CASE STUDY:

Inexpensive open source data loggers and sensors for water levels and hydrologic measurements in least developed countries

WMO HydroHub First Innovation Call

Implementation dates:	December 2018 to May 2021
Innovation supplier:	Northern Widget
Project implementation country:	Afghanistan and Bhutan

Challenge

The provision of hydrological data is essential for understanding the availability of water resources in the face of climate and land-use changes in order to ensure sustainable development in view of population dynamics and to predict and respond to humanitarian crises before they occur. Hydrometric technologies are often expensive, hence not always affordable, especially for developing countries. Inexpensive field instrumentation – better, cheaper and open-source technologies – would help make environmental monitoring accessible and affordable for all.

The Technology

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Approach

The project was implemented in three phases:

1 Develop a total upgrade to the Margay Data Logger. This new logger, code named "Project Resnik" after the American astronaut, was eventually re-named "Okapi", inspired by that animals' long-distance communication. It includes a solar charge controller and connection points for both rechargeable Lithium-ion batteries and backup primary Alkaline batteries as well as a Feather-form-factor header for a paired telemetry board.

2 Design, build and test sensors. The project team first developed Project Walrus, a pressure transducer for water level, as well as Project Haar, a temperature, pressure, and relative humidity sensor, to obtain the atmospheric correction for water level measurements and other relevant hydrometeorological data. However, concern was raised that sensors could be damaged in streams. Therefore, we embarked on "Project Symbiont LiDAR" in which we prepared a circuit board to turn a standard Garmin laser-rangefinder into an oriented sensor capable of detecting water level and with specialized hardware to manage the laser power supply and the digital interface with the logger.

3 Construct the sensor stations and ship them to project partners in Afghanistan and Bhutan. For this work, we developed a fully waterproofed data logger housing with a mounting plate and places to secure the circuit board and batteries, using entirely off-the-shelf or 3D-printed hardware. Waterproof enclosures were developed for the Symbiont LiDAR sensor, the Haar sensor and the Walrus sensor, though only the Walrus was used in the end. These were sent to our partners in Afghanistan (five laser-rangefinder water level stations) and Bhutan (four laser-rangefinder water level stations) using Particle Boron 2G/3G mobile-phone telemetry. The identical system was tested in Minnesota, USA, and returned usable data to a Google spreadsheet.

Results

- Three new open source sensors and one new open source data logger were designed and produced for an estimated development cost of US$ 312 601.

- The data logger supports telemetry modules alongside a watchdog timer and real-time clock to minimize maintenance.

- These new open-source data loggers can be combined with three new sensors for hydrometry, alongside numerous other existing sensors that are compatible with the industry-standard analog and digital interfaces of the data logger, enabling the assembly of low-cost full hydrometry stations.

- The open source designs enable construction and assembly in developing countries.

- Both the data logger and the sensors have firmware libraries that use standardized names and approaches to streamline their interfaces and end-user programming.

- Documentation for construction, maintenance, repair, programming and operation of all the equipment was paired with trainings via teleconferencing in Afghanistan and Bhutan.

- Successful tests in Bhutan and the USA, as well as related deployments in Antarctica, Argentina and Canada, indicate that the system should be capable of providing water level data via an open source platform.

Way Forward

1 Continued laboratory and field testing will enable long-term improvements to the data-logger system and its usability.

2 Expanded partnerships with research institutions working in harsh environments (e.g., Argentine Antarctic Program, University of Minnesota, Escuela Politécnica Nacional) will provide further basis for improvement while expanding access to water and climate data in South America.

3 Northern Widget will continue communications with the project implementation partners in Bhutan and Afghanistan towards expanding the network of hydromet stations in both countries.

Partners

University of Colorado, Boulder

Kabul University, Afghanistan

ChhimiD Consulting, Bhutan

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