High-Resolution Data Loggers for Ecohydrological Wetland Research

Ecohydrological research is becoming increasingly important as threats to water resources and climate change concerns put more focus on water management, ecosystem protection and sustainable development. Ecohydrology can be defined as an integration of the fields of ecology and hydrology. The aim is to investigate how hydrological processes change over the long and short-term, and at the same time, how ecosystem functions, plants, and animals respond to these changes.

> *"It is essential to maintain wetland ecosystems for their natural benefits, as well as to make sure these stores of greenhouse gases remain intact."*

Increased attention to ecohydrological research in wetlands is gaining importance as they are recognised as significant stores of biomass. When wetlands are disturbed, through land development or from the impacts of climate change, they release large amounts of greenhouse gases - adding to climate change concerns. Ecohydrological research can help understand how wetlands function and how they may respond to these disturbances over the long term.

Wetland research and management is critical not only to combat and understand the potential effects of climate change and development, but also to maintain their other benefits. Wetlands provide natural nutrient cycling and water quality preservation, flood control and erosion protection, and are the habitat for an abundance of plant and animal species. Research to understand how wetland ecosystems respond to changes in hydrological conditions is essential when determining how to maintain, restore, and even create new wetlands.

Water Level Data Loggers Provide a Solution

In more sensitive wetland ecosystems, responses to changes in hydrological conditions occur very quickly. Therefore, studies require precise, high-resolution data in order to record the smaller timescales at which these reactions take place. More often, data loggers are being used to collect the more frequent readings required during ecohydrological studies, including fluctuations in water levels.

Water level data loggers can be set to record continuous, high frequency readings (as often as every 0.125 seconds or more) and can be left in the field unattended for extended periods. Water level data loggers provide accurate high-resolution data without the repeated site visits required when using conventional manual measurement techniques, such as water level meters or staff gauges.

Levelogger self-contained, water level and temperature datalogger

Leveloggers are one type of water level data logger that has become very useful tools in ecohydrological studies. They have been used to help understand processes in some of the most complex and unique wetland ecosystems. Research has been conducted in tidepools, saline wetlands and fens, and isolated ecosystems that are completely dependent on the upwelling of groundwater.

Data Loggers in Vernal Wetlands Research

Currently, the Institute for Ecohydrology Research in Davis, California, is using Leveloggers in multiple research projects. An overall goal of the Institute for Ecohydrology Research is to provide scientifically proven information on how wetlands and other aquatic ecosystems function, while using modern technologies that are cost-effective and provide high quality data.

They are using Leveloggers at various sites to prove to the Department of Defence and other federal U.S. facilities, a cost-effective method of collecting useful hydrological data. The Institute's work has already led to the recommended use of water level data loggers for hydrological monitoring, in upcoming U.S. federal guidelines on wetland monitoring.

With Leveloggers, the focus of their research is to establish an accurate and reliable method to measure the hydrological functioning and performance of natural and created vernal pool wetlands. Vernal wetlands are temporary pools of water that fluctuate seasonally with complex hydrological mechanisms. They receive inputs from precipitation, runoff, and subsurface flow, and are influenced by geology,

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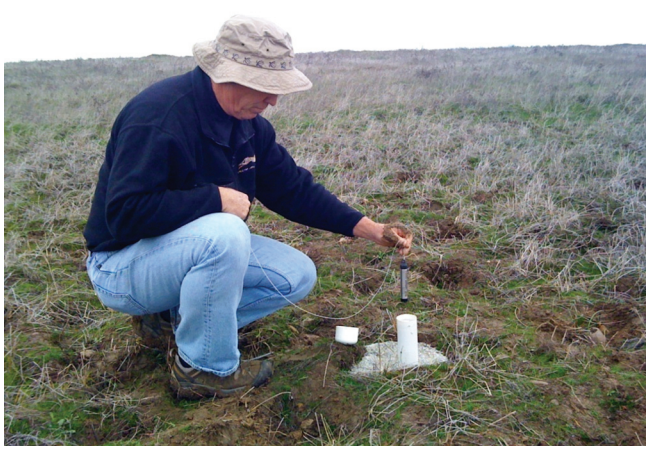


Installation of a Levelogger Junior at Beale Air Force Base as part of a wetland monitoring project for the U.S. Department of Defense. (Courtesy of The Institute for Ecohydrology Research)

Vernal pool wetland near Sacramento, CA in wet season, with slotted PVC pipes containing water level dataloggers. (Courtesy of The Institute for Ecohydrology Research)

Vernal pool wetland near Sacramento, CA during spring season, with slotted PVC pipes containing water level dataloggers. (Courtesy of The Institute for Ecohydrology Research)

soil, and climate. This creates a unique habitat for diverse flora, amphibians and insects, including some threatened and endangered species.

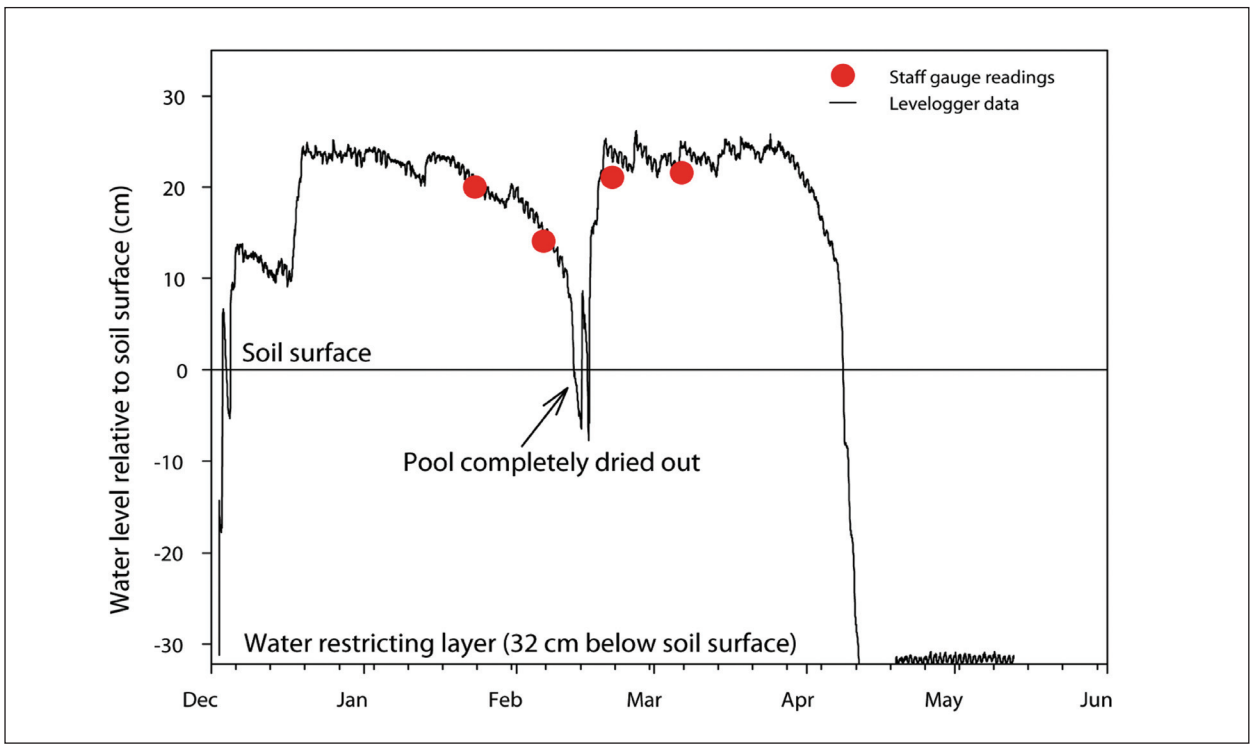
The Institute's on-going projects include a Department of Defence Environmental Security Technology Certification Program (ESTCP) demonstration project at Beale Air Force Base, California, where over a hundred Leveloggers are installed. In addition, a number of Leveloggers are being used for research at Travis Air Force Base and the Marine Corps Base at Camp Pendleton. Others are being used in a project at Mather Field, where this is the fifth consecutive year that Leveloggers are measuring vernal pool hydrology.

At these sites, Levelogger Junior F15/M5 Models are installed in slotted PVC pipes, and positioned on top of water restricting soil layers. They are then placed in upland and vernal pool wetlands, and set to record either surface or subsurface data. The water level data is collected once at the end of each wet season. The Leveloggers are removed from the field after the pools completely dry out and taken to their office for download. The water level data is used to create hydrographs, which include information on soil saturation and surface ponding periods.

Leveloggers allow the Institute to automatically collect hourly water level data, as compared to traditional staff gauge or water level meter measurements that are manually collected on a less frequent basis. The main benefit of using Leveloggers for monitoring vernal pools is the ability to continuously record water levels during the entire wet season, which is not possible with the traditional monitoring methods. From the continuous datasets, they are able to see if the vernal pools experience any mid-season dry-outs, which can be detrimental for invertebrate species living in the pools.

Dr. Niall McCarten, Executive Director of the Institute for Ecohydrology Research, is pleased with the results of their research: "We have found the Solinst Leveloggers to be very user friendly, cost-effective, and reliable. This technology provides a much higher scientific data standard than existing methods for monitoring wetlands."

The high-resolution water level data they gain by using data loggers throughout the year, combined with other research techniques, is used to better understand the differences between natural and created wetlands. This can lead to more efficient design and the successful implementation of created vernal pool wetlands. Vernal pools are being created for compensatory mitigation purposes, as natural pools are being filled or drained for other land uses.



Comparison of hourly water level data automatically collected by a datalogger, in contrast with the use of a staff gauge with only four data points manually collected by a technician. (Courtesy of The Institute for Ecohydrology Research)

The Importance of High Resolution Data

As Ecohydrological research in wetlands continues to increase in importance, data loggers are proving to be reliable tools. They are allowing the collection of data needed to understand the reactions that take place in ecosystems as hydrological conditions change. The high-resolution data is enabling ecohydrologists to see these reactions and relationships at a much higher scale not previously available with standard monitoring practices.

The continuous datasets, and high-resolution water level data that data loggers provide, have benefits in any ecohydrological research project. The datasets ensure entire monitoring seasons are recorded, without missing any critical events. Data collected over multiple seasons can identify trends coinciding with changing climate, or with developments and land use changes in watersheds.

Data that is more accurate will lead to better ecosystem management and conservation efforts. It is essential to maintain wetland ecosystems for their natural benefits, as well as to make sure these stores of greenhouse gases remain intact. In the future, wetlands, including vernal pools, could be created as a natural way to mitigate climate change, by building carbon stores. Therefore, it is imperative to understand how, and what, they need for healthy function. Accurate, high frequency data is one way to help determine this.

Leveloggers Simplify High Resolution Data Collection

Leveloggers are absolute water level and temperature data loggers, designed to measure both water and air pressure above its sensor zero point. They consist of a pressure transducer, temperature thermistor, and a long lasting internal battery to support applications where the unit will be left in the field for extended periods. The data logger itself can hold up to 120,000 sets of water level and temperature readings using a unique data compression setting. All components are contained within a 7/8" diameter stainless steel housing, with a titanium based PVD coating on certain models for extra corrosion resistance.

Leveloggers are self-contained, so they can be deployed without any other data logging equipment. Before going in to the field, they can be programmed using software, which is also later used to download the data and automatically perform barometric compensation on the data. A key advantage is the ability to pre-program the units in the office with a future start time. This allows time synchronisation, and sampling frequencies to be identical for all of the in-field water level data loggers, as well as an on-site Barologger. This level of control improves the accuracy of the water level readings, as well as decreasing the time at the end of the process to effectively analyse the field data. The Barologger is specifically designed to record barometric pressure, which is essential for removing barometric pressure fluctuations from the water level readings.

Like Leveloggers, many data loggers have the ability to connect to a telemetry system. A telemetry system takes real-time readings from the attached data loggers, and sends them to a central database, such as an office computer, using cellular, satellite or radio networks. This option is ideal for projects that are in hard to reach locations, where travel is not easy, and long-term deployment is required. Telemetry is an efficient way to have continuous access to remote real-time field data.

Overall, simplification of the water level data collection processes, using data loggers, has significantly increased the ability for environmental scientists and consultants to accumulate high-resolution data. This data is necessary to perform effective ecohydrological research, aimed at improving the understanding of environmental impacts, climate change and other factors that could affect the health of wetland ecosystems.

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