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Development of an Information System for the Administration of Environmental Monitoring Data

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Abstract: This paper presents the current state of the information system for administration of environmental monitoring data developed by Masaryk University in Brno (MU). The rising environmental database of MU can be considered as unique for the type and the quantity of stored data. The information system running over this database allows the management of monitoring projects, localities and samples and viewing of various data as well as exporting and simple analysis of the data. The paper describes the basic architecture of the developed information system and shows the most important parts of its data model. The system prototype is implemented as a web application for internal use at MU.

Keywords: Database system; Environmental data processing; Software development.

1. INTRODUCTION

To the main activities of the Research Centre for Environmental Chemistry and Ecotoxicology (RECETOX) of Masaryk University in Brno (Czech Republic), belong long-term environment pollution monitoring and ecotoxicological analysis of real matrices. The contaminants content and many different other parameters are measured in five basic matrices – soils, sediments, water, air and biota. A major part of the data set is formed from POPs and heavy metal (HMs) concentrations, physico-chemical parameters and the results of different ecotoxicological tests. The data collection has been proceeding in many parallel campaigns since the eighties, thus lot of data is available. Therefore a central information system for environmental monitoring data is needed. RECETOX started with the development of new data management system in 2006 and its purpose is to standardise and store data in a unified data format and allows data visualization in the form of predefined tables, graphs and maps.

2. RANGE OF ICT SUPPORT OF ENVIRONMENTAL MONITORING

Environmental projects of the RECETOX deal not only with sampling at selected localities and the laboratory analysis of samples, but they also include the data management, statistical support and visualisation of the results. These main points are fundamental to implement for each environmental monitoring program:

- Development of monitoring plan
- Cost calculation
- Identification of appropriate and feasible monitoring locations
- Identification of equipment requirements, procurement, and training
- Analytical laboratory assessment

- Sophisticated statistical analysis
- Data Quality Assurance/Quality Control (QA/QC)

A separate problem of the environmental monitoring is how to collect and manipulate the data or outputs (GIS maps, tables, graphs) from partial stages of the monitoring process and access to the data is according to property rights commonly differentiated into several levels.

Our information system does not support any aspects of the environmental monitoring. It is mostly oriented to the administration of monitoring projects data, localities data and samplings data. It also includes the set of basic statistical functions for data analysis, data interface to professional statistical software (SPSS and Statistica) and interface to the GIS (ArcGIS and MapInfo).

The following figure shows the recommended process for the editing, processing and visualization of data using the information system of the RECETOX.

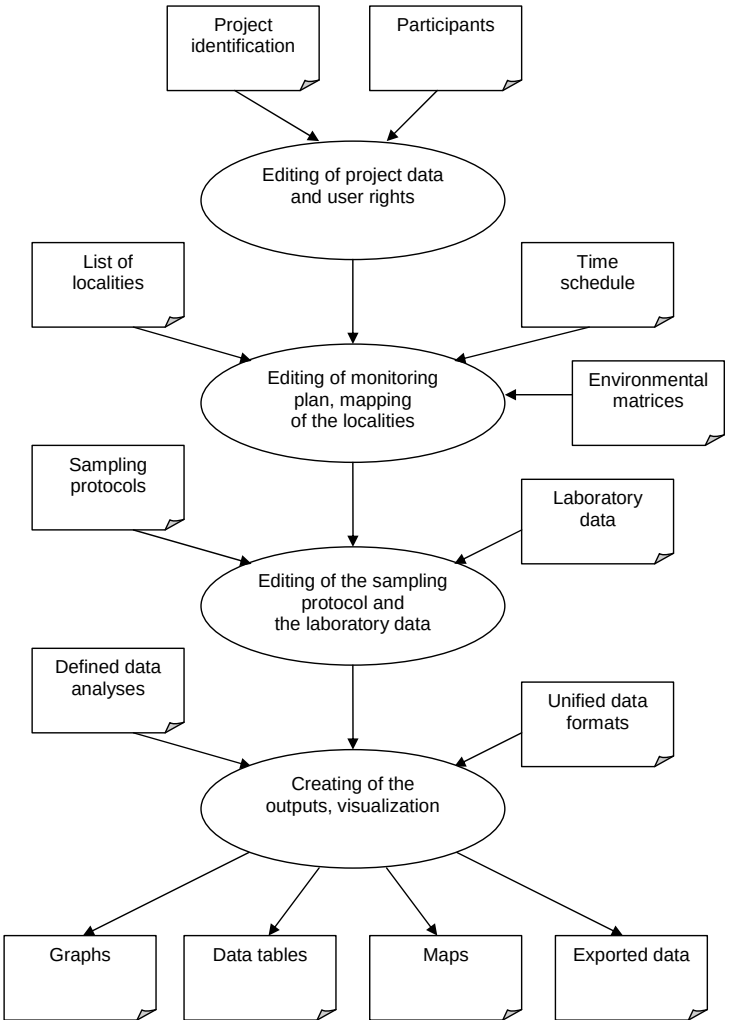

Figure 1. The main system process

We recommend inputting the data of the new monitoring project at first if you like to use the RECETOX information system for supporting your monitoring process. Then it is necessary to assign user rights for the new project. After it, the localities, matrices and sampling schedule can be assigned to the monitoring project.

Users send the data of sampling protocols (related to conditions at selected localities) together with laboratory results to the information system during the whole monitoring season. The last step of data processing is the creation of outputs in the form of graphs, maps, data tables and exchange data formats.

3. DATA MODEL

The ICT solution developed by Masaryk University is based on the relation data model. The data entities are separated into three basic parts:

- Part of sampling data – the data of individual samplings.
- Part of projects and localities – the data about monitoring projects and localities (areas) of samplings.
- Administration part – the data about users and executed changes in the database (logs).

Just the one locality for any sample has to be in the system. Localities and their samplings should be assigned to one or more monitoring processes. In the next articles are shown two basic parts of the database information system used for the processing of environmental monitoring data.

3. 1 Sampling part

The data entities of the sampling part, together with some entities from the part of projects and localities, are the core of the system data structure.

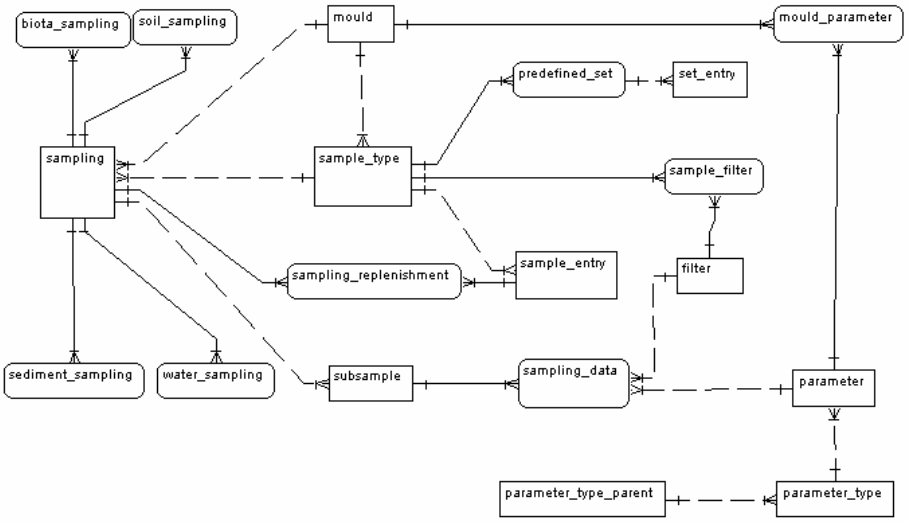

Figure 2. The data model of the sampling part

The most important data entities of this system part are:

- *Sampling* - This is the one of the most important entities in the system data model. It represents the realised samplings in the particular projects in the particular areas (localities). There exists a real sampling protocol for any sampling data set in the database.
- *Biota_sampling, Soil_sampling, Sediment_sampling, Water_sampling* - These entities contain the extensible data of sampling protocol of every particular (environmental matrices). It is the sampling depth for the soil mould, the biological material type for the biota mould and the sample amount and the sampling technology for the water mould. The entity of sediment contains data about the sampling amount, sample description and description of the sampling method, also for example temperature, pH, water flow, depth and sampling place and metrological conditions.

- *Sampling_data* - There are individual relationships *subsample – parameter – filter* and mainly measured value in this entity. The measured values of sampling are identified by the univocal key from attributes *filter_id*, *parameter_id* and *subsample_id*.
- *Subsample* - This entity represents subsamples with different modification and manipulation in a laboratory.
- *Sample_type* – The specific sample types of the particular mould are stored in this entity.
- *Parameter* - This entity is used as the set of all measured sample parameters (chemical element, chemical compound, etc.). It also contains the parameter name and its unit of measurement.
- *Filter* –The filters are created mainly for air mould.

3.2 Project and locality part

The data structure of the monitoring projects and localities is shown in the next figure.

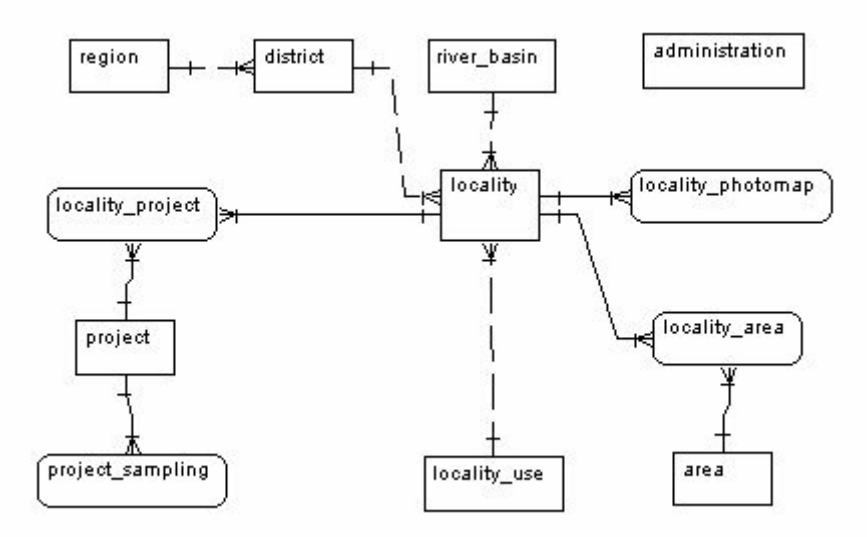

Figure 3. The data model of the project and locality part

The most important data entities of this part are:

- *Project* – There is the data about the particular project of the environmental monitoring in this entity.
- *Locality* - The entity stores information about localities where some monitoring is done and where any sampling campaign is made.
- *Locality_photomap* – The system is able to save photos and maps of the locality. It contains the picture name, its description, suffix, relationship to the picture and description of the type (for example satellite map).
- *Region*, *District, River_basin*, *Area* - The entities represent the geographical affiliation of the locality. The region is the first level of the public administration segmentation and the district is the second level. The area is defined as a group of localities from the point of view of the concrete user (for example group of localities in mountains or localities beside a highway).
- *Administration* - This entity saves the personal information of the project administrators.
- *Locality_use* - It is the codebook describing how the locality is used and what is there (built-up area, forests, vineyards, rocks, watercourses, meadows, technical areas, etc.).

4. IMPLEMENTATION

The system is implemented as a web based application and is accessible in the intranet of Masaryk University. PHP and Java are used as the two main programming languages and Oracle 9 is used as the database platform.

Behind the administration of the data of samplings, projects and localities the system provides other services. It can import data directly from selected laboratory machines and export data to the external data analysis. Currently tolls for the GIS connection and visualisation of the measured data are being developed.

The system also enables the functions of the predefined data analysis. There is shown an example of this analysis on the next figure.

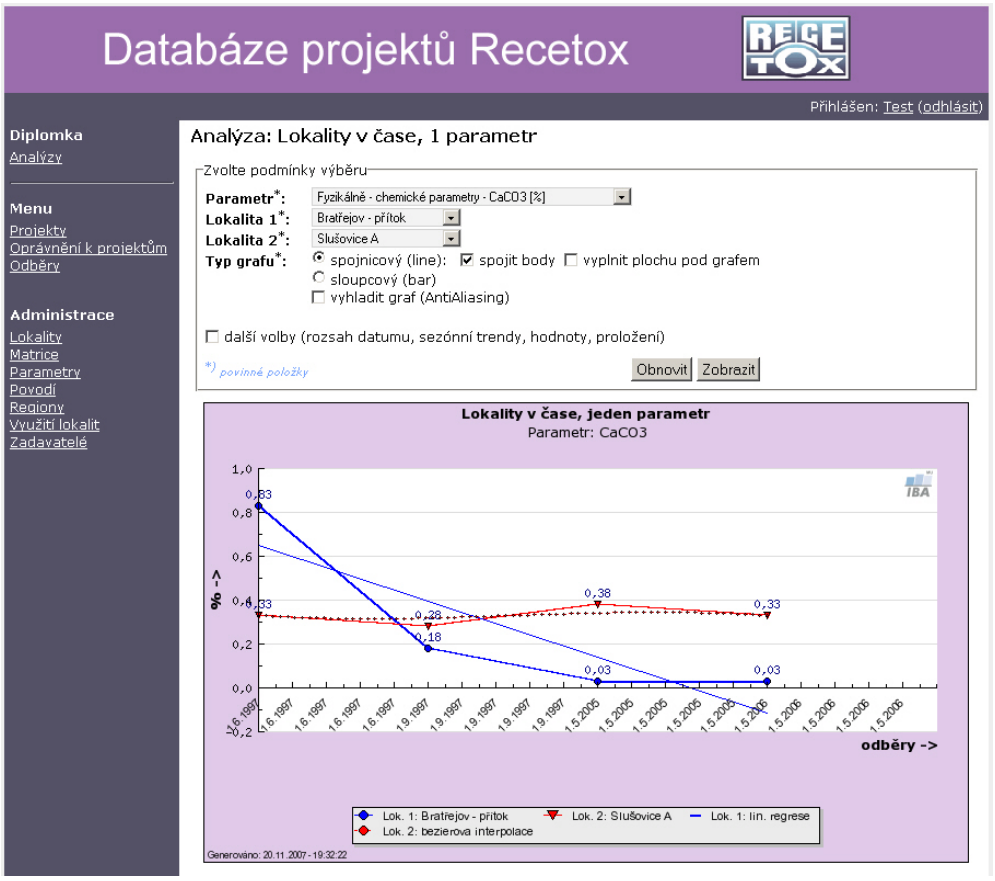

Figure 4. Tool of predefined data analysis (in Czech)

Figure 4 shows the screenshot of the comparison of one physical parameter at two different localities in the selected time interval. Using the predefined forms the user can combine the number of parameters (up to 5), the number of localities (up to 5), the type of the graph and the type of the approximation function.

A large set of the actual system data is targeted to the Zlín region (Czech Republic) or more precisely to the real contamination of the Zlín region. A multimedia sampling of sediment, soil, ambient air, surface water and biota, as the key components of the environmental system, has already been undertaken for many years. The selected priority pollutants from PAHs, PCBs, OCPs, PCDDs/Fs and HMs at chosen sampling sites are measured and various ecotoxicological tests with sampled matrices are being performed. Whereas disaster floods affected this region in July 1997, we have available very valuable data that allows us to study the impact of the floods on contaminant distribution in the environment.

The development of the described information system is continuing. The system prototype is actually running at the server of the Masaryk University but is accessible only for university employers at the address http://projects.cba.muni.cz/inchembiol/.

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