Department of the Interior
U.S. Geological Survey

README

PROVISIONAL DYNAMIC SURFACE WATER EXTENT (DSWE) PRODUCT

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Section 1 Product Packaging

Dynamic Surface Water Extent (DSWE) products are supplied in a gzip file (.tar.gz). Unzipping this file produces a tar package (.tar), which will "untar" to a Georeferenced Tagged Image File Format (GeoTIFF; .tif) file. The filenames are structured as the original scene ID appended with the product name suffix. The following are the components of a typical file:

LXXPPPRRRYYYYDDDSTNVR_dswe_prod.ext
(e.g., LE71820342003126ASN00_dswe_raw.tif)

LXX LE7 for Landsat 7 ETM+; LT5 for Landsat 5 TM; LT4 for Landsat 4 TM; LC8 for Landsat 8 OLI/TIRS

PPP Path
RRR Row
YYYY Year of Acquisition
DDD Julian Date of Acquisition
STN Receiving Station
VR Version Number
prod Product, such as "_diag", "_raw", "_ccss", or "psccss"
ext File format extension, such as "tif" or "xml"

Section 2 Product Characteristics

The DSWE product is generated by default at 30-meter spatial resolution on a Universal Transverse Mercator (UTM) or Polar Stereographic (PS) mapping grid. File format delivery is in a GeoTIFF (.tif) file format. DSWE products are derived from Landsat Surface Reflectance data, and use the C version of Fmask (CFmask) as the cloud masking criteria; both products are described in the Landsat 4-7 Surface Reflectance product guide (http://landsat.usgs.gov/documents/cdr_sr_product_guide.pdf) and the Landsat 8 Surface Reflectance product guide (http://landsat.usgs.gov/documents/provisional_l8sr_product_guide.pdf).

DSWE can currently be run on Landsat 4-5 TM, Landsat 7 ETM+, and Landsat 8 OLI/TIRS data.

DSWE products are currently delivered in four separate, condition-specific files. Specifications of each output file is described in **Table 2-A**.

1) Diagnostic layer – "_dswe_diag" – The results of the five original tests used to determine water probability. The output of the diagnostic tests used to determine water presence in each pixel is described in **Table 2-B**.

2) Raw DSWE – "_dswe_raw" – The output of the algorithm recoded to a smaller number of values than included in the diagnostic layer.
3) Raw DSWE with cloud/cloud shadow/snow – "_dswe_ccss" – the cloud, cloud shadow, and snow bands from the CFmask are applied to the raw DSWE product to mask out any areas declared as cloud, cloud shadow, or snow in CFmask, represented as a single bit.
4) Terrain corrected DSWE with cloud/cloud shadow/snow – "_dswe_psccss" – the result of the previous step (CCSS) is screened using a DEM converted to percent slope to eliminate terrain-based classification errors and retain the shadow/cloud/snow information. Just as cloud and cloud shadows are coded with the value "9," slopes greater than 6% (the current threshold applied) are also coded as a "9" in this output layer. Note that the percent slope data used for this processing are included in this provisional distribution to allow the application of different thresholds against the raw or CCSS layers.

Individual bit values for the Raw DSWE product are described in **Table** *2-C*, and for Percent Slope (PS) and Cloud/Cloud Shadow/Snow (CCSS) products in **Table 2-D**.

Table 2-A Dynamic Surface Water Extent Specifications

CFmask C implementation of Function of Mask, UINT8 8-bit unsigned integer, DSWE Dynamic Surface Water Extent, NA not applicable, INT16 16-bit signed integer, DEM Digital Elevation Model

Band Name	Description	Data Type	Units	Range	Valid Range	Fill Value	Saturate Value	Scale Factor
percent_slope	Percent slope derived from DEM	INT16	Percent slope	0-10000	0-10000	-9999	NA	0.01
dswe_diag	Dynamic Surface Water Extent – Algorithm test flags	INT16	Flag	0-11111	0-11111	-9999	NA	NA
dswe_raw	Dynamic Surface Water Extent - Raw	UINT8	Flag	0-3	0-3	255	NA	NA
dswe_ccss	Dynamic Surface Water Extent – cloud, cloud shadow, and snow filtered	UINT8	Flag	0-9	0-9	255	NA	NA
dswe_psccss	Dynamic Surface Water Extent - percent-slope, cloud, cloud shadow, and snow filtered	UINT8	Flag	0-9	0-9	255	NA	NA

Table 2-B Diagnostic Test Values for Dynamic Surface Water Extent (TM/ETM+ only)

MNDWI Modified Normalized Difference Wetness Index, MBSRV Multi-band Spectral Relationship Visible, MBSRN Multi-Band Spectral Relationship Near-Infrared, NIR Near Infrared band (TM Band 4), SWIR1 Shortwave Infrared Band 1 (TM Band 5), SWIR2 Shortwave Infrared Band 2 (TM Band 7), AWEsh Automated Water Extent Shadow, PSW1 Partial Surface Water 1, PSW2 Partial Surface Water 2

Value	Threshold (Landsat 4-7)	Threshold (Landsat 8)	Interpretation
00000	NA	NA	No conditions met.

00001	MNDWI > 0.0123	MNDWI > 0.1163	MNDWI greater than Wetness Index threshold.
00010	MBSRV > MBSRN	MBSRV > MBSRN	MBSRV (green + red) greater than MBSRN (NIR + SWIR1).
00100	AWEsh > 0.0	AWEsh > 0.0	Automated Water Extension Shadow (AWEsh) equation returns a value greater than than 0.
01000	MNDWI > -0.05 & SWIR1 < 1000 & NIR < 1500	MNDWI > -0.67 & SWIR1 < 1000 & NIR < 1500	Partial Surface Water 1 (PSW1) equations meet specific thresholds.
10000	MNDWI > -0.05 & SWIR2 < 1000 & NIR < 2000	MNDWI > -0.67 & SWIR2 < 1000 & NIR < 2000	Partial Surface Water 2 (PSW2) equations meet specific thresholds.

Table 2-C Raw Dynamic Surface Water Extent Bit Values

NA not applicable

Bit	Threshold	Interpretation
0	No tests are.	Not water
1	All tests are true.	High confidence of surface water
2	At least 3 but not all tests are true.	Moderate confidence of surface water
3	01000, 10000, or 11000	Partial surface water pixel
255	NA	Fill

Table 2-D Percent Slope (PS) and Cloud/Cloud Shadow/Snow (CCSS) Dynamic Surface Water Extent Bit Values

CFmask C implementation of Function of mask, NA not applicable

Bit	Threshold	Interpretation
0	No tests are true or slope > threshold.	Not water
1	All tests are true.	Water – high confidence
2	At least 3 but not all tests are true.	Water – moderate confidence
3	01000 or 10000 or 11000	Partial surface water pixel
9	CFmask == 4 or CFmask == 2 or CFmask == 3	Cloud, cloud shadow, and snow
255	NA	Fill

Section 3 User Services

Landsat higher level products and associated interfaces are supported by User Services staff at USGS EROS. Any questions or comments regarding data products or interfaces are welcomed through the Landsat “Contact Us” online correspondence form: http://landsat.usgs.gov/contactus.php?topic=UCE. E-mail can also be sent to the customer service address included below, with the same indication of topic.

USGS User Services
http://landsat.usgs.gov/contactus.php
custserv@usgs.gov

User support is available Monday through Friday from 8:00 a.m. – 4:00 p.m. Central Time. Inquiries received outside of these hours will be addressed during the next business day.

Appendix A Default File Characteristics

DSWE Dynamic Surface Water Extent, TIF Tagged Image File Format, CCSS cloud/cloud shadow/snow, PS percent slope

Description	Example File Size (bytes)	Example File Name
Percent slope	126,715,862	LE70150422000036EDC00_percent_slope.tif
Dynamic Surface Water Extent – Diagnostic Tests	126,715,862	LE70150422000036EDC00 _dswe_diag.tif
Dynamic Surface Water Extent - Raw	54,968,000	LE70150422000036EDC00_dswe_raw.tif
Dynamic Surface Water Extent – cloud, cloud shadow, and snow filtered	54,968,000	LE70150422000036EDC00_dswe_ccss.tif
Dynamic Surface Water Extent - percent-slope, cloud, cloud shadow, and snow filtered	54,968,000	LE70150422000036EDC00_dswe_psccss.tif
Metadata	33,185	LE70150422000036EDC00.xml

Appendix B Metadata Fields

Example of DSWE product XML metadata:


```
<bands>
    <band product="dswe" source="sr_refl" name="dswe_raw" category="qa" data_type="UINT8"
nlines="6951" nsamps="7931" fill_value="255">
        <short_name>LT5DSWE_RAW</short_name>
        <long_name>dynamic surface water extent: raw</long_name>
        <file_name>LT50100542011071CHM00_dswe_raw.tif</file_name>
        <pixel_size x="30" y="30" units="meters"/>
        <resample_method>none</resample_method>
        <data_units>quality/feature classification</data_units>
        <valid_range min="0" max="3"/>
        <class_values>
          <class num="0">not water</class>
          <class num="1">water - high confidence</class>
          <class num="2">water - moderate confidence</class>
          <class num="3">partial surface water pixel</class>
          <class num="255">fill</class>
        </class_values>
        <app_version>dswe_1.0.5</app_version>
        <production_date>2016-02-22T18:24:29Z</production_date>
    </band>
    <band product="dswe" source="sr_refl" name="dswe_ccss" category="qa" data_type="UINT8"
nlines="6951" nsamps="7931" fill_value="255">
        <short_name>LT5DSWE_CCSS</short_name>
        <long_name>dynamic surface water extent: filtered by: cloud - cloud shadow -
snow</long_name>
        <file_name>LT50100542011071CHM00_dswe_ccss.tif</file_name>
        <pixel_size x="30" y="30" units="meters"/>
        <resample_method>none</resample_method>
        <data_units>quality/feature classification</data_units>
        <valid_range min="0" max="9"/>
        <class_values>
          <class num="0">not water</class>
          <class num="1">water - high confidence</class>
          <class num="2">water - moderate confidence</class>
          <class num="3">partial surface water pixel</class>
          <class num="9">cloud, cloud shadow, and snow</class>
          <class num="255">fill</class>
        </class_values>
        <app_version>dswe_1.0.5</app_version>
        <production_date>2016-02-22T18:24:29Z</production_date>
    </band>
    <band product="dswe" source="sr_refl" name="dswe_psccss" category="qa" data_type="UINT8"
nlines="6951" nsamps="7931" fill_value="255">
        <short_name>LT5DSWE_PSCCSS</short_name>
        <long_name>dynamic surface water extent: filtered by: percent slope - cloud - cloud shadow -
snow</long_name>
        <file_name>LT50100542011071CHM00_dswe_psccss.tif</file_name>
        <pixel_size x="30" y="30" units="meters"/>
        <resample_method>none</resample_method>
        <data_units>quality/feature classification</data_units>
        <valid_range min="0" max="9"/>
```

```
        <class_values>
          <class num="0">not water</class>
          <class num="1">water - high confidence</class>
          <class num="2">water - moderate confidence</class>
          <class num="3">partial surface water pixel</class>
          <class num="9">cloud, cloud shadow, and snow</class>
          <class num="255">fill</class>
        </class_values>
        <app_version>dswe_1.0.5</app_version>
        <production_date>2016-02-22T18:24:29Z</production_date>
      </band>
      <band product="dswe" source="sr_refl" name="dswe_diag" category="qa" data_type="INT16"
nlines="6951" nsamps="7931" fill_value="-9999">
        <short_name>LT5DSWE_DIAG</short_name>
        <long_name>dynamic surface water extent: raw diagnostic tests</long_name>
        <file_name>LT50100542011071CHM00_dswe_diag.tif</file_name>
        <pixel_size x="30" y="30" units="meters"/>
        <resample_method>none</resample_method>
        <data_units>quality/feature classification</data_units>
        <valid_range min="0" max="11111"/>
        <app_version>dswe_1.0.5</app_version>
        <production_date>2016-02-22T18:24:29Z</production_date>
      </band>
      <band product="dswe" source="sr_refl" name="percent_slope" category="image" data_type="INT16"
nlines="6951" nsamps="7931" fill_value="-9999" scale_factor="0.010000">
        <short_name>LT5PERCENT_SLOPE</short_name>
        <long_name>dynamic surface water extent: percent slope</long_name>
        <file_name>LT50100542011071CHM00_percent_slope.tif</file_name>
        <pixel_size x="30" y="30" units="meters"/>
        <resample_method>none</resample_method>
        <data_units>quality/feature classification</data_units>
        <valid_range min="0" max="10000"/>
        <app_version>dswe_1.0.5</app_version>
        <production_date>2016-02-22T18:24:29Z</production_date>
      </band>
    </bands>
```