



In-situ water quality data harmonization and sharing Challenges and opportunities

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In situ calibration and validation of satellite products of water quality and hydrology

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The UNEP Global Environment Monitoring System for Freshwater (GEMS/Water)



2014: UNEA Res. 1/9

⇒ GEMS/Water

2018: UNEA Res. 3/10

⇒ WWQA

⇒ SDG 6

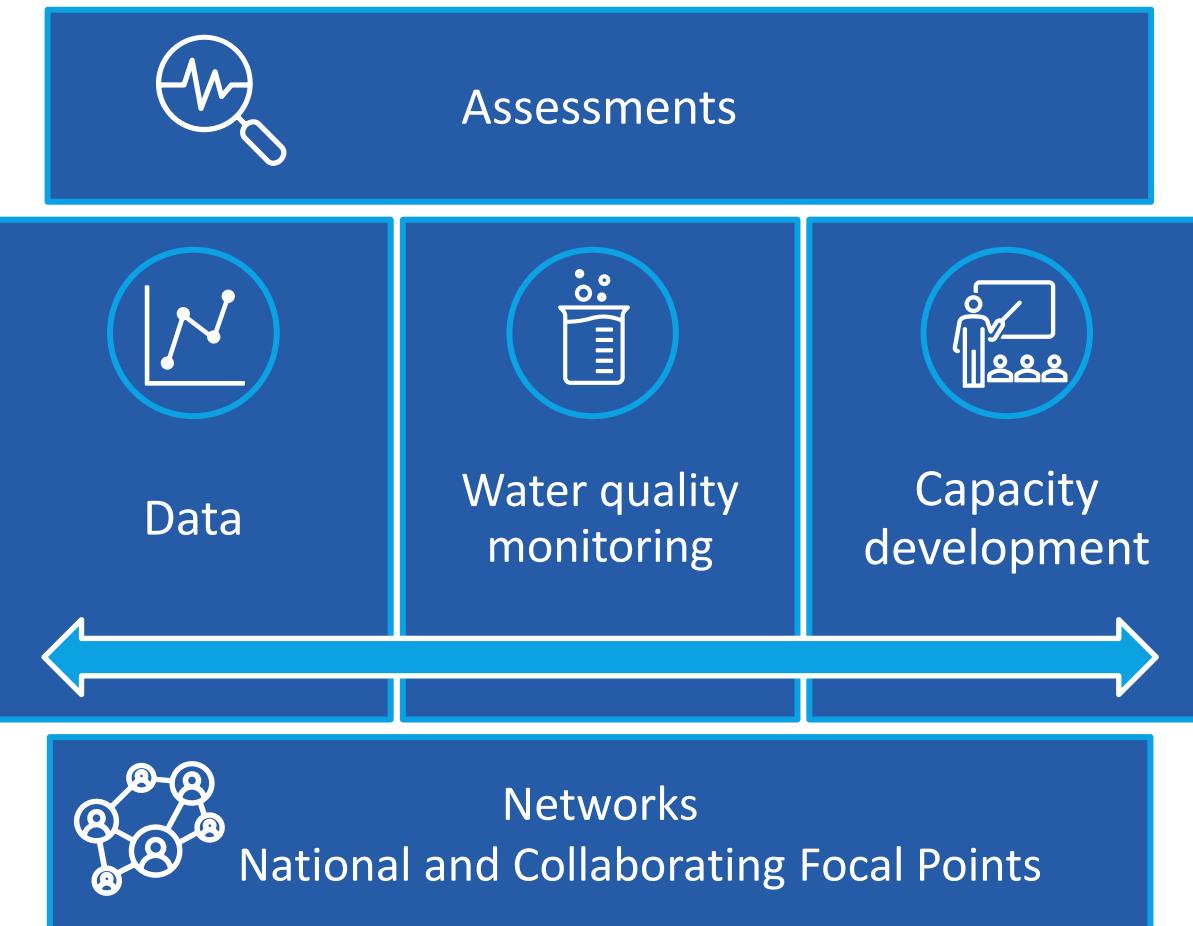


GEMS/Water Coordination Unit

Nairobi, Kenya



**GEMS/Water Data
Centre**
Koblenz, Germany



**GEMS/Water Capacity
Development Centre**
Cork, Ireland



University College Cork, Ireland
Coláiste na hOllscoile Corcaigh



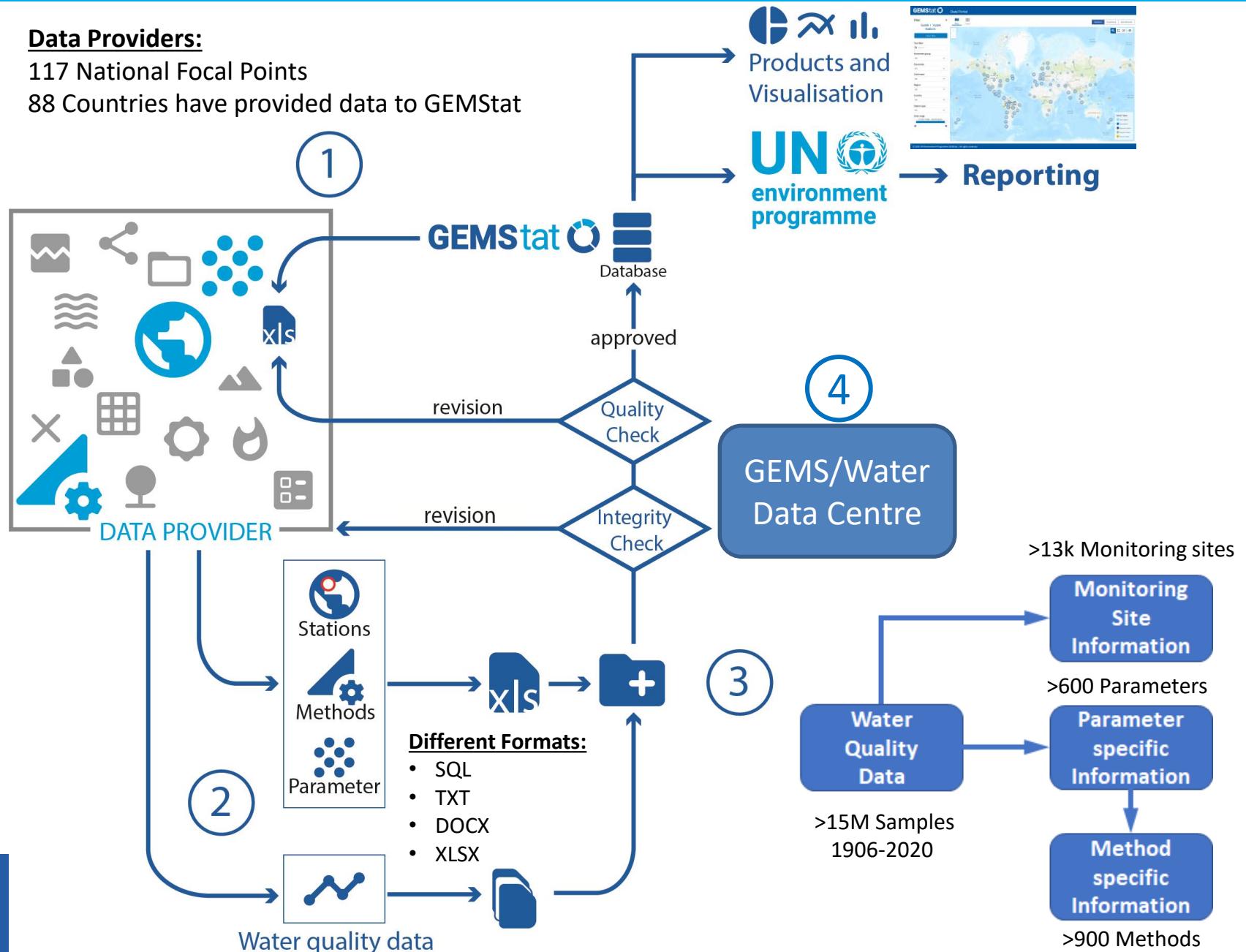
The global water quality database and information system **GEMStat**



Data Providers:

117 National Focal Points

88 Countries have provided data to GEMStat



Data Submission Workflow

1. Data Provider receives templates for reporting metadata on monitoring locations, water quality parameters and analytical methods
2. Data Provider compiles information on monitoring locations, water quality parameters and analytical methods, and establishes relation between their water quality data and these three entities.
3. Data Provider submits registration template with above three entities and their water quality data.
4. GEMS/Water Data Centre checks integrity of relationships between water quality data and entities, registers new entities where necessary within GEMStat database and checks quality of data submission.

Challenges for harmonizing and sharing water quality data



Example dataset from Lake Victoria

STATION	Date	Time	Long.	Lat.	Depth	Secchi	Sampling parameters								
							TA	TH	DO	Turb	Cond	pH	Redox	Temp	
Samunyi RM	18-Dec-13	09:49	34.41647	-0.51892	1.3	0.62	68	38	2.26	25.7	160.5	7.41	17	24	
Oluch RM	18-Dec-13	11:33	34.50118	-0.46207	2	0.34	62	40	6.97	289	152.5	7.87	-49	26.2	
Mirunda (RM)	19-Dec-13	12:19	34.34233	-0.49338	1.4	0.4	44	62	7.32	248	148.3	7.71	-31	28.7	
Sori	20-Dec-13	14:33	34.16403	-0.84513		1.2	40	36	6.6	107	6.26	7.33	-18	27.3	
kuja RM	21-Dec-13	10:50	34.14307	-0.90677	1	0.1	52	40	3.8	310	116.3	6.29	26	23.9	
Kadimo Bay (Anyanga)	22-Dec-13		34.0908	-0.08544	1.2	1.1	46	24	7.35	7.16	106	8.48	-61	27.6	
Usenge Beach	22-Dec-13	18:06	34.06362	-0.07072		1.5	36	66	6.44	2.69	107.6	7.61	-26	27.8	
Yala RM (Goye)	23-Dec-13	07:31	34.03563	-0.06894	1		48	56	3.08	3.9	104.5	6.82	5	25.3	
Bulwani	23-Dec-13	10:22	33.99582	0.00707	2.3	1.1	42	34	1.47	6.51	86.1	6.92	43	23.4	
Sio RM	23-Dec-13	16:05	34.00782	0.21936	1.2	0.8	42	34		11.6	113.5	7.95	-25	27.6	
Lwanda Kotieno	24-Dec-13	13:42	34.29225	-0.38361		1.2	46	42	6.78	11.9	127.4	6.99	9	27.9	
Asembo Bay	25-Dec-13				3.1	0.4	64	44	6.81	47.7	149.8	7.72	-44	25.8	
Nyando RM	26-Dec-13	09:57	34.83022	-0.2623	1.8	0.3	112	66	3.77	61.2	184.7	6.88	16	26.9	
Kisumu Bay	26-Dec-13	12:09	34.44568		1.9	0.1	264	44	6.15	85.9	159	7.48	-2	25.7	
Homa bay	19-Dec-13	09:36	34.27764	0.30916	3.88	0.6	64	56	5.33	27	154.6	7.84	-42	25.8	
Got Kachola	21-Dec-13	09:28	34.1355	-0.93565	0.5		50	44	1.03	4.43	95	7.12	11	24.5	
Bridge Island	22-Dec-13	10:36	34.06792	-0.2068	39.8	2.7	44	44	6.5	2.69	104	7.1	5	25.4	
Asat RM	25-Dec-13	11:06	34.5165	-0.18528	1.6	0.4	60	68	5.92	69	153	7.51	-25	26.7	
Kendu Bay	25-Dec-13	15:56	34.67217	-0.35298	1.5		62	42	4.4	79.6	158.1	7.15	19	28.6	
Fisheries Pier	26-Dec-13				1.9	0.1	264	44	11.83	27.3	169.7	8.48	-75	31.6	

Sampling parameters

Unclear metadata

- Parameters?
- Reference systems?

Missing metadata

- Units?
- Methods?
- Station metadata
 - Water body type

... and Opportunities

- Use open application schemata/ontologies to encode water quality (meta)data
- Use linked water quality vocabularies to facilitate harmonization and interoperability:
 - Water quality parameters
 - Units
 - Sampling and analytical methods
 - Data quality, ...
- Provide access through standard protocols/web services and formats
- Publish data using (open) licenses

FAIR data principles



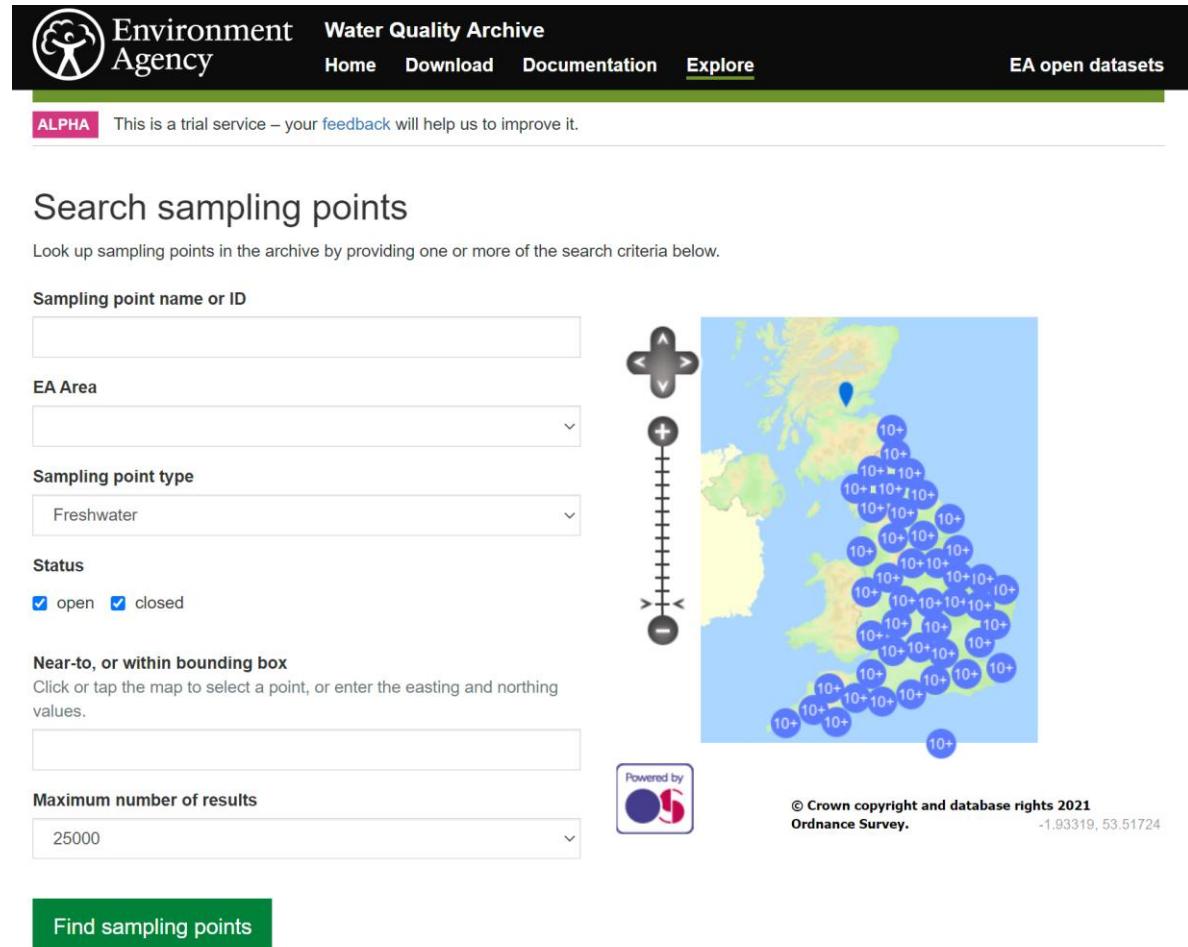
<https://www.andis.org.au/working-with-data/fairdata/training>, CC-BY 4 International

FAIR water quality data - The UK Water Quality Archive



- Use open application schemata/ontologies to encode water quality (meta)data 
- Use linked water quality vocabularies to facilitate harmonization and interoperability:
 - Water quality parameters: 
 - [https://environment.data.gov.uk/water-quality/def/determinands.html? _limit=100& _sort=label](https://environment.data.gov.uk/water-quality/def/determinands.html?_limit=100&_sort=label)
 - Units: 
 - [https://environment.data.gov.uk/water-quality/def/units.html? _sort=label](https://environment.data.gov.uk/water-quality/def/units.html?_sort=label)
 - Sampling and analytical methods 
 - Data quality, ... 
- Provide access through standard protocols/web services and formats
 - REST API => JSON, CSV, RDF
- Publish data using (open) licenses
 - UK [Open Government License](#) 

<https://environment.data.gov.uk/water-quality/view/landing>



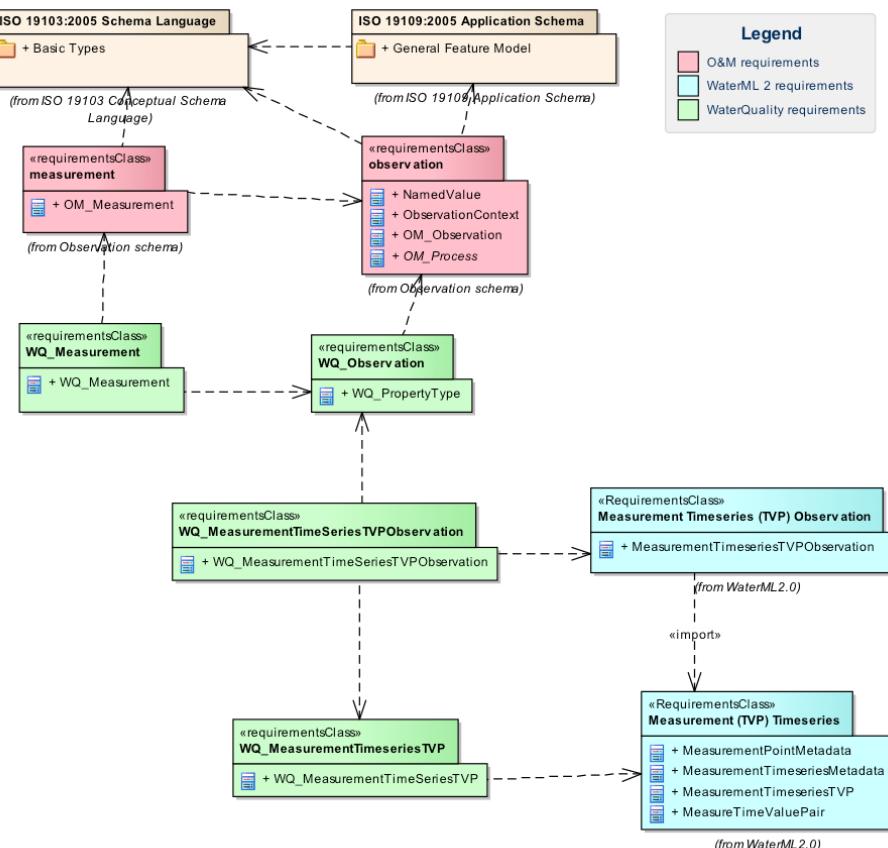
Reusable water quality data – Community standards



OGC WaterML- WQ

<http://docs.opengeospatial.org/bp/14-003/14-003.html>

1. single measurements of a single water quality parameter, where the result is a scalar value
2. multiple measurements of a single water quality parameter related to a single location, where the result is organized into a time-series, as time-value pairs (TVP).



W3C/OGC Semantic Sensor Network Ontology

<https://w3c.github.io/sdw/ssn/>

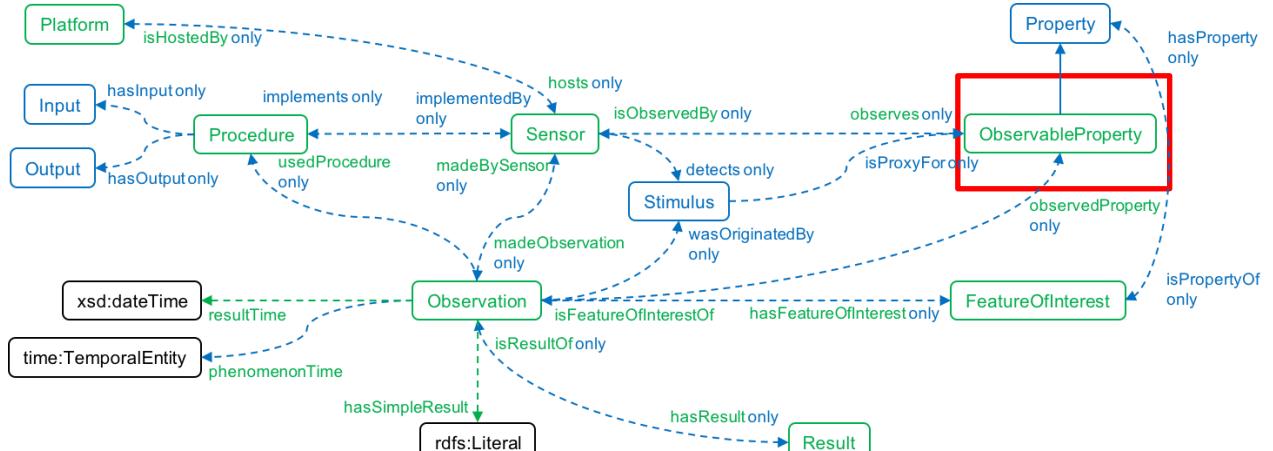


Figure 10 Classes and relationships involved in Observation (SOSA/SSN)

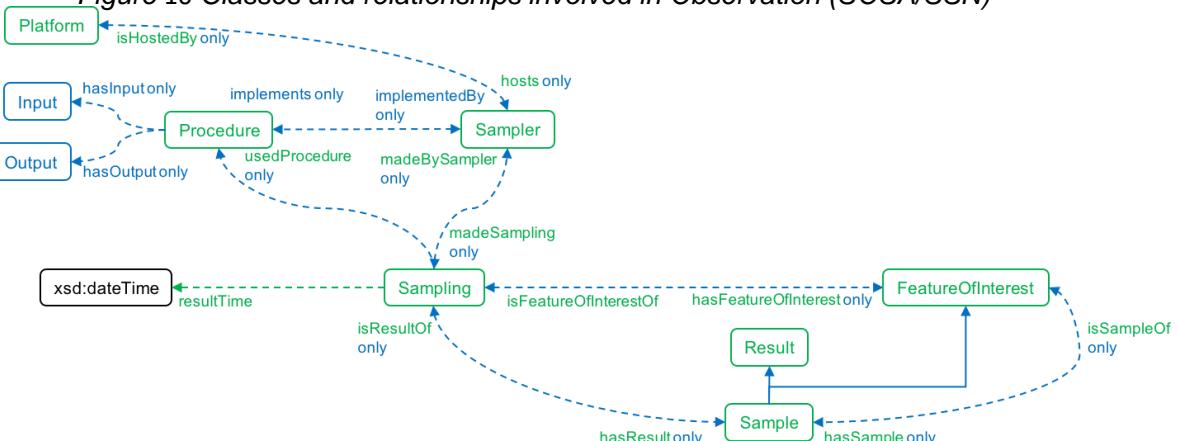


Figure 14 Classes and relationships involved in Sampling (SOSA/SSN)

Interoperable water quality data – FAIR vocabularies



eReefs Observable Property vocabulary

<http://registry2.it.csiro.au/def/property>

CSIRO Linked Data Registry Browse About Advanced ▾ Search Submit

http://registry.it.csiro.au/def/environment/_property

stable

Register: observable properties

URI: <http://registry.it.csiro.au/def/environment/property>

A collection of observable properties. This vocabulary defines terms for observed properties originally used for groundwater, surface water and marine water quality observations. Most PropertyKinds are associated with a Species object via the objectOfInterest property or a real-world Feature via the featureOfInterest property. The sub-class of PropertyKinds that can be measured are ScaledQuantityKinds, which have appropriate units of measure (qudt:unit property). This water quality ontology re-uses the Quantities, Units, Dimensions, Data Types (QUDT) ontology which is developed by TopQuadrant and NASA.

Contents (tree view)

- + chemistry observable properties A collection of observable chemistry properties **stable**
- + life form observable properties A collection of observable organism properties **stable**
- + major element observable properties A collection of observable major elements as specified by Australia... **stable**
- + minor or trace element observable properties A collection of observable minor trace elements as specified by Aus... **stable**
- + nutrient observable properties A collection of observable nutrients **stable**
- + organic observable properties A collection of observable organic material **stable**
- + physical observable properties A collection of observable physical properties **stable**
- + trace element observable properties A collection of observable trace elements as specified by Australia... **stable**

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Developed by Epimorphics Ltd
Sponsored by CSIRO Australia

SKOS vocabulary based on existing ontologies QUDT + ChEBI

Core metadata
Reg metadata
Download
History
Send comment

Item: nitrogen concentration

URI: http://environment.data.gov.au/def/property/nitrogen_concentration

[nitrogen concentration](#)

Definition

broader non-metal concentration | Concentration
broader relative abundance | chemical entity concentration
transitive | abundance
description nitrogen concentration
generalization Concentration | non-metal concentration
label nitrogen concentration
narrower inorganic nitrogen concentration | nitrate and nitrite N concentration | nitrogen oxides concentration
narrower nitrite N concentration | nitrate N concentration
transitive
object of nitrogen
interest
pref label nitrogen concentration
source eReefs
specialization nitrogen oxides concentration | nitrate and nitrite N concentration | inorganic nitrogen concentration
type scaled quantity kind | chemistry quantity kind | Concept
unit Mole Percent | Milligrams per Litre | Milligrams per Cubic Meter | Milligrams per Square Meter

Links

Has broader concept

- non-metal concentration
- Concentration

Has broader transitive concept

- chemical entity concentration
- abundance
- relative abundance

Has narrower concept

- nitrate and nitrite N concentration
- inorganic nitrogen concentration
- nitrogen oxides concentration

Has narrower transitive concept

- nitrate N concentration
- nitrite N concentration

Object of interest

- nitrogen

Has more general quantity kind

- non-metal concentration
- Concentration

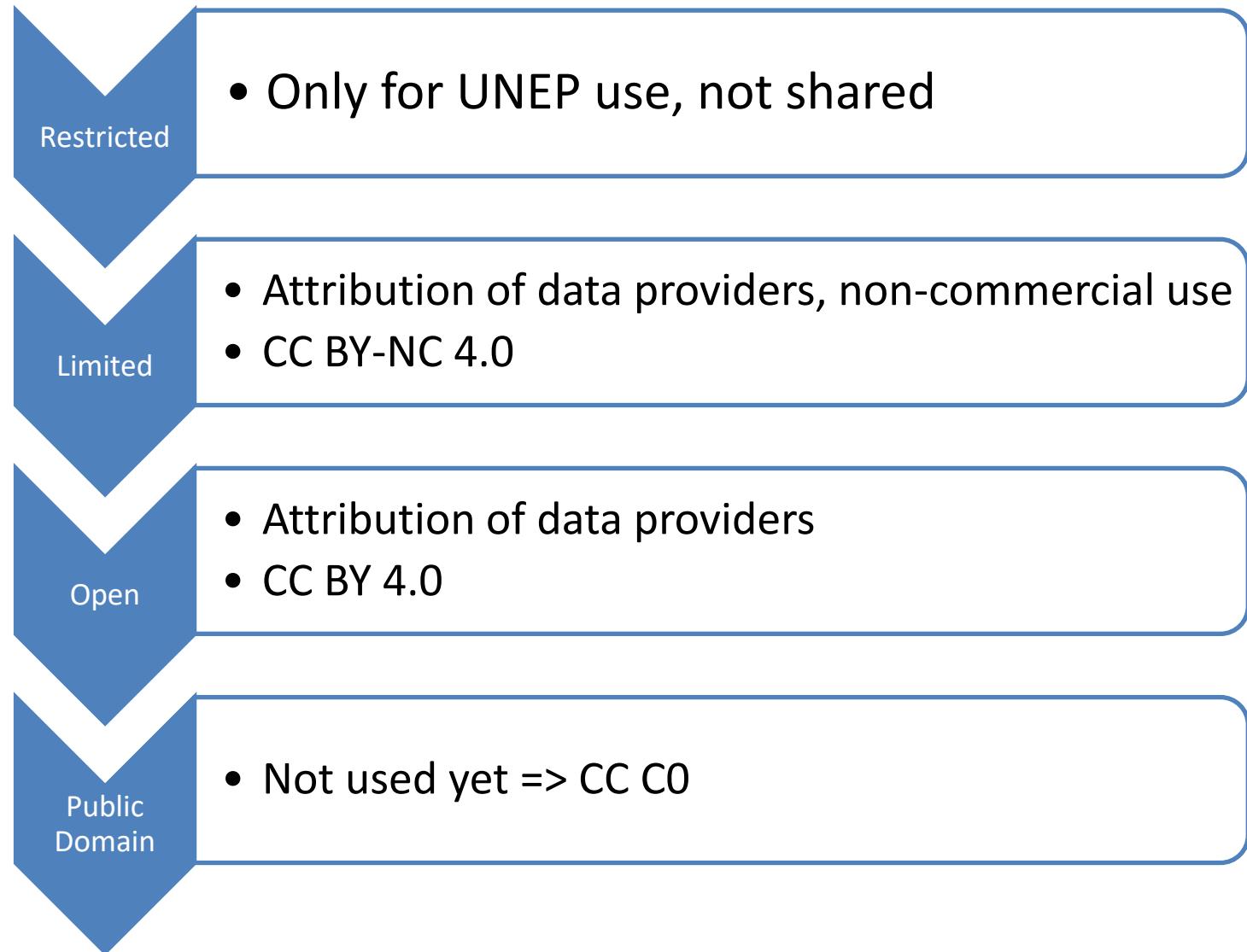
Has more specialized quantity kind

- nitrate and nitrite N concentration
- inorganic nitrogen concentration
- nitrogen oxides concentration

Has unit of measure

- Milligrams per Cubic Meter
- Milligrams per Litre
- Milligrams per Square Meter
- Mole Percent

http://registry2.it.csiro.au/def/property/_nitrogen_concentration



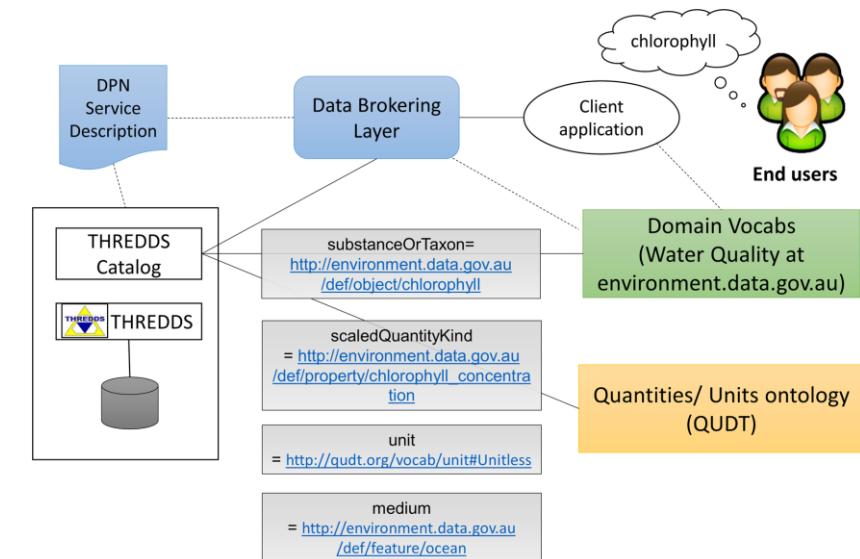
Future directions

- Publish GEMStat database under Open Data Commons Open Database Licence
- Publish contents under respective data provider licenses

Recommendations to improve data harmonization and sharing



- Further develop and publish upper-level ontologies/vocabularies for water quality parameters, analytical methods, ...
 - Governance?
- Encourage data providers to share data as open as possible referencing international licenses (compatible)
 - Creative Commons or Open Data Commons
- Further develop and agree upon standard protocols and formats for making data accessible
 - OGC data format standards (WaterML 2 WQ)
 - OGC APIs (SOS, EDR)
- Develop tools to deal with complex standards



Thank you for your attention!



Contact:

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Head of the GEMS/Water Data Centre



United Nations
Educational, Scientific and
Cultural Organization



International Centre
for Water Resources and Global Change
under the auspices of UNESCO

GEMStat The logo for GEMStat, consisting of the word "GEMStat" in bold capital letters followed by a stylized water droplet or wave icon.

<https://gemstat.org>

