

A low-cost wireless sensor network for citizen science water quality monitoring

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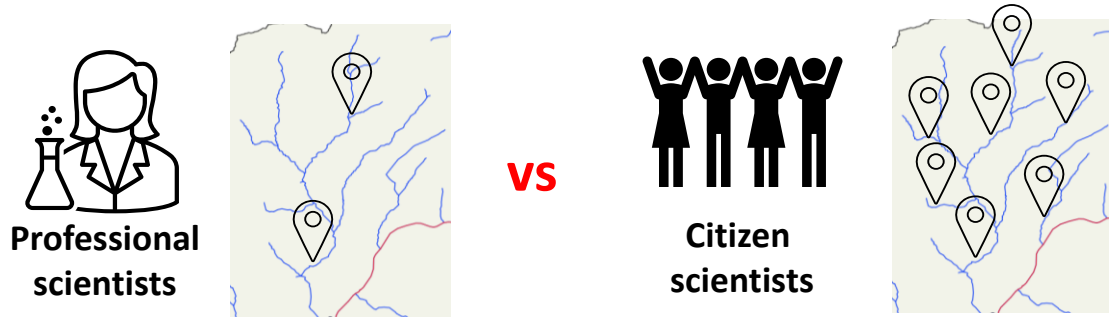
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Water quality monitoring programme design

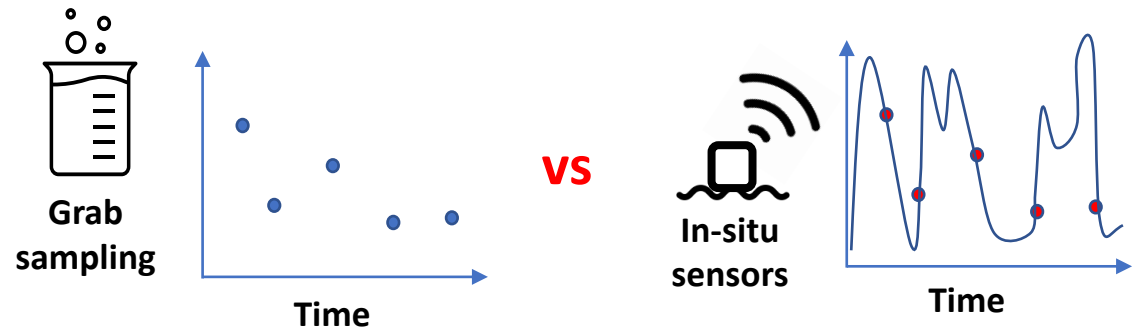
Adopting new approaches to catchment water quality monitoring can improve spatial and temporal coverage.

Improving spatial resolution

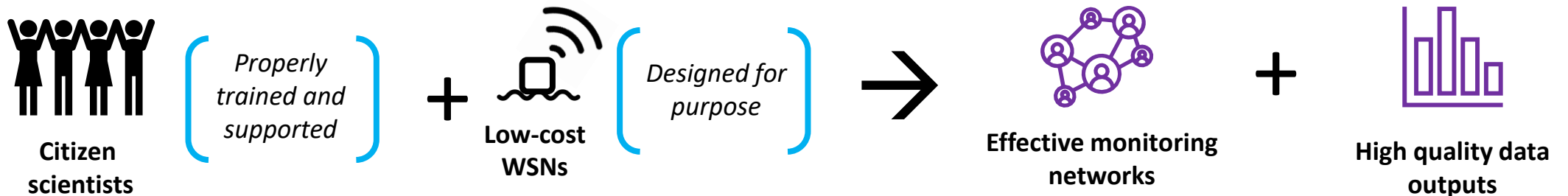


Citizen scientist's involvement improves the **spatial resolution** of water quality monitoring compared to that which can be achieved by professional scientists alone.

Improving temporal resolution

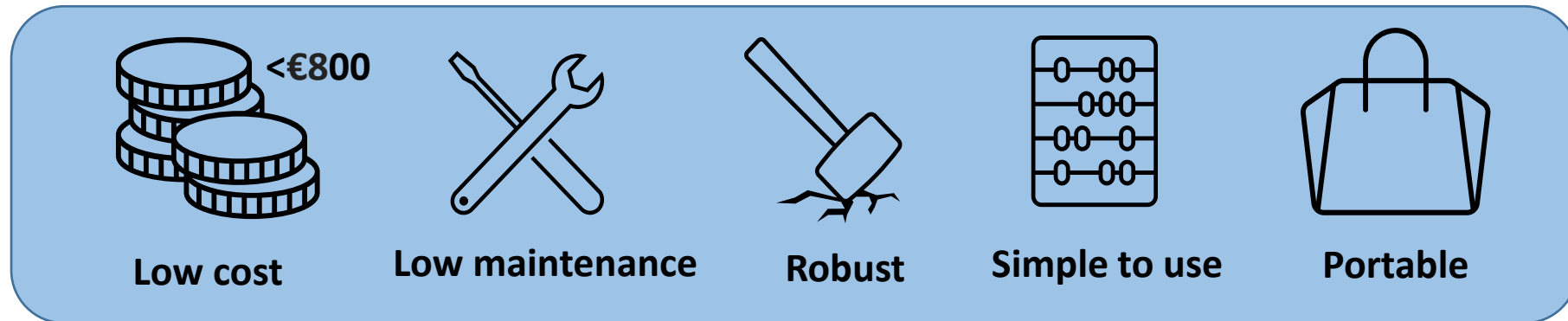


In-situ sensors improve the **temporal resolution** of water quality monitoring compared to traditional grab sampling approaches.



Designing Wireless Sensor Networks (WSNs) for citizen scientists

Critical design specification for a citizen science WSN :



- Citizen scientists can deploy and maintain WSNs if they receive the correct support and training.
- Compared to typical low-cost citizen science test kits, low-cost WSN's improve the:
(i) temporal resolution, (ii) real-time capabilities, and (iii) quality, of citizen science data acquisition.
- Existing WSNs do not meet citizen science requirements for water quality monitoring applications.
- Low-cost WSNs should be specifically designed for use by citizen scientists if they are to become effective monitoring tools.

The Hydrobean Wireless Sensor Network

Hydrobean is a low-cost wireless sensor with a base station, specifically designed for use by citizen scientists.

Hydrobean



Rechargeable power pack

Temperature sensor

Electrical conductivity sensor

Pressure sensor

VHF Radio



Base station



Solar power

Data packages are transmitted and uploaded to the online data portal every 5 minutes

Mobile



Monitor My Watershed



Data visualisation and download

Free open source online data portal presented by Stroud Water Research Centre

Electrical conductivity, temperature and pressure are monitored by Hydrobean because:

- (i) low-cost sensor technology currently exists to measure these water quality parameters reliably;
- (ii) analysed simultaneously, these three parameters can give a good indication any diversions from baseline water quality conditions, and therefore infer potential contamination incidents

Initial field test

- Hydrobean was tested in a rural Welsh stream for 5 days in January 2021
- No precipitation events occurred during this period



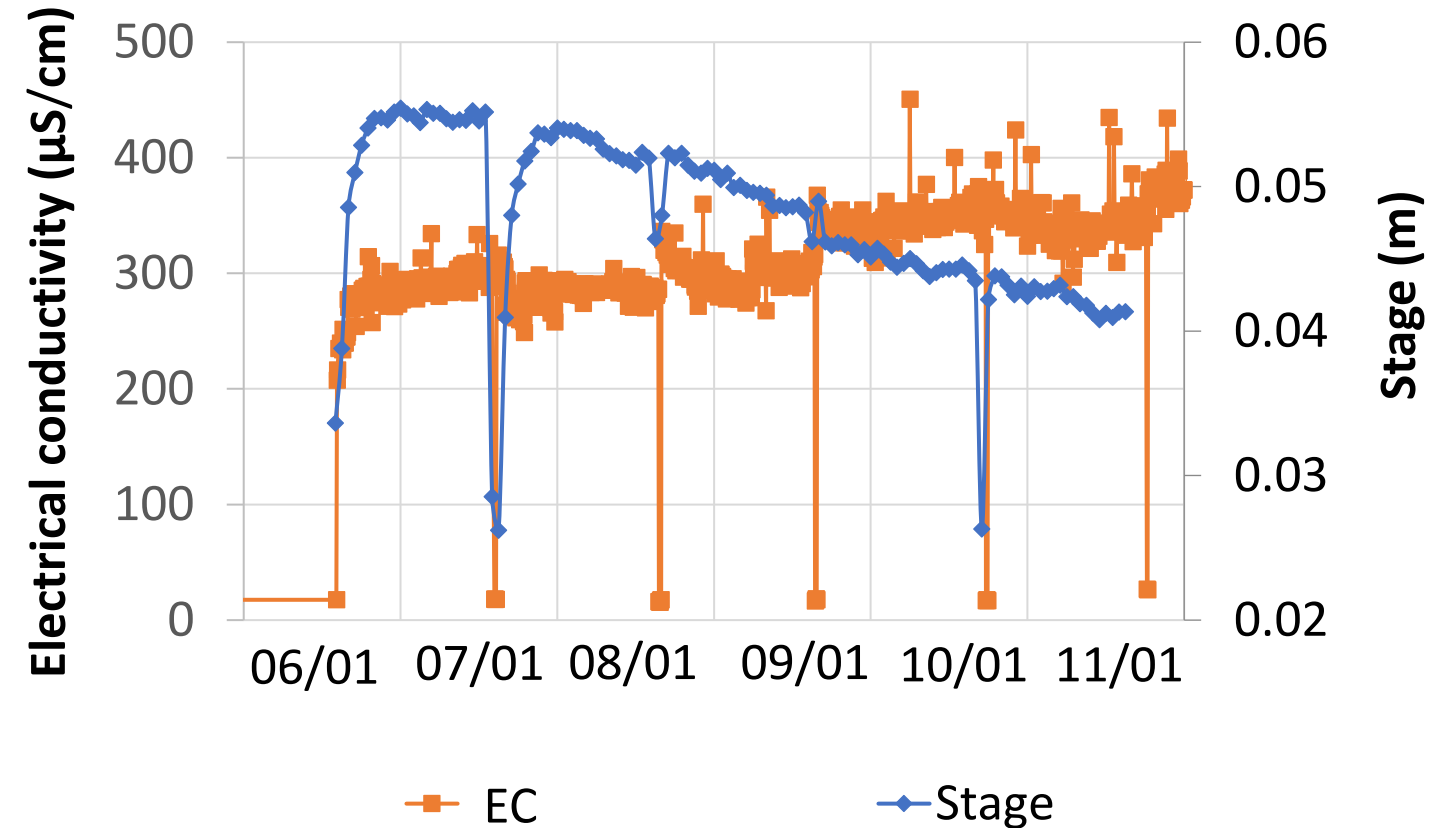
January field test of Hydrobean

Analysis

- Trends in EC and stage data observed were as predicted: reduced stormflow contributions to total stream flow decreased water level in the stream and reduced the degree of dilution of baseflow contributions, increasing EC.
- The battery in the prototype needed to be replaced every 24hr, causing the spikes in data. Future versions will have longer power budget.

Results

- EC temperature corrected using Hydrobean's temperature sensor
- Stage is calculated using sensor pressure and atmospheric pressure data



Next steps...

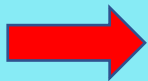
Updating the design

A new version of Hydrobean is being developed which will include the following design improvements:

- A more stable pressure sensor
- A longer life battery
- A more compact enclosure to house the electronic components



Hydrobean
Prototype V1



Hydrobean
Prototype V2

Further field testing

- Hydrobean will be field tested against industry standard in-situ EC, temperature and pressure sensors for extended periods to assess the data quality obtained and durability.

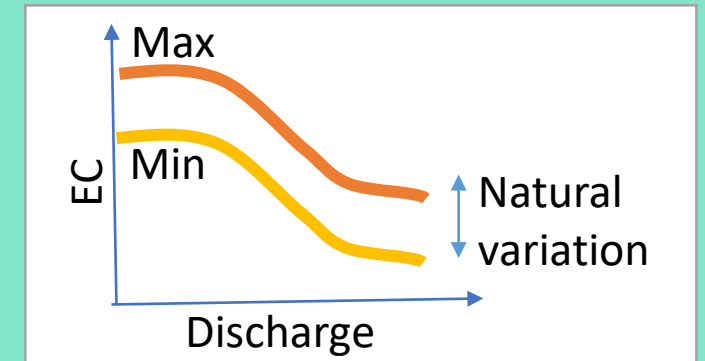


Campbell Scientific EC and Temperature sensor

- Hydrobean will be piloted with citizen science volunteers to assess their experience of using the low-cost WSN for river water quality monitoring.

Developing a model

- A model will be developed using baseline data to define boundary conditions for natural variations in EC, based on changes in water temperature and stream discharge.



- Data output from Hydrobean will be integrated into the model to indicate, in real-time, the occurrence of any contamination incidents at a monitoring site.