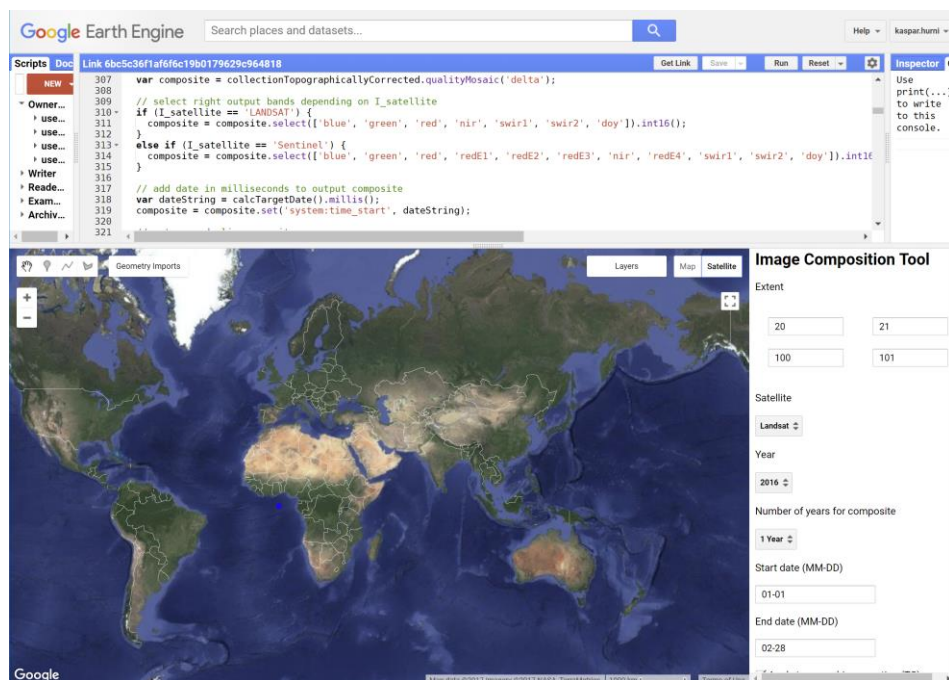


# Google Earth Engine Image Pre-processing Tool:

## User guide



Lukas Würsch, Kaspar Hurni, and Andreas Heinimann

Centre for Development and Environment (CDE)  
University of Bern

2017

## Introduction

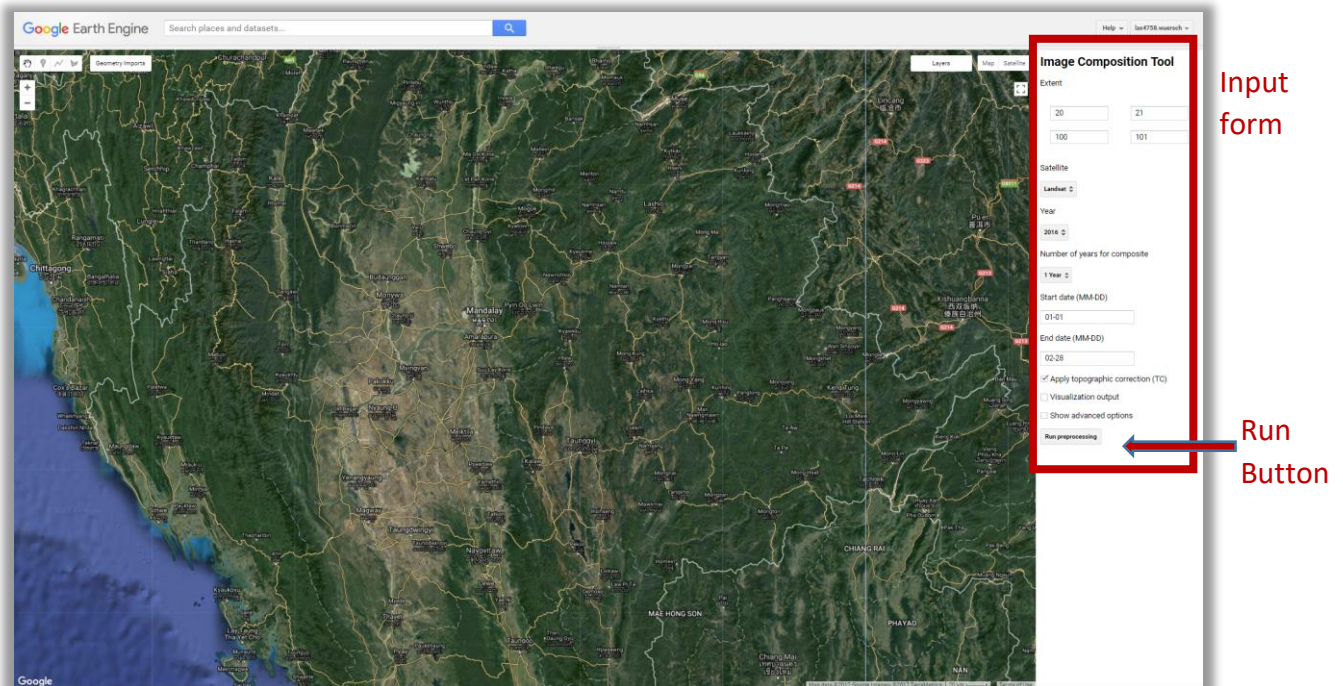
The image pre-processing tool allows the user to create cloud free, topographically corrected image composites for a user defined extent and period in Google Earth Engine (GEE). Image composites are either based on Landsat 5/7/8 (circa 1985 - present, 30m pixel size) or Sentinel 2 (circa 2015 – present, 10m/20m pixel size). The tool visualizes the image composite within a few seconds, enabling the user to perform a crosscheck and to adjust composition strategy if necessary. The image composite can then be exported to the user’s Google Drive for offline use.

This document is the user guide of the pre-processing tool, for a detailed overview on background, methods, and approaches, please consult the technical documentation.

## Setup and quick start

To access the pre-processing tool, a Google Earth Engine account is required. If you do not have access to Google Earth Engine yet, please sign up [here](#).

With access to GEE, start the application (link can be found on the CDE homepage). This opens the following user interface (you may need to login with your GEE account):

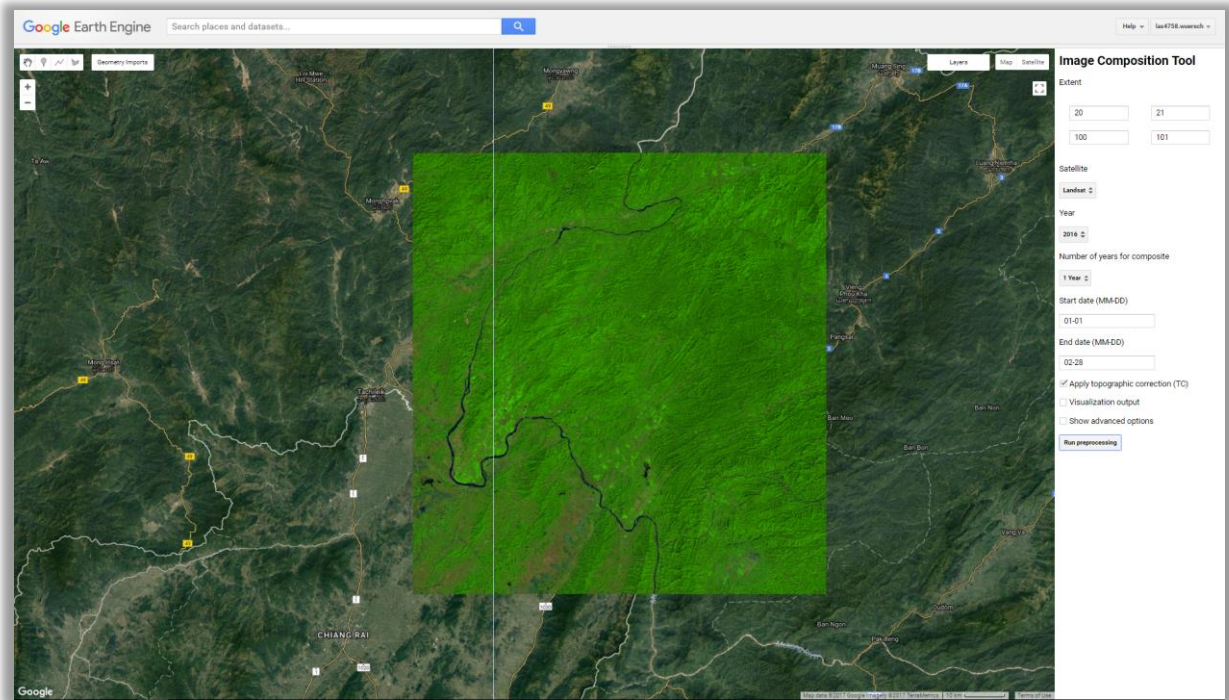


Press the ‘Run preprocessing’ button to create a topographically corrected image with the pre-defined values in the input form.

**Run preprocessing**

After processing the data, the tool adds the image composite automatically to the map view. For information on the user defined image composition options in the input form, see the section [User Inputs](#). For an export of the composite image to your Google Drive, follow the instructions in section [Run Tool and Export](#). If you are having issues with the tool, check the [Troubleshooting](#) section.

The figure below shows a screenshot of the pre-processing tool after performing the image composition using the pre-defined values. The image composite is visualized as natural color view with swir2 (shortwave infrared), nir (near infrared), and green as RGB bands.



## User inputs: Overview

**Extent**

<input type="text" value="20"/>	<input type="text" value="21"/>
<input type="text" value="100"/>	<input type="text" value="101"/>

**Satellite**

**Year**

**Number of years for composite**

**Start date (MM-DD)**

**End date (MM-DD)**

Apply topographic correction (TC)

Visualization output

Show advanced options

Apply semi-empirical TC

**Resolution (meters)**

**Image composition strategy**

Priorise recent images

### [Define study area](#)

Enter the extent manually (decimal degrees) or click on the map to add points

### [Choose satellite](#)

Landsat (using data from Landsat 5/7/8 missions) or Sentinel 2 can be selected

### [Select year](#)

Year for which the image composite is built

### [Select multiple years](#)

Number of consecutive years over which the composite is built

### [Chose start and end date](#)

Start and end date (MM-DD) of the period / season over which the composite is built

### [Apply topographic correction \(TC\)](#)

Check the box for a topographically corrected image composite (not available for Sentinel)

### [Visualization output](#)

Only the natural color view bands (green, nir, swir2) are exported and the resolution is scale dependent

### [Apply semi-empirical TC](#)

Applies a semi-empirical topographic correction. Computationally intensive, limitations described below!

### [Resolution](#)

Resolution of the composite when exporting to Drive

### [Image composition strategy](#)

'Median' (standard), 'upper' focuses on high vegetation greenness, 'lower' on low vegetation

### [Priorise recent images](#)

Pixels of recent years are preferred in the composite

### [Run preprocessing](#)

Adds an image composite the map view and allows the user to initiate the export of the composite

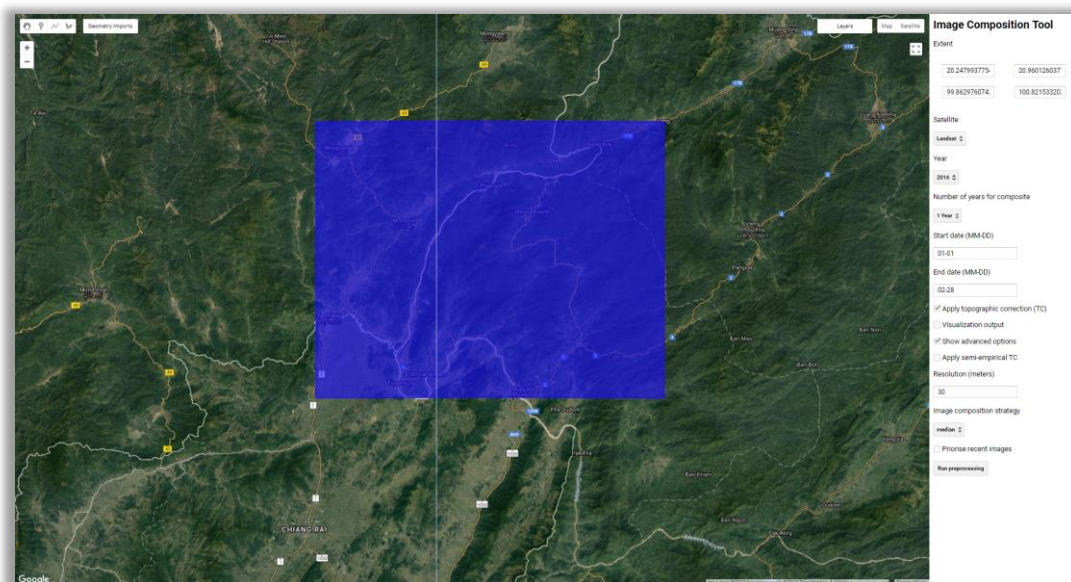
## User inputs: Details

### Extent

The extent specifies the region of interest (a rectangle) that define the boundaries of the image composite. The coordinates yMin / xMin and yMax / xMax, entered in decimal degrees, define the corners of the rectangle. Image composite export time increases substantially (or even fails) for extents > 180x180km (Landsat) and extents > 90x90km (Sentinel).

The tool offers two ways of defining the area of interest:

1. Enter the coordinates manually by writing in the input fields (decimal degrees).
2. Enter the coordinates by clicking on the desired map location. The first click defines the upper left corner and the second click defines the lower right corner. The two points thus define the rectangle and each click that follows overwrites the first point of the two and the rectangle boundary is redrawn using the new coordinates.



### Satellite

Specify which remote sensing data is used to create the image composite. The tool offers the options Landsat (using all surface reflectance Landsat 5, 7, and 8 data available for the period/extent) and Sentinel 2. Notice that the 10m resolution of Sentinel 2 increases the computation cost and export time substantially.

### Year

Enter the year from which the tool selects images to create the composite. Landsat data is available circa 1985-2017, but this can vary heavily depending on study site location. Sentinel 2 data is available circa 2015-2017. The selectable years depend on 'Satellite' specified above.

### Number of years for the image composite

Defines the number of years used for the composite. Choose 1 if the composite should be based on imagery from a specific year only (e.g. 2010). Choose >1 if the composite should be based on multiple years. For example, if 'Number of years for composite' equals 3 and 'Year' is 2010, imagery from the years 2010, 2011 and 2012 are used. Choosing multiple years may include land cover changes in the composite, but at the same time this tends to minimize "no data" pixels.

### Start Date / End Date

These fields define the season for which the image composite is created. Dates have to be entered in the form of MM-DD. Only images acquired between 'Start date' and 'End date' are considered for the composite.

**Note:** If 'Start date' is later than 'End date', images from one more year are considered. For example if 'Year' equals 2014, 'No. years for composite' equals 1, 'Start date' is 12-01 and 'End date' 01-31, the composite is created with images from 2014-12-01 to 2015-01-31.

### Apply Topographic Correction

If this box is checked, the image composite is corrected for variations in topographic illumination conditions. By default, a physical topographic illumination correction approach (computationally efficient) is applied. **This is not yet available for Sentinel data** (see chapter 'Limitations' in the technical documentation).

### Image Composition Strategy

The image composition strategy defines the target reflectance (based on the NIR band) of the image composite. "Median" is the default and balances best between oversaturated and low pixel values. "Lower" focuses on low vegetation greenness (e.g. dry season composites), avoids oversaturated pixels, but can include artefacts due to shadows. "Upper" focuses on high vegetation greenness (e.g. growing season composites), but can include artefacts due to clouds and oversaturated pixels.

### Show Advanced Options

If checked, the input form is extended and provides the user with additional options. The advanced options are discussed below.

By unchecking 'Show advanced options', the advanced options disappear from the user interface and all advanced options are reset to default.

## Advanced User Inputs

### Apply Semi-Empirical Correction

By checking this box, a semi-empirical topographic illumination correction method is applied instead of the physical topographic correction. The semi-empirical correction usually provides better results than the physical, but it is computationally more intensive. As a result, image composites with the semi-empirical correction applied are not displayed within the GEE map view and can only be exported. When specifying large extents, multiple years, and/or long image composition periods, the semi-empirical correction approach may time out and the composite is not exported. Information on errors and timeouts is provided in the [Common Error Messages](#) section.

### Resolution

Specify the resolution of the output image composite in meters. Defaults to 30m for Landsat and 10m for Sentinel (20m Sentinel pixels are resampled to 10m). When changing the field 'Satellite', the field 'Resolution' is automatically adjusted to 30m or 10m for Landsat or Sentinel respectively.

Do not specify a resolution below 30m for Landsat and 10m for Sentinel, as these are their native resolutions and defining lower pixel sizes will not improve your data, but it will increase file size and computation time substantially.

When hitting performance issues (e.g. data export >20 hours or timeout errors), increasing the resolution can speed up the computation or allows the processing of larger extents. We recommend working in smaller subsets when creating image composites over large extents.

### Visualization Output

If 'Visualization output' is checked, only the bands 'green', 'nir', 'swir2' are exported (natural color image composite) and the 'Resolution' is set dynamically in relation to the specified 'extent'. The bigger the extent, the lower the resolution of the output image composite. When checking the field 'Visualization output', the user defined 'Resolution field' is ignored!

This option is computationally more efficient and tends to export the composite faster. However, as it may degrade the output resolution, this option should only be used for visualization and not for analysis.

### Priorise recent images

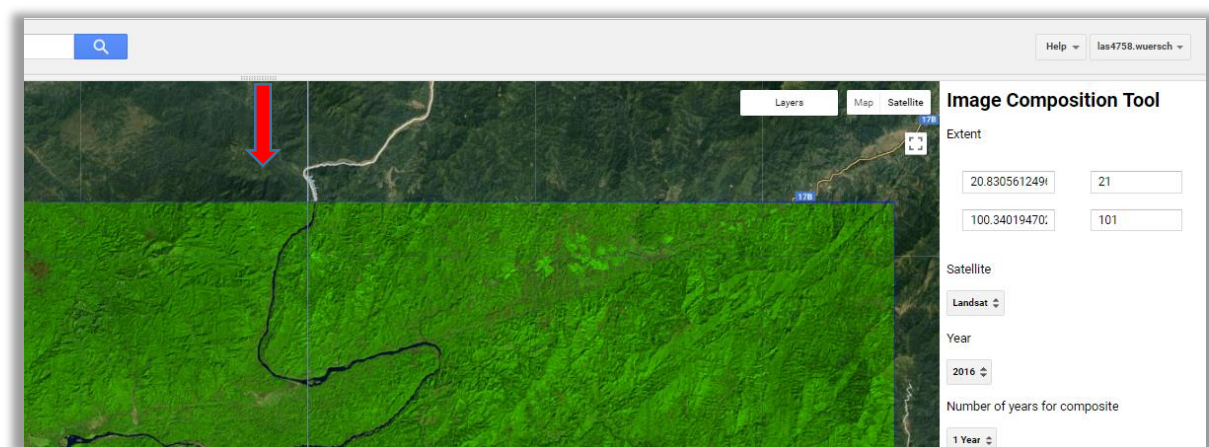
This box is only relevant when using multiple years to create the image composite. With this box checked, pixels of images acquired in the later years of the multiple years specified are preferred over pixels of images acquired in the earlier years. The composite thus tends to include more recent pixels given their quality is sufficient. Use this option if your study focus is on land cover change and by specifying only one year, your image composite still shows too many "no data" areas.

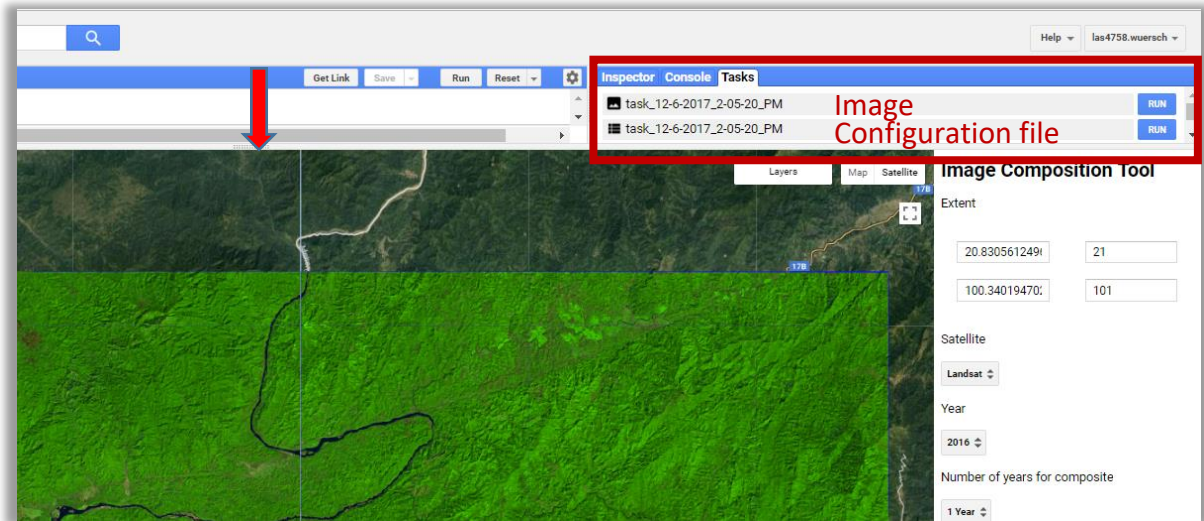
When unchecked, the tool creates a temporally more balanced image composite with stronger focus on pixel quality/reflectance than acquisition year. In such a case, the year(s) in the middle of the period obtain the highest weight and the last and first years the lowest.

## Run Tool and Export

When all the inputs are valid, press the 'Run preprocessing' button. After a little while, the image should appear within the specified extent.

To export the image to Google Drive, the "Tasks" menu bar needs to be accessed by pulling down the grey bar located at the top of the map, as illustrated by the images below:

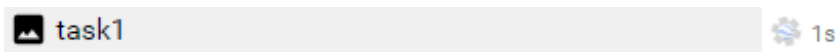




The image can now be exported by clicking the blue 'Run' button on the right. In addition, a configuration file that provides the user defined parameters can be exported. The tool automatically sets unique names for the exported files (depending on date and time) but users can define their own file names.

### Monitoring running tasks

In the Tasks menu bar the state of the started tasks can be seen:



The Task is still running. Runtime is usually between several minutes to several hours, depending on processing extent, topographic illumination correction method, resolution, and number of years used for composite.



Task finished successfully. Access the exported .tif image in your Google Drive folder or web interface.

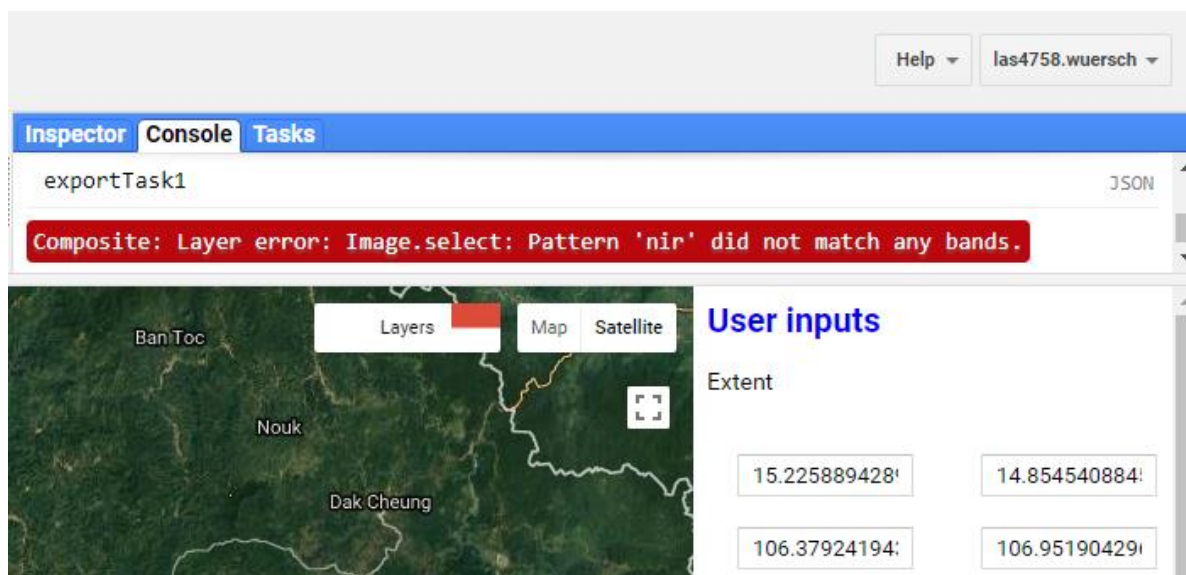


Task failed. To get hints why the task failed, click on the question mark at the end of the task bar.



## Troubleshooting

When encountering errors, Google Earth Engine prints messages to the “Console” tab, which informs you about the problem. You find the “Console” tab next to the “Tasks” tab (the grey bar at the top of the map view has to be drawn down first, as described [above](#)). Note: only errors occurring in the map view are printed to the console. Errors that happen during an export task are displayed in the “Tasks” tab.



### Common Error Messages

**Composite: Layer error: Image.select: Pattern 'nir' did not match any bands.**

Indicates that there is no valid image (or no image with valid (e.g. un-clouded) pixels) in the chosen extent during the specified period (years, season). To obtain an image composite for the selected extent, adjust the season (e.g. choose a different or longer season), adjust the year, use images from multiple years, or use the other satellite.

**List (Error)**  
Computation timed out.

Computation times out when the task is larger than what Google Earth Engine can handle. This can occur when specifying large extents in relation to the native image resolution, or using multiple years and/or long seasons for the image composition (especially when performing the semi-empirical topographic illumination correction). **Running an export task may fix this error, because the exporter can handle larger tasks than the map view. Running the same task multiple times can also lead to success because Earth Engine caches the results of previous (timed out) tasks.** By restarting the same task again, GEE will continue with the calculations where they were dropped by the previous run. You may use the exported configuration file to make sure the same task is started again. **However, when defining large extents and hitting time-outs, it is most efficient to export multiple subsets within the study area.**

Note that error messages from previous runs do not disappear from the console when a new processing is performed. If you want to clear the console of all error messages, the tool has to be restarted.

## Contact

Remote sensing image availability and quality varies by location and time and we adjusted the tool so that it is operational despite these variations. However, as shown above, there are still some issues that could not be eliminated yet. Please do not hesitate to contact us in case you have questions, the tool/export of the data is not working, or if there are issues with the composite (excessive cloud cover, composition artifacts, etc.). **Please provide the configuration file and/or error messages when contacting us concerning specific problems.**

Kaspar Hurni: [kaspar.hurni@cde.unibe.ch](mailto:kaspar.hurni@cde.unibe.ch)

Lukas Würsch: [lukas.wuersch@cde.unibe.ch](mailto:lukas.wuersch@cde.unibe.ch)