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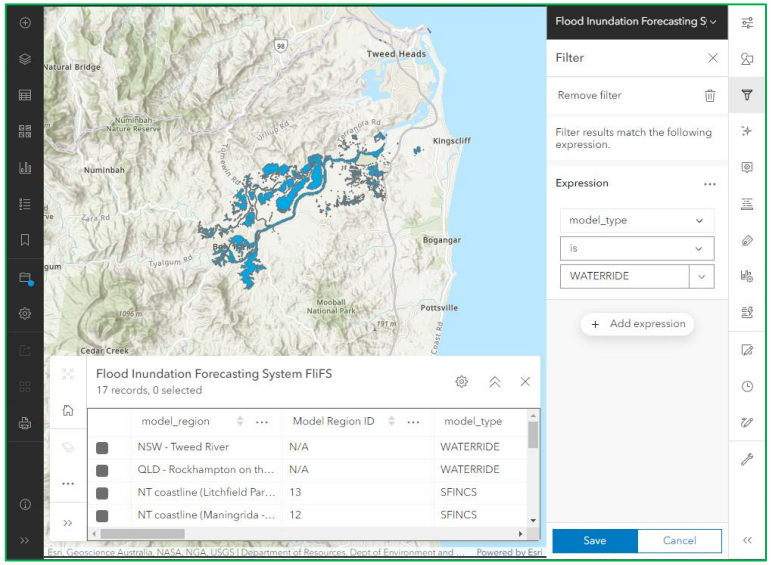
Delft-FEWS – Improving the link with GIS

New features & enhancements in Delft-FEWS 2022.02

Video and voice-over by: **Matthijs Lemans**

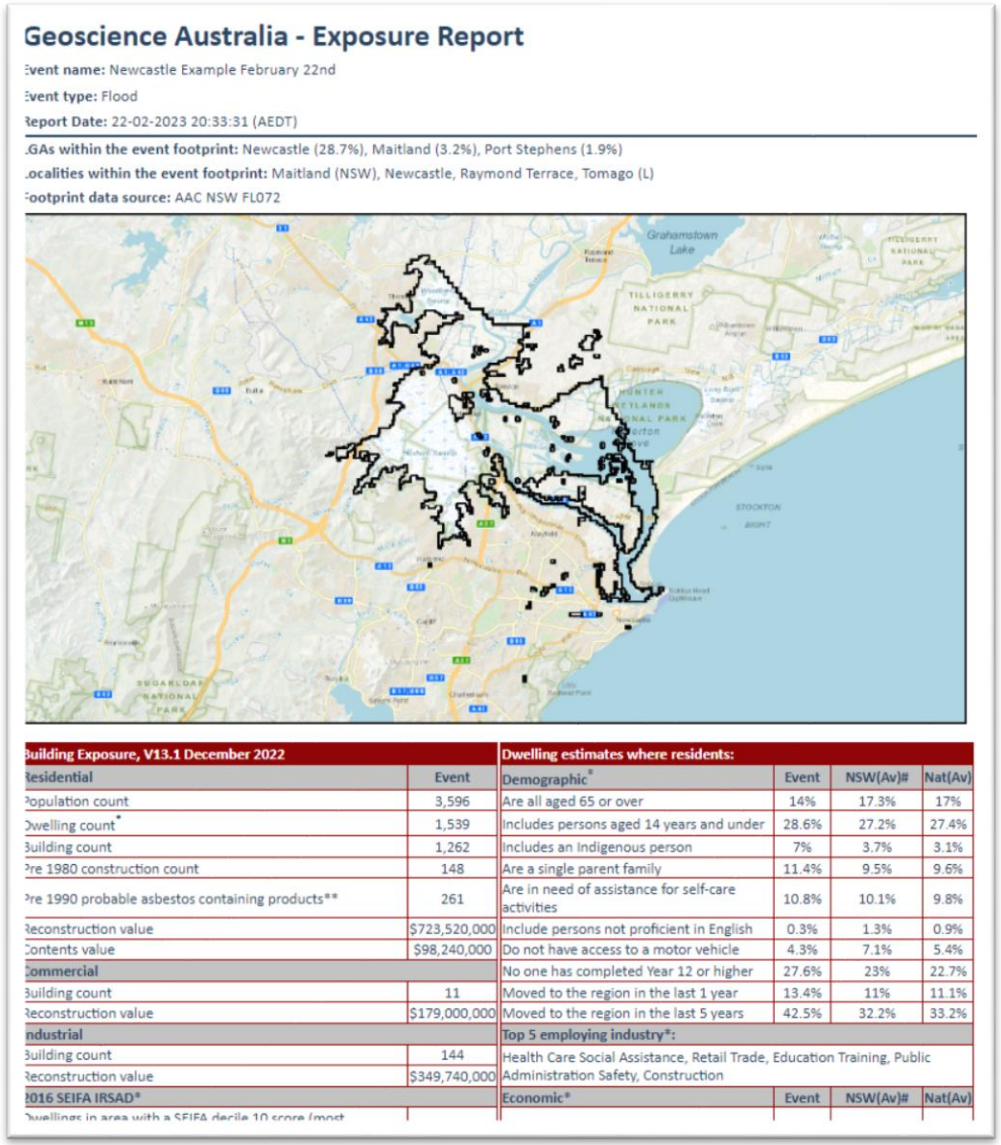
Content

- Why improve the link between Delft-FEWS and GIS?
- Overview of current shapefile generation and dissemination functionality of Delft-FEWS
- Enhancements to Delft-FEWS related to shapefiles:
  - Create high-resolution flood extent shapefiles using DEM/CTA files
  - Produce flood extents (shapefile) for custom areas (polygons)
  - Clean up/simplify flood extent shapefiles using custom python script
  - Import/export shapefiles, including attributes
  - Upload shapefiles to ArcGIS Online, including metadata
  - Web Feature Service (for 2023.01)



Why improve the link between Delft-FEWS and GIS?

- To help mitigate the impacts of flooding, **emergency services** benefit from **accurate real-time flood inundation maps** to support **decision-making** before, during, and after flood events.
- Emergency services are very much **GIS-oriented (shapefile/vector)**, allowing them to integrate and analyse **critical exposure data** such as:
  - Population and business information
  - Roads and supply chains
  - Infrastructure and buildings
- To address these use cases, Delft-FEWS has expanded in 2022.02 to disseminate flood maps in GIS-compatible formats (shapefiles).



Geoscience Australia - Exposure Report

Event name: Newcastle Example February 22nd

Event type: Flood

Report Date: 22-02-2023 20:33:31 (AEDT)

LGAs within the event footprint: Newcastle (28.7%), Maitland (3.2%), Port Stephens (1.9%)

Localities within the event footprint: Maitland (NSW), Newcastle, Raymond Terrace, Tomago (L)

Footprint data source: AAC NSW FL072

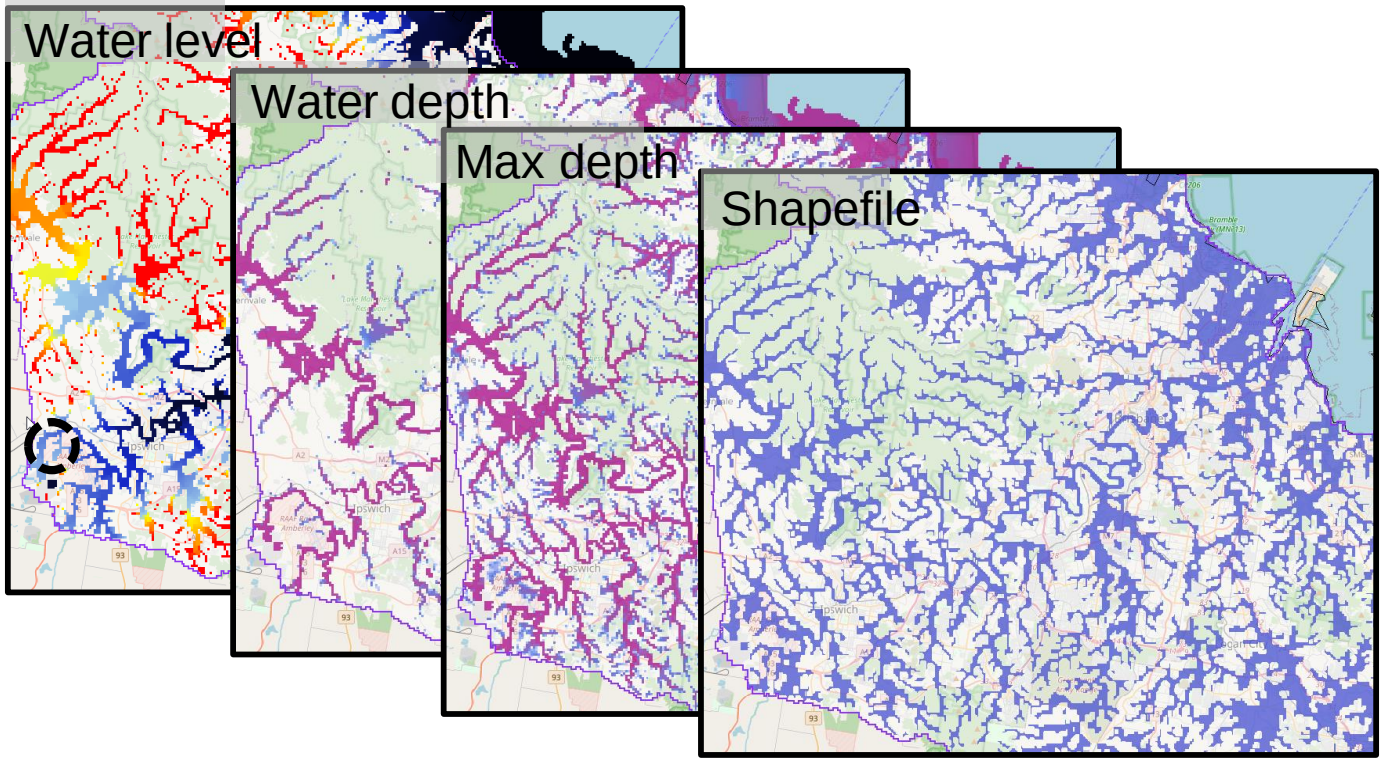
Building Exposure, V13.1 December 2022	
Residential	**Event**
Population count	3,596
Dwelling count*	1,539
Building count	1,262
Pre 1980 construction count	148
Pre 1990 probable asbestos containing products**	261
Reconstruction value	$723,520,000
Contents value	$98,240,000
Commercial	
Building count	11
Reconstruction value	$179,000,000
Industrial	
Building count	144
Reconstruction value	$349,740,000
2016 SEIFA IRSAD*	
Dwellings in area with a SEIFA decile 10 score (most	

Dwelling estimates where residents:			
Demographic*	**Event**	**NSW(Av)#**	**Nat(Av)**
Are all aged 65 or over	14%	17.3%	17%
Includes persons aged 14 years and under	28.6%	27.2%	27.4%
Includes an Indigenous person	7%	3.7%	3.1%
Are a single parent family	11.4%	9.5%	9.6%
Are in need of assistance for self-care activities	10.8%	10.1%	9.8%
Include persons not proficient in English	0.3%	1.3%	0.9%
Do not have access to a motor vehicle	4.3%	7.1%	5.4%
No one has completed Year 12 or higher	27.6%	23%	22.7%
Moved to the region in the last 1 year	13.4%	11%	11.1%
Moved to the region in the last 5 years	42.5%	32.2%	33.2%
Top 5 employing industry*:			
Health Care Social Assistance, Retail Trade, Education Training, Public Administration Safety, Construction			
Economic*	**Event**	**NSW(Av)#**	**Nat(Av)**

Why improve the link between Delft-FEWS and GIS?

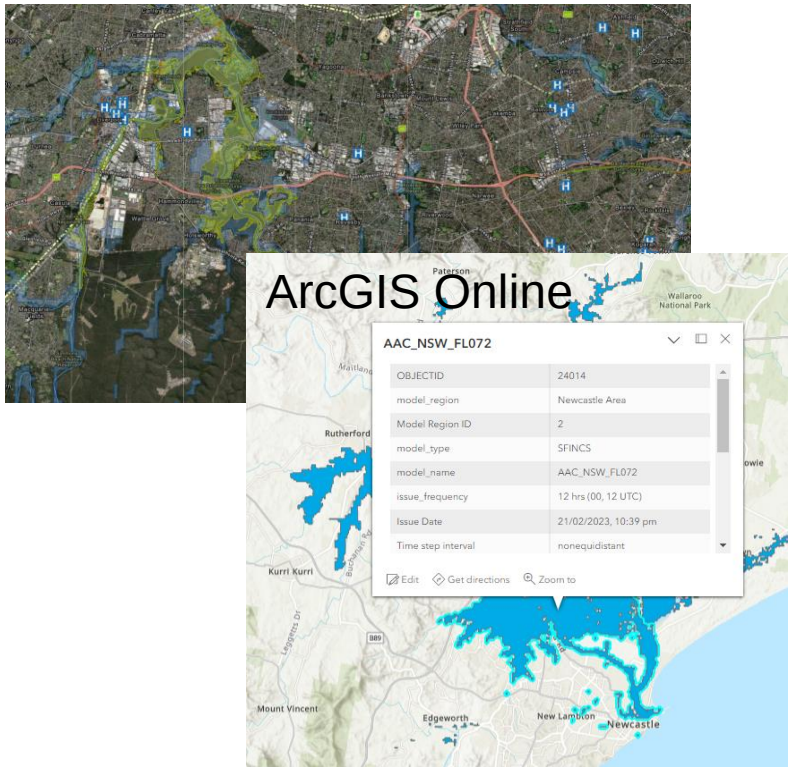
Delft-FEWS

- Shapefiles
- Grids



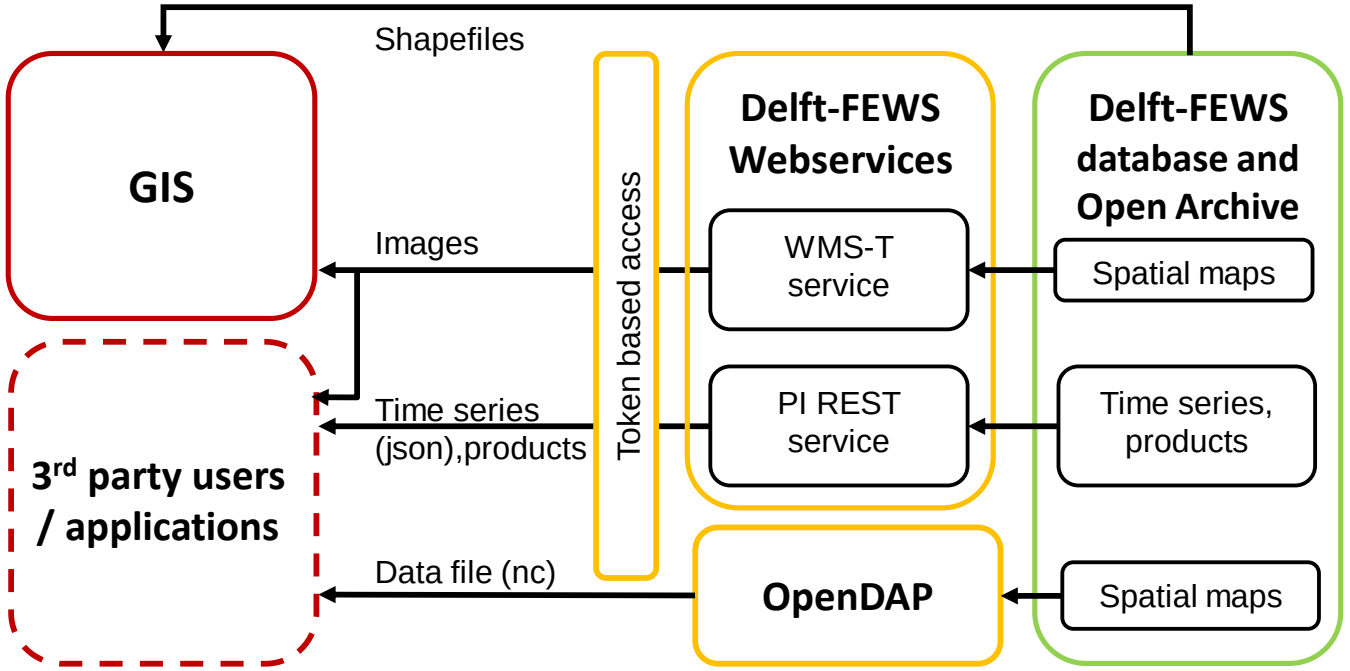
GIS

- Exposure data
- Features/attributes

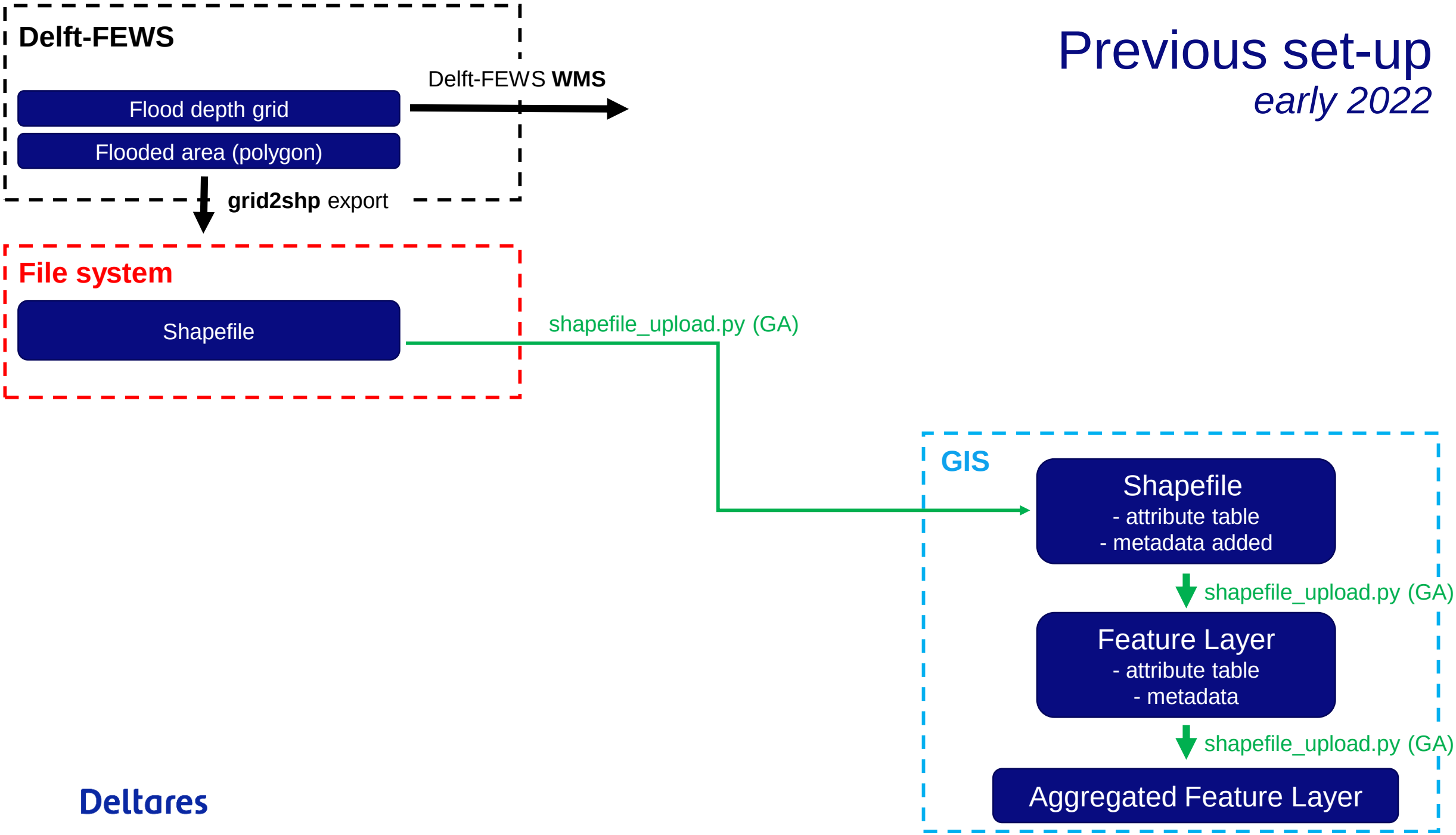


Dissemination of grids and shapefiles

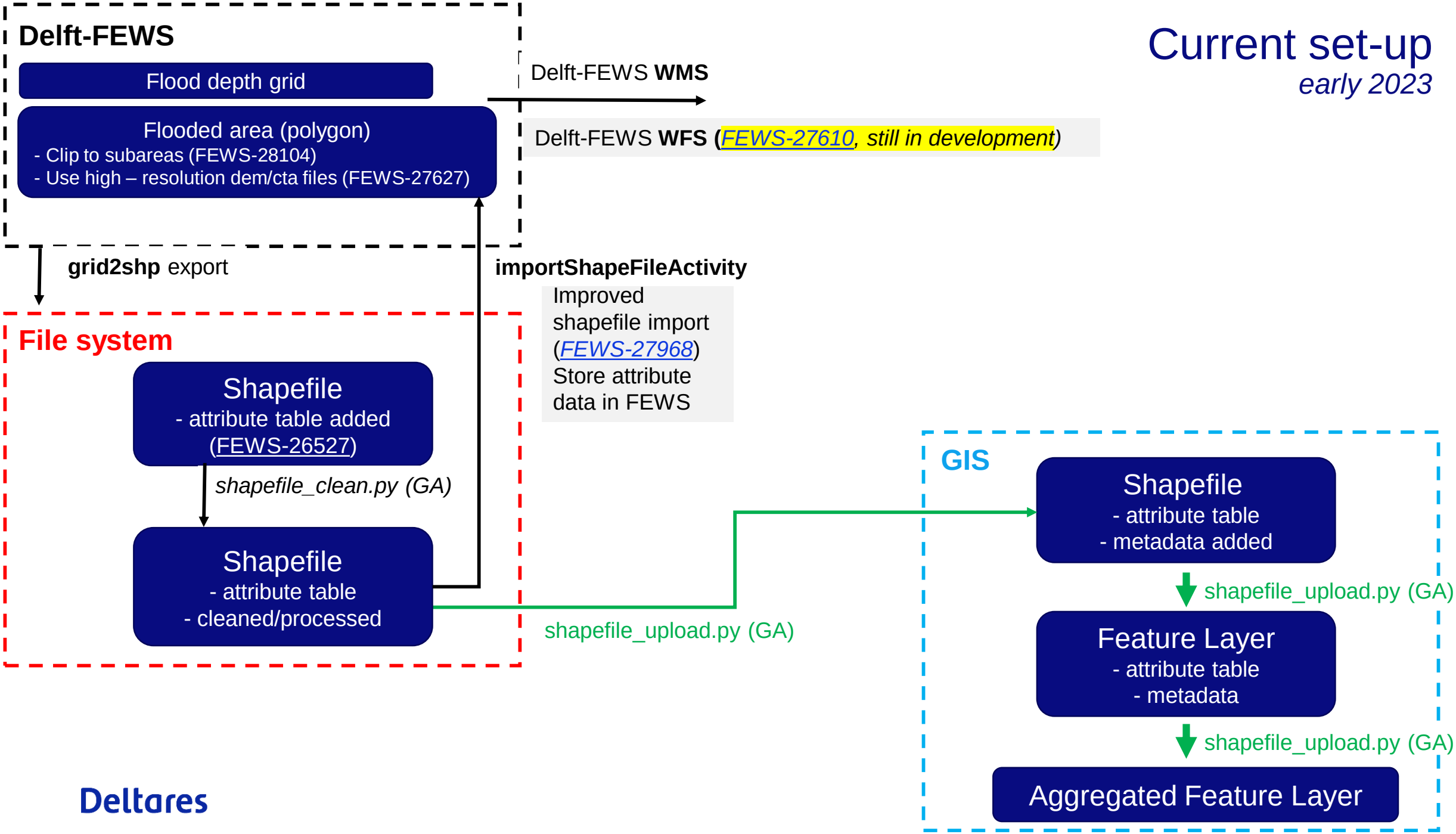
- GIS
  (shapefiles)
- OpenDAP
  (gridded data in netcdf files)
- Delft-FEWS API
  (WMS-T, png and REST, scalar)



Previous set-up
early 2022



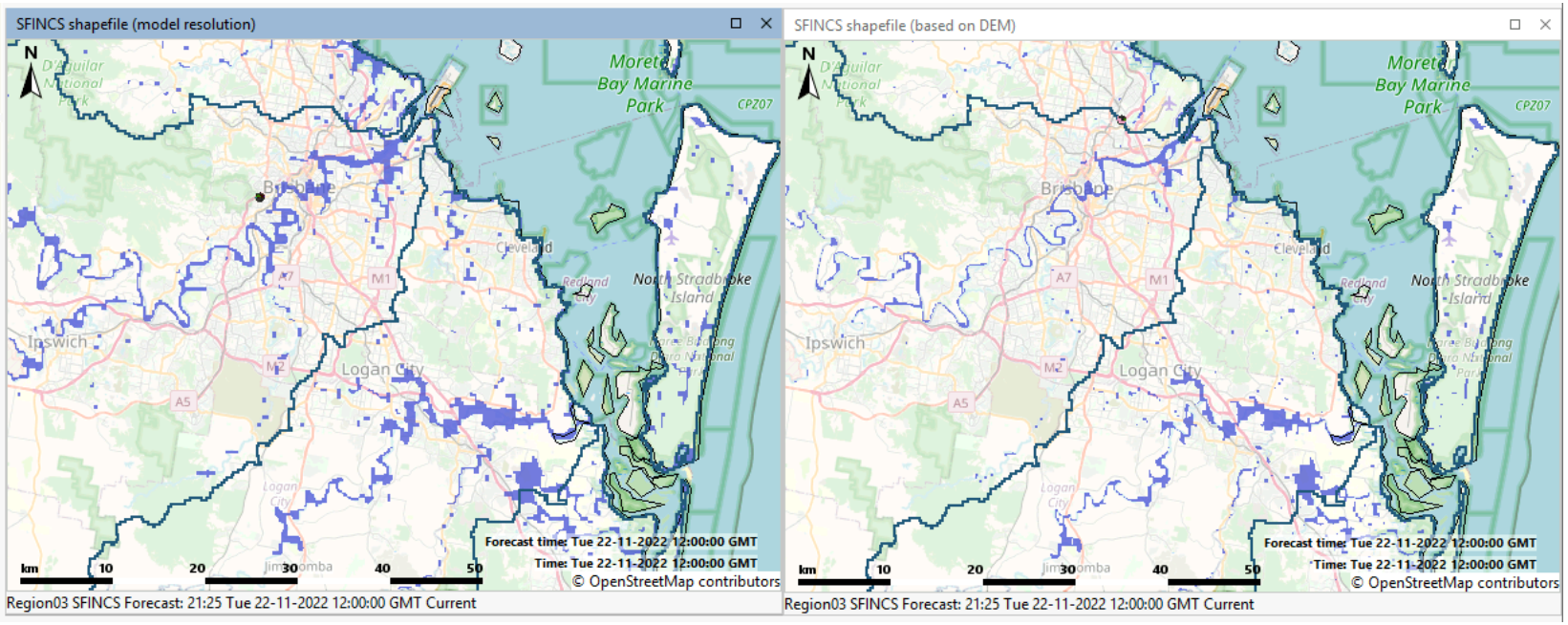
Current set-up
early 2023



Use high-resolution DEM to improve flood map

- Since 2022.02 the GridToPolygons transformation supports DEM/CTA layers
- This means the high-resolution water depth is calculated by subtracting high-resolution elevation (at a specified zoom level) from the water level grid
- The grid is first converted to a high-resolution grid based on the resolution of the DEM/CTA layer.

Original resolution (based on model)



New resolution (based on DEM)

Use high-resolution DEM to improve flood map

- The new options are *localDatumCoverageTileArchiveFile* and *zoomLevel*.
- The grid is first converted to a temporary grid that matches the configured zoom level. Every grid cell in this temporary grid contains the height from the cta and the global water level from the original grid.
- A bilinear interpolation is applied to the global water level of the original grid. This is the same as in the spatial display.

```
<transformation id="gridToPolygon_cta">
    <interpolationSpatial>
        <gridToPolygons>
            <inputVariable>
                <variableId>reg_grid_max_H</variableId>
            </inputVariable>
            <polygonValue>0.1</polygonValue>
            <areaOfInterestLocationId>$LOOP_LOCATION_ID$_clipper</areaOfInterestLocationId>
            <localDatumCoverageTileArchiveFile>$CTA_FOLDER$/topobathy_all_regions.cta</localDatumCoverageTileArchiveFile>
            <zoomLevel>$CTA_ZOOMLEVEL$</zoomLevel>
            <outputVariable>
                <variableId>polygon_cta</variableId>
            </outputVariable>
        </gridToPolygons>
    </interpolationSpatial>
</transformation>
```

Wiki: https://publicwiki.deltares.nl/display/FEWSDOC/Grid+to+Polygons

Output shapefiles for custom regions

In the same gridToPolygon transformation, one can use the areaOfInterestLocationId option to output shapefiles to smaller regions of interest, like flood watch areas.

```
<transformation id="gridToPolygon_cta">
    <interpolationSpatial>
        <gridToPolygons>
            <inputVariable>
                <variableId>reg_grid_max_H</variableId>
            </inputVariable>
            <polygonValue>0.1</polygonValue>
            <areaOfInterestLocationId>$LOOP_LOCATION_ID$_clipper</areaOfInterestLocationId>
            <localDatumCoverageTileArchiveFile>$CTA_FOLDER$/topobathy_all_regions.cta</localDatumCoverageTileArchiveFile>
            <zoomLevel>$CTA_ZOOMLEVEL$</zoomLevel>
            <outputVariable>
                <variableId>polygon_cta</variableId>
            </outputVariable>
        </gridToPolygons>
    </interpolationSpatial>
</transformation>
```

Wiki: https://publicwiki.deltares.nl/display/FEWSDOC/Grid+to+Polygons

Add attributes to exported shapefile

The grid2shp export type now supports custom attributes (dbf-columns). This metadata is used for GIS users to select and filter the desired features from the shapefile.

```
<export>
  <general>
    <exportType>grid2shp</exportType>
    <folder>$EXPORT_FOLDER$\Flifs\$MODEL$\$CATCHMENT$_$FORECAST_TYPE$\orig\</folder>
    <exportFileName>
      <name>$MODEL$_$CATCHMENT$_$FORECAST_TYPE$_PoC_orig</name>
    </exportFileName>
    <exportMissingValue>-999</exportMissingValue>
    <geoDatum>WGS 1984</geoDatum>
  </general>
  <metadata>
    <customAttributes>
      <string key="model_type" value="$MODEL$"/>
      <string key="model_reg" value="@REGION_DESCRIPTION@"/>
      <string key="model_id" value="@MODEL_NUM@"/>
      <string key="model_name" value="$CATCHMENT$"/>
      <string key="issue_freq" value="$ISSUE_FREQ$"/>
      <string key="t_issue" value="%CURRENT_TIME(yyyy-MM-dd HH:mm:ss z)%"/>
      <string key="t_step_int" value="nonequidistant"/>
      <string key="variable" value="$PARAM_DESCRIPTION$"/>
      <string key="prod_type" value="$FORECAST_TYPE$"/>
      <string key="t_start" value="%TIME_ZERO(yyyy-MM-dd HH:mm:ss z)%"/>
      <string key="t_end" value="%FORECAST_END_TIME(yyyy-MM-dd HH:mm:ss z)%"/>
      <string key="t_length" value="$FC_LENGTH_DAYS$ days"/>
      <string key="bom_region" value="@BOM_REGIONS@"/>
      <string key="current" value="1"/>
      <string key="expired" value="0"/>
      <string key="remarks" value="This shapefile is produced by a pilot forecasting system and should not be used for decision-making in an operational setting."/>
    </customAttributes>
  </metadata>
  <timeSeriesSet>
    <moduleInstanceId>$CATCHMENT$_$MODEL$_PolygonClip_$FORECAST_TYPE$</moduleInstanceId>
    <valueType>polygon</valueType>
    <parameterId>D.sim.fcst</parameterId>
    <qualifierId>Max</qualifierId>
    <qualifierId>cta</qualifierId>
    <locationId>$MODEL$.$CATCHMENT$.polygon</locationId>
    <timeSeriesType>simulated forecasting</timeSeriesType>
    <timeStep unit="nonequidistant"/>
    <relativeViewPeriod unit="day" start="0" startOverrulable="true" end="0" endOverrulable="true"/>
    <readWriteMode>read only</readWriteMode>
  </timeSeriesSet>
</export>
```

Wiki: https://publicwiki.deltares.nl/display/FEWSDOC/Grid+to+ESRI+Shapefile+Export

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Python script – clean shapefile

- Shapefiles generated by Delft-FEWS can benefit from some geoprocessing (to simplify the shapefile) that is not (yet) available in Delft-FEWS.
- However, Delft-FEWS can launch a Python script (available upon request) that does the following cleaning functions:
  1. Deletes small puddles using area threshold
  2. Fills small holes using area threshold
  3. Reduces number of vertices using distance tolerance

Python script – clean shapefile – input parameters

Inputs/variables (to be read via .xml run file as exported by the General Adapter):

- **file_path_in** = Path to shapefile that will be processed
- **file_path_out** = Where to save processed shapefile
- **area_min_puddle_sqm** = Puddle min area threshold (square meters)
  - Default value: 100,000 m (10 ha)
- **area_min_hole_sqm** = Hole min area threshold (square meters)
  - Default value: 100,000 m (10 ha)
- **tolerance_m** = Generalize tolerance (meters)
  - Default value: 10 m
- **epsg_code** = numerical EPSG code of projected coordinate system)

Python script – clean shapefile – example

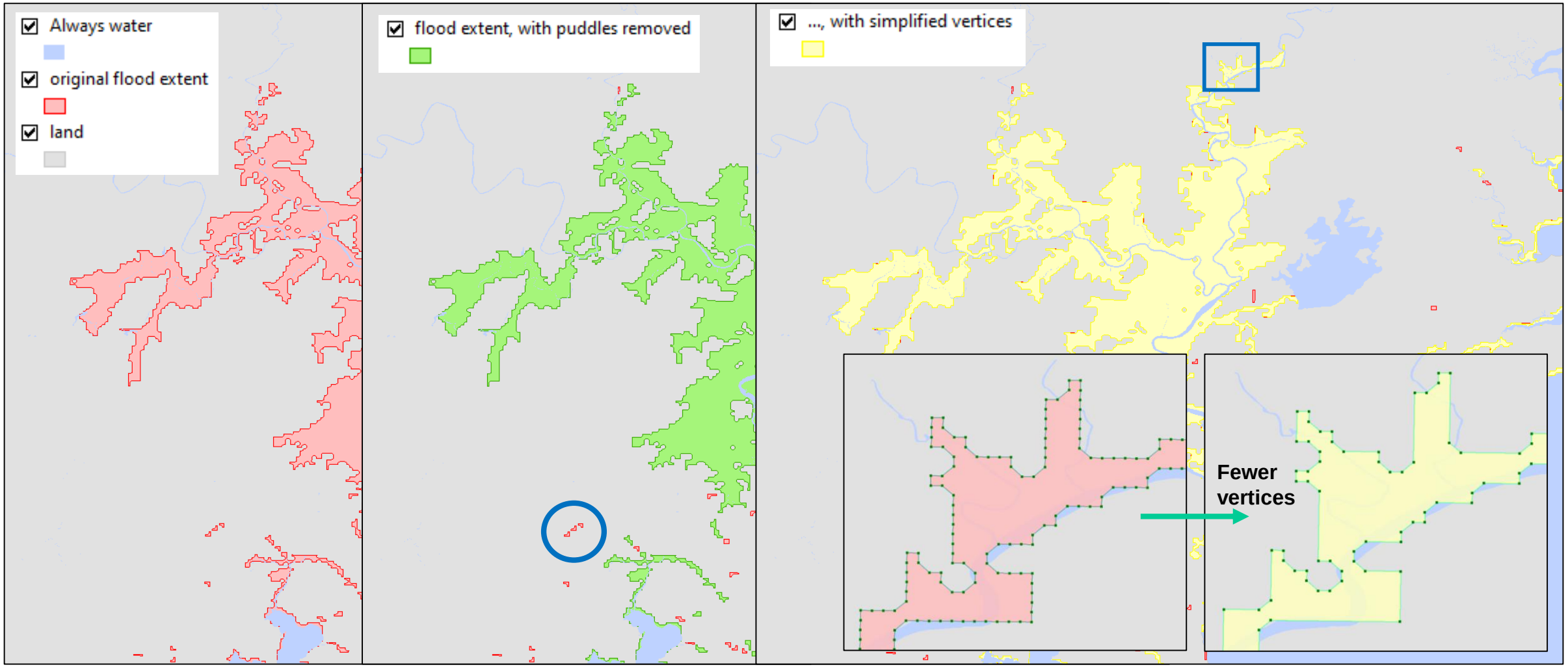
Newcastle, Oct 6, 2022
SFINCS region 2

Original:
1.49 MB
1175 polygons

Puddles removed:
1.31 MB
625 polygons

… and simplified vertices:
0.64 MB
625 polygons

min area = 10 ha
vertice tolerance = 10 m



Importing shapefiles into Delft-FEWS (improved)

The General Adapter ImportShapeFile activity can now import the shapefile attributes as time series properties. These properties can be used by the upcoming WFS service to filter the polygons.

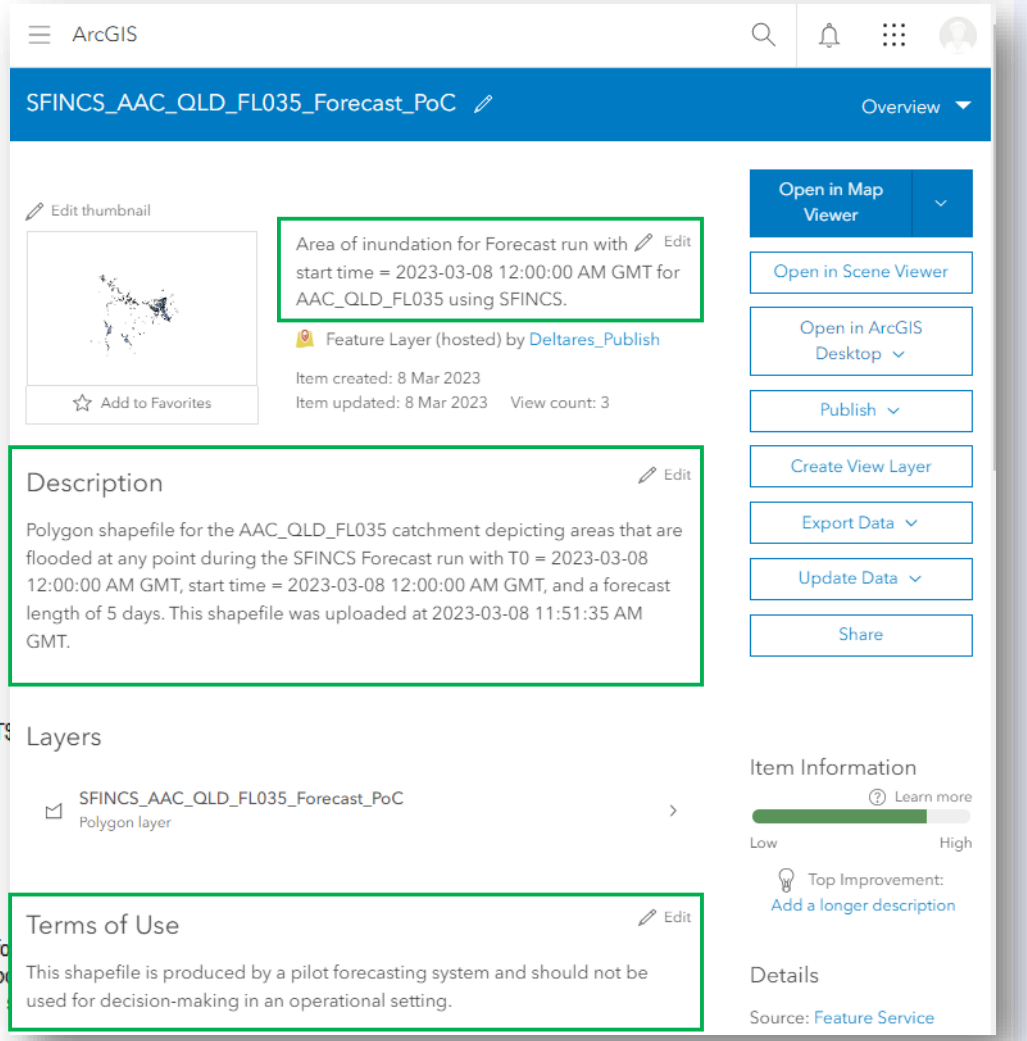
```
<importActivities>
  <importShapeFileActivity>
    <shapeFileImportDir>$CATCHMENT$_$FORECAST_TYPE$</shapeFileImportDir>
    <geoDatum>WGS 1984</geoDatum>
    <charset>ISO-8859-1</charset>
    <shapeFileAttribute attributeId="model_type" propertyKey="model_type"/>
    <shapeFileAttribute attributeId="model_reg" propertyKey="model_reg"/>
    <shapeFileAttribute attributeId="model_id" propertyKey="model_id"/>
    <shapeFileAttribute attributeId="model_name" propertyKey="model_name"/>
    <shapeFileAttribute attributeId="issue_freq" propertyKey="issue_freq"/>
    <shapeFileAttribute attributeId="t_issue" propertyKey="t_issue"/>
    <shapeFileAttribute attributeId="t_step_int" propertyKey="t_step_int"/>
    <shapeFileAttribute attributeId="variable" propertyKey="variable"/>
    <shapeFileAttribute attributeId="prod_type" propertyKey="prod_type"/>
    <shapeFileAttribute attributeId="t_start" propertyKey="t_start"/>
    <shapeFileAttribute attributeId="t_end" propertyKey="t_end"/>
    <shapeFileAttribute attributeId="t_length" propertyKey="t_length"/>
    <shapeFileAttribute attributeId="bom_region" propertyKey="bom_region"/>
    <shapeFileAttribute attributeId="current" propertyKey="current"/>
    <shapeFileAttribute attributeId="expired" propertyKey="expired"/>
    <shapeFileAttribute attributeId="remarks" propertyKey="remarks"/>
    <timeSeriesSet>
      <moduleInstanceId>$MODULE_INSTANCE_ID$</moduleInstanceId>
      <valueType>polygon</valueType>
      <parameterId>D.sim.fcst</parameterId>
      <qualifierId>Max</qualifierId>
      <qualifierId>cta</qualifierId>
      <qualifierId>clean</qualifierId>
      <locationId>SFINCS.$CATCHMENT$.polygon</locationId>
      <timeSeriesType>simulated forecasting</timeSeriesType>
      <timeStep unit="nonequidistant"/>
      <readWriteMode>add originals</readWriteMode>
    </timeSeriesSet>
  </importShapeFileActivity>
</importActivities>
```

Wiki:
https://publicwiki.deltares.nl/display/FEWSDOC/05+General+Adapter+Module

Upload shapefiles to ArcGIS Online

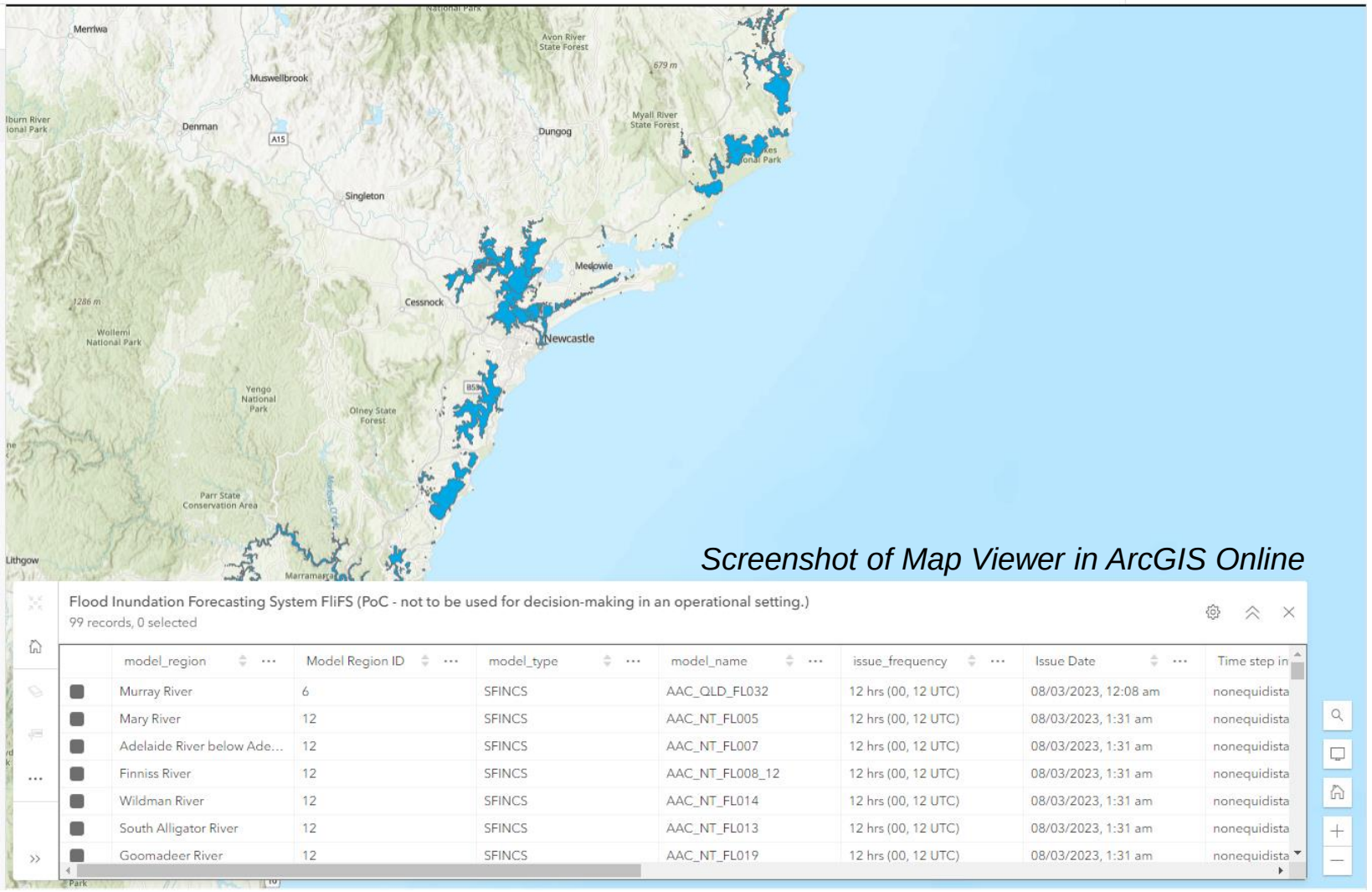
- Upload shapefiles produced by Delft-FEWS to ArcGIS Online using custom python script.
- Upload as feature layer in ArcGIS Online, including metadata.
- Metadata provided to python script via <exportRunFileActivity> in a Delft-FEWS General Adapter.

```
<exportRunFileActivity>
  <exportFile>%WORK_DIR%\shapefile_upload.xml</exportFile>
  <properties>
    <string key="url" value="$ARCGIS_ONLINE_URL$"/>
    <string key="file_path" value="$EXPORT_FOLDER$\Flifs\$MODEL$\$CATCHMENT$_$FORECAST_TYPE$\$MODEL$_$CATCHMENT$
    <string key="update_metadata" value="True"/>
    <string key="field_mapping" value="%WORK_DIR%\field_mapping.csv"/>
    <string key="field_formatting" value="%WORK_DIR%\field_formatting.csv"/>
    <string key="date_validation_field" value="%START_DATE_TIME(formatid_metadata)%"/>
    <string key="delete_existing_upload" value="True"/>
    <string key="share_groups" value="$ARCGIS_ONLINE_SHARE_GROUPS$"/>
    <string key="service_title" value="$MODEL$_$CATCHMENT$_$FORECAST_TYPE$_PoC"/>
    <string key="service_snippet" value="Area of inundation for $FORECAST_TYPE$ run with start time = %TIME0(formatid_metadata)% fo
    <string key="service_description" value="Polygon shapefile for the $CATCHMENT$ catchment depicting areas that are flooded at any p
%TIME0(formatid_metadata)%, start time = %START_DATE_TIME(formatid_metadata)%, and a forecast length of $FC_LENGTH_DAYS$ days. This
    <string key="service_terms_of_use" value="$TERMS_OF_USE$"/>
    <string key="service_credits" value="$SERVICE_CREDITS$"/>
    <string key="service_tags" value="FliFS"/>
    <string key="destination_item_id" value="$ARCGIS_ONLINE_DESTINATION_ITEM_ID$"/>
  </properties>
</exportRunFileActivity>
```



Upload shapefiles to ArcGIS Online

- Python script can also append/overwrite features in an existing feature layer.
- Result: One feature layer in ArcGIS Online which contains the latest flood extents.



Screenshot of Map Viewer in ArcGIS Online

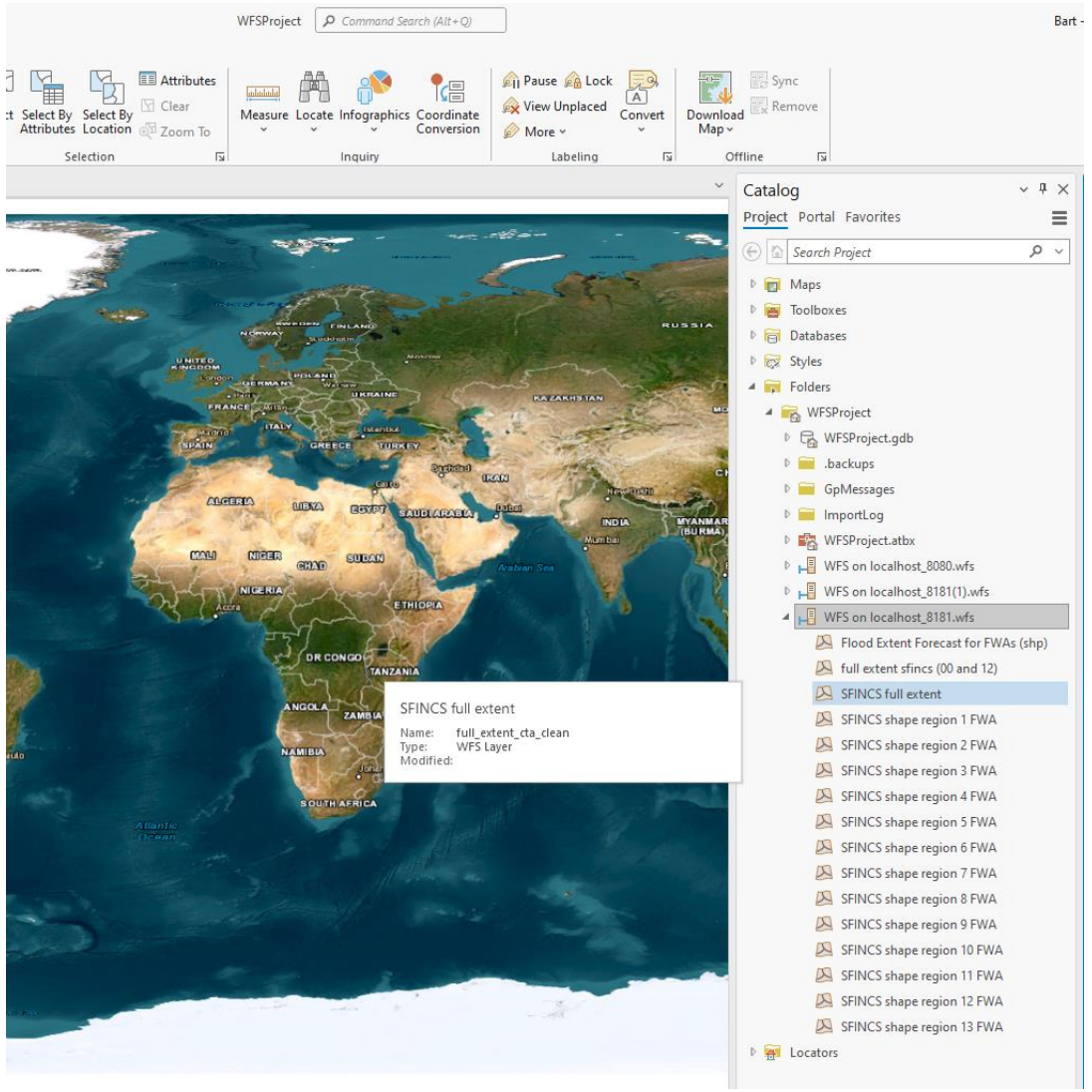
WFS requirements – available in 2023.01

A new **WFS web service** endpoint, in analogy with the existing Delft-FEWS WMS service

- OGC WFS 2.0 compliant, taking the WFS document as design guide, no certification required.
- Simple WFS conformance class (GetCapabilities, DescribeFeatureType, ListStoredQueries, DescribeStoredQueries, GetFeature operation with only the StoredQuery action) using only NVP GET operations (Name Value Pair arguments on url)
- GML and GeoJSON output as provided by org.geotools library (which is used also by GeoServer)
- Support for polygon features
- Support for WGS84 lat-lon and WebMercator projection
- Vendor specific parameters (when applicable) implemented similarly to the Delft-FEWS WMS service
- Configuration of available features to request through the Delft-FEWS grid display.
  In other words, **WFS allows for requesting features (filtered by properties) to be retrieved from layers that have been configured in the relevant gridPlots of the Delft-FEWS grid display**.
- A test page is required, similar to the WMS

WFS requirements – available in 2023.01

- First draft of GetCapabilities class is complete
- GetCapabilities can be read into ArcGIS Pro
- Additional classes are in progress (i.e. data still needs to be connected to the layers show in the screenshot)



Contact

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