FREQUENTLY ASKED QUESTIONS & ANSWERS

In this document you will find all frequently asked questions about iFLUX, prerequisites & the installation, how it works, flux results and more. If something is still unclear, or you have a question that is not yet in the list, please contact us at carolien@ifluxsampling.com

iFLUX

FAQ

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iFLUX

What can iFLUX measure?

With the passive sampling cartridges, we measure groundwater flow velocity and direction in combination with the contaminants fluxes. This is the amount of water and contamination passing by the well during a fixed period.

With the iFLUX digital sensors we can continuously, simultaneously and remotely measure the groundwater horizontal or vertical flow velocities and directions, according to depth.

Which **pollutants** can iFLUX measure and how do the cartridges differ?

We have several analysis packages for the cartridges. The design for these cartridges is the same, but what's inside differs depending on what we're measuring. You can find the complete list of analysis packages here. Currently, we only do the analyses of free cyanides, not the complex cyanides.

How do you ensure a **good capture** of all parameters?

Upon validation of the analysis of cartridges, recovery tests are performed that determine ad- and desorption capacity. The results of these tests are co-processed by the lab for reporting of the results. For example, Vinyl Chloride is known to be harder to capture. For this parameter we have a resin that adsorbs it for at least 60%. SGS takes the results of the recovery tests into account when reporting the analysis results.

Can you also measure in **salt** water?

We have experience with sampling in brackish to saline environments. These were mainly analyses on organic parameters. The organic substances are captured on a non-ionic resin that is almost not subject to desorption. If there are indications of salt or brackish water, it is best to inform us about this. We will then check if it is feasible and perform sorption test.

Do you work in cooperation with **soil remediation** companies or do you carry over the remediation by yourselves?

iFLUX is an independent company and we don't perform the actual remediation. We are specialized to do the measurements of the groundwater dynamics and provide detailed data reporting and interpretation.

Can mass fluxes also be measured **vertically**?

Yes, we have 3 applications for vertical flux measurements:

- One application concerns measurements of the flow velocity and mass flux inside the straw of Treewell applications, specifically applied during Fytoremediation. For this purpose, cartridges and a specific sensor were developed and installed in the blind part of the well to measure efficiency
- A second application concerns a measurement directly in the sediment of a watercourse of the vertical flow of water and its direction, to determine and calculate interaction between groundwater and surface water. For this we use iFLUX real-time vertical flow sensors with about 20 minutes of measurement time per point.
- In parallel a third application, the Sediment Bed Samplers, licensed by UFlorida, are used to quantify vertical mass flows in sediment. The devices make it possible to distinguish ascending flows (drainage) from descending flows (infiltration).

What exactly is the IFLUX **digital smart water grid**? How is it different from soil remediation?

It is much broader than remediation and essentially concerns the real-time monitoring of horizontal or vertical fluxes via flux sensors in applications as diverse as the monitoring of dike or dam breaks, the impermeability of engineered landfill sites, surface water infiltration projects into water tables, the protection of drinking water catchments, prevention of flooding and droughts etc...

iFLUX will research and design a smart groundwater system to provide an answer on complex groundwater issues in real-time. The smart water grid will be tailored to the customer and his questions (ex. quality of the water system, drought and flood...). iFLUX smart water grid integrates available information as flux measurements, groundwater level, precipitation... from the water system and provides communication technology in order manage the water system and its challenges efficiently.

What is the purpose of the **digital sensor** of iFLUX?

They are able to continuously measure Darcy flows and real-time fluctuations according to depth. In addition, these measurements make it possible to determine the flow direction(s). The development was initiates to calculate the tidal effect which is present at several industrial sites near harbors and rivers.

But the field of application is very wide, from the monitoring of groundwater catchments or other structures (forecasting breakage of dykes, dams, etc.) to remediation and civil engineering works and even for precision agriculture.

Can you do **real-time continuous** measurements?

Yes, the digital sensor is able to do this. Technically the measurements remain discontinuous, but we can set the measurement frequency ourselves. For example, 1 measurement every second, every hour or every day

PREREQUISITES & INSTALLATION

Can I do the **installation** myself and how do I do this?

In the FLUXeye platform, the free platform where we provide customers and prospect with their project data and a demo, there is a field manual that explains the installation process step by step.

Is it possible to install the cartridges in **existing monitoring wells**?

Yes, it is possible to install cartridges in existing monitoring wells, if the inner diameter is at least 25mm. Our product design will be adapted to fit the well properly.

What **filter diameters** are suitable for flux measurements?

Most commonly used cartridges are those for wells with an internal diameter ranging from 25mm to 110 mm. However, we are not limited by a maximum well size. Larger cartridges or sensors can be tailor made. We even have experience with well diameters of 200 mm.

Which **filter material** is optimal for flux measurements?

It depends on the borehole diameter in relation to the well diameters (ID/OD) and the hydraulic conductivity of the surrounding aquifer. Filter material should not be of less hydraulic conductivity than the aquifer to avoid flow bypass.

At what **depth** should the cartridges be installed?

The iFLUX project manager will discuss the scope and features of the project with you. He will then guide you in deciding the best depth for installing the cartridges.

Which **ranges** can be measured?

Standard iFLUX measurements and sampling work best under a range of 300 µS/m to 3000 µS/m. This would be in general the condition of groundwater with a good to poorer quality in cold to temperate climatic conditions. For the mass fluxes, everything depends on the parameter analyzed and the concentrations of other compounds fixed by the resin.

For water flux cartridges, we measure fluxes between ±2cm/day and ±200cm/day.

What site information do you need and which **background information** (e.g. aquifer characteristics) will improve the results?

We usually need at least a description of the borehole to install the samplers in the wells. In addition, the wells are sampled and we get the results of the groundwater analysis.

The better the Conceptual Site Model is designed and the more available preliminary data, the better More available data/information results in less uncertainty (for example in the alpha factor – see further in this document) which will improve the calculated results and delivered interpretation.

Which **drilling technique** is optimal?

Pulse drilling is a technique that least disturbs the soil around the borehole. As a result, the permeability of the soil (k) just near the borehole is closest to the effective permeability of the aquifer. The effective permeability is used in the calculation of the flow field distortion (alpha factor) of the fluxes in and around the monitoring wells. We prefer pulsed drilling, to limit the effect of the drilling technique on the permeability near the borehole.

However, other drilling techniques, such as Sonic drilling, percussion drilling, rotary drilling, hollow stem auger, manual drilling, … , will not cause the measurements to fail. Still, it is important to know what we are really measuring and interpret results accordingly.

How long do cartridges stay in a groundwater well?

It all depends on the desired resolution. The water flux cartridges are generally exposed for 2 to 6 weeks depending on the expected flow velocity.

For mass flux, if the question is what the annual mass flux is, you would want to expose them for 12 months, whereas if you want to measure seasonal variations in dynamics for example, you would rather multiply and shorten the measurement period to the frequency and length of the phenomenon to be measured.

That being said, the objective is to measure a flux. However, if the mass flux cartridge is saturated because the concentrations and/or flow velocities are very high, we can only conclude that the mass flux is higher than the value of the flux at saturation. So, it is often the expected velocity combined with groundwater concentrations that define exposure times.

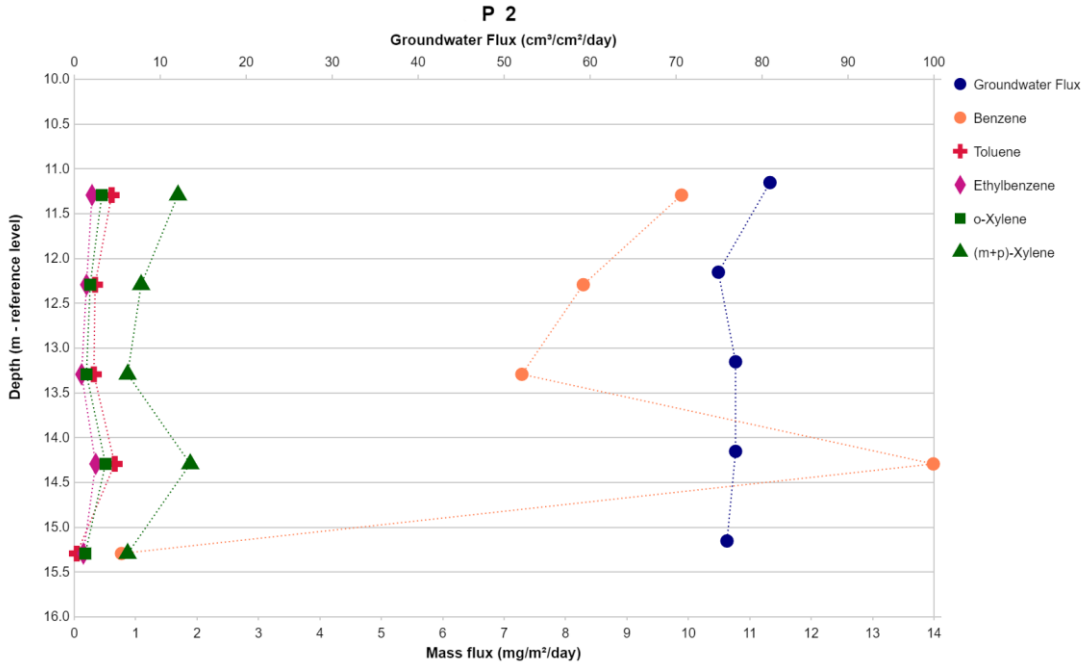
RESULTS

When will I get my results?

Water flux cartridges are usually exposed for 2 to 6 weeks, depending on the expected flow velocity and the goal of the research. Afterwards, the cartridges get analyzed and the data will be processed . We aim to deliver project results 2 weeks after site retrieval. Depending on the scale and scope of the project this could take more time. Our project manager will be able to make a more accurate assessment after consultation on a specific case.

How do we **interpret** the graphs with the results?

Below you can see an example of a graph that is reported in FLUXeye. The graph shows the vertical evolution of flux values. The flow velocities (blue dots) can be read on the upper scale and are expressed in cm/d. These blue dots represent Darcy's velocity or flow rate. The mass fluxes of the pollutants (other colored dots) can be read on the lower scale and are expressed in mg/m²/d. These data can be plotted on a map in the from of a diagram showing the composition and magnitude of the fluxes or the mass discharge.



Will **one monitoring** round be sufficient?

An iFLUX monitoringcampaign will measure the current state of the dynamics in the groundwater. Based on this campaign, it will be possible to estimate the evolution of the groundwater contamination, but only in the exposed term. For longer monitoring campaigns, the performance of additional campaigns will provide additional insights into the evolution of the contamination.

Furthermore, in some cases it is necessary to draw up an inventory of the initial state prior to the implementation of remediation works and to re-measure the situation enduring or after the works depending on the solutions applied to assess remediation efficiency.

How to determine **mass discharge** based on mass flux?

Mass discharge is calculated by integrating the individual values of the mass fluxes measured in the wells. The total mass discharge is obtained by integrating all the values. An interpolation of the results may be necessary depending on the density of the measured points. The mass discharges can also be determined at 1 point or through a control plain, depending on the data that is integrated.

Because mass discharge combines 3 factors 1) contaminant concentration in water 2) groundwater flow rate and 3) size of the source zone, mass discharge is a relevant value to evaluate the contamination and its behavior and risks. In the US a plume magnitude classification system exists for DNAPL based on mass discharge (Newell et al (2011)) which allows to evaluate the risk for a receptor downstream. A nice summary about the use of mass flux and mass discharge can be found here.

What is the **alpha** factor?

The alpha factor is the ratio between the flux measured in the monitoring well and the effective flux in the soil. The calculation of alpha considers the permeability and thickness of each of the media through which the flux passes (cartridge, monitoring well trenches, gravel pack or filter pack and aquifer). The chosen drilling technique will impact this as well.

When the thickness and permeability of a layer is not known, it is more difficult to take it into account in the alpha calculation and an unknown uncertainty factor will be added.

An uncertainty factor is implicitly always present, as you know with normal concentration measurements. So, all available information about these permeabilities will improve the delivered results.

Is a measured flux ($mg/m^2/d$) a **high or a low value**?

Whether a measured flux is a high or a low value strongly depends on the specific situation, i.e. which parameter(s) measured at the source or downstream in the plume zone, near a receptor and the type of receptor.

iFLUX has gained experience in recent years and would be happy to share this experience with you in order to come to an optimal advice.

Does the calculation of results also consider the **natural degradation**?

We determine the groundwater and mass fluxes in a well for a defined period. When natural degradation occurs in the groundwater, this will affect the mass flux composition that we measure.

Natural degradation of the resin in the cartridge is limited by the size of the adsorption sites in the sorbent which do not allow bacterial entry.

Is the use of the results of the measurements agreed by **authorities**?

Whether mass flux and mass discharge is accepted by authorities depends on the specific policy requirements. They can differ for each, country or region. Globally relevant policies or guideline make very limited direct reference to the use of flux measurements in managing groundwater issues. However, this does not indicate the use of flux measurement are not accepted.

In most countries authorities allow a risk based approach to remediate and manage soil and groundwater contamination. Mass flux methods can support a risk based approach and decision, although this needs to be demonstrated clearly. In an ideal case, regulators or stakeholder are engaged early in the process to discuss the use of mass flux and mass discharge.

Several countries like Switzerland, Austria and even Australia have introduced the flux concepts in their respective legislations. Holders of obligations are required to report the contaminant fluxes.

iFLUX can only strongly advice the use of flux measurements because they provide additional and much valuable information on groundwater and contamination dynamics, compared to the common groundwater sampling techniques.

OTHER

Which **(transport)model** do you advice to assess spreading risks?

Several models are available to assess spreading risks. The advantage of flux measurements is that they can be used directly to calibrate elaborated models (direct input) like Modflow (USGS), FEFLOW, more specific models like Biochloor, Remchlor, or to feed calculation in reduced or "home-made" spreadsheet models.

How do you deal with the variety in environmental regulations for different **countries**?

The European Union has a uniform regulation policy over its member states, but all states or regions do apply the Soil Regulation in its own terms. Some environmental regulations already include the need to assess the pollutant fluxes as in Switzerland or Austria. In other countries, flux measurements are generally used as a decision-support tool for determining the risk of dispersion and for sizing or monitoring remediation or risk management measures.

Our client has the responsibility to inform iFLUX with local regulations and procedures. If necessary, we will adapt our installation and retrieval procedures, measure up to local needs and report according the rules.

What is the **average investment** for an iFLUX campaign?

iFLUX is keen to deliver a full-service project. Final output of a project is a data report, including flux data &graphs, interpretation notes and if possible some site maps.

Our pricing strategy includes a fixed cost of €2000. This covers preparations, coordination and reporting on our online platform FLUXeye. In addition, a cost of €400 per cartridge is foreseen. This includes materials, manufacture and 1 analysis package.

iFLUX can take care of the installation and collection, but the customer can also do this himself. This installation by iFLUX will be added as an hourly fee.

Are the cartridges **disposable or reusable**?

Our cartridges are made of recyclable PE or nylon. We do not reuse cartridges as this could negatively influence the quality of the results.