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BOM Plans for the FEWS Archive

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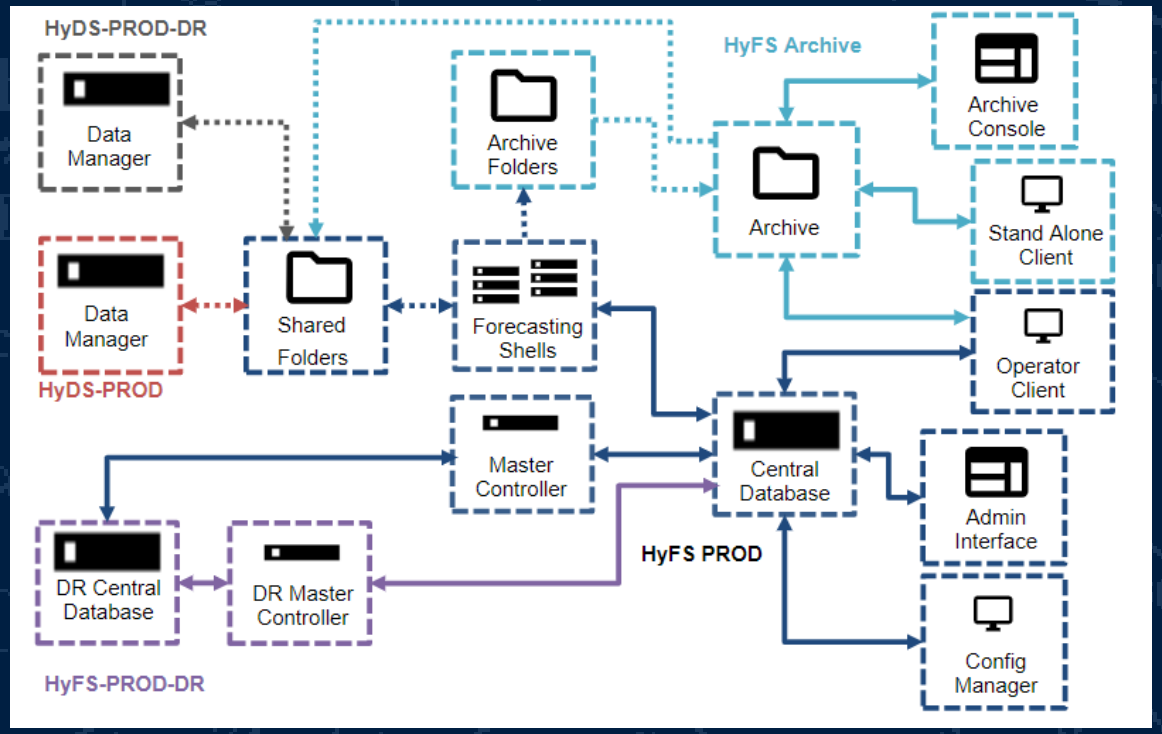
How is the FEWS Open archive used at BOM?

- Archive has been used operationally with HyFS since commissioning in 2015, developed by Deltares in conjunction with BOM
  - Data from FEWS database is automatically archived once a day
  - Data stored on archive as flat files
  - Stand Alone and Operator Clients can read and write data from / to archive, and seamlessly integrate archive and database data
  - Administered via web Console



Two key archive use cases:

The archive is NOT a backup service!

1. Hold the data that were available at the time for the Bureau in developing flood forecasts and warnings
2. Hold quality controlled data for later use in model development, calibration, and training exercises

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What is stored in the HyFS archive?

- Stores datasets generated and used in HyFS
- Archive data has defined finite lifetime

/thredds/catalog/data/2022/08/yarra/21/observed/catalog.html

Dataset	Size	Last Modified
observed		--
metaData.xml	20.05 Kbytes	2022-08-22T05:20:31Z
WaterLevel Processed 1h.nc	65.67 Kbytes	2022-08-22T05:20:31Z
WaterLevel Processed 15min.nc	81.18 Kbytes	2022-08-22T05:20:31Z
WaterLevel Observed.nc	355.8 Kbytes	2022-08-22T05:20:30Z
Rainfall Processed 1h.nc	64.16 Kbytes	2022-08-22T05:20:31Z
Rainfall Processed 15min.nc	77.72 Kbytes	2022-08-22T05:20:31Z
Rainfall Observed 1h.nc	45.32 Kbytes	2022-08-22T05:20:31Z
Rainfall Observed 15min.nc	72.51 Kbytes	2022-08-22T05:20:31Z
Flow Rated 1h.nc	57.68 Kbytes	2022-08-22T05:20:31Z
Flow Rated 15.nc	76.48 Kbytes	2022-08-22T05:20:31Z
Astro Forecast Processed.nc	44.64 Kbytes	2022-08-22T05:20:31Z
Astro Forecast.nc	43.74 Kbytes	2022-08-22T05:20:31Z

e.g. observed data are archived per-catchment once a day

Data type	Lifetime
Observed [2]	2 years
Simulated	7 years
External forecast (surge and NWPs) [2]	1 year
Issued and provisional forecasts	permanent
Messages (forecaster notes)	permanent
Configuration	permanent
Rating curves	permanent
Tagged events [1] **(flood, historic and WaterCoach)**	permanent
Calibration reports	permanent

[1] After expiry, data are removed from the archive unless they are retained as **events**

[2] Observed and external forecast data are archived permanently elsewhere in the Bureau

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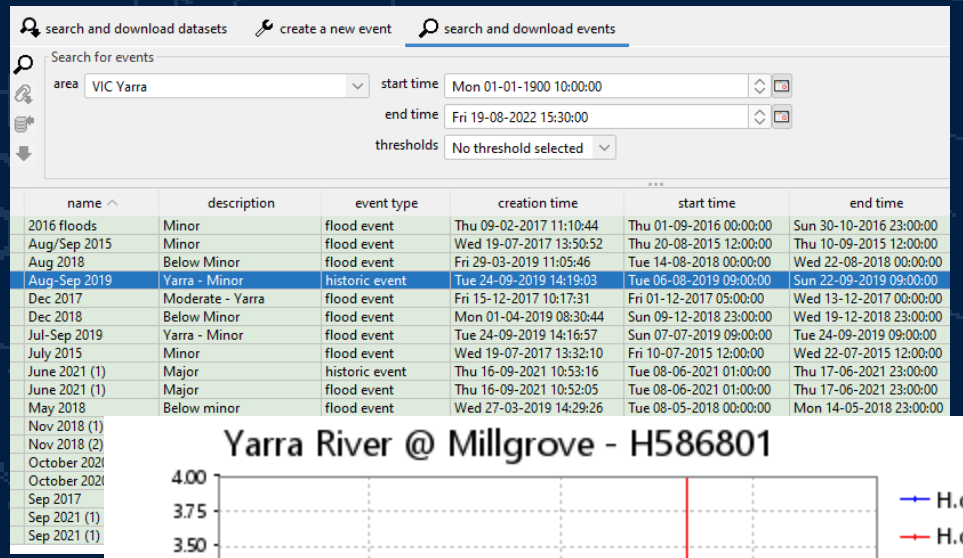
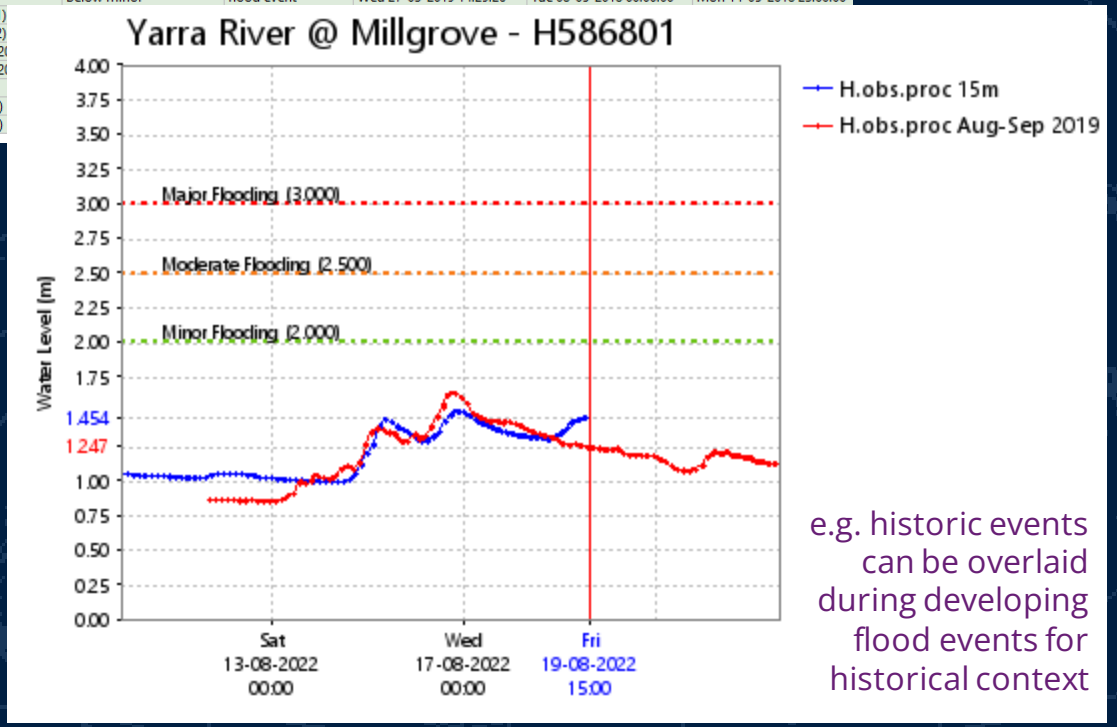
Retaining events in the archive

- Forecasters tag periods of interest for certain areas (e.g. river basin, all Australia) so that important data can be permanently stored in the archive and retrieved long term
  - Historic event: observed timeseries
  - Flood event: observed, external forecast, simulated timeseries, and model modifiers
  - WaterCoach event: observed and external forecast timeseries

Archive data searchable / downloadable from HyFS clients



name	description	event type	creation time	start time	end time
2016 floods	Minor	flood event	Thu 09-02-2017 11:10:44	Thu 01-09-2016 00:00:00	Sun 30-10-2016 23:00:00
Aug/Sep 2015	Minor	flood event	Wed 19-07-2017 13:50:52	Thu 20-08-2015 12:00:00	Thu 10-09-2015 12:00:00
Aug 2018	Below Minor	flood event	Fri 29-03-2019 11:05:46	Tue 14-08-2018 00:00:00	Wed 22-08-2018 00:00:00
Aug-Sep 2019	Yarra - Minor	historic event	Tue 24-09-2019 14:19:03	Tue 06-08-2019 09:00:00	Sun 22-09-2019 09:00:00
Dec 2017	Moderate - Yarra	flood event	Fri 15-12-2017 10:17:31	Fri 01-12-2017 05:00:00	Wed 13-12-2017 00:00:00
Dec 2018	Below Minor	flood event	Mon 01-04-2019 08:30:44	Sun 09-12-2018 23:00:00	Wed 19-12-2018 23:00:00
Jul-Sep 2019	Yarra - Minor	flood event	Tue 24-09-2019 14:16:57	Sun 07-07-2019 09:00:00	Tue 24-09-2019 09:00:00
July 2015	Minor	flood event	Wed 19-07-2017 13:32:10	Fri 10-07-2015 12:00:00	Wed 22-07-2015 12:00:00
June 2021 (1)	Major	historic event	Thu 16-09-2021 10:53:16	Tue 08-06-2021 01:00:00	Thu 17-06-2021 23:00:00
June 2021 (1)	Major	flood event	Thu 16-09-2021 10:52:05	Tue 08-06-2021 01:00:00	Thu 17-06-2021 23:00:00
May 2018	Below minor	flood event	Wed 27-03-2019 14:29:26	Tue 08-05-2018 00:00:00	Mon 14-05-2018 23:00:00
Nov 2018 (1)					
Nov 2018 (2)					
October 202					
October 202					
Sep 2017					
Sep 2021 (1)					
Sep 2021 (1)					



e.g. historic events can be overlaid during developing flood events for historical context

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Archive pain points for the BOM

- Safely adding new data to the archive
  - e.g. adding new models / catchments requires:
    - Importing timeseries to a Stand Alone client
    - Export from Stand Alone client to NetCDF files
    - Manual copying of NetCDF files to archive server by IT team
      → many possible points of failure

- Quality controlling data on the archive
  - There are many different ways / places to QA / QC data within the HyFS ecosystem – we want one point of truth (this can't be solved with just the FEWS archive, but it is an important part)

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Proposed new functionality

1. Store both Raw and Quality Controlled imported time series on the archive
   - Want to know what data, and what QC, were available at a given time

2. Perform Quality Control on time series from Operator-Client and Stand Alone, then upload and merge to the archive
   - Use one process for QC, whether current or historical data
   - (Potentially) leave a paper trail about what QC was done and when

3. Add new time series to Stand Alone database, and upload directly to archive
   - Greatly simplify adding new data to the archive, in particular during new model development and review

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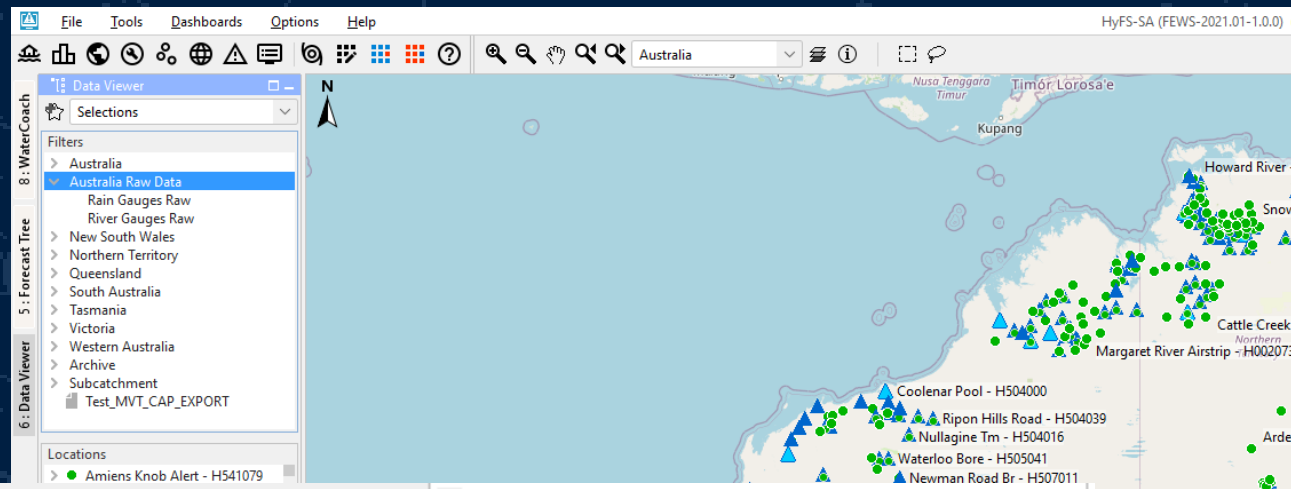
Storing both Raw and QC time series on archive

- On import, copy transformation module copies imported observed time series as Raw
- Raw observed timeseries have a special filter in Data Viewer, and are read-only
- Raw timeser… archive as N… import



8	Merge Hobs Raw
9	Copy Qobs

user

simple

expression Qobs noneq

merge

	= id	= name	validationIcons
1	Australia	Australia	false
2	Australia_raw	Australia Raw Data	false
3	Rain gauges	Rain Gauges	false
4	Rain gauges raw	Rain Gauges Raw	false
5	River gauges	River Gauges	false
6	River gauges raw	River Gauges Raw	false

netcdfExportActivity (16)

	fileName	areaId	ncMetaData	includeComments	includeFlags	thresholdGroupId	timeSeriesSet
1	WaterLevel_Observed.nc	$BASIN$	ncMetaData	true	true	Waterlevel	timeSeriesSet
2	WaterLevel_Observed_Raw.nc	$BASIN$	ncMetaData	true	true	Waterlevel	timeSeriesSet
			title: Observed Water Levels				moduleInstanceId: ImportObserved
			institution: Bureau of Meteorology				valueType: scalar
			source: Delft-FEWS (HyFS)				parameterId: H.obs
			comment: Raw Data				qualifierId: Raw
							locationSetId: $BASIN$_Sensors_H
							timeSeriesType: external historical
							timeStep unit=nonequidistant
							readWriteMode: read only
3	Flow_Observed.nc	$BASIN$	ncMetaData	true	true		timeSeriesSet
4	Flow_Observed_Raw.nc	$BASIN$	ncMetaData	true	true		timeSeriesSet
			title: Observed Flows				moduleInstanceId: ImportObserved
			institution: Bureau of Meteorology				valueType: scalar
			source: Delft-FEWS (HyFS)				parameterId: Q.obs
			comment: Raw Data				qualifierId: Raw
							locationSetId: $BASIN$_Sensors_Q
							timeSeriesType: external historical
							timeStep unit=nonequidistant
							readWriteMode: read only

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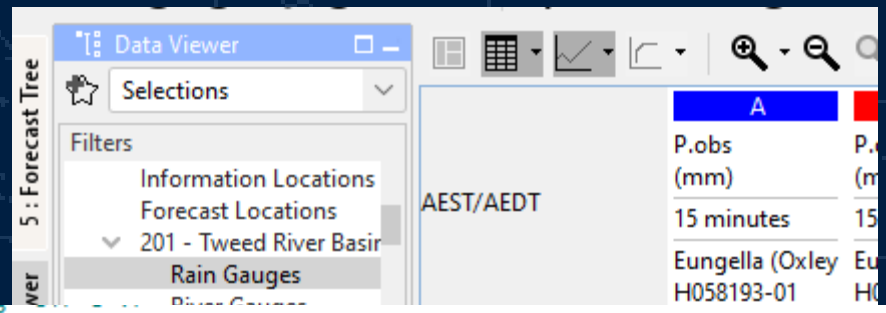
Use case 1: daily QC in OC (data in HyFS database)

- Forecaster manually corrects observed time series in HyFS OC Time Series Display in near real time
- Clicking Save in Time Series Display immediately uploads the data corrections to HyFS Archive (OC only!)
- Corrections are stored in an XML file on the archive



```
<TimeSeries xmlns="http://www.wldelft.nl/fews/PI" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xsi:schema
version1.0/pi-schemas/pi_timeseries.xsd" version="1.31" xmlns:fs="http://www.wldelft.nl/fews/fs">
    <timeZone>0.0</timeZone>
    <series>
        <header>
            <type>accumulative</type>
            <moduleInstanceId>ImportObserved</moduleInstanceId>
            <locationId>H058193-01</locationId>
            <parameterId>P.obs</parameterId>
            <qualifierId>15m</qualifierId>
            <timeStep unit="second" multiplier="900"/>
            <startDate date="2022-05-31" time="18:30:00"/>
            <endDate date="2022-05-31" time="18:30:00"/>
            <missVal>NaN</missVal>
            <stationName>Eungella (Oxley River) - H058193-01</stationName>
            <lat>-28.3538</lat>
            <lon>153.293</lon>
            <x>153.293</x>
            <y>-28.3538</y>
            <units>mm</units>
        </header>
        <event date="2022-05-31" time="18:30:00" value="0.0" valueSource="MAN" flag="1" user="Greg Keir"/>
    </series>
    <series>
        <header>
```

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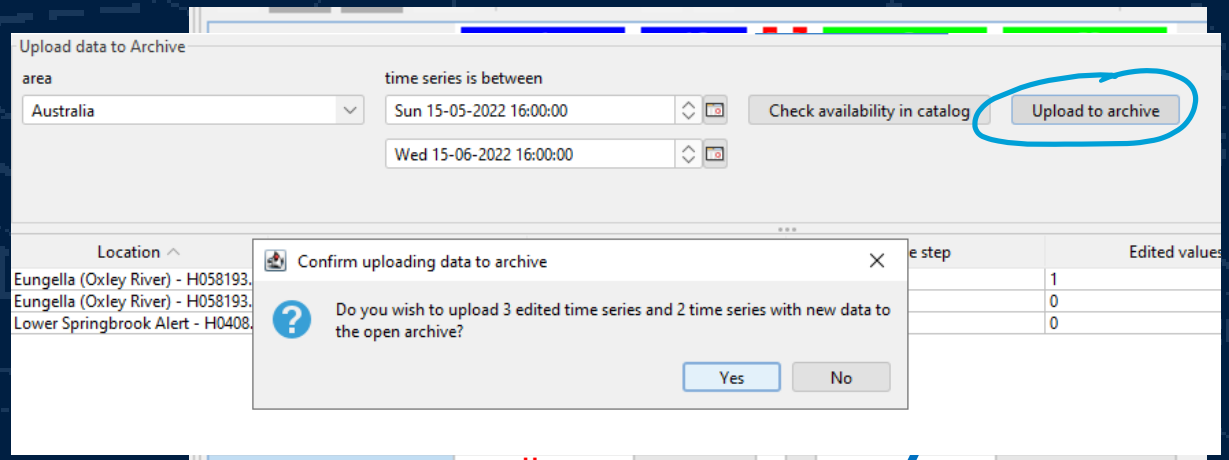
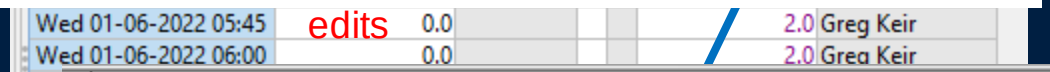
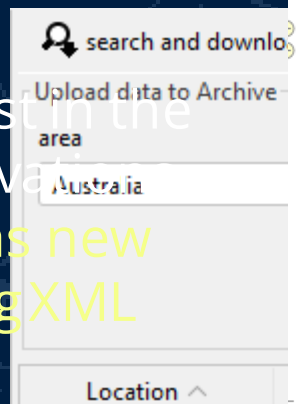
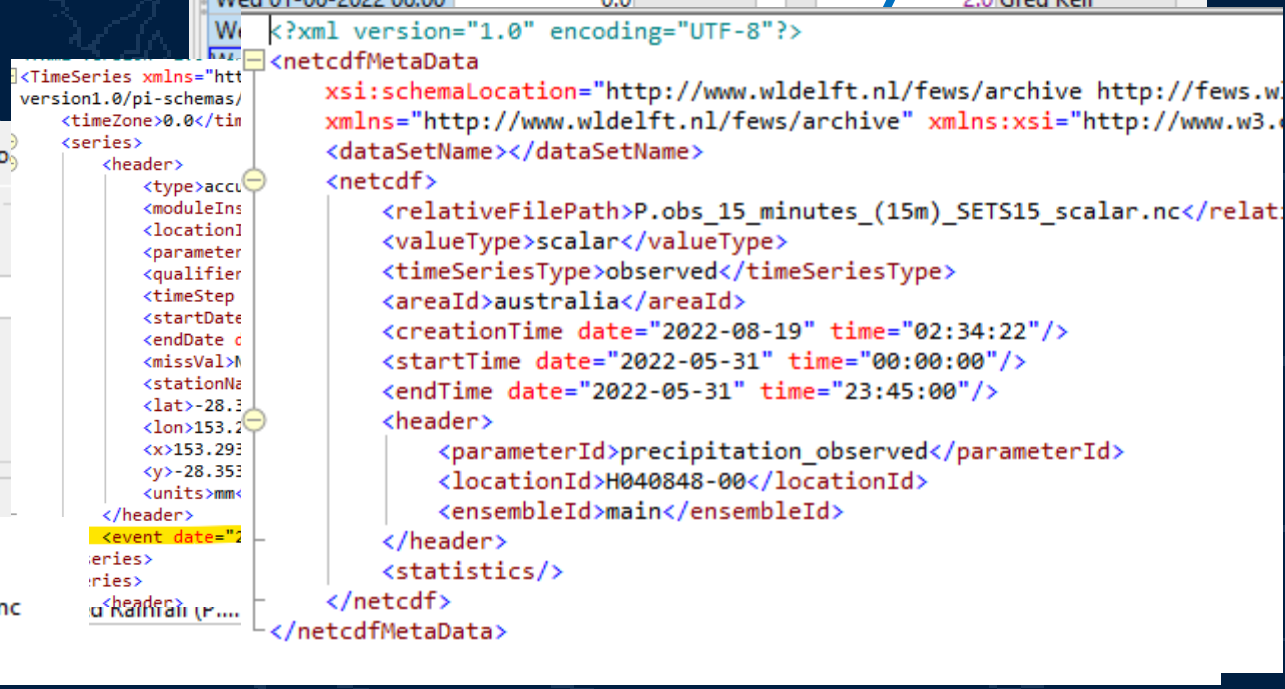
Use case 2: ad-hoc QC in the SA

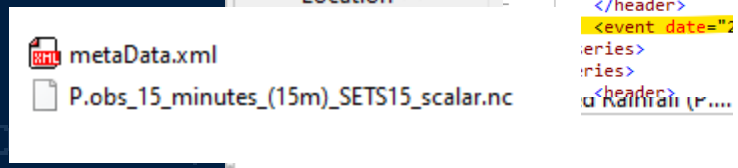
- Forecaster populates SA database with data from archive and manually corrects / adds timeseries in HyFS SA Time Series Display
- Forecaster opens Archive Display and selects new Upload to Archive tab, using Check availability in catalog functionality
- Edits to time series that already exist in the archive are stored as XML
- New time series that do not exist in the archive (including adding observations previously missing) are stored as new NetCDF files with accompanying XML metadata





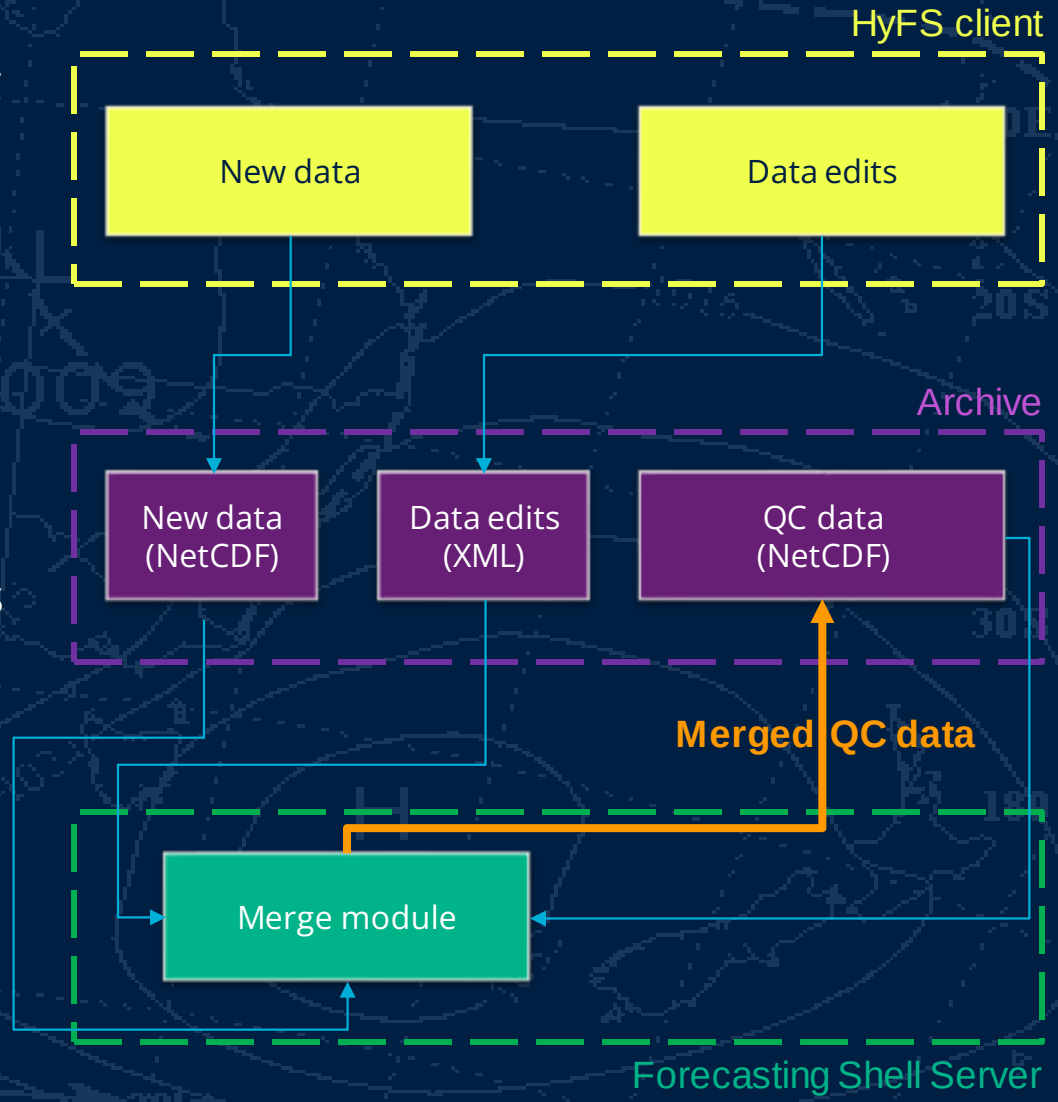






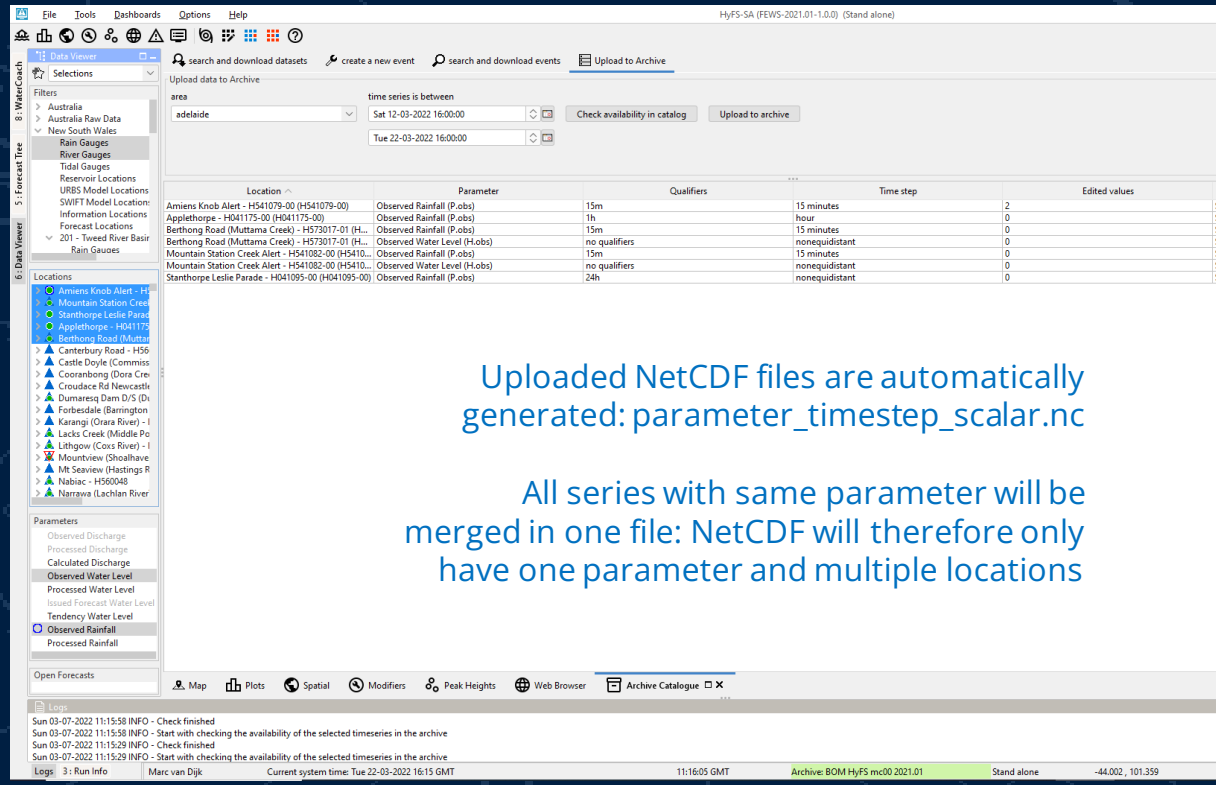
Merging of QC data on the archive

- New Archive Export Merge module contains a new activity to merge the edits contained in uploaded XML files with existing archived NetCDF files
  - Can be scheduled or run manually (e.g. by forecaster immediately after upload)
- Merge activity:
  - updates the (QC) NetCDF files in archive with values, validation flags and comments in uploaded XML
  - merges new NetCDF files with existing (QC) NetCDF files in archive
- The combination of the upload and merge functionality also provides us with a convenient way of adding large amounts of new data to the archive…



Use case 3: adding new timeseries in SA (bulk upload)

- Developer populates SA database with data imported from files, and manually corrects timeseries in HyFS SA Time Series Display
- Forecaster opens Archive Display and selects new Upload to Archive tab, using Check availability in catalog functionality
  - New time series that do not exist in the archive stored as NetCDF with accompanying XML metadata
  - Merge activity merges in new NetCDF data to QC NetCDF files, and / or updates existing QC NetCDF with edits from XML where overlaps occur
- Process can be repeated, with edits to already uploaded data stored as XML, and new time series stored as NetCDF



Uploaded NetCDF files are automatically generated: parameter_timestep_scalar.nc

All series with same parameter will be merged in one file: NetCDF will therefore only have one parameter and multiple locations

Merge activity subsequently generates / updates QC NetCDF files by area

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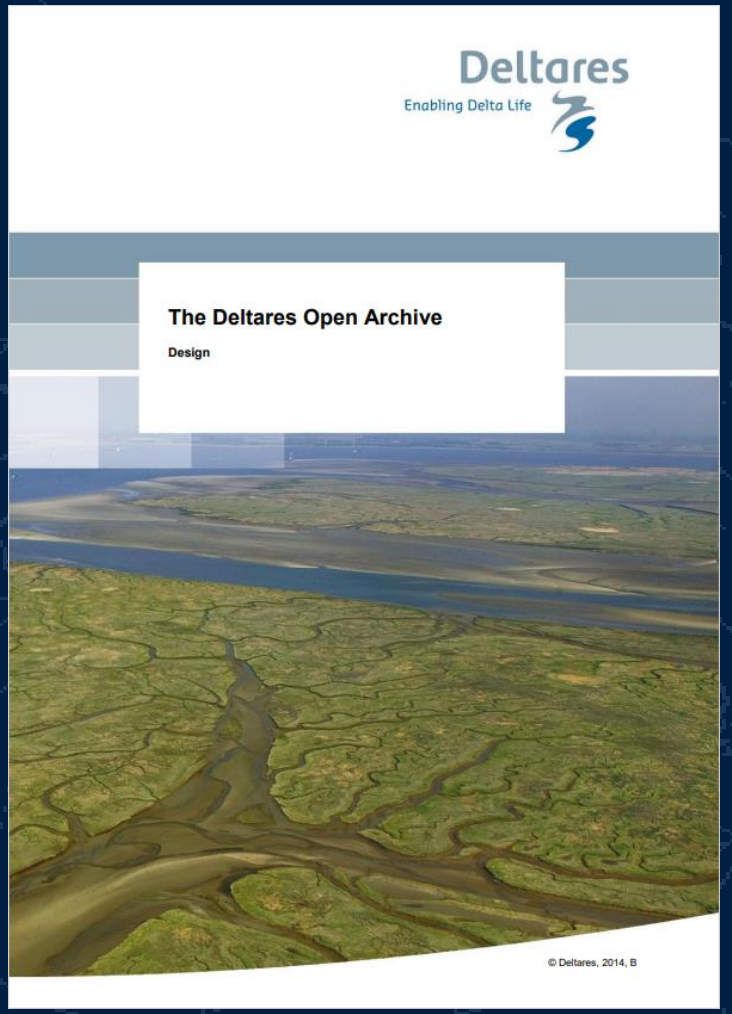
Next steps

- Work through more use cases and implementation details
  - How do we guard against uploading of incorrect data?
  - How much can we automate?
- Test functionality on live development archive server
- Trial with BOM users:
  - Forecasters for QC and post flood activities
  - Model developers for adding new models

- Further reading on the Deltares Open Archive: https://publicwiki.deltares.nl/download/attachments/112167190/DeltaresOpenArchive_Design.pdf?version=1&modificationDate=1427763119000&api=v2



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Thank you

Any questions?

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