Instruction for the ArcGIS Pro Tool “CDOM in Lakes”

CDOM in Lakes is a tool that allows ArcGIS Pro users to calculate CDOM from lakes from the satellite mission Landsat 8 OLI and Sentinel 2A using several different algorithms. The tool also allows to mask out water areas using MNDWI Index or an existing ESRI shapefile.

General functionality

- An overview of the tool’s functionality is shown in a flowchart (Figure 1).
- First the user selects the satellite mission. Sentinel 2A and Landsat 8 OLI are available.
- The next step is to select the algorithm for CDOM calculation.
- The available algorithms in the tool and their equations are listed in Table 1.
- Depending on which algorithm is used, two to three bands need to be selected from either Sentinel 2A or Landsat 8 OLI.
- As an optional choice, water can be masked out from the image by either using the MNDWI or using an existing polygon shapefile that covers the area of interest.
- MNDWI is calculated with (Green – SWIR)+(Green+SWIR) (Xu 2006). Values below zero are not considered water and will be reclassified as NODATA values. Values above zero will get the value one. This layer will be multiplied with the layer of calculated CDOM values.
- The output layer will only have CDOM values where the MNDWI index identified water.
- Finally, the output file name and location are specified. Here, the output raster layer with calculated CDOM values will be saved.

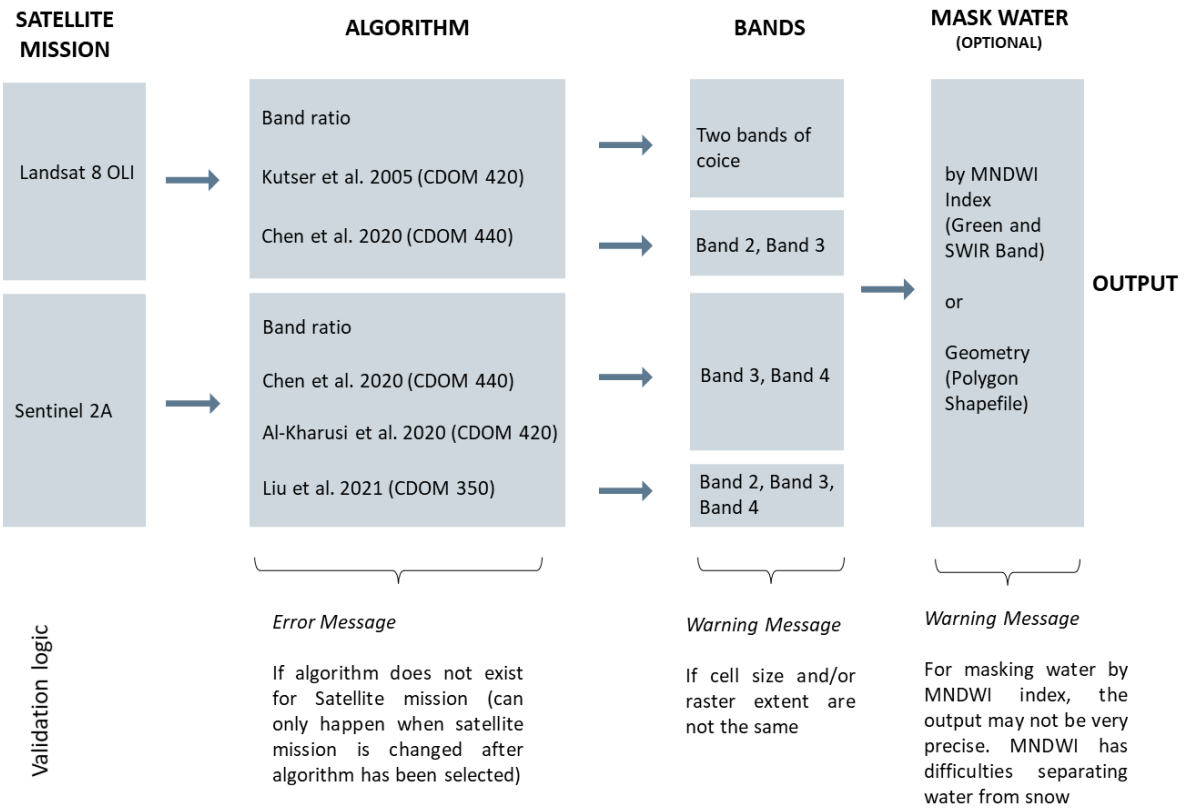


Figure 1 The functionality of the tool in a flow diagram

Table 1: The available algorithms of the tool and equations.

Tool Algorithm	Satellite Mission	Equation
Band ratio	Landsat 8 OLI and Sentinel 2A	$a_{CDOM} = First\ Band / Second\ Band$
Kutser et al. (2005)	Landsat 8 OLI	$a_{CDOM}(420) = 5.13\ (\text{Band 2 / Band 3})^{-2.67}$
Chen et al. (2020)	Landsat 8 OLI	$a_{CDOM}(440) = 40.75\ e^{-2.463\ (\text{Band 3/Band 4})}$
Chen et al. (2020)	Sentinel 2A	$a_{CDOM}(440) = 28.966\ e^{-2.015\ (\text{Band 3/Band 4})}$
Al-Kharusi et al. (2020)	Sentinel 2A	$a_{CDOM}(420) = 2.809\ (\text{Band 3/Band 4})^{-2.341}$
Liu et al. (2021)	Sentinel 2A	$a_{CDOM}(350) = 0.6503\ (\text{Band 4 / Band 2}) + 0.2334\ (\text{Band 3/Band 2}) + 0.00529$

Tutorial

Data

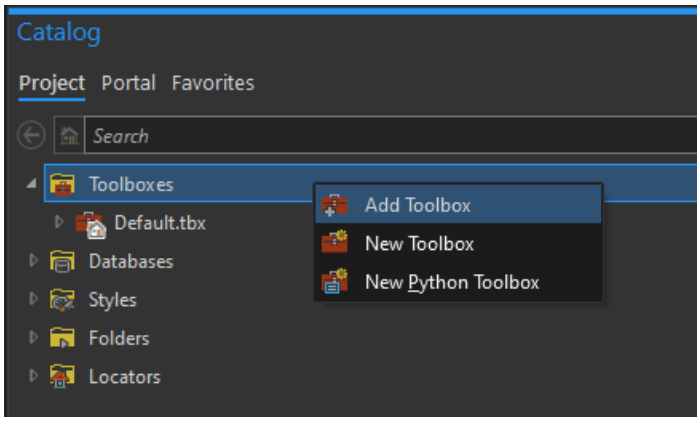
Next to the Toolbox file (CDOM_in_Lakes.tbx) click the folder “Test_Data”.

The Folder should contain following items:

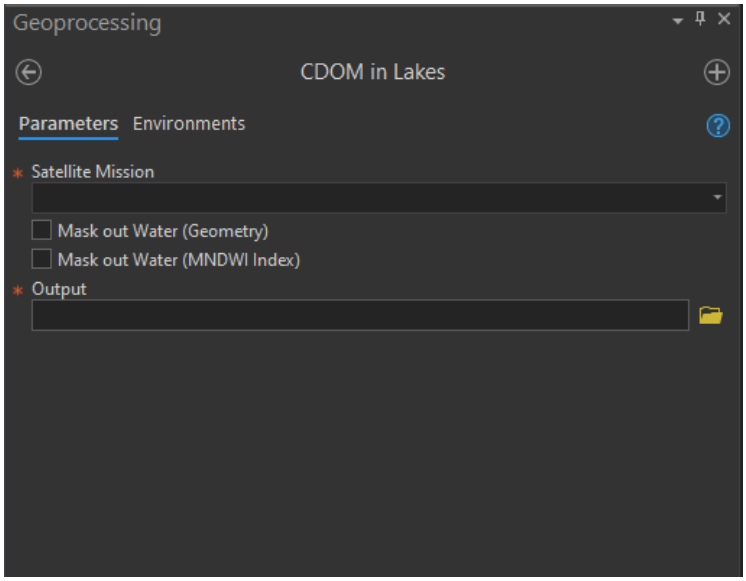
Folder “Sentinel2A”	Folder containing 12 Bands from a clipped Sentinel 2A scene.
Folder “Landsat 8 OLI”	Folder containing 7 Bands from a clipped Landsat 8 OLI scene.
study_lakes (.shp, .dbf, .prj. ,.shx, .cpg)	Polygon shapefile of 10 lakes in northern Sweden

Tasks

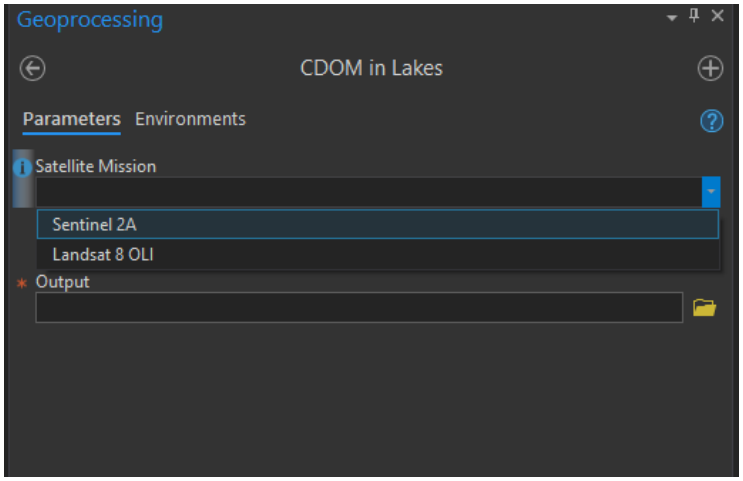
- Open ArcGIS Pro.
- In the catalog pane go to “Toolboxes”, right-click and go to “Add Toolbox



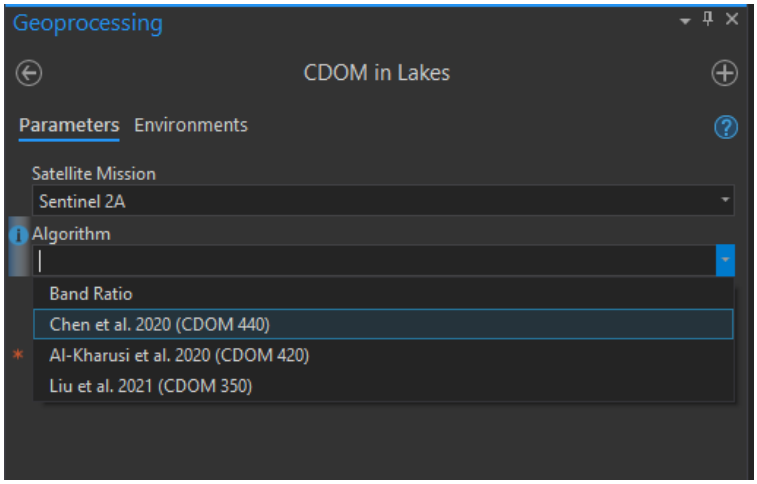
- Select CDOM_in_Lakes.tbx.
- Open the Tool CDOM in Lakes.
- You should now see this interface:



– Select a Satellite Mission



– The parameter “Algorithm” should pop up.
– Select any of the available algorithms.

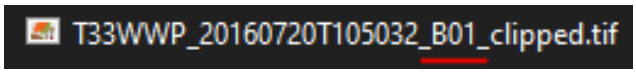


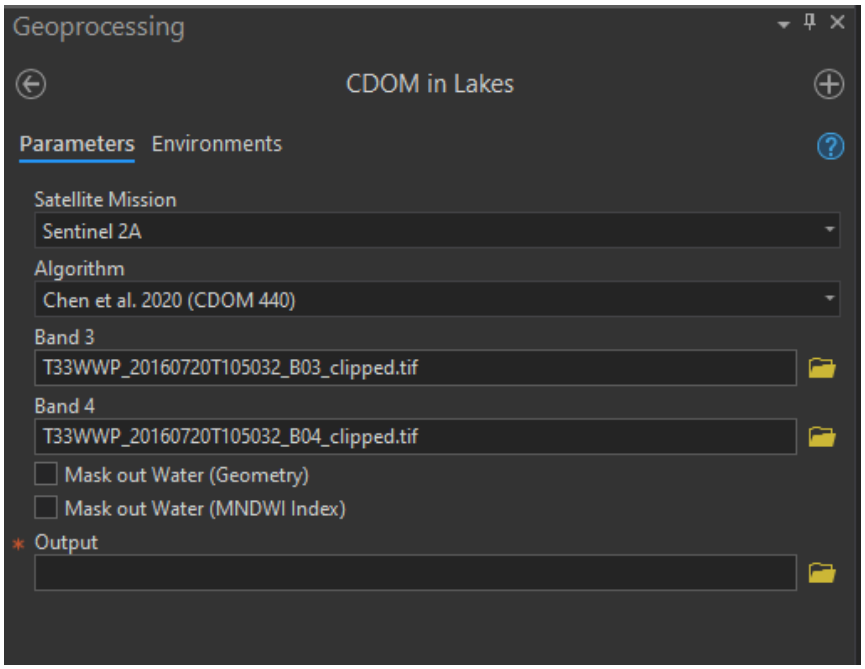
– The Band Parameter should appear.

- Select the appropriate bands for the algorithms in the Folder Sentinel 2A (if the Satellite mission you chose is Sentinel 2A) or the Folder Landsat8OLI (if the Satellite mission you chose is Landsat8OLI).
- The Band number can be seen near the end of the file names.

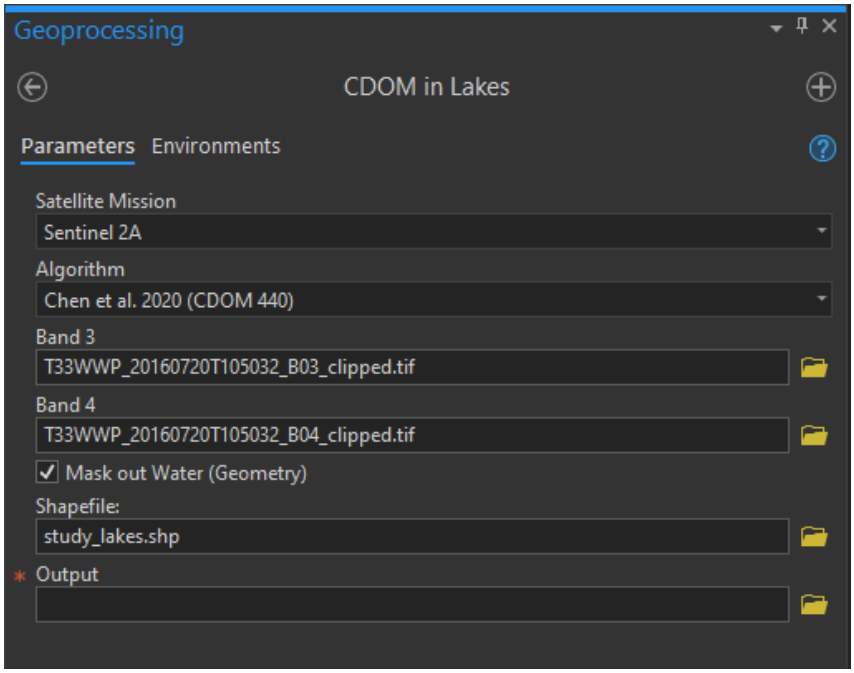
Landsat OLI:

Sentinel 2A:

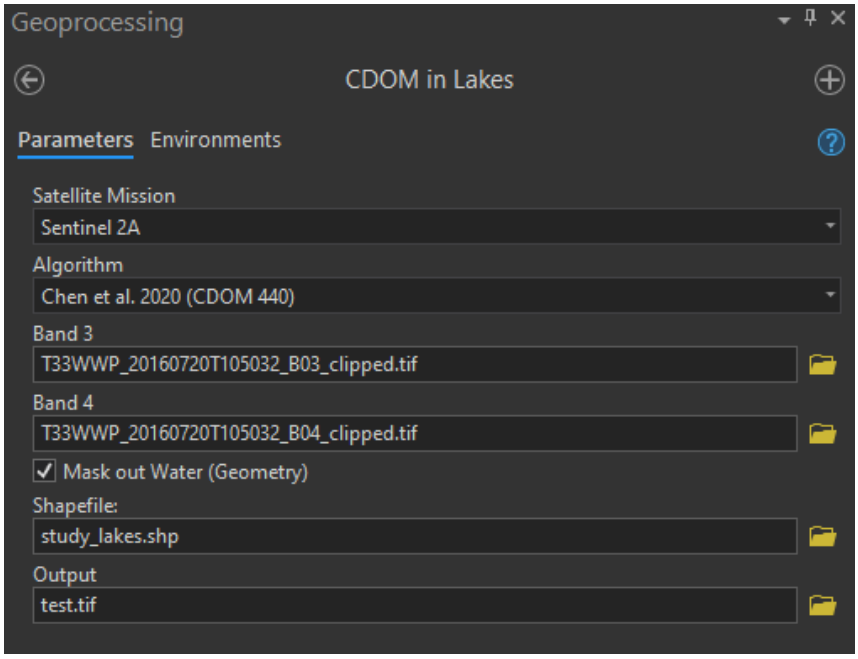




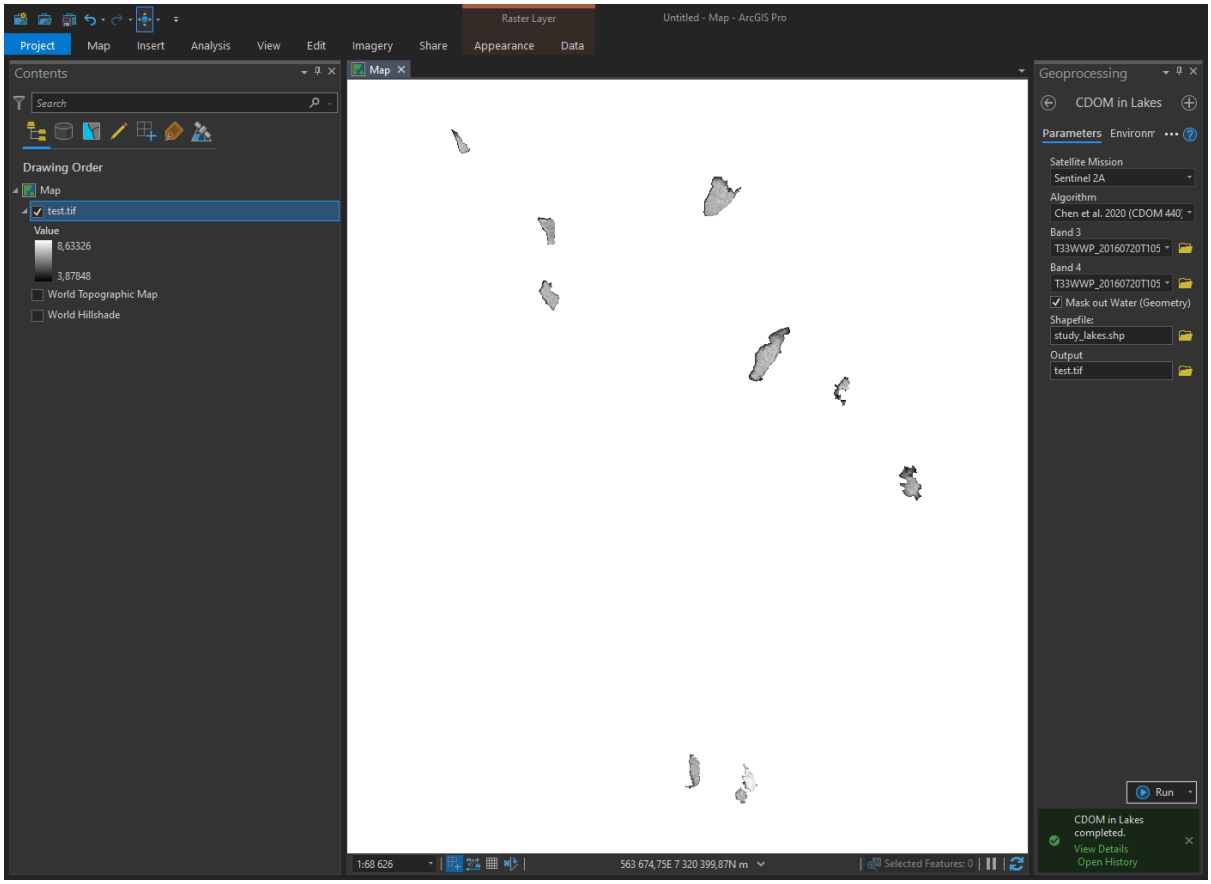
- Now tick the box with the option “Mask out Water (Geometry)”
- As Shapefile select study_lakes.shp in the Test_Data Folder.



– Now specify you output file (name, location and format). In this example the output file is called “test.tif”



– Click on Run.
– The output should look like this (values and pixel size may differ if other options than in the screenshot have been selected.)



End of Tutorial.

References

Al-Kharusi, E.S., Tenenbaum, D.E., Abdi, A.M., Kutser, T., Karlsson, J., Bergström, A.-K., & Berggren, M. (2020). Large-Scale Retrieval of Coloured Dissolved Organic Matter in Northern Lakes Using Sentinel-2 Data. *Remote Sensing, 12*

Chen, J., Zhu, W., Tian, Y.Q., & Yu, Q. (2020). Monitoring dissolved organic carbon by combining Landsat-8 and Sentinel-2 satellites: Case study in Saginaw River estuary, Lake Huron. *Science of The Total Environment, 718*, 137374

Kutser, T., Pierson, D.C., Kallio, K.Y., Reinart, A., & Sobek, S. (2005). Mapping lake CDOM by satellite remote sensing. *Remote Sensing of Environment, 94*, 535-540

Liu, G., Li, S., Song, K., Wang, X., Wen, Z., Kutser, T., Jacinthe, P.A., Shang, Y., Lyu, L., Fang, C., Yang, Y., Yang, Q., Zhang, B., Cheng, S., & Hou, J. (2021). Remote sensing of CDOM and DOC in alpine lakes across the Qinghai-Tibet Plateau using Sentinel-2A imagery data. *Journal of Environmental Management, 286*

Xu, H. (2006). Modification of normalised difference water index (NDWI) to enhance open water features in remotely sensed imagery. *International Journal of Remote Sensing, 27*, 3025-3033