OPERA

Observational Products for End-Users from Remote Sensing Analysis

GIS Visualization Guide: OPERA Dynamic Surface Water Extent Product

Observational Products for End-Users from Remote Sensing Analysis (OPERA) Project

Tutorial 101: How to visualize OPERA Level-3 Dynamic Surface Water Extent Product layers using a GIS software

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For this tutorial, download the provisional DSWx-HLS ([20200402](#); [20200520](#)) and DSWx-S1 ([20200328](#); [20200527](#)) products. The data can be viewed on a local machine using any GIS software. In this example, we will demonstrate the steps to visualize the flooding extent caused by a series of dam failures in Midland, Michigan in May 2020 using the DSWx-HLS and DSWx-S1 provisional products via [QGIS](#). We will compare products that leverage data acquired before and after flooding, respectively.

1) Download and unzip the provisional datasets. Each DSWx product package consists of multiple GeoTiff files. Each of the GeoTiff files has the following filename structure:

   OPERA_<LEVEL>_<PRODUCT>_<TILE>_<ACQUISITION_DATE>_<PROCESSING_ DATE>_<SENSOR>_<RESOLUTION>_<RELEASE_VERSION>_<BAND_NUMBER>_< DESCRIPTION>.tif

   e.g.
   for DSWx-HLS:
     OPERA_L3_DSWx-HLS_T16TGP_20200402T162137Z_20220806T024706Z_L8_30_v0.1_B01_WTR.tif
   for DSWx-S1:
     OPERA_L3_DSWx-S1_T16TGP_20200328T233213Z_20231101T000403Z_S1B_30_v0.1_B01_BWTR.tif

   For this specific tutorial, we will only explore the ***B01_WTR.tiff** and ***B01_BWTR.tiff** files, which are the primary product in the DSWx-HLS and DSWx-S1 product suite, respectively, to visualize the flood extent before and after the disaster.

   Navigate through the **20200402** and **20200520** folders. Open the *****B01_WTR.tif** in each folder by dragging and dropping them into QGIS.
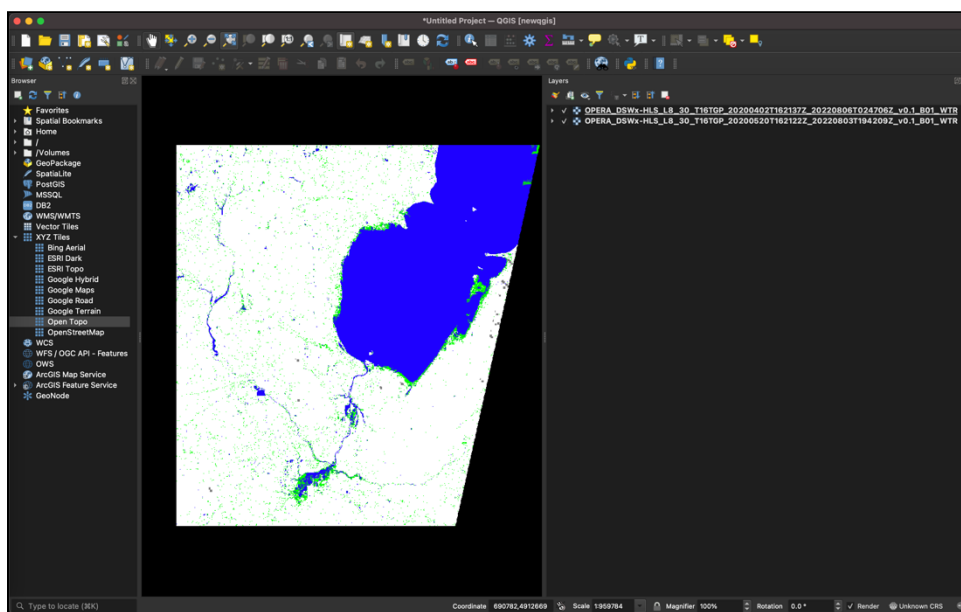

Figure 1a. Each DSWx-HLS product contains 10 bands. **B01_WTR raster** layers from April 02, 2020 and May 20, 2020 are loaded and shown above.

Now navigate through the **20200328** and **20200527** folders. Open the ***B01_BWTR.tif** in each folder by dragging and dropping them into QGIS.
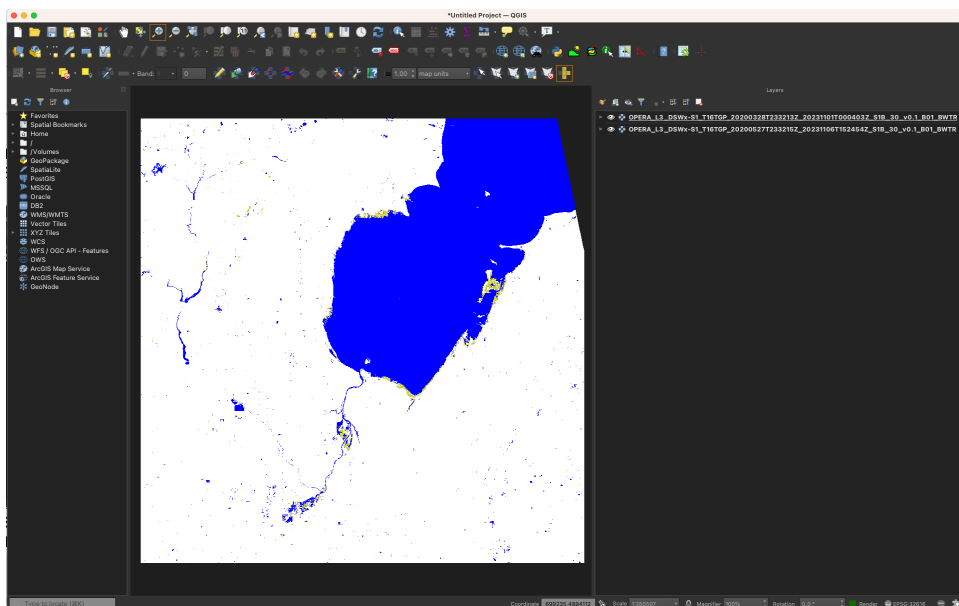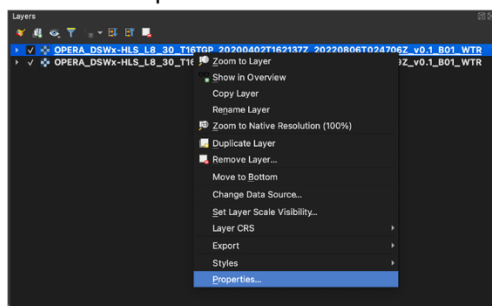

Figure 1b. Each DSWx-S1 product contains 3 bands. **B01_BWTR raster** layers from March 28, 2020 and May 27, 2020 are loaded and shown above.

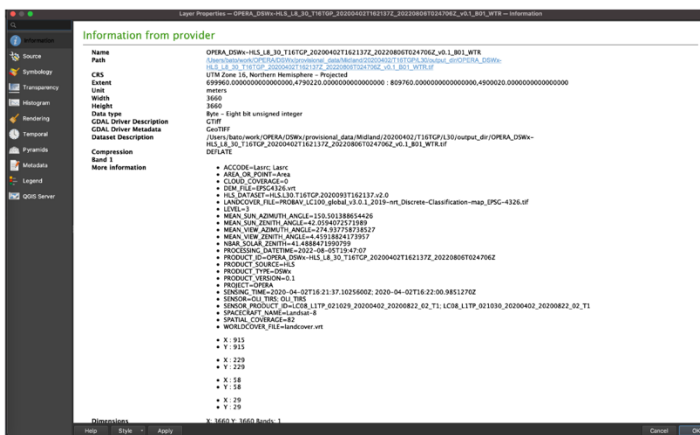2) To inspect the metadata layer associated with the loaded files, follow the steps in Figure 2.

Figure 2. View metadata associated with the product.

3)

    a) Loading DSWx-HLS **B01_WTR** by default shows pixel values ranging from 0-255. However, in effect, this layer only contains five classes* with values that are pre-associated to a specific color:

0: not water (white)

1: open water (blue)

2: partial surface water (green)

9: cloud/cloud mask (gray)

255: no data (transparent)

==***NOTE**: Here we visualize legacy sample products, which do not reflect the updated classes and corresponding designated pixel values and colors as defined in the product specifications of the final version of the delivered products, which are denoted as so (with *changes highlighted*):==

0: not water (white)

1: open water (blue)

*2: partial surface water *(light green)*

252: snow/ice (cyan)

253: cloud/cloud shadow (gray)

254: ocean masked (dark blue)

255: no data (transparent)

To reclassify the colors to only five classes, right click on the raster layer, then click on 'Properties', and select 'Classify' in the 'Symbology' tab.

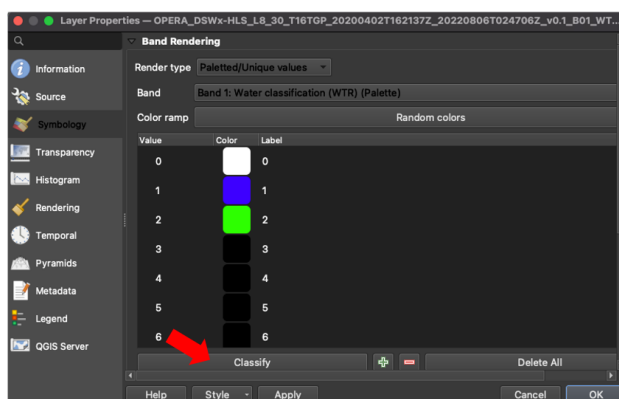1   Right click on the product layer and select 'Properties'
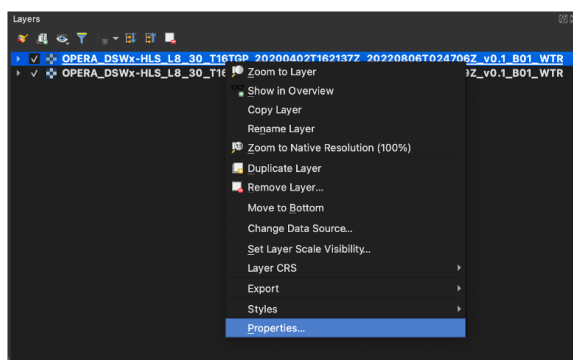
2   Click 'Classify'.

Figure 3a. Steps to reclassify the colors to the actual number of classes in **B01_WTR**.

b) Loading DSWx-S1 **B01_BWTR** by default shows pixel values ranging from 0-255. However, in effect, this layer only contains six classes* with values that are pre-associated to a specific color:

0: not water (white)
1: open water (blue)
5: Height Above Nearest Drainage (HAND) masked (light gray)
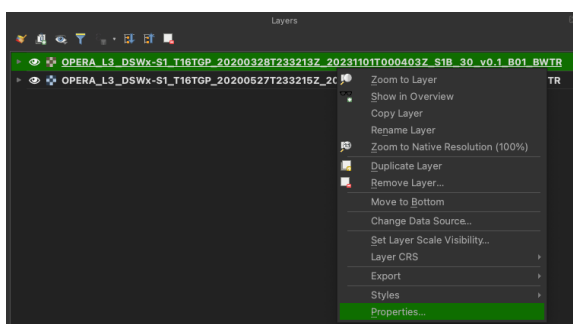*6: layover/shadow masked (dark gray)*
7: inundated vegetation (yellow)
120: no data (transparent)
254: ocean masked (dark blue)

To reclassify the colors to only five classes, right click on the raster layer, then click on 'Properties', and select 'Classify' in the 'Symbology' tab.

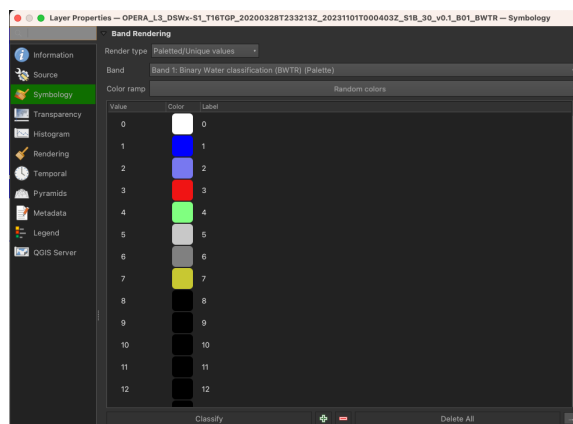**1** Right click on the product layer and select 'Properties'

2 Click 'Classify'.

Figure 3b. Steps to reclassify the colors to the actual number of classes in **B01_BWTR**.

4) To add a basemap layer in QGIS, users can follow the instructions given in this link or follow the instructions in Figure 5. Alternatively, users can directly copy and paste the following URL into the 'URL' field under 'Connection Details':

```
https://a.basemaps.cartocdn.com/light_nolabels/{z}/{x}/{y}@2x.png
```

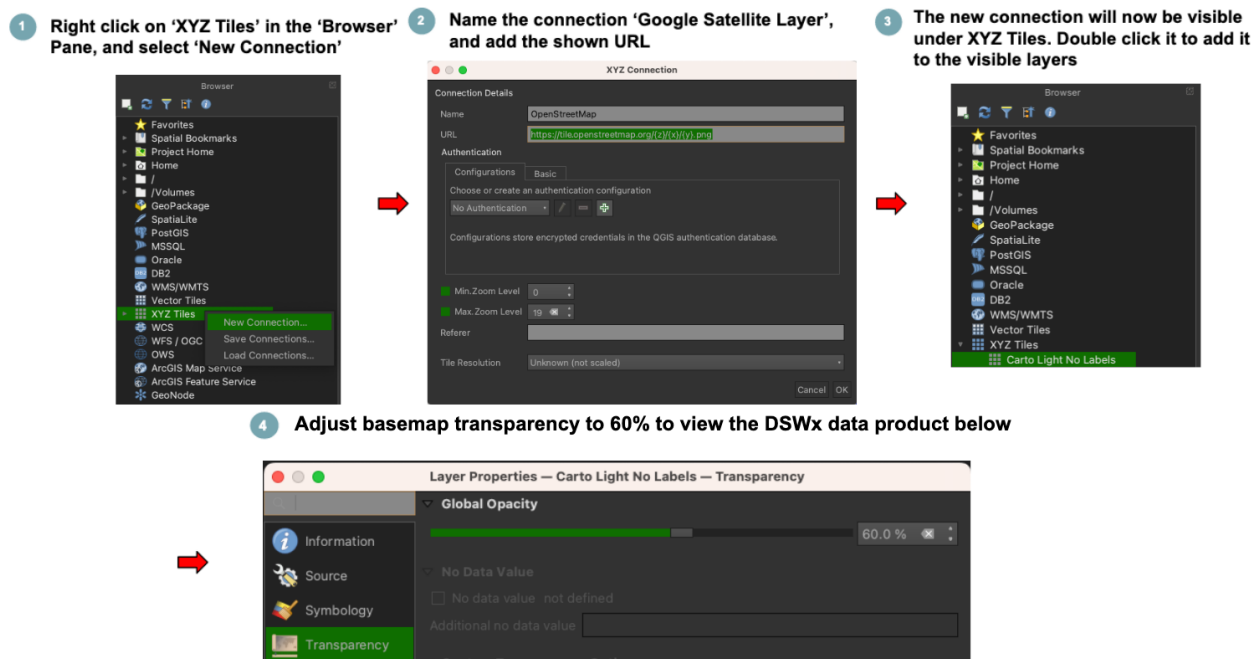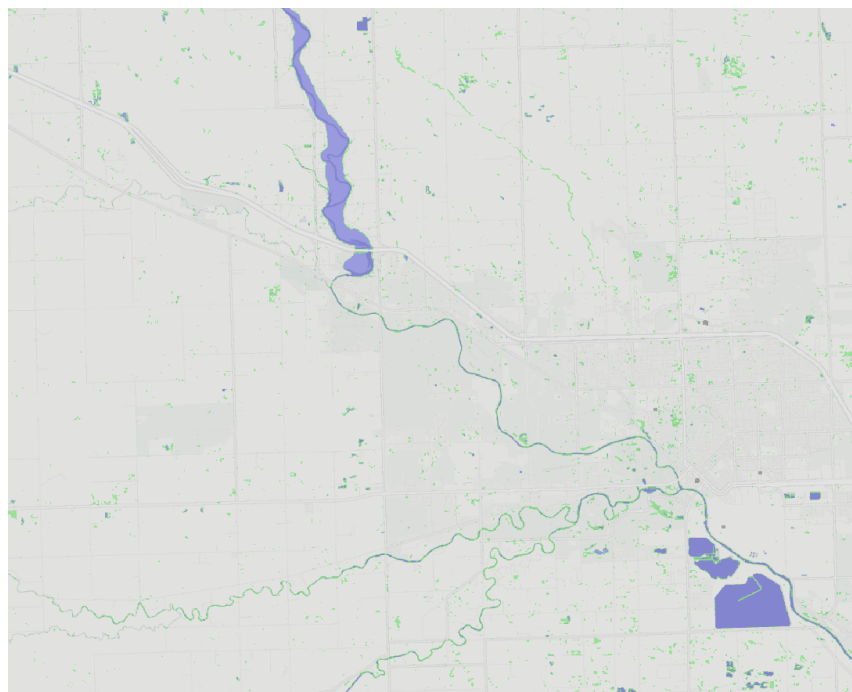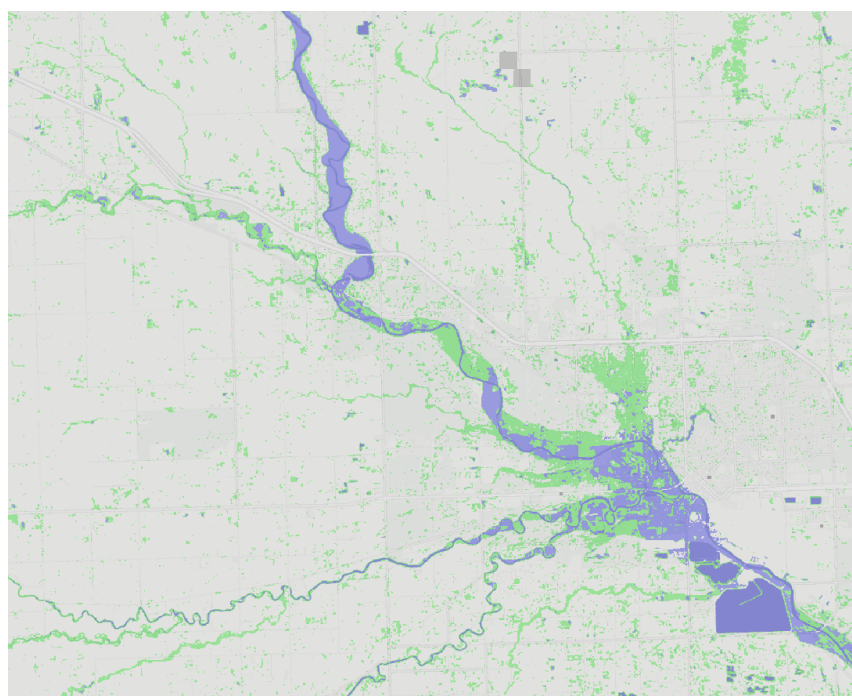This should enable `Carto Light No Labels` base maps as a layer option under 'XYZ Tiles'.

Figure 5. Adding a basemap to QGIS.

Repeat **Steps 1 to 4** for the 20200520 DSWx-HLS product and 20200527 DSWx-S1 product to compare before and after water extent images of the flood.

(Before dam failures - April 02, 2020)

(After dam failures - May 20, 2020)

Figure 6a. Water extent data showing before and after images of the flooding disaster in Midland Michigan caused by series of dam failures in May 2020, visualized using the **B01_WTR** OPERA DSWx-HLS data product, and overlaid on top of a Google basemap. Zero values have been masked out.
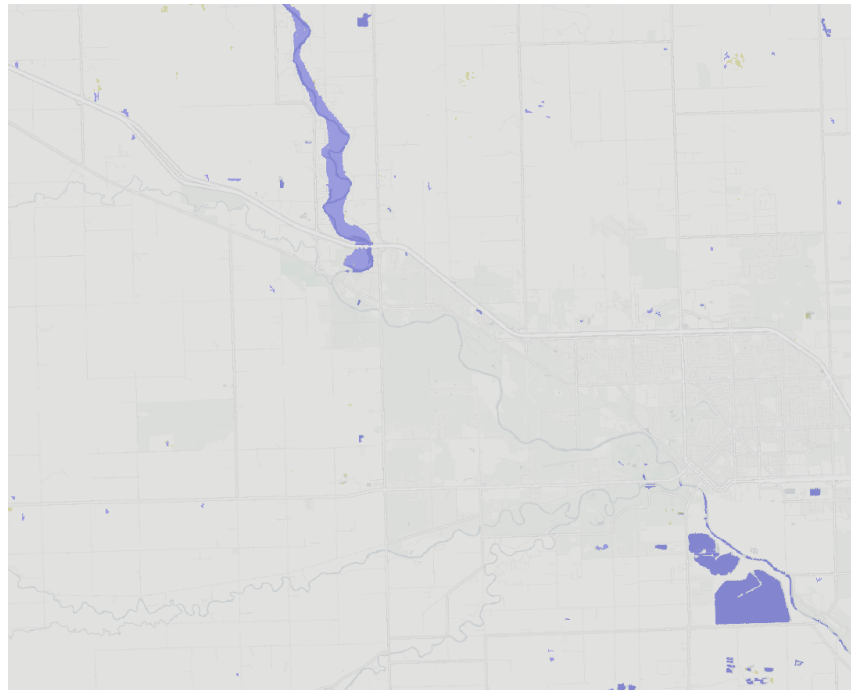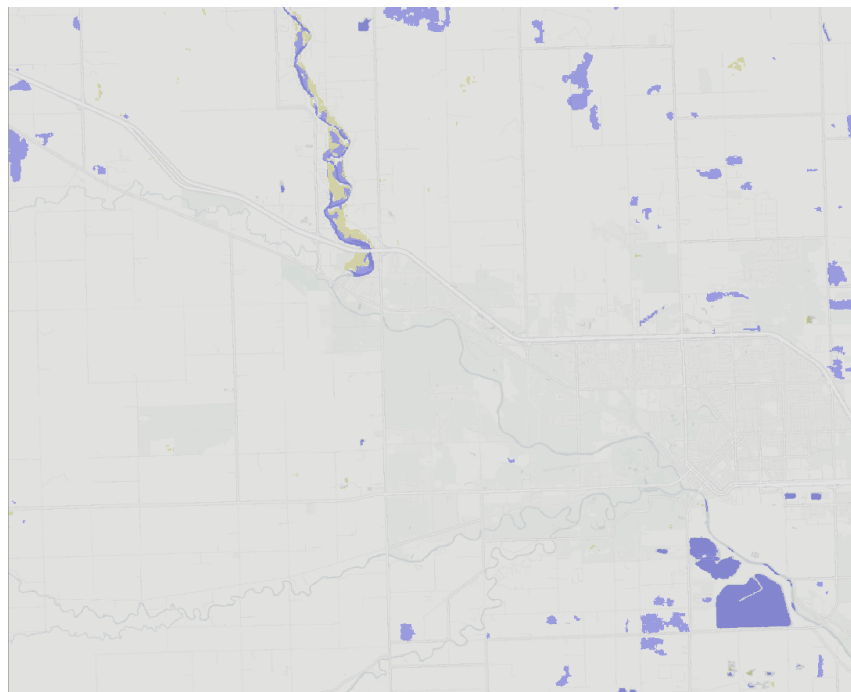
(Before dam failures - March 28, 2020)

(After dam failures - May 27, 2020)

Figure 6b. Water extent data showing before and after images of the flooding disaster in Midland Michigan caused by series of dam failures in May 2020, visualized using the **B01_BWTR** OPERA DSWx-S1 data product, and overlaid on top of a Google basemap. Zero values have been masked out.

Congratulations! You should have now produced a map in a GIS software showing water extent datasets before and after a flooding event, in this case, due to a series of dam failures (Figure 6). By activating/deactivating the before and after images in the 'Layers' panel, areas that are affected by the flooding can be easily identified. **B01_WTR** is a raster layer inside the OPERA DSWx-HLS product suite that shows pixel-wise water classification (i.e. *not water, open water, partial surface water*), cloud/cloud shadow, and no data classes. And **B01_BWTR** is the counterpart raster layer inside the OPERA DSWx-S1 product suite that shows pixel-wise water classification (i.e. *not water, open water, inundated vegetation*), layover/shadow mask, and no data classes. For additional details about the OPERA DSWx-HLS products and layers, please refer to the **Product Specification** [document](). And for additional details about the OPERA DSWx-S1 products and layers, please refer to the **Product Specification** [document](). To learn more about OPERA and its products, please visit [our website]().

List of hyperlinks in this document

1. Provisional OPERA DSWx data products for Midland, Michigan are available at the following URLs:
   a. DSWx-HLS
      i. April 2nd 2020:
         [https://d2pn8kiwq2w21t.cloudfront.net/documents/OPERA_L3_DSWx-HLS_T16TGP_20200402T162137Z_20220806T024706Z_L8_30_v0.1.zip]()
      ii. May 20th 2020
         [https://d2pn8kiwq2w21t.cloudfront.net/documents/OPERA_L3_DSWx-HLS_T16TGP_20200520T162122Z_20220803T194209Z_L8_30_v0.1.zip]()
   b. DSWx-S1
      i. March 28th 2020:
         [https://d2pn8kiwq2w21t.cloudfront.net/documents/OPERA_L3_DSWx-S1_T16TGP_20200328T233213Z_20231101T000403Z_S1B_30_v0.1.zip]()
      ii. May 27th 2020
         [https://d2pn8kiwq2w21t.cloudfront.net/documents/OPERA_L3_DSWx-S1_T16TGP_20200527T233215Z_20231106T152454Z_S1B_30_v0.1.zip]()
2. QGIS can be downloaded from the following link:
   [https://www.qgis.org/en/site/forusers/download.html]()
3. Instructions on adding Google Satellite data as a basemap in QGIS can be found at this URL:
   [https://www.geodose.com/2018/03/how-to-add-google-maps-layer-QGIS-3.html]()
4. Information about the OPERA DSWx-HLS products and layers can be found in the product specification document :
   [https://d2pn8kiwq2w21t.cloudfront.net/documents/ProductSpec_DSWX.pdf]()
5. Additional information about OPERA and data products can be found at our project page:
   [https://www.jpl.nasa.gov/go/opera/products]()