Case study - MOUSE GANDALF application in monitoring projects

K.PRYL, D.HRABAK
DHI Hydroinform, a.s
Na vsrích 5
100 00 Prague 10
Czech Republic

1 Introduction

Urban Drainage Master Plans are rather comprehensive and large-scale projects combining a number of interrelated activities. To fulfil suggested methodology, it is necessary to execute a lot of subtasks that fall within the scope of the project. As a typical example of such subtask, we could mention long or short term monitoring including all the consequent subparts – providing the measurement technology and equipment, definition of the measurement scheme including organisation aspects, data transfer proposal, etc.

To gain useful information from the measured data father data processing is needed. This is done using data processing tool. Example of this tool is software from the DHI software family – GANDALF, which is intended for this activity.

The results and outputs from Master Plan Monitoring campaign are very crucial not only for the Master Plan elaboration, but also for other activities related to the design, operation and evaluation of urban drainage systems.

2 Monitoring for Prague Master Plan

Rather comprehensive example of a full application of such monitoring strategy could be found in the monitoring part of the Urban Drainage Master Plan for the City of Prague. The main aims of this activity are summarised as follows:
1) monitoring stations installation (flowmeter, water level meter or water quality sampler) to sewer system
2) raingauge station installation as a stable monitoring network fundamental in Prague
3) monitoring station refitting (thrice of project)
4) calibration measured value (verification speed sensors on ADS)
5) operation maintenance
6) setting water quality sampler for dry weather flow and rain flow

Fig.1. Monitoring equipment used for measurements in Prague: flowmeter ADS 3600, water level meter Fiedler MS4016, raingauge Fiedler SR03 RD/V, water quality sampler SIGMA 900MAX
There are many problematic parts during the monitoring campaign. The major one was the installation of monitoring stations to large profiles in Prague sewer system, more than 2 meters high, the majority of which is found around the central WWTP. The installations in these profiles were not possible without the help of the PVK a.s. organisation, that operates the sewer system.

The second problematic part due to the presence of fine and normal sand in sewer system. Both kinds of sand are found in Prague sewer system in great amount and very often damage speed sensors.

The proposed approach for the execution of the mathematical modelling projects relies on a set of information concerning the actual behaviour and changes of the system variables. The actual way of "getting to know" this behaviour is based on the in-situ measurements. The procedure of setting up a monitoring system is proposed within the frame of the project activities. The main aims are summarised as follows:

- calibration and verification of the simulation model
- examination of the actual state of the system
- proof of the correctness of the executed measures
- statistical evaluation of trends

From the Master Plan elaboration point of view, measurements belong to the most important sources of knowledge about actual operation conditions of the system, they are inputs for a definition and evaluation of discharge and pollution load trends and above all, considering a basic Master Plan technology, they represent main input for calibration and verification of mathematical models.

During elaboration on Prague Master Plan 19 flowmeters, 24 water level meters, 18 raingauges and 3 water quality samples were used. The entire monitoring campaign started on May 1999 and finished at the end of September 2000. While raingauges were in operation for the whole period, other equipment was used for shorter periods, based on the scope of the project duration. We get about 50 000 - 300 000 values from one monitoring point.

2.1 DATA COLLECTION, PROCESSING AND CONTROL

To be able to handle such amount of measured/obtained data safely, it is necessary to have a relevant and capable software tools for data processing. Based on a number of executed projects a technological line using MOUSE GANDALF software will be presented. GANDALF is software for processing, control and presentation of time series data, mainly focused on urban drainage data processing. There are a number of procedures for dependent data calculations using empirical equations and regression relations. Software also supports various data formats of different monitoring devices used in the project. Both, raw and processed data can be stored in different formats, including time series for mathematical simulation by DHI software. All time series can be browsed, edited and presented in text and/or graphical form.

2.1.1 Data processing

The data that are measured in every single monitoring station must be transferred from the monitoring station to the mathematical model. The main aims of this activity in Prague Master Plan are summarised as:

- to download data from data loggers (RS 232) to notebook
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- to import data from notebook to data server
- to use GANDALF import data utility
- to use GANDALF “mismatch” flags for no relevant data definition (bug in ultrasonic or speed sensor)
- to connect relevant measured data with previous time series data (once of month)
- to prepare data input for the computation utility (merge, combination….)
- to compute final data (Q_Manning, Q_Continuity, statistic of rains…..) and use “computed” flags
- graphical presentation
- check up data (Scatter graph or other graphical presentation) and use “user” flags for important data
- to export data to final time series for mathematical model

Fig. 3. Import utility for more measured data format to Time Series in GANDALF software

Within the project elaboration, attention will be focused to scatter graph implementation, table calculations, fixed and user defined formulas, equation modifications, global statistics, number of different imports including advanced ones, rain data including different data imports and exports, data evaluation and graphical outputs.

2.1.2 Data computation and analysis
Data collected usually once per month are therefore directly transferred to GANDALF software, where they are checked, transferred into adequate formats, required outputs are calculated (overall discharges, total rain depths per certain time period, etc.) and finally prepared for either mathematical simulations or graphical presentations.
Looking on measured data, there is a number of possibilities to find relationships between different locations and measured parameters, and based on them, to observe and evaluate the overall system performance under different loads and boundary conditions. Such example is shown in Figure 6., where is scatter graph for discharge computation from water level and velocity records in measurement point Q25.

Fig.4. TS - example editing wrong registration values from monitoring station in GANDALF (red point).

Fig.5. Computation utility for more items. Every item has its sub-window.
3 Conclusions

Measurements and monitoring represent an essential part of urban drainage master plan elaboration. Measured and evaluated data belong to the most important input conditions for modelling activities. To be able to handle such amount of data safely, it is necessary to have a relevant and capable software tool for data processing.

GANDALF is software from the DHI software family intended for processing, control and presentation of time series data and this software also offers a number of procedures for dependent data calculations using empirical equations and regression relations.

In contrast to standard software (database, Excel,...), there are many reasons to use GANDALF for large projects. GANDALF is most favoured for:

- GANDALF does not “really” have data limit
- It is possible to connect an import utility for whatever monitoring station
- All measured data are available during long term project at one place
- It is possible to connect all data (measured, flagged, computational, presentation and other) to a monitoring point
- Easy graphical presentation and graphical data editing

For the above mentioned characteristics GANDALF is used as a data processing tool during Prague Master plan elaboration. It provides easy and safe way for data collection, processing and control, especially when there are about one hundred monitoring stations in this project. During all the monitoring campaign over 10 million values were measured. Data processing for projects of such a scale as Prague Master plan is (drainage area, sewer system size and number of monitoring points), would hardly be possible without conformable software.