A Very Flexible Web based Database System for Environmental Research

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1. Introduction
At the Max-Planck-Institute for Biogeochemistry in Jena, Germany an Internet based database system is currently being developed for various kinds of research data. It will document continuous greenhouse gas measurements, plant, animal, microbial and soil parameters, satellite images and model runs.

While the initial purpose was to archive and provide data produced by the institute itself the scope of data has been widened to acquired data and to data of projects where the institute is only one participant of many. This way the projects TCOS-Siberia and CHIOTTO of the European FP5 project cluster Carbo-Europe are supported through the database system. It shall additionally be used as a central data catalogue for the complete FP6 climate research project CarboEurope-IP, hosting data descriptions that link to data stored in component databases of the project.

2. Database Design
The database system is very flexible through its abstract concept allowing storing virtually all kinds of data and references to external online and offline data sources. Metadata and data are not distinguished in principle. All data are handled as descriptions of aspects of reality. Descriptions can be linked with each other in various ways resulting in an information network. A site for example has links to a name, an altitude, to coordinates and responsible scientists as well as to temperatures measured at specific timestamps.

A definition level in the database system on the other hand prevents unstructured data storage. Within this definition level types of data and connections between them are described that can be used in the data level. Only through these definitions a soil sample has a sample number, an originating place, an analysis description and a C concentration.

The database concept is object oriented but in a much atomized manner. Each data item is of a pre-defined item class. Such item classes represent projects, sites and samples as well as project names and concentration values. The project item is nothing more than a placeholder for a project. Only through links to other items (e.g. a project name) it has attributes. These links are described as link classes in the definition level. Compared to the normal object oriented view class attributes are here defined by link classes from an item class to other item classes. Link classes can even allow threefold links with an activity or event as the third item class meaning that it establishes the connection between the two other item classes (e.g. a concentration measurement causing the connection between soil sample and C concentration).

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2 5th framework programme of the EU
3. **User Rights**

User rights can be defined for each item independently whereas a propagation mechanism for privileges makes explicit definition of user rights unnecessary in most cases. This way privileges to read, use and write data and to change privileges are assigned. Users normally log in with a personal user name and password. Data being made public can however also be viewed using an anonymous guest login.

4. **Data Versioning**

A versioning system allows storing old descriptions besides new ones. This is necessary to support comprehension of conclusions drawn or new data derived from data even when the original data should have been replaced by new versions in the meantime. By default descriptions are tentative. This status allows normal changes and deletions, provided the user has the necessary privileges. As soon as descriptions are approved, changes and deletions are still possible, however the user has to state a reason or describe the nature of change and the old version is preserved. Normally the current version is presented, but users can choose to see previous versions as well. These are tagged as rejected or replaced to indicate that they are not valid anymore. Replaced data are linked with their new versions to allow listing the change history.

5. **User Interface**

Database access is entirely web based. There are only a few different types of Internet pages that adapt themselves to various item classes: The Retrieval Form allows assembling directly and indirectly linked items in a tabular overview for display and download, the Display Form and Tree View can show virtually all kinds of descriptions. The only exception applies for data series values that can be displayed and downloaded using the Series Display. Manual data editing can be enabled within the display form then presenting buttons for changing and deleting descriptions as well as links for adding data. Manual changes and creation of new descriptions are actually performed in an Input Form. Additional Internet pages allow data upload from files. As descriptions may contain HTML references, links to database external online resources can easily be added to the database.