Special Session 13

Groundwater Monitoring: How & Why?

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Preamble

Monitoring is a universal practice as far as environment is concerned.
As a rule, monitoring deals with groundwater, sometimes with surface waters, often in a context of historical pollution or plant discharges or emissions.
Air monitoring is also frequent, but usually, it concerns plant emission, or urban air quality.
Sometimes other kinds of monitoring can be planned: Plant tissues, animals, ...

More often, Monitoring is associated with groundwater, and the European Framework Water Directive will make it a compulsory action.
However, until now, in too many cases, monitoring is the result of a regulator request. The regulator gets back an Excel Worksheet, full of numbers, with few comments or none at all.

We may wonder about the interest of such practices, which are often expensive ones, and about their involvement in risk management.

Finally, when dealing with brownfields, one should wonder what is of most interest: risk or guidelines?

Questions

In front of this, we must ask ourselves some questions:
The first one to be asked is: **what does the monitoring aim at**?
Collecting data and transmitting them to the authorities which made the request is certainly not a sufficient answer.
The second question is: **how are the samples taken**? In other words, does a precise sampling protocol exist and are packaging and transport to the lab carefully and rigorously carried out?
Lastly, **which event will trigger an action**? There can be thresholds or tendencies, or any other element.

The aim of monitoring

we Usually see one of these two cases:

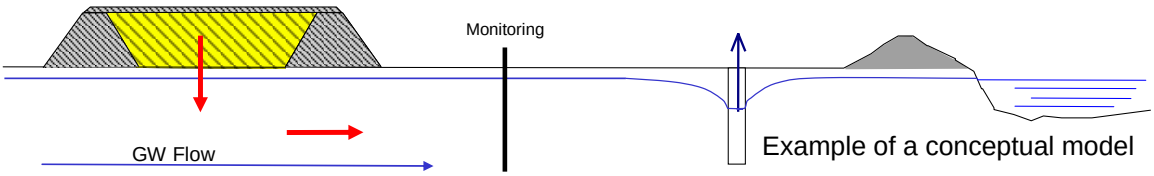
1. Either our knowledge about the site is poor, and we must collect data to understand what is going on: actually, this is not monitoring, but characterization.
2. Or we have got a rough idea of the mechanisms concerned, and we want to make sure ourselves that our assumptions are right.

In both cases, it is compelling to have an idea of how things are supposed to happen. For that, it is building a conceptual model is necessary.
In the first case, there will be lots question marks in the conceptual model: the aim of the "monitoring", or rather of the data acquisition, will be to raise the question marks.
In the second case, the aim will be to check that things occur as expected.

It should be well understood that one cannot manage a monitoring without a guide, at the risk of accumulating data without deprive of true interest.

Some common instances:

1. There is a pollution source, but because of the poor mobility of the pollutants, groundwater is clean. A well will be drilled just downstream of the source to control the water quality: this means it exists a conceptual model, maybe an implicit one, which assumes that the probability to contaminate groundwater is low. If it was not so, something else should be done.
2. In other cases, Groundwater is contaminated and there is a well supplying drinking water not far away. Usual practice is to drill monitoring wells between the source and the target. However, when doing this, one assumes that the contamination will not reach the well, or has a very low probability of doing so.



Example of a conceptual model

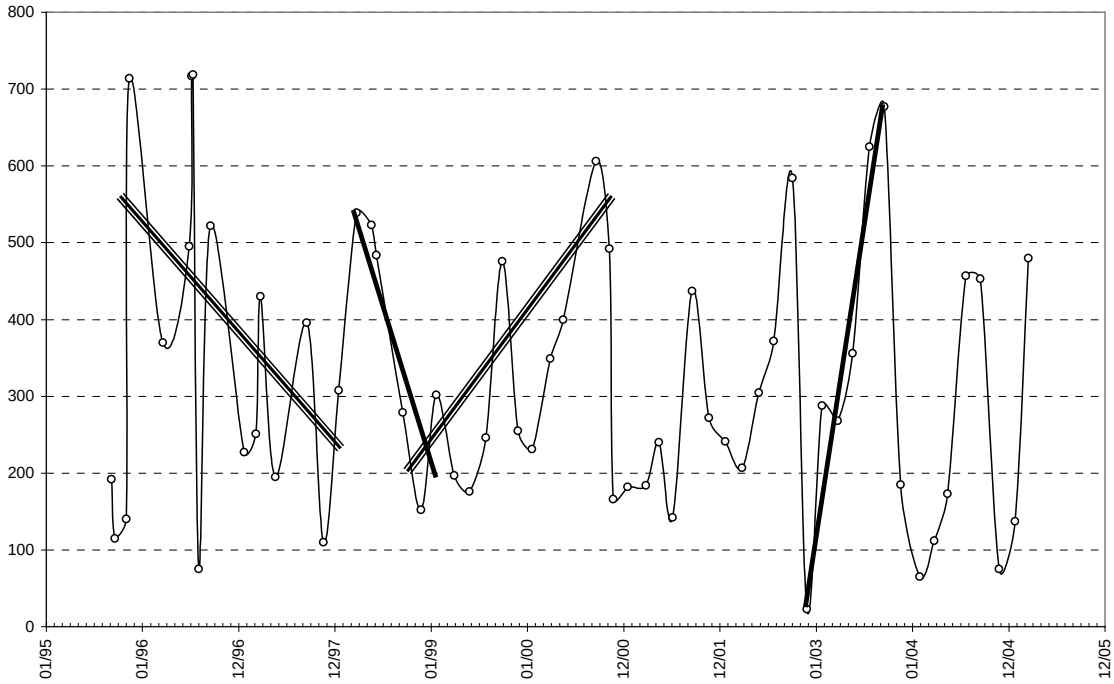
3. Third common case is monitoring a plume. Designing the monitoring requires knowledge of how the plume will behave: will it move, will concentrations rise or not, may pollution reach any target? …

I mean the conceptual model is necessary to design a successful monitoring progrm. There answers will be found to design the monitoring progrm: number and depth of wells, sampling protocol, sampling frequency, chemicals to be analysed…

Sampling

Sampling is a difficult matter.
It is obvious when one wants to sample ambient air outside. Everyone is quite conscious that the sample will be affected by the weather conditions (wind, rain, temperature), but also localization, particularly in built environement, or even the height above ground-level.
On the other hand, it seems easy to have a sample representative of groundwater taken out of a well. You'll just have to pump it !
However, when taking water out of a well, the only thing you can affirm is that it is subsoil water... if it is. Heterogeneities of the aquifer cause disruptions in subsoil circulations so that the result depends on the flow of purging and sampling, on the depth of sampling and so forth...

Absolute values may be of little meaning, and best is to think of tendencies.
Here is an example of what you can get in a 10-year observation.



Values range from 23 to 719, with an average of 323: how can we make a decision if guideline is 300?
If we consider a six-measure sequence (i.e. one-year observation), the trend can be upwards or downwards depending at which point you begin. Even with a 2 years sequence, trends can be opposite, depending on the period: 96-97 or 99-2000.
A two-year observation along with eight samples are requires to make quite sure the trend is significant.
A specialist in the field puts it you can get the concentration you want by adapting the sampling protocol...

Triggering Actions.

As far as true monitoring is concerned, there exists a true conceptual model. The aim of monitoring is to check if this conceptual model is valid. This cannot be done by comparing pollutant concentrations to a threshold value or to a guideline.
When is the value exceeded? How many values shall we need to decide it is significant? Or, how do we take into account (large) uncertainty of measurements?

In fact, the action will be started, when the collected elements clearly show that the model is defective. The criteria which will define that the model is defective must be specified at the design stage of the monitoring.
In any case, monitoring cannot be a routine, mechanical action. Critical interpretation of results is always necessary.