USGS
Dynamic Surface Water Extent (DSWE)
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This is the algorithm description derived from the prototype implementation provided by the authors and subsequent conversations and emails.

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Algorithm Description - Overview:

The algorithm relies on a series of relatively simple and efficient water detection tests, each with their own output code for a "positive" test result or 0 for a negative test result. Resulting in a 5 digit output value in the range 00000 to 11111, where each digit corresponds to a specific test.

These test results are then further refined (recoded) to the following values:

```
  0 -> Not Water
  1 -> Water - High Confidence
  2 -> Water - Moderate Confidence
  3 -> Partial Surface Water Pixel
  9 -> Cloud, Cloud Shadow, or Snow
255 -> Fill (no data)
```

The algorithm provides an output of 3 files. The first file represents the Raw DSWE (recoded values 0, 1, 2, 3, and 255; sceneid_dswe_raw.tif). The second represents the Raw DSWE with filtering applied for Cloud and Cloud Shadow (recoded values 0, 1, 2, 3, 9, and 255; sceneid_dswe_ccs.tif). The third represents the Raw DSWE with filtering applied for Percent-Slope, Cloud, Cloud Shadow, or Snow (recoded values 0, 1, 2, 3, 9, and 255; sceneid_dswe_psccs.tif).

Percent-Slope is utilized to remove locations where the terrain is too sloped to hold water. Any values that meet this criteria are recoded to a value of 0.

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Algorithm Description - Inputs:

Primary source of the input is Surface Reflectance derived from L1T products. Specifically the Blue, Green, Red, NIR, SWIR1, and SWIR2 Surface Reflectance bands, along with the CFmask band.

A DEM is also utilized to generate an internal Percent-Slope band for the required slope filtering.

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Algorithm Description - Detailed:

NOTE: Keep in mind during the processing of the Raw DSWE band, the output is filtered for fill data and those values are set to 255.

Raw DSWE -> Output:

1) Calculate Modified Normalized Difference Wetness Index (MNDWI) from the Green and SWIR1 bands.

```
mndwi = (Green - SWIR1) / (Green + SWIR1)
```

2) Calculate Multi-band Spectral Relationship Visible (MBSRV) from the Green and Red bands.

```
mbsrv = Green + Red
```

3) Calculate Multi-band Spectral Relationship Near-Infrared (MBSRN) from the NIR and SWIR1 bands.

```
mbsrn = NIR + SWIR1
```

4) Calculate Automated Water Extent Shadow (AWEsh) from the Blue, Green, and SWIR2 bands, along with MBSRN.

```
awesh = (Blue
 + (2.5 * Green)
 + (-1.5 * mbsrn)
 + (-0.25 * SWIR2))
```

5) Perform the first test by comparing the MNDWI to a Wetness Index threshold; Where the threshold ranges from 0.0 to 2.0 and is defaulted to a value of 0.0123.

```
if (mndwi > 0.0123) set the ones digit  (Example 00001)
```

6) Perform the second test by comparing the MBSRV and MBSRN values to each other.

```
if (mbsrv > mbsrn) set the tens digit  (Example 00010)
```

7) Perform the third test by comparing AWEsh to an Automated Water Extent Shadow threshold; Where the threshold ranges from -2.0 to 2.0 and is defaulted to a value of 0.0.

if (awesh > 0.0) set the hundreds digit (Example 00100)

8) Perform the fourth test by comparing the MNDWI along with the NIR and SWIR1 bands to the following thresholds. Partial Surface Water Test-1 threshold; Where the threshold ranges from -2.0 to 2.0 and is defaulted to a value of -0.5. Partial Surface Water Test-1 NIR threshold; Where the threshold ranges from 0 to data maximum and is defaulted to a value of 1500. Partial Surface Water Test-1 SWIR1 threshold; Where the threshold ranges from 0 to data maximum and is defaulted to a value of 1000.

if (mndwi > -0.5
&& SWIR1 < 1000
&& NIR < 1500) set the thousands digit (Example 01000)

9) Perform the fifth test by comparing the MNDWI along with the NIR and SWIR2 bands to the following thresholds. Partial Surface Water Test-2 threshold; Where the threshold ranges from -2.0 to 2.0 and is defaulted to a value of -0.5. Partial Surface Water Test-2 NIR threshold; Where the threshold ranges from 0 to data maximum and is defaulted to a value of 1700. Partial Surface Water Test-2 SWIR2 threshold; Where the threshold ranges from 0 to data maximum and is defaulted to a value of 650.

if (mndwi > -0.5
&& SWIR2 < 1000
&& NIR < 2000) set the ten-thousands digit (Example 10000)

10) Recode the results from the previous steps using the following ranges and values.

11001 11111 : 1 (Water - High Confidence)
10111 10999 : 1
01111 01111 : 1

11000 11000 : 3 (Partial Surface Water Pixel)
10000 10000 : 3
01000 01000 : 3

10012 10110 : 2 (Water - Moderate Confidence)
10011 10011 : 2
10001 10010 : 2
01001 01110 : 2
00010 00111 : 2

00000 00009 : 0 (Not Water)

11) Output the Raw DSWE

Raw DSWE -> Cloud, Cloud Shadow, or Snow -> Output:

1) Perform a test by comparing CFmask band to the Cloud, Cloud Shadow, and Snow values.

if (cfmask == 2 or cfmask == 4 or cfmask == 3) set the cloud/cloud shadow/snow filtered Raw DSWE to a recoded value of 9, otherwise set to Raw DSWE

2) Output the Cloud, Cloud Shadow, and Snow filtered Raw DSWE.

Raw DSWE -> Percent-Slope -> Cloud, Cloud Shadow, or Snow -> Output:

1) Build a Percent-Slope band from the DEM source.

2) Perform a test by comparing the Percent-Slope band to a Percent-Slope threshold; where the threshold ranges from 0.0 to 100.0 and is defaulted to a value of 6.0.

if (percent-slope >= 6.0) set the Percent-Slope filtered Raw DSWE to a recoded value of 0, otherwise set to Raw DSWE

3) Perform a test by comparing CFmask band to the Cloud and Cloud Shadow values.

if (cfmask == 2 or cfmask == 4 or cfmask == 3) set the Percent-Slope filtered Raw DSWE to a recoded value of 9, otherwise leave alone

4) Output the Percent-Slope, Cloud, Cloud Shadow, and Snow filtered Raw DSWE.