**BROSS User Manual- Google Earth Engine App**

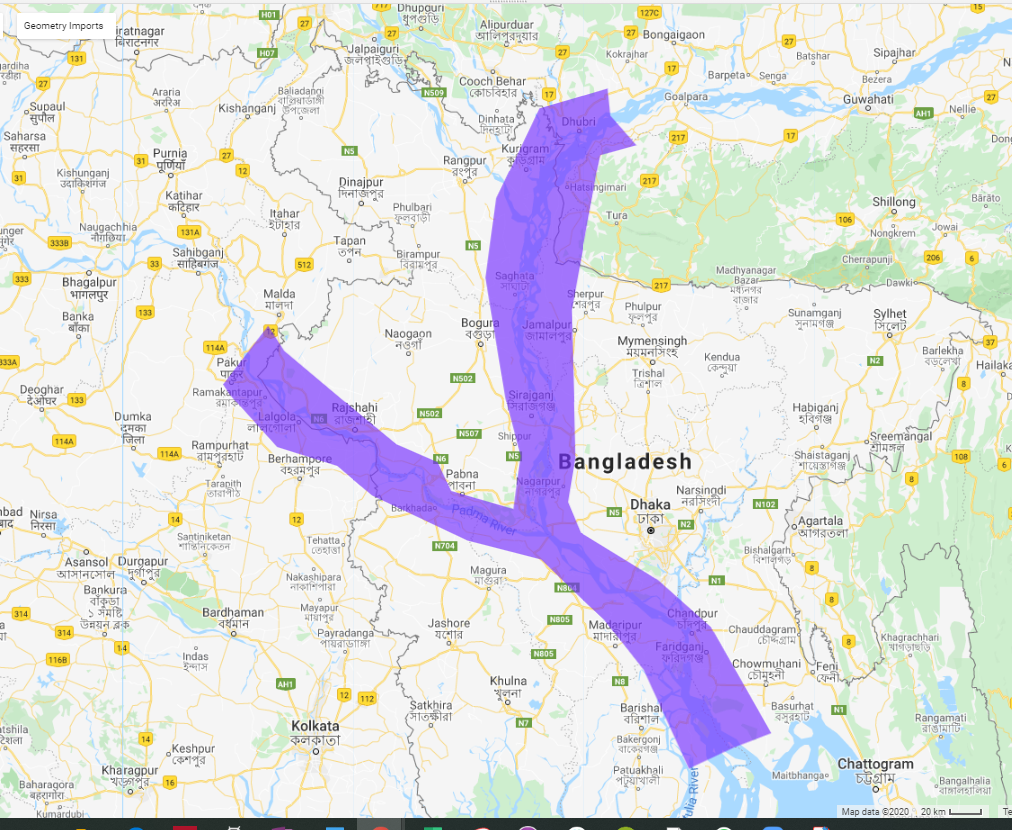
*Written by Claire Beveridge of University of Washington SASWE Research Group.*

*Reviewed by Udoy? Arif?*

*Originally published on April 14, 2020. Last modified on April 14, 2020.*

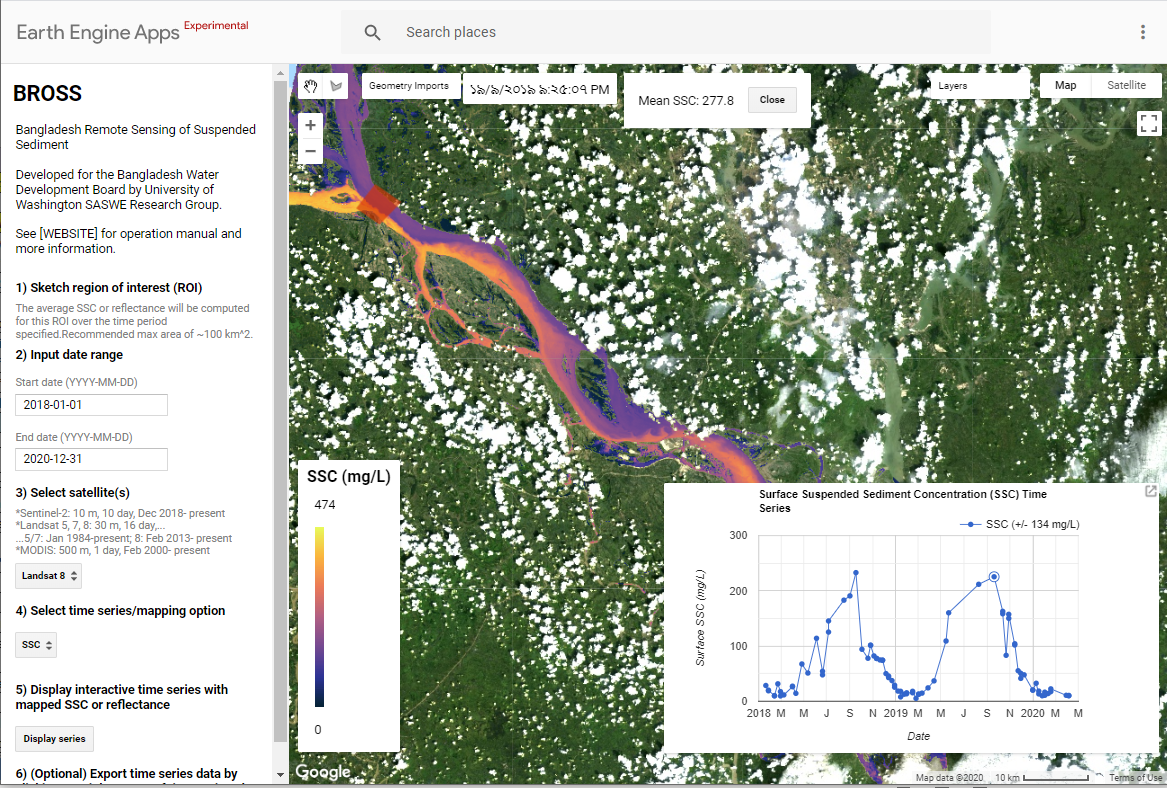
1. **Introduction**

BROSS (“Bangladesh Remote Sensing of Suspended Sediments”) is a tool developed for the Bangladesh Water Development Board (BWDB) by the University of Washington SASWE Research Group. BROSS provides spatially and temporally distributed SSC predictions for the Brahmaputra-Jamuna, Ganges-Padma, and Padma rivers of Bangladesh (Figure 1) using satellite remote sensing imagery in the visible (red, green, blue) and near-infrared (NIR) spectra. It is intended that BROSS will help BWDB with sediment monitoring and management in major rivers. This is a user manual for operating the BROSS system implemented in Google Earth Engine. The technical manual provides more detailed technical background and is found at [INSERT LINK].



**Figure 1: BROSS (GEE tool) domain**

This manual is for the BROSS system implemented in Google Earth Engine. This system provides two data output options: (1) SSC estimated from satellite data using a regression model; and (2) satellite reflectance data in the visible (red, green, and blue) and near-infrared (NIR) wavelengths. Each of these outputs are provided in two forms (Figure 2): (1) a time series of SSC estimates or reflectance data averaged within a user-specified region of interest (ROI), over a specified date range; and (2) mapped over the BROSS domain (Figure 1) for each date of the time series. The SSC and satellite reflectance time series can be downloaded.



**Figure 2: Example output of BROSS in GEE**- A map of SSC along the Padma river and a time series of the SSC averaged for region of interest (red box, upper left of satellite image)

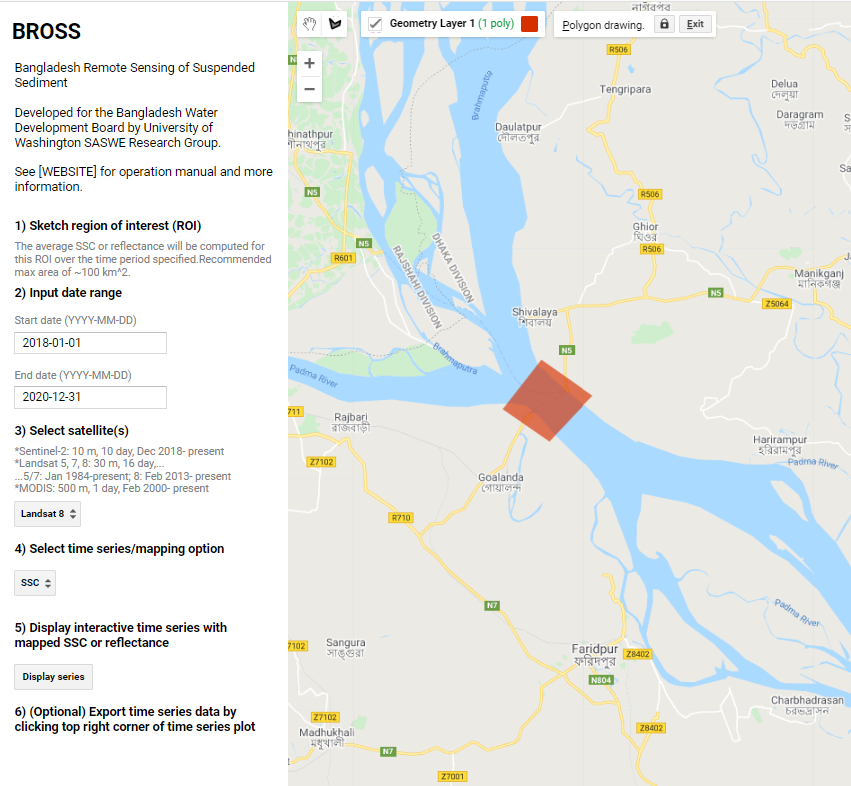
Accompanying the GEE tool is a computational notebook that uses the satellite reflectance data downloaded from GEE to generate a time series of SSC predicted from an artificial neural network (ANN) model (see more information in step v of Section 2)

In addition to the GEE tool, there is a standard SASWE monitoring system which displays prediction of SSC from both regression and ANN models. Table 1 summarizes the differences between the GEE and SASWE tool. The SASWE tool is found at <http://depts.washington.edu/saswe/bross/> and its manual is found at [INSERT LINK].

**Table 1: Comparison of BROSS tools- GEE and SASWE standard monitoring systems**

1. **Operational steps**
2. **Start application.** In a web browser, navigate to the BROSS GEE website: <https://cbev.users.earthengine.app/view/bwdb-ssc-prototype>
3. **Set up filters.** Note that parts a-d can be completed in any order, but all must be completed for BROSS to work.
   1. **Sketch a region of interest (ROI) within the BROSS domain (Figures 2 and 3).** The average SSC or surface reflectance will be computed for this ROI over the time period specified (in step 2)**.**

* The ROI must be a closed polygon for BROSS to work. You will know that it is closed if it turns red (see Figure 3)
* It is okay for the ROI to encompass land area as BROSS will automatically distinguish surface water pixels.
* You can move, reshape, or redo the ROI- see the “Frequently asked questions”



**Figure 3: Example region of interest (ROI)**

* 1. **Input the date range of interest.** The time series of SSC will be provided for this date range.
* There are default dates already in the boxes which can be modified.
* The input format is YYYY-MM-DD (e.g., 2019-03-26 for 26 March 2019).
  1. **Select satellite(s) from the dropdown menu.** The time series and mapped data will be generated using data from the satellite selected.
* The satellites vary in their spatial resolution, temporal resolution, date range of availability, and performance, as shown in Table 2.

**Table 2: Satellite data information**



* 1. **Select time series/mapping option from the dropdown menu.** The time series and map will be shown for either SSC or the surface reflectance (red/blue/green/NIR).
* Surface reflectance (red/blue/green/NIR) is directly from the satellite
* SSC is computed using surface reflectance and a relationship developed from empirical regression.

1. **Click “Display interactive time series with mapped SSC or reflectance.”** This will apply the filters set up in step ii and begin calculating the time series for the SSC or surface reflectance.

* The box in the bottom right hand corner will say “Generating chart…” after you click this. The box will also display an alert if and error occurs.
* It may take a few seconds or up to several minutes for the processing to finish depending on the filters applied.

1. **Optional Steps in GEE:**
   1. **Click a point on the time series to show the mapped data (SSC or reflectance) for that date.**

* Reflectance data is not automatically added to the map (SSC data is). To add reflectance data, hover over the “Layers” panel in the upper right hand corner. Check the box for the layer (e.g., Red) that you would like to add to the map.
  1. **If you do step iii.a., click a pixel of mapped SSC/surface reflectance to get the value at that point. You may need to type the “Esc” key first to get the appropriate cursor.**
  2. **Export the time series plot data and/or image by clicking on the small boxed arrow on the top right hand corner of the chart.**
  3. **View the soil texture map**
  + Hover over the “Layers” panel in the upper right hand corner. Check the box for “Soil texture.” The “Soil Texture” legend is shown on the left hand side of the map. To close the legend, click the “Close” button at the bottom.
  1. **Generate an SSC time series for the ROI that is predicted using ANN**
* Export and save the reflectance time series for the ROI. Navigate to [Web link for Colab notebook] and follow the instructions.

1. **Produce ANN time series for ROI**
   1. Follow steps i-iii to generate a time series of surface reflectance (in step ii.d., must select “surface reflectance)
   2. On the time series chart on the bottom right hand corner of the screen, click on the small boxed arrow on the top right hand corner of the chart.
   3. A new tab will open in your browser showing the time series. On that tab, click on the “Download CSV” button at the top right hand corner.
   4. A file called “ee-chart.csv” will download. You will need this file in the next steps, so know where the file is located.
   5. If desired, you can download multiple files of satellite reflectance data and combine them into a single Excel file to input into the
   6. Navigate to the “Google Colab” notebook: <https://colab.research.google.com/drive/1xR-YsvHcMfTR-HOhXeUWskIM3wQIqE2a?authuser=2#scrollTo=wd2Kaupw_Hid>
   7. Follow the steps in the notebook.
2. **Troubleshooting**
3. **In GEE, the computation is taking too long or is timing out.** Try to decrease the size of the ROI (try ~100 km2 or smaller) and/or reduce the data range (try ~2 years)
4. **In GEE, the box in the lower right hand size says: “Error generating chart: Array: No number in ‘values’, must provide a type.**” Check that an ROI is sketched and that it is filled with red on the inside. Check that remainder of the criteria are filled out. Check that the date range is valid (e.g., end date comes after the start date). Check that the date range entered is within the date range that the satellite you selected is available (date ranges are in Table 1 and listed under “3) Select satellite(s)” on the BROSS interface).
5. **In GEE, I cannot sketch an ROI.** Go to the upper left hand corner of the screen and hover over “Geometry layer 1.” It will then turn to a dropdown box with a heading of “Geometry Imports.” Click on/toggle “Geometry layer 1” and ensure that it’s bolded. Then, you should be able to sketch the ROI directly on the map.
6. **In GEE, why do there appear to be “stripes” in the images?** Unfortunately, this is a known issue with Landsat data. Please see the following link for more information: <https://www.usgs.gov/land-resources/nli/landsat/detector-striping?qt-science_support_page_related_con=0#qt-science_support_page_related_con>
7. **Frequently Asked Questions (FAQ)**
8. **In GEE, how do I modify or redo the ROI after I have sketched it?**

* To modify the ROI, you will need to first click on it. Then, you can move it by clicking, holding, and dragging it. You can reshape it by selecting vertices and moving them.
* To redo the ROI, click on it and hit “Delete” on your keyboard. Go to the upper left hand corner of the screen and hover over “Geometry layer 1.” It will then turn to a dropdown box with a heading of “Geometry Imports.” Click on/toggle “Geometry layer 1” and ensure that it’s **bolded.** Then, you should be able to sketch a new ROI directly on the map.

1. **How do I cite this tool?** See the information at the following link: <http://depts.washington.edu/saswe/bross/cite.html>