MOUNTAIN EVO INSIGHTS

mountain EVO
environmental virtual observatories

espa ecosystem services for poverty alleviation | Imperial College London | University of Birmingham | Wageningen University & Research
CONDESAN | Society of Hydrologists and Meteorologists जल तथा मौसम विद् समाज | UCA University of Central Asia
Cornell University | Universiteit Antwerpen | Freie Universität Berlin | UNESCO United Nations Educational, Scientific and Cultural Organization

Building hydrological monitoring **sensor networks** with low-cost technologies

Thanks to the development of **low-cost Information and Communication Technologies (ICTs)**, the barrier and cost of building hydrological monitoring networks has significantly reduced.

This poster visually presents how hydrological sensor networks in rural areas can be **understood and assembled** at different scales, from (1) individual technologies and components, to (2) basic network nodes, to (3) local and regional hydrological sensor networks.

ICT components

Low cost monitoring networks are usually built with ICTs that are inexpensive, energy efficient, have large learning communities, and a variety of types (Figure 1).

Arduino Uno
~ $25.00

The IDE for Arduino
free

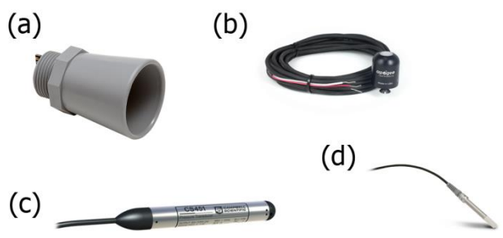
Arduino
- Open source single-board micro-controller
- Integrated Development Environment (IDE)
- www.arduino.cc

Raspberry Pi 3 model B,
released in Feb 2016
Power: 4 w
~ $40.00

Raspberry Pi Zero,
released in Nov 2015
Power: 0.8 w
~ $5.00

Raspberry Pi
- Single-board micro-processor or computer
- www.raspberrypi.org

Sensors
(a) Ultrasonic Range Finder (MaxSonar)
(b) Radiation (Apogee Instruments SP-110)
(c) Pressure transducer (Campbell CS451)
(d) Temperature and relative humidity (Campbell CS215)



Xbee
~ $20.00 *
Outdoor line-of-sight: ~ 1.2 km *

Xbee Pro
~ $40.00 *
Outdoor line-of-sight: ~ 3.2 km *

* depends on models

Xbee
- Wireless data transmission module
- Self-configuring mesh network
- www.digi.com/lp/xbee

***Figure 1**. Examples of low-cost technologies and components.*

References: Buytaert, W., Dewulf, A., De Bièvre, B., Clark, J., & Hannah, D. M. (2016) Citizen Science for Water Resources Management: Toward Polycentric Monitoring and Governance? J. Water Resour. Plan. Manag. 142, 1816002. http://doi.org/10.1061/(ASCE)WR.1943-5452.0000641 | Karpouzoglou, T., Zulkafli, Z., Grainger, S., Dewulf, A., Buytaert, W., & Hannah, D. M. (2016) Environmental Virtual Observatories (EVOs): prospects for knowledge co-creation and resilience in the Information Age. Curr. Opin. Environ. Sustain. 18, 40–48. http://doi.org/10.1016/j.cosust.2015.07.015 | Buytaert, W. et al., 2014. Citizen science in hydrology and water resources: opportunities for knowledge generation, ecosystem service management, and sustainable development. Front. Earth Sci. 2, 1–21. https://doi.org/10.3389/feart.2014.00026

Basic network nodes

Network nodes are composed of certain ICT components, and each has certain functions and roles in the network (Figure 2).

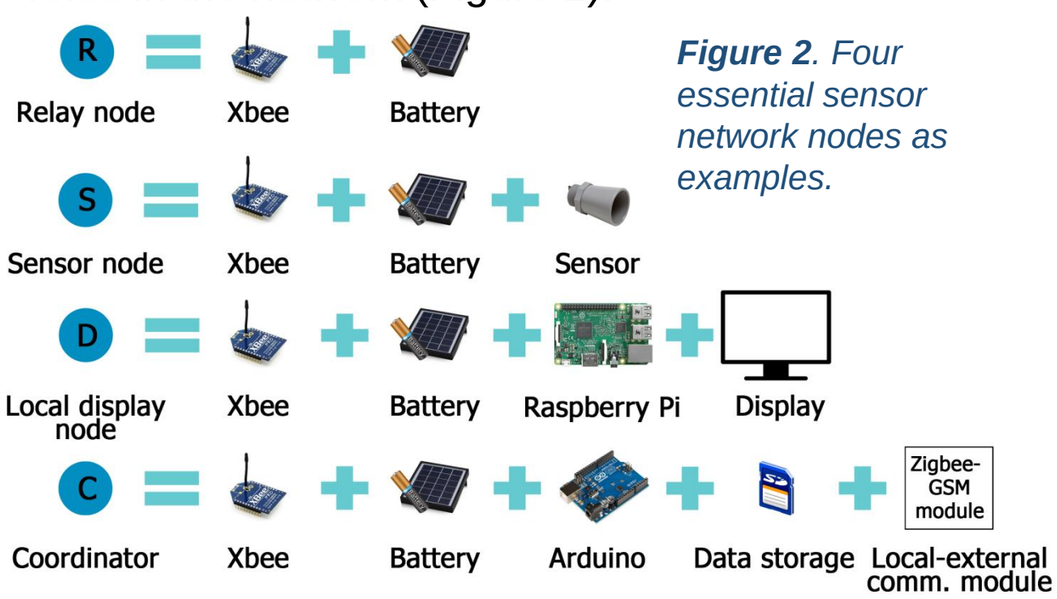


***Figure 2**. Four essential sensor network nodes as examples.*

Sensor network

In simple words, a sensor network is a collection of connected nodes (see Figure 2). Figure 3 demonstrates an example network scheme.

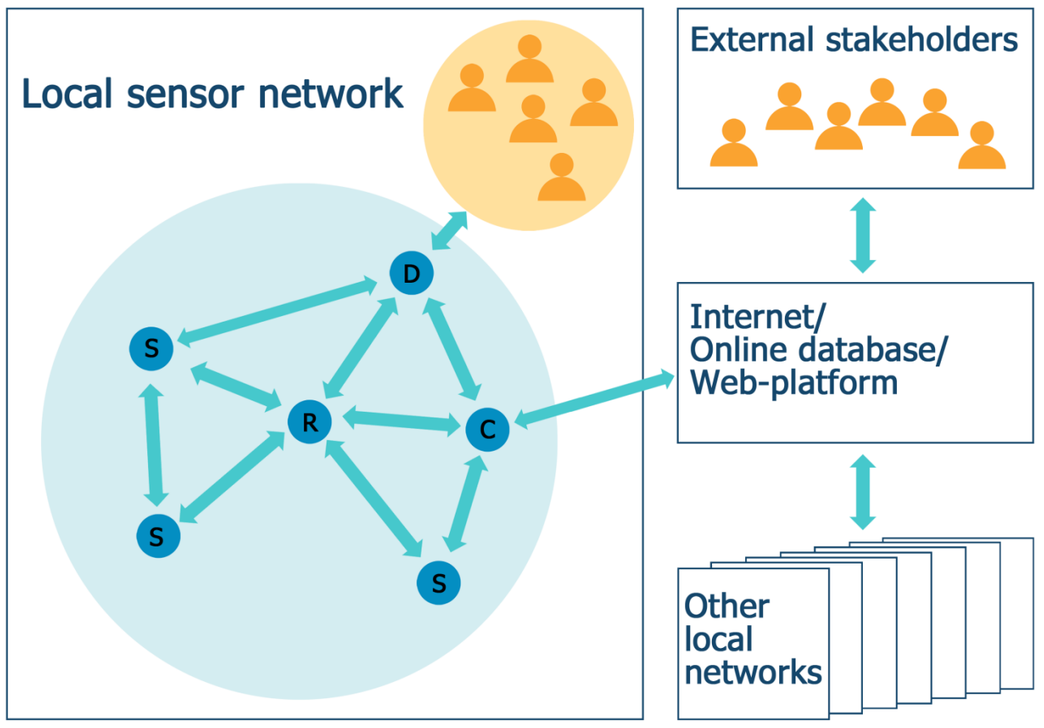


***Figure 3**. An example scheme of hydrological sensor network.*

Take home messages

- Low-cost ICTs provide opportunities to build inexpensive sensor networks to monitor hydrology in remote areas.
- We need to consider the conditions in rural areas, such as limited electricity accessibility, internet coverage, or ICT capacities.
- Stakeholder engagement is crucial to the success of these monitoring networks. e.g.,
  - Co-designing the network and participatory monitoring with local community members
  - Making the collected data locally useful
  - Connecting local and external stakeholders

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