Gandalf in Practical Use in Scandinavia

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Abstract:

Gandalf is a powerful data processing software solution, created and developed by our colleagues at DHI a.s., to process, control and present time series data. Gandalf was designed to support many different data formats from many different types of monitoring devices, as well as to treat enormously large time series.

DHI AB began working with Gandalf in earnest about 2 years ago. Immediately realizing the advantages Gandalf presents as a data handling software, we identified areas where Gandalf could be expanded to make it even more desirable within the Scandinavian market place. DHI a.s. went to work expanding and further developing Gandalf as a tool that could be used to calculate pump station flows. They also made it possible for Gandalf to connect to an existing external data base (eg. SCADA system).

Presented here are some practical experiences working with Gandalf in Scandinavia, where it has proved to be an invaluable tool in the processing and presentation of measurement data.

1. *Karlskrona, Sweden: Data connection to SCADA system.*
2. *Karlskrona, Sweden: Pump station flow calculation and performance statistics.*
3. *Examples from Rough impervious area (Afrc) calculation and statistics*.

Introduction:

For many years, there has been a great desire in Sweden to find or develop a better solution for the calculation of pump station flow. A solution that was user friendly and very flexible compared with others in use today.

Since its introduction, Gandalf, was recognized as having the potential to fill this need within the Scandinavian marketplace. This software solution, developed with the capability to support the different data formats from many different types of flow monitoring equipment and rain gauges, was further expanded by DHI a.s. to support data from pump station loggers, making it an even more powerful tool for the processing and presentation of data.

Additional developments by DHI a.s. also made it possible to connect to an existing external data base for the easy transfer of data directly into the Gandalf.

The following are just a few examples of how Gandalf software solution is being used in Sweden today.

Data connection to SCADA system and pump station flow calculation/performance statistics.

Karlskrona, Sweden

Karlskorna, a city which lies on the southern coast of Sweden, has a population of approximately 61,000. (fig. 1) The central part of the city lies on an island known as Trossö.

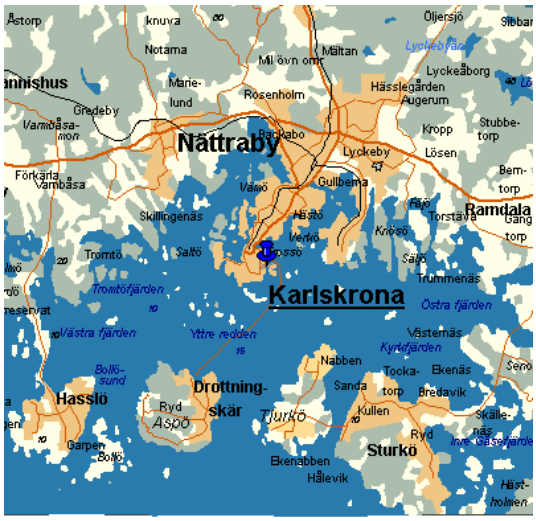


fig.1 Karlskrona, Sweden

Trossö's sewer network is greatly impacted by the level of the sea. Every year DHI performs a study to measure sea level impact and to help to the City plan maintenance actions to decrease the negative consequences sea level causes. DHI also runs hydraulic models in MOUSE to verify what, if any, improvement can be seen from the work performed on the system the previous year, and to calculate discharge from the 18 emergency discharge outlets. To verify the MOUSE model, measurement data is required. There are 14 different pump stations located on Trossö which are connected to a SCADA (Supervisory Control And Data Acquisition) system. (fig. 2)

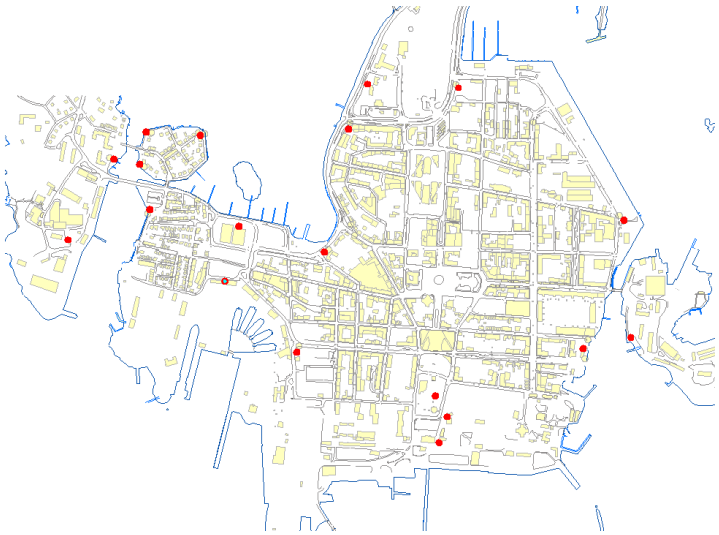
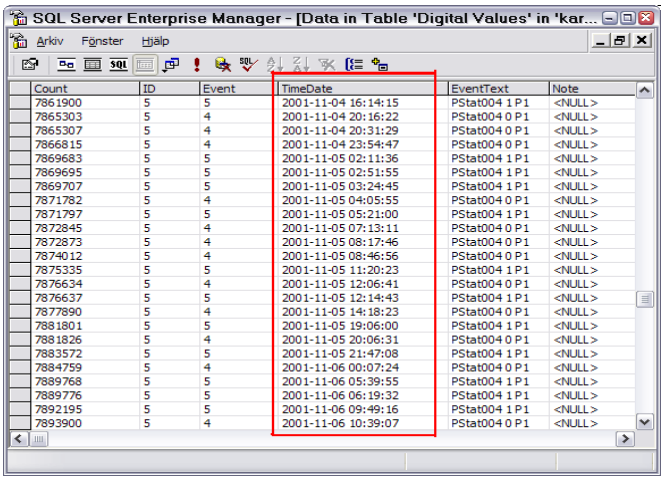


fig. 2 Pump stations on Trossö

The online control system logs pump station start/stop times. This is a massive amount of data, and it was recognized early on that Gandalf was a much better suited tool for handling these large time series. It was also determined that in order to transport data of quantity into Gandalf, it might be easier to develop a link allowing Gandalf to connect directly to the City's database SQL-server. After communicating with DHI a.s., a data link was created which allows Gandalf to connect with Karlskrona's SQL-server for direct downloads of indata into Gandalf.

In order to create this data link, the following steps were performed:

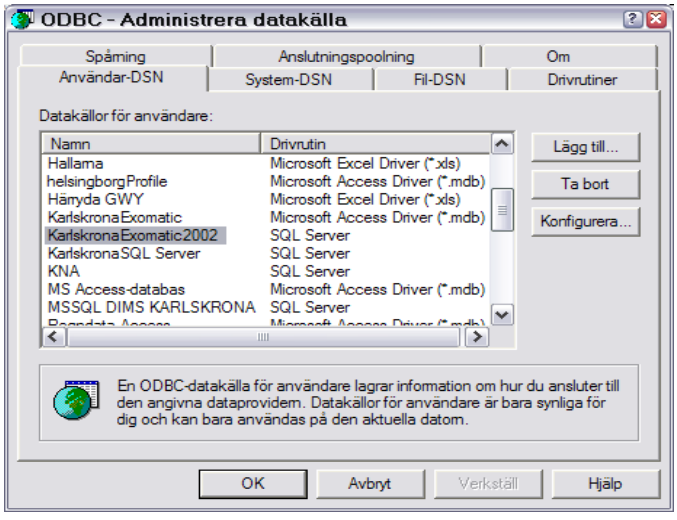
1. Data base conditions – it is important to have a data base where the time column format is date + time together. (fig. 3)



Count	ID	Event	TimeDate	EventText	Note
7861900	5	5	2001-11-04 16:14:15	PStat004 1 P1	<NULL>
7865303	5	4	2001-11-04 20:16:22	PStat004 0 P1	<NULL>
7865307	5	4	2001-11-04 20:31:29	PStat004 0 P1	<NULL>
7866815	5	4	2001-11-04 23:54:47	PStat004 0 P1	<NULL>
7869683	5	5	2001-11-05 02:11:36	PStat004 1 P1	<NULL>
7869695	5	5	2001-11-05 02:51:55	PStat004 1 P1	<NULL>
7869707	5	5	2001-11-05 03:24:45	PStat004 1 P1	<NULL>
7871782	5	4	2001-11-05 04:05:55	PStat004 0 P1	<NULL>
7871797	5	5	2001-11-05 05:21:00	PStat004 1 P1	<NULL>
7872845	5	4	2001-11-05 07:13:11	PStat004 0 P1	<NULL>
7872873	5	4	2001-11-05 08:17:46	PStat004 0 P1	<NULL>
7874012	5	4	2001-11-05 08:46:56	PStat004 0 P1	<NULL>
7875335	5	5	2001-11-05 11:20:23	PStat004 1 P1	<NULL>
7876634	5	4	2001-11-05 12:06:41	PStat004 0 P1	<NULL>
7876637	5	5	2001-11-05 12:14:43	PStat004 1 P1	<NULL>
7877890	5	4	2001-11-05 14:18:23	PStat004 0 P1	<NULL>
7881801	5	5	2001-11-05 19:06:00	PStat004 1 P1	<NULL>
7881826	5	4	2001-11-05 20:06:31	PStat004 0 P1	<NULL>
7883572	5	5	2001-11-05 21:47:08	PStat004 1 P1	<NULL>
7884759	5	4	2001-11-06 00:07:24	PStat004 0 P1	<NULL>
7889768	5	5	2001-11-06 05:39:55	PStat004 1 P1	<NULL>
7889776	5	5	2001-11-06 06:19:32	PStat004 1 P1	<NULL>
7892195	5	5	2001-11-06 09:49:16	PStat004 1 P1	<NULL>
7893900	5	4	2001-11-06 10:39:07	PStat004 0 P1	<NULL>

(fig.3 data base time format)

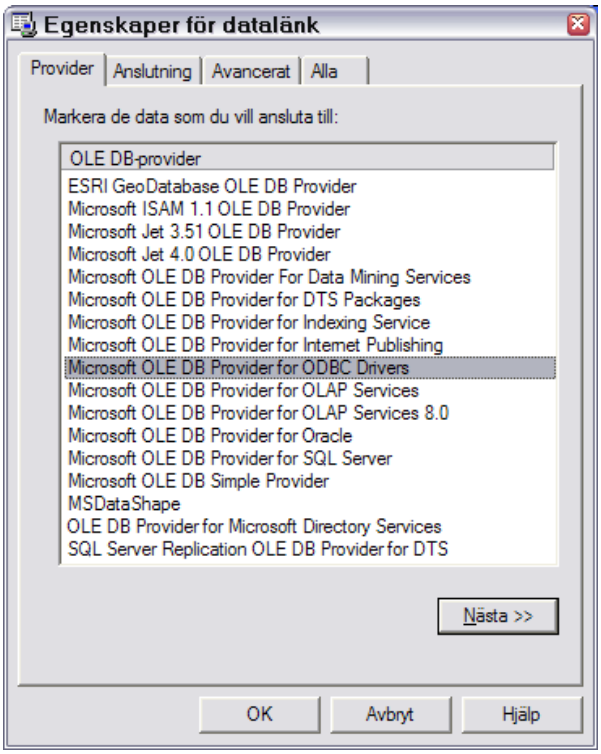
2. Create a data source in ODBC Data Source manager in Windows. (fig. 4)



(fig. 4 Data source Administrator)

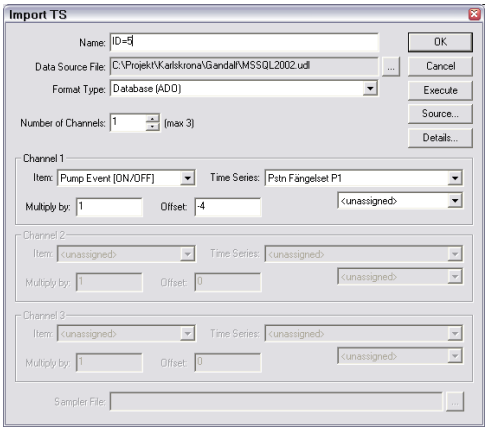
3. Create a connection with the data source. There are two possibilities:

   - *.udl file (fig. 5)
   - connection string

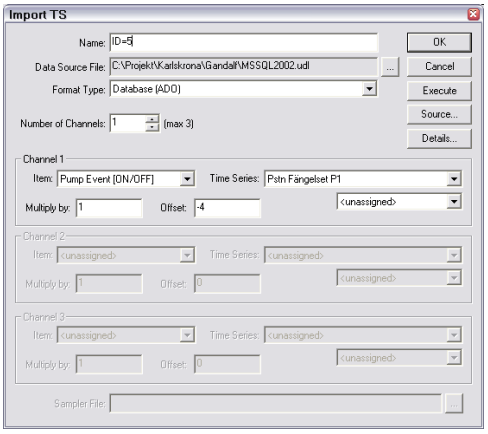


*(fig. 5 *.udl file)*

4. Create a new import in Gandalf. (fig. 6.1 & 6.2)



(fig. 6.1 Gandalf import definition)



(fig. 6.2 Gandalf import definition)

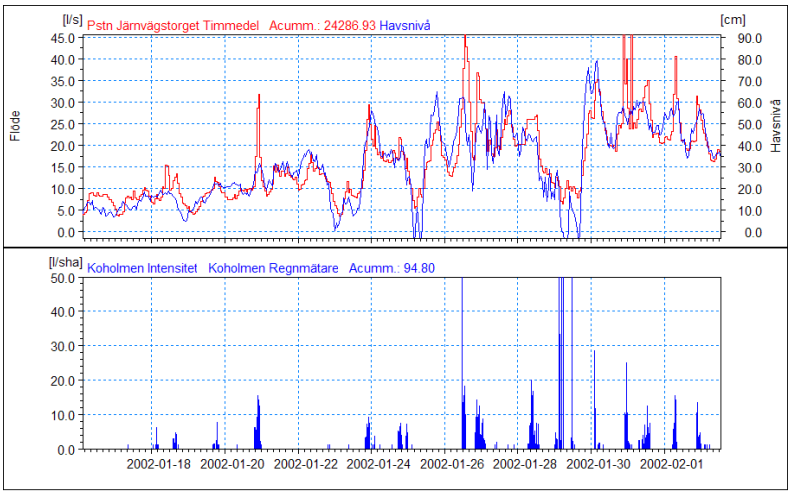
For security reasons, the City does not allow remote (modem) access to their server, but this would be possible. At the moment, the downloads occur on-site in the offices of the Karlskrona Technical Department.

Pumpstation flow calculation and performance statistics Karlskrona, Sweden

After the implementation of the direct on-line download capability, data for the last year from all 14 pumpstations was downloaded directly into Gandalf. This data, in the form of pump start/stop time, was analysed in Gandalf in order to calculate flow into and out from the pump station. To calculate inflow (fill time), Gandalf uses the volume of the pump sump and the time between pump stop and start. (Method A) To calculate flow out from the pump station, Gandalf uses the pump capacity and the time between pump start and stop. (Method B). A third calculation, (Method A + B) is used during high flow events when the pumps are running longer than usual. In Gandalf, one can choose which method one prefers to use for the calculation of flow, and in the case of Method A + B, one can define in terms of seconds the amount of time the pumps are running before Gandalf switches between Method A and Method B. (Method A becomes inaccurate when the pumps are running too long.)

Gandalf also has the capability of calculating flows from multiple pumps and double pumping events.

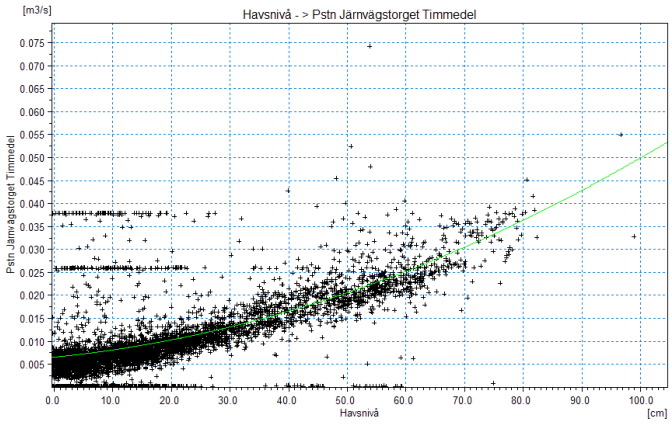
In the case of Karlskrona, pump station flows were calculated in Gandalf and compared with sea level as well as precipitation (fig. 7)



(fig. 7 Pump station flow, sea level and rain)

After calculating pump station inflow and outflow in Gandalf, the data can be exported directly into MOUSE where it can be used to calibrate/verify the results of the model simulations.

Gandalf software solution can also be used to provide a variety of statistical analyses which can be used to gauge the performance of the system. Once again, in the case of Karlskrona, Gandalf Scattergraph functions provided a graphical analysis of the impact sea level has on the different pumpstations. (fig. 8)



(fig. 8 Pump station flow versus sea level)

Here one can clearly see a relationship between sea level and the amount of flow from this one particular pump station.

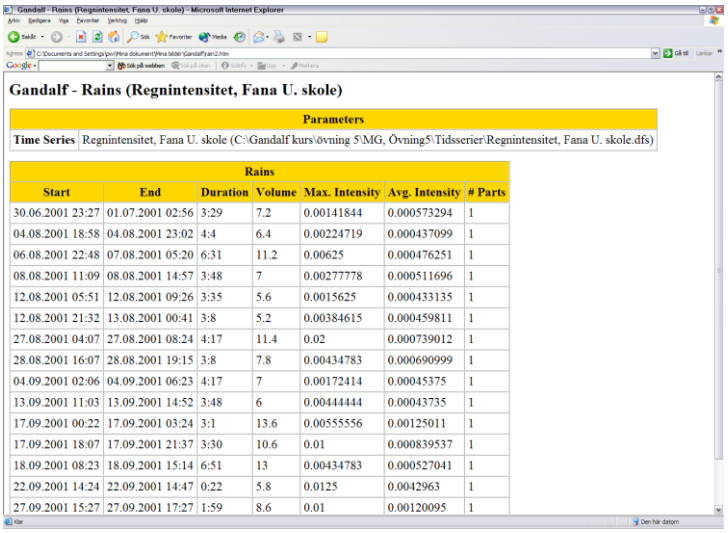
This same analysis can be applied to sea level and/or rain in relation to emergency overflow events in the community.

Examples of rough A_{frc} calculation in Gandalf

The Fast Runoff Component, FRC, used in Mouse RDI can be estimated from flow data. When calculating the effective area (A_{frc}) that contributes to the FRC , the increased flow due to a rain event is related to the rain volume.

FRC can be different for the same catchment area depending on the intensity and volume of a particular rain event. It is therefore important to compare several different rain events of varying volume and intensity to get a better idea of the catchments characteristics.

There are certain criteria that one should keep in mind when calculating A_{frc}. For example, one would like to select rains that are >5mm in volume and rain events that have 4 dry days previous to the event. Fortunately, we have the possibility to use the rain query function in Gandalf to make the work easier. By predefining which rains are interesting in accordance with the correct criteria, Gandalf selects and lists which rains are pertinent for A_{frc} calculation. (fig. 9)



Gandalf - Rains (Regnintensitet, Fana U. skole)

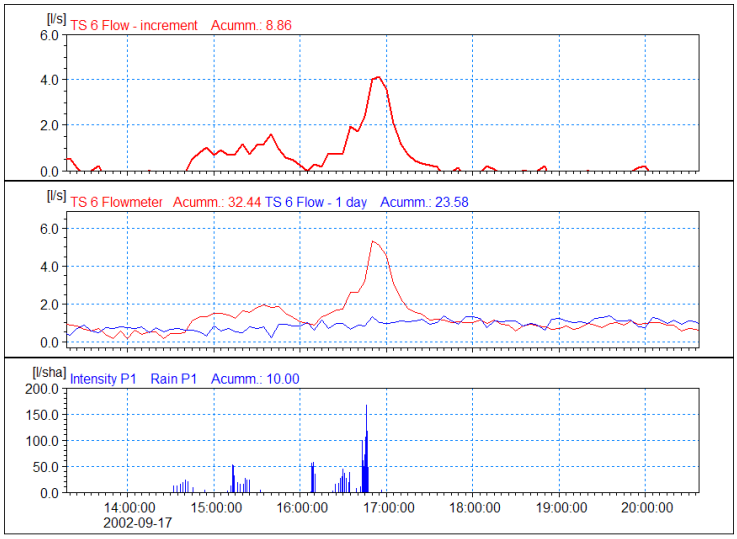
Parameters	
Time Series	Regnintensitet, Fana U. skole (C:\Gandalf kurs\övning 5\MG, Övning5\Tidsserier\Regnintensitet, Fana U. skole.dfs)

Rains

Start	End	Duration	Volume	Max. Intensity	Avg. Intensity	# Parts
30.06.2001 23:27	01.07.2001 02:56	3:29	7.2	0.00141844	0.000573294	1
04.08.2001 18:58	04.08.2001 23:02	4:4	6.4	0.00224719	0.000437099	1
06.08.2001 22:48	07.08.2001 05:20	6:31	11.2	0.00625	0.000476251	1
08.08.2001 11:09	08.08.2001 14:57	3:48	7	0.00277778	0.000511696	1
12.08.2001 05:51	12.08.2001 09:26	3:35	5.6	0.0015625	0.000433135	1
12.08.2001 21:32	13.08.2001 00:41	3:8	5.2	0.00384615	0.000459811	1
27.08.2001 04:07	27.08.2001 08:24	4:17	11.4	0.02	0.000739012	1
28.08.2001 16:07	28.08.2001 19:15	3:8	7.8	0.00434783	0.000690999	1
04.09.2001 02:06	04.09.2001 06:23	4:17	7	0.00172414	0.00045375	1
13.09.2001 11:03	13.09.2001 14:52	3:48	6	0.00444444	0.00043735	1
17.09.2001 00:22	17.09.2001 03:24	3:1	13.6	0.00555556	0.00125011	1
17.09.2001 18:07	17.09.2001 21:37	3:30	10.6	0.01	0.000839537	1
18.09.2001 08:23	18.09.2001 15:14	6:51	13	0.00434783	0.000527041	1
22.09.2001 14:24	22.09.2001 14:47	0:22	5.8	0.0125	0.0042963	1
27.09.2001 15:27	27.09.2001 17:27	1:59	8.6	0.01	0.00120095	1

(fig. 9 Gandalf rain statistics)

Once the appropriate rains are listed, Gandalf can then be used as a tool to calculate the Afrc. By graphically displaying time series for rain and flow, as shown in figure 10, one can quickly calculate the area for the given measuring point.



(fig. 10 Method for calculating rough Afrc)

In the example above, the middle graph shows the difference in flow between a normal dry day (blue) and flow resulting from the rain event (red). The top graph shows this difference in m^3. This difference in flow divided by the rain for this event gives a rough estimate of the Afrc. Here, 8.86 m^3 (flow difference) / 0.01m (rain) = 886 m^2 of Afrc.

Summary

Presented here were just a couple of examples of how Gandalf is being used in Scandinavia. Gandalf is quickly becoming an indispensable tool for the handling and presentation of different types of measurement data. The potential for further development of more complex analyses and use in areas as yet untapped seems limitless. Used alone or together with other DHI software programs, it is a powerful tool for everyone.