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WISKI – A software package for acquisition, analysis and administration of time series data

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Abstract

This paper describes the WISKI Hydrological, Meteorological, and Environmental data management software package. In this paper are primarily concerned with hydrological data management. WISKI is a Microsoft Windows™ based client/server system that uses relational databases, and was designed in cooperation with water agency authorities, engineers and hydrologists. It combines the modern standards of data management with advanced tools to collect, edit, store, and present time series data to intranet, internet and GIS users.

WISKI consists of three parts, a remote data acquisition server, a central database server for storage and management, and a Windows™ based hydrological workbench. The system allows automatic and effortless flow of time series data from the measuring site to the database. Data are reviewed using powerful graphical and tabular interface tools. Accepted data are then ready for further analysis using either internal or external statistical and modeling packages. The WISKI package is a complete solution for decision support and management of resources or events.

1 Introduction

With the ever-increasing emphasis on management of our natural resources (especially water), the need has intensified for the collection, management and presentation of hydrological and environmental data for complete river basin management systems. The huge amounts of data typically collected for basin management creates significant data analysis challenges. Up until recently, there

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have been no commercially available data management platforms for managing these large quantities of data. This paper briefly describes a new international data management system, known as WISKI, that has just recently been available for use in the United States.

Information Technology, using client/server applications running on relational databases, is an ideal foundation to implement and interconnect Hydrologic Information Systems. These systems must have a full range of capabilities, from the automatic acquisition of field data, to the production of final verified data sets and reports. The integrated handling and evaluation of various data from different sources (such as water level, discharge or precipitation) as well as time-series modeling, statistical analysis and event alarms, are now possible.

2 Requirements for a hydrological data management system

Today the management of hydrological networks and the evaluation of data are typically practiced by governmental organizations and water agencies. The most efficient means of storing, managing and distributing the huge amounts of data typical of these networks is with client/server computer technology. This technology can be easily adapted to central relational databases for use in multi-user environments that exist in large organizations.

To work in this environment, a hydrological information system must have a minimum four main parts:

1. An automated telemetry system for remote data acquisition;
2. A central database server for data storage and management;
3. A Windows oriented client system or hydrological workbench; and
4. An automated procedure for data publication to and from other agencies.

The automated telemetry system must be capable of collecting remote data from a number of different platforms. The collection process must have the capabilities of scheduled, manual or event-triggered acquisition. Once acquired, the data must be checked and stored to the correct time series within the database.

The hydrological workbench represents a focal point from which the hydrologist has access to the data. This central point provides access to the tools necessary for quality control of new data, graphical and tabular visualization, editing, rating curve estimation, statistics, reports or internet publications. Tools such as tabular and graphical data editors are required for hand editing of the data, as well as automated editing procedures for quality control checks, gap filling, primary value calculation or transformation of measured water levels to discharge rates. All of these tools allow the hydrologist to rapidly transform raw field data to usable production data for publication and further analysis.

Hydrological information systems are becoming a necessity for hydrologists to reduce data processing time and enhance the quality of data. These

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information systems broaden the areas of management by implementing monitoring and evaluation systems for large river observation systems, storage and reporting system for SCADA systems, data server for state wide hydrological information, or as an integration tool for decentralized databases with possibilities of multi jurisdictional river management.

3 Data integration

A modern hydrological information system should be capable of acquiring and storing a variety of data types. Although primarily focused on the quantity and quality aspects of hydrology data, it is also useful to store other types of information, such as gate position, bearing temperatures, or kilowatt-hour production. Thus, all time series type information must be stored and analyzed within the information system, to support decisions for planning and operation. The WISKI software package provides these capabilities and includes the potential to store a wide array of other useful related data.

Examples of additional data integration possibilities from the WISKI system are as follows:

1. Portable field devices can be connected directly to WISKI via com-port with automated import capabilities;
2. WISKI provides a general import format interpreter to integrate data from other systems;
3. WISKI also supports a long list of data specific import formats;
4. DIGIT, a WISKI module, provides a user interface for digitizing graphical charts directly into the database; and
5. If manual entry of data is necessary WISKI also has a tabular data editor.

WISKI's versatility of data integration expands its ability to manage all of the necessary data for the day-to-day operation and management of large river basin systems.

4 Data processing and evaluation – the hydrological workbench

WISKI is a client/server system based on relational databases, designed under close collaboration with water agencies and hydrologists. It has been tested in systems tracking data from 30,000 hydrological stations and 150 concurrent users and can be run a variety of operating systems and database platforms.

WISKI consists of three parts, a data acquisition server for remote control and telemetry, a central database server and a graphical user interface, termed the hydrological workbench.

The hydrologist uses the hydrological workbench (Figure 1) to perform all of the necessary work to transform raw data to final data. This process can consist of quality control checking of new data using the graphical and tabular visualization tools for error correction, gap filling, flow calculation, statistics and

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summary reports for documentation in hydrological yearbooks or publication to the Internet. The workbench also has the ability to act as an alert system for flood management. Alarms can be configured for monitoring tasks such as the calculation of storage for retention basin management or early warning systems.

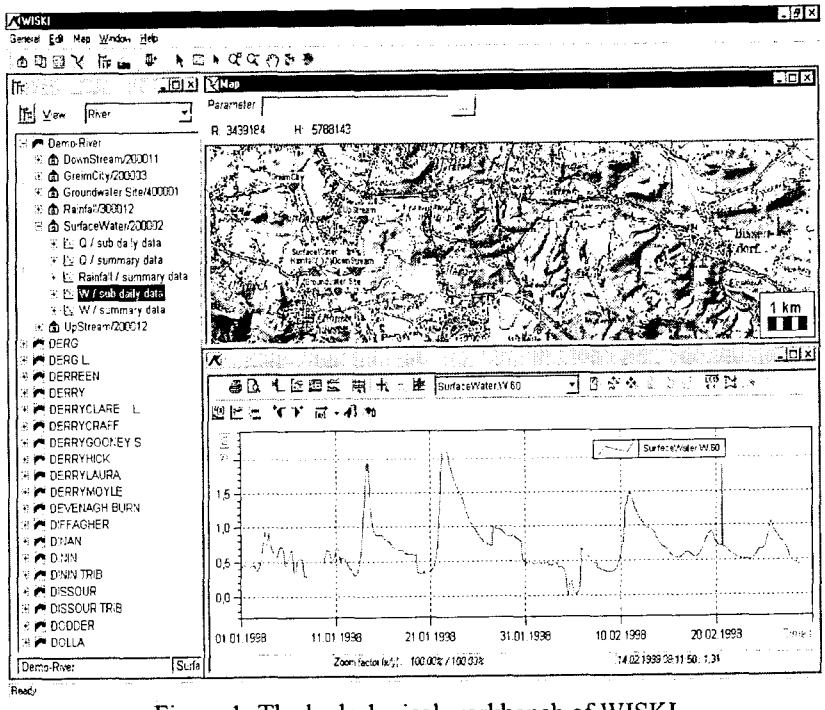

Figure 1: The hydrological workbench of WISKI

A variety of tools are integrated into the hydrological workbench to support the hydrologist's work. There are configurable tabular and graphical data editors, automated procedures for standard tasks such as quality control checks, filling of data gaps, primary value calculations or transformation of measured water levels to discharge rates. One of the most important time-savings tools of the workbench is the rating curve editor. This tool supports the hydrologist by assisting in the rapid construction of rating curves from discharge measurements as well as monitoring valid rating curve periods (Figure 2). Another feature of WISKI is the GIS interface. This module allows the user to display a map of the river basin as well as geographical information allowing the user graphical access to station information and associated time series data directly from the database server

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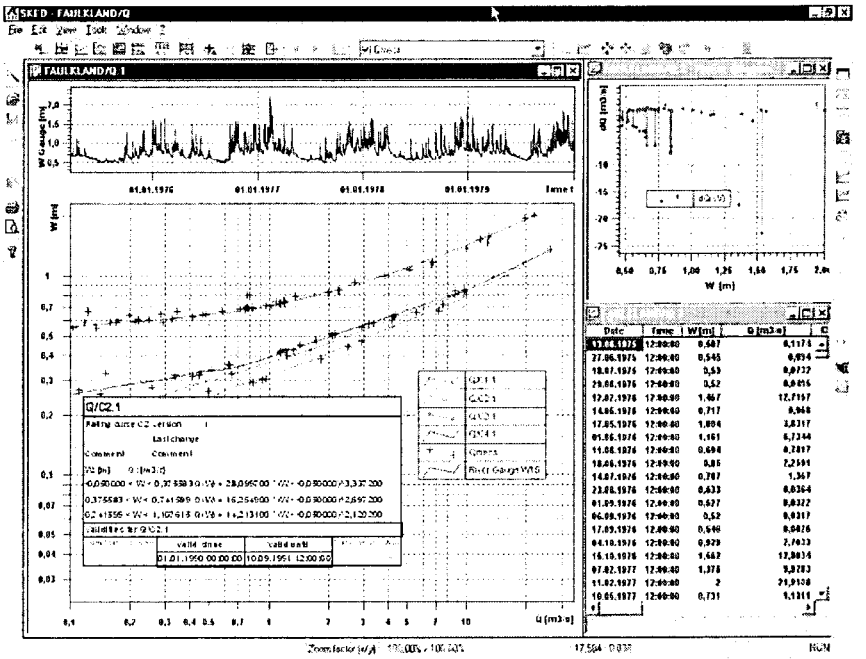

Figure 2: Rating Curve Editor

An example of integration of the central database with data collected in the field is the BIBER-software module. This module resides on a laptop computer that taken into the field. Once discharge measurements are completed they can be imported directly to BIBER on the laptop, evaluated and corrections made, before returning to the office. Later, in the office, the discharge measurements are then directly imported via local or wide area network into the central database where updates of all related data, e.g. rating curves or shift corrections, are performed automatically.

Once the field data has been evaluated and imported to WISKI the next step is to evaluate the high-resolution stage data. This task is performed directly from the workbench. Basic evaluation procedures are:

1. Calculation of datum corrections for the stage;
2. Calculation of stage and time related shift corrections;
3. Preparation and validation of rating curves;
4. Calculation of discharge data; and
5. Calculation of daily, monthly and annual minimum, maximum and mean values for stage and discharge.

WISKI provides hydrologists with a toolkit of functions adapted especially for hydrological data evaluation. Most of the tools found in WISKI provide the user with two modes of operation, either automated or user driven. The automated tools can be set to trap and edit minor problems. This provides the user with a first version of calculation results before any manual editing has started.

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To maintain simplicity in the process of data correction and evaluation, WISKI uses the method of original and production data. This means, that the original or raw data and automatically calculated values are stored in read-only time series. Users are only allowed to directly edit the production time series.

Data is stored in a relational data base management system and is monitored for new or updated records. If found, WISKI updates all calculated or derived values. For example, if you change the rating curve or the water level, (a single 15-minute value), WISKI will automatically recalculate the derived discharge for that time period. WISKI will then recalculate all derived primary values (e.g. daily water level and discharge, monthly main values, annual main values).

The user is always able to restore the original data because WISKI can distinguish between original data (data not editable by definition) and production data (editable data). Another level of security is the user administration module, which can administer different permission levels to different users and to different work stations.

Automated quality control checks and data calculations can be performed unattended by WISKI's Calculation Server. Examples of these quality control checks are:

1. Identification of data gaps with conditional automatic filling;
2. Identification of minimum / maximums;
3. Identification of minimum / maximum gradients;
4. Quality control evaluation by user defined formulas;
5. Periodic quality control testing; and
6. Comparison to other time series.

The results of these automated calculations are stored in the database and can be used in the time-series visualization to identify intervals in the time-series, which are not reasonable. Any changes to data either automatic or manual are recorded in the remarks field with a date/time stamp thereby providing a very effective means of quality assurance in the hydrometric network.

Using the graphical visualization tools errors can be identified immediately. The user can directly edit them graphically or in a tabular format. If the data is edited, WISKI will automatically record the changes in a remarks field. This provides an immediate indication to others that the data has been edited. Furthermore, you can reload the original data at any time and compare original time-series data and corrected production time series data in one graph.

For advanced analysis of data sets WISKI supports the hydrologist with statistical analysis tools such as:

1. Linear and non-linear regression analysis;
2. Duration line analysis (Figure 3);
3. Peak flood and low flow event detection;
4. Peak flood statistics;
5. Low flow analysis; and
6. Storm frequency analysis.

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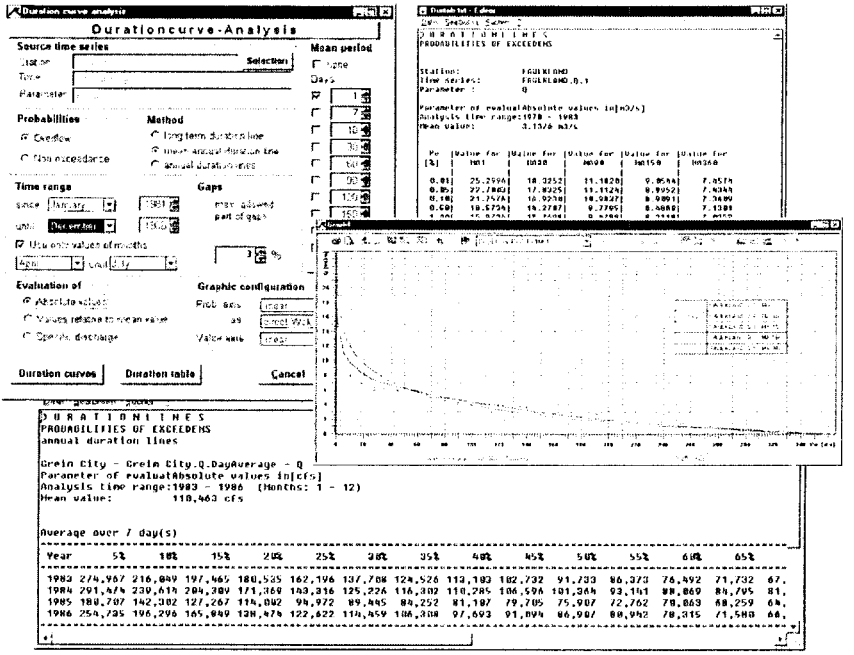

Figure 3: Duration line analysis

All of these tools were developed in close collaboration with hydrologists in different countries and are based on appropriate national and international standards such as the United States Geological Survey and World Meteorological Organization guidelines or ISO standards.

5 Integration of national standards for data evaluation and data reporting

In hydrology, it is very important that the evaluation and reporting methods used by a software package fully comply with the national standards of the authority in the country in which it is used. Since WISKI has been in use for over 7 years by authorities in Europe and Asia, it has become very flexible and easily adapted to meet new requirements. The most important requirements that must be met in the United States are:

1. Full support of English, imperial and metric units;
2. Rounding methods according to the USGS guidelines;
3. Datum corrections and stage shifts for stage time series;
4. Rating curve development with shifted power law function in log-log-scale;
5. Discharge measurement import and evaluation;
6. Typical US import and export formats; and
7. Typical US data reports

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In the United States, the United States Geological Service (USGS) will continue to be consulted to insure that all policies and procedures established by their agency are met. Special algorithms and standardized "template" stations have been created to accommodated the USGS data collection and correction methodology.

6 Case study – Idaho power project

The first installation of WISKI in the United States occurred at the headquarters of Idaho Power in Boise, Idaho. Idaho Power is an electric utility with a large hydroelectric system. Before the WISKI installation, the utility used a number of custom in-house developed data management tools, as well as available software applications to analyze and report the data.

These tools, although automated, were not integrated and presented unique problems that required constant support. Portions of the data required hand formatting for input and output to the system. Daily hydrological reports were compiled manually, decreasing staff efficiency and increasing costs. Many times the reports were late due to staff difficulties. Computer system upgrades were limited because some of the custom applications were still running under the DOS environment.

WISKI was installed on a server with three client workstations. A fourth workstation was used to support administrative requirements and the background operation of the import server. For the first three months the WISKI system operated in a test mode on an isolated server to allow the IT and hydrological staff to set up the system and evaluate its performance. At the end of the trial period the WISKI system was placed on the "production server" and is currently being used to produce year-end reports for the stations being tracked.

Additional data and reporting requirements were recognized during this process and changes made to the database structure, processing algorithms and reports to accommodate the USGS methodology and the specific needs of Idaho Power and United States users.

As of January 2002, Idaho Power was in the process of moving approximately 280 stations to the WISKI platform with a total of over 1,000 years of combined data. The WISKI system will ultimately be responsible for automatically collecting data for all 280 stations. The hydrologist will then be able to use the hydrological workbench to evaluate and manage the records and the daily reports that were so arduous to construct manually, will be generated automatically.

It has been proposed that WISKI additionally manage an environmental database currently in use at the site. This would add up to 80 clients to the WISKI system and considerably more data.

7 Conclusion

The efficient management of hydrological data is now possible with the WISKI software package. The package can acquire, store, and completely analyze data using powerful graphical and tabular tools. The WISKI package

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dramatically reduces data processing time and labor and enhances the quality of data presentation. WISKI has been in use in Europe for over seven years. The initial U.S. installation was completed in Idaho in 2000 and the most recent in Iowa in 2001. WISKI provides the hydrologist with the latest in hydrological data management software interfaced to standard client/server database technology.

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