user to access the Swift Creek database and either import, chart or export the data

3.54 Geomorphology Tool Box

The 'geomorphology tool box', another dialog box created for this project, provides a more controlled, direct means of accessing the database (Figure 6). The 'Geomorphology Tool Box' is composed of a number of tools that import and chart data for a specific variable and study site. This ability to rapidly view a graphical form of the data stored in the database was specified as one of the primary requirements of the RMS group. Where appropriate, the mean, maximum and minimum statistics for the graphed data are displayed below the title of the chart. The tools display information on turbidity, electrical conductivity, pH, solutes, bedload, suspended sediments., cross sectional surveys, suspended sediments (> 63*um*), total suspended sediments, discharge, and rainfall.

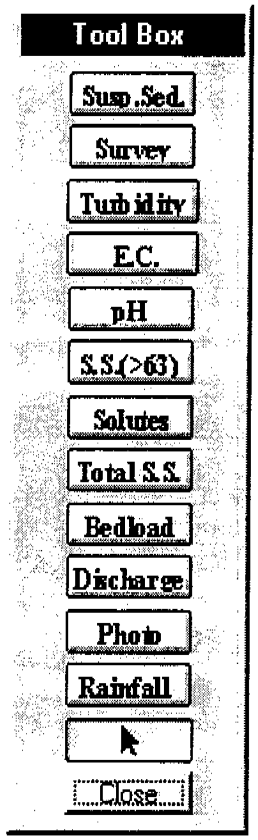

Figure 6: The geomorphology tool box provides a number of simple tools that access the Swift Creek database, importing data for the selected site and automatically displaying the information

4. POPULATING THE DATABASE

The RMS group's investigation into the impact of the ERA Jabiluka Mine on the Swift Creek catchment has involved the production of a number of different data sets. The methods and processes required to store, retrieve and manipulate the datasets resulting from these investigations are diverse, ranging from individual spreadsheets and statistical analysis to spatial databases and visual analysis. Data emanating from this project can be grouped into five categories, based on these methods and processes; (1) High Temporal Resolution Spreadsheet Data, (2) Low Temporal Resolution Spreadsheet Data, (3) Raster Data, (4) Vector (dGPS) Data and, (5) Model Data. The following section provides a general account of the methods used in the collection of these datasets. A more detailed description and storage location reference for each dataset collected for the Jabiluka impact project can be found in Appendix 4. The directory structure implemented for the storage of these datasets is described in Appendix 6.

4.1 High Temporal Resolution Spreadsheet Data

During the dry season of 1998 (April – October), 3 gamet automatic water sampling gauging stations were established by ***eriss*** within the Swift Creek catchment (Figure 7). Data are collected from these stations at relatively high, temporal resolutions. Turbidity, rainfall and stage height information is collected by each station at 6 minute intervals. Suspended sediment concentrations, electrical conductivity, pH and turbidity samples are collected 24 times per week on rising and falling stage heights. Discharge and bedload information are collected weekly. Data of a similar nature will also be obtained by ***eriss*** from Earth, Water, Life Sciences (EWLS) who have a further three gauging stations on the three stream channels directly draining the ERA Jabiluka Mine site (Tributaries South, Central and North). Statistical analysis of variations in sediment movement and the measured in-stream water quality variables between the two control sites, located up stream of the mine site, and the impacted site will enable the identification of changes associated with the mine's development. The high temporal resolution of these data will enable an accurate determination of the duration, frequency and magnitude of possible mine impacts. Analysis within the GIS will enable further spatial examination and explanation of these variations.

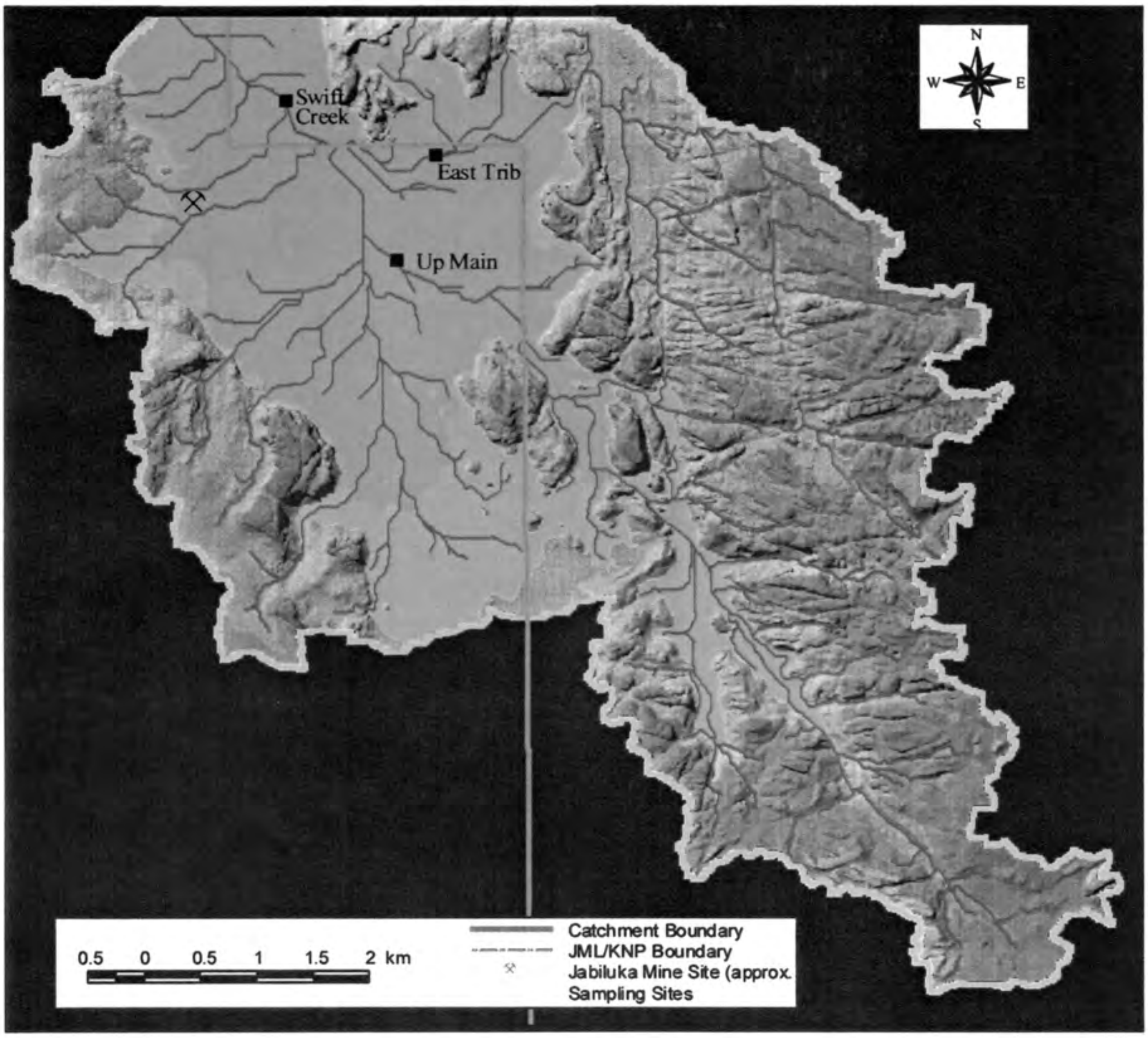

Figure 7: The Swift Creek gauging stations are located on the Swift Creek main channel down-stream of the mine, the Swift Creek main channel up-stream of the mine and the East Tributary.

4.2 Low Temporal Resolution Spreadsheet Data

Within this study, low temporal resolution spreadsheet data refers to spreadsheet data that are collected at a maximum temporal resolution of once per year. As is commonly the case, the lower temporal resolution of these data allows a greater spatial resolution in the sampling program (Quiroga et al., 1996). This data category primarily refers to the stream channel cross-sectional information, but also includes scour chain, erosion pin and cross-sectional sediment particle size analysis information gathered from the field. These data are similarly entered into the database and statistically analysed in the spreadsheet. Analysis of this information will provide an insight into possible impacts of the ERA Jabiluka mine on stream channel stability and sediment movement patterns within the Swift Creek catchment. Interpolation of the surveyed cross section point data will allow the derivation of spatial datasets showing stream section planform. This allows visualisation and quantitative assessment of annual changes in bed- and plan-form. This is a valuable geomorphic tool as it allows the user to assess not only two dimensional channel cross-sectional variation, but the movement of three dimensional sediment bedforms (Saynor and Boggs, *pers. comm.*). However, the density of the cross sectional information will determine what scale of bedform variation can be assessed using this technique, with the degree of interpolation involved determining the amount of uncertainty and error associated with the analysis (Lam and Swayne, 1993).

4.3 Raster Data

The term 'raster data structure' refers to a matrix composed of distinct units called cells (Grids) or pixels (Images). Each pixel or cell stores a numeric value (ARC/INFO, 1998). As every cell or pixel within a raster dataset has both a geographic location reference and numeric value, these datasets require large and well-organised data banks as well as user-friendly data processing hardware and software. A GIS offers a highly suitable opportunity for efficient storage, retrieval and analysis of large raster data sets. Grid data obtained by the RMS group for the Jabiluka impact project primarily consists of a Digital Elevation Model (DEM) and subsequently derived grid datasets for the Swift Creek catchment. DEM represent an efficient means be which detailed topographic information can be derived on a catchment scale (Moore et al, 1991; Quinn et al, 1992). The flowchart shown in Figure 8 describes the basic set of processes used in the derivation of the grid datasets. The primary grid datasets resulting from the application of various functions to the Swift Creek DEM include a hill shaded grid, an escarpment grid, a flow direction grid, a number of catchment grids, a flow accumulation grid and a stream grid. The location of these grids can be found in the master data list (Appendix 3). However, there also exists some digital georeferenced, ortho-photos of the Jabiluka mine site. These image datasets are stored as georeferenced TIFF images, and are thus composed of two files including a TIFF 'world' file (which contains header information describing the dataset) and a TIFF file (which contains the data itself).

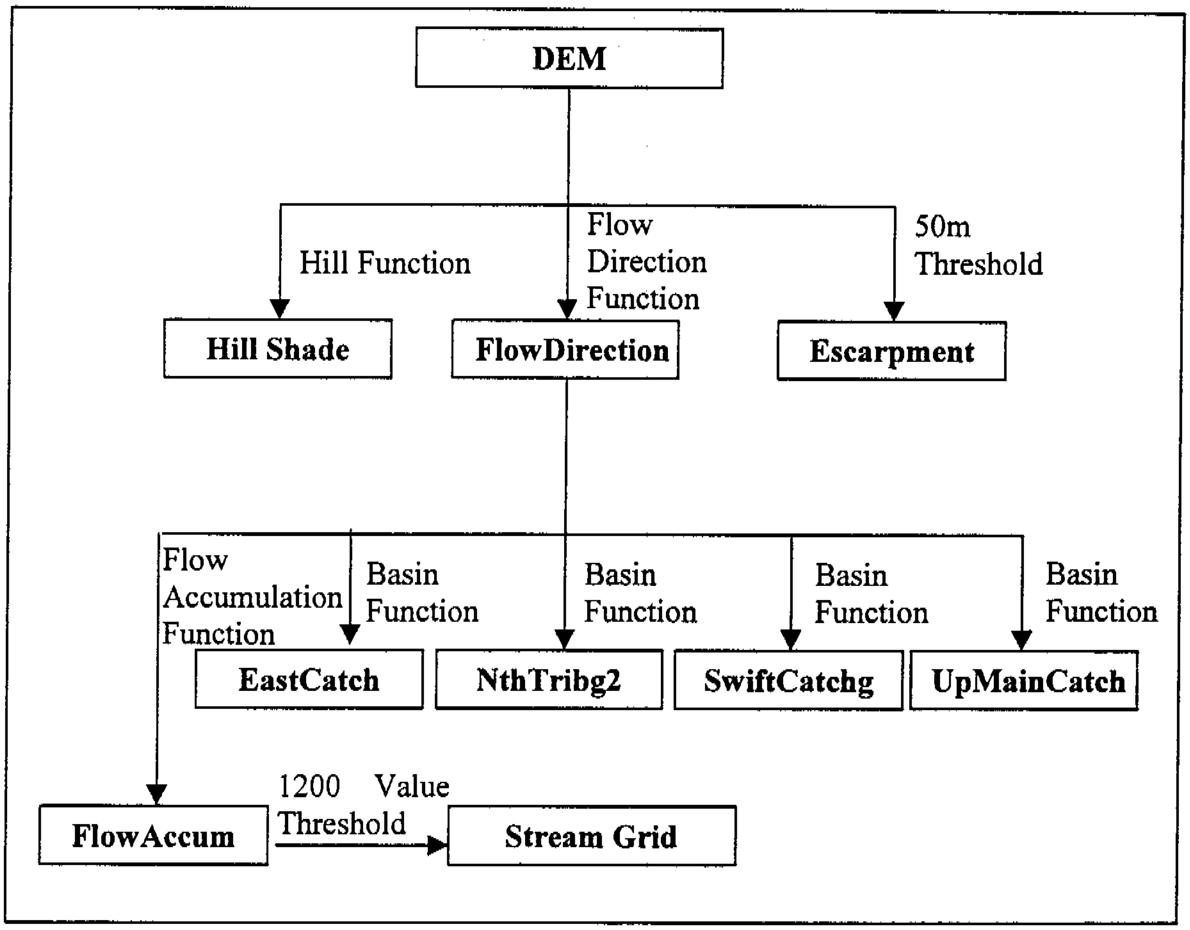

Figure 8: A flow chart depicting the derivation of a number of grid datasets from the Swift Creek DEM.

4.4 Vector Data

Another important data source for the Jabiluka impact project is vector data. The vector data model represents geographic features in a similar manner to maps. That is, through the use of points, lines and polygons, with each location recorded as a single x,y coordinate. The ability of GIS to store and analyse this data structure represents one of the prime reasons for the high level of attention paid to GIS over the past 30 years (Lam and Swayne, 1993). The existing ***eriss*** GIS vector database largely consists of the Topo-250k digital data product produced by AUSLIG. A number of vector datasets have also been generated or collected specifically for the Jabiluka impact project. The use of these datasets, which range from dGPS/Aerial Photograph Interpretation produced maps to datasets derived from the Digital Elevation Model (through vectorisation of the grid datasets), are stored as either ArcView shape files or ARC/INFO coverages, both of which can be viewed and analysed within the ArcView GIS environment (Appendix 3). The use of dGPS to provide cost effective, accurate raw geographical information in environmental impact assessment is widely recognised (Cornelius et al., 1994). A detailed description of the dGPS and DEM data collected for this project is provided in Appendix 4.

4.5 Modelling Data

The final data type utilised in the Jabiluka impact project is that associated with the hydrological and geomorphological modelling of the Swift Creek catchment. This section of the project has only recently been initiated and thus little modelling data have been generated. However, the inputs required for the model are derived from the high and low temporal resolution attribute data and vector and raster spatial data, for which much of the GIS database has been populated.

5. PRESENT GIS CAPABILITY

This report represents the conclusion of the RMS group GIS establishment phase of the Jabiluka impact project. The RMS group GIS has been developed to such a point that it is now available for use by the group members and other ***eriss*** staff. A GIS can be defined as;

> *An organised collection of computer hardware, software, geographic data and personnel designed to efficiently capture, store, update, manipulate, analyse and display all forms of geographically referenced information' (ESRI, 1997)*

Each component of this definition has been addressed during this phase of the project. It has been established that each member of the RMS group has access to sufficient computer hardware to support the use of GIS. Each of these computers is able to access the software required to perform GIS functions. Whilst the database has been designed and populated to the extent that all members of the group have access to both spatial and attribute information associated with this project. Finally, it has been established that there will be a member of the group that will provide on-going management of the GIS, whilst other members of the group have been educated in the application of the GIS technology.

The present capability of the GIS can be divided into three categories, data input, data retrieval and analysis, and information output.

5.1 Data Input

Geographic data are key to the success of a Geographic Information System (GIS), with the preparation of digital data often accounting for 60 to 80 percent of the cost of implementing a GIS. An extensive base GIS dataset has been established for the Jabiluka impact project, with data from all aspects of the project, including both high and low temporal resolution spreadsheet data, vector and raster spatial datasets and modelling data being included within the GIS database. Having been established, this database can now be easily updated, accommodating both changing datasets and the addition of new data.

One of the primary benefits of a GIS is the ability to visualise data within a spatial context. All data generated by the Jabiluka impact project can be accessed through the GIS. Spatial data can be added directly into ArcView from the GIS database, whilst attribute data can be imported directly from the Swift Creek database using the database access dialog box and geomorphology toolbox created for this project. This provides a central focus point which brings together all spatial and aspatial information for the Jabiluka project into a common analytical environment. This will provide more comprehensive analysis of these data, allowing the user to view previously hidden patterns and geographic relationships in the data.

5.2 Data Retrieval and Analysis

Once the data has been imported into the ArcView GIS environment, all functionality associated with the ArcView software package can be used in the data analysis. The type of analysis functionality available to the user varies with the document being analysed. Within ArcView geographic data can be displayed in interactive maps called 'Views'. Every view is composed of a number of thematic data layers that are referenced within a 'Table of Contents', making it easy to understand and control what is displayed. A number of analysis options are associated with ArcView View documents, from buffering and overlaying data layers, to performing proximity analyses. Additional functionality can be added to the basic ArcView GIS environment through the use of available extensions. The current RMS group GIS has a number of associated extensions available for the end user. The 'Spatial Analyst' and '3-D Analyst' extensions, which increase the raster analysis and 3-D visualisation functionality of the basic ArcView GIS, are likely to provide the additional functionality required by the RMS group.

ArcView 'Table' documents are associated with a number of other ArcView analytical functions, with ArcView's table having a full range of features for obtaining summary statistics, sorting and querying. Tabular data within ArcView allows further investigation of the spatial component of the data. For example, the user can select features on a view, and their records will highlight in the table displaying the feature's attributes. Conversely, the user can select records in the table and the features they represent highlight on the view. However, the organisation of tabular data as a combination of records and fields creates problems when the user requires more advanced, spreadsheet based analytical functions. Tables can be exported from ArcView in a number of formats and easily opened within spreadsheet packages that contain the functionality required to perform the desired analysis. Further, the database access dialog box created for the RMS group GIS allows the user to export data from the Swift Creek database directly to a Microsoft Access spreadsheet.

ArcView 'chart' documents offer a powerful business graphic and data visualisation capability that is fully integrated into ArcView's geographic environment. Users can simply click on features within a view to add them to the chart. ArcView allows the user to work simultaneously with geographic, tabular and chart representations of the data.

The added functionality associated with the creation of the database access dialog box and geomorphology tool box allows the user to access data from the Swift Creek database and analyse it within all three document environments described above. Through the direct creation of charts, the user will be able to make a rapid assessment of temporal and spatial variations in the collected attribute data, guiding further data analysis.

5.3 Information Output

ArcView's 'layouts' are the medium by which final maps are produced. ArcView allows the user to create high quality, full colour maps as the user can arrange the various graphic elements on-screen to obtain the best possible result. These can be sent to a wide range of printers and plotters at a number of resolutions. Layouts also maintain a live link with the data they represent. Hence, when a layout is printed, any changes to the data are automatically included, ensuring that everything on the map is up-to-date.

The geomorphology toolbox provides a means by which the user can directly import and chart data for the desired variable and sample location. The most common form in which the data are displayed is through scatter charts of trends in the variable over time, allowing a fast and efficient method for the user to view variations in the sampled variables over time for the selected site (Figure 9a). However, the XY scatter graph gallery available in ArcView currently lacks the functionality to graph lines. Thus for charts that require a line to be used in their display, a simple line chart has to be used. The bedload particle size distribution information is displayed as line graphs of cumulative particle size distributions for a particular date, as selected by the user (Figure 9b). The low temporal resolution cross sectional information is displayed as cross sectional charts for the individual sampling events, allowing comparisons of channel bank and bed changes between the sampling dates (Figure 9c). However, it may be possible in future developments of the ArcView GIS software, to display these cross sections on the same axis to allow a more effective display of channel cross section changes. This is an issue that needs to be addressed further. The toolbox also contains a tool to display photos, the pathnames of which are stored in the Swift Creek database. The currently available photos allow the user to select photos showing each site during low, moderate and high flow events. A detailed description of the functionality of each of the controls located on the geomorphology toolbox is given in Appendix 1, whilst the script head information associated with these tools are contained in Appendix 2.

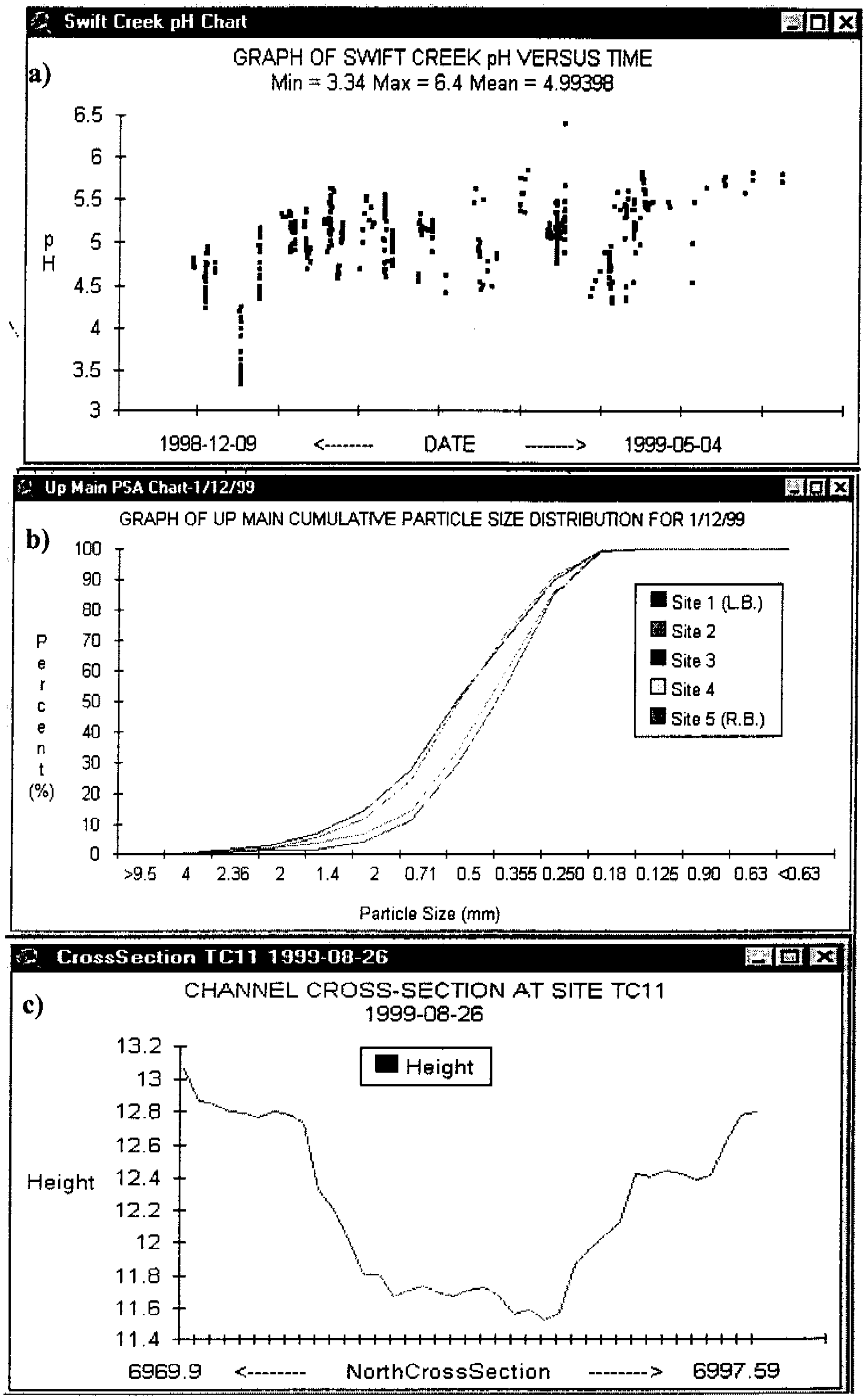

Figure 9: a) A chart of pH variations over time at Swift Ck through the 1998/1999 wet season; b) A cumulative particle size distribution chart for UpMain on the 1/12/99; c) Surveyed cross section of site TC11 on the 29/8/99.

Report generation represents another important element in the production of data outputs. The ArcView GIS package's 'Report Writer' extension integrates the powerful Seagate Crystal Reports report generation and editing application with the existing ArcView Table, View and Project user interface. This tool streamlines the process of data selection and preparation for the reporting process by providing a means by which the user can specify the desired type of report, choose whether selected records or entire tables are used in the report generation process and the output report name.

6. FUTURE DEVELOPMENT

6.1 Erosion, Hydrological and Topographical Modelling

GIS and environmental modelling are considered to be highly complementary with both technologies attempting to analyse spatially distributed and time dependent objects and processes (Fedra, 1993). However, since GIS and environmental modelling have evolved separately they have different data structures, functions and methods for inputting and outputting spatial information (Maidment, 1993). Over the past two decades there has been considerable research into the integration of these two technologies to the extent that the synthesis of spatial data representations and environmental models has been described as the new 'Holy Grail' (Raper and Livingstone, 1996). Currently there exist many different approaches to linking environmental models with GIS, from the very simple, in which the GIS is used for writing model input and the analysis of model output, to closely integrated systems (Charnock et al., 1996).

The Rehabilitation of Mine Sites group currently employs three environmental models in their assessment of mine site landform stability and off-site geomorphological and environmental impacts; 1) a basic sediment transport model, 2) the Distributed Field Williams (DISTFW) hydrology model (Field And Williams, 1987) and, 3) the SIBERIA landform evolution model (Willgoose et al, 1991a; Willgoose et al., 1991b). External inputs into these models are derived from two sources including a digital elevation model and field data describing stream water and sediment discharge. Linking these models with the GIS will provide the final element in the establishment of a GIS centred data management approach for this project (Figure 10). Having all five data categories linked by the GIS will allow the models to be directly supplied with the required input data from the entire project dataset (primarily the high temporal resolution spreadsheet data and raster data). The models will be accessed and run via a customised, user-friendly GIS interface with output data also being linked directly into the GIS, facilitating more efficient analysis and interpretation of the model output.

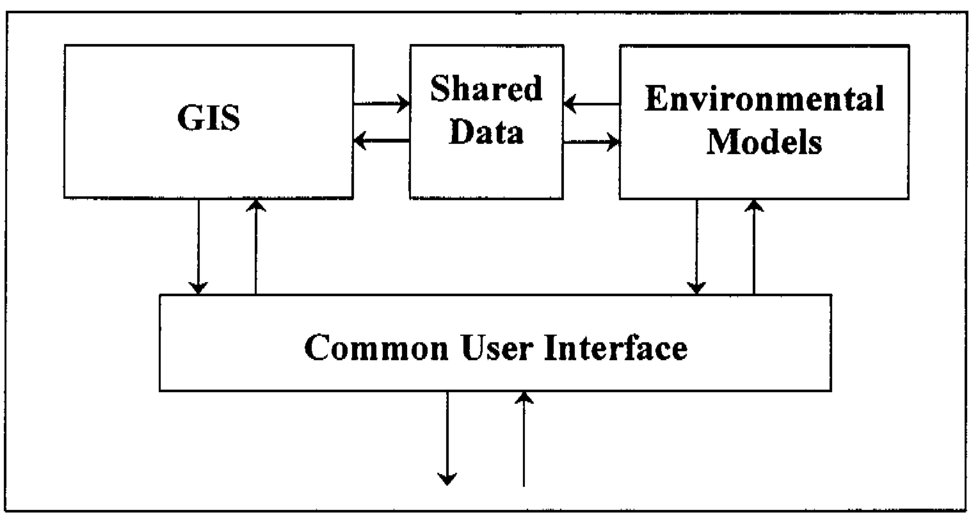

Figure 10: The intended method for integrating the GIS and RMS group suite of models

One of the primary advantages of linking environmental models to a GIS is the possibility of rapidly producing modified input-maps with different management practices to simulate alternative scenarios (De Roo, 1996). Having both the parameter and DEM input data sources as well as the modelling functionality directly accessible through the GIS interface provides an uncomplicated and rapid method to analyse various scenarios of mine site design. It is expected that these model simulations will focus on the final mine development alternative, addressing various design scenarios incorporated in the alternative. Impacts of the alternative management scenarios on catchment evolution will be assessed both over long- and short-term time scales. Outcomes derived from these modelling scenarios will be used in the formation of management recommendations once final decisions on mine development and design are made (Boggs et al., 1999a).

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APPENDIX 1: APPLICATIONS DEVELOPMENT

A1.1 Development environment

There exists two primary methods for developing and customising the GIS software ArcView environment. These methods include; (1) the customisation of the ArcView graphical user interface and; (2) the development of programs using the object-oriented scripting language associated with ArcView, 'Avenue'. Customisation of the COTS ArcView interface, including manipulation of the menus, button bars, tool bars and popup menus, allows the GIS developer to tailor the appearance and available functionality of the ArcView package to suit the individual needs of the end-users. Although the appearance of the ArcView interface can also be customised using Avenue, the most important purpose of developing programs using Avenue is to increase or develop new functionality in order to achieve the results desired by the end-user. This is especially important when developing a GIS for a specialised group of end-users, such as the eriss RMS group. Dialog boxes represent a means of combining these two methods for developing and customising the ArcView GIS package. Dialog boxes allow the GIS developer to organise a single task or set of related tasks onto a separate window, much like the organisation of related tasks under a particular menu item or on the button bar.

A1.2 Software Development Requirements

Through consultation with the staff of the RMS group and investigation of the data associated with the group, it was determined that the COTS ArcView software should be customised and developed to suit the requirements of the group. A general simplification of the ArcView View GUI retained the functionality required by the group, whilst providing a more user-friendly interface for the group. The buttons and tools removed from the View GUI are listed and described in Table A1.1. These buttons and tools can be added to the View GUI of the RMS group GIS if or when the requirements of the group expand or change.

Table A1.1.: These buttons and tools have been removed from the View graphical user interface (GUI) of the standard COTS ArcView package to provide a simpler, more user-friendly form of GUI.

Theme Properties	Displays the dialog box to edit properties of the active theme	View.ThemeProperties View.ActiveThemesUpdate
Edit Legend	Edit Legend//Displays the legends of the active themes	View.EditLegendClick View.ActiveThemesUpdate
Locate Address	Locates an address in the active, matchable theme	View.Locate View.LocateUpdate
Zoom to Selected	Zooms to the extent of the selected features	View.ZoomToSelected View.SelectableThemesUpdate
Select Features Using Graphic	Selects features in active themes using selected graphics	View.SpatialSelect View.SpatialSelectUpdatae
Vertex Edit	Adds, moves and deletes vertices of features and graphics	View.SelectToEdit View.SelectToEditUpdate
Hot Link	Follows a hot link in the active themes	View.HotLink View.HotLinkUpdate
Area of Interest	Sets the view's Area of Interest for library based themes	View.AOITool View.AOIToolUpdate
Snap	Sets the general snapping tolerance for the editable theme	View.SnapTool View.SnapToolUpdate
Snap (2)	Sets the interactive snapping tolerance for the editable theme	View.InteractiveSnapTool View.InteractiveSnapToolUpdate

The primary requirement of the GIS identified by the RMS group was to provide direct, spatial access to data generated by the group's Jabiluka Impact project. The large amount of data generated by this project has been collated and stored in a single Microsoft Access database. By linking this database with the GIS, a more clearly organised and user friendly approach can be made to extracting data. That is, data can be extracted from the database for a specific location simply by clicking on the location within a View. A dialog box has been designed to provide this functionality for the RMS group GIS. This dialog box is described in more detail in section A1.5 below. To run this dialog box a button and tool have been added to the RMS group GIS View GUI. Both the button and tool launch the dialog box. However the tool allows the user to select which location the data is to be imported for whilst the button will import data for all study sites within the database.

Another dialog box created for this project provides a more controlled, direct means of accessing the database. The 'Geomorphology Tool Box', described in more detail below, is composed of a number of tools that import and chart data for a specific variable and study site. This ability to rapidly view a graphical form of the data stored in the database was specified as one of the primary requirements of the RMS group. A button has been provided on the View GUI to launch this dialog box. The final button added to the View GUI of the RMS group GIS opens the Metadata Database and data entry form generated for this project, providing a prompt and easy method for accessing and updating the Metadata database.

A1.3 Documentation and Implementation

All documentation regarding the development and implementation of the RMS group GIS can be found in this appendix and appendix 2 (scripts). The documentation in these appendices describe the manipulation of the COTS ArcView GIS graphic user interface (GUI), the development and configuration of the dialog boxes and the Avenue scripts written and compiled which function behind the GUI and dialog boxes. Further help systems are being developed that will provide direct support for the RMS group GIS.

The current implementation procedure for the RMS group GIS is simply to load the base RMS group GIS project. This project is stored in two locations, h:\ArcView\SwiftCreekBase.apr and h:\geomorphology\projects\SwiftCreekBase.apr. When this project is opened the GUI of the COTS ArcView will revert to the customised version of the RMS group GIS, providing access to all tools, buttons and dialog boxes developed for this project. This project has a large number of relevant themes already loaded, at both the Alligator Rivers Region scale and the Swift Creek catchment scale, allowing the user instant access to both the customised RMS group GIS and relevant data sets for manipulation and analysis.

The database access dialog boxes developed for this project, however, require that an ODBC connection has been established with the Swift Creek project Microsoft Access database on the users personal computer. This can be established through the Windows control panel ODBC connections utility. The database is stored in h:\geomorphology\general\SwiftCreek.mdb. If the ODBC connection is named Swift2 the project will open directly. However, if the connection is given another name the user will be prompted to enter the name of the ODBC connection. Once entered all database access tools and buttons will be available to the user.

A1.4 List Of Objects

A1.4.1 Database Access Dialog Box

Object 1.	Cancel Button
Object 2.	Delete Button
Object 3.	Available Tables Combo Box
Object 4.	Available Fields Combo Box
Object 5.	Selected Fields List Box
Object 6.	Output Table Name Text Line
Object 7.	Done Button
Object 8.	Chart Button
Object 9.	Excel Button

A1.4.2 Geomorphology Tool Box

Object 10.	Suspended Sediment Tool
Object 11.	Survey Tool
Object 12.	Turbidity Tool
Object 13.	E.C. Tool
Object 14.	pH Tool.
Object 15.	Suspended Sediment (>63 um) Tool
Object 16.	Solutes Tool
Object 17.	Total Suspended Sediments Tool
Object 18.	Bedload Tool
Object 19.	Discharge Tool
Object 20.	Photo Display Tool
Object 21.	Rainfall Tool
Object 22.	Unselect Button
Object 23.	Close Button

A1.5 Database Access Dialog Box

A1.5.1 overview

The functionality required for the user to access the Swift Creek database and either import, chart or export the data from within the ArcView environment has been provided through the development of a 'database access dialog box' (Figure 5). A tool and button have both been provided on the ArcView menu bar to allow the user to access the dialog box. By providing tool-access to the dialog box, it allows the user to select a site on the view for which the information is to be imported, charted or exported, before displaying the dialog box. If the user requires information to be imported for all sites the information can be accessed using the button option.

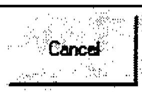
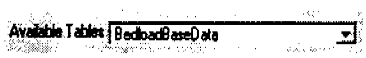
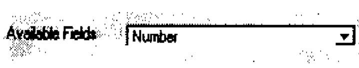
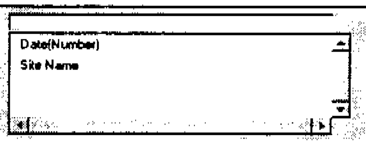
The dialog box consists of five buttons labelled 'delete', 'cancel', 'done', 'create chart' and 'excel', as well as four data selection/entry boxes (available tables, available fields, selected fields and output table name). The delete button, enabled when a field has been selected, allows the user to delete fields contained within the 'selected fields' box. The cancel button simply closes the dialog box. The 'available tables' box is a combo box which contains a drop down list of all tables contained within the Swift Creek database. The user selects the table from which information is to be imported through this combo box. The 'available fields' box similarly provides a drop down list of the fields contained within the selected table. From this box the user can select the fields which are to be imported. The selected fields are displayed in the 'selected fields' box as they are selected. The 'output table' box allows the user to specify the name of the resulting table. A table name must be entered into this box by the user for the procedure to continue. The 'done' button will import the data into an ArcView table, and will link the new table with the sampling sites theme's attribute table. That is, if data was imported for all sites, this will allow the user to select information in the imported table by site, by interactively selecting the sampling site within the view. The scripts which run behind these buttons are contained in Appendix 2.

A1.5.2 Function List

The database access dialog box is composed of a number of controls that allow the user to access the Swift Creek database and either import, chart or export the data. The specific components of the database access dialog box are listed in Table A1.2. These components are identical for both the database access tool and database access button. However, there are differences in the scripts associated with some of the controls of each dialog box. This difference is noted in both the description and reference scripts columns of Table A1.2.

As with the geomorphology toolbox, a number of Avenue scripts are associated with database access dialog box to ensure the correct functioning of the dialog itself. The property with which they are associated, a description of their function and their associated script references are also provided in Table A1.2.

TableA1.2: This table describes the functions contained in the database access dialog box, providing a picture, description and script reference for each of the controls contained within the dialog box.

Control Object	Description of Control's Function	Script Reference
button   tool	Opens the dialog box	database_button.ave or database_tool.ave
	Removes selected elements from a list box	Database_lbtdelete.ave
	Closes the dialog box	Database_cancel.ave
	Populates the sqlFields combo box with the fields of the currently selected table	Database_cbxtabsel.ave
	Inserts the selected value into a listbox	Database_cbxfieldsel.ave
	Displays the list of fields selected from the available fields combo box	Nil
	Allows the user to input an output table name	Nil
	Imports a table for the selected fields for all sites or the selected site if run as a tool	Databaselbtdone(but).ave or DatabaseAccess.lbt_Done(tool)
	Plots a chart of the selected fields for all sites or the selected site if run as a tool	Database_lbtchart(bu).ave or database_lbtchart(to).ave
	Exports a table from the external database to Microsoft Excel for the selected fields for all sites or the selected site if run as a tool	Databaselbtexcel(but).ave or databaselbtexcel(to).ave
Open	Clears out the list box, populates the tables and fields combo boxes and disables the delete, done, chart and excel buttons.	database_open(but).ave or database_open(tool).ave
DocActivate	Disables a selection of controls on a dialog box when the active document is not a view.	database_docact.ave

APPENDIX 2: AVENUE SCRIPTS

A2.1 Introduction to Avenue

The ArcView GIS customisation and development environment consists of an object oriented programming language called Avenue (ESRI, 1997). Through the use of Avenue it is possible to:

- Customise the way ArcView looks.
- Modify ArcViews standard tools.
- Create new tools.
- Integrate ArcView with other applications
- Develop and distribute custom applications on top of ArcView (ESRI, 1996)

The object oriented nature of Avenue means that the language functions by focussing on identifying objects and then sending them requests. An object can be viewed as a package that is comprised of tightly coupled data and functionality. This is contrasted with procedural programming practices in which the language places an emphasis on the function (procedure) (ESRI, 1996). That is, Avenue sends a request to an object, instead of calling functions explicitly with arguments. When an object receives this request it performs some action. ArcViews objects are members of a class hierarchy that are organized into functional categories related to all aspects of the application. An object in Avenue always responds to a request by returning an object; in some cases, the request creates a new object and in other cases, the original request returns an existing object (ESRI, 1997). In procedural languages, writing code consists of establishing routines that call other routines. You maintain the state of the program in variables (basic types or structures, with global or local scopes) and these routines operate on the state of these variables. Variable names commonly relate to the object they describe. In Avenue, you maintain and control the state of the system in the objects that have been instantiated.

A2.2 Conventions

A2.2.1 Header Information

The standard format used for Avenue script headers throughout this project is based on the guide provided within the ArcView Avenue documentation. The format is as shown below;

Name: Name is the script name this script should have when it is loaded into ArcView. The name should have an identifying prefix. (eg. DocGUI.AddToolMenu, Project.DeleteEmbeddedScript, View.FindNearestFeatureTool)

Filename: This is the name of the text file under which the script has been exported from ArcView.

Title: Title identifies the purpose of the script. The script title is commonly less than 50 characters long and may contain spaces to separate words. The title should accurately identify the utility of the script. The title must describe what the script does.

Topics: Topics names the categories under which this script will be listed in the contents page. More than one topic can be specified if necessary, but in most cases, the script should fall under one category.

Description: Description provides a complete discussion of what this script does and how it works. It describes any special algorithms or techniques employed by this script. Some description of the script must be provided. The description can be any length.

Requires: Requires details the conditions necessary for this script to run. This often includes stating the kind of document that must be active for this script to run, the kind of event this script should be associated with if there are special conditions, required extensions, required data or files or system conditions, and so forth.

Self: Self describes the Self object required by this script. Scripts called by other scripts use the Self object to pass values. Scripts associated with events use the Self object to identify the object that initiated that event (eg. an update script on a control, an open script on a document). If the script does not use the Self object, this section is left empty. This section can be any length.

Returns: Returns identifies any objects returned or opened by the script. Scripts that are called by other scripts may also return a value to the calling script. If the script does not return an object, this section is left empty. This section can be any length.

Created: Created identifies the author of the script and the initial date on which the script was created.

A2.2.2 Comments

Comments in scripts document how the code works or provide a means to include any other text with the code. When a script is compiled or run, ArcView ignores any comments in the script. ArcView considers any text on the line to the right of a single quotation mark (apostrophe) to be a comment. You can place a comment on a line by itself or you can place a comment on the same line as code, provided it comes after the code you want to execute.

A2.2.3 Structure

Along with comments, the structure of a script can make it easier to read and understand. ArcView ignores blank lines in scripts. Blank lines can therefore be used to make scripts easier to read by separating out nested groups of functions. Within branching and looping statements it is standard to move functions contained within the statement one tab space to the right of the statements margin. When multiple branching and looping statements are made within each other this can clarify exactly where each statement begins and ends.

A2.2 Storage

All scripts contained within this Appendix can be found within the SwiftCreekBase project. At present two copies of this project are available for use by staff at ***eriss***;

- the first is found in h:\ArcView\swiftcreekbase.apr and;
- the second is found in h:\Geomorphology\Projects\swiftcreekbase.apr

Neither of these projects can be modified by non-GIS staff or students within ***eriss***. However, copies of these projects can be made which are then available for modification.

The individual scripts have all been exported as text files with the extension .ave. These files have been exported under the name described in the 'FileName' property within each scripts header listed below. All script text files are stored within the h:\geomorphology\scripts sub-directory.

A2.3 Implementation

Presently all scripts described within this project are attached to either menus, buttons, tools or dialog boxes and controls and are therefore ready for implementation. A short help sentence can be obtained about the tool/button/control by holding the mouse cursor over the button for a few seconds. This help generally states the name of the tool/button/control and the general function which it performs. However, many of the scripts depend on the existence of an Open Database Connectivity (ODBC) connection with the Swift Creek base Microsoft Access database. This ODBC connection must be constructed on each individual personal computer before the scripts will function. Establishing this connection involves;

1) Going to the Windows start menu - Settings

2) Opening the Control Panel

3) Opening the ODBC icon

4) Adding a User DSN

5) Selecting a Microsoft Access Driver

6) Giving the connection a name and selecting the Swift Creek base database as the required database.

7) Pressing OK

If this connection is not named Swift2 then when the ArcView project opens the user will be prompted to enter the name of the ODBC connection. Once entered all scripts should be available for implementation by the user.

Another factor to consider when implementing these Avenue scripts is that they are highly dependent on the state of the database they are accessing. If data is missing or not updated within the database, this will be highlighted in the results obtained through the implementation of these scripts.

A2.4 List of scripts

1. Script 1.: DatabaseAccess.button
2. Script 2.: DatabaseAccess.Cancel
3. Script 3.: DatabaseAccess.cbx_FieldsSelect
4. Script 4.: DatabaseAccess.cbx_TablesSelect
5. Script 5.: DatabaseAccess.DocActivate
6. Script 6.: DatabaseAccess.lbt_chart(button)
7. Script 7.: DatabaseAccess.lbt_chart(tool)
8. Script 8.: DatabaseAccess.lbt_Delete
9. Script 9.: DatabaseAccess.lbt_Done(button)
10. Script 10.: DatabaseAccess.lbt_Done(tool)
11. Script 11.: DatabaseAccess.lbt_excel(button)
12. Script 12.: DatabaseAccess.lbt_excel(Tool)
13. Script 13.: DatabaseAccess.lbx_update
14. Script 14.: DatabaseAccess.Open(but)
15. Script 15.: DatabaseAccess.Open(Tool)
16. Script 16.: DatabaseAccess.Tool
17. Script 17.: MetaData.Open
18. Script 18.: project.save(geomorph)
19. Script 19.: project.SaveAs(geomorph)
20. Script 20.: startup.Welcome
21. Script 21.: ToolBox.Button
22. Script 22.: ToolBox.Close
23. Script 23.: ToolBox.Discharge
24. Script 24.: ToolBox.DocActivate
25. Script 25.: ToolBox.EC
26. Script 26.: ToolBox.Open
27. Script 27.: ToolBox.pH
28. Script 28.: ToolBox.PhotoDisplay
29. Script 29.: ToolBox.PSA
30. Script 30.: ToolBox.Rainfall
31. Script 31.: ToolBox.Solutes
32. Script 32.: ToolBox.SS
33. Script 33.: ToolBox.SS(>63)
34. Script 34.: ToolBox.Survey
35. Script 35.: ToolBox.TotalSS
36. Script 36.: ToolBox.Turbidity
37. Script 37.: ToolBox.Update

Script 1.

Name: DatabaseAccess.button

File Name: database_button.ave

Title: Opens the dialog box

Topics: Dialog box

Description: Run this script from a button choice in a DocGUI that supports view documents. This script checks that there is only one active theme before opening the DatabaseAccess(button) dialog box

Requires: One theme to be active

Self:

Returns: A dialog box

Created: Guy Boggs, 12/10/1999

Script 2.

Name: DatabaseAccess.Cancel

File Name: database_cancel.ave

Title: Closes the dialog box.

Topics: Dialog box

Description: Run this script from a control on the dialog box. This script closes the dialog box on which the control is located.

Requires:

Self: Control

Returns:

Created: Guy Boggs, 12/10/1999

Script 3.

Name: DatabaseAccess.cbx_FieldsSelect

File Name: database_cbxfieldsel.ave

Title: Inserts the selected value into a listbox

Topics: Dialog box

Description: Attach this script to the select property on a combo box. This script takes the currently selected value in the combo box and inserts it into the next available row of a list box, and then broadcasts all listeners to run their update scripts.

Requires:

Self: A combo box

Returns:

Created: Guy Boggs, 11/10/1999

Script 4.

Name: DatabaseAccess.cbx_TablesSelect

File Name: database_cbxtabsel.ave

Title: Populates the sqlFields combo box with the fields of the currently selected table

Topics: Dialog box

Description: Attach this script to the select property on a combo box. This script takes the currently selected value in the combo box runs an sql query on a database to return all fields contained within the selected database table. These fields are then used to populate the sql Fields combo box and then broadcasts all listeners to run their update scripts. This script requires a database to have been constructed with the tables SSBaseData, SSSummaryInformation, BedLoadBaseData, DailyRainfallBaseData, DischargeBaseData and SurveyBaseData. An ODBC connection must have already been created for this database and defined within ArcView as the global variable _ODBC.

Requires: A database with the tables SSBaseData, SSSummaryInformation, BedLoadBaseData, DailyRainfallBaseData, DischargeBaseData and SurveyBaseData and an ODBC connection _ODBC.

Self: A combo box

Returns:

Created: Guy Boggs, 11/10/1999

Script 5.

Name: DatabaseAccess.DocActivate

File Name: database_docact.ave

Title: Disables a selection of controls on a dialog box when the active document is not a view.

Topics: Dialog box

Description: Attach this script to the DocActivate property of the dialog box.
This script disables a selection of controls on a dialog box when the active document is not a view.

Requires:

Self: A dialog box

Returns:

Created: Guy Boggs, 12/10/1999

Script 6.

Name: DatabaseAccess.lbt_chart(button)

File Name: database_lbtchart(bu).ave

Title: Plots a chart of the selected fields for all sites

Topics: Charts, Tables

Description: Run this script from a button on a dialog box document. The idea
behind this script is to allow you to create a chart from any data contained within the database with the ODBC connection named _ODBC. Since ArcView does not directly support this, this script is necessary.

This script requires that a database exists that has had an ODBC connection established. This connection must be defined within ArcView as a global variable named _ODBC before the script is run. Once the appropriate fields have been selected within the dialog box and an output table name has been entered, this script can be run. This script firstly prompts the user to select the field with which to order the chart (left to right). A message box then appears prompting the user to decide whether it will be necessary to retain the chart after the project has been closed. The user selects the field to label the X axis next. Finally, if there is more than one number field selected, the user can choose which variable to chart. A chart will then appear occupying the whole screen. The corresponding table is also imported into the project. This script can be manipulated to work with differently defined databases.

Requires: A database must have been created from which a number of fields have been selected, with at least one number field. An ODBC connection must be defined for this database, referenced by a global variable _ODBC. A number of fields must be selected from this database. A table name must also have been input into the dialog box.

Self: control on the dialog box running this script

Returns: A chart and table of data contained within a database.

Created: Guy Boggs, 03/10/1999

Script 7.

Name: DatabaseAccess.lbt_chart(tool)

File Name: database_lbtchart(to).ave

Title: Plots a chart of the selected fields for a previously selected site

Topics: Charts, Tables

Description: Run this script from a button on a dialog box document. The idea
behind this script is to allow you to create a chart from any data contained within the database with the ODBC connection named _ODBC for a previously selected site. Since ArcView does not directly support this, this script is necessary.

This script requires that a database exists that has had an ODBC connection established. This connection must be defined within ArcView as a global variable named _ODBC before the script is run. Once the appropriate fields have been selected within the dialog box and an output table name has been entered, this script can be run. This script firstly prompts the user to select the field with which to order the chart (left to right). A message box then appears prompting the user to decide whether it will be necessary to retain the chart after the project has been closed. The user selects the field to label the X axis next. Finally, if there is more than one number field selected, the user can choose which variable to chart. A chart will then appear occupying the whole screen. The corresponding table is also imported into the project. This script can be manipulated to work with differently defined databases.

Requires: A database must have been created from which a number of fields have been selected, with at least one number field. An ODBC connection must be defined for this database, referenced by a global variable _ODBC. A number of fields must be selected from this database. A table name must also have been input into the dialog box. A site must have been previously selected, with _theVal being the Site Name

Self: control on the dialog box running this script

Returns: A chart and table of data contained within a database.

Created: Guy Boggs, 04/10/1999

Script 8.

Name: DatabaseAccess.lbt_Delete

File Name: database_lbtdelete.ave

Title: Removes selected elements from a list box

Topics: Dialog box

Description: Run this script from a control on the dialog box. This script deletes the currently selected element in a list box. The script disables the delete button, done button, chart button and excel button if no elements exist in the list box as a result of the delete operation.

Requires: A selected option within a list box (lbx_SelectedFields)

Self: Control running this script

Returns:

Created: Guy Boggs, 12/10/1999

Script 9.

Name: DatabaseAccess.lbt_Done(button)

File Name: databaselbtdone(but).ave

Title: Imports a table for the selected fields for all sites

Topics: Tables

Description: Run this script from a button on a dialog box document. The idea behind this script is to allow you to import data from an external database with the ODBC connection named _ODBC. Since ArcView does not directly support this, this script is necessary.

This script requires that a database exists that has had an ODBC connection established. This connection must be defined within ArcView as a global variable named _ODBC before the script is run. Once the appropriate fields have been selected within the dialog box and an output table name has been entered, this script can be run. This script imports the selected information from the database into a table in ArcView. If the active theme in the view has either a Site Name field or CrosSecID field then this table is linked to the attribute table of the active theme using one of these fields. This script can be manipulated to work with differently defined databases.

Requires: A database must have been created from which a number of fields have been selected. An ODBC connection must be defined for this database, referenced by a global variable _ODBC. A number of fields must be selected from this database. A table name must also have been input into the dialog box.

Self: control on the dialog box running this script

Returns: A table of data contained within a database.

Created: Guy Boggs, 01/10/1999

Script 10.

Name: DatabaseAccess.lbt_Done(tool)

File Name: databaselbtdone(to).ave

Title: Imports a table for the selected fields and selected site

Topics: Tables

Description: Run this script from a button on a dialog box document. The idea behind this script is to allow you to import data from an external database with the ODBC connection named _ODBC for a previously selected site. Since ArcView does not directly support this, this script is necessary.

This script requires that a database exists that has had an ODBC connection established. This connection must be defined within ArcView as a global variable named _ODBC before the script is run. Once the appropriate fields have been selected within the dialog box and an output table name has been entered, this script can be run. This script imports the selected information from the database for the selected site into a table in ArcView. This table is linked to the attribute table of the active theme by the sites name field. This script can be manipulated to work with differently defined databases.

Requires: A database must have been created from which a number of fields have been selected. An ODBC connection must be defined for this database, referenced by a global variable _ODBC. A number of fields must be selected from this database. A table name must also have been input into the dialog box. The site name of the previously chosen location is required as variable _theVal.

Self: control on the dialog box running this script

Returns: A table of data contained within a database.

Created: Guy Boggs, 02/10/1999

Script 11.

Name: DatabaseAccess.lbt_excel(button)

File Name: databaselbtexcel(but).ave

Title: Exports a table from the external database to Microsoft Excel for the selected fields for all sites

Topics: Tables

Description: Run this script from a button on a dialog box document. The idea behind this script is to allow you to export data from an external database to a Microsoft Excel spreadsheet without leaving the ArcView environment. This requires the external database to have an ODBC connection named _ODBC. Since ArcView does not directly support this, this script is necessary.

This script requires that a database exists that has had an ODBC connection established. This connection must be defined within ArcView as a global variable named _ODBC before the script is run. Once the appropriate fields have been selected within the dialog box and an output table name has been entered, this script can be run. This script imports the selected information from the database into a table in ArcView. It then exports this table using Dynamic Data Exchange (DDE) queries to a Microsoft Excel spreadsheet. This script will open Microsoft Excel if the program is not already open. This script can be manipulated to work with differently defined databases.

Requires: A database must have been created from which a number of fields have been selected. An ODBC connection must be defined for this database, referenced by a global variable _ODBC. A number of fields must be selected from this database. A table name must also have been input into the dialog box.

Self: control on the dialog box running this script

Returns: A table of data contained within a database.

Created: Guy Boggs, 08/10/1999

Script 12.

Name: DatabaseAccess.lbt_excel(Tool)

File Name: databaselbtexcel(to).ave

Title: Exports a table from the external database to Microsoft Excel for the selected fields
for the selected site.

Topics: Tables

Description: Run this script from a button on a dialog box document. This script allows you to export data from an external database to a Microsoft Excel spreadsheet without leaving the ArcView environment. This requires the external database to have an ODBC connection named _ODBC. Since ArcView does not directly support this process, this script is necessary.

This script requires that a database exists that has had an ODBC connection established. This connection must be defined within ArcView as a global variable named _ODBC before the script is run. Once the appropriate fields have been selected within the dialog box and an output table name has been entered, this script can be run. This script imports the selected information for the selected site from the database into a table in ArcView. It then exports this table using Dynamic Data Exchange (DDE) queries to a Microsoft Excel spreadsheet. This script will open Microsoft Excel if the program is not already open. This script can be manipulated to work with differently defined databases.

Requires: A database must have been created from which a number of fields have been selected. An ODBC connection must be defined for this database, referenced by a global variable _ODBC. A number of fields must be selected from this database. A table name must also have been input into the dialog box. The site name of the previously chosen location is required as the variable _theVal

Self: control on the dialog box running this script

Returns: A table of data contained within a database.

Created: Guy Boggs, 16/10/1999

Script 13.

Name: DatabaseAccess.lbx_update

File Name: database_lbxupdate.ave

Title: Enables some buttons on the the dialog

Topics: Dialog box

Description: Attach this script to the update property on a list box. This script enables a selection of buttons on the dialog box if an object is added to the list.

Requires:

Self: A list box

Returns:

Created: Guy Boggs, 12/10/1999

Script 14.

Name: DatabaseAccess.Open(But)

File Name: database_open(but).ave

Title: Clears out the list box, populates the tables and fields combo boxes and disables the delete, done, chart and excel buttons

Topics: Dialog Box

Description: Attach this script to the Open property of the dialog box. This script will establish the initial settings of the dialog box. The script will empty the listbox, populate the tables combo box with the tables available in the database and select the BedLoad table as the initial selection. The fields combo box is populated through an sql query with the external database for the selected table. The delete, done, chart and excel buttons are disabled and the listeners set for the table combo box and fields combo box.

Requires: A database must have been created with an ODBC connection defined for this database, referenced in ArcView by a global variable _ODBC.

Self: A dialog box

Returns:

Created: Guy Boggs, 13/10/1999

Script 15.

Name: DatabaseAccess.Open(Tool)

File Name: database_open(tool).ave

Title: Clears out the list box, populates the tables and fields combo boxes and disables the delete, done, chart and excel buttons

Topics: Dialog Box

Description: Attach this script to the Open property of the dialog box. This script will establish the initial settings of the dialog box. The script will
empty the listbox and populate the tables combo box with the tables available in the database. If the selected theme contains the field CrosSecID, only the SurveyBaseData table is made available, whilst all other tables are made available if the selected theme contains the field Site Name. The Surveybasedata or BedLoadBasedata are initially selected, depending on the active theme. The value of either the CrosSecID or Site Name field at the selected location is made available to other scripts through the definition of the global variable _theVal. The fields combo box is populated through an sql query with the external database for the selected table. The delete, done, chart and excel buttons are disabled and the listeners set for the table combo box and fields combo box.

Requires: A database must have been created with an ODBC connection defined for this database, referenced in ArcView by a global variable _ODBC. An interactively selected point on the view is also required as input.

Self: A dialog box

Returns:

Created: Guy Boggs, 13/10/1999

Script 16.

Name: DatabaseAccess.Tool

File Name: database_tool.ave

Title: Opens the dialog box

Topics: Dialog box

Description: Run this script from a tool choice in a DocGUI that supports view documents. This script checks that there is only/at least one active theme, that the active theme contains either a CrosSecID or Site Name field and that the user has selected a point on the active theme. The script then opens the database access dialog box.

Requires: One theme to be active, with either a CrosSecId or Site Name field. A selected point on the active theme.

Self:

Returns: A dialog box

Created: Guy Boggs, 12/10/1999

Script 17.

Name: MetaData.Open

File Name: metadata_open.ave

Title: Opens the Geomorphology MetaDatabase and data entry form

Topics: Database

Description: Run this script from a button choice in a DocGUI that supports view documents. This script checks whether Microsoft Access is already open before opening the Microsoft Access database defined by the global variable _MetaData. The Microsoft Access MetaData entry form is then opened.

Requires: The path to the MetaData base to have been previously defined as _MetaData.

Self:

Returns: Microsoft Access Database and Entry Form

Created: Guy Boggs, 29/10/1999

Script 18.

Name: project.save(geomorph)

File Name: project_save.ave

Title: Saves the project

Topics: Project

Description: Run this script from a button choice in any DocGUI. This script checks to see whether the project is the orginal project. If it is, then the project.saveas(Geomorph) script is run. Otherwise the project is saved (if some edits have occurred since the last save.

Requires:

Self:

Returns:

Created: Guy Boggs, 01/11/1999

Script 19.

Name: project.SaveAs(geomorph)

File Name: project_saveas.ave

Title: Saves the project under a new name

Topics: Project

Description: Run this script from a button choice in any DocGUI. This script is the same as the standard Project.Save script, but with the default directory as h:\geomorphology\projects.

Requires:

Self:

Returns:

Created: Guy Boggs, 01/11/1999

Script 20.

Name: startup.Welcome

File Name: startup_welcome.ave

Title: Provides a Welcome message and a chance to define the global variables _MetaData and _ODBC

Topics: Startup

Description: Attach this script to the startup property of the project. The script will display a welcome message and set the name in the of the ArcView session to Rehabilitation of Mine Sites GIS. The script will check that the metadata base is located in h:\accessories\metadata and, if not, will provide an opportunity to input the new source of the metadata base. This script also checks to see if the ODBC connection Swift2 is available. If not, it allows the user to input the new name of the ODBC connection. In both cases, the user can cancel and still access the project, however, the scripts relying on the variables _MetaData and _ODBC will not be available.

Requires:

Self:

Returns:

Created: Guy Boggs, 01/09/1999

Script 21.

Name: ToolBox.Button

File Name: toolbox_button.ave

Title: Opens the Toolbox dialog box.

Topics: Dialog box

Description: Run this script from a button choice in a DocGUI that supports view documents. This script finds the ToolBox.Charts dialog box, enables the control panel and opens the dialog box in the top left corner of the view.

Requires: A dialog box named ToolBox.Charts to exist within the project

Self:

Returns: A dialog box

Created: Guy Boggs, 18/10/1999

Script 22.

Name: ToolBox.Close

File Name: toolbox_close.ave

Title: Closes the Toolbox dialog box.

Topics: Dialog box

Description: Run this script from a button choice on a dialog box document. This script selects the unselect tool before closing the dialog box on which the button is located.

Requires:

Self: Close button on the dialog box

Returns:

Created: Guy Boggs, 19/10/1999

Script 23.

Name: ToolBox.Discharge

File Name: toolbox_discharge.ave

Title: Plots an XY scatter chart of the selected sites stream discharge versus time

Topics: Charts

Description: Run this script from a tool choice in a DocGUI that supports view documents. The idea behind this script is to allow you to create an XY scatter chart of stream discharge versus time for a sampling point selected by the user on the view. Since ArcView does not directly support this, this script is necessary.

This script requires that a database has been created which contains a table named DischargeBaseData. This table must contain information concerning the sampling sites name (field 1 - named Site Name), date of sample collection (in Number format (field 2) and date format (field 3)) and the discharge at that point in time (field 4) (This field must be named Discharge). An ODBC connection must have been established for the database. This connection must be defined within ArcView as a global variable named _ODBC before the script is run. One theme must be active on the view. This theme must contain a field named Site Name within its attribute table which contains names for the sampling sites that match those listed in the databases Site Name field. Select the tool once the appropriate theme is made active and then choose the site in the view for which you would like to chart the discharge data. A chart will then appear in the bottom, central half of the view. A message box will appear above the chart asking "Would you like to view the charts table for further manipulation?". If yes is selected the associated table will be imported into the ArcView project and opened. If no is selected the table will not be imported. This script can be manipulated to work with differently defined databases.

Requires: A single theme must be selected. This theme must contain the field Site Name
within its attribute table. A database must have been created with Site Name,
Date(Number), Date and Discharge fields. An ODBC connection must be defined for
this database, referenced by a global variable _ODBC.

Self:

Returns: An XY scatter chart of stream discharge versus time and (when selected) the corresponding table.

Created: Guy Boggs, 20/10/1999

Script 24.

Name: ToolBox.DocActivate

File Name: toolbox_docactiv.ave

Title: Disables the toolbox when the active document is changed to a document other than a view

Topics: Dialog box

Description: Attach this script to the DocActivate property of the dialog box. This script finds the dialog box controls named pHTool, ECTool, TurbidityTool, SolutesTool, SSTool, TotalSSTool, SS>63Tool, BedLoadTool, CrossSectionTool, DischargeTool, PhotoTool and RainFallTool and disables them, whilst it enables the UnselectTool and CloseTool. The UnselectTool is also selected

Requires:

Self: A dialog box

Returns:

Created: Guy Boggs, 18/10/1999

Script 25.

Name: ToolBox.EC

File Name: toolbox_ec.ave

Title: Plots an XY scatter chart of the selected sites stream electrical conductivity (E.C.) versus time

Topics: Charts

Description: Run this script from a tool choice in a DocGUI that supports view documents. The idea behind this script is to allow you to create an XY scatter chart of stream E.C. versus time for a sampling point selected by the user on the view. Since ArcView does not directly support this, this script is necessary.

This script requires that a database has been created which contains a table named SSBaseData. This table must contain information concerning the sampling sites name (field 1 - named Site Name), sample number (named Sample No), date of sample collection (in Number format (field 4) and date format (field 5)) and the E.C. at that point in time (field 9). An ODBC connection must have been established for the database. This connection must be defined within ArcView as a global variable named _ODBC before the script is run. One theme must be active on the view. This theme must contain a field named Site Name within its attribute table which contains names for the sampling sites that match those listed in the databases Site Name field. Select the tool once the appropriate theme is made active and then choose the site in the view for which you would like to chart the E.C. data. A chart will then appear in the bottom, central half of the view. A message box will appear above the chart asking "Would you like to view the charts table for further manipulation?". If yes is selected the associated table will be imported into the ArcView project and opened. If no is selected the table will not be imported. This script can be manipulated to work with differently defined databases.

Requires: A single theme must be selected. This theme must contain the field Site Name
within its attribute table. A database must have been created with Site Name, Sample
No, Date(Number), Date and E.C. fields. An ODBC connection must be defined for
this database, referenced by a global variable _ODBC.

Self:

Returns: An XY scatter chart of stream E.C. versus time and (when selected) the corresponding
table.

Created: Guy Boggs, 21/10/1999

Script 26.

Name: ToolBox.Open

File Name: toolbox_open.ave

Title: When the dialog box is opened, it enable all controls and sets the listeners that will be sent the update event when the closeTool is sent the BroadcastUpdate request.

Topics: Dialog box

Description: Attach this script to the open property on a dialog box. This script enables all controls on a dialog box and defines the set of listeners to be sent the update event when the close button on the dialog box is sent the BroadcastUpdate request.

Requires:

Self: A dialog box

Returns:

Created: Guy Boggs, 18/10/1999

Script 27.

Name: ToolBox.pH

File Name: toolbox_ph.ave

Title: Plots an XY scatter chart of the selected sites stream pH versus time

Topics: Charts

Description: Run this script from a tool choice in a DocGUI that supports view documents. The idea behind this script is to allow you to create an XY scatter chart of stream pH versus time for a sampling point selected by the user on the view. Since ArcView does not directly support this, this script is necessary.

This script requires that a database has been created which contains a table named SSBaseData. This table must contain information concerning the sampling sites name (field 1 - named Site Name), sample number (named Sample No), date of sample collection (in Number format (field 4) and date format (field 5)) and the pH at that point in time (field 11). An ODBC connection must have been established for the database. This connection must be defined within ArcView as a global variable named _ODBC before the script is run. One theme must be active on the view. This theme must contain a field named Site Name within its attribute table which contains names for the sampling sites that match those listed in the databases Site Name field. Select the tool once the appropriate theme is made active and then choose the site in the view for which you would like to chart the pH data. A chart will then appear in the bottom, central half of the view. A message box will appear above the chart asking "Would you like to view the charts table for further manipulation?". If yes is selected the associated table will be imported into the ArcView project and opened. If no is selected the table will not be imported. This script can be manipulated to work with differently defined databases.

Requires: A single theme must be selected. This theme must contain the field Site Name within its attribute table. A database must have been created with Site Name, Sample No, Date(Number), Date and pH fields. An ODBC connection must be defined for this database, referenced by a global variable _ODBC.

Self:

Returns: An XY scatter chart of stream pH versus time and (when selected) the correspoding table.

Created: Guy Boggs, 22/10/1999

Script 28.

Name: ToolBox.PhotoDisplay

File Name: toolbox_photodisplay.ave

Title: Opens a picture in an image window (if it is an X-Bitmap (generated by "bitmap" utility on X Windows), MacPaint Microsoft DIB (Device-Independent Bitmap), Sun raster files XWD (X Windows Dump Format), GIF (Graphics Interchange Format), TIFF (Tag Image File Format), TIFF/LZW commpressed image data) or in a view if it is of the jpg format.

Topics: Images/Views

Description: Run this script from a tool choice in a DocGUI that supports view documents. The idea behind this script is to allow you to view a picture associated with a particular location, as selected by the user. Since ArcView does not directly support this, this script is necessary.

This script requires that a database has been created which contains a table named photos. This table must contain information concerning the sampling sites name (field 1 - named Site Name), photo location pathname (named PathName) and a short description of the photo (named photodescshort). An ODBC connection must have been established for the database. This connection must be defined within ArcView as a global variable named _ODBC before the script is run. One theme must be active on the view. This theme must contain a field named Site Name within its attribute table which contains names for the sampling sites that match those listed in the databases Site Name field. Select the tool once the appropriate theme is made active and then choose the site in the view for which you would like to view the photo. A list will then appear asking the user to select which photo for the chosen site is to be opened. This script can be manipulated to work with differently defined databases.

Requires: A single theme must be selected. This theme must contain the field Site Name within its attribute table. A database must have been created with Site Name, Pathname, and PhotoDescShort fields. An ODBC connection must be defined for this database, referenced by a global variable _ODBC.

Self:

Returns: An image window or view displaying a picture associated with the selected site.

Created: Guy Boggs, 25/10/1999

Script 29.

Name: ToolBox.PSA

File Name: toolbox_psa.ave

Title: Plots a cumulative particle size distribution line chart for bedload samples collected across a selected stream channel on a certain date

Topics: Charts

Description: Run this script from a tool choice in a DocGUI that supports view documents. The idea behind this script is to allow you to create a line chart showing the particle size distribution of bedload samples at various points cross a stream channel for a selected site and date. Since ArcView does not directly support this, this script is necessary.

This script requires that a database has been created which contains a table named BedLoadBaseData. This table must contain information concerning the sampling sites name (field 1 - named Site Name), Date (Date), Sample Number (Number), and Cumulative Particle Size Distribution Fields (named cum% >9,5mm, cum% 4- 9,5mm, cum% 2,36-4mm, cum% 2-2,36mm, cum% 1,4-2mm, cum% 1-1,4mm, cum% 710um-1mm, cum% 500-710um, cum% 355-500um, cum% 250-355um, cum% 180-250um, cum% 125-180um, cum% 90-125um, cum% 63-90um, cum% <63um). An ODBC connection must have been established for the database. This connection must be defined within ArcView as a global variable named _ODBC before the script is run. One theme must be active on the view. This theme must contain a field named Site Name within its attribute table which contains names for the sampling sites that match those listed in the databases Site Name field. Select the tool once the appropriate theme is made active and then choose the site in the view for which you would like to chart the solutes concentration data. A list box will then appear asking for the user to select the date for which the cumulative particle size distribution is to be viewed. A dialog box depicting the line chart options available will appear from which the user can select the most appropriate line style, after which the chart will be drawn. A message box will be shown above the chart asking "Would you like to view the charts table for further manipulation?". If yes is selected the associated table will be imported into the ArcView project and opened. If no is selected the table will not be imported. This script can be manipulated to work with differently defined databases.

Requires: A single theme must be selected. This theme must contain the field Site Name within its attribute table. A database must have been created with Site Name, Sample Number, Date and cumulative particle size distribution fields. An ODBC connection must be defined for this database, referenced by a global variable _ODBC.

Self:

Returns: A cumulative particle size distribution line chart and (when selected) the corresponding table.

Created: Guy Boggs, 23/10/1999

Script 30.

Name: ToolBox.Rainfall

File Name: toolbox_rainfall.ave

Title: Plots an XY scatter chart of the selected sites rainfall versus time

Topics: Charts

Description: Run this script from a tool choice in a DocGUI that supports view documents. The idea behind this script is to allow you to create an XY scatter chart of rainfall versus time for a sampling point selected by the user on the view. Since ArcView does not directly support this, this script is necessary.

This script requires that a database has been created which contains a table named DailyRainfallBaseData. This table must contain information concerning the sampling sites name (field 1 - named Site Name), date of sample collection (in Number format (field 2) and date format (field 3)) and the rainfall at that point in time (field 4). An ODBC connection must have been established for the database. This connection must be defined within ArcView as a global variable named _ODBC before the script is run. One theme must be active on the view. This theme must contain a field named Site Name within its attribute table which contains names for the sampling sites that match those listed in the databases Site Name field. Select the tool once the appropriate theme is made active and then choose the site in the view for which you would like to chart the rainfall data. A chart will then appear in the bottom, central half of the view. A message box will appear above the chart asking "Would you like to view the charts table for further manipulation?". If yes is selected the associated table will be imported into the ArcView project and opened. If no is selected the table will not be imported. This script can be manipulated to work with differently defined databases.

Requires: A single theme must be selected. This theme must contain the field Site Name within its attribute table. A database must have been created with Site Name, Date(Number), Date and rainfall fields. An ODBC connection must be defined for this database, referenced by a global variable _ODBC.

Self:

Returns: An XY scatter chart of rainfall versus time and (when selected) the corresponding
table.

Created: Guy Boggs, 22/10/1999

Script 31.

Name: ToolBox.Solutes

File Name: toolbox_solutes.ave

Title: Plots an XY scatter chart of the selected sites stream solutes concentration versus time

Topics: Charts

Description: Run this script from a tool choice in a DocGUI that supports view documents. The idea behind this script is to allow you to create an XY scatter chart of stream solutes concentration versus time for a sampling point selected by the user on the view. Since ArcView does not directly support this, this script is necessary.

This script requires that a database has been created which contains a table named SSBaseData. This table must contain information concerning the sampling sites name (field 1 - named Site Name), sample number (named Sample No) date of sample collection (in Number format (field 2) and date format (field 4)) and the solutes concentration at that point in time (field 13). An ODBC connection must have been established for the database. This connection must be defined within ArcView as a global variable named _ODBC before the script is run. One theme must be active on the view. This theme must contain a field named Site Name within its attribute table which contains names for the sampling sites that match those listed in the databases Site Name field. Select the tool once the appropriate theme is made active and then choose the site in the view for which you would like to chart the solutes concentration data. A chart will then appear in the bottom, central half of the view. A message box will appear above the chart asking "Would you like to view the charts table for further manipulation?". If yes is selected the associated table will be imported into the ArcView project and opened. If no is selected the table will not be imported. This script can be manipulated to work with differently defined databases.

Requires: A single theme must be selected. This theme must contain the field Site Name within its attribute table. A database must have been created with Site Name, Sample Number, Date(Number), Date and solutes concentration fields. An ODBC connection must be defined for this database, referenced by a global variable _ODBC.

Self:

Returns: An XY scatter chart of stream solutes concentration versus time and (when selected) the corresponding table.

Created: Guy Boggs, 24/10/1999

Script 32.

Name: ToolBox.SS(>63)

File Name: toolbox_ss(63).ave

Title: Plots an XY scatter chart of the selected sites in-stream suspended sediment (>63um) concentration versus time

Topics: Charts

Description: Run this script from a tool choice in a DocGUI that supports view
documents. The idea behind this script is to allow you to create an XY scatter
chart of stream suspended sediment (>63um) concentration versus time for a sampling point selected by the user on the view. Since ArcView does not directly support this, this script is necessary.

This script requires that a database has been created which contains a table named SSBaseData. This table must contain information concerning the sampling sites name (field 1 - named Site Name), sample number (named Sample No) date of sample collection (in Number format (field 2) and date format (field 4)) and the suspended sediment (>63um) concentration at that point in time (field 11). An ODBC connection must have been established for the database. This connection must be defined within ArcView as a global variable named _ODBC before the script is run. One theme must be active on the view. This theme must contain a field named Site Name within its attribute table which contains names for the sampling sites that match those listed in the databases Site Name field. Select the tool once the appropriate theme is made active and then choose the site in the view for which you would like to chart the suspended sediment concentration (>63um) data. A chart will then appear in the bottom, central half of the view. A message box will appear above the chart asking "Would you like to view the charts table for further manipulation?". If yes is selected the associated table will be imported into the ArcView project and opened. If no is selected the table will not be imported. This script can be manipulated to work with differently defined databases.

Requires: A single theme must be selected. This theme must contain the field Site Name within its attribute table. A database must have been created with Site Name, Sample Number, Date(Number), Date and Suspended Sediment Concentration (>63um) fields. An ODBC connection must be defined for this database, referenced by a global variable _ODBC.

Self:

Returns: An XY scatter chart of stream suspended sediment concentration (>63um) versus time and (when selected) the corresponding table.

Created: Guy Boggs, 23/10/1999

Script 33.

Name: ToolBox.SS

File Name: toolbox_ss.ave

Title: Plots an XY scatter chart of the selected sites in-stream suspended sediment concentration versus time

Topics: Charts

Description: Run this script from a tool choice in a DocGUI that supports view documents. The idea behind this script is to allow you to create an XY scatter chart of stream suspended sediment concentration versus time for a sampling point selected by the user on the view. Since ArcView does not directly support this, this script is necessary.

This script requires that a database has been created which contains a table named SSBaseData. This table must contain information concerning the sampling sites name (field 1 - named Site Name), sample number (named Sample No) date of sample collection (in Number format (field 2) and date format (field 4)) and the suspended sediment concentration at that point in time (field 12). An ODBC connection must have been established for the database. This connection must be defined within ArcView as a global variable named _ODBC before the script is run. One theme must be active on the view. This theme must contain a field named Site Name within its attribute table which contains names for the sampling sites that match those listed in the databases Site Name field. Select the tool once the appropriate theme is made active and then choose the site in the view for which you would like to chart the suspended sediment concentration data. A chart will then appear in the bottom, central half of the view. A message box will appear above the chart asking "Would you like to view the charts table for further manipulation?". If yes is selected the associated table will be imported into the ArcView project and opened. If no is selected the table will not be imported. This script can be manipulated to work with differently defined databases.

Requires: A single theme must be selected. This theme must contain the field Site Name within its attribute table. A database must have been created with Site Name, Sample Number, Date(Number), Date and Suspended Sediment Concentration fields. An ODBC connection must be defined for this database, referenced by a global variable _ODBC.

Self:

Returns: An XY scatter chart of stream suspended sediment concentration versus time and
(when selected) the corresponding table.

Created: Guy Boggs, 24/10/1999

Script 34.

Name: ToolBox.Survey

File Name: toolbox_survey.ave

Title: Plots a line chart depicting the selected sites channel cross-section. One chart is plotted for each date a channel cross section was surveyed.

Topics: Charts

Description: Run this script from a tool choice in a DocGUI that supports view documents. This script allows you to create line charts of stream channel cross-sections for the dates surveyed and the site selected by the user on the view. Since ArcView does not directly support this, this script is necessary.

This script requires that a database has been created which contains a table named SurveyBaseData. This table must contain information concerning the sampling sites name (field 1 - named CrosSecID), Date, North Cross Section bearing (NorthCrossSection), East Cross Section bearing (EastCrossSection) and height. An ODBC connection must have been established for the database. This connection must be defined within ArcView as a global variable named _ODBC before the script is run. One theme must be active on the view. This theme must contain a field named Site Name within its attribute table which contains names for the sampling sites that match those listed in the databases Cross Section ID field. Select the tool once the appropriate theme is made active and then choose the site in the view for which you would like to chart the solutes concentration data. A chart will then appear in the bottom, central half of the view. A message box will appear above the chart asking "Would you like to view the charts table for further manipulation?". If yes is selected the associated table will be imported into the ArcView project and opened. If no is selected the table will not be imported. This script can be manipulated to work with differently defined databases.

Requires: A single theme must be selected. This theme must contain the field CrosSecID within its attribute table. A database must have been created with Site Name, Sample Number, Date(Number), Date and solutes concentration fields. An ODBC connection must be defined for this database, referenced by a global variable _ODBC.

Self:

Returns: A line chart channel cross section for each date surveyed and (when selected) the corresponding table.

Created: Guy Boggs, 26/10/1999

Script 35.

Name: ToolBox.TotalSS

File Name: toolbox_totalss.ave

Title: Plots an XY scatter chart of the selected sites in-stream total suspended sediment concentration versus time

Topics: Charts

Description: Run this script from a tool choice in a DocGUI that supports view
documents. The idea behind this script is to allow you to create an XY scatter
chart of total stream suspended sediment concentration versus time for a sampling point selected by the user on the view. Since ArcView does not directly support this, this script is necessary.

This script requires that a database has been created which contains a table named SSBaseData. This table must contain information concerning the sampling sites name (field 1 - named Site Name), sample number (named Sample No) date of sample collection (in Number format (field 2) and date format (field 4)) and the total suspended sediment concentration at that point in time (field 14). An ODBC connection must have been established for the database. This connection must be defined within ArcView as a global variable named _ODBC before the script is run. One theme must be active on the view. This theme must contain a field named Site Name within its attribute table which contains names for the sampling sites that match those listed in the databases Site Name field. Select the tool once the appropriate theme is made active and then choose the site in the view for which you would like to chart the total suspended sediment concentration data. A chart will then appear in the bottom, central half of the view. A message box will appear above the chart asking "Would you like to view the charts table for further manipulation?". If yes is selected the associated table will be imported into the ArcView project and opened. If no is selected the table will not be imported. This script can be manipulated to work with differently defined databases.

Requires: A single theme must be selected. This theme must contain the field Site Name within its attribute table. A database must have been created with Site Name, Sample Number, Date(Number), Date and Total Suspended Sediment Concentration fields. An ODBC connection must be defined for this database, referenced by a global variable _ODBC.

Self:

Returns: An XY scatter chart of stream total suspended sediment concentration versus time and (when selected) the corresponding table.

Created: Guy Boggs, 23/10/1999

Script 36.

Name: ToolBox.Turbidity

File Name: toolbox_turbidity.ave

Title: Plots an XY scatter chart of the selected sites in-stream turbidity concentration versus time

Topics: Charts

Description: Run this script from a tool choice in a DocGUI that supports view documents. The idea behind this script is to allow you to create an XY scatter chart of stream turbidity concentration versus time for a sampling point selected by the user on the view. Since ArcView does not directly support this, this script is necessary.

This script requires that a database has been created which contains a table named SSBaseData. This table must contain information concerning the sampling sites name (field 1 - named Site Name), sample number (named Sample No) date of sample collection (in Number format (field 2) and date format (field 4)) and the turbidity concentration at that point in time (field 10). An ODBC connection must have been established for the database. This connection must be defined within ArcView as a global variable named _ODBC before the script is run. One theme must be active on the view. This theme must contain a field named Site Name within its attribute table which contains names for the sampling sites that match those listed in the databases Site Name field. Select the tool once the appropriate theme is made active and then choose the site in the view for which you would like to chart the turbidity concentration data. A chart will then appear in the bottom, central half of the view. A message box will appear above the chart asking "Would you like to view the charts table for further manipulation?". If yes is selected the associated table will be imported into the ArcView project and opened. If no is selected the table will not be imported. This script can be manipulated to work with differently defined databases.

Requires: A single theme must be selected. This theme must contain the field Site Name within its attribute table. A database must have been created with Site Name, Sample Number, Date(Number), Date and Turbidity Concentration fields. An ODBC connection must be defined for this database, referenced by a global variable _ODBC.

Self:

Returns: An XY scatter chart of stream turbidity concentration versus time and (when selected) the correspoding table.

Created: Guy Boggs, 23/10/1999

Script 37.

Name: ToolBox.Update

File Name: toolbox_update.ave

Title: Enables the dialog box when the broadcast update is sent

Topics: Dialog box

Description: Attach this script to the update property of listening controls on the dialog box.

Requires:

Self: The control

Returns:

Created: Guy Boggs, 25/10/1999

APPENDIX 3: MASTER DATA LIST

The existing ***eriss*** spatial database in Jabiru contains approximately 12Gbytes of data, including thematic coverages, aerial photography, satellite imagery and DEM data. The base GIS consists of the topographic 1:250000 digital data product produced by AUSLIG (which includes layers of drainage, waterbodies, roads etc) with some of the data available at 100k scale. Additional data layers are related to individual projects and have been obtained in the field or from aerial photography or other imagery (Bull, 1999). ***eriss*** also has access to a comprehensive satellite imagery archive stored at the Environmental Resources Information Network (ERIN) in Canberra, details of which are available through the internet.

The master data list provided is a composite of all data entities (features) and their attributes that have been identified as necessary to achieving the goals of this project. This list is represented by Table A3.1.

Table A3.1: This table provides a master data list of the data required to achieve the goals of this project. Within the location column, the prefix G = H:\geomorphology\ geographic\geographic66 whilst the prefix U = H:\geomorphology\utm\utm66.

Name	Type	Location	Description
Nt.shp	Vector: Line	G \ntclipped	An outline of the Northern Territory
Nt10mroads.shp	Vector: Line	G \ntclipped	NT clipped version of 1:10 million scale roads
Nt2p5roads.shp	Vector: Line	G \ntclipped	NT clipped version of 1:2.5 million scale roads
Ntgeol.shp	Vector: Polygon	G \ntclipped	NT clipped version of Auslig's 1:250 000 scale geology
Nthydro2p5m.shp	Vector: Line	G \ntclipped	NT clipped version of Auslig's 1:2.5 million scale drainage
Ntpopplace.shp	Vector: Point	G \ntclipped	NT clipped version of Auslig's 1:2.5 million scale populated places
Ntsoils.shp	Vector: Polygon	G \ntclipped	NT clipped version of Auslig's 1:250 000 scale soils
Nttenure_250k.shp	Vector: Line	G \ntclipped	NT clipped version of Auslig's 1:250 000 scale tenure

Ntveg.shp	Vector: Line	G \ntclipped	NT clipped version of Auslig's 1:250 000 scale vegetation
Topendclip.shp	Vector: Line	G \ntclipped	Clip of the Northern Territory top end region
Topendrivers.shp	Vector: Line	G \ntclipped	Top end clipped version of Auslig's 1:250 000 scale rivers
Magela.shp	Vector: Polygon	G:\project	A detailed map of the vegetation of the Magela Floodplain
Town.shp	Vector: Points	G: \project	Oenpelli, Jabiru and Darwin town locations
Drainage.shp	Vector: Line	U: \arrgis	Kakadu N.P. clipped version of Auslig's 1:250 000 scale drainage
Approxmine.shp	Vector: Point	U: \project	Approximate location of the Jabiluka mine site
Catchsamples.shp	Vector: Point	U: \project	Location of the Swift Creek geomorphology project sample sites
Crosssections.shp	Vector: Point	U: \project	Cross Section locations in the Swift Creek catchment.
Demstreams6.shp	Vector: Line	U: \project	Swift Creek catchment streams derived from DEM
Dgpsaistreams.shp	Vector: Line	U: \project	Central channel reaches of Swift Creek catchment collected using DGPS and AI interpretation techniques
Jml.shp	Vector: Polygon	U: \project	Jabiluka Mineral Lease boundary polygon
Kakbound.shp	Vector: Polygon	U: \project	Kakadu National Park boundary (with internal sections)
Roads2.shp	Vector: Line	U: \project	Section of Oenpelli Rd passing Jabiluka Mine

Easttribcatch	Vector: Polygon	U: \project	Catchment up stream of East Trib sampling station
Escarp2	Vector: Polygon	U: \project	Areas of escarpment around the Magela Creek and Pit 1 site
Nthtribp	Vector: Polygon	U: \project	An elevation point file of the north Tributary catchment
Swiftescarp	Vector: Polygon	U: \project	Areas of escarpment and lowland in the Swift Creek catchment
Swiftmcatch	Vector: Polygon	U: \project	Catchment upstream of the Swift Creek Main sampling site
Upmaincatch	Vector: Polygon	U: \project	Catchment upstream of the Up Main sampling site
Dem25	Grid: 25m	U: \project	Swift Creek DEM with grid cell resolution of 25m
Dem5	Grid: 5m	U: \project	Swift Creek DEM with grid cell resolution of 5m
Dirg3	Grid: 5m	U: \project	Flow direction grid of the Swift Creek catchment
Eastcatchg	Grid: 5m	U: \project	Catchment up stream of the East Trib sampling site
Flowaccum	Grid: 5m	U: \project	Flow accumulation grid of the Swift Creek catchment
Hillg1	Grid: 5m	U: \project	A hillshade grid of the Swift Creek catchment
Nthtribg2	Grid: 5m	U: \project	An elevation grid of the North Tributary catchment
Swiftcatchg	Grid: 5m	U: \project	The catchment upstream of the Swift Creek sampling site
Upmaincatchg	Grid: 5m	U: \project	The catchment upstream of the Up Main sampling site
SwiftCreek.mdb	Attribute: Database	H:\geomorphology \general	Microsoft Access Database of data emanating from the Jabiluka Study

APPENDIX 4: DGPS AND DEM DATA

A4.1 dGPS Data

The ability of GIS to store and analyse vector data represents one of the prime reasons for the high level of attention paid to GIS over the past 30 years (Lam and Swayne, 1993). The vector database established for ***eriss*** chiefly consists of the Topo-250k digital data product produced by AUSLIG (which includes layers of drainage, waterbodies, roads etc) with some of the data available at 100k scale. Additional data layers are related to individual projects and have been obtained in the field or from aerial photography or other imagery (Bull, 1999). As much of these base vector data are too coarse for investigations at the Jabiluka project scale, the primary vector data source is from DEM/remote sensing derived products and dGPS acquired data.

Many public and private agencies involved in the environmental impact assessment process are turning to GPS and GIS technologies to deliver precision at an acceptable cost and a refined database essential to intelligent assessment of environmental impacts (Rodbell 1993). dGPS provide a cost effective, accurate source of raw geographical information valuable in the mapping, field data collection and GIS database construction phases of the geomorphological impact assessment process (Cornelius et al., 1994). dGPS, along with aerial photography interpretation, has been successfully used in initial channel reach characterisation and geomorphic mapping of the Swift Creek catchment (Saynor pers comm., 1999). This characterisation of the catchment will enable the identification of sites most likely to be affected by mining impact and will allow the detection of possible geomorphologic imbalances resulting from mining activities at Jabiluka. dGPS information has also been collected on knick-point migration rates. GIS analysis of these snapshot datasets will provide vital information on quantifying mining impact on gully formation and extension rates. The use of dGPS to geo-reference field sites is crucial to the GIS-centred data management approach as all data are linked to a spatial location, facilitating the incorporation of all field project data into the information management system.

A4.2 DEM Data

Raster data obtained by the Rehabilitation of Mine Sites group for the Jabiluka impact project primarily consists of a Digital Elevation Model (DEM) grid, constructed from 1:30,000 pre-mining (1991) aerial photography, and remotely sensed imagery (including Aerial photography, Landsat TM and MSS imagery) (Figure A4.1). Raster data sets are generally composed of large amounts of data and thus require large and well-organised data banks as well as user-friendly data processing hardware and software. A GIS offers a highly suitable opportunity for efficient storage, retrieval and analysis of large raster data sets (Schultz, 1993).

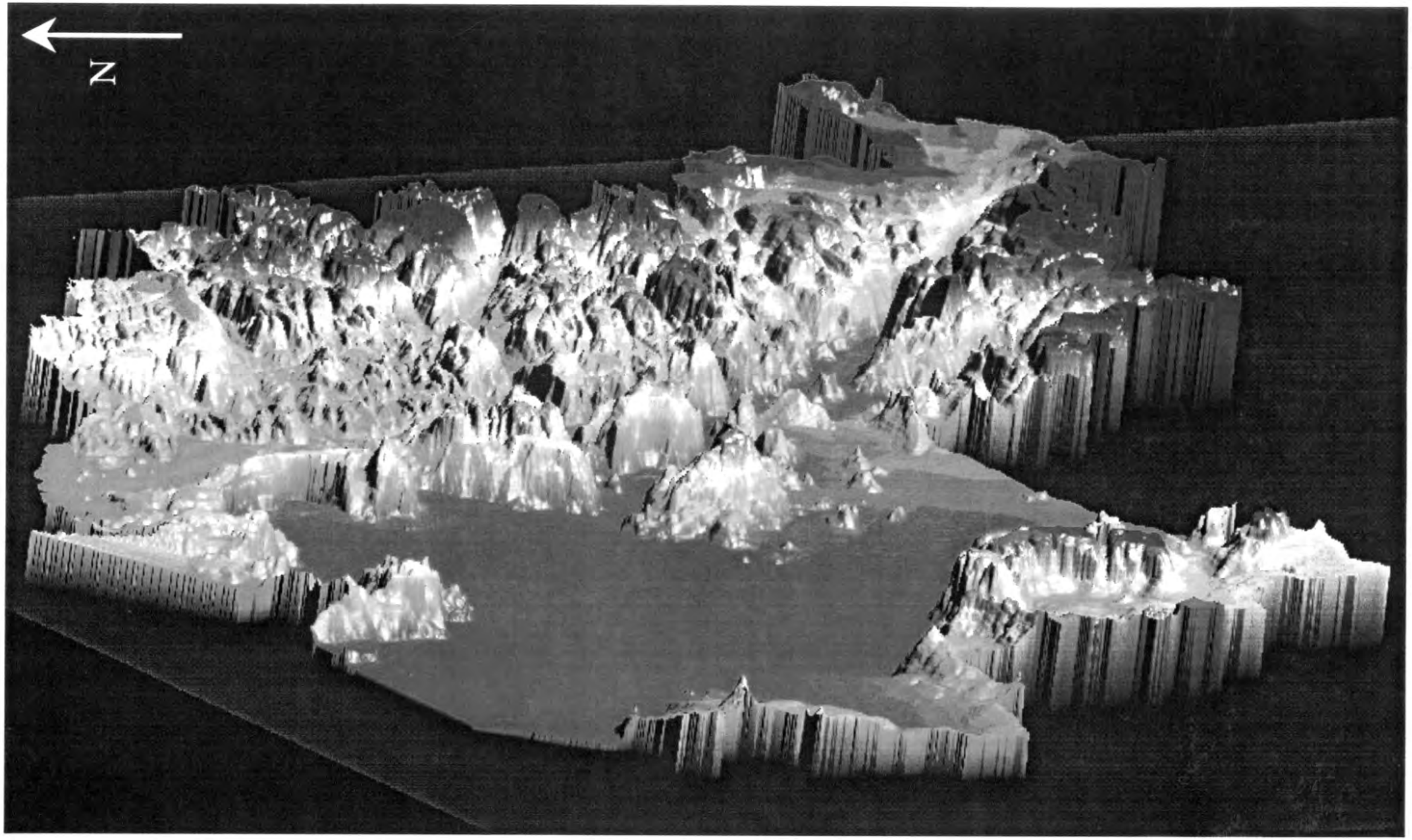


Figure A4.1: A 3-D perspective of the Swift Creek DEM, looking over the Jabiluka outlier, up the Swift Creek catchment.

One of the great advantages of using DEM and remote sensing derived data in hydrological and geomorphological studies is that more spatially variable information can be obtained, as opposed to the more common point data (eg rain gauges) (Schultz, 1993). The DEM constructed for this project covers the Swift Creek catchment. DEMs are currently used in many geomorphologic studies as they allow the extraction of terrain and drainage features to be fully automated and have been used to delineate drainage networks and watershed boundaries, to calculate slope characteristics and to produce flow paths of surface runoff (Moore et al., 1991, Quinn et al., 1992). Remotely sensed imagery, on the other hand, is considered to be a rapid and flexible method for obtaining updated data. Remotely sensed images are easily stored and interpreted in a GIS (Al-Ankary, 1991). Maintaining a GIS as the central data management system allows DEM and remote sensing derived data to be directly linked to data emanating from the other four categories of data collected for this project. These data, therefore, are useful in the examination and explanation of the low and high temporal resolution spreadsheet data and provide direct inputs into the hydrology and landform evolution models. Further analysis of the modelled output DEM within the GIS will enable temporal and spatial variations in mining impacts on landform evolution to be detected.

The inability of DEMs to capture small variations in elevation in low relief landscapes is recognised as an important issue throughout many hydrological and geomorphological investigations. Within the Swift Creek catchment almost half of the area is occupied by low relief, non-escarpment country. As a result of this situation, the Swift Creek catchment DEM has been found to have trouble predicting the location of stream channels within the lowland area. This problem will be compounded during the application of hydrological and geomorphological models to this DEM. A method for correcting this error has been proposed and initial attempts have been made to correct the DEM through its application. This method involves accurately mapping the location of creek lines through the use of both aerial photographic interpretation and dGPS ground mapping. A map of the primary creek lines located on the Swift Creek floodplain has been produced through the application of this method and is available in H:\geomorphology\utm\utm66\project\ dgpsaistreams.shp. This map has been compiled from the on-screen digitising of a georeferenced ortho-photo and the dGPS mapping of parts of Swift Creek, North Tributary, Central Tributary, South Tributary and Tributary West by Michael Saynor (***eriss***) and Bryan Smith (***eriss***). This creek line map will be used in the interpolation of a hydrologically correct DEM of the Swift Creek catchment.

The Swift Creek DEM has been used in the derivation of a number of raster grids and, through the vectorisation of these grids, vector coverages. The flowchart shown in Figure 8 describes the basic set of processes used in the derivation of the grid datasets. The primary grid datasets resulting from the application of various functions to the Swift Creek DEM include a hill shaded grid, an escarpment grid, a flow direction grid, a number of catchment grids, a flow accumulation grid and a stream grid. The location of these grids can be found in the master data list (Appendix 3).

APPENDIX 5: METADATA

Metadata are commonly defined as being 'data about data'. Metadata describe the content, quality, condition and other characteristics of data and help a person to locate and understand data (USGS, 1994). The presence of accurate metadata is especially important with regard to GIS and related data sets due to the large amounts of original and derived data commonly involved with such projects. The metadata database compiled for this project, adapted from Schweitzer (1998), has been devised as a simple, user friendly database to encourage all users to maintain an accurate and up to date metadata. This database is designed to work with the more detailed ***eriss*** database which is based on the ANZLIC metadata standards (Bull, 1999). Metadata standards documents, such as these ANZLIC metadata guidelines, tend to emphasise many of the fine details of geospatial data. However, whilst these serve a useful purpose for government departments and large organisations they can be overwhelming, or even irrelevant, at the small project level where metadata is still very important but rigid adherence to standards may not be practical. The questions associated with the final project metadata database therefore do not necessarily cover all the metadata fields in the various standards but convey in plain language the basic information needed at the outset about each dataset to be used in a given project (Devonport pers. comm., 1999).

The data entry form prepared for the metadata database is shown in Figure A5.1. As shown in this figure, the questions asked can be grouped into six major categories, which together give an overall description of the content, quality, condition and location of the data. These categories are (1) Existing Metadata – enabling the user to check whether there is existing metadata and where it can be located; (2) Dataset Description – providing a sound description of the spatial, temporal and attributal nature of the dataset; (3) Dataset Producers/Owners – allowing the user to view who to get in contact with regarding further information on the dataset; (4) Reasons for Dataset Production – providing contextual information on the dataset and alternative sources of further information; (5) Dataset Production Methods – information concerning how the dataset was produced can be used in the identification of potential sources of error and the production of other, similar datasets; (6) Dataset Reliability – describing what errors exist in the horizontal, vertical and attribute information contained within the dataset. This database therefore provides sufficient information at the project level of data management to ensure future users have a good understanding of the data generated during this project and where it can be located. This metadata entry form can be accessed directly from a button located on the GIS view menu bar.

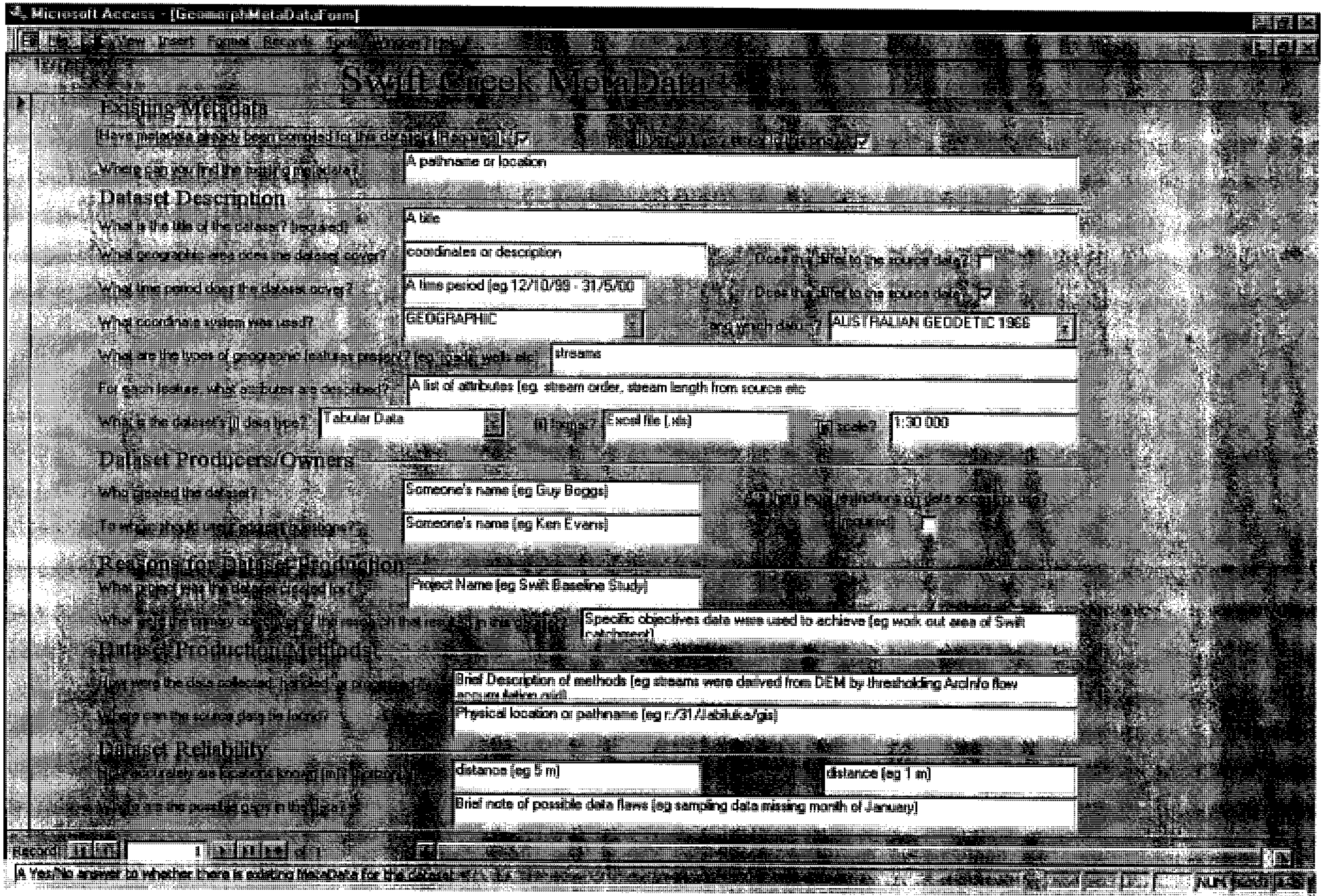


Figure A5.1: The user-friendly data entry form used for entering data into the metadata database

APPENDIX 6: DIRECTORY STRUCTURE

The GIS network path is GISData on 'GIS' and should be mapped as H: drive. The top level directory structure of the existing ***eriss*** spatial database is composed of a number of directories. The directories which are specifically connected with this project are;

- utm and geographic directories which contain the base GIS data organised by projection, datum and spatial extent

- project directories (including geomorphology, wetland and enrad) which are directories designed to accommodate all data associated with specific GIS projects within each of these groups at ***eriss***

- metadata directory containing all metadata databases (including the project level metadata databases as well as the ***eriss*** base GIS metadata database

The directory structure of the geomorphology project directory has been designed with specific consideration of the base ***eriss*** GIS directory structure. The directory structure of the geomorphology project directory is shown in the diagram below (Figure A6.1). The 'General' sub-directory is a generic sub-directory that contains variable format files related to the project. The 'geographic' directory is modelled on the top level geographic directory of the ***eriss*** GIS, containing all spatial data projected in geographic coordinates. The sub-directories within the geographic directory organise the data based on datum (AGD66 or WGS84) and spatial extent (NT, arrgis and project scale). The 'phdproject' directory provides an area within the GIS directory for data directly associated with the project 'Application of GIS to the Assessment and Management of Mining Impact', but not yet available for use within other ***eriss*** projects. The 'projects' directory contains ArcView projects created specifically for the Rehabilitation of Mine Sites group. The 'Temp' directory is available for the creation of temporary files. However, this directory will be emptied on a relatively regular basis. The final directory directly under 'geomorphology' is the 'utm' directory which, like the geographic directory, is modelled on the top level utm directory of the ***eriss*** GIS. The directory therefore contains all spatial data projected using the Universal Transverse Mercator (UTM) projection. These data are again organised within this directory based on its datum (AGD66 and WGS84) and spatial extent (NT, ARRGIS and Project). Within these directories and sub-directories there often exist 'info' directories. The 'info' directories are associated with ARC/INFO workspaces, storing the INFO database for the set of coverages and grids found within the directory or sub-directory.

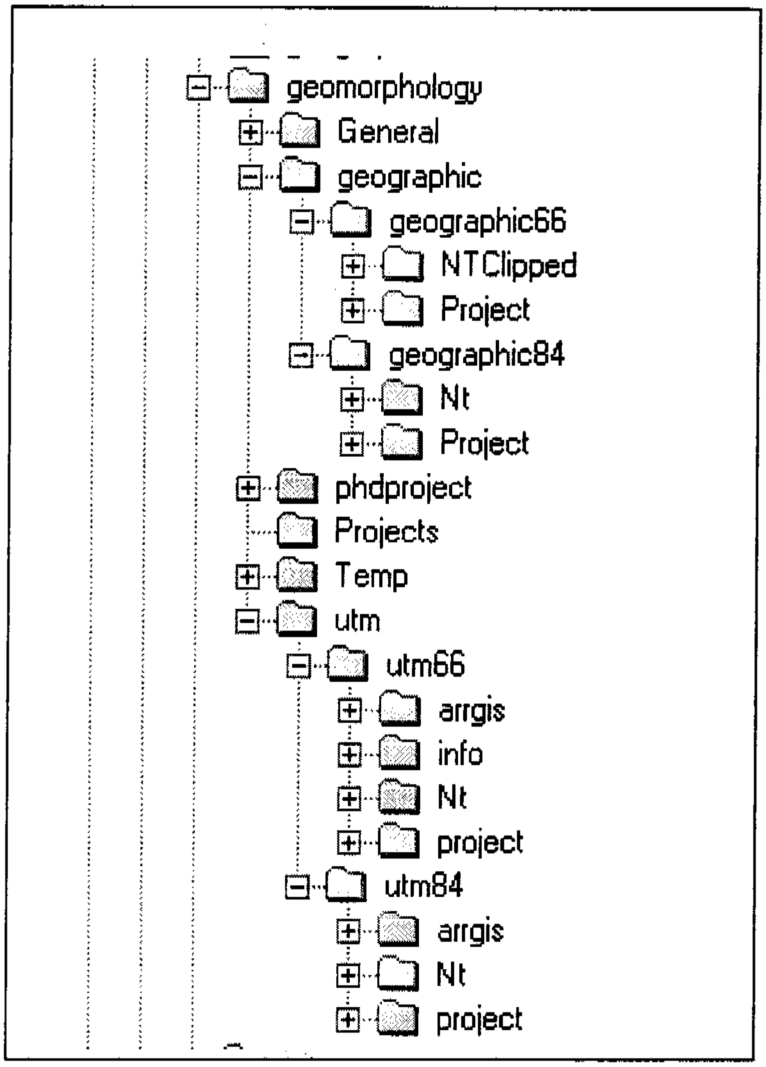


Figure A6.1: A diagram showing the directory structure of the geomorphology directory on the eriss base GIS – all spatial data are stored within the 'geographic' or 'utm' directories, depending on its projection.