Big/open data and citizen science for Socio-Ecological-Systems Management and Water-Environment Nexus Experiences of UNIFI- Water Harvesting Lab

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Outlines

- **Socio-Ecological-Systems (SES):** are linked systems of people and nature, emphasizing that humans must be seen as a part of, not apart from, nature (Berkes and Folke, 1998)
- They are **complex** and **adaptive**
- Their **monitoring and management** is vital for the **sustainable and resilient management of our planet**

We present **two experiences** showing strategies of innovative management and monitoring of SES with **Big/open data** and **cloud computing**, and **citizen science**, from different contexts

Case 1: Water-Environment-Climate Nexus

Evidences of climate mitigation from Landscape Restoration and Water Harvesting

PhD thesis of Giulio Castelli, Water Harvesting Lab (Supervisor **Elena Bresci**)

SES: Agro-ecological system in rural arid highlands of Tigray region (Ethiopia)

Study Area: Enabered catchment, Ethiopia

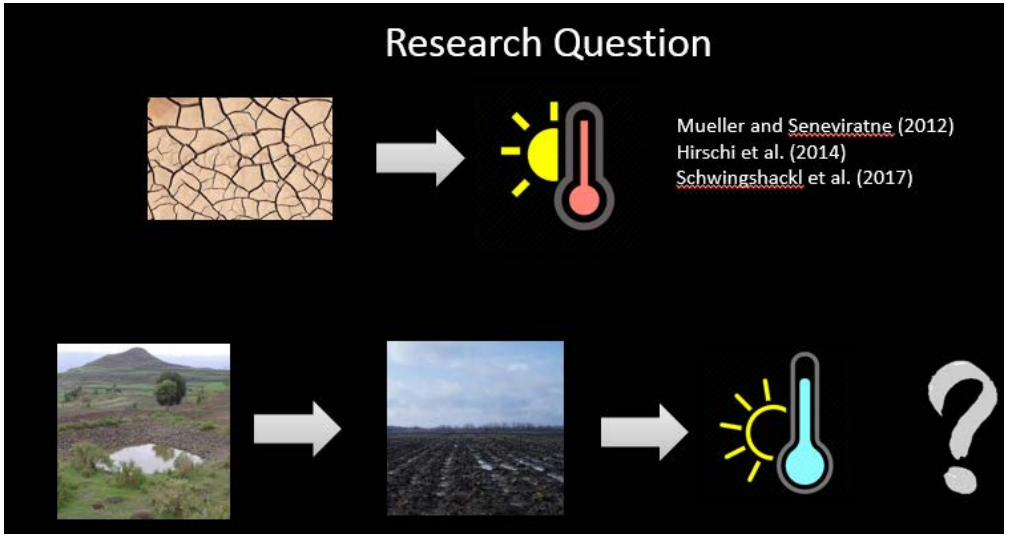
→ Large scale Landscape Restoration and Water Harvesting implemented in 2008

Case 1: Water-Environment-Climate Nexus

Methodology: use of Google Earth Engine for big data analysis, to determine if the use of Landscape Restoration and Water Harvesting (LRWH) provided an increase of soil moisture in a target catchment and thus a regulation of temperatures.

Question:

If soil moisture deficit induces heatwaves, can soil moisture retention induce climate regulation?



Case 1: Water-Environment-Climate Nexus

- $WCI_i(y) = 1000 \frac{NDII_i(y)}{R_{rs}(y)}$

Water Conservation Index (monthly)

Normalised Difference Infrared Index (NDII): From long term Landsat 7 time series (Google Earth Engine)

Rainfall of the rainy season, from CHIRPS dataset (Funk et al., 2015), available on Google Earth Engine

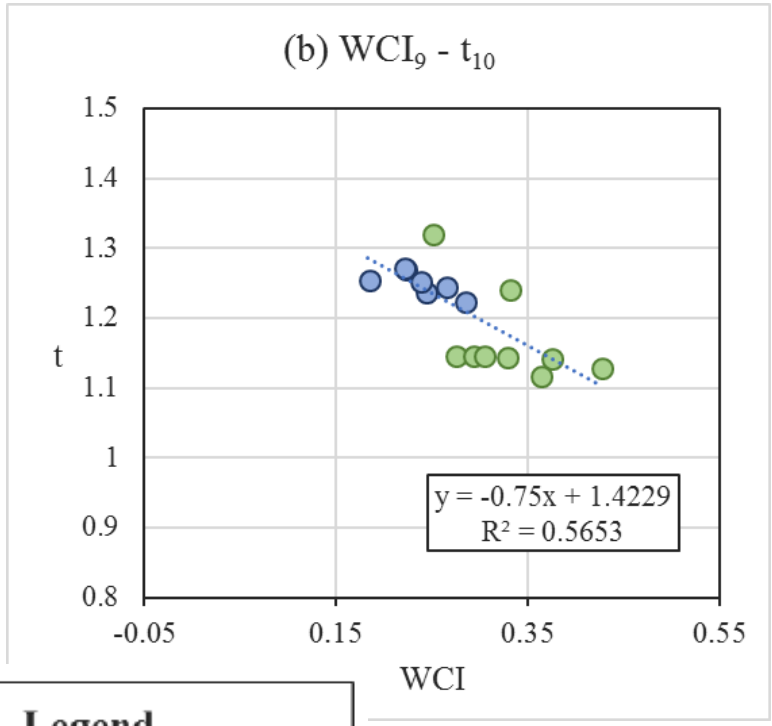
$$t_i(y) = {LST_i(y)} \Big/ {T_{850,i}(y)}$$

temperature Index (monthly)

Land Surface Temperature (°C) from MODIS data (Google Earth Engine)

Temperature at 850 hPa at 12:00 a.m. (°C) obtained from ERA-INTERIM climatic reanalysis dataset (Balsamo et al., 2015)

Case 1: Water-Environment-Climate Nexus



WCI of September versus t of October

Results:

- Evident increase of WCI (Soil Moisture) after LRWH implementation
- Decrease of t after LRWH implementation
- Decrease of T (average of 2000-2008 period) – (average of 2010-2017 period = **1.74 °C**
- **Soil Moisture Temperature Coupling occurrence detected**

Case 2: Citizen science for participatory Water-Ecosystems Nexus management

Water Values: Participatory Water Ecosystem Services Assessment in the Arno River Basin

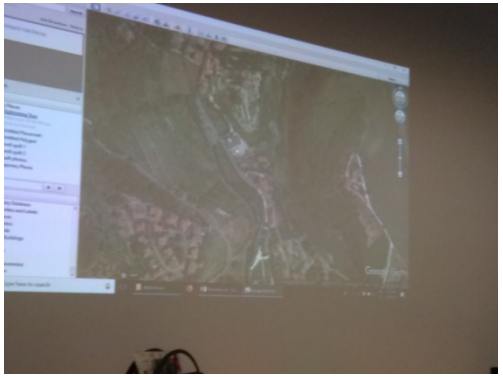
Giulio Castelli, Tommaso Pacetti, Bernardo Mazzanti, Lapo Cecconi, Lorenzo Tilli, Marco Dugini, Bianca Cinelli, Enrica Caporali & **Elena Bresci**

SES: Riverine Municipality (Arno River) in Tuscany Region (Italy)

→ The project is financed by the Tuscany Region (Italy) in the framework of the Regional Law for Participation 46/2013 (15,000 E)

Case 2: Citizen science for participatory Water-Ecosystems Nexus management

- **Methodology:** participatory meetings with local groups of citizen (diversity in age, gender, position of housing in the municipality)
- Mapping and evaluations of **Water related Ecosystem Services (WES)**
- Identification of **Ecosystem Services in Critical Status**
- **Final Panel with local municipality**
- Elaboration of the **document of the participatory process** (legal document) with main outcomes



ACTIONS PROPOSED

Type of WES	Description	Production	Status	Criticism
Cultural	Recreational (fishery)	River Arno		Low quality of water
Cultural	Cultural value	River Arno		Low quality of water
Support	Support to aquatic biodiversity	River Arno		Low quality of water
Support	Water quality	River Arno		Low quality of water
Cultural	Recreational (riverside)	River Arno		Partial accessibility to riverside (dowstream Incisa Area), Low quality of water
Provisioning	Drinking water supply	River Arno		Lack of water during summer
Regulating	Flood protection	Drainage network		Low maintenance

Low quality status:

- Already known by River Basin Authority Assessment
- The perception of the problem justifies additional investments and Payment for ES approach

Recreational WES on riverside:

- Well developed only in Figline upstream area
- Justif and encourage investments

Conclusions

Case 1: Water-Environment-Climate Nexus

- Use of Open/Big data and cloud computing allowed the detection of **Water-Environment-Climate Nexus in Socio-Ecological-Systems**, used by **local farmers to manage meso-climate**
- The analysis was carried out in a **remote area (extreme climate) where ground data are lacking**

Case 2: Citizen science for participatory Water-Ecosystems Nexus management

- **Laws are in place** to support the use of scientific-based citizen science for Water Resources Management
- The correct **evaluation of the value of WES** is **key to generate water management policies** targeting both ecosystem valuation and the integration of citizens participation within the management framework, as prescribed by **EU Water Framework Directive – Article 14.**

Contact info

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- Check our Website: https://www.gesaaf.unifi.it/vp-466-wh-lab.html