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

SUPSI

Managing and Sharing Sensor Time-Series Data with istSOS

Massimiliano Cannata, Milan Antonovic

Content

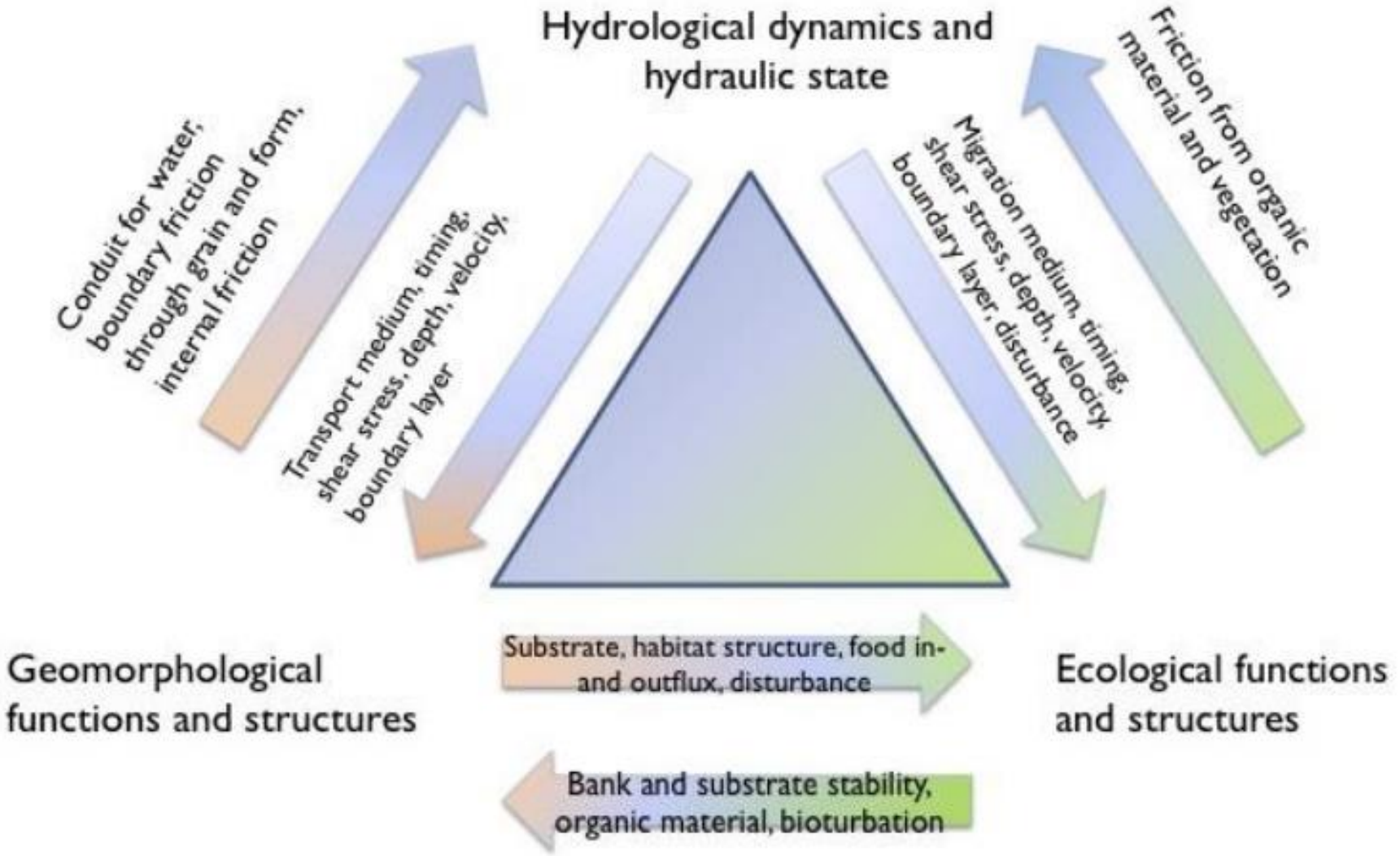
- Why do we need to monitor?
- The Locarno example
- HydroMet data monitoring system of Canton Ticino
- The application for the civil protection to support decision making
- istSOS: a SOS compliant software with special features

Why do we need to monitor?

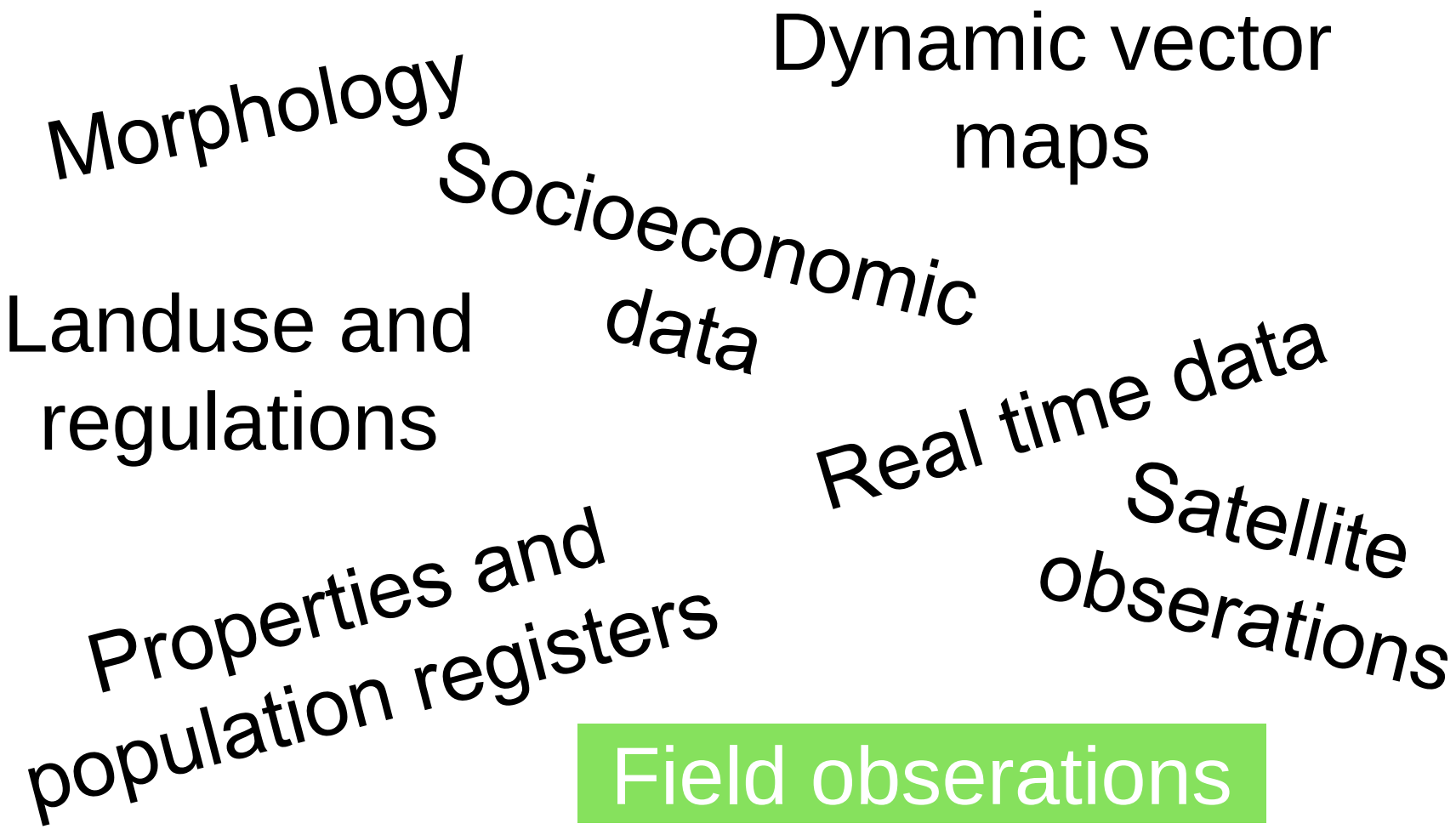
Solving societal challeneges

Strengthening data production and the use of better data in policymaking and monitoring are becoming increasingly recognized as fundamental means for development

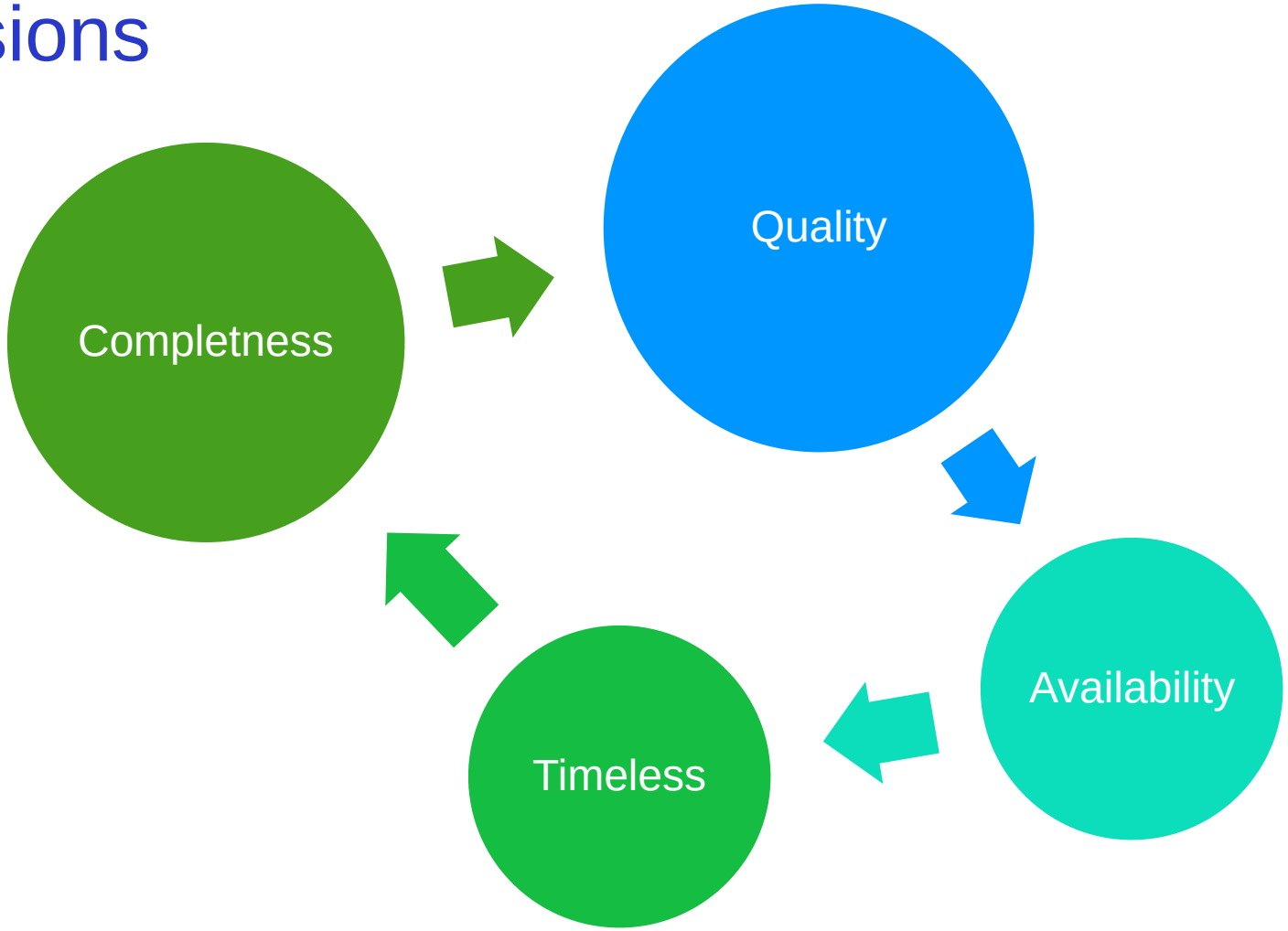
Water monitoring to understand the system



Understanding by (spatially) integrating multiple information source



Understanding data is a key aspects for wise decisions



Understand the situation and timely react

The Locarno example

Lake Verbano shores are exposed to flooding events that cause extensive damages

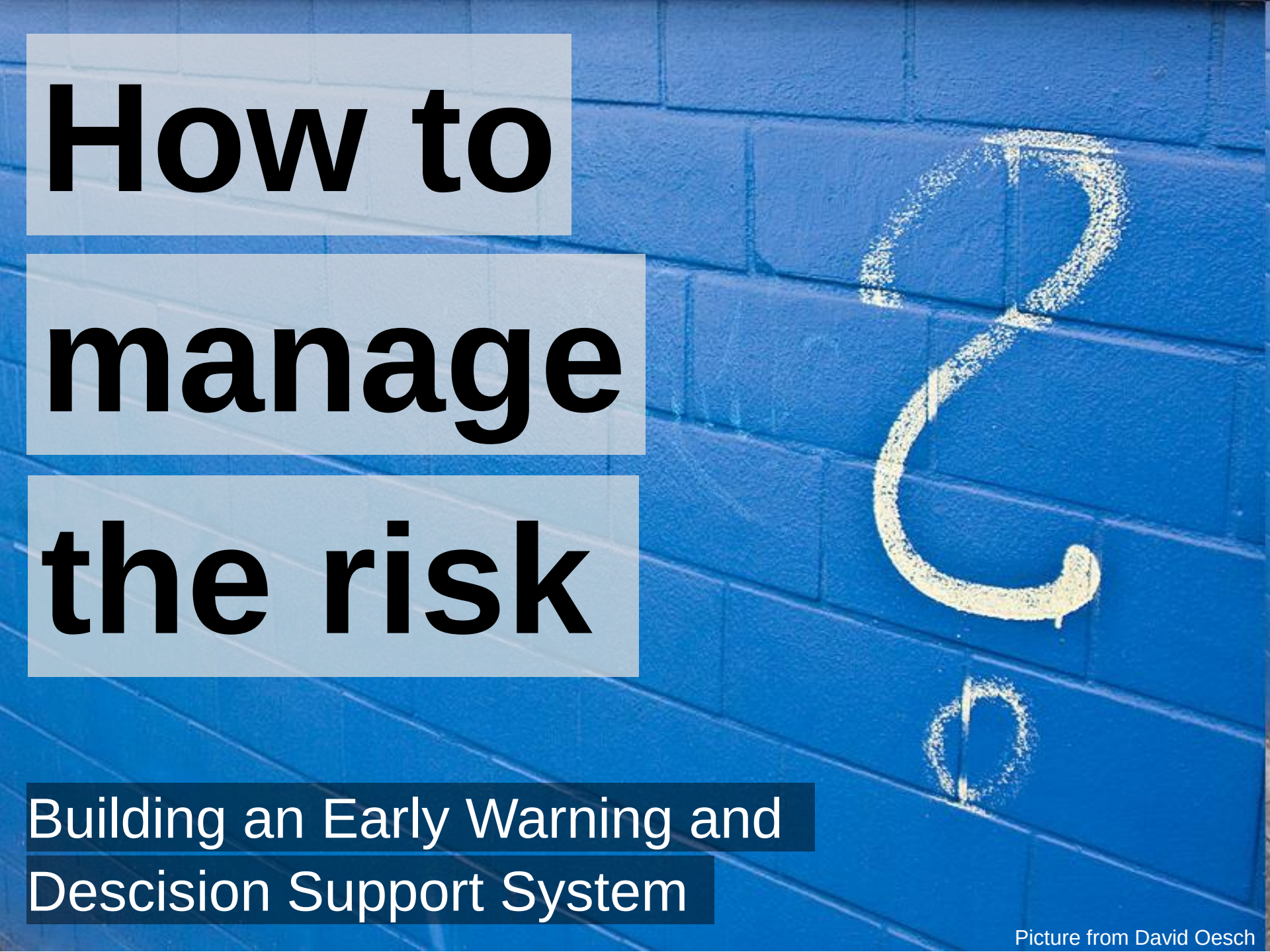
Picture by Julien Daulte

Locarno: almost flat area highly urbanized

Intense reainfall events compared to maximum discharge (2,000 m^3/s)

Large basins (6’386 km^2) compared to limited lake area (213 km^2)

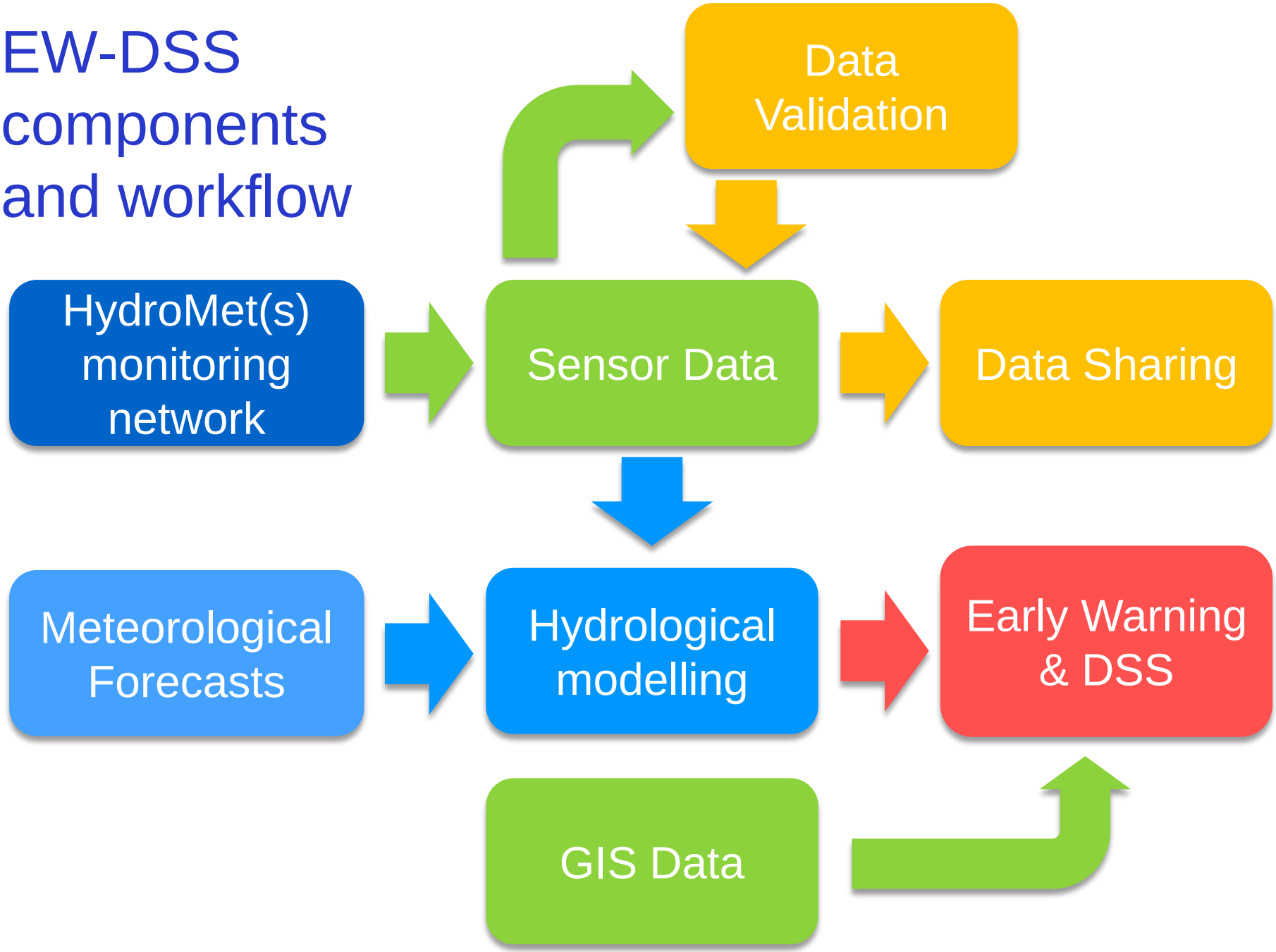
How to manage the risk



Building an Early Warning and Descision Support System

Picture from David Oesch

EW-DSS components and workflow



International Basin

5 HydroMet networks

HydroMet data monitoring system of Canton Ticino

Open Source Technolgies

Open standard to foster interoperability

Free and Open Source Sowftare to guarantee durability and flexibility

Past experiences proprietary solutions showed limitations that killed us ☹

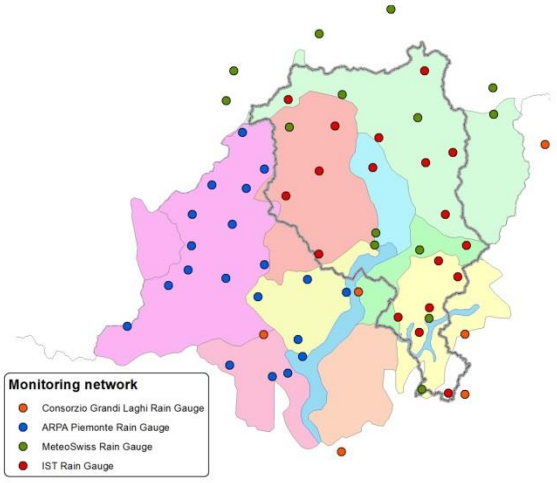
Management of the HydroMet monitoring network of Canton Ticino, southern Switzerland

2010

Real time data collection

In 2010, switch from analogue modem (collection every 4 hours) to GPRS sensor data transmission (real time)

Needs for smarter system for collecting and dispatch measurements



Looking for a solution...

Simple

Open

Standard

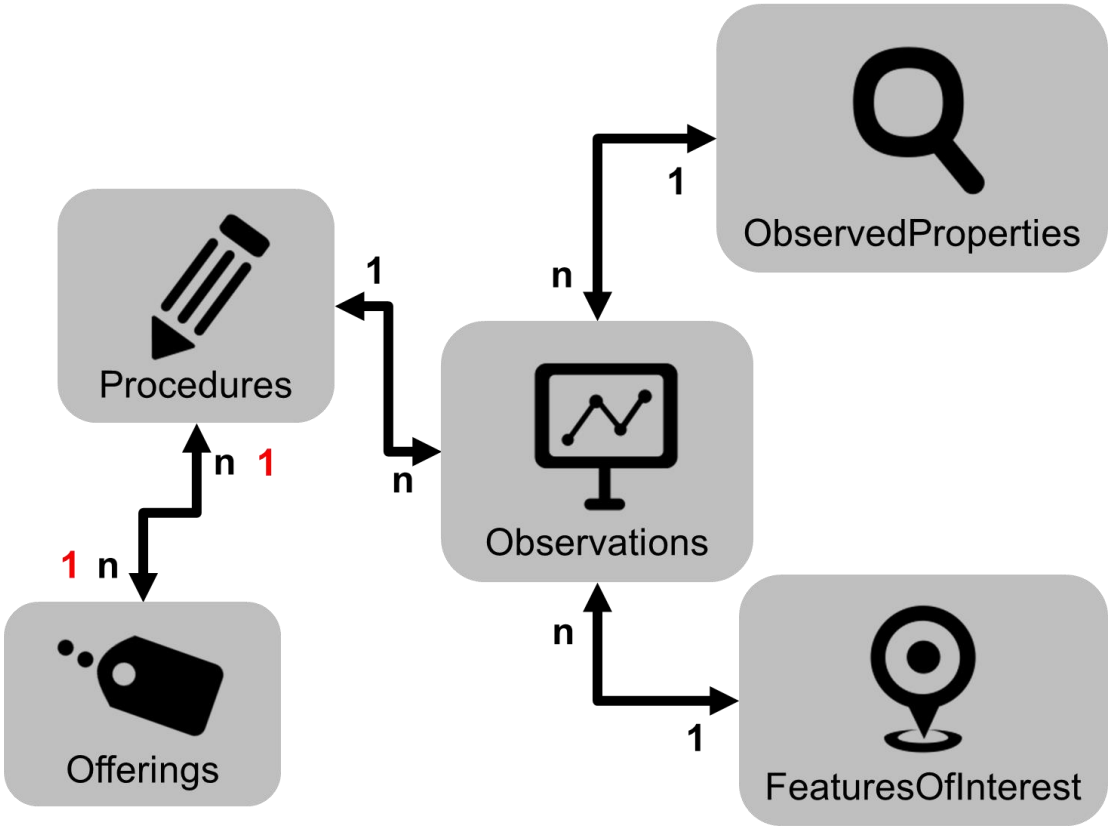
(possibly Python... shhh!)

The Sensor Observation Service standard

From http://www.opengeospatial.org/standards/sos

"The Sensor Observation Service standard is applicable to use cases in which sensor data needs to be managed in an interoperable way. This standard defines a Web service interface which allows querying observations, sensor metadata, as well as representations of observed features. Further, this standard defines means to register new sensors and to remove existing ones. Also, it defines operations to insert new sensor observations. This standard defines this functionality in a binding independent way; two bindings are specified in this document: a KVP binding and a SOAP binding (in version 2.0)."

SOS (v1.0, v2.0)



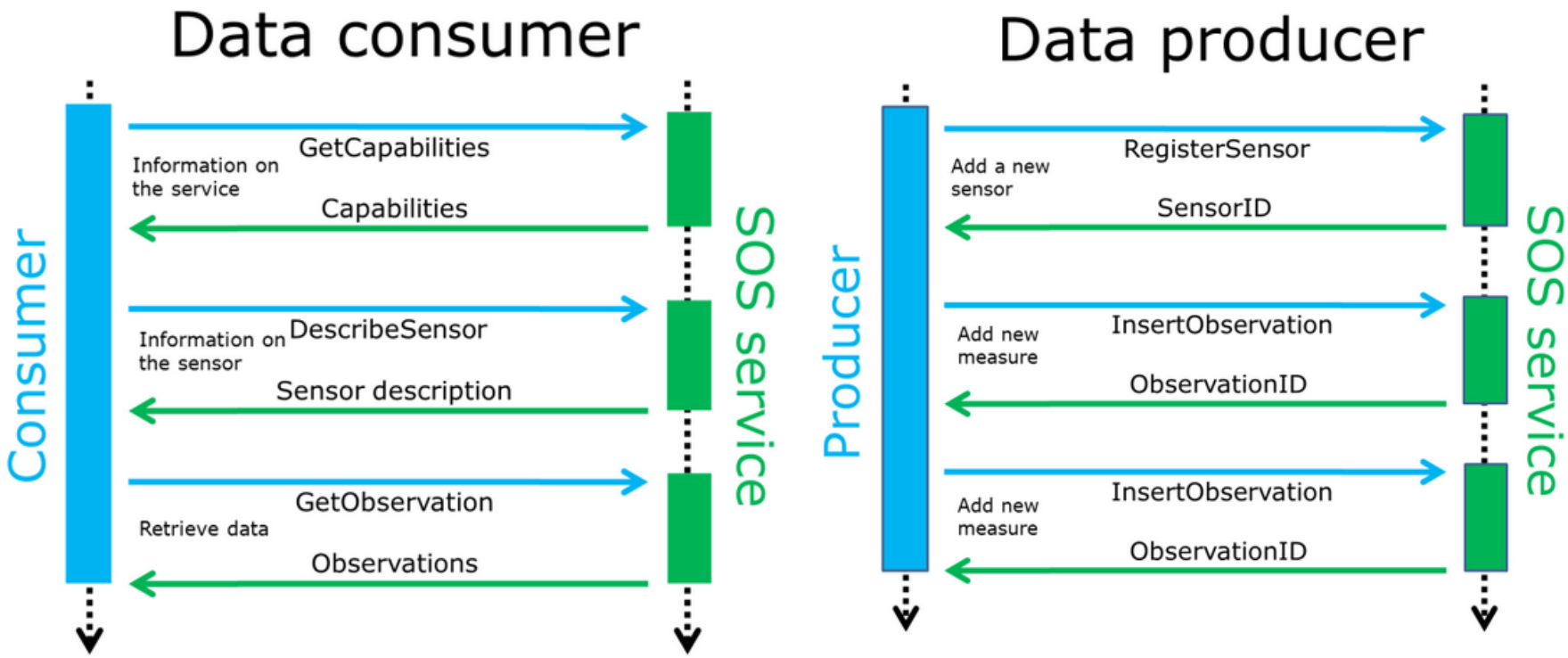
From system to users

- GetCapabilities
- DescribeSensor
- GetObservation

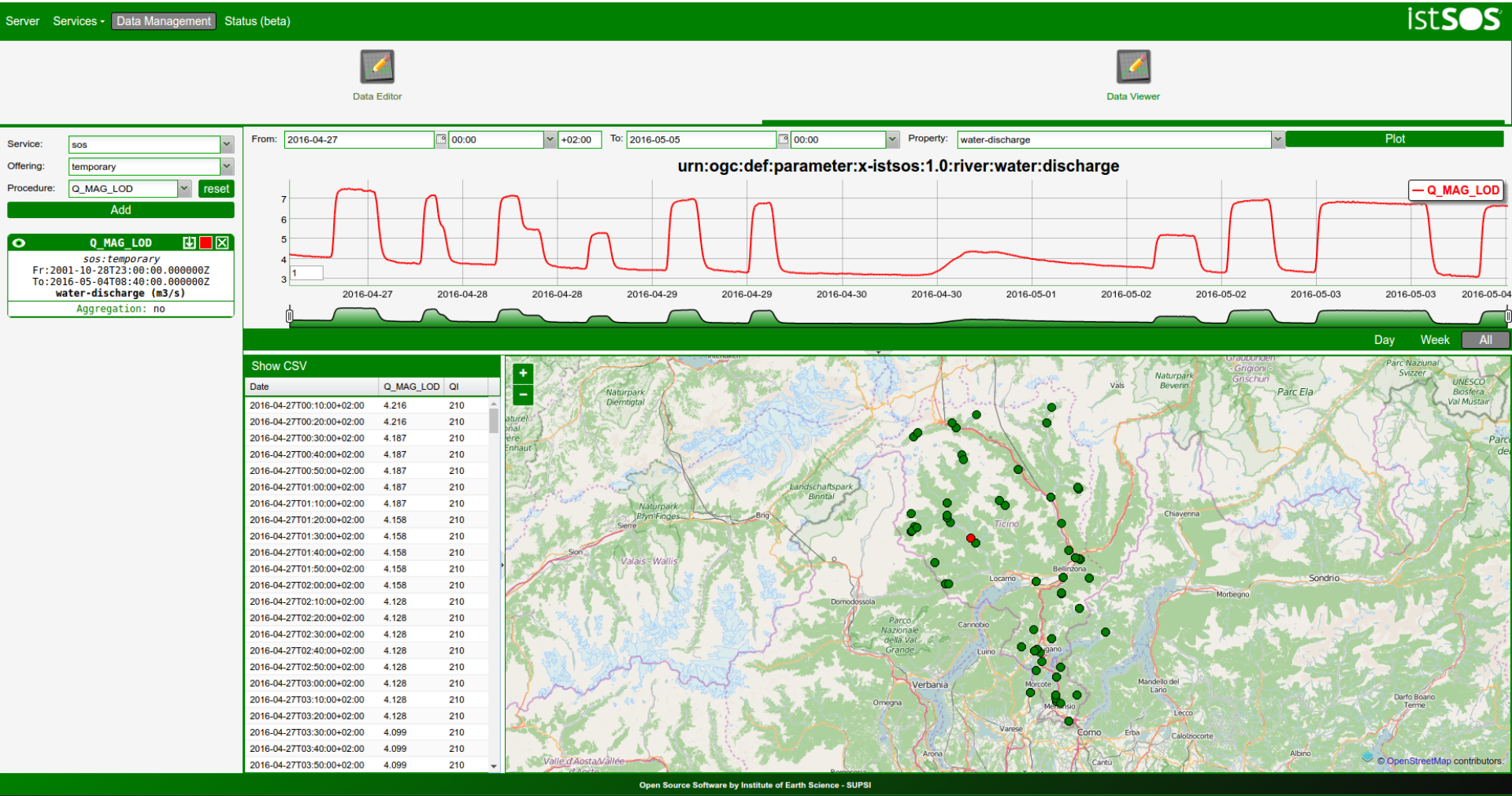
- RegisterSensor
- InsertObservation

From sensors to system

SOS User types



istSOS service for Canton Ticino HydroMet



istSOS service for Canton Ticino HydroMet

151 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)

40 years of data (1976-2016)

88.5 Mio registered observations

32 GB of database

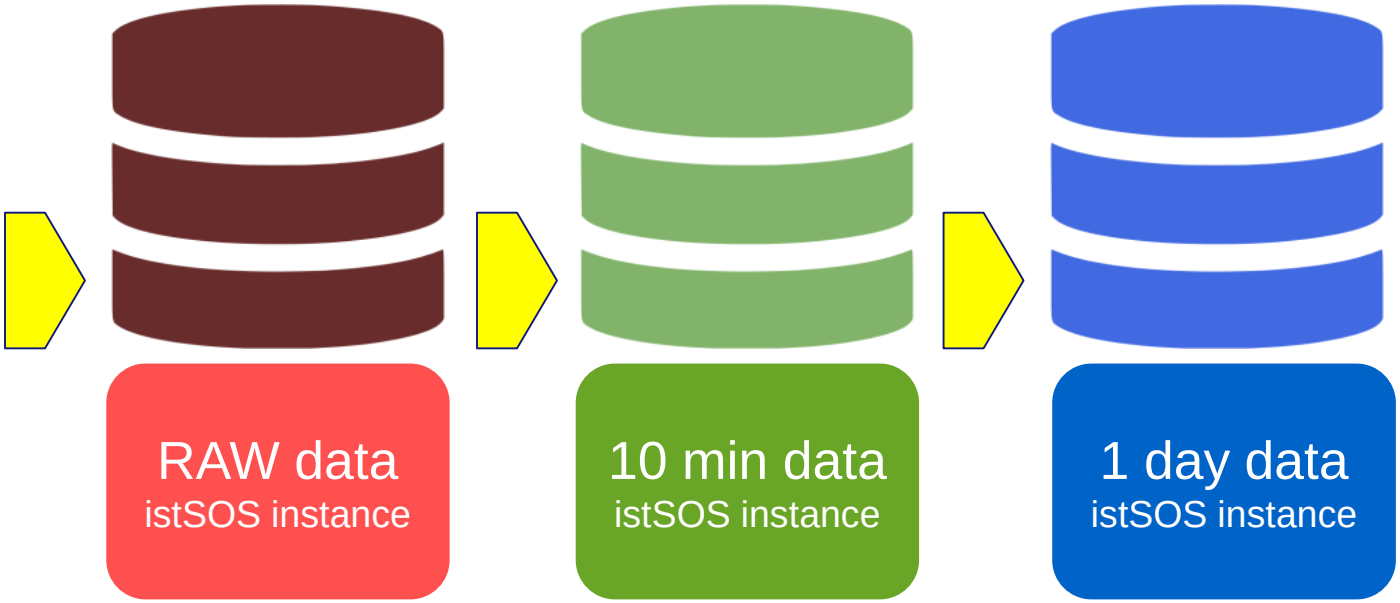
8 GB of data served in April

(4.5 GB with SOS requests & 3.21 GB with istSOS RESTful API)

5.7 Mio served requests in April

1 Internal server error response (500) in April

istSOS service for Canton Ticino HydroMet



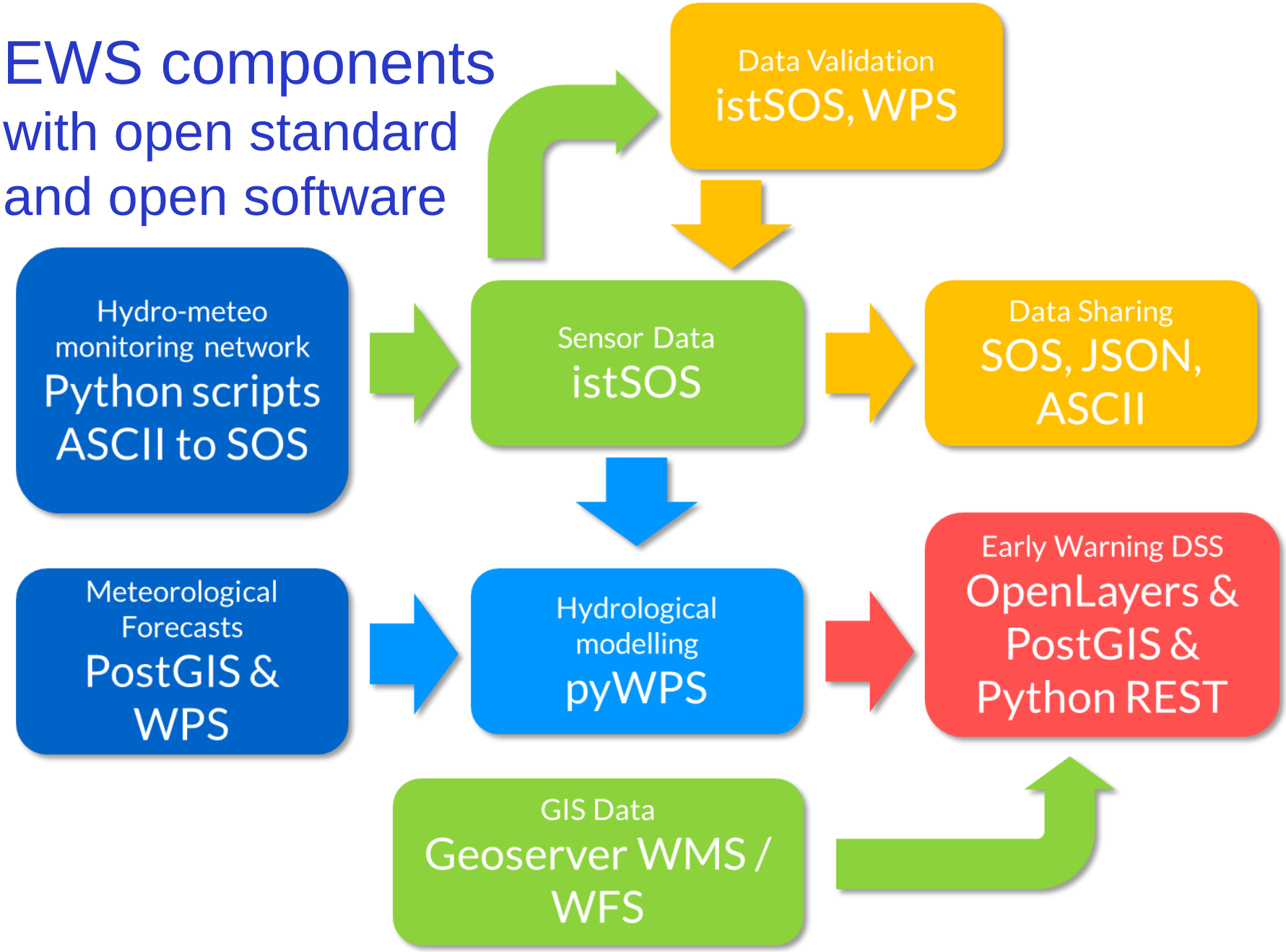
OBS: 38 Mio
STAT: 151
SIZE: 19 GB
SOS: 1.4 GB
WA: 2.45 GB
Req: 2.4 Mio
Years: 26

OBS: 49,6 Mio
STAT: 151
SIZE: 13 GB
SOS: 3.1 GB
WA: 0.76 GB
Req: 3.3 Mio
Years: 26

OBS: 0.9 Mio
STAT: 151
SIZE: 184MB
SOS: 10 MB
WA: 3 MB
Req: 190
Years: 40

The application for the civil protection to support decision making

EWS components
with open standard and open software

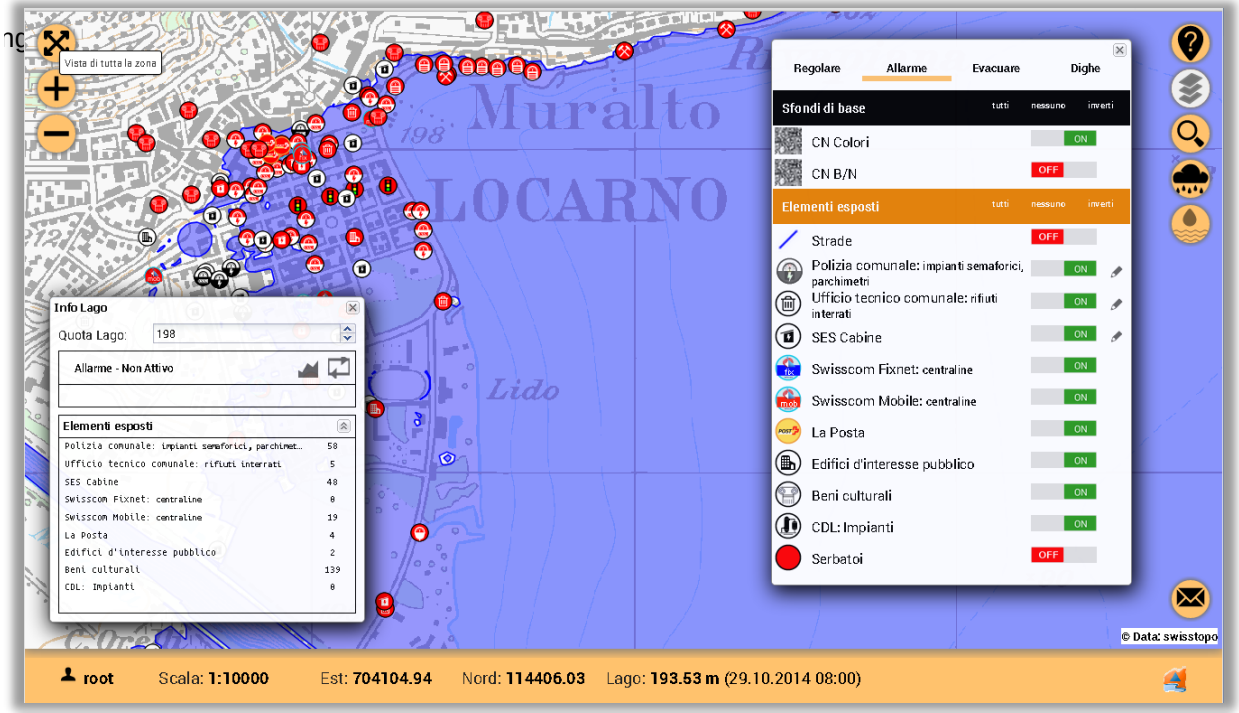


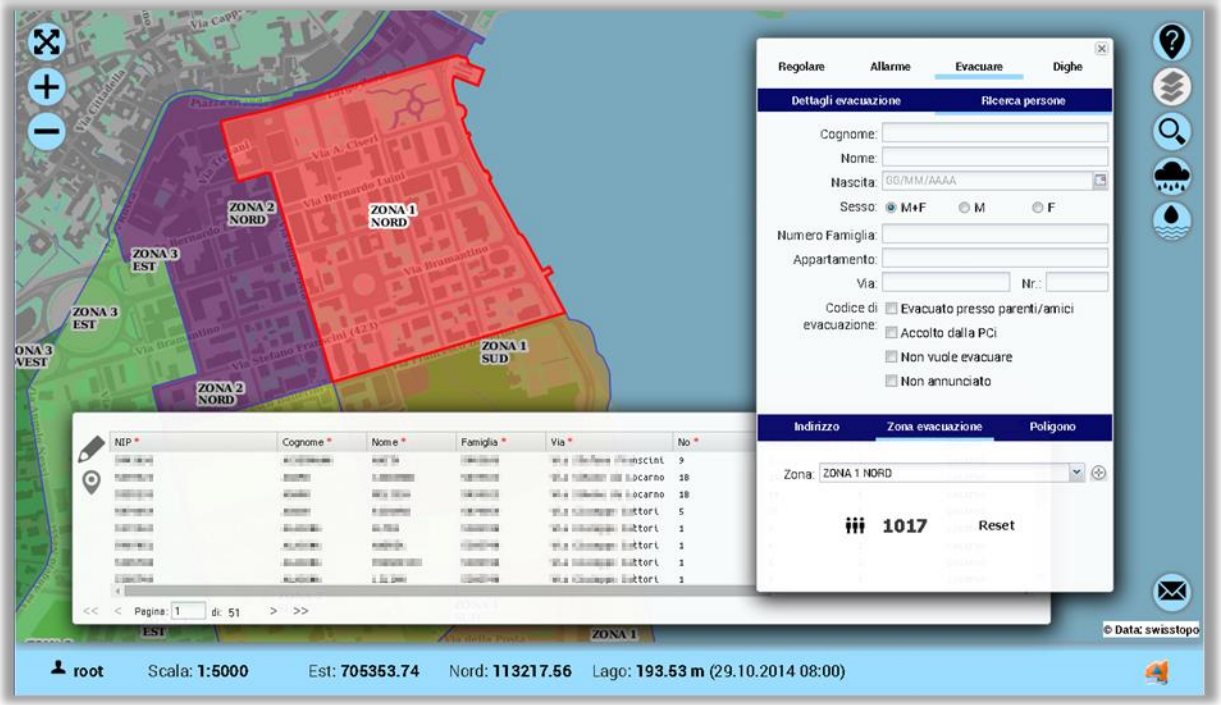
Mode «Regular»: access to data and funtions for resources management
(search for parcel, address or person, query and eventually edit elements details, etc.)

Mode «Alarm»: access to forecasted lake levels and exposed elements data
(detect exposed elements with a given lake level, see plots of forecasted lake level, access instructions to secure exposed elements, etc.)

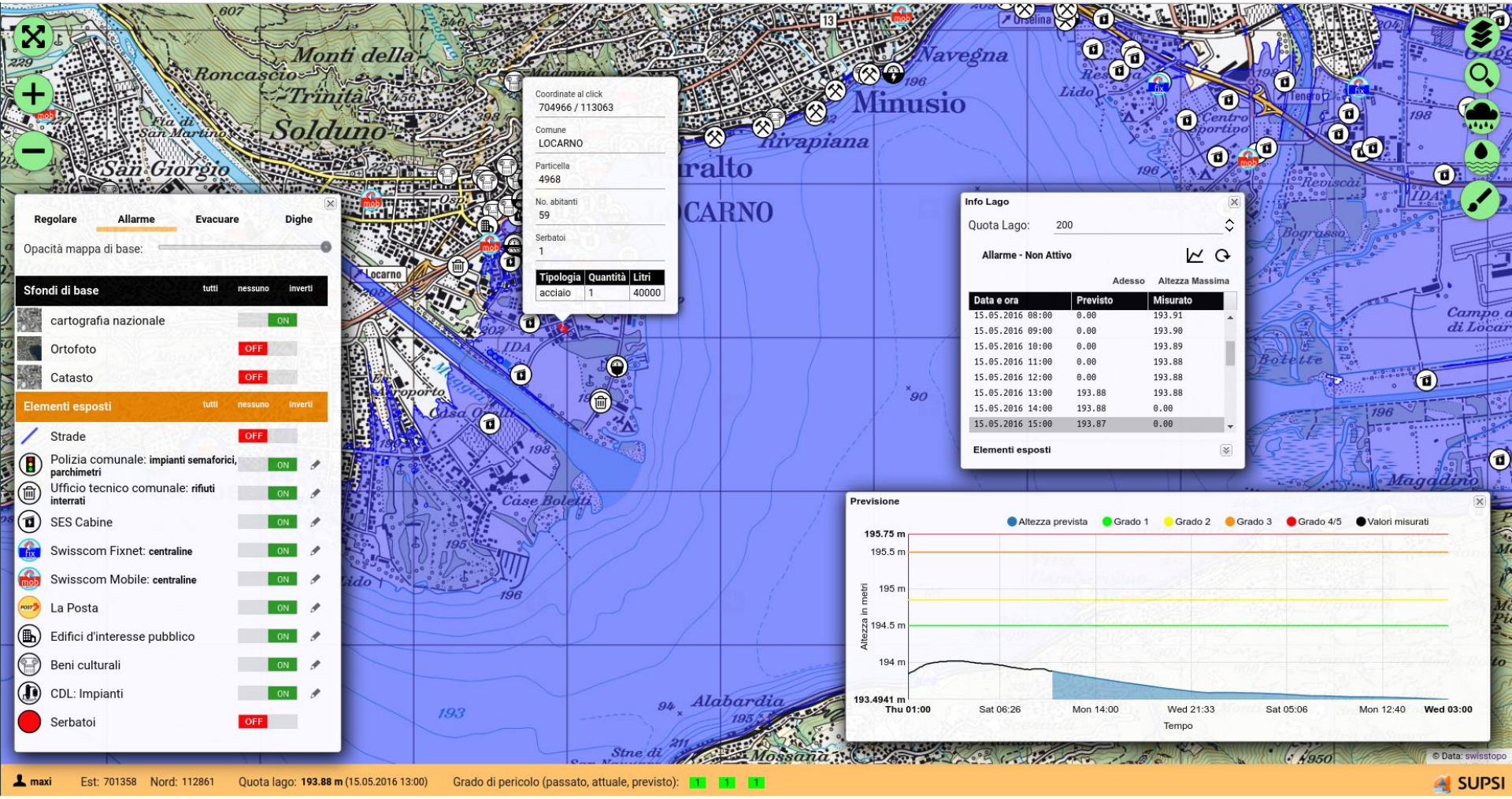
Mode «Evacuation»: access to datails of population to manage evacuation
(create evacauation event, search and locate person, count people in an area, assign people an evacauatio status, etc.)

Mode «Dams»: access to dam-break hazard zones and wave arrival times





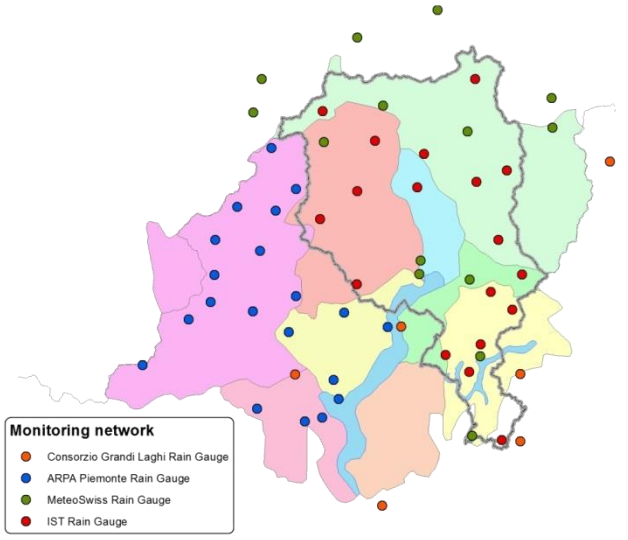
Access protected for data sensibility

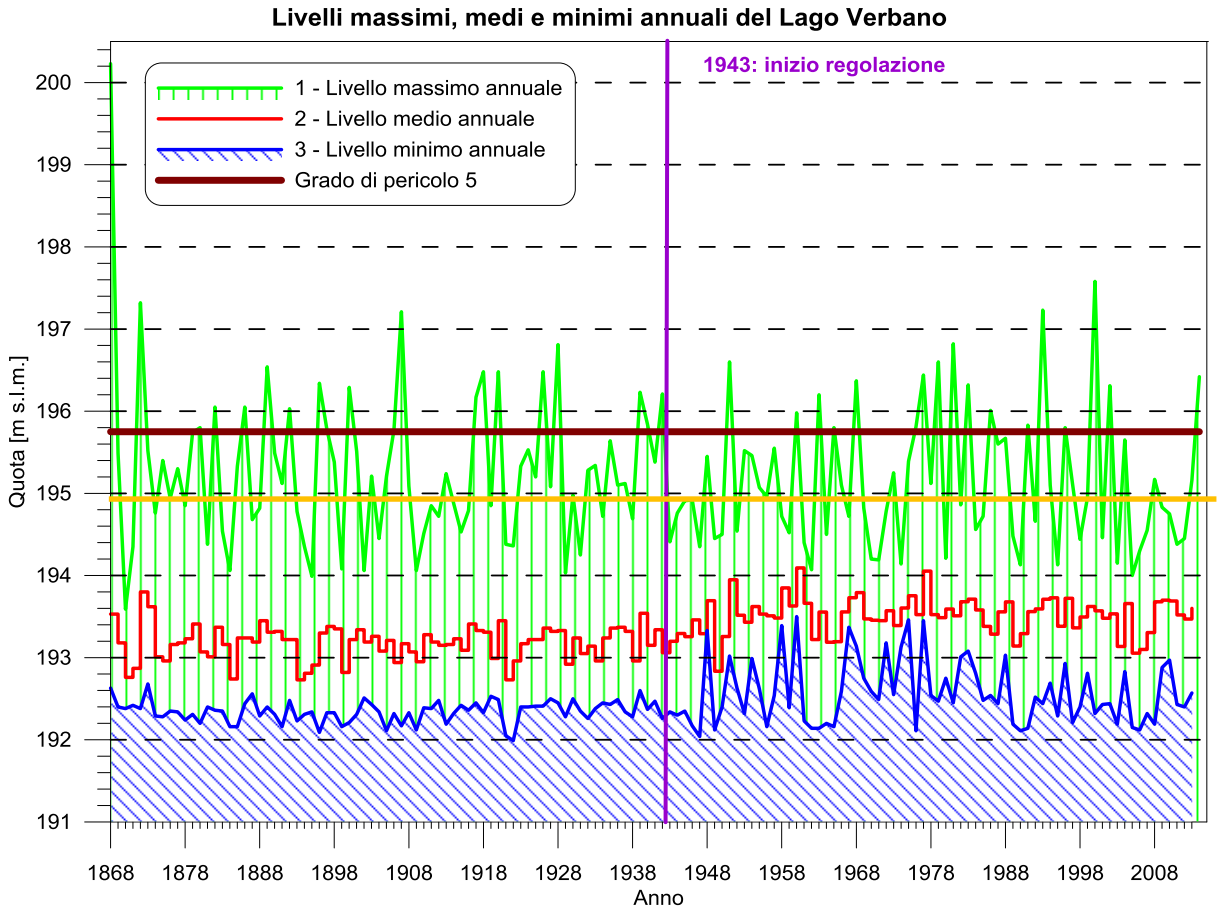


Lake Verbano events

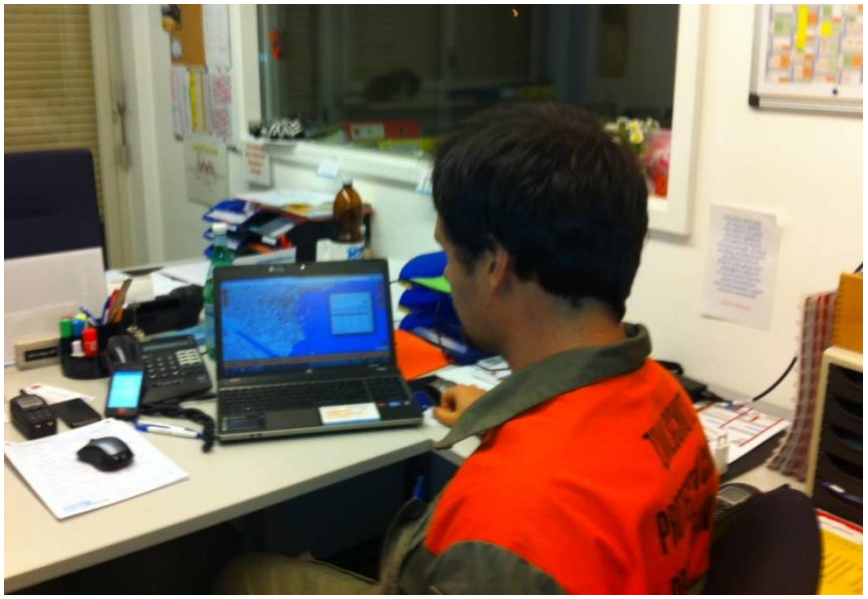
Basin = 6,386 km²
Lake = 213 km²
Discharge
max = ca. 2,000 m³/s

	ave	pre-alarm	alarm 5
Lake Levels	193.66	194.85	195.75





Flood of the 12-21.11.2014 max lake level 196.42 (alarm level 5)



SITGAP2: Average Daily Statistics during the last flood

Unique Visitors: **50**
Requests / Second: **2.5 - 30**

REQUESTS	Requests	Bandwidth
SITGAP Web Services	25’372	0.83 GB
WMS	190’112	2.57 GB
Total	**215’484**	**3.4 GB**

REQUESTS	%	ERROR	CODE
205132	95.20	OK - The request sent by the client was successful	200
9568	4.44	Not Modified - Resource has not been modified	304
401	0.19	Unauthorized - Request needs user authentication	401
365	0.17	Bad Request - The syntax of the request is invalid	400
5	0.002	Document Not Found - Requested resource could not be found	404
10	0.004	Internal Server Error	500

istSOS: a SOS compliant software with special features

The software

Open Source Software (GPL v2)

Home / Browse / Development / WWW/HTTP / HTTP Servers / istSOS / Download Statistics

istSOS

Free and Open Source Sensor Observation Service Data Management System

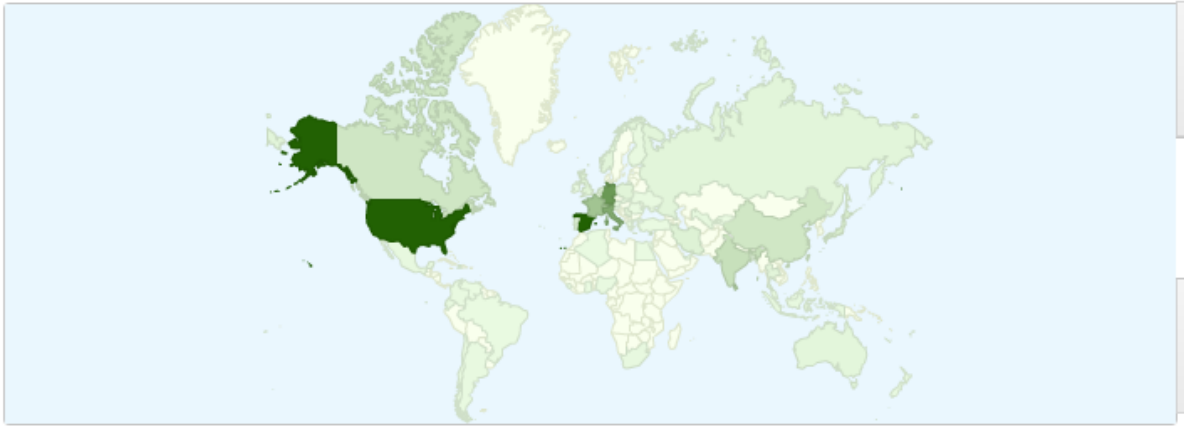
Brought to you by: mantonovic, maxicannata

2016

Summary | Files | Reviews | Support | Code | Wiki | Tickets | Blog | Admin | Add New...

Home (Change File)

Date Range: 2016-01-01 to 2017-01-01



DOWNLOADS

1,255

In the selected date range

TOP COUNTRY

Spain

18% of downloaders

TOP OS

Other

41% of downloaders

OS downloads as: Percent

	Country	Android	Linux	Macintosh	Unknown	Windows	Total
1.	Spain	0%	13%	4%	78%	5%	231
2.	United States	0%	3%	3%	89%	5%	230
3.	Germany	0%	19%	1%	62%	18%	146
4.	Italy	1%	42%	3%	8%	46%	118
5.	France	0%	44%	29%	6%	21%	82
6.	Sri Lanka	0%	84%	0%	0%	16%	68
7.	Switzerland	0%	57%	16%	13%	14%	63
8.	India	0%	38%	2%	0%	60%	40
9.	Canada	0%	13%	19%	0%	68%	31
10.	China	0%	0%	14%	3%	83%	29

Suported system types (up-to-now)

in-situ - fixed - point

in-situ - mobile - points

Supported versions

SOS v1.0.0

(core & transactional)

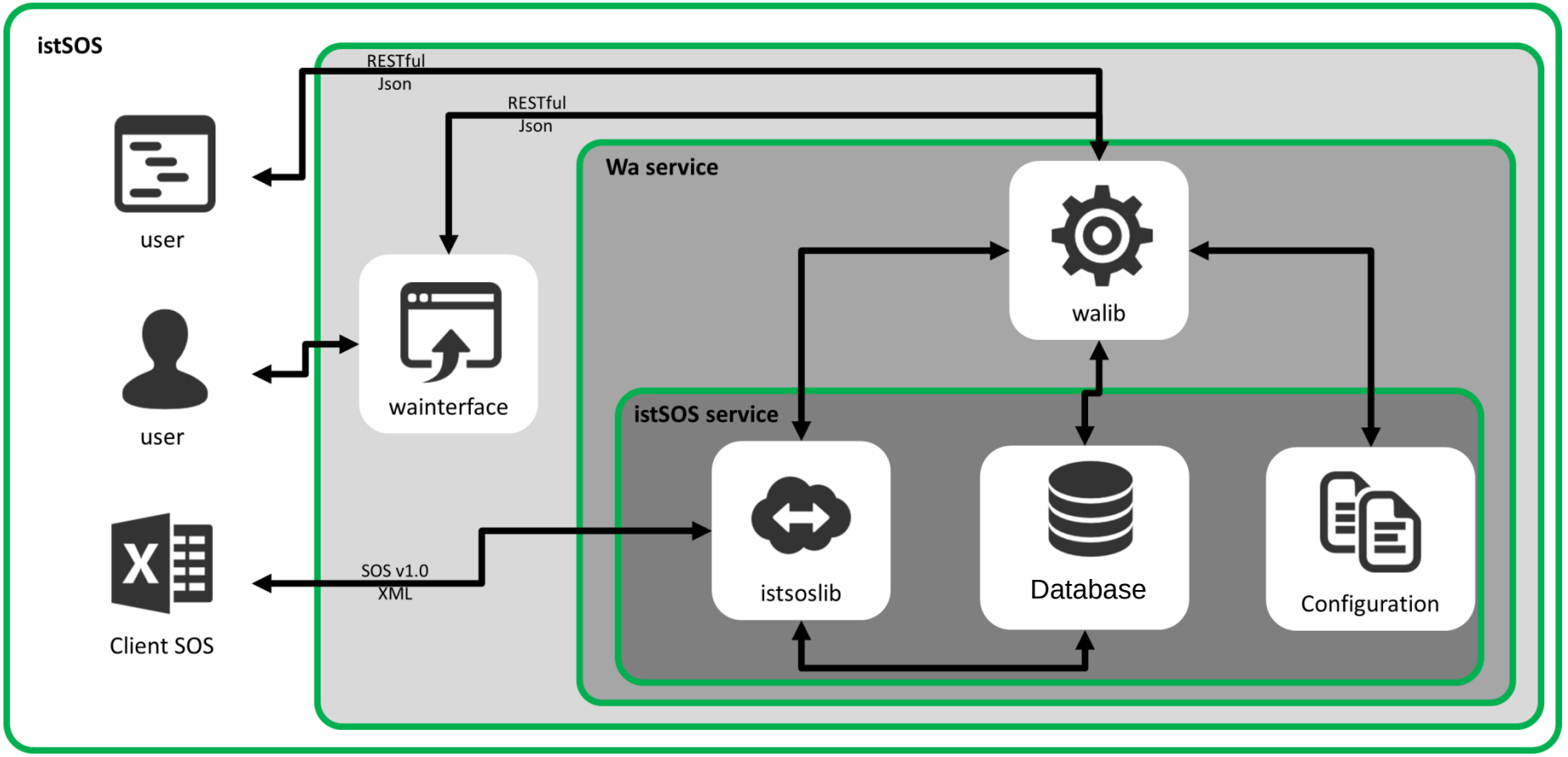
&

SOS v2.0

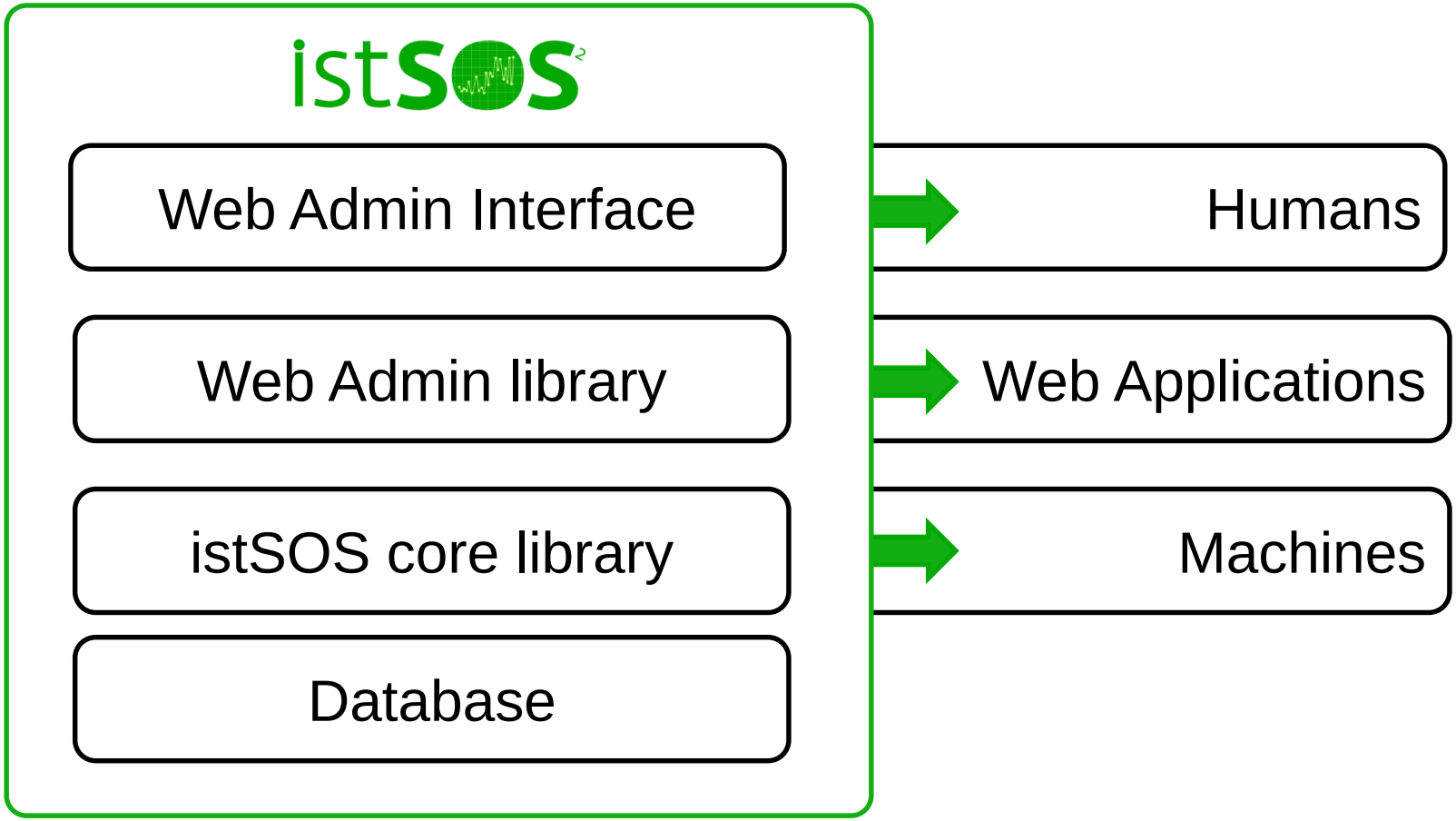
(core)

The istSOS software

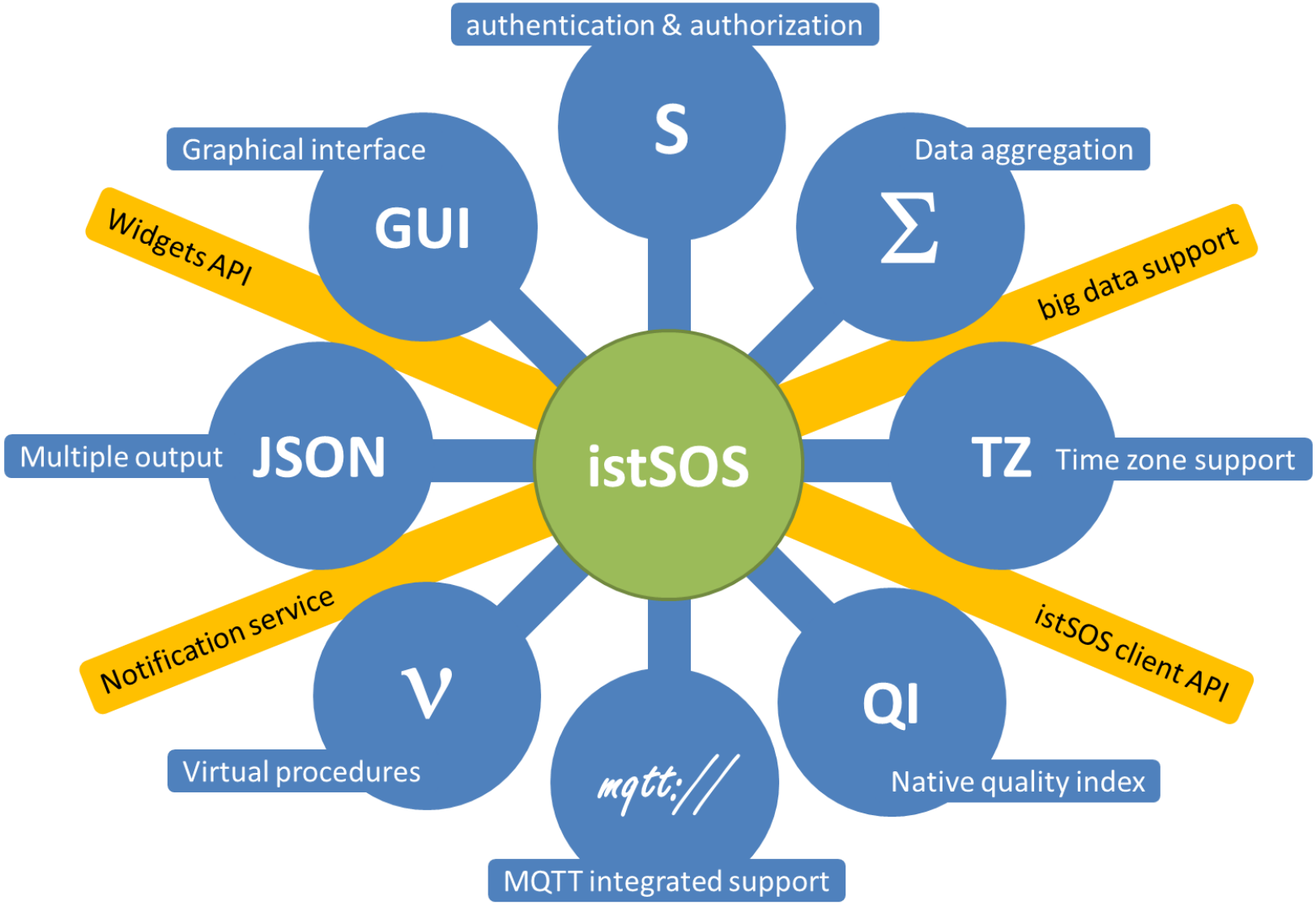
isodate
psycopg2
pytz



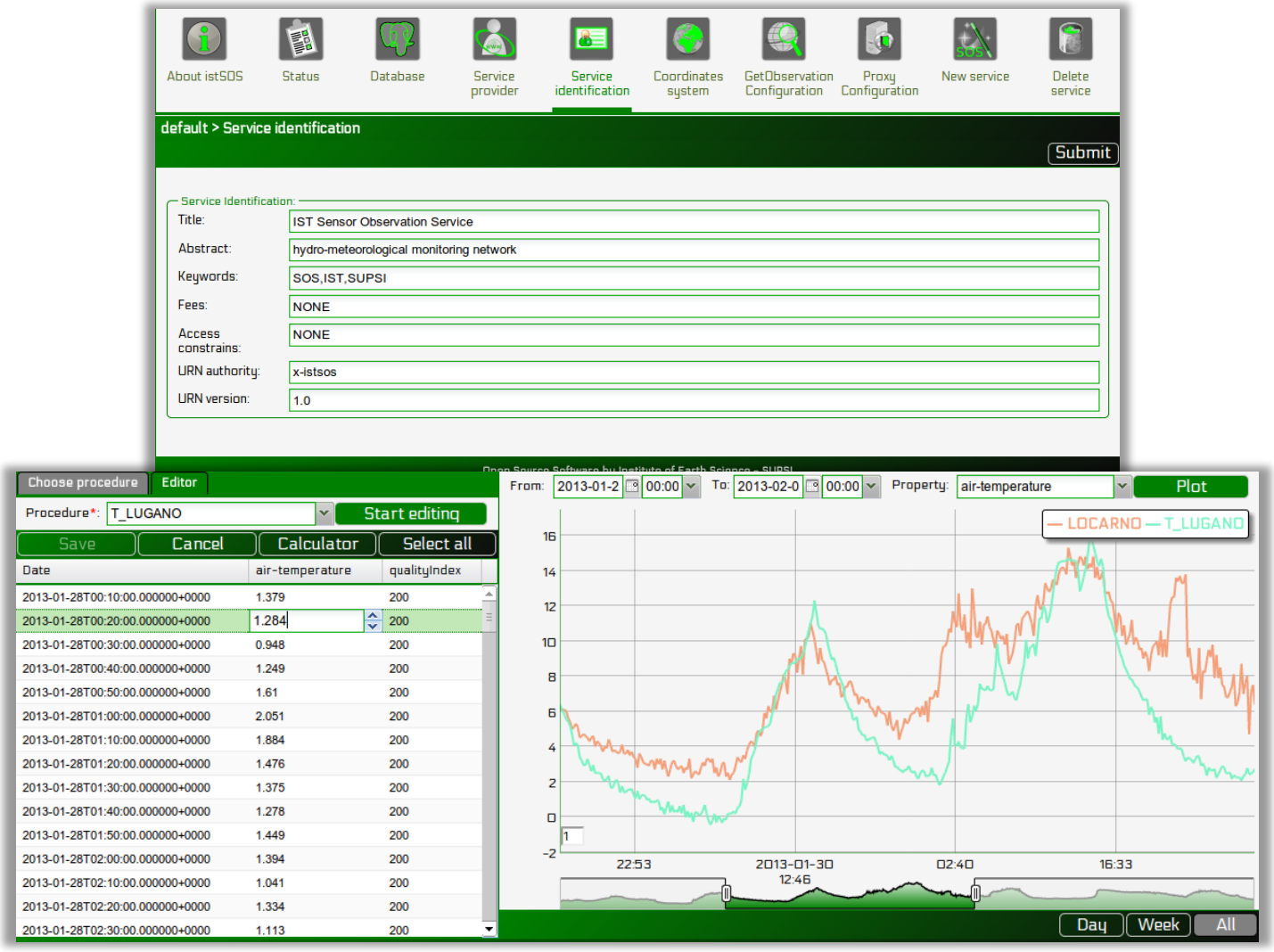
The istSOS software architecture



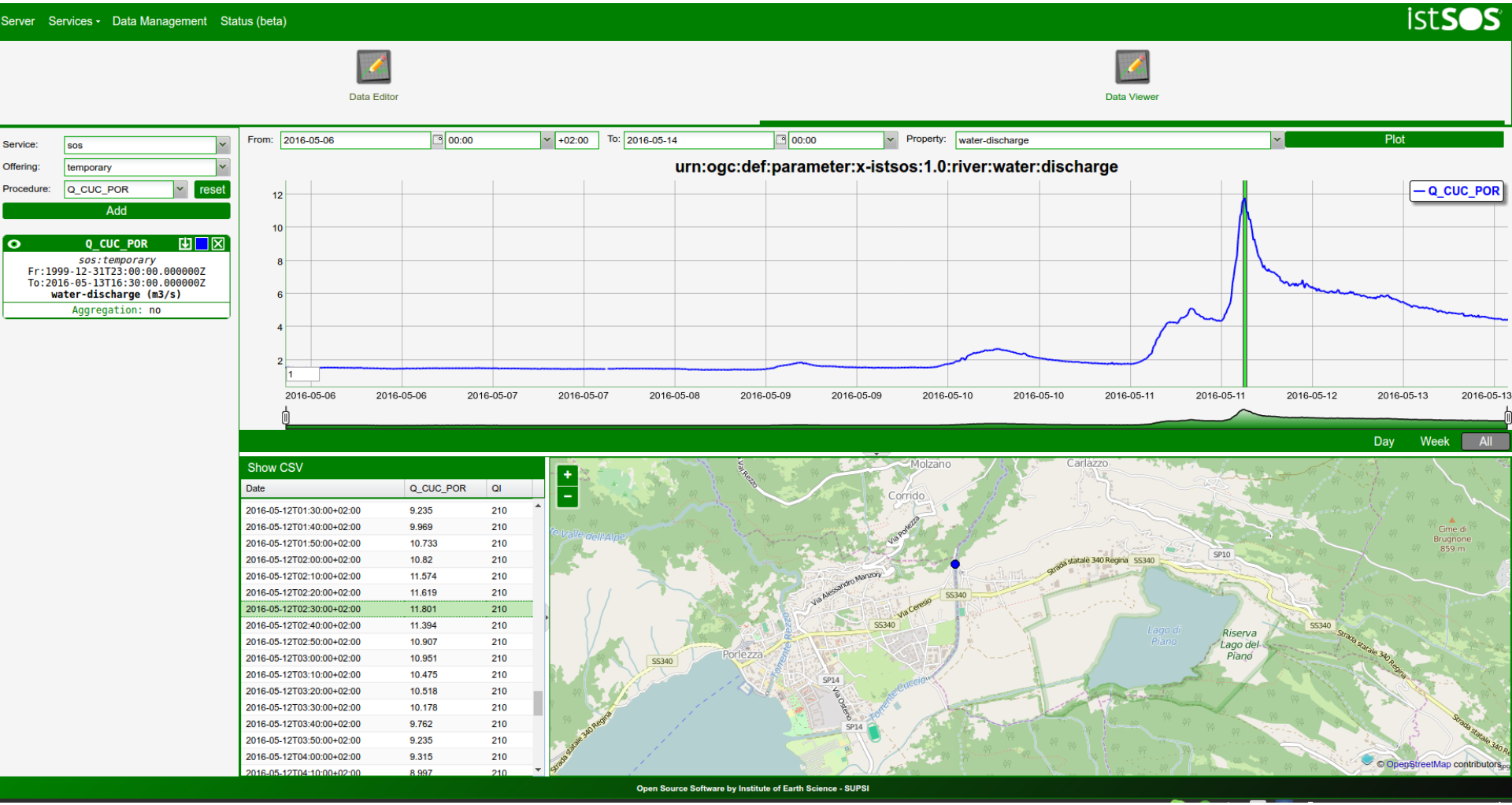
Some of the special features...



Easy installation and initialization and management using GUI (WebAdmin Interface)



Data viewer


Server
Services
Data Management
Status (beta)
istSOS
Data Editor
Data Viewer
Service: sos
Offering: temporary
Procedure: Q_CUC_POR
reset
Add
Q_CUC_POR
sos:temporary
Fr:1999-12-31T23:00:00.000000Z
To:2016-05-13T16:30:00.000000Z
water-discharge (m3/s)
Aggregation: no
From: 2016-05-06
00:00
+02:00
To: 2016-05-14
00:00
Property: water-discharge
Plot
urn:ogc:def:parameter:x-istsos:1.0:river:water:discharge
Q_CUC_POR
Day
Week
All
Show CSV
Date
Q_CUC_POR
QI
2016-05-12T01:30:00+02:00 9.235 210
2016-05-12T01:40:00+02:00 9.969 210
2016-05-12T01:50:00+02:00 10.733 210
2016-05-12T02:00:00+02:00 10.82 210
2016-05-12T02:10:00+02:00 11.574 210
2016-05-12T02:20:00+02:00 11.619 210
2016-05-12T02:30:00+02:00 11.801 210
2016-05-12T02:40:00+02:00 11.394 210
2016-05-12T02:50:00+02:00 10.907 210
2016-05-12T03:00:00+02:00 10.951 210
2016-05-12T03:10:00+02:00 10.475 210
2016-05-12T03:20:00+02:00 10.518 210
2016-05-12T03:30:00+02:00 10.178 210
2016-05-12T03:40:00+02:00 9.762 210
2016-05-12T03:50:00+02:00 9.235 210
2016-05-12T04:00:00+02:00 9.315 210
Molzano
Carlazzo
Corrido
Porlezza
Lago di Piano
Riserva Lago del Piano
Cime di Brughione 859 m
Strada statale 340 Regina
SS340
SP10
SP14
Torrente Cuccio
© OpenStreetMap contributors
Open Source Software by Institute of Earth Science - SUPSI

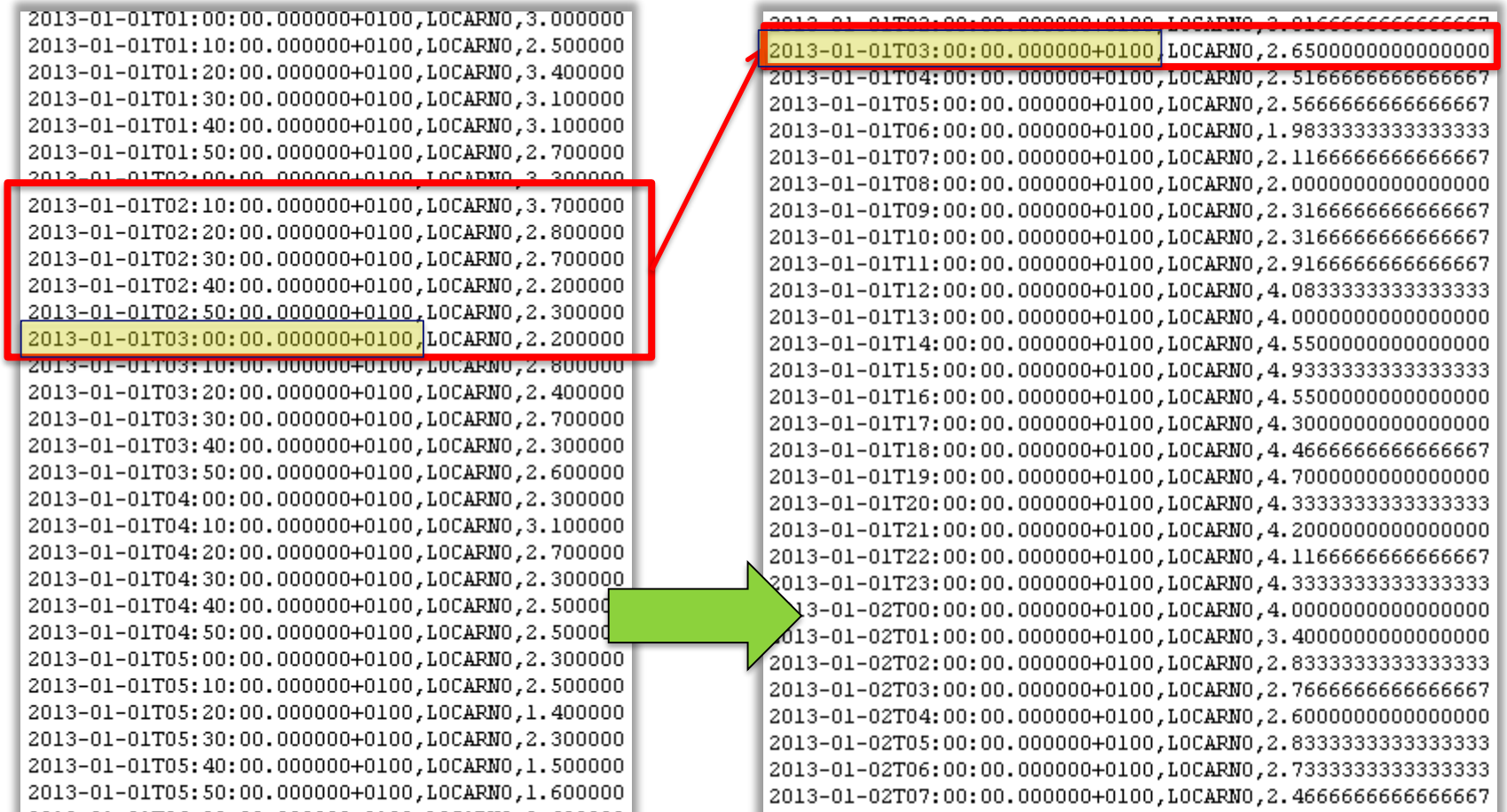
Output formats from GetObservation request

XML – CSV - JSON

Aggregation on-the-fly with GetObservation request

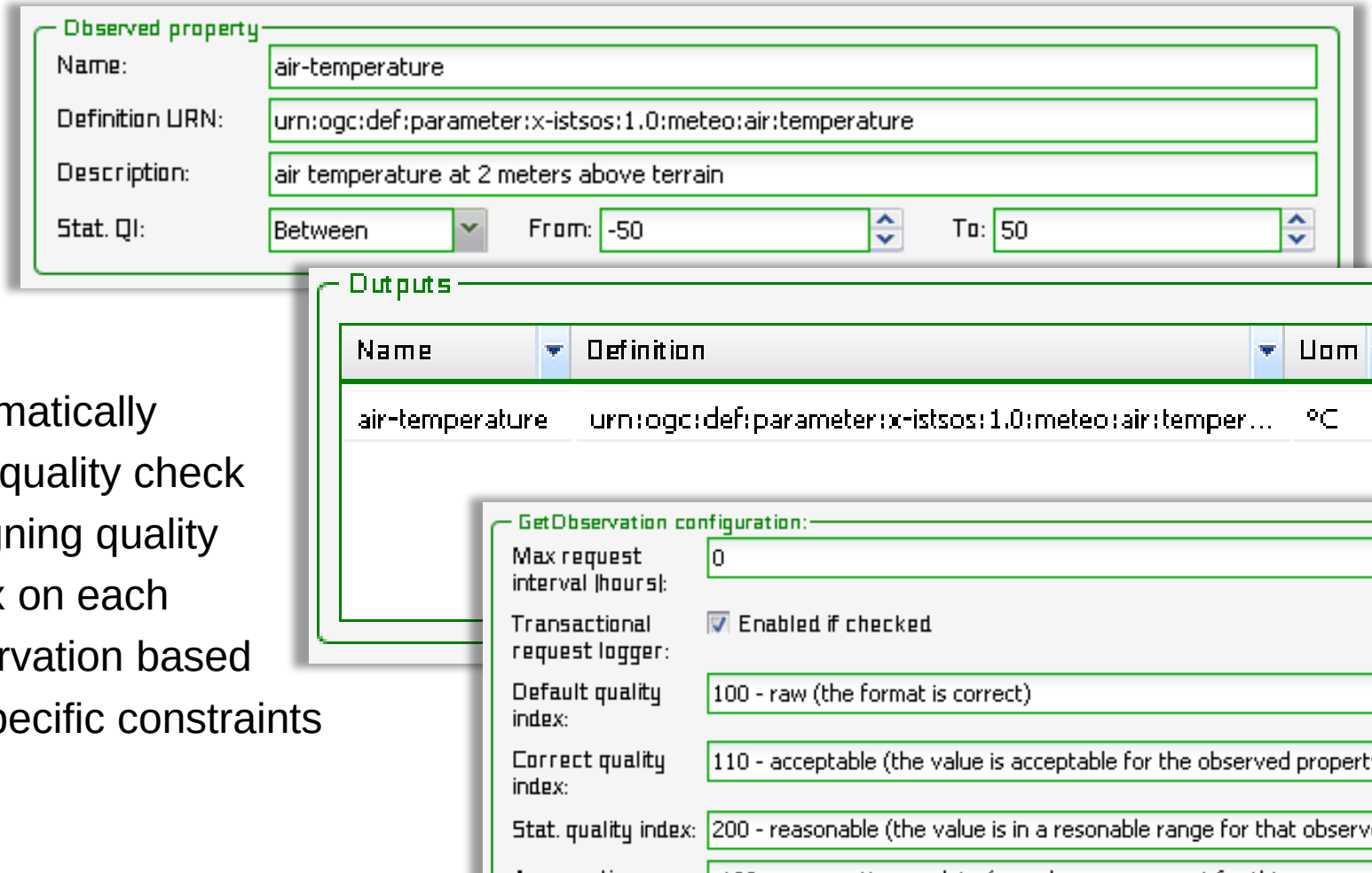
AVG, SUM, MAX, MIN

Extra parameters: aggregateInterval = PT1H & aggregateFunction = AVG



Real Time Quality Check

Configuration of quality index on the observed property level or sensor specific.



Automatically data quality check assigning quality index on each observation based on specific constraints

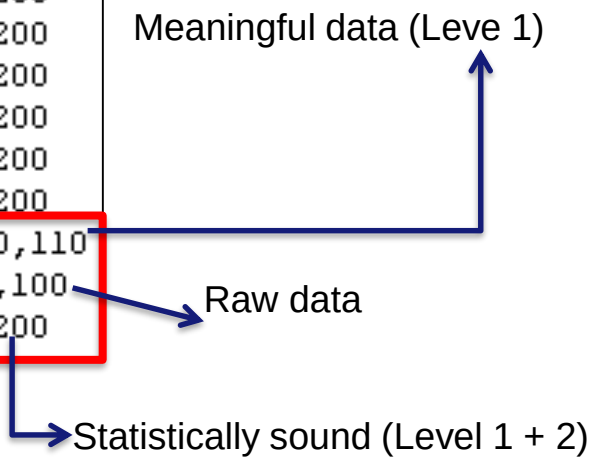
Quality index example

Raw data

```
urn:ogc:def:parameter:x-istsos:1.0:time:iso8601,urn:ogc:def:parameter:x-
istsos:1.0:meteo:air:temperature
2013-02-05T00:10:00.000000+0100,-45.000000
2013-02-05T00:20:00.000000+0100,80.000000
2013-02-05T00:30:00.000000+0100,1.56100
```

Assignment of quality indices during insertion:

```
2013-02-04T23:00:00.000000+0100,T_LUGANO,1.803000,200
2013-02-04T23:10:00.000000+0100,T_LUGANO,2.211000,200
2013-02-04T23:20:00.000000+0100,T_LUGANO,1.901000,200
2013-02-04T23:30:00.000000+0100,T_LUGANO,1.910000,200
2013-02-04T23:40:00.000000+0100,T_LUGANO,1.613000,200
2013-02-04T23:50:00.000000+0100,T_LUGANO,1.560000,200
2013-02-05T00:00:00.000000+0100,T_LUGANO,1.599000,200
2013-02-05T00:10:00.000000+0100,T_LUGANO,-45.000000,110
2013-02-05T00:20:00.000000+0100,T_LUGANO,80.000000,100
2013-02-05T00:30:00.000000+0100,T_LUGANO,1.561000,200
```



Time-Zone support

eventTime
2013-01-01T01:00:00**+01** / 2013-01-07T01:00:00**+01**

eventTime
2013-01-01T02:00:00**+02** / 2013-01-07T02:00:00**+02**

```
2013-01-01T01:10:00.000000+0100,LOCARNO,2.500000
2013-01-01T01:20:00.000000+0100,LOCARNO,3.400000
2013-01-01T01:30:00.000000+0100,LOCARNO,3.100000
2013-01-01T01:40:00.000000+0100,LOCARNO,3.100000
2013-01-01T01:50:00.000000+0100,LOCARNO,2.700000
2013-01-01T02:00:00.000000+0100,LOCARNO,3.300000
2013-01-01T02:10:00.000000+0100,LOCARNO,3.700000
2013-01-01T02:20:00.000000+0100,LOCARNO,2.800000
2013-01-01T02:30:00.000000+0100,LOCARNO,2.700000
2013-01-01T02:40:00.000000+0100,LOCARNO,2.200000
2013-01-01T02:50:00.000000+0100,LOCARNO,2.300000
2013-01-01T03:00:00.000000+0100,LOCARNO,2.200000
2013-01-01T03:10:00.000000+0100,LOCARNO,2.800000
2013-01-01T03:20:00.000000+0100,LOCARNO,2.400000
2013-01-01T03:30:00.000000+0100,LOCARNO,2.700000
2013-01-01T03:40:00.000000+0100,LOCARNO,2.300000
2013-01-01T03:50:00.000000+0100,LOCARNO,2.600000
2013-01-01T04:00:00.000000+0100,LOCARNO,2.300000
2013-01-01T04:10:00.000000+0100,LOCARNO,3.100000
2013-01-01T04:20:00.000000+0100,LOCARNO,2.700000
2013-01-01T04:30:00.000000+0100,LOCARNO,2.300000
2013-01-01T04:40:00.000000+0100,LOCARNO,2.500000
```

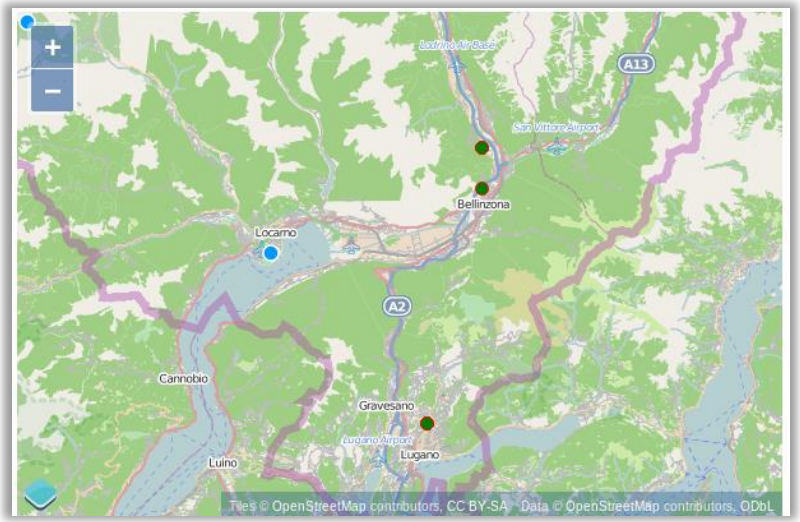
```
2013-01-01T02:10:00.000000+0200,LOCARNO,2.500000
2013-01-01T02:20:00.000000+0200,LOCARNO,3.400000
2013-01-01T02:30:00.000000+0200,LOCARNO,3.100000
2013-01-01T02:40:00.000000+0200,LOCARNO,3.100000
2013-01-01T02:50:00.000000+0200,LOCARNO,2.700000
2013-01-01T03:00:00.000000+0200,LOCARNO,3.300000
2013-01-01T03:10:00.000000+0200,LOCARNO,3.700000
2013-01-01T03:20:00.000000+0200,LOCARNO,2.800000
2013-01-01T03:30:00.000000+0200,LOCARNO,2.700000
2013-01-01T03:40:00.000000+0200,LOCARNO,2.200000
2013-01-01T03:50:00.000000+0200,LOCARNO,2.300000
2013-01-01T04:00:00.000000+0200,LOCARNO,2.200000
2013-01-01T04:10:00.000000+0200,LOCARNO,2.800000
2013-01-01T04:20:00.000000+0200,LOCARNO,2.400000
2013-01-01T04:30:00.000000+0200,LOCARNO,2.700000
2013-01-01T04:40:00.000000+0200,LOCARNO,2.300000
2013-01-01T04:50:00.000000+0200,LOCARNO,2.600000
2013-01-01T05:00:00.000000+0200,LOCARNO,2.300000
2013-01-01T05:10:00.000000+0200,LOCARNO,3.100000
2013-01-01T05:20:00.000000+0200,LOCARNO,2.700000
2013-01-01T05:30:00.000000+0200,LOCARNO,2.300000
```

JSON RESTful API

RESTful API for accessing and managing istSOS:

- Get service status, test database connection, initialize new servces
- Get, insert, update and delete:
  - sensors,
  - offerings,
  - observed properties,
  - quality indexes,
  - unit of measures,
  - service metadata,
  - observations,
  - fetaures of interest,
  - supported epsg,
  - etc…

WALib supporting Sensors Mapping and Charting Observations



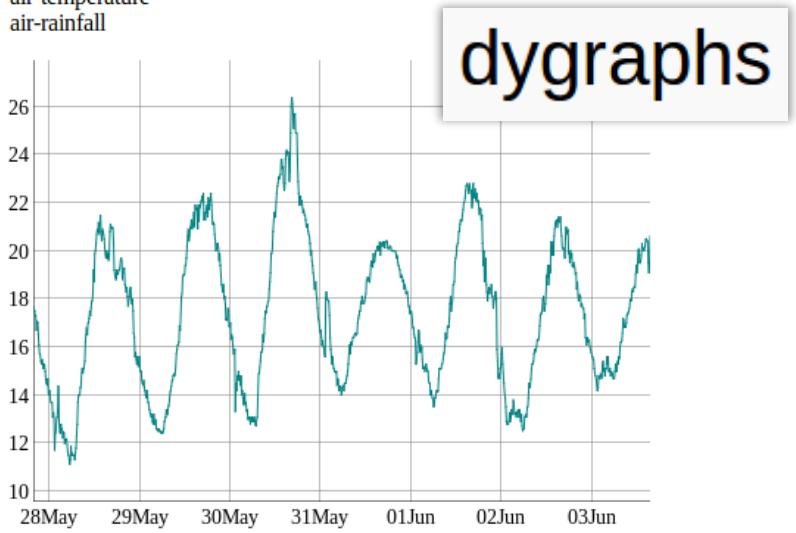
OpenLayers 3

LOCARNO

Begin: 2014-05-03T16:30:00+0200
End: 2014-06-03T19:50:00+0200

Observed properties:

1. air-temperature
2. air-rainfall




```
var vector = new ol.layer.Vector({
  source: new ol.source.Vector({
    parser: new ol.parser.GeoJSON(),
    url: '/istsos/wa/istsos/services/demo/procedures/operations/geojson?epsg=4326'
  })
});
```

Virtual procedures (EVAPOTRANSPIRATION)

GRABOW

Air Temperature
Relative humidity
Wind velocity
Solar radiation

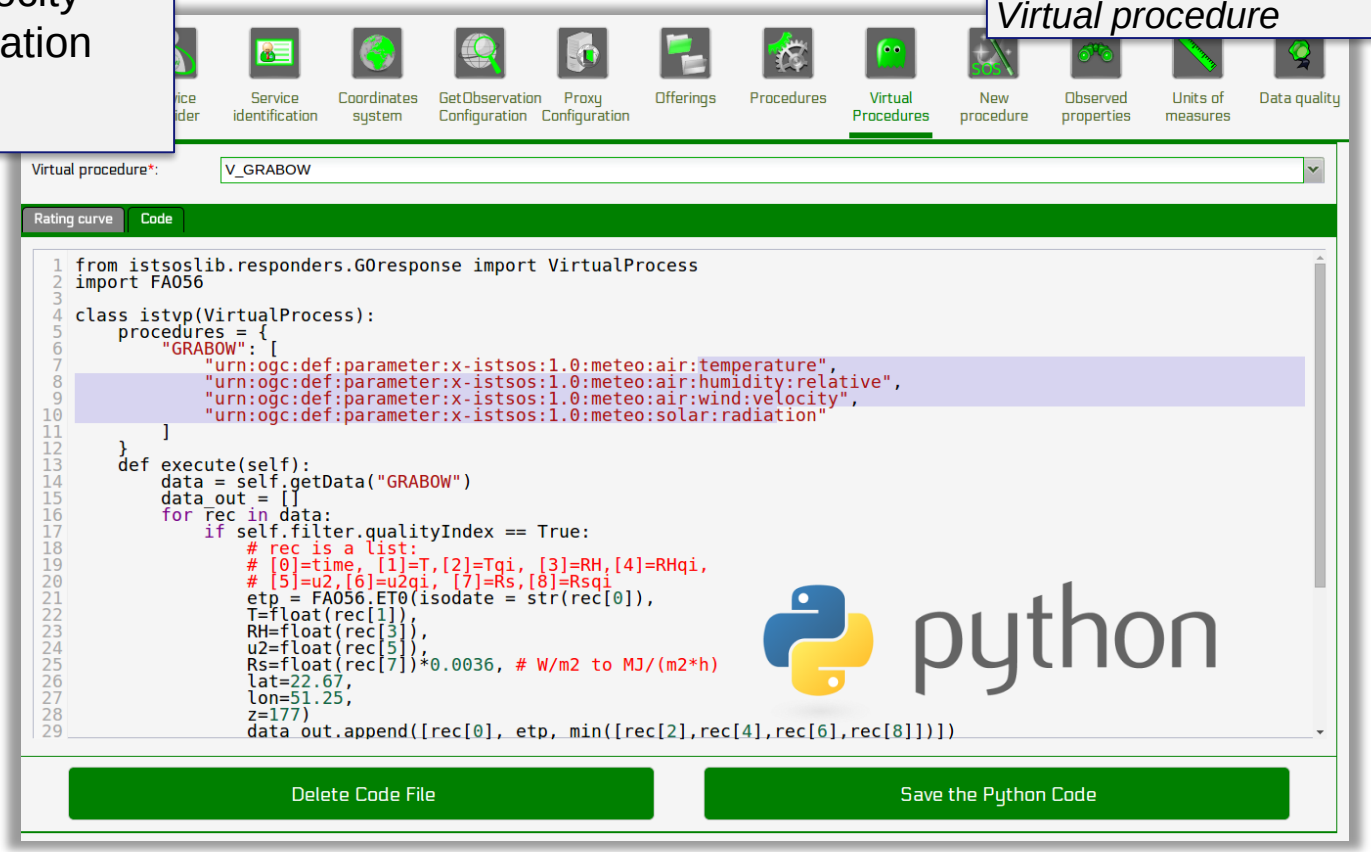
Real Sensor

FAO56 Calculation

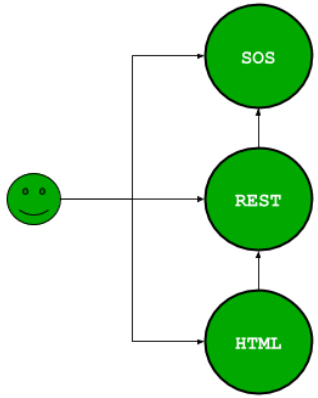
V_GRABOW

Reference evapotranspiration

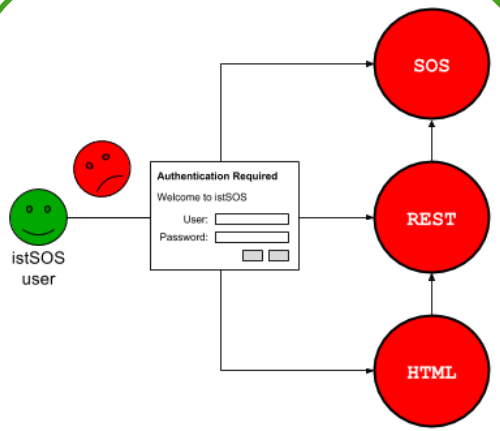
Virtual procedure



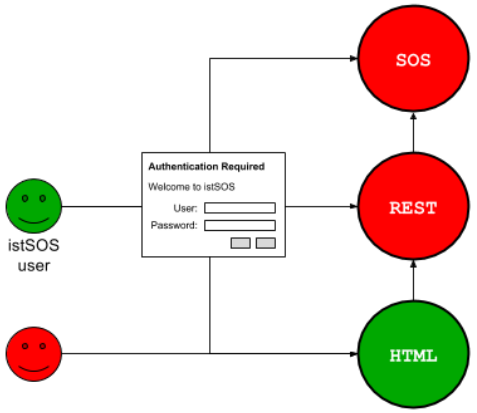
(NEW) Security configurations



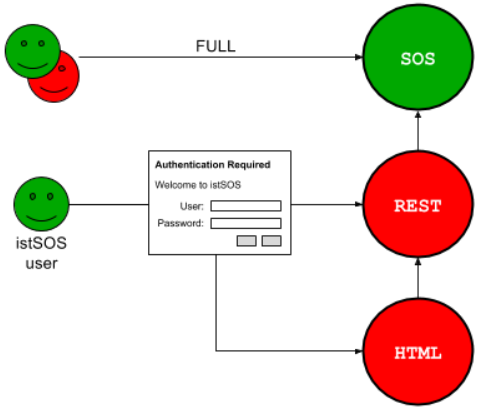
Fully Open



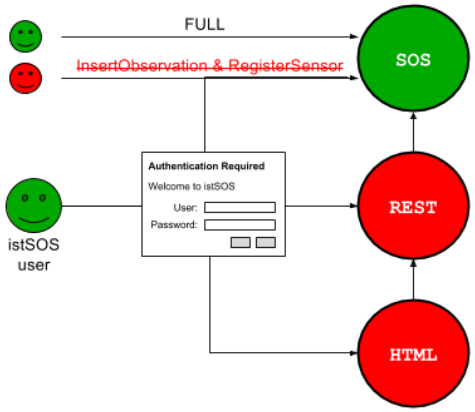
Fully closed



Only welcome page open



Only SOS requests open



Only non-transactional SOS requests open

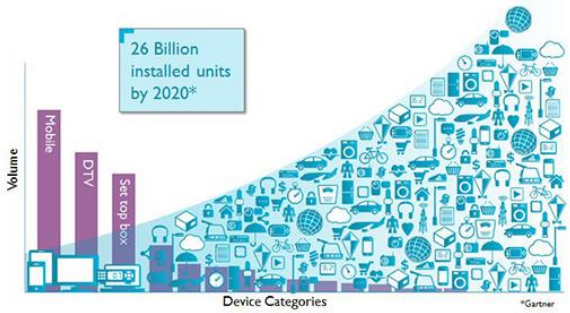
(NEW) User profiles

admin:
users with this role have access to all the istSOS features

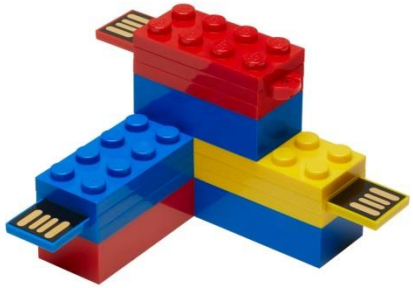
datamanager:
users with this role can modify only measures and procedures metadata

visitor:
users with this role can only view measures

istSOS one enabler of the IOT



The Internet of Things (IoT) is the collection of billions of end devices intelligently connected and interoperating with servers and services.



Combine “Things” like Lego blocks to create applications, services, values….

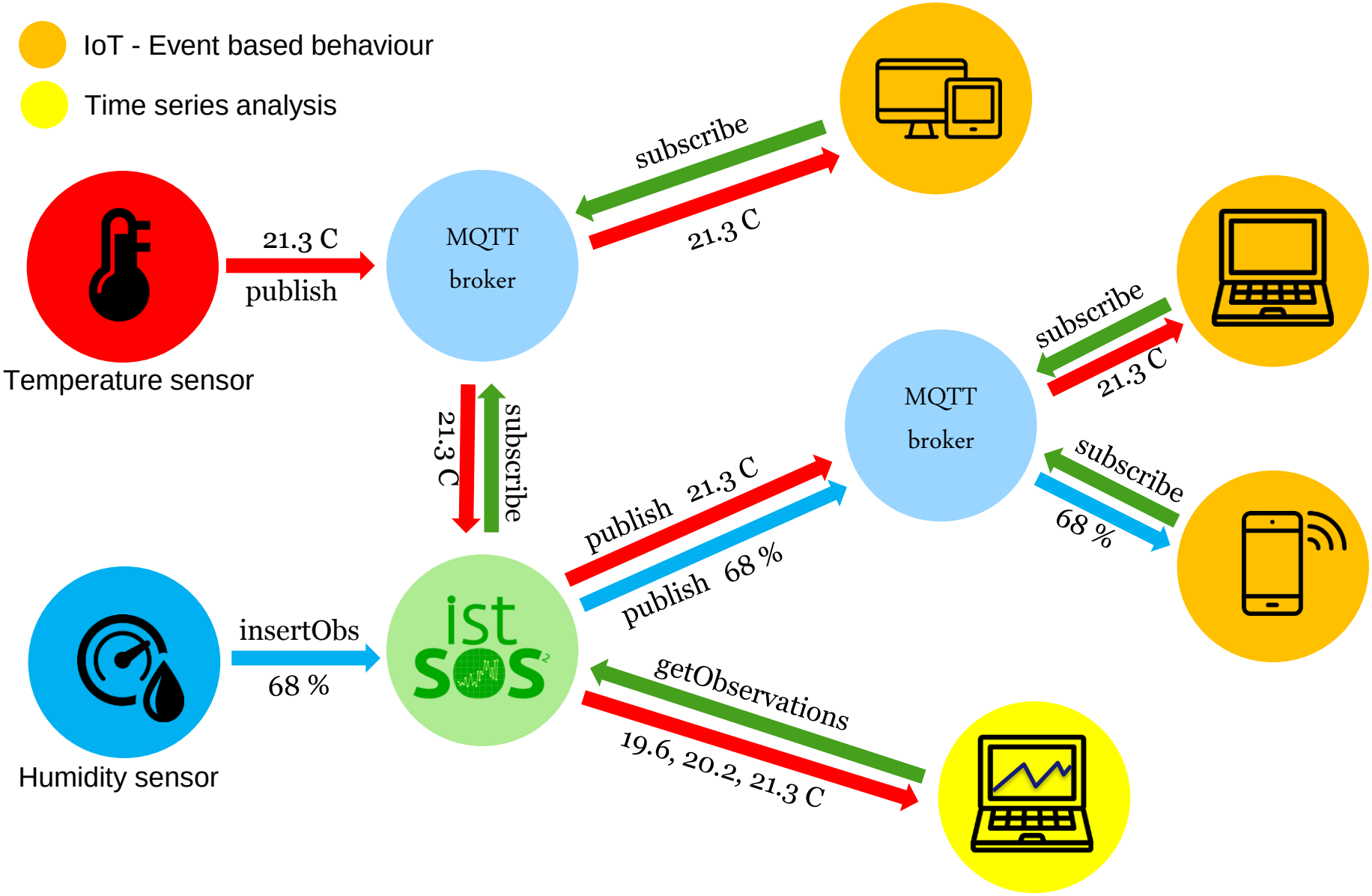
How to chose the blocks? what are they? how do they fits together? We need well known language: standards for machine – machine interaction!

SOS is an OGC standard to:

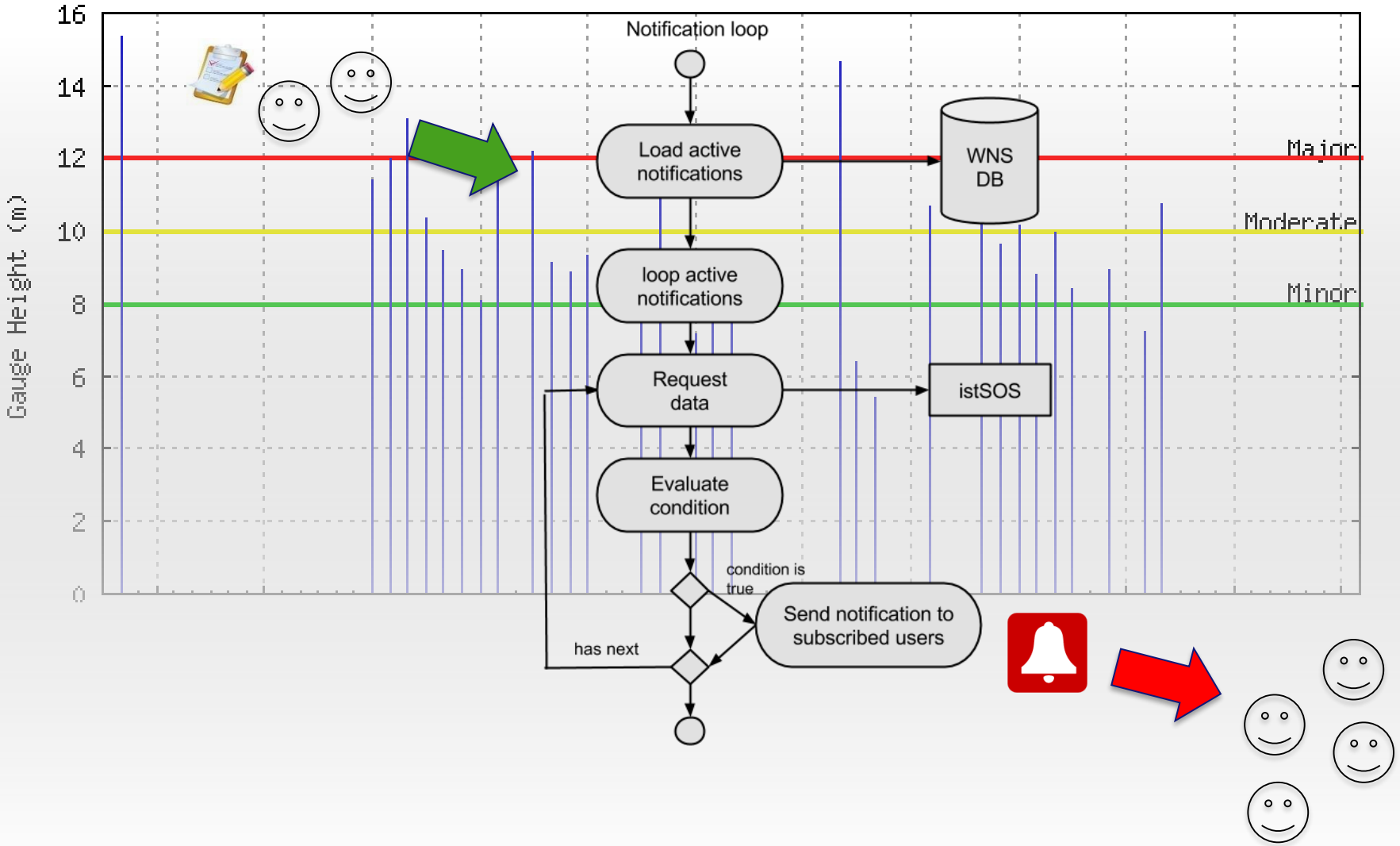
- register new sensor (THING) to the Web,
- storing new observations
- retrieving desired data

istSOS

(NEW) MQTT support



(2014) istSOS Alert & Notification Service



(2016) Google Summer of Code

- **istSOS widget**
  HTM embaddable elements

- **istSOS Android API**
  library to build-up Android application with enabled istSOS features

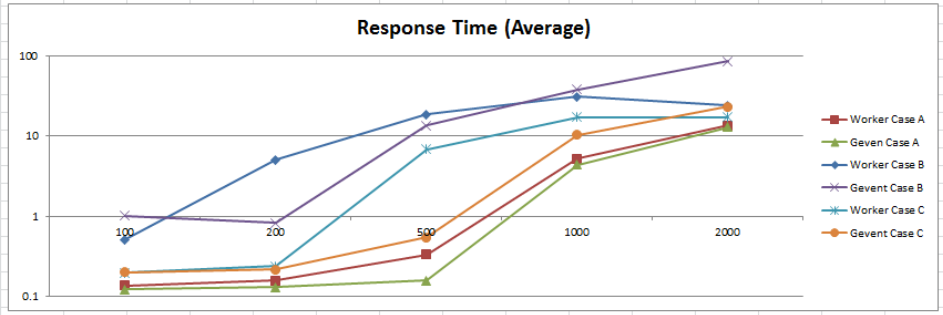
- **VistSOS client API**
  library to enable complex visualization of istSOS time-series data

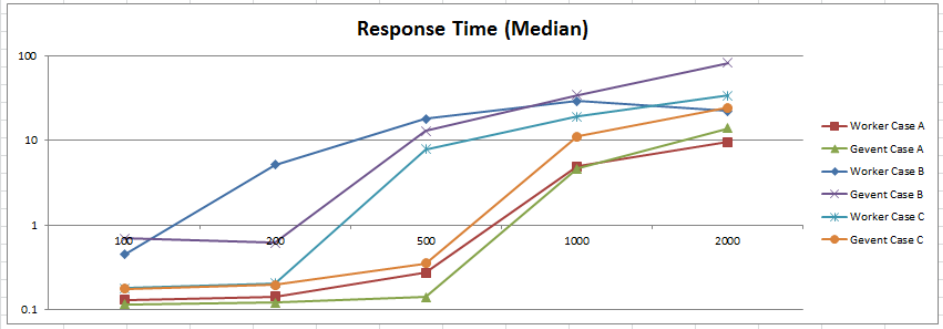
Next research steps

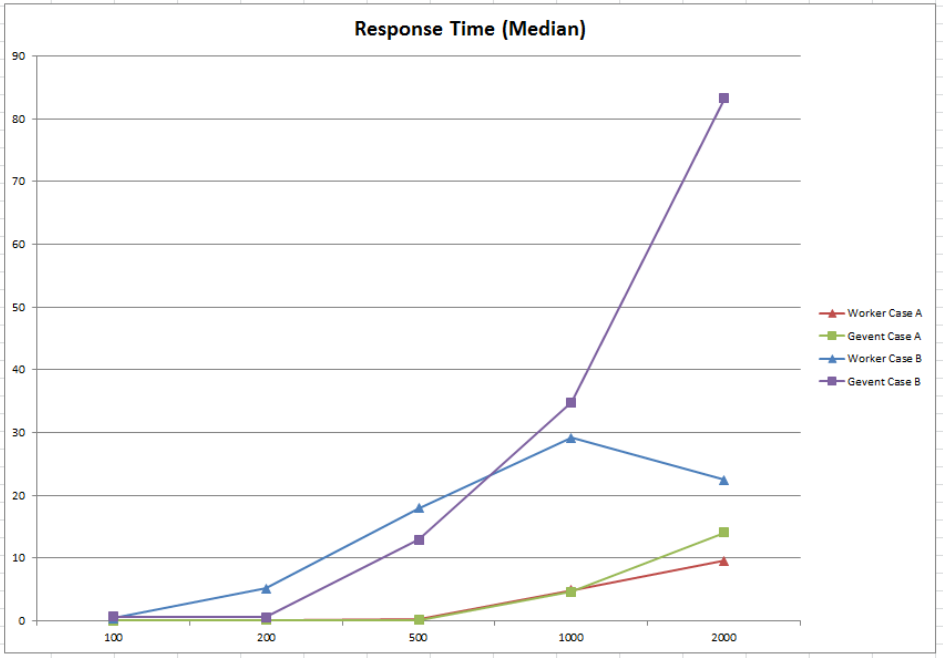
istSOS loading test to identify bottlenecks

PAPER IN PROGRESS

- 3 different cases
- 2 different WGSI server solution
- 2 different user types
- 5 different concurrent users scenarios (100, 200, 500, 1'000, 2'000)



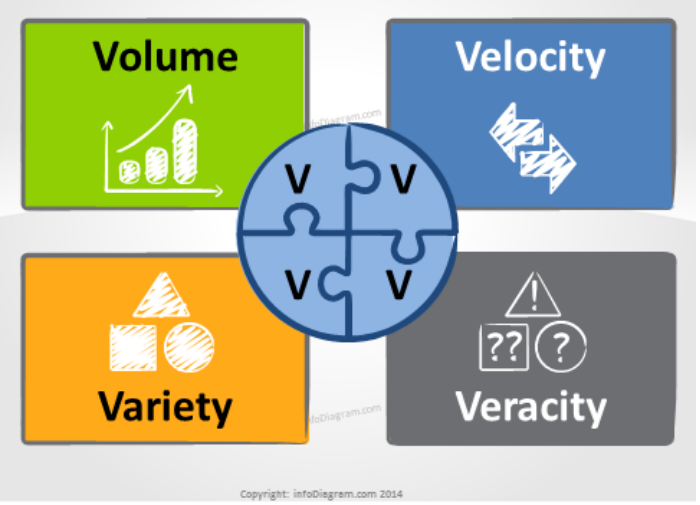




Big data issue

- Deploying the system worldwide we can immagine million of sensors with bilion of centralized data to be served and ingested

- We need a scalable and adaptable and fast:
  a solution for big data !



Thanks

http://istsos.org

OSGeo
Your Open Source Compass