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Water Quality Interoperability Experiment demo

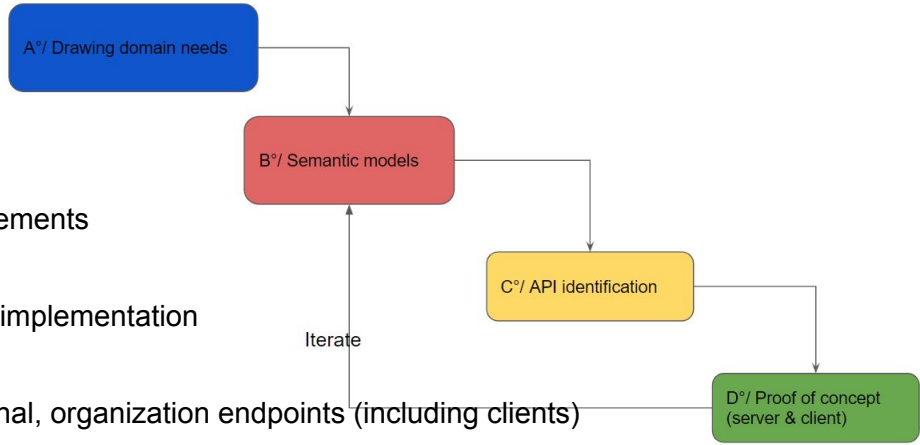
Sylvain Grellet
18/06/2024 - Hydro Domain Working Group

With support from WQ IE group member: Tony Boston, Cristina Cismasu, Igor Chernov, Kevin Christian, Lindsay Day, Adam Griggs, Candice Hopkins, Meghan McLeod, Kyle Onda, Washington Otieno, Philipp Saile, Hylke van der Schaaf, Kathi Schleidt, Lee Stanish

OGC Water Quality IE tl;dr;

- 1°/ WMO-UNEP-WHO-UNESCO Water Quality workshop in March 2022 (29-31) : Surface & Ground water
- 2°/ Kick-off 13/09/2022

… 77 (+ impromptu) meetings later



- A Best Practice on Observations, measurements and samples for Water Quality
- A ST API 1.1 + WQ extension (reference implementation in FROST) paving the road to ST API 2.0
- Running implementations in various national, organization endpoints (including clients)
- A steadily growing uptake through initial IE partners + 2 important EU projects and WMO members

3°/ The Engineering Report will prepare next steps on

- a Best Practice for WQ Data Exchange : upgrading OGC WaterML2.0 - Part 5 (OGC 14-003) : O&M Profile for WQ Data
- a review of OGC WaterML2.0 - Part 1 (OGC 10-126r3) : Timeseries

Both to be updated with regards O&M revision into OMS + major change in the OGC API context

It all starts here : https://github.com/opengeospatial/WaterQualityIE/
(model, FROST plugin, …)

Water Quality IE - setting the scene

OGC Water Quality IE set up

- Third time the topic is proposed within the OGC Hydro Domain Working Group

- Enough momentum and interest from parties
  ⇒ WMO-UNEP-WHO-UNESCO Water Quality workshop in March 2022 (29-31)
  https://external.ogc.org/twiki_public/HydrologyDWG/WaterQualityWorkshopSprint2022
  ⇒ confirmation of the necessity and organizations interest. Identification of interested parties and IT challenges
  Discussion on the best approach ⇒ an OGC Interoperability Experiment

- Water Quality IE inception

⇒ Charter, call for participation, kick-off (20/09/2022)

Co-chairs : Sylvain Grellet (BRGM), Kyle Onda (Lincoln Institute)

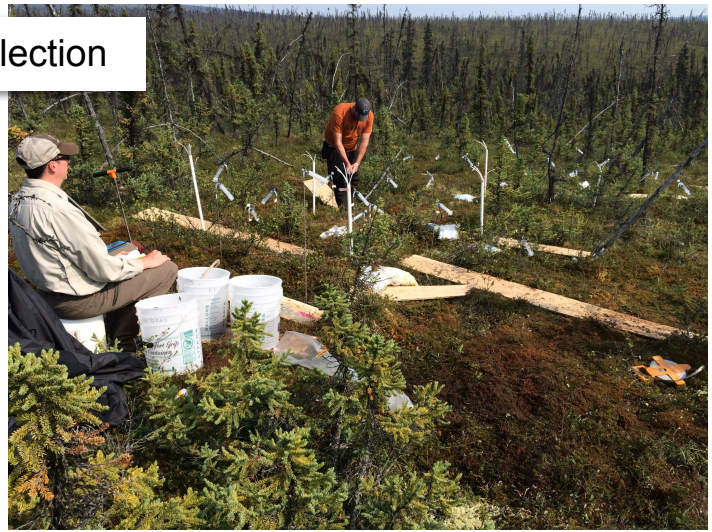
Since then :

- Starting point : https://github.com/opengeospatial/WaterQualityIE
- Weekly meetings
- Shared material
  - Rolling meeting minutes document,
  - One focal point for UML models
  - Shared deployment documentation initiated
- Note : shared images in that presentation represent **Work In Progress** currently being tested

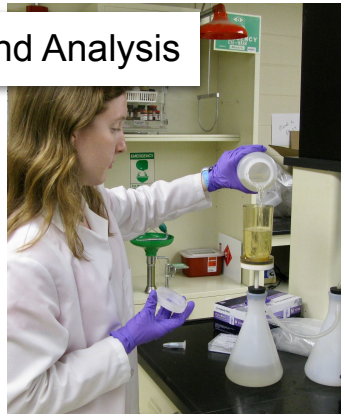
The Engineering Report will summarize the group conclusions

Water Quality Use Cases

Sample collection



Processing and Analysis



Data

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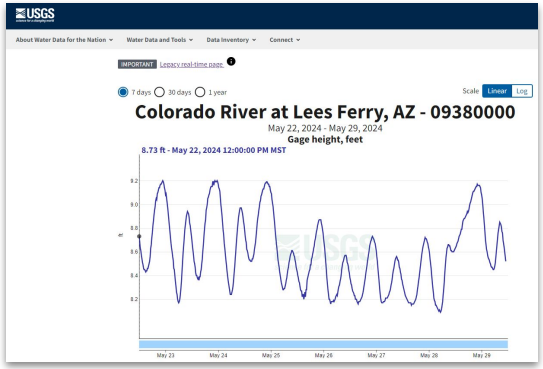
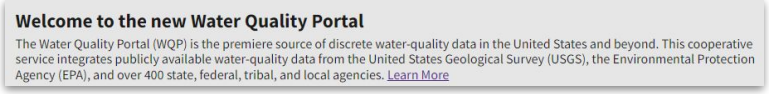
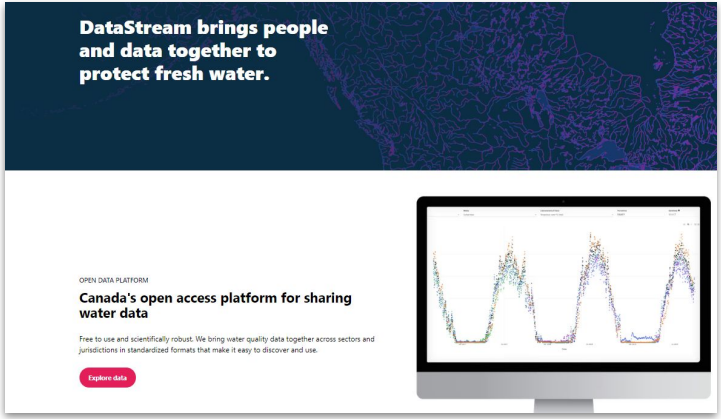
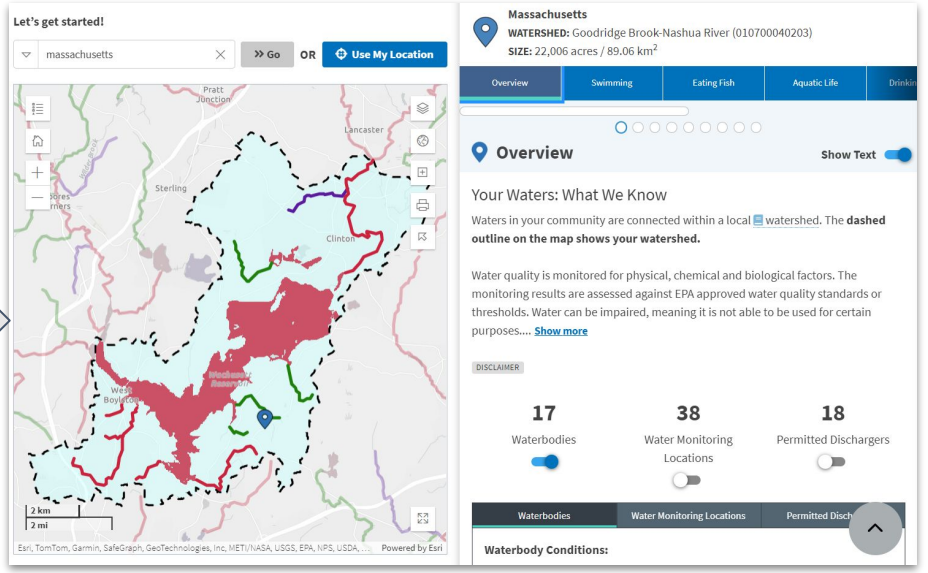
Conceptual Goal
Bringing together individual data streams







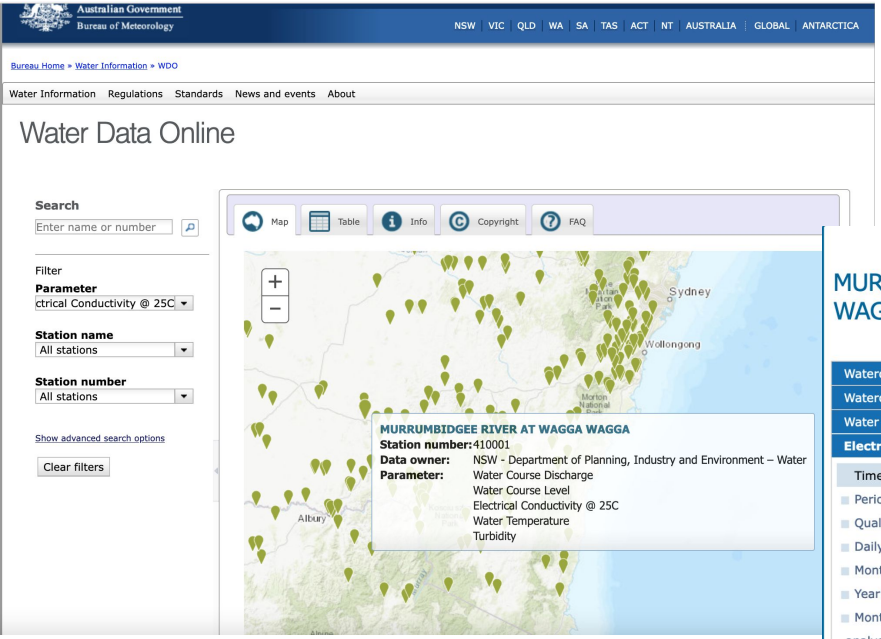
North-America

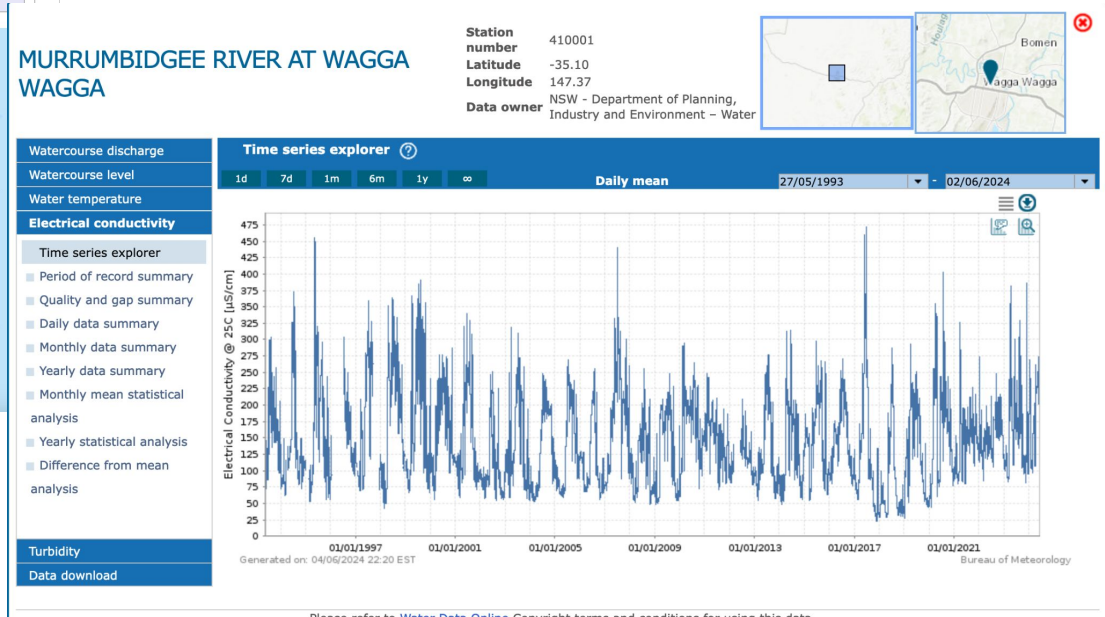


Aggregated data enable visualization and analysis for informed decision-making across national boundaries

Setting the scene: Water Quality Use Cases (country to country)

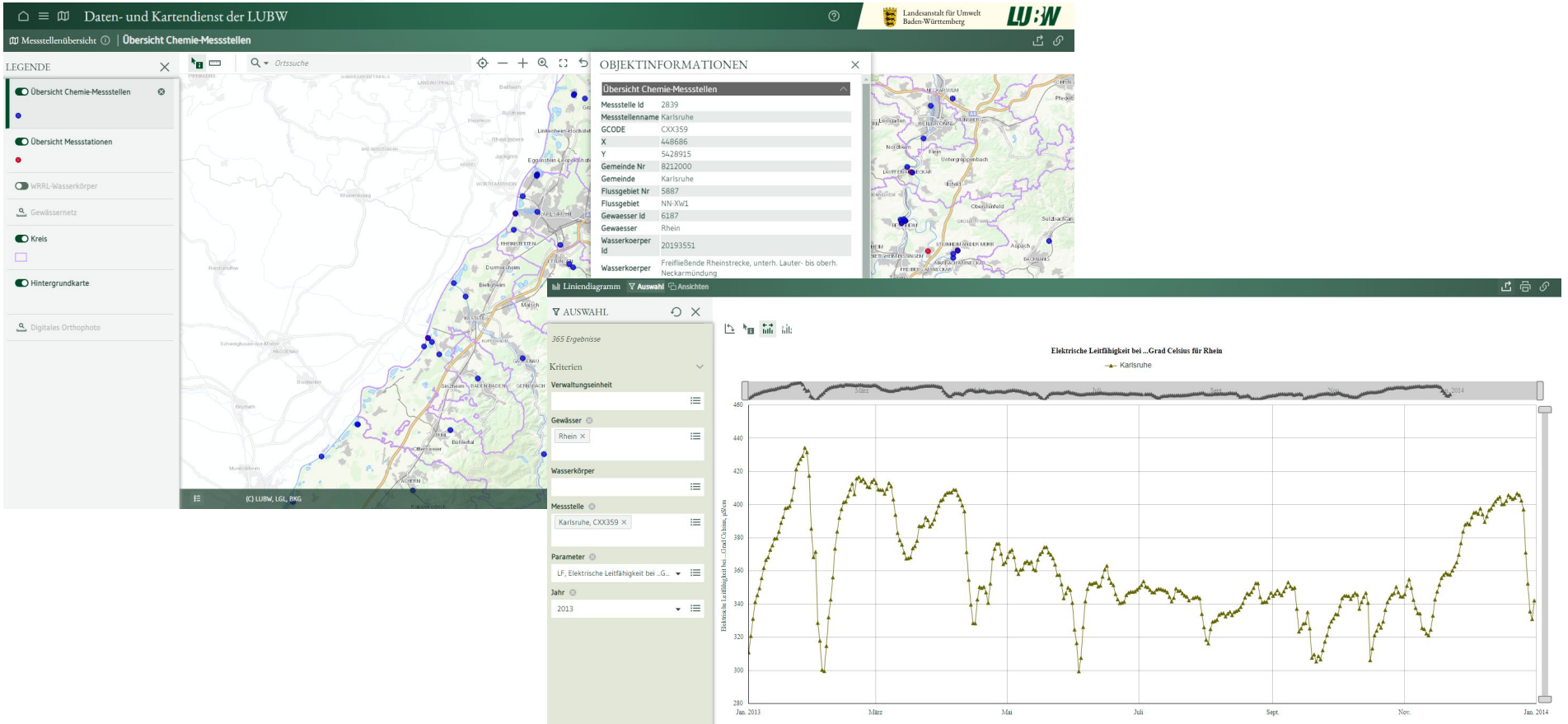
Australia





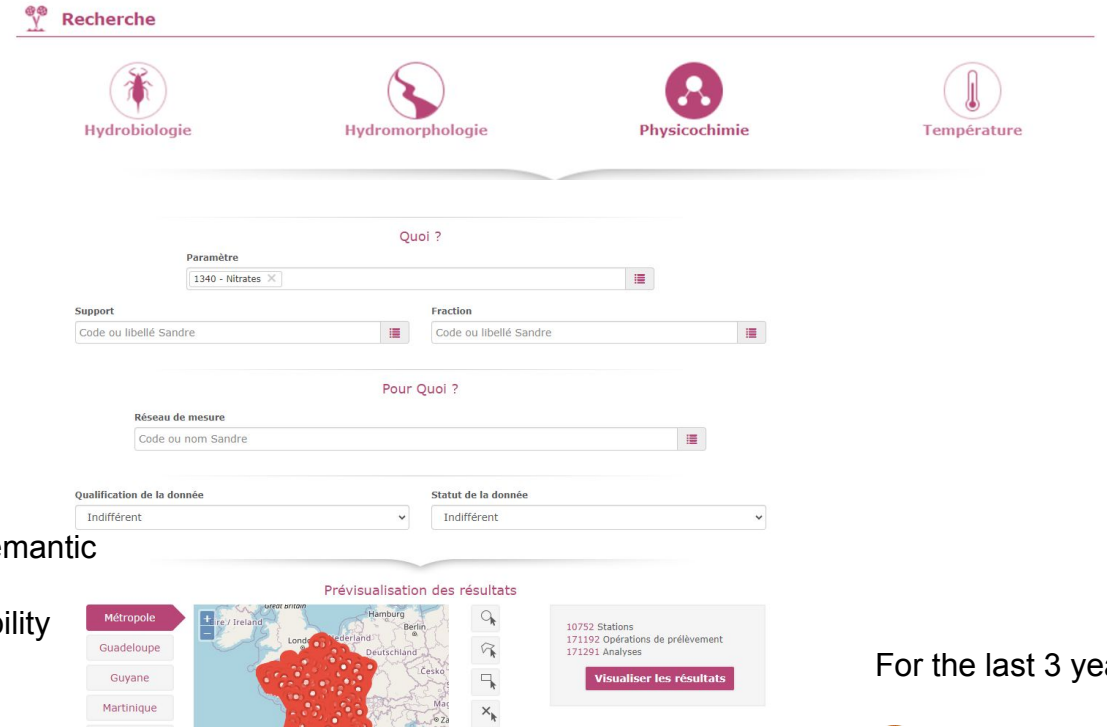
Setting the scene: Water Quality Use Cases (country to country)

Land Baden-Württemberg



Setting the scene: Water Quality Use Cases (country to country)

France (Surface Water)



Water Agencies

French Biodiversity Office (OFB)

Partner networks (ex : DREAL, …)

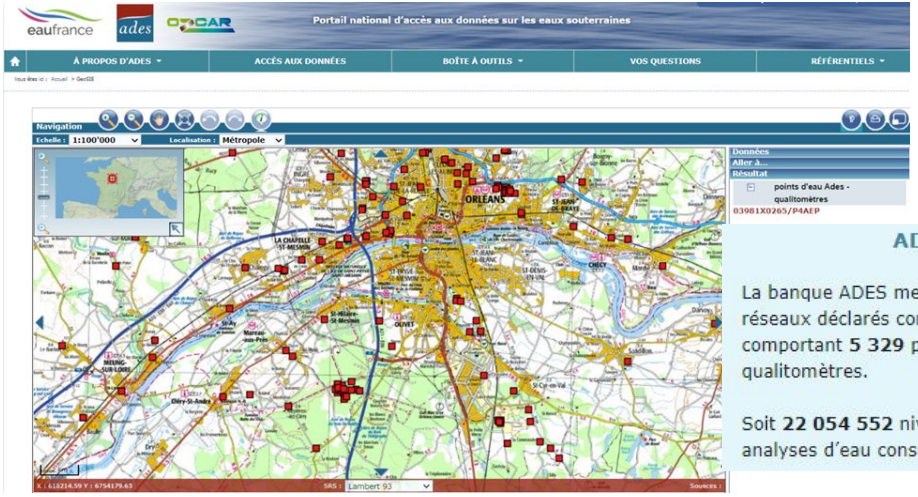
National semantic & technical interoperability

For the last 3 years

Since 1969 - around 260 Million Observations on water physics & chemistry

Setting the scene: Water Quality Use Cases (country to country)

France (Ground Water)



ADES en chiffres

La banque ADES met à disposition à ce jour **353** réseaux déclarés contenant **82 174** points d'eau comportant **5 329** piézomètres et **78 623** qualitomètres.

Soit **22 054 552** niveaux d'eau et **135 586 152** analyses d'eau consultables en ligne.

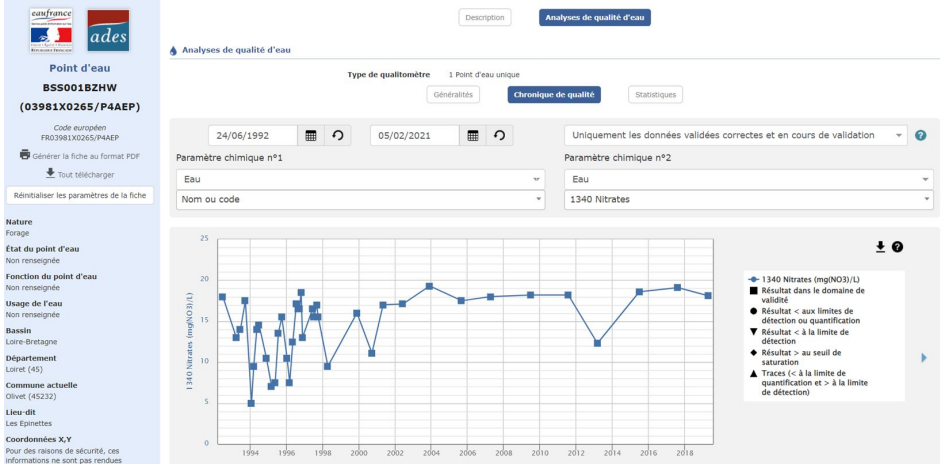
Water Agencies

French Geological Survey (BRGM)

Various ministries (Health, industry,..)

Partner networks (ex : local water councils, …)

National semantic & technical interoperability



Setting the scene: Water Quality Use Cases (country to country)

Europe

Shared codeLists
https://dd.eionet.europa.eu/vocabularies

/vocabulary/wise/ObservedProperty/view

Id	Label	Status	Status Modified	Notation
CAS_100-00-5	1-chloro-4-nitrobenzene	Valid	12.10.2020	CAS_100-00-5
CAS_100-01-6	4-Nitroaniline	Valid	03.12.2021	CAS_100-01-6
CAS_100-02-7	Nitrophenol	Valid	12.10.2020	CAS_100-02-7
CAS_100-41-4	Ethylbenzene	Valid	12.10.2020	CAS_100-41-4
CAS_100-42-5	Styrene	Valid	12.10.2020	CAS_100-42-5
CAS_100-44-7	Benzyl chloride	Valid	12.10.2020	CAS_100-44-7
CAS_1002-53-5	Dibutyltin	Valid	12.10.2020	CAS_1002-53-5
CAS_10028-17-8	Tritium	Valid	12.10.2020	CAS_10028-17-8
CAS_10061-01-5	cis-1,3-dichloropropene	Valid	12.10.2020	CAS_10061-01-5
CAS_10061-02-6	trans-1,3-dichloropropene	Valid	12.10.2020	CAS_10061-02-6

EU country A

EU country B

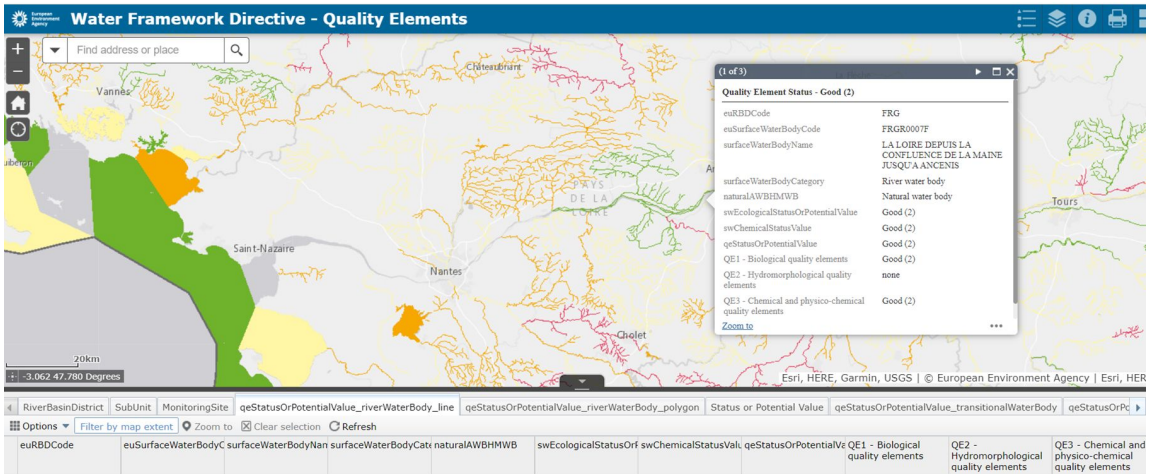
EU country C

EU Reporting according to EU specs
https://dd.eionet.europa.eu/

Mostly file based

Mainly stations, network, indicators.
Only one with observations

Reported Data from the EU WISE portal



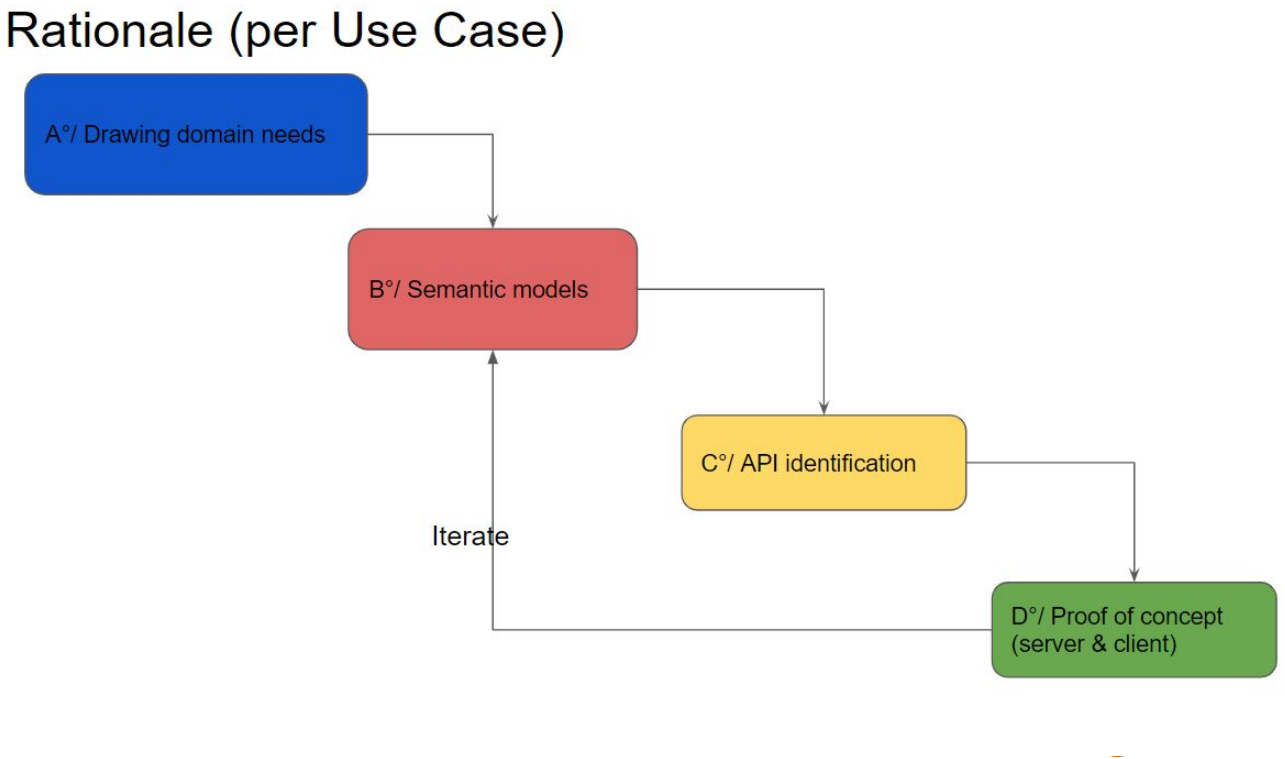
Use Cases identification and work methodology

	Org	FoI Type: Water (Surface and Ground together at this stage)			
Method	*Observed Property group*	Quantity	Physical properties	Chemistry	Biology
	Samples	Here as a support to WQ	1	2	3
	Sensors				
	Hydro Models				
	Remote Sensing				

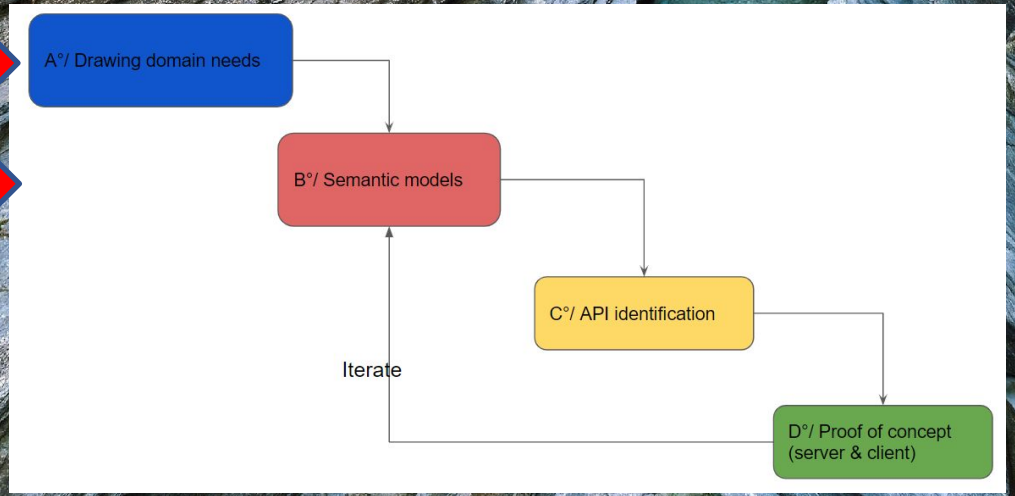
FoI = Feature Of Interest = the real world feature on which observation is made

- Water Quality Use Case prioritisation
  - Physical Properties (ex : Temperature, Conductivity), Chemistry
  - + Water Quantity as a support to Water Quality
  - *Out of scope this IE : Biology (taxa observation), Hydro Models, Remote Sensing*

Use Cases identification and work methodology

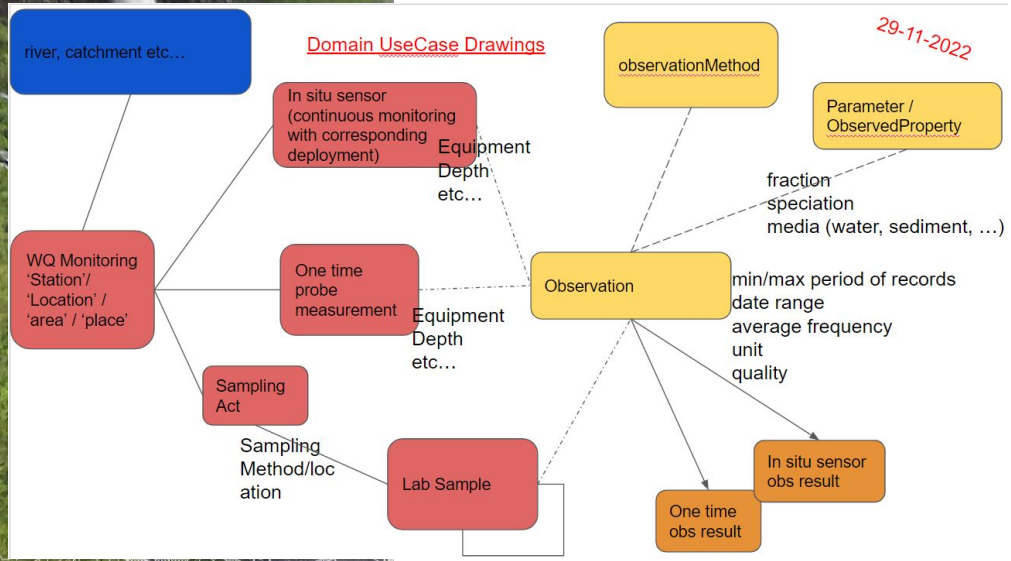


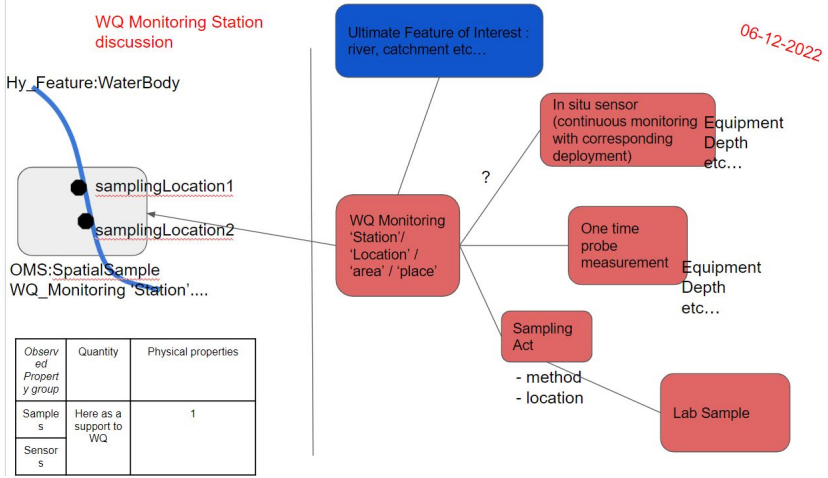
Water Quality IE - what do we want to exchange on ?



Conceptual Modelling

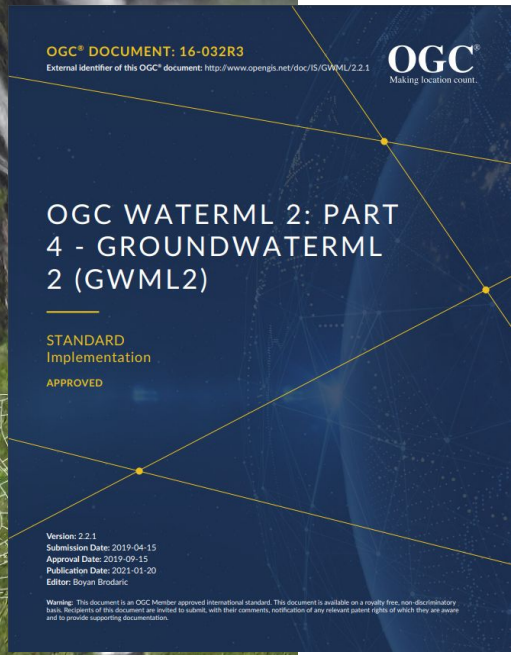
- Step 1°/ Express the domain need stemming from the UseCases

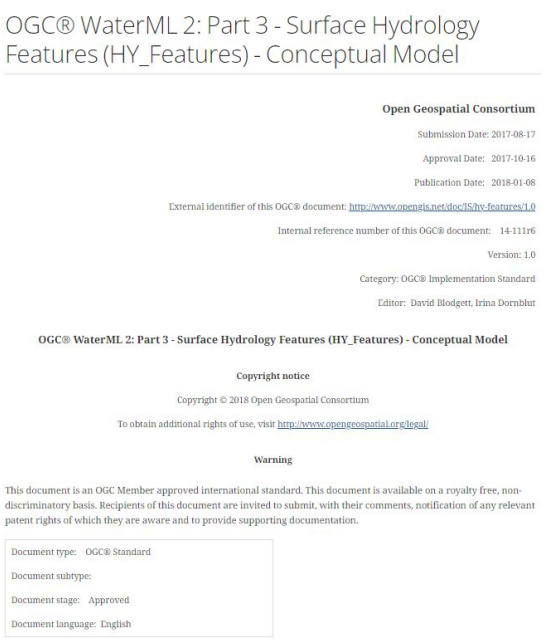




Conceptual Modelling

- Step 2°/ Identify the standards in the OGC standard baseline to build on
  - 2 OGC-WMO water standards : GroundWaterML2.0 & HY_Features
  - THE OGC-ISO standard for Observations & Samples : ISO 19156:2023 : Observations, measurements and samples





OGC® WaterML 2: Part 3 - Surface Hydrology Features (HY_Features) - Conceptual Model

Open Geospatial Consortium

Submission Date: 2017-08-17

Approval Date: 2017-10-16

Publication Date: 2018-01-08

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Internal reference number of this OGC® document: 14-111r6

Version: 1.0

Category: OGC® Implementation Standard

Editor: David Blodgett, Irina Dornblut

OGC® WaterML 2: Part 3 - Surface Hydrology Features (HY_Features) - Conceptual Model

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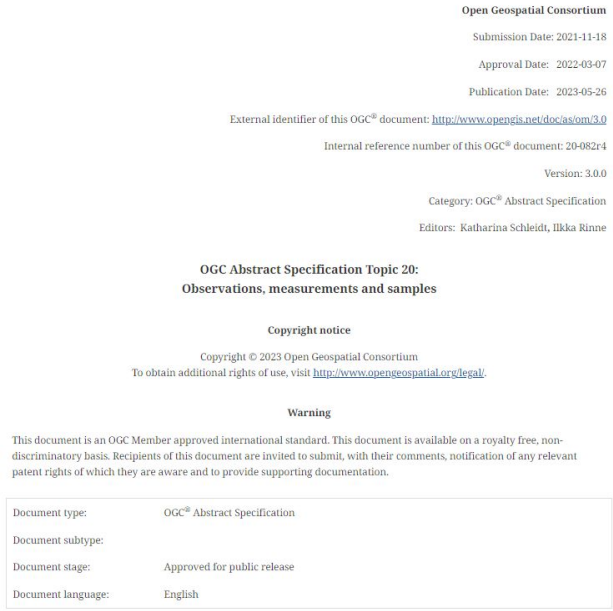

Open Geospatial Consortium

Submission Date: 2021-11-18

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Publication Date: 2023-05-26

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Editors: Katharina Schleidt, Ilkka Rinne

OGC Abstract Specification Topic 20: Observations, measurements and samples

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Document type:	OGC® Abstract Specification
Document subtype:	
Document stage:	Approved for public release
Document language:	English

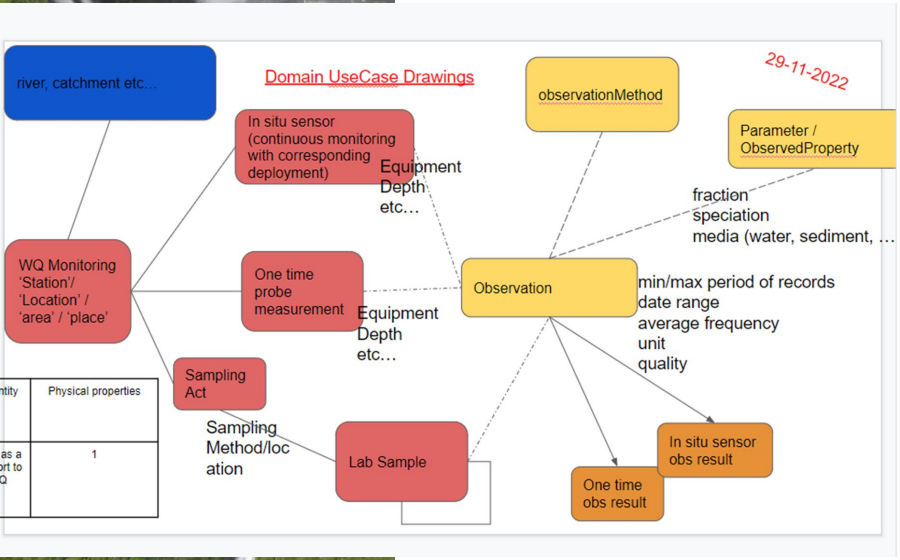
Conceptual Modelling

- Step 3°/ Express domain needs according to the OGC standard baseline

⇒ Almost everything is in, just need to agree on how to use it

⇒ mainly UML “Object diagrams exercise” to document the use of the standards

FROM



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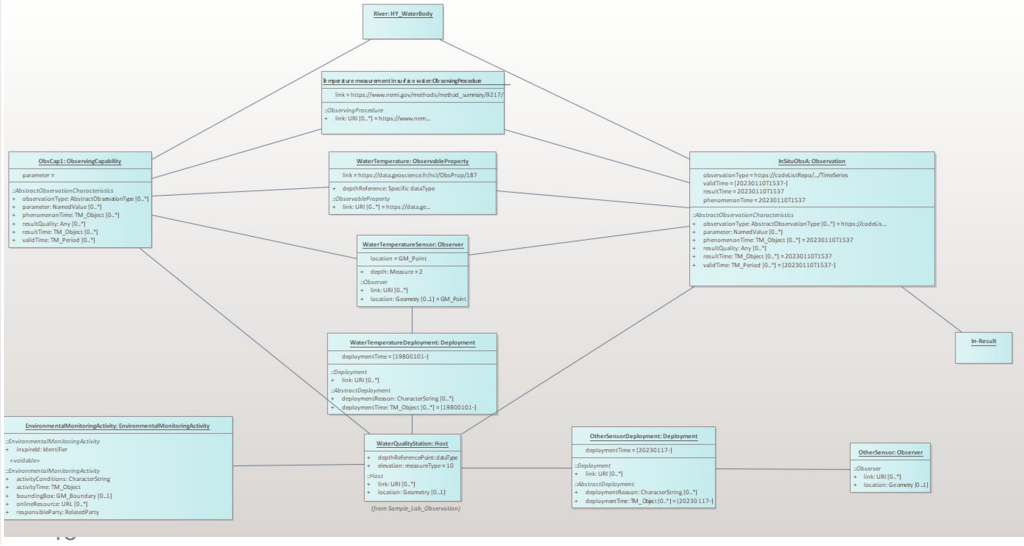
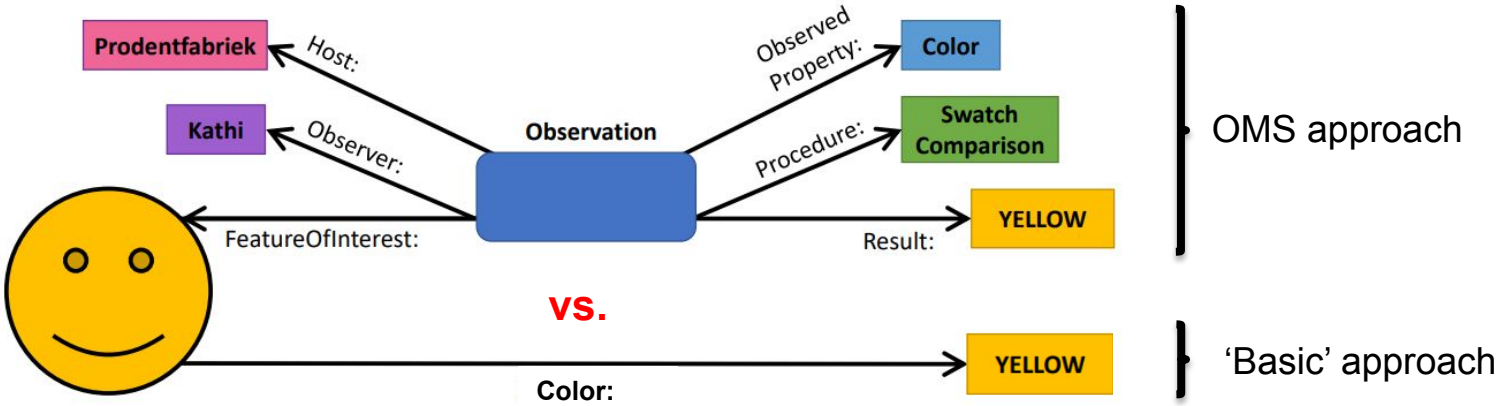


Conceptual Modelling

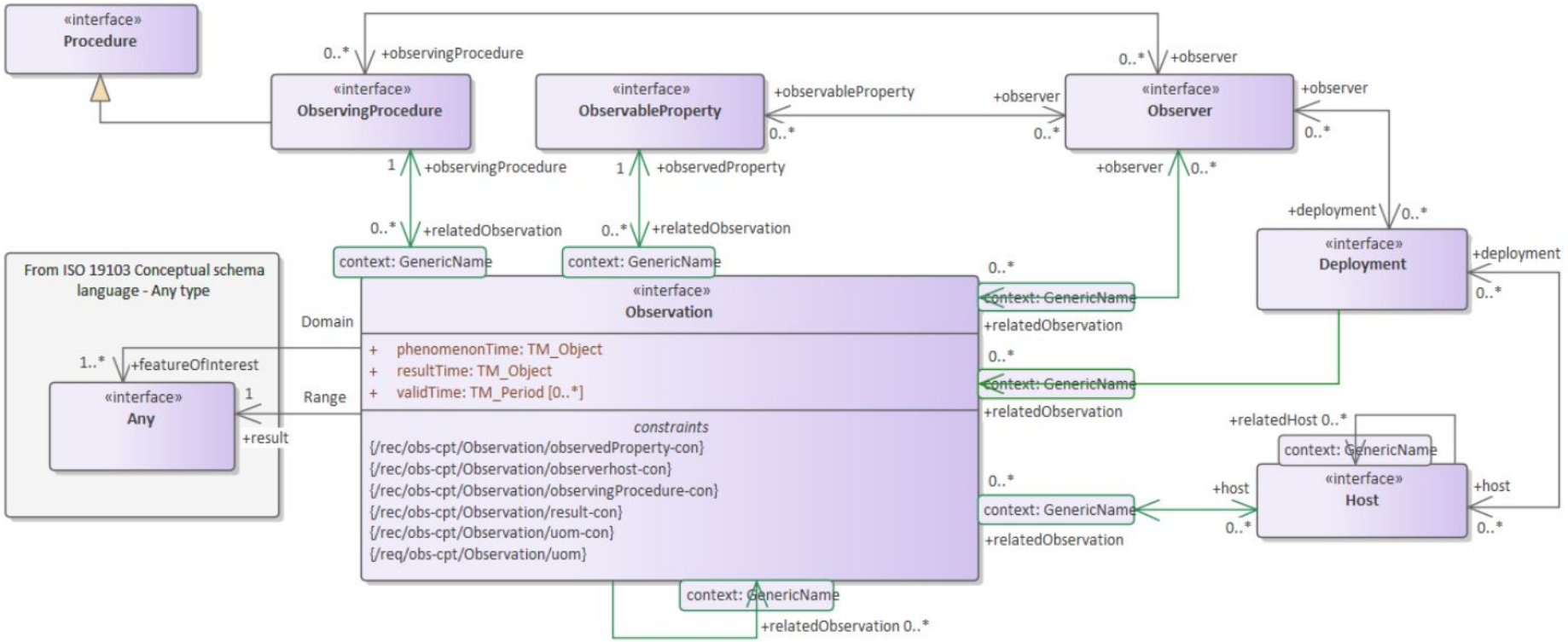
- Backbone to build on: OGC/ISO 19156 (2023) : Observations, measurements and samples (a.k.a OMS)



Credits: Kathi Schleidt, DataCove
https://www.youtube.com/watch?v=bYDSgs2fKLk

Conceptual Modelling

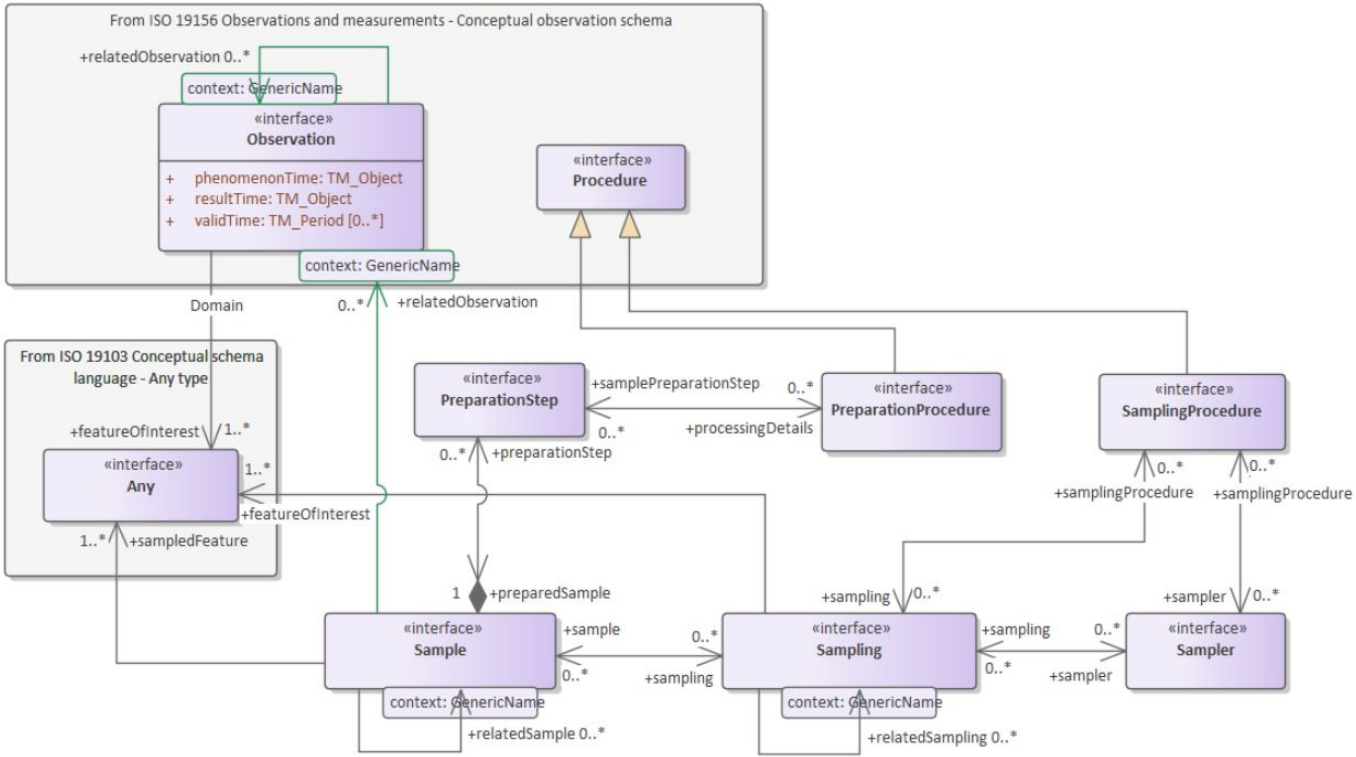
- Backbone to build on: Observations, measurements and samples



Conceptual Observation schema

Conceptual Modelling

- Backbone to build on: Observations, measurements and samples



Conceptual Sample schema

Conceptual Modelling

- Work organised around the identified UseCases

- Everything available online : https://umltool.ogc.org/login.php
  - Follow this path /OGC IEs/ WaterQuality_IE/ WaterQuality_Instance

- Ground Water (GW)
  - GW_InSitu_QuantityObservation
  - GW_InSitu_QualityObservation
  - GW_ExSitu_QualityObservation

- Surface Water (SW)
  - SW_InSitu_QuantityObservation
  - SW_InSitu_QualityObservation
  - SW_ExSitu_QualityObservation

Conceptual Modelling

- 2 modelling patterns
- GW_InSitu_QuantityObservation < > SW_InSitu_QuantityObservation

  GW_InSitu_QualityObservation < > SW_InSitu_QualityObservation

In situ sensor

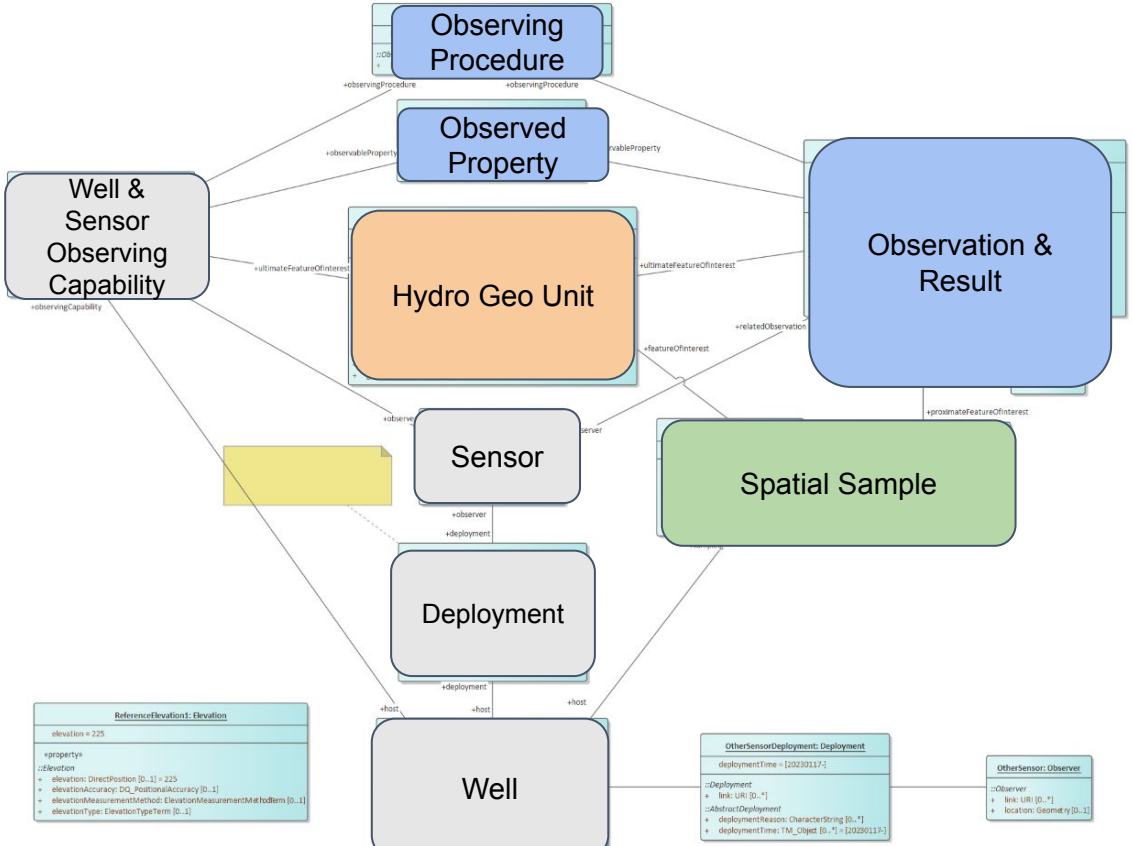
- GW_ExSitu_QualityObservation <> SW_ExSitu_QualityObservation

Ex situ = Laboratory

Conceptual Modelling

In situ sensor

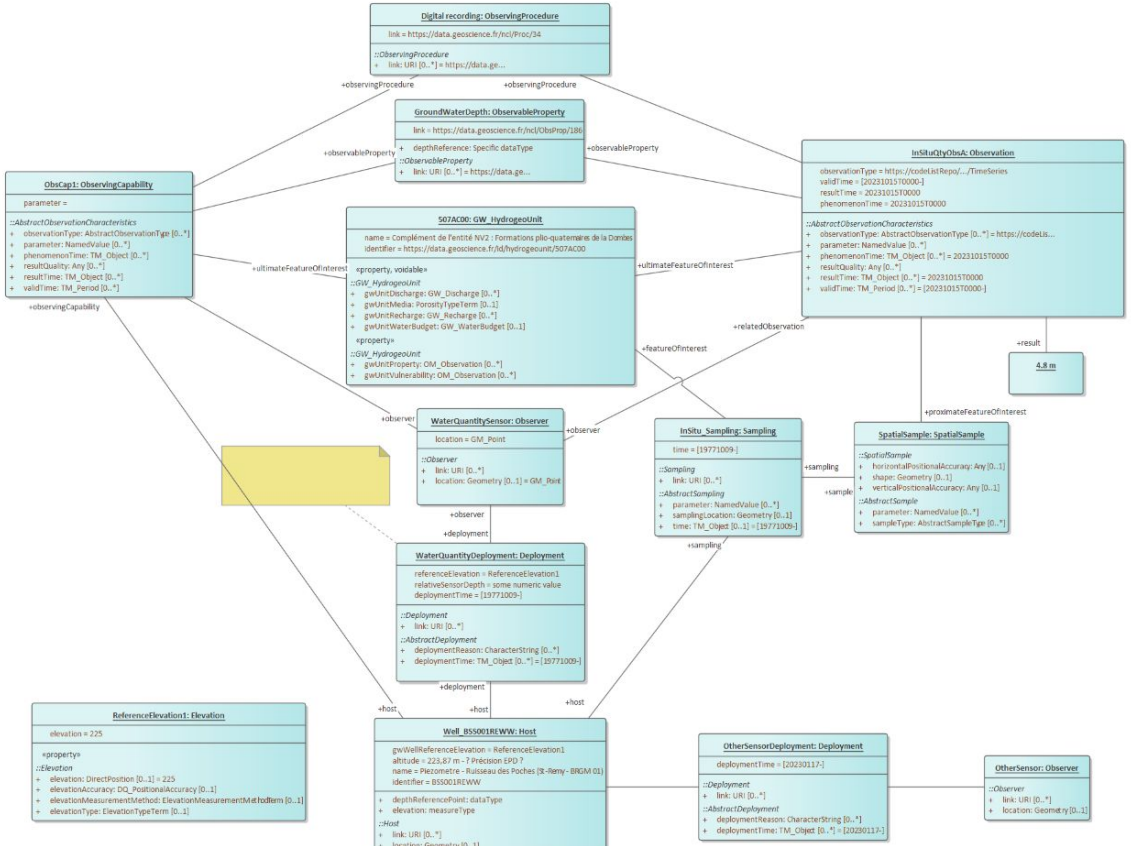
- **GW**_InSitu_**Quantity**Observation (water level)



Conceptual Modelling

In situ sensor

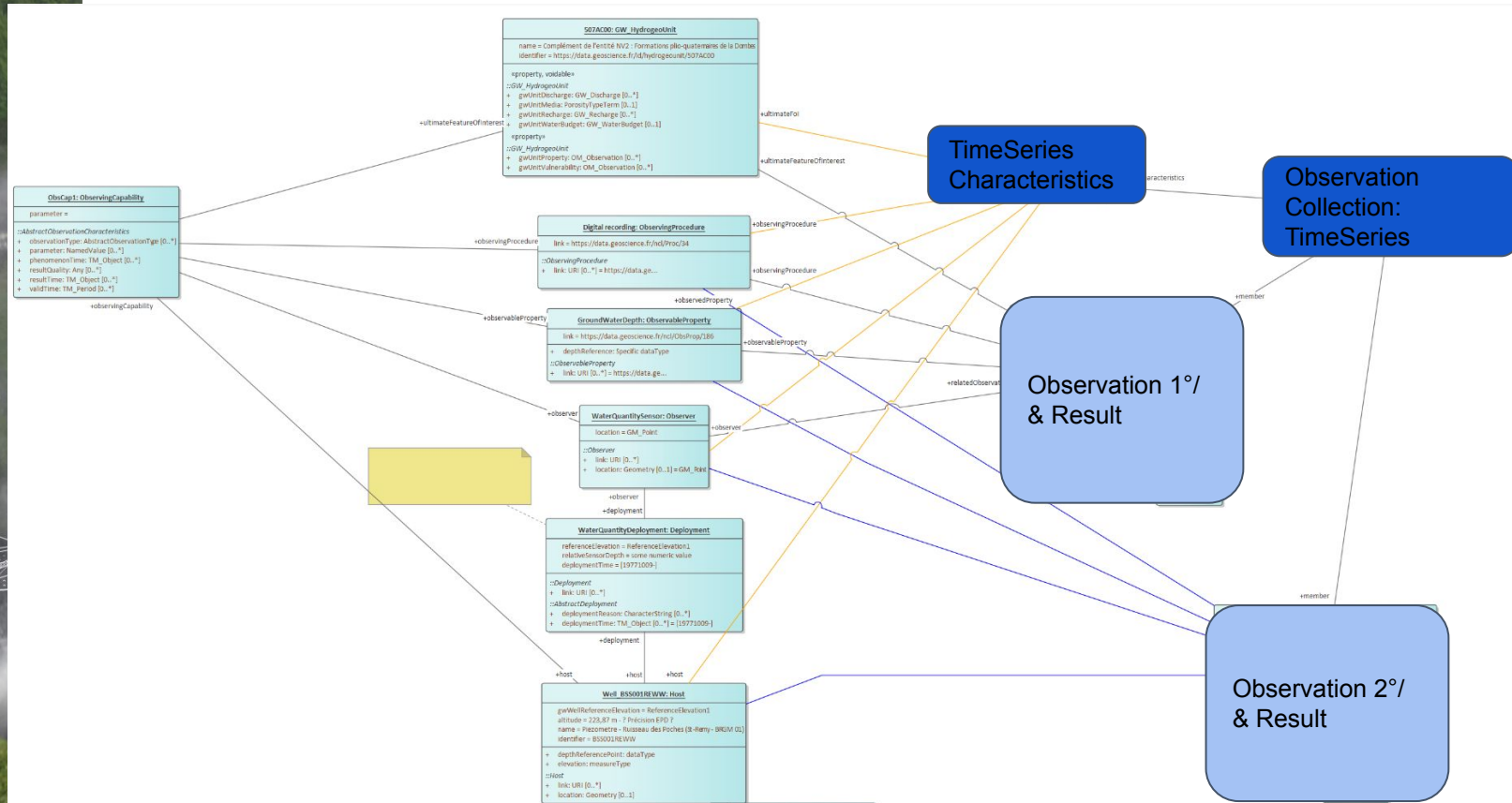
- **GW**_InSitu_**Quantity**Observation (water level)



Conceptual Modelling

In situ sensor

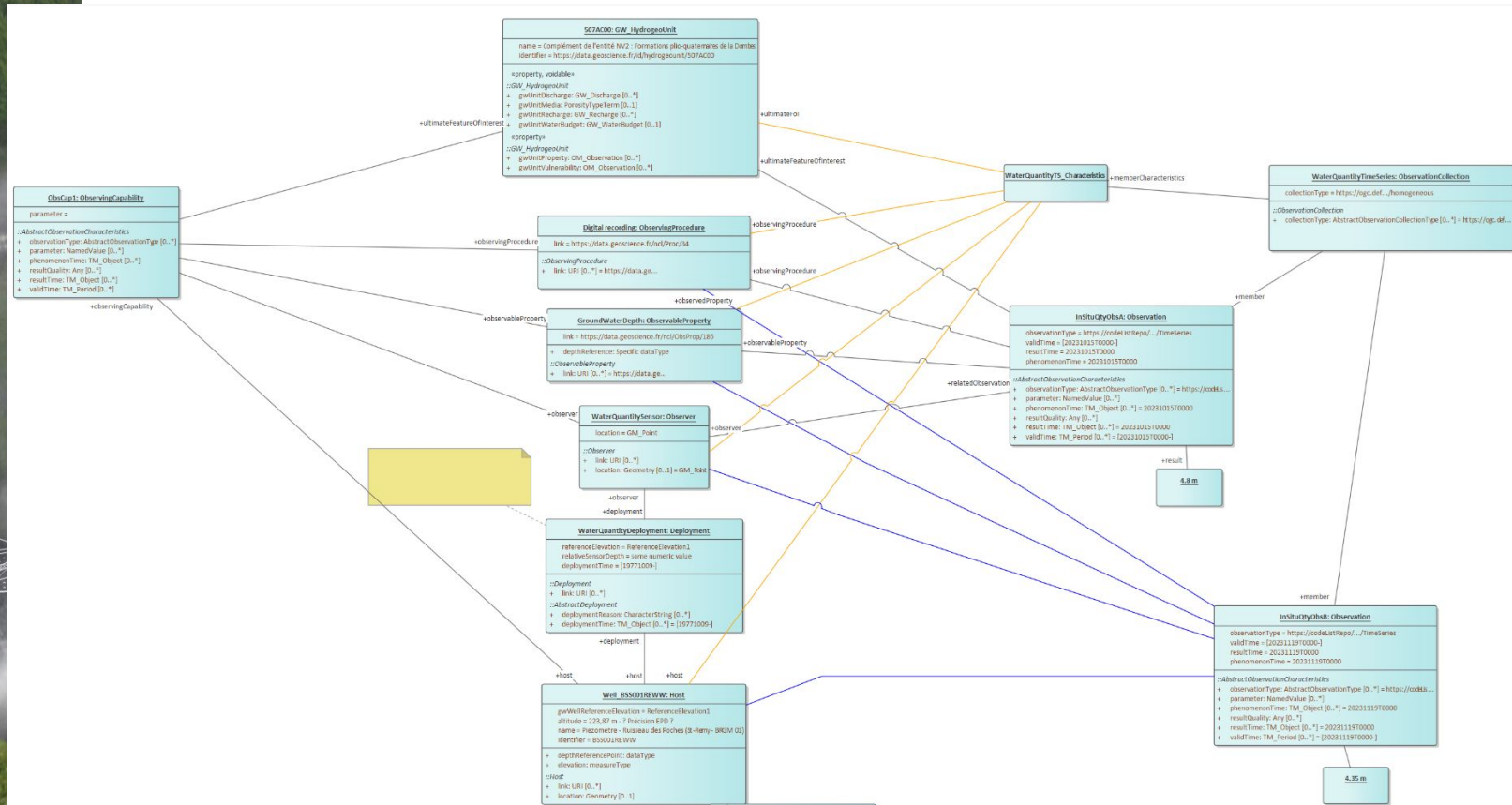
- **GW**_InSitu_**Quantity**Observation (water level)



Conceptual Modelling

In situ sensor

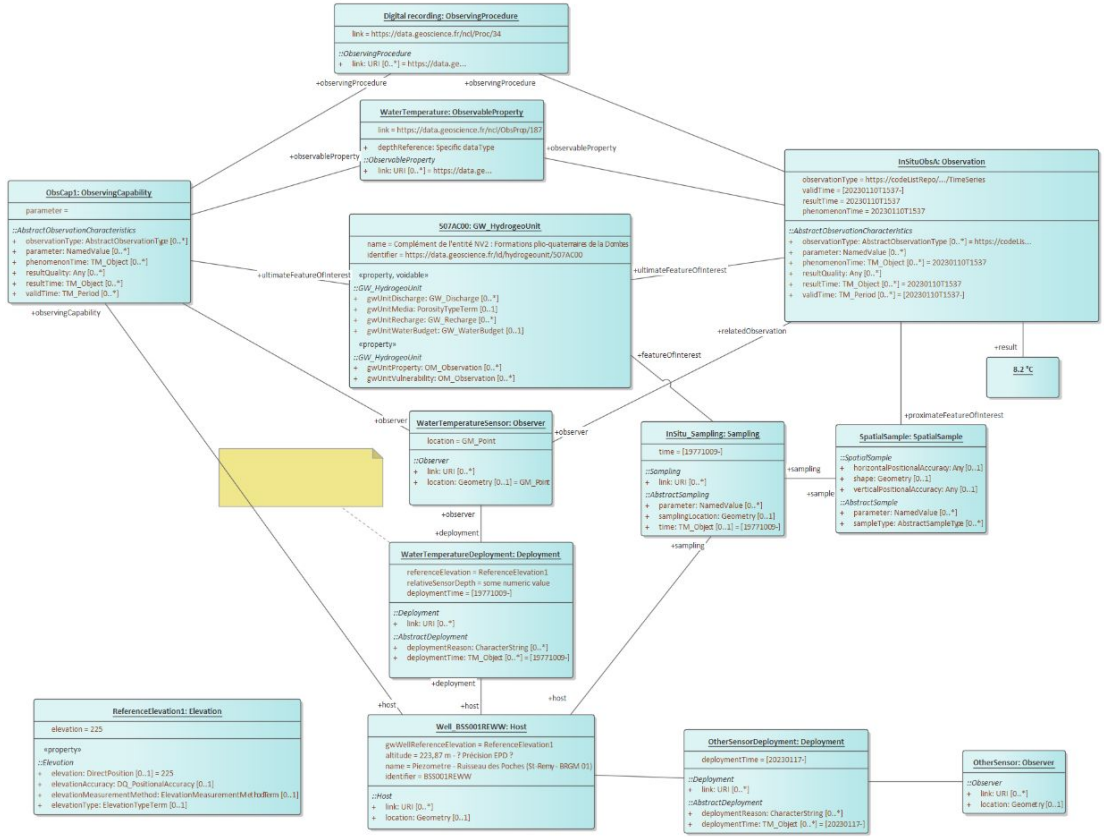
- **GW**_InSitu_**Quantity**Observation (water level)



Conceptual Modelling

In situ sensor

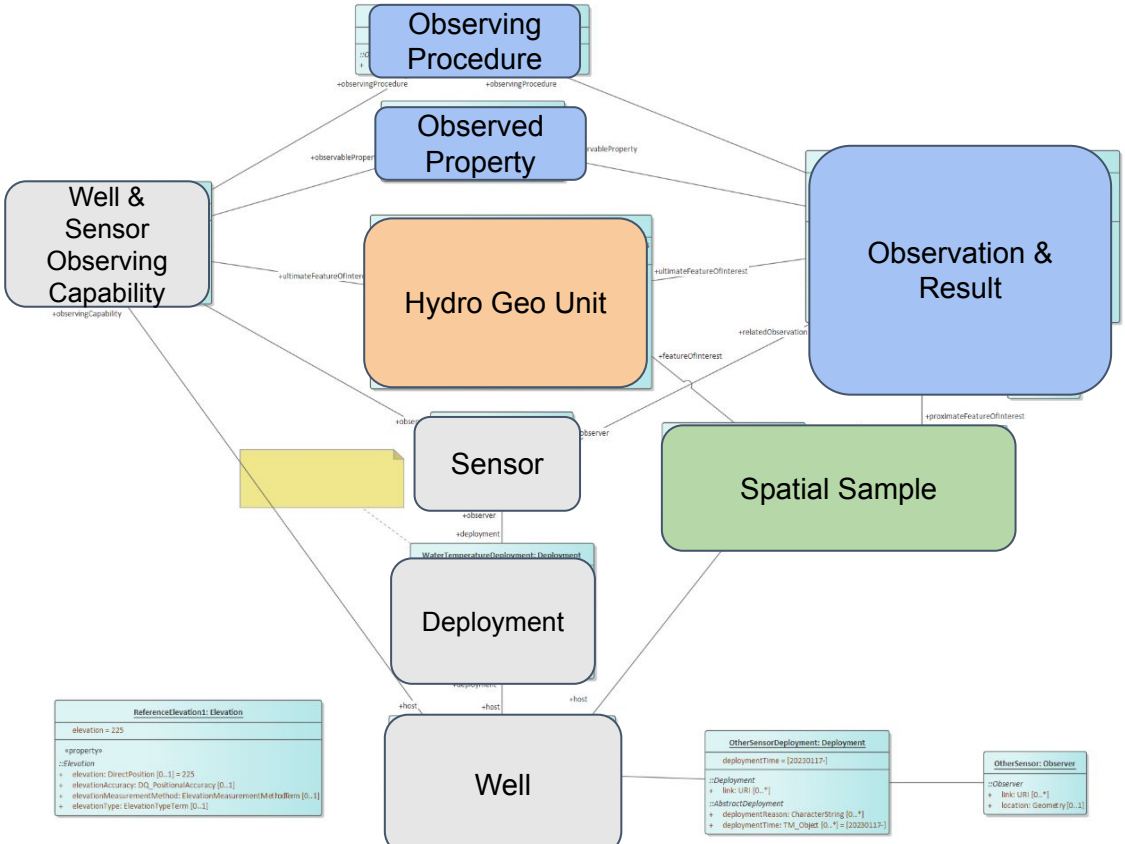
- **GW**_InSitu_**Quality**Observation (temperature) => same pattern



Conceptual Modelling

In situ sensor

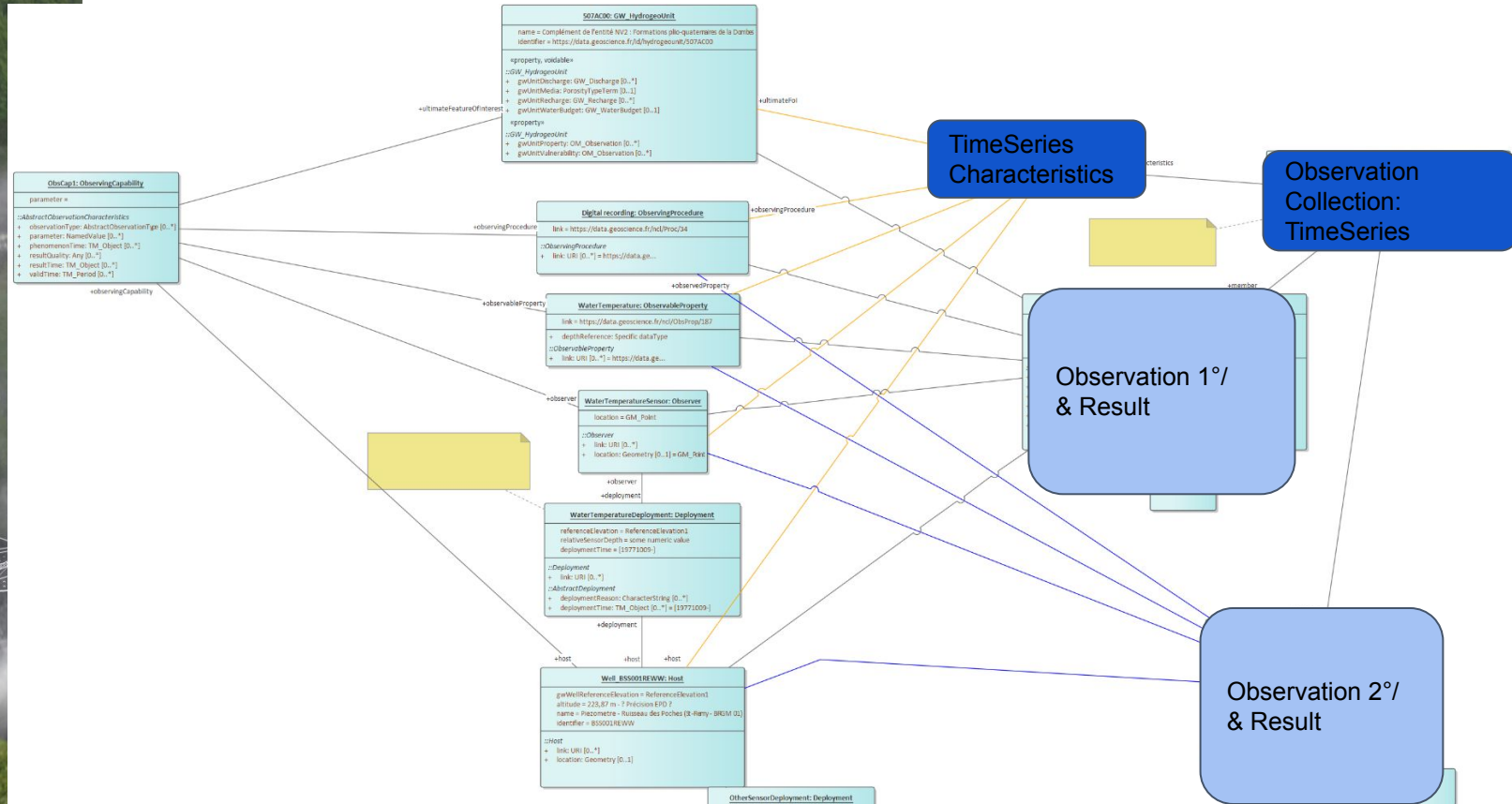
- **GW**_InSitu_**Quality**Observation (temperature) => same pattern



Conceptual Modelling

In situ sensor

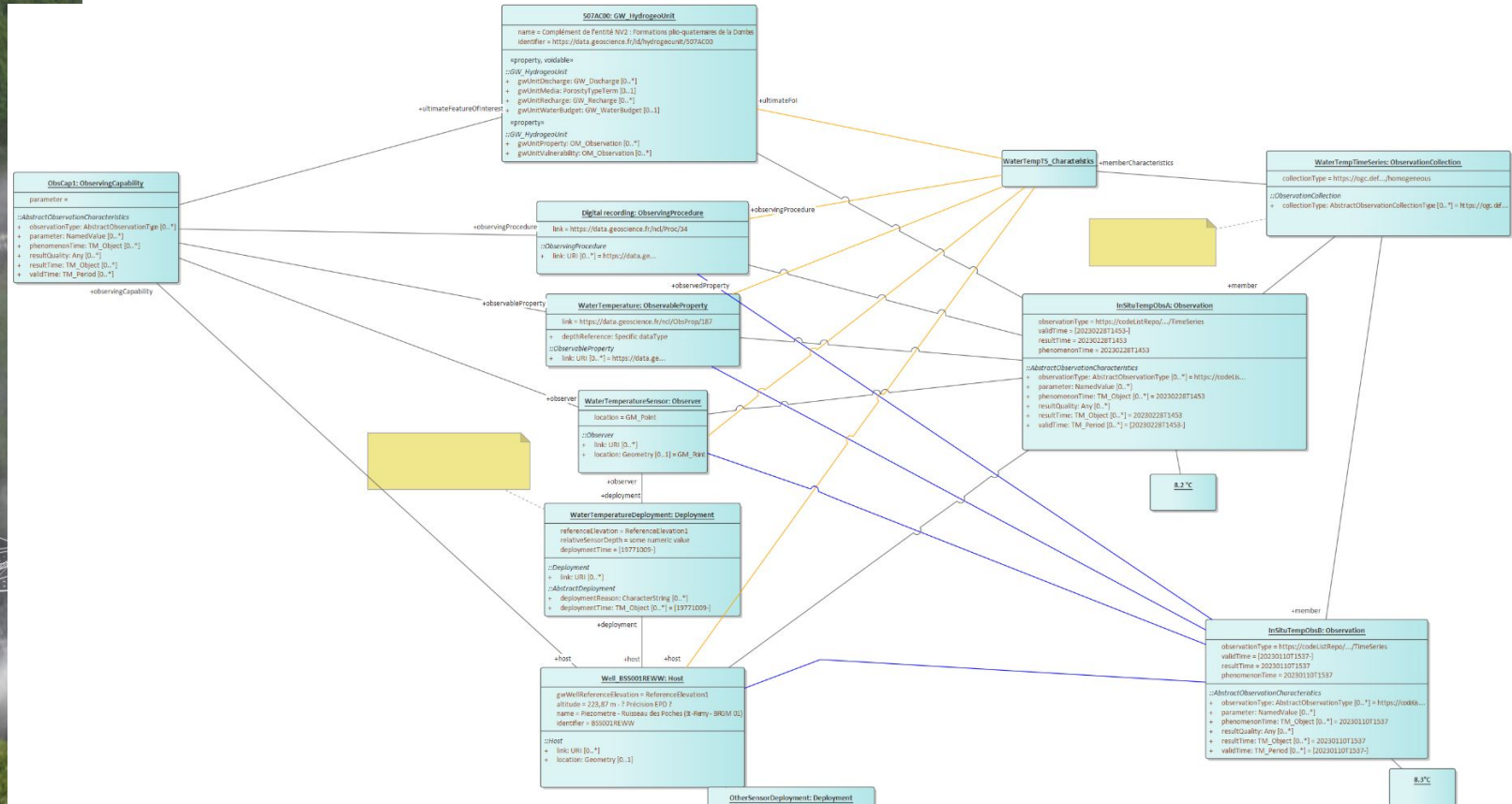
- **GW**_InSitu_**Quality**Observation (temperature) => same pattern



Conceptual Modelling

In situ sensor

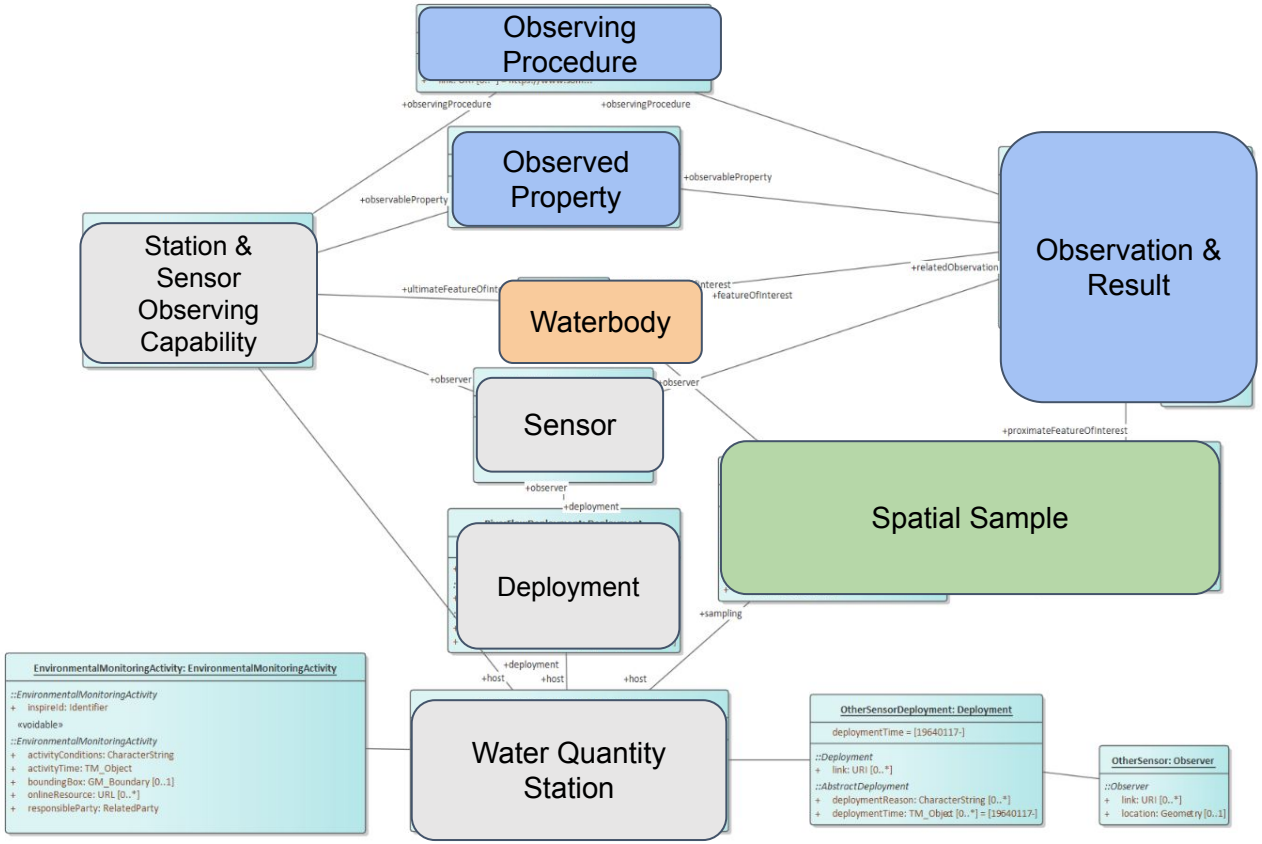
- **GW**_InSitu_**Quality**Observation (temperature) => same pattern



Conceptual Modelling

In situ sensor

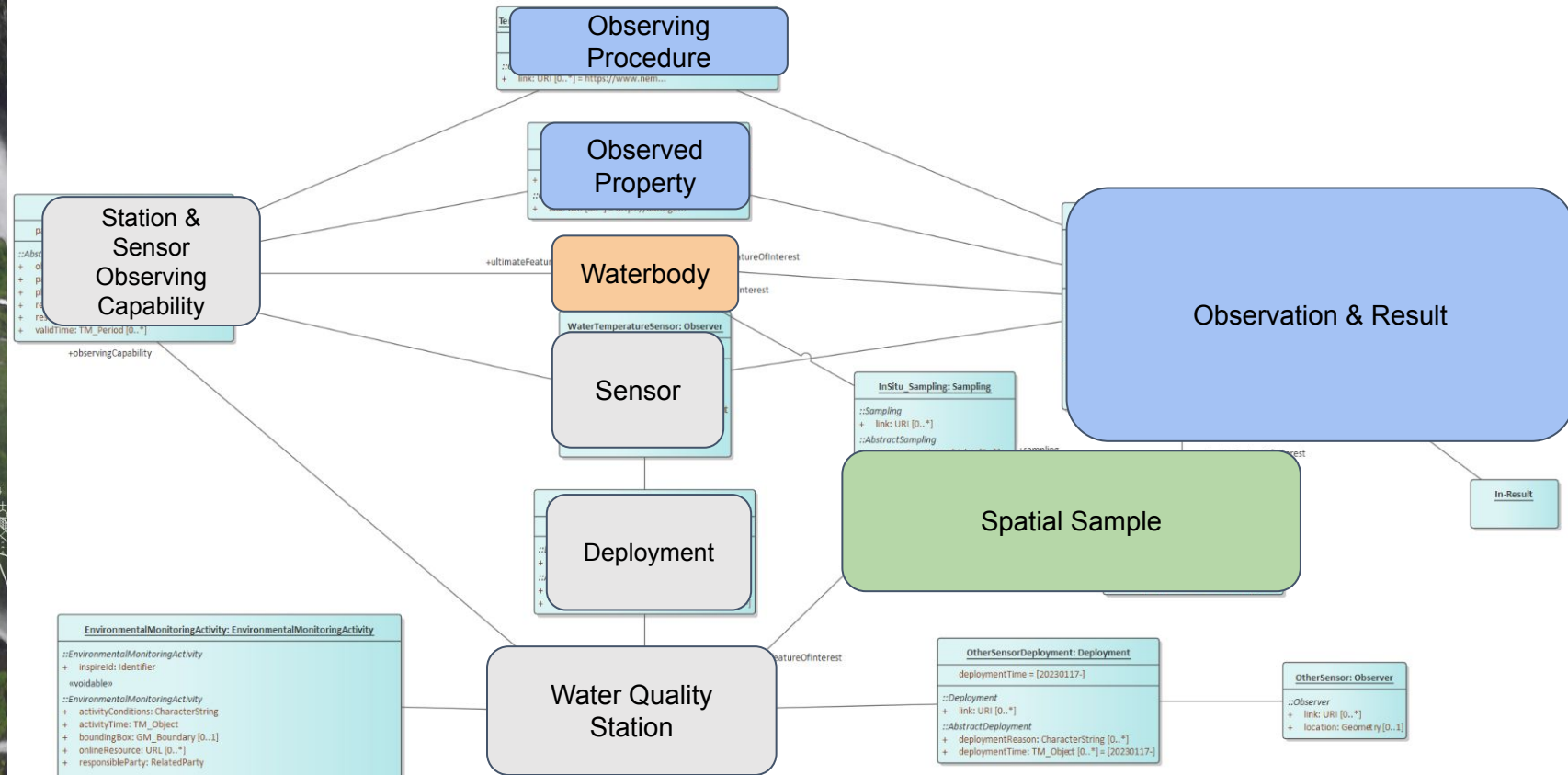
- **SW**_InSitu_**Quantity**Observation (river flow) => same pattern



Conceptual Modelling

In situ sensor

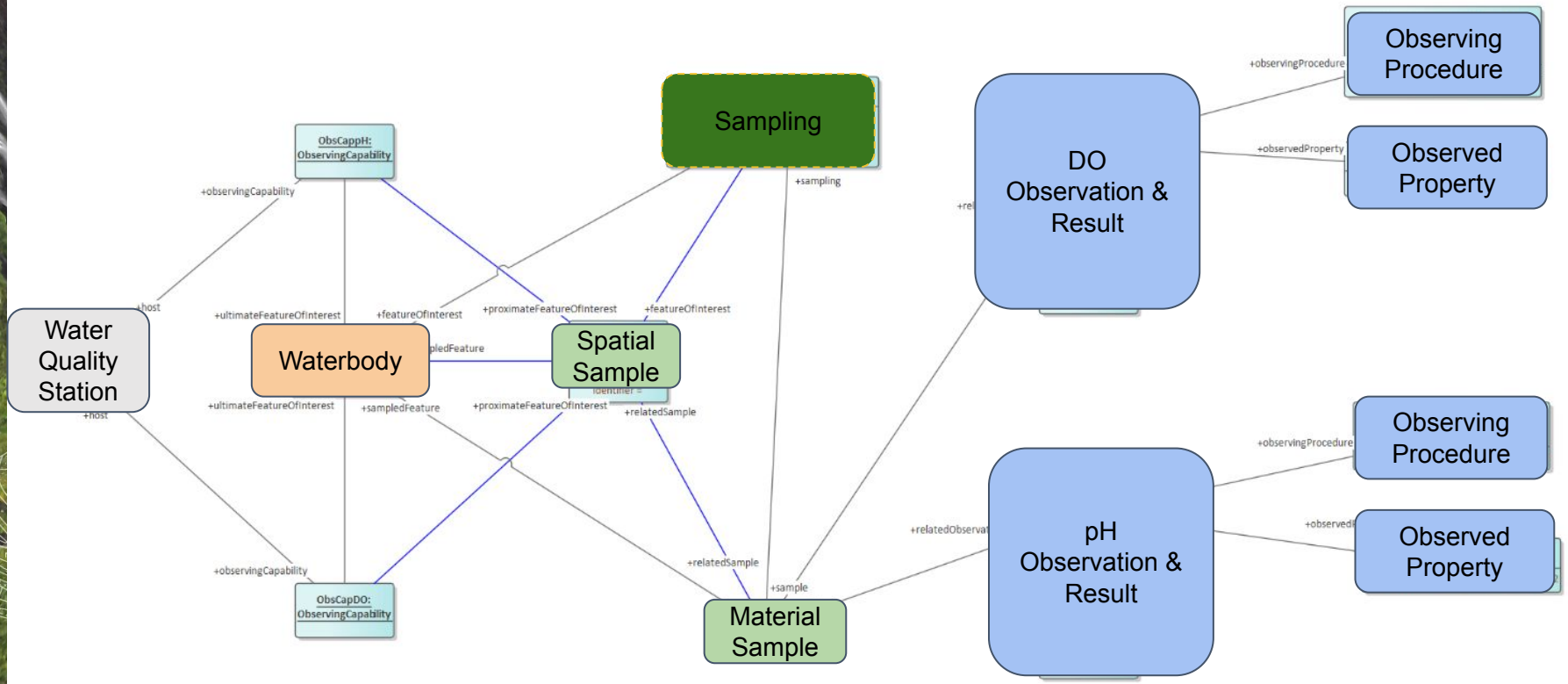
- **SW**_InSitu_**Quality**Observation (temperature, pH) => same pattern



Conceptual Modelling

Ex situ = Lab

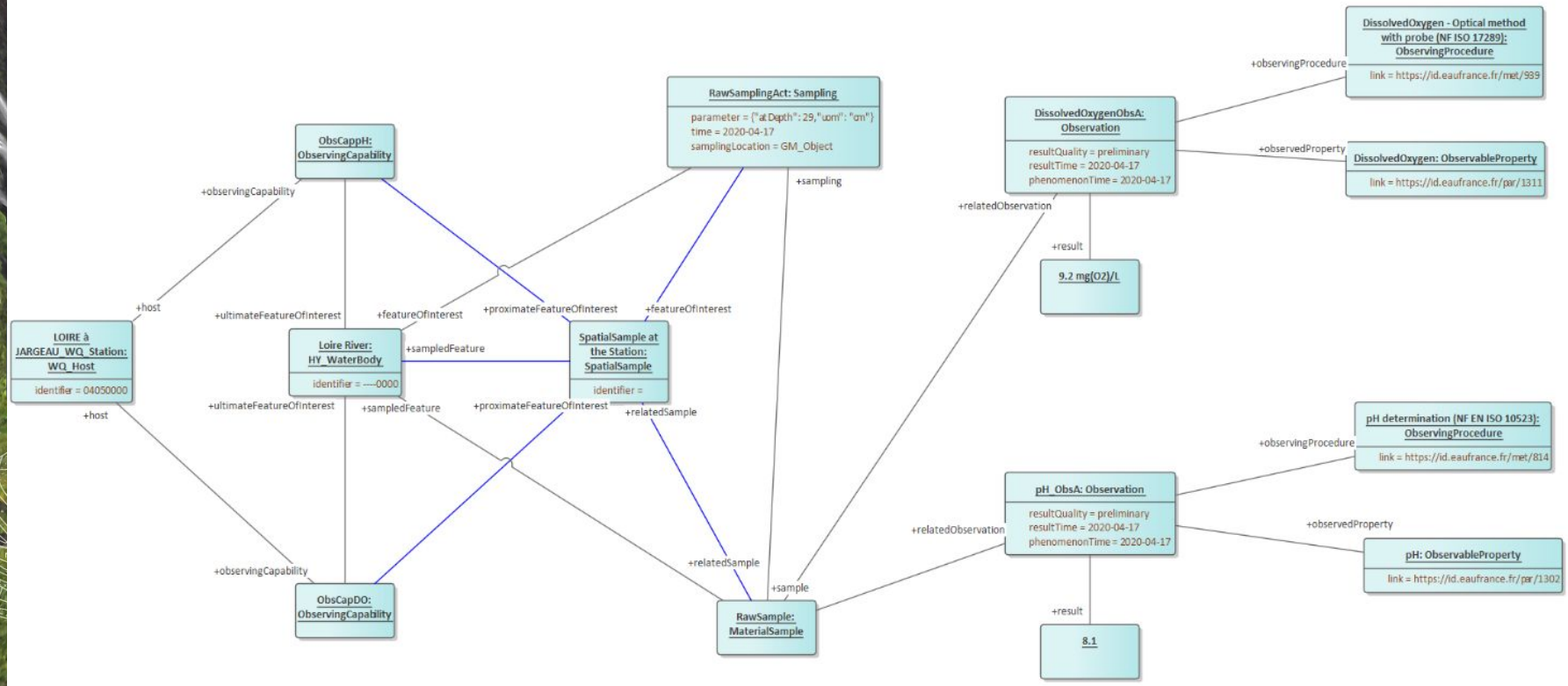
- **SW**_ExSitu_**Quality**Observation (ex : Dissolved Oxygen, pH)



Conceptual Modelling

Ex situ = Lab

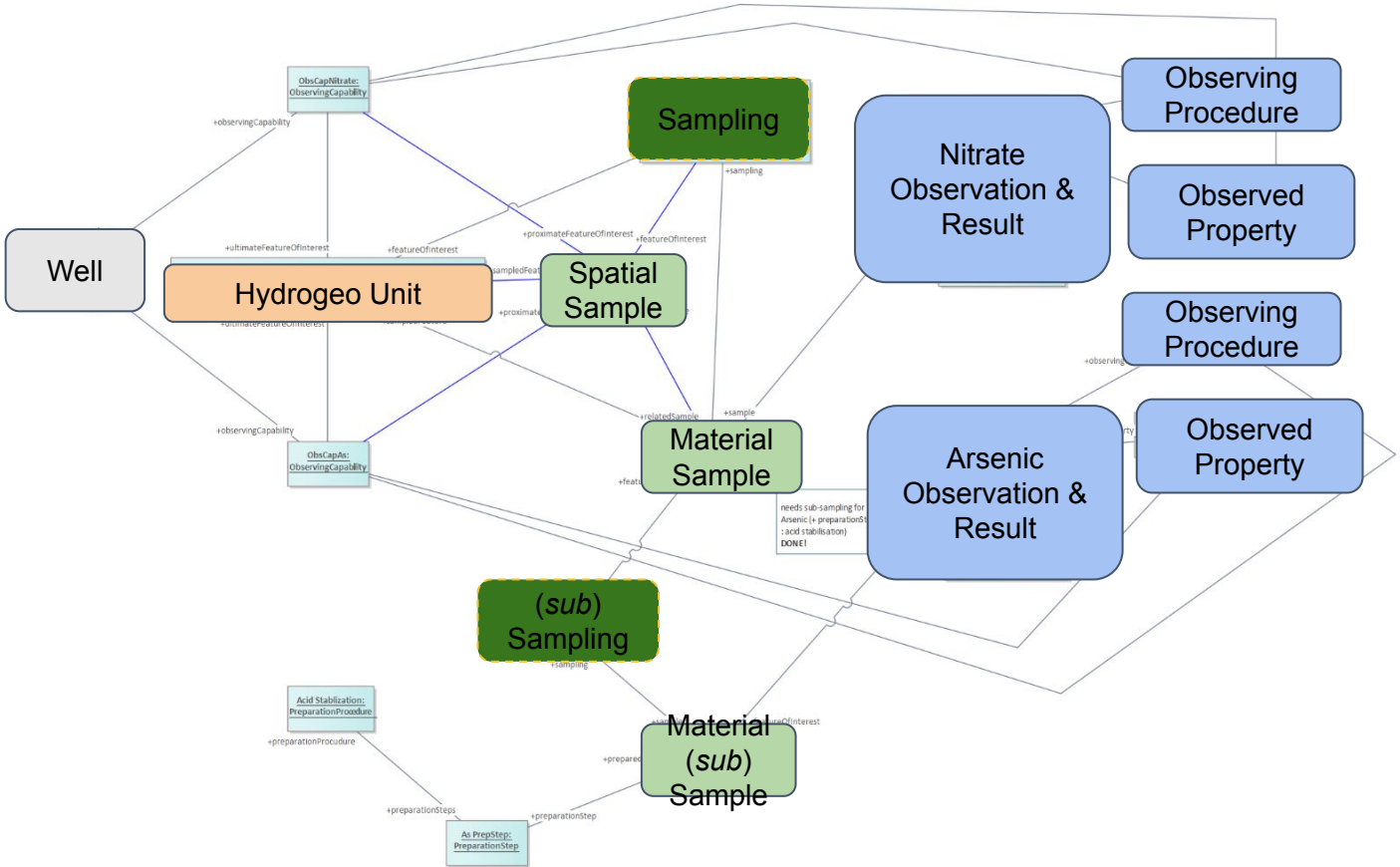
- **SW**_ExSitu_**Quality**Observation (ex : Dissolved Oxygen, pH)



Conceptual Modelling

Ex situ = Lab

- **GW**_ExSitu_**Quality**Observation (ex : Nitrate, Arsenic) => same pattern



Conceptual Modelling

Ex situ = Lab

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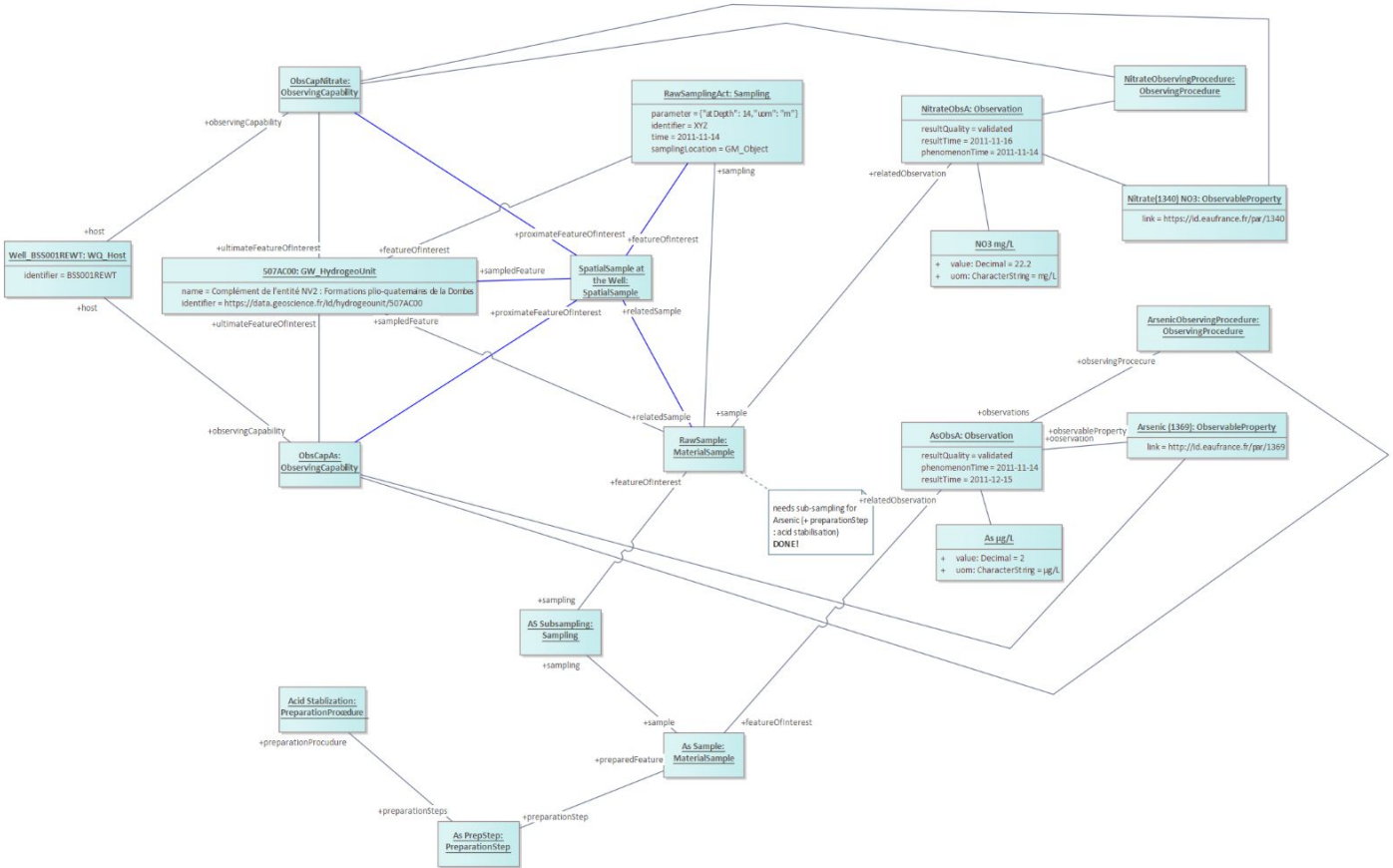
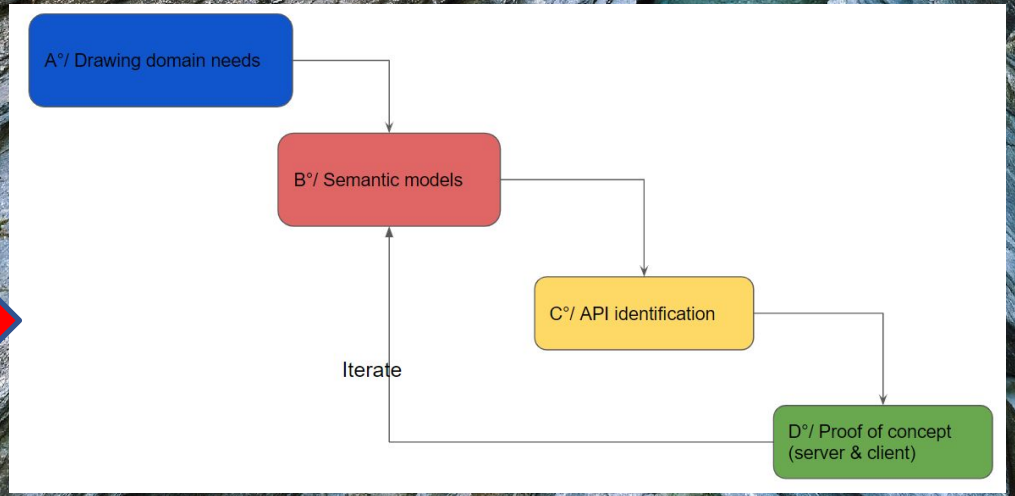


Water Quality IE - how do we want to exchange ?



Which interoperable / FAIR API ?

Available options

1. OGC WFS/API Features :
   - All the identified concepts are Features => could work
   - Not tied to a specific semantic/model and quite limited query mechanism on Observation topics

2. OGC SensorThings API
   - Semantics : Already Observations & Measurements compliant
   - Powerful query mechanism based on OASIS oData

Decision

1. Use OGC SensorThings API for Observation, Samples sharing and also a bit of River, Aquifer, Well information => core of the implementation, work presented here

2. Use OGC WFS / API – Features for pure geospatial features description / Use Cases : River, Aquifer, Well etc…

OGC SensorThings API?

- An OGC standard for exchanging sensor data and metadata
  - Historic data & current data
  - JSON Encoded
  - RESTful
  - Adapting OASIS OData URL patterns and query options
  - Supporting ISO MQTT messaging

- Easy to use & understandable
  - Discoverable with only a web browser

OGC SensorThings API?

Layman's terms

Observation method

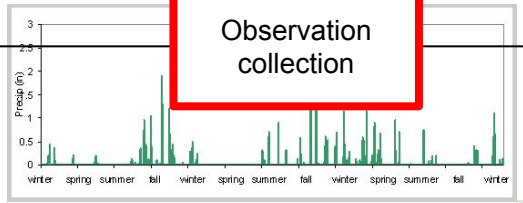
Sensor type
= Rain gauge

Observed property

= rainfall amount

"2021-05-07T09:50:00.000Z":"16

Observation collection



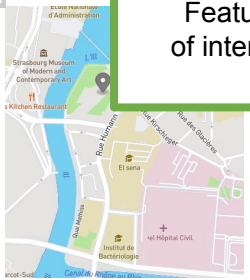
= rainfall time series

Observation

Observer / Sensor / Station

Sensor intance = The Strasbourg meteo station

Feature of interest



= Representative zone around the station

OGC SensorThings API?

Terms from the standard

Sensor

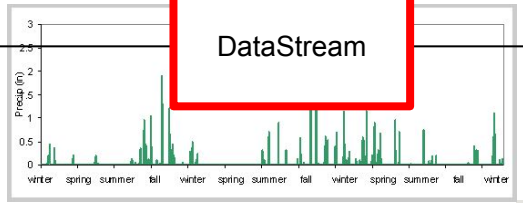
Sensor type
= Rain gauge

Observed property

= rainfall amount

"2021-05-07T09:50:00.000Z":"16

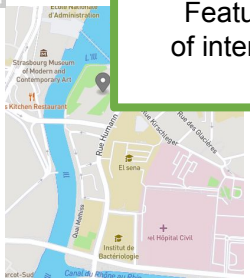
DataStream



= rainfall time series

Observation

Feature of interest



= Representative zone around the station

Sensor intance = The Strasbourg meteo station

Thing

Historical location

Location

SensorThings API 1.1 – Data Model

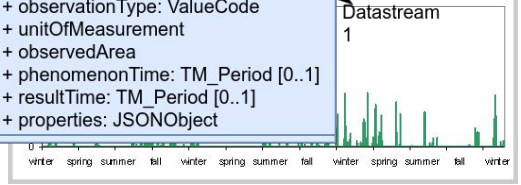
Sensor
+ id: <<idType>>
+ name: String
+ description: String
+ properties: JSONObject
+ encodingType: String
+ metadata: <<any>>

ObservedProperty
+ id: <<idType>>
+ name: String
+ definition: URI
+ description: String
+ properties: JSONObject

ObservedProperty 1
Datastreams 0..*
Sensor 1
Datastreams 0..*

Datastream
+ id: <<idType>>
+ name: String
+ description: String
+ observationType: ValueCode
+ unitOfMeasurement
+ observedArea
+ phenomenonTime: TM_Period [0..1]
+ resultTime: TM_Period [0..1]
+ properties: JSONObject

Observations 0..*
Datastream 1



Observation
+ id: <<idType>>
+ result: <<any>>
+ phenomenonTime: TM_Object
+ resultTime: TM_Instant [0..1]
+ validTime: TM_Period [0..1]
+ resultQuality: DQ_Element [0..1]
+ parameters: JSONObject

Thing 1
Datastreams 0..*

Thing
+ id: <<idType>>
+ name: String
+ description: String
+ properties: JSONObject

Observations 0..*
FeatureOfInterest 1
Thing 1
HistoricalLocations 0..*
0..* Things
Locations 0..*

HistoricalLocation
+ id: <<idType>>
+ time: TM_Instant

Location
+ id: <<idType>>
+ name: String
+ description: String
+ properties: JSONObject
+ encodingType: String
+ location: <<any>>

HistoricalLocations 0..*
Locations 1..*

FeatureOfInterest
+ id: <<idType>>
+ name: String
+ description: String
+ properties: JSONObject
+ encodingType: String
+ feature: <<any>>

SensorThings live demo

- https://airquality-frost.k8s.ilt-dmz.iosb.fraunhofer.de/v1.1
  ~760 000 000 Observations
  ~21 000 Datastreams
  ~5 000 Stations

- Docker Quick-Start:
  https://fraunhoferiosb.github.io/FROST-Server/deployment/docker.html

- Full SensorThings API Tutorial
  https://fraunhoferiosb.github.io/FROST-Server/sensorthingsapi/1_Home.html

SensorThings API 1.1 – API

HTTP:

	GET	POST	PATCH	DELETE
v1.1	Get index			
v1.1/Type	Get all of type	Create		
v1.1/Type(id)	Get one of type		Update	Delete
v1.1/Type(id)/Entity	Get linked entity			
v1.1/Type(id)/EntitySet	Get all linked	Create Linked		

MQTT:

1. Subscribe
   - v1.1/Things
   - v1.1/Datastreams(x)
   - v1.1/Datastreams(x)/Observations
   - etc.
2. Get Notified

- Fully Explorable with just a browser
- Composable Responses
- Powerful filtering

https://datacoveeu.github.io/API4INSPIRE/sensorthingsapi/1_Home.html

Fancy Queries

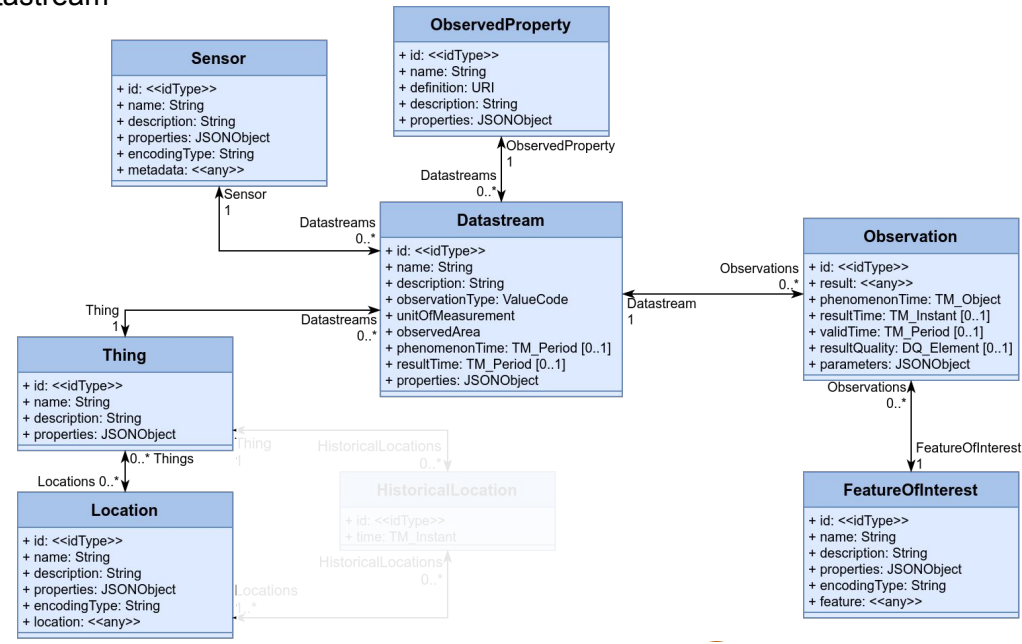
All data for a map:

```
v1.1/Things?
    $select=id,name,description,properties&
    $top=10&
    $filter=properties/countryCode eq 'HR'&
    $expand=
     Locations($select=location),
     Datastreams(
          $select=id,name,unitOfMeasurement;
          $expand=
          ObservedProperty($select=name),
          Observations(
               $select=result,phenomenonTime;
               $orderby=phenomenonTime desc;
               $top=1)
     )
```

Link

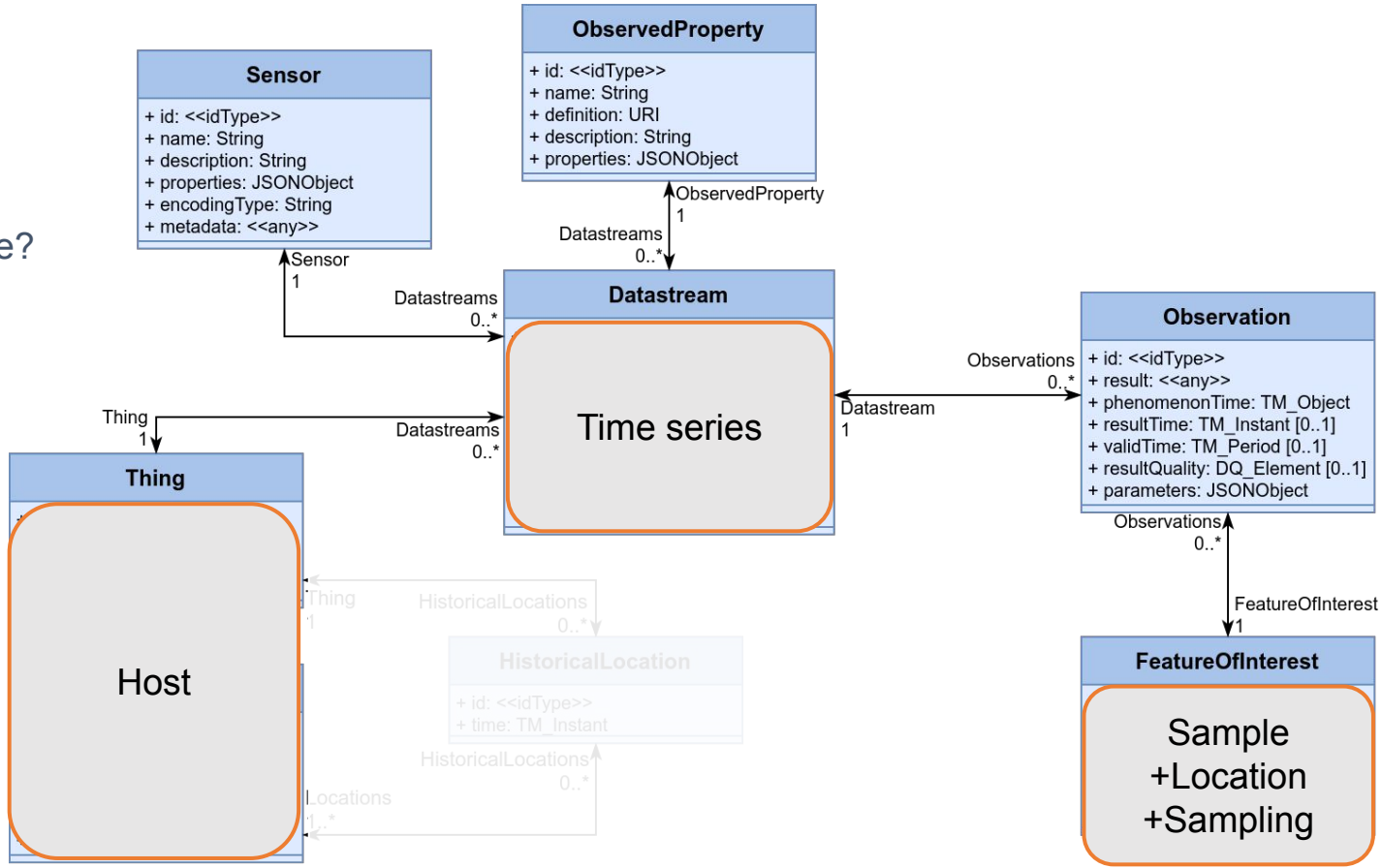
Physical model → Mapping to OGC SensorThings API

1. Map matching concepts
   - Monitoring Facility → Thing + Location
   - Observed Property → ObservedProperty
   - Observation Collection → Datastream
   - Observation → Observation
   - Observer → Sensor
   - Sample → FeatureOfInterest
2. Add missing Classes
   - SampledFeature (River)?
   - Deployment?
   - Sampler?
   - ObservingProcedure?



SensorThings API 1.1 – Water Quality

- River? (SampledFeature)
- Deployment?
- Sampler?
- ObservingProcedure?

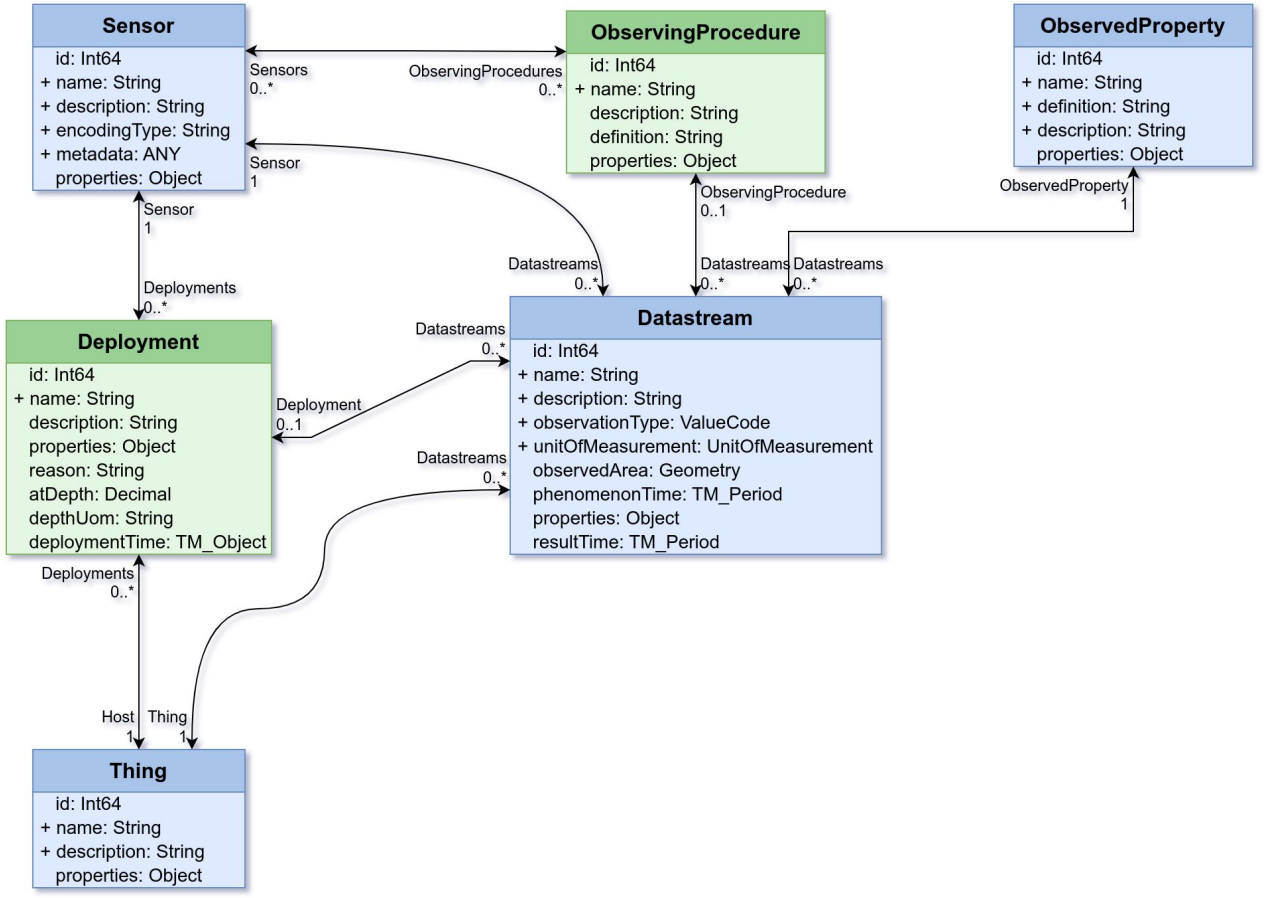


STA 1.1 WQ-IE – Sensor Extensions

Extending the Sensor

+ Deployment
+ ObservingProcedure

OMS addition

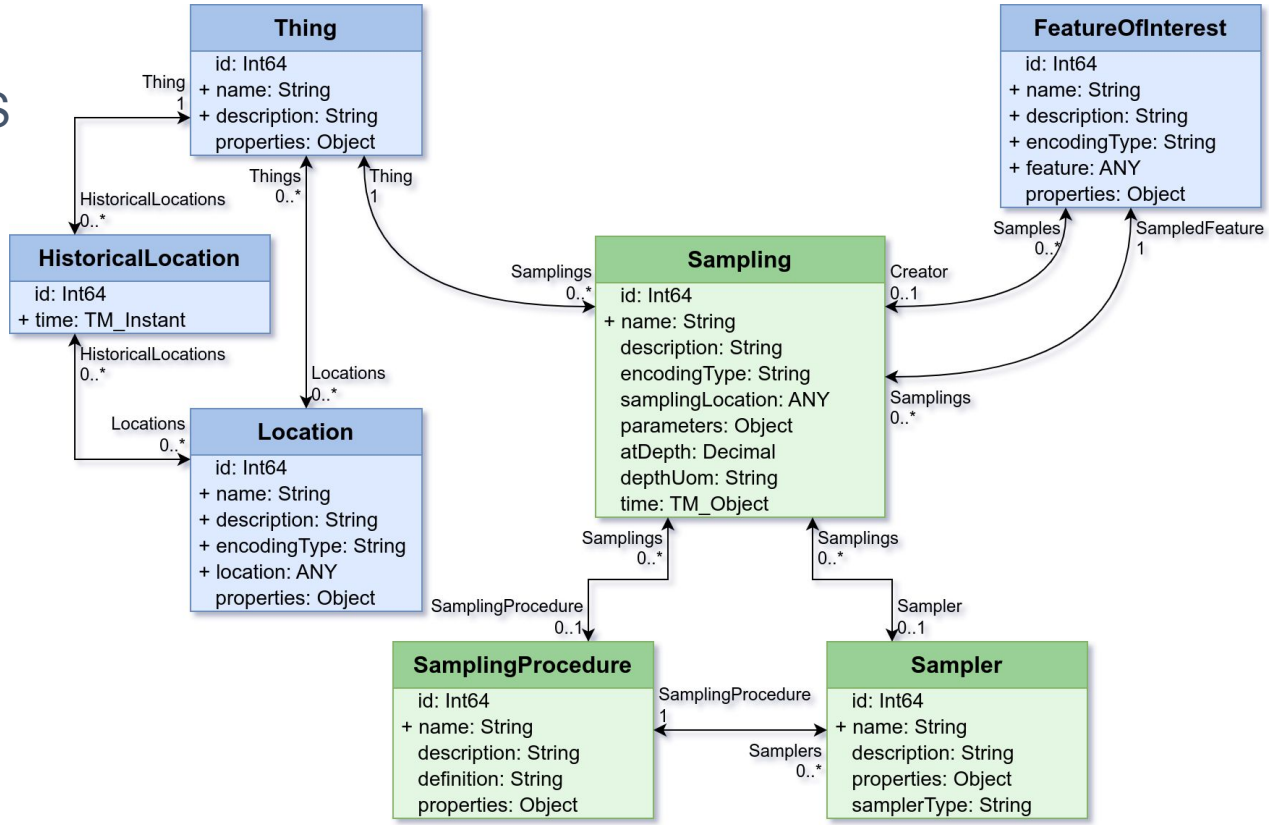


STA 1.1 WQ-IE – Sampling

Adding Sampling from OMS

- \+ Sampling
- \+ Sampler
- \+ SamplingProcedure

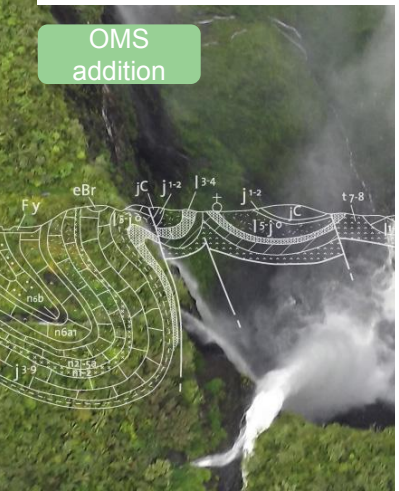
OMS addition

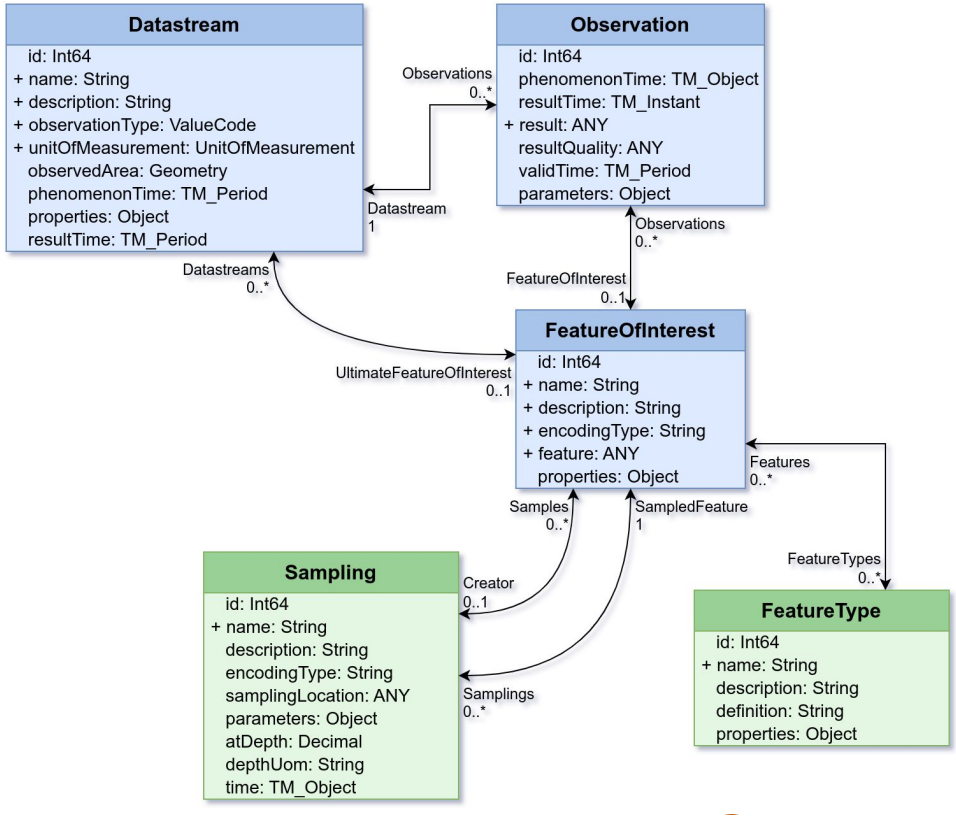


STA 1.1 WQ-IE – Features

Adding the River as Feature and linking a time series

- \+ FeatureType
- \+ Datastream → UltimateFeatureOfInterest





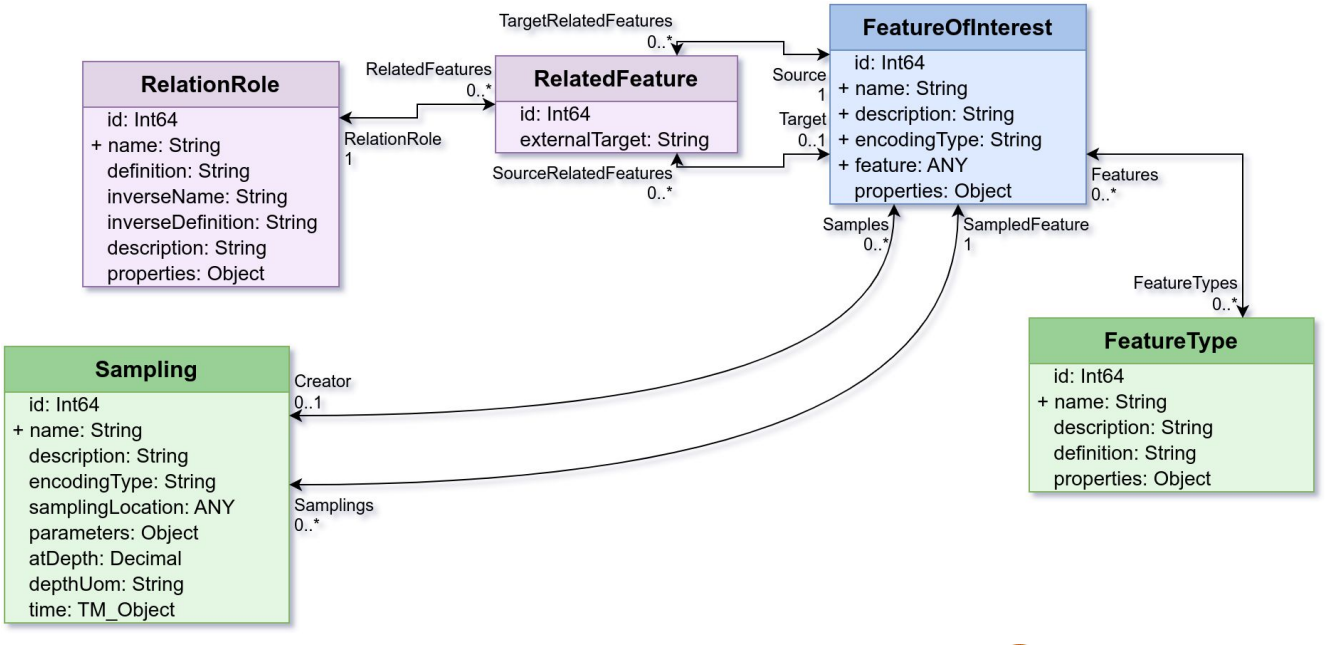
STA 1.1 WQ-IE – Relations

Relating Features to other Features

+ RelatedFeature
+ RelationRole

The same for:

+ RelatedThing
+ RelatedDatastream
+ RelatedObservation



STA 1.1 WQ-IE

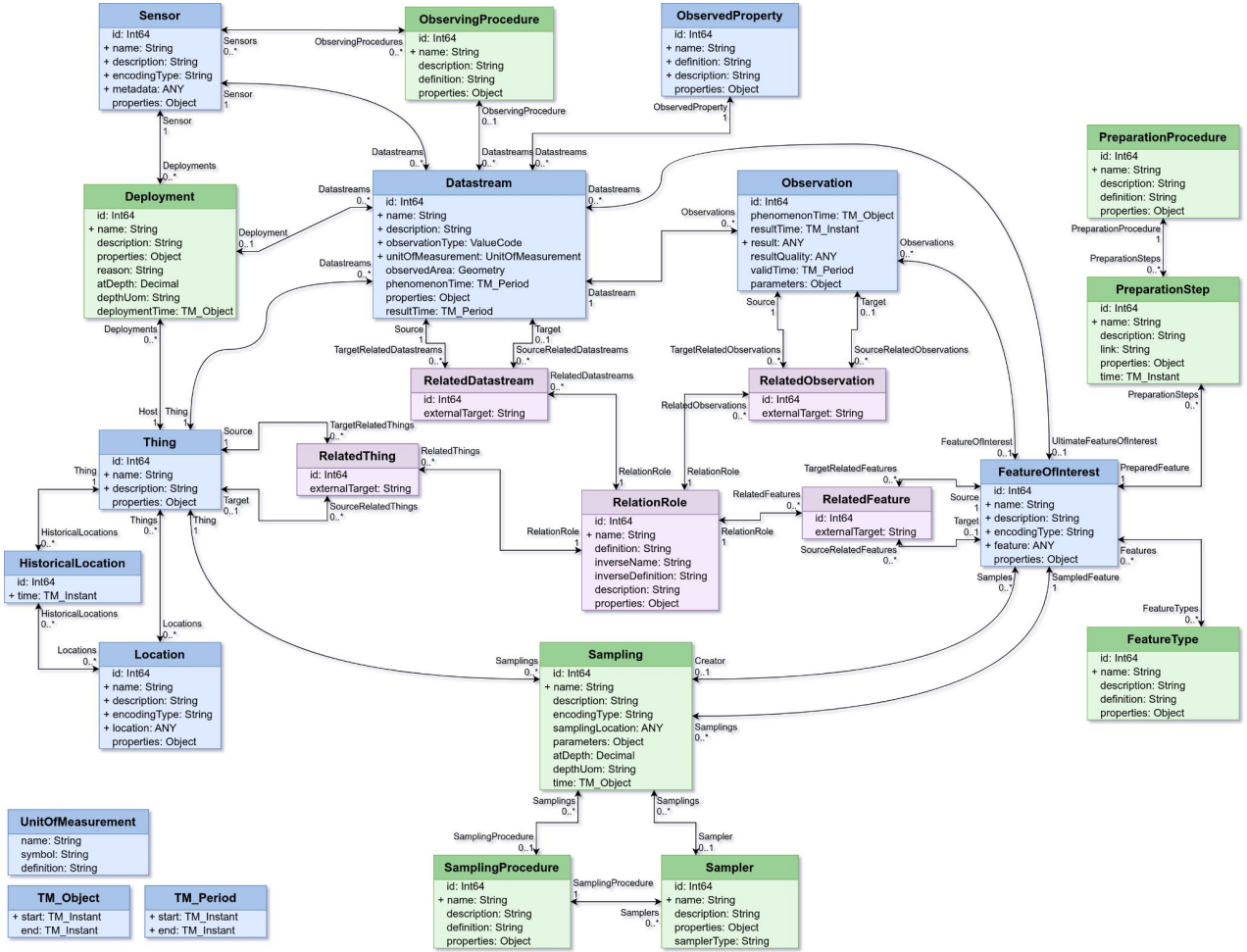
Full data model

- Still v1.1 compatible
- Paving the way to STA 2.0

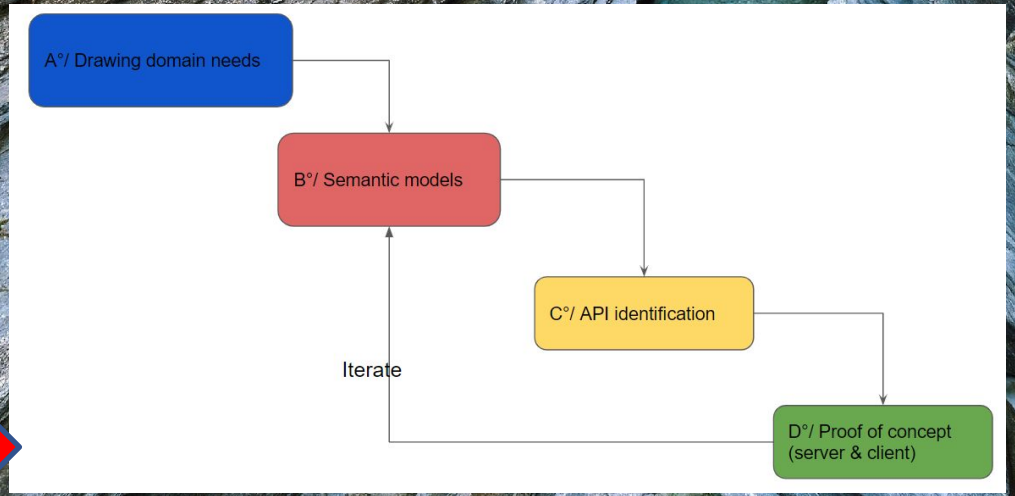
STA 1.1

OMS addition

Relation extension



Water Quality IE - lets try and see how this works !



Implementation

- Who
  - Water Quality IE members USGS, USEPA, DataStream (Canada), BRGM, BaFG (Unesco Gems water), Fraunhofer
  - EU Water4All project partners
    - Ex : Danish DEP, ISPRA, Fraunhofer, VITO etc…
  - EU GSEU project partners
    - Many EU geological surveys

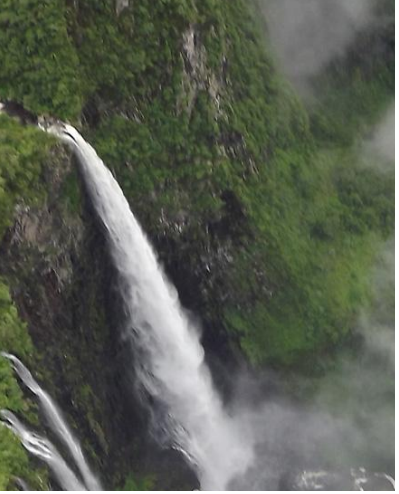
- What
  - FROST Data Model Plugin https://github.com/hylkevds/FROST-Server.Plugin.WaterQualityIE
  - Docker Image https://hub.docker.com/r/hylkevds/frost-http-waterquality

Implementation

- How to get a quick demo
  - Quick Demo Service:
    https://ogc-demo.k8s.ilt-dmz.iosb.fraunhofer.de/FROST-WaterQuality/v1.1
  - Docker
    - Fetch Docker-Compose file
      wget https://raw.githubusercontent.com/hylkevds/FROST-Server.Plugin.WaterQualityIE/main/scripts/docker-compose.yaml
    - Start FROST
      docker-compose up
    - Fetch demo data
      wget https://raw.githubusercontent.com/hylkevds/FROST-Server.Plugin.WaterQualityIE/main/scripts/BatchSTA-WQ-IE.json
    - Load demo data
      curl -X POST -H "Content-Type: application/json" -d @BatchSTA-WQ-IE.json http://localhost:8080/FROST-Server/v1.1/$batch
    - Browse to http://localhost:8080/FROST-Server/v1.1
- Longer Documentation:
  https://docs.google.com/document/d/1Oqjxrz8uY_Q9OKBwEM2ZufrCEnlYvA4vWIIJSiMyGT4/edit

Implementation

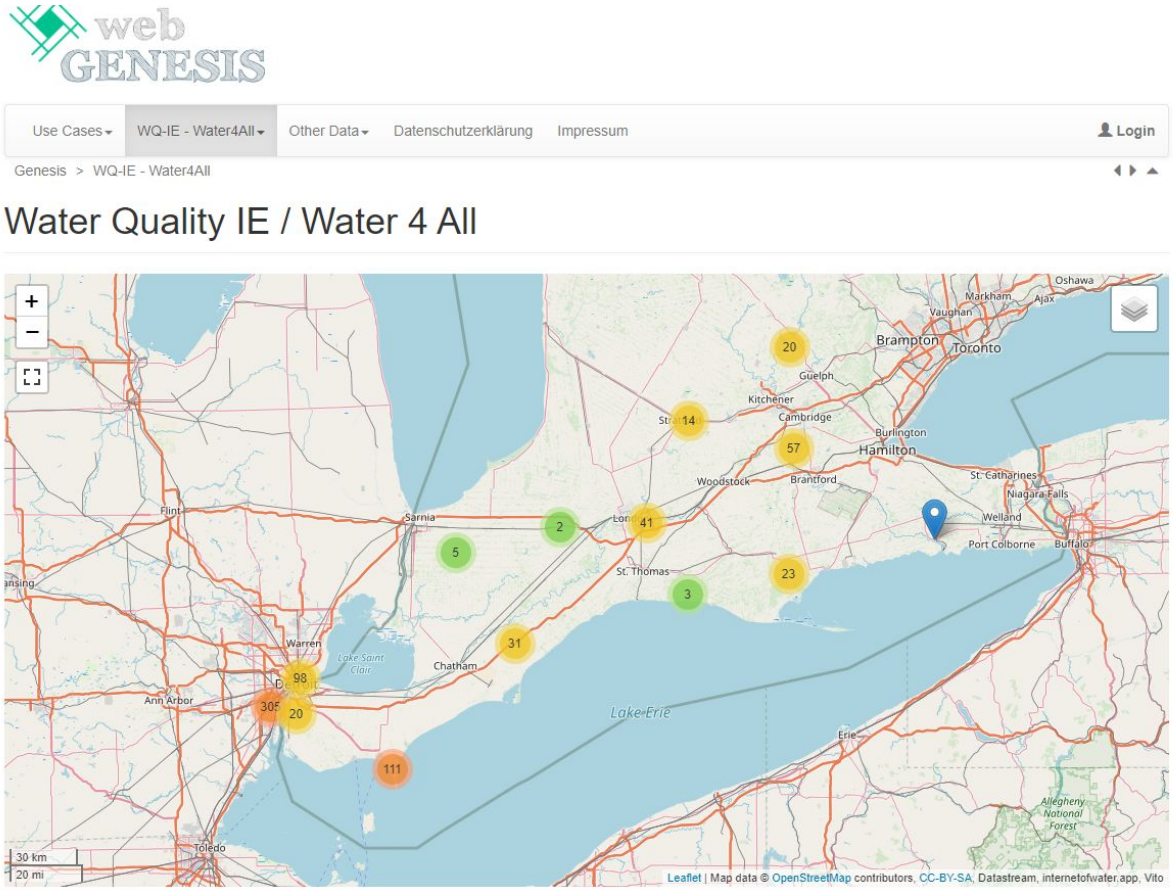
- Demo endpoints
  - Generic Map client : https://api4inspire.k8s.ilt-dmz.iosb.fraunhofer.de/servlet/is/226/
    Also tested in QGIS SensorThings API Plugin
  - Open Free-For-All Service (no data yet)
    https://ogc-demo.k8s.ilt-dmz.iosb.fraunhofer.de/FROST-WaterQuality/v1.1/
  - USGS endpoint (work in progress)
    Data: https://wqp.wqie.internetofwater.app/FROST-Server/v1.1
    Map: https://wqp.wqie.internetofwater.app/

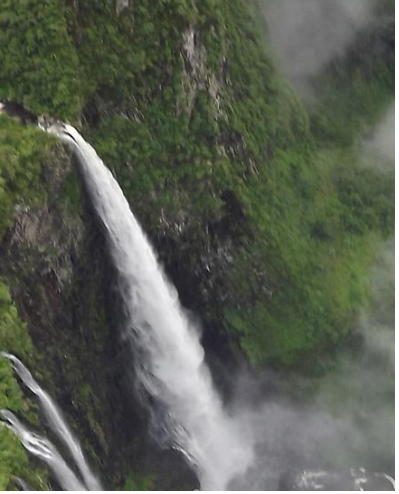


Surface water quality
US - Canada : great lakes region

Implementation - WebGenesis client

- It works !





Surface water quality
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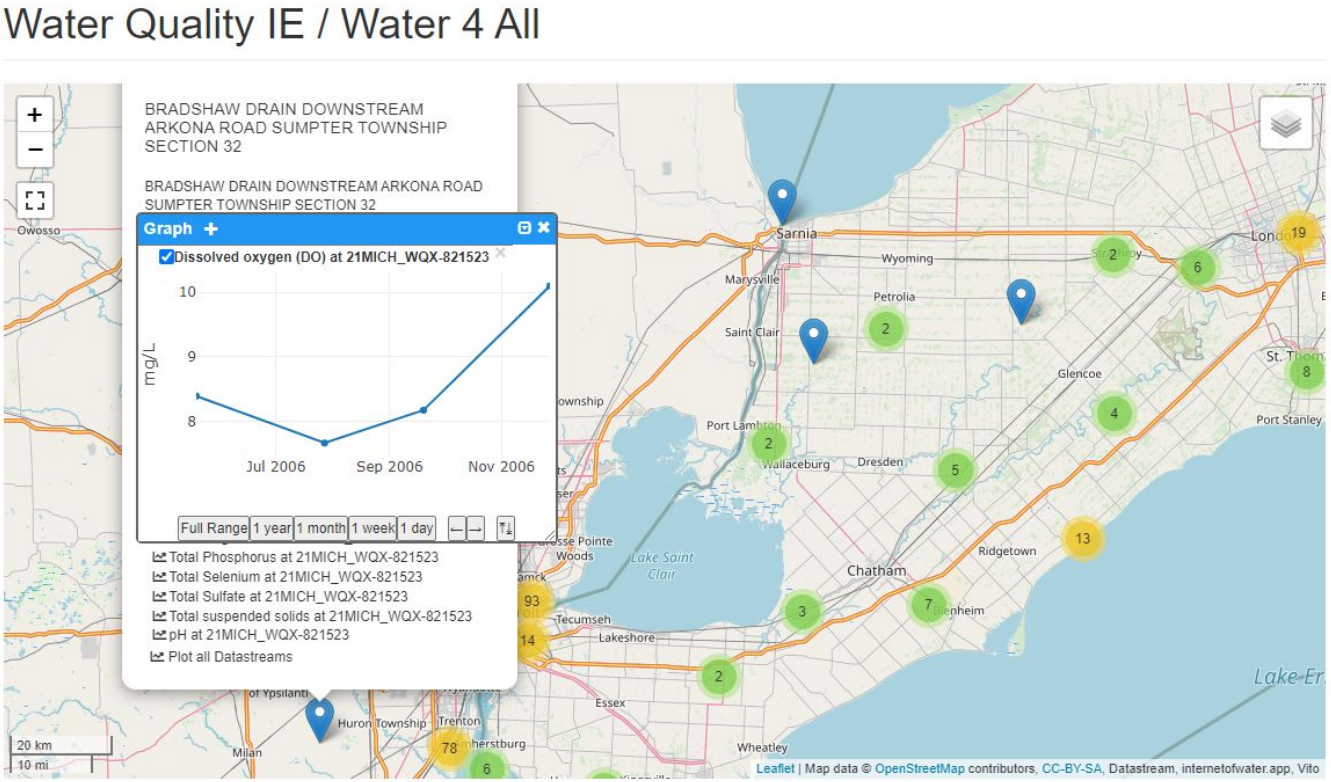
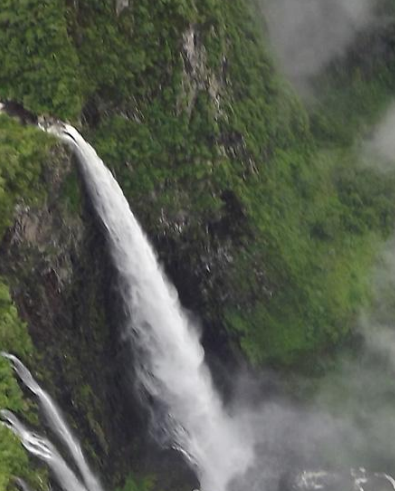




Surface water quality
US - Canada : great lakes region

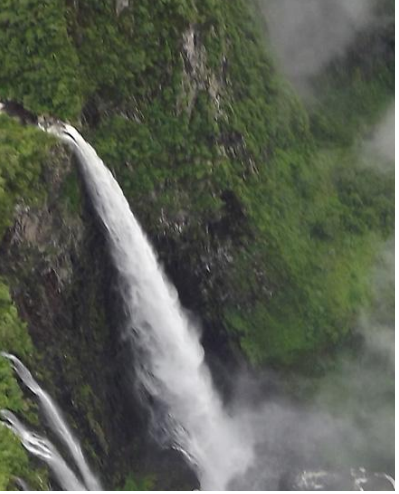
Implementation - WebGenesis client

- It works !


```
// 20240619103007
// https://wqp.wqie.internetofwater.app/FROST-Server/v1.1/Datastreams('fec02df5-a2f8-0255-74e5-6cada9d66cb6')

{
  "@iot.selfLink": "https://wqp.wqie.internetofwater.app/FROST-Server/v1.1/Datastreams('fec02df5-a2f8-0255-74e5-6cada9d66cb6')",
  "@iot.id": "fec02df5-a2f8-0255-74e5-6cada9d66cb6",
  "name": "Dissolved oxygen (DO) at 21MICH_WQX-821523",
  "description": "Dissolved oxygen (DO) at 21MICH_WQX-821523",
  "observationType": "http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_Measurement",
  "unitOfMeasurement": {
    "name": "mg/L",
    "symbol": "mg/L",
    "definition": "mg/L"
  },
  "observedArea": {
    "type": "Point",
    "coordinates": [
      -83.51139,
      42.10036
    ]
  },
  "phenomenonTime": "2006-05-18T10:00:00Z/2006-11-27T10:00:00Z",
  "properties": {
    "ActivityIdentifier": "21MICH_WQX-821523_7/28/2016",
    "ActivityMediaName": "Water",
    "ActivityTypeCode": "Sample-Routine"
  },
  "resultTime": "2006-05-18T10:00:00Z/2006-11-27T10:00:00Z",
  "ObservedProperty@iot.navigationLink": "https://wqp.wqie.internetofwater.app/FROST-Server/v1.1/Datastreams('fec02df5-a2f8-0255-74e5-6cada9d66cb6')/ObservedProperty",
  "ObservingProcedure@iot.navigationLink": "https://wqp.wqie.internetofwater.app/FROST-Server/v1.1/Datastreams('fec02df5-a2f8-0255-74e5-6cada9d66cb6')/ObservingProcedure",
  "Sensor@iot.navigationLink": "https://wqp.wqie.internetofwater.app/FROST-Server/v1.1/Datastreams('fec02df5-a2f8-0255-74e5-6cada9d66cb6')/Sensor",
  "Thing@iot.navigationLink": "https://wqp.wqie.internetofwater.app/FROST-Server/v1.1/Datastreams('fec02df5-a2f8-0255-74e5-6cada9d66cb6')/Thing",
  "UltimateFeatureOfInterest@iot.navigationLink": "https://wqp.wqie.internetofwater.app/FROST-Server/v1.1/Datastreams('fec02df5-a2f8-0255-74e5-6cada9d66cb6')/UltimateFeatureOfInte
  "Observations@iot.navigationLink": "https://wqp.wqie.internetofwater.app/FROST-Server/v1.1/Datastreams('fec02df5-a2f8-0255-74e5-6cada9d66cb6')/Observations",
  "SourceRelatedDatastreams@iot.navigationLink": "https://wqp.wqie.internetofwater.app/FROST-Server/v1.1/Datastreams('fec02df5-a2f8-0255-74e5-6cada9d66cb6')/SourceRelatedDatastrea
  "TargetRelatedDatastreams@iot.navigationLink": "https://wqp.wqie.internetofwater.app/FROST-Server/v1.1/Datastreams('fec02df5-a2f8-0255-74e5-6cada9d66cb6')/TargetRelatedDatastrea
}
```


Datastream content
WQ IE Compliant



Surface water quality
US - Canada : great lakes region

Implementation - WebGenesis client

- It works !


```
// https://wqp.wqie.internetofwater.app/FROST-Server/v1.1/Datastreams('fec02df5-a2f8-0255-74e5-6cada9d66cb6')?$expand=Observations

{
  "@iot.selfLink": "https://wqp.wqie.internetofwater.app/FROST-Server/v1.1/Datastreams('fec02df5-a2f8-0255-74e5-6cada9d66cb6')",
  "@iot.id": "fec02df5-a2f8-0255-74e5-6cada9d66cb6",
  "name": "Dissolved oxygen (DO) at 21MICH_WQX-821523",
  "description": "Dissolved oxygen (DO) at 21MICH_WQX-821523",
  "observationType": "http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_Measurement",
  "unitOfMeasurement": {
    "name": "mg/L",
    "symbol": "mg/L",
    "definition": "mg/L"
  },
  "observedArea": {
    "type": "Point",
    "coordinates": [
      -83.51139,
      42.10036
    ]
  },
  "phenomenonTime": "2006-05-18T10:00:00Z/2006-11-27T10:00:00Z",
  "properties": {
    "ActivityIdentifier": "21MICH_WQX-821523_7/28/2016",
    "ActivityMediaName": "Water",
    "ActivityTypeCode": "Sample-Routine"
  },
  "resultTime": "2006-05-18T10:00:00Z/2006-11-27T10:00:00Z",
  "Observations@iot.count": 4,
  "Observations": [
    {
      "@iot.selfLink": "https://wqp.wqie.internetofwater.app/FROST-Server/v1.1/Observations('91cef6b4-2dc1-11ef-a098-a7aa9b8c2d4d')",
      "@iot.id": "91cef6b4-2dc1-11ef-a098-a7aa9b8c2d4d",
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      "resultTime": "2006-05-18T10:00:00Z",
      "result": 8.39,
      "resultQuality": "Final",
      "parameters": {
        "modified": "2016-01-04T15:21:23",
        "publisher": "STORET",
        "status": "Final",
        "valueType": "Actual"
      }
    },
```
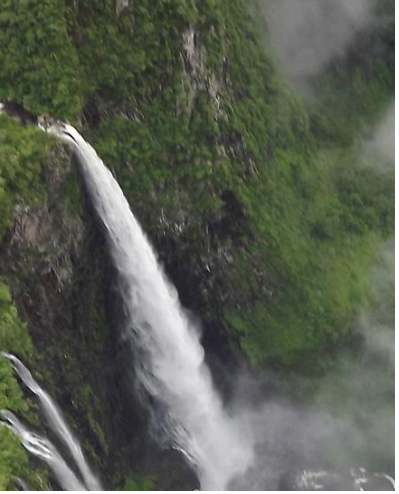


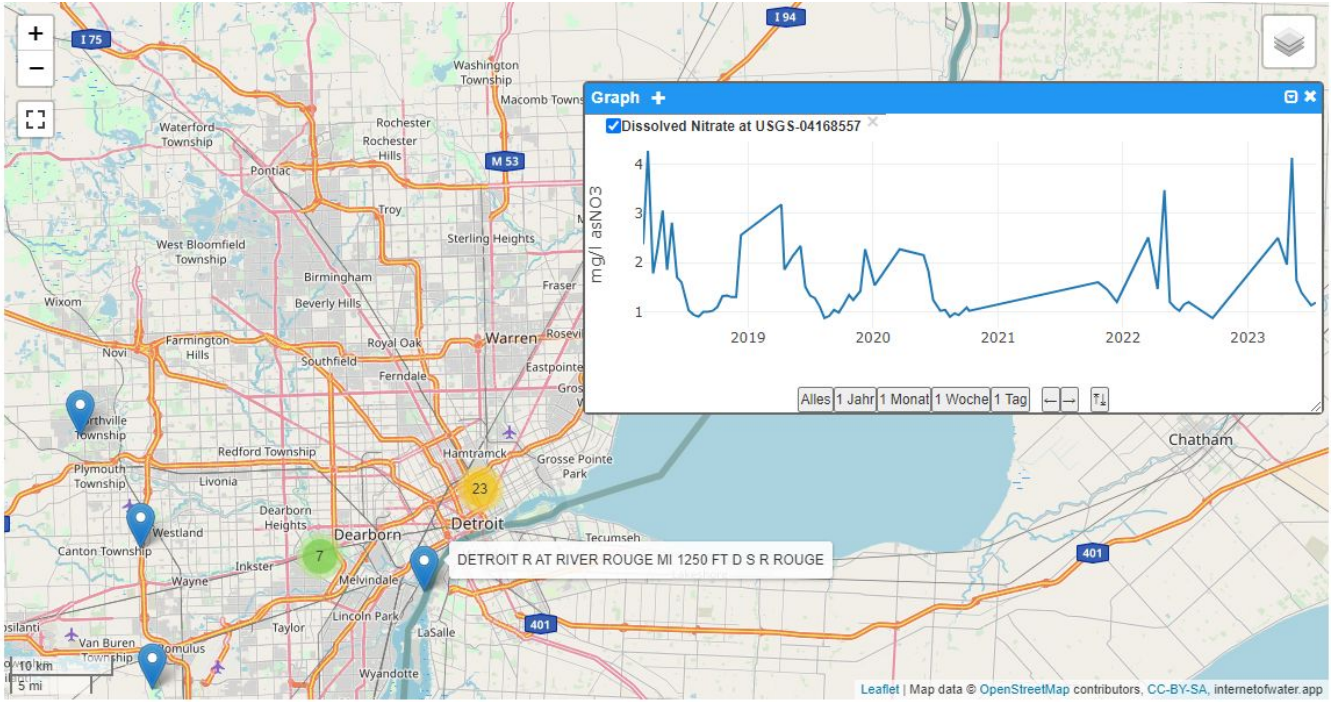
Datastream/Observation content: WQ IE Compliant



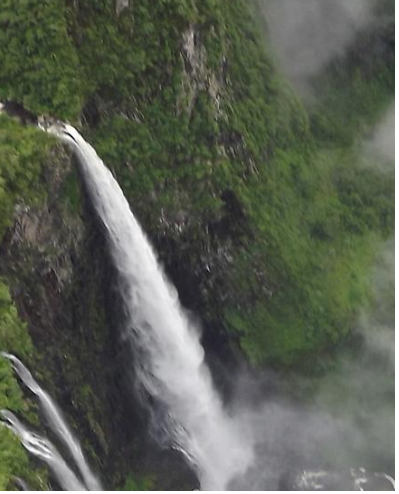
Surface water quality
US - Canada : great lakes region

Implementation - WebGenesis client

- It works !



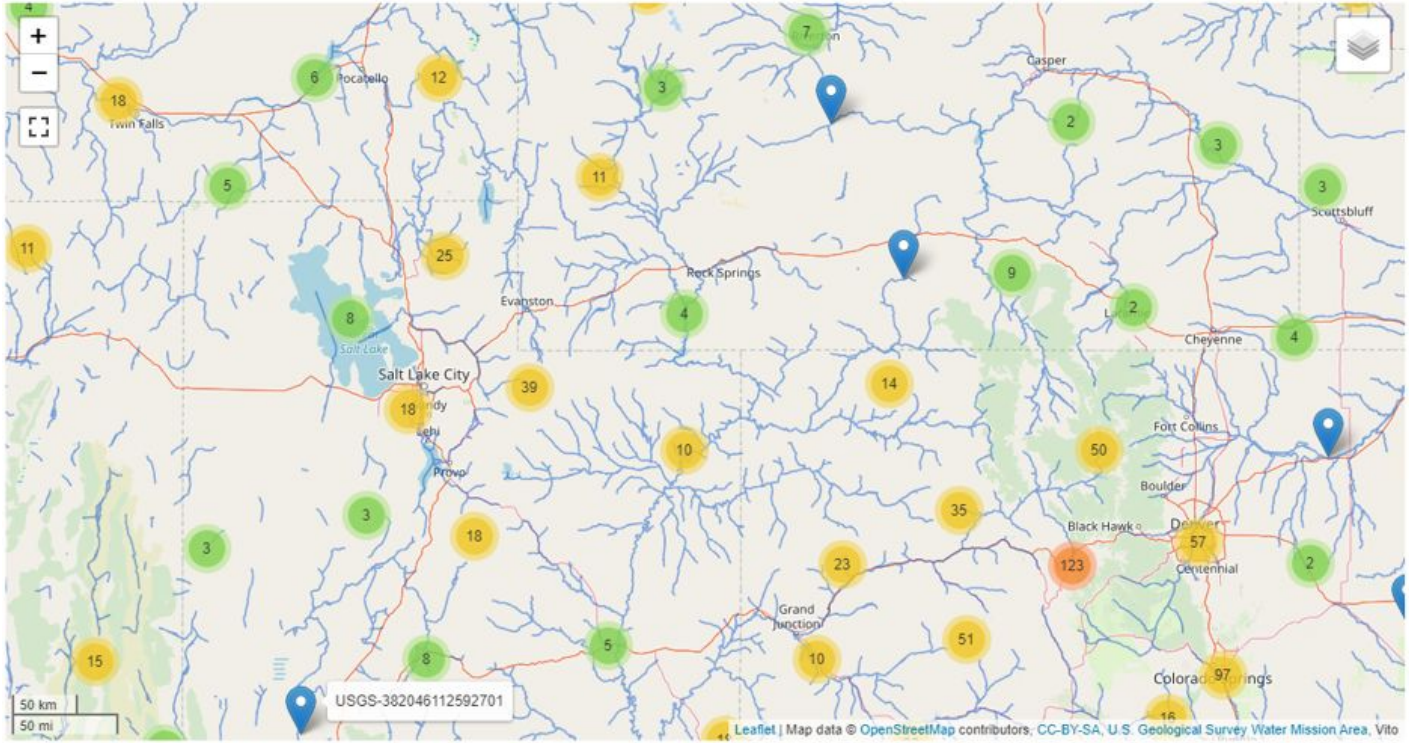
USGS – US Internet of Water
- US Water Quality Portal



Implementation - WebGenesis client

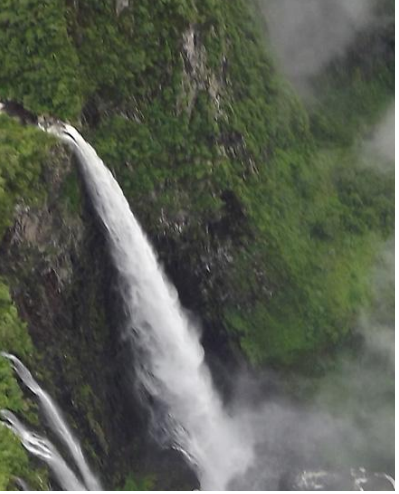
- It works !

Other implementation in the US : insitu, groundwater quantity

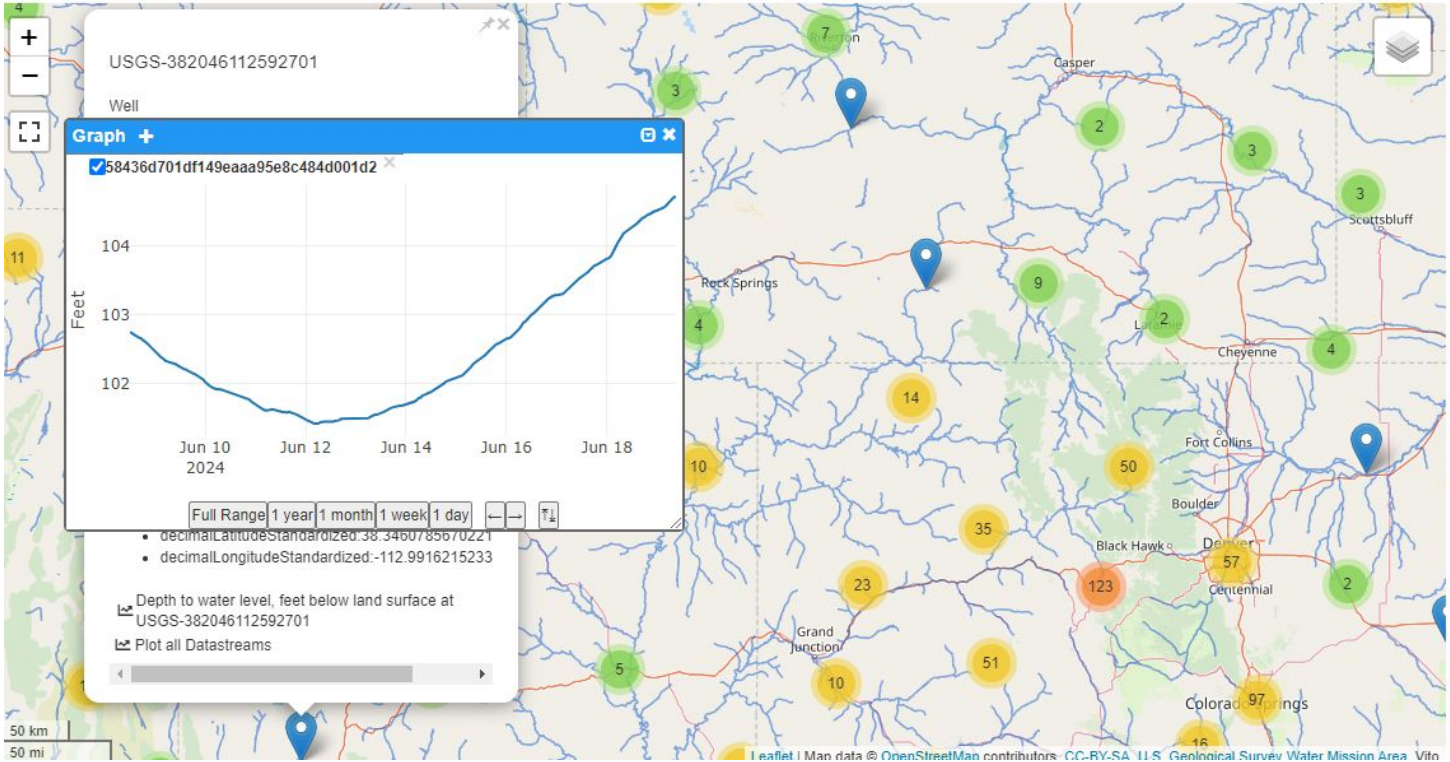


Implementation - WebGenesis client

- It works !



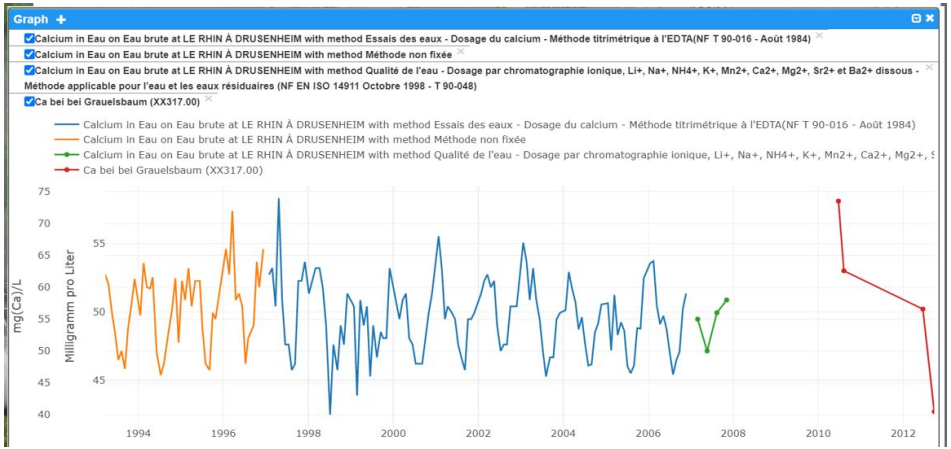
Other implementation in the US : insitu, groundwater quantity



Implementation - WebGenesis client

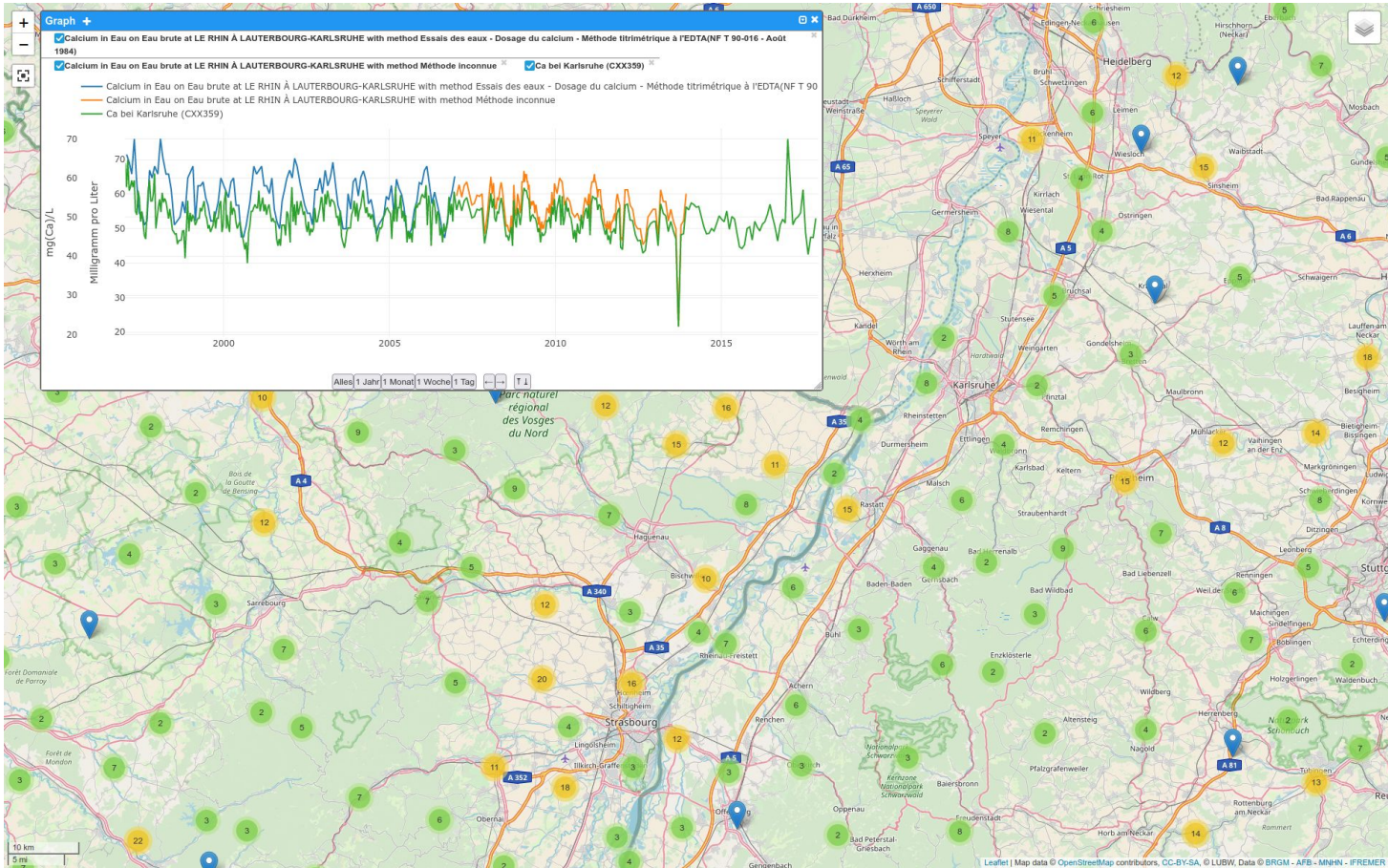
- It works !

Surface water quality, ex-situ, France - Germany



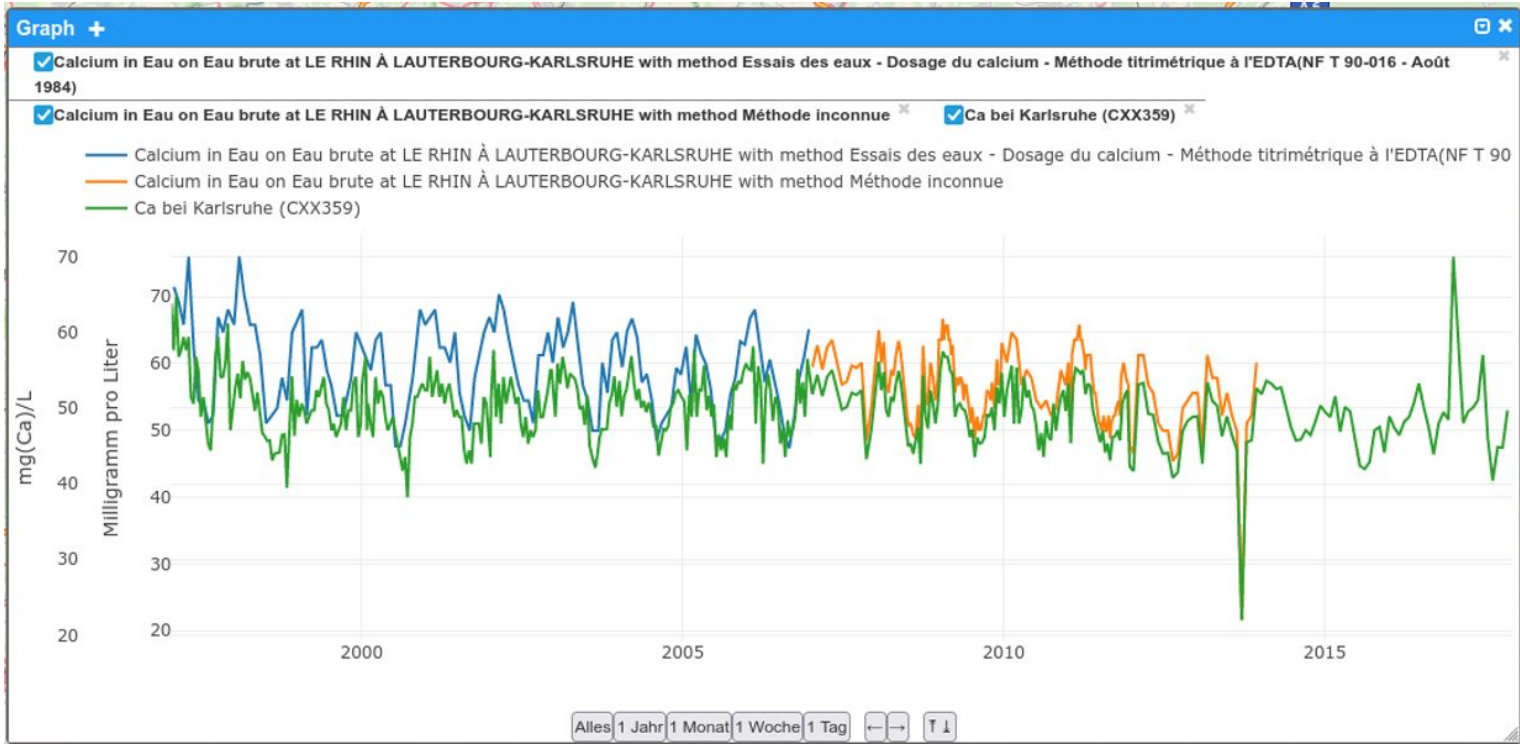
Implementation - WebGenesis client

- French & German Data
- 1 Map



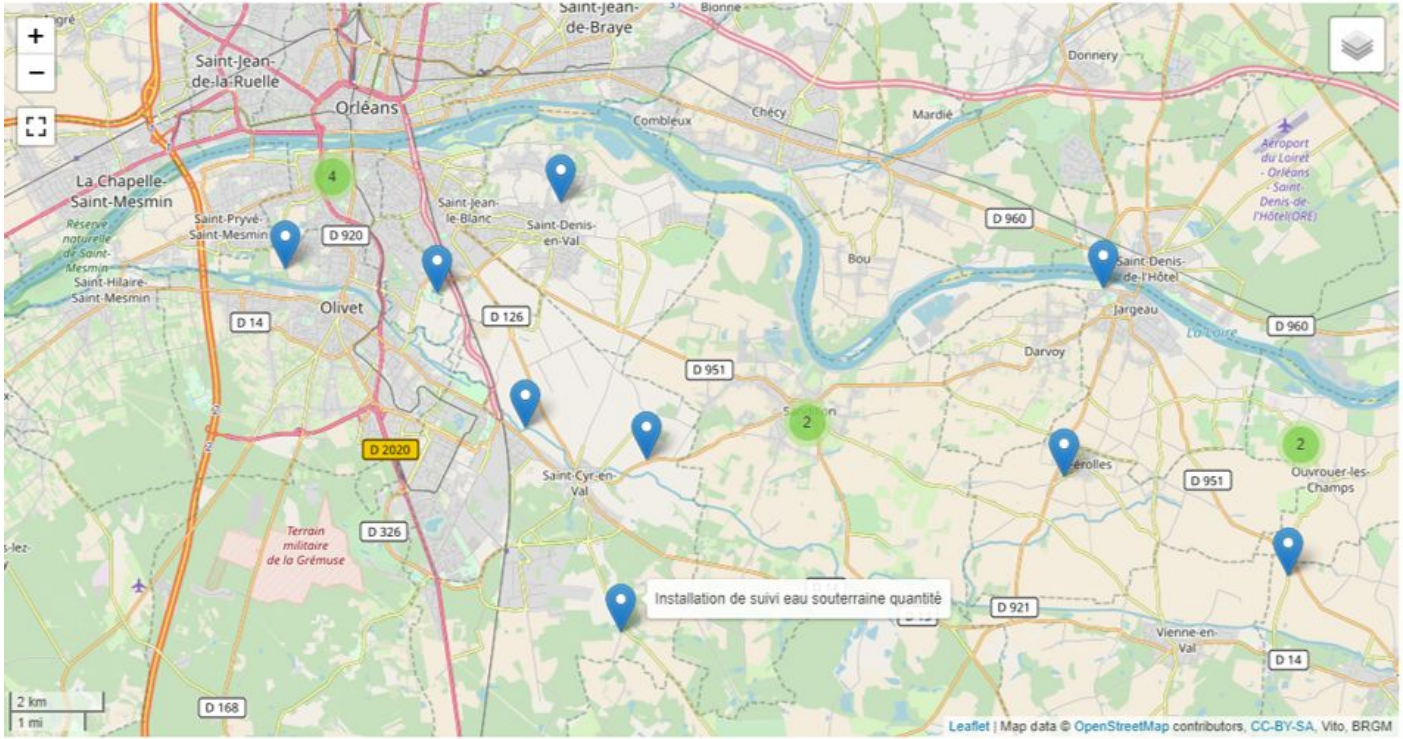
Implementation - WebGenesis client

- French & German Data
- 1 Map



Implementation - WebGenesis client

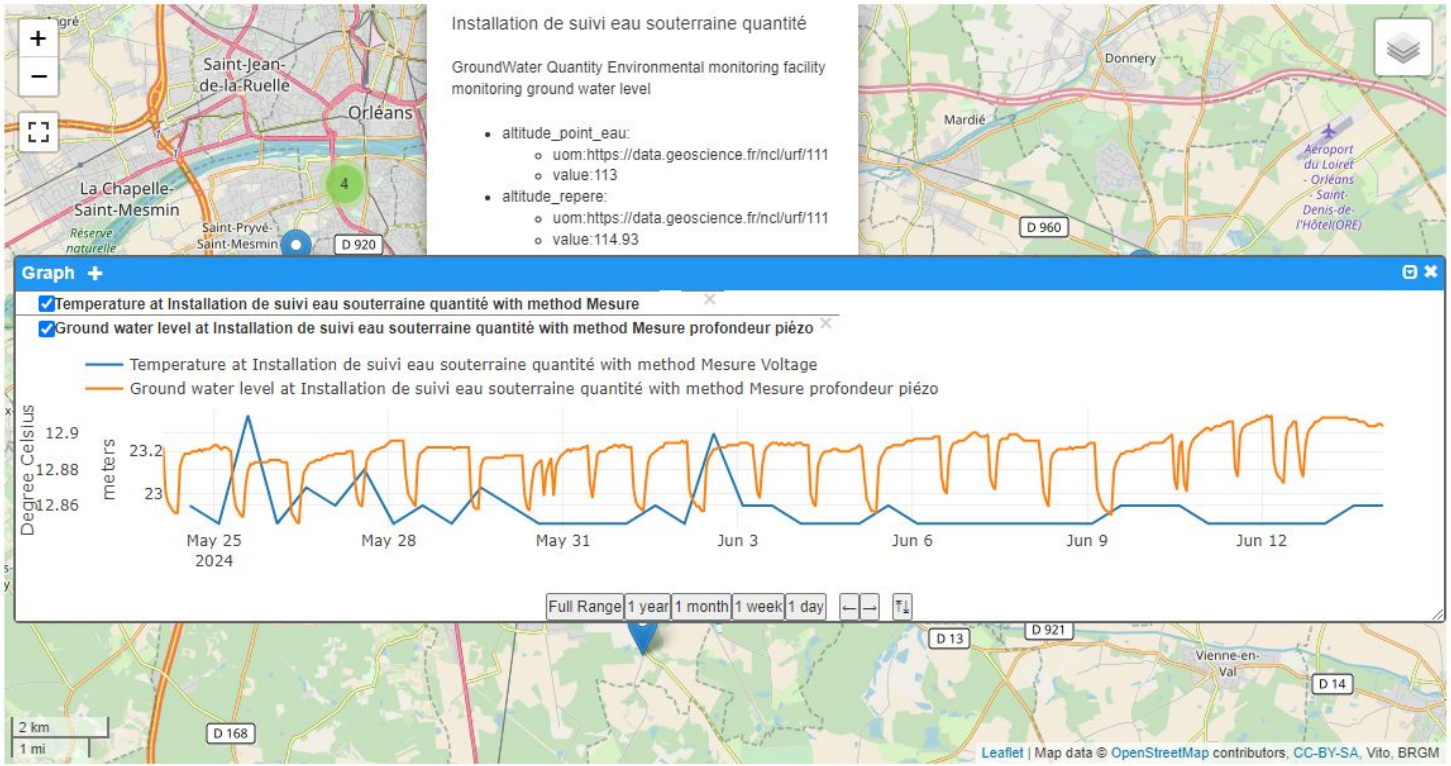
Other French data :
raw insitu groundwater quantity & quality



Implementation - WebGenesis client

Other French data :
raw insitu groundwater quantity & quality

Water Quality IE / Water 4 All



Implementation - QGIS client

Same French & German Data

- ST API compliant version 3.36+
- ST API plugin under revision to use this

*Projet sans titre — QGIS

Projet Éditer Vue Couche Préférences Extensions Vecteur Raster Base de données Internet Maillage SensorThings API Traitement Aide

Explorateur

- Scènes
- SensorThings
  - BRGM Water Quality IE
    - Datastreams
    - Features of Interest
    - Historical Locations
    - Locations
      - Points
      - MultiPoints
      - Lines
      - Polygons
    - Observations
    - Observed Properties
    - Sensors
    - Things
  - LUBW - API4INSPIRE
  - USGS Water Quality IE

Information GPS

Connecter

Latitude

Couches

- Locations_MultiPolygon
- Locations
- BRGM Water Quality IE - Locations
- Fonds cartographiques du monde -
- Fonds cartographiques du monde -

Location

Karlsruhe (CXX359)

Station Karlsruhe (CXX359)

Karlsruhe (CXX359) - Messtation Karlsruhe (CXX359) bei Rhein

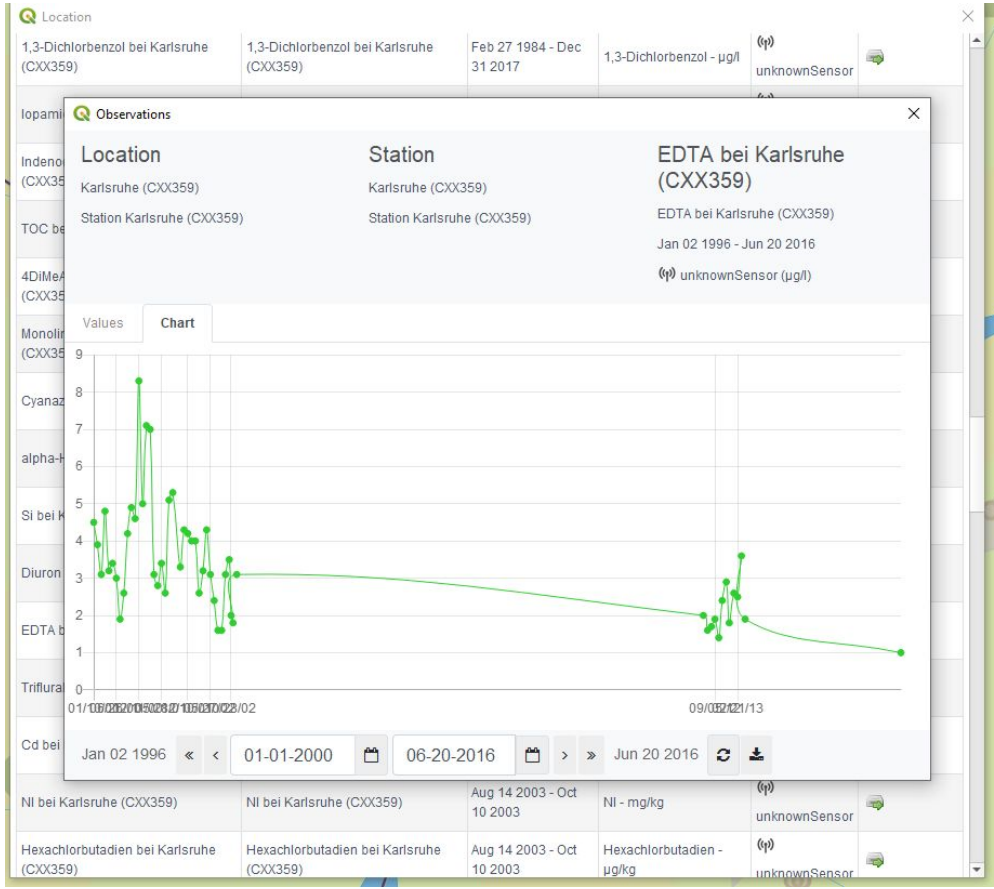
Available observations

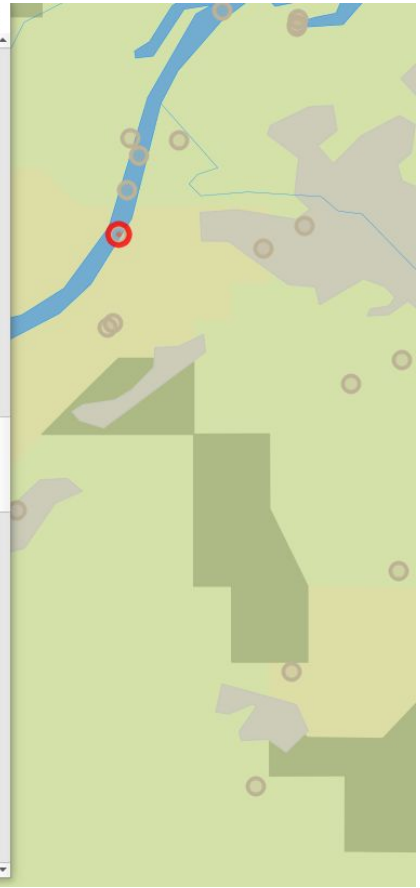
Name	Description	Ref. dates	Observed property	Sensor	Observations
Frigen113 bei Karlsruhe (CXX359)	Frigen113 bei Karlsruhe (CXX359)	Jan 08 1990 - Dec 23 1991	Frigen113 - µg/l	unknownSensor	
Fluoranthen bei Karlsruhe (CXX359)	Fluoranthen bei Karlsruhe (CXX359)	Jan 02 1981 - Dec 04 2017	Fluoranthen - µg/l	unknownSensor	
O2 bei Karlsruhe (CXX359)	O2 bei Karlsruhe (CXX359)	Jan 22 1973 - Dec 18 2017	O2 - mg/l	unknownSensor	
1,2,3-Trichlorbenzol bei Karlsruhe (CXX359)	1,2,3-Trichlorbenzol bei Karlsruhe (CXX359)	Jan 02 1996 - Dec 04 2017	1,2,3-Trichlorbenzol - µg/l	unknownSensor	
2Aminobenz bei Karlsruhe (CXX359)	2Aminobenz bei Karlsruhe (CXX359)	Jan 05 2015 - Dec 04 2017	2Aminobenz - µg/l	unknownSensor	
Iodocarb bei Karlsruhe (CXX359)	Iodocarb bei Karlsruhe (CXX359)	Jan 05 2015 - Dec 04 2017	Iodocarb - µg/l	unknownSensor	
Acetamid bei Karlsruhe (CXX359)	Acetamid bei Karlsruhe (CXX359)	Jan 05 2015 - Nov 07 2016	Acetamid - µg/l	unknownSensor	
3PhenBeSre bei Karlsruhe (CXX359)	3PhenBeSre bei Karlsruhe (CXX359)	Jan 05 2015 - Dec 04 2017	3PhenBeSre - µg/l	unknownSensor	
2,4-DP bei Karlsruhe (CXX359)	2,4-DP bei Karlsruhe (CXX359)	Feb 05 2001 - Dec 04 2017	2,4-DP - µg/l	unknownSensor	
m-/p-Xylol bei Karlsruhe (CXX359)	m-/p-Xylol bei Karlsruhe (CXX359)	Dec 26 2005 - Dec 31 2005	m-/p-Xylol - µg/l	unknownSensor	
DTPA bei Karlsruhe (CXX359)	DTPA bei Karlsruhe (CXX359)	Dec 23 2002 - Dec 04 2017	DTPA - µg/l	unknownSensor	

Implementation - QGIS client

Same French & German Data

- ST API compliant version 3.36+
- ST API plugin under revision to use this





Implementation - R client

- USGS Water Quality Portal data
- + continuous sensor (ex: pH)

RPubs by RStudio

Sign in Register

US WQP (Samples) WQIE STA

USGS STA (Continuous Sensors)

Animas River

id	ac7d64e0-c197-f1ed-dae9-f4e8e885111c
name	pH at CORIVWCH_WQX-3438
description	pH at CORIVWCH_WQX-3438
observationType	http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_Measurement
unitOfMeasurement/definition	None
unitOfMeasurement/name	None
unitOfMeasurement/symbol	None
phenomenonTime	2010-09-20T10:00:00Z
properties/ActivityIdentifier	CORIVWCH_WQX-3438.005
properties/ActivityMediaName	Water
properties/ActivityTypeCode	Sample-Routine
resultTime	2010-09-20T00:00:00Z
mvFeatureId	39

GRAND JUNCTION Aspen COLORADO MOAB Alamosa DURANGO Page Farmington

Zoom full

30 km 30 mi

Leaflet | © OpenStreetMap contributors © CARTO

HTML by Kyle Onda Last updated 1 day ago

Comments (–) Share Hide Toolbars

Implementation

- Let’s do some live demo with
  - Generic clients : https://api4inspire.k8s.ilt-dmz.iosb.fraunhofer.de/servlet/is/226/

    And QGIS ST API compliant + QGIS ST API plugin

  - Some SensorThings API 1.1 WQ IE compliant data in the US-Canada node

Water Quality IE - Conclusion

Landing the Interoperability Experiment

- When
  - Current target => OGC Member Meeting in June 2024 (OGC Hydro DWG session)

- What
  - Demo based on the implementation feedback

  - + draft Engineering Report : will be produced September 2024 onwards
    - summarizing the findings from the IE
    - and proposing next steps. Ex : adoption of a Best Practice for Water Quality data exchange Water ML2.0 Part 5 and (potentially) a revision of WaterML2.0 Part 1 : TimeSeries

Steps after the Interoperability Experiment

- Finalize a Best Practice for Water Quality data exchange Water ML2.0 Part 5 and start a draft revision of WaterML2.0 Part 1 : TimeSeries (to align with OMS and ST API)

- Work on shared ‘controlled’ vocabularies
  - Observed Property (? using I-ADOPT ?), Observing Procedure, …

- Current UseCases
  - More implementations : La Plata basin countries (through WMO), more Water4All and GSEU project partners

- Address the other UseCases
  - Out of scope this IE : Biology (taxa observation), Hydro Models, Remote Sensing

⇒ Enough material for a WQ IE 2 ☺

Some hindsight on the effort

- ***How the new "Observations, measurements and samples (OMS) " is meaningful to the Interoperability Experiment ?***

  - Most of what is needed semantically is already within the OGC semantic baseline : OMS + OGC WaterML2.0 part 3 (HydroFeatures) and part 4 (GroundWaterML 2.0)

  - OGC SensorThings API 1.1 being already Observations & Measurements compliant we just needed to add the missing elements to make it OMS compliant (ex : MaterialSample and some others)

    This is now embedded in SensorThings 2.0 working draft (revision ongoing)

Some hindsight on the effort

- ***How the new "Observations, measurements and samples (OMS) " is meaningful to the Interoperability Experiment ?***

⇒ No need to reinvent the wheel, just use the available standards and document it

Some context supporting this work

- Some supporting national /EU projects from our end (both running now)

OneWater Eau Bien Commun / PROGRAMME NATIONAL DE RECHERCHE SUR L'EAU — RÉPUBLIQUE FRANÇAISE — FRANCE 2030

  - French Research project, 53 Million €, 10 years
  - https://www.onewater.fr/en (ANR project : 22-PEXO-0009)
  - Many domain objectives including FAIR (interoperable) Water Data Exchange

Water4All
Water security for the planet

  - EU joint research partnserhip
  - https://www.water4all-partnership.eu/
  - 31 countries, 7 years, 81 Million € for the 2 years.
  - Many domain objectives including FAIR (interoperable) Water Data Exchange

- Your project could join the effort

⇒ join the OGC Hydro DWG discussions

Thank you

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