Analyzing Groundwater Quality Data and Contamination Plumes: GWSDAT

Wayne Jones[1], Mike Spence[2] and Matthijs Bonte[3]

1. Shell Global Solutions Ltd, Manchester, United Kingdom, wayne.w.jones@shell.com
2. CONCAWE, Brussels, Belgium, mike.spence@concawe.org
3. Shell Global Solutions BV, Rijswijk, The Netherlands, matthijs.bonte@shell.com

What is GWSDAT?

GWSDAT IN A NUTSHELL

- A user-friendly, free and open-source, decision-support tool for the analysis and reporting of groundwater monitoring data
- Sophisticated data analyses using spatiotemporal penalized spline statistical modelling
- Rapid interpretation of plume behaviour using plume metrics (mass, concentration, area)

KEY BENEFITS

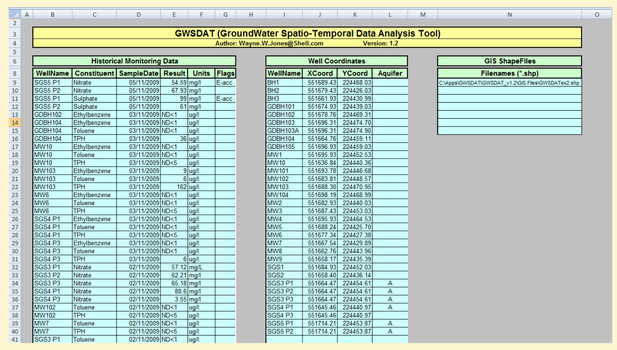
- Improved data transparency to design and optimize groundwater monitoring
- Clarity on the relations between dissolved contaminant concentrations, NAPL thicknesses, and groundwater flow
- Rapid interpretation of complex data sets from large groundwater monitoring networks
- Facilitated report and (graphics) generation

How does it work?

Step 1: Install GWSDAT

- GWSDAT will run on any PC (XP | later) with Microsoft Excel.
- Download R and GWSDAT (both free).
- GWSDAT is run as a Excel add-in.

Step 2: Enter your data



GWSDAT (GroundWater Spatio-Temporal Data Analysis Tool)

Author: Wayne.W.Jones@Shell.com Version: 1.2

Historical Monitoring Data

WellName	Constituent	SampleDate	Result	Units	Flags
SGS5 P1	Nitrate	05/11/2009	54.55	mg/l	E-acc
SGS5 P2	Nitrate	05/11/2009	67.93	mg/l	
SGS5 P1	Sulphate	05/11/2009	99	mg/l	E-acc
SGS5 P2	Sulphate	05/11/2009	61	mg/l	
GDBH102	Ethylbenzene	03/11/2009	ND<1	ug/l	
GDBH104	Ethylbenzene	03/11/2009	ND<1	ug/l	
GDBH104	Toluene	03/11/2009	ND<1	ug/l	
GDBH104	TPH	03/11/2009	36	ug/l	
MW10	Ethylbenzene	03/11/2009	ND<1	ug/l	
MW10	Toluene	03/11/2009	ND<1	ug/l	
MW10	TPH	03/11/2009	ND<5	ug/l	
MW103	Ethylbenzene	03/11/2009	9	ug/l	
MW103	Toluene	03/11/2009	6	ug/l	
MW103	TPH	03/11/2009	162	ug/l	
MW6	Ethylbenzene	03/11/2009	ND<1	ug/l	
MW6	Toluene	03/11/2009	ND<1	ug/l	
MW6	TPH	03/11/2009	ND<5	ug/l	
SGS4 P1	Ethylbenzene	03/11/2009	ND<1	ug/l	
SGS4 P1	Toluene	03/11/2009	ND<1	ug/l	
SGS4 P1	TPH	03/11/2009	ND<5	ug/l	
SGS4 P3	Ethylbenzene	03/11/2009	ND<1	ug/l	
SGS4 P3	Toluene	03/11/2009	ND<1	ug/l	
SGS4 P3	TPH	03/11/2009	6	ug/l	
SGS3 P1	Nitrate	02/11/2009	67.12	mg/l	
SGS3 P2	Nitrate	02/11/2009	62.21	mg/l	
SGS3 P3	Nitrate	02/11/2009	66.18	mg/l	
SGS4 P1	Nitrate	02/11/2009	88.4	mg/l	
SGS4 P3	Nitrate	02/11/2009	3.55	mg/l	
MW102	Toluene	02/11/2009	ND<1	ug/l	
MW102	TPH	02/11/2009	ND<5	ug/l	
MW7	Toluene	02/11/2009	ND<1	ug/l	
MW7	TPH	02/11/2009	ND<5	ug/l	
SGS3 P1	Toluene	02/11/2009	ND<1	ug/l	

Well Coordinates

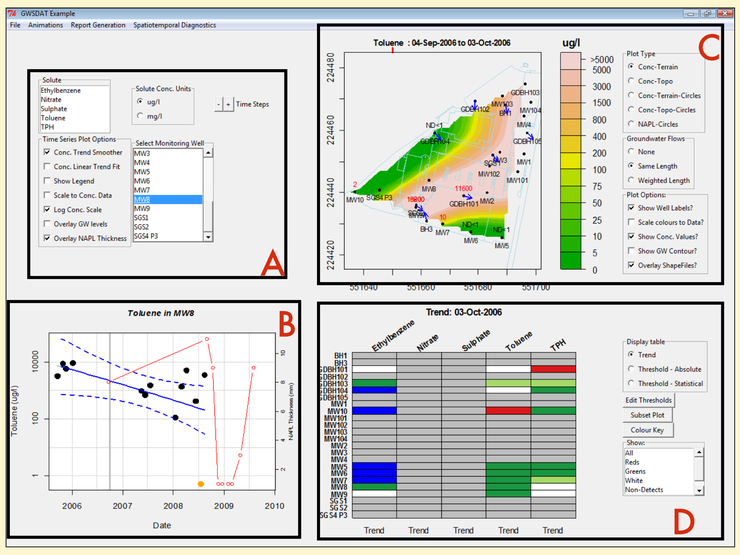
WellName	XCoord	YCoord	Aquifer
BH1	551689.43	224468.03	
BH2	551679.43	224426.63	
BH3	551661.93	224430.99	
GDBH101	551674.93	224439.03	
GDBH102	551678.76	224469.31	
GDBH103	551696.31	224474.70	
GDBH103A	551696.31	224474.90	
GDBH104	551664.76	224459.11	
GDBH105	551696.93	224459.03	
MW1	551696.93	224452.53	
MW10	551636.84	224440.36	
MW101	551693.78	224446.68	
MW102	551683.81	224446.57	
MW103	551688.36	224470.95	
MW104	551696.19	224468.99	
MW2	551682.93	224440.03	
MW3	551687.43	224453.03	
MW4	551695.93	224464.53	
MW5	551688.24	224426.79	
MW6	551677.34	224427.38	
MW7	551667.54	224429.89	
MW8	551662.76	224443.96	
MW9	551658.17	224435.39	
SGS1	551684.93	224452.03	
SGS2	551668.40	224436.14	
SGS3 P1	551664.47	224454.61	A
SGS3 P2	551664.47	224454.61	A
SGS3 P3	551664.47	224454.61	A
SGS4 P1	551645.46	224440.97	A
SGS4 P3	551645.46	224440.97	A
SGS5 P1	551714.21	224453.87	A
SGS5 P2	551714.21	224453.87	A

GIS ShapeFiles

Filenames (*.shp)
C:\Apps\GWSDAT\GWSDAT_v1.2\GIS Files\GWSDATex2.shp

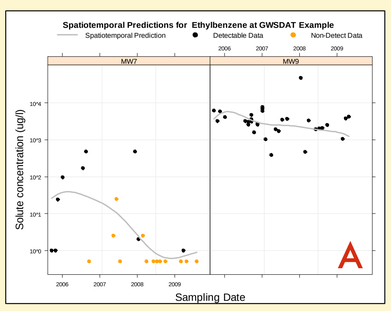
- Enter data in a standard intuitive spreadsheet.
- Add shapefile for basemap.

Step 3: Analyze your data

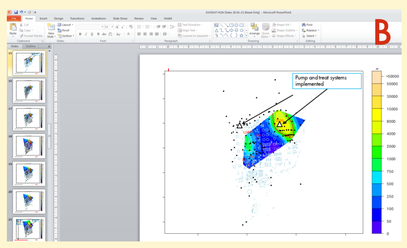


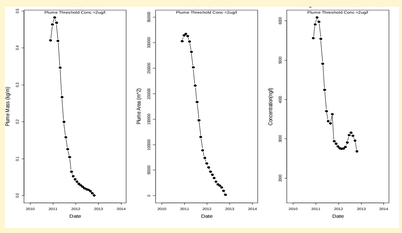
- Select analyte, well, and time (panel A)
- Rapid visual check (panel B)
- Concentration contour maps (panel C)
- Investigate data trend and threshold (panel D)

Step 4: Export the figures



- Plots can directly be exported (A)
- Export a sequence of plots of different time slices (B)
- Export plume metrics graphs (C)





More information?

- Jones, W.R.; M. J. Spence; A. W. Bowman, L. Evers, D. A. Molinari (2014) A software tool for the spatiotemporal analysis and reporting of groundwater monitoring data. Environmental Modelling & Software: 55, p242-249 (doi:10.1016/j.envsoft.2014.01.020)
- Jones, W.R.; M. J. Spence; M. Bonte (2015) Analyzing Groundwater Quality Data and Contamination Plumes with GWSDAT. Ground Water: 53:4: p513-514 (doi: 10.1111/gwat.12340)
- Bowman, A. W.; L. Evers, D. A. Molinari, W. R. Jones, M. J. Spence (2015) Efficient and automatic methods for flexible regression on spatiotemporal data, with applications to groundwater monitoring. Environmetrics (DOI: 10.1002/env.2347)