



Exploring real-time geospatial data with SensorThings API

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Introduction

- › **My own learning curve**
- › **Goal: provide a practical example & reduce friction for beginners**
- › **A practical workflow with real-time data:**

QGIS Desktop



QWC web map



What is SensorThings?

- › The OGC SensorThings API is an open standard for publishing sensor observations and time-series data through a web API
- › It helps answer:
 - › Where was it measured?
 - › What was measured?
 - › When was it measured?
 - › Which value was observed?

SensorThings API is a QGIS data source

SensorThings API as a QGIS data source

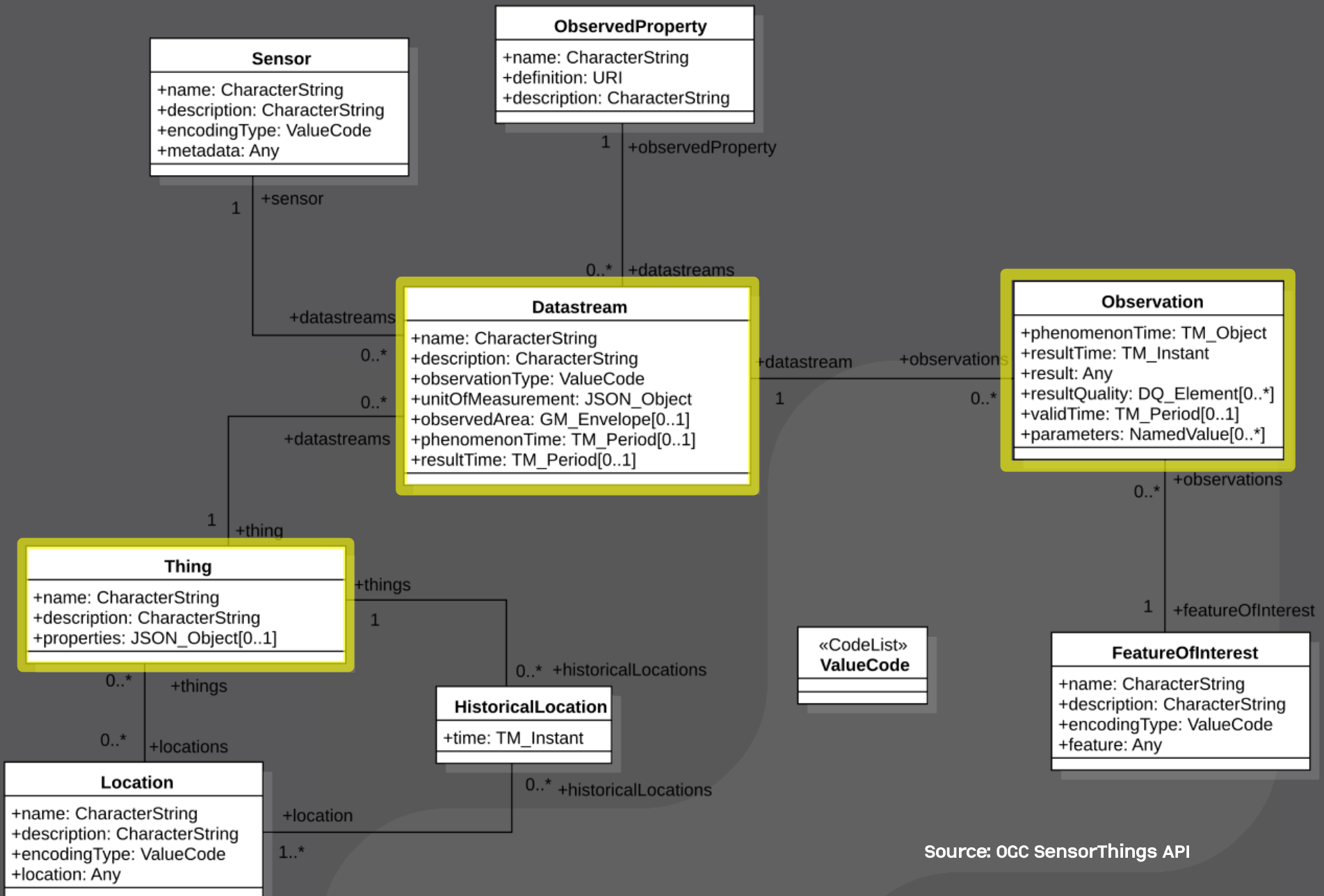
- SensorThings API provides a way to access real-time sensor observations
- In QGIS, these observations can be consumed directly as live geospatial layers

Why it matters for this demo:

- QGIS does not need a static dataset: it can connect to an API endpoint and display continuously updated observations



The SensorThings model



Source: OGC SensorThings API



SensorThings servers in the wild

Public FROST / OGC SensorThings endpoints across different domains

› Geoscience / environment

- › Fraunhofer Air Quality — <https://airquality-frost.k8s.ilt-dmz.iosb.fraunhofer.de/v1.1/>

› Urban / municipal IoT

- › DE Hamburg — <https://iot.hamburg.de/v1.1/>
- › DE Kreis Herford — <https://geoportal.kreis-herford.de/iot/v1.1>
- › IT Municipality of Ferrara — <https://iot.comune.fe.it/FROST-Server/v1.1/>

› Water & groundwater

- › Fraunhofer Water Data — <https://ogc-demo.k8s.ilt-dmz.iosb.fraunhofer.de/v1.1>
- › UK British Geological Survey — <https://sensors.bgs.ac.uk/FROST-Server/v1.1>
- › USA New Mexico — <https://nmenv.newmexicowaterdata.org/FROST-Server/v1.1>

› Demographic data

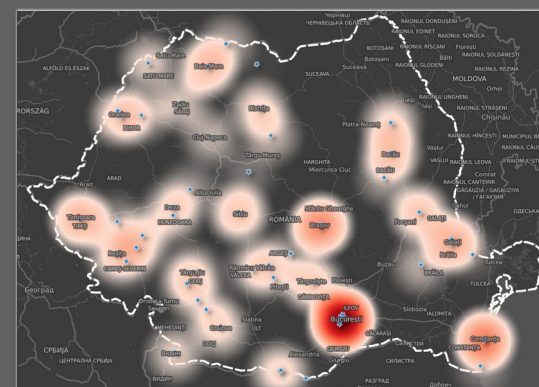
- › Fraunhofer Demography — <https://demography.k8s.ilt-dmz.iosb.fraunhofer.de/v1.1>



Chosen data source: Air Quality FROST Server

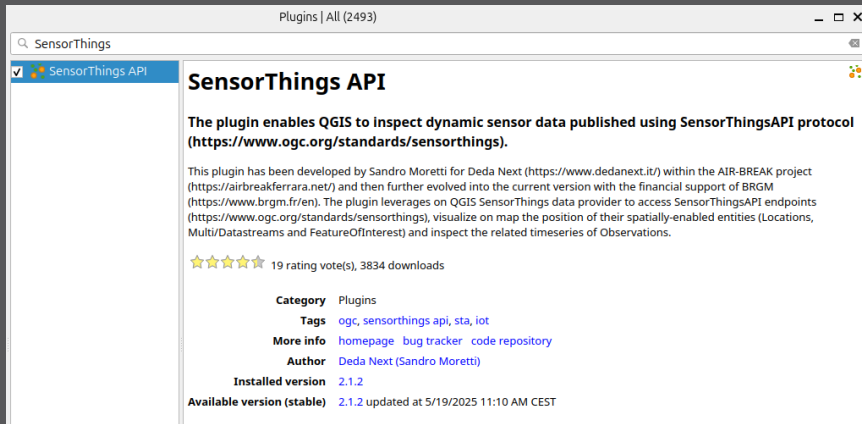
GOAL:

**Create a QWC web map for exploring
real-time air quality observations in
Romania**

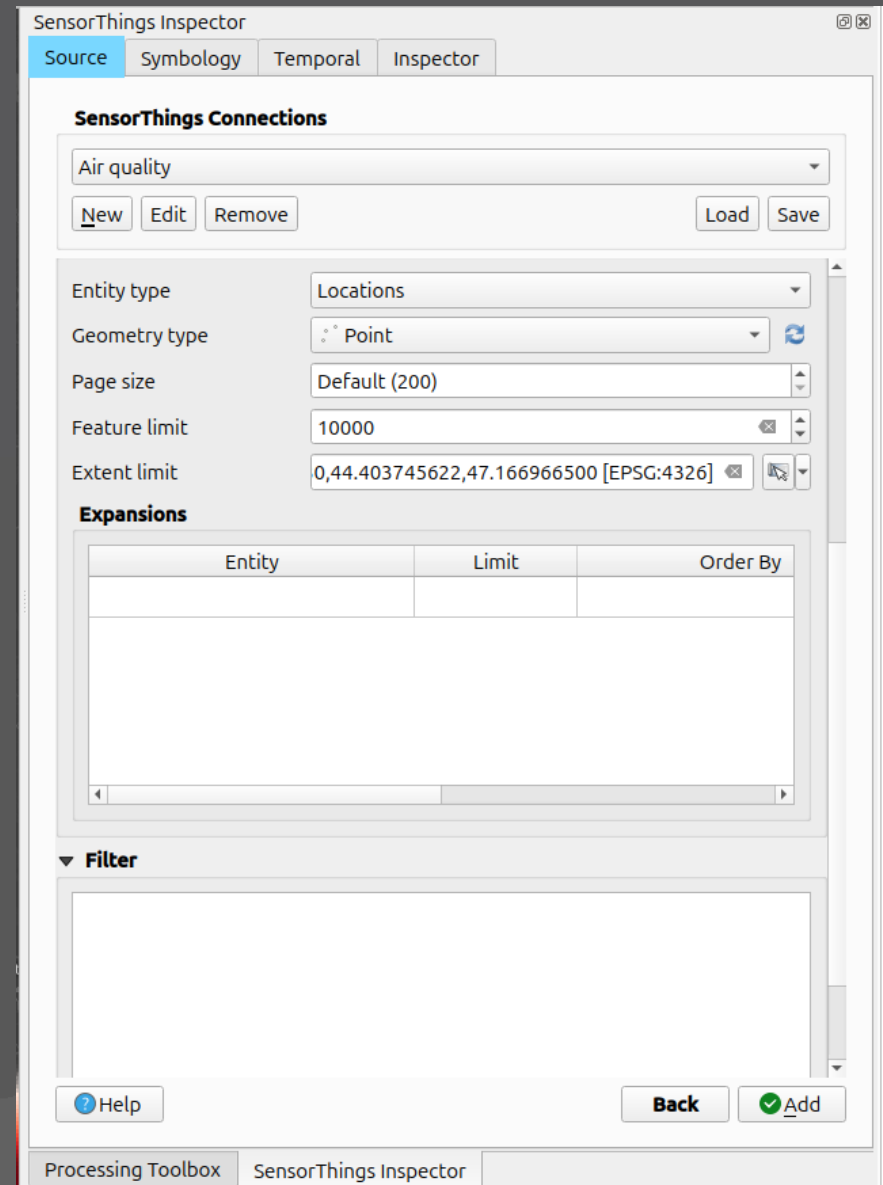


Importing SensorThings data in QGIS Desktop

- Install the QGIS SensorThings plugin.

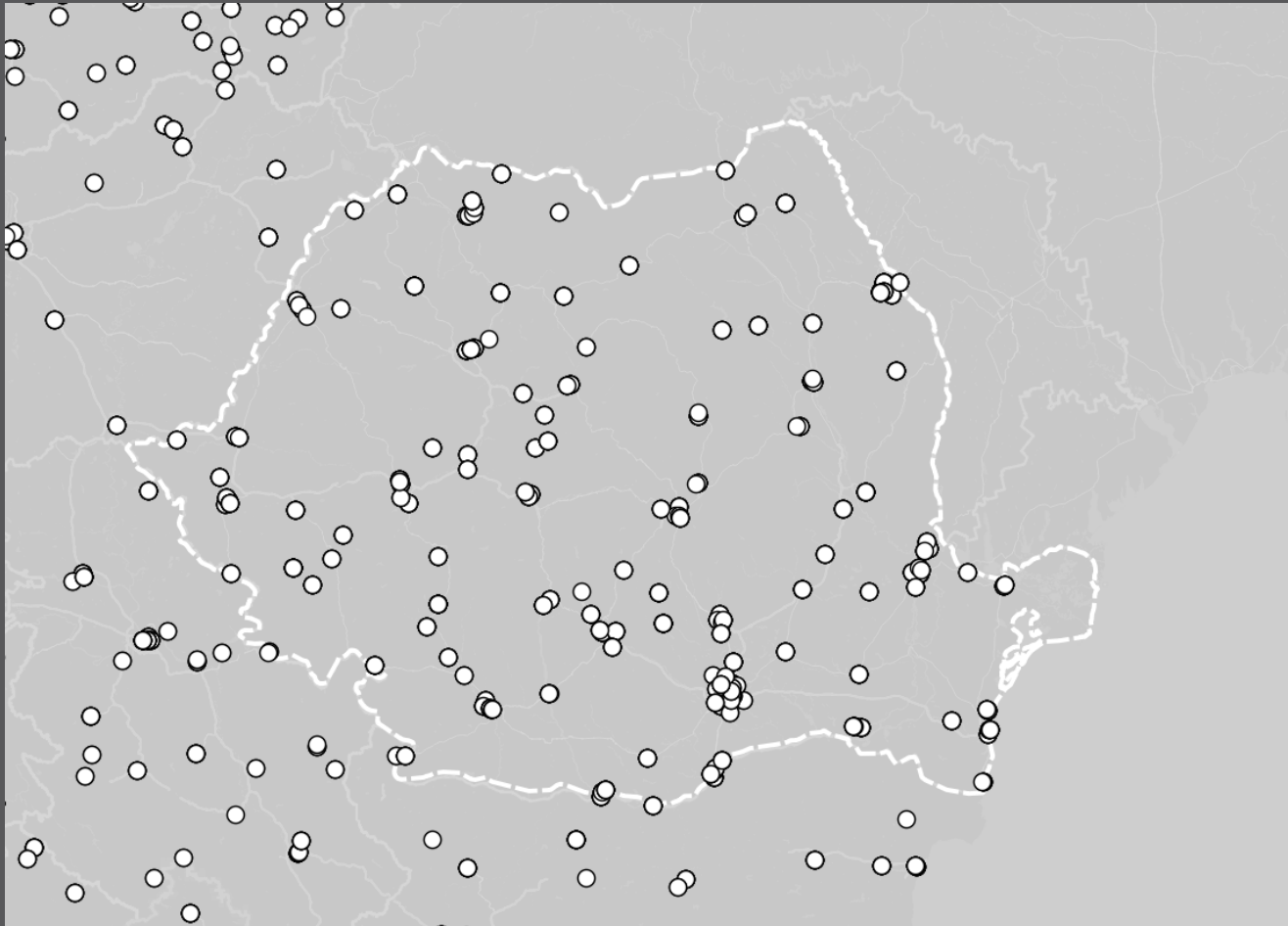


- Import workflow
 - Endpoint URL
 - SensorThings connection
 - Select entity
 - Add layer





I have this API. Now what?



➤ The data exists, but is not yet a map

➤ What I want?

I want a map with last N02 observations



I have this API. Now what?

selfLink	name	description	properties	Thing_id	Thing_selfLink	Thing_name	Thing_description	Thing_properties	Thing_datastream	datastream_name	datastream_unitOfMeasure	datastream_phenomenon
https://airq...	STA_RO0176A	Location of ...	"metadat...	4801	https://airq...	STA_RO0176A	Measur...	"mediaM...	19915	https://airq...	SPO_RO0176...	NO2 at STA...
https://airq...	STA_RO0177A	Location of ...	"metadat...	4802	https://airq...	STA_RO0177A	Measur...	"mediaM...	19916	https://airq...	SPO_RO0177...	NO2 at STA...
https://airq...	STA_RO0178A	Location of ...	"metadat...	4803	https://airq...	STA_RO0178A	Measur...	"metadat...	19917	https://airq...	SPO_RO0178...	NO2 at STA...
https://airq...	STA_RO0179A	Location of ...	"metadat...	4857	https://airq...	STA_RO0179A	Measur...	"mediaM...	19918	https://airq...	SPO_RO0179...	NO2 at STA...
https://airq...	STA_RO0180A	Location of ...	"metadat...	4858	https://airq...	STA_RO0180A	Measur...	"metadat...	19919	https://airq...	SPO_RO0180...	NO2 at STA...
https://airq...	STA_RO0181A	Location of ...	"metadat...	4860	https://airq...	STA_RO0181A	Measur...	"mediaM...	19923	https://airq...	SPO_RO0181...	NO2 at STA...
https://airq...	STA_RO0182A	Location of ...	"metadat...	4806	https://airq...	STA_RO0182A	Measur...	"mediaM...	19924	https://airq...	SPO_RO0182...	NO2 at STA...
https://airq...	STA_RO0184A	Location of ...	"metadat...	4859	https://airq...	STA_RO0184A	Measur...	"mediaM...	19920	https://airq...	SPO_RO0184...	NO2 at STA...
https://airq...	STA_RO0185A	Location of ...	"metadat...	4804	https://airq...	STA_RO0185A	Measur...	"mediaM...	19921	https://airq...	SPO_RO0185...	NO2 at STA...
https://airq...	STA_RO0187A	Location of ...	"metadat...	4805	https://airq...	STA_RO0187A	Measur...	"mediaM...	19922	https://airq...	SPO_RO0187...	NO2 at STA...
https://airq...	STA_RO0188A	Location of ...	"metadat...	4807	https://airq...	STA_RO0188A	Measur...	"mediaM...	19926	https://airq...	SPO_RO0188...	NO2 at STA...
https://airq...	STA_RO0189A	Location of ...	"metadat...	4862	https://airq...	STA_RO0189A	Measur...	"mediaM...	19927	https://airq...	SPO_RO0189...	NO2 at STA...
https://airq...	STA_RO0190A	Location of ...	"metadat...	4863	https://airq...	STA_RO0190A	Measur...	"mediaM...	19928	https://airq...	SPO_RO0190...	NO2 at STA...
https://airq...	STA_RO0191A	Location of ...	"metadat...	4810	https://airq...	STA_RO0191A	Measur...	"mediaM...	20001	https://airq...	SPO_RO0191...	NO2 at STA...
https://airq...	STA_RO0192A	Location of ...	"metadat...	4820	https://airq...	STA_RO0192A	Measur...	"mediaM...	19939	https://airq...	SPO_RO0192...	NO2 at STA...
https://airq...	STA_RO0194A	Location of ...	"metadat...	4809	https://airq...	STA_RO0194A	Measur...	"mediaM...	19933	https://airq...	SPO_RO0194...	NO2 at STA...
https://airq...	STA_RO0195A	Location of ...	"metadat...	4867	https://airq...	STA_RO0195A	Measur...	"mediaM...	19934	https://airq...	SPO_RO0195...	NO2 at STA...
https://airq...	STA_RO0196A	Location of ...	"metadat...	4868	https://airq...	STA_RO0196A	Measur...	"mediaM...	19935	https://airq...	SPO_RO0196...	NO2 at STA...
https://airq...	STA_RO0197A	Location of ...	"metadat...	4869	https://airq...	STA_RO0197A	Measur...	"mediaM...	19936	https://airq...	SPO_RO0197...	NO2 at STA...
https://airq...	STA_RO0198A	Location of ...	"metadat...	4870	https://airq...	STA_RO0198A	Measur...	"mediaM...	19937	https://airq...	SPO_RO0198...	NO2 at STA...
https://airq...	STA_RO0199A	Location of ...	"metadat...	4871	https://airq...	STA_RO0199A	Measur...	"mediaM...	19938	https://airq...	SPO_RO0199...	NO2 at STA...
https://airq...	STA_RO0200A	Location of ...	"metadat...	4864	https://airq...	STA_RO0200A	Measur...	"mediaM...	19929	https://airq...	SPO_RO0200...	NO2 at STA...
https://airq...	STA_RO0201A	Location of ...	"metadat...	4808	https://airq...	STA_RO0201A	Measur...	"mediaM...	19930	https://airq...	SPO_RO0201...	NO2 at STA...
https://airq...	STA_RO0204A	Location of ...	"metadat...	4876	https://airq...	STA_RO0204A	Measur...	"mediaM...	19976	https://airq...	SPO_RO0204...	NO2 at STA...
https://airq...	STA_RO0205A	Location of ...	"metadat...	4814	https://airq...	STA_RO0205A	Measur...	"mediaM...	19944	https://airq...	SPO_RO0205...	NO2 at STA...
https://airq...	STA_RO0207A	Location of ...	"metadat...	4841	https://airq...	STA_RO0207A	Measur...	"mediaM...	19889	https://airq...	SPO_RO0207...	NO2 at STA...
https://airq...	STA_RO0208A	Location of ...	"metadat...	4792	https://airq...	STA_RO0208A	Measur...	"mediaM...	19890	https://airq...	SPO_RO0208...	NO2 at STA...
https://airq...	STA_RO0209A	Location of ...	"metadat...	4842	https://airq...	STA_RO0209A	Measur...	"mediaM...	19891	https://airq...	SPO_RO0209...	NO2 at STA...
https://airq...	STA_RO0210A	Location of ...	"metadat...	4875	https://airq...	STA_RO0210A	Measur...	"mediaM...	20002	https://airq...	SPO_RO0210...	NO2 at STA...
https://airq...	STA_RO0211A	Location of ...	"metadat...	4846	https://airq...	STA_RO0211A	Measur...	"metadat...	19902	https://airq...	SPO_RO0211...	NO2 at STA...
https://airq...	STA_RO0213A	Location of ...	"metadat...	4751	https://airq...	STA_RO0213A	Measur...	"mediaM...	19870	https://airq...	SPO_RO0213...	NO2 at STA...
https://airq...	STA_RO0216A	Location of ...	"metadat...	4752	https://airq...	STA_RO0216A	Measur...	"mediaM...	19841	https://airq...	SPO_RO0216...	NO2 at STA...



I have this API. Now what?

The screenshot shows a dialog box titled "Organize Table columns" with a list of API fields. Each field has a checkbox to its left. The fields are:

- abc id
- abc selfLink
- abc name
- abc description
- {} properties
- abc Thing_id
- abc Thing_selfLink
- abc Thing_name
- abc Thing_description
- {} Thing_properties
- abc Thing_Datastream_id
- abc Thing_Datastream_selfLink
- abc Thing_Datastream_name
- abc Thing_Datastream_description
- {} Thing_Datastream_unitOfMeasurement
- abc Thing_Datastream_observationType
- {} Thing_Datastream_properties
- 🕒 Thing_Datastream_phenomenonTimeStart
- 🕒 Thing_Datastream_phenomenonTimeEnd
- 🕒 Thing_Datastream_resultTimeStart
- 🕒 Thing_Datastream_resultTimeEnd
- abc Thing_Datastream_Observation_id
- abc Thing_Datastream_Observation_selfLink
- 🕒 Thing_Datastream_Observation_phenomenonTimeStart
- 🕒 Thing_Datastream_Observation_phenomenonTimeEnd
- abc Thing_Datastream_Observation_result
- 🕒 Thing_Datastream_Observation_resultTime
- [a] Thing_Datastream_Observation_resultQuality
- 🕒 Thing_Datastream_Observation_validTimeStart
- 🕒 Thing_Datastream_Observation_validTimeEnd
- {} Thing_Datastream_Observation_parameters
- 🛠 [Action Widget]

At the bottom of the dialog, there are three buttons: "Show All", "Hide All", and "Toggle Selection". On the right side, there are "Cancel" and "OK" buttons.



I have this API. Now what?

	description	Thing_Datastream_name	Thing_Datastream_phenomenonTimeEnd ^	Thing_Datastream_Observation_result
115	Location of station STA-RO0067A	SPO-RO0067A_00008_100	6/24/26 08:00:00 (UTC)	47.3086
116	Location of station STA-RO0067A	PM10 at B-3	6/24/26 08:00:00 (UTC)	40.9379
117	Location of station STA-RO0067A	SPO-RO0067A_00010_100	6/24/26 08:00:00 (UTC)	0.34104
118	Location of station STA-RO0142A	SPO-RO0142A_00008_100	6/24/26 08:00:00 (UTC)	14.6921
119	Location of station STA-RO0142A	SPO-RO0142A_00001_100	6/24/26 08:00:00 (UTC)	5.87986
120	Location of station STA-RO0142A	PM10 at GL-2	6/24/26 08:00:00 (UTC)	14.6778
121	Location of station STA-RO0142A	SPO-RO0142A_00007_100	6/24/26 08:00:00 (UTC)	50.0592
122	Location of station STA-RO0142A	SPO-RO0142A_00010_100	6/24/26 08:00:00 (UTC)	0.20183
123	Location of station STA-RO0128A	NO2 at CS-2	6/24/26 08:00:00 (UTC)	11.2191
124	Location of station STA-RO0128A	SPO-RO0128A_00005_100	6/24/26 08:00:00 (UTC)	24.1396
125	Location of station STA-RO0134A	SPO-RO0134A_00008_100	6/24/26 08:00:00 (UTC)	18.4732
126	Location of station STA-RO0134A	PM10 at CT-4	6/24/26 08:00:00 (UTC)	22.0389
127	Location of station STA-RO0167A	SPO-RO0167A_00008_100	6/24/26 08:00:00 (UTC)	6.29073
128	Location of station STA-RO0167A	SPO-RO0167A_00001_100	6/24/26 08:00:00 (UTC)	5.22189
129	Location of station STA-RO0167A	PM10 at MS-1	6/24/26 08:00:00 (UTC)	15
130	Location of station STA-RO0167A	SPO-RO0167A_00007_100	6/24/26 08:00:00 (UTC)	30.054
131	Location of station STA-RO0167A	SPO-RO0167A_00010_100	6/24/26 08:00:00 (UTC)	0.07443
132	Location of station STA-RO0126A	SPO-RO0126A_00008_100	6/24/26 08:00:00 (UTC)	19.9825
133	Location of station STA-RO0126A	SPO-RO0126A_00001_100	6/24/26 08:00:00 (UTC)	19.9825
134	Location of station STA-RO0126A	PM10 at CL-2	6/24/26 08:00:00 (UTC)	19.9825
135	Location of station STA-RO0126A	SPO-RO0126A_00007_100	6/24/26 08:00:00 (UTC)	19.9825
136	Location of station STA-RO0126A	SPO-RO0126A_00010_100	6/24/26 08:00:00 (UTC)	19.9825
137	Location of station STA-RO0184A	SPO-RO0184A_00008_100	6/24/26 08:00:00 (UTC)	20.0825
138	Location of station STA-RO0184A	SPO-RO0184A_00005_100	6/24/26 08:00:00 (UTC)	20.0825
139	Location of station STA-RO0184A	SPO-RO0184A_00007_100	6/24/26 08:00:00 (UTC)	20.0825
140	Location of station STA-RO0184A	SPO-RO0184A_00010_100	6/24/26 08:00:00 (UTC)	0.15561

Thing → STA-ROXXX
Datastream → NO2, PM10, O3
Datastream → time
Observation → value



Source tab configuration

SensorThings Inspector

Source | Symbology | Temporal | Inspector

Entity type: Locations

Geometry type: Point

Page size: Default (200)

Feature limit: 10000

Extent limit: Not set

Expansions

Entity	Limit	Order By	Sort Order	Filter
Thing	100		Ascending	substringof('RO',description)
Datastream	10		Ascending	startswith(description,'NO2')
Observation	1	phenomenonTime	Descending	

▼ Filter

Only Romania

Only NO2

Last observation






Source tab configuration

OGC SensorThings Data Filter

Set filter for layer

Fields

- abc id
- abc selfLink
- abc result
-  resultTime
-  resultQuality
-  parameters

Operators

Comparisons

eq ne gt ge lt le

Logical operators **Date**

and or not now()

Arithmetic

add sub mul div mod

OGC SensorThings Filter Expression



Simbology tab configuration

Measurement station ($\mu\text{g}/\text{m}^3$)

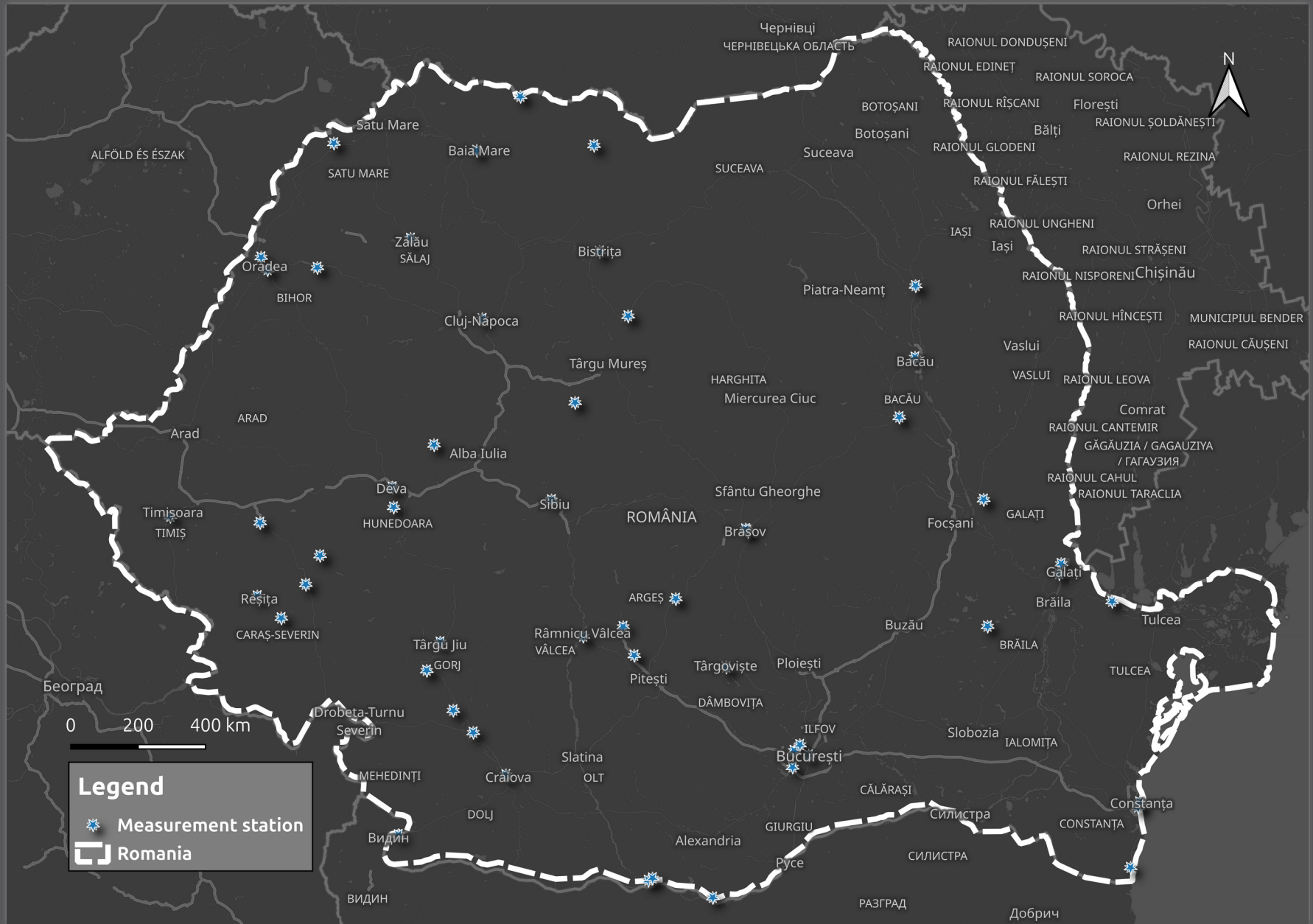
The screenshot shows the 'SensorThings Inspector' window with the 'Symbology' tab selected. The 'Single Symbol' dropdown is set to 'Marker'. A preview window shows a blue diamond marker. Below the preview, the 'Color' is set to blue, 'Opacity' is 100.0%, 'Size' is 3.20000 Millimeters, and 'Rotation' is 0.00°. A search bar contains 'All Symbols'. Under the 'Default' section, four symbols are displayed: 'diamond blue', 'diamond green', 'diamond red', and 'dot black'. At the bottom, there are 'Save Symbol...', 'Advanced', 'Layer Rendering', 'Reload', and 'Apply' buttons.

Heatmap weighted by latest N02 observation

The screenshot shows the 'SensorThings Inspector' window with the 'Symbology' tab selected. The 'Heatmap' dropdown is active. The 'Color ramp' is a red-to-white gradient. 'Radius' is 20.000000 Millimeters. 'Maximum value' is set to 'Automatic'. 'Weight points by' is set to 'to_real("Thing_Datastream_Observation_result")'. 'Rendering quality' is set to 'Best'. A 'Legend Settings...' button is visible. At the bottom, there are 'Layer Rendering', 'Reload', and 'Apply' buttons.

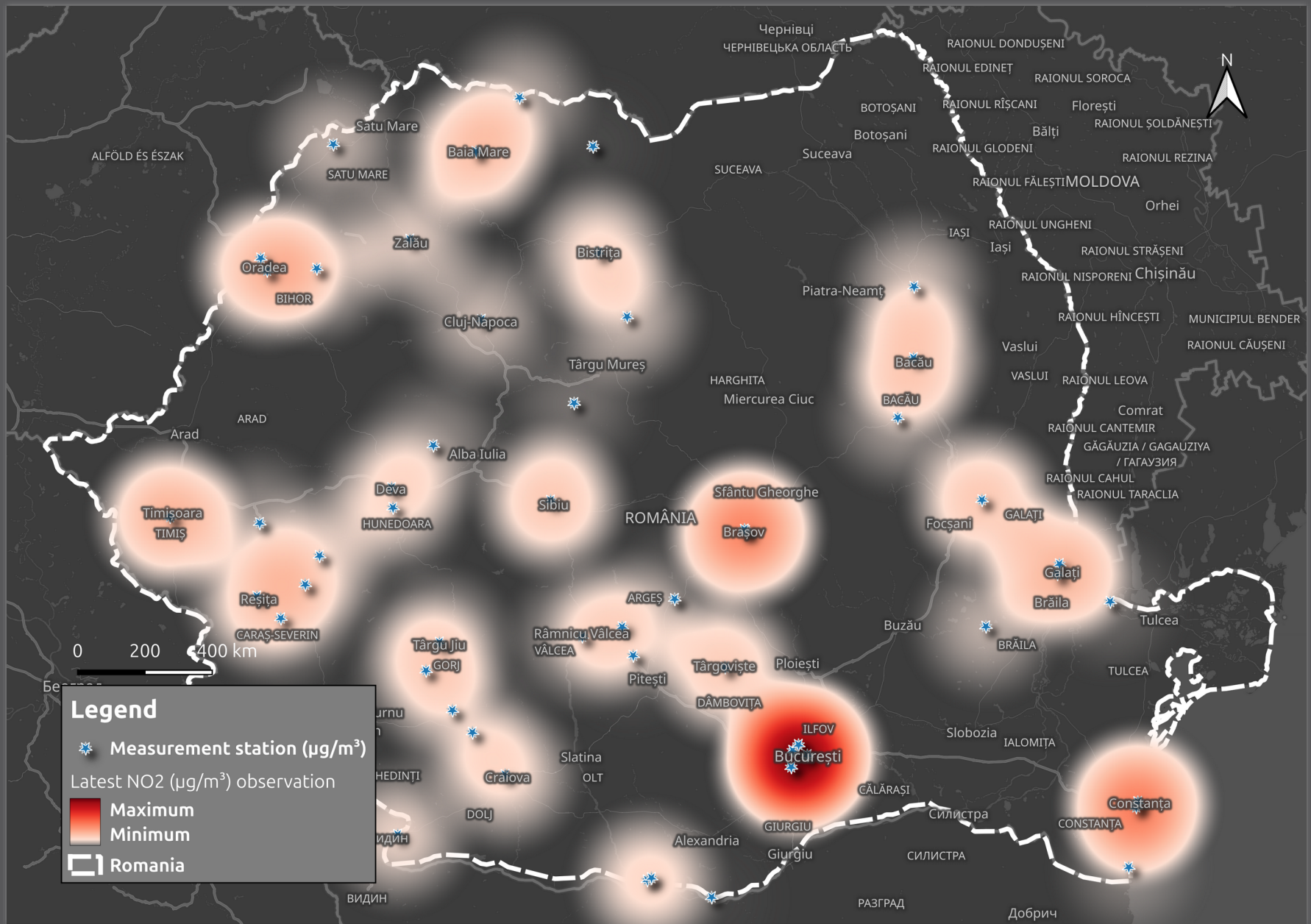


N02 Measurements stations - Romania





Heat map + stations - Romania





Temporal tab configuration

Temporal Controller

Current frame: 2/10

Total frames: 10

Loop

SensorThings Inspector

Source Symbology Temporal Inspector

Dynamic Temporal Control

Configuration: Single Field with Date/Time

Limits: Include Start, Exclude End (default)

Individual features from the layer will be rendered if the field's value falls within the map's temporal range.

If a duration is set for the events then the event will be considered as occurring from $Field \leq t < Field + duration$.

Field: Thing_Datastream_resultTimeStart

Event duration: 2.00 Months

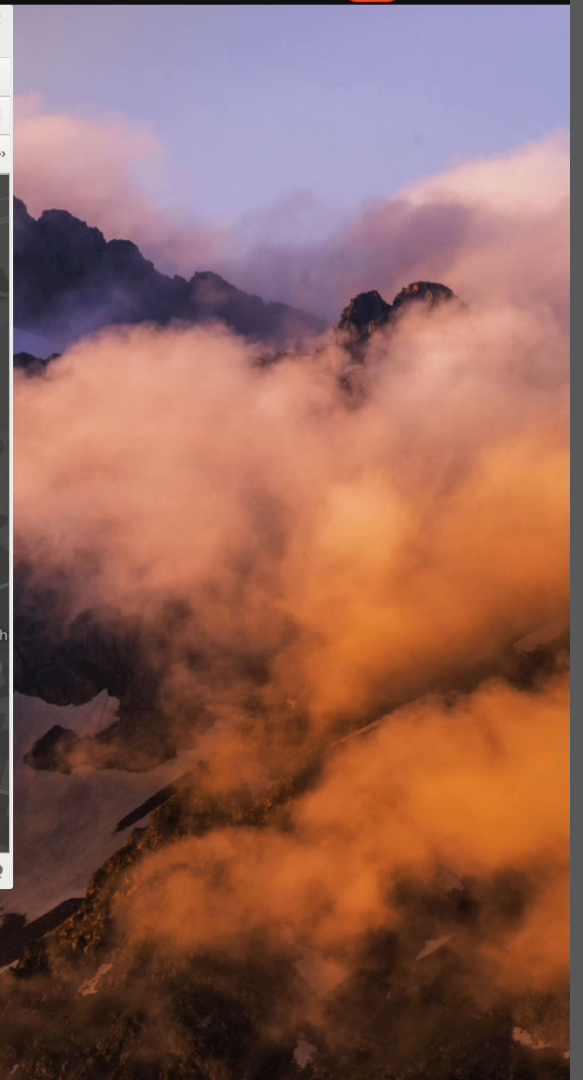
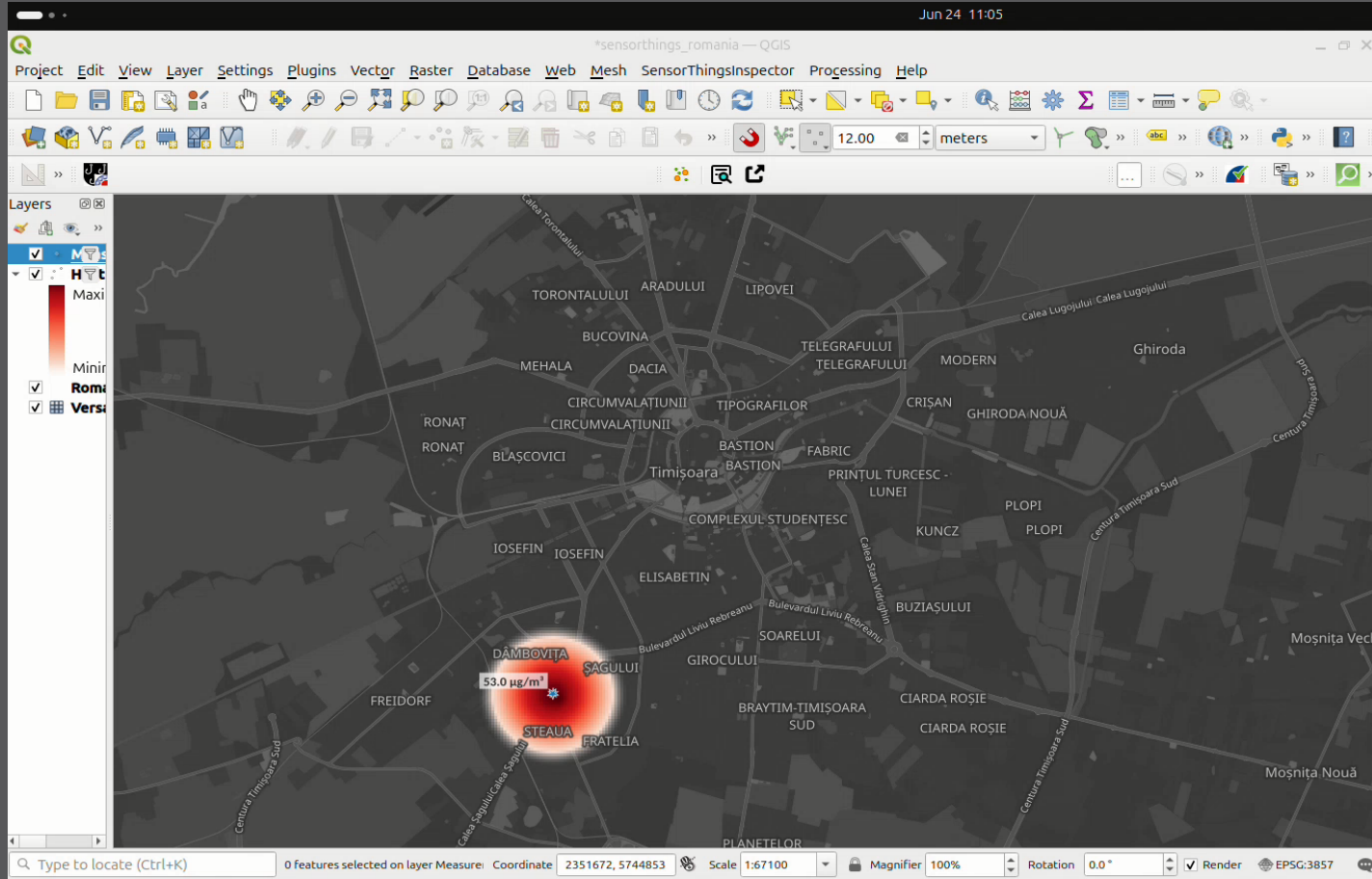
Event durations in *Months* assume a fixed 30-day month length, and durations in *Years*, *Decades* or *Centuries* assume a 365.25-day year length.

Accumulate features over time

Apply



Inspector tool





Inspector tool

STA-RO0193A

Location of station STA-RO0193A

TM-1

TM-1: Measurement station STA-RO0193A

Available observations

Name	Description
NO2 at TM-1	NO2 at STA-RO0193A
SPO-RO0193A_00001_100	SO2 at STA-RO0193A
SPO-RO0193A_00005_100	PM10 at STA-RO0193A
SPO-RO0193A_00010_100	CO at STA-RO0193A

Complex time series

Name	Description
NO2 at TM-1 [1 Days]	NO2 at STA-RO0193A agg
SPO-RO0193A_00001_100 [1 Days]	SO2 at STA-RO0193A agg
SPO-RO0193A_00005_100 [1 Days]	PM10 at STA-RO0193A agg
SPO-RO0193A_00010_100 [1 Days]	CO at STA-RO0193A aggregated per 1 Days

Observations

Location: STA-RO0193A
Station: STA-RO0193A
NO2 at TM-1
Invalid Date - Jun 24 2026
SPP-RO_A_chemi_enrivoAC31M (µg/m3)

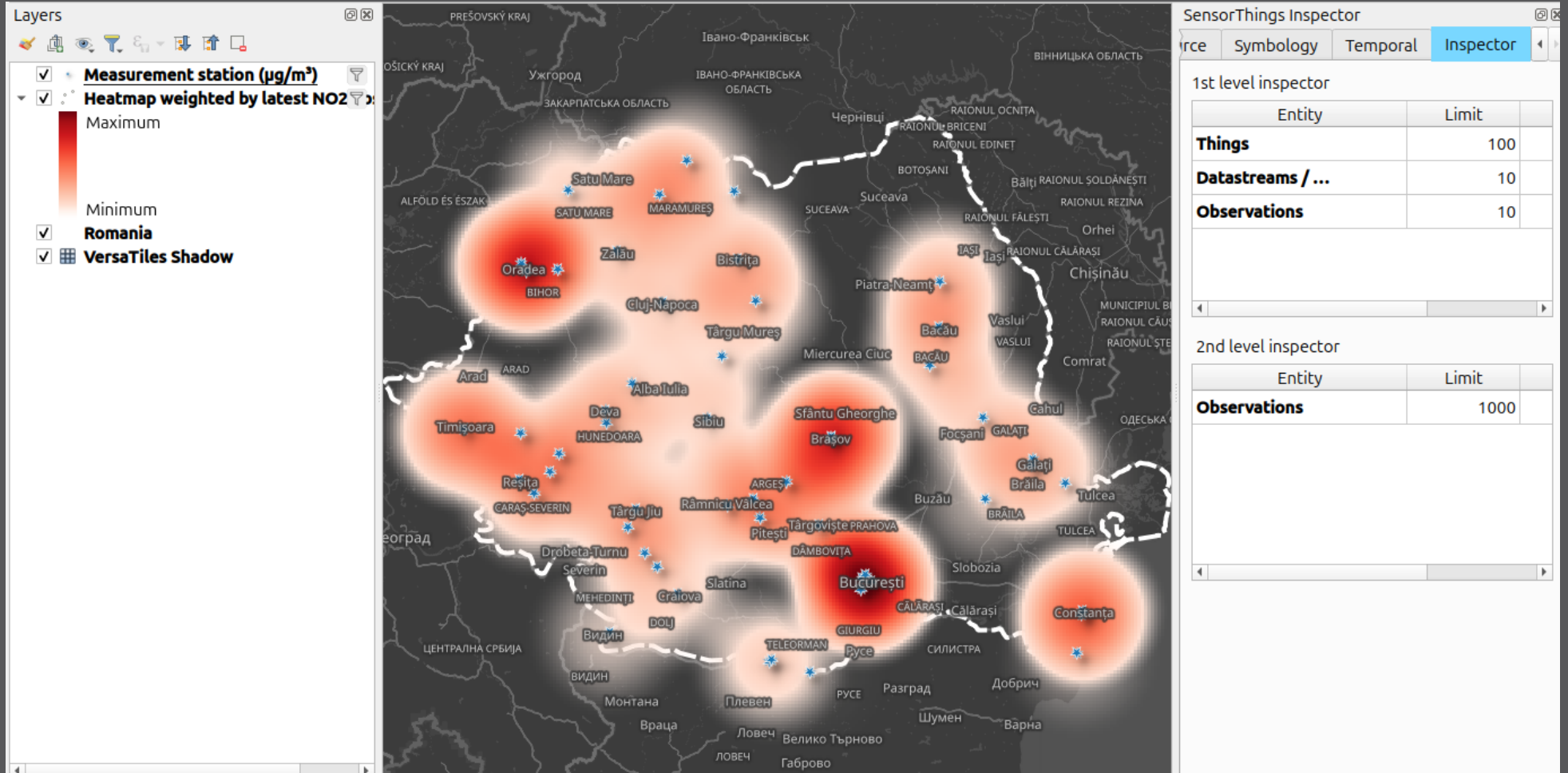
Values | Chart

Jan 01 2017 << < 06-17-2026 06-24-2026 > >> Jun 24 2026

Observations
NO2 at TM-1
SO2 at STA-RO0193A
PM10 at STA-RO0193A
CO at STA-RO0193A
A_chemi_enrivoAC31M
A_UV-FL_ML9850
N_gravi_tecoraSentinelPM
SPP-RO_A_NDIR_enviroCO11M



Final view QGIS Desktop before QWC





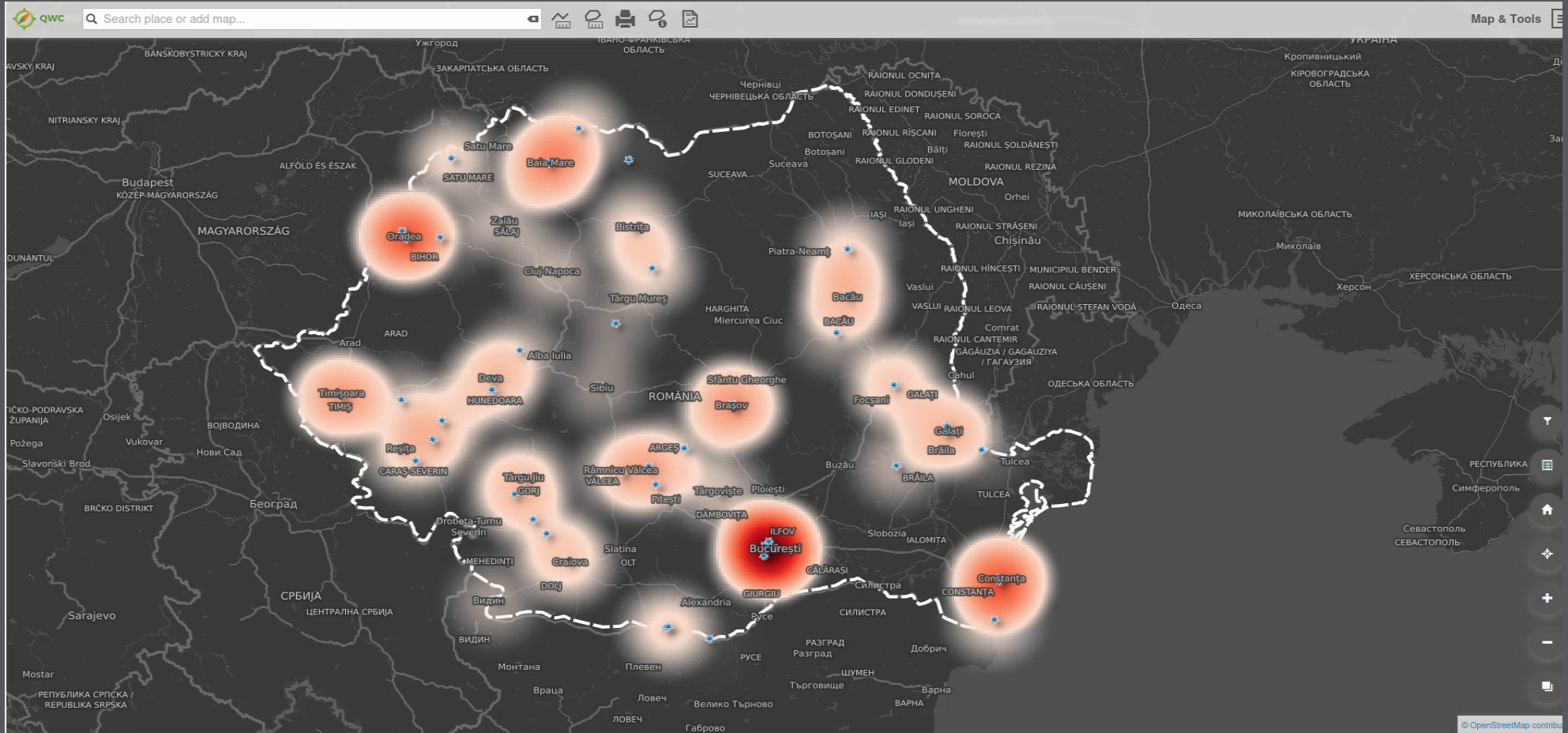
QWC setup

- 1. Save the QGIS project
- 2. Generate QWC service configurations
- 3. Enable the SensorThingsTool plugin
- 4. Add the plugin button to the map viewer
- 5. Allow the required plugin permissions in QWC Admin
- 6. Open the QWC map viewer and test the layer





QWC DEMO: Latest N02 observation, Romania





References

› Presentation

- › QWC-Demo: `click_me`
- › GitHub Repo: <https://github.com/msalas-sourcepole/foss4ge26-sensorthings>

› SensorThings API

- › <https://www.ogc.org/standards/sensorthings/>
- › <https://fraunhoferiosb.github.io/FROST-Server/>

› QGIS Desktop set up

- › <https://qgis.org/>
- › <https://plugins.qgis.org/plugins/SensorThingsAPI/>

› QWC set up

- › <https://docs.qwc.app/master/>
- › https://docs.qwc.app/master/references/qwc2_plugins/#sensorthingstool

› More questions? msalas@sourcepole.ch



Thank you!
Mulțumesc!



Mariano Salas