# Geo-Database Modelling Using CASE tools

## Design, Modelling and Documentation of the NZERN Geo-databases

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CONTENTS

# 1 PROJECT DESCRIPTION

The project carried out from Nov-Dec 2005 as a part of an internship at the New Zealand Ecological Restoration Network Inc. ***[NZERN]***, Christchurch, New Zealand focussed on the development of a conceptual geo-database structure for several Personal Geo-databases, transfer of the conceptual model into a physical model in ArcCatalog for further migration in ArcSDE (scheduled for 2006), as well as documenting of the Geo-database design using MS Visio.

# 2 OBJECTIVES

The scope of the project made it necessarily to divide the workload up into manageable parts which are supplementary to each other. Following objectives define the main steps that had to be carried out to accomplish the given task.

**Objective I:**

Developing a logical geo-database model from the real world model, already available on the ***NZERN*** server

**Objective II:**

Modelling the physical model in MS Visio using ***UML***

**Objective III:**

Transfering the UML model in ArcCatalog using the ***CASE*** tool schema wizard

**Objective IV:**

Modelling topology rules in ArcCatalog

**Objective V:**

Documenting the Geo-database design using the ***ESRI*** Geo-database Diagrammer

# 3 METHODOLOGY

## 3.1 Literature Review

The first step in getting into the topic was scoping the literature available on the web as well as in the NZERN and University libraries. The literature reviewed did not merely cover topics such as geo- database design, but also more specific publications about the ArcHydro Model itself. A detailed list of all the reviewed and used literature is included in the appendix.

The most important document has been the ArcHydro book, as it includes all the relevant information about the particular components of the ArcHydro model which has been used as a template to develop one of the NZERN Geo-databases, the hydrography one.

## 3.2 Exploring Datasets available on the NZERN server

One crucial step in the whole project process was taking a decent look at the already existing data structure on the NZERN server in order to gain a better insight into the organisations structure, tasks, as well as potential requirements for the geo-database layout to be developed. A list of all the datasets with all the relevant shape files, tables, etc. has been available in one MS Excel spreadsheet that provided a good overview about the status quo.

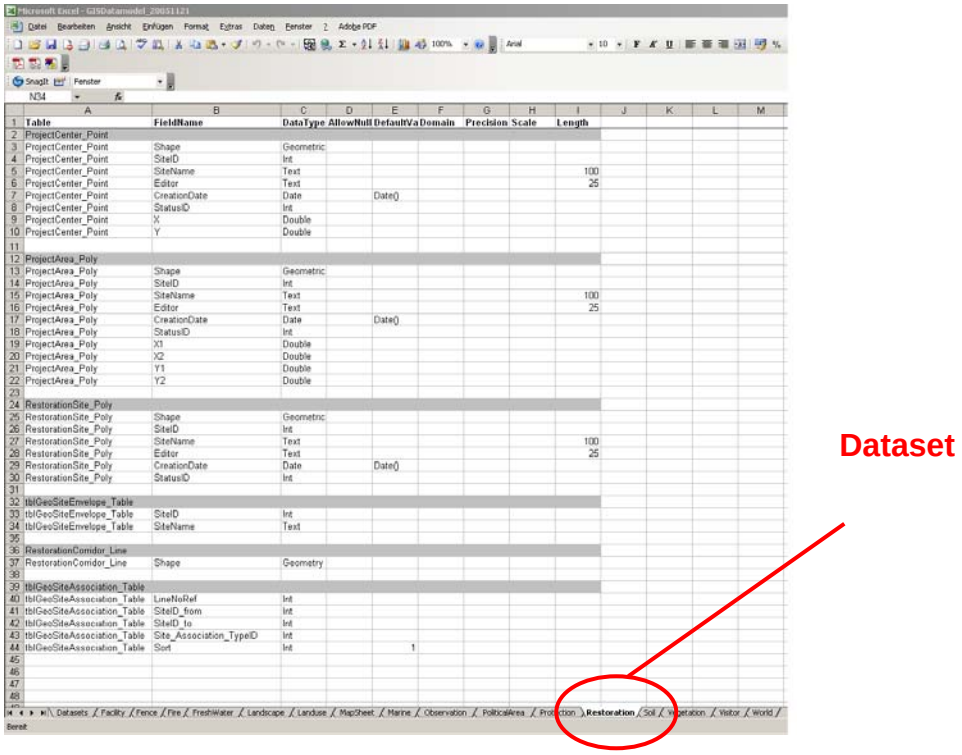



**figure 1: NZERN GIS-data**

## 3.3 Regular group meetings and discussions among group members

Another key component of the work was the collaboration within the team in order to sort out questions and issues regarding the expected design, functionalities and most important correct interpretation of the real world into the Geo-database model.

Conclusive one can say that ongoing collaboration and adjustments to the model according to the meeting's outcomes is a crucial step for a well developed geo-database design.

## 3.4 ESRI Virtual Campus Courses:

Using CASE Tools to create geo-database designs in Microsoft Visio is an advanced tool and requires basic knowledge about the use of MS Visio as well as general geo-database design. Following three courses/workshops have been very useful to gain the necessary knowledge, respectively becoming more confident with geo-database design, in particular.

### 3.4.1 Using CASE Tools

Course Overview in reference to the ESRI Virtual Campus website:

"*Computer Aided Software Engineering (CASE) tools provide the ArcGIS user an efficient means to design and create geodatabases. CASE uses the Unified Modeling Language (UML) to create elements that represent geodatabase components such as feature datasets, feature classes, and tables. In a modelling environment, such as Visio, you are able to assign properties to your database components and build necessary associations to model the geodatabase structure. Using CASE offers several advantages: different portions of the design can be built in different drawing diagrams; the design is documented and can be shared with others; and the geodatabase schema can be updated easily by reapplying the model*."[1]

This course, which consists of presentation and software demonstration as well as exercises and Q&A sessions, can be completed by passing an exam. The course is designed for an audience of GIS data modellers, database designers, and analysts "who want to learn how to construct geodatabase schemas that fit their specific application needs."[2]

[11] http://campus.esri.com, retrieved on the 20/12/2005

[2] ibid

### 3.4.2 Creating, Editing, and Managing Geodatabases for ArcGIS 9

This course focuses on how to work within a geo-database environment in ArcCatalog, creating a geo-database from scratch as well as how to add and edit features or behaviour to/in a geo-database. This course is designed as a workshop with sample data to carry out real world exercises.

Overall this course covers a wide range of topics related to geo-database design and can be recommended for everyone who wants to become more proficient with the functionalities of ArcCatalog in managing geographic data within a personal geo-database.

### 3.4.3 Working with Geodatabase Precision and Spatial Domain

"*This seminar explains how to determine appropriate precision and spatial domain values given the real-world accuracy of your data and how to specify those values when adding data to a geodatabase. The seminar also discusses how precision and spatial domain are maintained by the geodatabase and how they affect the overall GIS environment.*"[3]

Having a good knowledge about spatial domain and precision is very important and a lack thereof can result in hours of work further down the track when data with a greater extent should be added to the geo-database.

## 3.5 Use of online support systems

The support website from ESRI International as well as the GIS user New Zealand forums are a viable part of every act of solving a GIS related problem. Due to the international network of GIS specialists most of the questions can be answered by other GIS users or can be found in the ESRI online support systems itself, which contains numerous documents about how to tackle common issues.

The relevant threads that helped to accomplish the task are further explained in section 5 of this document.

[3] http://campus.esri.com, retrieved on the 20/12/2005

## 3.6 Documenting database design using the Geodatabase-Diagrammer

Maintaining a standardises documentation of the developed geo-database design to communicate the results to other team members without any knowledge about CASE tools or UML models is also a considerable part when creating a geo-database design for any particular organisation. With the Geo-database Diagrammer, downloadable from the ArcScripts website, ESRI provides a forceful tool to visualise any geo-database design using corporate design standards, as one can see in the ESRI press books.

This tool has been used to create a MS Visio diagram of the developed geo-database, its feature datasets, classes and even relationships and has been further customised in Corel Draw to match certain design criteria and needs for additional information.

The diagrammer is available for no costs from the ArcSripts website and merely requires a licensed copy of Microsoft Visio Professional 2002 or later.

Following URL links to the download site
http://arcscripts.esri.com/details.asp?dbid=13616&td=1

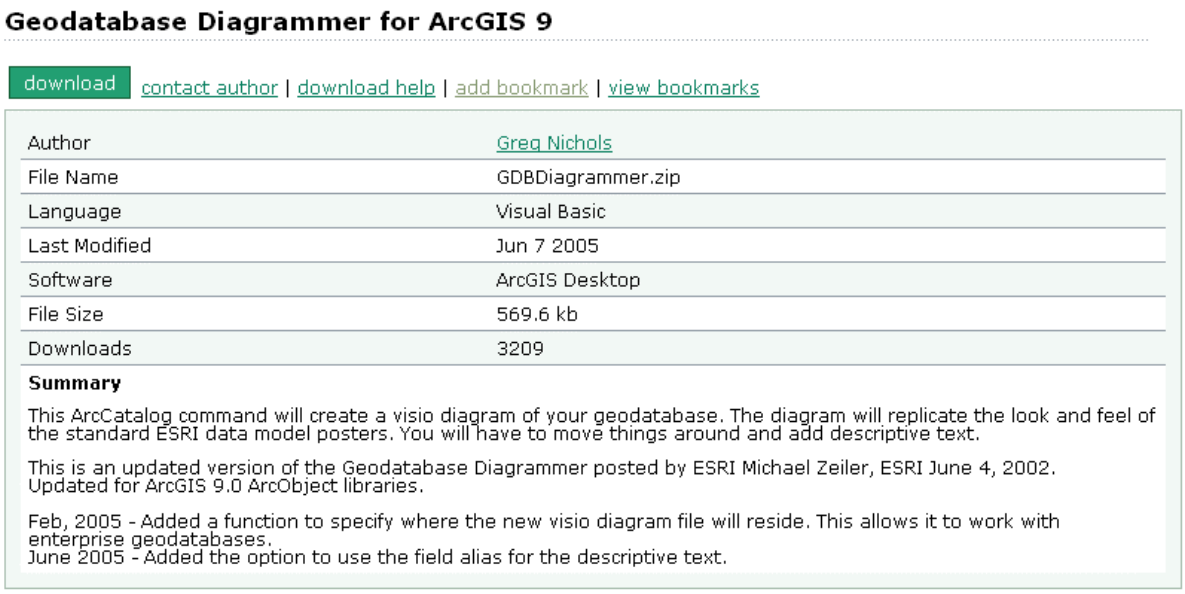



**figure 2: geo-database diagrammer**[4]

[4] http://arcscripts.esri.com/details.asp?dbid=13616&td=1, retrieved on 18/12/2005

# 4 NZERN GEO-DATABASE MODELS

Following three models have been developed and applied to ArcCatalog as a part of the internship at NZERN. More models are to come for further migration into ArcSDE in 2006. The models are generally described, in terms of purpose and data structure. For more detailed information about the data models, please look at the relevant data model posers, respectively literature, when referenced.

## 4.1 Hydrography

### 4.1.1 Purpose

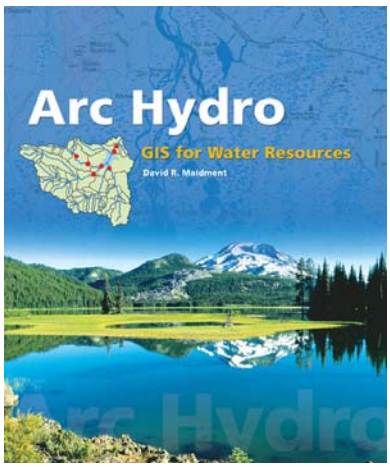
The first and most sophisticated model to develop and adjust was the “hydrography” model based on the ArcHydro model template and linked to the “freshwater” dataset available on the NZERN data server. The ArcHydro model has been developed by ESRI in order to maintain water resources. The model focuses on surface water with input from key state, national, and international contributors.[5]

### 4.1.2 Data structure

According to the template the model includes following feature datasets, which can also be seen in the model documentation:

- Channel
- Drainage
- Hydrography
- Network

In addition to those datasets several object classes and relationship classes define the spatial relationships of the freshwater systems. All those datasets, relationships, and how it all fits together can be further examined in the book “ArcHydro GIS for Water Resources” which I can highly recommend as a good start in water resource modelling and understanding the GIS interpretation of water flows, etc.




[5] cp. http://support.esri.com, retrieved on 21/12/2005

## 4.2 Observation

### 4.2.1 Purpose

The “observation” model represents sites observed by one or several of NZERN’s volunteers. Depending on the level of accuracy when collecting the data, the observation sites can be points, lines or polygons. In general, those sites could stand for any kind of observation made, such as a water sample location.

### 4.2.2 Data structure

The “observation” data model is not as complex as the “hydrography” model as it merely represents various locations and the link between those locations and a table containing information about the person who carried out the observation and what kind of observation it was. This simple data structure requires only one dataset with a few feature classes and one related table. For further information, see “observation” data model poster.

## 4.3 Restoration

### 4.3.1 Purpose

The “restoration” model contains the spatial representation of NZERN’s restoration sites and also the individual projects within those restoration sites, represented by project areas or if not available just the project centre point. All those project sites have to be within one particular restoration site.

### 4.3.2 Data Structure

The database model consists of merely one feature dataset containing the relevant feature classes for the restoration sites and project sites. Several relationship classes and a topology rule manage the data correctness. For further information, see “restoration” data model poster.

# 5 TROUBLESHOOTING, HINTS AND TIPS

## 5.1 Prerequisites

You need to have a current ArcGIS Editor or Info license as well as a MS Visio Professional 2002 (or later) or Rational Software Corporation's Rational Rose in place to run the CASE tools command in ArcCatalog or to create UML models in MS Visio. All relevant files to install the tool are available on the ESRI support website http://support.esri.com/index.cfm?fa=knowledgebase.documentation.viewDoc&PID=43&MetaID=658
Or just search for "Building Geodatabases with CASE Tools" on the ESRI support website.

## 5.2 Installation steps

#### *INSTALL VISIO 2003 PROFESSIONAL EDITION.*

#### *INSTALL THE ESRI CASE PATCH*

Copy the file ESRI XMI Export.vsl located under the ArcGIS installation folder ...\Program Files\ArcGIS\CaseTools\Utilities.
Paste this file to the Visio 2003 installation folder ...\Program Files\Microsoft Office\Visio11\1033.
Copy ...Program Files\ArcGIS\CaseTools\Utilities\uml.dtd and paste it into the directory to which models will be exported.

#### *INSTALL THE XMI EXPORTER*

Next, you will download a Microsoft patch for the XMI Export process.
From the Microsoft Downloads page, search using the keyword XMI.
http://www.microsoft.com/downloads/search.aspx?displaylang=en
Select the UML to XMI Export download for Visio 2003.
Download the file XMIExprt.exe and unzip.
Copy and paste the file XMIExprt.dll to the Visio 2003 installation folder ...\Program Files\Microsoft Office\Visio11\DLL.
Start Visio 2003 Professional.
Select Tools > Options.
In the Options dialog, select the Advanced Tab and click the File Paths... button.
Select the browse button for Add-Ons field and browse to the Visio 2003 installation folder ...\Program Files\Microsoft Office\Visio11\1033 and click Select.
Click OK to close the File Paths and Options dialogs.
Select Tools > Macros > Security.
On the Security Level tab, change the level to Low and click OK.
Restart Visio 2003 Professional to have changes take effect.

Install the ESRI Visio 2003 template from the zip file (ArcInfoUMLModel.zip) to ..\Program Files\ArcGIS\CaseTools\Uml Models
The template is also available from the support site at http://support.esri.com/index.cfm?fa=knowledgebase.documentation.viewDoc&PID=43&MetaID=658

## 5.3 Introductory tutorial

The best way to get started with the software is to do the tutorials available for free from the ESRI website. Link stated above. This tutorial provides you with enough knowledge to get started on your own model and covers most of the topics you will need to model your very own geo-database. Some of the topics covered are

- Designing the object model
- Exporting a model to XMI
- Adding custom behaviour
- Creating the schema
- Using the custom features in ArcMap

For further information see the CASE_Tools_Tutorial or the ArcGIS 9 documentation "Designing Geodatabases With Visio".

An even better way to get into UML modelling for GIS with CASE tools is the online tutorial, available on the ESRI website. "Using CASE Tools (for ArcEditor and ArcInfo)", which costs US$30.

Hint: You get 40% off through the educational discount, if you're currently enrolled at a University or other organisation providing tertiary education.

## 5.4 “An ERROR occurred while parsing the XML document.”

This error can occur when trying to run the semantic checker in MS Visio in order to validate the developed model. This seems to be a quite common problem as ESRI provides an individual help document for this issues on their support website.

Error Message
Schema Wizard returns an error when importing a XMI file:

"An error occurred while parsing the XML document. Error number : 516"

### Cause

The uml.dtd file does not exist in the same directory as the XMI file.

### Solution or Workaround

The file uml.dtd must be present in the directory that contains the XMI files.

1. Copy the uml.dtd file from the appropriate location. For ArcGIS 8.x, the default location would be C:\ArcGIS\arcexe83\CaseTools\Utilities. For ArcGIS 9.0, the default location would be C:\Program Files\ArcGIS\CaseTools\Utilities.
2. Paste the uml.dtd file in the same folder as the XMI file being used.

## 5.5 “No OBJECT ID and no proper geometry field defined”

Trying to run the semantic checker for one of the models (restoration) the semantic checker log file did give out the message that there is no OBJECTID and that the geometry field has not been defined correctly.

Solution or Workaround
Always check on the correct direction of the arrows linking the inheritance class to the object class. If the arrow is the wrong way, the object class cannot inherit any attributes from the inheritance class, such as OBJECTID or Geometry.

For further information see the ESRI documentation and the tutorial.

## 5.6 Geodatabase Diagrammer

One good possibility to maintain a consistent documentation layout and a high standard of visualisation is the use of the Geodatabase Diagrammer, which allows the user to create standardised Visio diagrams of his or her geo-database layout.

The results can further be changed and modified in Visio or for a more sophisticated design in Adobe Illustrator or Corel Draw. The data model poster available on the ESRI homepage have all been created with this diagrammer and have further been designed in Adobe Illustrator.

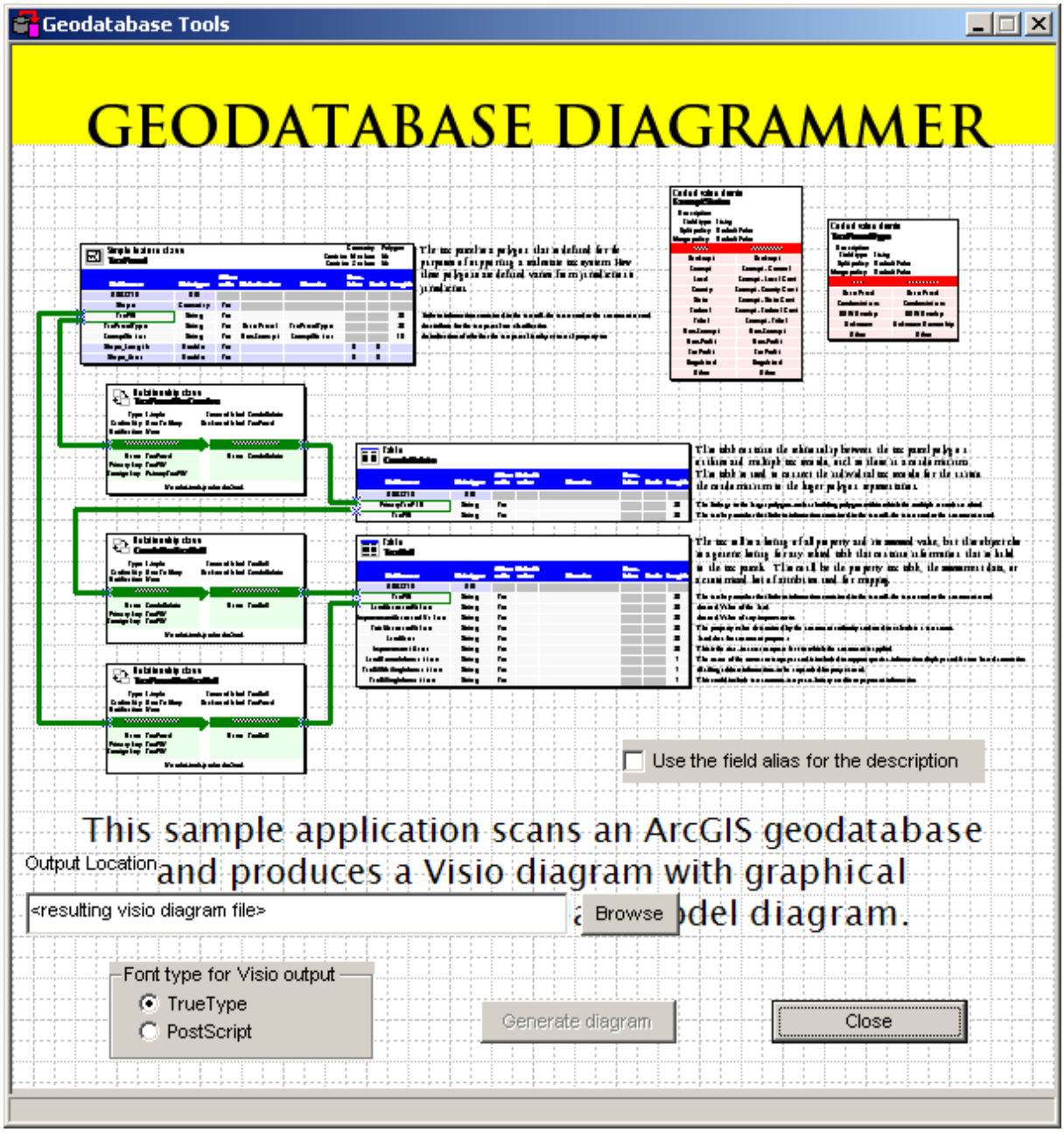



**Figure 3: geodatabase diagrammer start**

The Geodatabase Diagrammer is available for free on the ESRI website. Just go to http://arcscripts.esri.com/details.asp?dbid=13616&td=1

**To run this tool, follow these steps:**

1. You must have Visio 5 or better installed. Go to the PutInVisioStencilsFolder and copy GeodatabaseDiagrammer*.vss and .vst files to your Visio stencils folder. For Visio 5 and Visio 2000, this is likely the c:\Program Files\Visio\Solutions folder. For Visio 2002, it could be Program Files\Microsoft Office\Visio10\1033\Solutions\Visio Extras (These are Visio stencil and template files that the command uses for primitives and layout. One set is for TrueType fonts (for general use) and one for PostScript fonts (for publication).

2. Install and register the GeodatabaseDiagrammer.dll.

3. Start ArcCatalog. Right mouse click on an empty field on the toolbar, choose “Geodatabase Diagrammer”

That creates a blank toolbar. You have to add the command itself to the blank toolbar in a second step.
- Right click on the toolbar
- customize
- go to "command" tab
- go to category "Geodatabase Diagrammer"
- drag and drop the command "Geodatabase Diagrammer" from the window on the right hand side onto your blank toolbar.

4. Then, select a geodatabase. When a geodatabase is selected, the command will be active. Click it.

5. A dialog appears. If you are publishing documentation, select PostScript fonts. Otherwise, select TrueType fonts. Click Generate Diagram.

6. Watch Visio get launched and create graphics of your feature classes and other geodatabase elements
automatically. When done, you'll find a diagram in the same folder as the geodatabase.

# 6 CONCLUSION

Documenting the Geodatabase design is a worthwhile part of each GIS project and can help to achieve greater quality outcomes as well as it provides the user with a tool to distribute and communicate the Geodatabase design to other GIS users as well as to lay people.

CASE tools can help to achieve this objective and are very useful for large and sophisticated databases rather than for small, simple ones. They require the user to have at least basic skills in object oriented modelling and a good overall knowledge about Geodatabase design itself to develop a model that fits a company's needs and is extendable when necessary. In retrospect, it can only be recommended to do extensive study about Geodatabase design and CASE tools (e.g. free tutorial and virtual campus course) before designing the first database from scratch or by customising a given model, such as the ArcHydro or Parcel model template.

One can say, that even for small and simple databases, documenting the final design with the Geodatabase diagrammer is an simple and time efficient step to get a document that can easily be read and understood by other people, even with minor experience in GIS.

# READINGS

## Literature

**Arctur D., Zeiler M.** [2004] Designing Geodatabases, Case Studies in GIS Data Modeling, ESRI Press, Redlands California, U.S.

**Longley et al.** [2005] Geographic Information Systems and Science, ESRI Press, Redlands California, U.S.

**Maidment D. R.** [2002] ArcHydro, GIS for Water Resources, ESRI Press, Redlands California, U.S.

**Zeiler M.** [1999], Modeling Our World, The ESRI Guide to Geodatabase Design, ESRI Press, Redlands California, U.S.

## Web resources

**ESRI Virtual Campus**, http://campus.esri.com

**ESRI User Forum,** http://support.esri.com

**New Zealand ESRI User Group Forums,** http://forums.gisuser.co.nz

**Consortium for GIS in Water Resources,** http://www.crwr.utexas.edu/giswr

# APPENDICES

**Appendix I: Hydrography model poster**

**Appendix II: Observation model poster**

**Appendix III: Restoration model poster**