Citizen science and water resources management: Potential for transdisciplinary research

Wouter Buytaert and the Mountain-EVO team

Imperial College London
UNIVERSITY OF BIRMINGHAM
WAGENINGEN UR For quality of life
CONDESAN Consorcio para el Desarrollo Sostenible de la Ecorregion Andina
SOCIETY OF HYDROLOGISTS AND METEOROLOGISTS जल तथा मौसम विद् समाज
UCA UNIVERSITY OF CENTRAL ASIA
Cornell University
Freie Universität Berlin
UNESCO United Nations Educational, Scientific and Cultural Organization
Universiteit Antwerpen

Mountain environments

A “perfect storm” caused by a combination of:

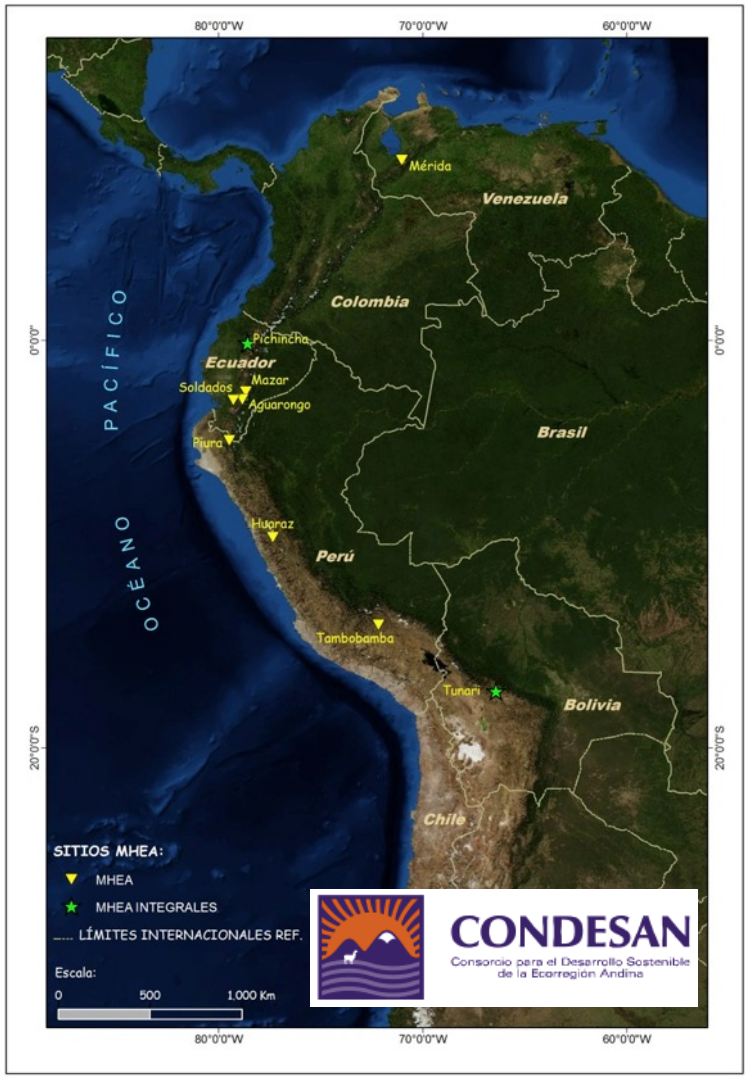
- complex environmental system undergoing rapid change;
- vulnerable populations (“poverty pockets”) relying strongly on ESS;
- extreme data scarcity and uncertainties.



Participatory monitoring

- Precipitation and river discharge
- Responding to local questions on land-use impacts
- Cheap sensor package (~ 5000 USD)
- Local buy-in and participation

Iniciativa Regional de
Monitoreo Hidrológico
de Ecosistemas Andinos



navegación

- Página principal
- Portal de la comunidad
- Actualidad
- Cambios recientes
- Página aleatoria
- Ayuda

buscar

Buscar

Ir Buscar

herramientas

- Lo que enlaza aquí
- Cambios relacionados
- Subir un archivo
- Páginas especiales
- Versión para imprimir
- Enlace permanente

Iniciativa Regional de Monitoreo Hidrológico de Ecosistemas Andinos: el Wiki [editar]

El wiki de la Iniciativa iMHEA colecta información práctica sobre la instalación y manejo de equipo de monitoreo hidro-meteorológico; la colección, manejo y control de calidad de datos; y la interpretación de los resultados.

CONTENIDO [editar]

Introducción [editar]

Una introducción breve en la práctica del monitoreo hidrológico, su importancia e relevancia.

Medición de la precipitación [editar]

la instalación y manejo de pluviómetros

Medición del caudal [editar]

El diseño y la instalación de vertederos, tal como métodos sin estructura.

Control de calidad de datos [editar]

Cómo identificar errores y problemas de calidad.

Tratamiento de datos [editar]

Tratamiento y procesamiento de datos hidrometeorológicos

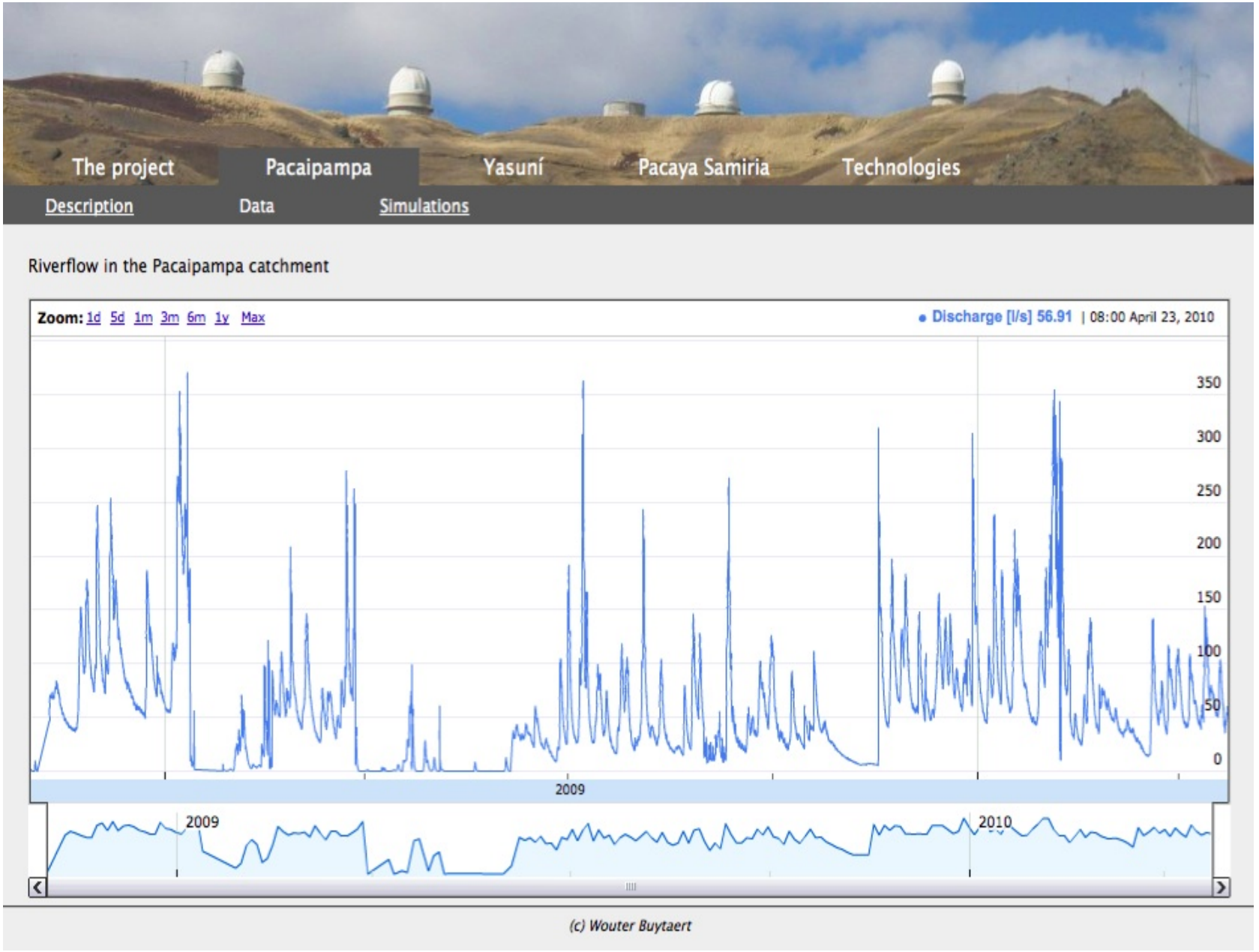
La plataforma Arduino [editar]

Instrucciones para la construcción de dataloggers con la plataforma abierta y de bajo costo Arduino

Bibliografía [editar]

Referencias y otros fuentes de literature útiles.

Environmental virtual observatories



“Citizen science”

- How to create long term sustainability?
- How to maximize local impact?
- How to integrate scientific with local knowledge?
- How to foster sustainable development and poverty reduction?

UK NERC/ESRC/DFID ESPA programme funded project:

Adaptive governance of mountain ecosystem services for poverty alleviation enabled by environmental virtual observatories (Mountain-EVO, 2013 – 2017)

espa
ecosystem services
for poverty alleviation

frontiers in
EARTH SCIENCE

REVIEW ARTICLE
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Citizen science in hydrology and water resources: opportunities for knowledge generation, ecosystem service management, and sustainable development

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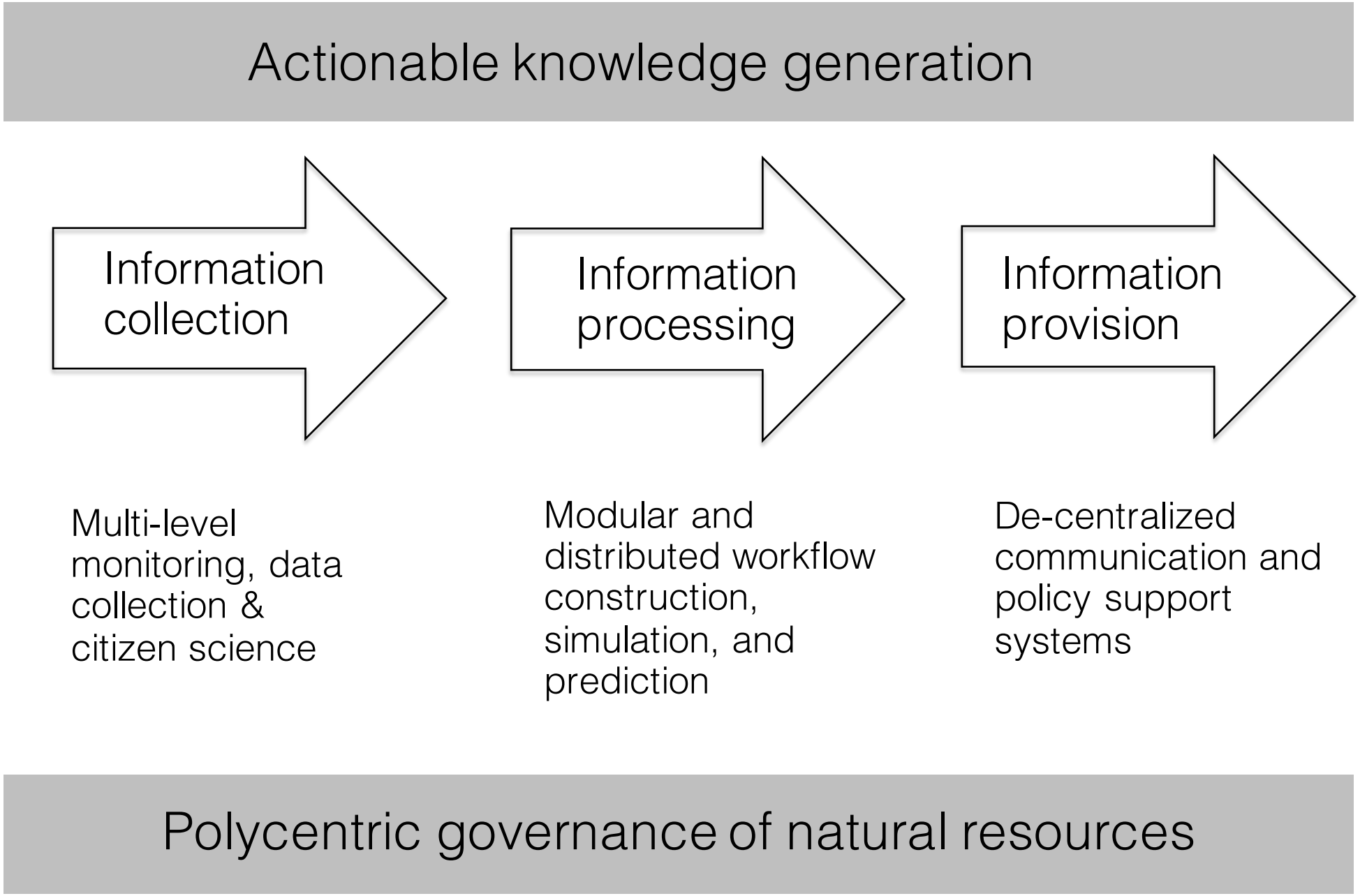
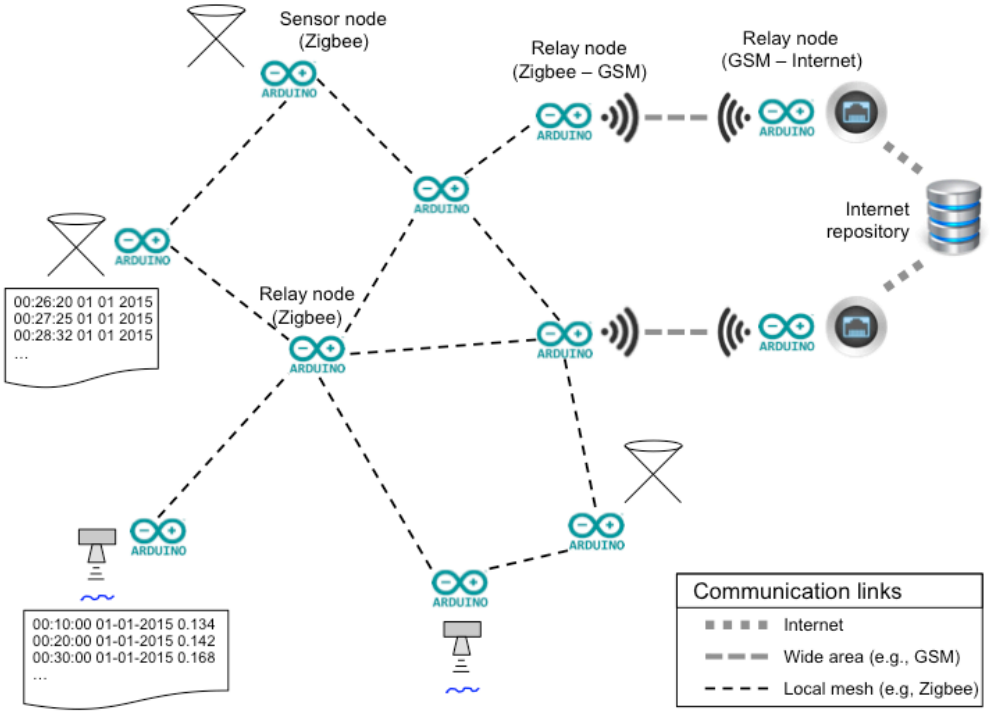
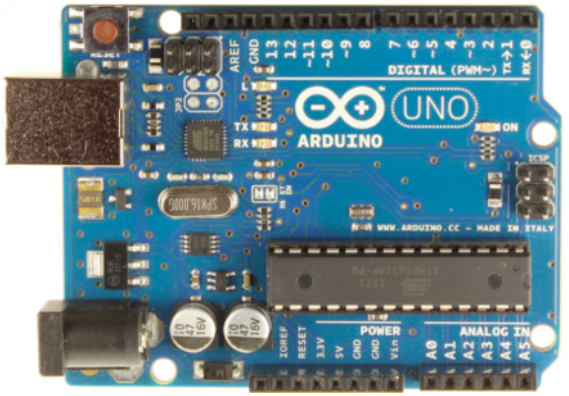
The participation of the general public in the research design, data collection and interpretation process together with scientists is often referred to as citizen science. While citizen science itself has existed since the start of scientific practice, developments in sensing technology, data processing and visualization, and communication of ideas and results, are creating a wide range of new opportunities for public participation in scientific research. This paper reviews the state of citizen science in a hydrological context and explores the potential of citizen science to complement more traditional ways of

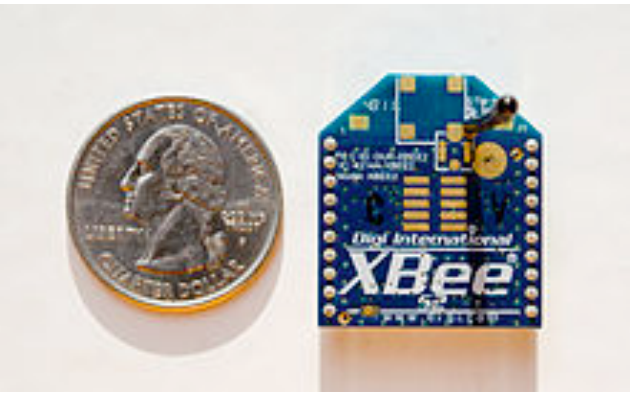

Actionable knowledge generation
Information collection
Information processing
Information provision
Multi-level monitoring, data collection & citizen science
Modular and distributed workflow construction, simulation, and prediction
De-centralized communication and policy support systems
Polycentric governance of natural resources

Information collection: new technologies



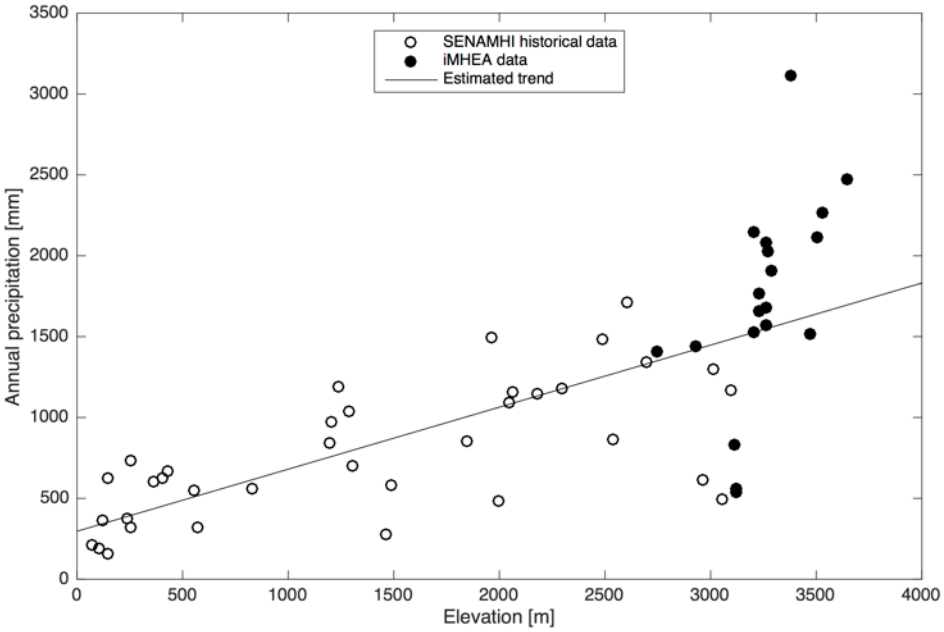
oxfloodnet.co.uk





Information collection: new institutional dynamics

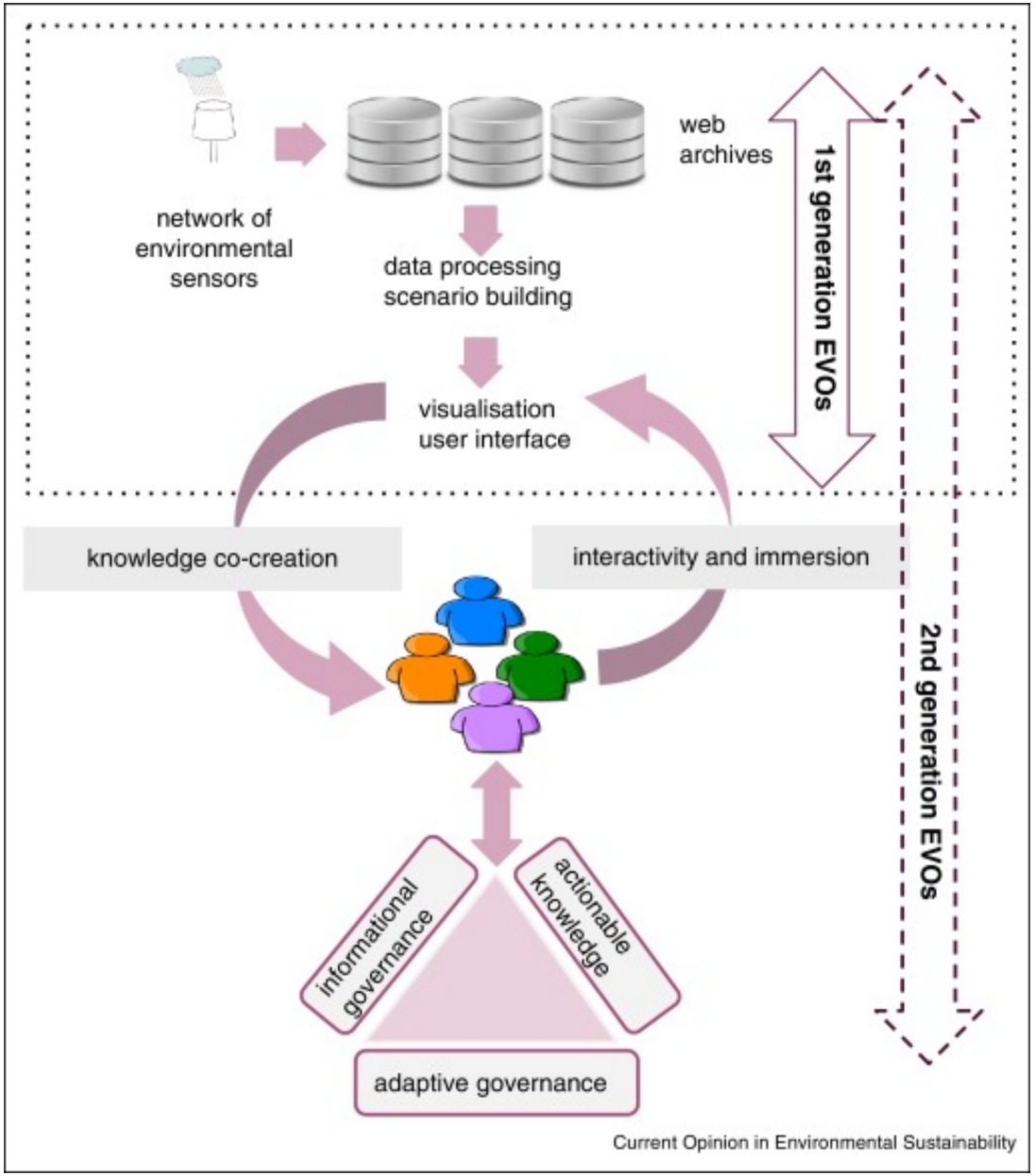
- Potential to break open traditional and formal monitoring silos
- Multilevel, multipurpose
- Complementarity vs. resilience
- Adaptive governance
- Trust, credibility, acceptance
- “Polycentric monitoring”



Buytaert, W., Dewulf, A., De Bièvre, B., Clark, J., & Hannah, D. M. (2016). Citizen Science for Water Resources Management: Toward Polycentric Monitoring and Governance? Journal of Water Resources Planning and Management, 01816002.

Information processing

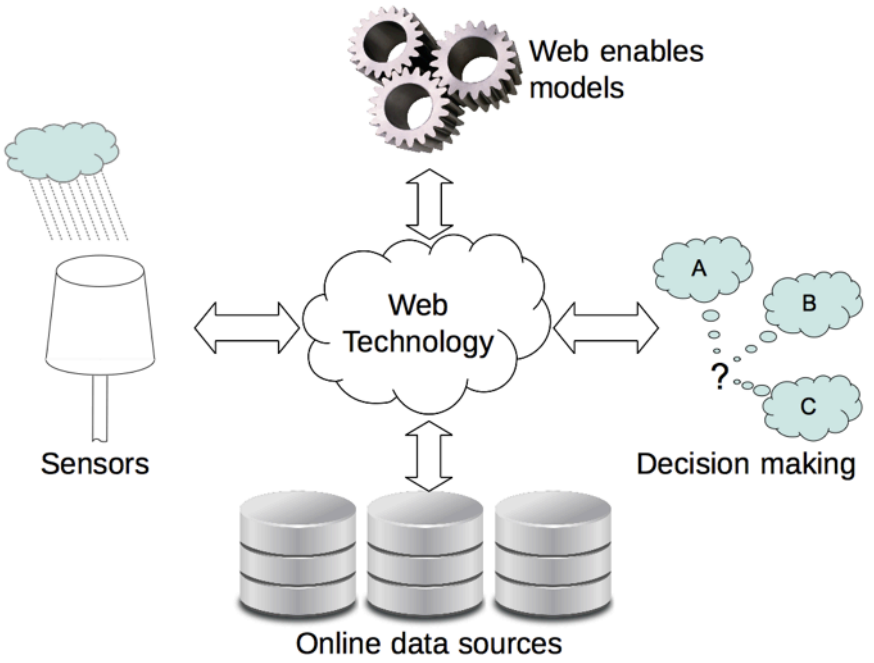
- ICT, web technologies
- Multilevel, multipurpose, multidirectional
- Integration of heterogeneous data & knowledge
- Polycentric models of data curation, knowledge co-generation, and governance



Karpouzoglou, T., Zulkafli, Z., Grainger, S., Dewulf, A., Buytaert, W., & Hannah, D. M. (2015). Environmental Virtual Observatories (EVOs): Prospects for knowledge co-creation and resilience in the Information Age. Current Opinion in Environmental Sustainability, 18, 40–48.

Technical challenges and opportunities

- Cloud computing
- Big data
- Web-based processing and modelling
- Model coupling, uncertainty analysis, uncertainty propagation
- Several initiatives: CUAHSI, OGC, GEOSS, …



Vitolo, C., El-Khatib, Y., Reusser, D., Macleod, C. J. a., & Buytaert, W. (2015). Web Technologies for Environmental Big Data. Environmental Modelling & Software, 63, 185–198.

Beven, K., Buytaert, W., & Smith, L. A. (2012). On virtual observatories and modelled realities (or why discharge must be treated as a virtual variable). Hydrological Processes, 26, 1906–1909.

Simulating the impact of land-use changes

This system allows you to simulate the impact of land-use changes in the Pacaipampa basin. Select the land-use scenario with the sliders below and click the simulation button. Simulations are performed in real-time using a hydrological model (topmodel).

Basin characteristics

Land use

Change the sliders from top to bottom. You cannot change the last slider. Instead change the other three.

Native Forest:		15%
Pine forest:		0%
Grassland:		80%
Cultivation:		5%

Simulate

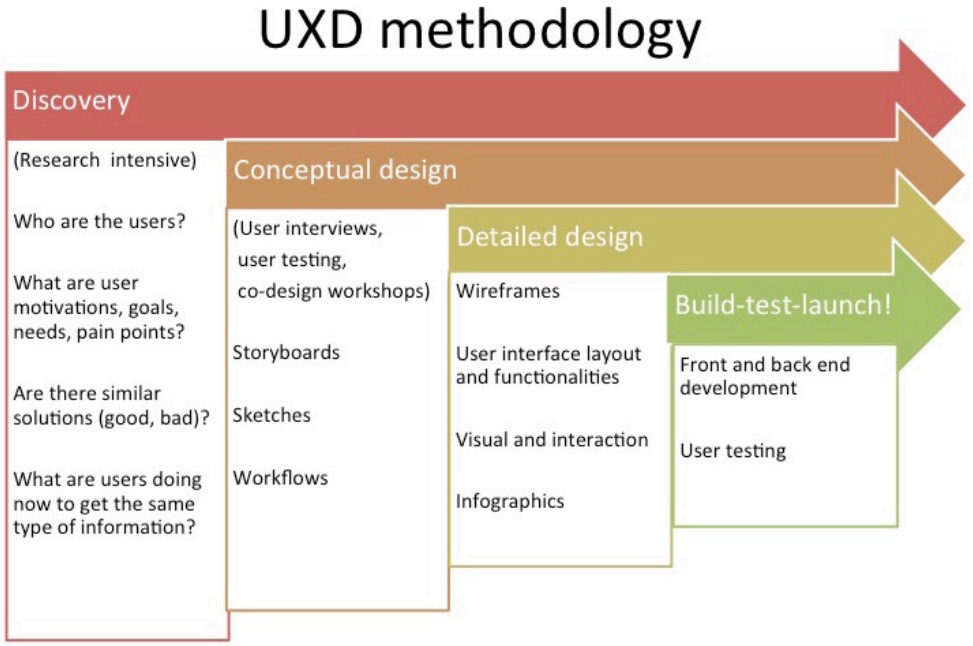
You can also call the modelling server directly using this link or pasting the following url in your browser:

http://paramo.cc.ic.ac.uk/espa/server?
Service=WPS&Version=1.0.0&Request=GetCapabilities

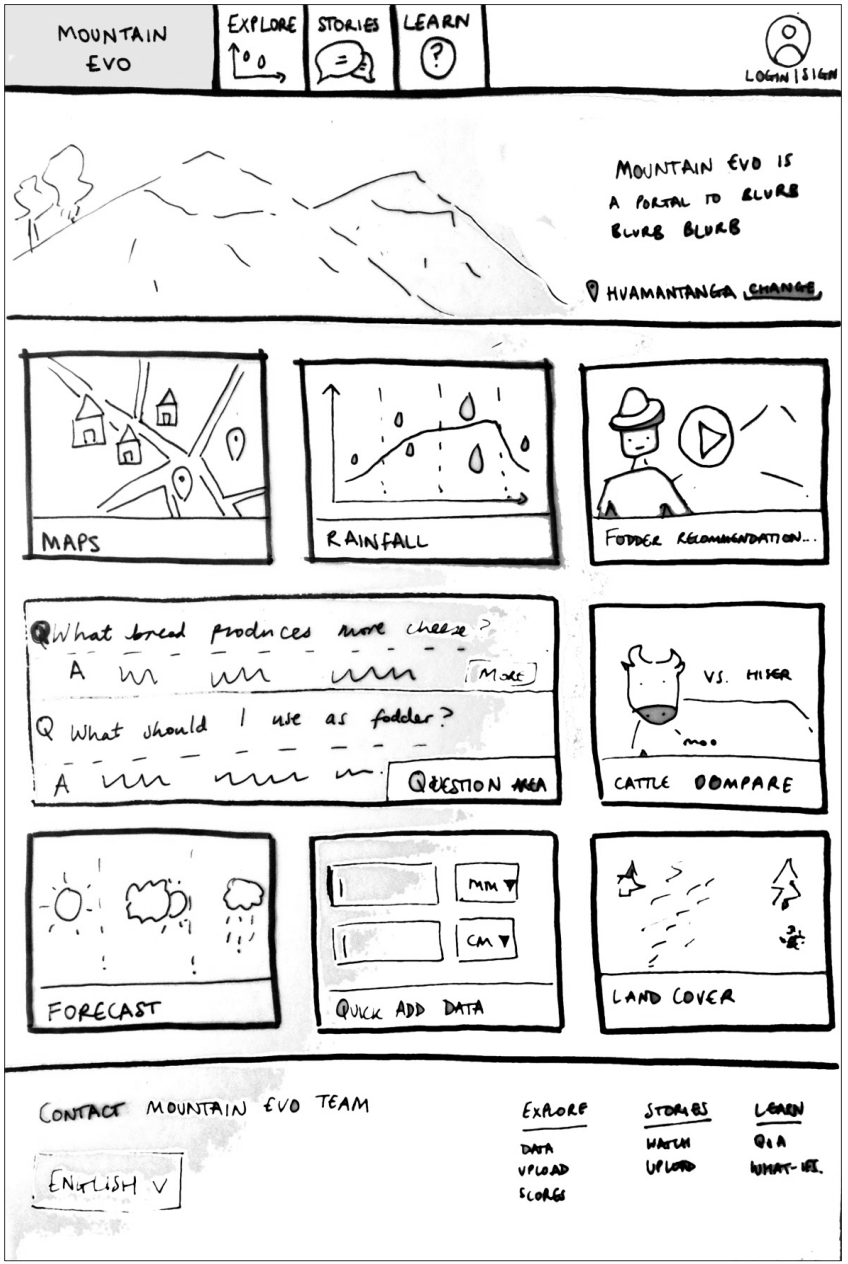
Note: you will need to authenticate first.

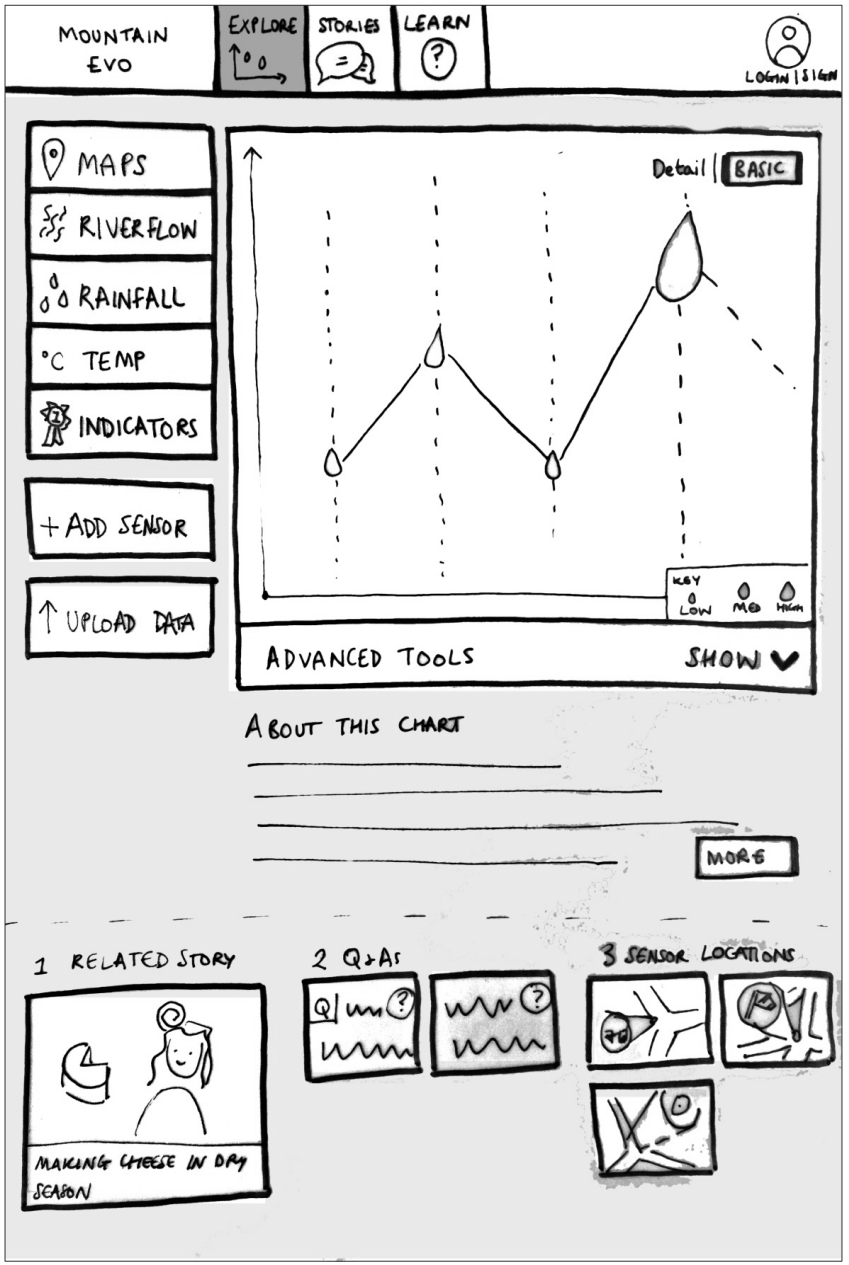
Information provision

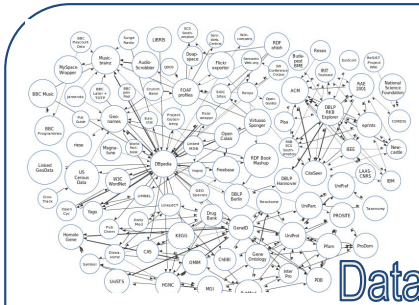
- Visualization & communication
- User interface design
- Scenario building



Prototyping





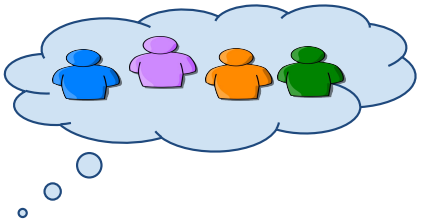


Data possibilities

Technological possibilities

Conceptual design

- DSS type
- Information base
- Interactivity
- Visualisation



Design space

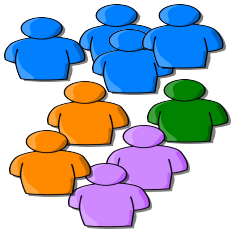
User space

Iteration

Build!

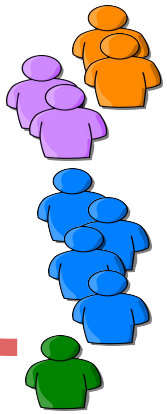
Deploy

User testing



Actor-network analysis

- Roles and relations
- Interests
- Decision making processes and goals
- Knowledge creation and exchange



User requirements

- useful information
- usable information
- exchangeable information

Phase 1: Define ***Phase 2: Refine*** ***Phase 3: Deliver***

Zulkafli et al., in review

Challenges

- Leveraging new technologies
- Ensuring a user centered approach
- Recognizing the polycentric nature of systems
- Adaptive governance & knowledge co-generation

Thank you

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for poverty alleviation

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