TRITON – Complex System for Surface Water Quality Assessment

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Abstract

The complex monitoring of surface water quality produces a huge amount of data on abiotic and biotic samples. We provide TRITON SW, which is a complex system for handling and analyzing this data. TRITON is capable of visualizing data, analyzing it using standard parametric and non-parametric statistical methods and time series analysis. It provides data aggregations, standardized output forms and export for external analyses. As a top analysis method multivariate probability assignment into quality classes is implemented.

1. Introduction

System Triton is designed for the processing, assessment and visualization of data from surface water monitoring in the Czech Republic that is provided by AWMA (Agricultural Water Management Authority). The assessment process combines information from two different sources. The first source is abiotic monitoring that has been operating since 1992. The monitoring network for abiotic parameters consists of 1500 locations that are equally distributed throughout the whole Czech Republic. Samples are taken monthly, with more than 50 chemical and physical parameters which are observed. The second source is data from biotic monitoring that has been operating since 2002. The monitoring network for biotic parameters consists of 300 locations. Samples are taken twice a year (spring, autumn) and biomonitoring is based on analysis of macrozoobenthos population. The Principal aim of the Triton system is the complex assessment of observed locations by combining of data from both monitoring processes and find out their overall ecological state.

System Triton was developed to fulfill requirements of two users groups. In first group are routine workers of monitoring; in the second group are managers and research workers. The requirements of first group are covered by many basic graphical and statistical outputs. The user interface of this part of the system is user friendly, routine workers can easily find their required output. The second part of Triton system covers more sophisticated scientific needs and offers tools for explorative statistical analysis. An Analytical and graphical module is included. The analytical module contains many statistical functions for basic data assessment; a tool for multivariate statistical analysis is also included.

2. System architecture

System Triton is based on client-server architecture. All data is gathered on the central server which is called Salamander. The majority of data that is stored on the central server is created in laboratories. Information about measured data is uploaded to the central server from laboratories through an internet network. The central server can accept data through the web form or directly in specialized text file. The first step in the importing process is data validation. All data incoming to the central server has to be checked for accuracy and invalid data is returned back. The central server provides a web interface for further data
maintenance and management. The client software (Triton) was developed to provide access to all functions and analyses required in the biomonitoring assessment. The client software is installed on the users’ PC and must be connected to the central server Salamander to ensure data integrity and to set up user rights. New data from the central server is automatically downloaded to the client’s local database. Analytical outputs and report are also stored and managed centrally; the user only obtains analyses according to his rights after login.

The central server consists of many different technologies. The Borland Interbase is used for data storing, and validation processes are written as stored procedures in the database server. As the WWW server Apache is used, the generation of WWW pages is provided by PHP. Client was written in C++ language, local data is stored in Visual FoxPro files (dbf). Communication between client software and database provides FoxPro OLEDB provider through OLEDB interface in SQL language. Communication between client software and the central server runs on HTTPS protocol, secure transfer is provided by third party software stunnel.

3. User’s hierarchy

System Triton defines three types of users. They differ in their privileges. First user group “Administrator” has access to all client functions and in addition he can modify some of the data on the central server. Biotic and ecological indexes and scores are calculated for their complexity in administrator’s version of client software. The administrator also grants rights to other users. The second user group is called “explorer”. Users with these rights have access to all the analytical functions of client software and they can carry out explorative statistical analyses. They can define new outputs and reports, they can find out new ways (how) to assess and evaluate biomonitoring data. New approaches discovered by “explorer” users can be uploaded onto central server and can be shared with other users. This group is mostly aimed to research workers. Third user group is called “worker”. Its users have granted access to only predefined functions and they are supposed to carry out only routine assessment of biomonitoring data.
4. **Client software Triton – description**

Client software has modular structure. The base for all other modules is an analytical module. The other modules are: graphical, comparative, importing and exporting, GIS, a module for creating user macros, reporting.

5. **Analytical and graphical module**

The user interface of the analytical module is designed as a spreadsheet and allows users to do most operations found in similar products. Some wizards are defined to help users with importing data into the sheet by SQL query or to assemble mathematical expressions for further data processing. A special wizard for multivariate statistical analysis is also included. The range of statistical functions covers all needs for successful data assessment. The main groups are the following: descriptive analysis, normality testing, relationship between parameters (correlation analyses), comparisons of two or more samples, regression analysis and time series analyses. Users have direct access to all functions from the system menu or they can write their own analytic procedures in macro language. All outputs from analytical module can be defined in the graphical or tabular form. More than fifteen basic types of graphs are implemented inside the analytical module. All the graphs are fully editable and can be saved or exported to many formats.

6. **Comparative module**

The comparative module is a multivariate addition to the analytical module and its primary aim is the complex assessment of observed locations. The way to find out the ecological score of a selected location is by finding similarities with referential groups. At the beginning of the assessment process a comparative model must be defined that describes referential categories. The selected location is linked to the nearest referential category of comparative model according to its properties (altitude, flow rate, ground substrate etc.). The overall ecological state is measured as a distance of the location from the centroid of the linked referential category. The overall distance is based on distances in the biotic and abiotic parameters and mathematically is done by the computation of the Gower index. This method is a simple alternative to standard multivariate methods and can be easy implemented in the process of surface water quality assessment.
7. **Defining user analyses, creating macros**

Users with sufficient rights can create their own analyses or they can modify existing procedures. Saved analyses can be used in the future and they can be shared with other users through the central server. Definition of own analysis consists of three steps that users have to complete. The first step is importing data to the analytical module. Mostly it is done by the list of SQL queries from the linked database. The second step is modifying imported data into required form and further data processing; all functions and procedures from the analytical module can be used in this step. The final step is defining graphs and tables and putting everything together in the output report in the reporting module.

8. **Conclusion**

System Triton provides most of the necessary tools for biomonitoring data assessment. The system was designed as “open” and can be extended in future. We are proposing an alternative robust solution for surface water quality assessment based on nonparametric statistics. System Triton has been fully operating since year 2003 in AWMA (Agricultural Water Management Authority).

**Bibliography**


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