

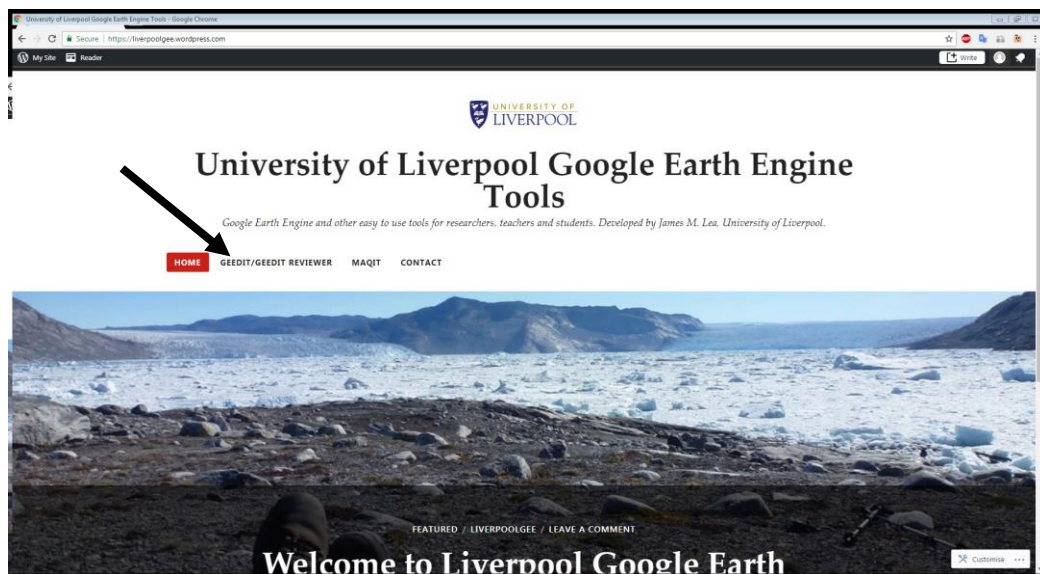
GEEDiT/GEEDiT Reviewer/MaQiT Readme

Below are described the steps to run the tools described in the manuscript. A YouTube video walkthrough of the tools is also available here: [LINK](#)

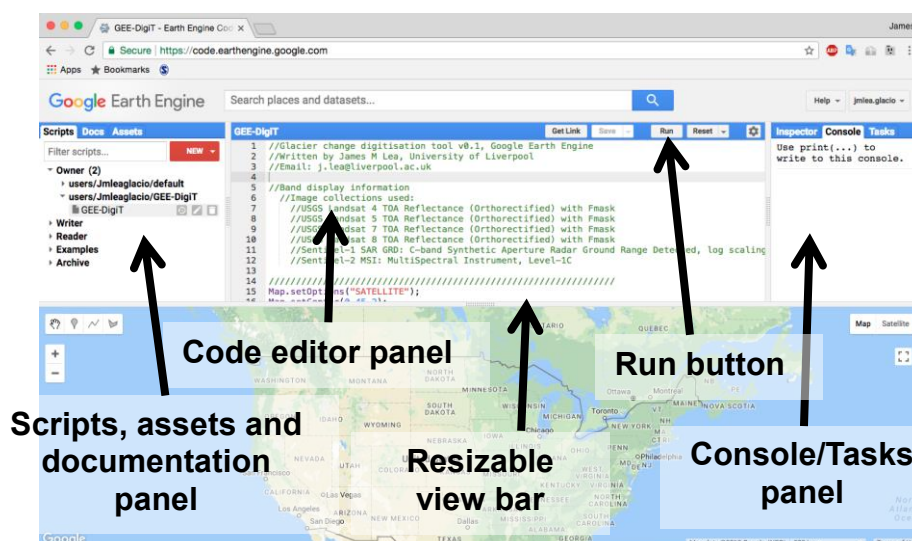
GEEDiT

The steps described below match to each of the panels in appended figure.

1. Navigate to www.liverpoolGEE.wordpress.com, read the background information on the website regarding how to acknowledge GEEDiT in your work, and click on the link to access GEEDiT.

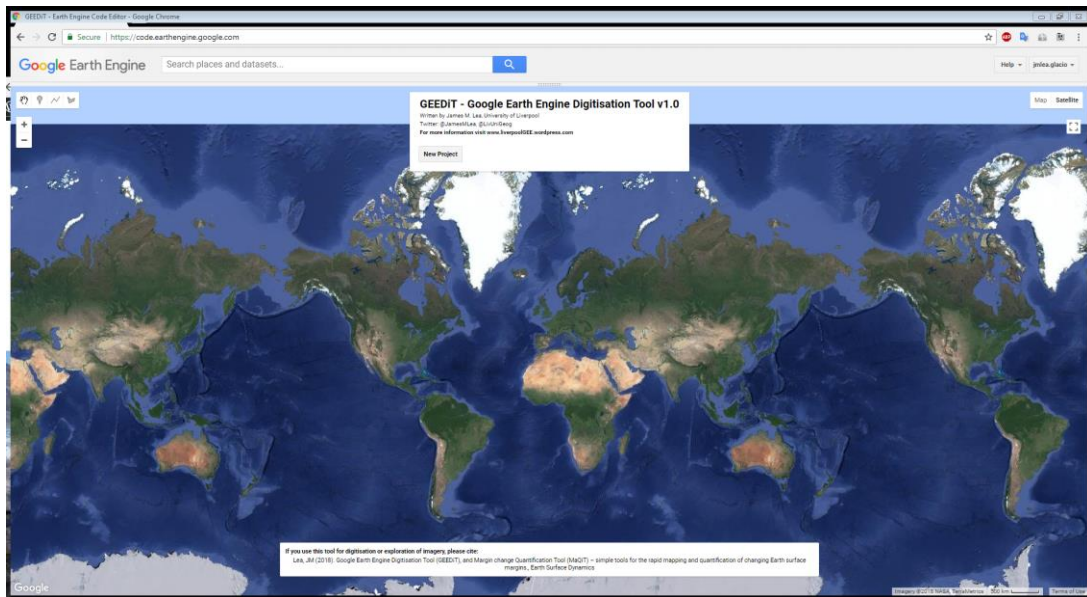


2. If the program does not automatically start, click 'Run' located above where the script can be viewed in the code editor panel. Once this has been done the screen divider can be moved to allow the image of the Earth to occupy the majority of the screen. The tool's

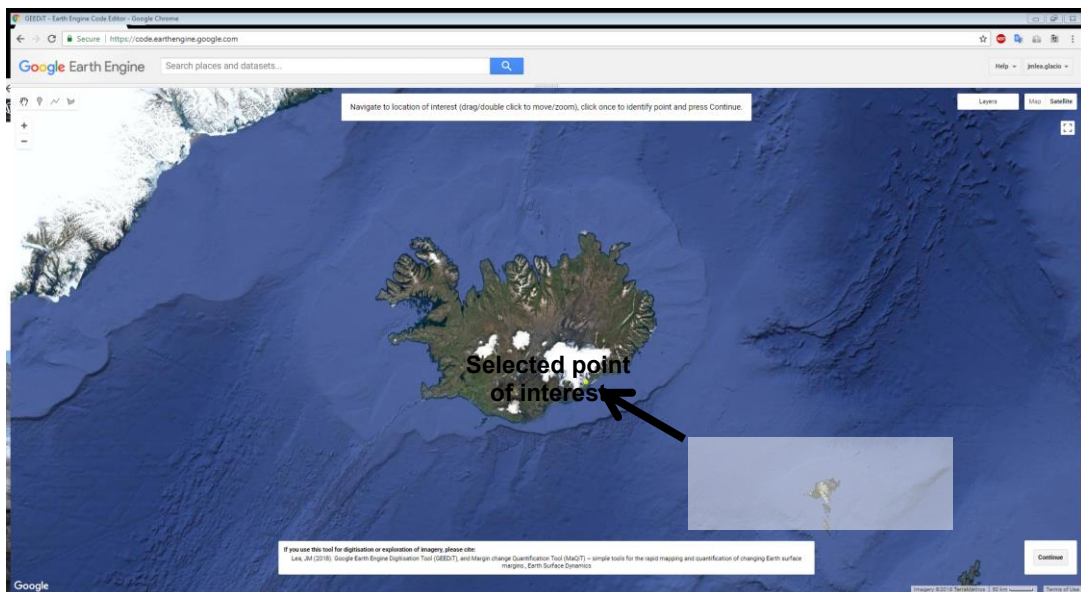


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welcome panel should have appeared. Click 'New Project'.

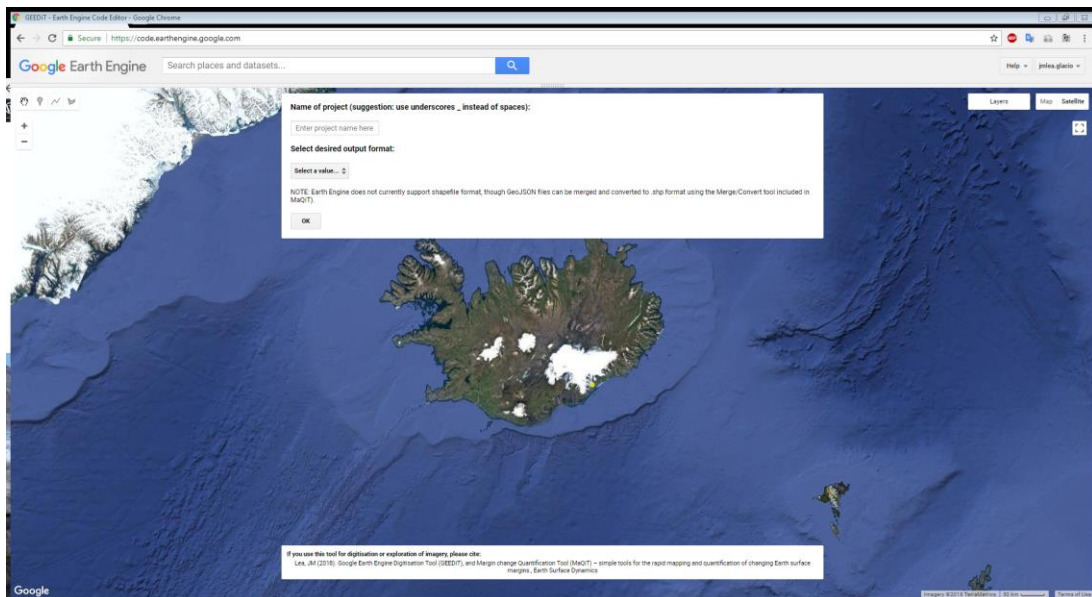


3. The tool asks the user to navigate to an area of interest (i.e. where the data should be visualised for) and click once to identify the location. Once this is done, the user should click 'Continue' in the bottom right corner.



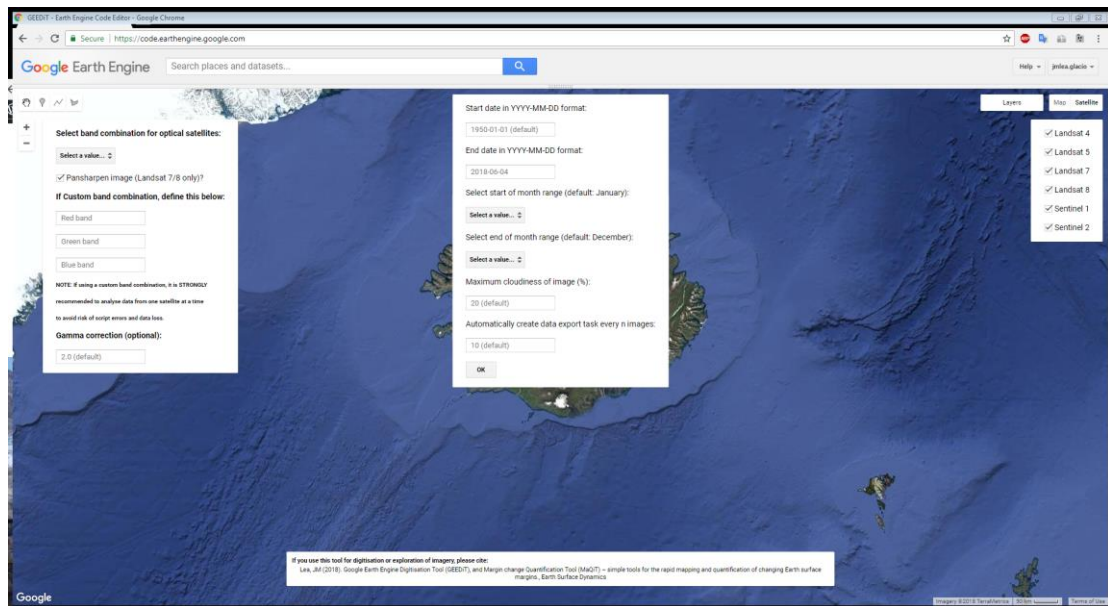
4. The name of the project can now be entered. If this field is left empty the project will be called 'Undefined'. The project name will form the first part of the output filename. The output file format should also be selected on this panel. If data are to be used subsequently in MaQiT or GIS software, it is recommended that data are output as GeoJSON format (this is the default format if none is selected) for subsequent conversion to shapefile format using the tool included in MaQiT (see step 9). Click 'OK'.

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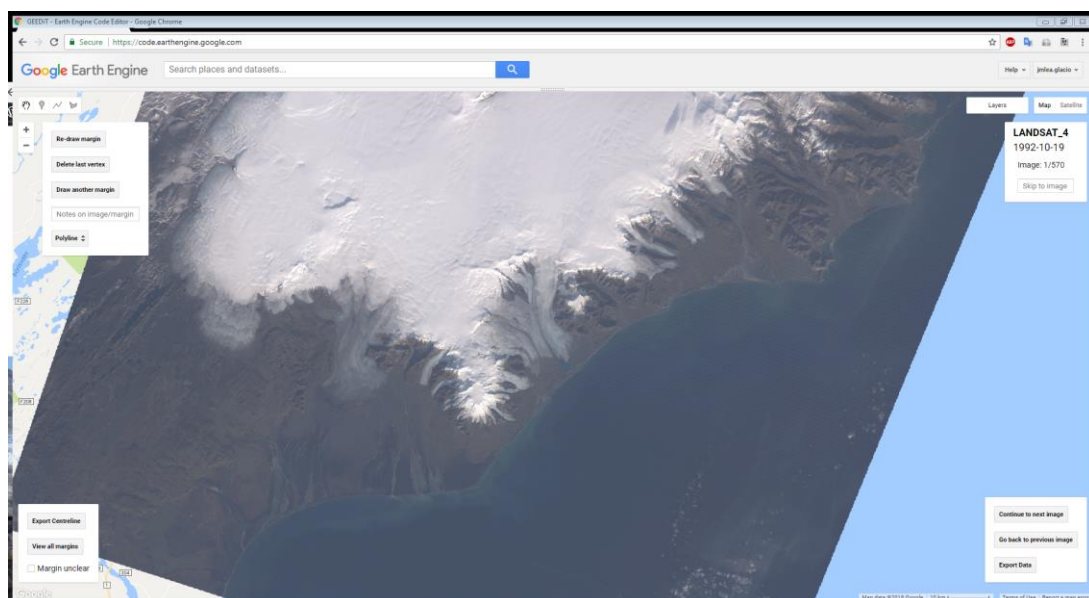


5. The central panel that appears allows the user to filter the images that will be included by date, month, and maximum acceptable cloud cover. If all fields are left unaltered, the default values indicated are used. The left hand panel determines how the images will be visualised. There are 'natural' (i.e. true colour), 'false colour' and 'custom' options (Table 1), and the option to turn on/off pansharpening for Landsat 7 and 8 (i.e. merging lower resolution multi-spectral bands with a higher resolution panchromatic (band 8) to increase image resolution to 15 m). If the 'custom' option is selected the bands of interest should be entered into the relevant text boxes. If using a custom band combination it is strongly recommended to analyse imagery from one satellite at a time. This is due to the wavelengths of different satellite band numbers not always matching (Table 2). The satellite platforms of interest can be selected using tickboxes on the right hand panel. To minimise the potential of significant data loss due to internet connection failure, it is possible to manually define how often (i.e. after how many images) data are exported (see step 8). It is strongly recommended that as soon as each export task is set up that this is run to download the data to the user's Google Drive (see step 8). Tasks that have not been run before the program is restarted are automatically discarded by GEE. Once the desired options have been selected from all 3 panels, click 'OK' at the bottom of the middle panel.

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6. The earliest image from the oldest satellite is visualised first, and the browser automatically zooms in so that the image occupies the screen centred on the chosen point of interest. The satellite platform, date of image and image number are shown in the top right panel. Each image can be explored by dragging/scrolling. The next image can be visualised by clicking the 'Continue to next image' button in the bottom right of the screen.



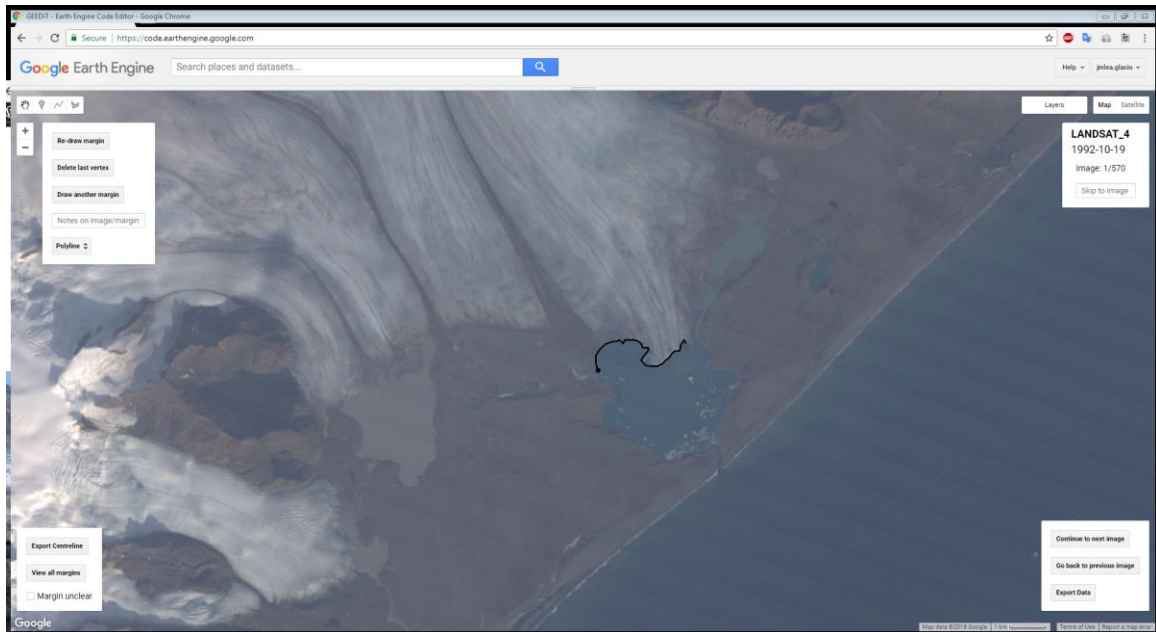
7. Single clicks on the map will begin the digitisation of a margin. If a user wishes to digitise a polygon rather than a polygon they should select the option from the dropdown menu in the top right panel. Each single click will record a vertex location. The lines marking where the margin has been digitised may be lagged appearing on the screen, however the locations of all single clicks are recorded by the tool near-instantaneously.

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- a. If a mistake on a single vertex is made, this can be deleted using the button in the top left of the screen, or the entire margin deleted by clicking 'Re-draw margin'.
- b. If multiple margins need to be digitised on a single image, click 'Draw another margin' in the top left panel once digitisation of the initial margin is complete. Margins that have already been digitised for that image will appear in a different colour. Note that the quantification tools in MaQiT will only work where one margin per image has been digitised, and each margin intersects with the centreline that has been digitised.
- c. Where it is relevant to record whether the margin is unclear for a given image the 'Margin Unclear' checkbox can be selected – where checked, this will record a value of 1 in the relevant metadata field, but will otherwise be recorded as 0. If the margin is unclear and no line is digitised a small line from the centre of the field of view is constructed to allow the metadata value to be recorded.
- d. It is possible to append notes to the metadata of individual margins using the text box in the top left panel. It is also possible to use this to make notes on individual images without digitising a margin. In the case of the latter, the notes are appended to a small line automatically generated in the centre of the field of view.
- e. If no margin, or less than 2 points are digitised, then no margin is recorded and information from that image will not appear in the exported data. To log analysis as being finished for an image click 'Continue to next image'. To digitise another feature on the same image click 'Draw another margin'. Previously digitised margins on that date will appear on the screen in a different colour (note that MaQiT will only quantify changes for individual features (i.e. changes occurring for one glacier margin). Users who wish to use data from GEEDiT in MaQiT should therefore digitise a maximum of one margin per image).
- f. At any stage, all margins that have been digitised during a session can be viewed by clicking the 'view all margins' button in the bottom left corner of the screen.
- g. Users can digitise a centreline that intersects with the margins in GEEDiT or GEEDiT Reviewer (the latter is recommended when digitisation has been undertaken in multiple sessions). To digitise the centreline, first ensure that all margins are viewed on the screen (step 7f), and digitise a line in an upstream to downstream (for a coastal change example, this would be landward to seaward) direction, beginning and ending the centreline at least 2 margin widths upstream and downstream of the nearest margin. The centreline can then be exported as a separate GeoJSON file by

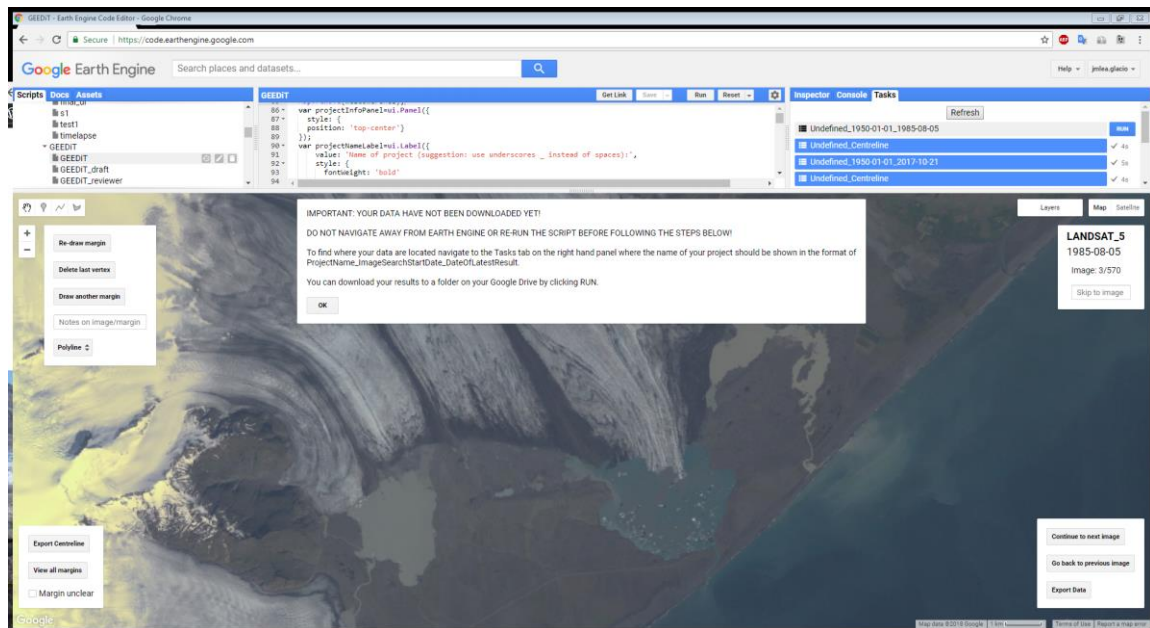
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clicking the 'Export Centreline' button in the bottom left corner of the screen. This file can be downloaded to the user's Google Drive by running the export task in the 'Tasks' tab (top right of the API panel, see also step 8) and converted to a shapefile using MaQiT (see step 9). Note that use of exceptionally long centrelines (e.g. >50-100 km) may affect the performance speed of MaQiT.



8. Once digitisation of margins from all images is finished, data can be exported using the 'Export Data' button in the bottom right of the screen. This will create a 'Task' which can be viewed in the Tasks tab of the top right panel next to the code editor (resize the horizontal screen divider to view this if necessary). To download the data to Google Drive click the 'Run' button next to the relevant task in the right hand panel. Make sure that the desired file format is selected in the dialog box that appears. The default filename is the project name with the user defined start date, followed by the final date where a margin has been digitised for in the format *ProjectName_YYYY-MM-DD_YYYY-MM-DD*. Note that until this step has been taken that the data have not been saved, and will be lost if the browser window is closed or refreshed, or if the program is restarted. The warning screen that appears after the 'Export Data' button is clicked highlights this. The format of the output file allows users to save work regularly and easily identify how much of the record has been analysed. While GEE does not allow data to be downloaded directly to the user's hard drive, this can be done once the data have been saved to the user's Google Drive.

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9. To convert and/or merge multiple GEEDiT outputs in GeoJSON format to shapefile format open MaQiT (see section MaQiT readme below) and click the 'Merge/Convert Tool' button. Dialog boxes will appear asking which files to merge/convert to a single shapefile, before a second dialog box will ask to define the name of the output shapefile. This will generate a shapefile with 'Line_' appended to the defined filename for polylines, and 'Polygon_' for polygon vectors. This allows both lines and polygons to be digitised within the same session. Centrelines converted using this tool will not have any extra characters appended to the defined output filename.

Margin change Quantification Tool (MaQiT) v1.0
 Author: James M. Lea (University of Liverpool, UK. Twitter: @JamesMLea)
 For more information visit: www.liverpoolGEE.wordpress.com

Input shapefile (can use Merge Files tool to convert multiple .shp or .GeoJSON files to a single .shp):

Output spreadsheet of results (.csv format [Excel compatible]):

Method: Centrelines shapefile:

Window of interest (Multi-Centrelines Method only) [optional]
 To quantify change between every observation, leave blank:
 Min. gap between obs. Max. gap between obs.

Box width (Curvilinear Box Method only):

Plot output? [recommended]

If you use this tool, please cite:
 Lea, J. M. (2018). Google Earth Engine Digitisation Tool (GEEDiT), and Margin change Quantification Tool (MaQiT) – simple tools for the rapid mapping and quantification of changing Earth surface margins, Earth Surf. Dynam.

If you access/download these tools as part of your work, you agree to cite the associated manuscript (Lea, 2018. Earth Surface Dynamics) in any publications

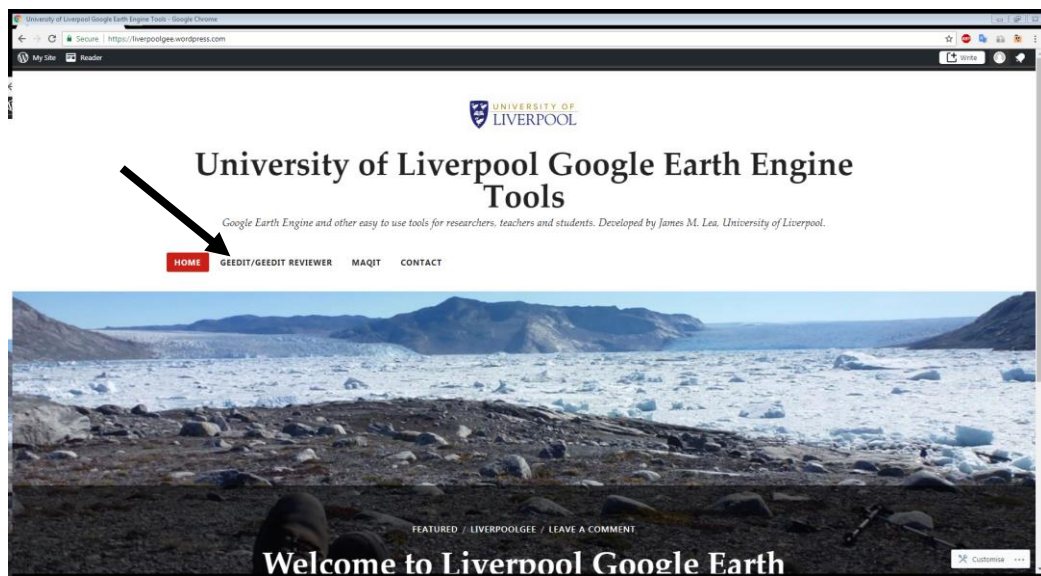
Metadata associated with each margin/boundary	Variable name
Date of image acquisition	date
Name of satellite	satellite
Name of Project	Name
Image identification path	image_path
Is the margin unclear?	unclear
Ascending/Descending Sentinel 1 orbit	Asc_Desc
User notes on an image/margin	notes

Table S1 – Fields included in shapefiles produced by GEEDiT/MaQiT

GEEDiT Reviewer

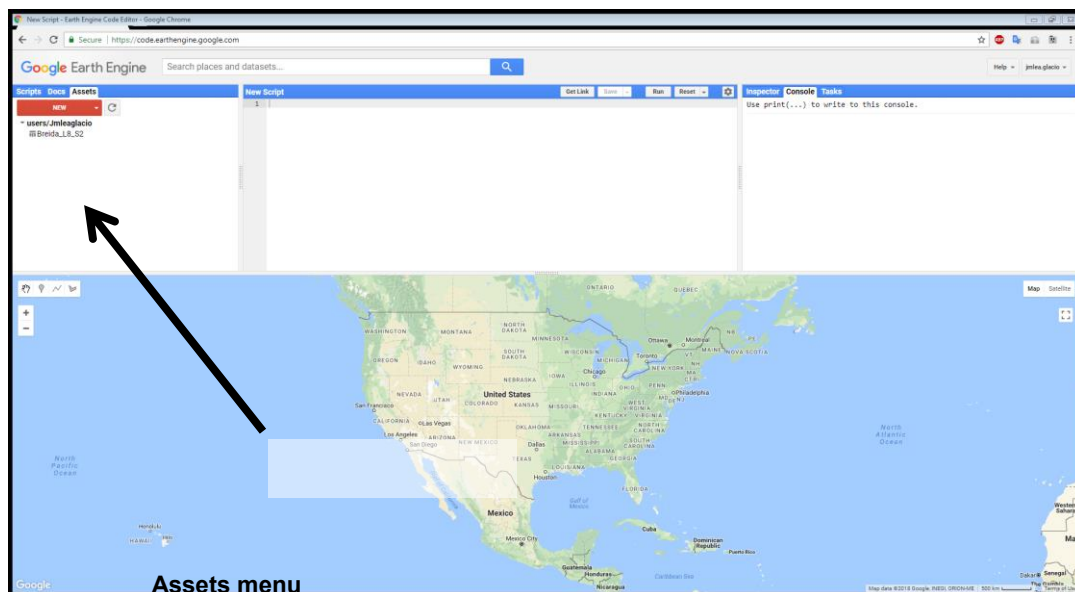
The GEEDiT Reviewer Tool allows users to quality control and filter their own or other's data produced by GEEDiT that have been converted to shapefiles using MaQiT and uploaded to Google Earth Engine (GEE) as an 'asset'. It can also be used to digitise centrelines. The following describes how to upload an asset to GEE and use GEEDiT Reviewer.

1. Navigate to www.liverpoolGEE.wordpress.com, read the background information on the website regarding how to acknowledge GEEDiT Reviewer in your work, and click on the link to access GEEDiT Reviewer.

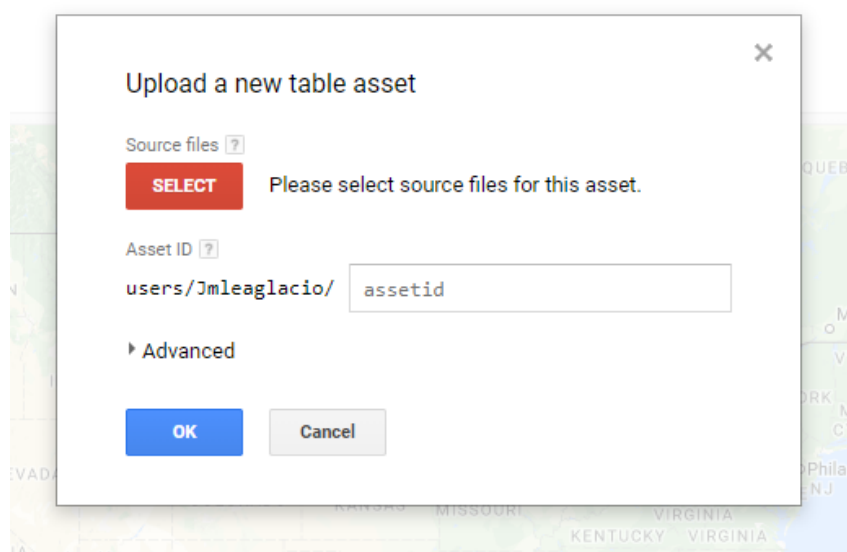


2. *Uploading an asset:* once the GeoJSON files produced by GEEDiT have been merged and/or converted into a shapefile using MaQiT they can be uploaded into Google Earth Engine (GEE) as an 'asset'. An asset is a user generated file that can be uploaded to use as the basis for subsequent analysis in GEE (see https://developers.google.com/earth-engine/asset_manager for more information). Once uploaded, assets can be viewed in the left panel of the API under the 'Assets' tab.

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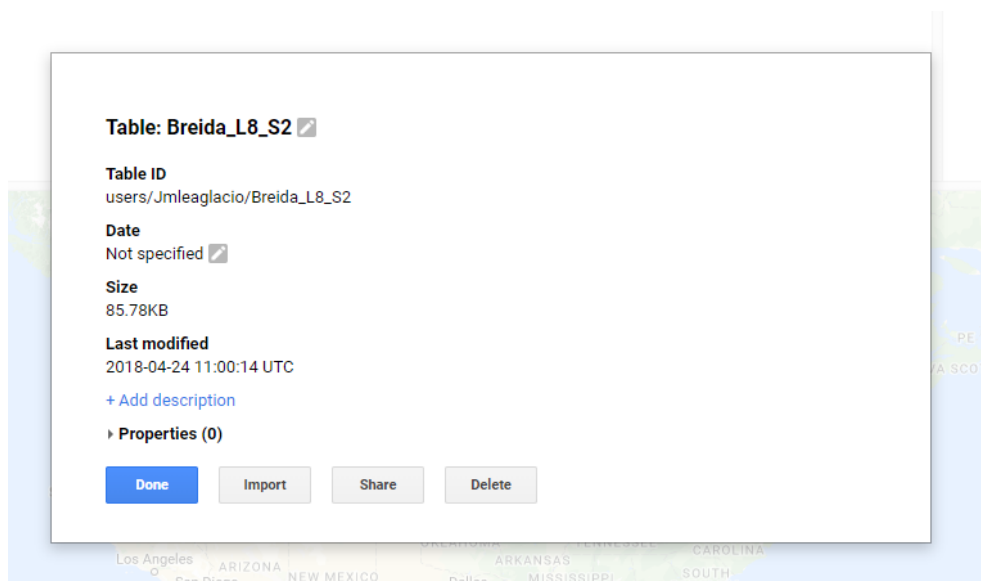
To upload a GEEDiT shapefile, click on the red 'New' button, and select 'Table upload'. You will then be prompted to select the source files and define the asset ID.



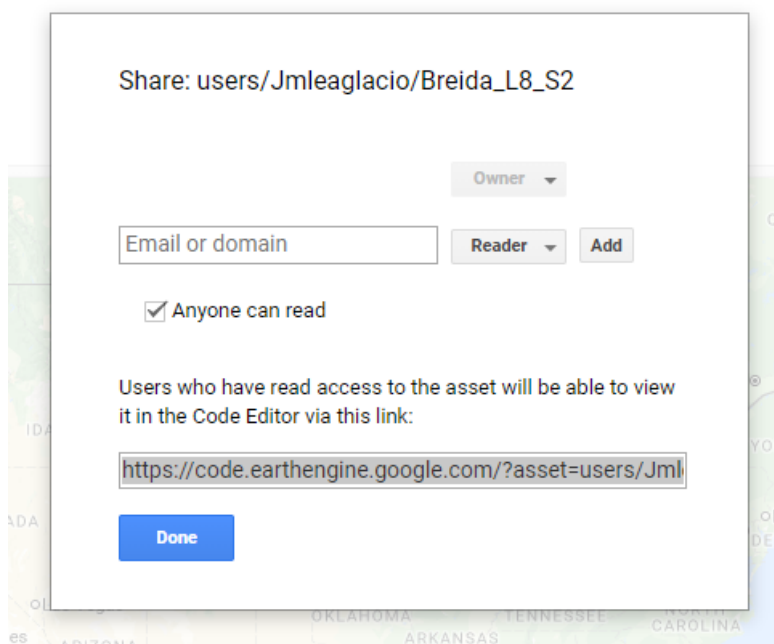
When selecting the shapefile, ensure that **all** the files associated with the shapefile are uploaded. Typically this includes at least the files with .shp, .shx and .dbf suffixes. Once the files have been selected and the asset ID defined (note: avoid spaces in the name), click ok to begin uploading the files. Even though the files are typically small, it can take several minutes for GEE to process the files.

3. Once uploaded, information about an asset can be viewed by clicking on the file in the asset table. Note the Table ID of the asset, as this will be the path that will be used to ensure data can be visualised in GEEDiT Reviewer.

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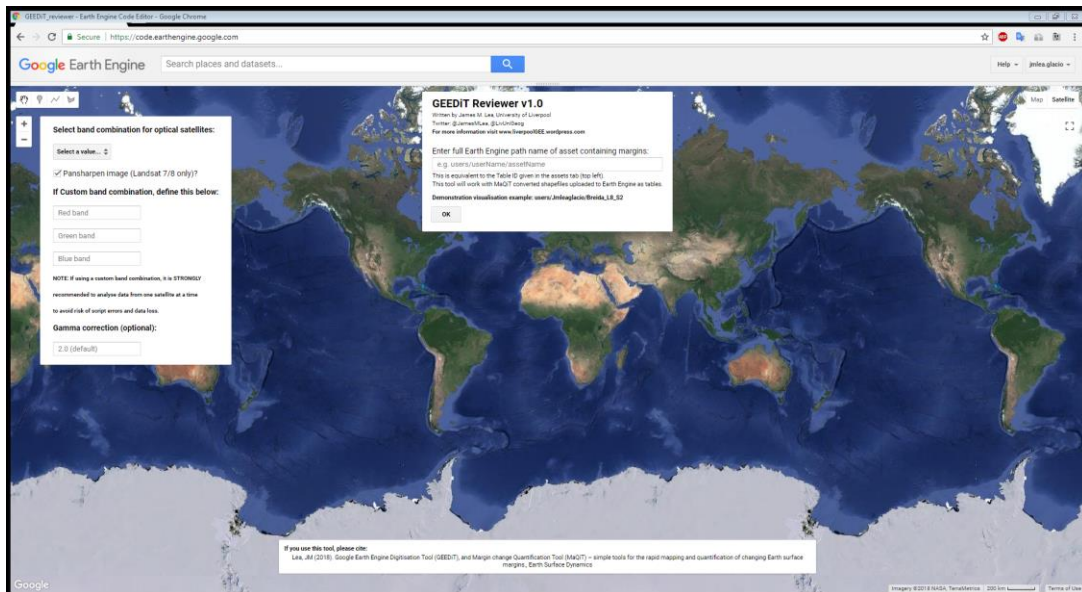
If you wish for others to be able to access the asset, you can make it readable by anyone by clicking 'Share' and ensure the 'Anyone can read' checkbox is selected. Only those who know the Table ID will be able to access the file.



4. **Running GEEDiT:** Once you have clicked the link to GEEDiT Reviewer from the LiverpoolGEE website the tool should run automatically. If it does not automatically start, click 'Run' located above where the script can be viewed in the code editor panel. Once this has been done the screen divider can be moved to allow the image of the Earth to occupy the majority of the screen. Type/paste the table ID of the asset you want to review in the text box of the welcome screen. This example uses margins digitised from Landsat 8 and Sentinel

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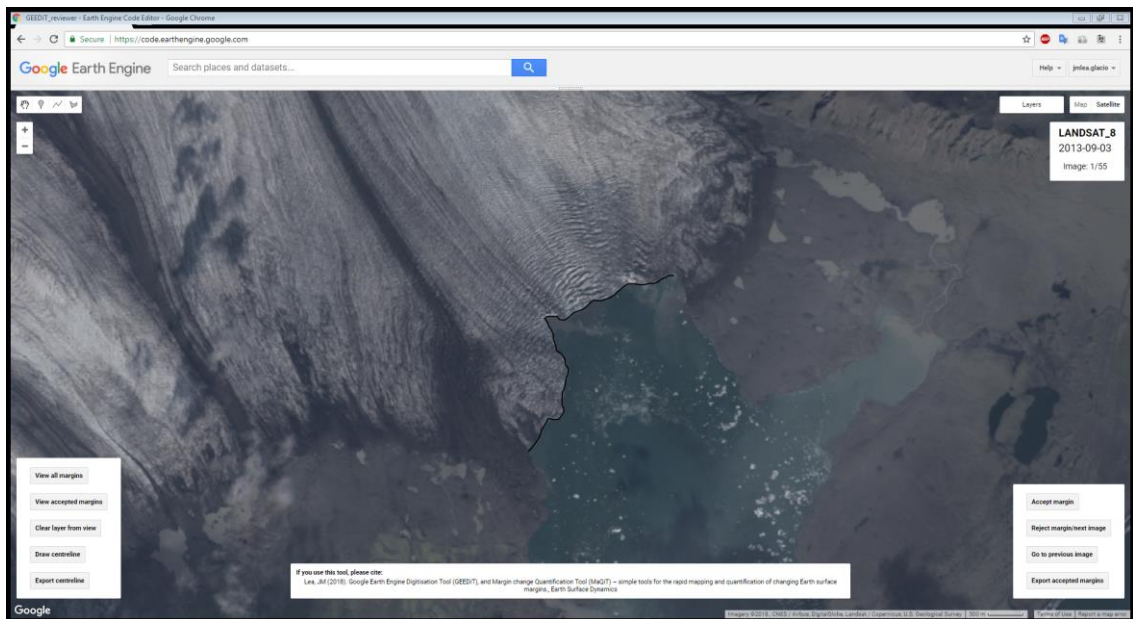
2 imagery from Breiðamerkurjökull, Iceland. These data can be accessed by copying and pasting `users/Jmleaglacio/Breida_L8_S2` into the text box on the welcome screen.



The left panel of the screen also provides different visualisation options for the imagery. If left undefined the imagery will be visualised as true colour.

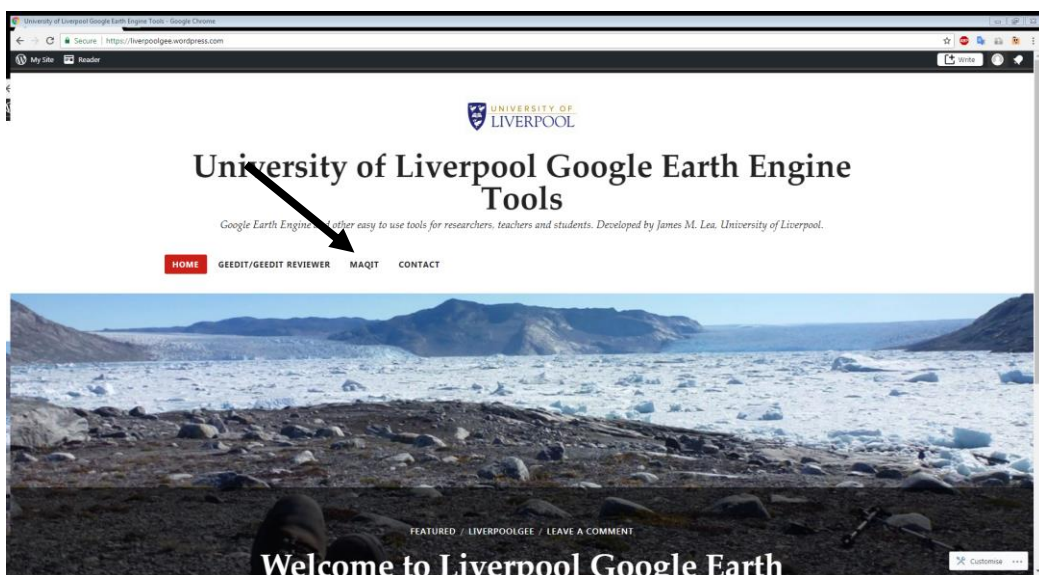
5. Users can scroll through imagery where margins have been digitised for quality control and dataset filtering purposes using the options in the bottom right panel of the screen. If users wish to export a filtered dataset they should click the 'Export selected margins' button and download it to their Google Drive from the Tasks tab (see GEEDIT, step 8). Users also have the option visualise all digitised margins or all accepted margins using the bottom left panel. These options are of most use when digitising centrelines (click 'Draw margin' button in bottom left panel before digitising a centreline, and click 'Export centreline' to create an export task).

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MaQiT

MaQiT can be downloaded by navigating to www.liverpoolGEE.wordpress.com, and clicking on the link to a Windows/Mac installer, or downloading the Matlab functions. Remember to read the background information on the website regarding how to acknowledge MaQiT in your work.



MaQiT can be run as a free standalone application without the need for a general Matlab license, or can be run programmatically for those with a Matlab license. For those without a license, users will be prompted to download the free software *Matlab Runtime*, which allows MaQiT to run. Unfortunately this can take up to 1Gb of hard drive space, though it means that the tool can be run totally free of any license charges.

At a minimum the tool requires two shapefiles for analysis to be undertaken, though some methods require extra parameters to be defined by the user. Further information on the methods *If you access/download these tools as part of your work, you agree to cite the associated manuscript (Lea, 2018. Earth Surface Dynamics) in any publications*

that MaQiT can apply to margin information can be found in the main manuscript. The first shapefile should contain every margin location. The fields should include the compulsory fields/information formatted in the manner indicated shown in Table S2. Data obtained via GEEDiT are guaranteed to be compatible with MaQiT. Data digitised by other means can be read by MaQiT if it contains the correctly formatted compulsory fields/information, though MaQiT will ignore any fields that are not listed in Table S2.

Margins/Boundaries compulsory field names

Variable Name	Notes
X	Can be latitude/longitude or UTM. Note that this field is not normally shown in a GIS attribute table
Y	Can be latitude/longitude or UTM. Note that this field is not normally shown in a GIS attribute table
Date	Must be in the format YYYY_MM_DD (the YMD seperators do not have to be '_'s though '/'s are discouraged)
Geometry	Line/'Polyline'/similar

Centreline/transect compulsory shapefile field names

Variable Name	Notes
X	Can be latitude/longitude or UTM. Note that this field is not normally shown in a GIS attribute table
Y	Can be latitude/longitude or UTM. Note that this field is not normally shown in a GIS attribute table
Geometry	Line/'Polyline'/similar

Table S2 – Compulsory field names for shapefile inputs into MaQiT

The second input required is a centreline/transect that intersects with each margin/boundary. This should be digitised from an 'upstream' to 'downstream' (or for a coastal change example, landward to seaward) direction to ensure that negative values provided by the methods correspond to retreat, while positive values link to advance. If the centreline does not intersect with a boundary it may result in the analysis failing. It is possible to identify the vector that causes the analysis to fail by viewing the Windows console (automatically opens with the Windows standalone version), the MaQiT_log file (for Mac/Linux installations) or the Matlab console (for those with a Matlab license).

MaQiT will also accept vector information given in Universal Transverse Mercator (UTM) format and automatically convert data given in decimal degrees to UTM to allow measurements of change to be given in meters.

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Merging/converting files with MaQiT

It would be suitable to use the 'Merge/Convert Tool' in MaQiT under two scenarios:

1. One (or more) GeoJSON files exported from GEEDiT need to be converted and/or merged into a single shapefile.
2. Pre-existing shapefiles need to be merged into a single shapefile. The pre-existing shapefiles should be polylines and takes the first 10 characters of its filename as the date of the observation (i.e. YYYY_MM_DD).

In each case this can be easily done by opening MaQiT and clicking the 'Merge/Convert Tool' button in the bottom left of the window. This should create a single shapefile suitable for use in MaQiT while also retaining all of the original shapefiles/GeoJSON files.