

## Chapter 2. HydroDesktop

### 2.1 Initial Objectives

HydroDesktop (formerly referred to as HIS Desktop) is a new component of the HIS project intended to address the problem of how to obtain, organize and manage hydrologic data on a user's computer to support analysis and modeling. As designed and developed thus far, HydroDesktop is focused on facilitating the discovery and access of hydrologic data and, secondarily, providing support for data manipulation and synthesis. It also provides a visualization tool for HIS Server based data and a platform for the integration of HIS data.

HydroDesktop is being developed using the open source MapWindow 6 open source GIS (geographic information system) software development toolkit together with a number of existing open source spatial and temporal data analysis and visualization tools. In this way, the full software package meets the requirement of being completely open source and accessible for third party developers and researchers. Additionally, HydroDesktop's design maintains the use of a plug-in architecture that allows for the extension of the program's core functionality and encourages third party participation in the open development community.

This chapter provides a brief overview of the HydroDesktop program as it exists thus far then address progress regarding data discovery and manipulation and community development.

### 2.2 Overview

HydroDesktop has a familiar primary interface similar to most desktop GIS programs with the addition of tools and forms specifically related to time series data visualization and analysis.

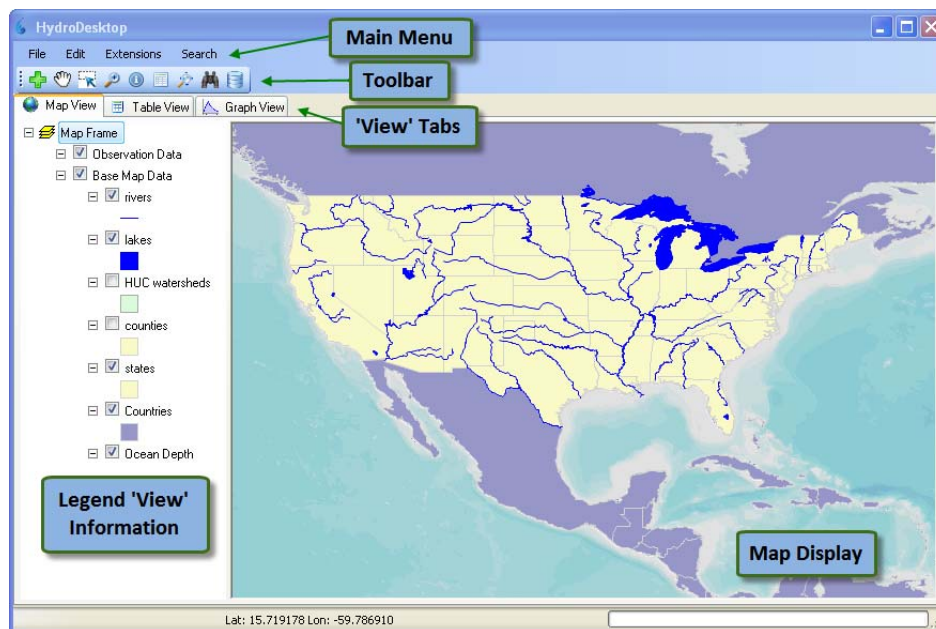



Figure 2 - 1 HydroDesktop Main Interface

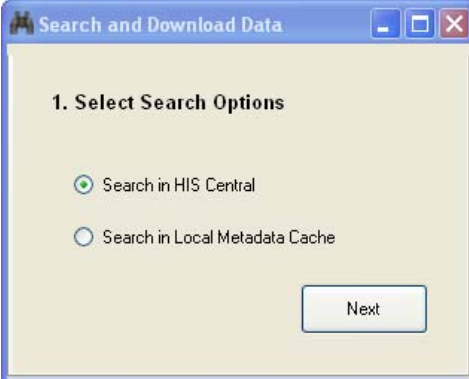
Figure 2-1 shows the HydroDesktop default interface as it appears on a user's local computer. Included are a *Main Menu*, *Toolbar*, *'View' Tabs*, *Legend*, and a main *Map Display*. The *Map Display* is the main

visualization tool while the other portions of the interface provide tools for searching, obtaining and managing data. It is anticipated that the program will be used by a wide variety of users from elementary school students to university faculty to scientific consultants. With this wide base of users in mind, HydroDesktop maintains a user friendly interface that can be easily managed regardless of the operator's technical background.

## 2.3 Discovering and Accessing Data

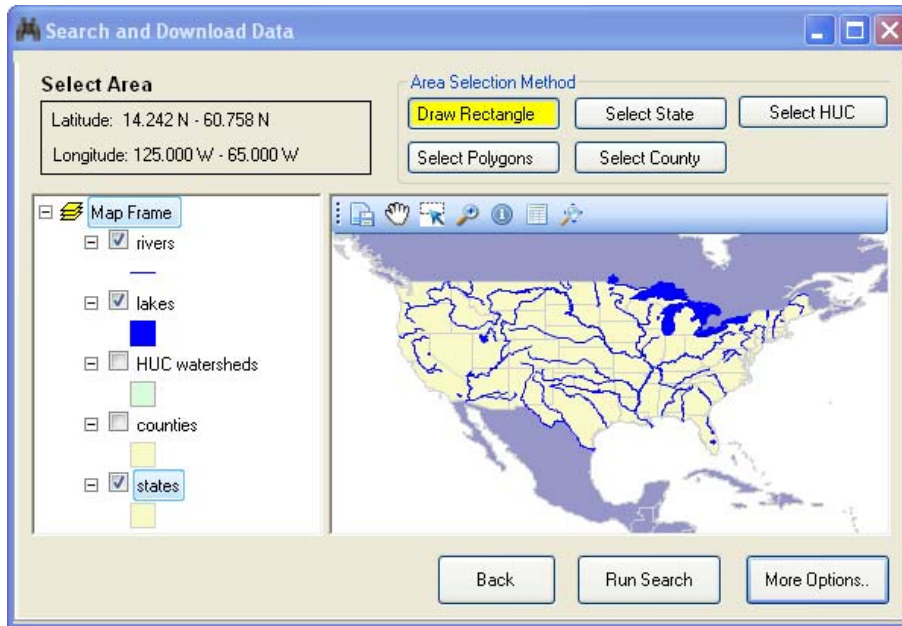
HydroDesktop uses the methods from the HIS Central metadata catalog API to provide search capabilities across the catalog to determine relevant data sets for a specific user. A series of data discovery forms have been developed to provide the user with a quick and easy, step by step means of establishing the type of data they are looking for and the source from which they wish to find it. These forms can be accessed simply by clicking the  *Search and Download Data* button in the *Toolbar*. These forms present the user with the option to input one or more of the subsequent search criteria.

The first form allows the user to establish whether to search the HIS Central catalog or to search a local metadata source.



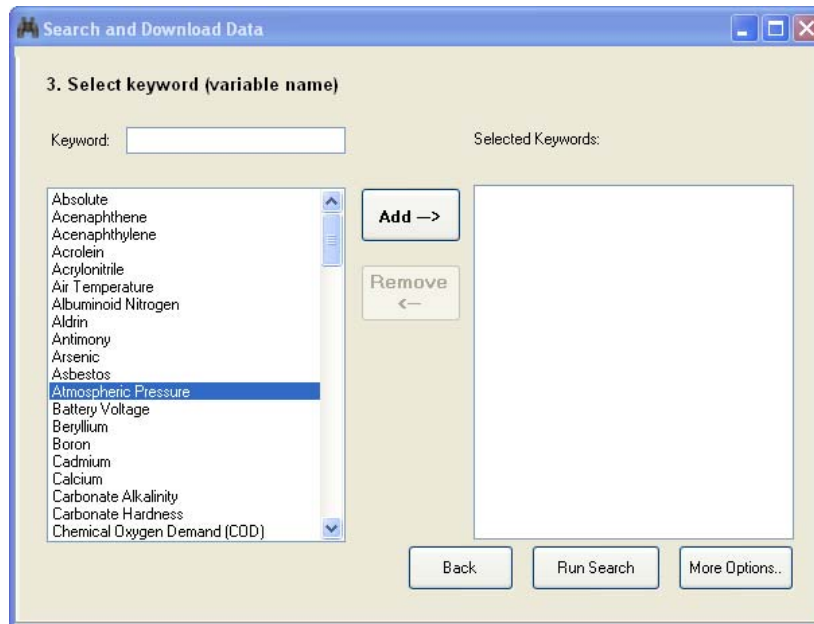
**Figure 2 - 2 First Data Discovery Form**

The second form creates a latitude/longitude bounding box to serve as the spatial constraint on the query. This form makes use of the interactive map to set the context for the data discovery. An area of interest is often used as a filter for narrowing a search for data. The box can be input by typing in coordinates, by drawing a rectangle on the HydroDesktop map, or by selecting a feature from one of the layers in the HydroDesktop map (e.g., a watershed boundary, a county or a state – the extent of the feature would be converted to a latitude/longitude box). Note that this and subsequent forms can be skipped or that the search can be run at any given point in the series of forms. All that is necessary is that at least one of the criteria be entered.



**Figure 2 - 3 Second Data Discovery Form**

The third form allows the user to search concepts from the HIS Ontology. The ontology-based search uses keywords that are either input by the user or selected from a list.



**Figure 2 - 4 Third Data Discovery Form**

The fourth form allows the user to enter a start date and an end date to serve as the temporal constraint on the query. This function is especially important to the purposes of the HIS project in that it deals with observational time series data as well as simple geospatial data.

**Figure 2 - 5 Fourth Data Discovery Form**

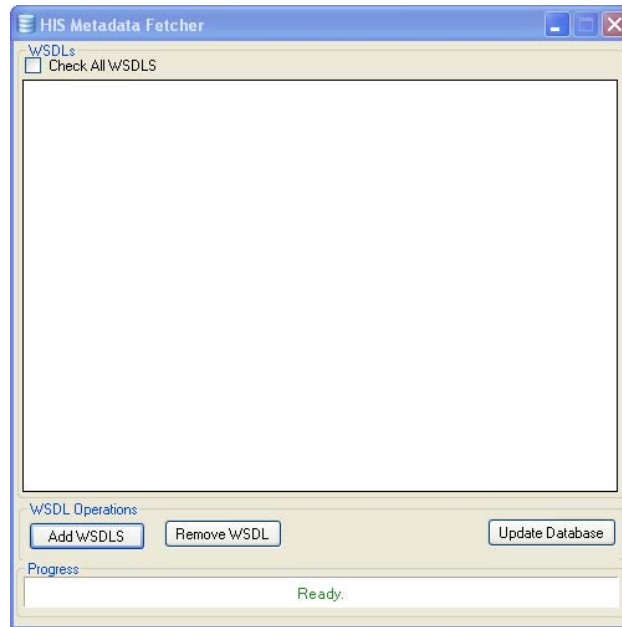
The fifth form provides a list of web services to include in the search. This is a user-specified subset of the web services registered at HIS Central that limits search results to only a selected set of services. The user may also elect to search through the entire catalog of registered HIS Central web services.

**Figure 2 - 6 Fifth Data Discovery Form**

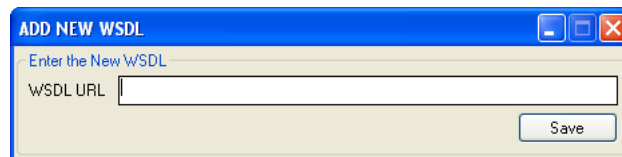
All of the data series cataloged at HIS Central that meet the search criteria are returned in a format that allows the user to easily streamline and store the results of the query. This process will be discussed in the next section.

The data discovery forms allow the user to access data which is supported by HIS Central metadata web services. HydroDesktop also provides the capability to access web services that have not been registered with HIS central and add them the catalog of searchable services. This option makes use of datasets that are stored on individual or regional HIS Servers but not necessarily registered with HIS Central. Again, a simple button click is all that is necessary to initiate this function. The user simply clicks the [Metadata Fetcher](#) button in the *Toolbar* which opens the 'HIS Metadata Fetcher' window. This window allows the

user to add new web service description languages (WSDL's) to the current HIS Central catalog simply by entering the URL for the unregistered web service. The desired service is then added to the list of searchable web services as seen in figure 2-6 and the user can then add the unregistered service to their data discovery search criteria.



**Figure 2 - 7 HIS Metadata Fetcher Window**

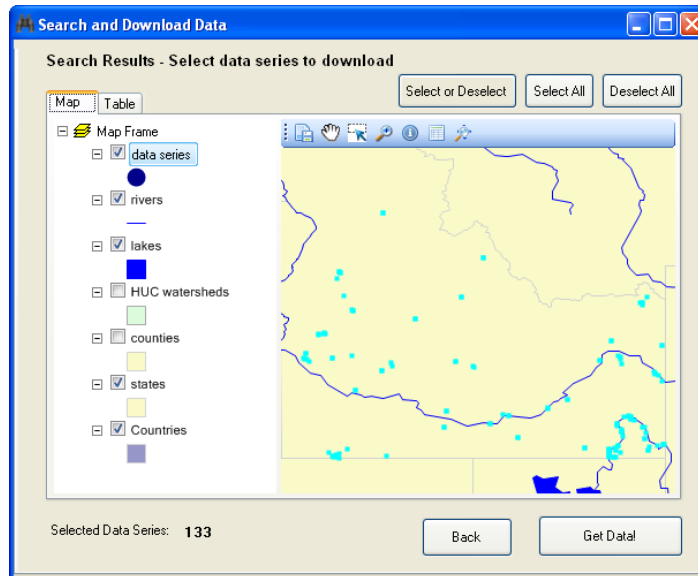


**Figure 2 - 8 Add New WSDL Window**

## 2.4 Data Download, Manipulation and Synthesis

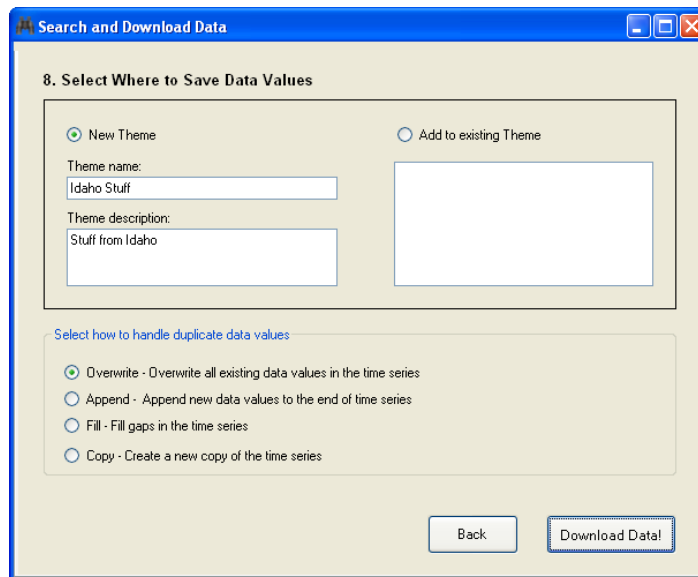
As an interactive GIS, HydroDesktop focuses on visualization. Once the data discovery process described above is complete the results are plotted as layers on the HydroDesktop map. HydroDesktop uses functions in the underlying MapWindow GIS system to provide users with the ability to visualize and manipulate a variety of vector, raster and image GIS data types. It also includes functionality for navigating the map as well as many other GIS tools and features. All of the functionality provided by MapWindow for visualization and manipulation of GIS datasets is available within HydroDesktop.

The map is presented in another window in the series of 'Search and Download Data' forms. From this new form, the user can operate the various GIS functions to continue to narrow down the selected data before moving on to the download process which is initiated simply by clicking the *Get Data!* button.



**Figure 2 - 9 'Get Data!' Form**

At this point the user is presented another form which allows them to assign the chosen data to a new or pre-existing user defined “theme.” Also the user is able to establish how to handle duplicate data where the new data overlaps with previously downloaded data sets.



**Figure 2 - 10 'Download Data!' Form**

Once observational data have been retrieved and downloaded, HydroDesktop provides users with tools for visualizing and analyzing the data. A GIS data layer showing the locations of the data sites is added to the HydroDesktop *Legend* and displayed in the *Map Display*. The user can then manipulate the layer’s symbology, properties and label set up among many other features. Also, the user can switch to ‘Table View’ using the ‘*View Tabs*’ and quickly access attribute tables pertaining to each data site.

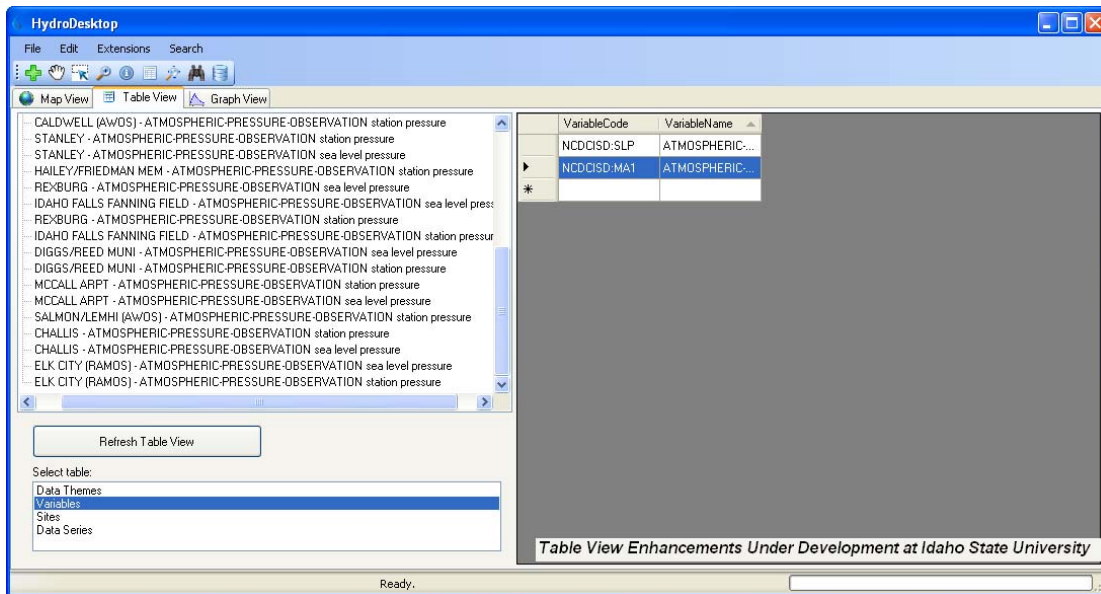


Figure 2 - 11 HydroDesktop Table View

## 2.5 Additional Plugins

The tabbed interface and plug-in architecture presented in HydroDesktop have been developed such that third party programmers and researchers can relatively easily add functionality to the software by programming custom code and compiling it to a separate dynamic link library (DLL) that is “dropped” in an appropriate folder and is recognized by HydroDesktop. This plug-in architecture will allow for a distributed development effort both during the active development phase as well as in the future.

At present, Utah State University is actively engaged in developing the graphing and time series visualization tools that will appear under the “graph” tab. This is being done using the plug-in interface to both test the approach and also to simplify and separate that programming effort from programming of the core system. This has also allowed the USU team to build their plug-in using the VB.NET programming language instead of C# which HydroDesktop primarily uses, hence allowing for significant code reuse from their other existing projects. An alpha version of the Time Series Analyst for HydroDesktop plug-in will be available at the end of 2009.

The OpenMI based HydroModeler plug-in under development at University of South Carolina is another example of this distributed software development approach.

## 2.6 Open Source Community Development

HydroDesktop is under active development and a community of users/developers is growing - largely from the developer ranks of the CUAHSI project – but with growing interest from third party researchers. The source code for HydroDesktop is maintained at <http://www.hydrodesktop.org> which is based on a community open source software development portal maintained by Microsoft. Also available at this site is a download for the 0.1.3568 Alpha Installer for the software that has full HIS Central search capabilities. The community web site also includes discussion forums, a bug tracking system and a documentation Wiki. We have endeavored to make have a relatively low bar of entry for participation in the open development community by making the source code and bug tracking system and forums open access for all to see, with various levels of authentication required for posting to the site.

Also, recognizing the value of community based code development as a means of ensuring end-user adoption, this project has adopted an “iterative” or “spiral” software development approach where 1) the general project requirements and hard boundary conditions are specified at the outset (this requirements document has been posted on the community portal); 2) an initial brief functionality requirements list is developed; 3) the initial limited system is produced primarily by the core funded developer team, but with voluntary external programmer support as it becomes available (ongoing development can be seen in the form of repository commit notifications at the web site; 4) testing and bug fixes by the developer team; 5) deployment of an installation package for end-users (a first installer is now available); 6) collection of bug notices and feature requests from end-users; 7) identification of specific bugs and features to be addressed in a new release; 8) addition of these features by the developer team, etc.

This development approach is the most common approach used by open source projects because of its flexible and dynamic nature. This model is well suited to a community project where it is difficult (and often not useful) to fully-specify the functionality set required for a software release. Rather it is desirable to maintain an open structure that can easily be extended through the development of third party plug-ins to support as-yet unknown functions and capabilities, as well as a clear policy on how code is moved into the core system, and how external developers are included in the developer team.

The screenshot shows the HydroDesktop website interface. At the top, there's a CodePlex logo and a search bar. Below that is a navigation menu with tabs for Home, Downloads, Discussions, Issue Tracker, Source Code, Stats, People, and License. The main content area features the HydroDesktop logo and a 'Project Summary' section for CUAHSI. The 'Building the HydroDesktop Team' section includes a list of links for discussion, database structure, and functional specifications. On the right side, there's a 'Downloads' section with a 'Download Now' button and an 'Activity' section showing statistics like page views and discussion posts.

**Figure 2 - 12 HydroDesktop Home Page**

The HydroDesktop development team set out to create a GIS tool for obtaining, organizing and managing CUAHSI HIS data on a local user’s computer with emphasis placed on modeling and analysis. This is being achieved by tailoring the open source MapWindow GIS toolkit and other existing software to suit the needs of the CUAHSI HIS, creating a series of user friendly tools and forms that focus around data discovery, download and manipulation, and establishing an online open source software development community to update and maintain the software.