

Manual

# Using the Nile Basin Spatial Text Library System. An Introduction to Georeferencing and Spatial Querying of digital Text Documents

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# Preface

This training manual introduces a set of new software tools that allows the full integration of qualitative, natural language information, in the form of digital text documents, into a typical GIS environment. The development of these new tools have been motivated by the paradoxical situation, that;

- Probably the biggest part of geographical information in the Nile Basin, still exists in the descriptive form of text documents and yet GIS database systems are widely ignoring these geographical information sources, as they can not appropriately handle the relatively unstructured form in which natural language information is traditionally compiled.

- The oldest known written information in the world, originates from within the Nile Basin and ever since, large amounts of work have been documented throughout the region. However with the ever increasing amount of documents being produced, straightforward identification and access to the most relevant text documents, is becoming an increasing problem.

In order to overcome the above mentioned limitations, the Nile Basin spatial text library allows geographic storage and retrieval of digital, spatial text documents. It combines full text search engine tools with the spatial visualization and analytical powers of Geographical Information Systems. The combined techniques enable a new way of handling and integrating natural language information in the form of text and in conjunction with other qualitative and quantitative spatial data sources. As such this software aims to empower its users with optimal access to information, by taking maximum advantage of integrating multiple source data from variable and complex geographical settings.

This manual has been written for the combined public of library developers and library users. It provides a comprehensive introduction to all interested groups and individuals, by means of a set of self-explanatory exercises. Upon completion of these exercises, the participant will be proficient in using all the system features for developing, accessing and disseminating the Nile Basin Spatial Text Library system.

Of particular interest to the purpose of the “Water Use Survey”, as executed by FAO’s Nile Basin project, is to demonstrate how not only the quantitative information, for example on “irrigation schemes”, can be stored and queried in a GIS system, but that also valuable reports about such schemes can be added to improve the overall informative use of the spatial database compilation.

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# Concepts of a Spatial Text Library

## 1.1 Introduction

This chapter introduces and describes the concepts of a spatial text library. As opposed to other library systems, the spatial text library only deals with geographical text documents. Meaning that its documents always describe phenomena, processes or conditions at one or more specific geographical locations. Through these locations the documents are georeferenced.

Georeferencing is mapping terminology for relating an object to a map by means of real world coordinates. In the case of a spatial text library system, these objects are not traditional cartographical objects, as rivers, town or settlements, but reports in the form of digital text documents.

## 1.2 What is spatial text?

Spatial text concerns all text documents that contain geographic locational references. As such it involves all reports or narratives that in a descriptive manner relate to a condition, event or process in one or more locations on the earth. Spatial text therefore clearly holds one or more geographic place names in such a way that the information or parts of the information specifically refer to these locations.

Not all text is spatial. Typical examples of none spatial texts are thematic documents. These documents rather describe universal processes, object or events for which it is irrelevant where these occur. Many documents however do relate to a specific geographic context and are for example indicated by region, country, district, river valley, irrigation scheme, mountain peak, wetland, national park, town, village, etc.

Within the concept of spatial text there is however also a wider range to the extent of which text documents are spatial. Some documents broadly relate to an entire region, whereas others are very specific by village or even more detailed in geographical location. In order to demonstrate how many text documents in a library collection may be spatial and which spatial extents they may have, some indicative research results are shown in the diagram below.

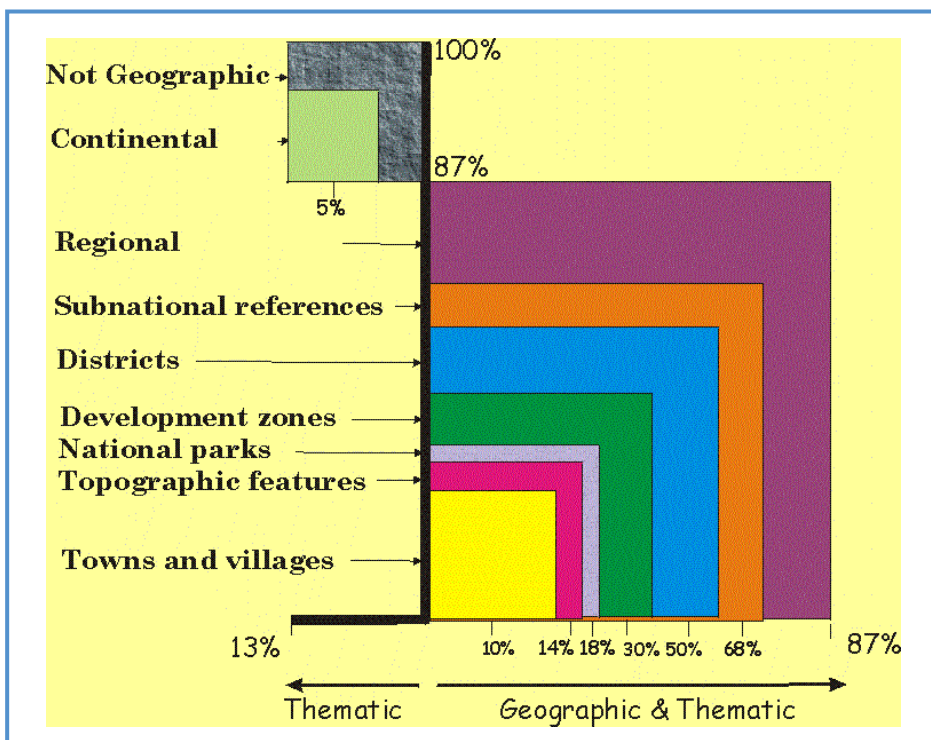


Fig.1 Proportions and scales of geographic information observed in a small document collection.

When a document is of a clear spatial nature as described above, it can in principle be georeferenced. The most direct way to do this, is to find the place names in a gazetteer and use the corresponding latitudal and longitudinal position to relate the document to the map. A gazetteer in this respect is referred to as an extensive list of place names and corresponding geographic coordinates, either with or without a geographical hierarchy for the various features described.

### 1.3 Elements of a Spatial Text Library

Where Geographical Information Systems are generally designed to handle both quantitative and qualitative information, such systems are usually not equipped to handle full text documents. Searches executed under GIS systems are typically deterministic and exact by nature. The field that deals with the processing of full text natural language information is generally referred to as “Information Retrieval” and in contrast is approximate by nature (Rijsbergen, 1979). Information retrieval involves a blend of probabilistic techniques including semantic and heuristic relationships. A series of such techniques is usually involved in the design of successful search engines as for example known from the internet.

A blend of GIS and full text processing capacities techniques, may be referred to as “Qualitative Geographical Information retrieval”. The processing of spatial text that is involved with this is characterised by a series of elements or processing steps, as described below.

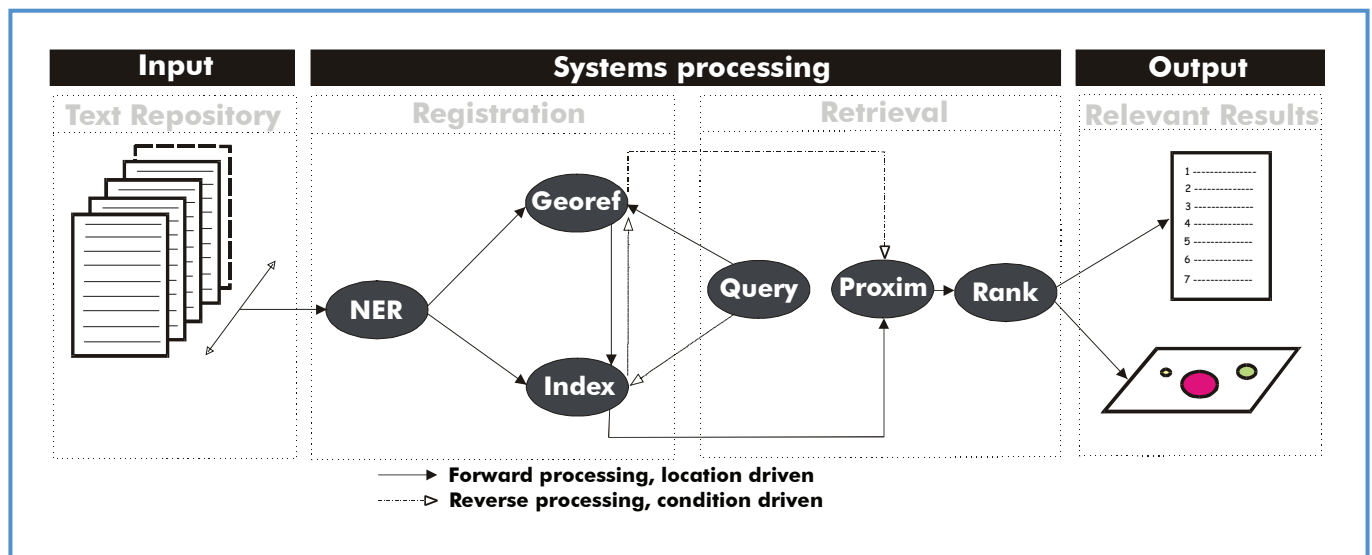


Fig.2 Elements of Qualitative Geographical Information Retrieval . (Source: Rotmans, 2006)

Where the procedure in a very broad sense works like any other system using input, which is processed to output, within the systems processing we may further distinguish a registration and retrieval part. The input is naturally formed by a text repository or library document collection. To engage the collection into processing, it is first required that all words representing geographical names in the documents are recognized. In figure 1 this is also referred to as “NER” or name entity recognition. After the geographic place name has been identified the document may be georeferenced through a gazetteer or in others ways. The third step of the registration deals with indexation and involves the stripping of the text, to remain with the most essential words only. These include the words that may later be used in a keyword search.

The retrieval part includes the “query formulation” after which the systems makes a proximation or a calculation of how probable it is that a document may be relevant to the query. Eventually a ranking takes place based on the probabilities observed. The document with the highest probability is returned as the top document in the search list. The traditional output from a search engine comes as a list of ranked documents and similarly this is also a typical output form in the Spatial text library. However optionally it is also possible to ask such systems for a map output instead of a list in which the size of the symbols can be used to express the relevance of the locations.

The spatial text systems processing, as described in figure 1, forms the ideal basis for a very powerful set of automated tools. However the full automation of figure 1 remains a challenge. While for all the elementary steps some attempts of automation do exist, the challenge remains to effectively and efficiently automate the processing as described in figure 1. Effective thematic query results are characterized by good recall and precision. Precision is measured as the ratio of documents that are retrieved and relevant over the total retrieved. Recall is defined as the ratio of documents that are retrieved and relevant over the total relevant. A good precision means few false alarms and a good recall few false dismissals (Kaufman 1997).

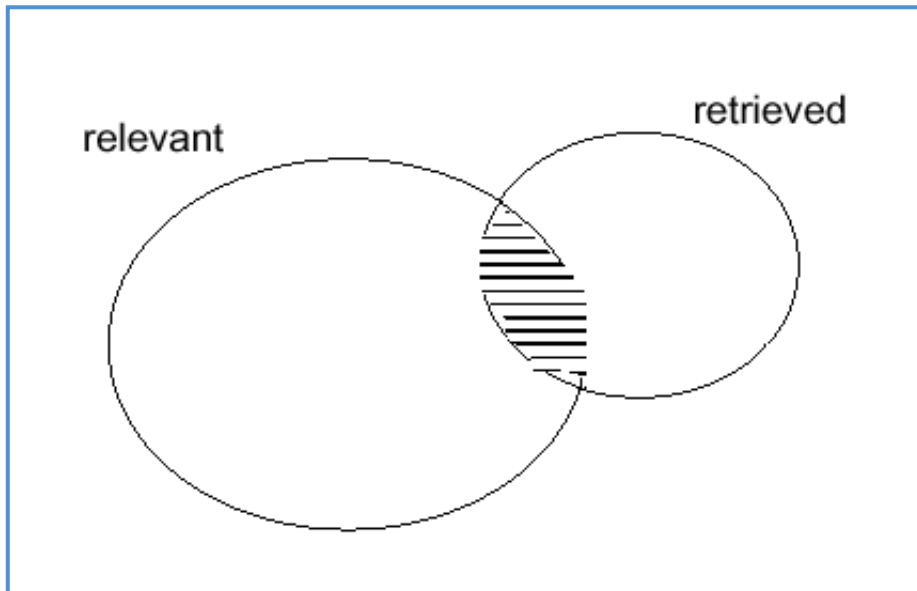


Fig 3 Precision versus recall

For the reasons as described above, effective spatial text libraries, for text volumes at the large sizes as available over the internet do not exist. So far, such volumes can not yet be automated effectively.

Major problems exist in the effective automation of the steps “NER” and “GEOREF” on such scales. One of the challenges lies in the disambiguation of place names. For example are there often more places with the same name and do usually various different ways of spelling exist. Figure 3 gives a broad overview on the uniqueness of geographical place names by continent.

Table 1: Ambiguity in Global place names by continent (source: Smith et al, 2001).		
Continent	Unique names in gazetteer	Multiple names for same place
Europe	83.4 %	18.2%
Africa	81.8%	27.0%
Asia	79.7%	32.7%
South America	75.0%	11.6%
Oceania	70.8%	6.9%
North & Central America	42.9%	11.5%

While the effective full automation of figure 1 for larger text collections remains a challenge, for smaller size libraries there is no problem to already start using these techniques. The Nile Basin Spatial text Library remains with one manual step, which is the name entity recognition or “NER”. The georeferencing step, “GEOREF” has been semi-automated and use a built in gazetteer. All the other steps have been fully automated.

Output is so far in this version of the software only provided in the traditional form of a ranked list of relevant document.

## 1.4 Features and functions of the Nile Basin Spatial Text Library software

The Nile Basin Spatial Text Library software is still in the form of a draft version and is expected to be released soon, as a joint output of NBI and the FAO Nile Basin Project.

The software contains the following library user and developer features:

Library user features:

- User Friendly GIS Interface and interactive Help System.
- Various Thematic Nile Basin Maps.
- Retrieval Interface, combining thematic keywords searches with a Geographic box.
- Ranked Listing of most relevant documents available within the user specified box.

Library developer features:

- A Digital Gazetteer containing +100.000 geographical names for the Nile Basin.
- Simple Tools with flexible options for georeferencing of PDF and HTML documents.
- Built in Tools for Indexation to facilitate effective and rapid full text searches.

Please note that the searchable spatial text archive, will now have to be built and is not available as yet.

The software has so far been tested to operate as a pc-based stand alone version or alternatively as a server based system. Both types of installation are operational. A display of the cd-rom and its file structure is shown below.

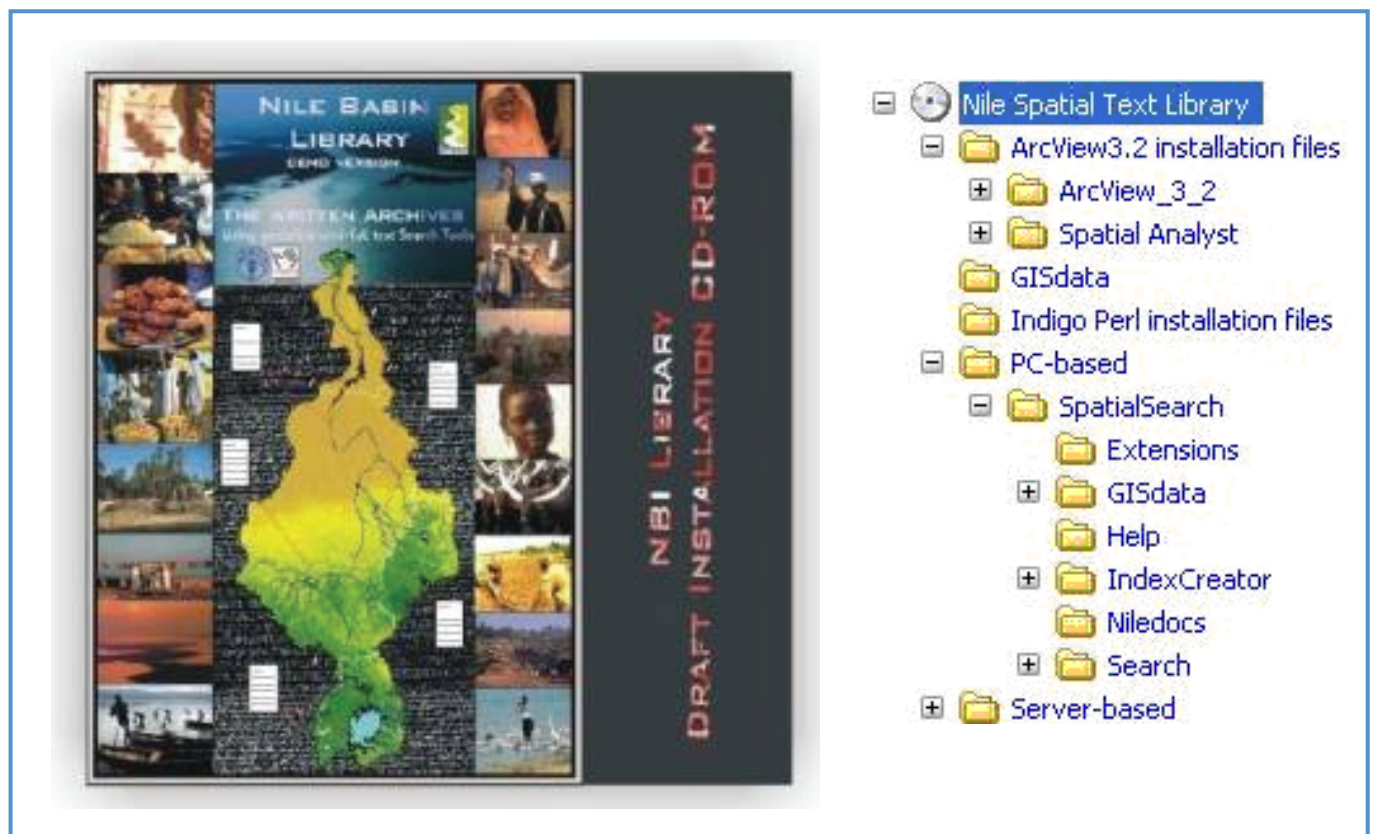


Fig 4 Expected to be released soon. The Nile Basin Spatial Text Library on cd-rom.



# Literature

- Rijsbergen van , C.J. 1979. Information Retrieval. London: Butterworths.
- Rotmans A.F, 2006 Integrating Qualitative and Quantitative Geographical Information Retrieval Part 1; A synthesis of concepts and potentials for spatial text.  
(Not yet published,contact Arjen.Rotmans@faonile.org)
- Rotmans A.F, 2006 Integrating Qualitative and Quantitative Geographical Information Retrieval Part 2; Design and Development of a "GIS-Google".  
(Not yet published,contact Arjen.Rotmans@faonile.org)
- Smith D. A. and Crane G., 2001. Disambiguating geographic names in a historical digital library. In Research and Advanced Technology for Digital Libraries: 5th European Conference, ECDL 2001, Darmstadt, Germany, September 4-9, 2001, pages 127-136.

# Computer Exercises

## Introduction to the exercises

In the following sections of this manual, a set of practical library system computer exercises has been worked out. The exercises have been designed in such a way that they can be completed rather independently, by following step by step instructions.

All text blocks below which are written in *Italic* hold practical instructions on what to do. These italic instructions are intermixed with computer screen cuts, to further clarify and visualize the instructions. Non-italic text blocks are intermixed in the exercises with purely informative or explanatory information, they do not hold any practical instructions or steps.

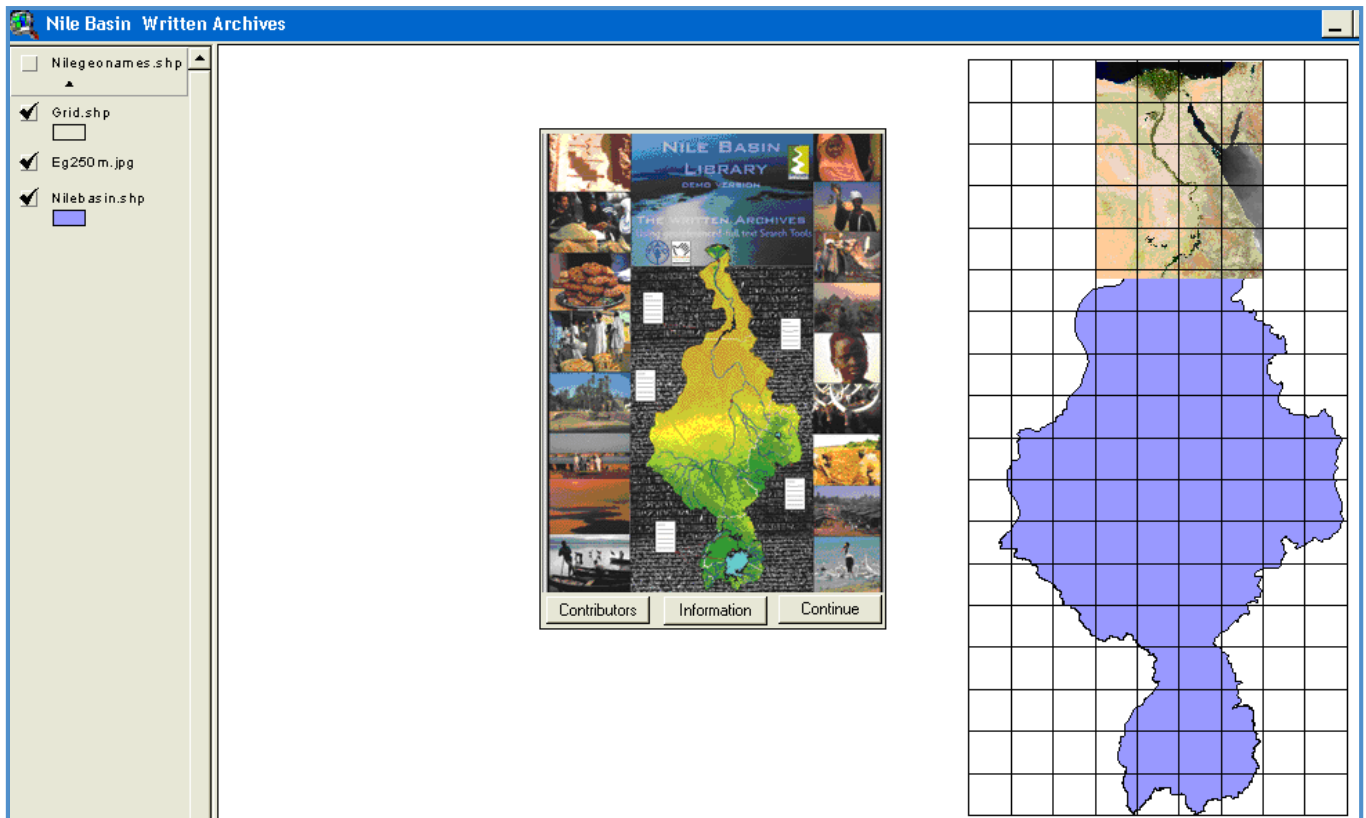
The exercises below make use of the ArcView 3.X GIS software, Internet Explorer and Acrobat Reader. It further uses MsAccess, ODBC data linkage and PERL, with Perl and Visual Basic scripts. Pre-knowledge of the ArcView software is an advantage, but is not strictly required.

## Opening the library and exploring the help system

To open the Nile library system, double click on the "Nile Doc" icon on your computer desktop, as shown below.



The system will automatically open the ArcView project file called "spatialsearch.apr". This project file contains a series of maps as well as a unique Arcview extension file called "spatialsearch.avx". This extension was specifically developed in avenue script, for this Nile Basin Spatial Text Library System. A typical example of the opening screen is shown below.

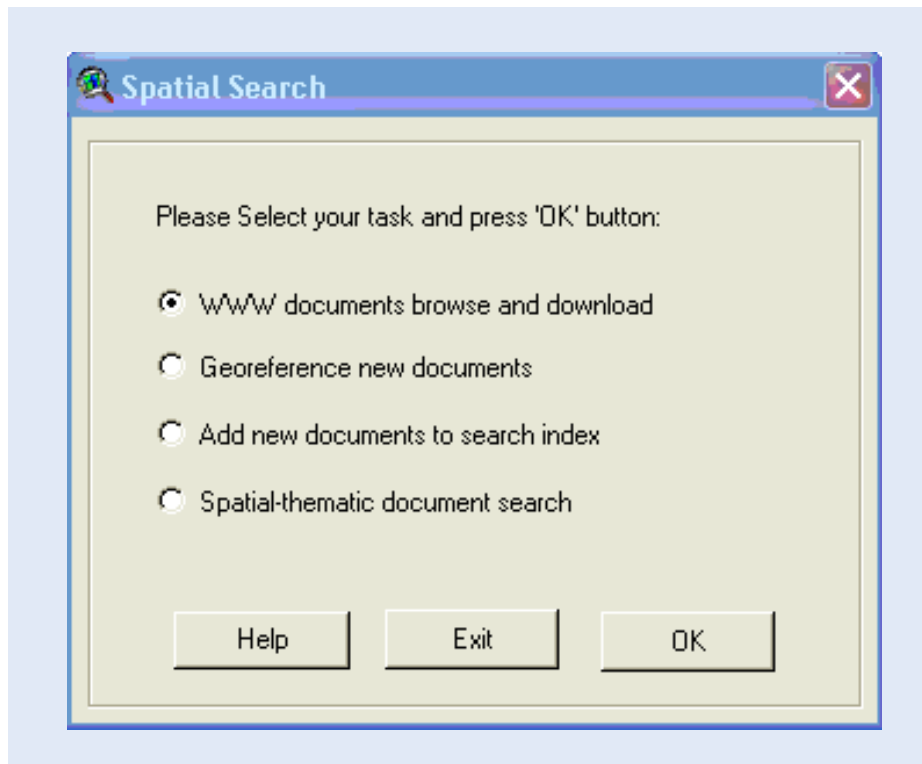


On the opening screen as shown above, click “Continue” to proceed.

In the same map frame as in the opening screen you will now see the library system’s main menu. The main menu, as shown below, holds four options and three buttons at the bottom of the screen. The four options represent the sequential steps required to develop and use the library system. As such the system also distinguishes between Library Developer and Library User tasks.

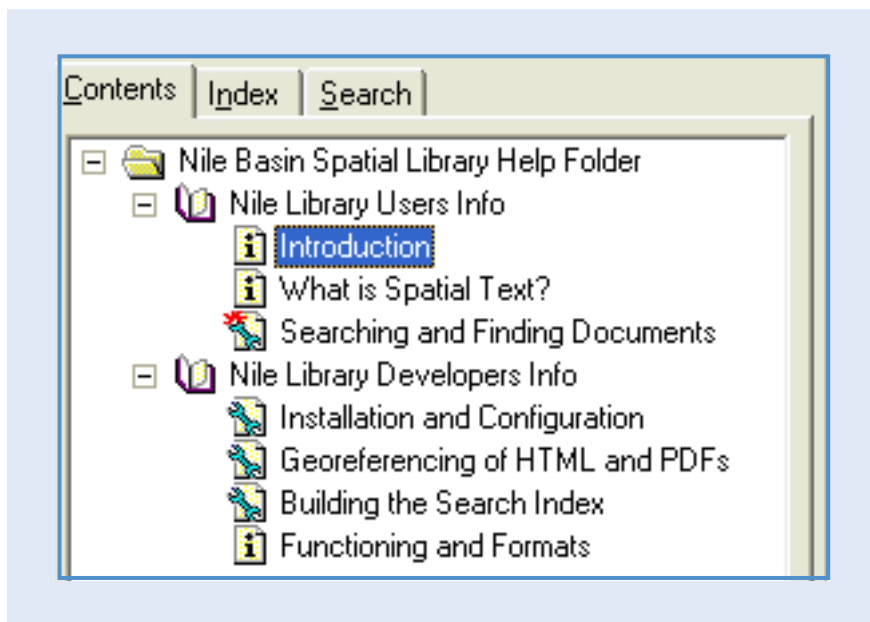
The first and last option, respectively “WWW documents browse and download” and “Spatial-thematic document search”, are typical library user activities. Both of them deal with searching information, the first with a classical internet Google search and the second with a pc-based, geographically confined, spatial text search.

The two middle options are not designed for regular library users, but are typical functions for librarians to build and expand the archive. In the users version of the software, these two middle functions can be made unavailable to prevent unauthorized changes to the archive. This training manual uses the “full access version” and in the following exercises each of these four options will be demonstrated and used.



Before executing any of the four tasks first click on the “Help” button to access the help system.

The help system is written in a standard Microsoft Window HTML help system file. The contents is broken down into a Library Users and Developers section. Both informative text and technical instructions are included under various chapters as shown below.



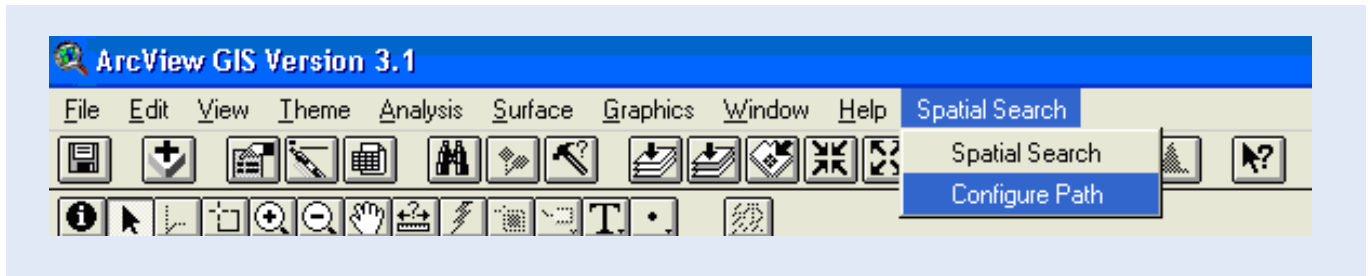
Select any of the seven chapters by double clicking on their titles and the corresponding information will appear in the large screen on the right side in a yellow background colour. Go through the various chapters and read any information of particular interest to you.

When finished with browsing the help system, close the help system and return to the main menu of the library system.

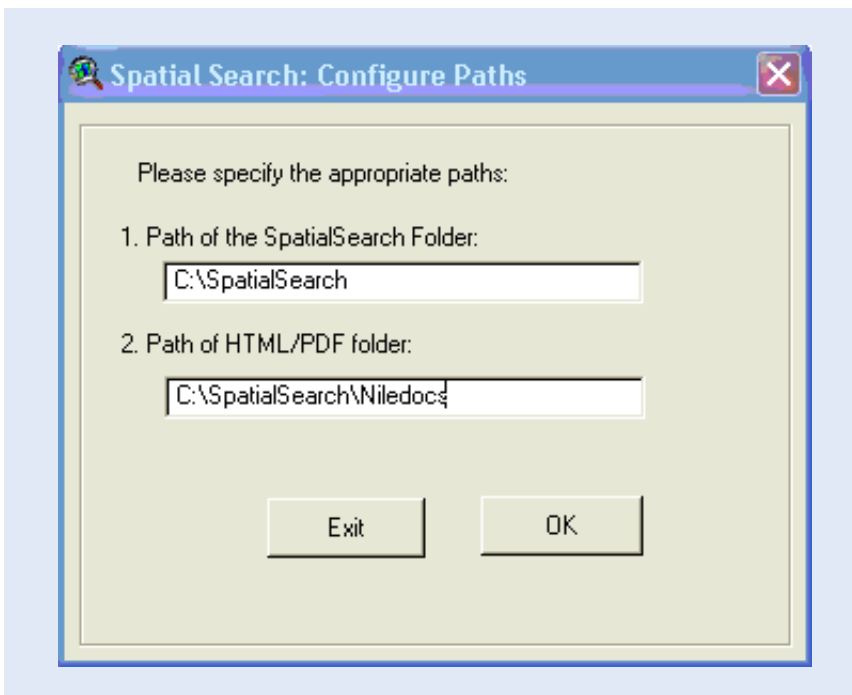
## Verifying the system settings

In order to make sure that all communication settings for the system are working properly, or in case of any trouble shooting, it is important to know the standard settings.

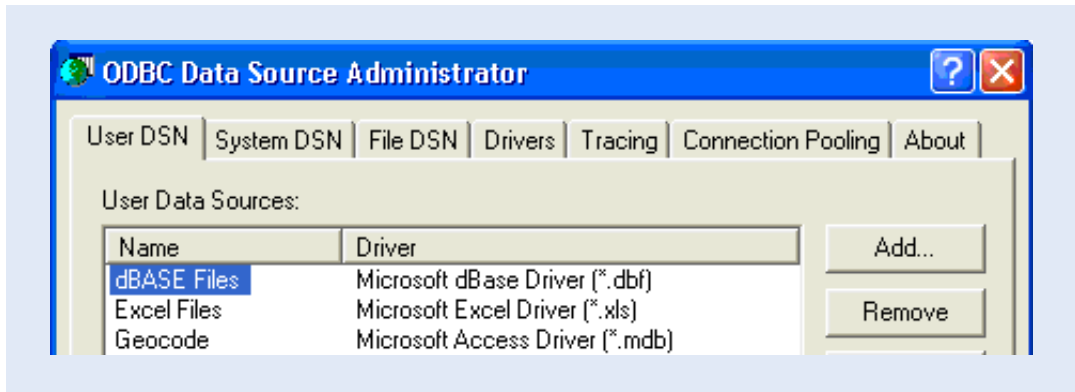
The first and most easily verifiable settings are located directly under the ArcView main menu. From this main menu, as shown below, click on “Spatial Search” and “Configure Path”.



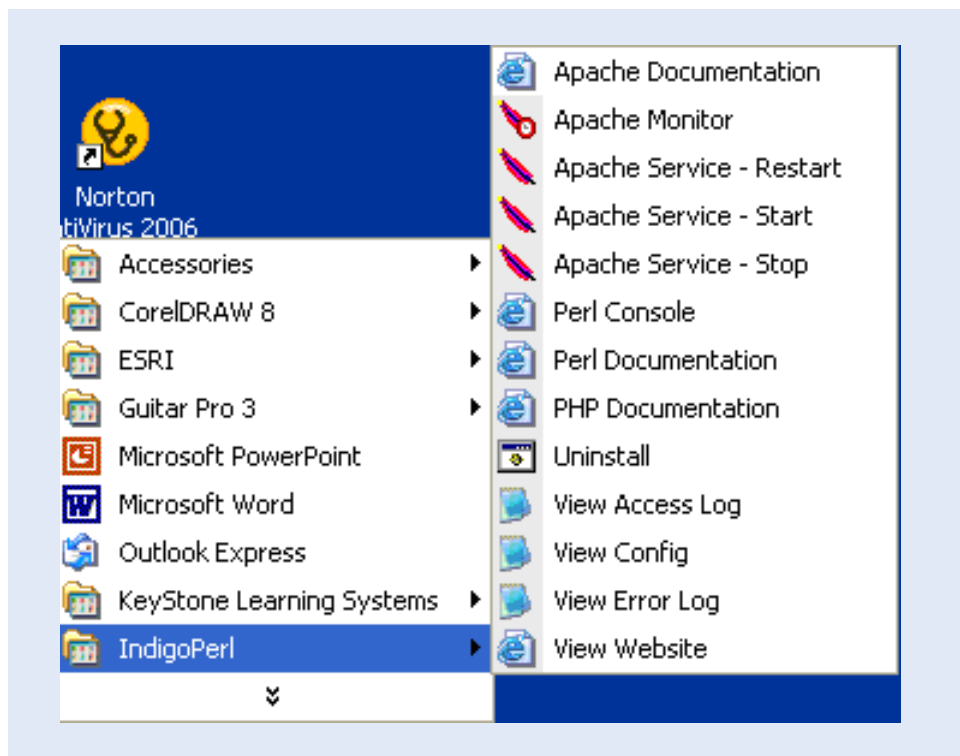
Verify the path specifications as shown in the “Configure Paths” window, by opening the windows explorer and checking these references on your hard disk. In case of any doubts, the help systems describes in detail what the correct configuration should be. If all appears correct, just press “OK”.



Another configuration check concerns the ODBC communication setting. To check this, open the “Windows Control Panel”, by clicking on “Start”, “Settings” and “Control Panel”. In the control panel select “Administrative Tools” and “Data Sources (ODBC)”, verify that the file “Geocode” occurs under the User DSN tab of the ODBC Data Administrator, see example below.



Finally verify that the Perl software was properly installed. For this purpose simply open your windows program list, via "Start" and "Programs" and look for the "IndigoPerl" application, as shown below.



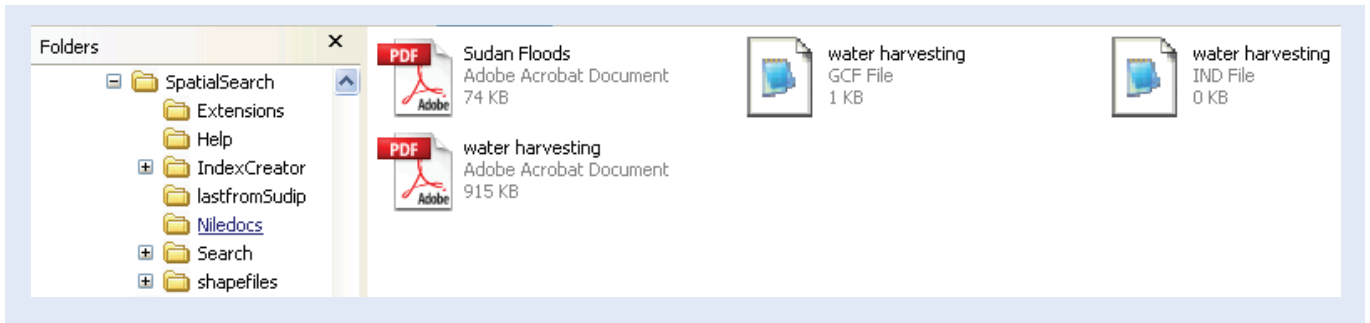
If all these settings appear to be correct, the system should work without any problems. If you are not sure or if you have discovered faulty settings, please check the help system to read on how to correct them.

### Georeferencing of a text document in three different ways

Where the first task in the main menu just opens the Google website to allow for a global search and download of interesting HTML or PDF documents, this is assumed to be a well know process and will not be further elaborated on in this manual.

The second task however is unique to this software and deals with the Georeferencing of a text document. As described in the theory of this manual, georeferencing deals with assigning geographic coordinate pairs to a document. If a text document contains geographical place names, it can be linked to these locations. In this system a document requires a minimum of one coordinate pair in order to be georeferenced. While a minimum of one location is required, the system allows a maximum of three locations to be specified for the same document. If there are more and very diverse locations mentioned throughout the text, it is recommended to split the document in two separate documents and to georeference them accordingly. This is also referred to as "text tiling".

In order to start georeferencing we first need to have a look at the text document. Open the windows explorer and go to the folder C:\spatialsearch\Niledocs. Double click on the file " Sudan Floods" as shown below.

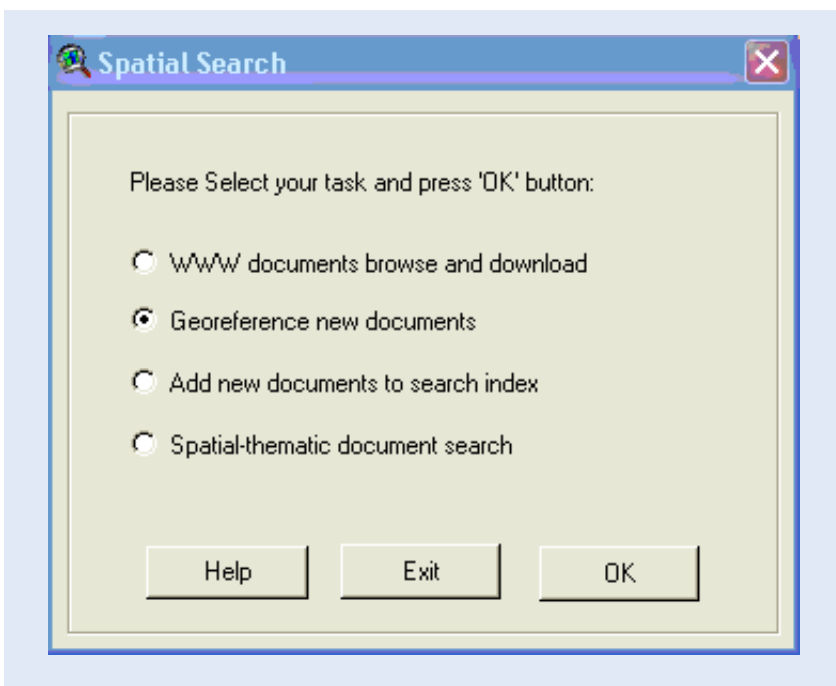



Adobe Acrobat Reader will now open the document to allow for viewing and browsing of the text contents.

Go through the text and write down below the different geographical place names mentioned in the document.

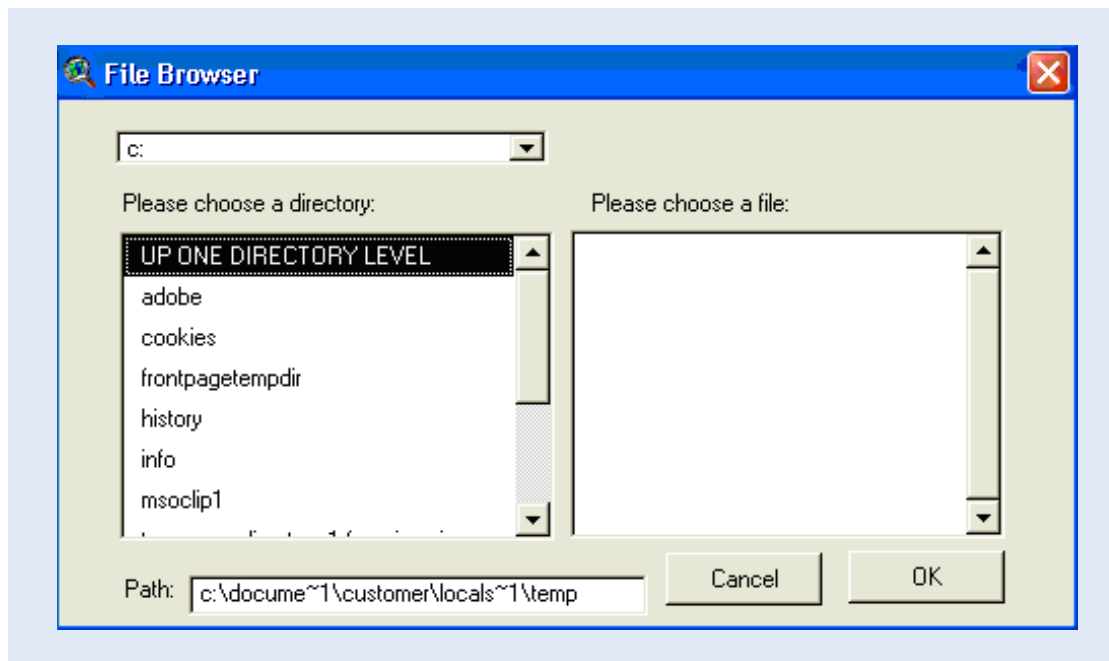
- Place name 1 .....
- Place name 2 .....
- Place name 3 .....
- Place name 4 .....
- Place name 5 .....

From the Library System Main Menu, select the option "Georeference new documents" as shown below and press "OK".



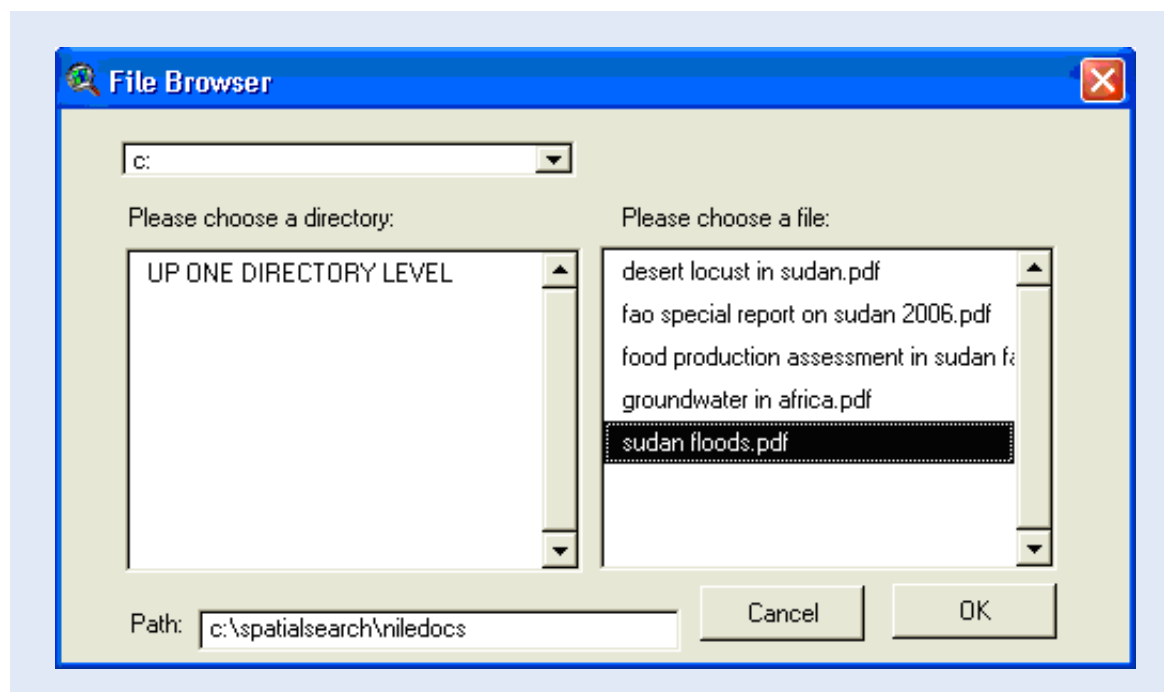
In the georeferencing window that has now appeared, press on the following button  behind the " full path "space in order to select a document that you want to georeference.

In the file browser, that has now appeared, double click on "Up One Directory Level" four times so that the path shows "C:\". Now scroll down in the directory list and find the "spatialsearch" folder. Double click the "spatialsearch" folder and then double click "Niledocs".



You will now see that a set of documents has appeared in the file browser list. The file browser will alphabetically list all the “ungeoreferenced” html and pdf formatted documents in the selected folder. All the documents that have been georeferenced before, will no longer appear in the list, this to prevent double additions and ambiguity in the archive.

Please note that the file browser will allow you to select documents from different locations. However once the documents have been georeferenced, they should remain available under the same file path. So it is important that you decide on any desired folder structure for storage of your document collection, before you start georeferencing.



Select the file “Sudan Floods” and press “OK”

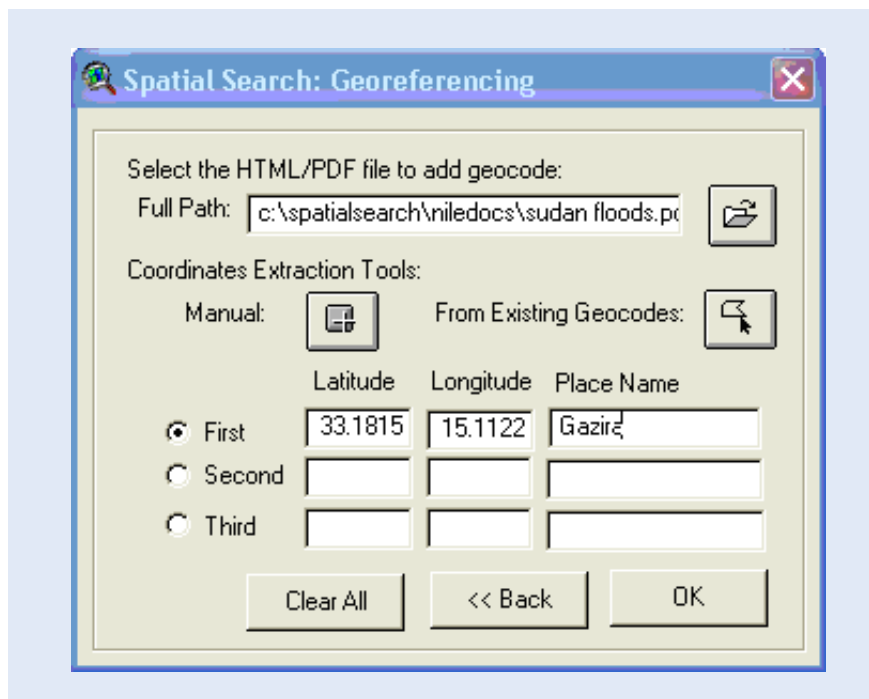
Now that you have selected a document for georeferencing, you have to specify the location(s) by providing the system information about the geographical latitude and longitude numbers. The georeferencing window shows



the options for a first, second and third location. The first coordinate pair always needs to be provided, the second and third are optional. Which location is entered respectively as the first, second and third coordinate pair, is completely arbitrary as all coordinate pairs are treated equally. The georeferencing window offers you in principle three different ways to specify a coordinate pair. The first option is simply by clicking in the respective spaces and to type coordinates. This can for example be done when you have GPS recordings from a field visit. The second and third option are provided through special buttons and are respectively indicated as “Manual” and “From Existing Geocodes”.

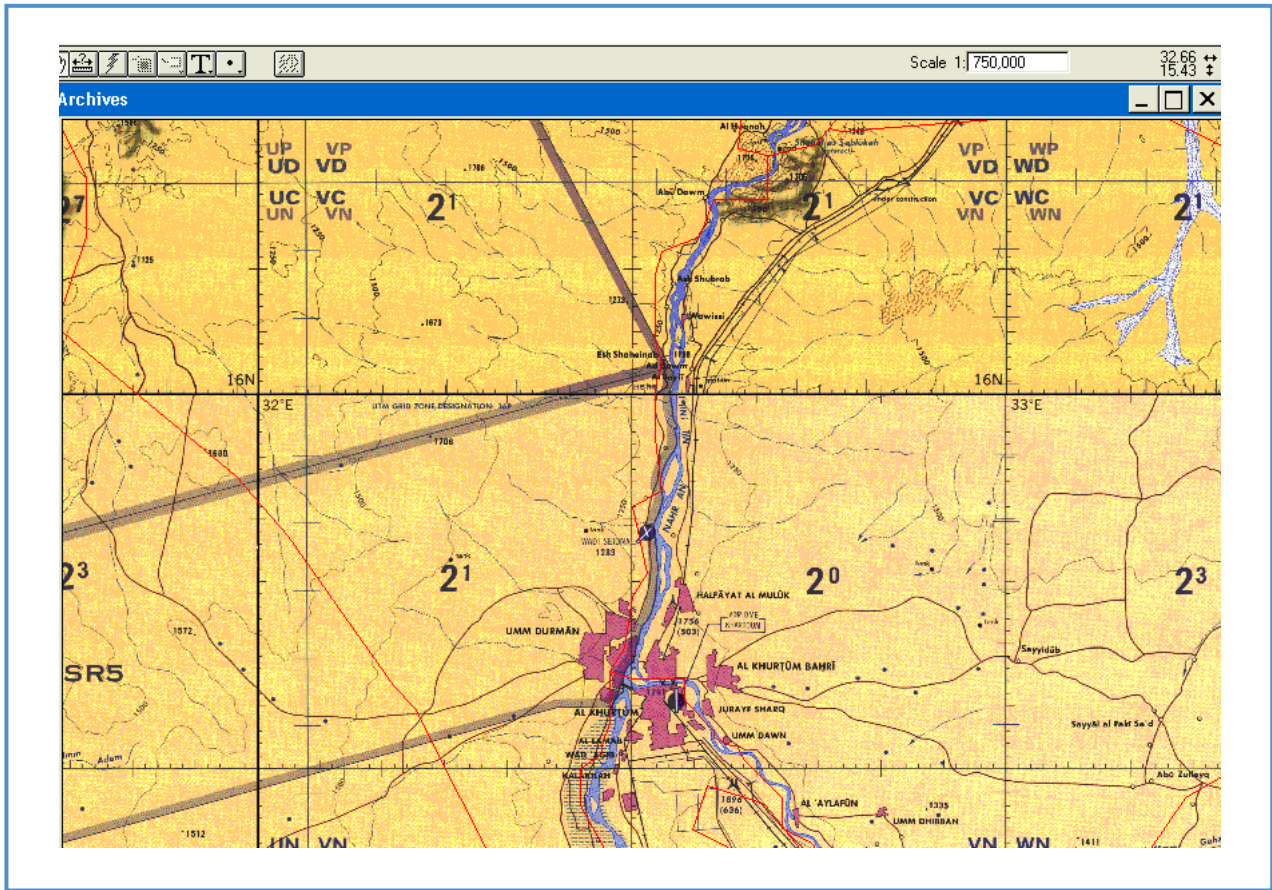
The manual option applies when you know where the location is. It allows you to navigate over the map and to use the cursor to point at the map location and through doing so, automatically pick the coordinate pair from this location. The third option applies when you know approximately where the location may be, but not exactly. Through this option you can click in any of the blocks of the grid map layer and obtain a listing of place names available in the systems gazetteer under that block. Typing of the first letters of the desired place name will interactively take you to the closest place name match, from which you can then select and obtain a coordinate pair from this gazetteer.

A place name that you have probably noted down on the previous page as one of geographical names found in the text document “Sudan Floods” is “Gazira”. The coordinates of “Gazira” happen to be known to you, as you are just back from a field visit and you stored a waypoint at this location in your GP. The position is 33.1815 degrees East and 15.1122 degrees North. Select the first coordinate pair for data entry. Click on the white horizontal bar under latitude and type “33.1815”. Click on the white horizontal bar under longitude and type “15.1122”. In a similar way enter “Gazira” as the place name, as shown below.



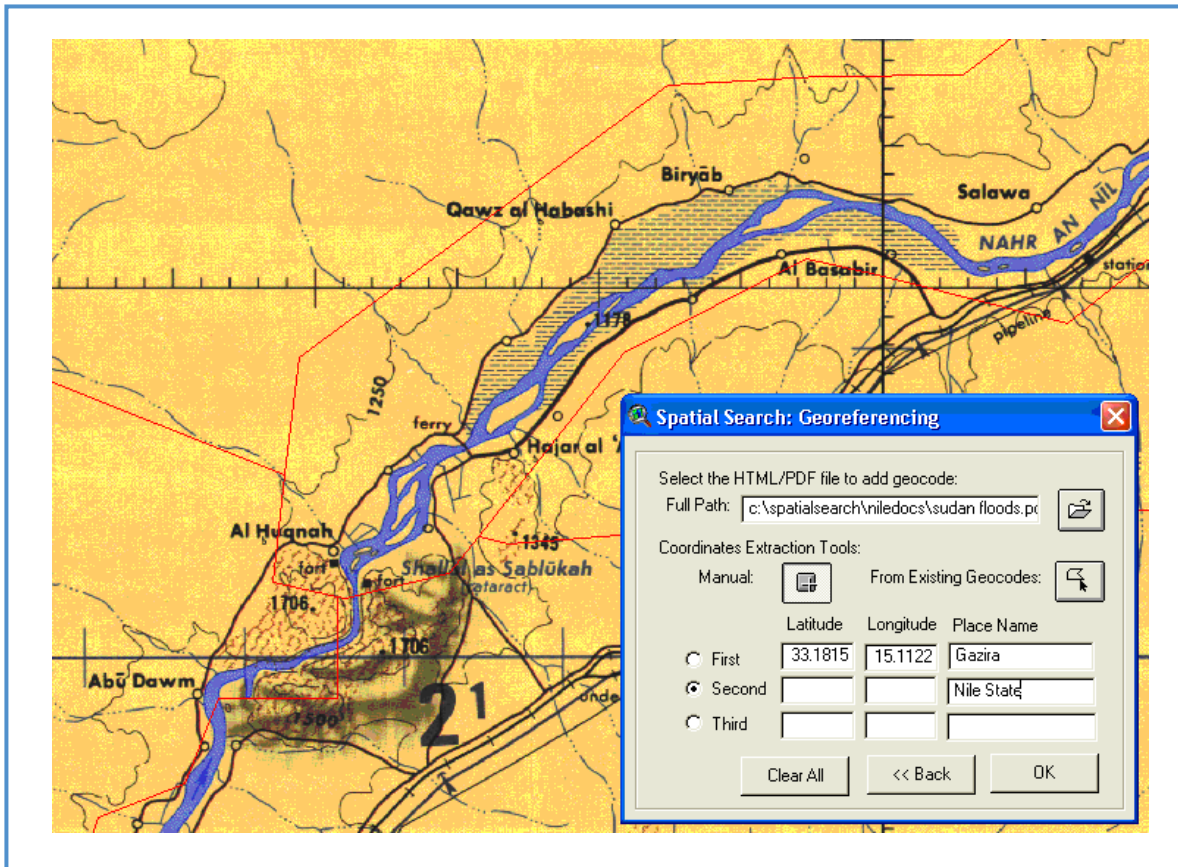
You have already related this document to one place name, but there were more. There was also mention of the River Nile State north of Khartoum. Now select the second coordinate pair and type under place name “Nile State”. Of course the “Nile State” is large, but it also mentions north of Khartoum. Here we can probably use the maps to identify an approximate location. Use respectively the zoom in, zoom out and pan buttons under the ArcView main menu to zoom into and navigate to the city of Khartoum on the map. Click on the map scale bar and set the display to a scale of 1:750,000.

Now switch on the map display for the layers “TPC\_K05A\_img” and “TPC\_J05C\_img” to assist you in finding the city of Khartoum. Your map screen should look similar to what is shown below.



In the map display partclick on the map layer Nileagri polygon to make it active and then click on the information button to indicate that you would like to see information from this map layer. Move your cursor over the map area and click in the ares north of Khartoum to see where “River Nile State” begins. In the Identify results window that appears, scroll down to find the fields “Name1” and “Type1” to see the state names.

Once you have found the point where “River Nile State” commences north of Khartoum, zoom into this area and study the river course as shown on the TPC map carefully. Note the shaded area in the map, along the river, as also seen below. This area is marked as an area prone to flooding, and would be a suitable approximate location to relate our document to.

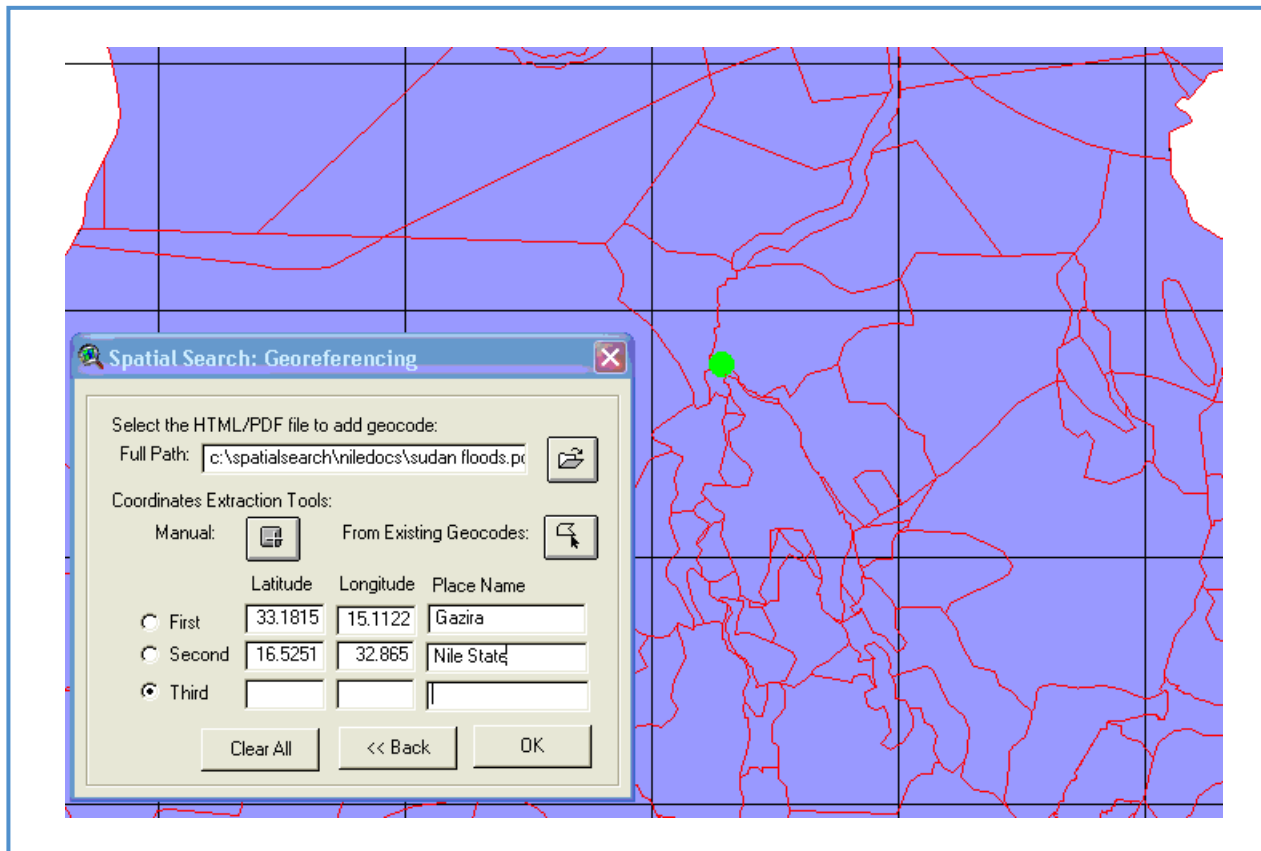


Now click on the manual button in the georeferencing window and then click with the cursor somewhere in the shaded part of the map along the river. Note that the coordinates for the second link to "River Nile State", have now emerged in the georeferencing window.

Another substantial city which is referred to in the document, regarding flooding events, is the city of Sinnar. As you have an approximate idea, where Sinnar lies, but not exactly, you can use the built in gazetteer, to locate and obtain coordinates for Sinnar.

In the Georeferencing window select the option to enter the third coordinate pair. In the map layer section on the left side of the screen switch off the display for the layers "TPC\_K05A\_img" and "TPC\_J05C\_img". Then use the zoom out button and click in the map to zoom out to an approximate scale of 1:5000,000.

In the map display you can see a map layer called "Grid.shp", which is represented on the map by a regular grid pattern of 2\*2 degrees, displayed in a black outline. The built in Gazetteer to the Nile Spatial Text Library can list its available place names per block of 2\*2 degrees, as shown below.



In order to activate the built in Gazetteer click on the button “From Existing Geocodes” in the georeferencing window. From your various field trips in Sudan you remember that Sinnar must be some 200 or 300 kilometers south of Khartoum along the Blue Nile. Now click with your cursor in the grid block below the one in which Khartoum is located. Instantly a new window will appear, with the listing of names available in the gazetteer under this block.

In the white horizontal bar entitled “Type the Geocode Name” type the first letter “S” from Sinnar and observe that the listing instantly responds to show all placenames starting with an “S”. Now type the letters “i”, “n”, “n” and find that the name Sinnar indeed exists in the Nile Library Gazetteer.

Now click on the name “Sinnar” in the list and press “OK”. Note that both the coordinates and the place name Sinnar have now automatically been recorded as the third geographical link for the “sudan floods” document.

Finally click OK to store all georeferences as specified for this particular document automatically to the underlying Spatial Text Relational Database.

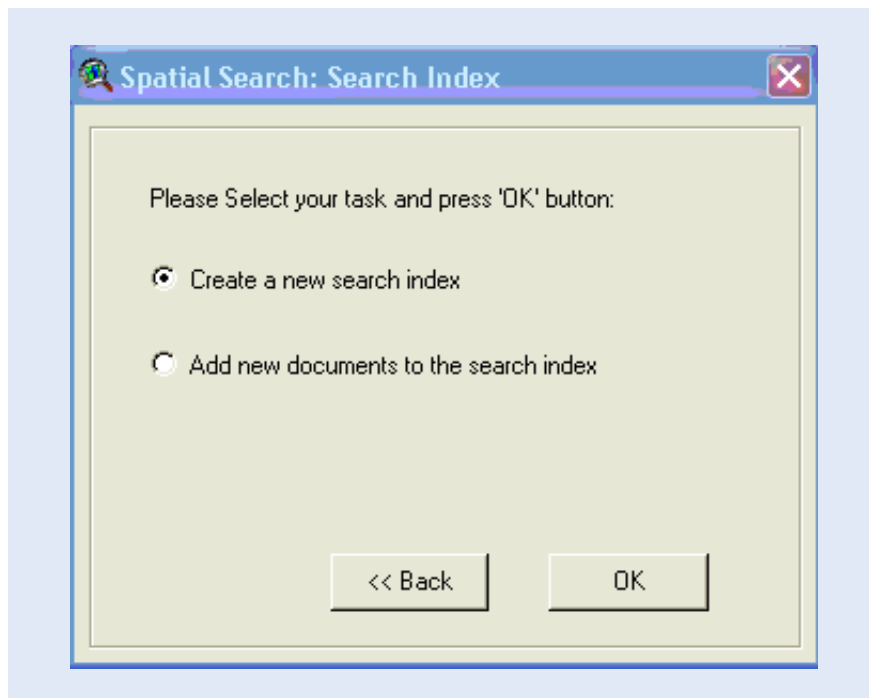
All interaction with this database is automated through the main menu and there is no direct need to understand this database itself. Even though all relational data are either in MsAccess or ascii format and therefore fully accessible for those who would like to see it. It is however recommended not to make any changes in another way, than provided through the menu system.

## Building and adding documents to the Search Index

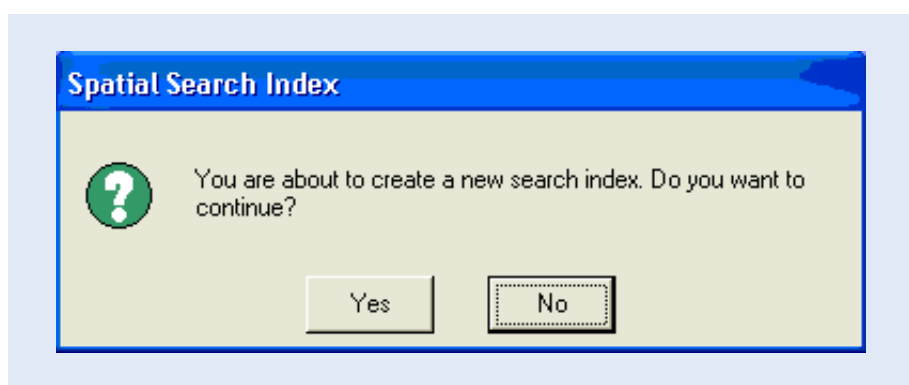
After a document has been georeferenced it can not yet be searched. It first requires to be indexed. This involves the stripping of all non-essential words, so that when the library archive grows, the full text search remains fast and time efficient. The indexation is fully automated through the library systems menu and uses a “PERL” programming language script. This is however not of much concern to the user, as the full operation of this remains invisible to the user and is fully directed through the main menu.

As you may still have the “georeferencing window” open, first click on the “Back” button to return to the main library menu. From the main library menu now select the third option “Add new document to the search index”

In the search index window as shown below, select “Create a new search Index” and press OK



A new window will appear which asks if you want to continue creating a new search index. If this is not the first time that you used the indexation tool, than an index will already exist. Continuing to create the new index will interfere with the old index. In case you are adding new documents to an already existing archive, go one step back and choose the second option in the window as shown above.

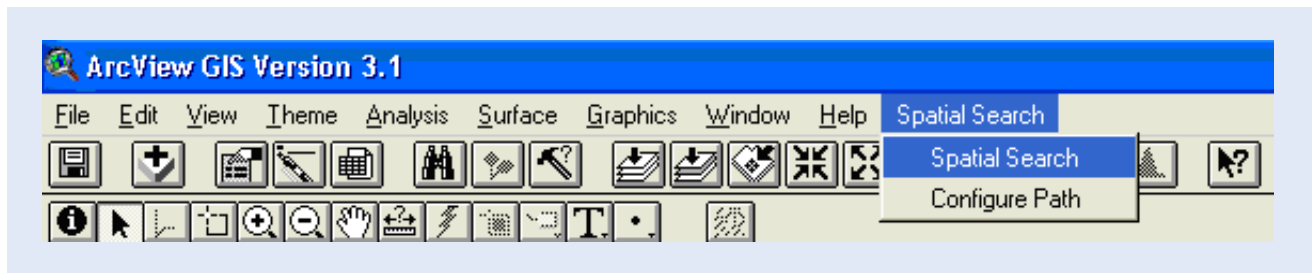


In our case at this stage we have just started to build our spatial text archive and therefore press “Yes”. Your document has now been added to the search index.

In the case that after indexation the library main menu has disappeared from the ArcView screen, reactivate it by



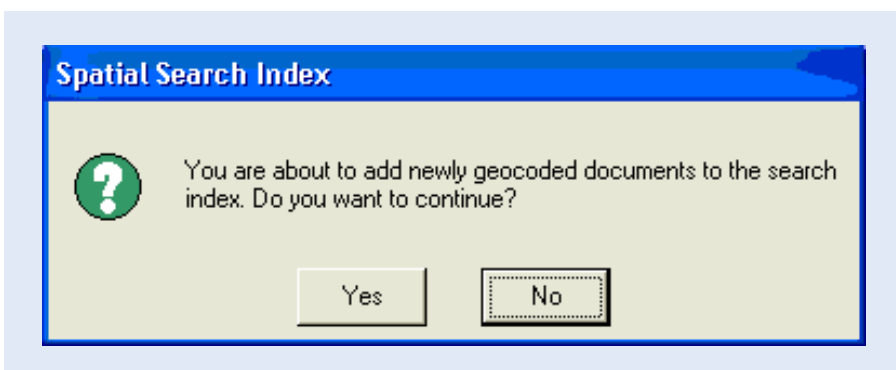
selecting two times “spatial search” from ArcView’s main menu (see below).



Before you continue with any further use of the system, let's quickly add another document to the archive. Open again the georeferencing window and from the same “Niledocs” folder select the document “water harvesting.pdf”.

Register this document to three map locations;	Amhara at latitude 13.5 longitude 39.5
	Tigray at latitude 11.167 longitude 39.167
	Adama at latitude 8.5 longitude 39.24

After having pressed “OK” in the georeferencing window, press the “back” button and now select the main menu option “Add new document to the search index”. This time choose the second option “Add new document to the search index” and press “OK”. The system will now ask you to confirm the addition to the search index, as shown below. Press “Yes”.

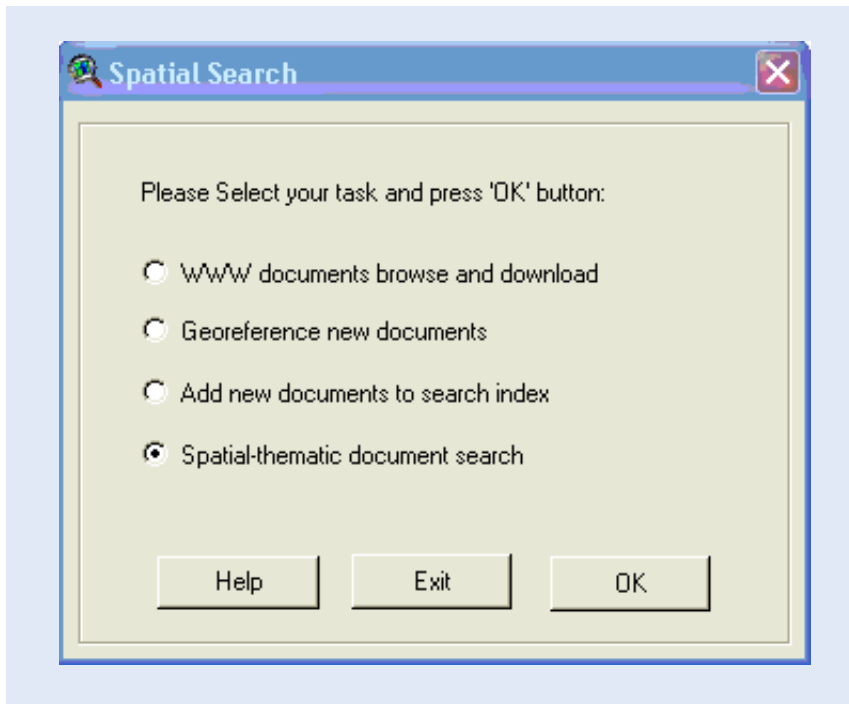



Congratulations! You have now built your first spatial text library archive containing two georeferenced digital spatial text documents, relating to six different locations in the Nile Basin.

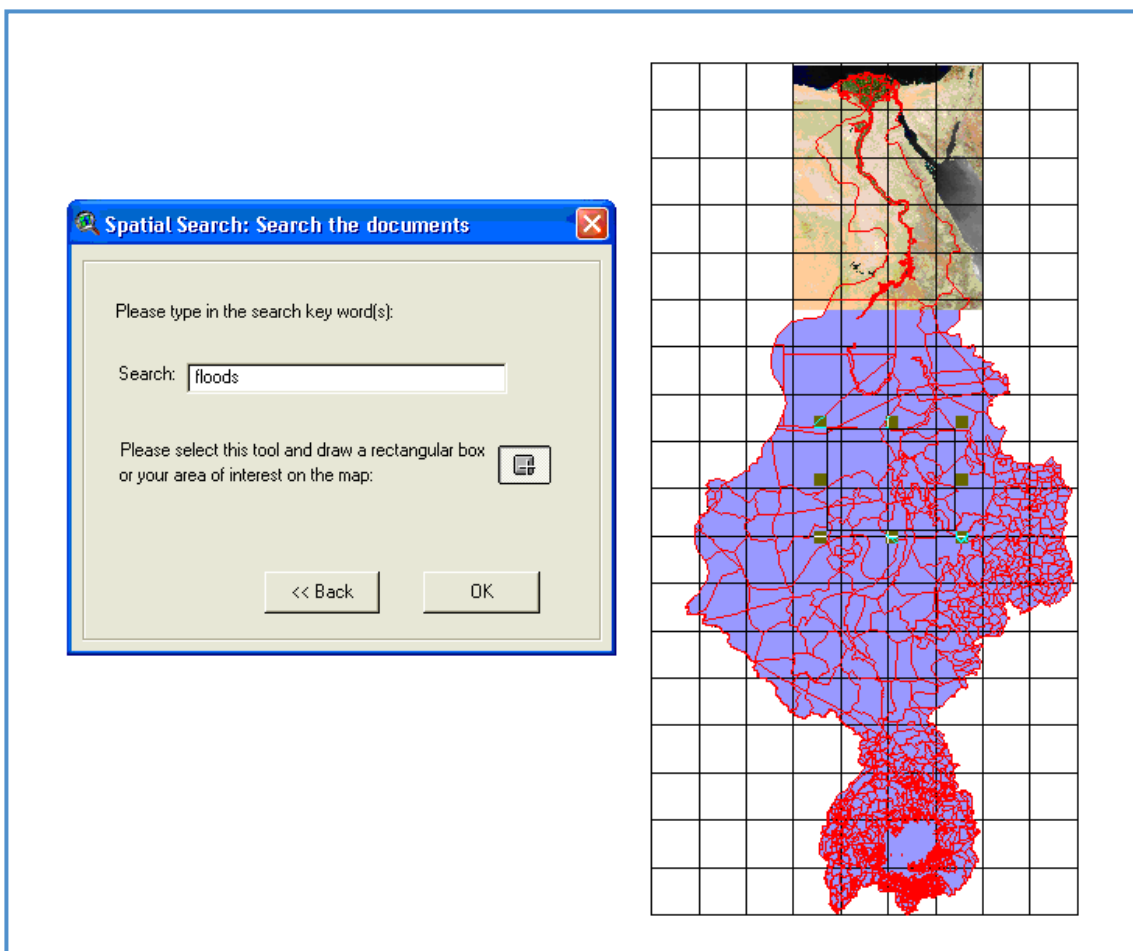
### Searching and finding documents

Searching and finding documents in combination with the assistance of keywords and map backgrounds is also referred to as “spatial browsing”. This forms the ultimate aim and value of the Nile Basin Spatial Text Library System.

In order to make a simple document search, select “Spatial-thematic document search” from the library systems main menu, as shown below.



In the new window that has now appeared, click in the horizontal white bar behind “Search:” and type floods. Then press on the box button  to start selecting an area over central Sudan. Move the cursor over the map and use the left mouse button to select one corner over central Sudan. Hold the mouse button pressed and drag the cursor to the other side to complete this search box over central Sudan, as shown below. Now press OK.



You will now see a new window appearing indicating that the system is searching and finally the windows explorer will bring forward your document about floods in Sudan. In the search window you can also use combinations of keywords using the same syntax as commonly used for internet search engines. Of course you can also proceed your query by a classical GIS analysis. For example if you are interested in water harvesting in Ethiopia, you could first take an annual rainfall map and extract all areas with more than 1500 mm rainfall assuming that these areas will have some excess rainfall. Then you can load a map with the length of growing seasons and extract all areas with a growing period less than 220 days. When you combine these two maps you have identified areas in Ethiopia with excess rainfall combined with a significant dry season. In such areas water harvesting may be a relevant technique. Then you could use the mapping result to more specifically or more geographically targeted ask for a document search on water harvesting in these locations.

Repeat the document search for the keyword “water harvesting” and draw a box over the Ethiopian part of the Nile Basin to verify that your second document can also be found.

Congratulations! You have successfully built and queried a Spatial Text Archive.



# Appendix 1

## Swapping the system from developer to user mode

The tasks as so far executed in the exercises, are typical library developers tasks. Users of the library are largely concerned with searching and "spatial browsing" of the information in the archive. As such it may in many cases not be desirable that users start georeferencing and modifying the central library archive. In all cases it recommended that certain standards are maintained in the archive development and is therefore best left to a centrally responsible unit. In order to restrict access to the library archive through the main menu, the software can be adjusted to have two different library main menu interfaces, one fully functional and one in which library development tools are switched off. In essence this is technically accomplished by changing the "SpatialSearch.avx" extension file to a different version.

In order to turn the library developers version into strictly a users version only, first close the library system and Arcview as used so far in the exercises.

Open the windows explorer and navigate to the folder; "C:\spatialsearch\extensions\Users Extension Version". From this folder copy the file "spatialsearch.avx" to the folder "C:\esri\av\_gis30\Arcview\ext32". Overwrite

Overwrite the previous file with the same name and reopen the library system. You will now find the developers tasks dimmed and not accessible by the users through this menu.