Data supporting the research on monitoring of water wells using fiber-optic sensors

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Contact information

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1 Introduction

A network of fiber optic sensors was installed 40 m deep in the ground, in the drinking water well field (map in Figure 1a). The sensors are called fiber Bragg grating (FBG) sensors and they are sensitive to changes in strain and temperature at the same time. The linked manuscript explains how to calculate pressure from the strain response and isolate temperature response using autoregressive (ARX) models.

2 Data structure

Data was collected in May-August 2019 by different types of sensors:

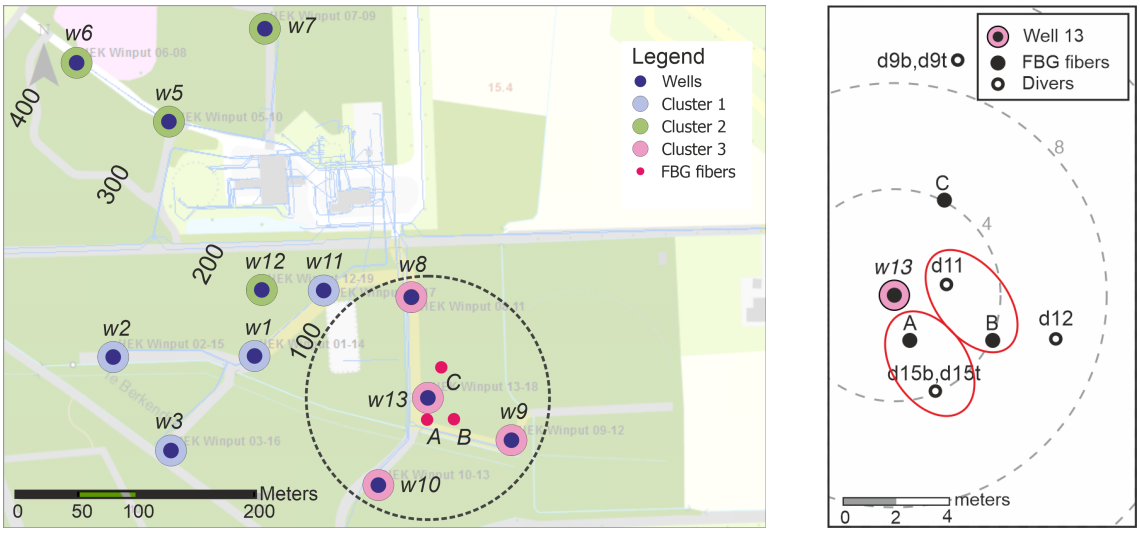
- FBG raw data (FBG interrogator Hyperion si155, LUNA). First column is Matlab timestamp, columns 2-9 are wavelengths is nm

  `mat/2019*.mat`

- Diver data: hydrostatic pressure, temperature in SI units. (van Essen Instruments)

  `mat/DiversSet2.mat`
  `DiversUncompensated20190813-0821.mat`

- Pump status: on/off resp. 1/0, Matlab timestamp



(a) (b)

Figure 1: A map of the drinking water well field: (**a**) Location of the extraction wells sorted in clusters. The area in the white rectangle is displayed in (**b**). (**b**) Location of the FBG bundles and reference divers near well 13.

mat/PumpSet2.mat

- Horizontal flow in m^3/h measured by a propeller inside of $w13$, while well was extracting(Ext) or infiltrating(Inf) at different flowrates (number in the variable names, in m^3/h).

  mat/HorizontalFlow.mat

Consult **Wells_Map_storage.png, FBG_Map_storage.png, Sensor_depth.odt** for the location of the sensors mentioned above.
Notice that wells and divers are labeled differently in the manuscript and in this data storage. See attached .png files.

3 Data processing

All data processing was performed in Matlab 2019a. For methods please consult the linked manuscript.

3.1 Generic

Plot_raw_FBG.m

This code is used to plot any raw FBG data.

3.2 Pressure

The scripts need to be run in the following order:

1. Scaling_factor.m

   Calculates scaling factor F for all FBG sensors during the time when $w13$ was not extracting. F includes effects of friction coefficient and soil compressibility.

2. Plot_pressure.m

   Converts FBG data to pressure using the scaling factor F, this time when $w13$ was extracting.

3. Plot_pressure_layers.m

   Compares FBG pressure data to diver pressure data.

3.3 Temperature

The scripts need to be run in the following order:

1. ARX_training.m

   Creates consolidation models for all FBG sensors and saves them as

   mat/MISOArx*.mat

2. ARX_validation.m

   Can be used for validating the consolidation models and separating the FBG temperature response. FBG temperature response is saved as

   mat/ResidualsFiltered*.mat

3. Plot_heat_maps.m

   FBG temperature response is interpolated to create heat maps vs. depth and time after injection of oxygenated water in the well. The script also plots flowrate measured in well $w13$. The script compares FBG temperature data to diver temperature data.

4. Real_diver_temperature.m

   Uses findpeaks to calculate groundwater temperature from the diver data.