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Nested sampling at karst springs: from basic patterns to event triggered sampling and on-line monitoring.

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In the last year, global changes in ecosystems, the growth of population, and modifications of the legal framework within the EU have caused an increased need of qualitative groundwater and spring water monitoring with the target to continue to supply the consumers with high-quality drinking water in the future. Additionally the demand for sustainable protection of drinking water resources effected the initiated implementation of early warning systems and quality assurance networks in water supplies.

In the field of hydrogeological investigations, event monitoring and event sampling is worst case scenario monitoring. Therefore, such tools become more and more indispensible to get detailed information about aquifer parameter and vulnerability. In the framework of water supplies, smart sampling designs combined with in-situ measurements of different parameters and on-line access can play an important role in early warning systems and quality surveillance networks.

In this study nested sampling tiers are presented, which were designed to cover total system dynamic. Basic monitoring sampling (BMS), high frequency sampling (HFS) and automated event sampling (AES) were combined. BMS was organized with a monthly increment for at least two years, and HFS was performed during times of increased groundwater recharge (e.g. during snowmelt). At least one AES tier was embedded in this system. AES was enabled by cross-linking of hydrological stations, so the system could be run fully automated and could include real-time availability of data.

By means of networking via Low Earth Orbiting Satellites (LEO-satellites), data from the precipitation station (PS) in the catchment area are brought together with data from the spring sampling station (SSS) without the need of terrestrial infrastructure for communication and power supply. Furthermore, the whole course of input and output parameters, like precipitation (input system) and discharge (output system), and the status of the sampling system is transmitted via LEO-Satellites to a Central Monitoring Station (CMS), which can be linked with a web-server to have unlimited real-time data access. The automatically generated notice of event to a local service team of the sampling station is transmitted in combination with internet, GSM, GPRS or LEO-Satellites. If a GPRS-network is available for the stations, this system could be realized also via this network. However, one great problem of these terrestrial communication systems is the risk of default when their networks are overloaded, like during flood events or thunderstorms. Therefore, in addition, it is necessary to have the possibility to transmit the measured values via communication satellites when a terrestrial infrastructure is not available. LEO-satellites are especially useful in the alpine regions because they have no deadspots, but only sometimes latency periods.

In the workouts we combined in-situ measurements (precipitation, electrical conductivity, discharge, water temperature, spectral absorption coefficient, turbidity) with time increments from 1 to 15 minutes with data from the different sampling tires (environmental isotopes, chemical, mineralogical and bacteriological data).