What happens underground made detectable

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When a person wearing a bright-orange protective suit and carrying a laptop climbs out of a sewer shaft, it could well be an employee of the Swiss Federal Institute of Aquatic Science and Technology (Eawag). Especially if this happens in Fehraltorf. Since 2016, Eawag has been constructing an internationally unique net of sensors that document water circulation in residential areas.

The hydrology infrastructure is one of Switzerland's largest civil engineering constructions. Sewers and the drinking water network contain more than 100,000 km of pipes; if one counts the private sector as well, the length of pipes and sewers nearly doubles. Added to this are c. 800 water treatment plants as well as 2500 water suppliers with holding tanks, reservoirs etc. For the wastewater infrastructure alone, the replacement value is c. 120 billion francs.

Almost all of this construction is hidden underground. Whether during a thunderstorm the sewer capacity reaches its limit, or a great deal of clean water is carried unnecessarily to the wastewater treatment plant, or if rain washes away problematic substances from roofs and roads – it all happens out of sight. To be sure, the system has been thought through, but times change in Fehraltorf as well: more and more surfaces are now sealed, climate change is resulting in new precipitation patterns, and knowledge about micropollution makes it clear just how important waterbody protection is.

Fehraltorf is a UWO

Water management in Fehlaltorf has been studied extensively, and Eawag has been closely involved with it for as long as 25 years. A major project has been underway since February 2016, and the whole of Fehraltorf has become an Eawag UWO. The abbreviation stands for "Urban Water Observatory", a field laboratory for the water in residential areas. Sensors in the sewers, in sewage shafts, in brooks, in

ground water and elsewhere measure rain, water levels and drainage. 60 sensors have already been installed. Thanks to digital technology, temporally high-resolution measurements can be made wirelessly, even in hard-to-reach locations. Every five minutes, most of the sensors send encrypted data to a base station over a low power wide area network (LPWAN). There it can be accessed over the Internet by central computers.

Water researchers hardly have to climb into the sewers any more. The sensors' batteries last for years, thanks to extremely energy-efficient technology, and the radiation of the LPWAN is only a fraction of the mobile-phone network. For the first time ever, it is now possible to follow the complex processes in the sewers and storm sewers very nearly in real time. Formerly, they could only be simulated later on in computer models. The underground world is becoming transparent, and the real-time data allow the model to be standardized for other towns as well.

Make the water infrastructure sustainable

UWO project leader Frank Blumensaat is fascinated by the new possibilities: "If the sewers could no longer take in water, for example from newly built-up areas, it was the practice in many towns to simply build new channels or storage tanks," says the environmental engineer. "With a better understanding of the precipitation and drainage processes, existing systems can be optimised before expensive excavations and laying of concrete becomes necessary. This helps the towns to make their water infrastructure more sustainable."

Blumensaat also means "sustainable" as it applies to water protection: No sewer system is built to cope with all the water from heavy storms; in Fehlaltorf for a short time polluted water overflowed into the river Kempt. Such occurrences can be minimised, thanks to data from the sensors. Flood warnings can be issued earlier and more precisely localised. When quality characteristics are measured, prevention strategies can also be developed: pollutants can be avoided or caught before they run downstream.

Classroom of real life

For Stefan Mathys, head of the town construction department in Fehraltorf, the research project financed jointly by Eawag and the ETH is a stroke of luck. Obtaining the same data any other way would be virtually impossible or very expensive for the town. And because there is already good information available about what actually happens in the sewers, Mathys hopes that money can also be saved in the future. For his part, Blumensaat describes the field laboratory not only as an exciting research location, but also as a "real-life classroom", which he as lecturer at the ETH under Prof. Max Maurer uses for teaching environmental engineers.

Somewhat surprisingly, Blumensaat talks not only about the advantages of digitalisation, but also the risks. Online data concerning water use or water quality allow ever more precise conclusions about the consumption behaviour of the people. Suddenly one is faced with sensitive questions about data protection, above all if the measurement data is made available to all, as is the plan, and the wireless infrastructure is used by the town for other purposes. Not a problem in Fehraltorf, according to Blumensaat: the sensor network is not dense enough to give data about single households. On the other hand, private interest in the data has already been expressed. A garden centre could profit from the precipitation measurements, and the Speck airfield could benefit from more precise ground water level information.

Internet of things
The sensors and the low-energy transmission network for communicating data in Fehraltorf

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can be described as being a part of the “Internet of things”. Installing sensors in objects or equipment can improve processes of every kind. For example, towns with information about the level of material in rubbish bins can optimise their collection routes. In Fehraltorf, Eawag and the Zurich University of Applied Sciences are working to further develop the already-installed star-shaped network into a mesh structure. This will enable better data communication from underground, among other improvements.

Rain measuring device at Speck airfield
(Photo: Frank Blumensaat, Eawag)

Level sensor with wireless transmission in a sewer
(Photo: Frank Blumensaat, Eawag)

Related Links

More information about the project

Blumensaat, F., Ebi, C., Dicht, S., Rieckermann, J., & Maurer, M. (2017). Langzeitüberwachung der Raum-Zeit- Dynamik in Entwässerungssystemen mittels Niedrigenergiefunk. Korrespondenz Abwasser Abfall, 64(7).

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https://www.eawag.ch/en/info/portal/news/news-archive/archive-detail/what-happens-underground-made-detectable