ODALA

Co-financed by the Connecting Europe Facility of the European Union

Activity 5: Interoperability framework for Environmental Sensing – Annex water quality implementation case of city of Bruges

Due date of deliverable:	31/07/23
Actual submission date:	28/07/2023
Version:	Version 1
Main Authors:	imec: Philip Leroux , Bart Matthys Sirus: Jens Rappé Digitaal Vlaanderen: Annelies De Craene, Simon Claus, Geraldine Nolf, Tom Callens
Abstract	In this deliverable, we show the implementation and replication potential of the Activity 5 building blocks. The water quality network of the city of Bruges is mapped to the OSLO Water quality application profile and published via a Linked Data Event Stream. The event stream is digested in a Digital Water Twin dashboard demonstrator application. Metadata is published via the official European data portal.
Keywords	Data model, OSLO standardisation, Linked Data Event Streams, Water Quality, Bruges, Open Data, Metadata

Table of content

1. INTRODUCTION

Based on the results of the environmental sensing toolkit (Activity 5) of the ODALA project the opportunity arose to foresee this work package of an extra by implementing its practicality and fit for purpose in the city of Bruges (Belgium).

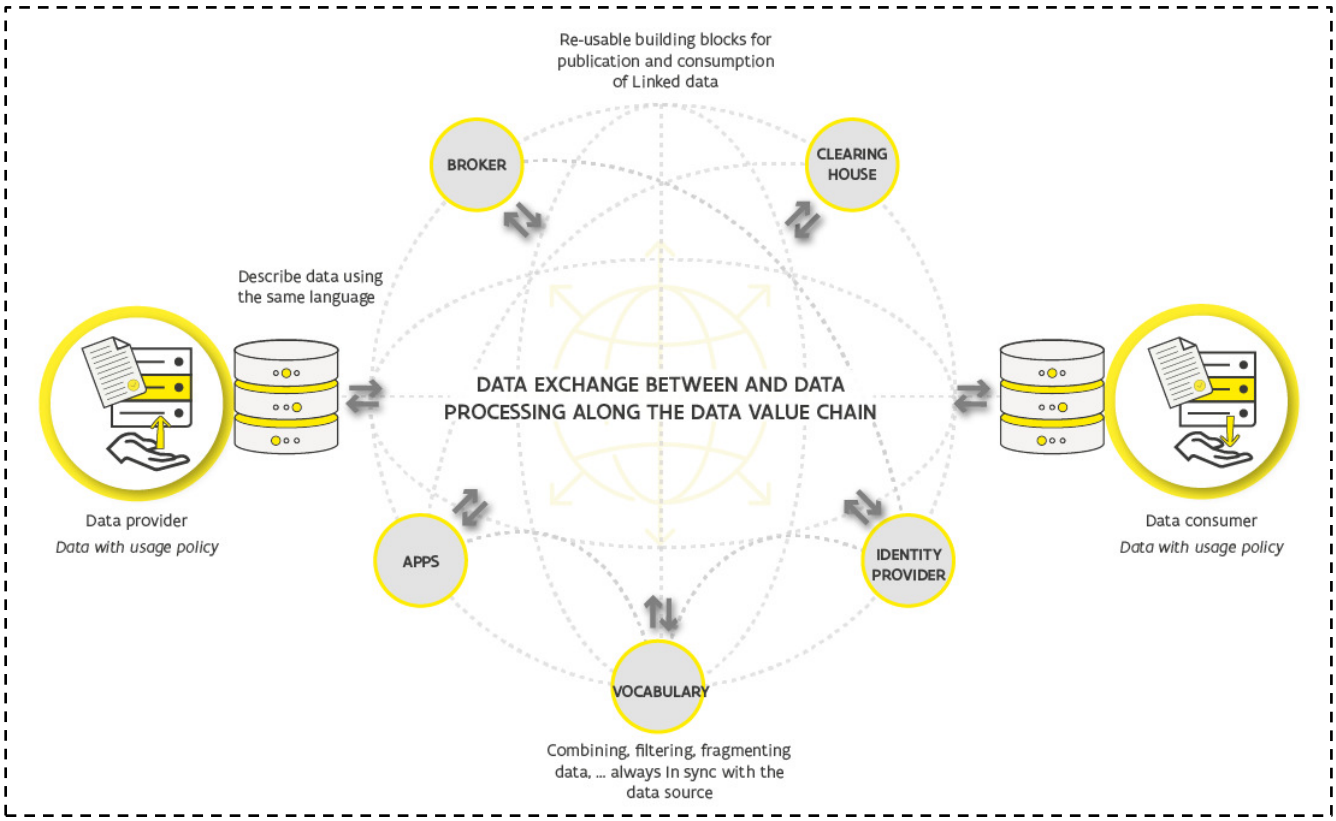
By putting these objectives into practice we offer a lot of advantages for the different participants in the datasharing ecosystem.

Furthermore the ODALA project team joined forces with the Flanders Smart Data Space to integrate the shared knowledge, onboard this data onto the Flanders Smart Data Space and make this data findable in an interoperable and scalable way through the VSDS[1]/LDES[2] objectives.

Based on the generally used roles and responsibilities of data spaces we identify a working separation of concern for the different participants in this demonstration ecosystem.

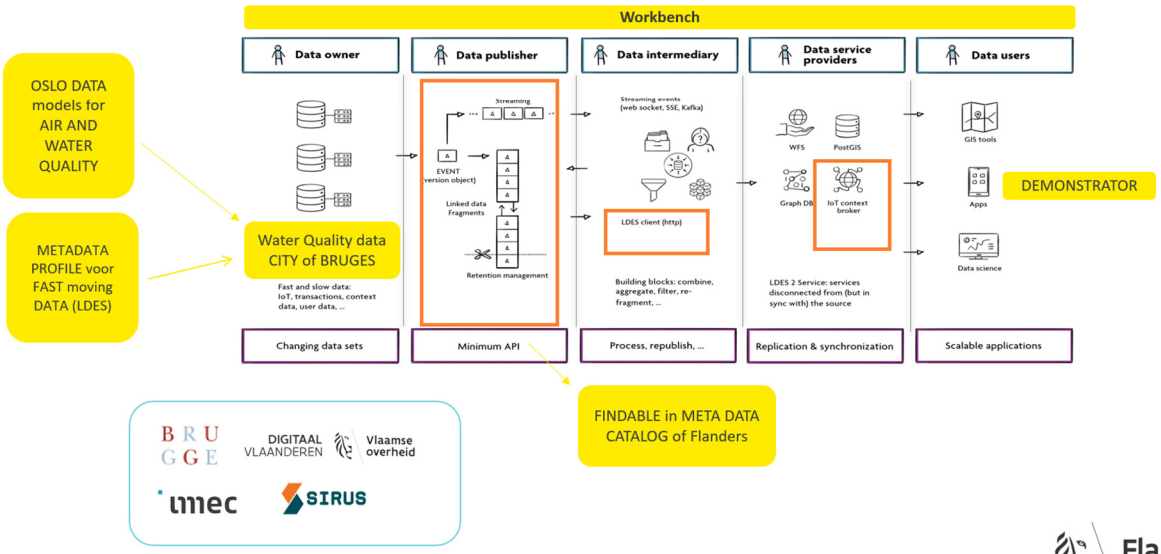
[1] VSDS is the initiative Vlaamse Smart Data Space (Flanders Smart Data Space) :https://www.vlaanderen.be/vlaamse-smart-data-space-portaal

[2] LDES refers to Linked data event streams, a semic living standard https://joinup.ec.europa.eu/collection/semic-support-centre/linked-data-event-streams-ldes and also a validated and adopted OSLO standard in Flanders : https://data.vlaanderen.be/doc/applicatieprofiel/ldes/



- 1) Data Owner: City of Bruges https://www.brugge.be/
- 2) Data Intermediary: Sirus (Urban Sense Platform) https://sirus.be/urban-sense/
- 3) Data re-user: imec
- 4) Vocabulary provider: Digitaal Vlaanderen - OSLO program
- 5) Metadata broker: Digitaal Vlaanderen - Metadata catalogue program
- 6) Data space software toolkit and connectors: Digitaal Vlaanderen - Flanders Smart Data Space program, imec Data Space teams (idlab, EDIT)

CEF ODALA : extract of the Flanders use case mapped on the data space approach (Water Labo data city of Bruges)



2. TRANSFORMING THE WATER QUALITY DATA MODEL TO THE OSLO WATER QUALITY DATA MODEL

The City of Bruges manages a long-term surface water quality monitoring program. These measurements allow the city of Bruges to monitor the quality of their surface waters and detect possible anomalies (pollution, …). At 64 locations in and around Bruges, 12 water quality parameters are measured such as temperature, pH, ammonium, Nitrate, Orthofosfaat, Chloride, Biochemical Oxygen Demand, Chemical oxygen demand, Total organic carbon, Total nitrogen and Sulfate. Furthermore, the Prati index is being calculated. These parameters are being monitored on a monthly basis and yearly averages are being derived. The water samples are analysed in a certified lab, from where the data is transferred onto a Laboratory Information Management System (LIMS) data system.

As part of this task, and in order to increase the interoperability of the dataset the semantic data model of this dataset has been mapped with the OSLO Water Quality data model. A test dataset has been provided by the City of Bruges, with data from the year 2021, which was analysed and mapped with the OSLO Water quality data model. Two workshops were organised in order to discuss both with the business owner of the city of Bruges and with the semantic linked data experts that the mapping has been done correctly. In a first iteration, the test dataset (sampling stations, time of sampling, parameter values, parameter units) has been mapped with the OSLO water quality dataset through a Data example that has been presented to the business owner. Based on these discussions additional metadata on the sampling protocol had been provided. Based on this additional information the Data example had been extended and the mapping file was finalized.

Example of the Data Example that maps the temperature value of the Water Quality dataset of Bruges with the OSLO Water Quality Model:

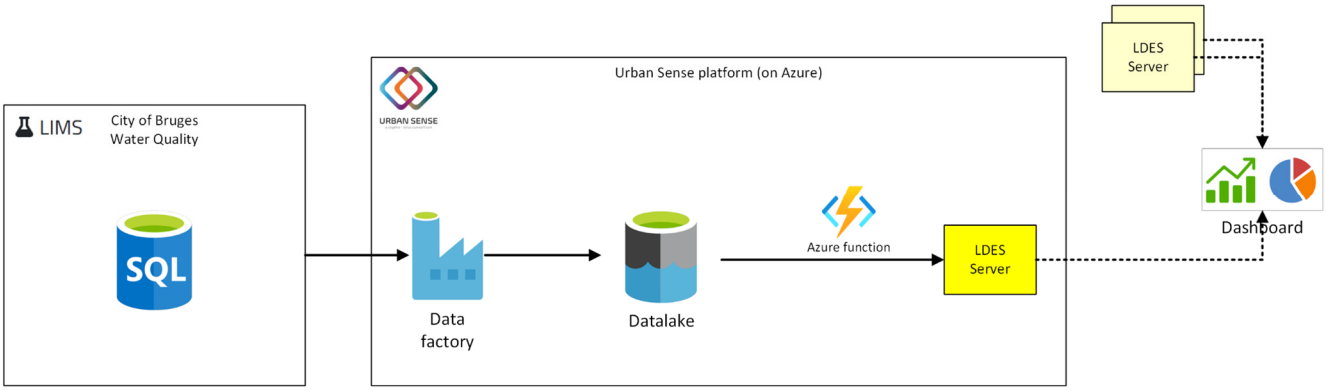
```
{
    "@context": [
        "",
        {
            "time": "http://www.w3.org/2006/time#",
            "dcterms": "http://purl.org/dc/terms/",
            "xml-schema": "http://www.w3.org/2001/XMLSchema#",
            "qudt-schema": "https://qudt.org/schema/qudt/",
            "cl-idt": "https://example.com/concept/identificatortype/",
            "cl-ovt":
"https://example.com/concept/observatieverzamelingtype/",
            "cl-opt":
"https://example.com/concept/observatieproceduretype",
            "cl-fch":
"https://data.omgeving.vlaanderen.be/id/concept/fysico-chemisch/",
            "cl-chs":
"https://data.omgeving.vlaanderen.be/id/concept/chemische_stof/",
            "qudt-unit": "https://qudt.org/vocab/unit/"
        }
    ],
    "@graph": [
        {
            "@id": "_:obv001",
            "@type": "Observatieverzameling",
            "": {
                "@type": "Identificator",
                "Identificator.identificator": {
                    "@value": "wa202115",
                    "@type": "cl-idt:verslagnummer"
                }
            },
            "Observatieverzameling.geobserveerdObject": "_:mon001",
            "Observatieverzameling.fenomeentijd": {
                "@type": "time:Instant",
                "time:inXSDDateTime": {
                    "@type": "xml-schema:dateTime",
                    "@value": "20210111T12:05:51.000"
```

```
                }
            },
            "Observatieverzameling.heeftLid": [
                "_:obs001",
                "_:obs002",
                ""
            ],
            "dcterms:type": {
                "@id": "cl-ovt:beproevingsverslag"
            }
        },
        {
            "@id": "_:obs001",
            "@type": "WaterkwaliteitParameterObservatie",
            "Observatie.geobserveerdObject": "_:mon001",
            "WaterkwaliteitParameterObservatie.geobserveerdKenmerk": "cl-
fch:0030",

"WaterkwaliteitParameterObservatie.waterkwaliteitParameterResultaat": {
                "@type": "Maat",
                "Maat.maat": {
                    "@type": "KwantitatieveWaarde",
                    "KwantitatieveWaarde.waarde": 3.6,
                    "KwantitatieveWaarde.standaardEenheid": {
                        "@type": "qudt-schema:Unit",
                        "@id": "qudt-unit:DEG_C"
                    }
                }
            },
            "Observatie.fenomeentijd": {
                "@type": "time:Instant",
                "time:inXSDDateTime": {
                    "@type": "xml-schema:datetime",
                    "@value": "20210111T12:05:51.000"
                }
            },
            "Observatie.resultaattijd": {
                "@type": "time:Instant",
                "time:inXSDDateTime": {
                    "@type": "xml-schema:date",
                    "@value": "20210219"
                }
            },
            "Observatie.gebruikteProcedure": {
                "@type": "Observatieprocedure",
                "Observatieprocedure.type": "cl-opt:laboanalyse",
                "Observatieprocedure.specificatie":
"https://reflabos.vito.be/2022/WAC_III_A_003.pdf"
            }
        },
```

3. PUBLICATION OF DATA BY SETTING UP A LINKED DATA EVENT STREAM

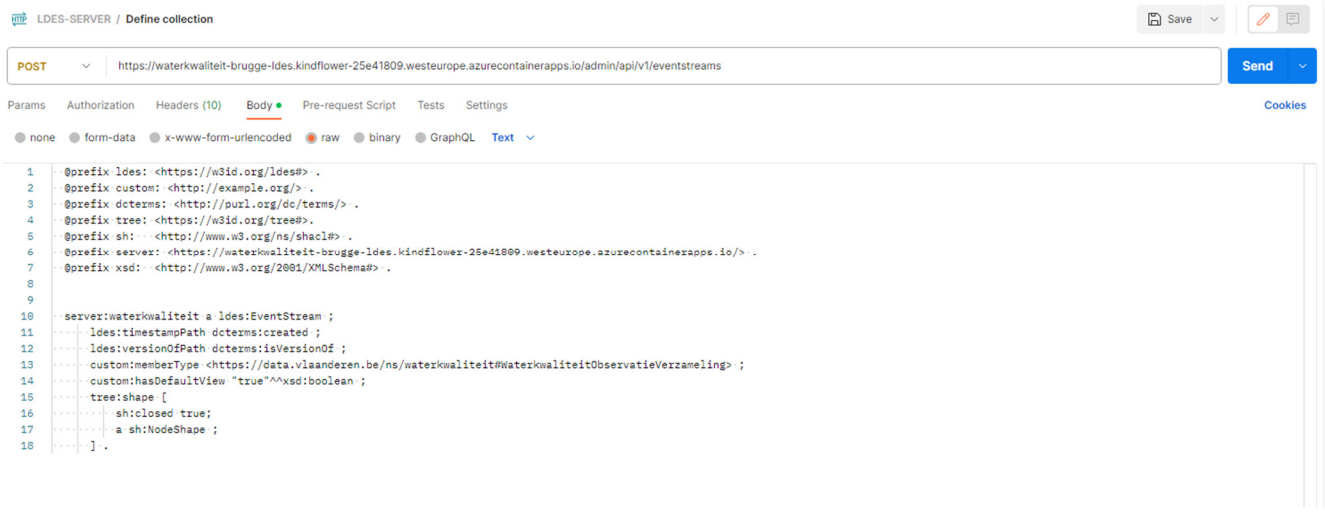
A data flow is set up in order to publish the data via the LDES server as linked data event stream. This flow contains a couple of different steps.



A network of water quality measurements is rolled out all over the city of Bruges. All the data is gathered in a central LIMS application. This application will provide the raw data of measurements such as temperature, pH, ammonium, Nitrate, etc… for different locations and for different timestamps. This data is extracted from the database, resided in a private domain of bruges. For every update a data flow is triggered in Azure Data Factory, and a json file with updated data is placed on a datalake. This step serves a couple of purposes:

- to store the raw data at all times in order trace or replay the data stream if necessary
- filter the scope of the data that is made available for publication
- extract the data from a private domain and make it available in a database/datalake that is still secure but accessible for the integrator.

An Azure function picks up the updates on the datal ake and harmonizes the raw data to an LDES format, that is subsequently proposed to the LDES server. This LDES server runs as a container in Azure.



The output json looks like this. By subscribing to this ldes stream (and other ldes streams) this can serve as a basis for dashboards and/or other applications.


```
{
    "@context": [
        {
            "time": "http://www.w3.org/2006/time#",
            "dcterms": "http://purl.org/dc/terms/",
            "xml-schema": "http://www.w3.org/2001/XMLSchema#",
            "qudt-schema": "https://qudt.org/schema/qudt/",
            "cl-idt": "https://example.com/concept/identificatortype/",
            "cl-ovt": "https://example.com/concept/observatieverzamelingtype/",
            "cl-opt": "https://example.com/concept/observatieproceduretype",
            "cl-fch": "https://data.omgeving.vlaanderen.be/id/concept/fysico-chemisch/",
            "cl-chs": "https://data.omgeving.vlaanderen.be/id/concept/chemische_stof/",
            "qudt-unit": "https://qudt.org/vocab/unit/",
            "@base": "https://brugge.be/id/"
        },
        "https://data.vlaanderen.be/doc/applicatieprofiel/waterkwaliteit/kandidaatstandaard/2022-10-17/context/waterkwaliteit-ap.jsonld"
    ],
    "@graph": [
        {
            "@id": "waterkwaliteitobservatieverzameling/2021000015/2023-07-07T12:10:44Z",
            "@type": "WaterkwaliteitObservatieVerzameling",
            "dcterms:created": {
                "@value": "2023-07-07T12:10:44Z",
                "@type": "xml-schema:dateTime"
            },
            "dcterms:isVersionOf": "waterkwaliteitobservatieverzameling/2021000015",
            "WaterkwaliteitObservatieVerzameling.geobserveerdObject": "bemonsteringsobject/2021000015/1",
            "WaterkwaliteitObservatieVerzameling.fenomeentijd": {
                "@type": "time:Instant",
                "time:inXSDDateTime": {
                    "@type": "xml-schema:dateTime",
                    "@value": "20210111T12:05:51.000"
                }
            },
            "WaterkwaliteitObservatieVerzameling.lid": [
                "waterkwaliteitparameterobservatie/2021000015/8",
                "chemischagensconcentratieobservatie/2021000015/11"
            ],
            "dcterms:type": {
                "@id": "cl-ovt:beproevingsverslag"
            }
        },
        {
            "@id": "waterkwaliteitparameterobservatie/2021000015/8",
            "@type": "WaterkwaliteitParameterObservatie",
```

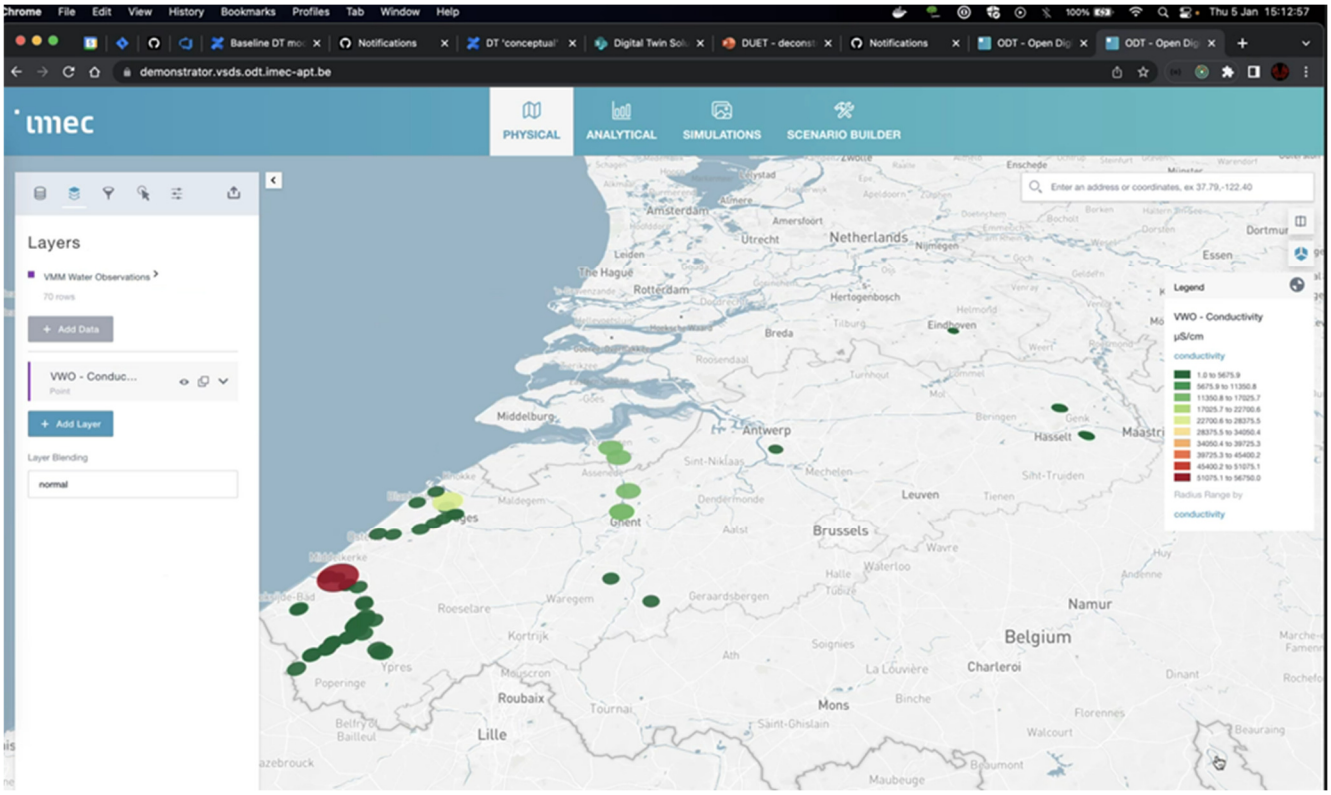
4. Open up the data service by making it discoverable through the European Data Portal

Metadata of the Linked Data Event Stream is being created and will be discoverable through the European data portal by the end of July 2023. Draft records are already available through the Flanders metadataportal:

- Dataset: Measurements of Water Quality about Watercourses of the City of Bruges - ODALA
  https://metadata.vlaanderen.be/srv/dut/catalog.search#/metadata/380683ef-9a90-4c53-bce4-e10ca3f21033
- Distribution: Linked Data Event Stream of Water Quality - Stad Brugge - ODALA
  https://metadata.vlaanderen.be/srv/dut/catalog.search#/metadata/0724e935-cc49-4fa5-9364-d99e07b77471

5. Visualise the data by Integrating the Local LDES together with the regional LDES

In 2022 as part of the VSDS project, a demonstrator was built to visualize IOW water quality data.



This was done as a proof of concept and had a few flaws:

- It was based on a single data stream
- It used a transformation from NGSI-LD to geoJSON
    - that transformation was hardcoded
    - the JSON output was not an actual stream but more a selection of data across time
    - metadata used was dependant on the frontend config

As input for ODALA we develop a version 2 of this demonstrator that builds on what was already done in the past but with a few core changes:

- will effectively parse an LDES stream
- is able to support multiple LDES streams (IOW data + labo data Brugge)
- uses dataspace building blocks designed in the VSDS project (LDES server, client, …)
- will be implemented more generically so different LDES streams can be added later on

6. CONCLUSIONS

In this deliverable, we have demonstrated the practical implementation and replication potential of the Activity 5 building blocks and standards of the ODALA project. The ODALA results were integrated in the Flanders Smart Data Space operational context.

- We have mapped the water quality data model of the city of Bruges to the OSLO Water Quality data model, which increases the interoperability and reusability of the data.
- We have published the data as a Linked Data Event Stream, which enables real-time and historical access to the data.
- We have made the data discoverable through the European Data Portal, which enhances the visibility and impact of the data.
- We have visualised the data in a Digital Water Twin dashboard, which provides a user-friendly and interactive way to explore the data.

By doing so, we have shown how different participants in the data-sharing ecosystem can benefit from using common standards, tools and services for environmental sensing data. We have in this case used the Flanders Smart Data Space building blocks at a higher TRL then the ODALA outcome provided in earlier TRL-stage.

This deliverable is a concrete example of how the ODALA project contributes to creating an operational system and data space approach as well as a single European data space for environmental data.