biodiversa+
European Biodiversity Partnership

Webinar on Sensor networks
Task 2.3.1 "Novel technologies and approaches"

Organized by DACC (Catalonia) and
Iiris Kallajoki (OT Biodiversa+)

March 18th, 2025

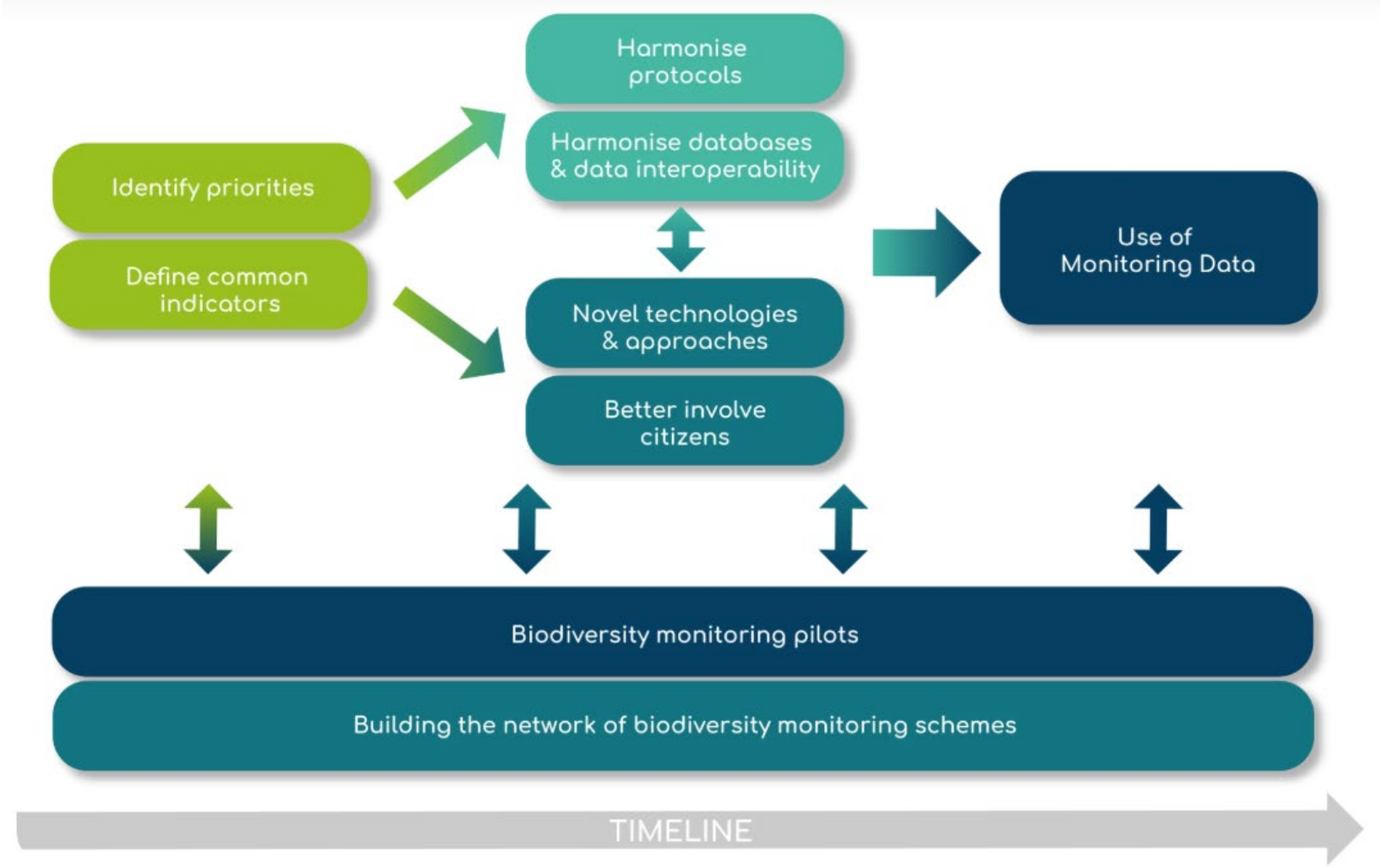
About Biodiversa+

Biodiversa+ is the European Biodiversity Partnership supporting excellent research on biodiversity with an impact on policy and society.

Workpackge 2: Set up a network of harmonised schemes to improve monitoring of biodiversity and ecosystem services across Europe

biodiversa+
European Biodiversity Partnership

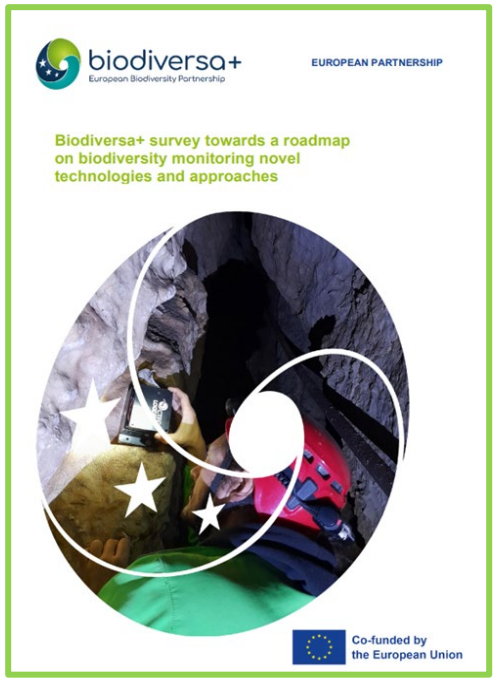
Biodiversa+ Workpackage 2, Task 2.3.1”Novel technologies and approaches”

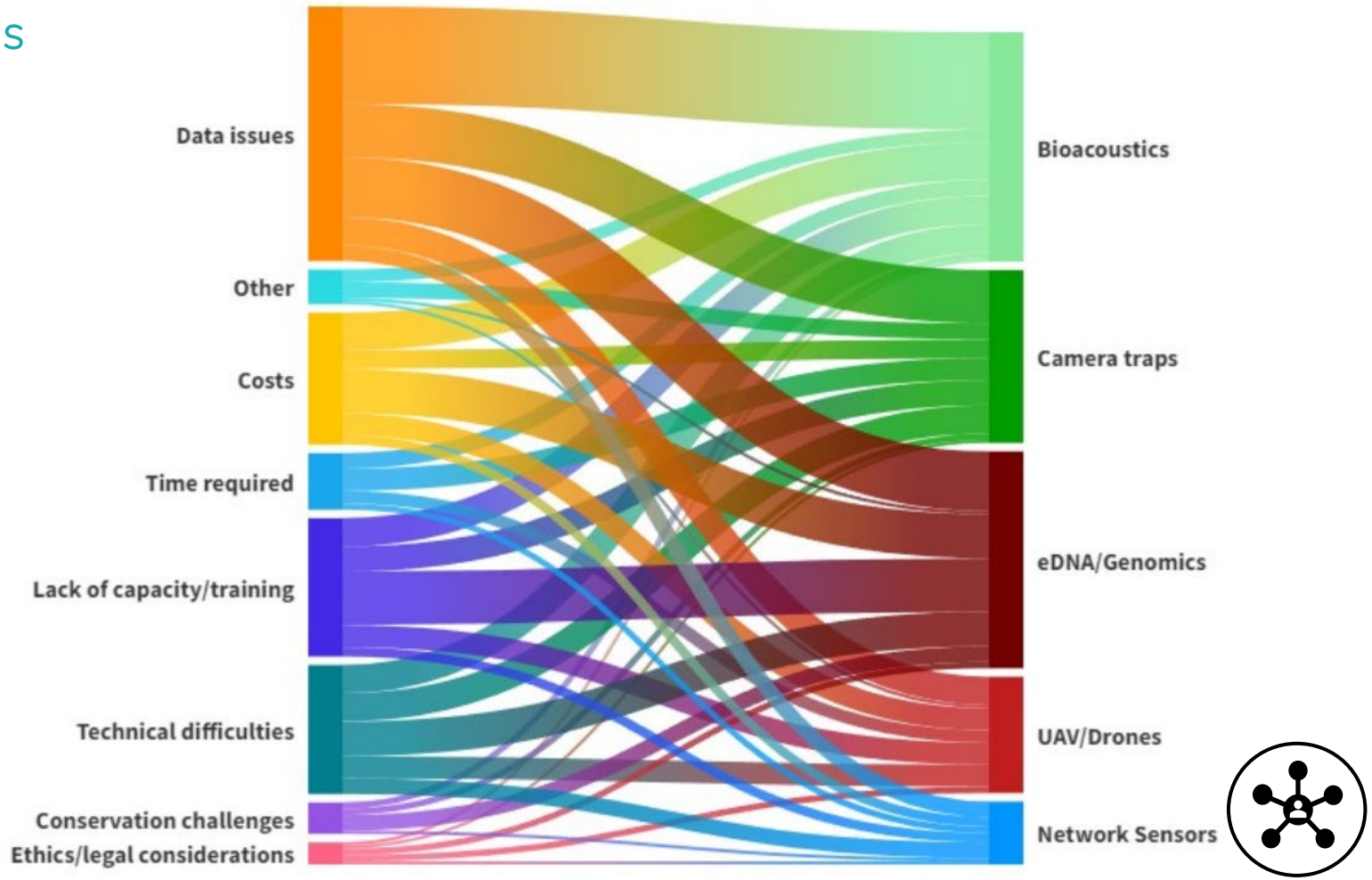


Biodiversa+ Workpackage 2, Task 2.3.1”Novel technologies and approaches”

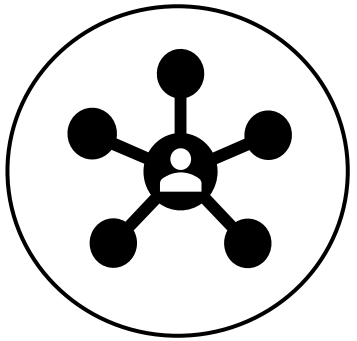
Survey of novel technologies monitoring across partners

- Deployment state / interest
- Targeted taxa and EBVs
- Challenges and constrains





Webinar agenda



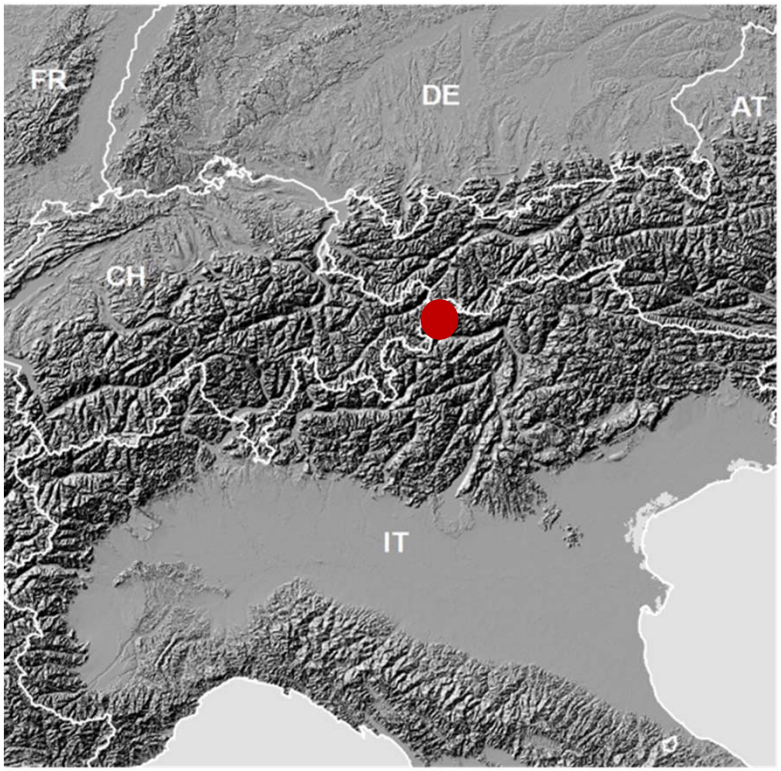
1. Introduction of the webinar and speakers
2. Presentation by Georg Niedrist (EURAC Research, Gov. of Bolzano)
3. Presentation by Lluís Gómez Gener (Institute of Environmental Assessment and Water Research, Catalonia)
4. Questions / debate

Sensor networks as a tool for environmental monitoring

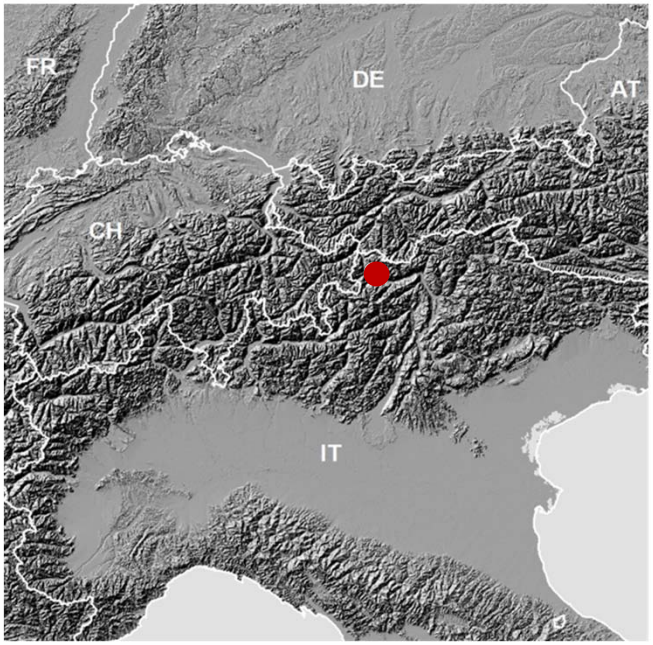
15 years of spatially distributed microclimatic measurements in the LTSER Site Matsch | Mazia (ITA)

G.Niedrist , A. Zandonai and many others

Background: Study site

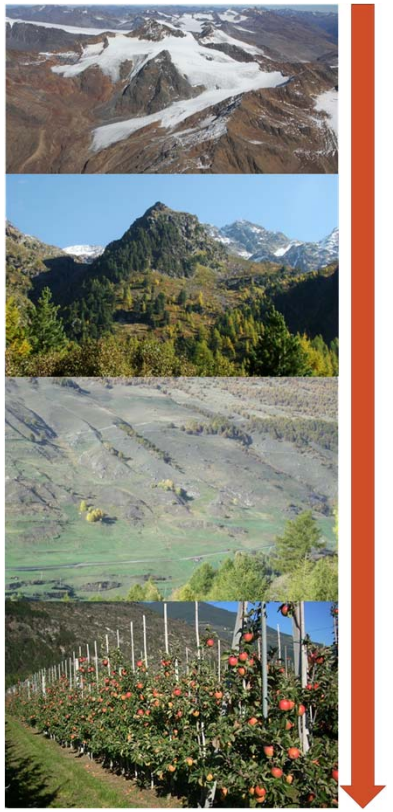


Background: Study site



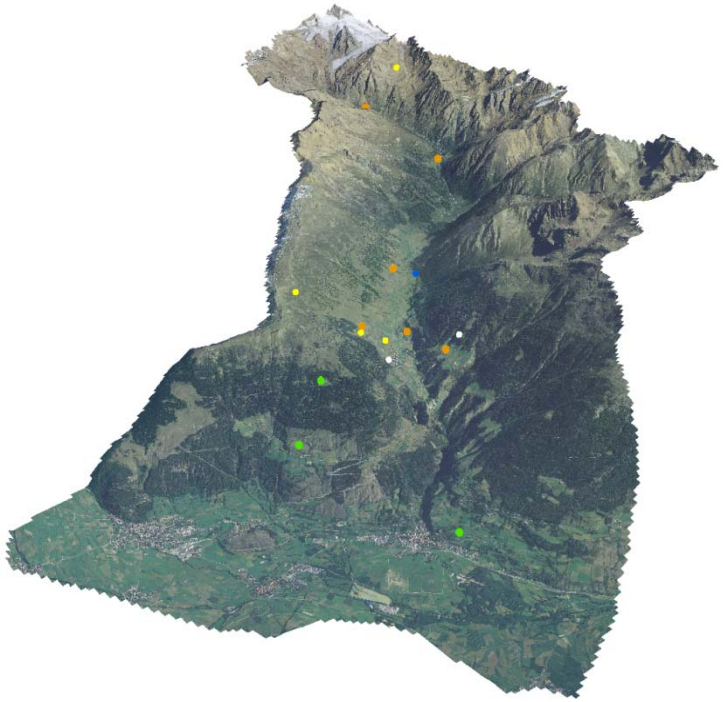
Main research topics

- Effects of climate- and landuse change on biodiversity & ecosystem functions
- Observe the effects through the scales and altitudinal gradients
- Human-environment interactions



Which microclimate?

THE LTSER RESEARCH SITE MATSCH/MAZIA (ITALIAN ALPS)

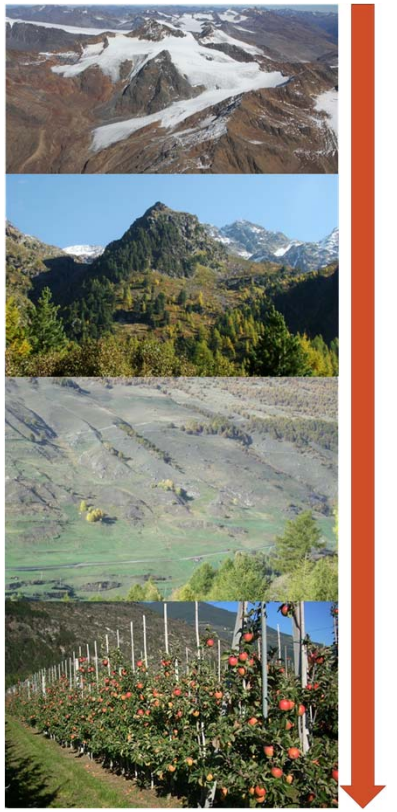


From isolated plot measurements

to

an environmental platform for interdisciplinary mountain research

„Open air laboratory Matsch/Mazia“



Microclimatic station network as backbone

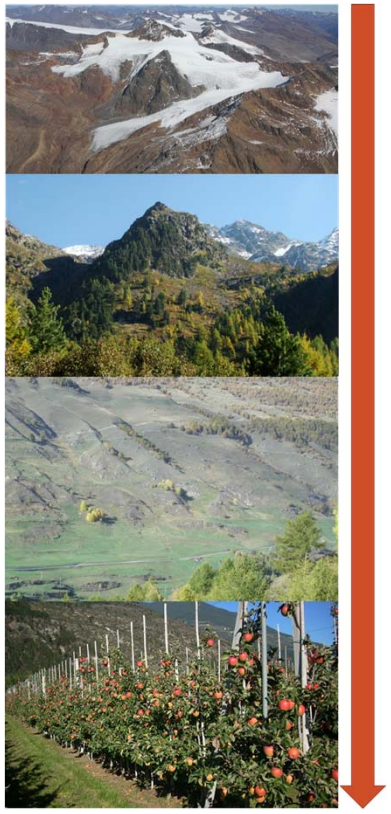
Starting from 2009

- Standard (micro-)climate
- (heated) totalisators
- Snow height

- Soil water content/potential
- Soil temperatures

- Short/longw. net radiation
- Direct/diffuse radiation
- Phenocam
- NDVI/PRI
- Leaf area index

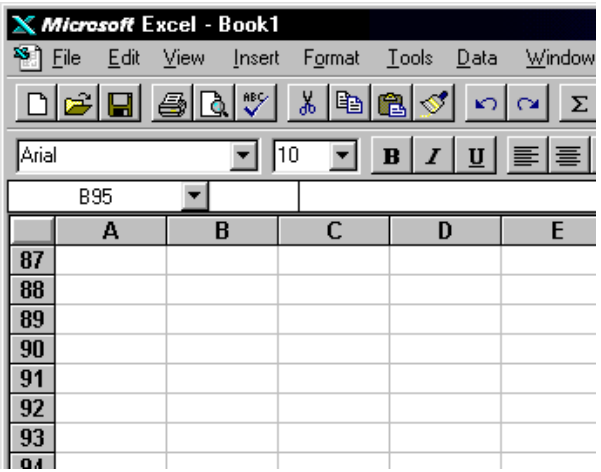
- Remote access+automated data transfer



In total:
24 stations

DATA
2M rec/week

Data flow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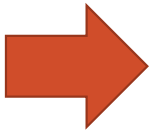

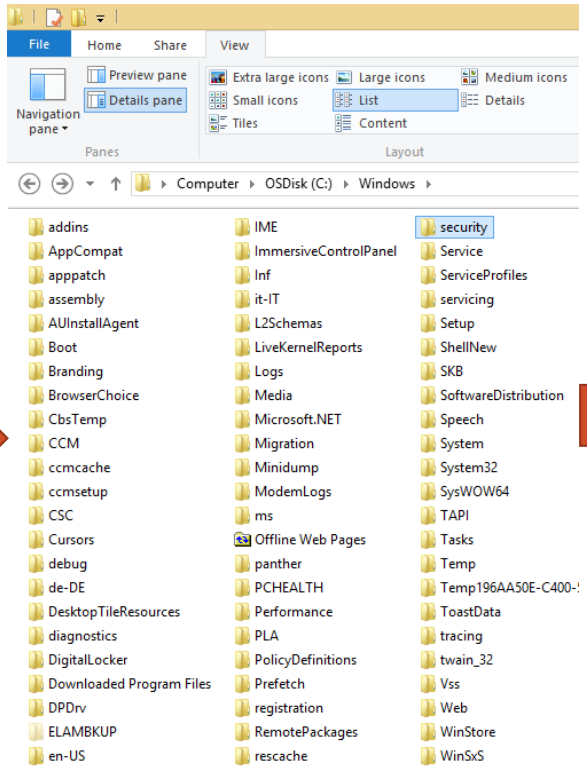
File Home Share View
Navigation pane
Preview pane
Details pane
Extra large icons
Large icons
Medium icons
Small icons
List
Details
Tiles
Content
Panes
Layout
Computer ▸ OSDisk (C:) ▸ Windows ▸
addins
AppCompat
apppatch
assembly
AUInstallAgent
Boot
Branding
BrowserChoice
CbsTemp
CCM
ccmcache
ccmsetup
CSC
Cursors
debug
de-DE
DesktopTileResources
diagnostics
DigitalLocker
Downloaded Program Files
DPDrv
ELAMBKUP
en-US
IME
ImmersiveControlPanel
Inf
it-IT
L2Schemas
LiveKernelReports
Logs
Media
Microsoft.NET
Migration
Minidump
ModemLogs
ms
Offline Web Pages
panther
PCHEALTH
Performance
PLA
PolicyDefinitions
Prefetch
registration
RemotePackages
rescache
security
Service
ServiceProfiles
servicing
Setup
ShellNew
SKB
SoftwareDistribution
Speech
System
System32
SysWOW64
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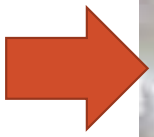
Temp196AA50E-C400-
ToastData
tracing
twain_32
Vss
Web
WinStore
WinSxS



2014-2020 Stations network renovation (SW)

1. LoggerNet Remote C.S.
   - Automatic download from stations
   - Weekly download → Hourly (data saving on Eurac server in near-real time)
2. Monitoring system
   - Real-time control of anomalies for stations, data and images, equipped with an email warning system
   - Weekly station status and data anomalies report

LTER - M4s - Data_overrange - Batt_V_Avg

data.quality.check@gmail.com
A Klotz Johannes; Zandonai Alessandro

http://report.alpenv.eurac.edu/LTER/M4s/Alerts/Warnings/M4s_202210251110_Data_overrange.html

LTER report

data.quality.check@gmail.com
A Klotz Johannes; Zandonai Alessandro; Scattolini Francesco

http://report.alpenv.eurac.edu/LTER/00_DQC_Reports/LTER_Report_20220911.html

Time to share!

Step 0 – FAIR Principles

Findable

- Data and Metadata traceable with a persistent identifier (**DOI**)

Accessible

- Data and Metadata stored in persistent repositories (**Zenodo, Pangea**)

Interoperable

- Standard formats make possible the **communication between different systems**

Reusable

- Well-documented data with clear licenses (**Creative Commons**) to facilitate its use

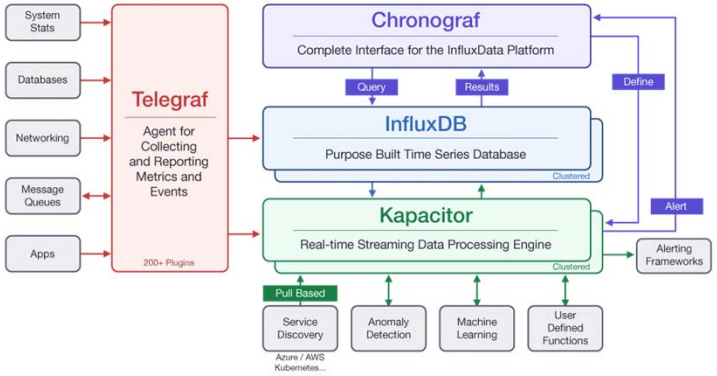
Time to share!

Step 1 – Local data organization (LTER DB)

LTSER Matsch I Mazia

InfluxDB (Time Series DB)

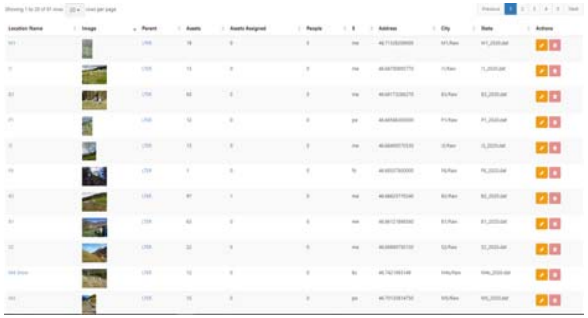
https://www.influxdata.com/time-series-platform/



influxdb

Snipe-IT ("static" metadata)

https://alpenv.assets.eurac.edu/locations



SNIPE-IT
OPEN SOURCE ASSET MANAGEMENT

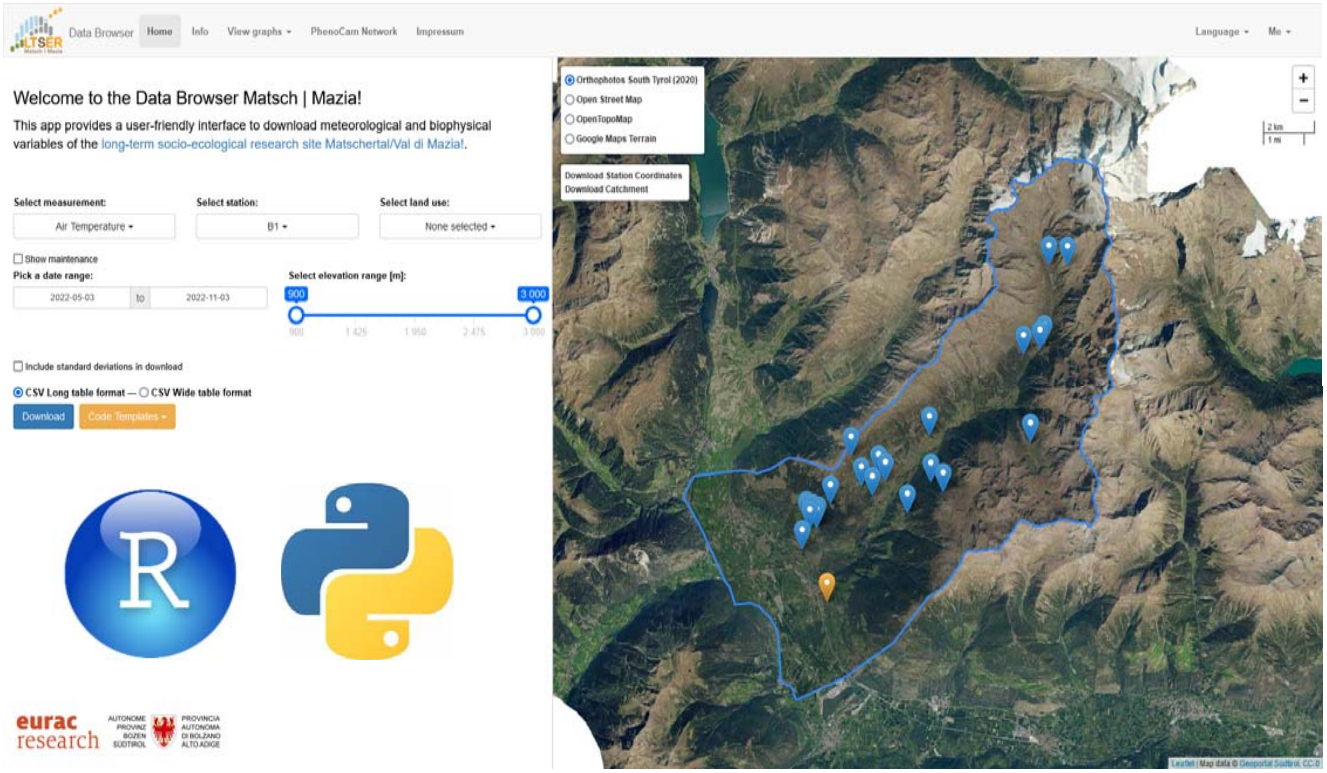
MariaDB

Time to share!

Step 2 – Data sharing (Data Browser)

Data Policy

- **Public** user
  - Common parameters
- **Research** user
  - Full dataset
  - Registration needed
  - More restrictions



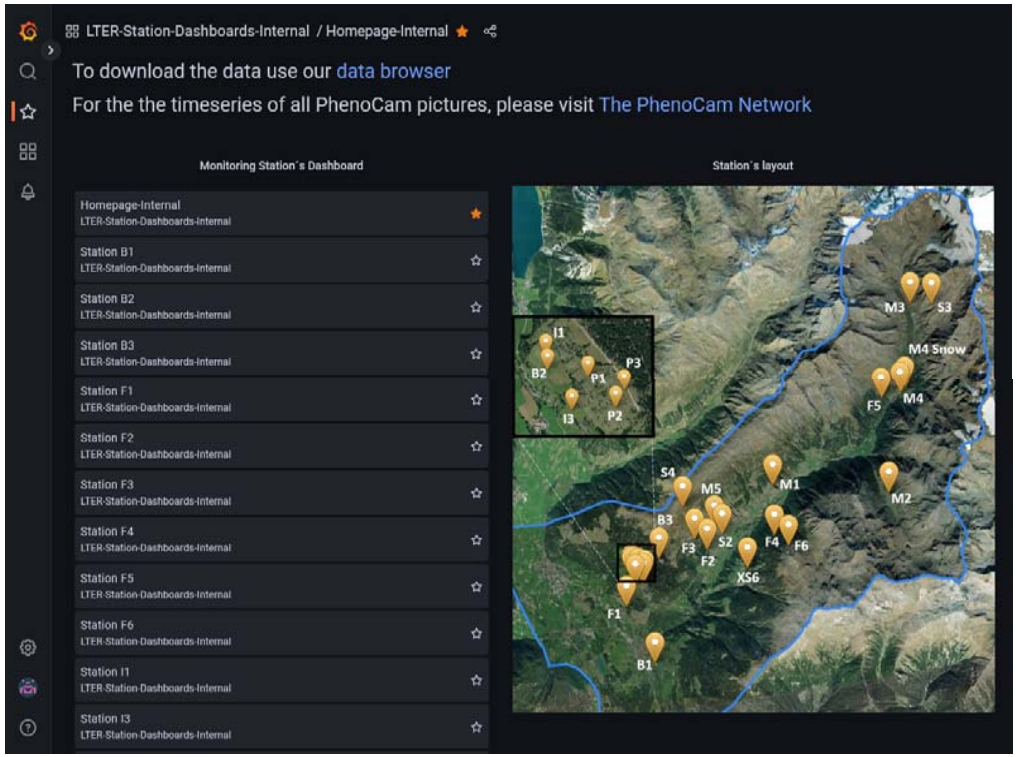
Time to share!

Step 3 – Data visualization (Grafana)

- DB queries –> dashboards
  - Interactive visualization
  - Data analysis

- “Public User”
  Reduced dataset: limited parameters and time range

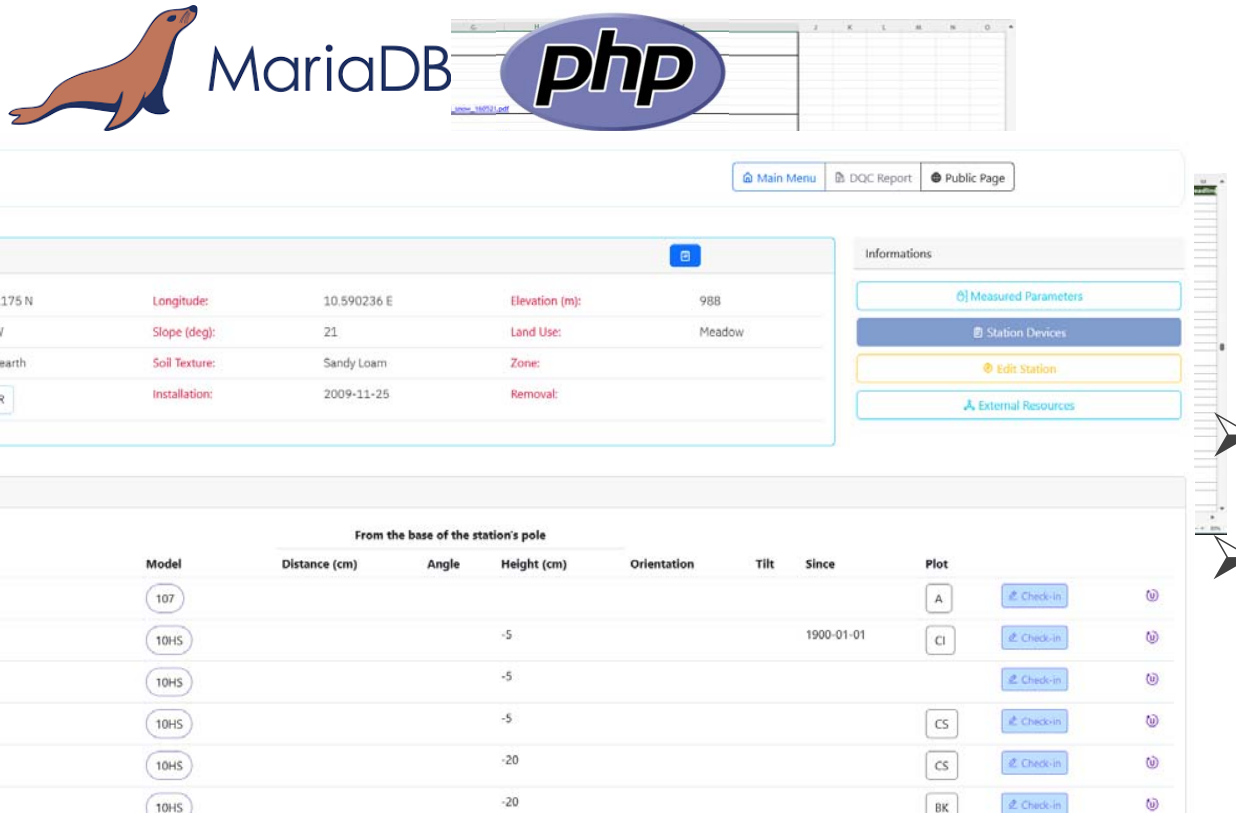
- “Research User”
  Full dataset
  - Thematic Dashboards (parameters compare)



https://dashboard.alpenv.eurac.edu/

Time to share!

Step 4 – Metadata sharing

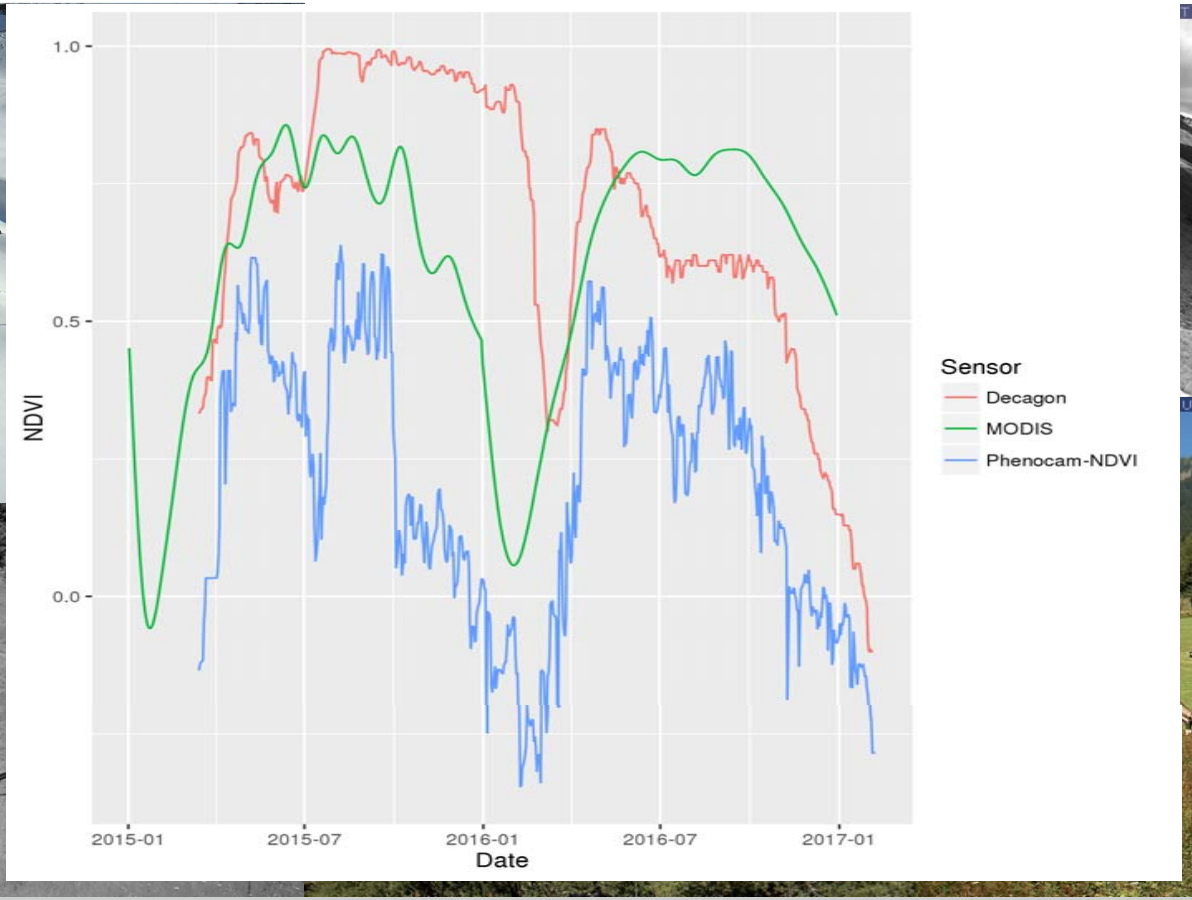


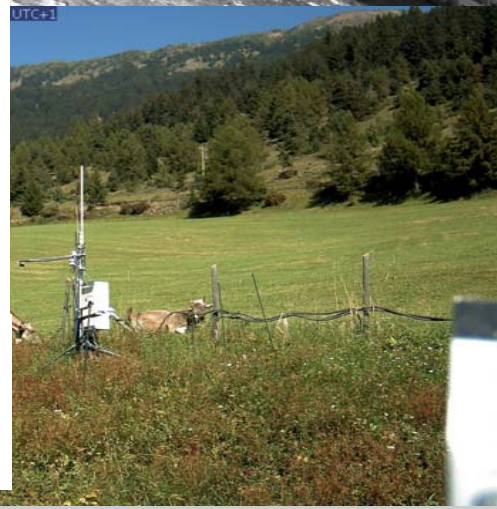
Stations Metadata DB

- Use for technical staff
- Use for in-depth data interpretation

Time to share!

Step 5 – Phenological images sharing (NAU portal)





Time to share!

Step 5 – Phenological images sharing (NAU portal)

- Images flow

1. Hourly sending of a pair of color and infrared images to the Eurac server
2. Check of successful reception, integrity and people detection (privacy)
3. Northern Arizona University portal submission

https://phenocam.nau.edu/webcam/

Recap…

Scheduling

File server

Data & Images Quality Check

Monitoring System

Metadata

Static MetaData DB

TimeSeries DB

Feeder application

FTP transfer

&

Data sharing tools

Grafana

Scripts

Data Browser

PhenoPics

Data Manager

Stations Maintenance DB

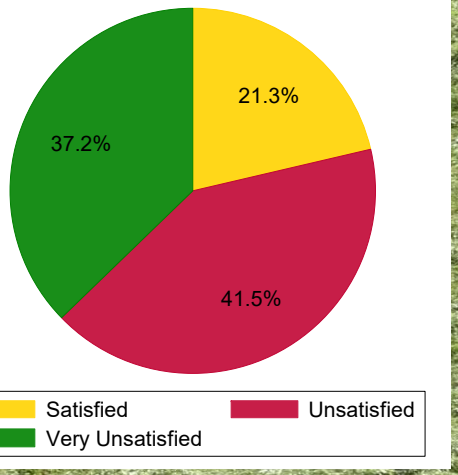
upcoming challenges:

- Heterogeneous timestamp
- Different methods for the same organisms
- → different quality
- Geolocation: from point to area
- Automation

Satisfaction about subsidies

In the past subsidies arrived punctual, nowadays they take long in coming. But if you just do it for the money then you can stop it anyway, to be a farmer. The farmers who are not farmers from the heart, so those which don't care for the nature and the homestead, should get less money"

Elmar



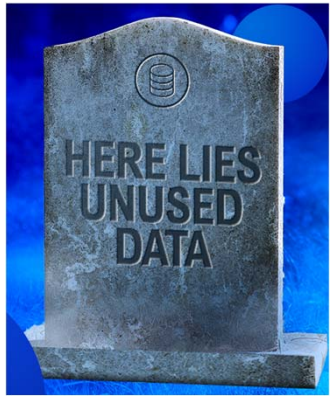
"The farmers are landscape gardeners, but for this activity they don't receive any support. In the range of politics, it needs a change. In my opinion the entire valley should be bio"

Rudolf

Final considerations

Think about your data management
before you buy the first instrument/sensor

1€ per sensor → 1€ for data management



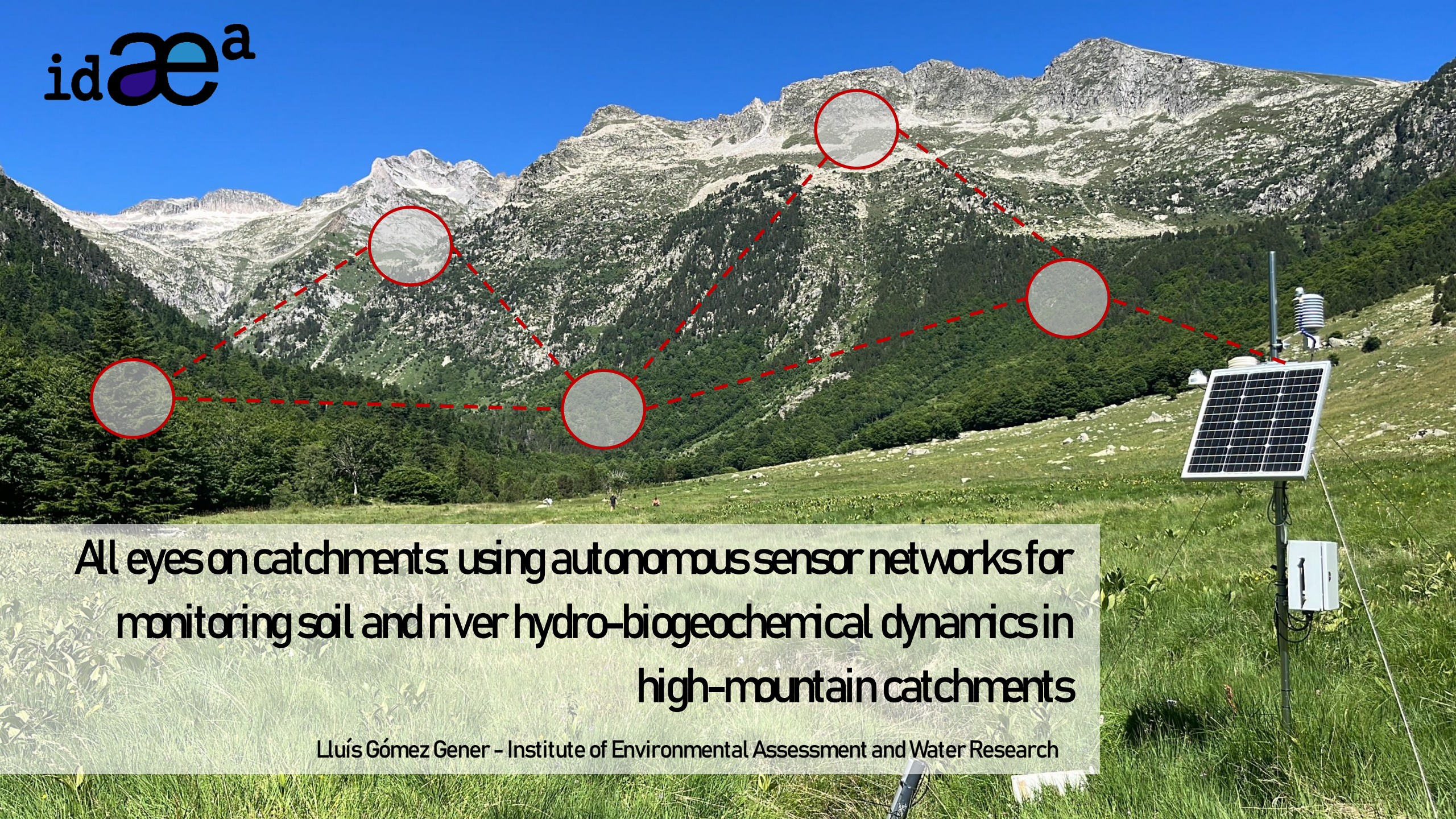
Final considerations

Step by step & customized

Final considerations

Effective sensor & data management needs teamwork


Thank you very *MATSCH*…
Georg.niedrist@eurac.edu



All eyes on catchments: using autonomous sensor networks for monitoring soil and river hydro-biogeochemical dynamics in high-mountain catchments

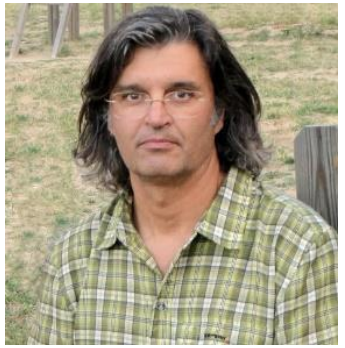
Lluís Gómez Gener - Institute of Environmental Assessment and Water Research

Acknowledgments

Pyrenees Limnological Observatory

LOOP

idaea



Lluís Camarero

Antoine W.

LTER AIGÜESTORTES

MINISTERIO DE CIENCIA, INNOVACIÓN Y UNIVERSIDADES

Cofinanciado por la Unión Europea

AGENCIA ESTATAL DE INVESTIGACIÓN

Contact

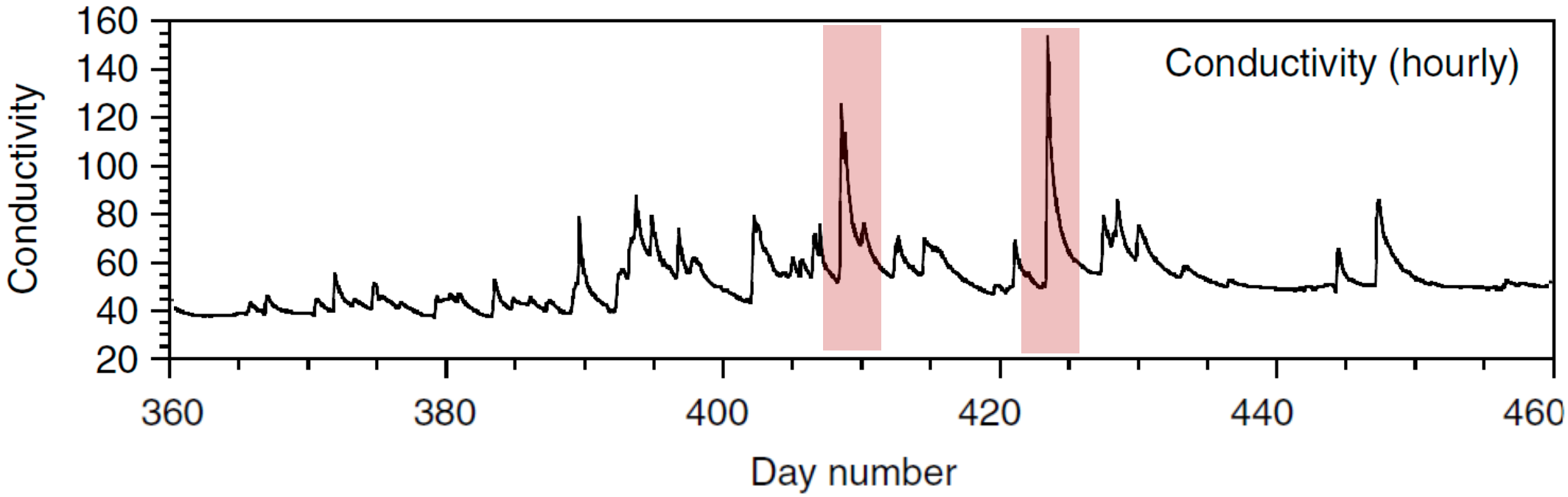
loop@ceab.csic.es

loopweb.org

loopdata.org

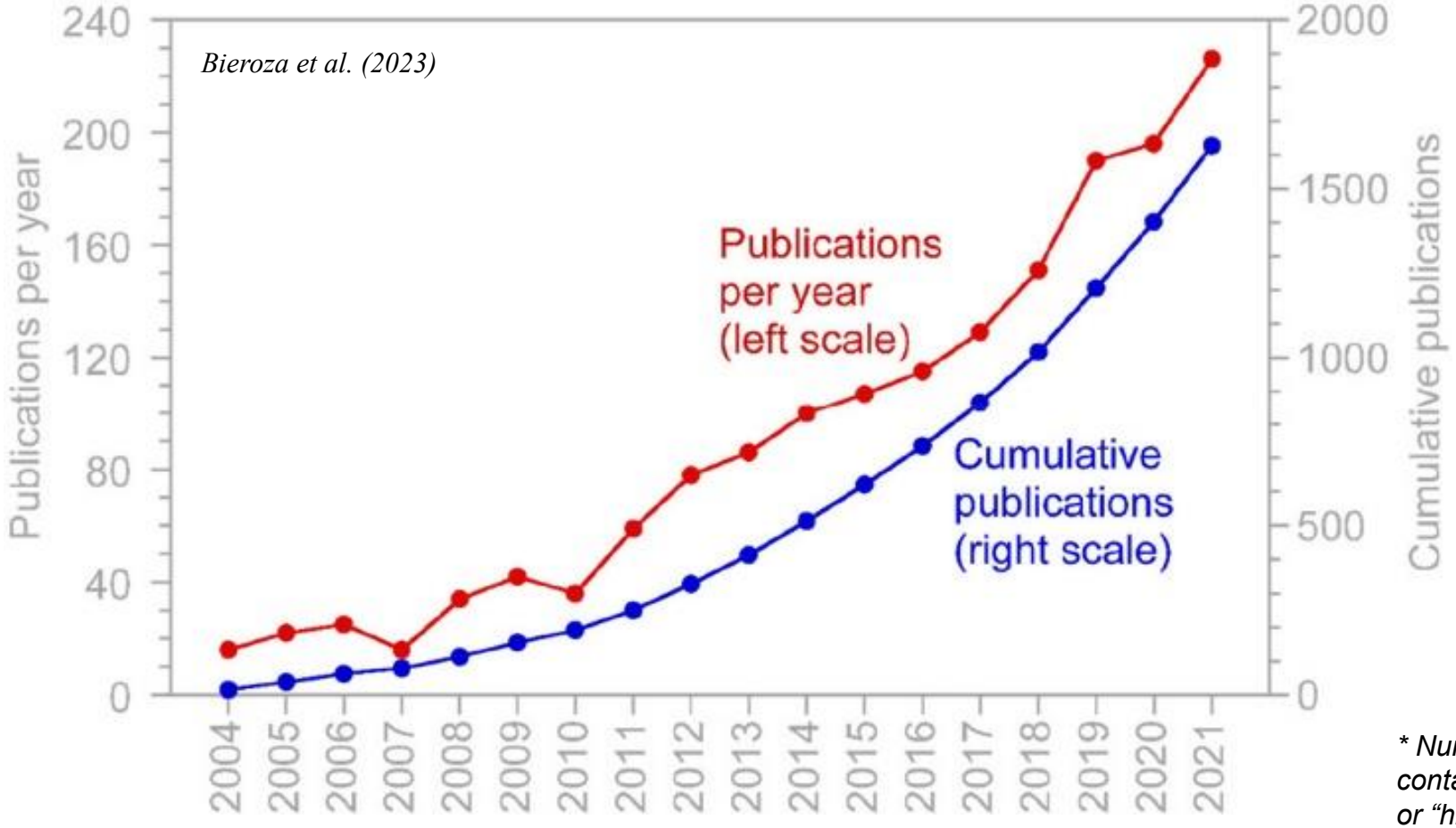
From "snap shots" to "regimes": The fine structure of ecosystem dynamics

From "snap shots" to "regimes": The fine structure of ecosystem dynamics



adapted from Kirchner et al. (2004)

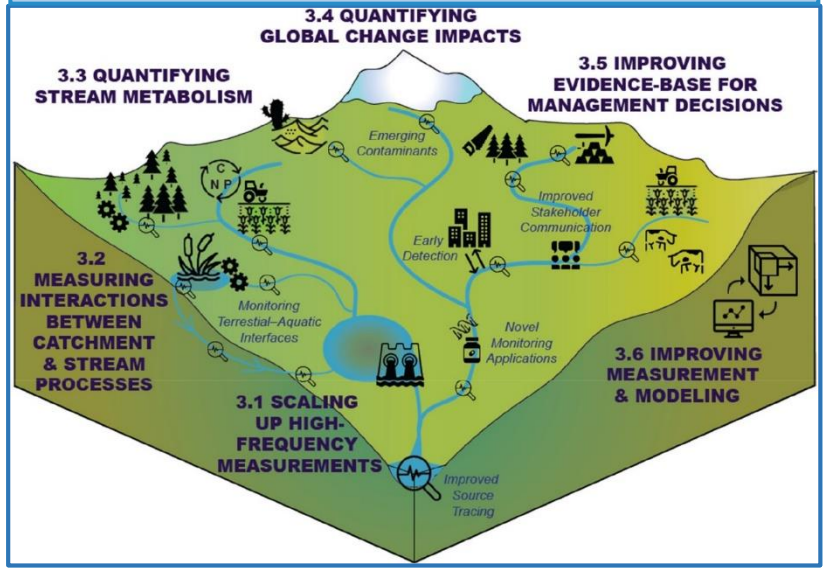
Sensors in the field: The High-Frequency Wave of the Present



** Number of peer-reviewed journal articles containing search phrases "high-frequency" or "high-resolution" and "water quality" in the title, abstract, or keywords. Based on a Web of Science search in August 2022.*

Sensors in the field: The High-Frequency Wave of the Present

Freshwater / catchment sciences



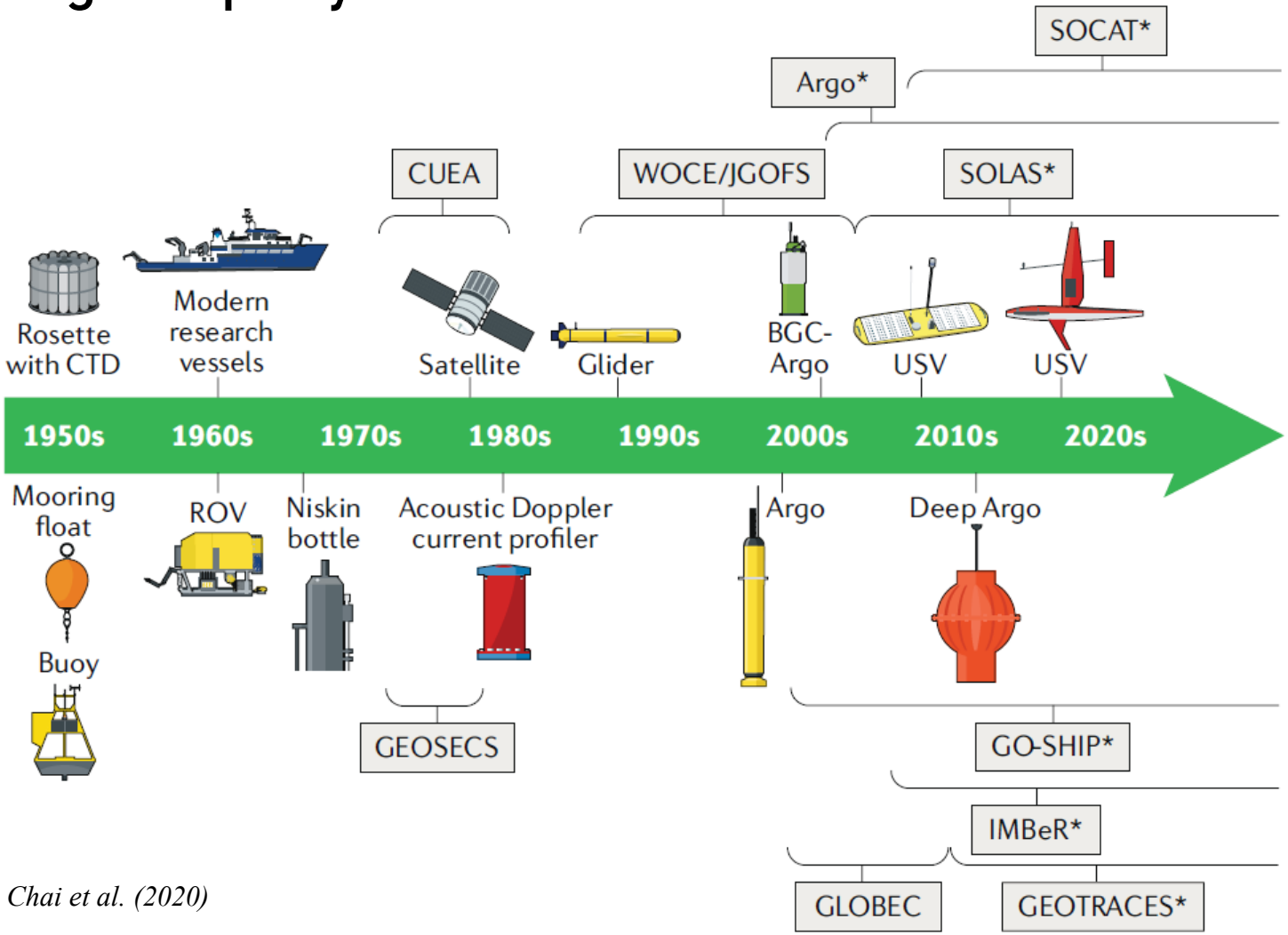
Bieroza et al. (2023)

Soil / Forestry / Agriculture sciences

Marine sciences

Chai et al. (2020)

Sensors in the field: The High-Frequency Wave of the Present



Chai et al. (2020)

Sensors in the field: The High-Frequency Wave of the Present

Sensors to monitor biodiversity

Wildlife camera traps
(Snyper Commander 4G Wireless)

Low-cost acoustic loggers
(AudioMoth)

Bird radar
(Birdscan MR1 Radar)

DIOPSIS

Automated moth camera trap

Intelligent camera with GPU computer

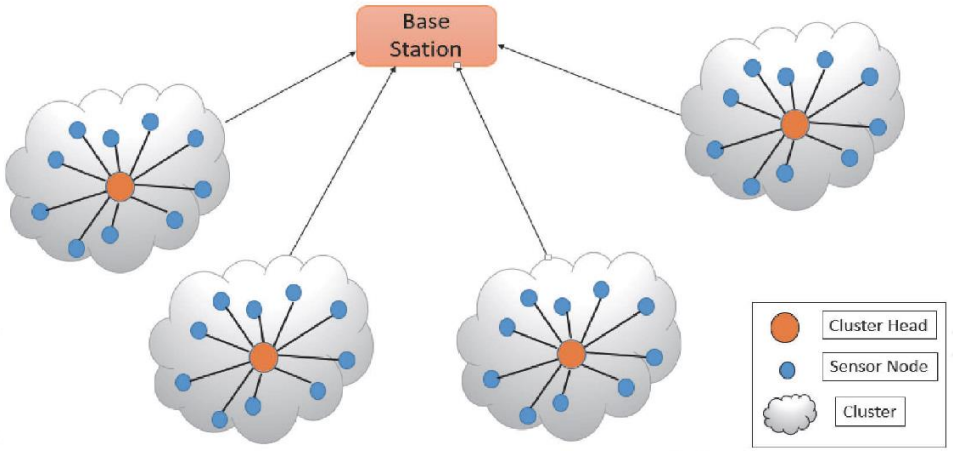
Advantages of environmental sensors vs. manual sampling

1. Continuous and real-time data collection
2. Higher data resolution (high-frequency)
3. Autonomy and reduced human intervention/error
4. Energy efficiency and long-term deployment
5. Remote acces/immediate alerts

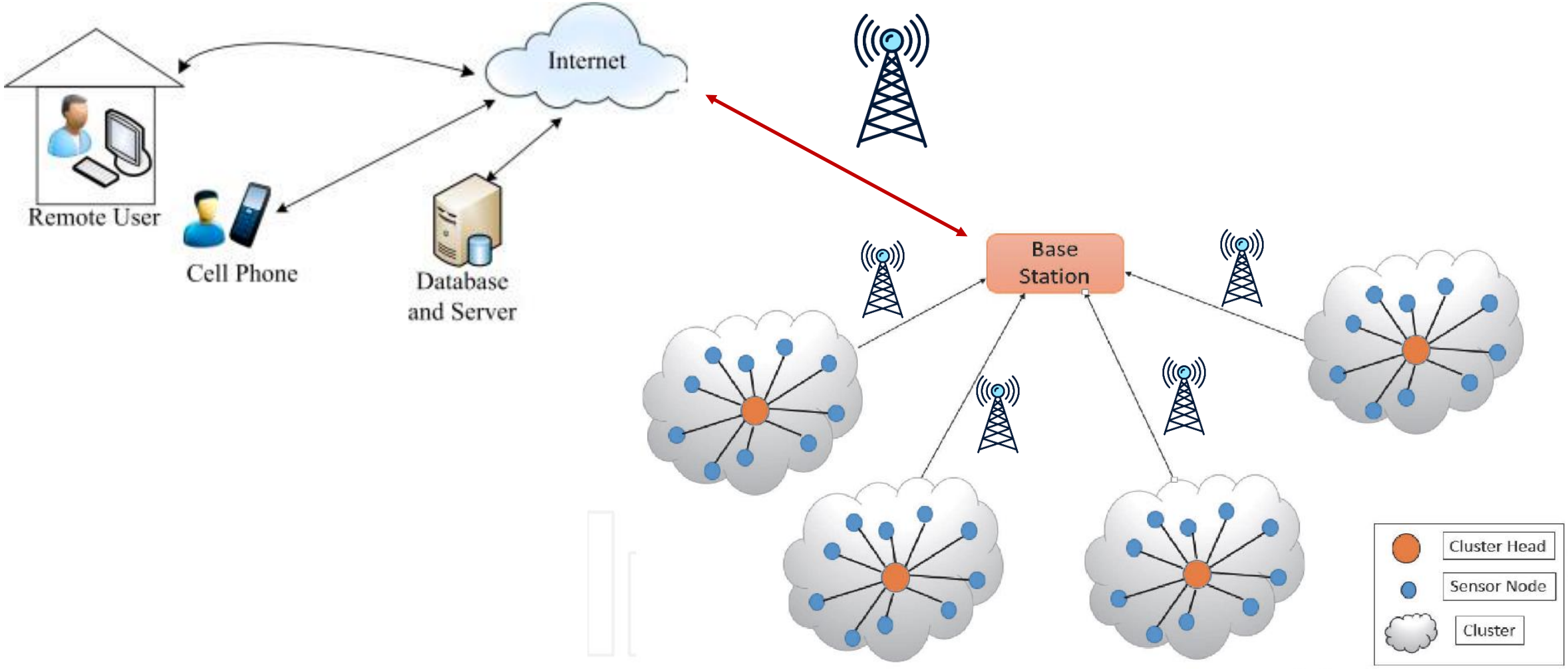
From individual sensors to sensor networks

1. Continuous and real-time data collection
2. Higher data resolution (high-frequency)
3. Autonomy and reduced human intervention/error
4. Energy efficiency and long-term deployment
5. Remote acces/immediate alerts

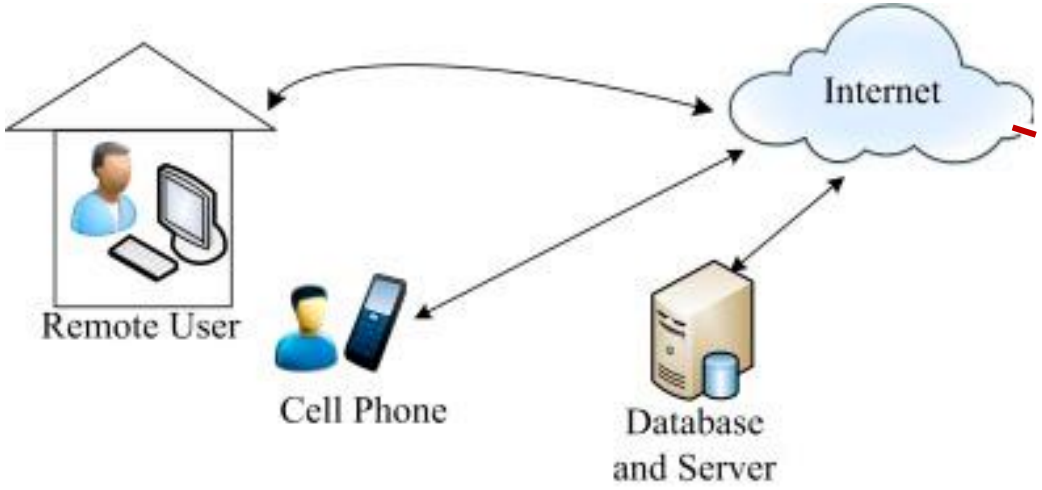
Network Integration

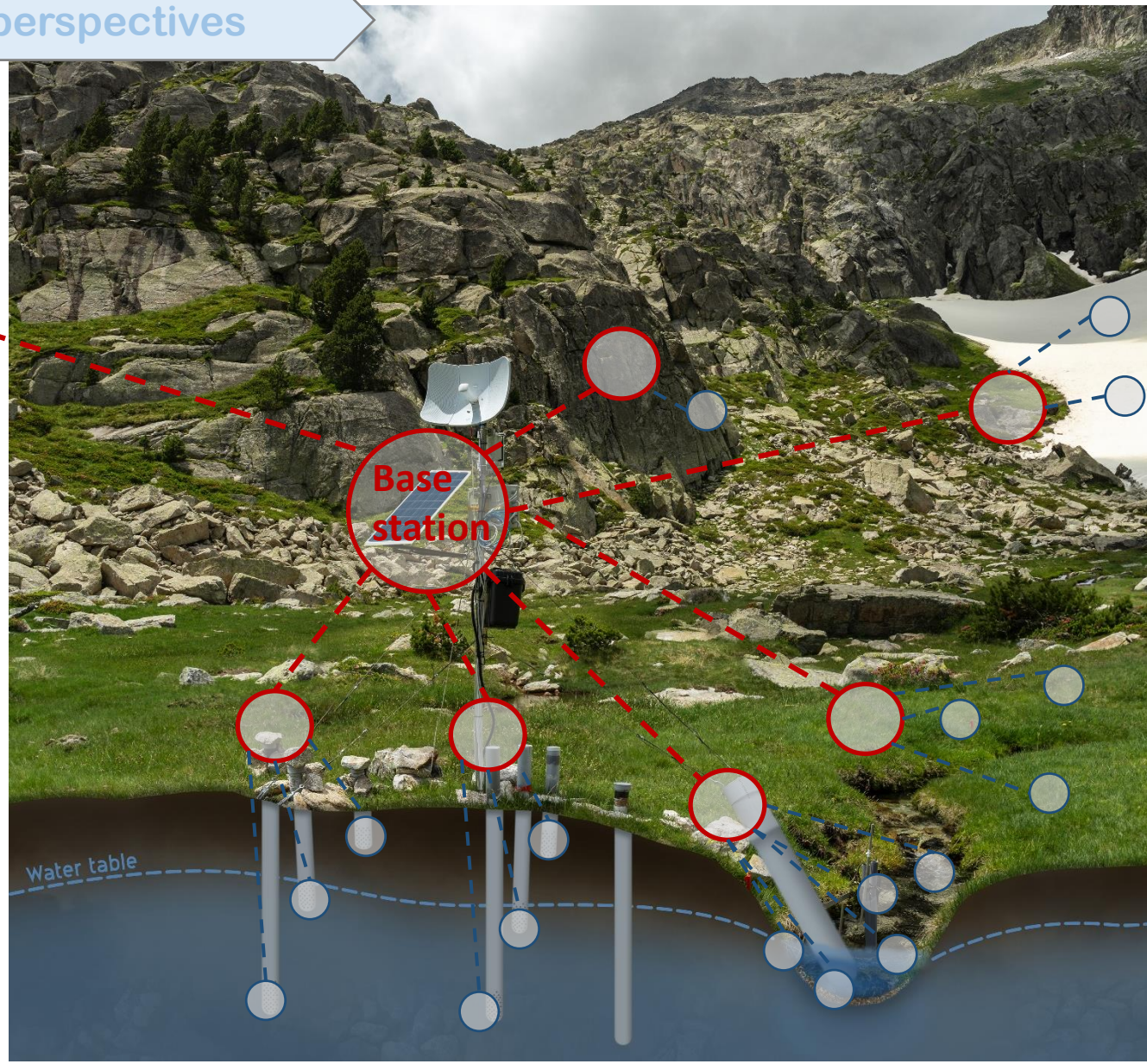


From individual sensors to sensor networks



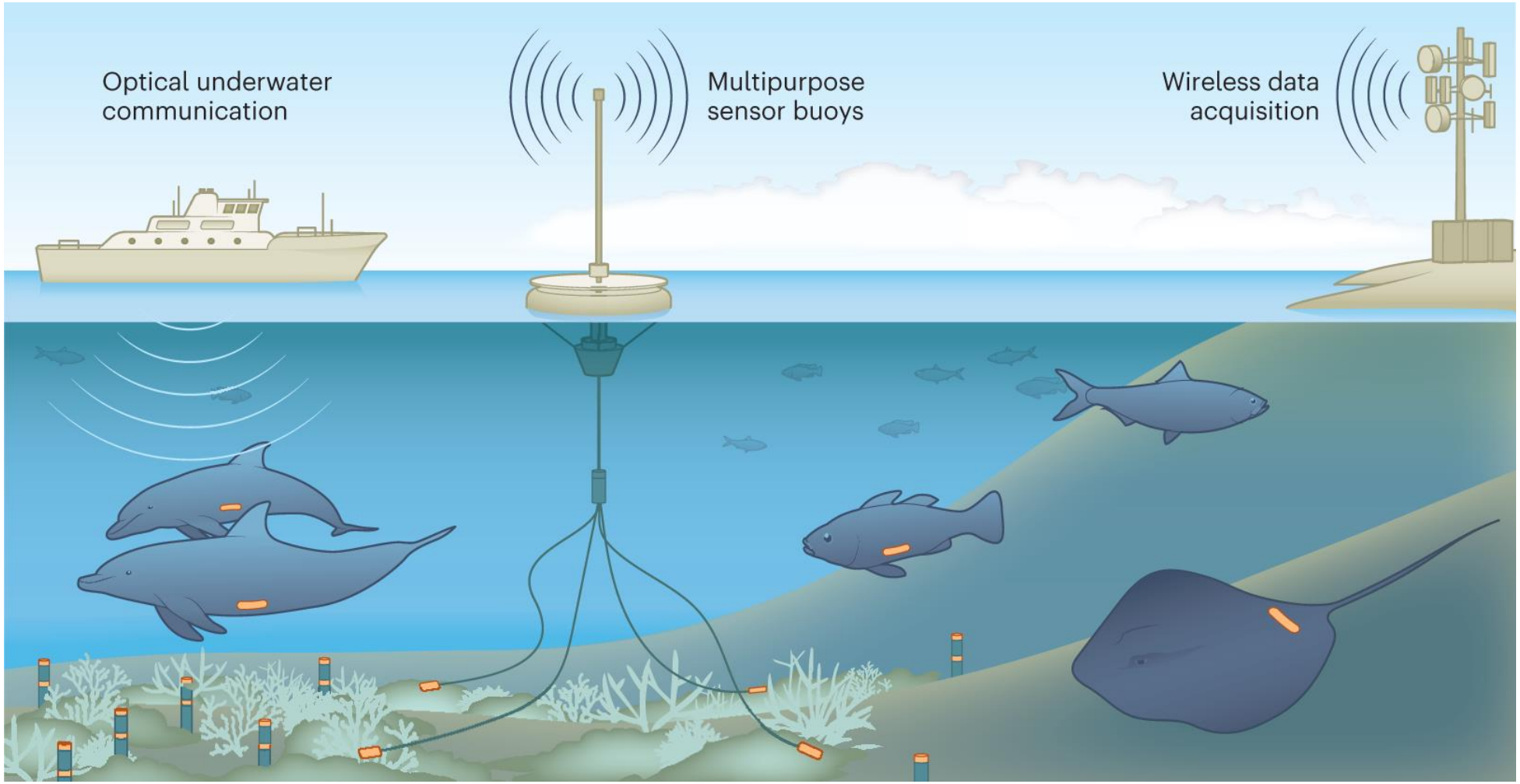
From individual sensors to sensor networks





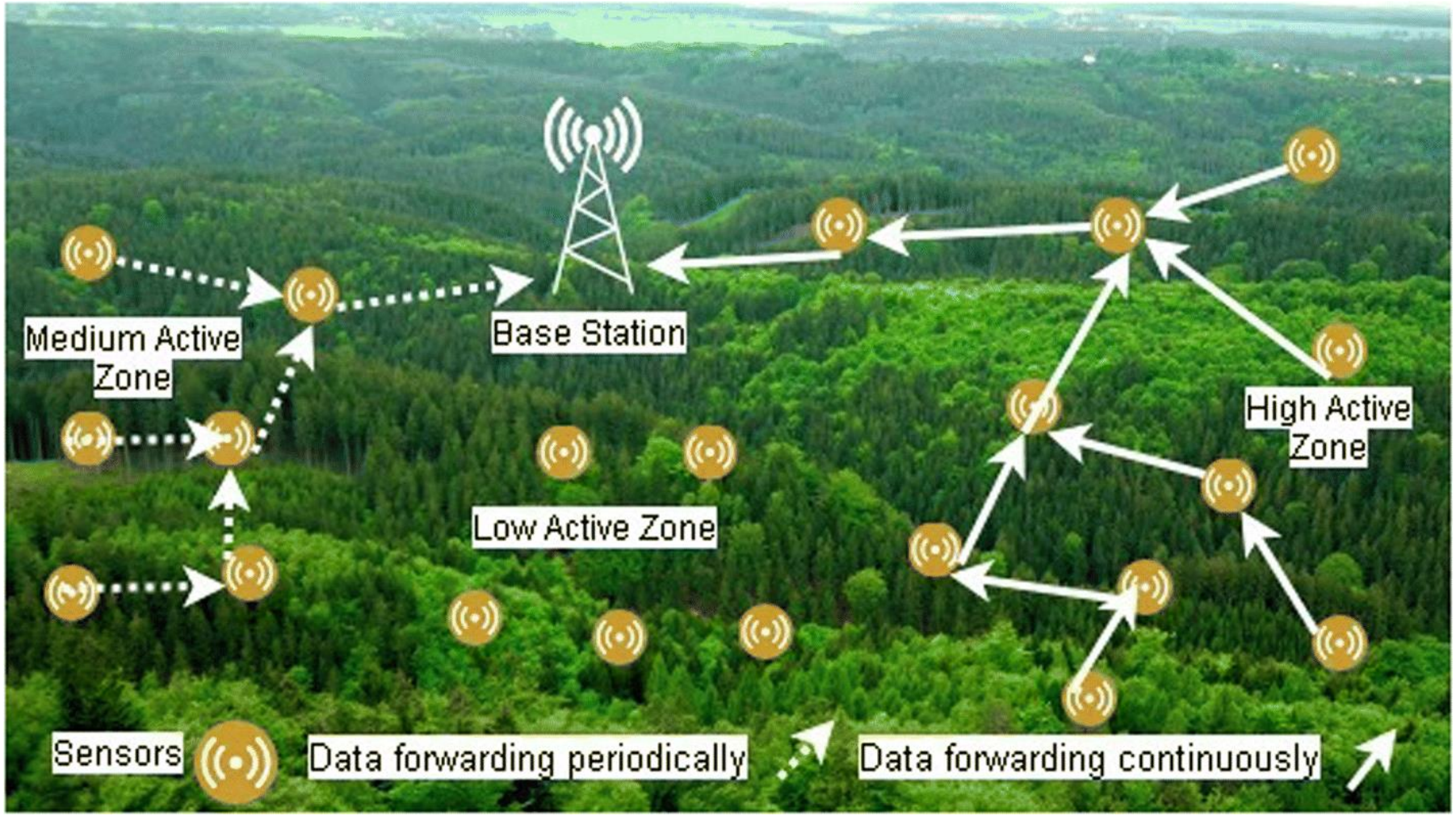
Ribereta de Contraix, Parc Nacional d'Aigüestortes i Estany de Sant Maurici, Pyrenees

From individual sensors to sensor networks



Kaidarova et al. (2023)

From individual sensors to sensor networks

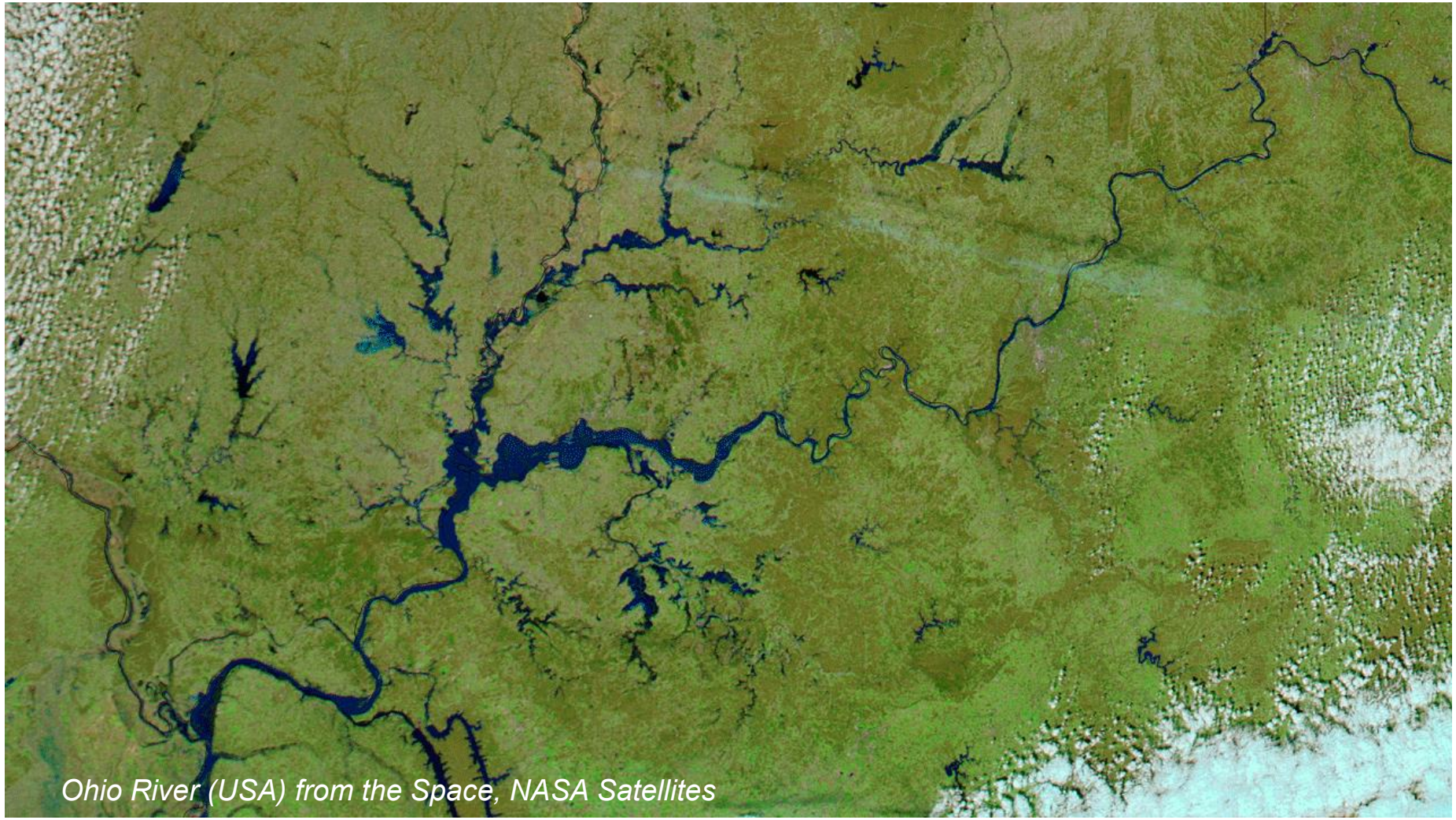


Vikram et al. (2020)

Case study:

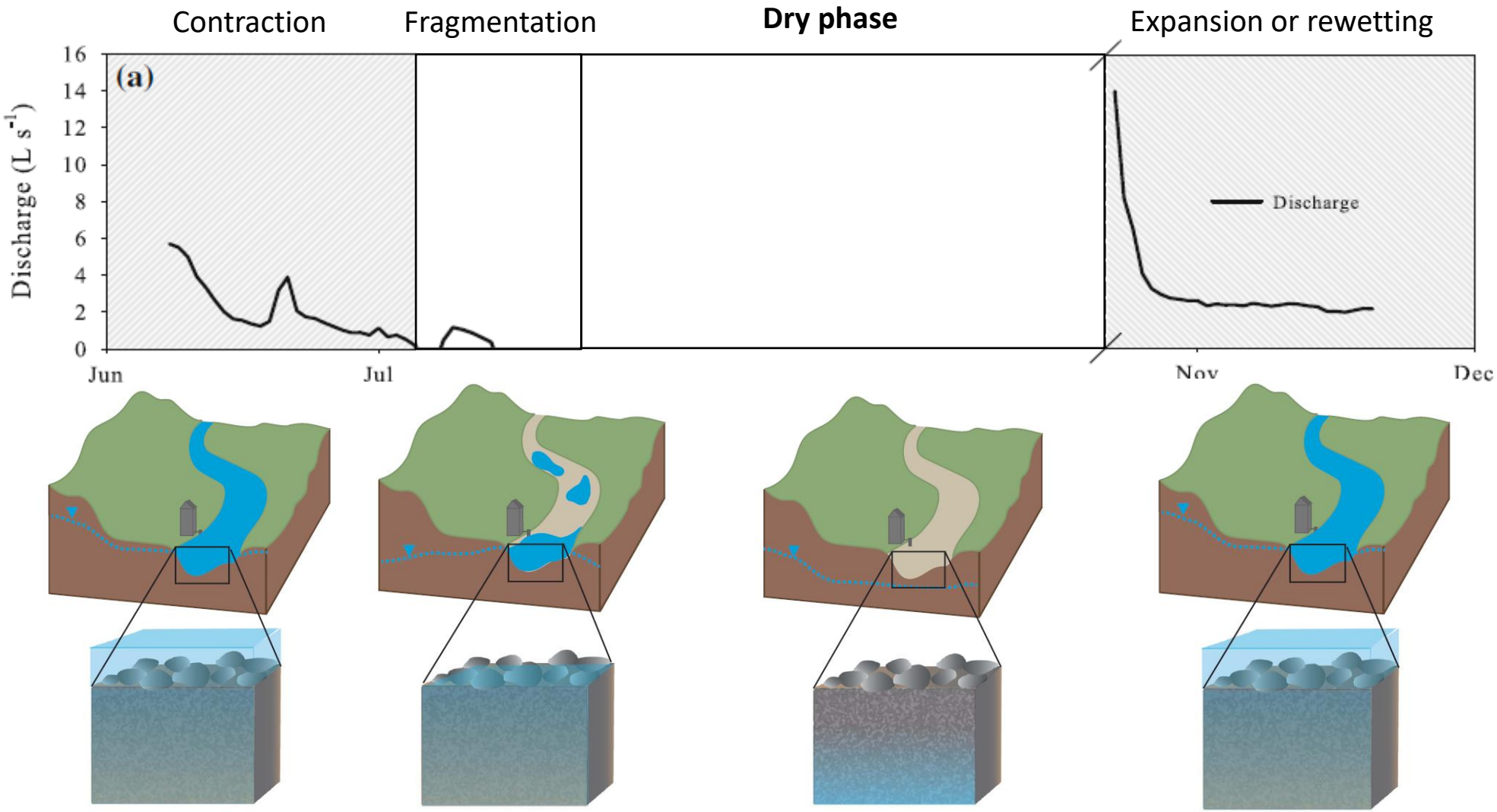
Using an automated sensor network to study hydrological intermittency in high mountain river networks

River networks are very dynamic



Ohio River (USA) from the Space, NASA Satellites

River networks are very dynamic



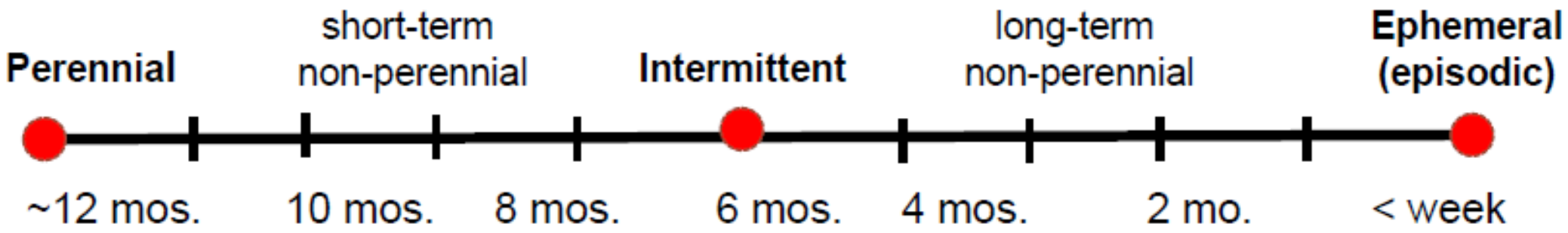
The hydrologic regime of "intermittent rivers"

Riu Ebre (Lluís Gómez)

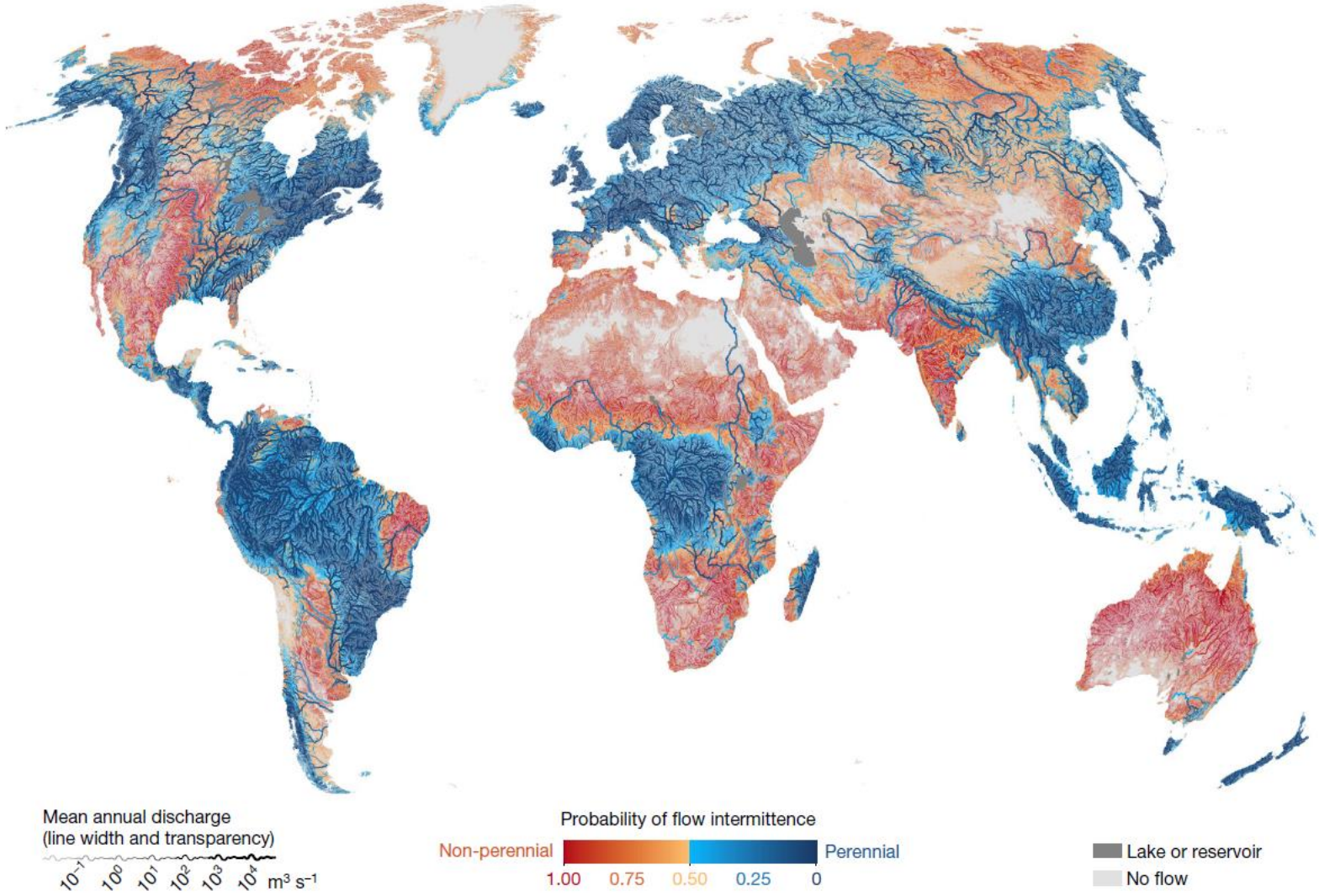
Riu Fluvià (Meritxell Abril)

Riera de Maspujols (Lluís Gómez)

Dry phase duration



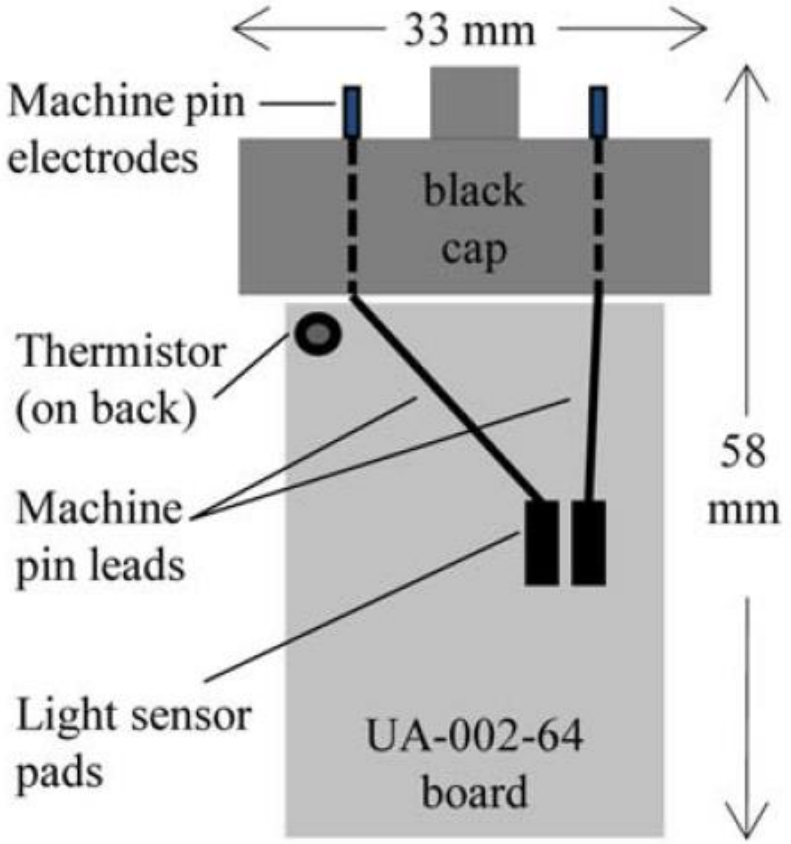
River networks are very dynamic



Messager et al., 2021

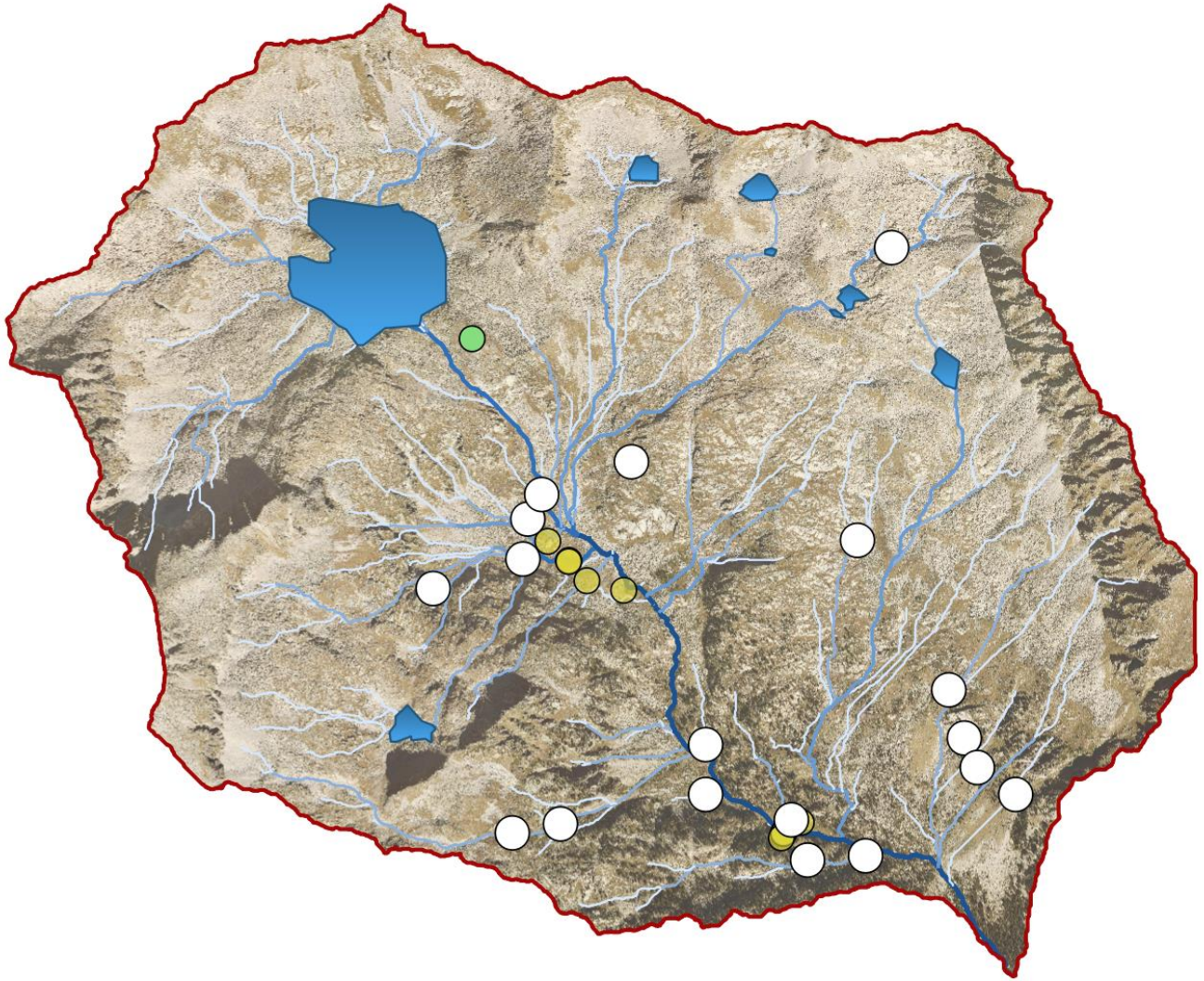
Why is it important to study intermittent rivers in high mountain areas?

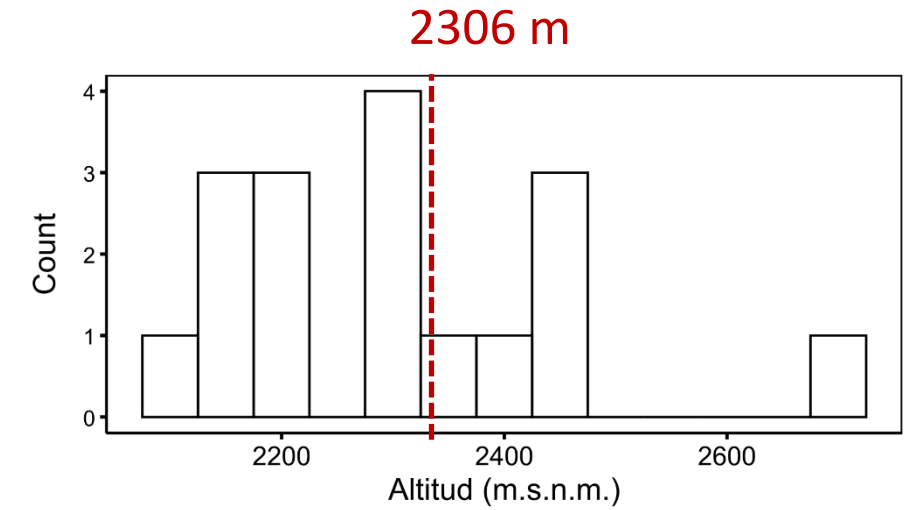
The "water presence" sensor

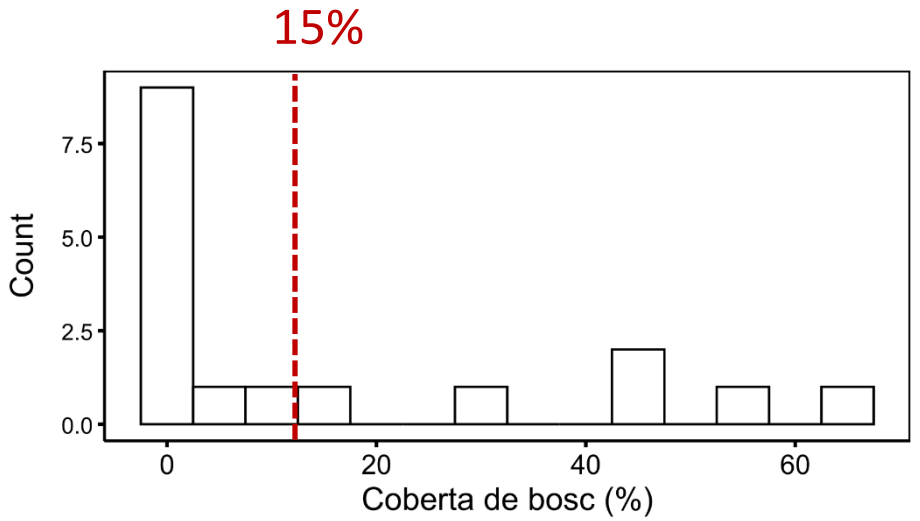


HOBO Pendant Temperature/Light 64K Data Logger UA-002-64

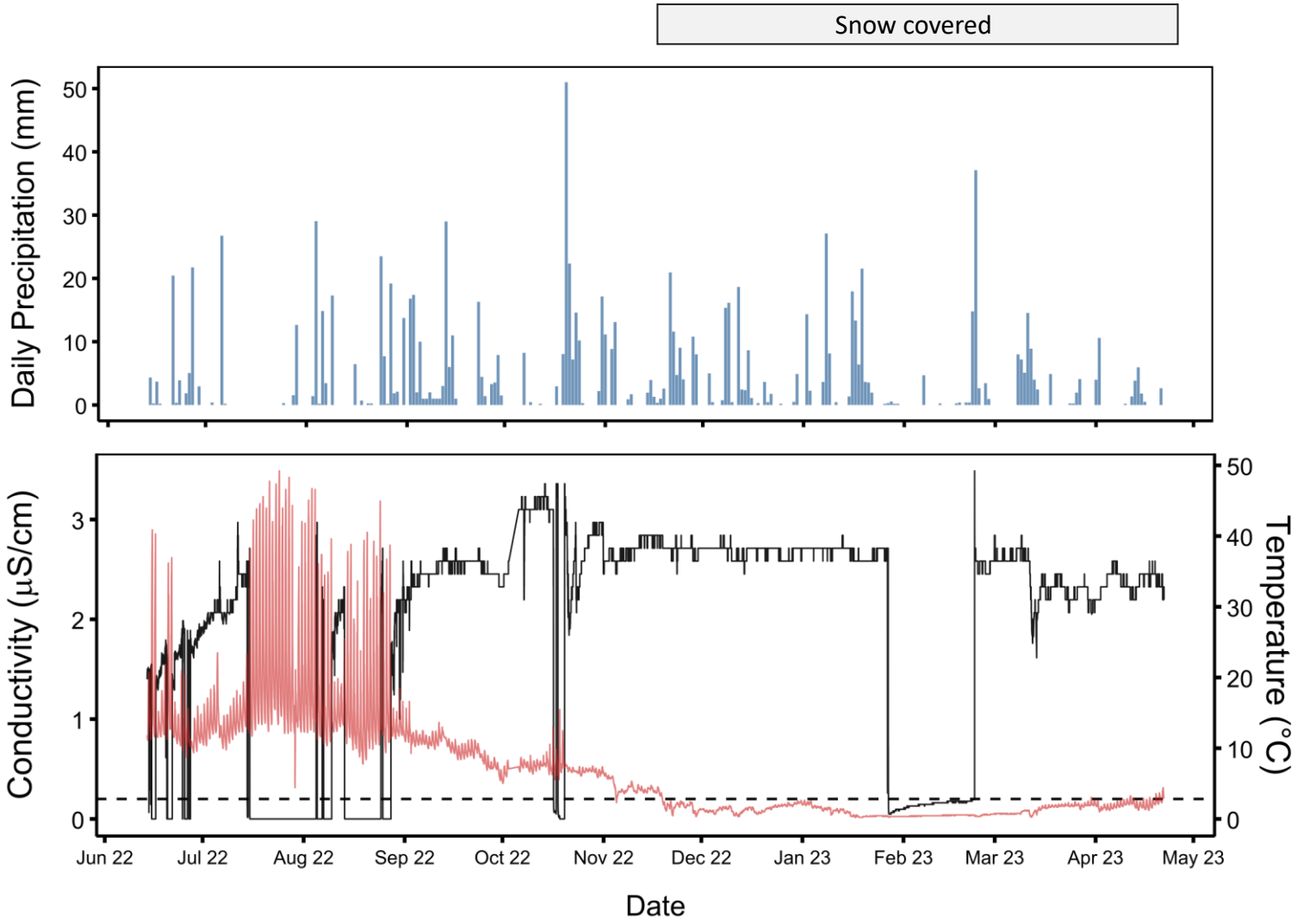
Deployment of sensors (n=17) at the Contraix Catchment (Central Pyrenees)



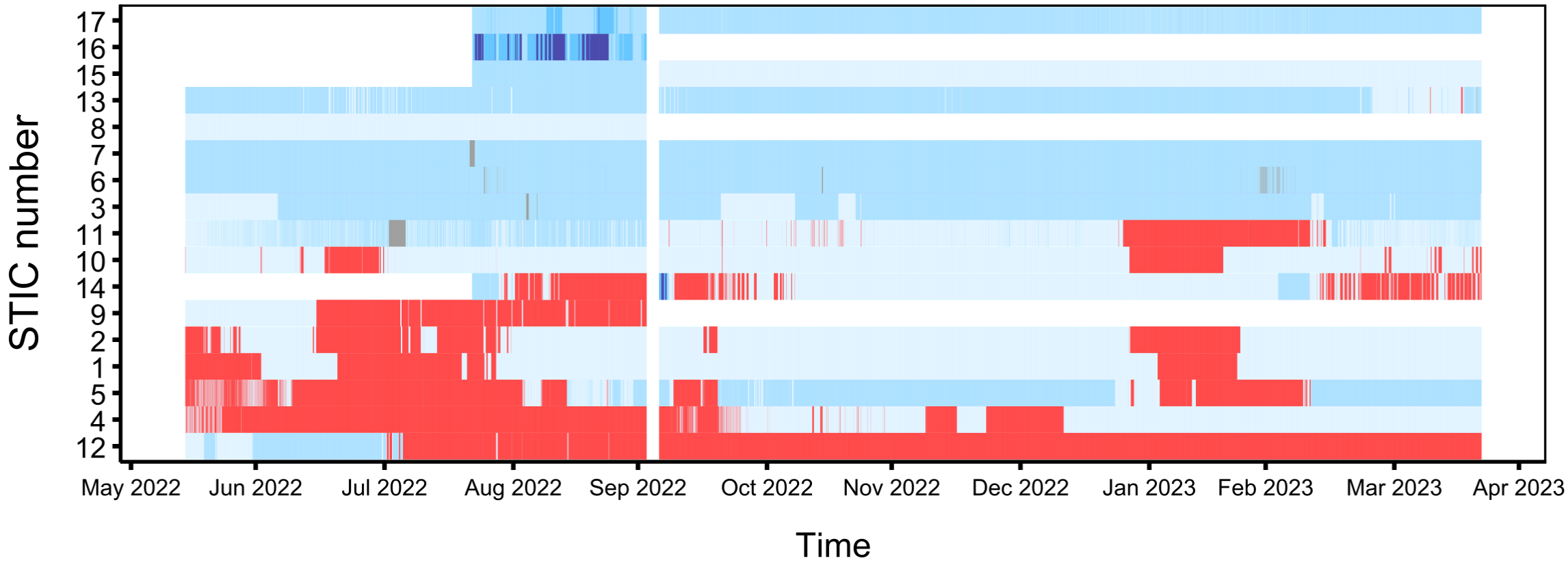




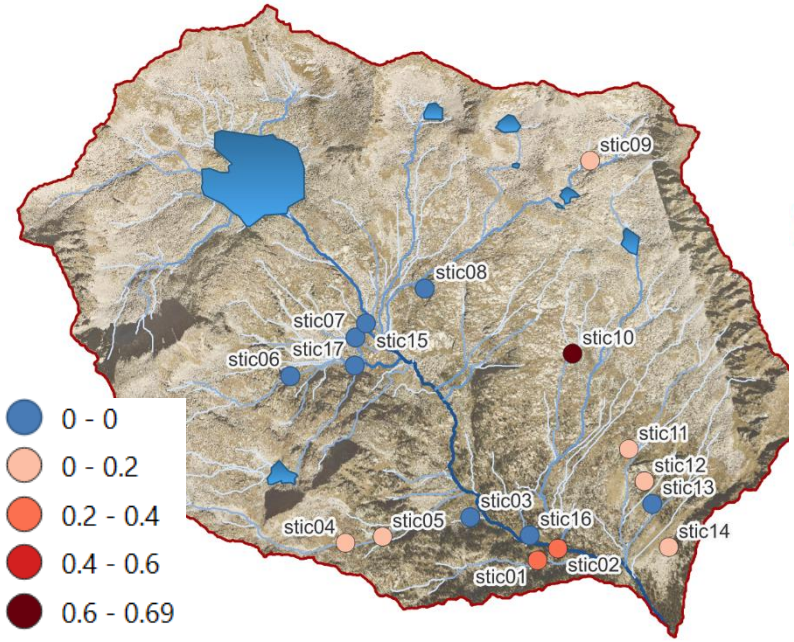
Results


Snow covered
Daily Precipitation (mm)
0
10
20
30
40
50
Conductivity (µS/cm)
0
1
2
3
Temperature (°C)
0
10
20
30
40
50
Jun 22
Jul 22
Aug 22
Sep 22
Oct 22
Nov 22
Dec 22
Jan 23
Feb 23
Mar 23
Apr 23
May 23
Date

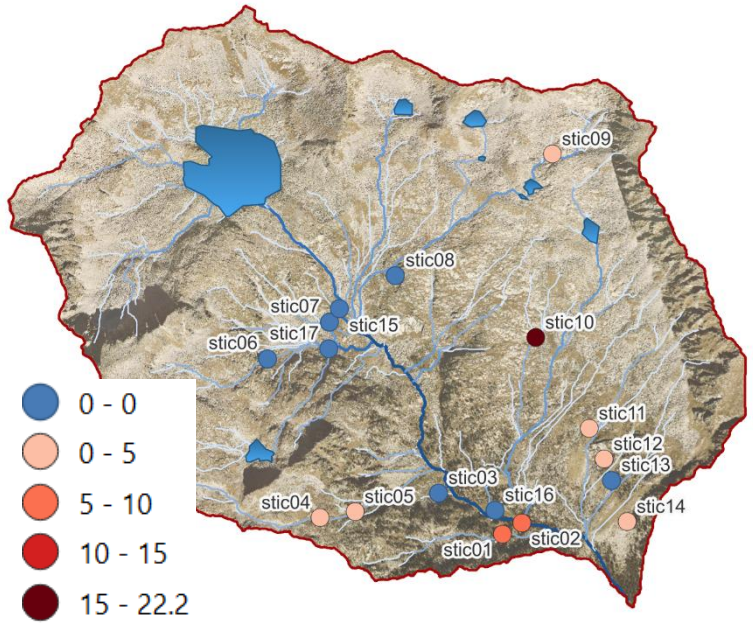
Results


STIC number
17
16
15
13
8
7
6
3
11
10
14
9
2
1
5
4
12
May 2022
Jun 2022
Jul 2022
Aug 2022
Sep 2022
Oct 2022
Nov 2022
Dec 2022
Jan 2023
Feb 2023
Mar 2023
Apr 2023
Time

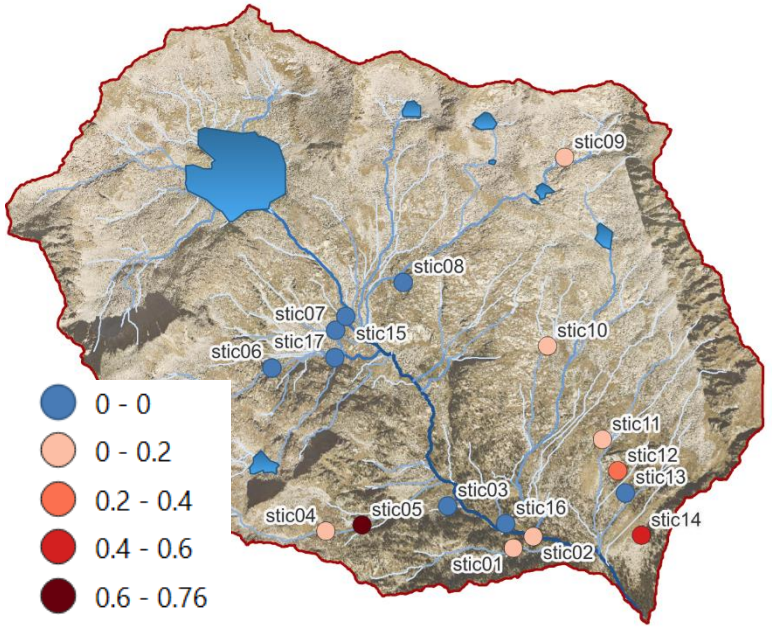
Results



On average, intermittent streams remain without flowing water **30% of the time.**



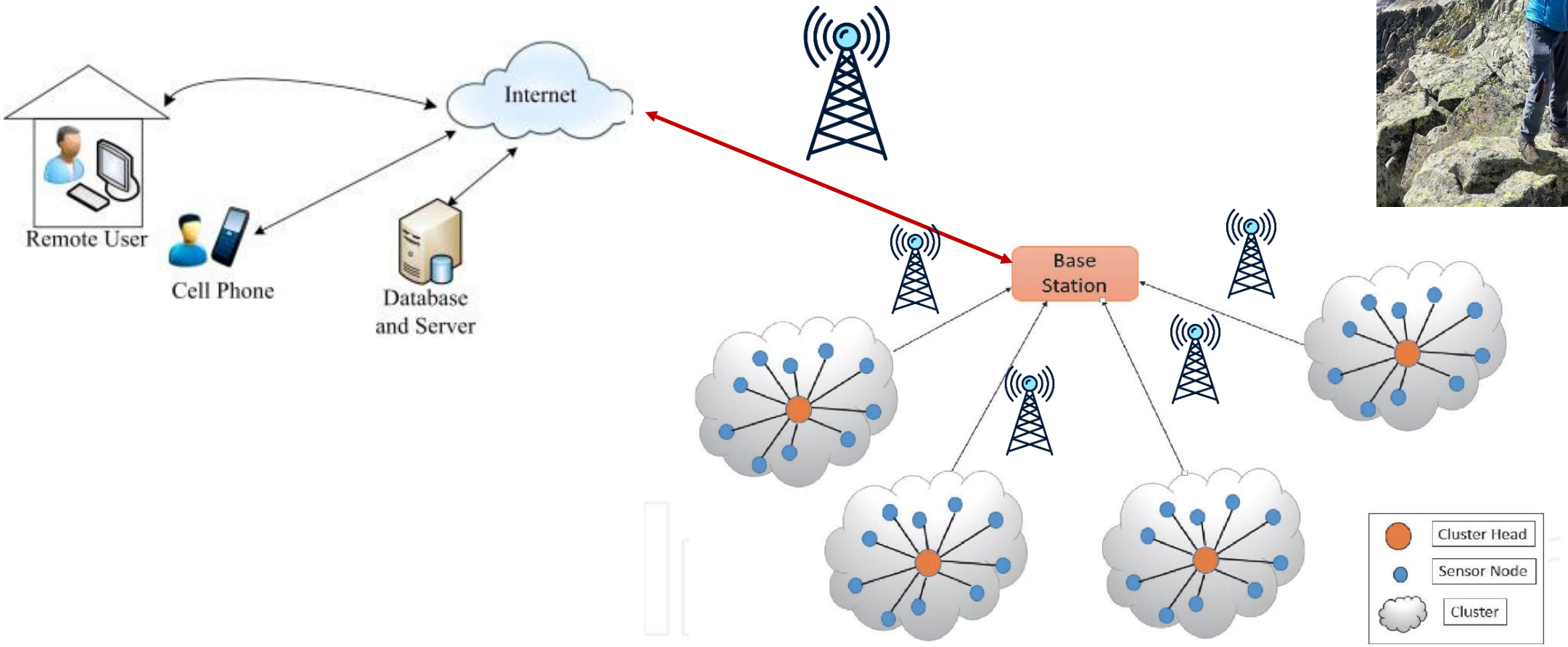
On average, intermittent streams remain dry for a period of **5.2 days** during each drying episode.



On average, intermittent streams dry up **63 times**.

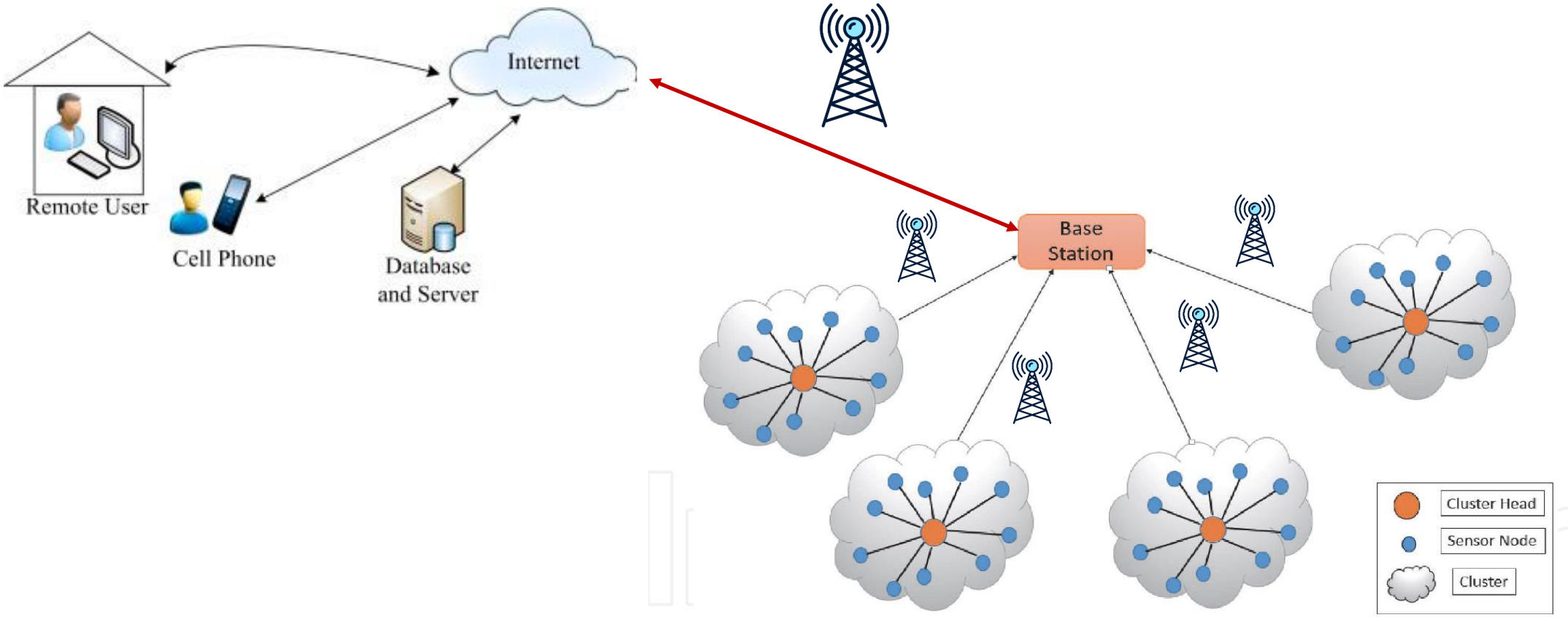
1. Connectivity and data transmition

Improving 2-way communication in remote or harsh environments



2 Integration & interoperability

Making sure that “biodiversity sensors” can work together and can be integrated with other sensor networks to provide cohesive insights.



3. Use DIY approaches

Using self-made, low-cost solutions to make it more affordable to everyone.

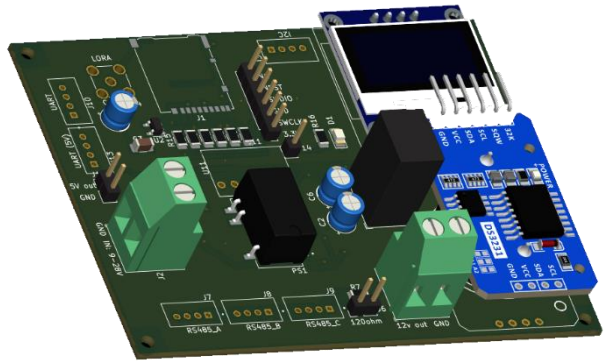
DIY Lab

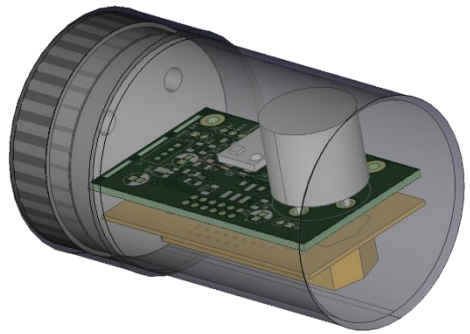
As limnologists, geoscientist or hydrologists, we require a variety of data: water temperature, dissolved oxygen levels, nutrient concentrations, water flow, and much more. However, the devices we need to collect this data are often too expensive, unavailable, or sometimes even non-existent. Therefore, it is sometimes necessary to build them ourselves!

This page is where you will find information about current and past DIY projects developed by myself and/or my colleagues. You will find documentation on various aspects of the project's status, development, deployment, usage and results.

Our projects revolve around these pillars:

- Using self-made, low-cost solutions to make it more affordable to everyone.
- Adopting the open-source hardware philosophy so that the broad community can use or modify the project.
- Using open-source hosting services for software development to ensures the re-usability of the code.
- Using open-web applications for interactive visualization.





TSF-4. Do-it-yourself (DIY) open source tools and projects in ecology

Organizers: María Leo, *Instituto de Ciencias Agrarias (ICA-CSIC)*; Ángel Lareo, *Universidad Autónoma de Madrid (UAM)*; Lluis Gómez Gener, *Centre de Recerca Ecològica i Aplicacions Forestals (CREAF)*.

III SIBECOL & XVII AEET MEETING

D -made equipment, often referred to as "do-it-yourself," (DIY) has a long history in science. However, inadequate c fragmented efforts hindering the widespread adoption of these valuable innovations. Our goal is to present successful o ed by the Iberian Ecology community, as they contribute to democratize science and enable research that might

Thank you very much!

lluis.gomez@idaea.csic.es