Monitoring the groundwater quality/quantity from your desktop – application to salt water intrusion monitoring
EMI: Environmental data Management Interface

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ABSTRACT

More and more data of groundwater quantity and quality is acquired and exists. The means to collect it (GPRS, Radio, IoT...) have been developed during the last years. Storing this data is not a problem. But, having a mean to have all the different data gathered in the same platform with the possibility to display and analyse them in a simple and rapid way doesn't exist enough. A web application has been developed to answer this problem. This application enables to store all type of groundwater data (water table elevation, groundwater quality, borehole information, water extraction data…) in order to display it. The organisation of this application allows displaying all the data by site. Several tools to analyse the data are included (calculation of hydrogeological parameters, statistics, interpolation) allowing a first data interpretation, in particular for salt water intrusion issues. This web application was born from collaboration between IT experts and environmental engineers.

INTRODUCTION

Connected instrumentation development, ioT objects for sensors and monitoring devices for groundwater, has met spectacular progress in the recent years. Consequently, more and more groundwater quality/quantity data is easily available.

The new challenge is not to collect data but finding a way to manage this huge data amount and having a rapid view of them. It is also to find a tool giving the possibility of analysis and allowing global indices generation for aquifers monitoring.

A purpose design online software platform (using an Internet browser), the Environmental Monitoring Interface (*EMI*), has been developed to collate and display information about the aquifer. It includes full description of water dynamics and has specific tools for salt-water intrusion data management. Current and historic data are available 24/7.

ARCHITECTURE

EMI application is based on two identities:

- A database where all the data coming from sensors installed in different sites is stored. Different processes to import data are available (several format files, API…)
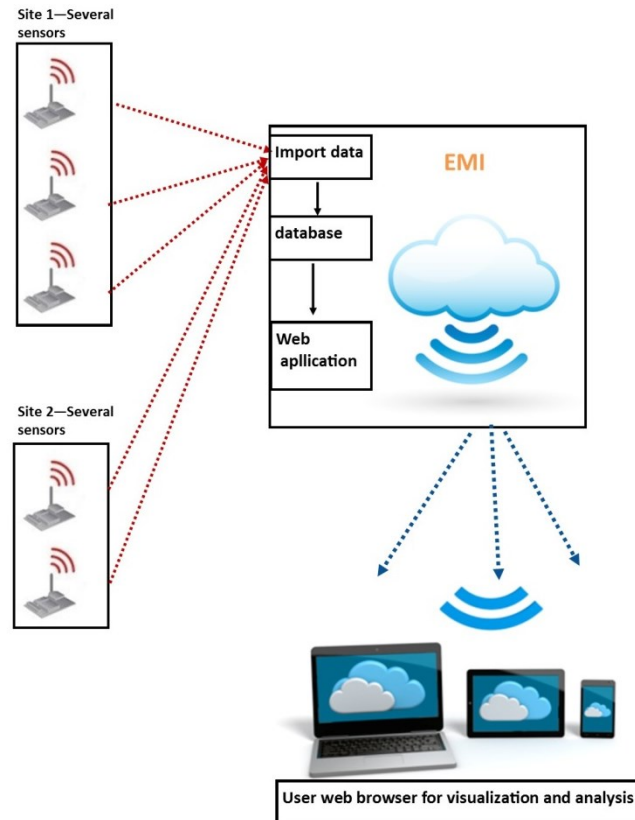- A web application allowing viewing and processing data

Figure 1: EMI architecture.

EMI can accept and integrate data from every monitoring tools already installed on the well field (whatever the tool and the manufacturing), such as flow meters, water level sensors, water quality sensors, pluviometers…

FEATURES
To enable accessing to the data online, an interface has been developed allowing to:
- viewing data on graphs (value parameter versus time)
- processing the data
  - calculate hydrogeological parameters
  - have statistics on data
  - interpolate the data on 3D graphs
- export, if necessary, a large samples of preformatted data in order to use it in other programs
- setting alerts and thresholds on some parameters (water level…)

EMI organization is based on tree architecture. For each defined site, several monitoring stations can be associated; and for each station, several sensors with several measured parameters can be defined.

The site overview can be used to locate the monitoring tools connected to EMI.
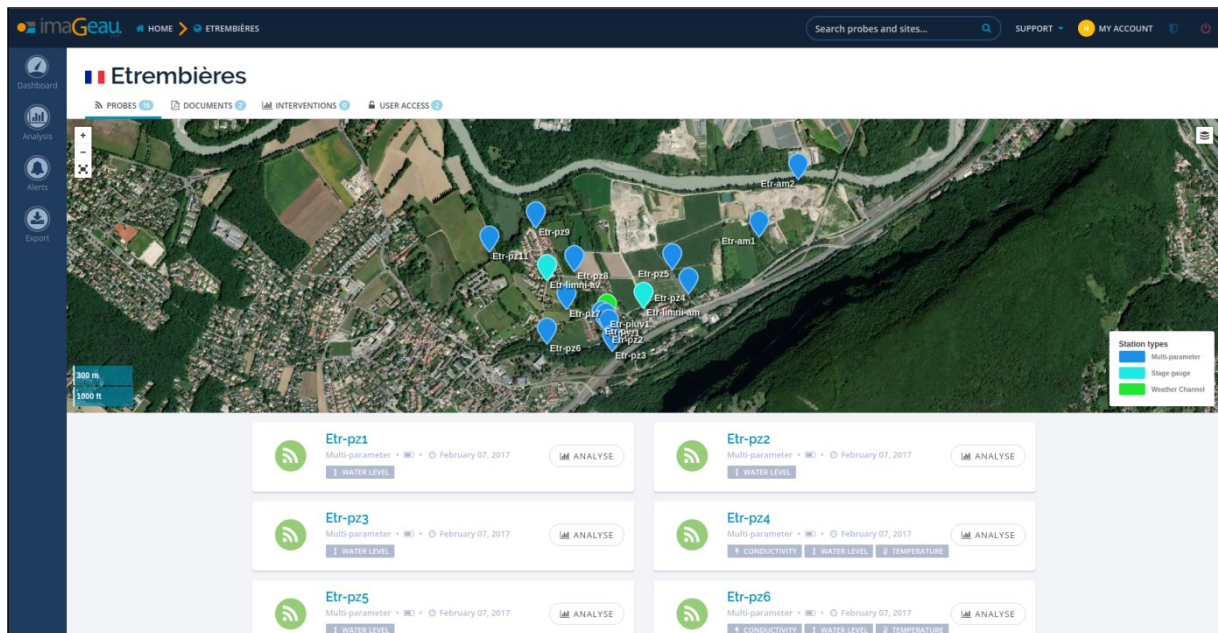
Figure 2: Site overview with different monitoring stations (dark blue: multi-parameters sensors (Cw, water level T°); light green: rain gauge; blue: water level sensor).

This organization allows having all the data associated to the same site in a same place in order to visualise and analyse it with different process. For example, on a site with several boreholes equipped with water level elevation sensors, all the water level elevation curves can be plotted on the same graph. If a rain gauge is installed on the site, the water level can be plotted in front of this rain gauge allowing having data cross-correlation.
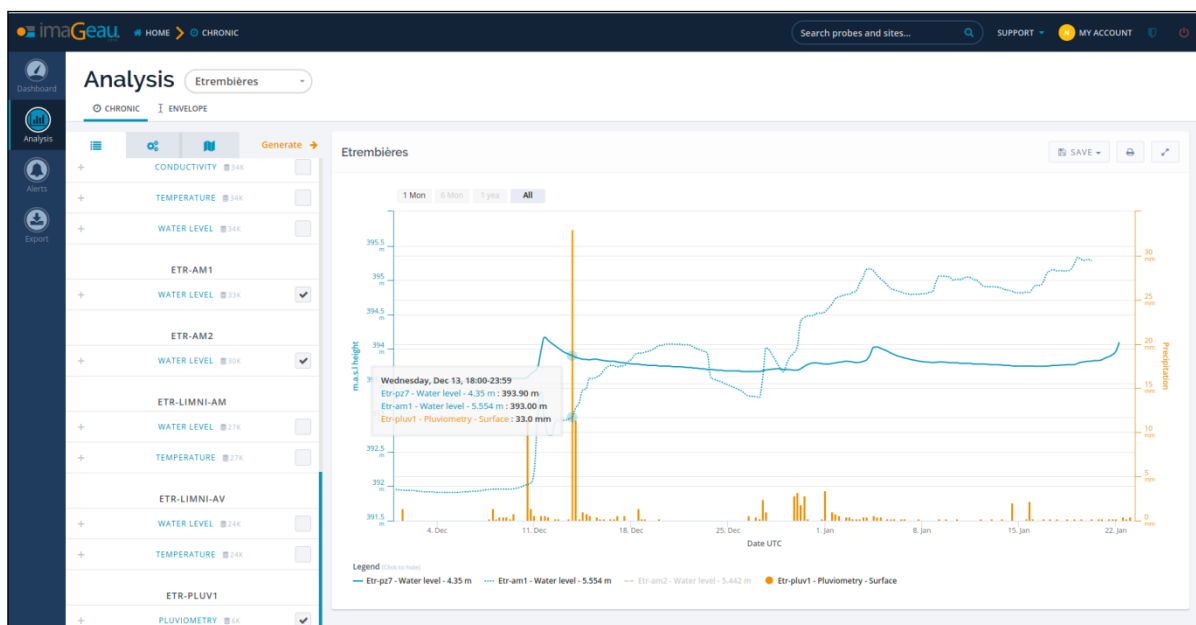

Figure 3: Site overview with different monitoring stations (dark blue: multi-parameters sensors (Cw, water level T°); light blue: rain gauge; green: water level sensor).

ANALYSIS TOOLS

Different viewing/analysis tools are available in order to better analyze the data. Depending on the sensor type, different analyses are available.

For single point sensor (i.e. water level sensor, quality sensor…), data can be plotted with:

- **"Temporal Chronic"**: Used to view environmental data changes in graph form. Up to ten curves can be added to the graph and multiple parameters can be viewed through linked graphs.

- **"Envelop"**: used to plot actual data relative to historic data (i.e. mean to see the evolution of the water level relative to anterior years)

When multiple parameters are measured at the same measurement station, it is possible to display them simultaneously on superimposed graphs with the same timescales. The browser's cursor can be used to directly compare different parameters at the same "T time."

Figure 4: Mutli-parameters curves displaying on the same graph with different colours and scales depending of the parameter (black: T°, blue: conductivity, orange: water level).

For multi-points sensors (i.e. SMD), in addition, other analyses are available:

- **"Interpolation"**: Used to interpolate multi-point data in order to create temporary iso-value maps, example: display the map of water conductivity changes over the whole aquifer block over a one-year period.
- **"Log"**: Used to view multi-point data in the form of a profile at a given date or over a given time interval.
- **"Saltwater intrusion interface"**: In the case of a conductivity profile measured using imaGeau systems (SMD), the saltwater intrusion interface can be used to follow over time the depth of an interface defined by the user, e.g.: change in depth of the fresh water/salt water interface (limit 5000 µS/cm). If multiple conductivity sensors are measuring changes over the entire vertical of a piezometer, it is useful to track the evolution of the depth of the interface between two masses of water of differing salinities. In the case of saltwater intrusion tracking, the depth of the

saltwater intrusion (freshwater/saltwater interface) is an essential parameter for understanding the evolution of the saltwater intrusion.
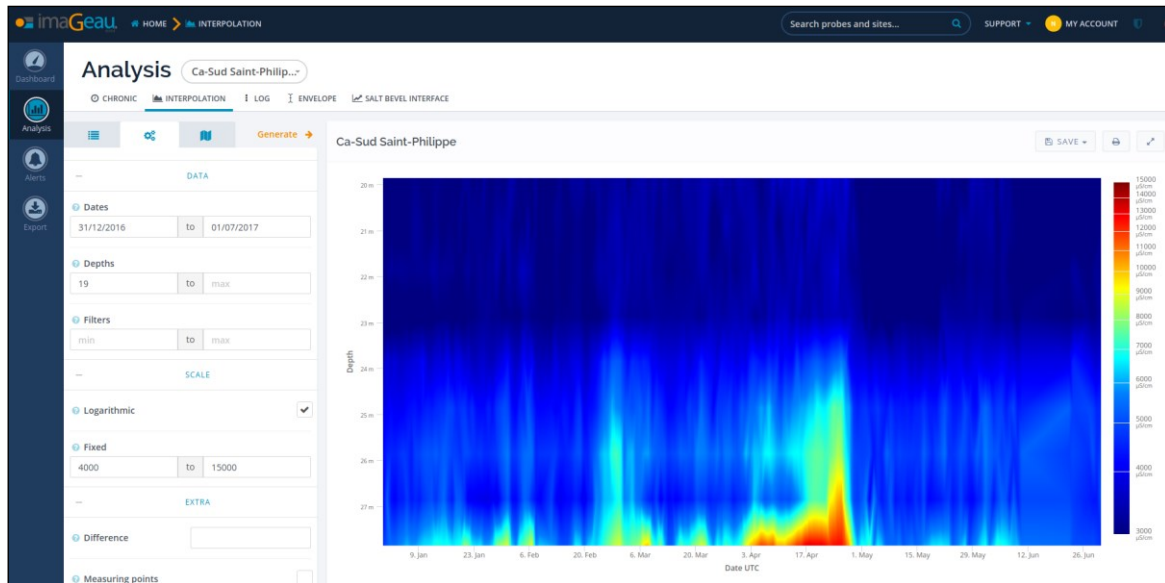

Figure 5: 3D interpolation generated from multi point data over vertical and time, example of SMD monitoring a salt water intrusion.
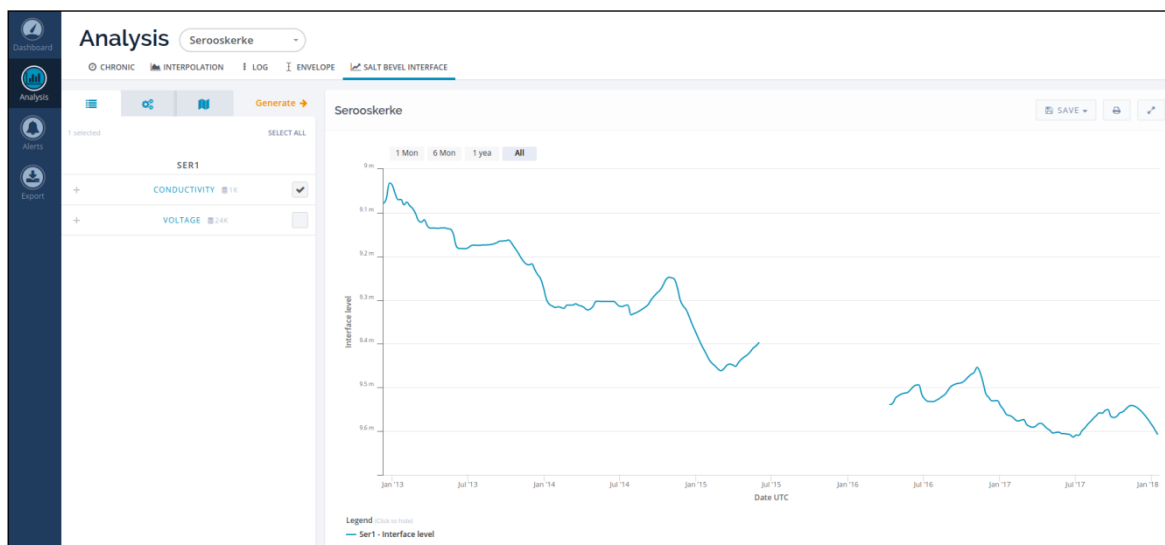

Figure 6: Freshwater/saltwater interface (8000 µS/cm value versus time) - calculated graph from a site in the Netherlands.

CONCLUSION

This web application was born out of collaboration between IT experts and environmental engineers so that its consistency and ergonomics would best meet the monitoring and operational needs. This service is used by water companies, water policy, governmental services and research institutes to monitor and manage coastal aquifers in real time, in particular in case of salt water intrusion monitoring. Several upgrades are in progress to take into account the groundwater data from a global point of view, working on water identity in regional scale. EMI uses "responsive" technology, which enables it to be used on any platform: PC, Mac, tablet, and Smartphone.