Scuola universitaria professionale della Svizzera italiana
Dipartimento ambiente costruzioni e design
Istituto scienze della Terra

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In-situ observation renaissance with istSOS and IoT

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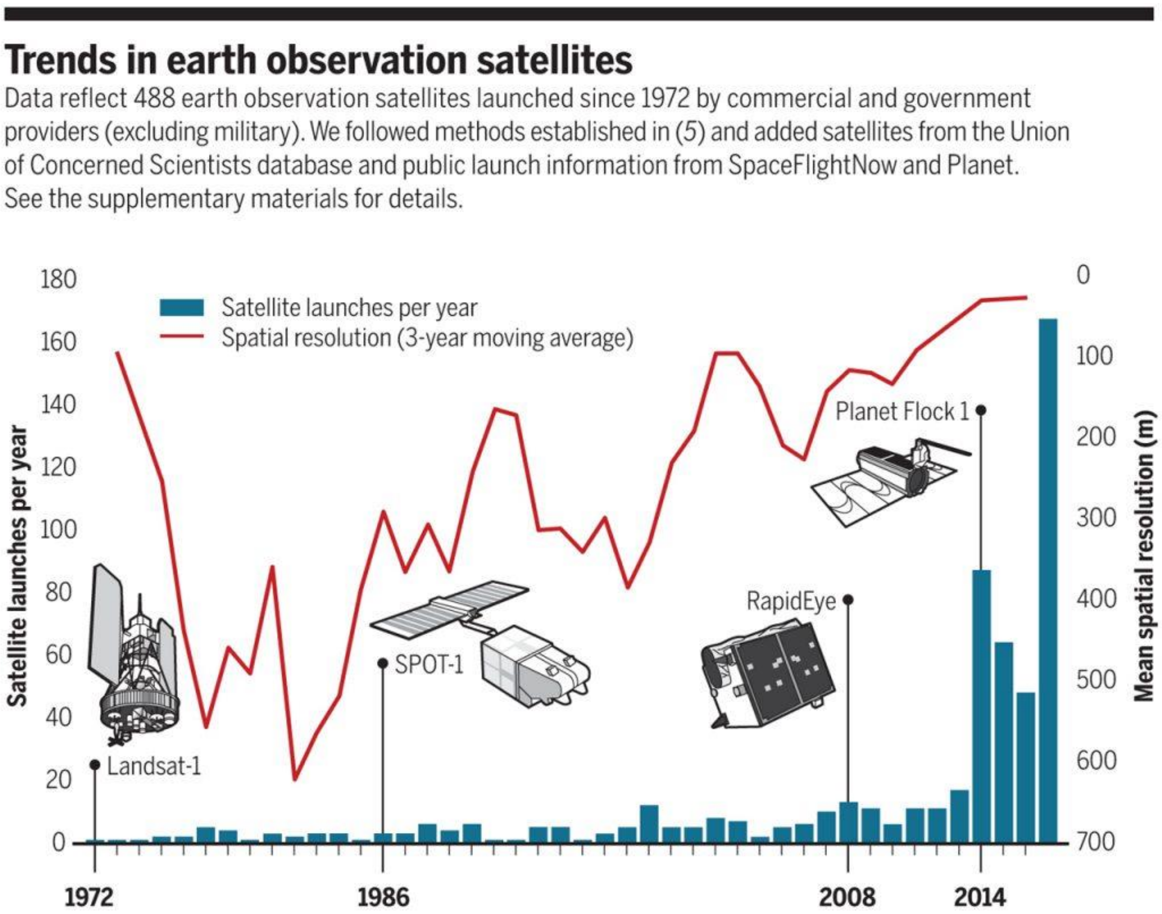
Time for in situ renaissance

By **Balázs M. Fekete,[1*] Richard D. Robarts,[2] Michio Kumagai,[3] Hans-Peter Nachtnebel,[4] Eric Odada,[5] Alexander V. Zhulidov[6]**

In situ monitoring of water dates to Pharaonic Egypt and remained the primary means of observation into the later part of the 20th century. Monitoring networks have declined (*1–4*) since the 1980s because of budgetary constraints and political instabilities. This decline paradoxically has coincided with growing interest in climate change. The rise of satellite remote sensing promised global observing capabilities and put in situ monitoring on the sidelines. Capabilities offered by in situ monitoring versus satellite remote sensing are very different and mostly complementary (*5*); thus, deployment should depend on monitoring requirements (observed parameter, data quality, spatiotemporal scale, data costs, and access).

Fekete, B.M.; Robarts, R.D.; Kumagai, M.; Nachtnebel, H.-P.; Odada, E.; Zhulidov, A.V. Time for in situ renaissance. Science 2015, 349, 685–686

Satellite data market is fast growing



- Spatially distributed
- High coverage
- Maintained by external institutions
- Low temporal and spatial resolution
- Indirect measures

Source: https://www.planet.com/pulse/protocol-tropical-deforestation-monitoring/

But, in situ observations are good in...

FIDELITY, RESOLUTION, CONSISTENCY. Only in situ sensors, typically in close contact with the monitored medium, can measure a host of water-related quantity and quality parameters and processes (*6*) with reliable accuracy and sufficient frequency. Remote sensing provides indirect measurements normally limited to the near surface of the monitored object and affected by the media between the sensors and the monitored object. Remote-sensing ob-

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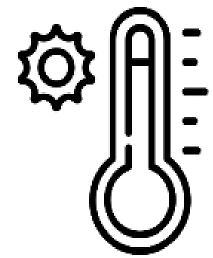
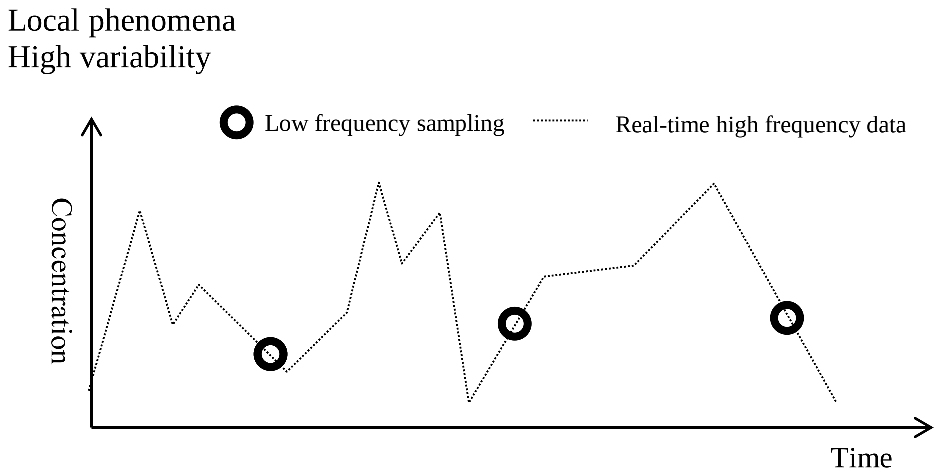
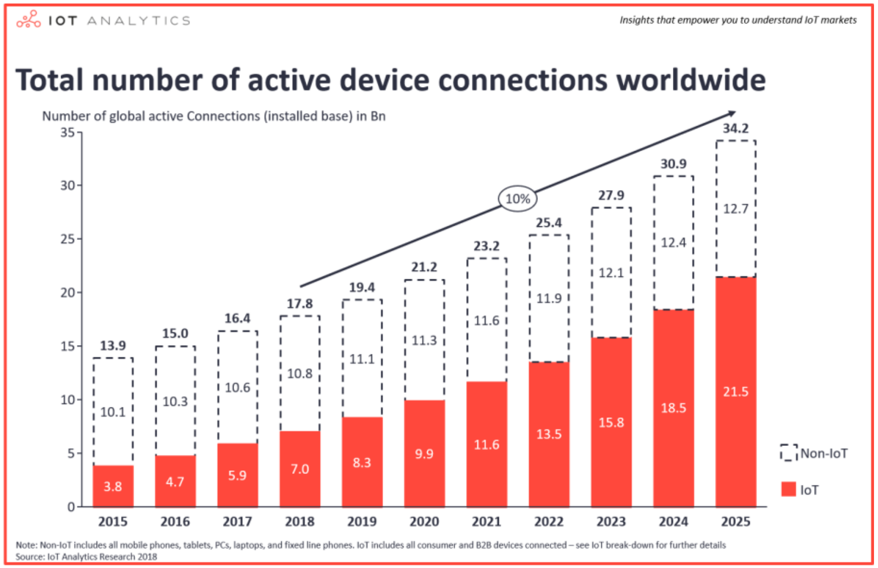


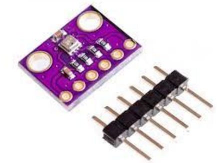
- Point-wise measurements
- High temporal resolutions
- High precision
- Low spatial resolution
- Costs of maintenance and Management at local scale



Thanks to the IoT market which is quickly growing and the low cost technologies...



LoRa™



ARDUINO

NB-IoT

LTE-M

RaspberryPi

pycom go invent

We are assisting at in situ observation renaissance...

In particular for «second level» networks...

- 1st level → high standards
  Federal monitoring networks have the goal to enable climate changes assessment and national level issues like aviation, forecasting, major river management

- 2nd level → problem specific
  Cantonal networks should ensure the usage of resources and related activities more specifically for the regional activities and details (minimal river flow, water concessions for drinking & power-plant)

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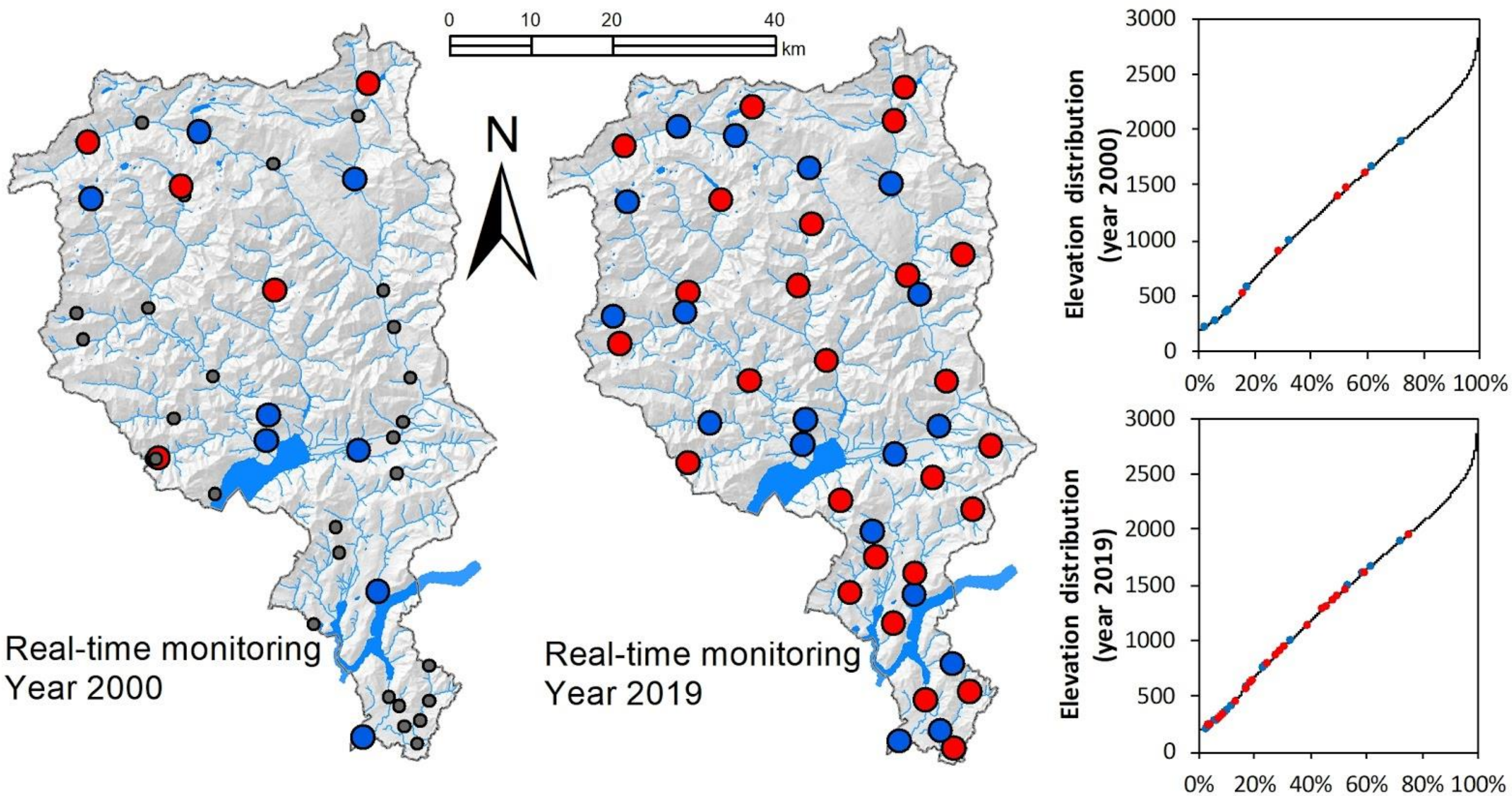
Trend is: densify & automate + integration & partnership

Evolution of rainfall real-time monitoring in the Canton Ticino from 2000 to 2019 and distribution of station sorted according to elevation.



MeteoSwiss station cantonal station non-real-time station in 2000

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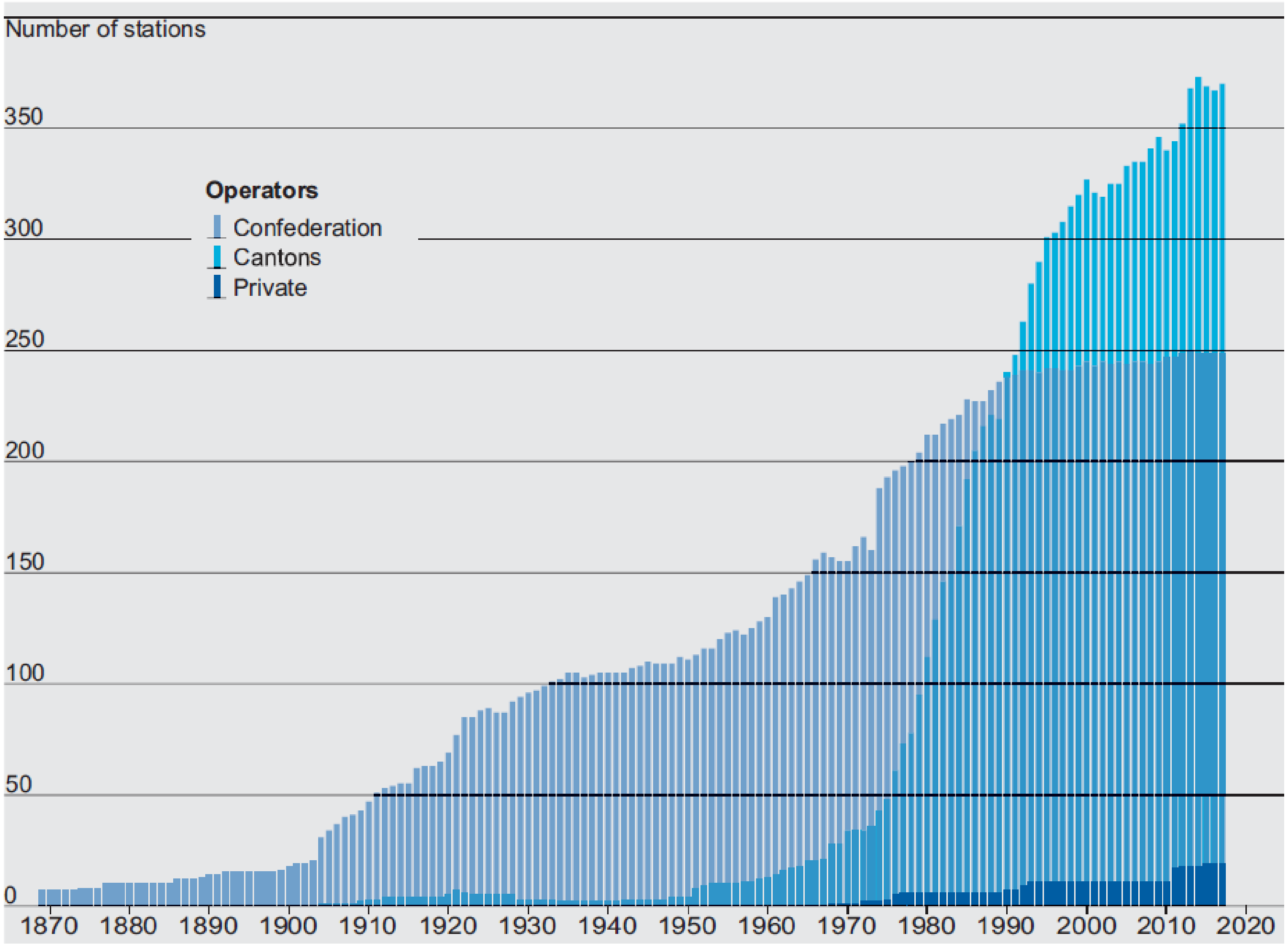
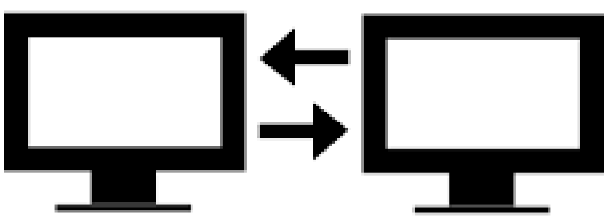
Networks evolutions



Development of hydrometric networks in Switzerland since 1869 (Schwanbeck *et al.* 2018)

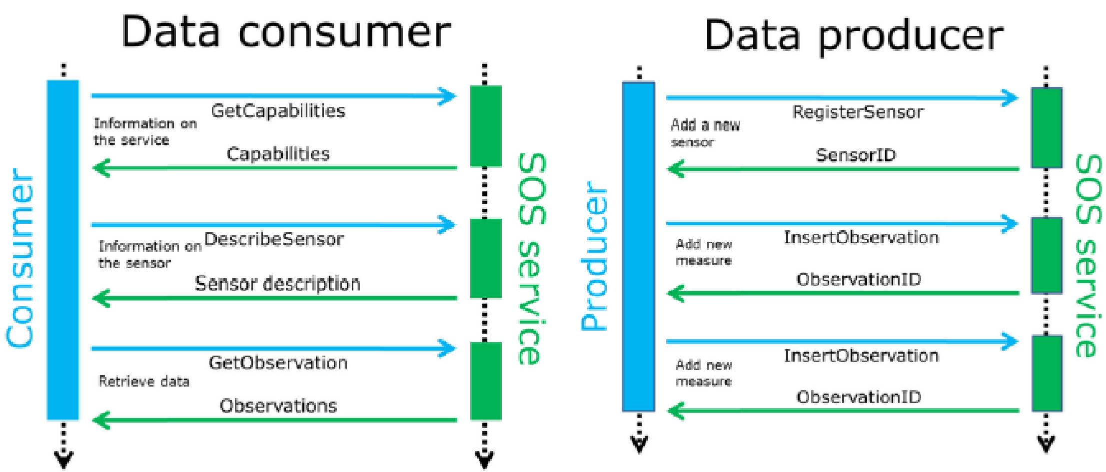
The Sharing issue…

Satellite observations are readily collected and shared across political boundaries with low heterogeneity



In-situ observations are highly heterogeneous and lack data sharing since it is voluntary, and agencies collecting the data rarely have obligation or incentives to share

Open Standards



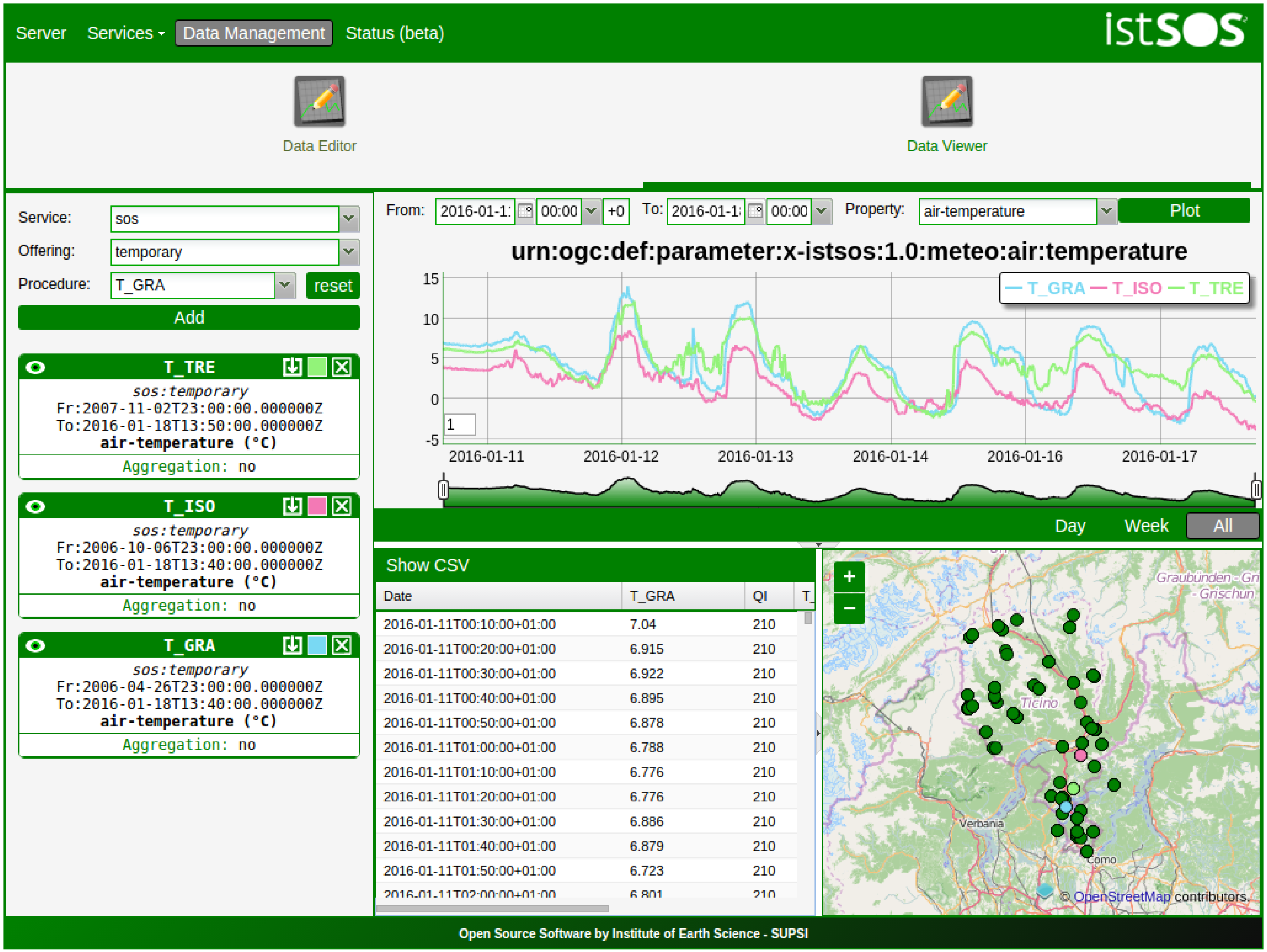
Interoperability trough standardized

- data access
- semantics data representation

Specifications are free and open without any implementation restriction

Sensor Observation Service (SOS)

Open Software



Open Source implementation of SOS by IST-SUPSI used for Ticino hydro-met data

istSOS is an OSGeo incubating project distributed under the GPL v2 license.

www.istsos.org

Where you can use it?

Decision support system

Monitoring

Input for models

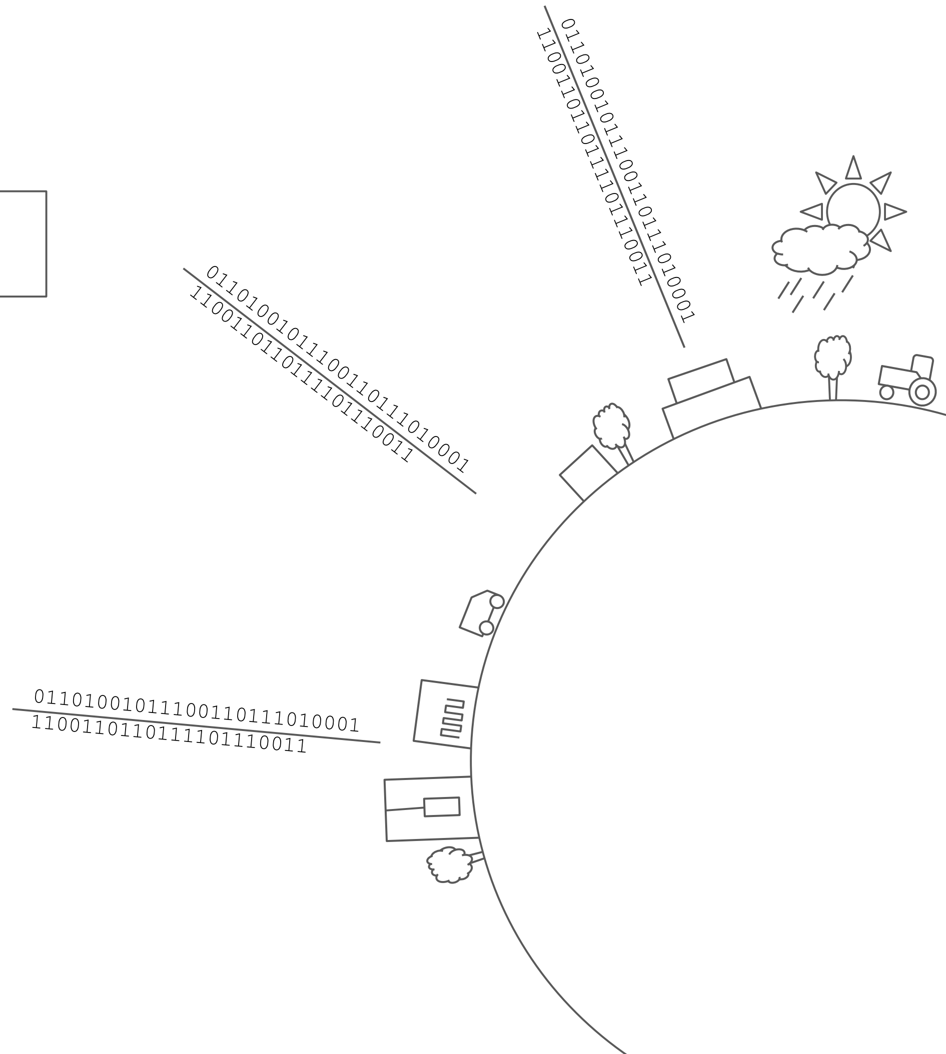
Data analysis

istSOS

Web / Mobile Applications

Sensor network management

Smart agriculture



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Lake Flooding Early Warning System

Based on a SOA (Service Oriented Architecture) and the Open Geospatial Consortium Standards

Data
- Web Feature Service
- Web Coverage Service
- **Sensor Observation Service**

▷

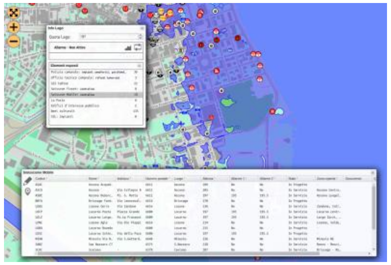
Analysis
- Web Processing Service

▷

Comprehension
- Web Notification Service
- Web Mapping Service & DSS

▷

Actions
- Intervention
- Policy Making



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MIARIA – Adaptive Hydrogeological Monitoring in support of the Alpine Integrated Risk plan

Dynamically identify impacts of impending scenarios and rise alerts

Interreg

Fondo Europeo di Sviluppo Regionale

ITALIA SVIZZERA - ITALIE SUISSE - ITALIEN SCHWEIZ

UNIONE EUROPEA

ENORASIS: every drop counts

ENORASIS is a FP7-ENV project with the objective of develop an **integrated decision support system for environmentally optimized and thus sustainable irrigation management for farmers and water management organizations** based on advanced technologies and models.

ENORASIS®

SEVENTH FRAMEWORK PROGRAMME

ENORASIS is supported by the European Commission under the 7th Framework Programme for Research in Environment.

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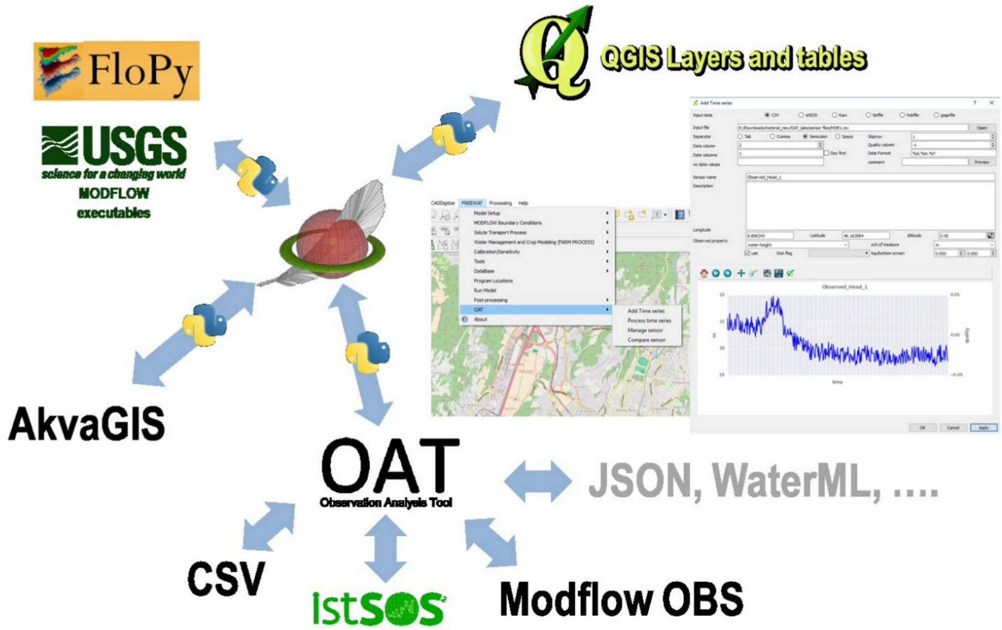
FREEWAT

Free and Open Source Software Tools for Water Resource Management

EU HORIZON 2020 Project

Open source water resource management platform



Horizon 2020
European Union Funding
for Research & Innovation

ict4water.eu

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The Canton Ticino HydroMet @ SUPSI

Configuration

669 registered sensors
15 observed properties
(air-temperature, air-rainfall, water-height, water-height, air-humidity, water-discharge, water-height, air-pressure, air-radiation, water-conductivity, water-temperature, water-temperature, battery-tension, water-tension, air-relative_humidity)

49 years of data (1970-2019)
147 Mio registered observations
190 GB of database

2018 Statistics

142 GB of data served
85 Mio served requests in 1Y
1 Internal server error response (500)

Uptime

99.902% Availability
9 hours Downtime

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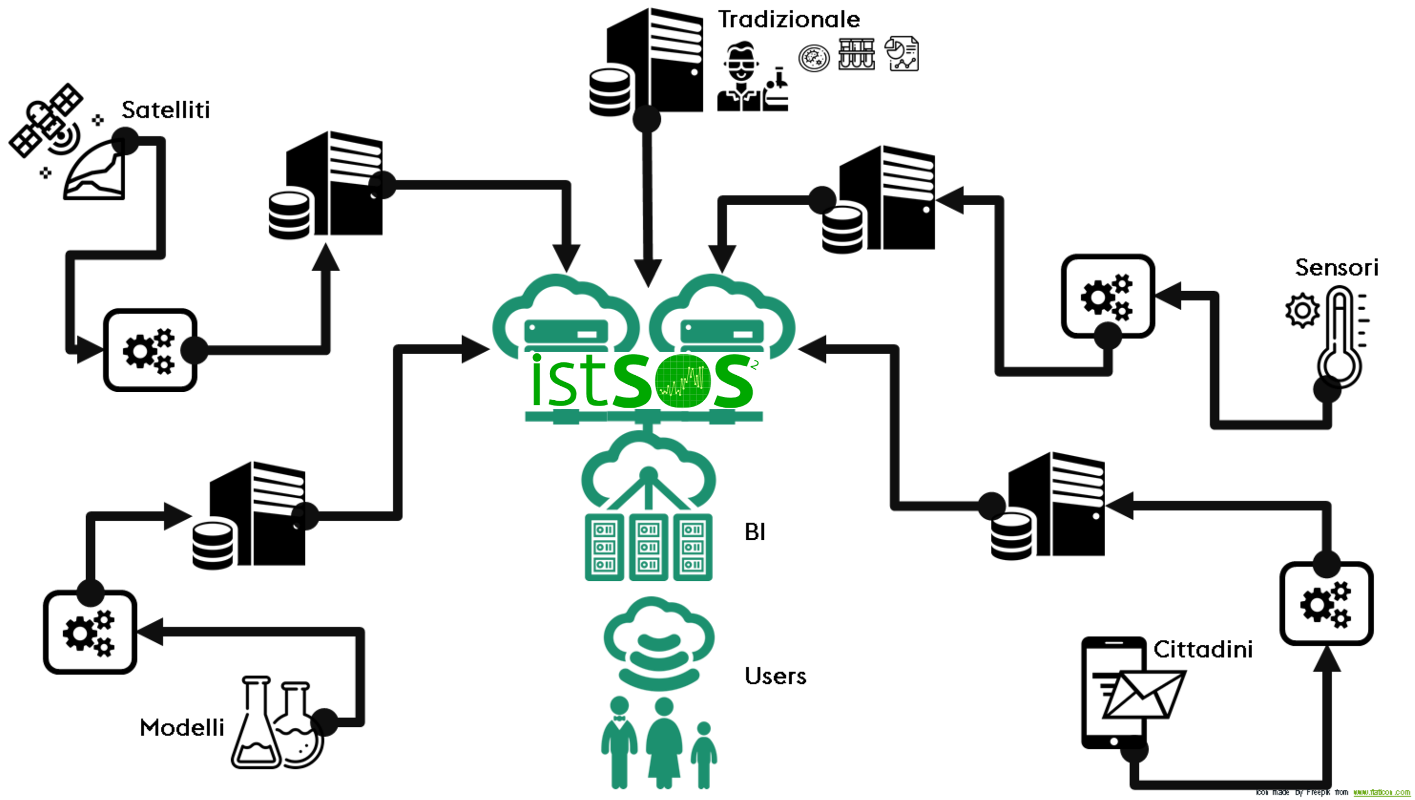
SIMILE
Integrated
Monitoring
System of
Sub Alpine
Lakes quality



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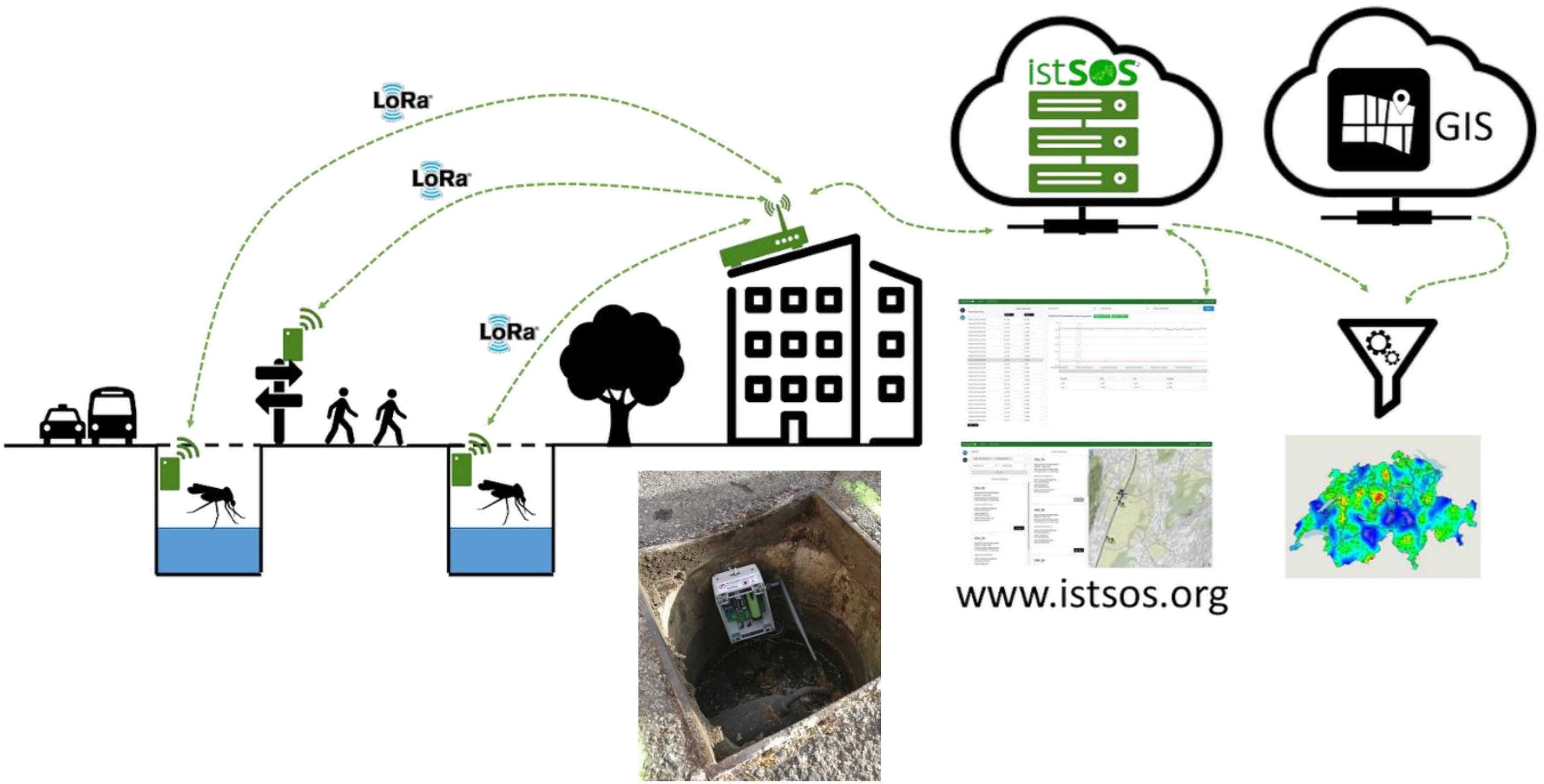
ALBIS

Tiger mosquito habitat monitoring



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4nse

Open Hardware
Arduino

Open Standard
OGC-SOS

Open Software
istSOS

Open Data CKAN

Analysis of 4 times Open Non-conventional system for Sensing the Environment. Empower environmental monitoring in developing countries using non-conventional and fully open solution.

FNSNF
Swiss National Science Foundation

Swiss Programme for Research on Global Issues for Development

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Swiss Agency for Development and Cooperation SDC

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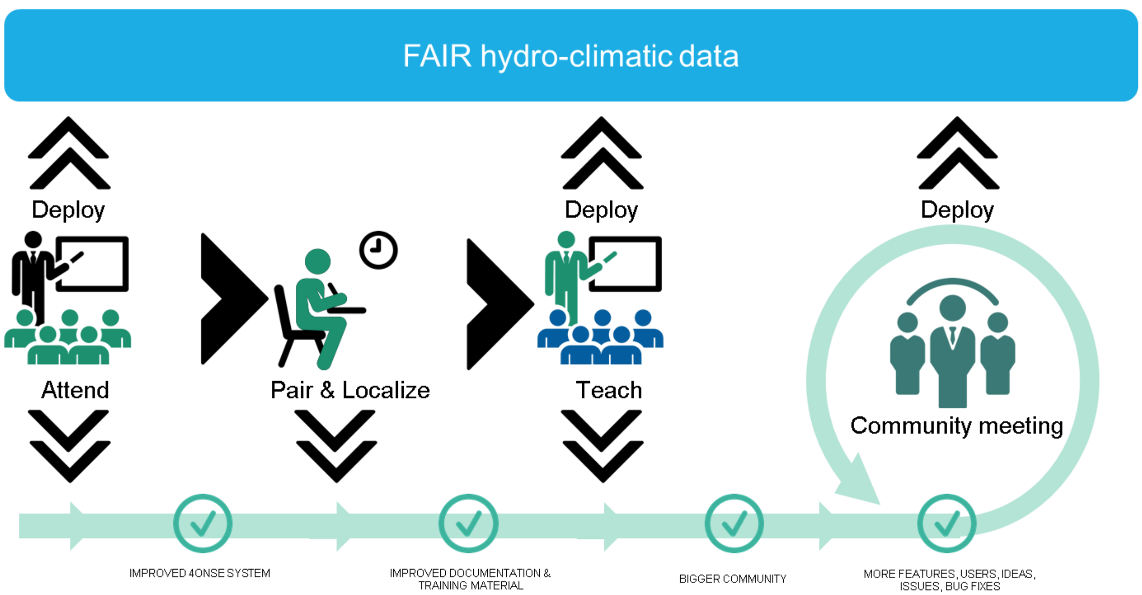
CALL FOR PARTNERS from LOW INCOME COUNTRIES

www.4onse.org/fair



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Evolving from a simple web service to a sensor management system

istSOS 1.0 is released

The first version was simply a Web Service implementing the OGC - SOS 1.0.0

istSOS 2.3.2 Today

Today istSOS 2 is a sensor data management system offering an extended list of features

2012

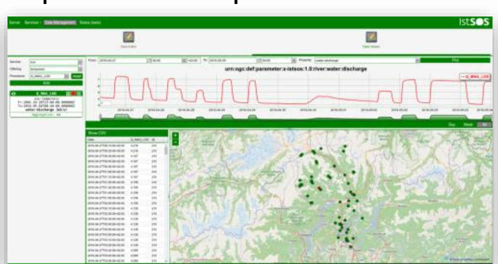
3,209 downloads

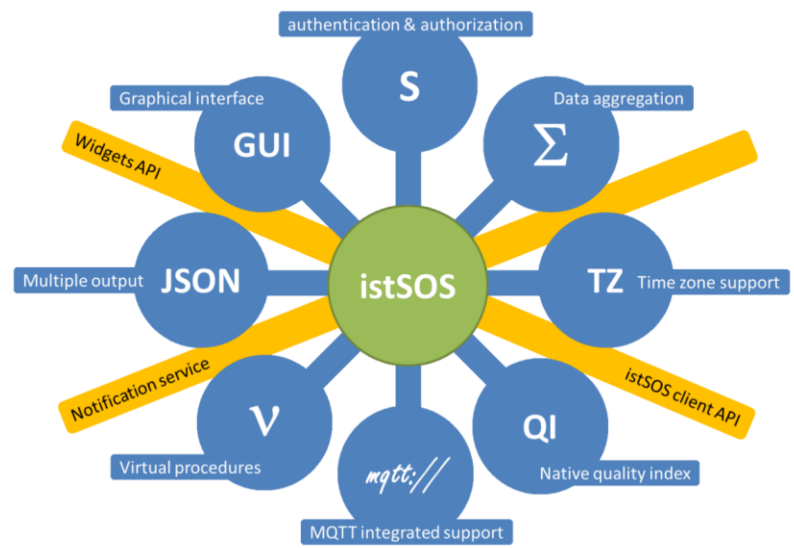
2010

2018

istSOS version 2.0

To make things easier a Web GUI is implemented in parallel with the RESTful API.





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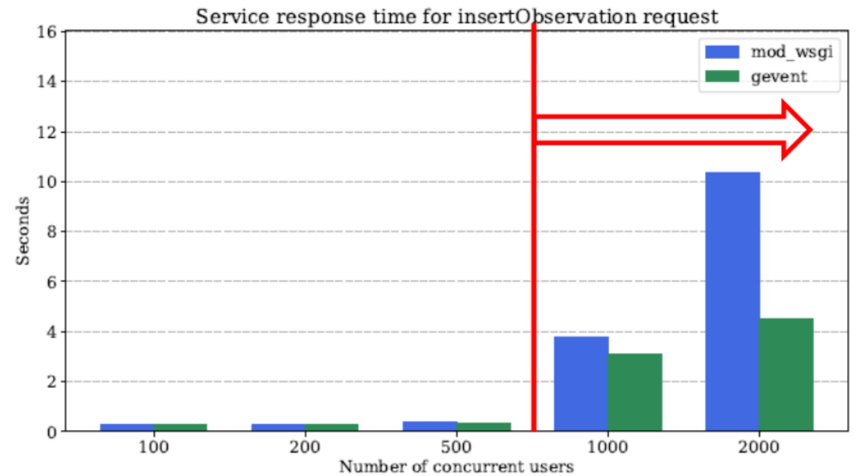
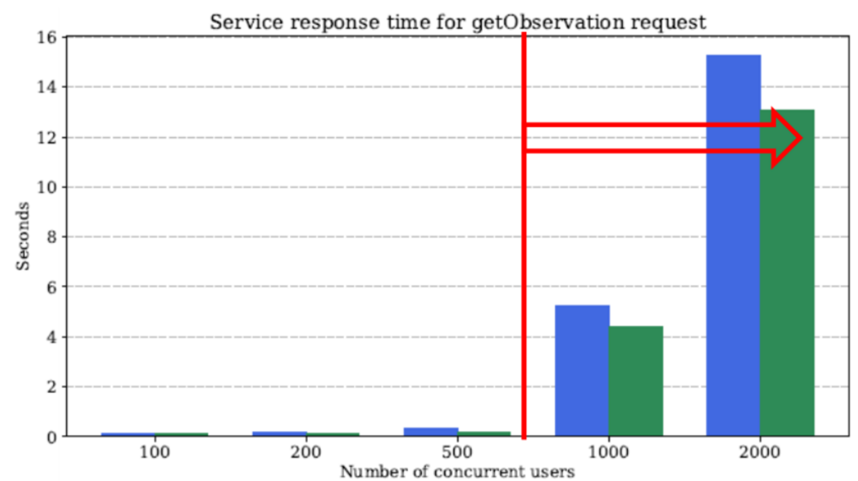
load testing

- 3 different database configurations

Sensors	Observations	Case
20	100’000’000	Regional Air Quality data
160	1’700’000’000	Swiss National Meteo Stations
5’100	2’000’000	Borehole Samplings

- 2 different WSGI server solutions
  (mod_wsgi / gevent)
- 2 different user types
  (data producer / data consumer)
- 5 different concurrent-users scenarios
  (100, 200, 500, 1’000, 2’000)





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What's next?

After 10 years of development, we were thinking if it's time for a **code refactoring**...

IoT and Big Data

- Need to improve the performance
  - Big-Data vs Multi-Users
  - Caching in real-time
- Extensible communication interface to accommodate IoT world (MQTT, LORA, Sensor Things API, istSOS-API, etc...)

Python 3 offers new opportunities

- New technologies accessible with Python 3 (for example Async)
- Python 2 will retire from 12th April 2020

... but then we decided to implement everything from scratch taking advantage from new technologies and our experience

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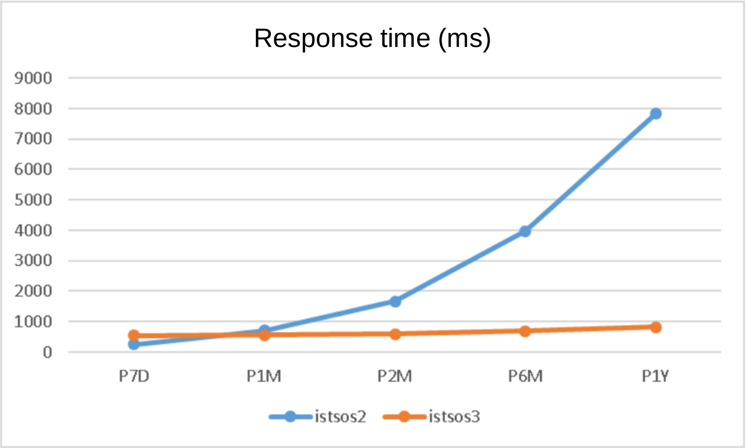
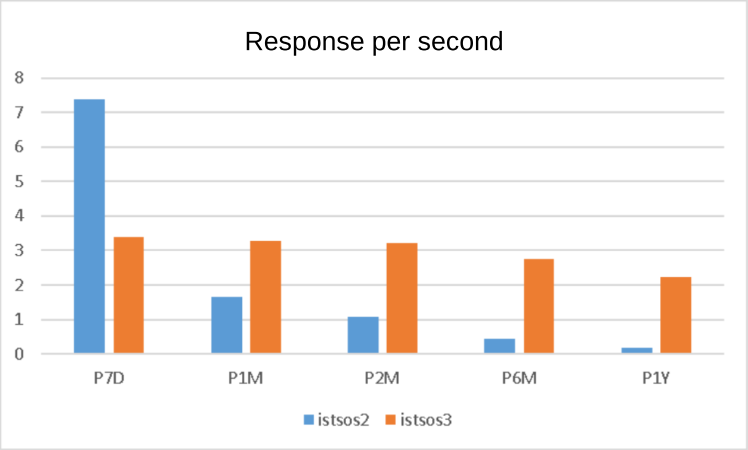
First rough tests of the REST API are promising

Development Laptop istSOS3
vs Production Server istSOS2
1 Thread x 1 Connection
1 Sensor x (1 observation / 10min)

ISO 8601 Code	Interval	Records
P7D	1 week	1’008
P1M	1 month	4’320
P2M	2 months	8’640
P6M	6 months	25’920
P1Y	1 year	51’840





istSOSμ is coming for 2020

…but this was «just» a performance advancement….

………………..so in FOSS4G-ASIA @ istSOS sprint……

………………………the core developers decided to go for….

………………………………a new concept of its architecture…..

Microservices

GRPc

Multi-Standard

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