Deltares
Enabling Delta Life

Comparison of time series ingest performance of various standardized file formats using DelftFEWS

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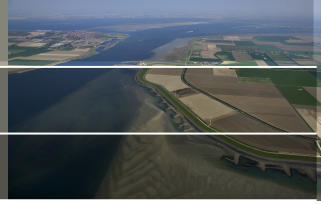
UNESCO-IHE
Institute for Water Education

Topics



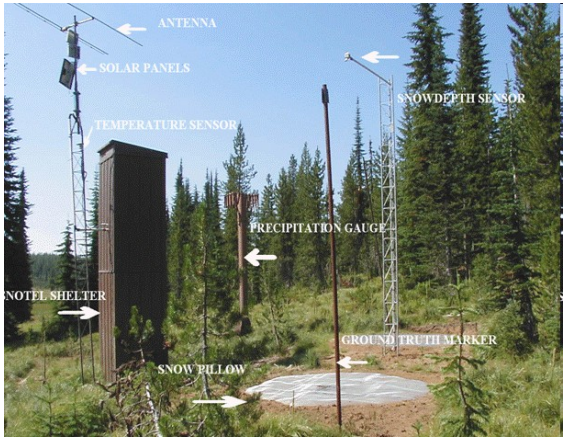
- Context
  - Standardization to share hydrological data
  - Flood Forecasting
- Objective of the experiment
- Results
- Lessons learned

Context (i): Data sharing

- DWG Hydro

- Sensor web enablement
- Hydrological time series data exchange
- WaterML 2.0

- Interoperability Experiments



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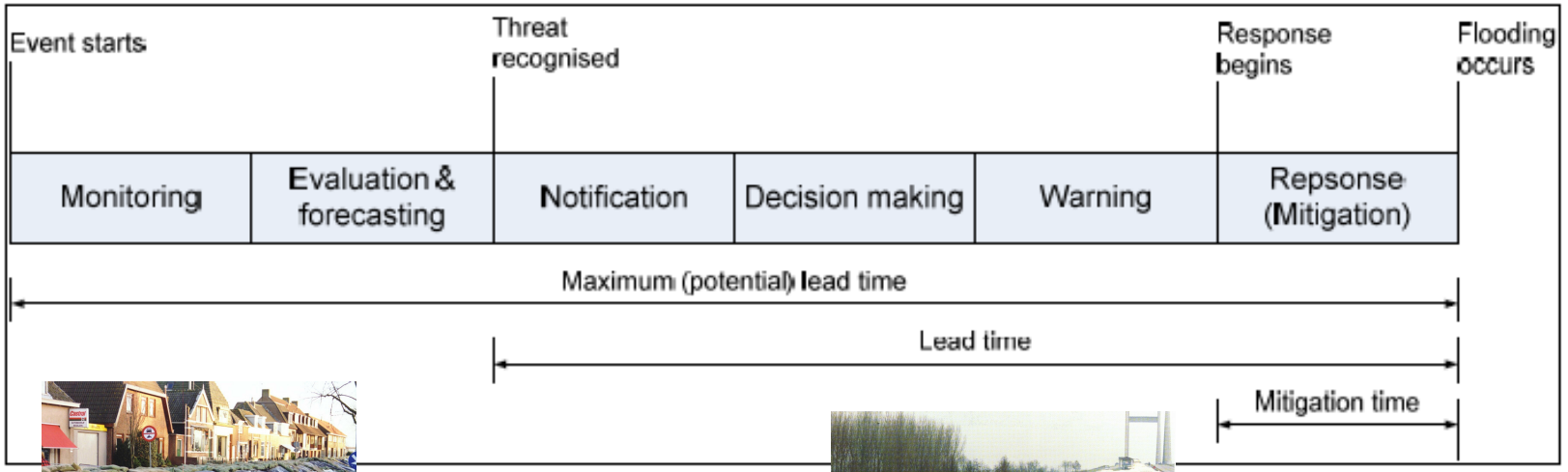
Context (ii): Flood Forecasting



Forecasts are only useful when there is time left to warn and act

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Surface Water Interoperability Experiment

- Part of Surface Water IE by DWG Hydro
- Use Case 2: data ingest

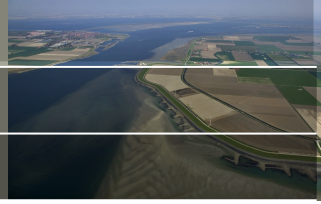
- Objective:
- Asses suitability of OGC standards for incremental data ingest in real time to support forecasting systems
  - SOS2.0: web-service (call method)
  - WaterML 2.0: data encoding (format)

Preparation for Hydrologic Forecasting IE

SWIE-UC2 (OHI0) – Operational Hydrologic incremental data Ingest
HFIE-OHF1 – Operational Hydrologic flood Forecasting
HFIE-HIO2 – Hydrologic Infrastructure Operation
HFIE-MHOF3 – joint Meteo-Hydro Operational Forecasting

Planning:
- Kickoff sep 2011

Methodology



Compare performance of data ingest of OGC encodings with other standardized data formats:

- NWS-SHEF
- FEWS-PI-xml
- O&M1 (SWE-common)
- WaterML 2.0

Comparison criteria:

- Lines of source code in client: → proxy for code complexity
- File size (un/compressed) → proxy for network load
- Ingest time (net) required by DelftFEWS

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File formats – NOAA/NWS-SHEF

Standard Hydrologic Exchange Format

Fortran aged encoding style (semi fixed formatting)

Various flavours (.A, .AR, .B., .E, .ER)

```
: SHEF file
: Date/time forecast: 20110413

.ER TAPM4 20110403 Z DH06/DC201104151718/QIN    /DIH01
.E1    780.00/  780.00/  785.00/  785.00/  785.00/  790.00/  795.00/  801.00/
.E2    801.00/  806.00/  811.00/  816.00/  821.00/  821.00/  826.00/  832.00/
```

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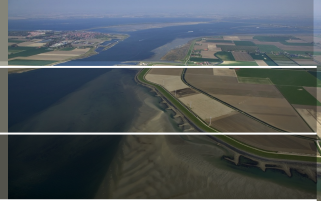
File formats – FEWS PI-xml



DelftFEWS Published Interface

xml-encoding

```
<TimeSeries xmlns="http://www.wldelft.nl/fews/PI" ....">
    <timeZone>0.0</timeZone>
    <series>
        <header>
            <type>instantaneous</type>
            <locationId>TAPM4</locationId>
            <parameterId>QIN</parameterId>
            <timeStep unit="nonequidistant"/>
            <startDate date="2011-04-13" time="06:00:00"/>
            <endDate date="2011-04-15" time="06:00:00"/>
            <missVal>-999.0</missVal>
            <stationName>Paradise 12W</stationName>
            <units>CMS</units>
        </header>
        <event date="2011-04-13" time="06:00:00" value="2329.9998" flag="0"/>
        <event date="2011-04-13" time="07:00:00" value="2329.9998" flag="0"/>
        <event date="2011-04-13" time="08:00:00" value="2329.9998" flag="0"/>
     ....
    </series>
</TimeSeries>
```

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File formats – OGC-O&M1- SWE common

OGC-Observatoins & Measurements using SWE Common encoding

```
<om:ObservationCollection gml:id="oc_oc1302859889906" ...>
  <gml:boundedBy>
    <gml:Envelope srsName="urn:ogc:def:crs:EPSG:4326">
      <gml:lowerCorner>51.58278906918545 11.794808643213615</gml:lowerCorner>
      <gml:upperCorner>51.58278906918545 11.794808643213615</gml:upperCorner>
    </gml:Envelope>
  </gml:boundedBy>
  <om:member>
    <om:Observation>
      <om:samplingTime>
        <gml:TimePeriod xsi:type="gml:TimePeriodType">
          <gml:beginPosition>2011-04-14T08:00:00.000+02:00</gml:beginPosition>
          <gml:endPosition>2011-04-15T05:00:00.000+02:00</gml:endPosition>
        </gml:TimePeriod>
      </om:samplingTime>
      <om:procedure xlink:href="Wasserstand-Wettin_Up_570840"/>
      <om:observedProperty>
        <swe:CompositePhenomenon gml:id="cpid0" dimension="1">
          <gml:name>resultComponents</gml:name>
          <swe:component xlink:href="urn:ogc:data:time:iso8601"/>
          <swe:component xlink:href="Wasserstand"/>
        </swe:CompositePhenomenon>
      </om:observedProperty>
      <om:featureOfInterest>
        <gml:FeatureCollection>
          <gml:featureMember>
            <sa:SamplingPoint gml:id="Wettin_Up_570840" xsi:schemaLocation=" http://www.opengis.net/sampling/1.0
http://schemas.opengis.net/sampling/1.0.0/sampling.xsd">
              <gml:name>Wettin Up - Kilometer: 70</gml:name>
              <sa:sampledFeature xlink:role="urn:x-ogc:def:property:river" xlink:href="SAALE"/>
              <sa:position>
                <gml:Point>
                  <gml:pos srsName="urn:ogc:def:crs:EPSG:4326">51.58278906918545 11.794808643213615</gml:pos>
                </gml:Point>
              </sa:position>
            </sa:SamplingPoint>
          </gml:featureMember>
        </gml:FeatureCollection>
      </om:featureOfInterest>
      <om:result>
        <swe:DataArray>
          <swe:elementCount>
            <swe:Count>
              <swe:value>57</swe:value>
            </swe:Count>
          </swe:elementCount>
          <swe:elementType name="Components">
            <swe:DataRecord>
              <swe:field name="Time">
                <swe:Time definition="urn:ogc:data:time:iso8601"/>
              </swe:field>
              <swe:field name="feature">
                <swe:Text definition="urn:ogc:data:feature"/>
              </swe:field>
              <swe:field name="Wasserstand">
                <swe:Quantity definition="Wasserstand">
                  <swe:uom code="cm"/>
                </swe:Quantity>
              </swe:field>
            </swe:DataRecord>
          </swe:elementType>
          <swe:encoding>
            <swe:TextBlock decimalSeparator="." tokenSeparator="," blockSeparator=";"/>
          </swe:encoding>
          <swe:values>2011-04-14T08:00:00.000+02:00,Wettin_Up_570840,366.0;2011-04-14T08:15:00.000+02:00,Wettin_Up_570840,366.0;</swe:values>
        </swe:DataArray>
      </om:result>
```

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File formats – OGC-WaterML 2.0

OGC-Observatoins & Measurements using WaterML2 encoding

```
<wml2:TimeseriesObservation ../waterml2.xsd">
<gml:identifier codeSpace="http://nwis.waterdata.usgs.gov/WI/nwis">USGS.04071765</gml:identifier>
<gml:name codeSpace="http://nwis.waterdata.usgs.gov/WI/nwis">OCONTO RIVER NEAR OCONTO, WI</gml:name>
<om:metadata>
        <wml2:ObservationMetadata>
                <gmd:contact xlink:href="mailto:h2o@usgs.gov"/>
                <gmd:dateStamp>
                <gco:Date>2011-04-13</gco:Date>
                </gmd:dateStamp>
                <gmd:identificationInfo xlink:href="urn:OGC:unknown"/>
                <wml2:status xlink:href="http://waterdata.usgs.gov/WI/nwis/help/?provisional"/>
        </wml2:ObservationMetadata>
</om:metadata>
<om:phenomenonTime>
        <gml:TimePeriod gml:id="ts_period">
                <gml:beginPosition>2011-04-03T00:00:00-06:00</gml:beginPosition>
                <gml:endPosition>2011-04-13T07:00:00-06:00</gml:endPosition>
        </gml:TimePeriod>
</om:phenomenonTime>
<om:resultTime>
        <gml:TimeInstant gml:id="result_time">
                <gml:timePosition>2011-04-13T09:43:31</gml:timePosition>
        </gml:TimeInstant>
</om:resultTime>
<om:procedure xlink:href="http://www.nemi.gov" xlink:title="Discharge"/>
<om:observedProperty xlink:href="urn:ogc:def:phenomenon:OGC:Discharge" xlink:title="Discharge"/>
<om:featureOfInterest>
        <wml2:MonitoringPoint gml:id="USGS.WMP.04071765">
                <sf:sampledFeature xlink:href="http://nwisvaws02.er.usgs.gov/ogc-swie/wfs?request=GetFeature&featureId=04071765"/>
                <sf:parameter>
                        <om:NamedValue>
                                <om:name xlink:title="Watershed"/>
                                <om:value>Oconto</om:value>
                        </om:NamedValue>
                </sf:parameter>
                <sams:shape>
                        <gml:Point gml:id="USGS.P.04071765">
                                <gml:pos srsName="urn:ogc:def:crs:EPSG:4269">44.86054589 -87.98399270</gml:pos>
                        </gml:Point>
                </sams:shape>
                <wml2:descriptionReference xlink:href="http://external.opengis.org/twiki_public/bin/view/HydrologyDWG/" xlink:title="IE"/>
                <wml2:timeZone>
                        <wml2:TimeZone>
                                <wml2:zoneOffset>-05:00</wml2:zoneOffset>
                                <wml2:zoneAbbreviation>CST</wml2:zoneAbbreviation>
                        </wml2:TimeZone>
                </wml2:timeZone>
        </wml2:MonitoringPoint>
</om:featureOfInterest>
<om:result>
        <wml2:owner>
                <gmd:organisationName>
                        <gmd:CharacterString>Wisconsin Water Science Center</gmd:CharacterString>
                </gmd:organisationName>
        </wml2:owner>
        <wml2:Timeseries gml:id="time_series_loc_0">
                <wml2:domainExtent xlink:href="ts_period">
                        <gml:TimePeriod gml:id="USGS.TP.04071765">
                                <gml:beginPosition>2011-04-03T00:00:00-06:00</gml:beginPosition>
                                <gml:endPosition>2011-04-13T07:00:00-06:00</gml:endPosition>
                        </gml:TimePeriod>
                </wml2:domainExtent>
                <wml2:defaultTimeValuePair>
                        <wml2:TimeValuePair>
                                <wml2:unitOfMeasure uom="cfs"/>
                                <wml2:dataType xlink:href="http://www.opengis.net/def/timeseriesType/WaterML/2.0/Continuous"
xlink:title="Continuous/Instantaneous"/>
                                <wml2:qualifier xlink:href="http://waterdata.usgs.gov/WI/nwis/help/?provisional" xlink:title="Provisional data subject to
revision."/>
                        </wml2:TimeValuePair>
                </wml2:defaultTimeValuePair>
                <wml2:point>
                        <wml2:TimeValuePair>
                                <wml2:time>2011-04-13T07:00:00-06:00</wml2:time>
                                <wml2:value>3240</wml2:value>
```

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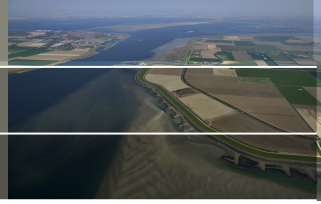
Service details



USGS (USA):

- SOS2 service with WaterML2.0 data encoding
  - Hourly data: 1 station
  - 15 min. data: 9 stations

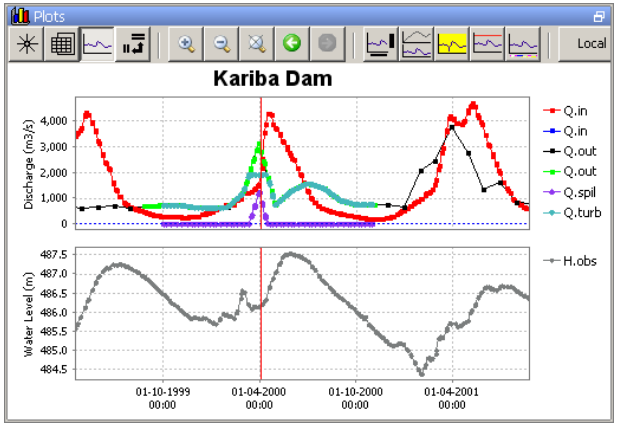
Pegelonline (Germany):

- SOS1 service with O&M1 (SWE common) data encoding
  - 1 min data: 1 station
  - 15 min. data: 7 stations

  - Data retrieval for ten days
  - Data retrieval for one day

Delft FEWS

Open Shell Forecasting System



System for operational forecasting (resilience!)

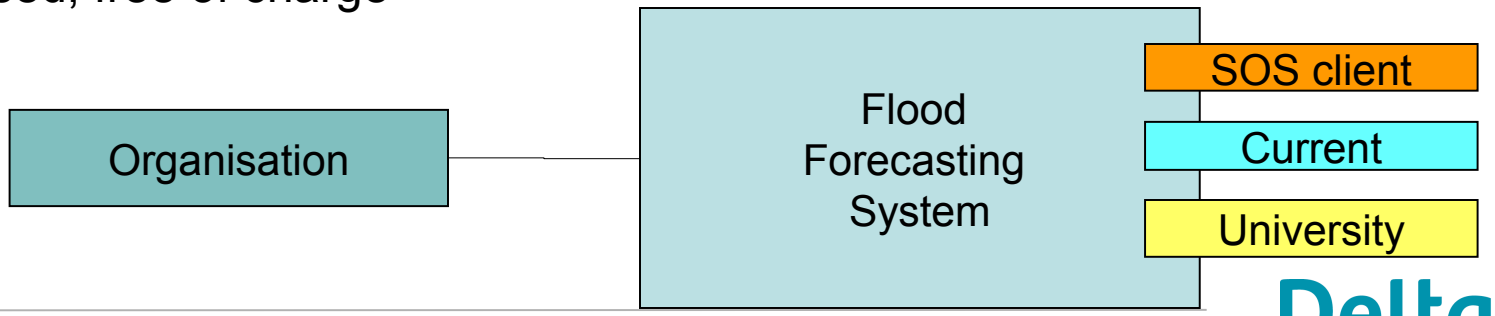
- Floods & droughts
- Reservoir operation
- Storm surge
- Water quality

Organise data from ingest to forecast

Open interface for variety of models

Fully configurable

Licensed, free of charge



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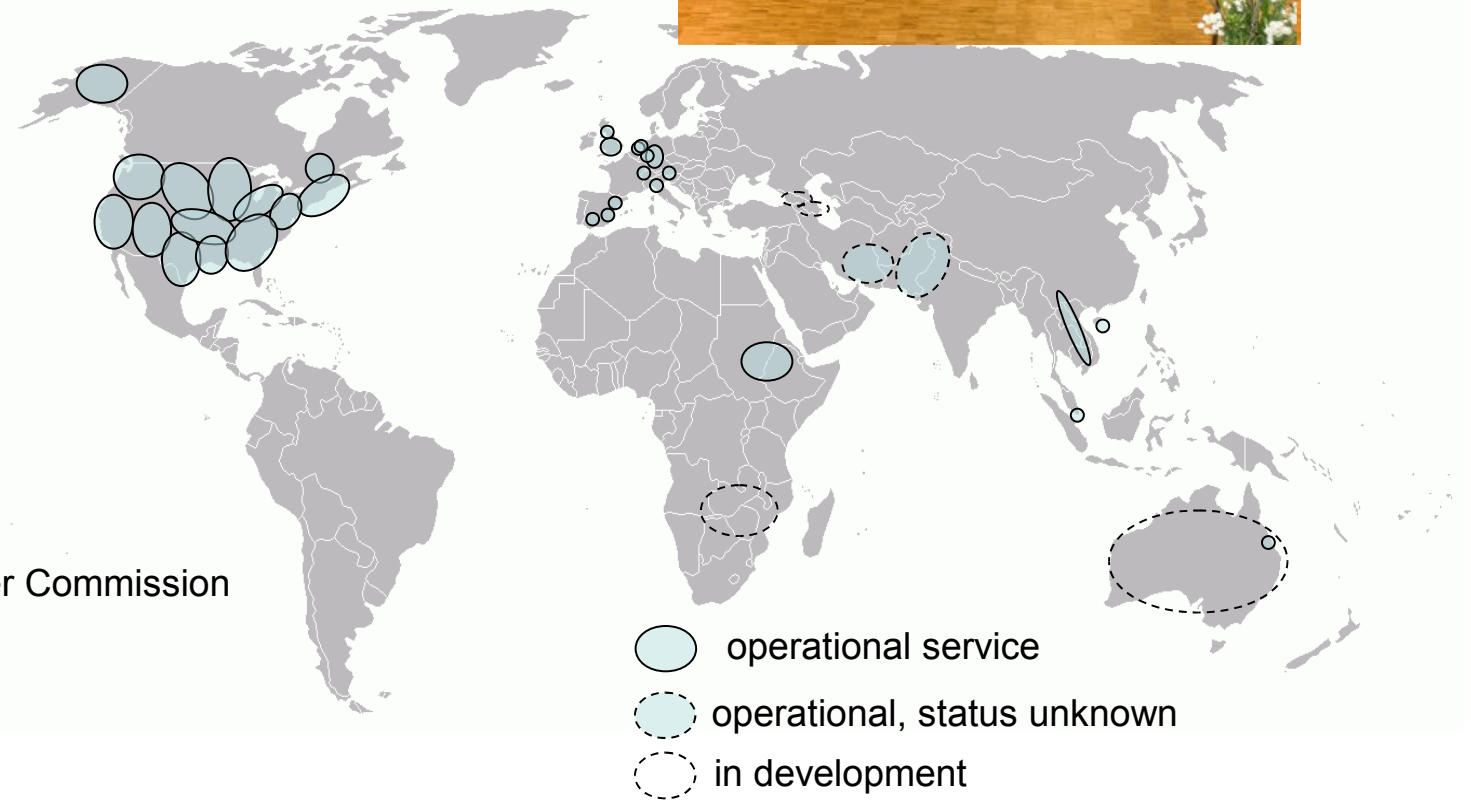
Delft FEWS

User Community

- USA (NWS)
- Canada
- UK
- Netherlands
- Germany
- Suisse
- Italy
- Austria
- Spain
- Singapore
- Taiwan
- Mekong River Commission
- Australia
- Sudan
- Georgia
- Azerbaijan
- Zambezi



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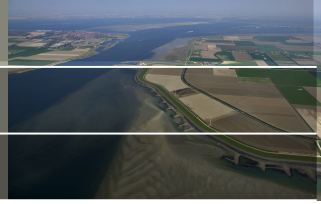
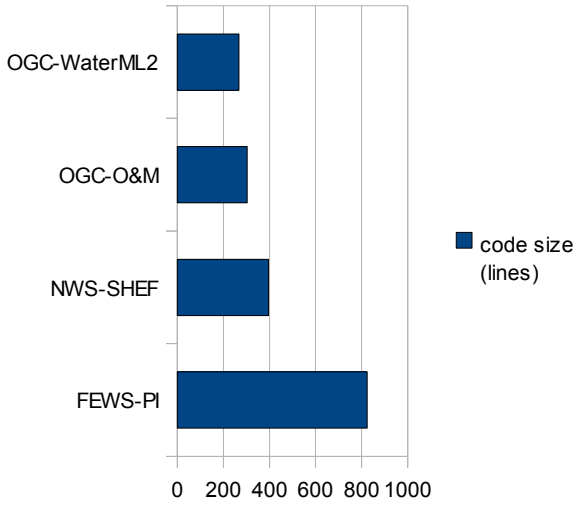
Preliminary results

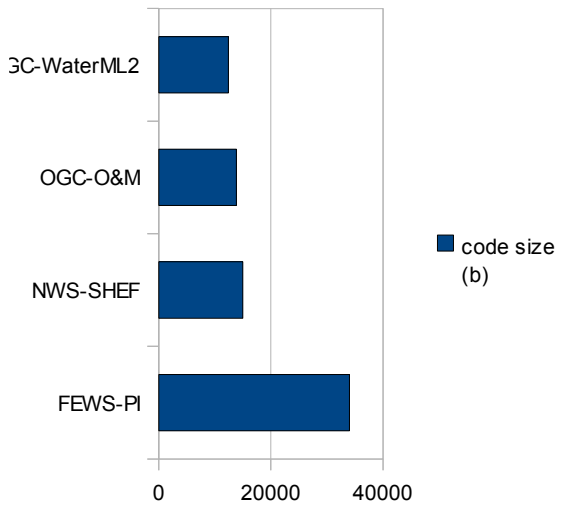


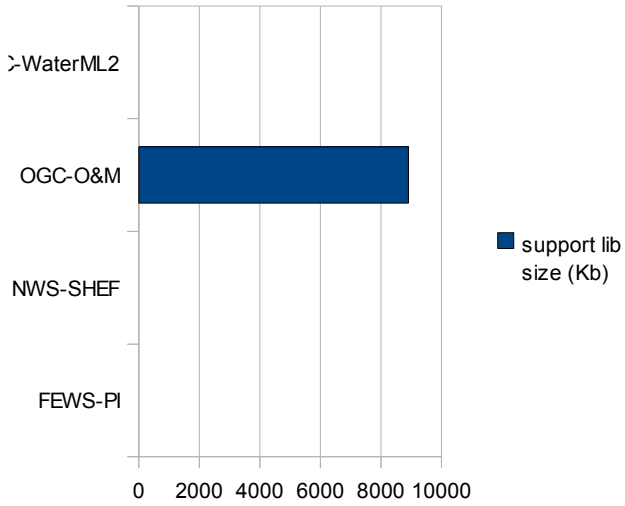
Comparison criteria:

- Lines of source code in client (→ proxy for code complexity)
- File size (→ proxy for network load):
  - > Uncompressed, compressed
- Ingest time (net) required by DelftFEWS

Preliminary results – code complexity of the client







	FEWS-PI	NWS-SHEF	OGC-O&M1	OGC-WaterML2
code size (lines)	824	396	303	267
code size (b)	34025	15005	13871	12420
support lib size (Kb)	0	0	8911	0

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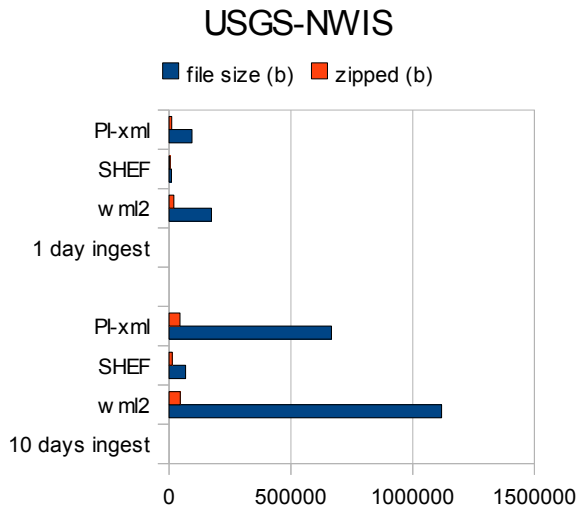
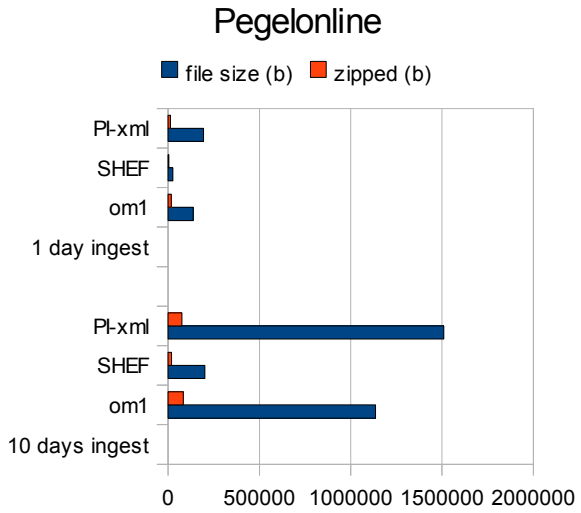
Preliminary results – File sizes





	File size (b)	Zipped (b)	nr.values	nr.series
10 days				
wml2	1119461	46245	8788	10
SHEF	68016	13387	7719	
PI-xml	666820	44145	8656	
1 day				
wml2	174294	19369	885	10
SHEF	9917	4114	875	
PI-xml	93541	10867	1117	

	File size (b)	Zipped (b)	nr.values	Nr series
10 days				
om1	1135933	82822	20787	8
SHEF	202350	19378	20309	
PI-xml	1509931	76389	20320	
1 day				
om1	137378	17129	2058	8
SHEF	26052	4409	2534	
PI-xml	193847	13618	2534	

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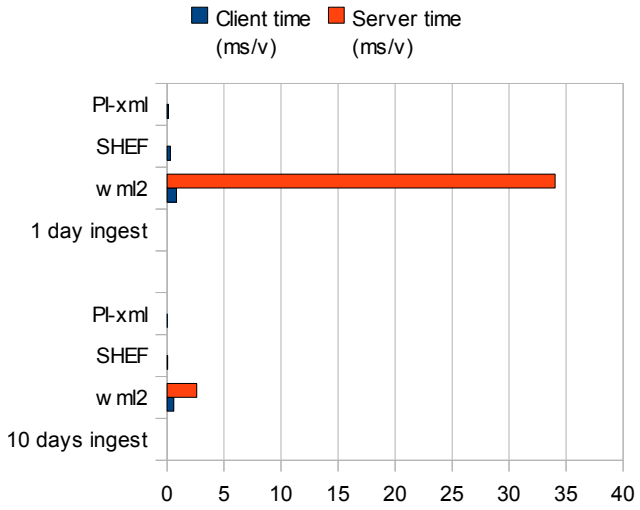
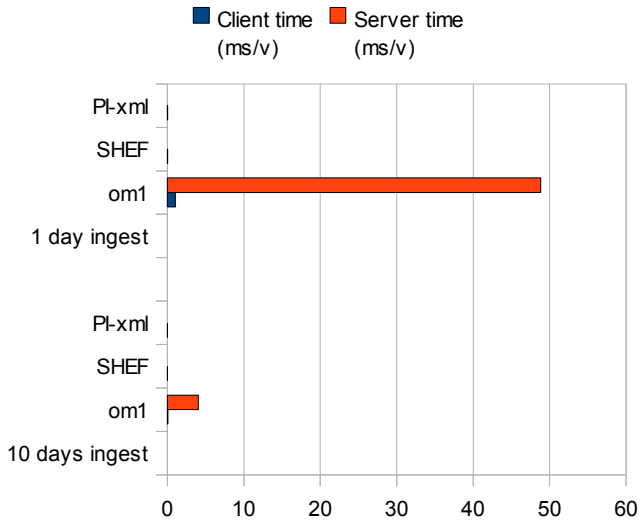
Preliminary results – Ingest performance

USGS-NWIS



10 days	Client (ms/value)	Server (ms/value)	Server (ms)	Client (ms)
wml2	0.594	2.62	23229	5273
SHEF	0.051		0	390
PI-xml	0.023		0	203
1 day				
wml2	0.828	34.04	30124	733
SHEF	0.285		0	249
PI-xml	0.126		0	141

Pegelonline



10 days	Client (ms/value)	Server (ms/value)	Server (ms)	Client (ms)
om1	0.071	4.06	84476	1466
SHEF	0.005		0	109
PI-xml	0.008		0	172
1 day				
om1	1.046	48.82	100481	2153
SHEF	0.037		0	93
PI-xml	0.043		0	110

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Lessons learned

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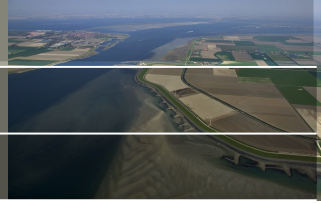
Lessons learned



File size

- WaterML2, O&M1-SWEcommon are a bit more volumious than FEWS-PI, especially with short timeseries

Performance

- WaterML2 and O&M1-SWEcommon are significantly slower than SHEF or FEWS-PI
- Efficiency with WaterML2 and O&M1-SWEcommon improves a little with longer timeseries

Binary representations might improve performance,

But ...

Still room for improvement

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