Monitoring Integrated Service for Land Degradation

Release 1.0.0

LocateIT Kenya Ltd

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ABOUT

The Monitoring Integrated System for Land Degradation MISLAND was developed under The Monitoring Integrated System for Land Degradation MISLAND was developed under GMES & Africa programme through a collaboration between the OSS and LocateIT as a Decision Support System (DSS) utilizing Earth Observation data to deliver information, promote awareness, and support decision making toward achieving Land Degradation Neutrality (LDN) in African countries.

At the very core, the service provides information to monitor SDG indicator 15.3.1 (Proportion of land that is degraded over the total land area). In addition, and to improve the understanding and the multi-faceted nature of the active processes behind land degradation, MISLAND service also provides information on vegetation loss and gain hotspots, forest change, forest fires and the Mediterranean Desertification and Land Use Model (MEDALUS), to assess desertification indicators.

Note: You can download the PDF Version of this doucument here.

CHAPTER

ONE

GENERAL INFORMATION

MISLAND-North Africa is an operational instrument relying on the international standards for reporting SDG 15.3.1 and technical approaches allowing the delivery of regular information on vegetation cover gain/loss to decision makers and environmental agencies at the first place.

The core-service provides land degradation indicators for six North African Countries at two levels:

- At the continental level(Africa) and five regional levels(North Africa, West Africa, East Africa, Central Africa, and South Africa) where low and medium resolution EO are used.
- At the pilot site level, where(customized indicators) can be developed, using medium resoultion data(landsat time series imagery and derived vegetation indices, combined with different satellite-derived climate data)

1.1 Get in touch with the team

Contact the MISLAND-Africa team with any comments or suggestions. If you have specific bugs to report or improvements to the tool that you would like to suggest, you can also submit them in the issue tracker on Github for MISLAND-Africa.

1.2 Authors

The MISLAND-Africa is a project by the OSS under the Global Monitoring for Environment and Security and Africa(GMES & Africa) framework that is co-funded by the African Union and the European Union.

Contributors to the documentation and to MISLAND-Africa include Mustapha MIMOUNI, Nabil KHATRA, Amjed TAIEB, Haithem REJEB, Toure SOULEYMANE, Anthony ODONGO, Vivianne META, Derick ONGERI, Grace AMONDI, and Brian CHELOTI.

1.3 Aknowledgement

Special appreciation to the Trends.Earth. Conservation International. Available online at http://trends.earth .2018. for providing input on the implementation of the SDG 15.3 and LDN indicators in MISLAND-North Africa, on the UNCCD reporting process, and also provided early input and testing of the tool.

The project also acknowledges the contribution of national and regional stakeholders; Algerian Space Agency(ASAL), ASAL (Algeria), DRC (Egypt), LCRSSS (Libya), CRTS (Morocco), AL-Aasriya University of Nouakchott (Mauritania) and CNCT (Tunisia) for the national level and CRTEAN and CRASTE-LF for the regional level

1.4 Linces

CHAPTER

TWO

DATA SOURCES

MISLAND-North Africa draws on a number of data sources. The data sets listed below are owned/made available by the following organizations and individuals under separate terms as indicated in their respective metadata.

2.1 NDVI

Sensor/Dataset	Temporal	Spatial	Extent	License
LANDSAT7	2001-2020	30 m	Global	Public Domain
AVHRR/GIMMS	1982-2015	8 km	Global	Public Domain
MOD13Q1-coll6	2001-2016	250 m	Global	Public Domain

2.2 Soil moisture

Sensor/Dataset	Temporal	Spatial	Extent	License
MERRA 2	1980-2016	0.5° x 0.625°	Global	Public Domain
ERA I	1979-2016	0.75° x 0.75°	Global	Public Domain

2.3 Precipitation

Sensor/Dataset	Temporal	Spatial	Extent	License
GPCP v2.3 1 month	1979-2019	2.5° x 2.5°	Global	Public Domain
GPCC V6	1891-2019	1° x 1°	Global	Public Domain
CHIRPS	1981-2016	5 km	50N-50S	Public Domain
PERSIANN-CDR	1983-2015	25 km	60N-60S	Public Domain

2.4 Evapotranspiration

Sensor/Dataset	Temporal	Spatial	Extent	License
MOD16A2	2000-2014	1 km	Global	Public Domain

2.5 Land cover

Sensor/Dataset	Temporal	Spatial	Extent	License
ESA CCI Land Cover	1992-2018	300 m	Global	CC by-SA 3.0

2.6 Soil carbon

Sensor/Dataset	Temporal	Spatial	Extent	License
Soil Grids (ISRIC)	Present	250 m	Global	CC by-SA 4.0

2.7 Agroecological Zones

Sensor/Dataset	Temporal	Spatial	Extent	License
FAO - IIASA Global Agroecological Zones (GAEZ)	2000	8 km	Global	Public Domain

2.8 Soil Quality

Sensor/Dataset	Temporal	Spatial	Extent	License
Soil Texture and Depth	Present	250 m	Global	CC by-SA 4.0
Parent Material	Present	N/A	Global	CC by-SA 4.0
Slope	Present	30 m	Global	JPL public

2.9 Climate

Sensor/Dataset	Temporal	Spatial	Extent	License
Terra Climate	1985-2019	30 m	Global	Public Domain

2.10 Administrative Boundaries

Sensor/Dataset	Temporal	Spatial	Extent	License
Natural Earth Administrative Boundaries	Present	10/50m	Global	Public Domain

Note: The Natural Earth Administrative Boundaries provided in MISLAND-North Africa are in the public domain. The boundaries and names used, and the designations used, in MISLAND-North Africa do not imply official endorsement or acceptance by Conservation International Foundation, or by its partner organizations and contributors.

If using MISLAND-North Africa for official purposes, it is recommended that users choose an official boundary provided by the designated office of their country.

CHAPTER

THREE

DATASET CODING

The spatial data produced by MISLAND-North Africa is in GeoTiff format. This is a widely supported format, so theese datasets can be used within QGIS as well as within any other GIS software.

If you wish to use MISLAND-North Africa data outside of the tool itself, you will need to know how the data is coded. The tables below provide guidance on what the exact layers are that are produced by each analysis in MISLAND-North Africa.

To see which of the below layers is contained within a MISLAND-North Africa output file, use the load data tool. When you choose a file with that toool, it will show you a list of the layers within that file, as well as the band number for each layer.

3.1 SDG 15.3.1 Indicator

Value	Meaning
-32768	No data
-1	Degradation
0	No change
1	Improvement

3.2 Productivity

3.2.1 Productivity trajectory (trend)

Value	Meaning
-32768	No data
Any other value	Linear trend of annually integrated NDVI, scaled by 10,000

3.2.2 Productivity trajectory (significance)

Value	Meaning
-32768	No data
-3	Significant decline (p > .99)
-2	Significant decline (p > .95)
-1	Significant decline (p > .90)
0	No significant change
1	Significant increase (p > .90)
2	Significant increase (p > .95)
3	Significant increase (p > .99)

3.2.3 Productivity performance (degradation)

Value	Meaning
-32768	No data
-1	Degradation
0	No change

3.2.4 Productivity performance (ratio)

Value	Meaning
-32768	No data
0	Ratio of mean NDVI and maximum productivity. See background on performance.

3.2.5 Productivity performance (units)

Value	Meaning
-32768	No data
Any other value	ID number of unit used to calculate performance. See background on performance.

3.2.6 Productivity state (degradation)

Value	Meaning
-32768	No data
Any other value	Change in productivity state classes between baseline and target period, calculated as the rank in the target period minus the rank in the baseline period. Positive values indicate improvement, negative values indicate decline.

3.2.7 Productivity state classes

Value	Meaning
-32768	No data
Any other value	Percentile class for productivity state. See background on productivity state.

3.2.8 Productivity state NDVI mean

Value	Meaning
-32768	No data
Any other value	Mean annually integrated NDVI for the baseline period chosen for productivity state, scaled by 10,000. See background on productivity state.

3.2.9 SDG 15.3.1 productivity indicator

Value	Meaning
-32768	No data
1	Declining
2	Early signs of decline
3	Stable but stressed
4	Stable
5	Increasing

3.2.10 Land productivity dynamics

Value	Meaning
-32768	No data
1	Declining
2	Moderate decline
3	Stressed
4	Stable
5	Increasing

3.3 Land cover

3.3.1 Land cover (degradation)

Value	Meaning
-32768	No data
-1	Degradation
0	No change
1	Improvement

3.3.2 Land cover (7 class)

Value	Meaning
-32768	No data
1	Tree-covered
2	Grasslands
3	Cropland
4	Wetland
5	Artificial
6	Other land
7	Water body

3.3.3 Land cover (ESA classes)

Value	Meaning
-32768	No data
10	Cropland, rainfed
11	Herbaceous cover
12	Tree or shrub cover
20	Cropland, irrigated or post-flooding
30	Mosaic cropland (>50%) / natural vegetation (tree, shrub, herbaceous cover) (<50%)
40	Mosaic natural vegetation (tree, shrub, herbaceous cover) (>50%) / cropland (<50%)
50	Tree cover, broadleaved, evergreen, closed to open (>15%)
60	Tree cover, broadleaved, deciduous, closed to open (>15%)
61	Tree cover, broadleaved, deciduous, closed (>40%)
62	Tree cover, broadleaved, deciduous, open (15-40%)
70	Tree cover, needleleaved, evergreen, closed to open (>15%)
71	Tree cover, needleleaved, evergreen, closed (>40%)
72	Tree cover, needleleaved, evergreen, open (15-40%)
80	Tree cover, needleleaved, deciduous, closed to open (>15%)
81	Tree cover, needleleaved, deciduous, closed (>40%)
82	Tree cover, needleleaved, deciduous, open (15-40%)
90	Tree cover, mixed leaf type (broadleaved and needleleaved)
100	Mosaic tree and shrub (>50%) / herbaceous cover (<50%)
110	Mosaic herbaceous cover (>50%) / tree and shrub (<50%)
120	Shrubland
121	Evergreen shrubland
122	Deciduous shrubland
130	Grassland
140	Lichens and mosses
150	Sparse vegetation (tree, shrub, herbaceous cover) (<15%)
151	Sparse tree (<15%)
152	Sparse shrub (<15%)
153	Sparse herbaceous cover (<15%)
160	Tree cover, flooded, fresh or brakish water
170	Tree cover, flooded, saline water
180	Shrub or herbaceous cover, flooded, fresh/saline/brakish water
190	Urban areas
200	Bare areas

continues on next page

Table 1 – continued from previous page

Value	Meaning
201	Consolidated bare areas
202	Unconsolidated bare areas
210	Water bodies
220	Permanent snow and ice

3.3.4 Land cover (transitions)

Value	Meaning
-32768	No data
1	Tree-covered - Tree-covered (no change)
2	Grassland - Grassland (no change)
3	Cropland - Cropland (no change)
4	Wetland - Wetland (no change)
5	Artificial - Artificial (no change)
6	Other land - Other land (no change)
7	Water body - Water body (no change)
12	Forest - Grassland
13	Forest - Cropland
14	Forest - Wetland
15	Forest - Artificial
16	Forest - Other land
17	Forest - Water body
21	Grassland - Forest
23	Grassland - Cropland
24	Grassland - Wetland
25	Grassland - Artificial
26	Grassland - Other land
27	Grassland - Water body
31	Cropland - Forest
32	Cropland - Grassland
34	Cropland - Wetland
35	Cropland - Artificial
36	Cropland - Other land
37	Cropland - Water body
41	Wetland - Forest
42	Wetland - Grassland
43	Wetland - Cropland
45	Wetland - Artificial
46	Wetland - Other land
47	Wetland - Water body
51	Artificial - Forest
52	Artificial - Grassland
53	Artificial - Cropland
54	Artificial - Wetland
56	Artificial - Other land
57	Artificial - Water body
61	Other land - Forest
62	Other land - Grassland

continues on next page

Table 2 – continued from previous page

Value	Meaning
63	Other land - Cropland
64	Other land - Wetland
65	Other land - Artificial
67	Other land - Water body
71	Water body - Forest
72	Water body - Grassland
73	Water body - Cropland
74	Water body - Wetland
75	Water body - Artificial
76	Water body - Other land

3.4 Soil organic carbon

3.4.1 Soil organic carbon (degradation)

Value	Meaning
-32768	No data
Any other value	Percentage change in soil organic carbon content (0 - 30 cm depth) from baseline to target year. Positive values indicate increase, negative values indicate decrease.

3.4.2 Soil organic carbon

Value	Meaning
-32768	No data
Any other value	Soil organic carbon content (0 - 30 cm depth) in metric tons per hectare

3.4.3 Population

Value	Meaning
-32768	No data
Any other value	Total population within grid cell

3.4.4 Delta Normalized Burnt Ratio

Value	Meaning
-500	No data
-350	Hight Severety
-300	Moderate High Severety
-200	Moderate Low Severety
-100	Low Severety
100	Unburned
300	Enhanced Growth Low
1000	Enhanced Growth High

CHAPTER

FOUR

FREQUENTLY ASKED QUESTIONS

This page lists some Frequently Asked Questions (FAQs) for the MISLAND-North Africa tool.

4.1 Installation of MISLAND-North Africa

4.1.1 What version of Quantum GIS (QGIS) do I need for the toolbox?

To download QGIS, please go to the QGIS Downloads page. As of February 2018, version 3.0 was released.

4.1.2 Do I need to download a 32-bit or 64 bit version of QGIS?

We recommend downloading 64-bit version (2.18), but you may need to download the 32-bit version for 32-bit operating systems. To find out if your computer is running a 32-bit or 64-bit version of Windows, search for System or msinfo32. This is found in the Control Panel and will bring up a window that says the system type e.g. System type: 64-bit Operating System, x64-based processor.

Windows 7 or Windows Vista:

1. Open System by clicking the Start button , right-clicking Computer, and then clicking Properties.
2. Under System, you can view the system type.

Windows 8 or Windows 10:

1. From the Start screen, type This PC.
2. Right Click (or tap and hold) This PC, and click Properties.

Mac:

1. Click the Apple icon in the top left and select "About this Mac".
2. For more advanced details click "More Info…" in the About This Mac window.

4.1.3 How do I install the plugin?

Open QGIS, navigate to Plugins on the menu bar, and select Install From Zipfile and install the Zipfile provided.

4.1.4 How do I upgrade the plugin?

If you have already installed the plugin, navigate to Plugins on the menu bar, and select Manage and install plugins. On the side menu, select Installed to view the plugins that you have installed in your computer. At the bottom of the window, select Upgrade all to upgrade the toolbox to the latest version.

4.1.5 How do I uninstall the plugin?

If you would like to uninstall the plugin, normally you can do so with the QGIS plugins manager. To access the tool, choose "Plugins" and then "Manage and Install Plugins…" from the QGIS menu bar. From the plugin manager screen, select "Installed" from the menu on the left-hand side. Then click on "MISLAND-North Africa" in the list of plugins, and on "Uninstall Plugin" to uninstall it.

If you encounter an error uninstalling the plugin, it is also possible to remove it manually. To manually remove the plugin:

1. Open QGIS
2. Navigate to where the plugin is installed by selecting "Open Active Profile Folder" from the menu under "Settings" - "User Profiles" on the menu bar.
3. Quit QGIS. You may not be able to uninstall the plugin if QGIS is not closed.
4. In the file browser window that opened, double click on "python", and then double click on "plugins". Delete the LDMP folder within that directory.
5. Restart QGIS.

4.2 Datasets

4.2.1 When will you update datasets for the current year?

MISLAND-North Africa uses publicly available data, as such the most up to date datasets will be added to the toolbox as soon as the original data providers make them public. If you notice any update that we missed, please do let us know.

4.2.2 Is there an option to download the original data?

Users can download the original data using the Download option within the toolbox.

4.2.3 Will the toolbox support higher resolution datasets?

The toolbox currently supports AVHRR (8km), LANDSAT 7 (30m) and MODIS (250m) data for primary productivity analysis, and ESA LCC CCI (300m) for land cover change analysis.

4.3 Methods

4.3.1 Who was the default time period for the analysis determined?

The default time period of analysis is from years 2001 to 2015. These were recommended by the Good Practice Guidelines., a document that provides detailed recommendations for measuring land degradation and has been adopted by the UNCCD.

4.3.2 Productivity

How does the result provided by state differs from trajectory?

The trajectory analysis uses linear regressions and non-parametric tests to identify long term significant trends in primary productivity. This method however, is not able to capture more recent changes in primary productivity, which could be signals of short term processes of improvement or degradation. By comparing a long term mean to the most recent period, state is able to capture such recent changes.

4.3.3 Land cover

Currently, the land cover aggregation is done following the UNCCD guidelines, but that classification does not take into account country level characteristics. Could it be possible to allow the user to define the aggregation criteria?

Users are able to make these changes using the advanced settings in the land cover GUI so that appropriate aggregations occur depending on the context of your country.

How can we isolate woody plant encroachment within the toolbox?

This can be altered using the land cover change matrix in the toolbox. For every transition, the user can mark the change as stable, improvement or degraded. The transition from grassland/rangeland to shrubland may indicate woody encroachment and this transition can be marked as an indicator of degradation.

4.3.4 Carbon stocks

Why use soil organic carbon (SOC) instead of above and below-ground carbon to measure carbon stocks?

The original proposed indicator is Carbon Stocks, which would include above and below ground biomass. However, given the lack of consistently generated and comparable dataset which assess carbon stocks in woody plants (including shrubs), grasses, croplands, and other land cover types both above and below ground, the Good Practice Guidelines published by the UNCCD recommends for the time being to use SOC as a proxy.

Is it possible to measure identify processes of degradation linked to salinization using this tool?

Not directly. If salinization caused a reduction in primary productivity, that decrease would be identified by the productivity indicators, but the users would have to use their local knowledge to assign the causes.

4.4 Land degradation outputs

4.4.1 How were the layers combined to define the final land degradation layer?

Performance, state, and trajectory (the three indicators of change in *productivity*) are combined following a modified version of the good practice guidance developed by the UNCCD (in section SDG Indicator 15.3.1 of this manual a table is presented). Productivity, soil carbon, and land cover chance (the three sub-indicators of SDG 15.3.1) are combined using a "one out, all out" principle. In other words: if there is a decline in any of the three indicators at a particular pixel, then that pixel is mapped as being "degraded".

4.4.2 Why do I see areas the data says are improving or degrading when I know they are not?

The final output should be interpreted as showing areas potentially degraded. The indicator of land degradation is based on changes in productivity, land cover and soil organic carbon. Several factor could lead to the identification of patterns of degradation which do not seem to correlate to what is happening on the ground, the date of analysis being a very important one. If the climatic conditions at the beginning of the analysis were particularly wet, for example, trends from that moment on could show significant decreases in primary productivity, and degradation. The user can use LMDS to address some of this issues correcting by the effect of climate. The resolution of the data could potentially be another limitation. MISLAND-North Africa by default uses global datasets which will not be the most relevant at all scales and geographies. A functionality to use local data will be added shortly.

4.4.3 All of the sub-indicators are measuring vegetation: how does this contribute to understanding and identifying land degradation?

Vegetation is a key component of most ecosystems, and serve as a good proxy for their overall functioning and health. The three subindicators used for SDG 15.3.1 measure different aspects of land cover, which do relate to vegetation. Primary productivity directly measures the change in amount of biomass present in one area, but it does not inform us if that change is positive or not (not all increases in plant biomass should be interpreted as improvement). Land cover fills that gap by interpreting the landscape from a thematic perspective looking at what was there before and what is there now. It does include vegetation, but also bare land, urban and water. Finally, the soil organic carbon indicator uses the land cover map to inform the changes in soil organic carbon over time. This method is not ideal, but given the current state of global soil science and surveying, there is consensus that it this point in time and globally, this is the best approach.

4.5 Future plans

4.5.1 When will there be an offline version of the toolbox?

The final toolbox will be available as both as an offline and online version. The online version allows users to access current datasets more easily, while also allowing users to leverage Google Earth Engine to provide computing in the cloud. An offline version allows users to access data and perform analyses where internet connectivity may be limited, but it does have the disadvantage of requiring users to have enough local computing capacity to run analyses locally. The technical team intends to build the offline version of the toolbox and provide countries with data relevant for reporting at the national level within the pilot project countries.

CHAPTER

FIVE

LAND DEGRADATION

Contents

5.1 Land Degradation Indicators

Land degradation, as defined by the United Nations Convention to Combat Desertification (UNCCD), is a complex process that refers to the long-lasting reduction or loss of biological and economic productivity of lands, caused by human activities, sometimes exacerbated by natural phenomena. Terrestrial vegetation including crops depend on appropriate soil which is the substrate on which vegetation/crops grow, besides other climatic factor requirements.

Different land masses are however affected by different factors at different levels. The factors pan from the climatic to soil properties, from land use land cover and to surface roughness which depends on the conditions that a given land mass is exposed to. Apart from the natural and geophysical causes, land degradation may also be influenced by anthropogenic factors which yield conditions for land degradation to take place, these activities may span from uncouth agricultural practices, desertification through illegal logging, top soil harvesting, mining activities among others.

The OSS.LDMS focuses on provision of evidence-based proofs on land degradation and its spatiotemporal distribution and therefore the hotspots where priority actions should be taken or awareness-raising campaigns should be planed. The figure below show key land degradation indicators included in the OSS.LDMS service

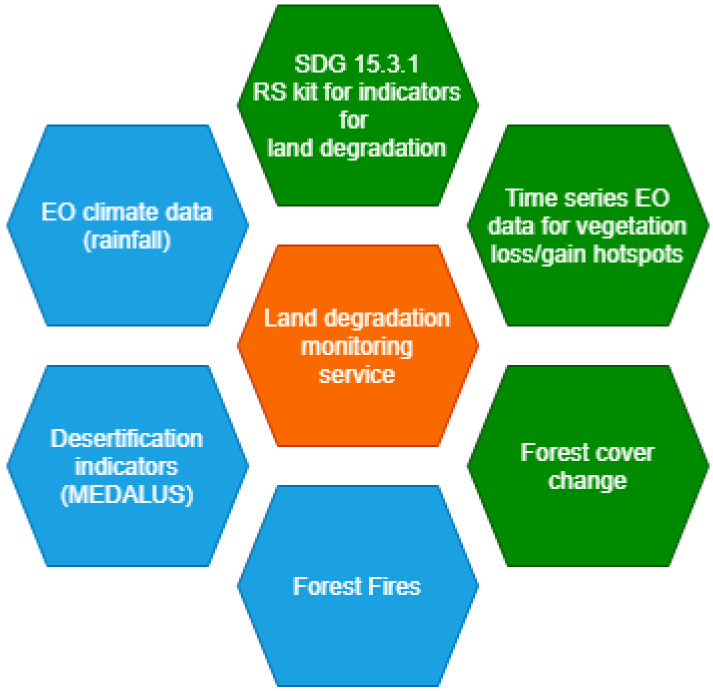


Fig. 1: Summary of included services on the OSS.LDMS service platform

5.1.1 SDG15.3.1 Indicator

As part of the Sustainable development Goals(SDGs), SDG 15 is to: "Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forest, combat desertification, and halt and reverse land degradation and halt biodiversity loss"

Target 15.3 aims to: "By 2030, combat desertification, restore degraded land and soil, including land affected by desertification, drought, floods, and strive to achieve land degradation-neutral world"

The indicator used to assess the progress of each SDG target is the 15.3.1 indicator: "Proportion of land that is degraded over total land area"

The basic land degradation indicators include three main sub-indicators of the SDG target 15.3.1 (proportion of land that is degraded over the total land area). As the custodian agency of SDG 15.3, the United Nations Convention to Combat Desertification (UNCCD) has developed recommendations/Good practice guide on how to compute SDG indicator 15.3.1 from 3 sub-indicators:

- Vegetation productivity
- Landcover
- Soil Organic carbon

Fig. 2: SDG 15.3.1 Indicators

SDG 15.3.1 Sub-indicators

Productivity

Land productivity is the biological productive capacity of the land (i.e. the ability to produce food, fibre and fuel that sustain life). For easy interpretation the annual mean vegetation indices values at the pixel level will be used to assess three measures of change (trajectory, state and performance) as summarized in the figure below and explained in the subsequent sub-sections:

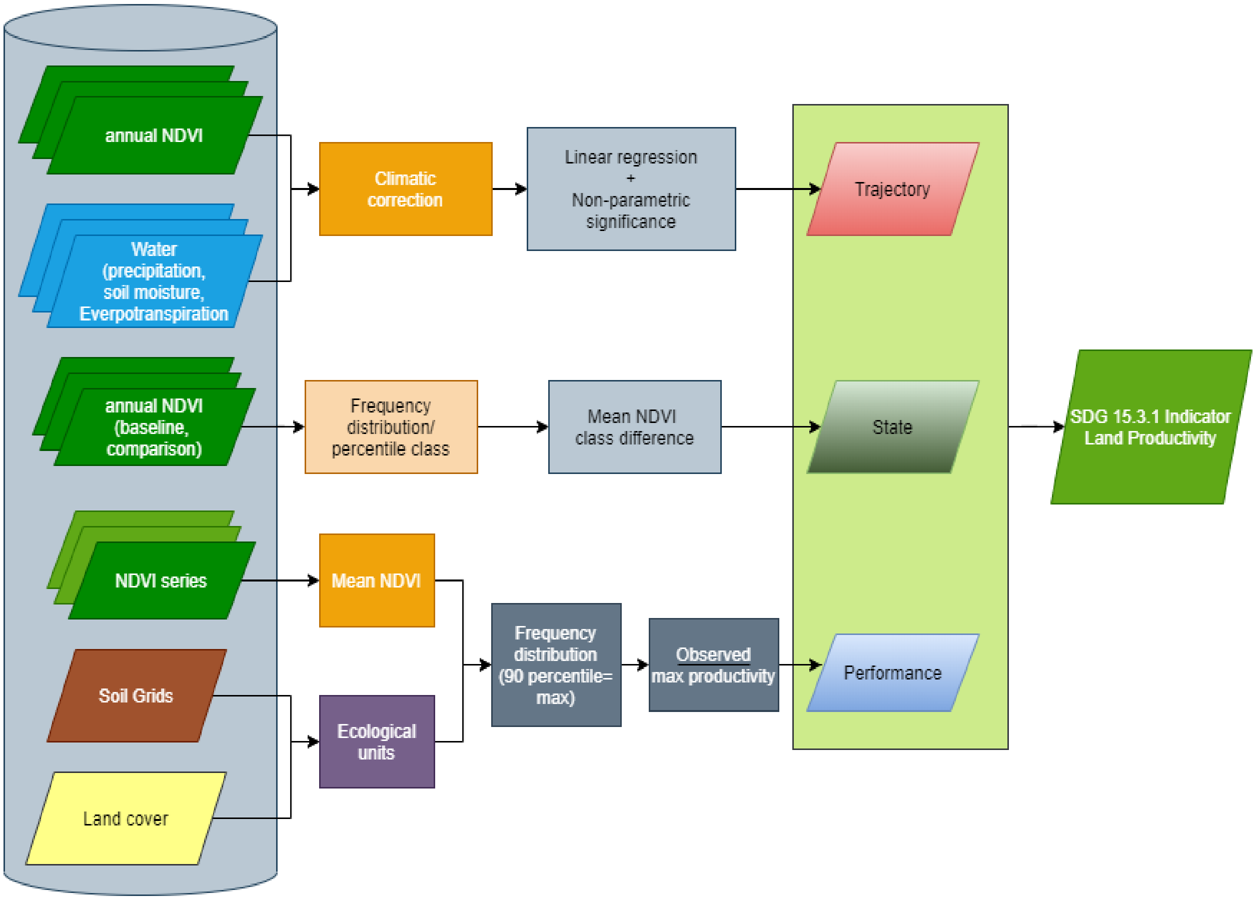


Fig. 3: Sammury methodology for conputing Land Productivity

Trajectory

The rate of change in primary productivity over time which will be computed using linear regression at the pixel level for various Landsat derived vegetation indices (NDVI, MSAVI2, SAVI). To identify areas experiencing changes in the primary productivity, a non-parametric significance test will be performed to show the significant changes (p-value of 0.05). Positive significant trends in the vegetation indices will indicate potential improvement while a negative significant trend will indicate potential degradation.

The annual integrals of the vegetation indices are interpreted alongside historical precipitation data as a context. The climatic correction method that will be applied is the Rain Use Efficiency (RUE). The rain use efficiency is the ratio of annual NPP to annual precipitation. After the RUE is computed, linear regression and nonparametric significance testing will be applied to the RUE over time. Positive significance in RUE indicates improvement while negative significance will indicate potential degradation.

State

The Productivity State indicator will be used to show recent changes in primary productivity compared to a baseline period. The indicator is computed from (NDVI, MSAVI2, SAVI) derived from medium resolution Landsat imagery following the steps outlined below:

1. A baseline period (historical period for comparison to recent primary productivity) will be defined. (This will be left open for selection of different periods by the users).
2. A comparison period (recent years for which the state is being analysed) will be defined. (The definition of this period will also be left open for the users of the service)
3. The annual integrals of the selected vegetation index for the baseline period will be used to compute a frequency distribution at the selected pixel. That frequency distribution curve will then be used to classify the values to the 10th percentile(1 to 10).
4. The next step would involve computing the mean of the selected vegetation index for the baseline period, and to determine the percentile class it belongs to. The computed mean value for the baseline period is then assigned a number which corresponds to that percentile class if falls between 1 and 10.
5. The mean value of the selected index for the comparison period is the computed and percentile class to which it belongs to. It is determined and placed in a class corresponding to its percentile class.
6. The difference between the assigned class number for the comparison and the baseline period (comparison minus baseline) will be computed and thresholded to show the productivity state of the land.

Perfomance

The Productivity Performance indicator will measure the local productivity relative to other similar vegetation types in similar ecological units. A combination of soil units (based on Soil Grids data at 250m resolution) and land cover (ESA CCI at 300m resolution) will be used to define the ecological units. The indicator will be computed as follows:

1. The analysis period is defined, and time series data is used to compute mean value for the selected vegetation index at pixel level.
2. Similar ecological units are derived as the unique intersections of different land cover types and soil types.
3. For each ecological unit, the frequency distribution of the mean pixel values obtained in step 1 shall be computed. From the distribution the value representing the 90th percentile will be considered the maximum productivity for that unit.
4. The ratio of mean NDVI and maximum productivity (in each case compare the mean observed value to the maximum for its corresponding unit) is computed. If the computed ratio is less than 50 %, the pixel shall be considered potentially degraded for this indicator.

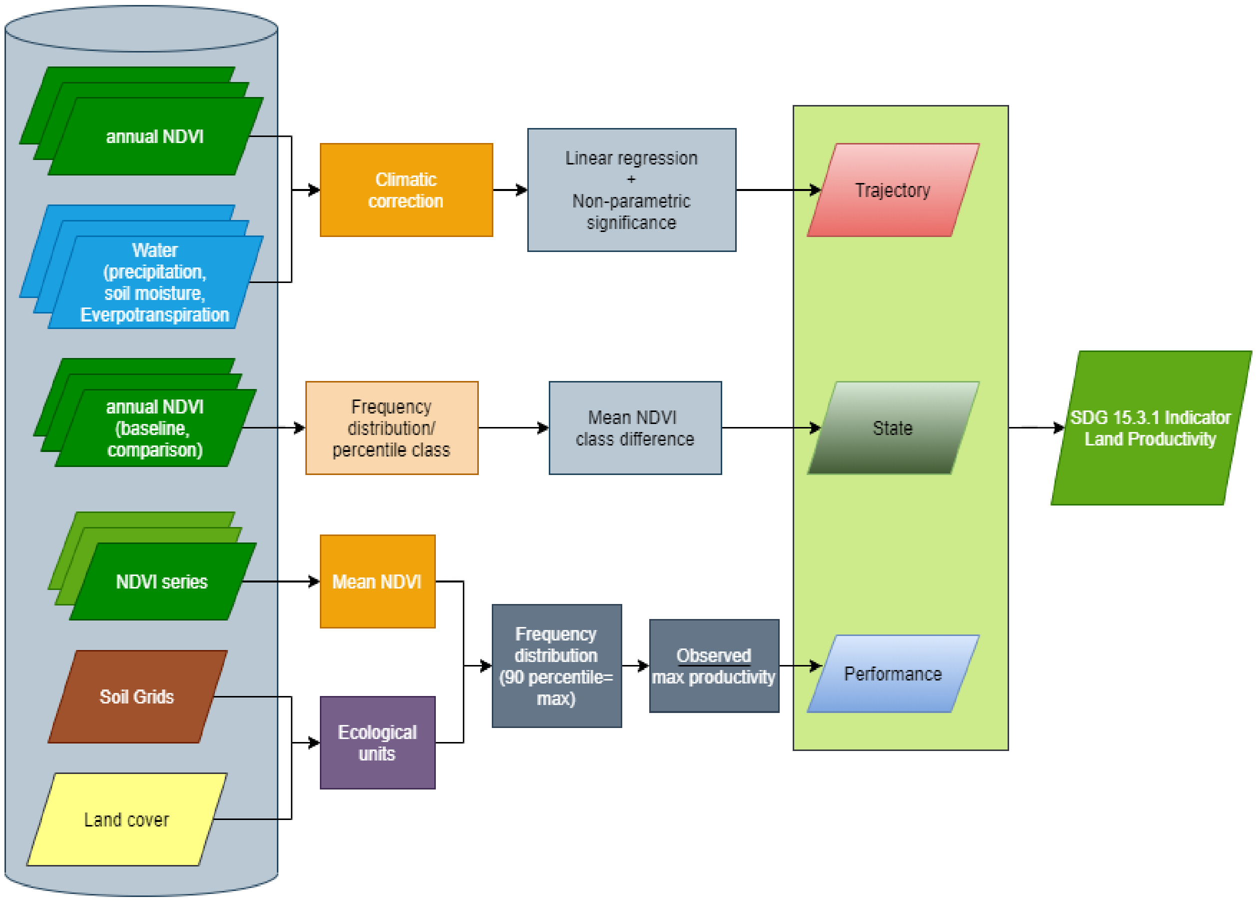


Fig. 4: Sammury methodology for conputing Land Productivity

Landcover

Monitoring of Land Use and Land Cover Changes (LULCCs) at both regional and local scales presents a major opportunity for identifying areas threatened by land degradation where mitigation measures should be taken. Traditionally, LULCCs have been interpreted by distinguishing between two transformation types: conversion and modification.

To assess changes in land cover users need land cover maps covering the study area for the baseline and target years. These maps need to be of acceptable accuracy and created in such a way which allows for valid comparisons. LDMS uses ESA CCI land cover maps as the default dataset, but local maps can also be used. The indicator is computed as follows:

1. Reclassify both land cover maps to the 7 land cover classes needed for reporting to the UNCCD (forest, grassland, cropland, wetland, artificial area, bare land and water).
2. Perform a land cover transition analysis to identify which pixels remained in the same land cover class, and which ones changed.
3. Based on your local knowledge of the conditions in the study area and the land degradation processed occurring there, use the table below to identify which transitions correspond to degradation (- sign), improvement (+ sign), or no change in terms of land condition (zero).

Land cover in target year

Land cover in baseline year	Forest	Grassland*	Cropland	Wetland	Artificial area	Bare land	Water body
Forest	0	-	-	-	-	-	0
Grassland*	+	0	+	-	-	-	0
Cropland	+	-	0	-	-	-	0
Wetland	-	-	-	0	-	-	0
Artificial area	+	+	+	+	0	+	0
Bare land	+	+	+	+	-	0	0
Water body	0	0	0	0	0	0	0

Legend

Degradation	Stable	Improvement
-	0	+

*The "Grassland" class consists of grassland, shrub, and sparsely vegetated areas (if the default aggregation is used).

4. LDMS will combine the information from the land cover maps and the table of degradation typologies by land cover transition to compute the land cover sub-indicator.

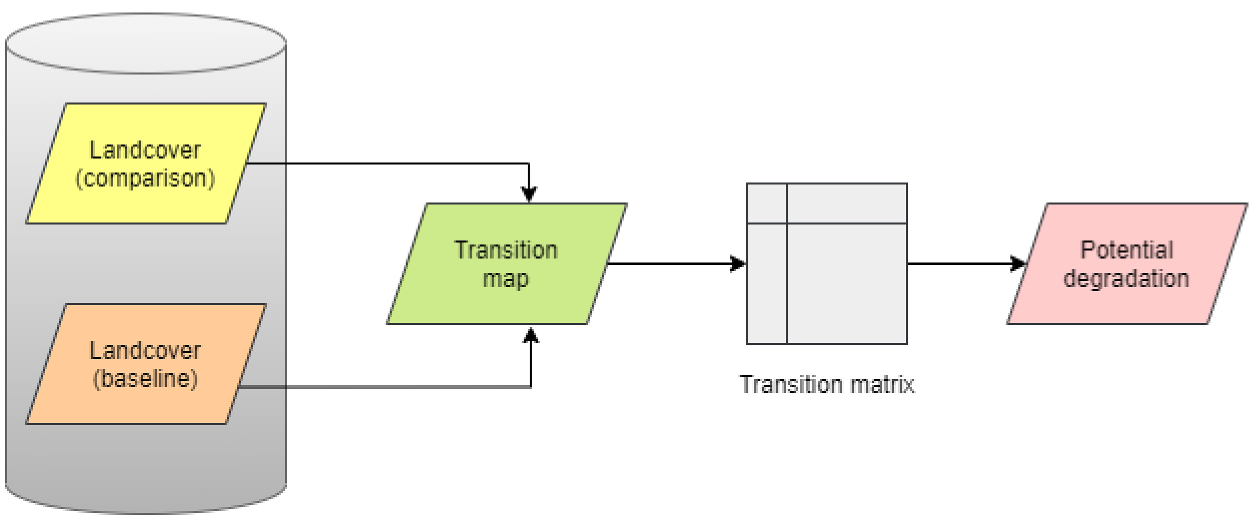


Fig. 5: Sammary methodology for computing land cover change

Carbon-stocks

The third sub-indicator for monitoring land degradation as part of the SDG process quantifies changes in soil organic carbon (SOC) over the reporting period. Changes in SOC are particularly difficult to assess for several reasons, some of them being the high spatial variability of soil properties, the time and cost intensiveness of conducting representative soil surveys and the lack of time series data on SOC for most regions of the world. To address some of the limitations, a combined land cover/SOC method is used in LDMS to estimate changes in SOC and identify potentially degraded areas. The indicator is computed as follows:

1. Determine the SOC reference values. LDMS uses SoilGrids 250m carbon stocks for the first 30 cm of the soil profile as the reference values for calculation (NOTE: SoilGrids uses information from a variety of data sources

and ranging from many years to produce this product, therefore assigning a date for calculations purposes could cause inaccuracies in the stock change calculations).

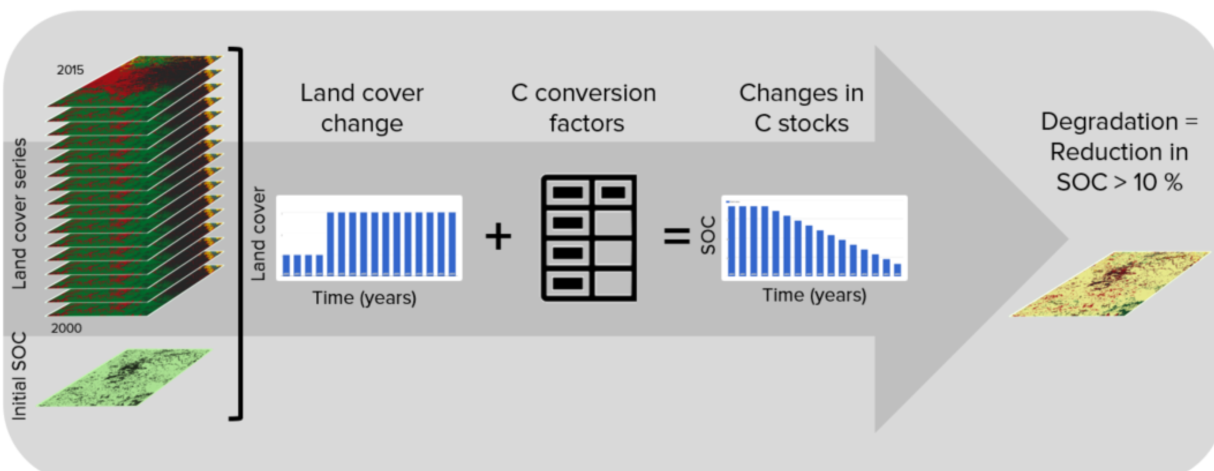
2. Reclassify the land cover maps to the 7 land cover classes needed for reporting to the UNCCD (forest, grassland, cropland, wetland, artificial area, bare land and water). Ideally annual land cover maps are preferred, but at least land cover maps for the starting and end years are needed.

3. To estimate the changes in C stocks for the reporting period C conversion coefficients for changes in land use, management and inputs are recommended by the IPCC and the UNCCD. However, spatially explicit information on management and C inputs is not available for most regions. As such, only land use conversion coefficient can be applied for estimating changes in C stocks (using land cover as a proxy for land use). The coefficients used were the result of a literature review performed by the UNCCD and are presented in the table below. Those coefficients represent the proportional in C stocks after 20 years of land cover change.

LU coefficients	Forest	Grasslands	Croplands	Wetlands	Artifical areas	Bare lands	Water bodies
Forest	1	1	f	1	0.1	0.1	1
Grasslands	1	1	f	1	0.1	0.1	1
Croplands	1/f	1/f	1	1/0.71	0.1	0.1	1
Wetlands	1	1	0.71	1	0.1	0.1	1
Artifical areas	2	2	2	2	1	1	1
Bare lands	2	2	2	2	1	1	1
Water bodies	1	1	1	1	1	1	1

Changes in SOC are better studied for land cover transitions involving agriculture, and for that reason there is a different set of coefficients for each of the main global climatic regions: Temperate Dry (f = 0.80), Temperate Moist (f = 0.69), Tropical Dry (f = 0.58), Tropical Moist (f = 0.48), and Tropical Montane (f = 0.64).

4. Compute relative different in SOC between the baseline and the target period, areas which experienced a loss in SOC of 10% of more during the reporting period will be considered potentially degraded, and areas experiencing a gain of 10% or more as potentially improved.



Combining Productivity Indicators

The three productivity sub-indicators are then combined as indicated in the tables below. For SDG 15.3.1 reporting, the 3-class indicator is required, but LDMS also produces a 5-class one which takes advantage of the information provided by State to inform the type of degradation occurring in the area.

Aggregating the productivity sub-indicators

Trajectory	State	Performance	3 Classes	5 Classes
Improvement	Improvement	Stable	Improvement	Improving
Improvement	Improvement	Degradation	Improvement	Improving
Improvement	Stable	Stable	Improvement	Improving
Improvement	Stable	Degradation	Improvement	Improving
Improvement	Degradation	Stable	Improvement	Improving
Improvement	Degradation	Degradation	Degradation	Stable
Stable	Improvement	Stable	Stable	Stable
Stable	Improvement	Degradation	Stable	Stable
Stable	Stable	Stable	Stable	Stable
Stable	Stable	Degradation	Degradation	Stable but stressed
Stable	Degradation	Stable	Degradation	Early signs of decline
Stable	Degradation	Degradation	Degradation	Declining
Degradation	Improvement	Stable	Degradation	Declining
Degradation	Improvement	Degradation	Degradation	Declining
Degradation	Stable	Stable	Degradation	Declining
Degradation	Stable	Degradation	Degradation	Declining
Degradation	Degradation	Stable	Degradation	Declining
Degradation	Degradation	Degradation	Degradation	Declining

5.1.2 Vegetation Loss/Gain hotspots

Land degradation hotsports (LDH) are produced via the analysis of time-series vegetation indices data and are used to characterize areas of different sizes, where the vegetation cover and the soil types are severely degraded.

Vegetation loss/gain hotspots will be calculated based on time series observation of selected suit of vegetation indices depending on the climatic zones and terrain morphology of the North African countries. The selected indices derived from Landsat data are as listed below:

> -NDVI for humid zones, sub-humid and semi-arid zones -MSAVI2 for arid and stepic zones -SAVI for desert areas

5.1.3 Forest Change

Forest Gain/Loss

The quantification of the forest gain/loss hotspots will be based on pre-existing high-resolution global maps derived from Hansen Global Forest change dataset that can be accessed using Google Earth Engine API.

The maps are produced from time-series analysis of Landsat images characterizing forest extent and change over time.

Forest Fires

Burnt areas and forest fires will be highlighted and mapped out form remotely sensed Landsat/Sentinel data using the Normalized Burn Ratio (NBR). NBR is designed to highlight burned areas and estimate burn severity. It uses near-infrared (NIR) and shortwave-infrared (SWIR) wavelengths. Before fire events, healthy vegetation has very high NIR reflectance and a low SWIR reflectance. In contrast, recently burned areas show low reflectance in the NIR and high reflectance in the SWIR band.

The NBR will be calculated for Landsat/Sentinel images before the fire (pre-fire NBR) and after the fire (post-fire NBR). The difference between the pre-fire NBR and the post-fire NBR referred to as delta NBR (dNBR) is computed to highlight the areas of forest disturbance by fire event.

Classification of the dNBR will be used for burn severity assessment, as areas with higher dNBR values indicate more severe damage whereas areas with negative dNBR values might show increased vegetation productivity. dNBR will be classified according to burn severity ranges proposed by the United States Geological Survey(USGS)

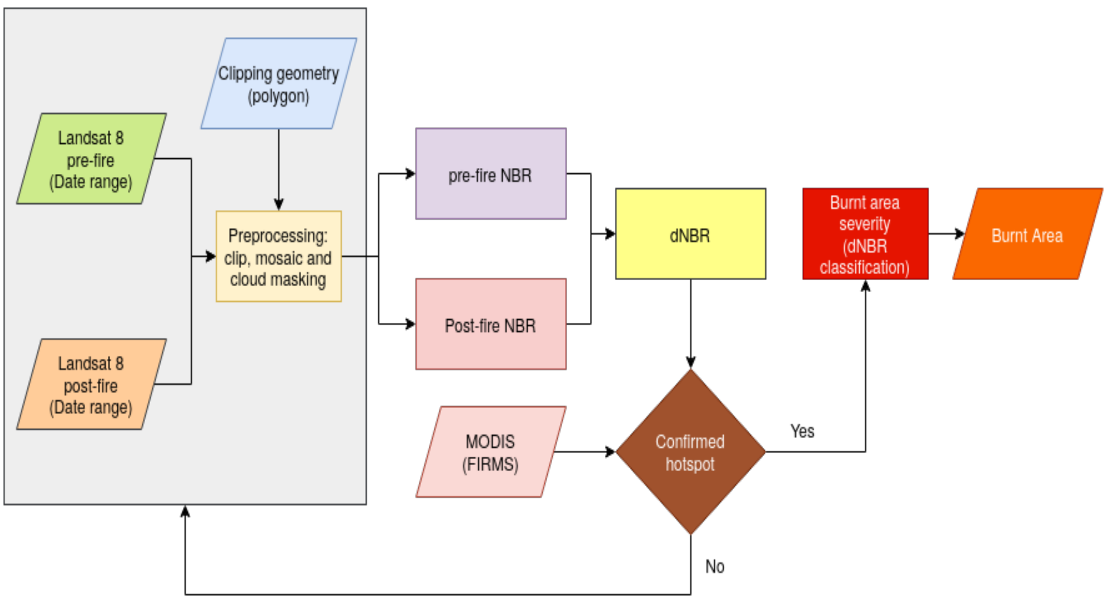


Fig. 6: Sammury methodology for conputing Burnt Areas

CHAPTER

SIX

SDG15.3.1 INDICATOR

As part of the Sustainable development Goals(SDGs), SDG 15 is to: "Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forest, combat desertification, and halt and reverse land degradation and halt biodiversity loss"

Target 15.3 aims to: "By 2030, combat desertification, restore degraded land and soil, including land affected by desertification, drought, floods, and strive to achieve land degradation-neutral world"

The indicator used to assess the progress of each SDG target is the 15.3.1 indicator: "Proportion of land that is degraded over total land area"

The basic land degradation indicators include three main sub-indicators of the SDG target 15.3.1 (proportion of land that is degraded over the total land area). As the custodian agency of SDG 15.3, the United Nations Convention to Combat Desertification (UNCCD) has developed recommendations/Good practice guide on how to compute SDG indicator 15.3.1 from 3 sub-indicators:

- Vegetation productivity
- Landcover
- Soil Organic carbon

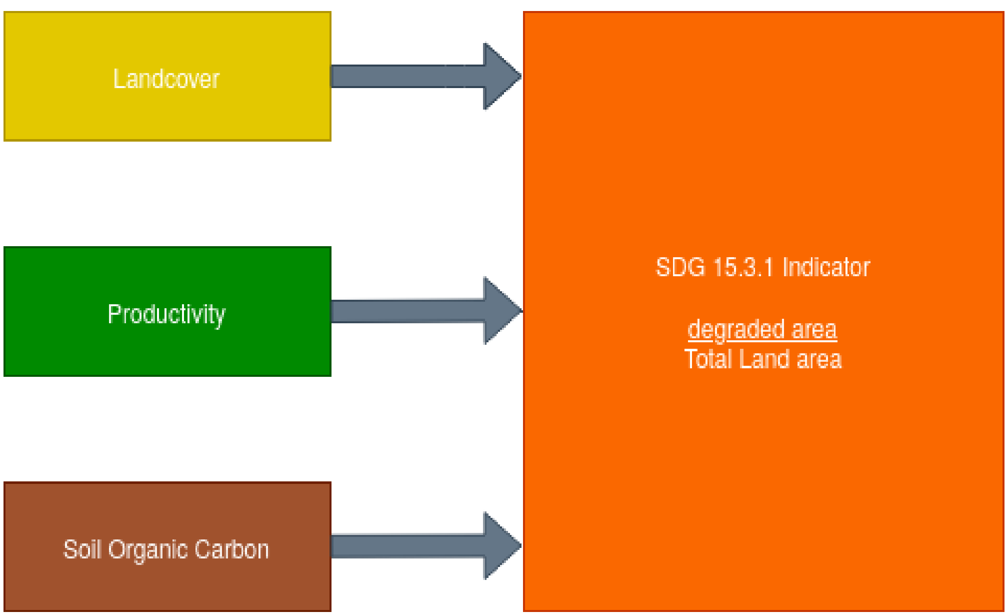


Fig. 1: SDG 15.3.1 Indicators

6.1 SDG 15.3.1 Sub-indicators

6.1.1 Productivity

Land productivity is the biological productive capacity of the land (i.e. the ability to produce food, fibre and fuel that sustain life). For easy interpretation the annual mean vegetation indices values at the pixel level will be used to assess three measures of change (trajectory, state and performance) as summarized in the figure below and explained in the subsequent sub-sections:

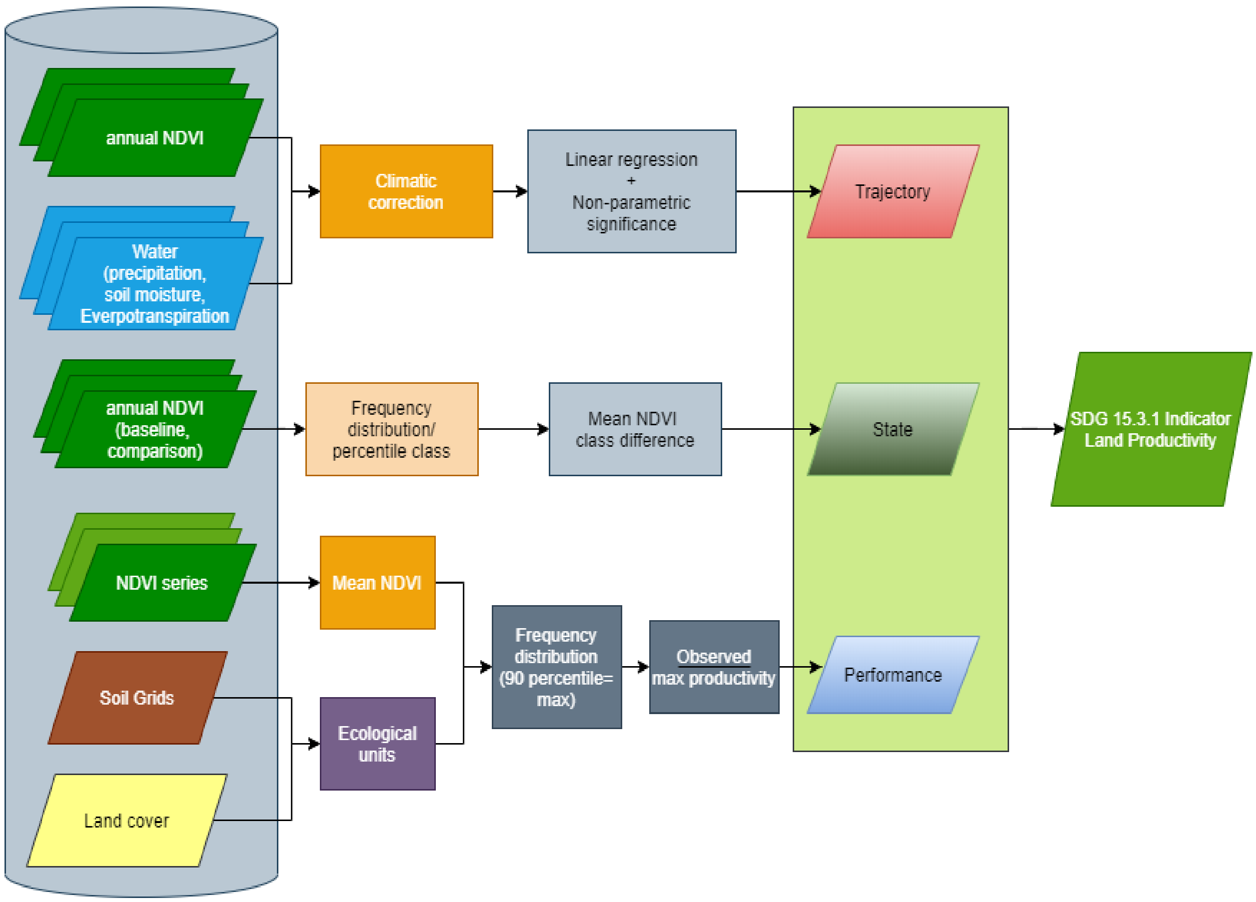


Fig. 2: Sammury methodology for conputing Land Productivity

Trajectory;

The rate of change in primary productivity over time which will be computed using linear regression at the pixel level for various Landsat derived vegetation indices (NDVI, MSAVI2, SAVI). To identify areas experiencing changes in the primary productivity, a non-parametric significance test will be performed to show the significant changes (p-value of 0.05). Positive significant trends in the vegetation indices will indicate potential improvement while a negative significant trend will indicate potential degradation.

The annual integrals of the vegetation indices are interpreted alongside historical precipitation data as a context. The climatic correction method that will be applied is the Rain Use Efficiency (RUE). The rain use efficiency is the ratio of annual NPP to annual precipitation. After the RUE is computed, linear regression and nonparametric significance testing will be applied to the RUE over time. Positive significance in RUE indicates improvement while negative significance will indicate potential degradation.

State;

The Productivity State indicator will be used to show recent changes in primary productivity compared to a baseline period. The indicator is computed from (NDVI, MSAVI2, SAVI) derived from medium resolution Landsat imagery following the steps outlined below:

1. A baseline period (historical period for comparison to recent primary productivity) will be defined. (This will be left open for selection of different periods by the users).
2. A comparison period (recent years for which the state is being analysed) will be defined. (The definition of this period will also be left open for the users of the service)
3. The annual integrals of the selected vegetation index for the baseline period will be used to compute a frequency distribution at the selected pixel. That frequency distribution curve will then be used to classify the values to the 10th percentile(1 to 10).
4. The next step would involve computing the mean of the selected vegetation index for the baseline period, and to determine the percentile class it belongs to. The computed mean value for the baseline period is then assigned a number which corresponds to that percentile class if falls between 1 and 10.
5. The mean value of the selected index for the comparison period is the computed and percentile class to which it belongs to. It is determined and placed in a class corresponding to its percentile class.
6. The difference between the assigned class number for the comparison and the baseline period (comparison minus baseline) will be computed and thresholded to show the productivity state of the land.

Perfomance;

The Productivity Performance indicator will measure the local productivity relative to other similar vegetation types in similar ecological units. A combination of soil units (based on Soil Grids data at 250m resolution) and land cover (ESA CCI at 300m resolution) will be used to define the ecological units. The indicator will be computed as follows:

1. The analysis period is defined, and time series data is used to compute mean value for the selected vegetation index at pixel level.
2. Similar ecological units are derived as the unique intersections of different land cover types and soil types.
3. For each ecological unit, the frequency distribution of the mean pixel values obtained in step 1 shall be computed. From the distribution the value representing the 90th percentile will be considered the maximum productivity for that unit.
4. The ratio of mean NDVI and maximum productivity (in each case compare the mean observed value to the maximum for its corresponding unit) is computed. If the computed ratio is less than 50 %, the pixel shall be considered potentially degraded for this indicator.

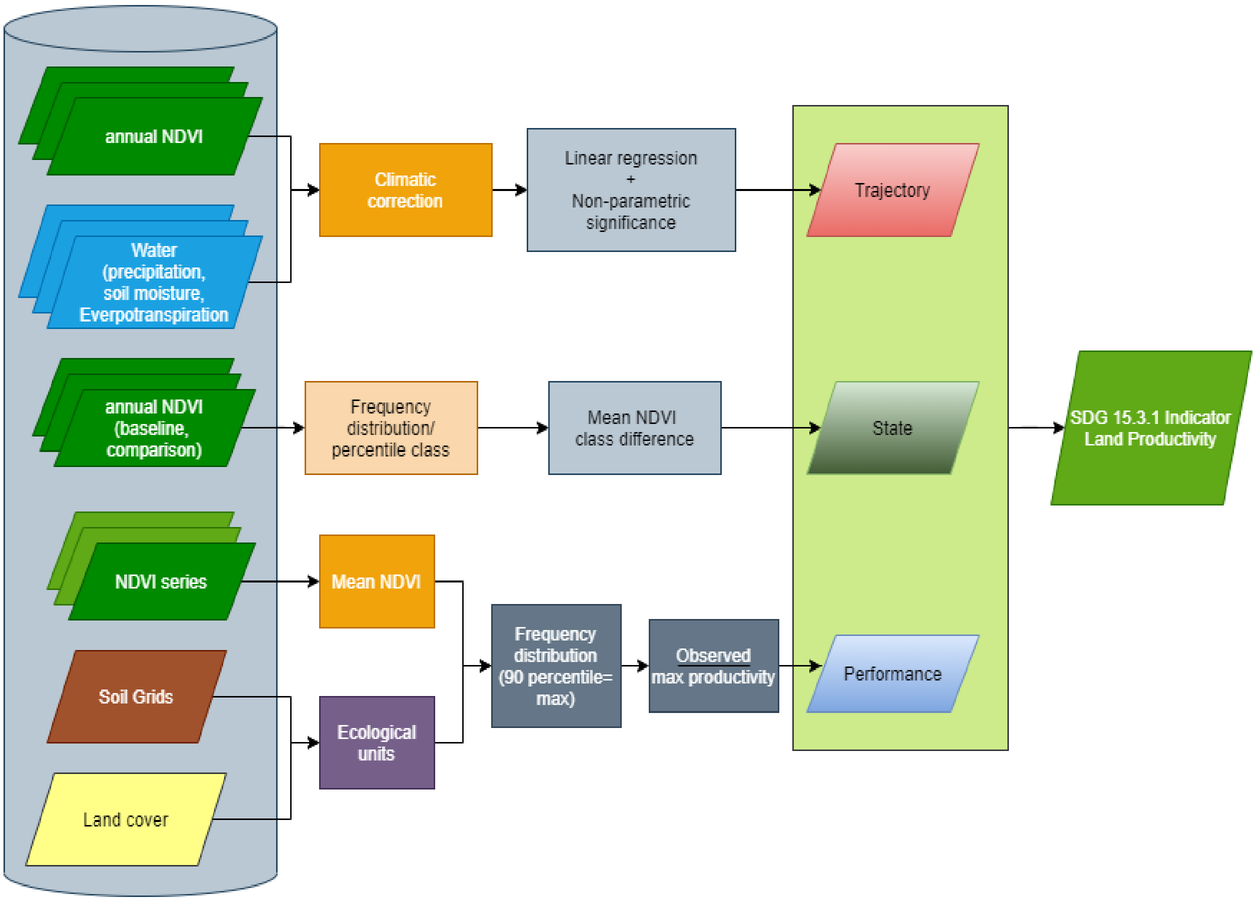


Fig. 3: Sammury methodology for conputing Land Productivity

6.1.2 Combining Productivity Indicators

The three productivity sub-indicators are then combined as indicated in the tables below. For SDG 15.3.1 reporting, the 3-class indicator is required, but LDMS also produces a 5-class one which takes advantage of the information provided by State to inform the type of degradation occurring in the area.

Aggregating the productivity sub-indicators

Trajectory	State	Performance	3 Classes	5 Classes
Improvement	Improvement	Stable	Improvement	Improving
Improvement	Improvement	Degradation	Improvement	Improving
Improvement	Stable	Stable	Improvement	Improving
Improvement	Stable	Degradation	Improvement	Improving
Improvement	Degradation	Stable	Improvement	Improving
Improvement	Degradation	Degradation	Degradation	Stable
Stable	Improvement	Stable	Stable	Stable
Stable	Improvement	Degradation	Stable	Stable
Stable	Stable	Stable	Stable	Stable
Stable	Stable	Degradation	Degradation	Stable but stressed
Stable	Degradation	Stable	Degradation	Early signs of decline
Stable	Degradation	Degradation	Degradation	Declining
Degradation	Improvement	Stable	Degradation	Declining
Degradation	Improvement	Degradation	Degradation	Declining
Degradation	Stable	Stable	Degradation	Declining
Degradation	Stable	Degradation	Degradation	Declining
Degradation	Degradation	Stable	Degradation	Declining
Degradation	Degradation	Degradation	Degradation	Declining

6.2 Landcover

Monitoring of Land Use and Land Cover Changes (LULCCs) at both regional and local scales presents a major opportunity for identifying areas threatened by land degradation where mitigation measures should be taken. Traditionally, LULCCs have been interpreted by distinguishing between two transformation types: conversion and modification.

To assess changes in land cover users need land cover maps covering the study area for the baseline and target years. These maps need to be of acceptable accuracy and created in such a way which allows for valid comparisons. LDMS uses ESA CCI land cover maps as the default dataset, but local maps can also be used. The indicator is computed as follows:

1. Reclassify both land cover maps to the 7 land cover classes needed for reporting to the UNCCD (forest, grassland, cropland, wetland, artificial area, bare land and water).
2. Perform a land cover transition analysis to identify which pixels remained in the same land cover class, and which ones changed.
3. Based on your local knowledge of the conditions in the study area and the land degradation processed occurring there, use the table below to identify which transitions correspond to degradation (- sign), improvement (+ sign), or no change in terms of land condition (zero).

Land cover in target year (columns); **Land cover in baseline year** (rows)

	Forest	Grassland*	Cropland	Wetland	Artificial area	Bare land	Water body
Forest	0	-	-	-	-	-	0
Grassland*	+	0	+	-	-	-	0
Cropland	+	-	0	-	-	-	0
Wetland	-	-	-	0	-	-	0
Artificial area	+	+	+	+	0	+	0
Bare land	+	+	+	+	-	0	0
Water body	0	0	0	0	0	0	0

Legend

Degradation	Stable	Improvement
-	0	+

*The "Grassland" class consists of grassland, shrub, and sparsely vegetated areas (if the default aggregation is used).

1. LDMS will combine the information from the land cover maps and the table of degradation typologies by land cover transition to compute the land cover sub-indicator.

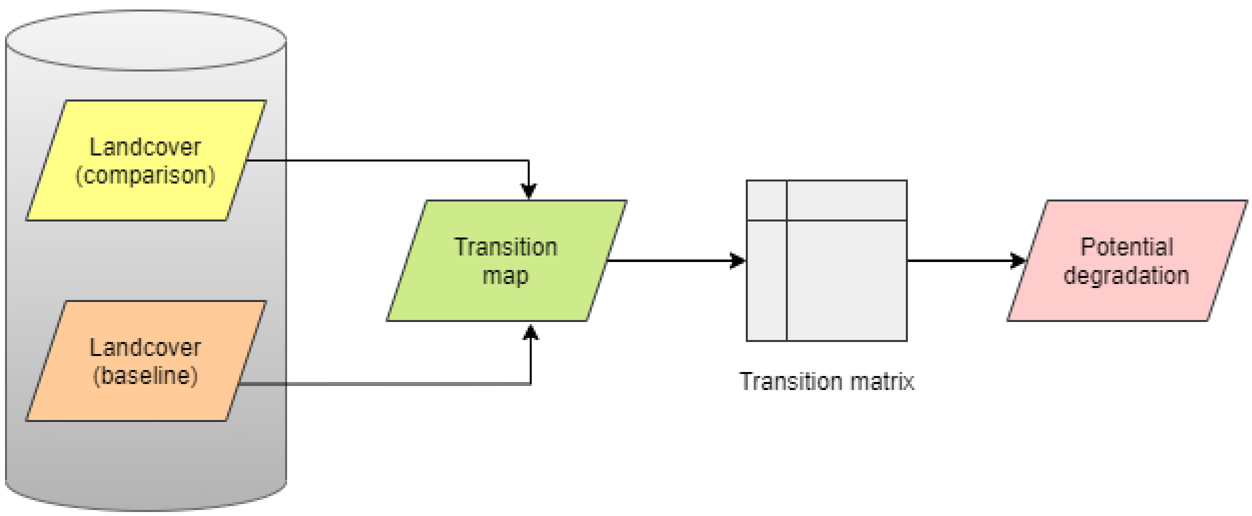


Fig. 4: Sammary methodology for computing land cover change

6.3 Carbon-stocks

The third sub-indicator for monitoring land degradation as part of the SDG process quantifies changes in soil organic carbon (SOC) over the reporting period. Changes in SOC are particularly difficult to assess for several reasons, some of them being the high spatial variability of soil properties, the time and cost intensiveness of conducting representative soil surveys and the lack of time series data on SOC for most regions of the world. To address some of the limitations, a combined land cover/SOC method is used in LDMS to estimate changes in SOC and identify potentially degraded areas. The indicator is computed as follows:

1. Determine the SOC reference values. LDMS uses SoilGrids 250m carbon stocks for the first 30 cm of the soil

profile as the reference values for calculation (NOTE: SoilGrids uses information from a variety of data sources and ranging from many years to produce this product, therefore assigning a date for calculations purposes could cause inaccuracies in the stock change calculations).

2. Reclassify the land cover maps to the 7 land cover classes needed for reporting to the UNCCD (forest, grassland, cropland, wetland, artificial area, bare land and water). Ideally annual land cover maps are preferred, but at least land cover maps for the starting and end years are needed.

3. To estimate the changes in C stocks for the reporting period C conversion coefficients for changes in land use, management and inputs are recommended by the IPCC and the UNCCD. However, spatially explicit information on management and C inputs is not available for most regions. As such, only land use conversion coefficient can be applied for estimating changes in C stocks (using land cover as a proxy for land use). The coefficients used were the result of a literature review performed by the UNCCD and are presented in the table below. Those coefficients represent the proportional in C stocks after 20 years of land cover change.

LU coefficients	Forest	Grasslands	Croplands	Wetlands	Artifical areas	Bare lands	Water bodies
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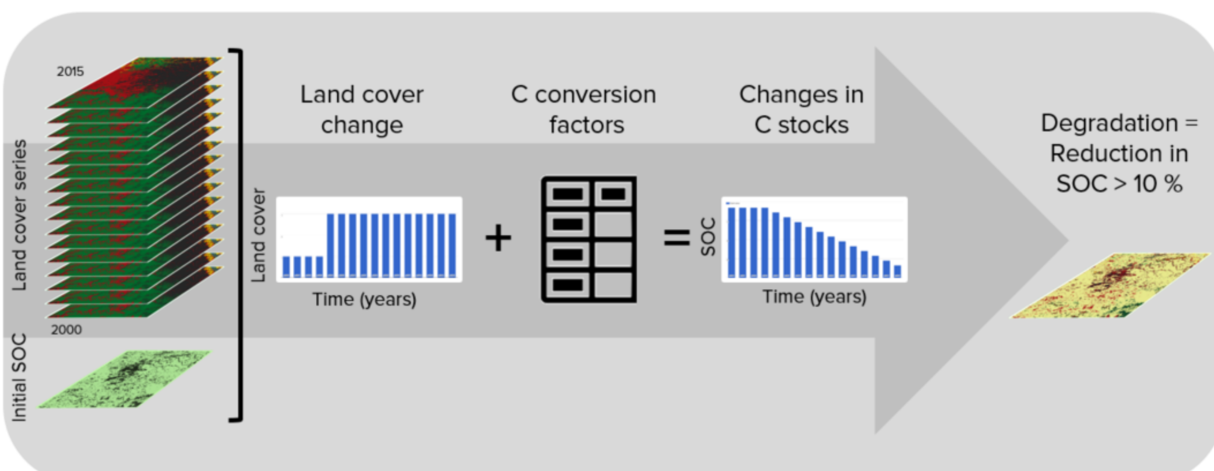
Grasslands	1	1	f	1	0.1	0.1	1
Croplands	1/f	1/f	1	1/0.71	0.1	0.1	1
Wetlands	1	1	0.71	1	0.1	0.1	1
Artifical areas	2	2	2	2	1	1	1
Bare lands	2	2	2	2	1	1	1
Water bodies	1	1	1	1	1	1	1

Changes in SOC are better studied for land cover transitions involving agriculture, and for that reason there is a different set of coefficients for each of the main global climatic regions: Temperate Dry (f = 0.80), Temperate Moist (f = 0.69), Tropical Dry (f = 0.58), Tropical Moist (f = 0.48), and Tropical Montane (f = 0.64).

4. Compute relative different in SOC between the baseline and the target period, areas which experienced a loss in SOC of 10% of more during the reporting period will be considered potentially degraded, and areas experiencing a gain of 10% or more as potentially improved.



CHAPTER

SEVEN

VEGETATION LOSS/GAIN HOTSPOTS

Land degradation hotsports (LDH) are produced via the analysis of time-series vegetation indices data and are used to characterize areas of different sizes, where the vegetation cover and the soil types are severely degraded.

Vegetation loss/gain hotspots will be calculated based on time series observation of selected suit of vegetation indices depending on the climatic zones and terrain morphology of the North African countries. The selected indices derived from Landsat data are as listed below:

> -NDVI for humid zones, sub-humid and semi-arid zones -MSAVI2 for arid and stepic zones -SAVI for desert areas

CHAPTER

EIGHT

FOREST CHANGE

8.1 Forest Gain/Loss

The quantification of the forest gain/loss hotspots will be based on pre-existing high-resolution global maps derived from Hansen Global Forest change dataset that can be accessed using Google Earth Engine API.

The maps are produced from time-series analysis of Landsat images characterizing forest extent and change over time.

8.2 Forest Carbon Emission

8.3 Forest Fire Risk

8.4 Forest Fires

Burnt areas and forest fires will be highlighted and mapped out form remotely sensed Landsat/Sentinel data using the Normalized Burn Ratio (NBR). NBR is designed to highlight burned areas and estimate burn severity. It uses near-infrared (NIR) and shortwave-infrared (SWIR) wavelengths. Before fire events, healthy vegetation has very high NIR reflectance and a low SWIR reflectance. In contrast, recently burned areas show low reflectance in the NIR and high reflectance in the SWIR band.

The NBR will be calculated for Landsat/Sentinel images before the fire (pre-fire NBR) and after the fire (post-fire NBR). The difference between the pre-fire NBR and the post-fire NBR referred to as delta NBR (dNBR) is computed to highlight the areas of forest disturbance by fire event.

Classification of the dNBR will be used for burn severity assessment, as areas with higher dNBR values indicate more severe damage whereas areas with negative dNBR values might show increased vegetation productivity. dNBR will be classified according to burn severity ranges proposed by the United States Geological Survey(USGS)

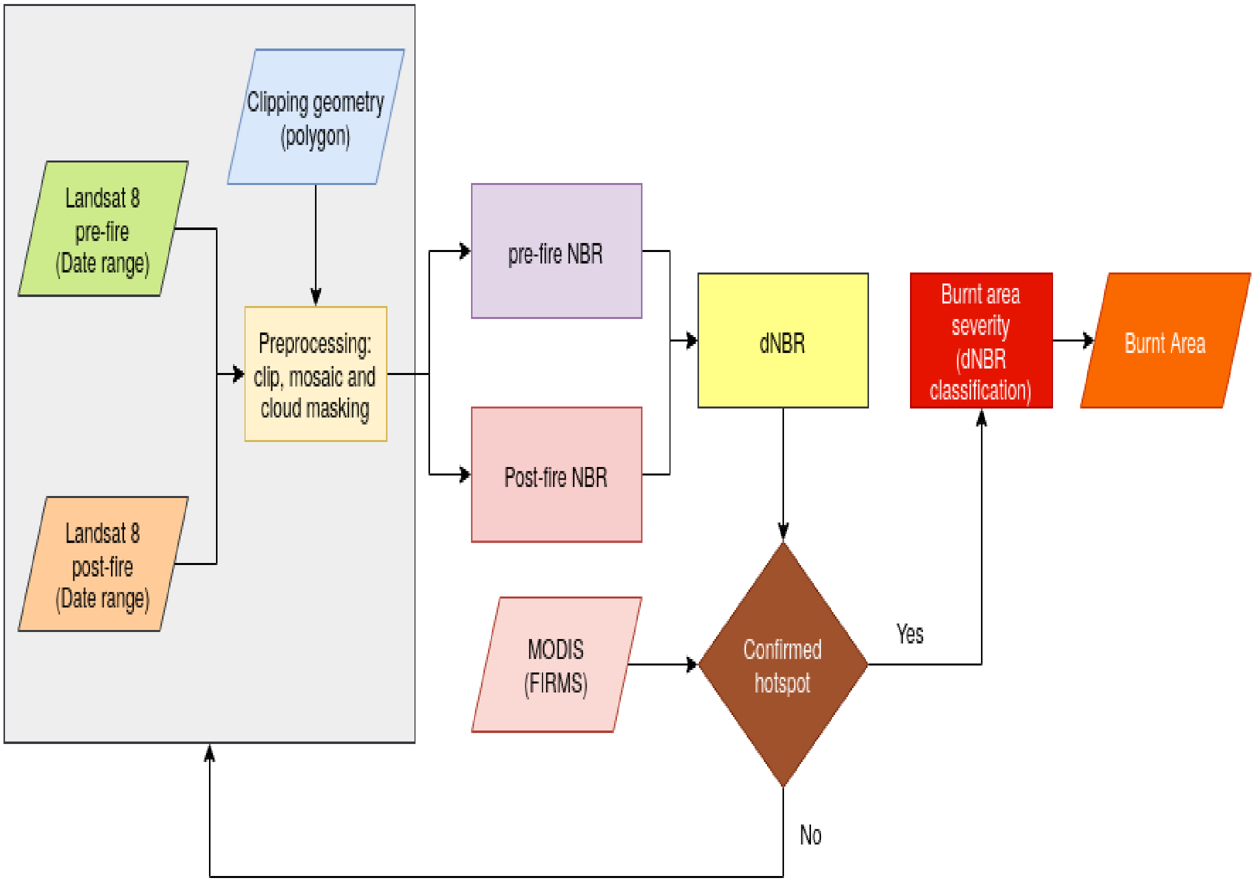


Fig. 1: Sammury methodology for conputing Burnt Areas

CHAPTER

NINE

SERIVICE GUIDE

9.1 MISLAND Site Tour

9.2 Registration and Log in

New users to the service will be required to register a new account to use the service. Registering a new account is a simple two step process

1. Click on the log-in icon on the right hand side of the navigation-bar

Fig. 1: Finding the log in option

2. Choose the 'Not a user? Sing up' option on the log in menu that pops up

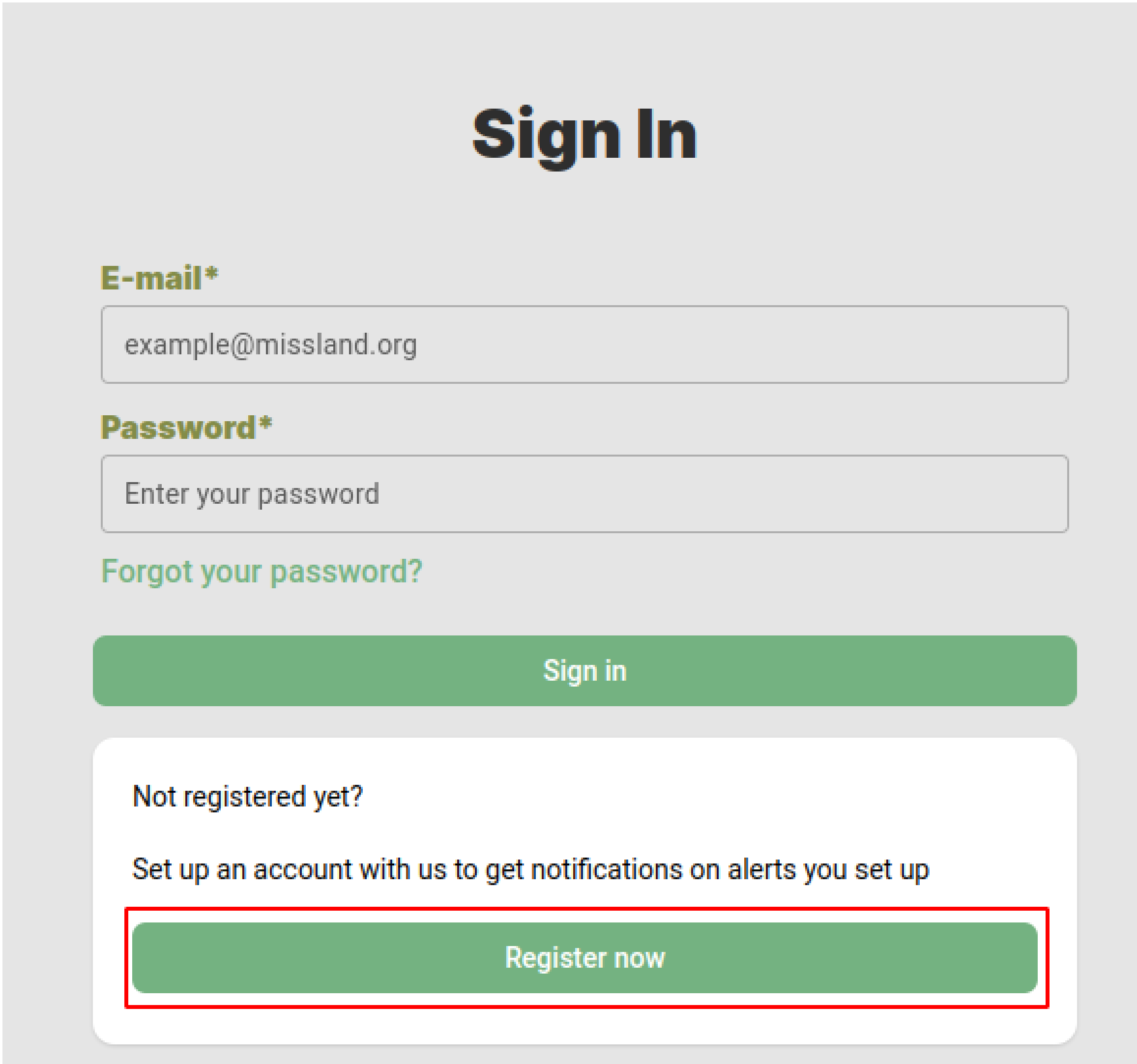


Fig. 2: new user registration

Registered users can proceed to log in with their Email and password.

9.3 User profile and custom uploads

Once loged in, users can select their profile to edit their information and for custom uploads. For custom area uploads, follow the simple steps as outlined below:

1. Click on the user-name that appears on the navingation bar items

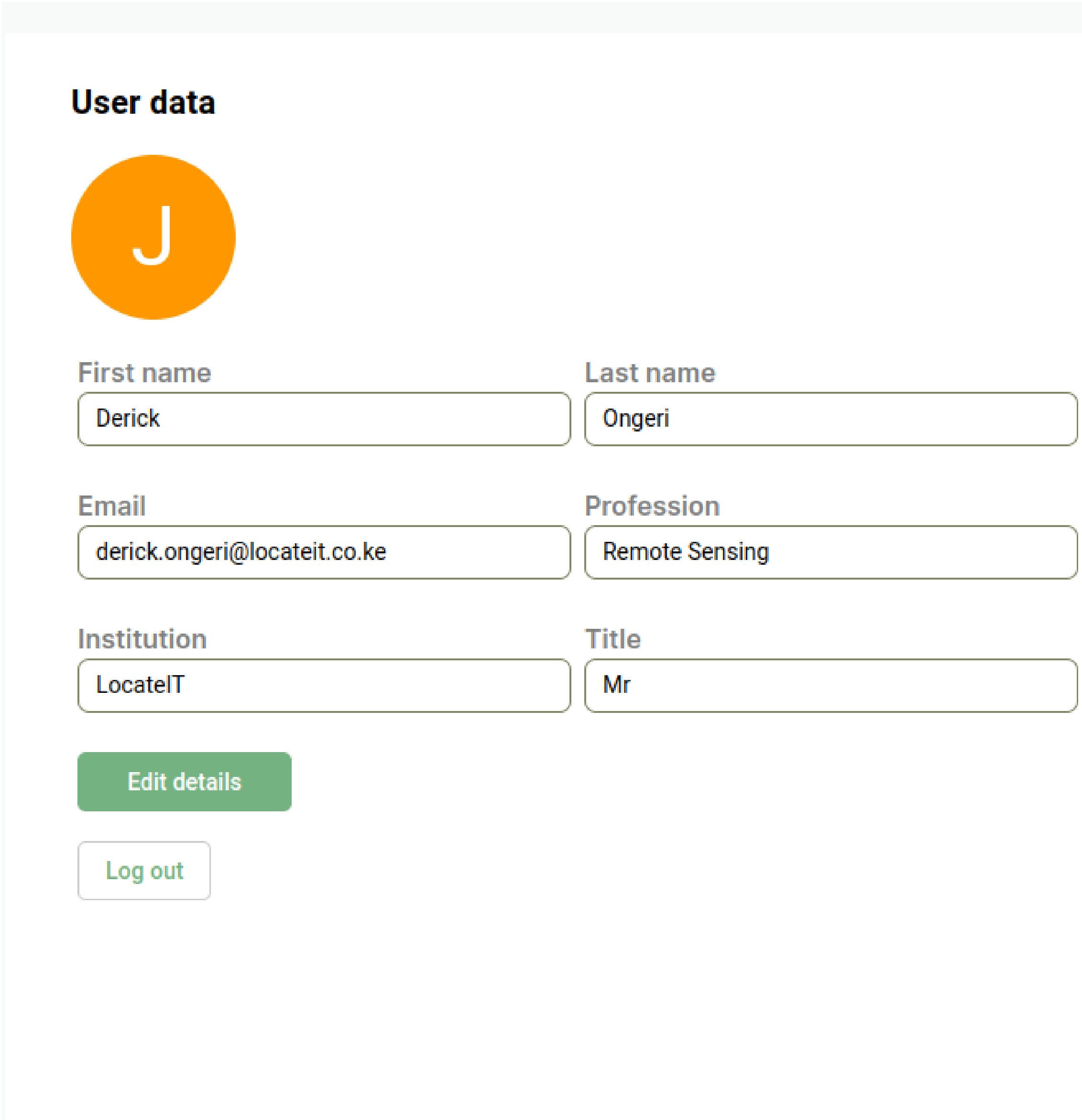


Fig. 3: User profile and options

CHAPTER

TEN

SDG 15.3.1 INDICATOR

10.1 Compute SDG 15.3.1 Sub-indicators

On the Service Menu bar, users can select the SDG Indicators option which appears as the first item in the menu to compute SDG 15.3.1 indicator and its sub-indicators forllowing the steps described below:

10.1.1 Computing Land Productivity

Land productivity is computed form vegetation indices using three measures of change i.e trajectory, state and performace. Any of the three sub-indicators measures of change as well as the productivity can be combuted as illustrated below

1. On the indicator menu bar that appears below the area selection panel click on the Land Productivity option. This should pop-up a selection panel as in the diagram below:

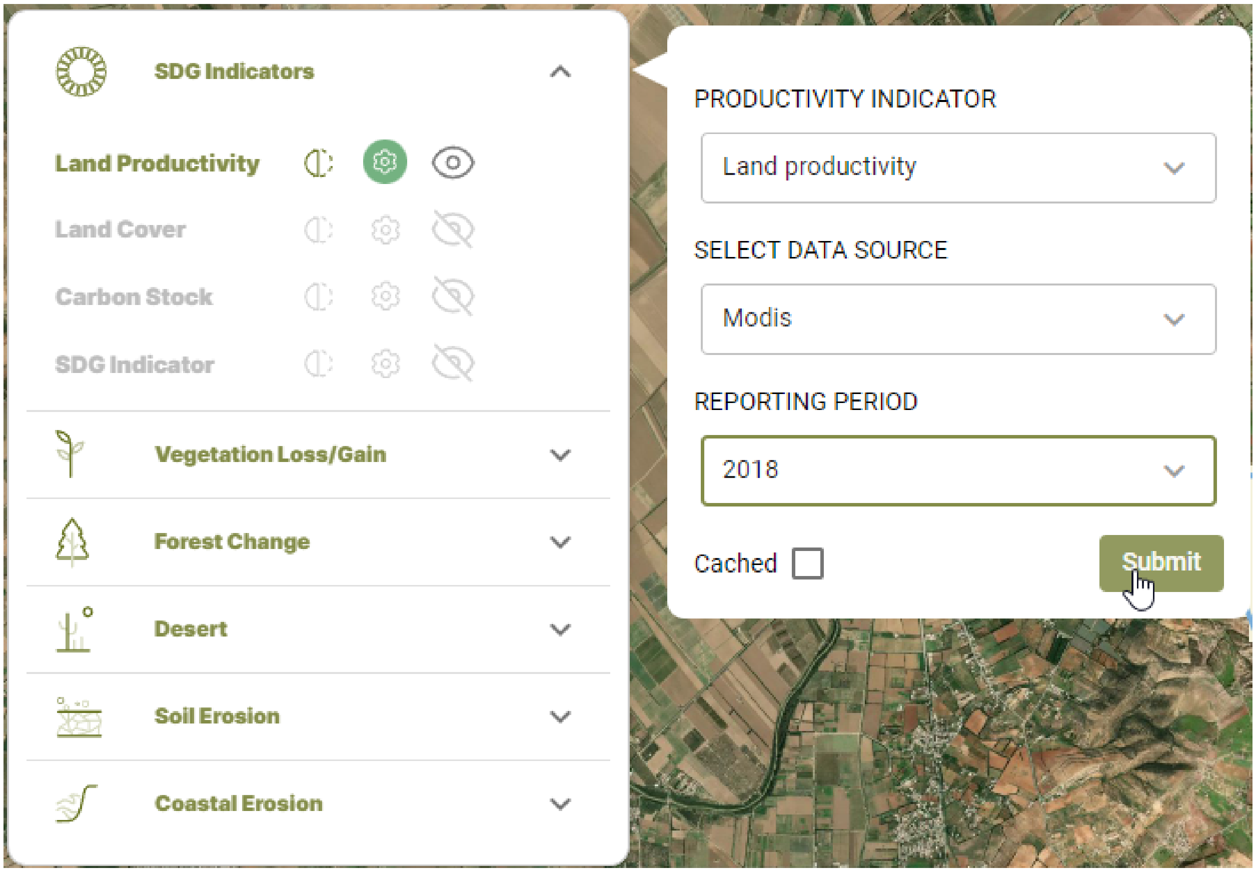


Fig. 1: selecting the land productivity option

2. Under the productivity indicator option on the pop-up menu, users can select either of the three land productivity sub-indicators i.e. State, performance, and trajectory or the final aggregated land productivity for their selected area of interest.

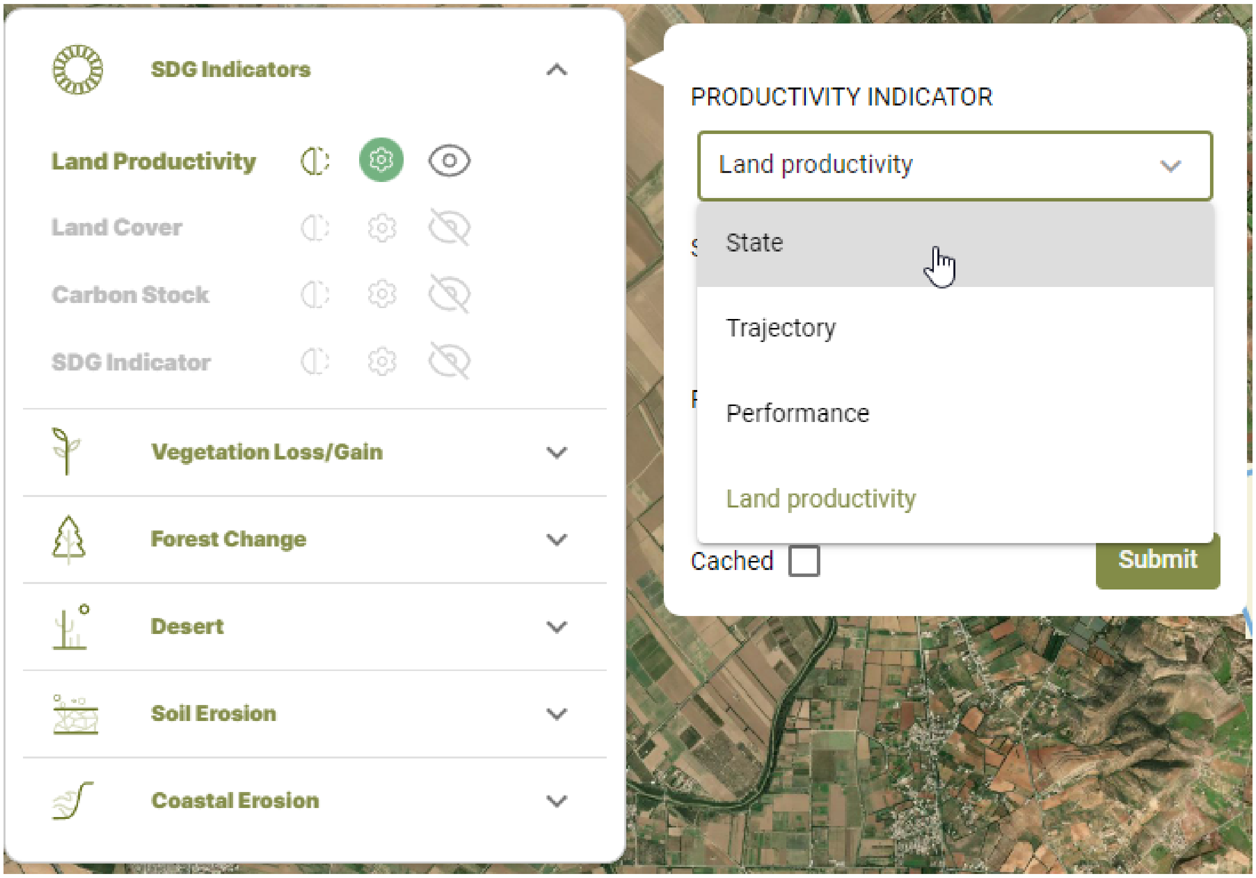


Fig. 2: Computing land productivity by combining state, trajectory and performance

3. Complete the selection by selecting the data source and the reporting period.

Note: MISLAND allows users to asses vegetation using high resolution Landsat derived vegetation indices. If the selection of the dataset is landsat the option to specify the vegetation index .i.e NDVI, MSAVI or SAVI will appear under the Advanced Parameters options.

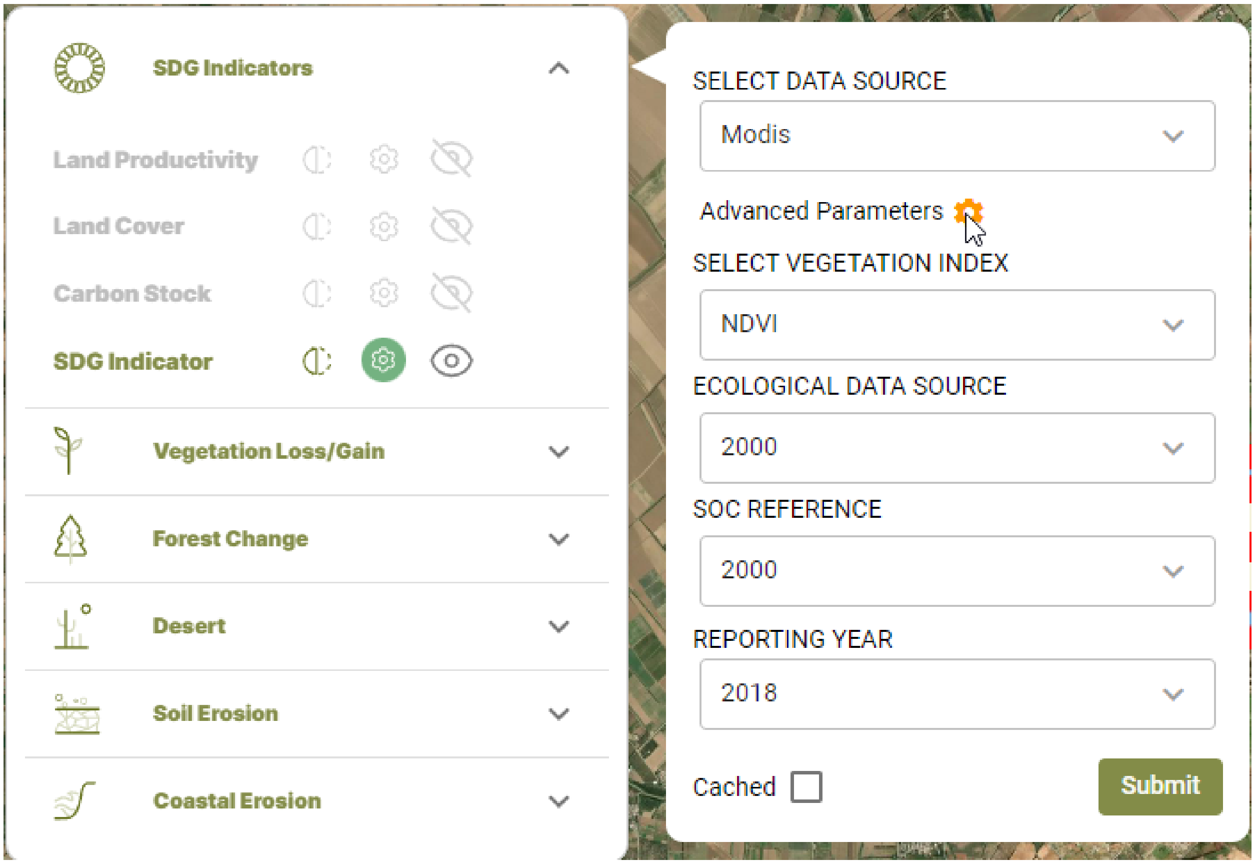


Fig. 3: Vegetation index selection

4. Once the selection of datasets and reporting period is complete click on the 

button at the pottom of the selection pop-up window to compute the selected indicator. The map and statistics should be dispalyed as shown below.

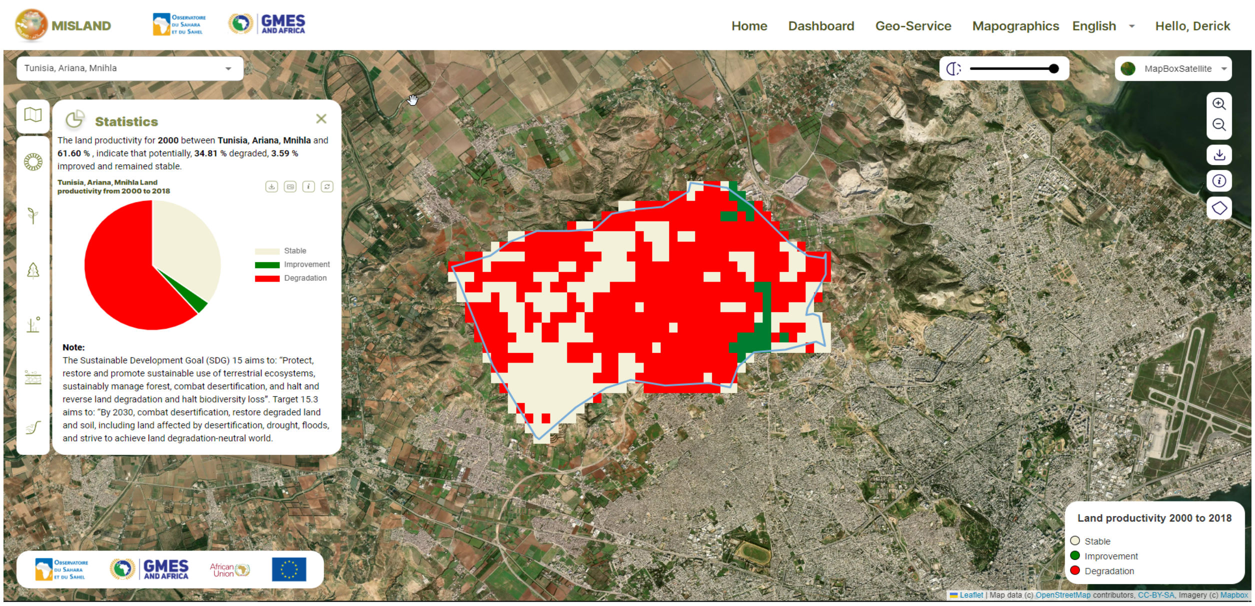


Fig. 4: Land productivity output

10.1.2 Computing Landcover Change

MISLAND allows the user to view land cover state for a particular year or to compute landcover changes between two years. The landcover change can be accessed from the **Land Cover** option under the SDG indicator menu as described in the steps below

1. Select **SDG Indicators** option on the services menu-bar and clic on the **Land Cover** option. This should pop up a selection panel as the one shown below

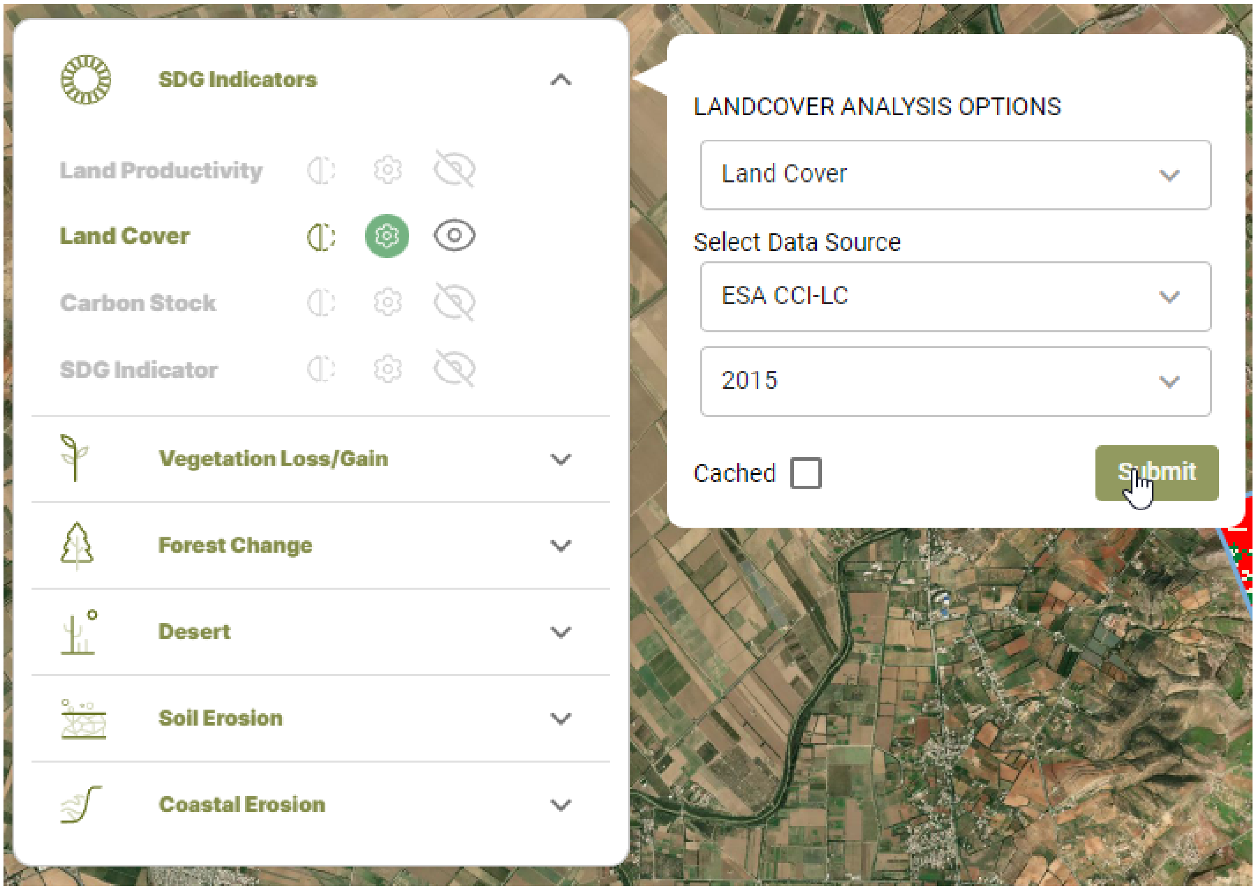


Fig. 5: Selecting the Land cover change under SDG 15.3.1 sub-indicators

2. To view the land cover data for a particular year, select 'Land Cover' option under the *LANDCOVER ANALYSIS OPTIONS* folled by a selection of the landcover data source and the year as shown below

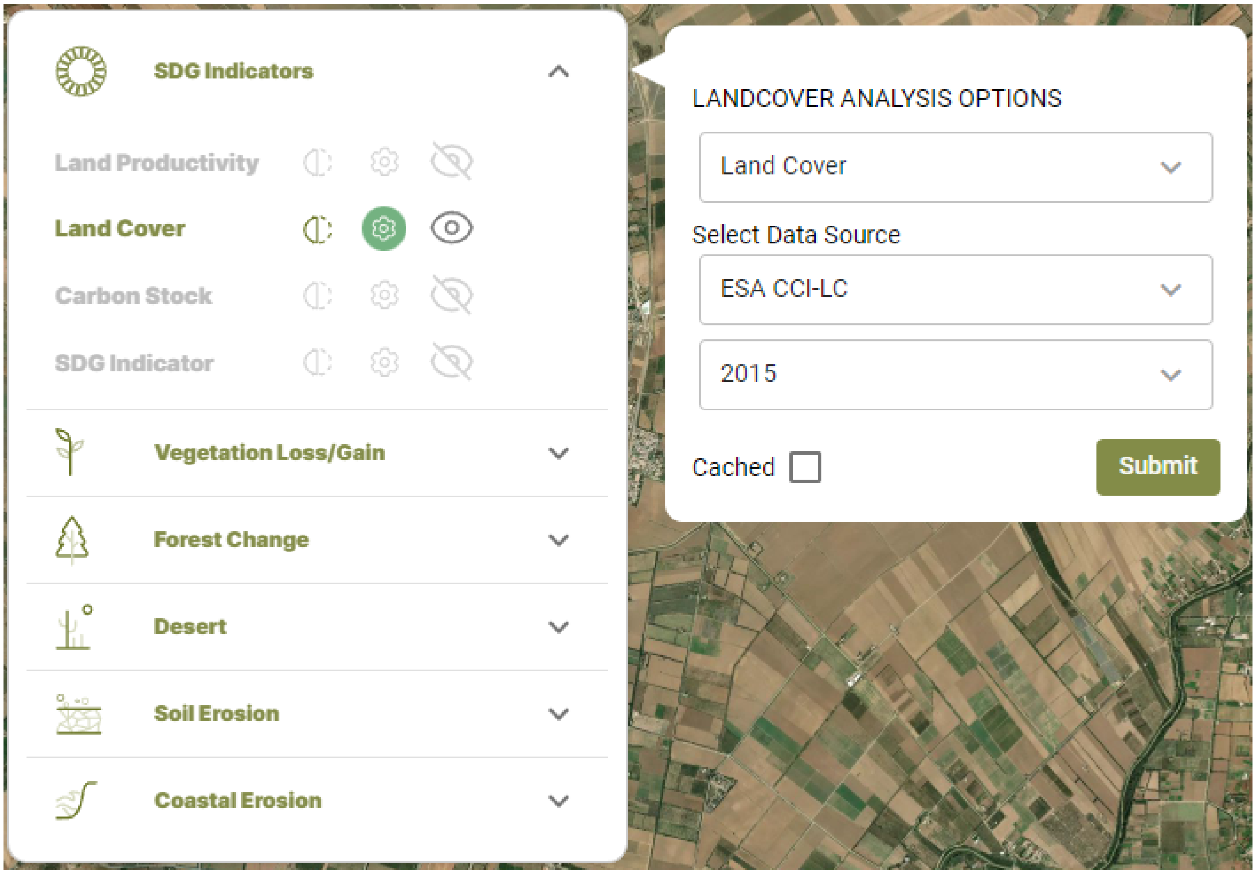


Fig. 6: Viewing the Land cover data for a particular year

Click on the 

button and the Land cover map for the chosen year and the summary statistics will be displayed on the map panel and the summary panel as shown below

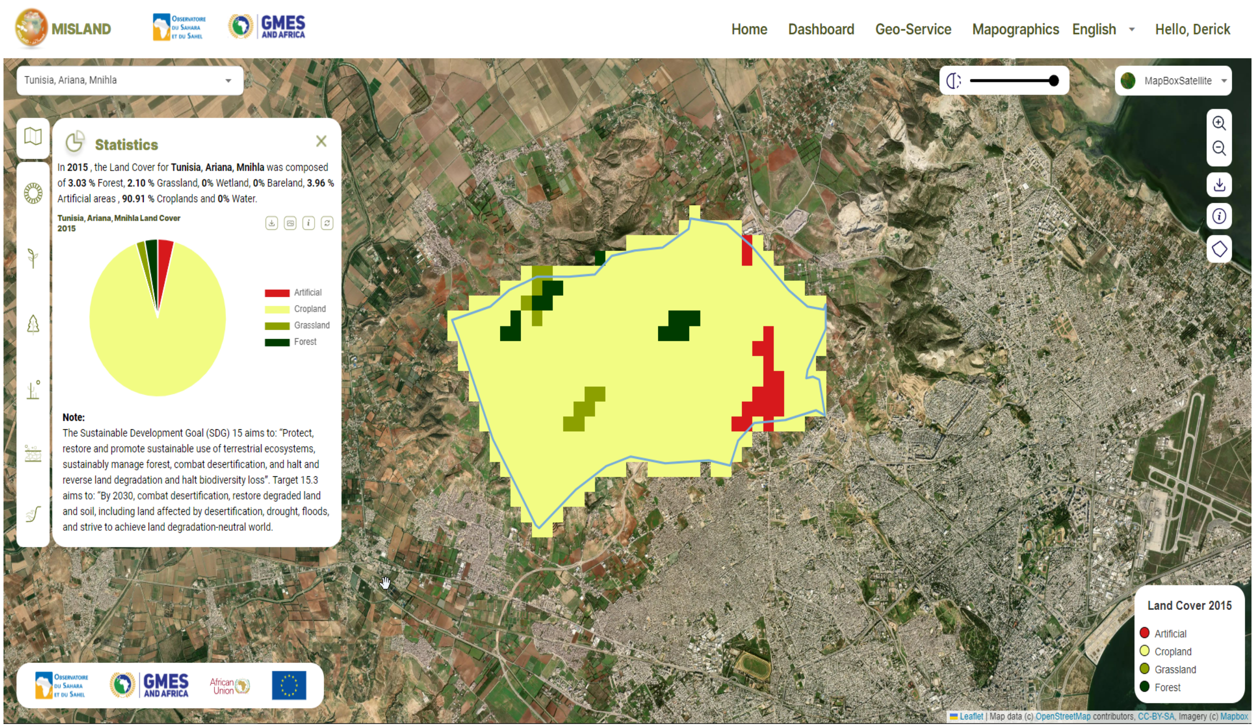


Fig. 7: Viewing the Land cover data for a particular year

3. To compute landcover change, selec the 'Landcover change' option option under the *LANDCOVER ANALYSIS OPTIONS*. select the data landcover data source and the baseline and reporting year for comparison as shown

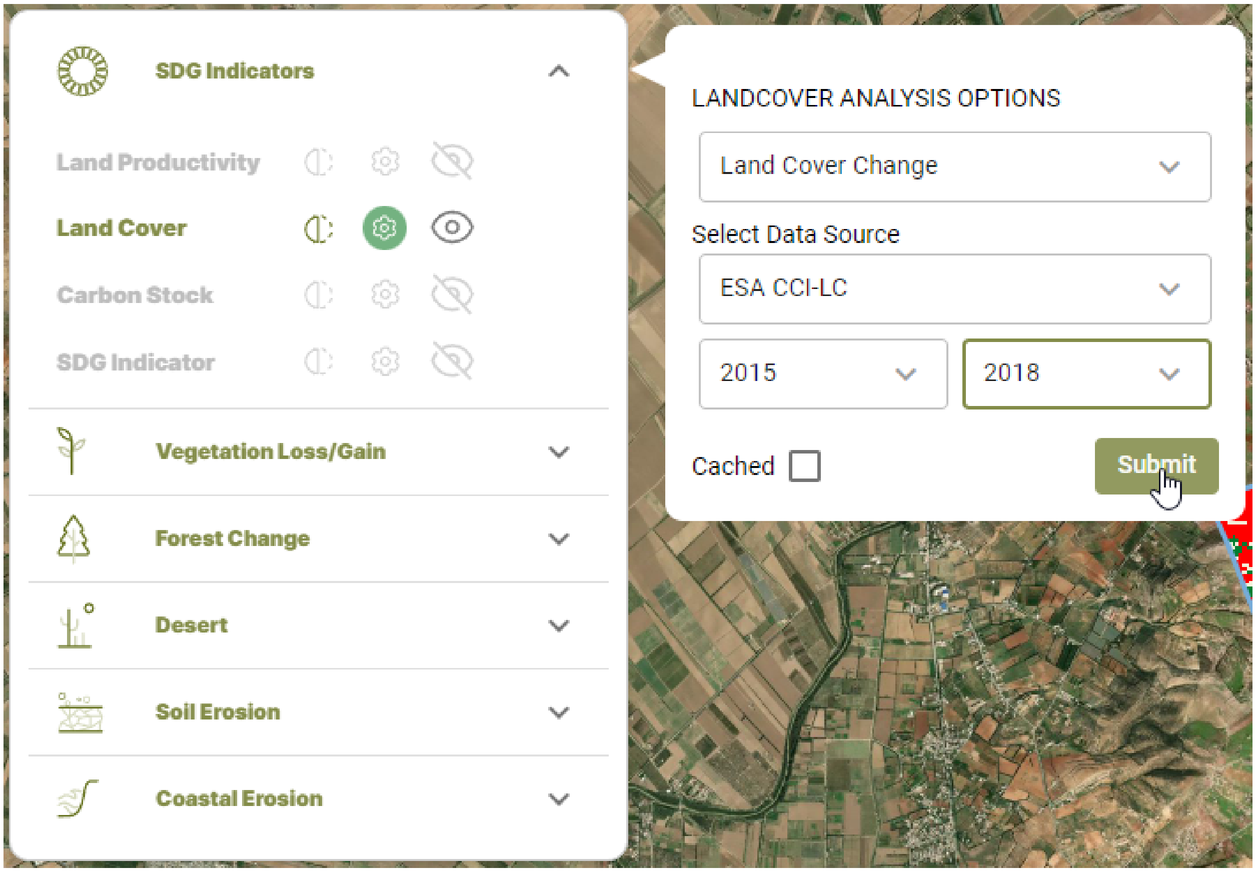


Fig. 8: Selecting the Landcover change option

The results will be displayed on the map panel and the summary statistics panel as shown below

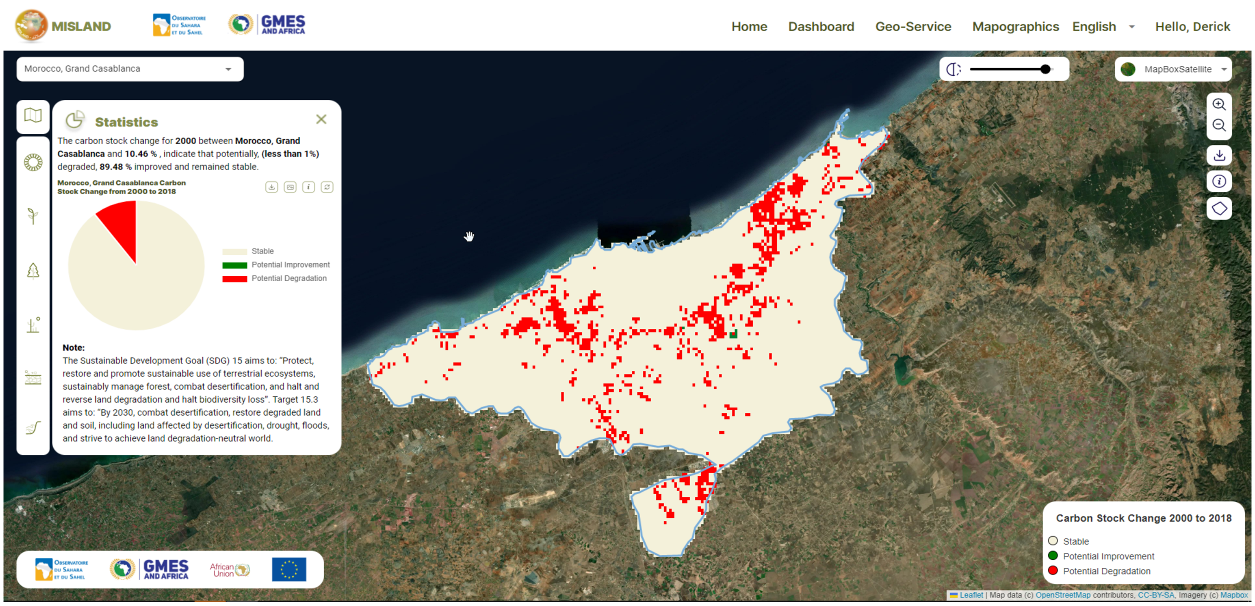


Fig. 9: landcover change map and statistics

10.1.3 Carbon Stocks

To compute changes in carbon stocks,

1. Select SDG Indicators option on the services menu-bar. Choose Carbon Stock option and under the SDG indicator menu-bar. This should pop-up a dialog as the one shown below

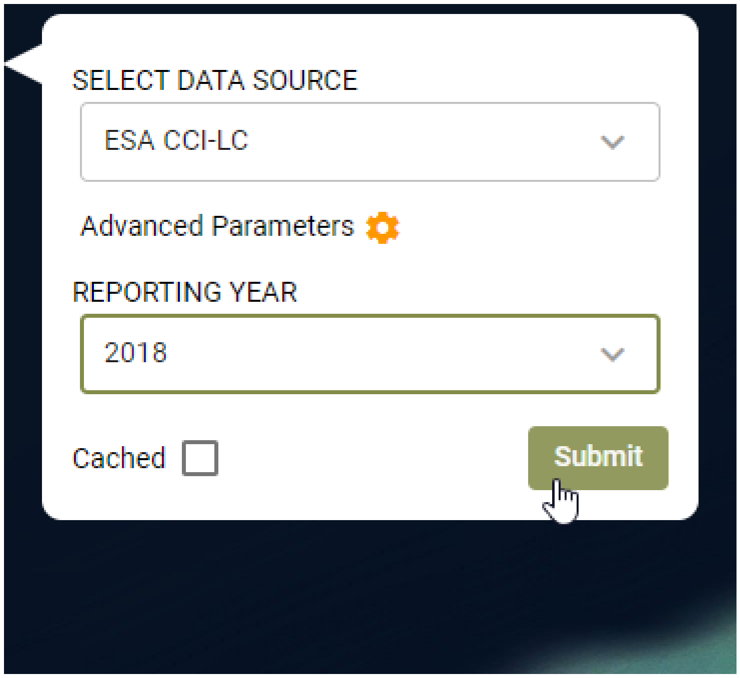


Fig. 10: Selecting the Carbon stock change SDG 15.3.1 sub-indicator

select the data source and the reporting period and click on the Submit button to view the carbon stock change for the selected reporting period

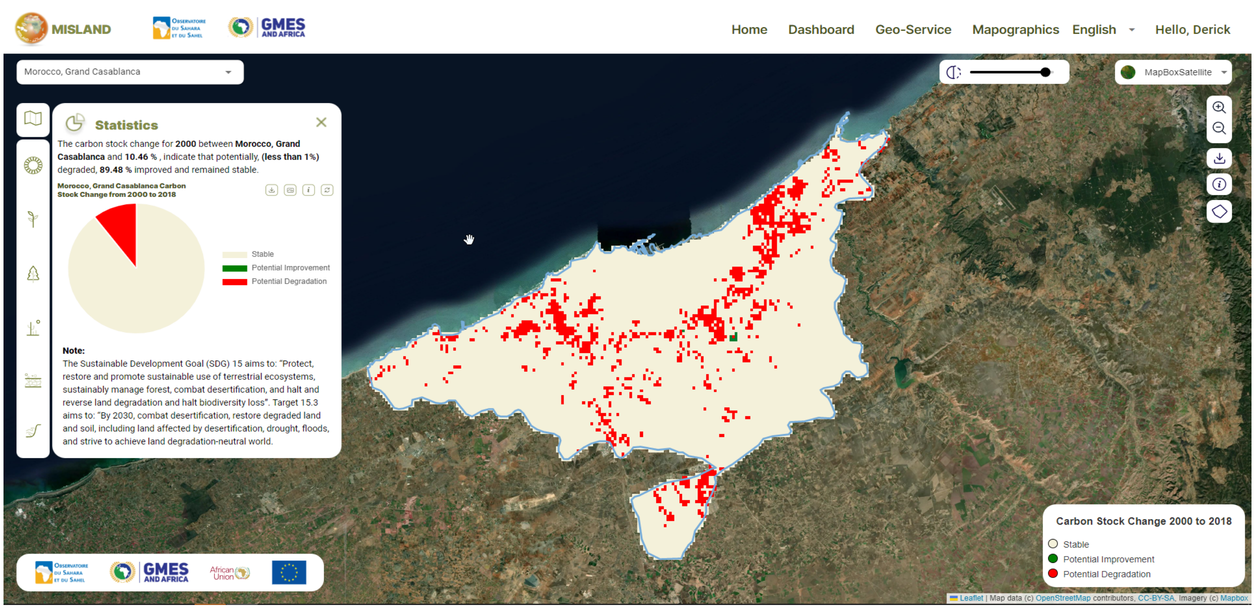


Fig. 11: Carbon stock change map and statistics

10.2 Compute SDG 15.3.1 Indicator

The SDG 15.3.1 Indicator combines the three sub-indicators .i.e changes in land productivity, landcover and carbon stocks discussed previously to asses the land degradation status of the selected area and period. The one-out, all-out (1OAO) approach is used to combine the results from the three sub-indicators, to assess degradation status for each monitoring period at the Indicator level. Within the study region, degradation is considered to have occurred if degradation is reported in any one of the sub-indicators.

To compute the SDG 15.3.1 indicator, follow these simple steps,

1. Select the SDG Indicators service, on the services menu-bar and click on the SDG INDICATOR 15.3.1 option. This should show a pop-up as the one shown below

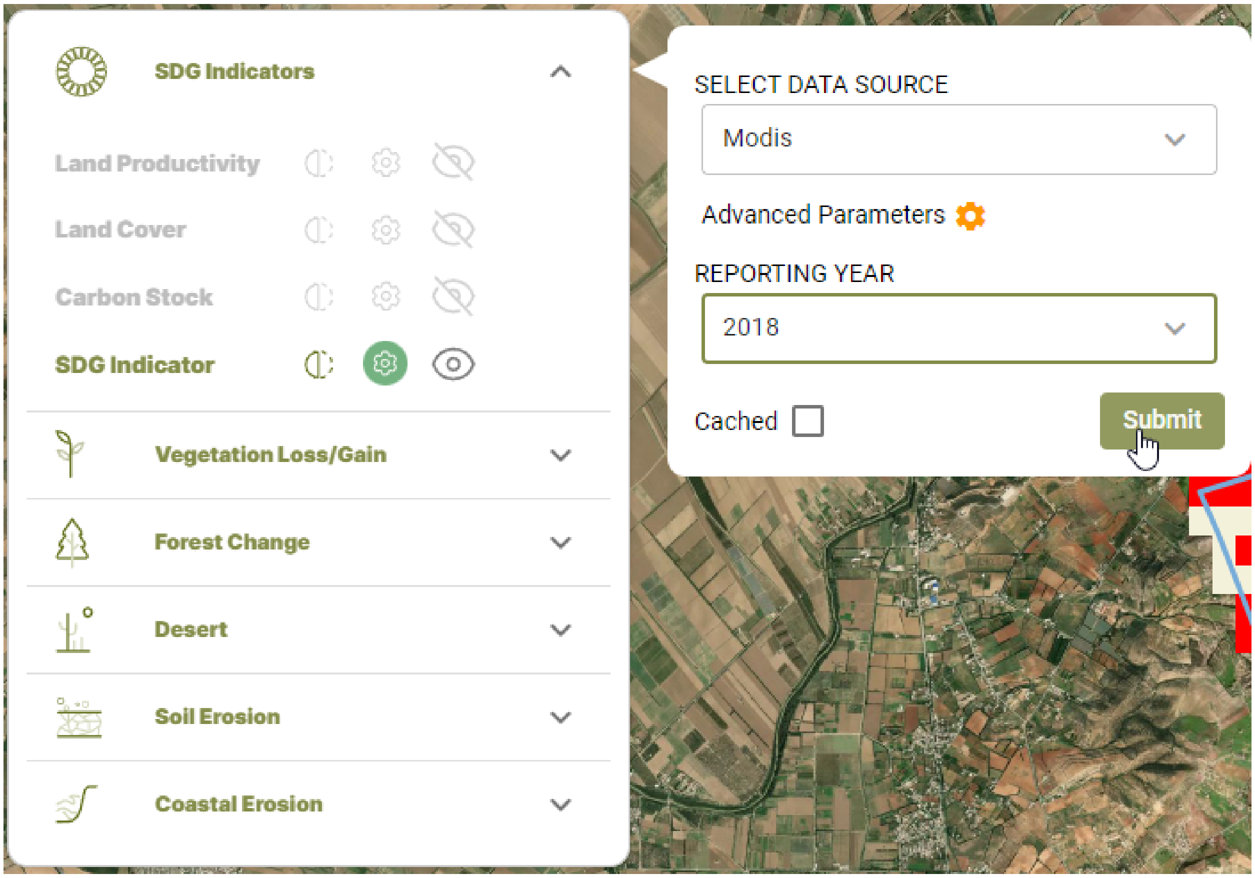
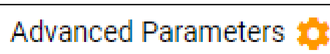


Fig. 12: SDG 15.3.1 indicator

2. On the dialog that pops up, select the datasource and the reporting period. and click on the 

button to get the results

Note: Clicking on the 

option provides more options to select the vegetation index of choise, the ecological unit dataset and the soil organic carbon reference raster as shown below.

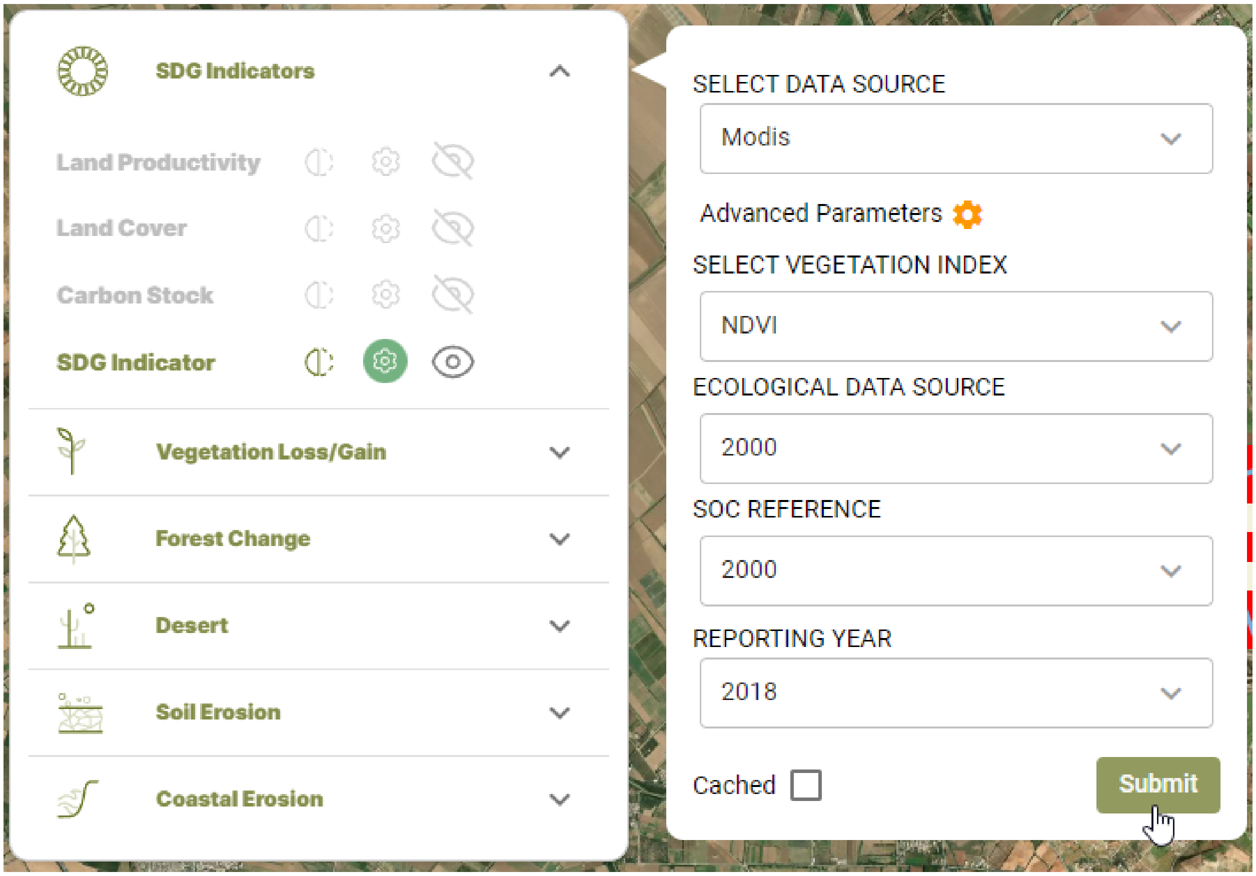
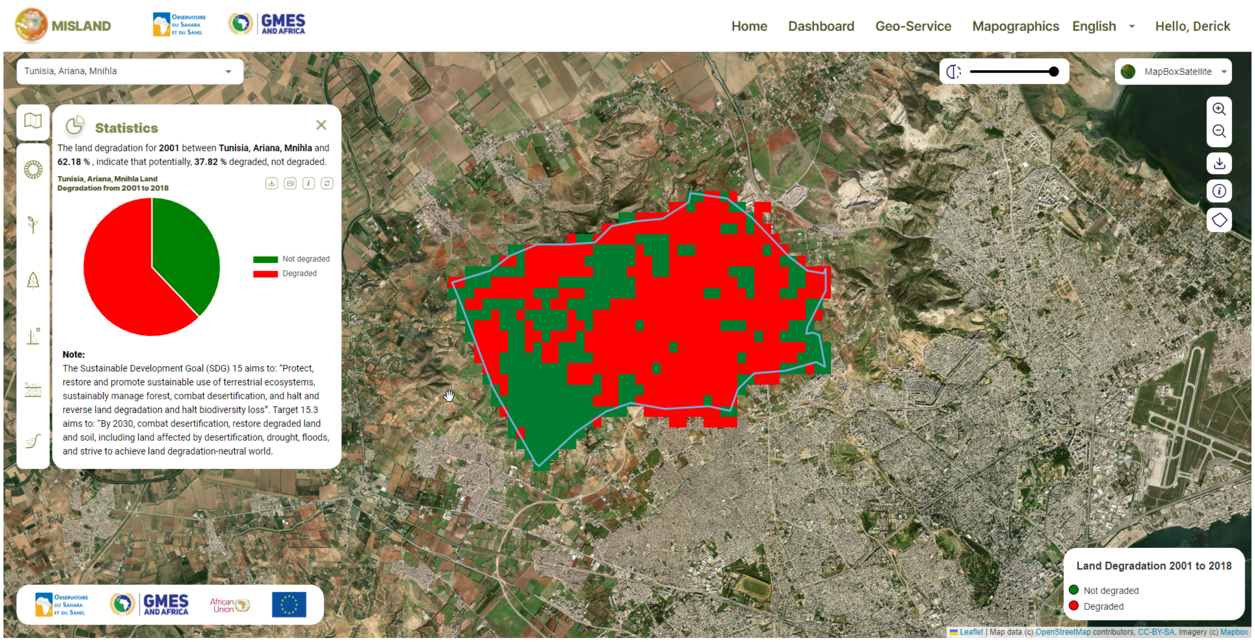


Fig. 13: Setting advanced options for the SDG 15.3.1 indicator

---

The map and computed statistics will be displayed on the map panel and summary pannel respectively.



MISLAND
GMES AND AFRICA
Home
Dashboard
Geo-Service
Mapographics
English
Hello, Derick
Tunisia, Ariana, Mnihla
MapBoxSatellite
Statistics
The land degradation for 2001 between Tunisia, Ariana, Mnihla and 62.18 % , indicate that potentially, 37.82 % degraded, not degraded.
Tunisia, Ariana, Mnihla Land Degradation from 2001 to 2018
Not degraded
Degraded
Note:
The Sustainable Development Goal (SDG) 15 aims to: "Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forest, combat desertification, and halt and reverse land degradation and halt biodiversity loss". Target 15.3 aims to: "By 2030, combat desertification, restore degraded land and soil, including land affected by desertification, drought, floods, and strive to achieve land degradation-neutral world.
Land Degradation 2001 to 2018
Not degraded
Degraded
Leaflet | Map data (c) OpenStreetMap contributors, CC-BY-SA, Imagery (c) Mapbox

CHAPTER

ELEVEN

CALCULATE VEGETATION LOSS/GAIN INDICATORS

To compute vegetation loss/gain on the service platform,

1. On the services menu, select the 

option

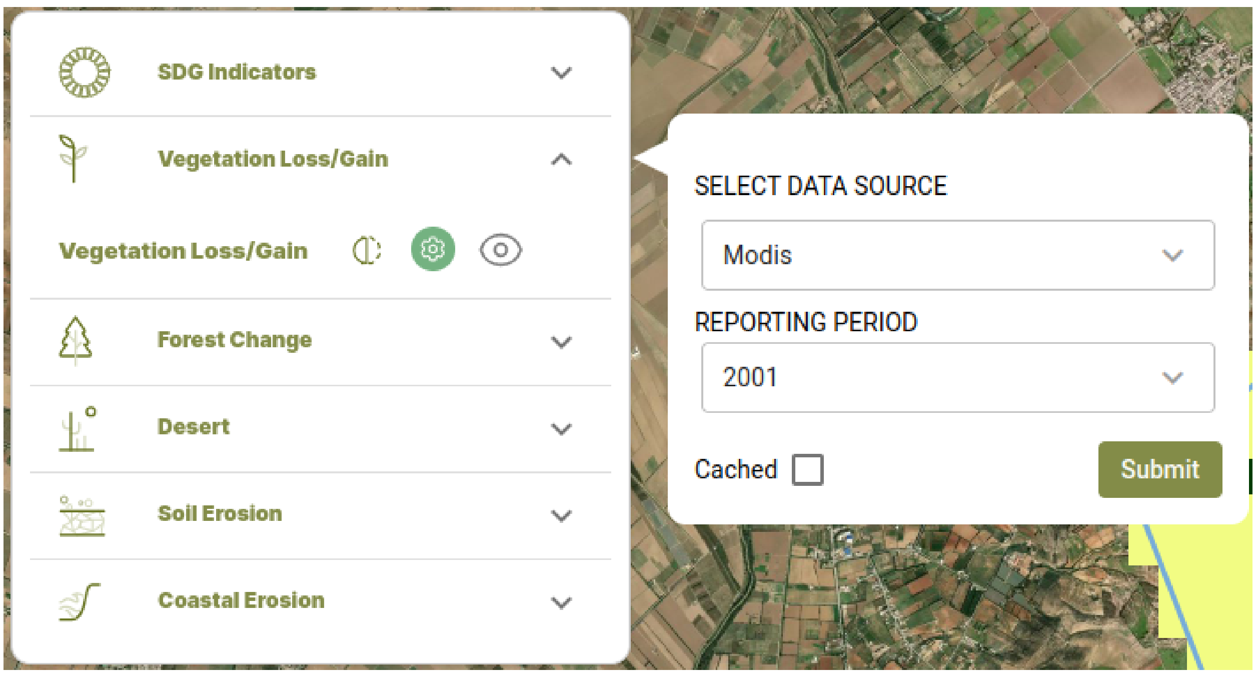


Fig. 1: Selecting the vegetation Loss/Gain Service

2. Click on the  icon to open the layer settings dialog and select the data source and reporting year as shown below.

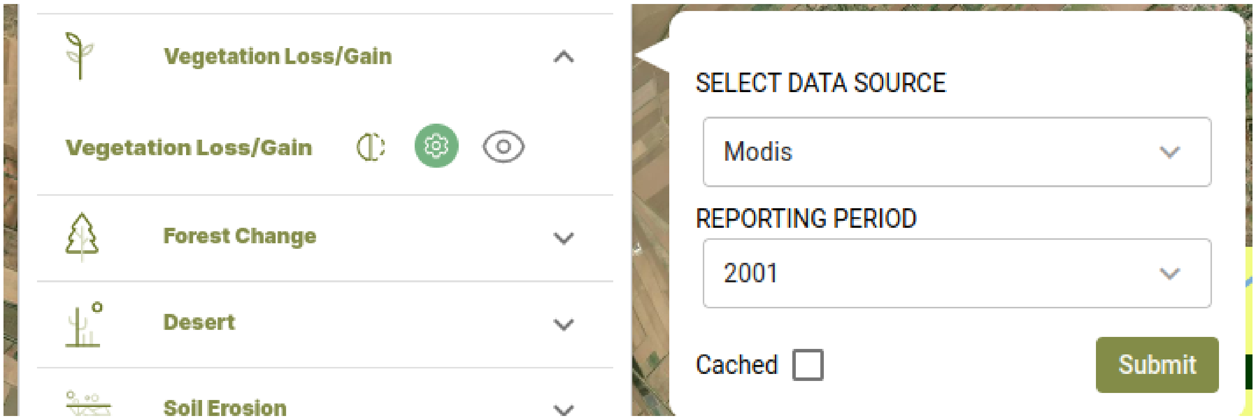


Fig. 2: Vegetation gain/loss outputs

To compute vegetation indices using Landsat derived vegetation indices(NDVI, MSAVI, SAVI),

1. On the Vegetation loss/gain dialog, select Landsat under the SELECT DATA SOURCE dropdown and click on the 

options to access the list of indices.

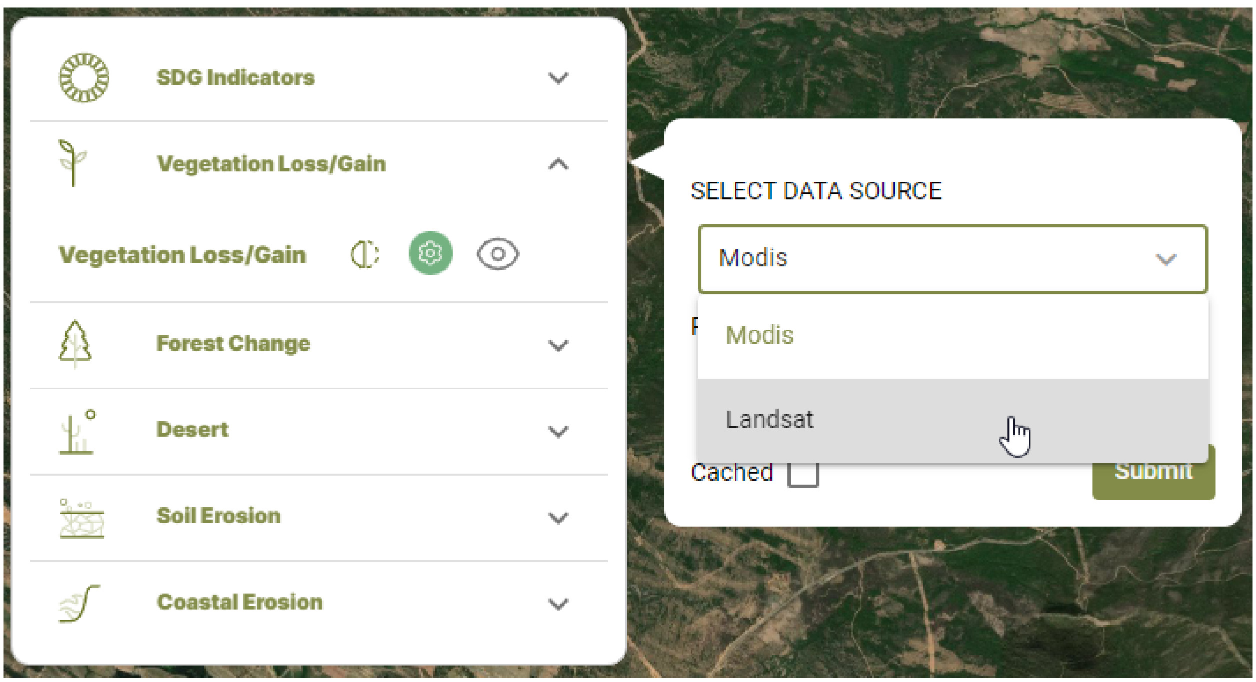


Fig. 3: Selecting the Landsat-derived vegetation index option

2. select the vegetation index form the SELECT VEGEATATION INDEX dropdown that is revealed. Select the reporting period before clicking on the 

button.

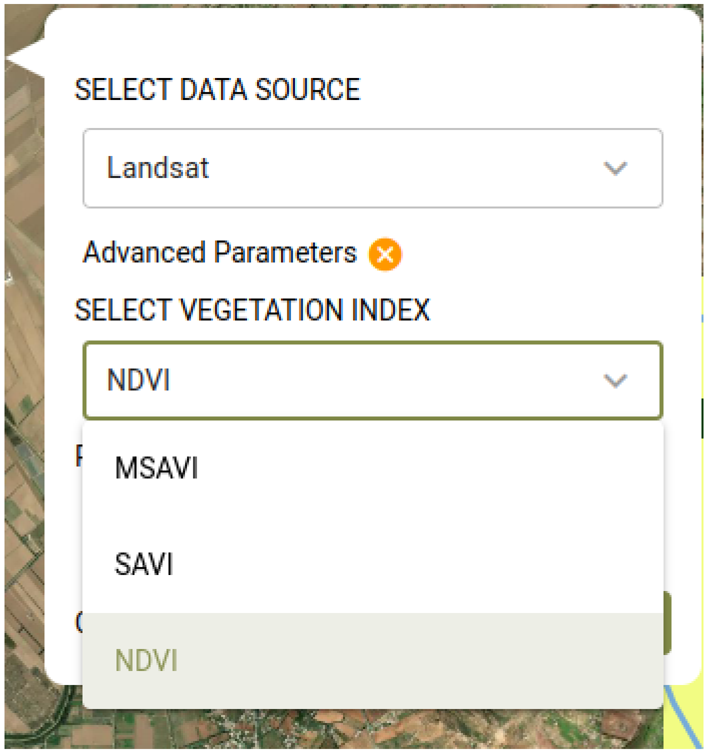


Fig. 4: Choosing the vegetation index to compute

The map and computed statistics will be displayed on the map panel and summary pannel respectively.

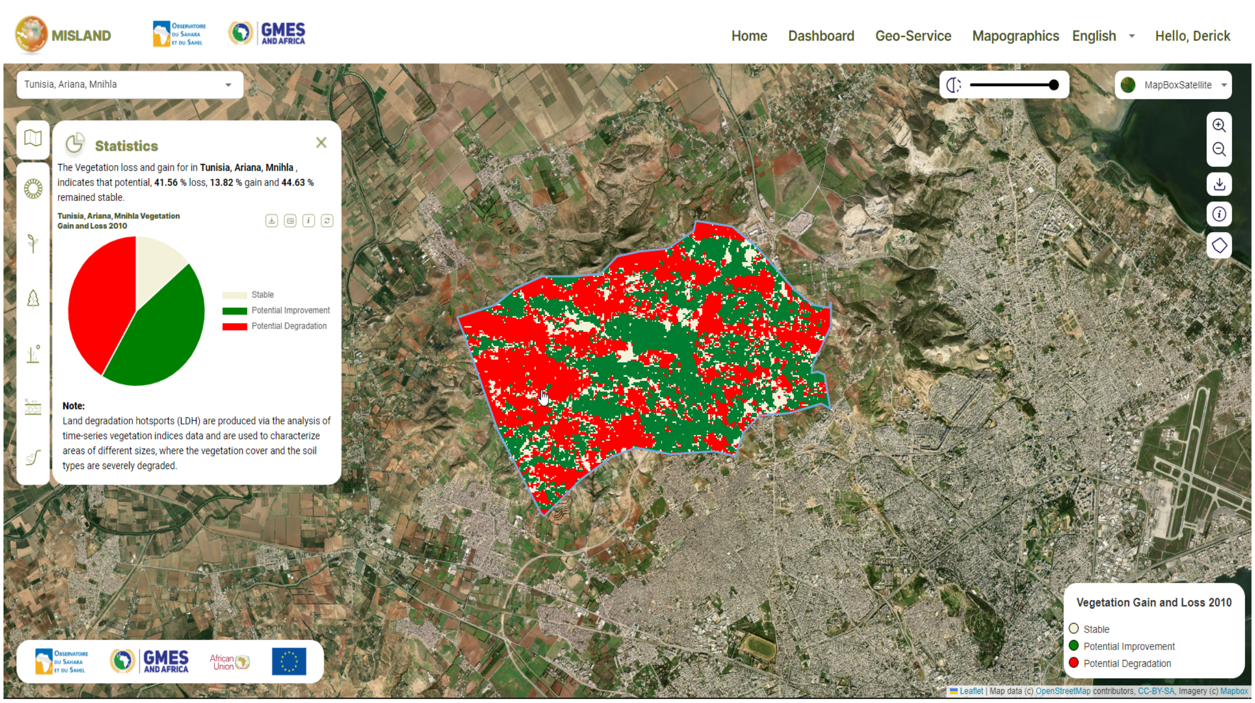


Fig. 5: Landsat derived vegetation loss and gain output

CHAPTER

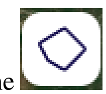
TWELVE

CALCULATE FOREST CHANGE

12.1 Computing Forest Loss

Note: The current release of the MISLAND-North Africa uses the High resolution Hansen Global forest Change data to compute forest loss for selected area and year.

To compute forest loss using the Hansen Global forest change dataset;

1. On the top left conner of the Map pannel, click on the  tool to toggle the drowing tools. Once the drawing tools are revealed, click on the  tool to start drowing a custom area on the map where you wish to compute the forest loss

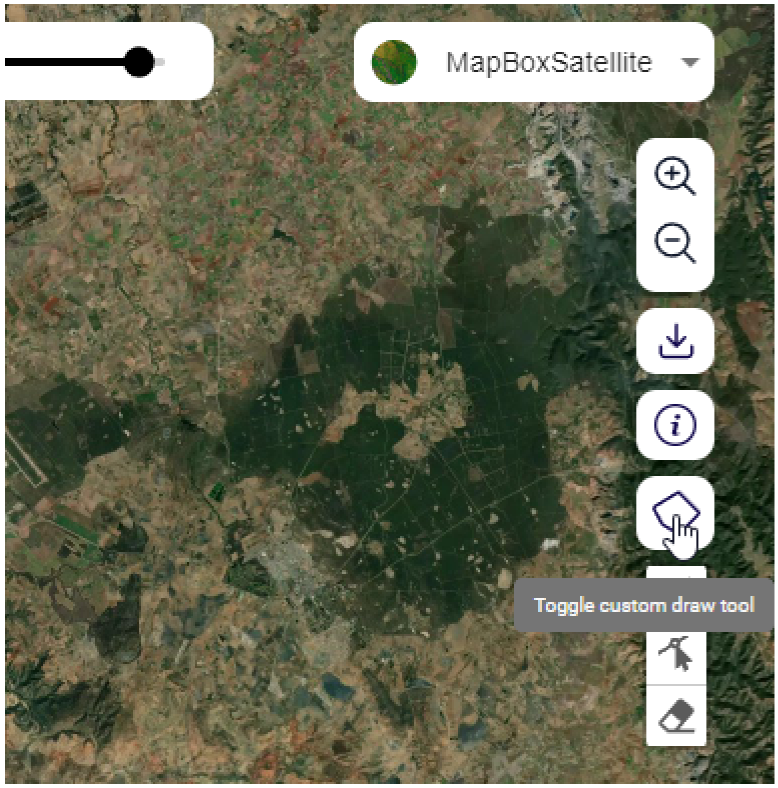


Fig. 1: Draw a polygon tool

Fig. 2: Draw a polygon tool

2. Select Forest Loss and click on the layer settings icon . On the layer settings dialog, under the 'SELECT DATA SOURCE' options, choose 'Hansen' and select the year you wish to compute the forest loss.

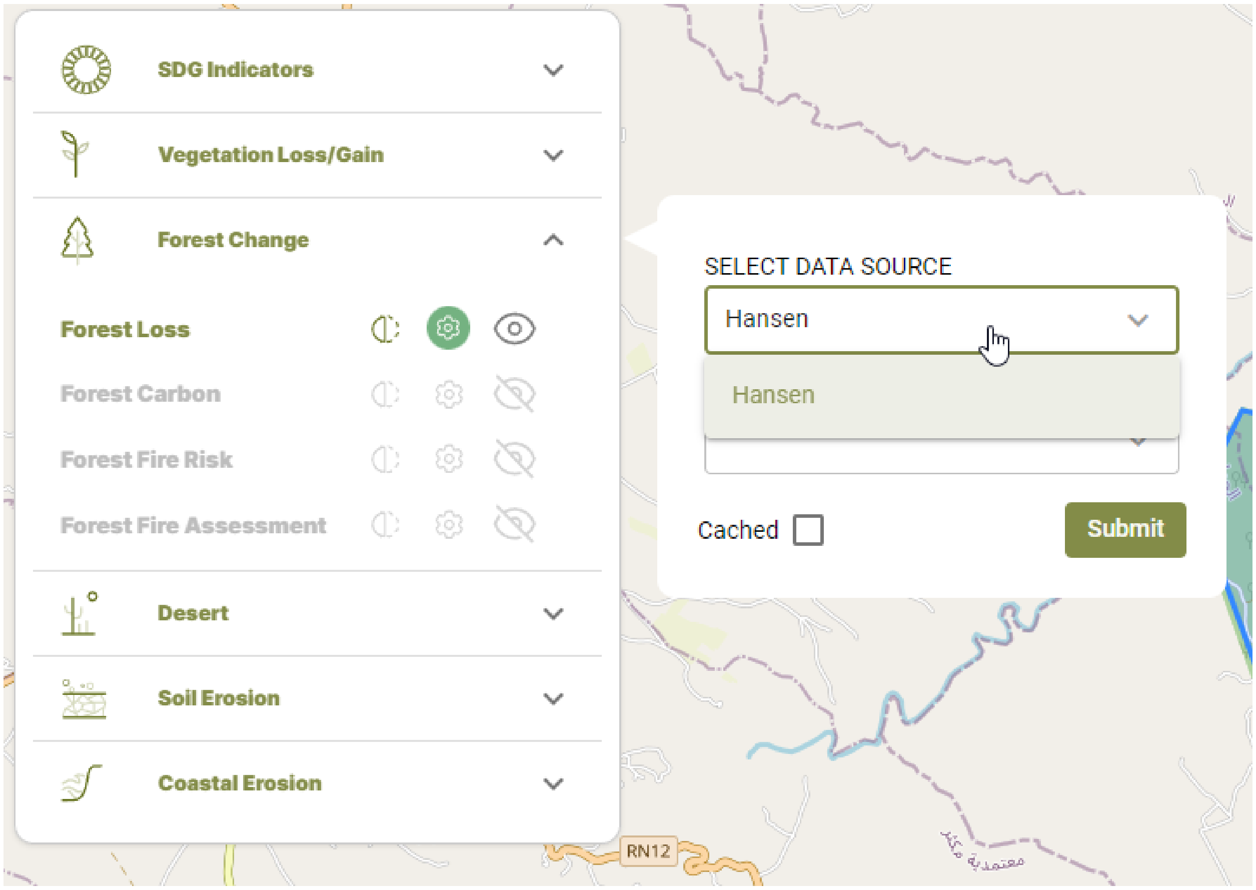


Fig. 3: Selecting the Hansen Forest loss data

On clicking Submit The map and computed statistics will be displayed on the map panel and summary pannel respectively.

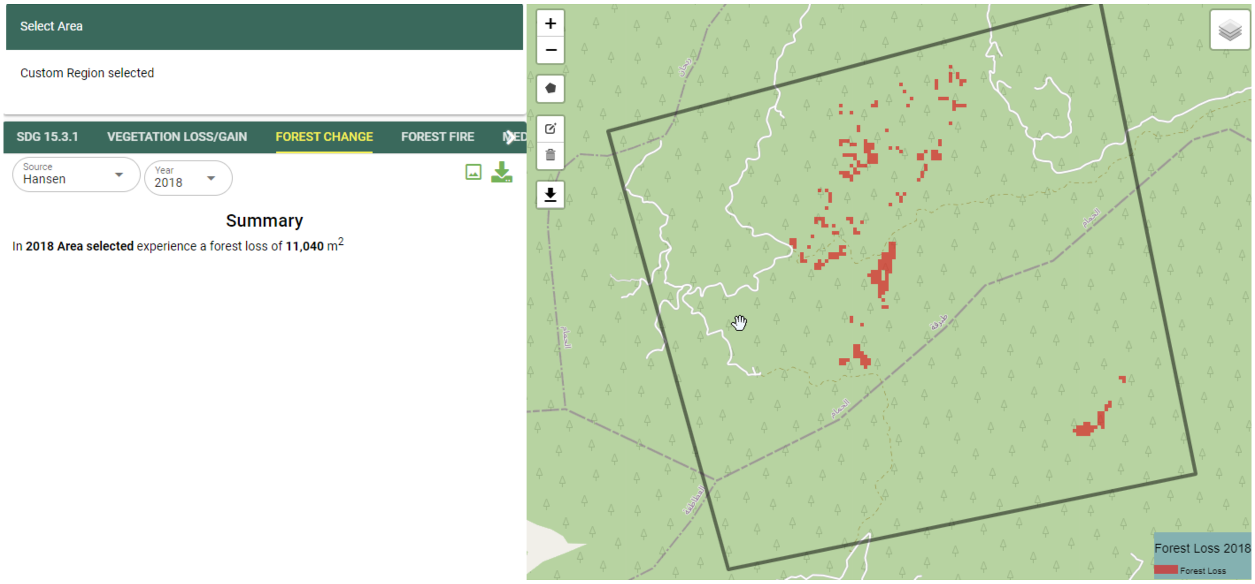


Fig. 4: Foret change outputs

12.2 Forest Fires Assesment

1. Select the Forest Change option from the service menu. Under the Forest Fire Assessment click on the icon to toggle the layer settings as shown below.

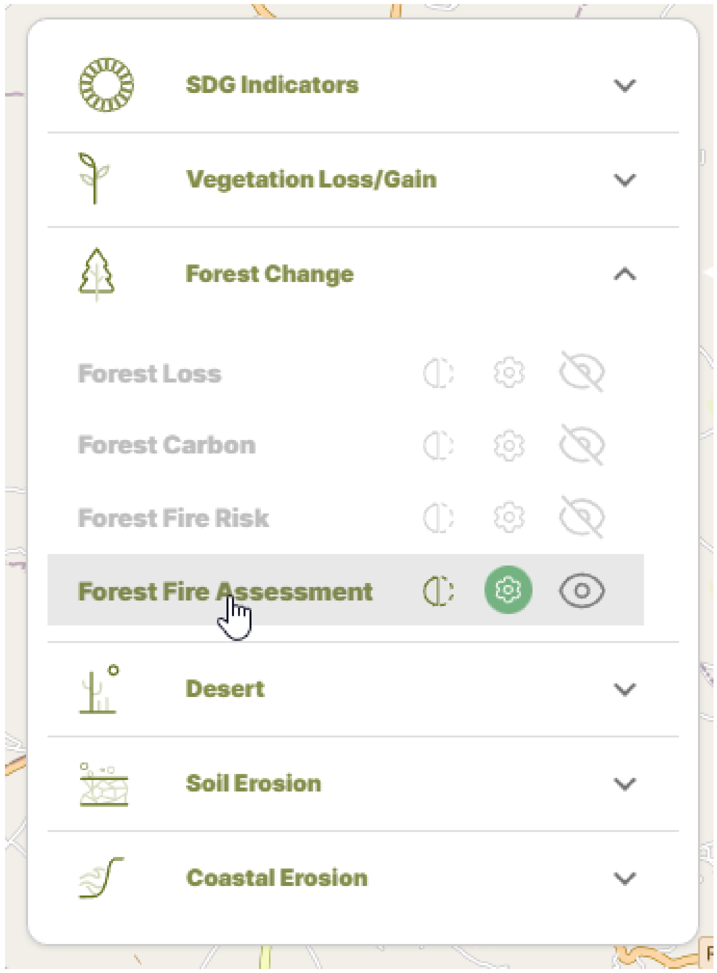


Fig. 5: Selecting the Forest-fires option from the service menu.

2. On the output layer options, select the pre and post fire dates using the calender

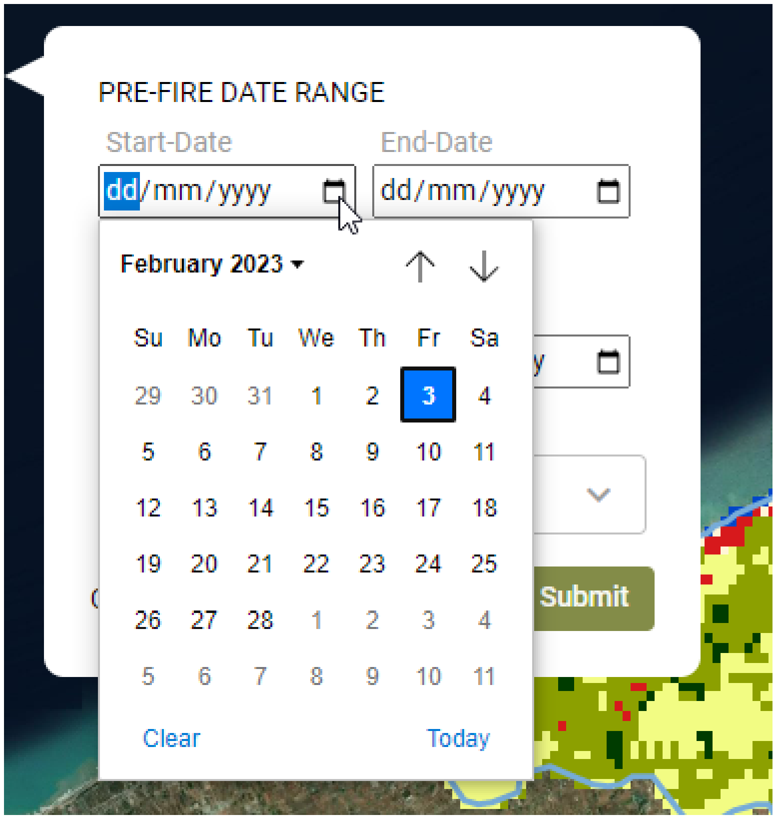


Fig. 6: Selecting the date from the calender tool.

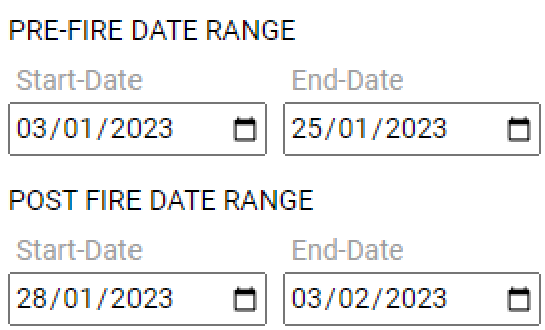


Fig. 7: Pre-fire and Post-fire dates

3. Choose the platform to use to compute the burnt area

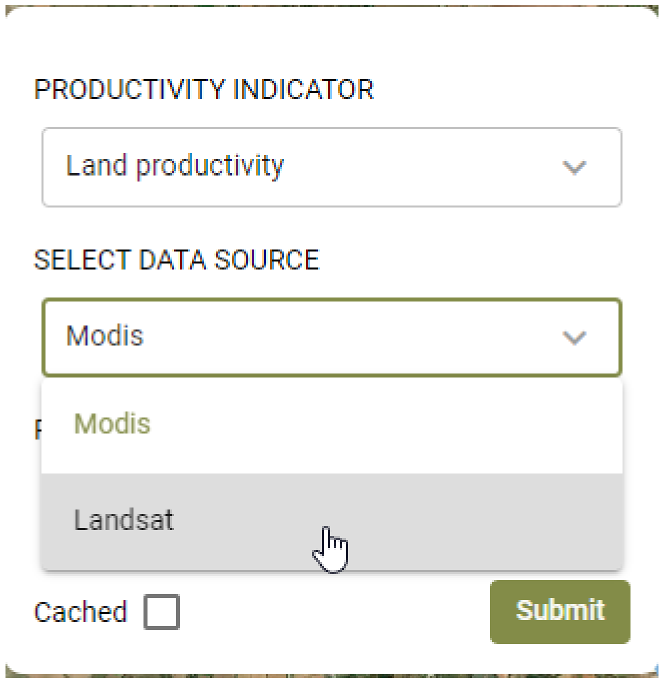


Fig. 8: Choosing the Platform/Sensor for computing forest fires.

The output showing the extent and severity of the fire will be as shown below

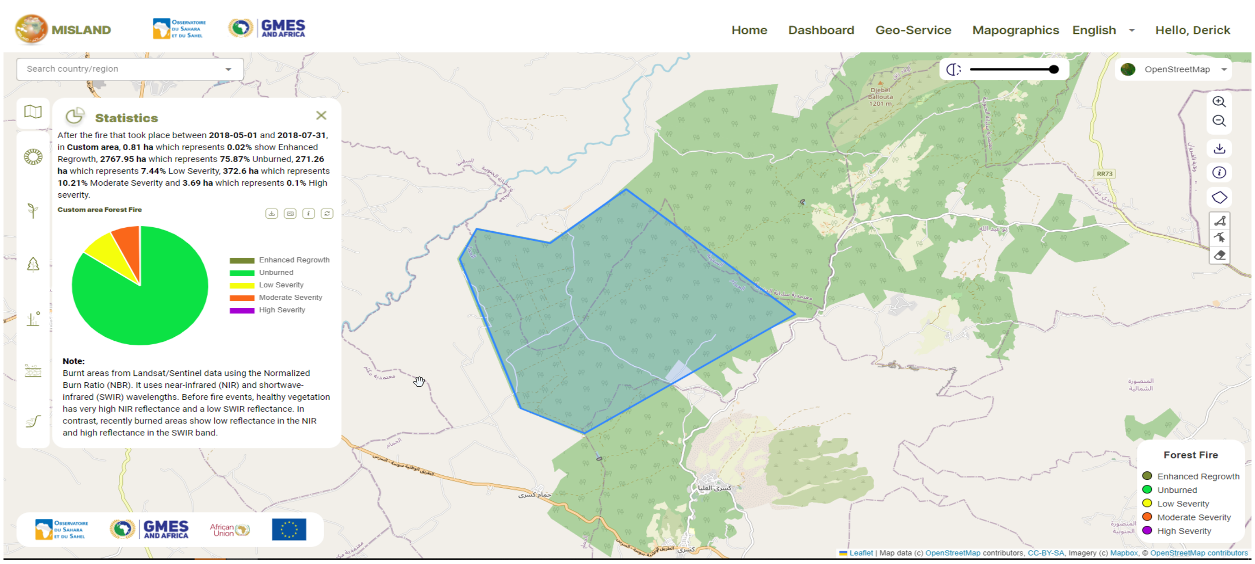


Fig. 9: Forest-fire Output.

CHAPTER

THIRTEEN

CALCULATING SENSITIVITY TO DESERTIFICATION (MEDALUS)

Land degradation and desertification (LDD) analysis is done using the MEDALUS–(Mediterranean Desertification and Land Use Model, a series of international cooperation research projects funded by the European Union) is used worldwide to identify 'sensitive areas' that are potentially threatened by land degradation and desertification (LDD). The distinctive outcome of the approach is a multidimensional index (the ESAI) composed of partial indicators of climate, soil, vegetation, and management quality that are derived from the elaboration of 14 elementary variables.

All the varialbes are grouped into four Quality Indicators (Soil quality, SQI; vegetation quality, VQI; climate quality, CQI; and management quality, MQI), which were estimated as the geometric mean of the respective scores of the elementary variables.

13.1 Calculating Individual Quality Indicators

The current implementation of the MEDALUS model in MISLAND overcomes the problem of no data by computing the geometric mean of Individual Quality Indicators by using the variables with available information for any of the elementary variables.

Note: To upscale the model for regional analysis, the following cosiderations were made for the selection of variables to be used in the computation of individual Quality indices: (a) Consistancy with the original MEDALUS Approach; (b) Time-series data availability and regularity for multi-temporal analysis; and (c) data source quality and reliability for future updates.

To compute the individual quality indicators(Soil quality, SQI; vegetation quality, VQI; climate quality, CQI; and management quality, MQI), Follow the following simple steps:

1. On the service menu-bar select the 

option and click on the  icon to togle the layer settings dialog as shown below:

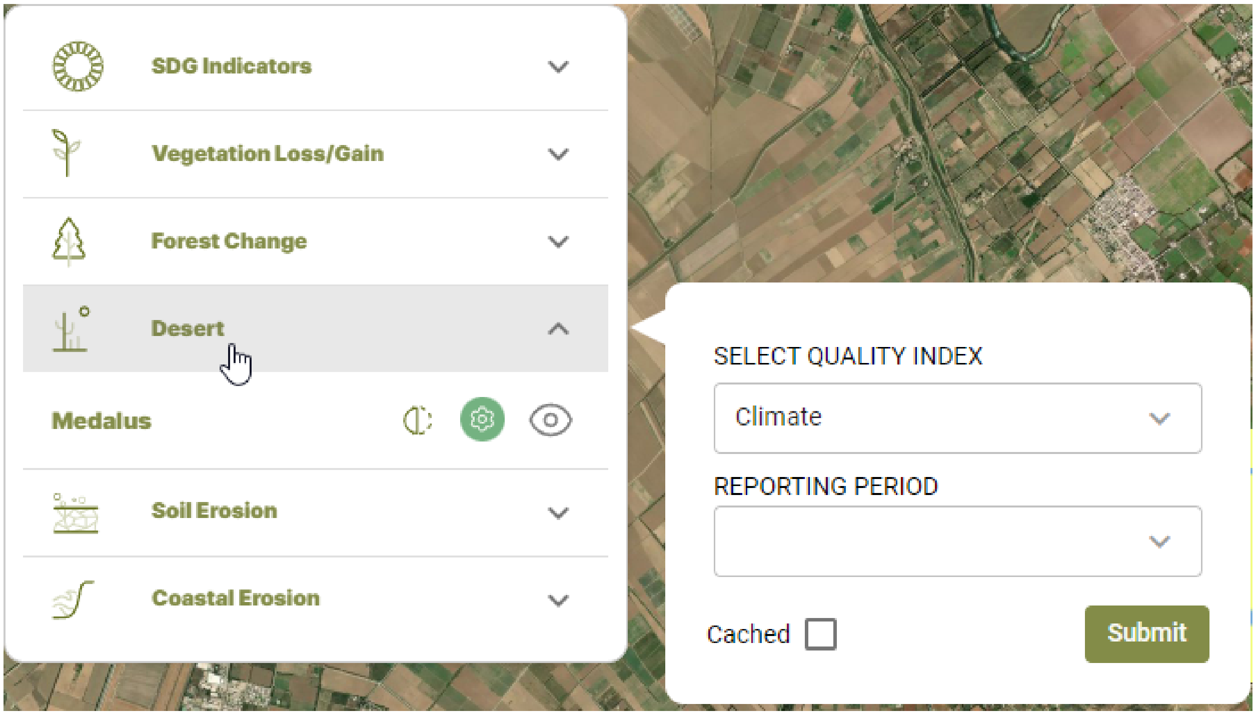


Fig. 1: MEDALUS layer settings dialog.

2. On the layer settings dialog select the Quality index to compute from the dropdown list and the year you wish to compute:

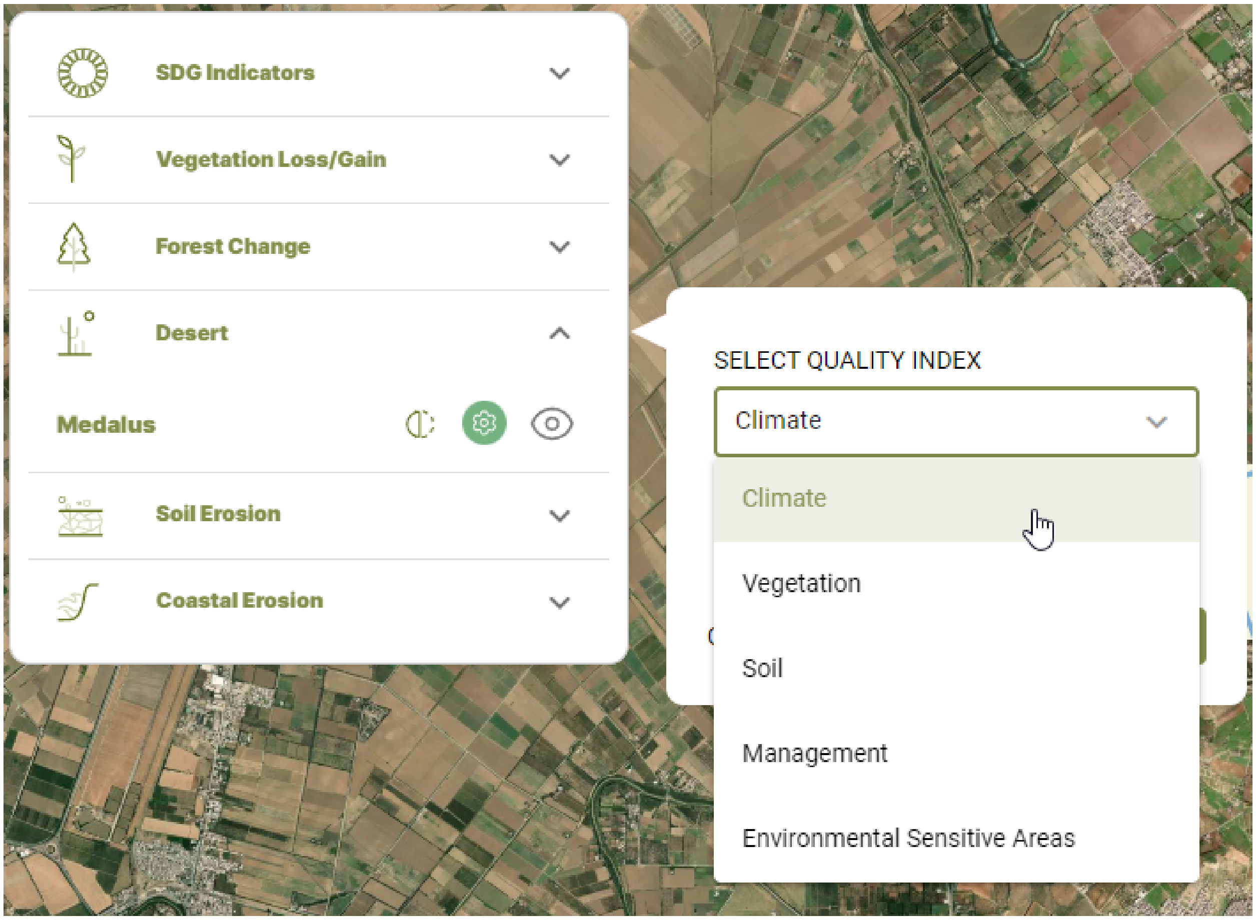


Fig. 2: Selecting the Quality index to compute

The resultant layer and statistics will be computed and visualized as shown

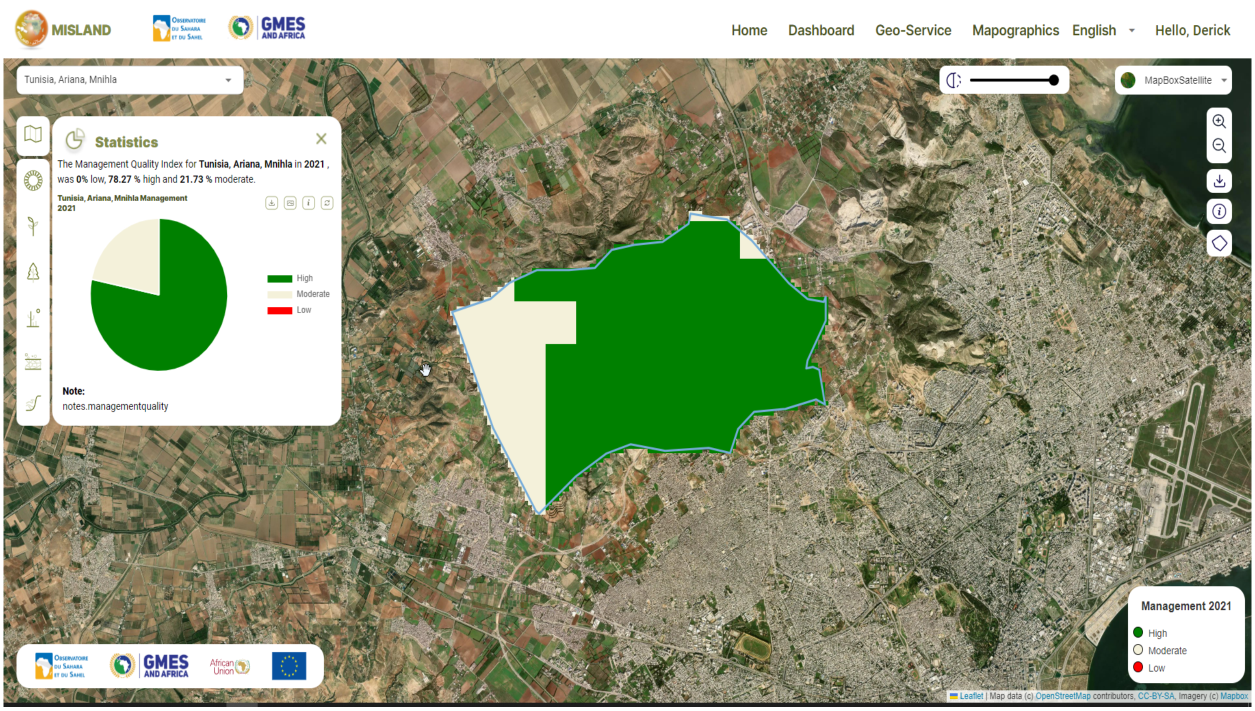


Fig. 3: Example of results for Management Quality Index computation

13.2 Calculate the Environmental Sensitivity Areas Index(ESAI)

To coumpute the Environmental Sensitivity Index select MEDALUS option from the service menu. On the layers selection option dropdown, selsect the ESAI option as shown below

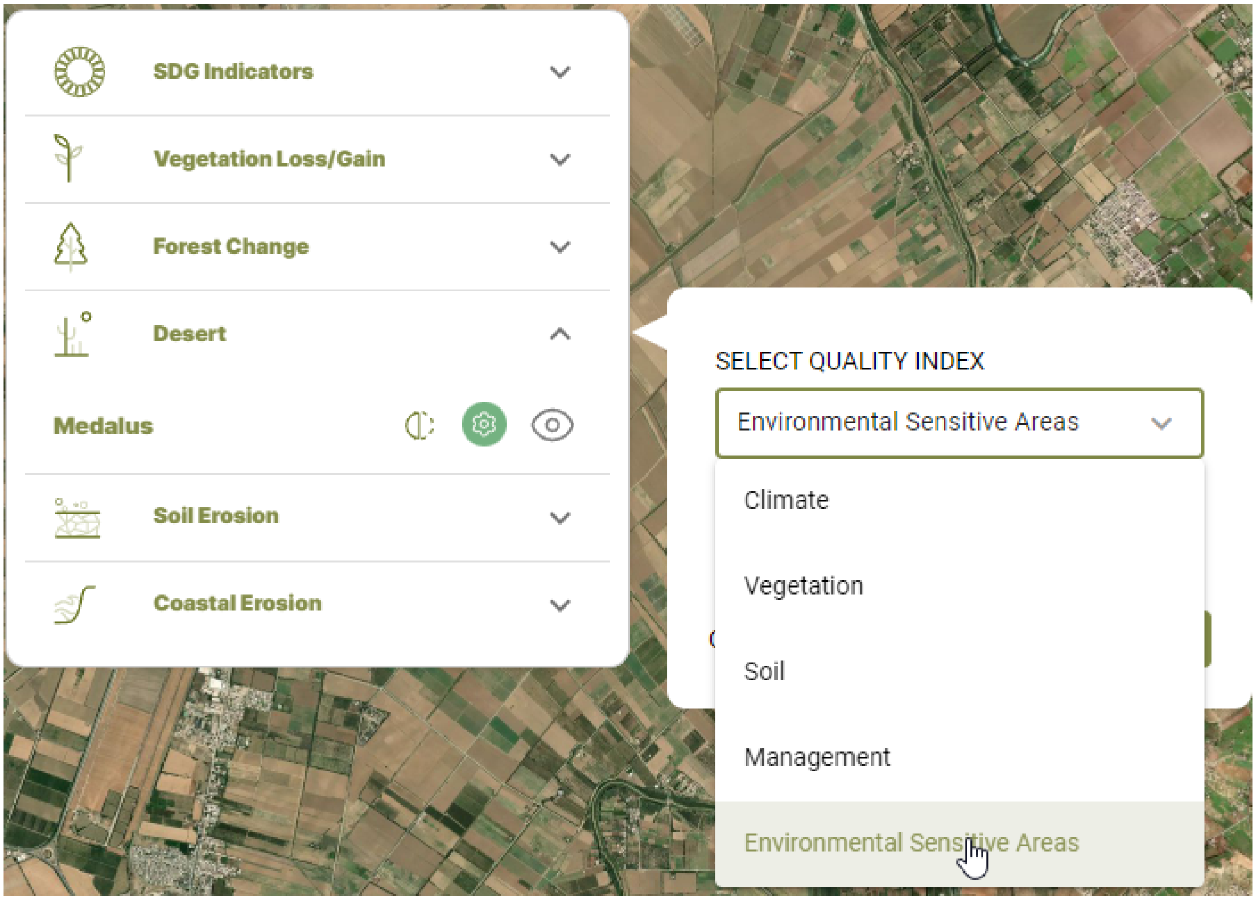


Fig. 4: Selecting the ESAI option from the layer selection dropdown

CHAPTER

FOURTEEN

EXPORTING OUTPUTS

Exporting outputs on the service is as simple and intuitive. Users can download the maps, charts and data following the steps highligted in this section of the document.

14.1 Export Map

Map outputs can be exported in .png format. To export the map, users can click on the export map tool that is found on the map navigation tools as shown below.

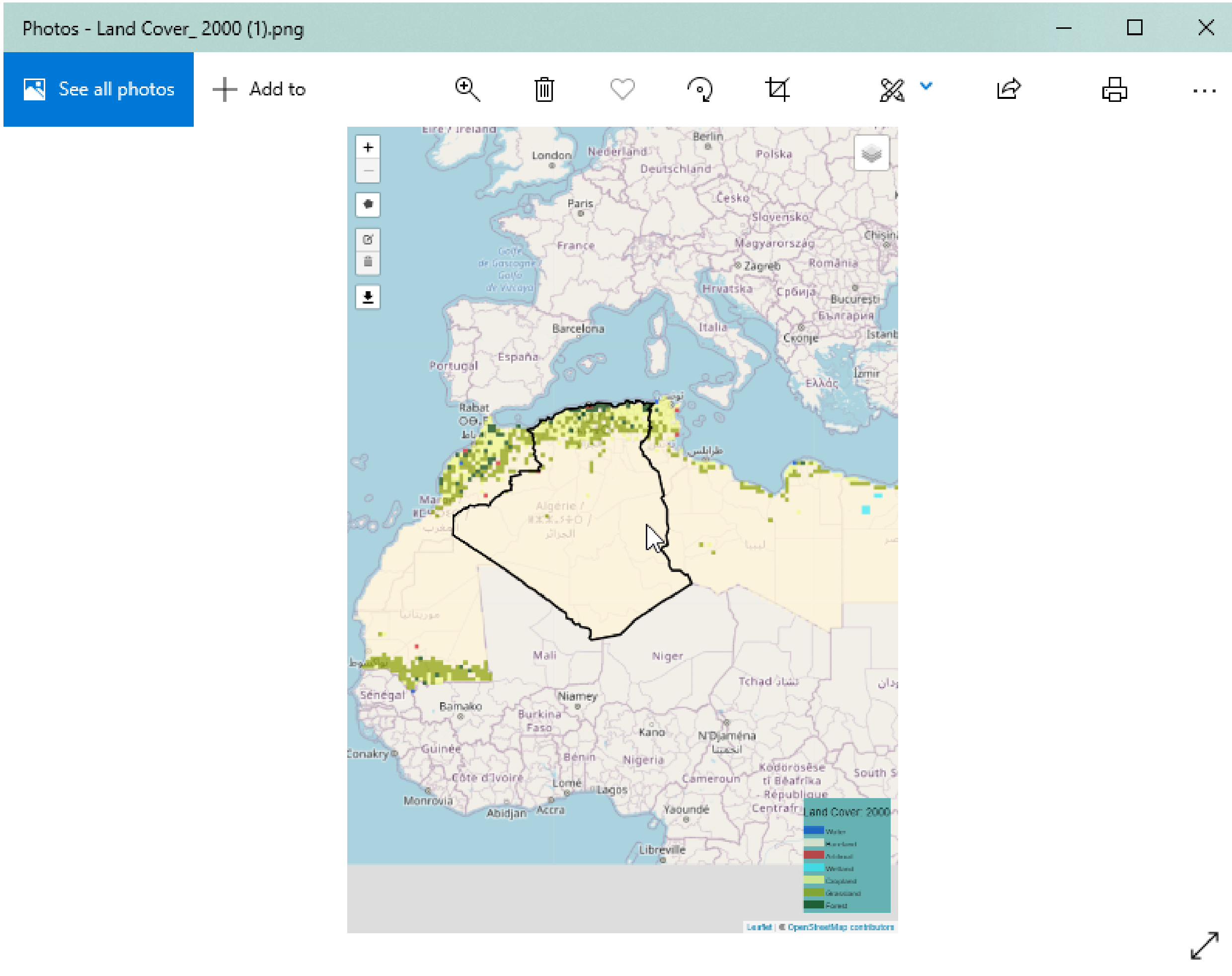


Fig. 1: Image file of exported map

14.2 Export Chart

The chart image can be exported from the statistics tab by clicking on the export image icon  on the list of icons at the top-right conner of the chart area.

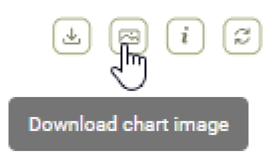


Fig. 2: Export chart as image

An example of an image file export is shown below.

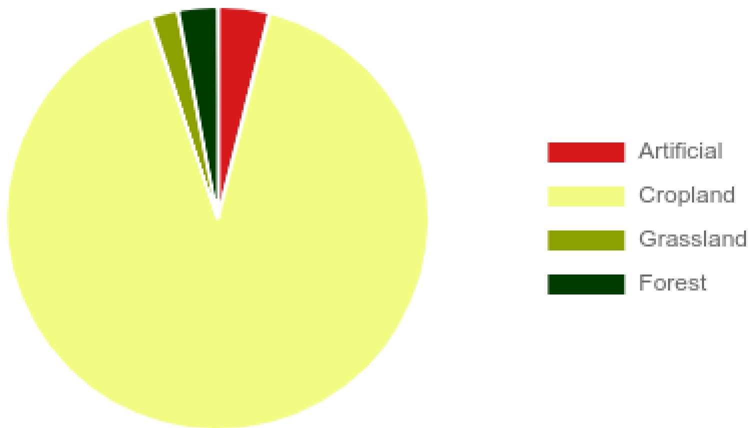


Fig. 3: Export chart as image

CHAPTER

FIFTEEN

DOWNLOAD DATA

In addition to exporting charts as an option, users can also downlad the data and create custom charts or perform further analyses.

The download data icon icon can be found just below the summary text under the statistics panel as in the figure below.

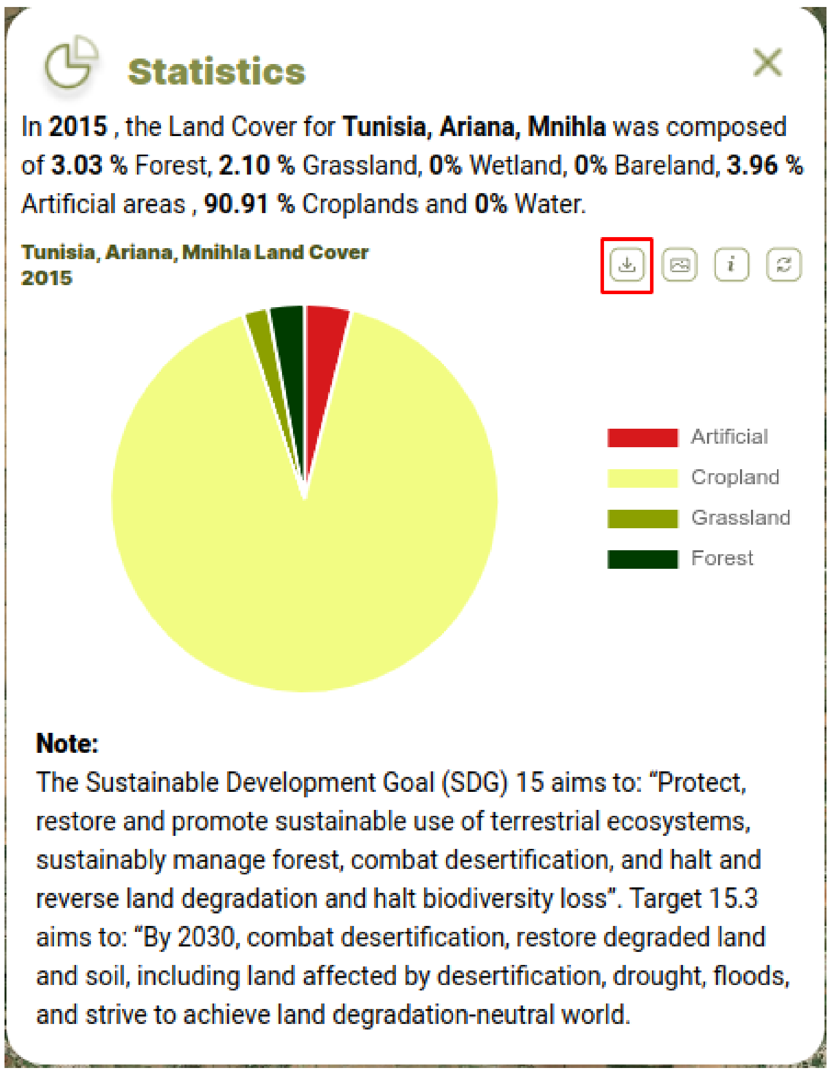


Fig. 1: Download CSV file option

The downloaded data is in .csv format and can be open in microsoft exel or similar software

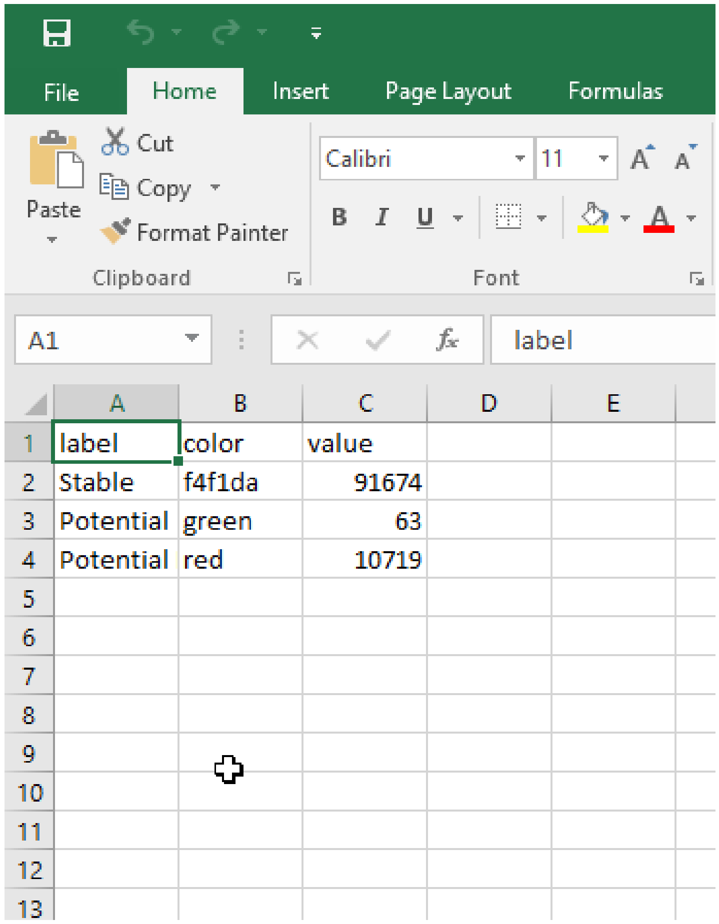


Fig. 2: Exported data as CSV

15.1 Downloading Raster Data

MISLAND Service users can also download the data in GeoTIF format for further analysis or visualization

To download the raster data, Click on the download tiff just below the service menu-bar as shown below

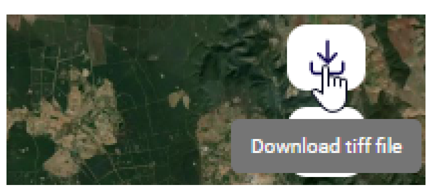


Fig. 3: Download tiff file option

This will prompt you to save the file in your desired location. The downloaded raster can be visualized and analysed with your desired software or tools.

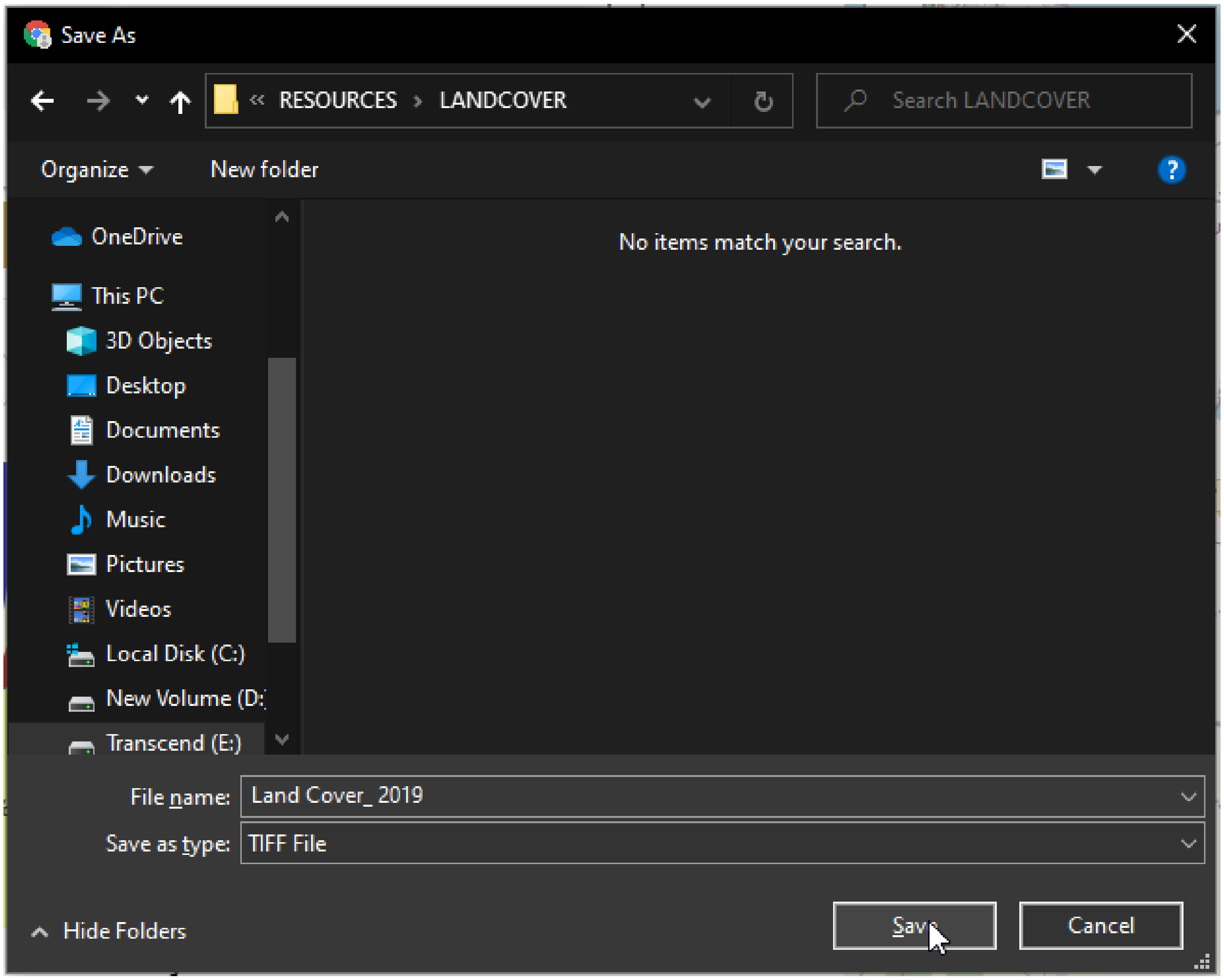


Fig. 4: Saving the downloaded tiff

CHAPTER

SIXTEEN

PLUGIN DEVELOPMENT

MISLAND is free and open-source software, licensed under the GNU General Public License, version 2.0 or later.

There are a number of components to the MISLAND tool. The first is a QGIS plugin supporting calculation of indicators, access to raw data, reporting, and production of print maps . The code for the plugin, and further instructions on installing it if you want to modify the code, are in MISLAND GitHub repository.

The MISLAND QGIS plugin is supported by a number of different Python scripts that allow calculation of the various indicators on Google Earth Engine (GEE). These scripts sit in the "gee" sub-folder of that GitHub repository. The GEE scripts are supported by the *landdegradation* Python module, which includes code for processing inputs and outputs for the plugin, as well as other common functions supporting calculation of NDVI integrals, statistical significance, and other shared code. The code for this module is available in the landdegradation repository on GitHub.

Further details are below on how to contribute to MISLAND by working on the plugin code, by modifying the processing code, or by contributing to translating the website and plugin.

Contents

16.1 Modifying the QGIS Plugin code

16.1.1 Downloading the MISLAND code

The MISLAND code for both the plugin and the Google Earth Engine scripts that support it are located on GitHub in the MISLAND repository. Clone this repository to a convenient place on your machine in order to ensure you have the latest version of the code.

There are a number of different branches of the MISLAND repository that are under active development. While the plugin does not yet officially support QGIS3, however the majority of development is occurring on the "master" branch, which is aimed at QGIS3. The "qgis2" branch is the older version of the plugin, and supports QGIS2 version 2.18+.

The first time you download the MISLAND code, you will also need to clone the "schemas" submodule that is located within it, under "LDMP\schemas". If you are using TortoiseGit on Windows, you can right-click anywhere within the MISLAND folder and choose "TortoiseGit" and then "Submodule Update…". Clicking ok in the window that comes up will checkout the schemas submodule. If you prefer, you can also do this from the command line by running the below two commands in shell:

```
git submodule init
git submodule update
```

Once you are done you should see files within the "LDMP\schemas" folder within the MISLAND folder.

16.1.2 Installing dependencies

Python

The plugin is coded in Python. In addition to being used to run the plugin through QGIS, Python is also used to support managing the plugin (changing the version, installing development versions, etc.). Though Python is included with QGIS, you will also need a local version of Python that you can setup with the software needed to manage the plugin. The easiest way to manage multiple versions of Python is through the Anaconda distribution. For work developing the plugin, Python 3 is required. To download Python 3.7 (recommended) though Anaconda, see this page.

Python dependencies

In order to work with the MISLAND code, you need to have Invoke installed on your machine, as well as a number of other packages that are used for managing the documentation, translations, etc. These packages are all listed in the "dev" requirements file for MISLAND, so they can be installed by navigating in a command prompt to the root of the MISLAND code folder and typing:

```
pip install -r requirements-dev.txt
```

Note: If you are using Anaconda, you will first want to activate a Python 3.7 virtual environment before running the above command (and any of the other invoke commands listed on the page). One way to do this is by starting an "Anaconda prompt", by following the instructions on this Anaconda page.

PyQt

PyQt5 is the graphics toolkit used by QGIS3. To compile the user interface for MISLAND for QGIS3 you need to install PyQt5. This package can be installed from pip using:

```
pip install PyQt5
```

Note: PyQt4 is the graphics toolkit used by QGIS2. The best source for this package on Windows is from the set of packages maintained by Christoph Gohlke at UC Irvine. To download PyQt4, select the appropriate package from this page. Choose the appropriate file for the version of Python you are using. For example, if you are using Python 2.7, choose the version with "cp27" in the filename. If you are using Python 3.7, choose the version with "cp37" in the filename. Choose "amd64" for 64-bit python, and "win32" for 32-bit python.

After downloading from the above link, use `pip` to install it. For example, for the 64-bit wheel for Python 3.7, you would run:

```
pip install PyQt4-4.11.4-cp37-cp37m-win_amd64.whl
```

16.1.3 Changing the version of the plugin

The convention for MISLAND is that version numbers ending in an odd number (for example 0.65) are development versions, while versions ending in an even number (for example (0.66) are release versions. Development versions of the plugin are never released via the QGIS repository, so they are never seen by normal users of the plugin. Odd-numbered development versions are used by the MISLAND development team while testing new features prior to their public release.

If you wish to make changes to the code and have downloaded a public release of the plugin (one ending in an even number), the first step is to update the version of the plugin to the next sequential odd number. So, for example, if you downloaded version 0.66 of the plugin, you would need to update the version to be 0.67 before you started making your changes. There are several places in the code where the version is mentioned (as well as within every GEE script) so there is an invoke task to assist with changing the version. To change the version to be 0.67, you would run:

```
invoke set-version -v 0.67
```

Running the above command will update the version number every place it is referenced in the code. To avoid confusion, never change the version to one that has already been released - always INCREASE the value of the version tag to the next odd number.

16.1.4 Testing changes to the plugin

After making changes to the plugin code, you will need to test them to ensure the plugin behaves as expected, and to ensure no bugs or errors come up. The plugin should go through extensive testing before it is released to the QGIS repository (where it can be accessed by other users) to ensure that any changes to the code do not break the plugin.

To test any changes that you have made to the plugin within QGIS, you will need to install it locally. There are invoke tasks that assist with this process. The first step prior to installing the plugin is ensuring that you have setup the plugin with all of the dependencies that it needs in order to run from within QGIS. To do this, run:

```
invoke plugin-setup
```

The above task only needs to be run immediately after downloading the MISLAND code, or if any changes are made to the dependencies for the plugin. By default `plugin-setup` will re-use any cached files on your machine. To start from scratch, add the `-c` (clean) flag to the above command.

After running `plugin-setup`, you are ready to install the plugin to the QGIS plugins folder on your machine. To do this, run:

```
invoke plugin-install
```

After running the above command, you will need to either 1) restart QGIS, or 2) use the plugin reloader to reload the MISLAND plugin in order to see the effects of the changes you have made.

By default `plugin-install` will overwrite any existing plugin files on your machine, but leave in place any data (administrative boundaries, etc.) that the plugin might have downloaded. To start from scratch, add the `-c` (clean) flag to the above command. You may need to close QGIS in order to successfully perform a clean install of the plugin using the `-c` flag.

Note: By default plugin-install assumes you want to install the plugin to be used in QGIS3. To install the plugin for use in QGIS3, add the flag `-v 2` to the `plugin-install` command. Remember the plugin may or may not be entirely functional on QGIS3 - the plugin was originally designed for QGIS2 and is still being tested on QGIS3.

16.1.5 Syncing and deploying changes to the binaries

To speed the computations in MISLAND, some of the tools allow making use of pre-compiled binaries that have been compiled using numba. Numba is an open source compiler that can compile Python and NumPy code, making it faster than when it is run as ordinary Python. To avoid users of MISLAND needing to download Numba and all of its dependencies, the MISLAND team makes pre-compiled binaries available for download if users choose to install them.

To generate pre-compiled binaries for the OS, bitness (32/64 bit) and Python version you are running on your machine, use:

```
invoke binaries-compile
```

Note: You will need a C++ compiler for the above command to work. On Windows, see this github page for details on how to install the Microsoft Visual C++ compiler needed for you Python version. On MacOS, you will most likely need to install Xcode. On Linux, install the appropriate version of GCC.

To make binaries publicly available, they are distributed through an Amazon Web services S3 bucket. To upload the binaries generated with the above command to the bucket, run:

```
invoke binaries-sync
```

Note: The above command will fail if you do not have keys allowing write access to the `MISLAND` bucket on S3.

The above command will sync each individual binary file to S3. However, users of the toolbox download the binaries as a single zipfile tied to the version of the plugin that they are using. To generate that zipfile so that it can be accessed by MISLAND users, run:

```
invoke binaries-deploy
```

Note: The above command will fail if you do not have keys allowing write access to the `MISLAND` bucket on S3.

16.1.6 Building a plugin ZIP file

There are several invoke tasks to help with building a ZIP file to deploy the plugin to the QGIS repository, or to share the development version of the plugin with others. To package the plugin and all of its dependencies into a ZIP file that can be installed following, run:

invoke zipfile-build

This command will create a folder named `build` at the root of the MISLAND code folder, and in that folder it will create a file called `LDMP.zip`. This file can be shared with others, who can use it to manually install MISLAND.

This can be useful if there is a need to share the latest features with someone before they are available in the publicly released version of the plugin.

16.1.7 Deploying the development version ZIP file

The MISLAND GitHub page gives a link a ZIP file that allows users who may not be developers to access the development version of MISLAND. To create a ZIP file and make it available on that page (the ZIP file is stored on S3), run:

```
invoke zipfile-deploy
```

Note: The above command will fail if you do not have keys allowing write access to the `misland` bucket on S3.

16.2 Modifying the Earth Engine processing code

The Google Earth Engine (GEE) processing scripts used by MISLAND are all stored in the "gee" folder under the main MISLAND folder. For these script to be accessible to users of the MISLAND QGIS plugin, they have to be deployed to the api.trends.earth serviceThe below describes how to test and deploy GEE scripts to be used with MISLAND.

16.2.1 Setting up dependencies

trends.earth-CLI

The "trends.earth-CLI" Python package is required in order to work with the api.trends.earth server. This package is located on GitHub in the trends.earth-CLI repository.

The first step is to clone this repository onto your machine. We recommend that you clone the repository into the same folder where you the trends.earth code. For example, if you had a "Code" folder on your machine, clone both the trends.earth repository (the code for the QGIS plugin and associated GEE scripts) and also the trends.earth-CLI repository into that same folder.

When you setup your system as recommended above, trends.earth-CLI will work with the invoke tasks used to manage MISLAND without any modifications. If, however, you download trends.earth-CLI into a different folder, then you will need to add a file named "invoke.yaml" file into the root of the MISLAND repository, and in that file tell MISLAND where to locate the trends.earth-CLI code. This YAML file should look something like the below (if you downloaded the code on Windows into a folder called "C:/Users/grace/Code/trends.earth-CLI/tecli"):

```
gee:
    tecli: "C:/Users/grace/Code/trends.earth-CLI/tecli"
```

Again, you **do not** need to add this .yaml file if you setup your system as recommended above.

docker

The trends.earth-CLI package requires docker in order to function. Follow these instructions to install docker on Windows, and these instructions to install docker on Mac OS. If you are running Linux, follow the instructions on this page that are appropriate for the Linux distribution you are using.

16.2.2 Testing an Earth Engine script locally

After installing the trends.earth-CLI package, you will need to setup a .tecli.yml file with an access token to a GEE service account in order to test scripts on GEE. To setup the GEE service account for tecli, first obtain the key for your service account in JSON format (from the google cloud console), then and encode it in base64. Provide that base64 encoded key to tecli with the following command:

```
invoke tecli-config set EE_SERVICE_ACCOUNT_JSON key
```

where "key" is the base64 encoded JSON format service account key.

While converting a script specifying code to be run on GEE from JavaScript to Python, or when making modifications to that code, it can be useful to test the script locally, without deploying it to the api.trends.earth server. To do this, use the `run` invoke task. For example, to test the "land_cover" script, go to the root directory of the code, and, in a command prompt, run:

```
invoke tecli-run land_cover
```

This will use the trends.earth-CLI package to build and run a docker container that will attempt to run the "land_cover" script. If there are any syntax errors in the script, these will show up when the container is run. Before submitting a new script to api.trends.earth, always make sure that `invoke tecli-run` is able to run the script without any errors.

When using `invoke tecli-run` you may get an error saying:

```
Invalid JWT: Token must be a short-lived token (60 minutes) and in a
reasonable timeframe. Check your iat and exp values and use a clock with
skew to account for clock differences between systems.
```

This error can be caused if the clock on the docker container gets out of sync with the system clock. Restarting docker should fix this error.

16.2.3 Deploying a GEE script to api.trends.earth

When you have finished testing a GEE script and would like it to be accessible using the QGIS plugin (and by other users of MISLAND), you can deploy it to the api.trends.earth server. The first step in the process is logging in to the api.trends.earth server. To login, run:

```
invoke tecli-login
```

You will be asked for a username and password. These are the same as the username and password that you use to login to the MISLAND server from the QGIS plugin. **If you are not an administrator, you will be able to login, but the below command will fail**. To upload a script (for example, the "land_cover" script) to the server, run:

```
invoke tecli-publish -s land_cover
```

If this script already exists on the server, you will be asked if you want to overwrite the existing script. Be very careful uploading scripts with even-numbered versions, as these are publicly available scripts, and any errors that you make will affect anyone using the plugin. Whenever you are testing be sure to use development version numbers (odd version numbers).

After publishing a script to the server, you can use the *tecli-info* task to check the status of the script (to know whether it deployed successfully - though note building the script may take a few minutes). To check the status, of a deployed script, run:

```
invoke tecli-publish -s land_cover
```

If you are making a new release of the plugin, and want to upload ALL of the GEE scripts at once (this is necessary whenever the plugin version number changes), run:

```
invoke tecli-publish
```

Again - never run the above on a publicly released version of the plugin unless you are intending to overwrite all the publicly available scripts used by the plugin.

CHAPTER

SEVENTEEN

BEFORE INSTALLING THE TOOLBOX

Before installing the toolbox, QGIS version **|qgisMinVersion|** or higher needs to be installed on your computer.

17.1 Download QGIS

To install the plugin, first install QGIS 3.10.3+ following the below steps:

1. Choose either 32 or 64 bit version

   You have the option of installing a 32-bit or 64-bit version of QGIS. To know which version to install, check which type of operating system you have following the below instructions. If you are unsure which you need, try downloading the 64 bit version first. If that version doesn't work properly, un-install it and then install the 32 bit version.

   - Windows 8 or Windows 10
     - From the "Start" screen, type "This PC".
     - Right click (or tap and hold) "This PC", and click "Properties".
   - Windows 7, or Vista
     - Open "System" by clicking the "Start" button , right-clicking "Computer", and then clicking "Properties".
     - Under System, you can view the system type.
   - Mac: Click the Apple icon in the top left and select "About this Mac".

2. After determining whether you need the 32 or 64 bit version, download the appropriate installer:

   - Windows: Download Windows installer from here.
   - MacOS: Download MacOS installer from here.
   - Linux: Download Linux installer from here, or from the repository for your Linux distribution.

17.2 Install QGIS

Once the installer is downloaded from the website, it needs to be run (double click on it). Select the Default settings for all options.

CHAPTER

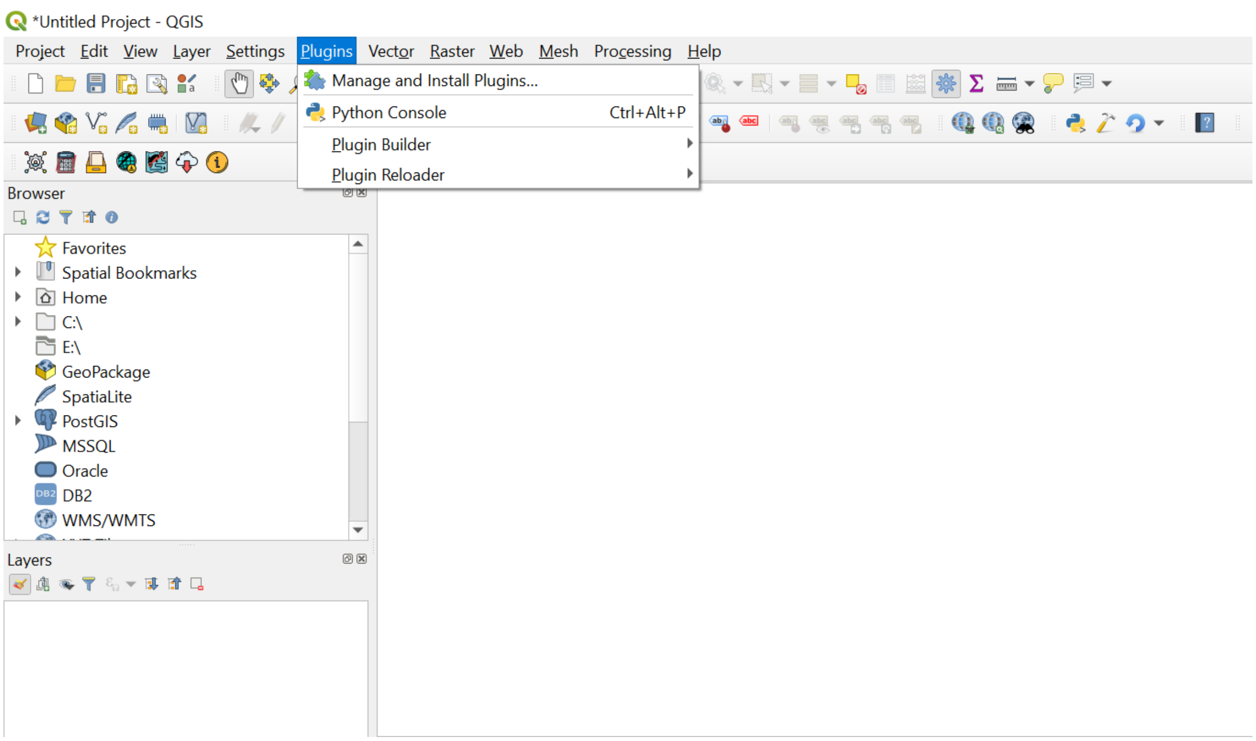
EIGHTEEN

INSTALLING THE TOOLBOX

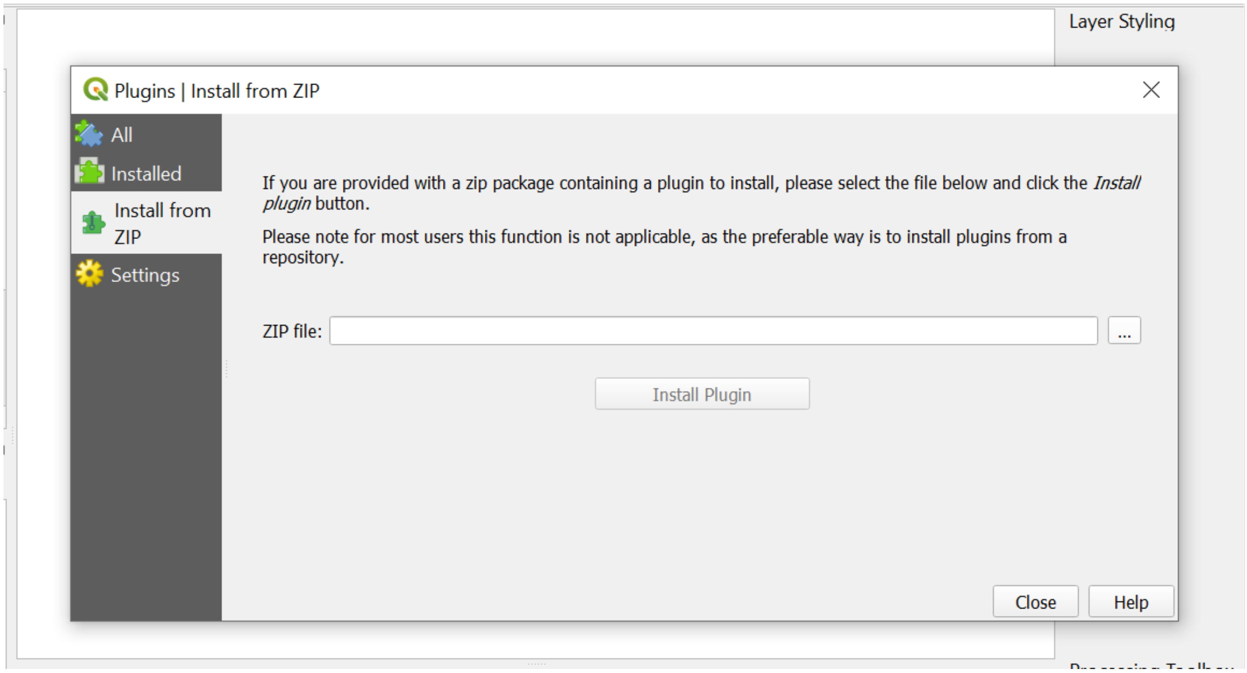
There are different ways to install MISLAND, depending on whether you want to install the stable version (recommended) or the development version.

18.1 Installing the development version

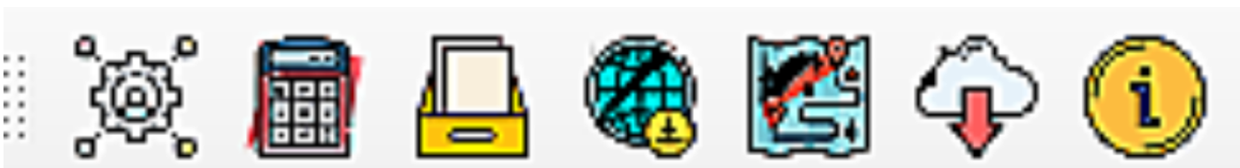
To install from within QGIS, first launch QGIS, and then go to *Plugins* in the menu bar at the top of the program and select *Manage and install plugins*.



Then search navigate to Install from ZIP and upload the LDMS plugin zipfile



If your plugin has been installed properly, there will be a menu bar in the top left of your browser that looks like this:



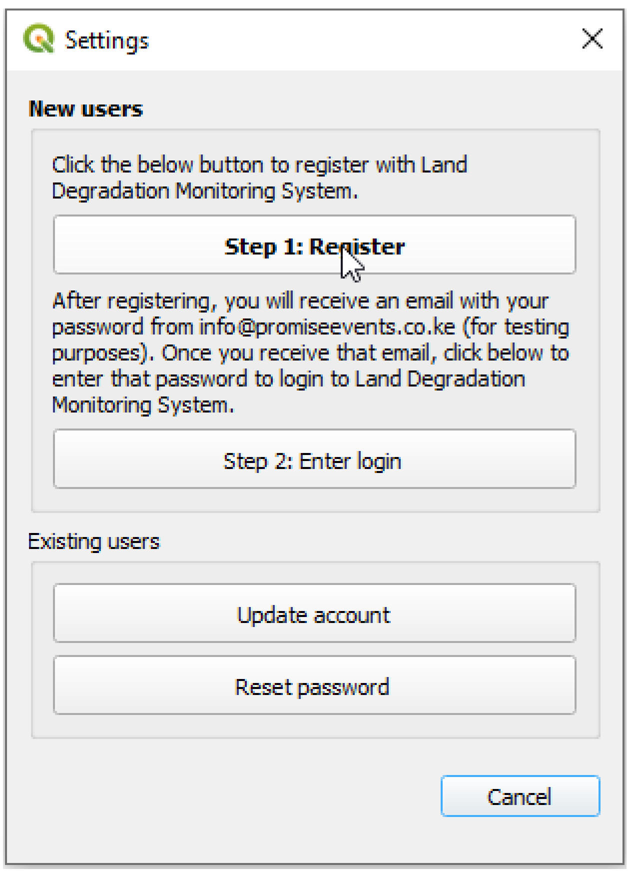
CHAPTER NINETEEN

REGISTRATION AND SETTINGS

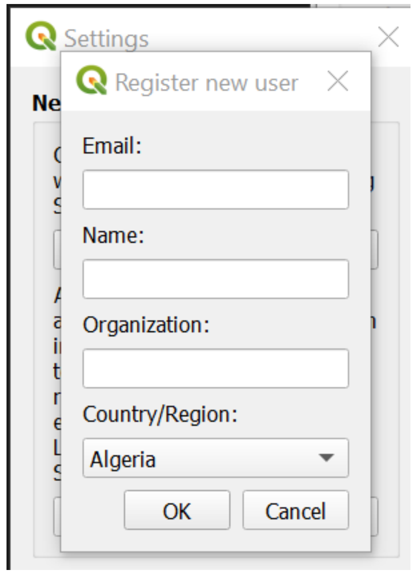
19.1 Registration

The toolbox is free to use, but you must register an email address prior to using any of the cloud-based functions.

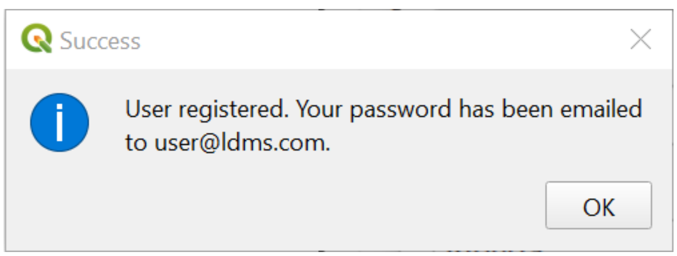
To register your email address and obtain a free account, select the highlighted above. This will open up the "Settings" dialog box:



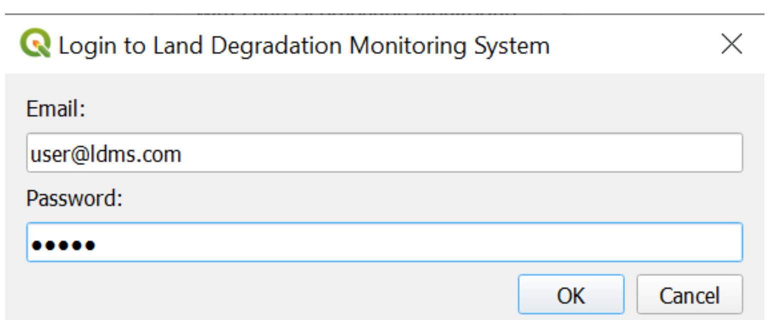
To Register, click the "Step 1: Register" button. Enter your email, name, organization and country(within North Africa region) of residence and select "Ok":



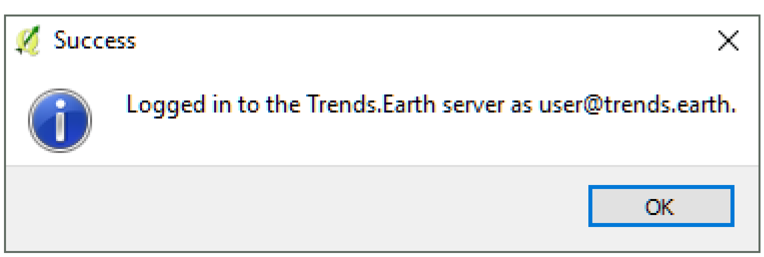
You will see a meesage indicating your user has been registered:



After registering, you will receive an email from info@promiseevnts.co.ke(for testing) with your password. Once you receive this email, click on "Step 2: Enter login". This will bring up a dialog asking for your email and password. Enter the password you received from info@promiseevnts.co.ke(for testing) and click "Ok":

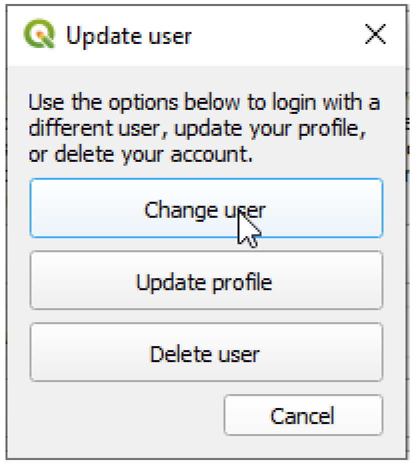


You will see a message indicating you have successfully been logged in:

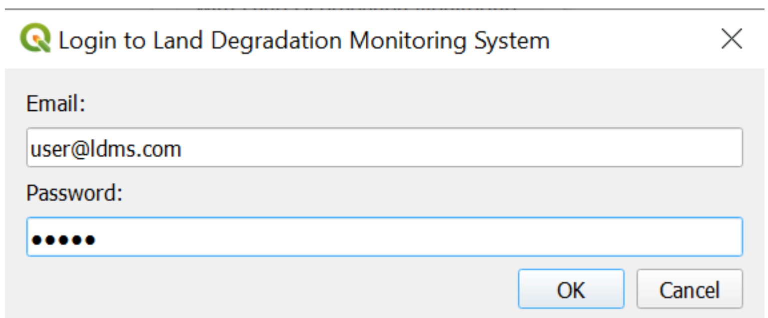


19.2 Updating your user

If you already are registered for LDMS but want to change your login information; update your name, organization, or country; or delete your user, click on "Update user" from the "Settings" dialog.



If you want to change your username, click on "Change user". Note that this function is only useful if you already have another existing LDMS account you want to switch to. To register a new user, see *Registration*. To change your user, enter the email and password you wish to change to and click "Ok":



If you want to update your profile, click on "Update profile". Update your information in the box that appears and click "Save":

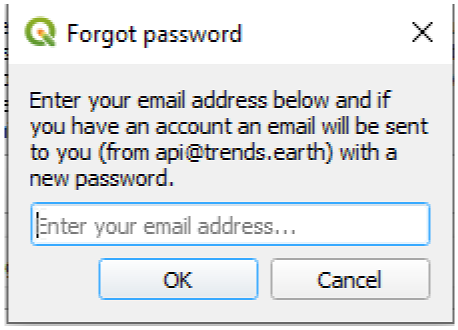
To delete your user, click "Delete user". A warning message will appear. Click "Ok" if you are sure you want to delete your user:

19.3 Forgot password

If you forget your password, click on "Reset password" from the settings dialog box.

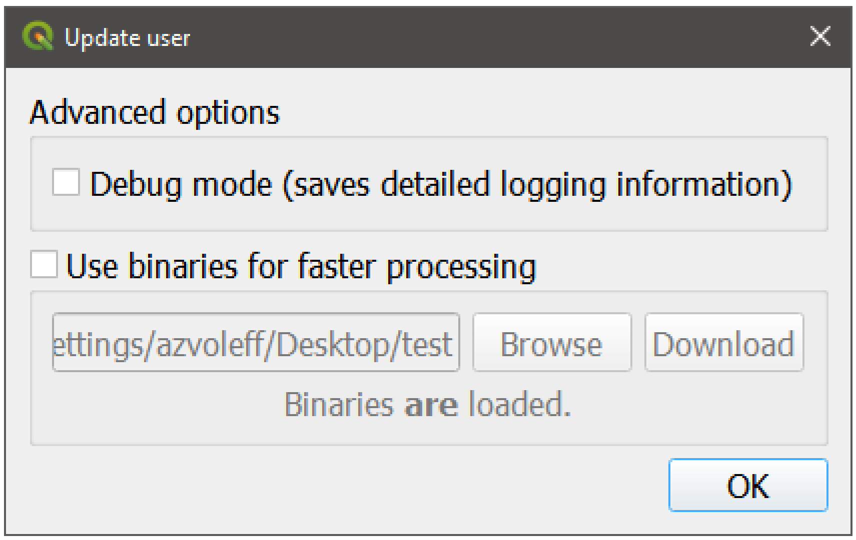
A password will be sent to your email. Please check your Junk folder if you cannot find it within your inbox. The email will come from info@promiseevnts.co.ke(for testing).

Once you receive your new password, return to the "Settings" screen and use "Step 2: Enter login" to enter your new pasword.



19.4 Advanced settings

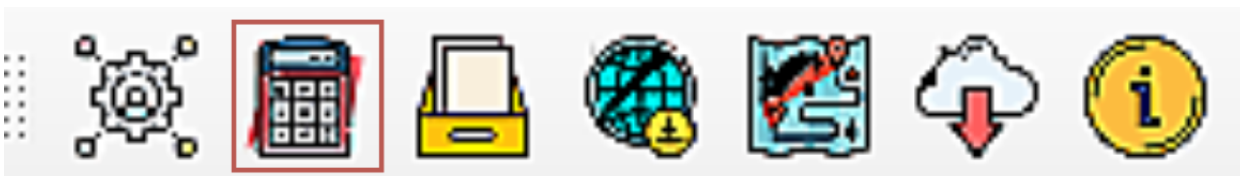
Click "Edit advanced options" to bring up the advanced settings page:



CHAPTER

TWENTY

CALCULATE SDG 15.3.1



Sustainable Development Goal 15.3 intends to combat desertification, restore degraded land and soil, including land affected by desertification, drought and floods, and strive to achieve a land degradation-neutral world by 2030. In order to assess the progress to this goal, the agreed-upon indicator for SDG 15.3 (proportion of land area degraded) is a combination of three sub-indicators: change in land productivity, change in land cover and change in soil organic carbon.

Contents

To select the methods and datasets to calculate these indicators, indicators click on the calculator icon highlighted above. This will open up the "Calculate Indicators" dialog box.

`_static/documentation/calculate/LDindicator.png`

Select the Land degradation indicator (SDG indicator 15.3.1) to open the window for this analysis.

_static/documentation/calculate/SDG15.png

There are several options for calculating the SDG 15.3.1 Indicator. MISLAND supports calculating the indicator using the same process as was used by the UNCCD for the default data provided to countries for the 2018 reporting process. The tool also supports customizing this data, or even replacing individual datasets with national-level or other global datasets.

- To calculate all three SDG 15.3.1 indicators in one step, using default settings for most of the indicators, click "Calculate all three indicators in one step".
- To calculate one of the three SDG 15.3.1 indicators, using customized settings, or national-level data, click "Productivity", "Land cover", or "Soil organic carbon".
- To calculate a summary table showing statistics on each of the three indicators, click "Calculate final SDG 15.3.1 indicator and summary table". Note that you must first compute the indicators using one of the above options.
- To calculate a summary table showing statistics on each of the three indicators for multiple sub-divisions, click "Calculate area summaries of a raster on sub-units". Note that you must first compute the indicators using one of the above options.

There are three different indicators that are combined to create the SDG 15.3.1 indicator

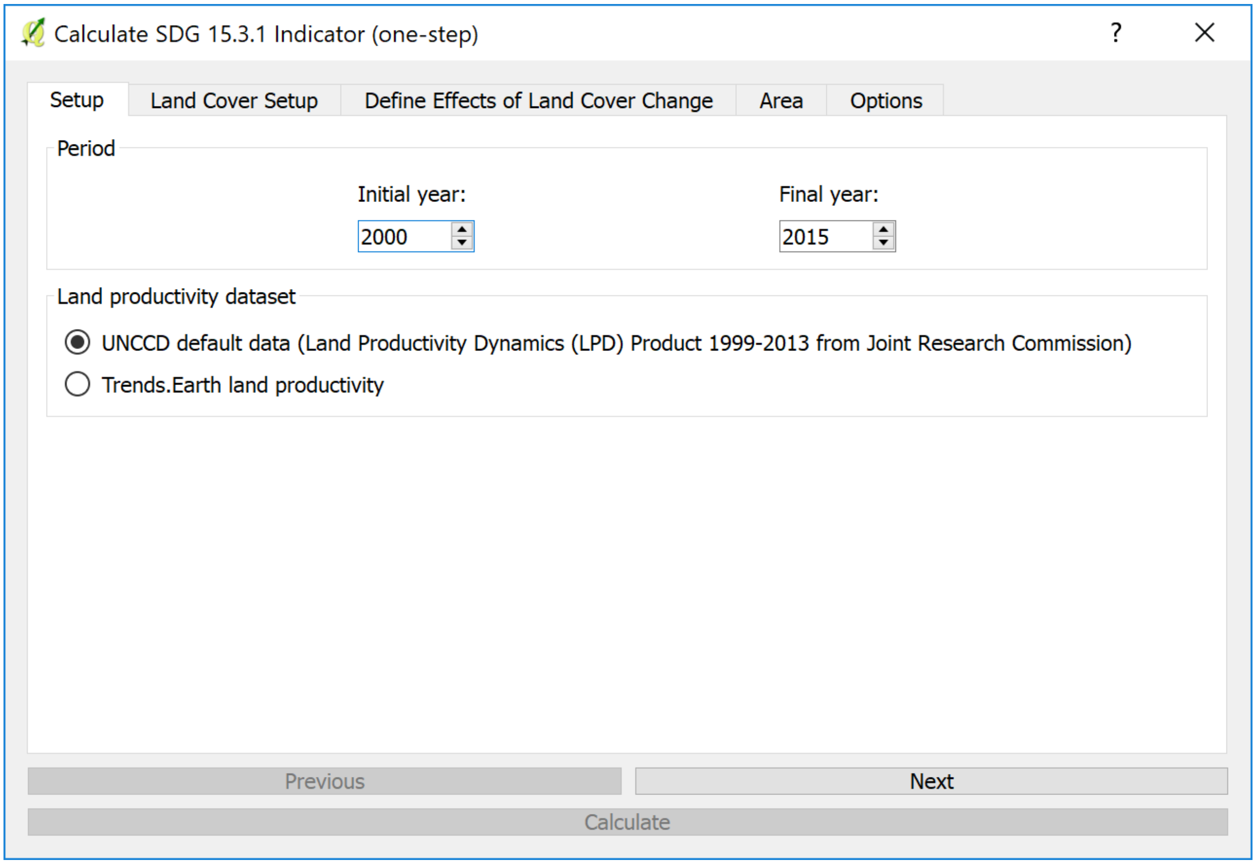
- Productivity: measures the trajectory, performance and state of primary productivity
- Land cover: calculates land cover change relative to a baseline period, enter a transition matrix indicating which transitions indicate degradation, stability or improvement.
- Soil carbon: compute changes in soil organic carbon as a consequence of changes in land cover.

There are two ways to calculate the indicators: 1) using a simplified tool that will calculate all three indicators at once, but with limited options for customization, or 2) using individual tools for each indicator that offer complete control over how they are calculated.

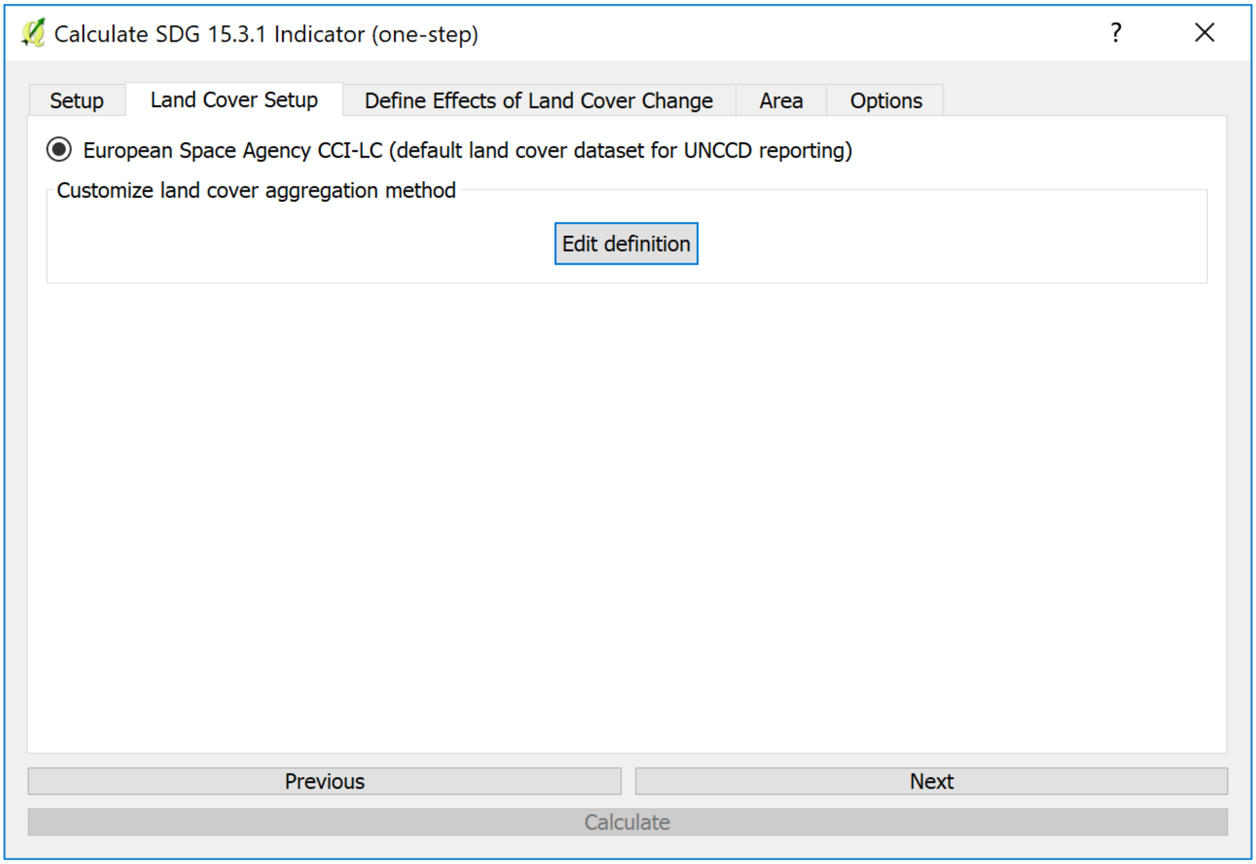
20.1 Calculate indicators with simplified tool

This tool allows users to calculate all three sub-indicators in one step. Select the "Calculate all three sub-indicators in one step" button.

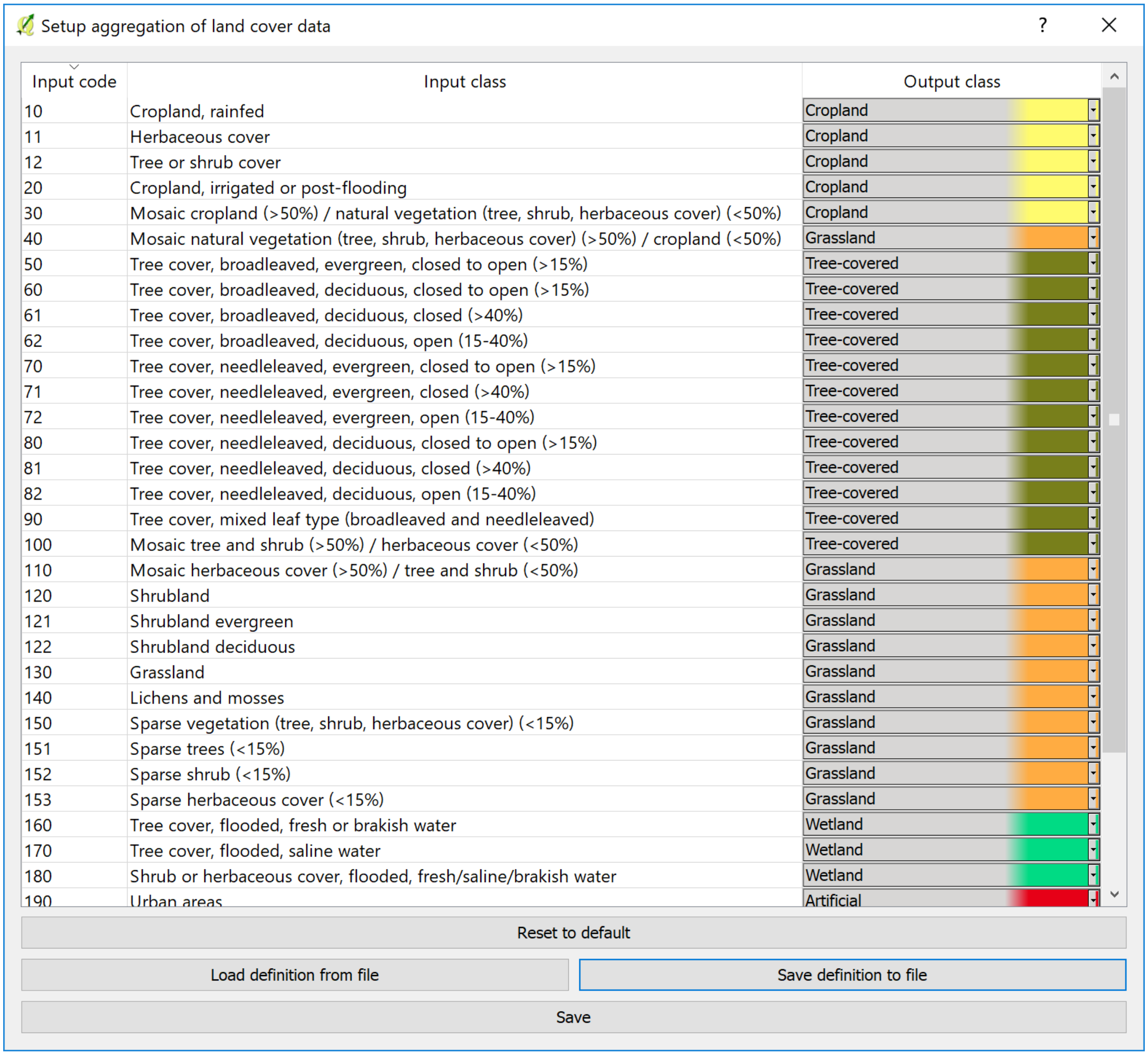
1. Select the parameters for Setup. The Period is the Initial and Final year for the analysis and select one of the two Land Productivity datasets. Select Next.



2. Select the Land Cover dataset. The first option is the default ESA dataset.

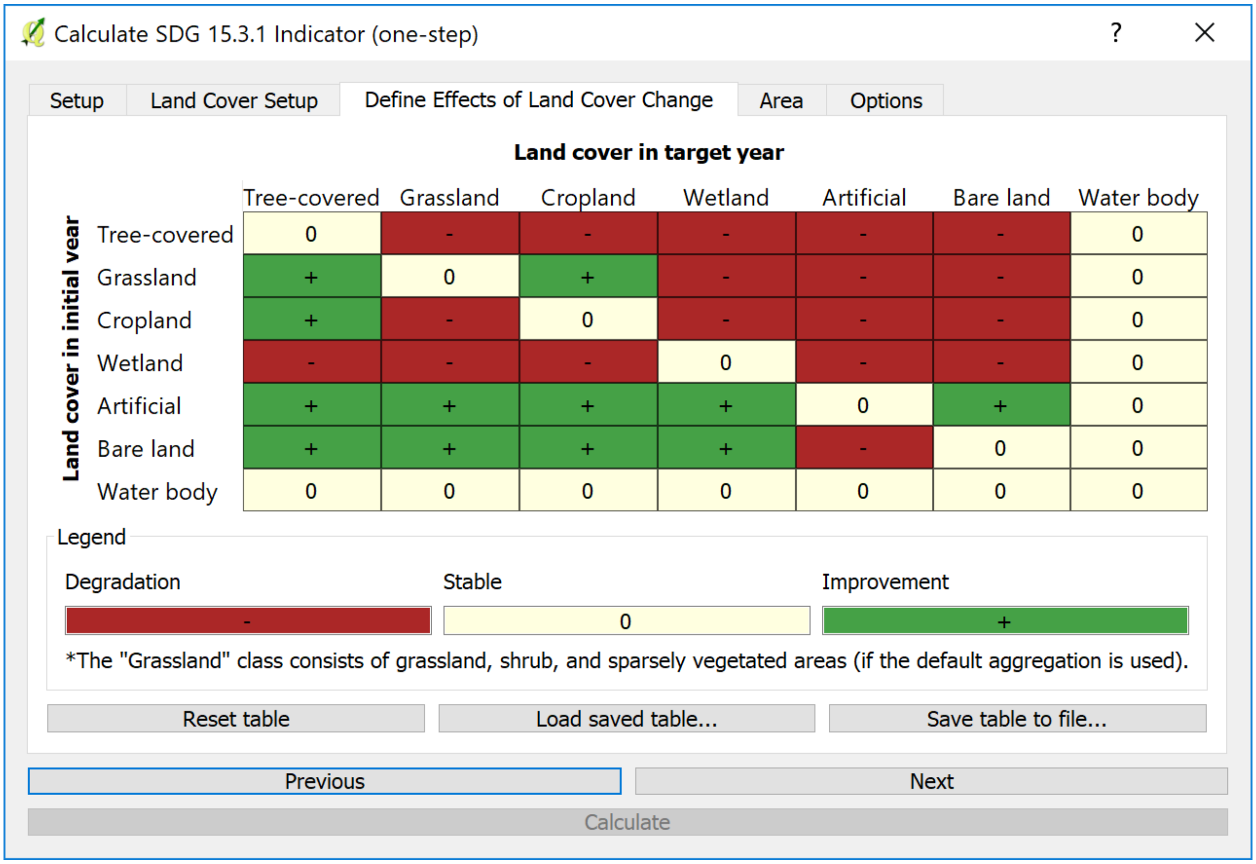


3. Select Edit definition to change the aggregation from the ESA Land Cover dataset into 7 classes.

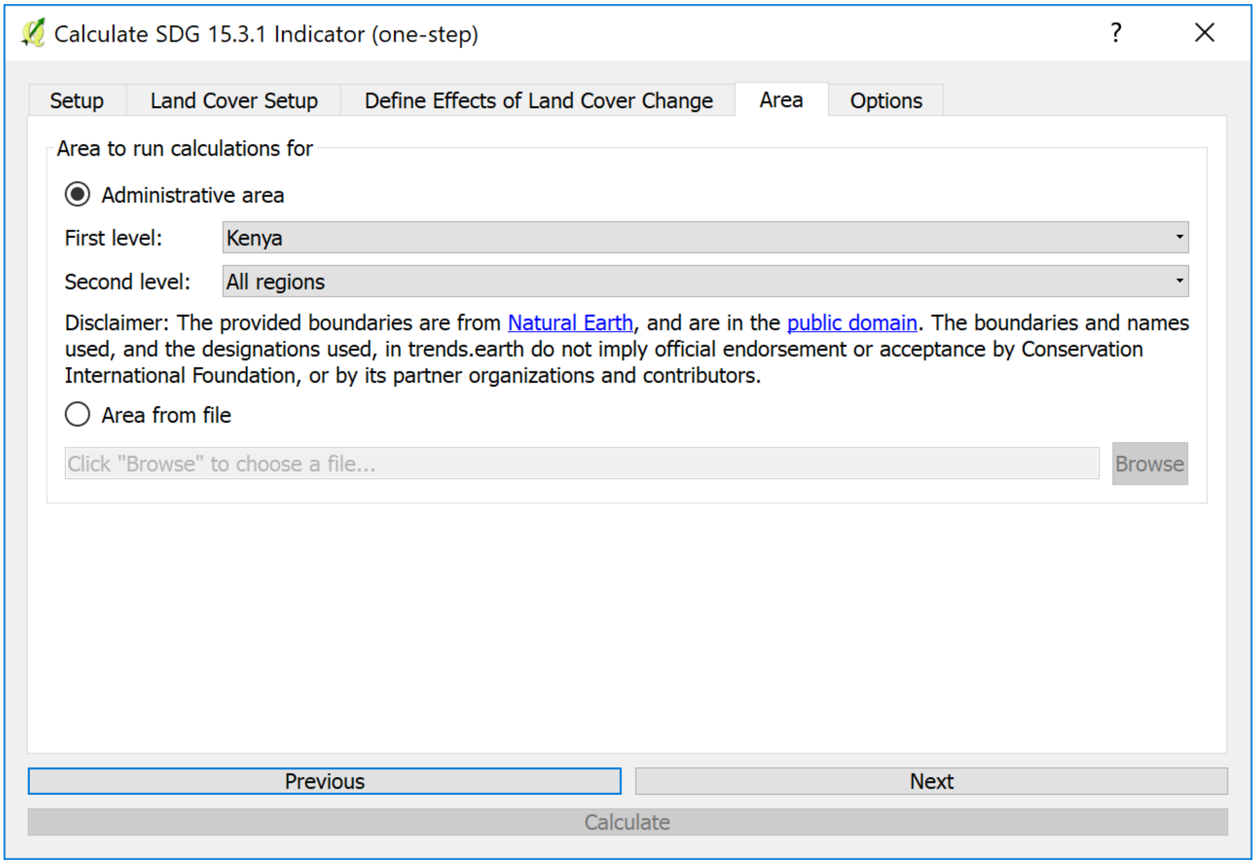


Input code	Input class	Output class
10	Cropland, rainfed	Cropland
11	Herbaceous cover	Cropland
12	Tree or shrub cover	Cropland
20	Cropland, irrigated or post-flooding	Cropland
30	Mosaic cropland (>50%) / natural vegetation (tree, shrub, herbaceous cover) (<50%)	Cropland
40	Mosaic natural vegetation (tree, shrub, herbaceous cover) (>50%) / cropland (<50%)	Grassland
50	Tree cover, broadleaved, evergreen, closed to open (>15%)	Tree-covered
60	Tree cover, broadleaved, deciduous, closed to open (>15%)	Tree-covered
61	Tree cover, broadleaved, deciduous, closed (>40%)	Tree-covered
62	Tree cover, broadleaved, deciduous, open (15-40%)	Tree-covered
70	Tree cover, needleleaved, evergreen, closed to open (>15%)	Tree-covered
71	Tree cover, needleleaved, evergreen, closed (>40%)	Tree-covered
72	Tree cover, needleleaved, evergreen, open (15-40%)	Tree-covered
80	Tree cover, needleleaved, deciduous, closed to open (>15%)	Tree-covered
81	Tree cover, needleleaved, deciduous, closed (>40%)	Tree-covered
82	Tree cover, needleleaved, deciduous, open (15-40%)	Tree-covered
90	Tree cover, mixed leaf type (broadleaved and needleleaved)	Tree-covered
100	Mosaic tree and shrub (>50%) / herbaceous cover (<50%)	Tree-covered
110	Mosaic herbaceous cover (>50%) / tree and shrub (<50%)	Grassland
120	Shrubland	Grassland
121	Shrubland evergreen	Grassland
122	Shrubland deciduous	Grassland
130	Grassland	Grassland
140	Lichens and mosses	Grassland
150	Sparse vegetation (tree, shrub, herbaceous cover) (<15%)	Grassland
151	Sparse trees (<15%)	Grassland
152	Sparse shrub (<15%)	Grassland
153	Sparse herbaceous cover (<15%)	Grassland
160	Tree cover, flooded, fresh or brakish water	Wetland
170	Tree cover, flooded, saline water	Wetland
180	Shrub or herbaceous cover, flooded, fresh/saline/brakish water	Wetland
190	Urban areas	Artificial

The second option allows users to upload a custom land cover dataset. This requires two datasets to compare change over time. Select Next.



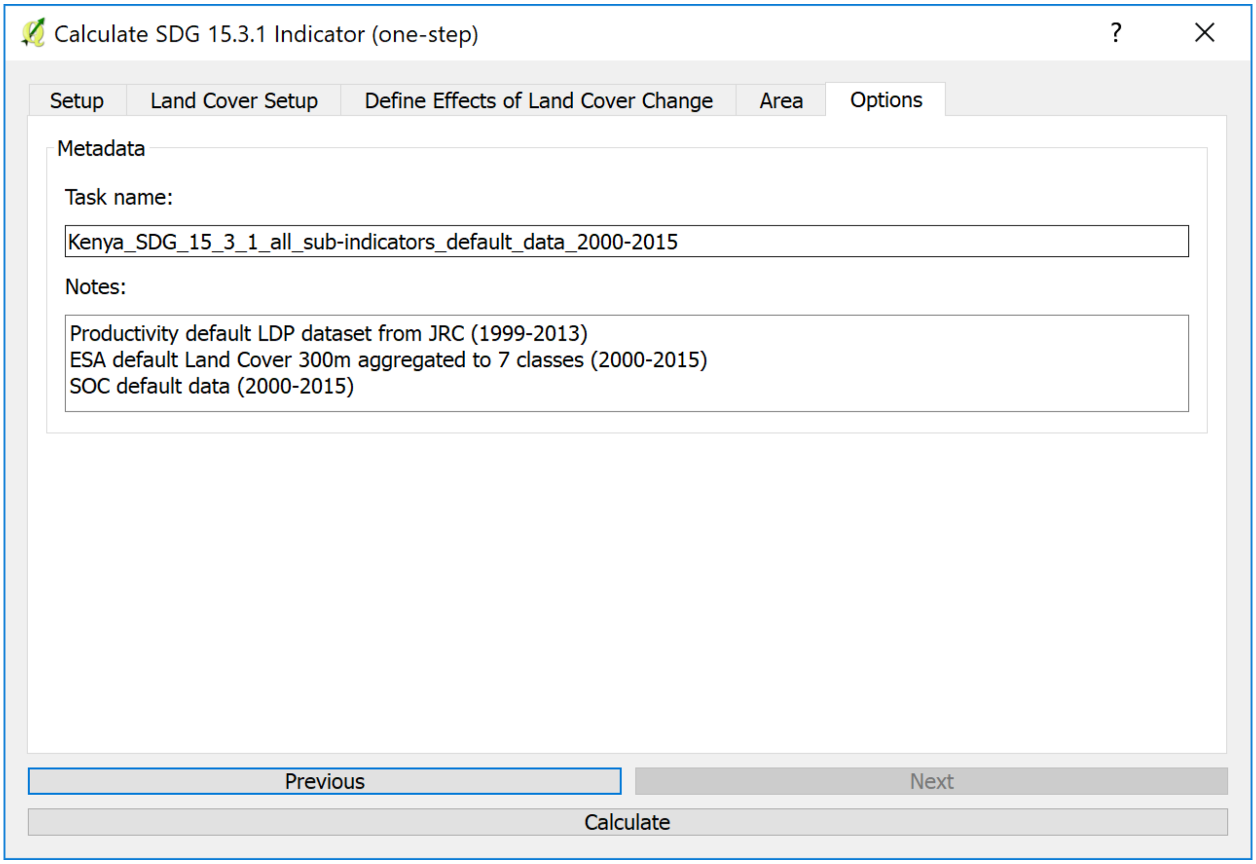
4. The user can now define the effects of land cover change and how it is classified as degrading or improving.



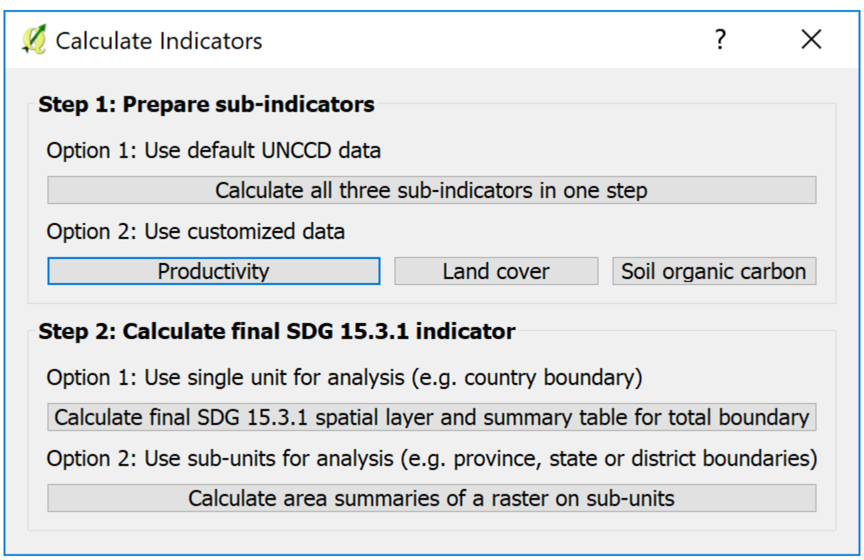
5. Select an area to run the analysis or upload a shapefile boundary

Note: The provided boundaries are from Natural Earth, and are in the public domain. The boundaries and names used, and the designations used, in MISLAND do not imply official endorsement or acceptance by Conservation International Foundation, or by its partner organizations and contributors.

If using MISLAND for official purposes, it is recommended that users choose an official boundary provided by the designated office of their country.



6. Name the task and make notes for future reference
7. Click on "Calculate" to submit your task to Google Earth Engine



20.2 Calculate productivity

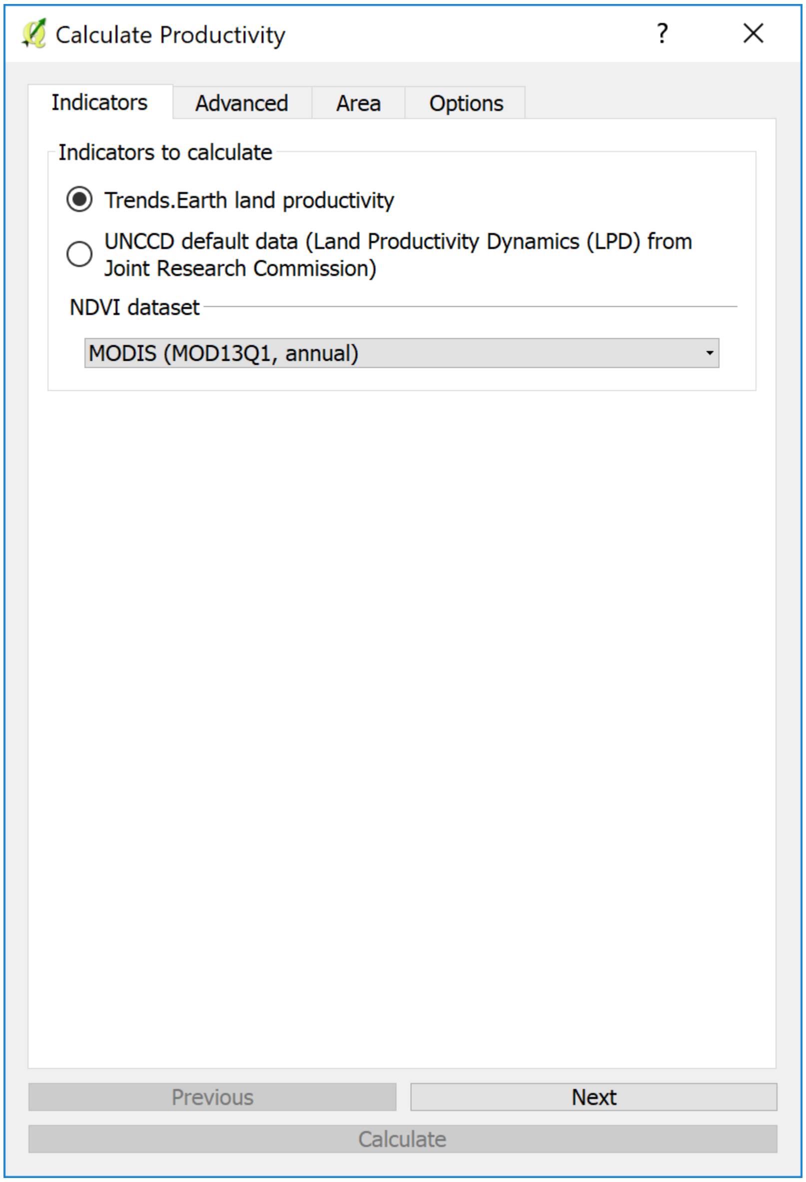
Productivity measures the trajectory, performance and state of primary productivity using either 8km AVHRR, 250m MODIS or 30m LANDSAT 7 (under development) datasets. The user can select one or multiple indicators to calculate, the NDVI dataset, name the tasks and enter in explanatory notes for their intended reporting area.

20.2.1 Productivity Trajectory

Trajectory assesses the rate of change of productivity over time. To calculate trajectory:

1) Select an indicator to calculate
2) Select NDVI dataset to use and select Next

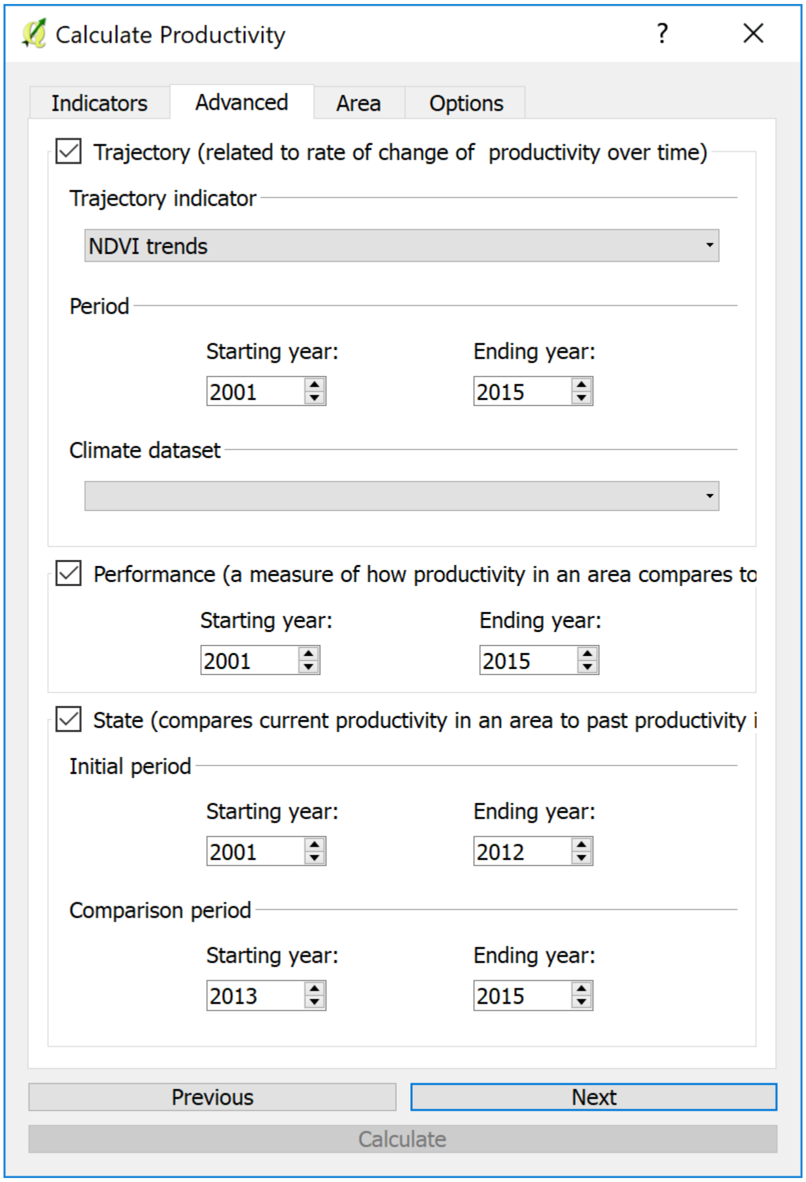
Note: The valid date range is set by the NDVI dataset selected within the first tab: AVHRR dates compare 1982-2015 and MODIS 2001-2016.



3) In the tab "Advanced", select the method to be used to compute the productivity trajectory analysis. The options are:

- **NDVI trend**: This dataset shows the trend in annually integrated NDVI time series (2001-2015) using MODIS (250m) dataset (MOD13Q1) or AVHRR (8km; GIMMS3g.v1). The normalized difference vegetation index (NDVI) is the ratio of the difference between near-infrared band (NIR) and the red band (RED) and the sum of these two bands (Rouse et al., 1974; Deering 1978) and reviewed in Tucker (1979).
- **RUE**: is defined as the ratio between net primary production (NPP), in this case annual integrals of NDVI, and rainfall. It has been increasingly used to analyze the variability of vegetation production in arid and semi-arid biomes, where rainfall is a major limiting factor for plant growth
- **RESTREND**: this method attempts to adjust the NDVI signals from the effect of particular climatic drivers, such as rainfall or soil moisture, using a pixel-by-pixel linear regression on the NDVI time series and the climate signal. The linear model and the climatic data is used then to predict NDVI, and to compute the residuals between the observed and climate-predicted NDVI annual integrals. The NDVI residual trend is finally plotted to spatially represent overall trends in primary productivity independent of climate.

- **WUE**: is defined as the ratio between net primary production (NPP), in this case annual integrals of NDVI, and evapotranspiration.



20.2.2 Productivity Performance

Performance is a comparison of how productivity in an area compares to productivity in similar areas at the same point in time. To calculate performance:

1) Select the start and end year of the period of analysis for comparison.

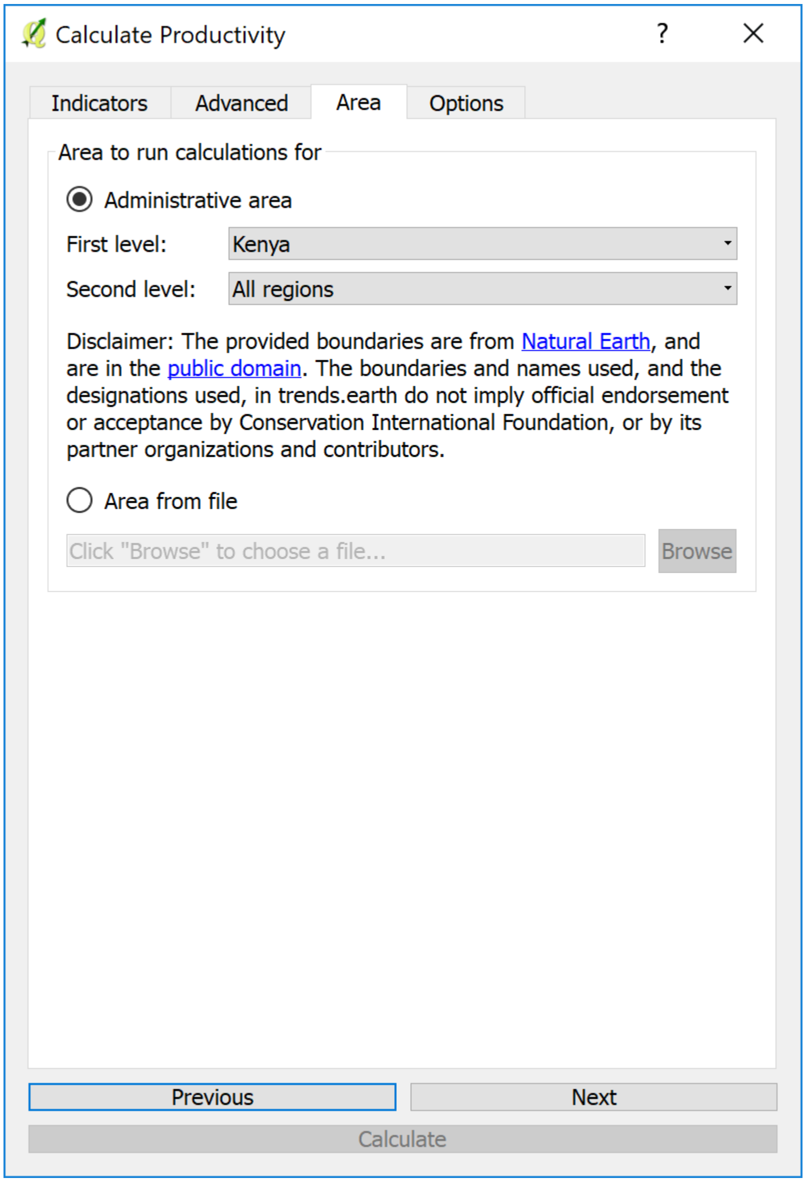
20.2.3 Productivity State

State performs a comparison of how current productivity in an area compares to past productivity. To calculate state:

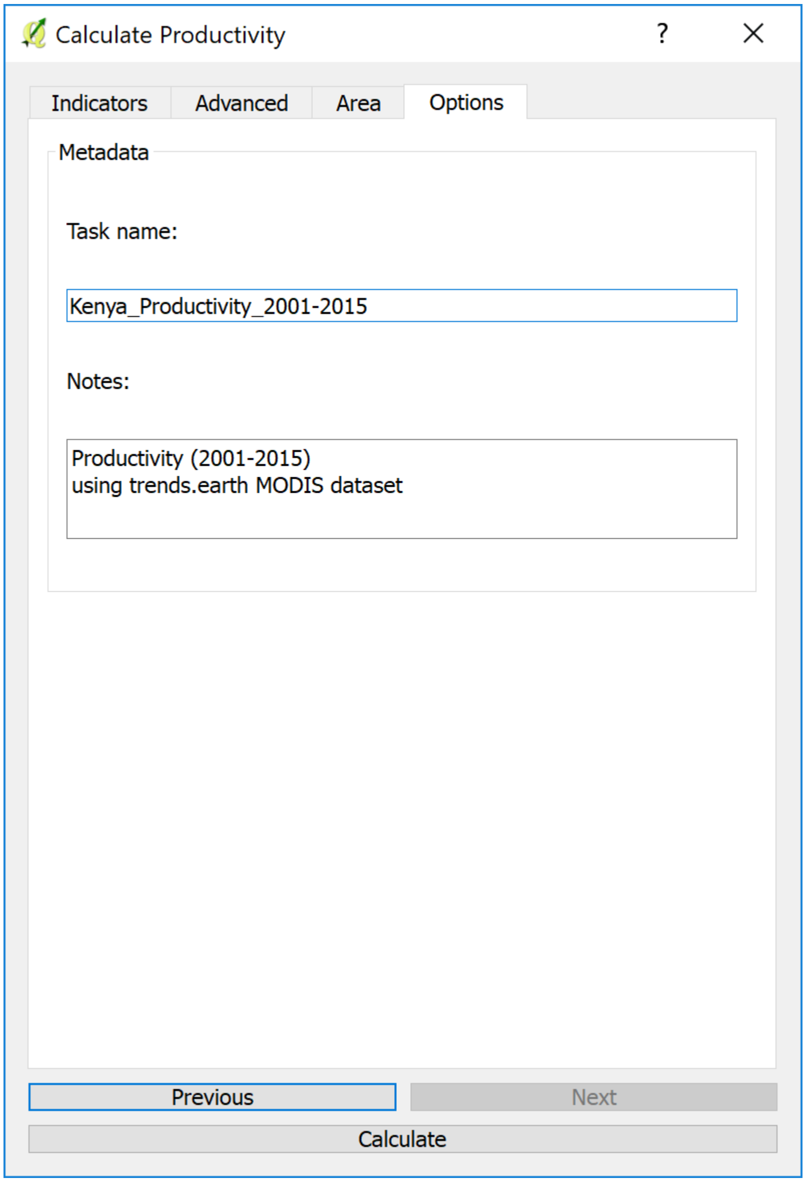
1) Define the baseline and comparison periods for the computation of the State sub-indicator.

The next step is to define the study area on which to perform the analysis. The tool allows selecting the area of interest in one of two ways:

1. Selects first (i.e. country) and/or second (i.e. province or state) administrative boundary from a drop-down menu.
2. The user can provide a shapefile, KML, or geojson defining an area of interest. Once this is done, Select Next.

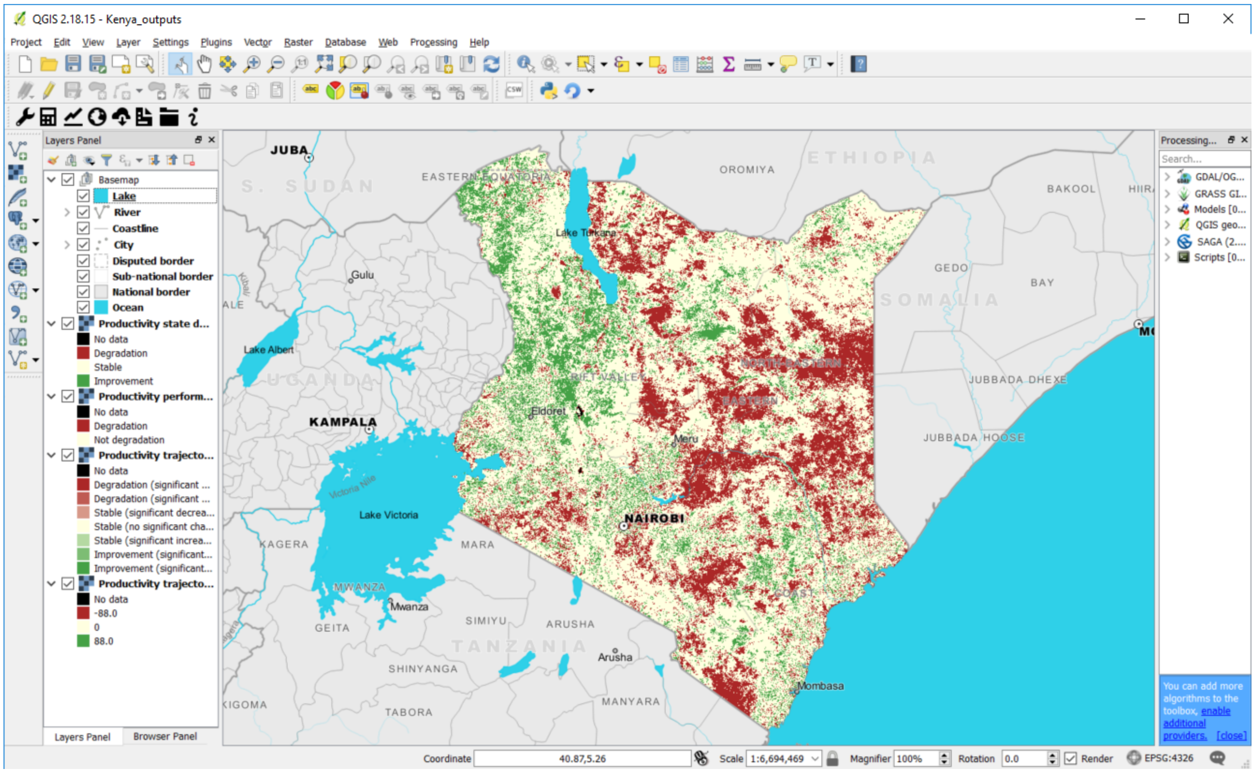


3. The next step is to write a Task name and some notes to indicate which options were selected for the analysis.



4. When all the parameters have been defined, click "Calculate", and the task will be submitted to Google Earth Engine for computing. When the task is completed (processing time will vary depending on server usage, but for most countries it takes only a few minutes most of the time), you'll receive an email notifying the successful completion.

5. When the Google Earth Engine task has completed and you received the email, click "Refresh List" and the status will show FINISHED. Click on the task and select "Download results" at the bottom of the window. A pop up window will open for you to select where to save the layer and to assign it a name. Then click "Save". The layer will be saved on your computer and automatically loaded into yoour current QGIS project.

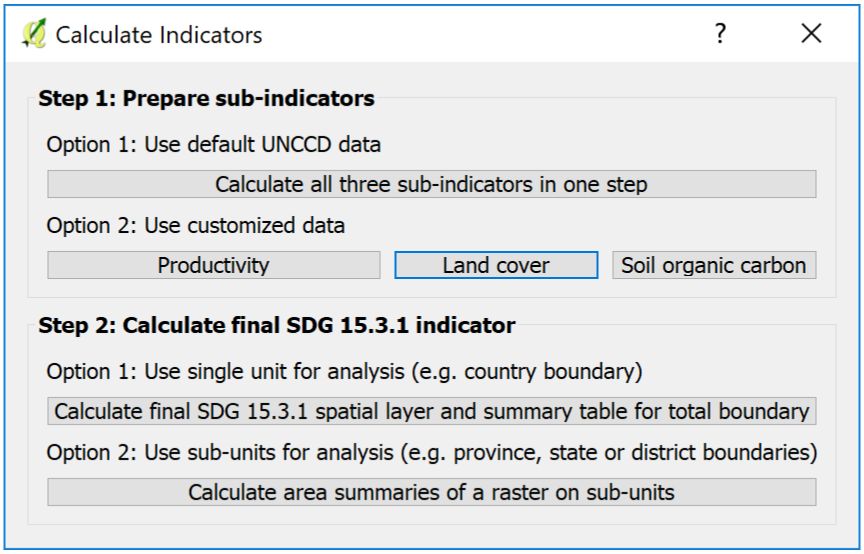


20.3 Calculate land cover

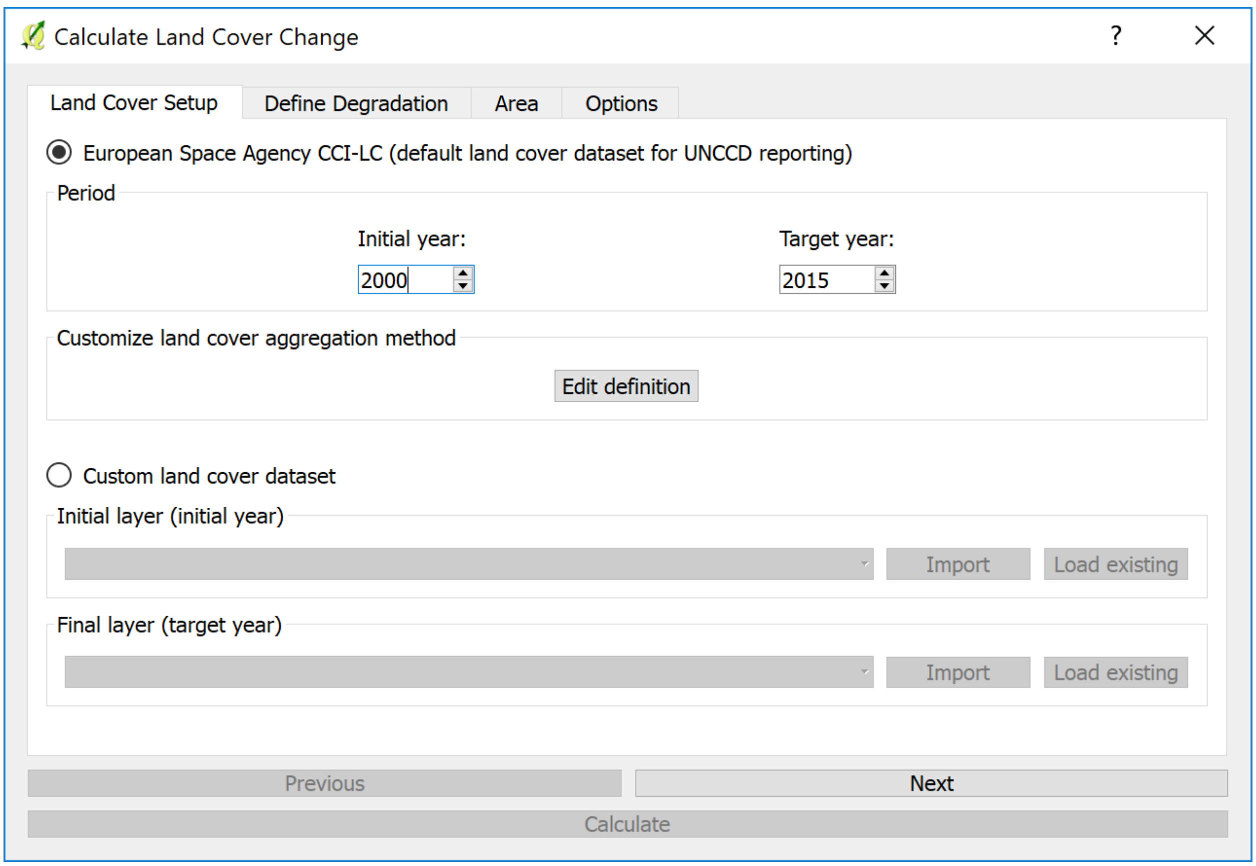
Changes in land cover is one of the indicators used to track potential land degradation which need to be reported to the UNCCD and to track progress towards SDG 15.3.1. While some land cover transitions indicate, in most cases, processes of land degradation, the interpretation of those transitions are for the most part context specific. For that reason, this indicator requires the input of the user to identify which changes in land cover will be considered as degradation, improvement or no change in terms of degradation. The toolbox allows users to calculate land cover change relative to a baseline period, enter a transition matrix indicating which transitions indicate degradation, stability or improvement.

To calculate the land cover change indicator:

1. Click on the Calculate Indicators button from the toolbox bar, then select Land cover.



2. Within the "Land Cover Setup tab" the user selects the baseline and target years

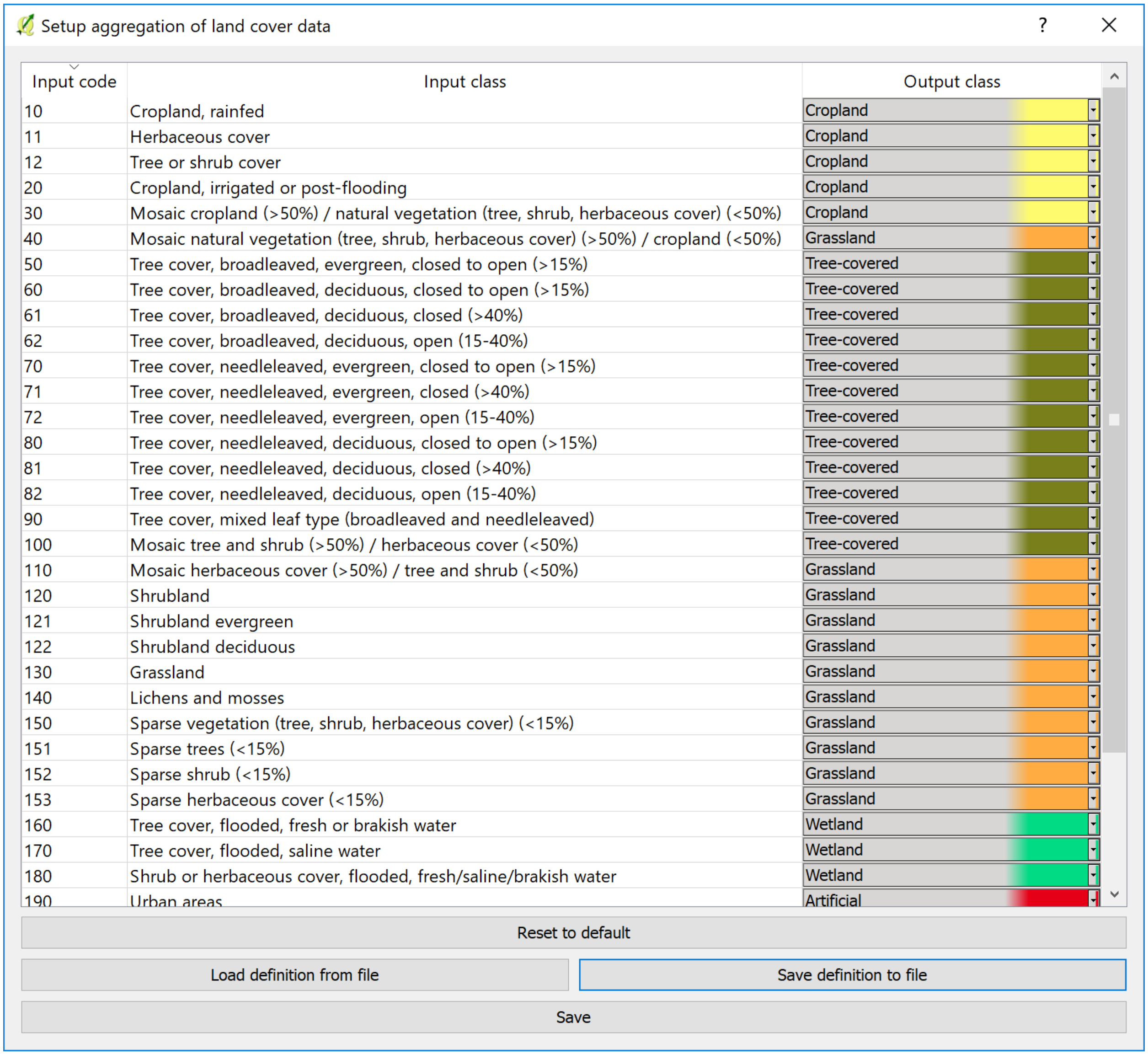


3. The land cover aggregation can be customized using the 'Edit definition' button. The user can define their own aggregation of land cover classes from the 37 ESA land cover classes to the 7 UNCCD categories.

   A. Select the dial button for the "Custom" option and select "Create new definition"

   B. Edit the aggregation suitable for the area of interest

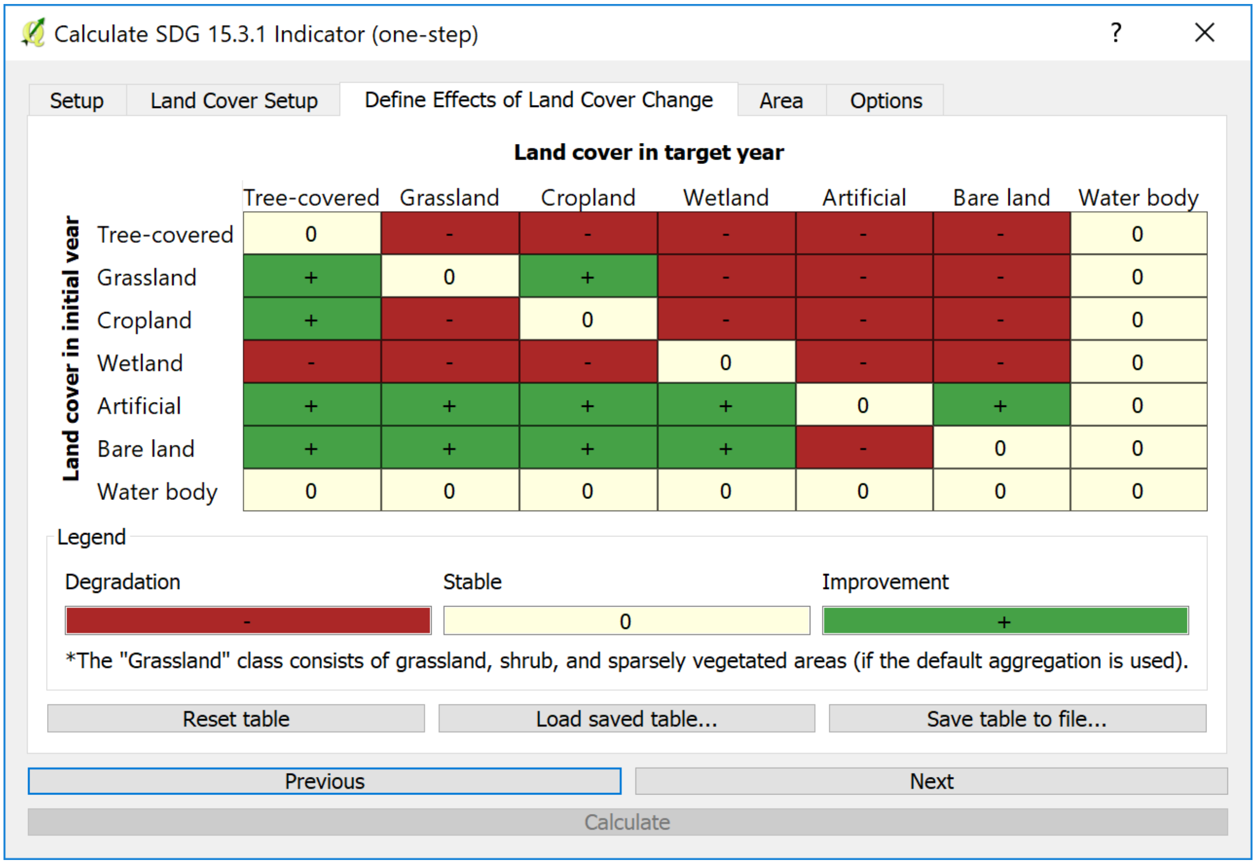
   C. Select "Save definition" and select Next



Input code	Input class	Output class
10	Cropland, rainfed	Cropland
11	Herbaceous cover	Cropland
12	Tree or shrub cover	Cropland
20	Cropland, irrigated or post-flooding	Cropland
30	Mosaic cropland (>50%) / natural vegetation (tree, shrub, herbaceous cover) (<50%)	Cropland
40	Mosaic natural vegetation (tree, shrub, herbaceous cover) (>50%) / cropland (<50%)	Grassland
50	Tree cover, broadleaved, evergreen, closed to open (>15%)	Tree-covered
60	Tree cover, broadleaved, deciduous, closed to open (>15%)	Tree-covered
61	Tree cover, broadleaved, deciduous, closed (>40%)	Tree-covered
62	Tree cover, broadleaved, deciduous, open (15-40%)	Tree-covered
70	Tree cover, needleleaved, evergreen, closed to open (>15%)	Tree-covered
71	Tree cover, needleleaved, evergreen, closed (>40%)	Tree-covered
72	Tree cover, needleleaved, evergreen, open (15-40%)	Tree-covered
80	Tree cover, needleleaved, deciduous, closed to open (>15%)	Tree-covered
81	Tree cover, needleleaved, deciduous, closed (>40%)	Tree-covered
82	Tree cover, needleleaved, deciduous, open (15-40%)	Tree-covered
90	Tree cover, mixed leaf type (broadleaved and needleleaved)	Tree-covered
100	Mosaic tree and shrub (>50%) / herbaceous cover (<50%)	Tree-covered
110	Mosaic herbaceous cover (>50%) / tree and shrub (<50%)	Grassland
120	Shrubland	Grassland
121	Shrubland evergreen	Grassland
122	Shrubland deciduous	Grassland
130	Grassland	Grassland
140	Lichens and mosses	Grassland
150	Sparse vegetation (tree, shrub, herbaceous cover) (<15%)	Grassland
151	Sparse trees (<15%)	Grassland
152	Sparse shrub (<15%)	Grassland
153	Sparse herbaceous cover (<15%)	Grassland
160	Tree cover, flooded, fresh or brakish water	Wetland
170	Tree cover, flooded, saline water	Wetland
180	Shrub or herbaceous cover, flooded, fresh/saline/brakish water	Wetland
190	Urban areas	Artificial

4. Within the "Define Degradation tab" user define the meaning of each land cover transition in terms of degradation. The options are: stable (0), degradation (-) or improvement (+). For example, the default for cropland to cropland is 0 because the land cover stays the same and is therefore stable. The default for forest to cropland is -1 because forest is likely cut to clear way for agriculture and would be considered deforestation. The user is encouraged to thoroughly evaluate the meaning of each transition based on their knowledge of the study area, since this matrix will have an important effect on the land degradation identified by this subindicator.

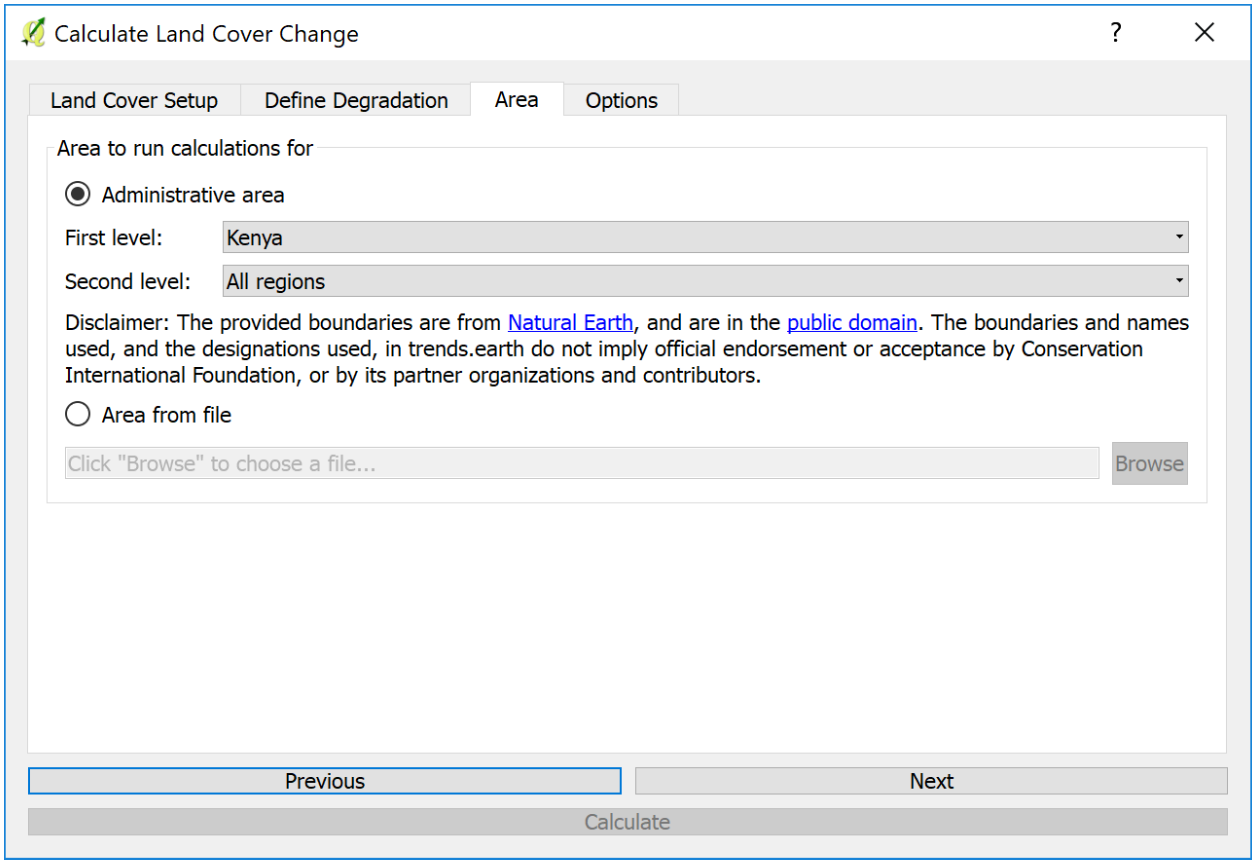
   Users can keep the default values or create unique transition values of their own.



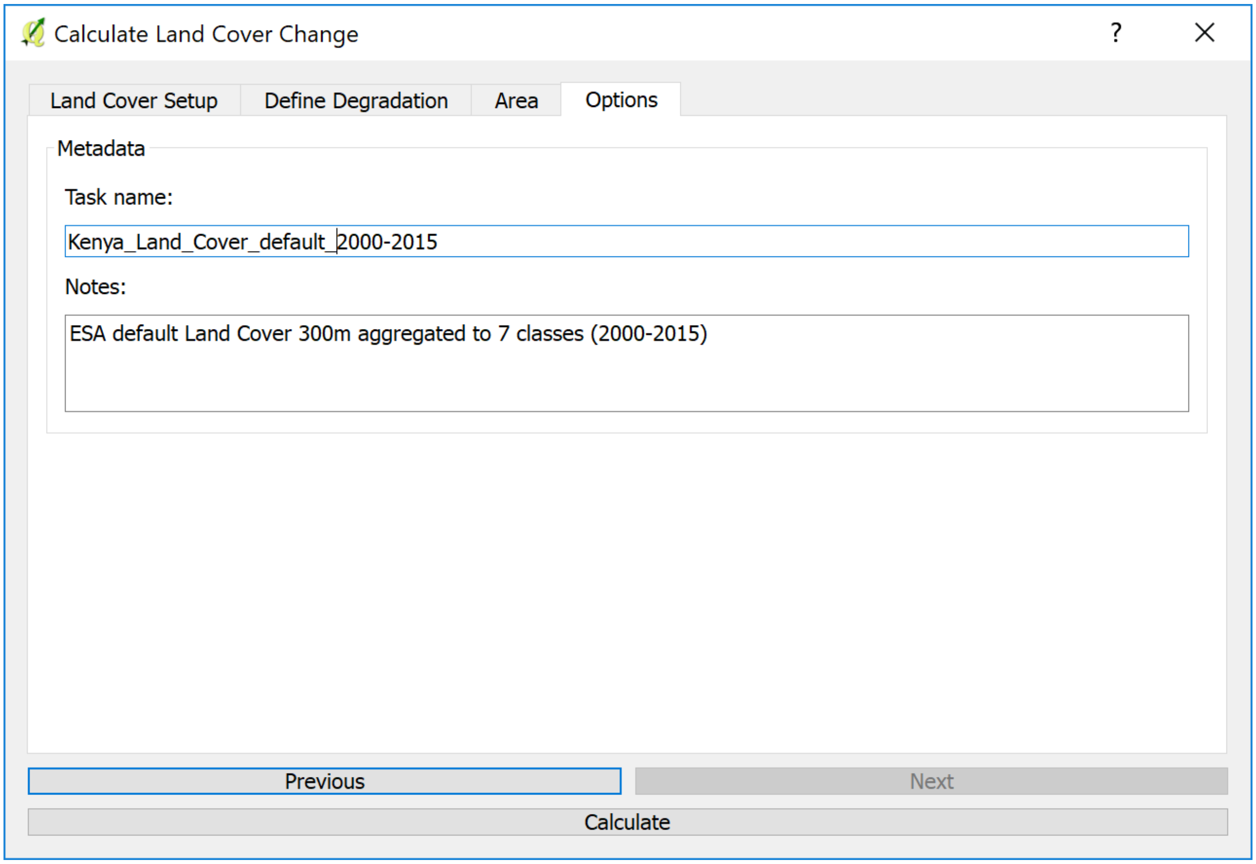
5. The next step is to define the study area on which to perform the analysis. The toolbox allows this task to be completed in one of two ways:

   A. The user selects first (i.e. country) and second (i.e. province or state) administrative boundary from a drop-down menu.

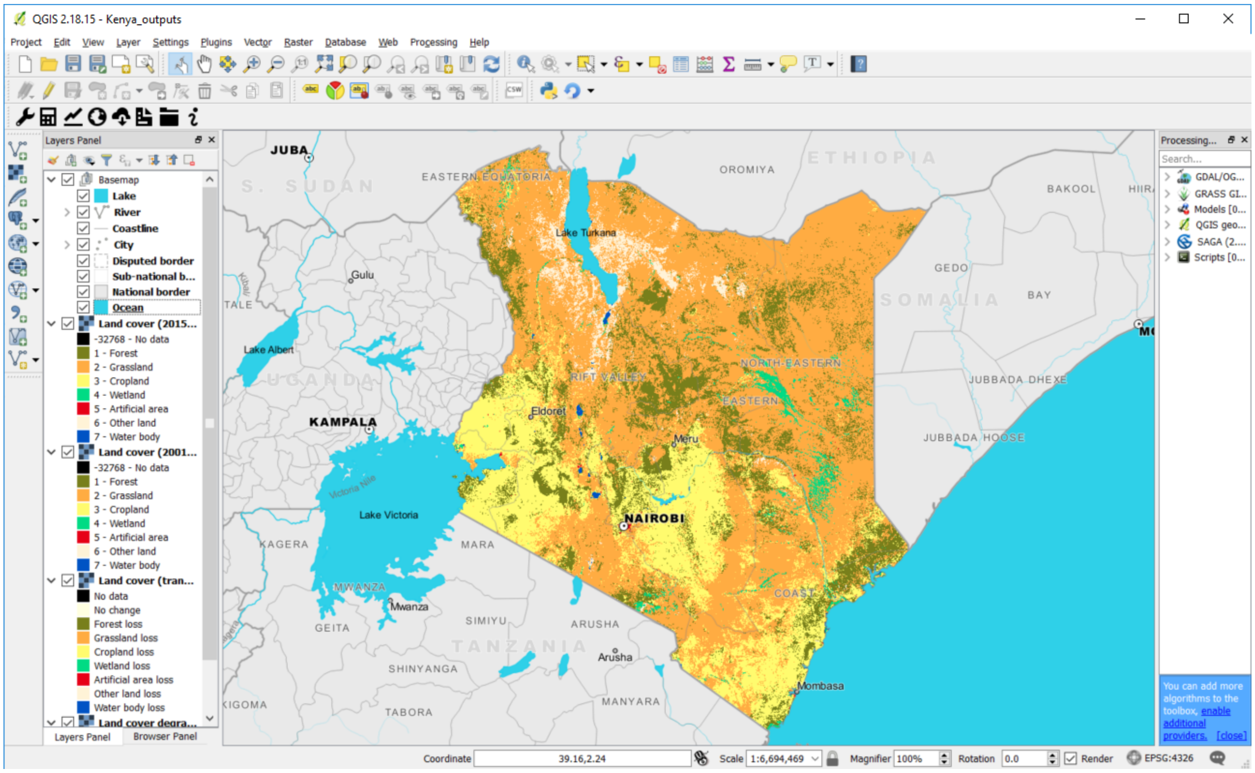
   B. The user can upload a shapefile with an area of interest.



6. The next step is to add the task name and relevant notes for the analysis.



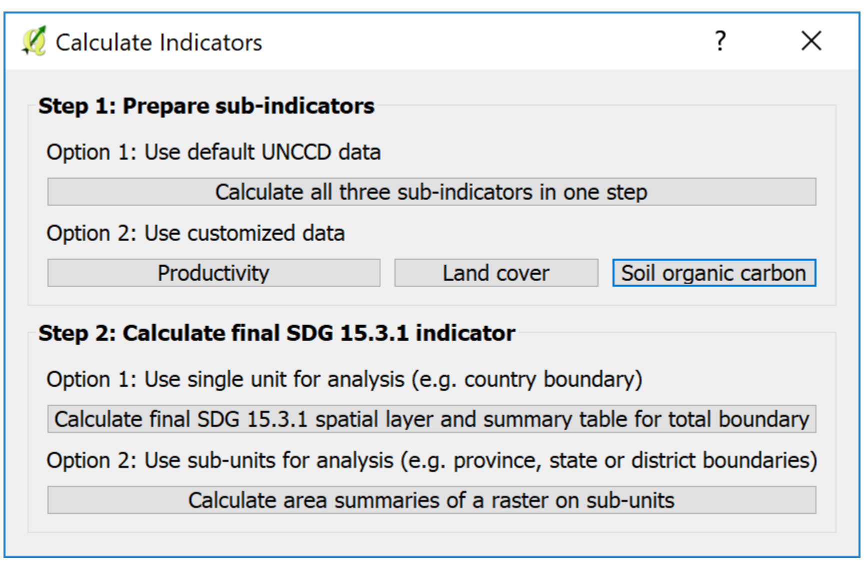
7. When all the parameters have been defined, click "Calculate", and the task will be submitted to Google Earth Engine for computing. When the task is completed (processing time will vary depending on server usage, but for most countries it takes only a few minutes most of the time), you'll receive an email notifying the successful completion.
8. When the Google Earth Engine task has completed and you received the email, click "Refresh List" and the status will show FINISHED. Click on the task and select "Download results" at the bottom of the window. A pop up window will open for you to select where to save the layer and to assign it a name. Then click "Save". The layer will be saved on your computer and automatically loaded into yoour current QGIS project.



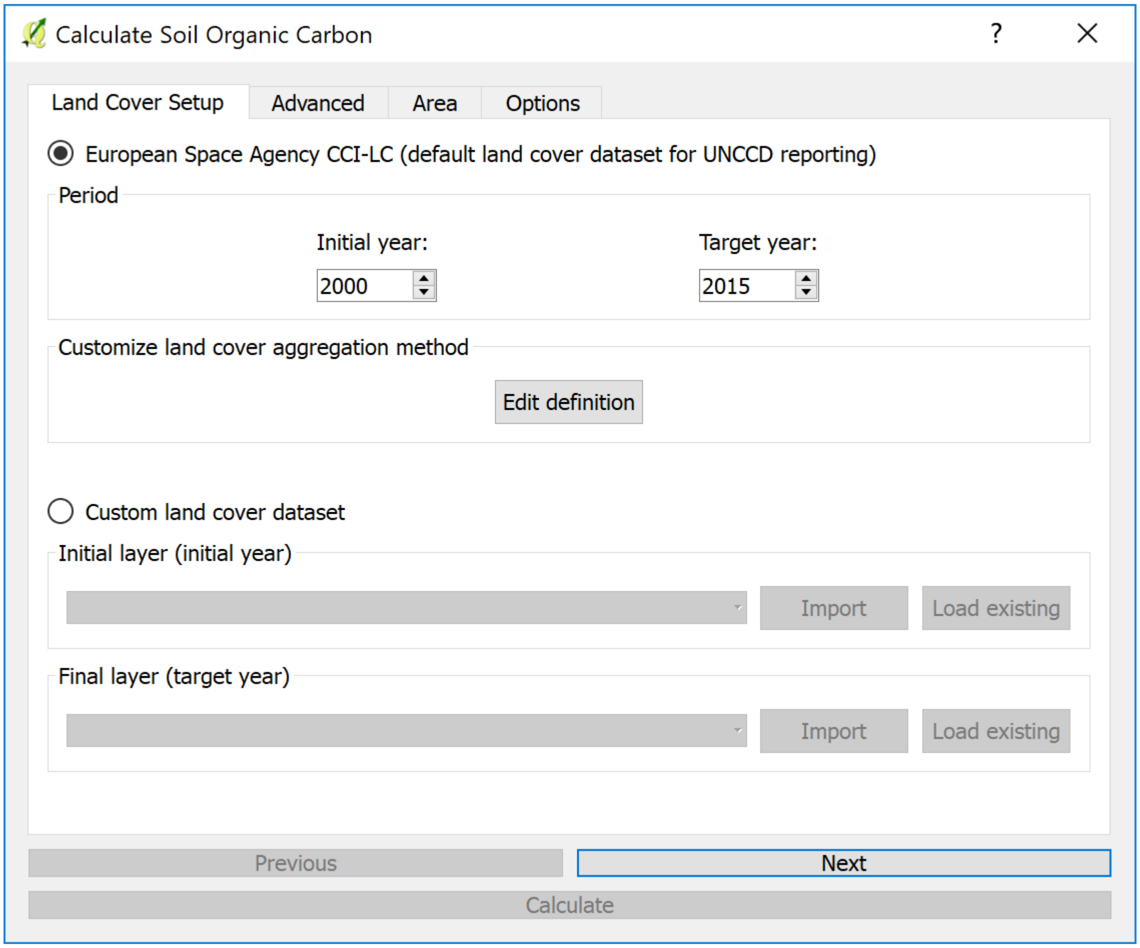
20.4 Calculate soil carbon

Soil Organic Carbon is calculated as a proxy for carbon stocks. It is measured using soil data and changes in land cover.

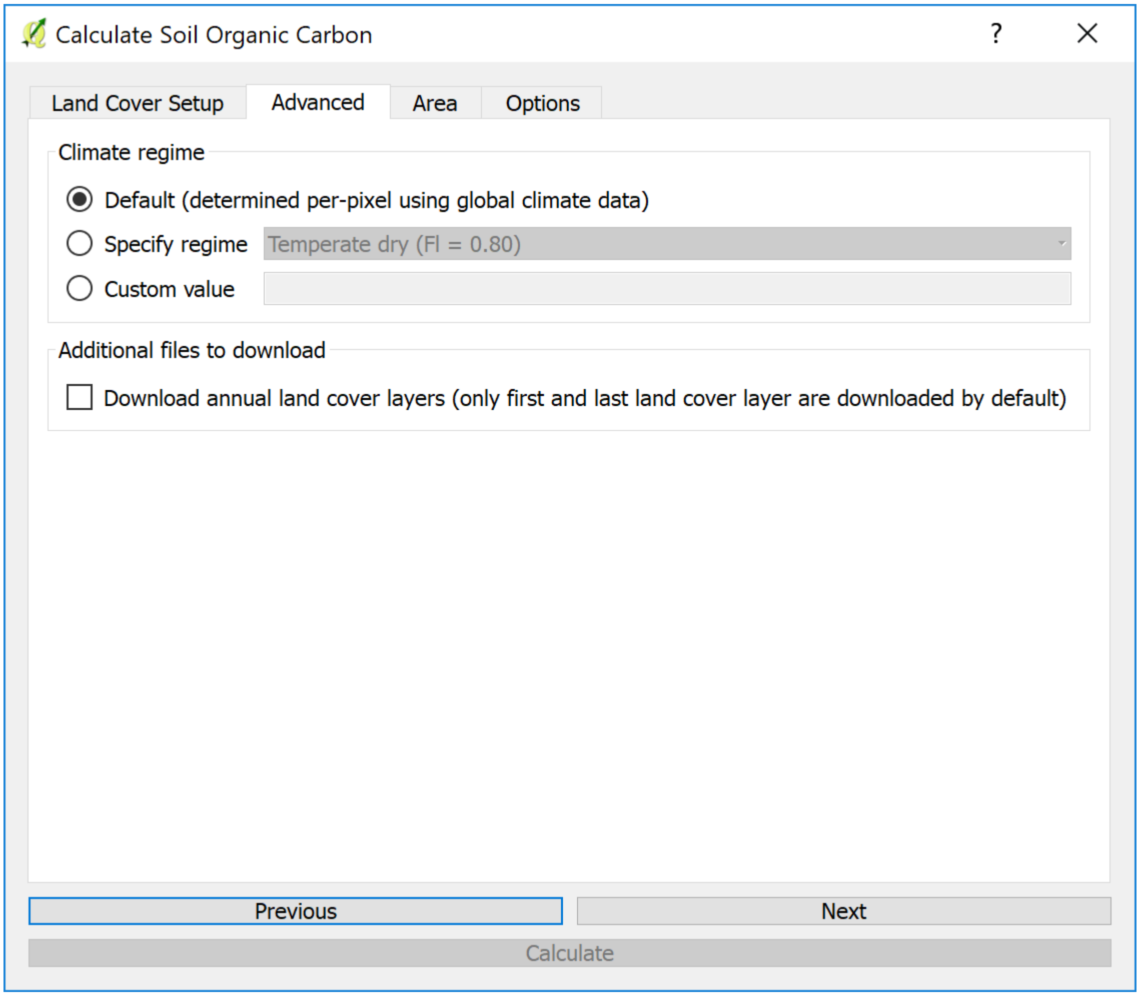
To calculate degradation in soil organic carbon:



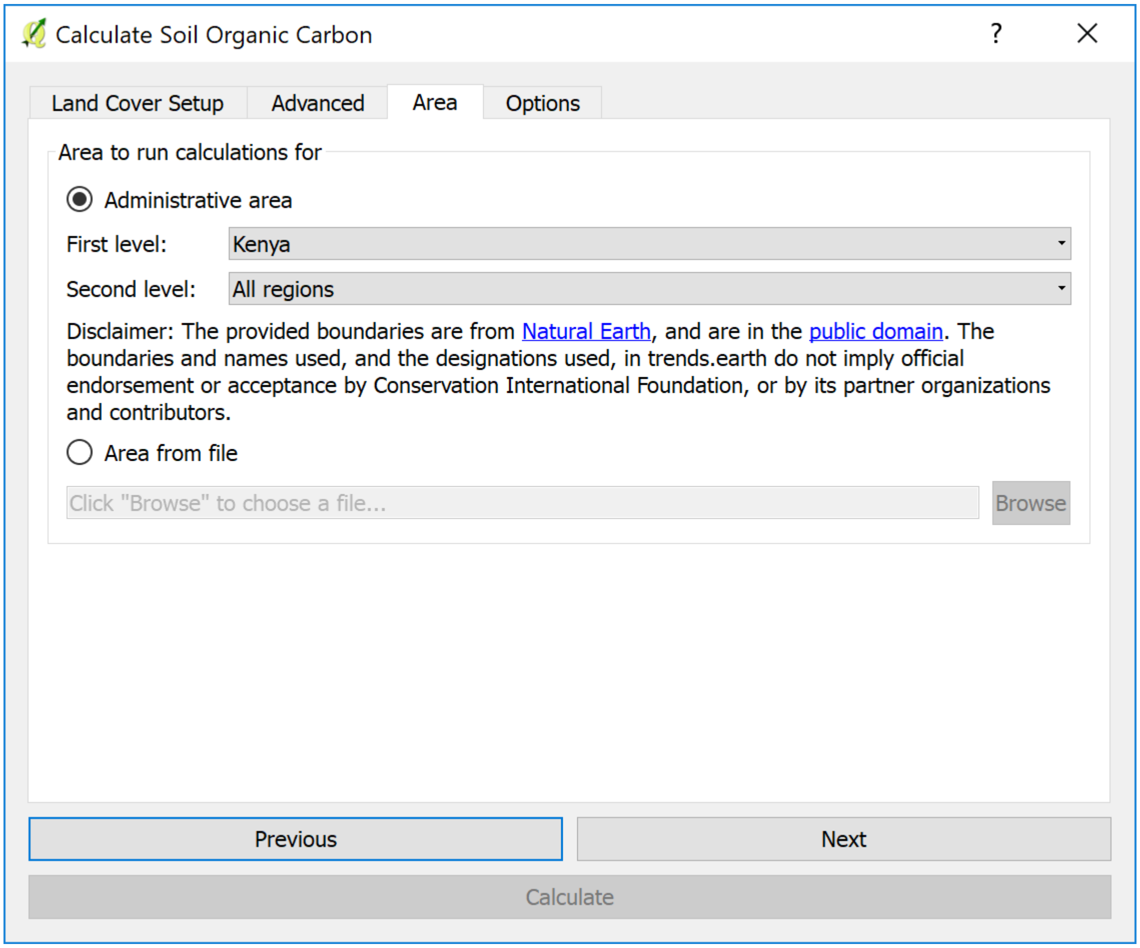
1. Select Soil organic carbon button under Calculate Indicators



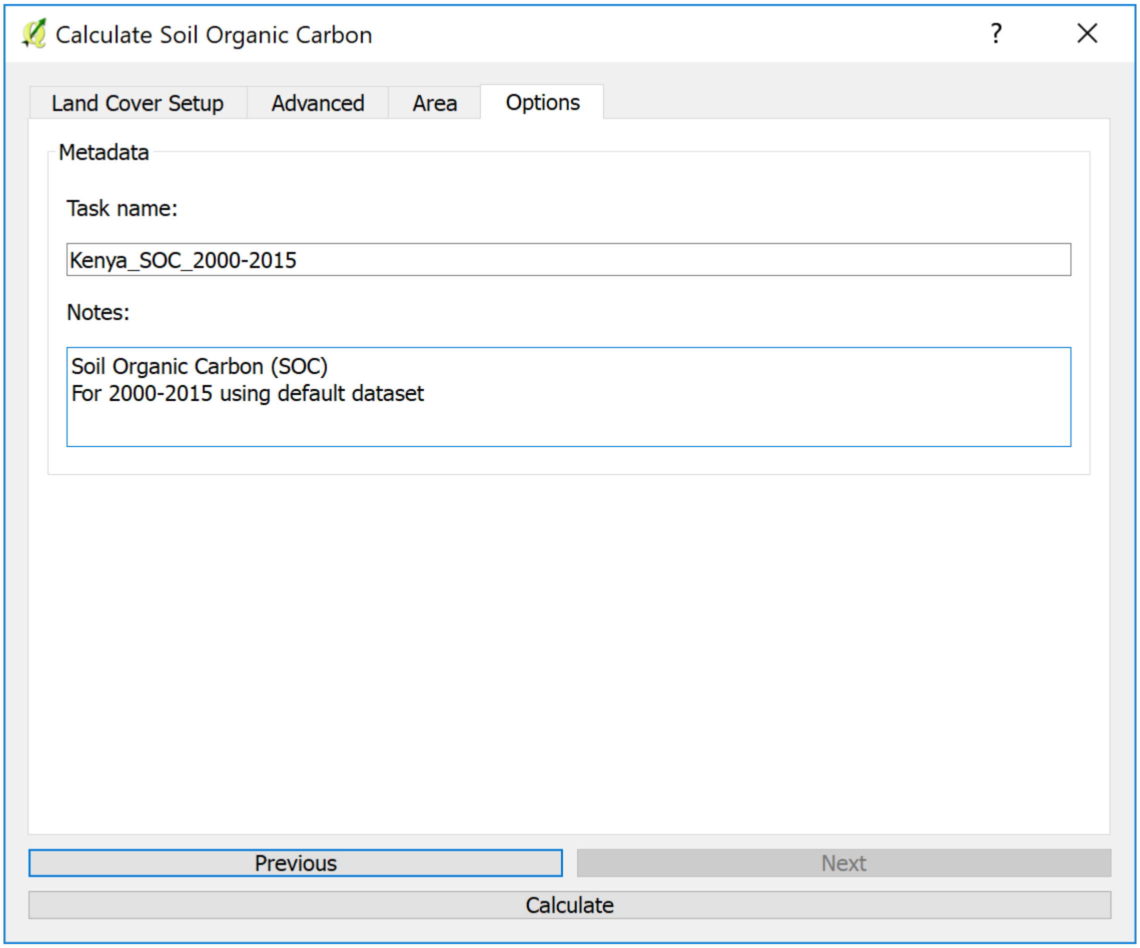
2. The Land Cover Setup tab allows the user to define the period for analysis with the baseline and target year. Users can select the Edit definition button to change the land cover aggregation method or upload a datasets.



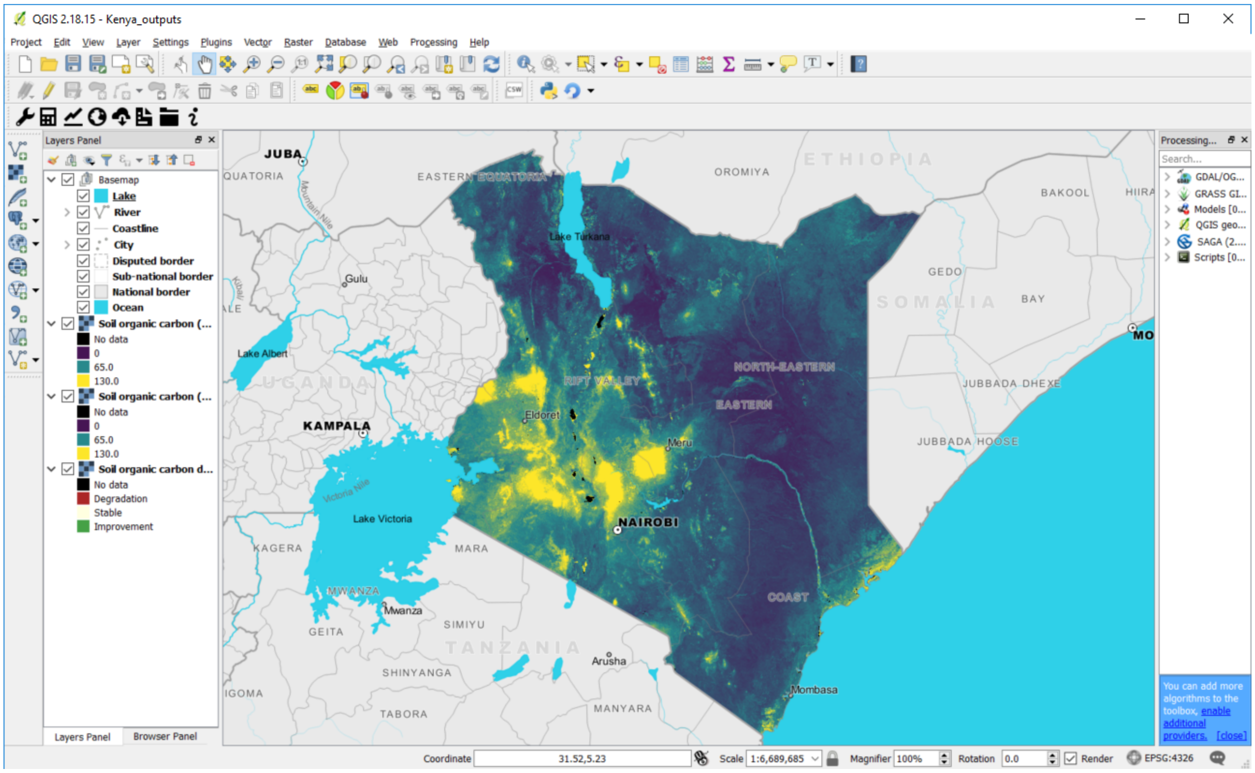
3. The "Advanced" tab allows users to specify the Climate regime.



4. Users can select an area or upload a polygon shapefile for analysis

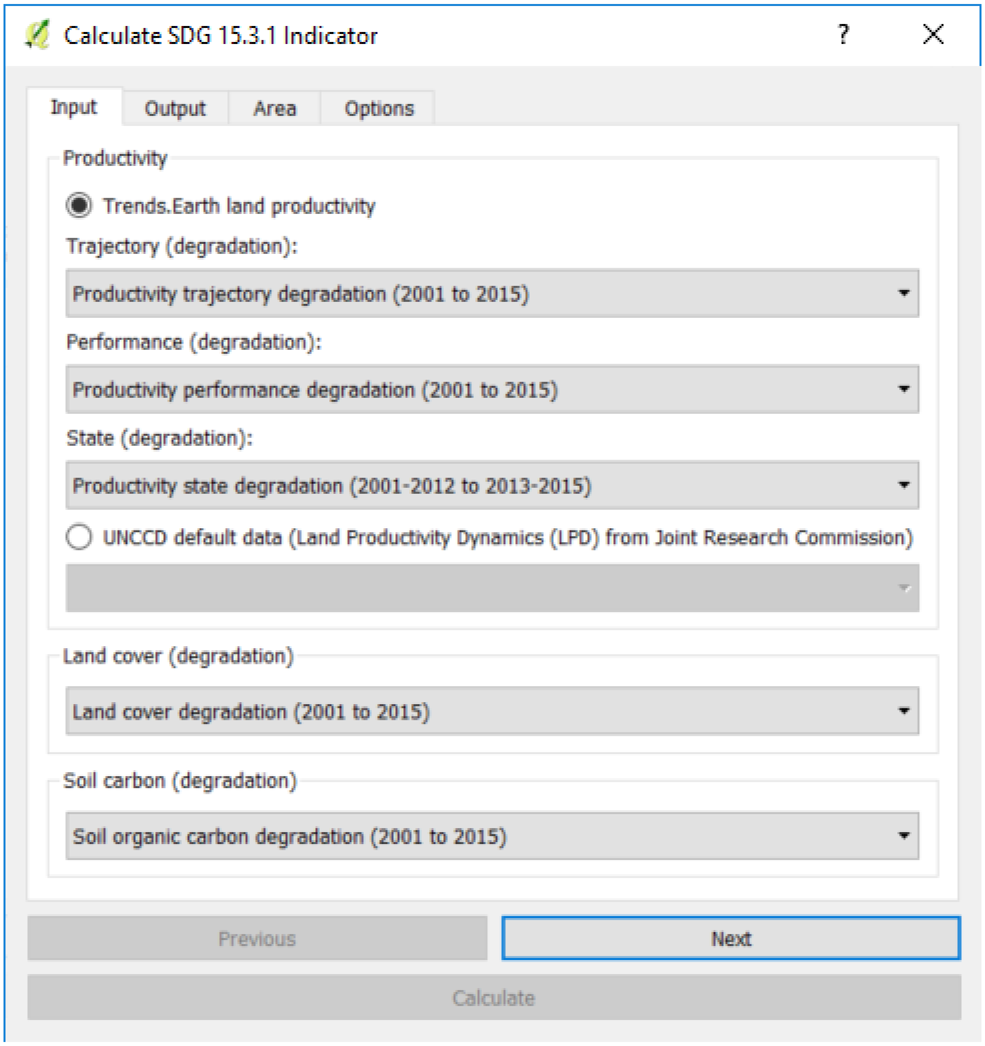


6. The next step is to add the task name and relevant notes for the analysis.
7. When all the parameters have been defined, click "Calculate", and the task will be submitted to Google Earth Engine for computing. When the task is completed (processing time will vary depending on server usage, but for most countries it takes only a few minutes most of the time), you'll receive an email notifying the successful completion.
8. When the Google Earth Engine task has completed and you received the email, click "Refresh List" and the status will show FINISHED. Click on the task and select "Download results" at the bottom of the window. A pop up window will open for you to select where to save the layer and to assign it a name. Then click "Save". The layer will be saved on your computer and automatically loaded into your current QGIS project.

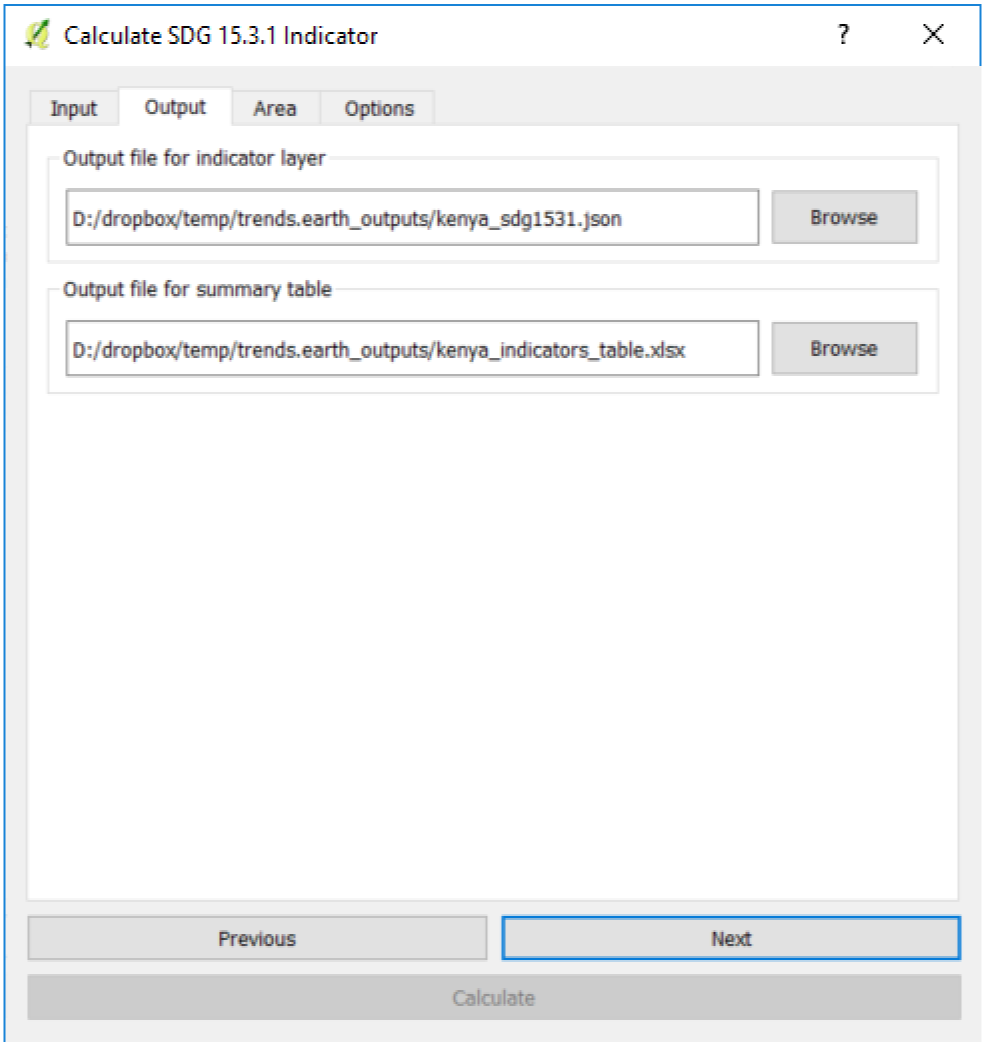


20.5 Compute SDG Indicator 15.3.1

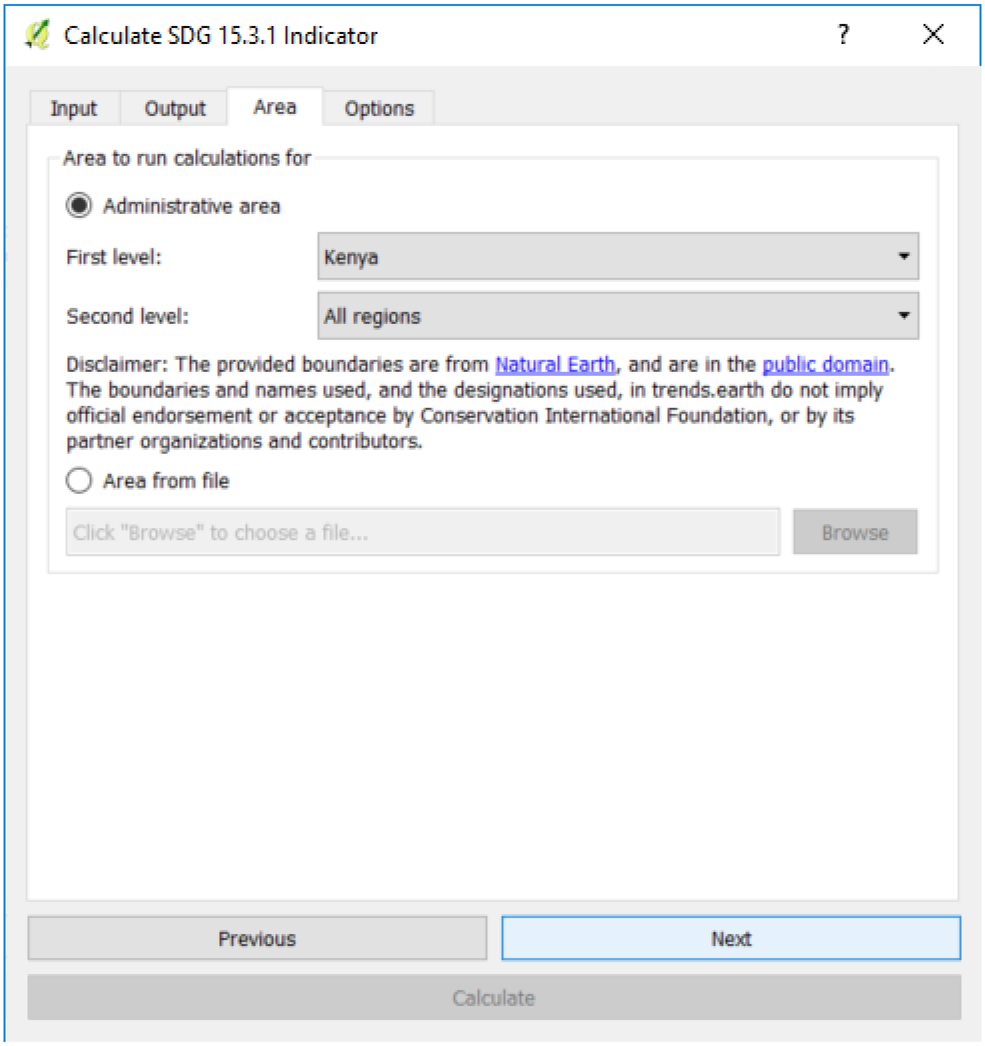
1. Once you have computed the three sub-indicators (productivity, land cover and soil organic carbon), and they are loaded into the QGIS project. Click on the Calculate icon. This will open up the "Calculate Indicator" dialog box. This time click on Step 2 "Calculate final SDG 15.3.1 indicator and summary table".
2. The input window will open already populated with the correct sub-indicators (that if you have them loaded to the QGIS map)



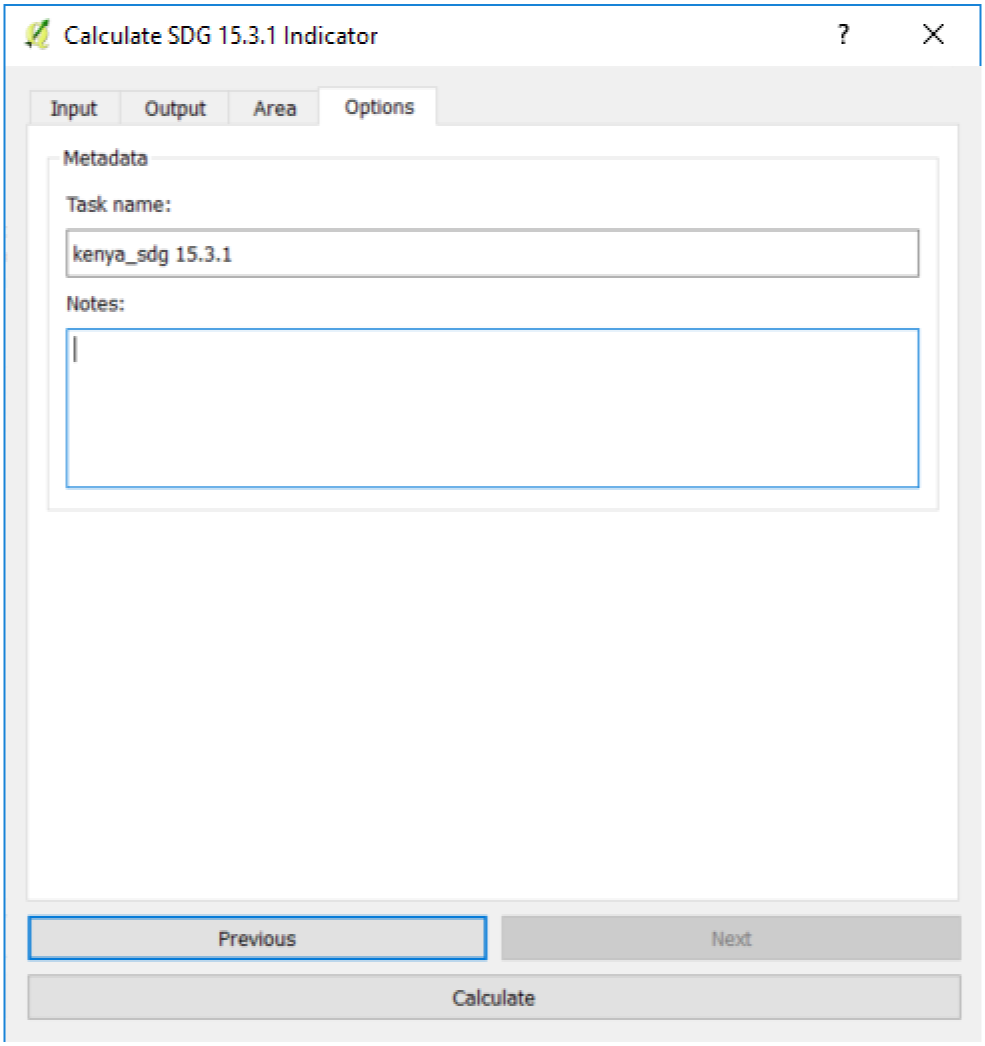
3. Select the name and location where to save the output raster layer and the excel file with the areas computed.



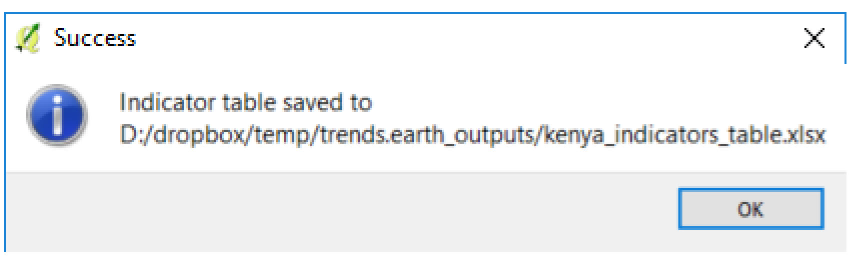
4. Define the area of analysis. In this example, the country boundary.



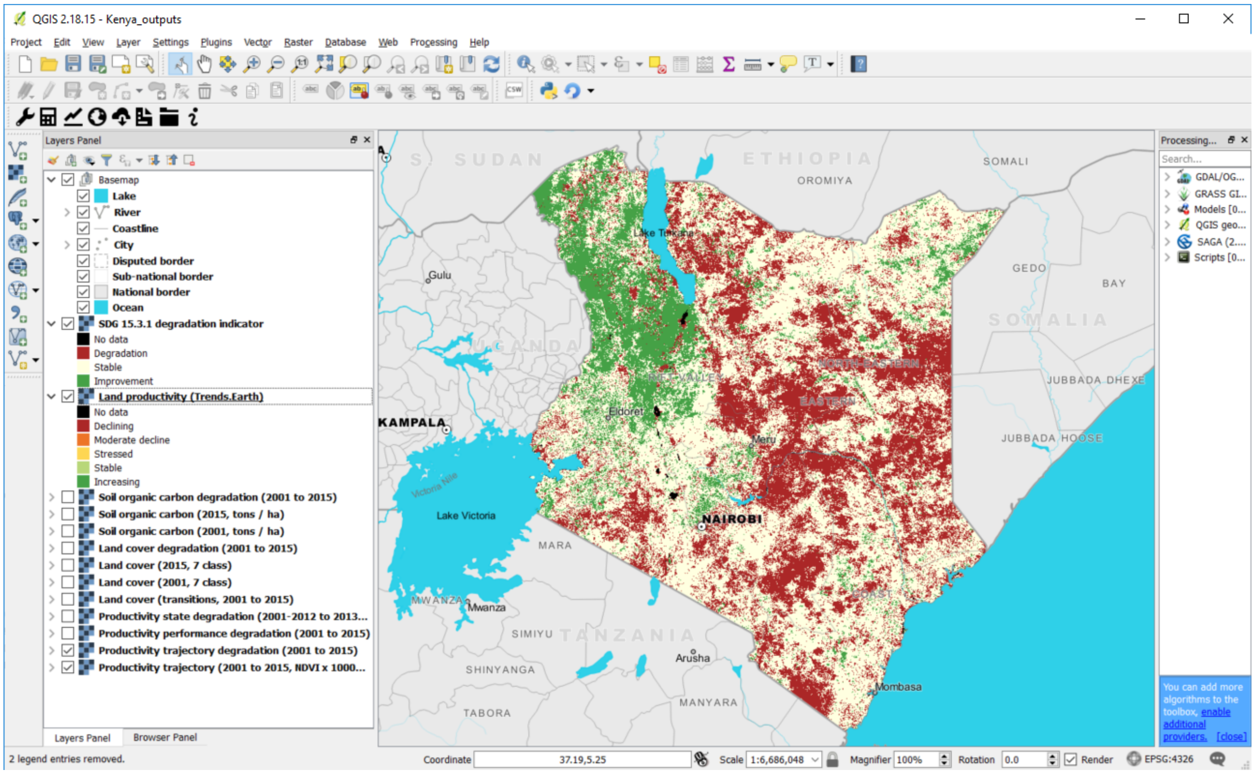
5. Give a name to the task and click "Calculate"



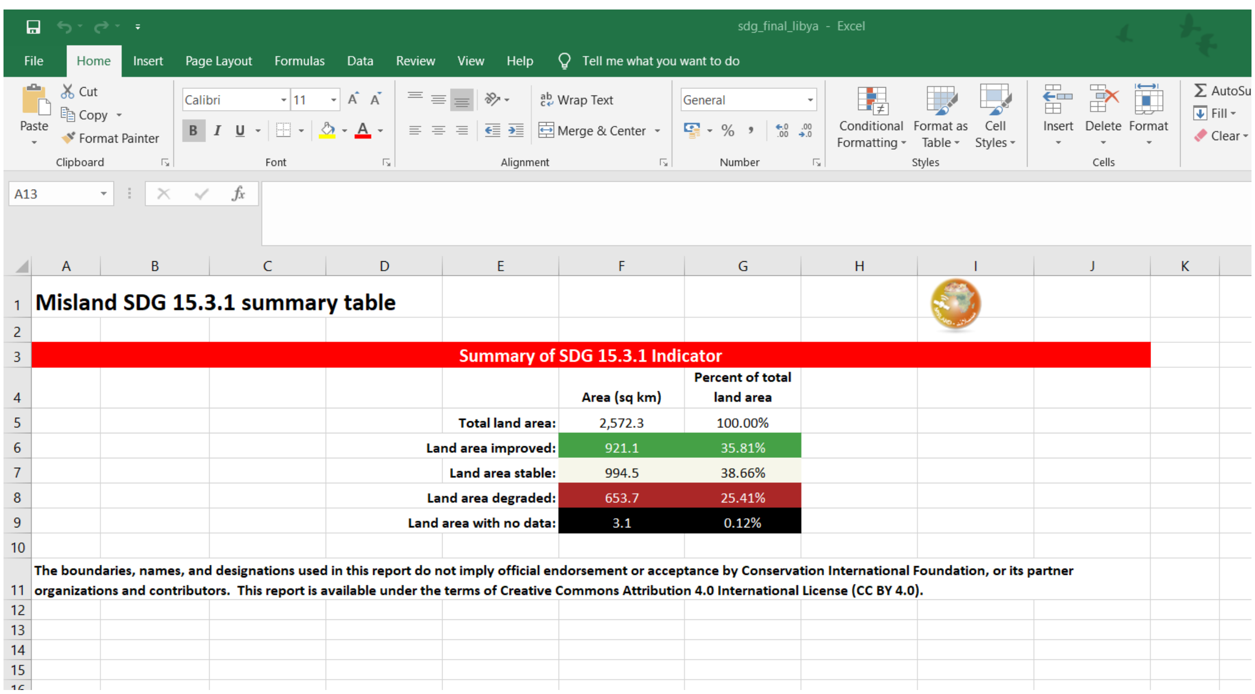
6. This calculation is run on your computer, so depending on the size of the area and the computing power of your computer, it could take a few minutes. When completed, the final SDG indicator will be loaded into the QGIS map and the Excel file with the areas will be saved in the folder you selected. when done, a message will pop up.



7. Click OK and two layers will be loaded to your map: the **5 classes productivity** and the **SDG 15.3.1** indicators.



8. If you navigate to the folder you selected for storing the files, you can open the Excel files with the areas computed for each of the sub-indicators and the final SDG. NOTE: You may get an error message when opening the file, just click ok and the file will open regardless. We are working to fix this error.



CHAPTER

TWENTYONE

CALCULATE VEGETATION DEGRADATION

21.1 Compute Vegatation Indices

Land degradation hotspots (LDH) are produced via the analysis of time-series vegetation indices data and are used to characterize areas of different sizes, where the vegetation cover and the soil types are severely degraded. Vegetation loss/gain hotspots will be calculated based on time series observation of selected suit of vegetation indices depending on the climatic zones and terrain morphology of the North African countries

Vegation Indices computed from Landsat 7 ETM+ include:

1. **NDVI (humid, sub-humid and semi-arid zones)**

   DVI is preferable for global vegetation monitoring since it helps to compensate for changes in lighting conditions, surface slope, exposure, and other external factors. NDVI is calculated in accordance with the formula:

   $$NDVI = \frac{NIR - RED}{NIR + RED}$$

   NIR – reflection in the near-infrared spectrum RED – reflection in the red range of the spectrum

   According to this formula, the density of vegetation (NDVI) at a certain point of the image is equal to the difference in the intensities of reflected light in the red and infrared range divided by the sum of these intensities.

   This index defines values from -1.0 to 1.0, basically representing greens, where negative values are mainly formed from clouds, water and snow, and values close to zero are primarily formed from rocks and bare soil. Very small values (0.1 or less) of the NDVI function correspond to empty areas of rocks, sand or snow. Moderate values (from 0.2 to 0.3) represent shrubs and meadows, while large values (from 0.6 to 0.8) indicate temperate and tropical forests.

2. **MSAVI2 (arid and stepic zones)**

   MSAVI2 is soil adjusted vegetation indices that seek to address some of the limitation of NDVI when applied to areas with a high degree of exposed soil surface.It eliminates the need to find the soil line from a feature-space plot or even explicitly specify the soil brightness correction factor:

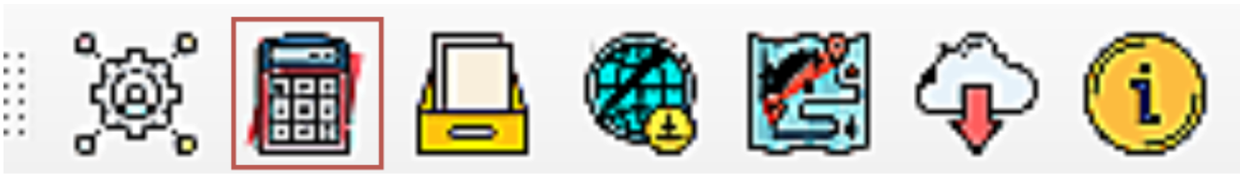
   $$MSAVI2 = \frac{\left(2 * NIR + 1 - \sqrt{(2 * NIR + 1)^2 - 8 * (NIR - RED)}\right)}{2}$$

3. **SAVI (desert areas)**

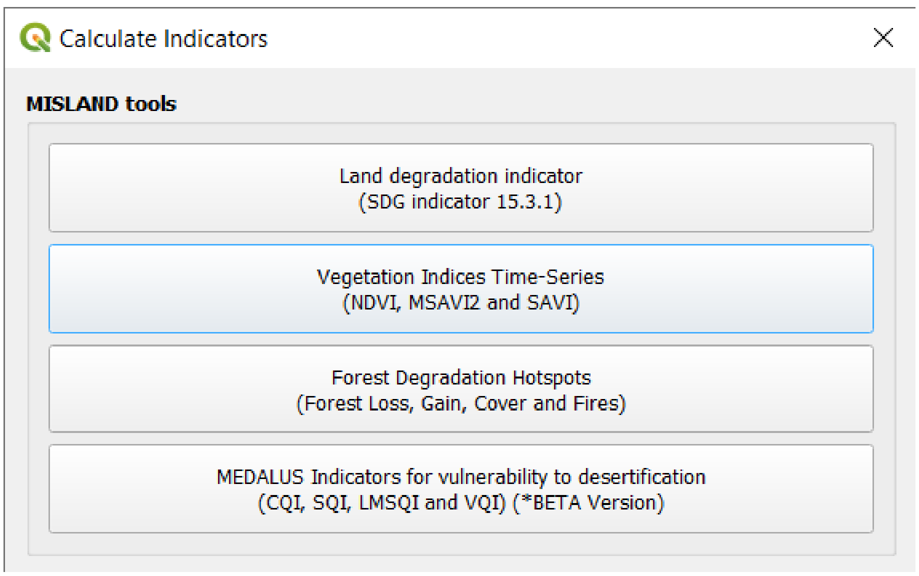
   SAVI is used to correct Normalized Difference Vegetation Index (NDVI) for the influence of soil brightness in areas where vegetative cover is low. Landsat Surface Reflectance-derived SAVI is calculated as a ratio between the R and NIR values with a soil brightness correction factor (L) defined as 0.5 to accommodate most land cover types.

$$SAVI = ((NIR - R) / (NIR + R + L)) * (1 + L)$$

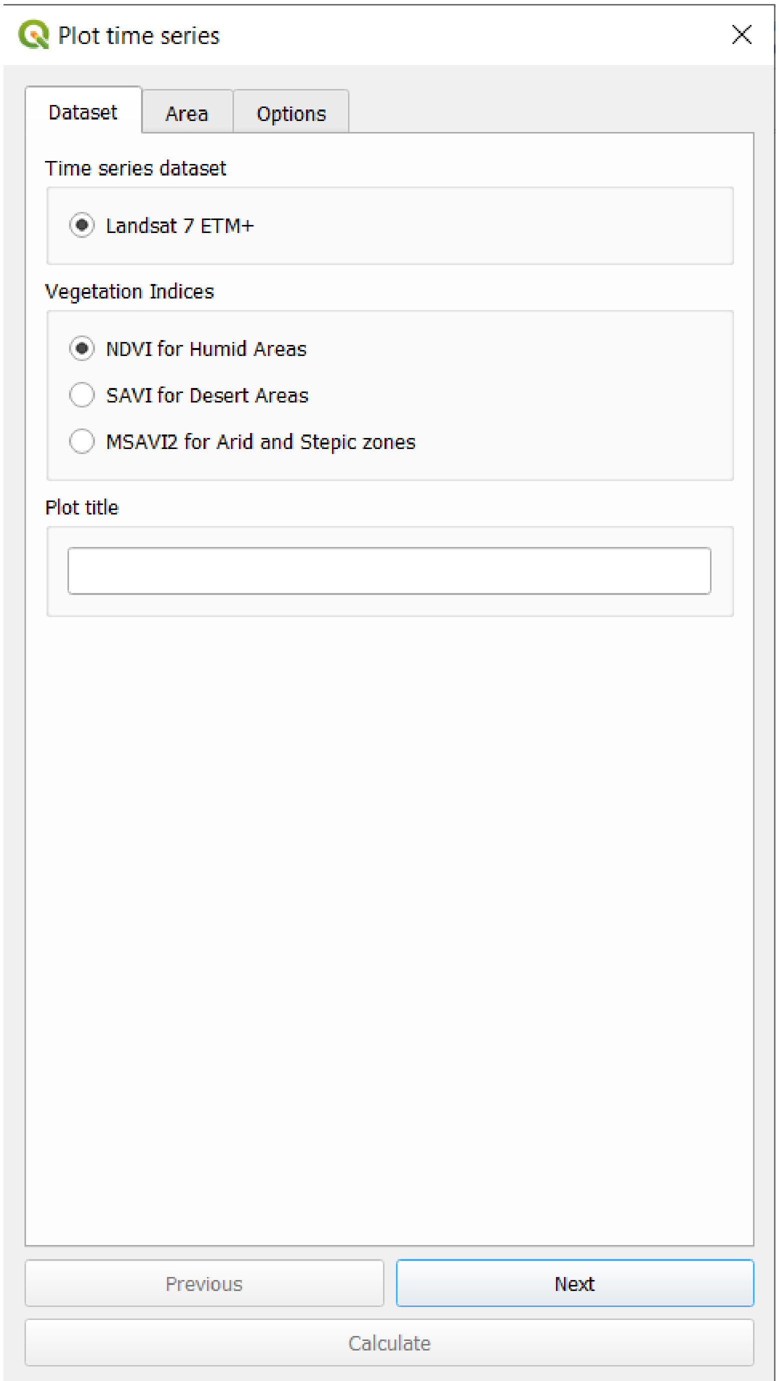
To compute the above vegetation indices, click on the calculator icon . This will open up the "Calculate Indicators" dialog box.



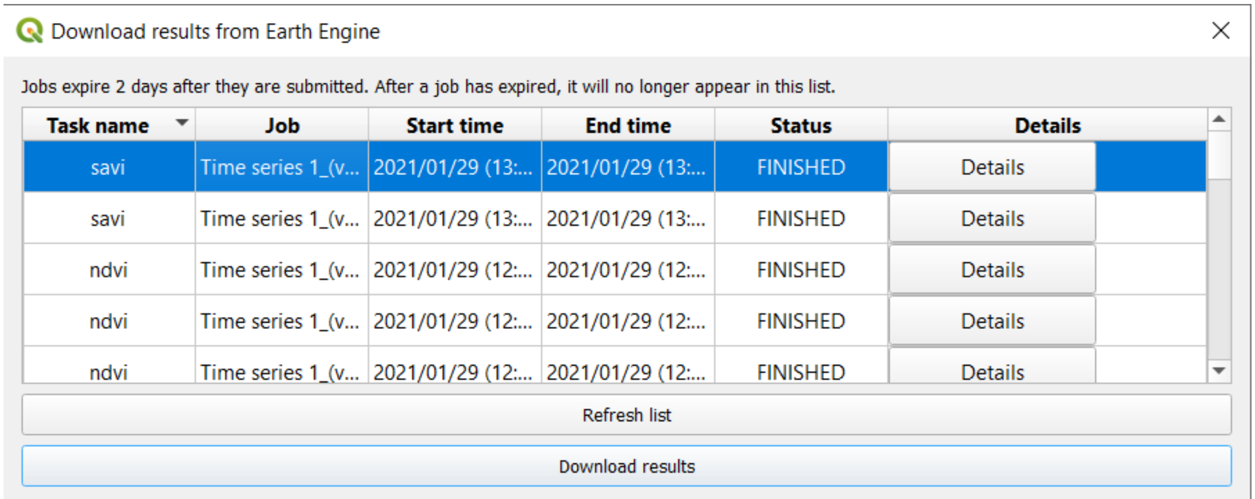
Select the "Vegetation Indices Time-Series" to open the window for this analysis.

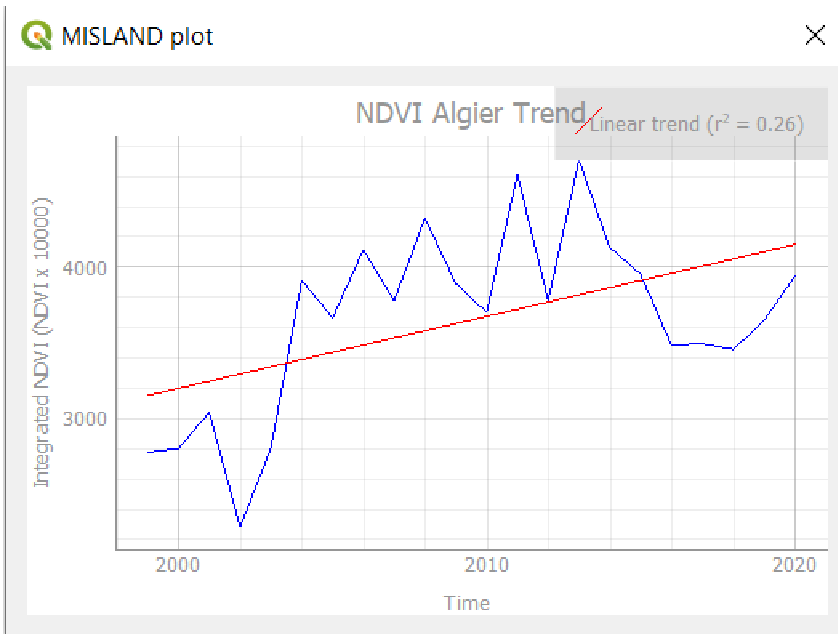


From the list of vegetation indices provided select your desired index and provide a title to your plot. Select the area of interest i.e point or polygon, label your task and calculate the index.



To view your final plot go to "Download results from Earth Engine" and refresh the list, then select the task and download the results. This will plot a graph of your index over time.


Download results from Earth Engine
Jobs expire 2 days after they are submitted. After a job has expired, it will no longer appear in this list.
Task name
Job
Start time
End time
Status
Details
savi | Time series 1_(v... | 2021/01/29 (13:... | 2021/01/29 (13:... | FINISHED | Details
savi | Time series 1_(v... | 2021/01/29 (13:... | 2021/01/29 (13:... | FINISHED | Details
ndvi | Time series 1_(v... | 2021/01/29 (12:... | 2021/01/29 (12:... | FINISHED | Details
ndvi | Time series 1_(v... | 2021/01/29 (12:... | 2021/01/29 (12:... | FINISHED | Details
ndvi | Time series 1_(v... | 2021/01/29 (12:... | 2021/01/29 (12:... | FINISHED | Details
Refresh list
Download results


MISLAND plot
NDVI Algier Trend
Linear trend (r^2 = 0.26)
Integrated NDVI (NDVI x 10000)
4000
3000
2000
2010
2020
Time

CHAPTER

TWENTYTWO

CALCULATE FOREST DEGRADATION

Contents

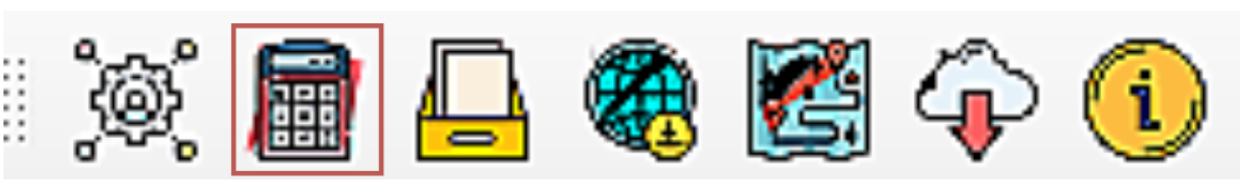
22.1 Compute Forest Fires

Burnt areas and forest fires are be highlighted and mapped out form remotely sensed **Landsat 8 /Sentinel 2** data using the Normalized Burn Ratio (NBR). NBR is designed to highlight burned areas and estimate burn severity. It uses near-infrared (NIR) and shortwave-infrared (SWIR) wavelengths. Before fire events, healthy vegetation has very high NIR reflectance and a low SWIR reflectance. In contrast, recently burned areas show low reflectance in the NIR and high reflectance in the SWIR band.

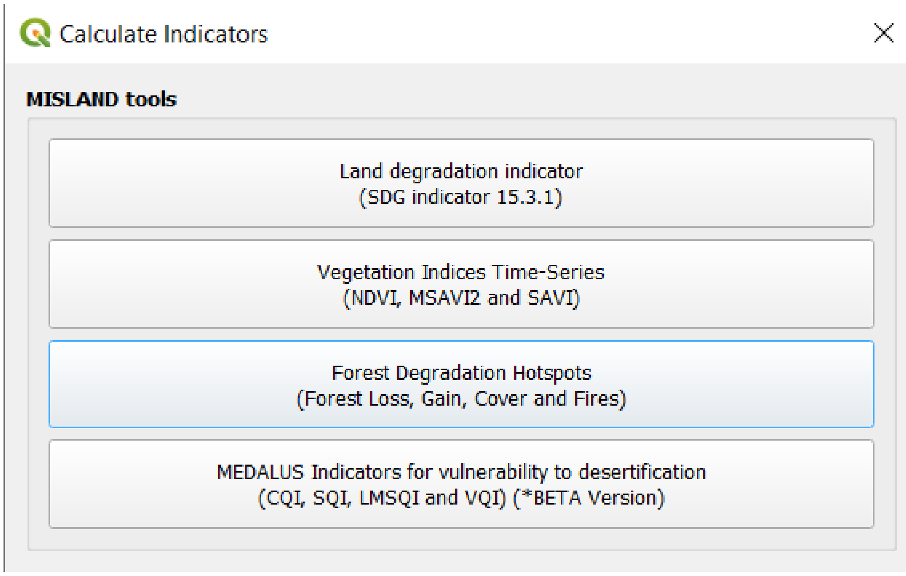
The NBR is be calculated for Landsat/Sentinel images before the fire (pre-fire NBR) and after the fire (post-fire NBR). The **difference between the pre-fire NBR and the post-fire NBR** referred to as **delta NBR (dNBR)** is computed to highlight the areas of forest disturbance by fire event.

Classification of the dNBR is be used for burn severity assessment, as areas with higher dNBR values indicate more severe damage whereas areas with negative dNBR values might show increased vegetation productivity. dNBR is classified according to burn severity ranges proposed by the United States Geological Survey(USGS)

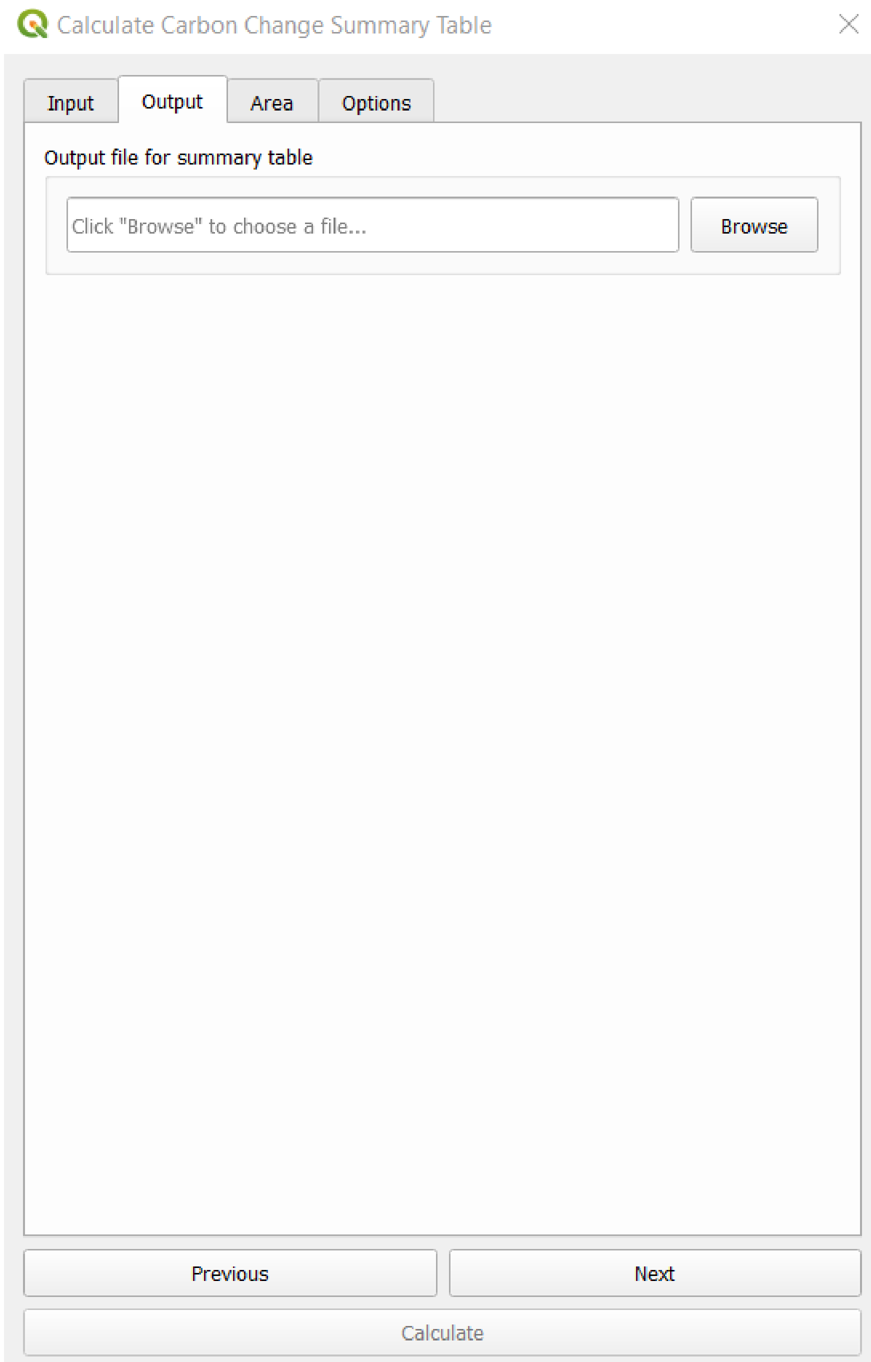
To compute the above forest fires, click on the calculator icon . This will open up the "Calculate Indicators" dialog box.



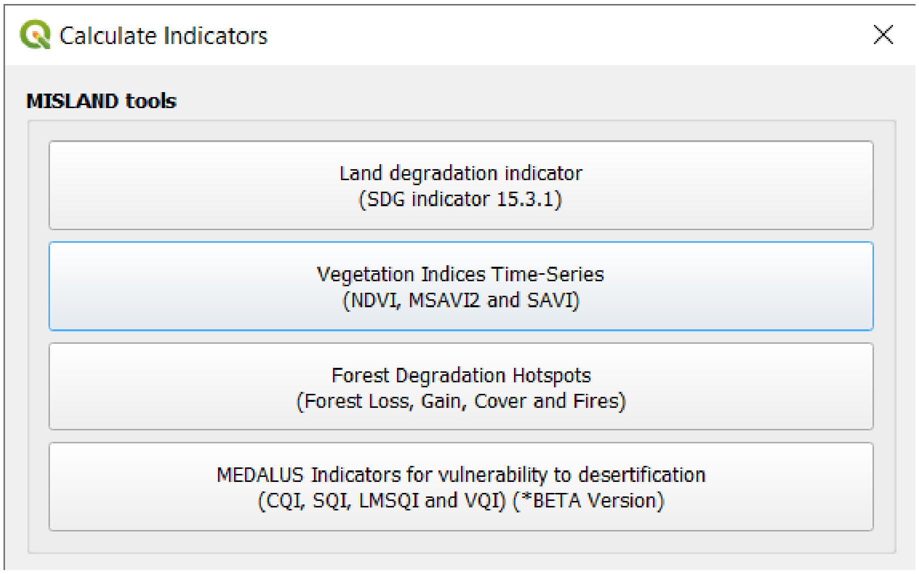
Select the "Forest Degradation Hotspots" to open the window for this analysis then select Forest Fires.



Select either “Landsat 8” or “Sentinel 2”, a Pre-fire and Post-fire perio, the area of interest then calculate your parameters.



To view your final result go to "Download results from Earth Engine" and refresh the list, then select the task and download the results. This will add 3 datasets to the map view i.e Prefire NBR, Postfire NBR and dNBR imagery.



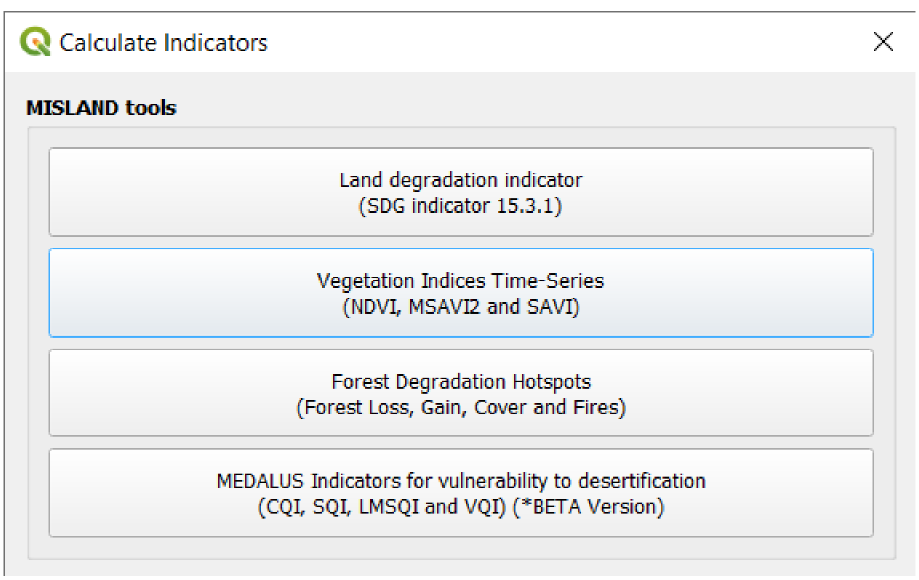
22.2 Compute Forest Change and Total Carbon & Summary

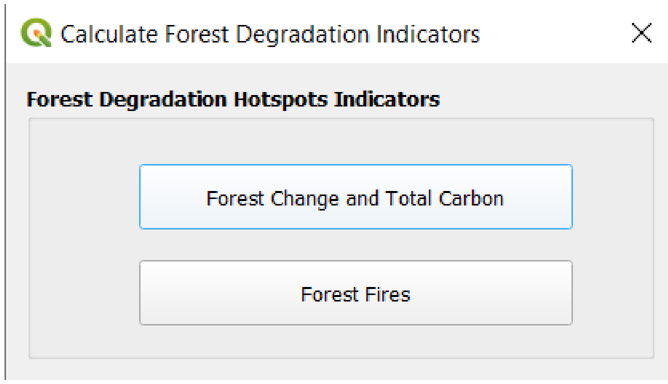
The quantification of the forest gain/loss hotspots will be based on pre-existing high-resolution global maps derived from Hansen Global Forest change dataset that can be accessed using Google Earth Engine API. The maps are produced from time-series analysis of Landsat images characterizing forest extent and change over time.

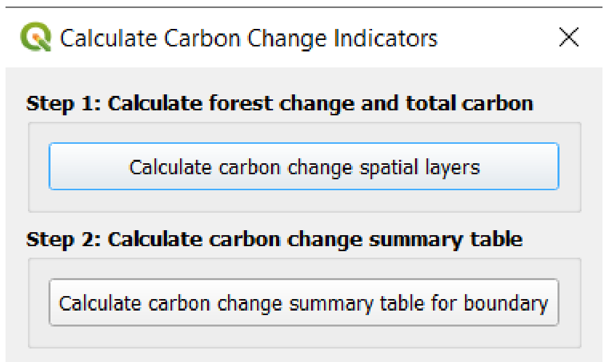
22.2.1 Step 1: Compute Forest Change and Total Carbon

To compute Forest Change and Total Carbon, click on the calculator icon . This will open up the "Calculate Indicators" dialog box.

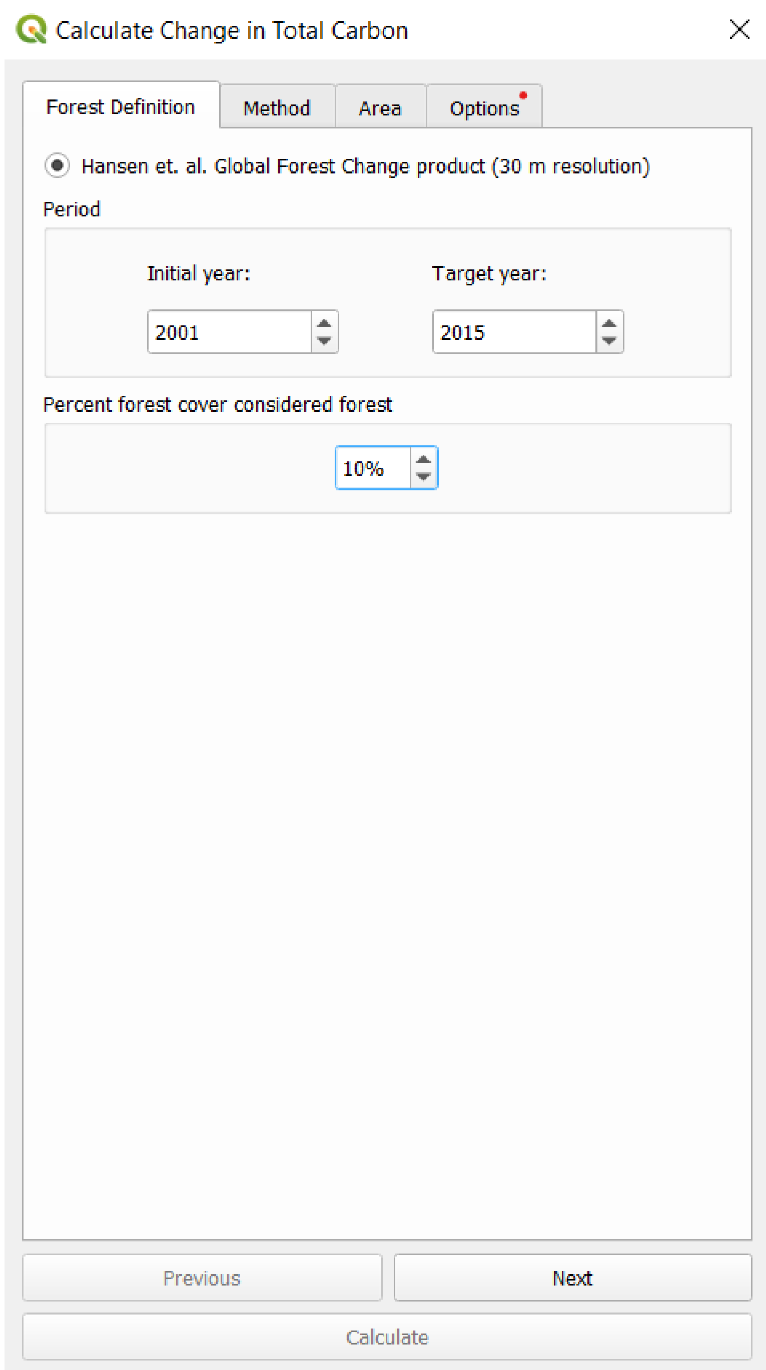
Select Forest Change and Total Carbon and select **Step 1**, calculate Forest Change and Total Carbon to open the window for this analysis.



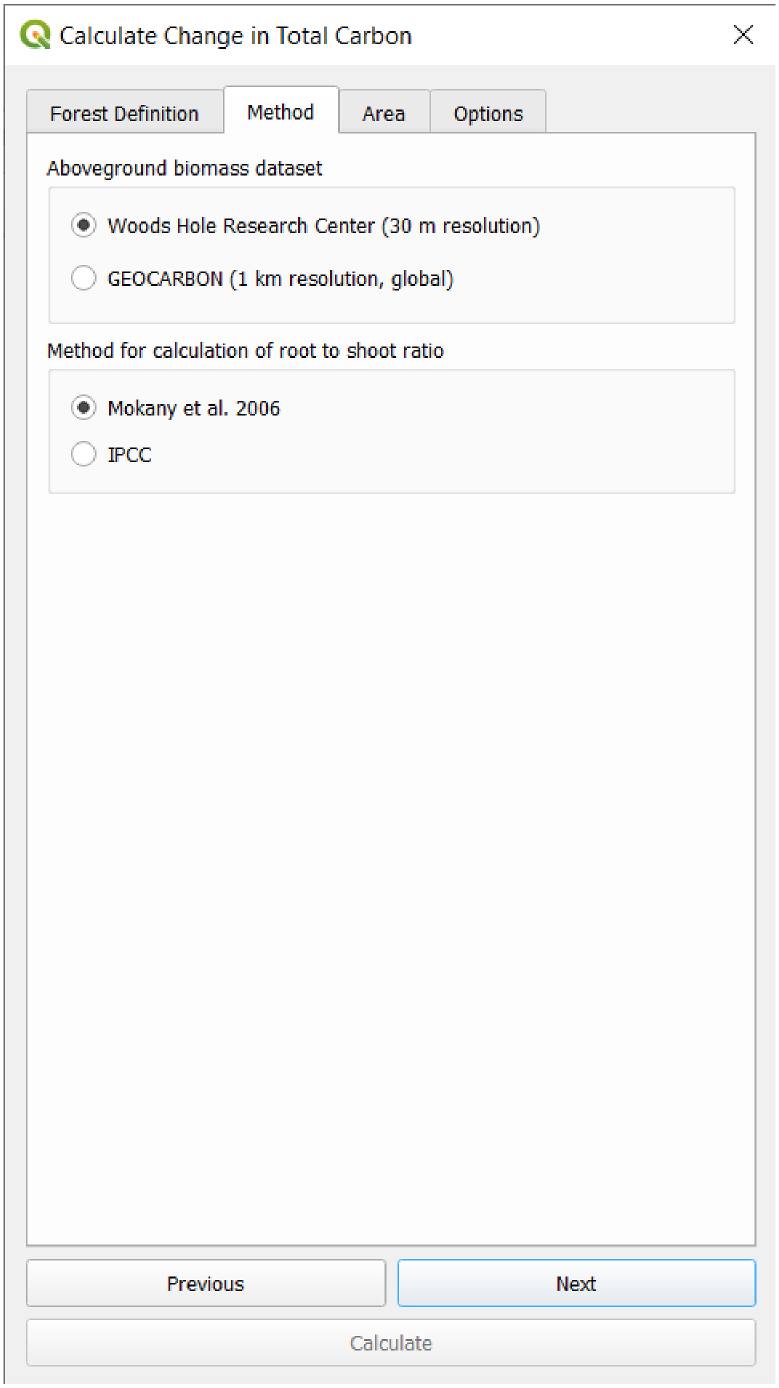




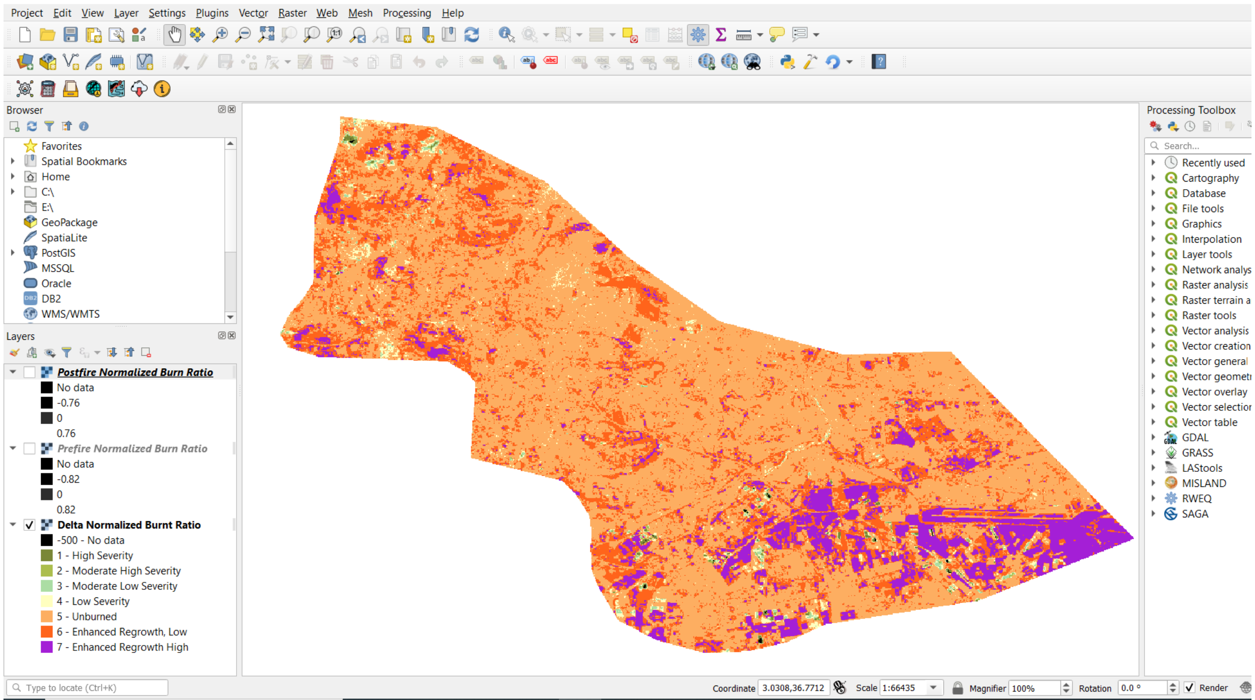
Provide an Initial and Target year for the Hansen Global Forest Change dataset. Also provide a value considered forest cover percentage.



Next select the above ground biomass dataset to be used and the method for calculating the root to shoot ratio. Procees to select the area of interest and label your task then calculate.

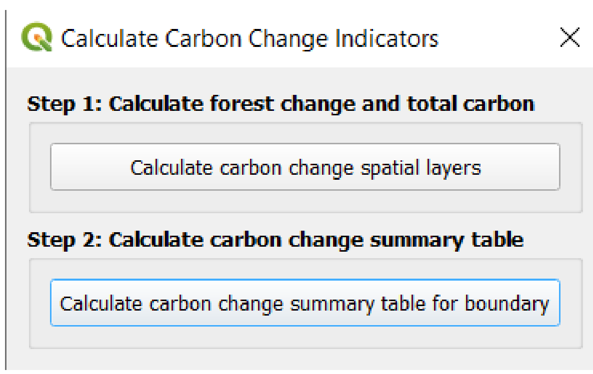


To view your final result go to "Download results from Earth Engine" and refresh the list, then select the task and download the results. This will add 2 datasets to the map view i.e Total carbon and Forest loss

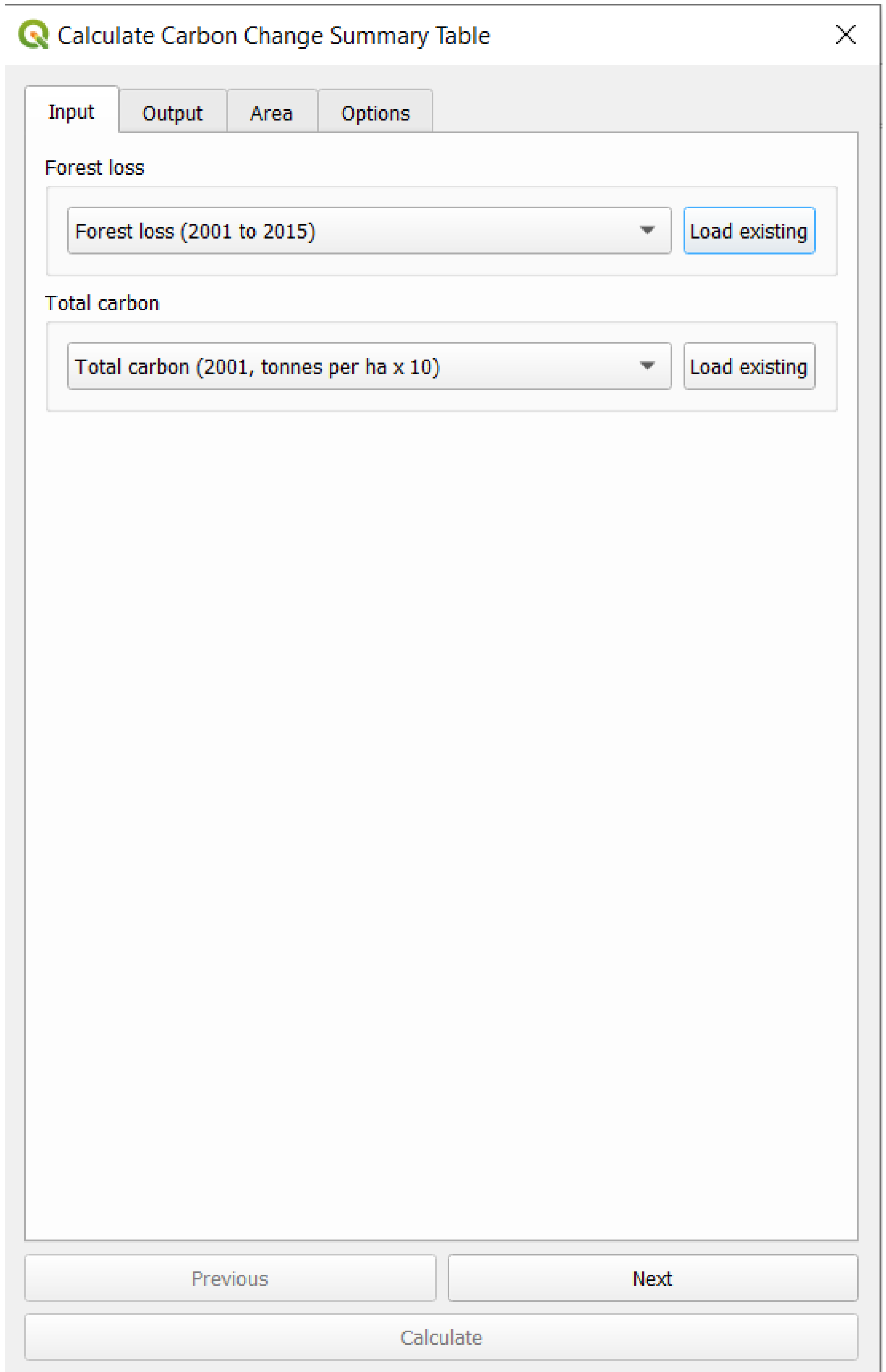


22.2.2 Step 2: Generate Carbon Change Summary

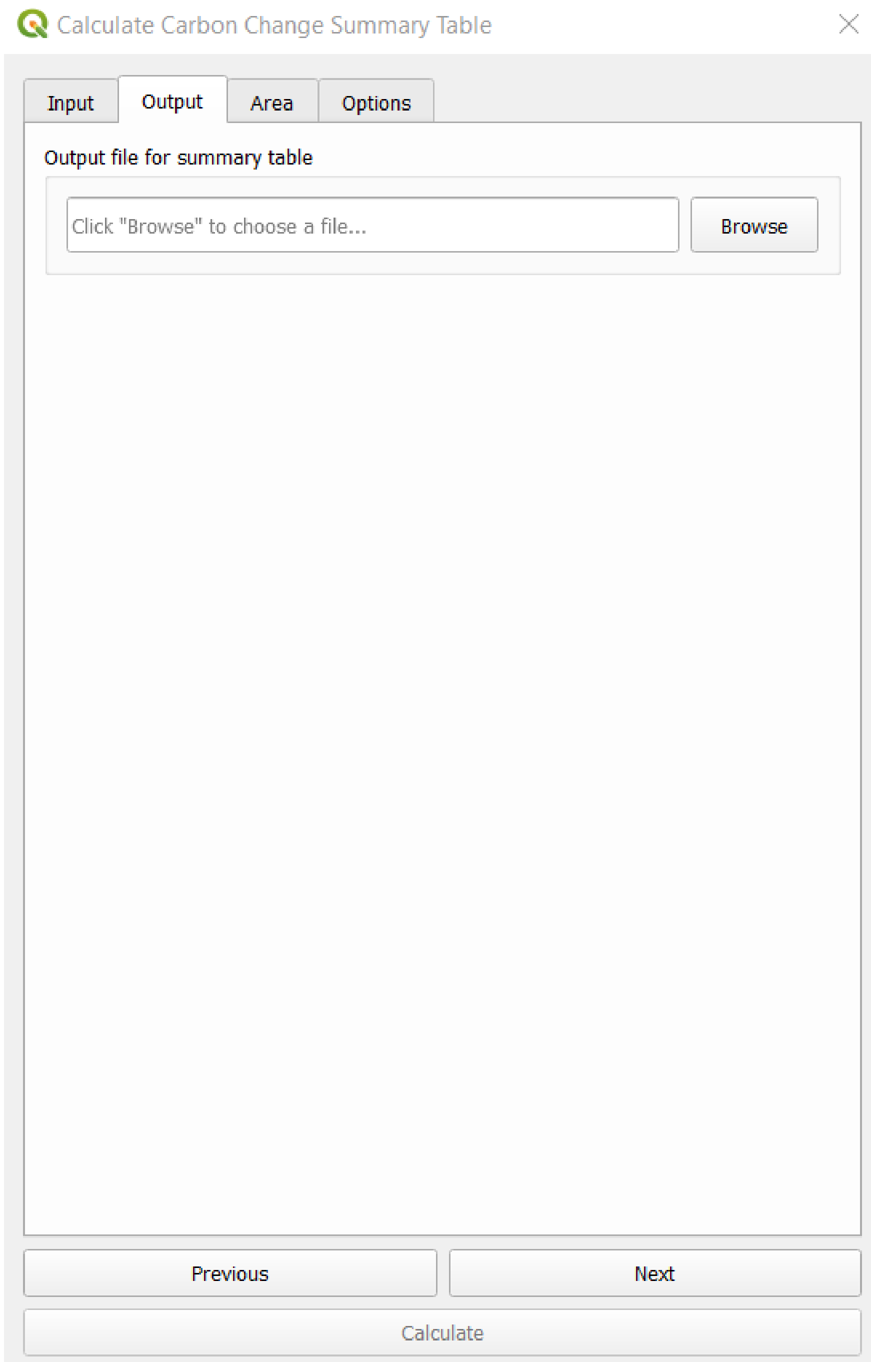
To generate a carbon change summary, select **Step 2**, Calculate carbon change summary table to open the window for analysis.



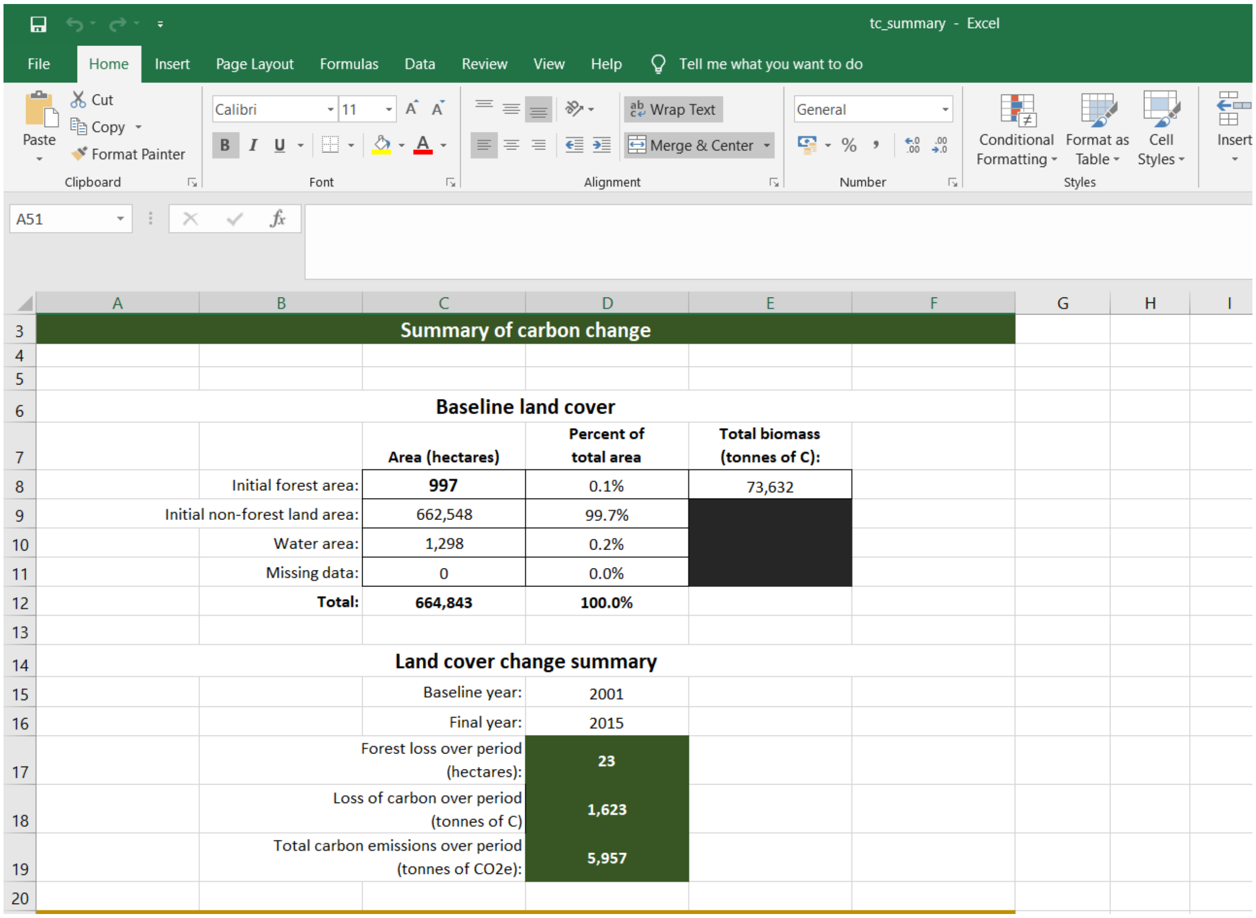
Provide the input datasets generated from step 1 (Auto-detected if already loaded onto the map view).



Set the output location for the summary table file, select the same area of interest as in step 1 and calculate.



A summary file in xlsx format will be generated on completion similar to the one shown below.



	A	B	C	D	E	F
3	Summary of carbon change					
4						
5						
6	Baseline land cover					
7			Area (hectares)	Percent of total area	Total biomass (tonnes of C):	
8		Initial forest area:	997	0.1%	73,632	
9		Initial non-forest land area:	662,548	99.7%		
10		Water area:	1,298	0.2%		
11		Missing data:	0	0.0%		
12		Total:	664,843	100.0%		
13						
14	Land cover change summary					
15			Baseline year:	2001		
16			Final year:	2015		
17			Forest loss over period (hectares):	23		
18			Loss of carbon over period (tonnes of C)	1,623		
19			Total carbon emissions over period (tonnes of CO2e):	5,957		
20						

CHAPTER

TWENTYTHREE

CALCULATE DESERTIFICATION (MEDALUS)

The Mediterranean Desertification and Land Use (MEDALUS) is the name of a project supported by Europe to assess, model and understand the desertification phenomena that increasingly affect the Mediterranean area. It provides a satisfied result about land degradation vulnerability.

The MEDALUS approach identifies environmentally sensitive areas (ESAs) through the Environmentally Sensitive Area Index (ESAI). This index can be used to obtain an in-depth understanding of the parameters causing the desertification threat at a certain point. This approach is simple, robust, widely applicable, and acceptable to new indicators and parameters and can be adjusted to several level scales. , the method was used for the analysis of the main indicators identified to be driving forces of land degradation.

Note: Maintain the same area of interest for all computations within MEDALUS.

Contents

23.1 1. Soil Quality Index (SQI)

Soil is a crucial factor in evaluating the Environmental Sensitivity of an ecosystem, especially in the arid, semi-arid and dry sub-humid zones. Soil properties related to desertification and degradation phenomena affect two principal parameters: (i) water storage and retention capacity; (ii) erosion resistance.

The formula used to compute the SQI is as shown below:

SQI = (Parent material x Depth x Texture x Slope x Drainage x Rock Fragments)^1/6

Default datasets used for sqi are as shown below:

Indicator	Variables	Data Source
Soil Quality Index	Slope	SRTM Digital Elevation
	Soil Depth	Custom User Input
	Rock Fragments	Harmonized World Soil Database
	Parent Material	Digital Sol Map of the world
	Drainage	Harmonized World Soil Database
	Soil Texture	OpenLandMap Soil texture class (USDA system)

Soil Quality Index can be calculated in two ways:

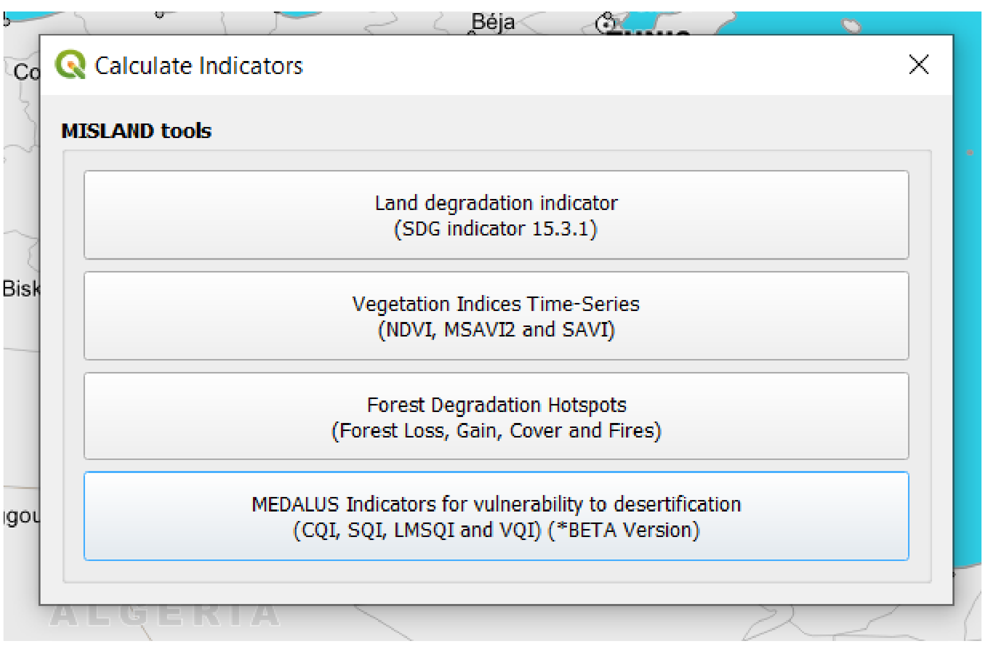
a. Using default data (Computed on Google Earth Engine)

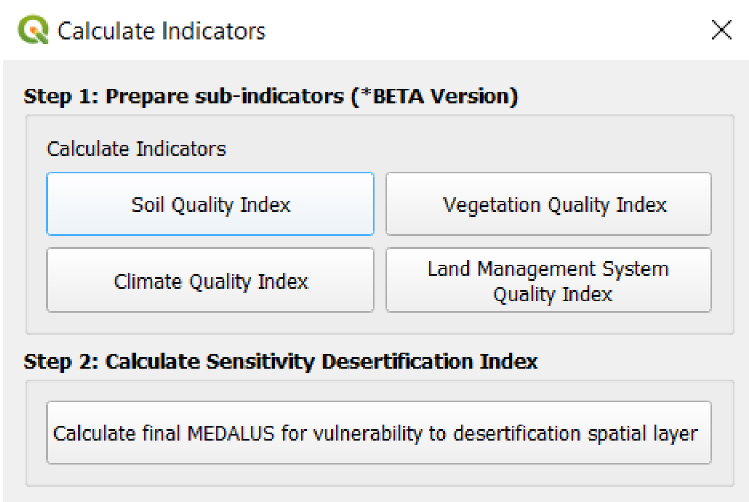
b. Using Custom data (Computed locally on device)

23.1.1 a. Using default data (Computed on Google Earth Engine)

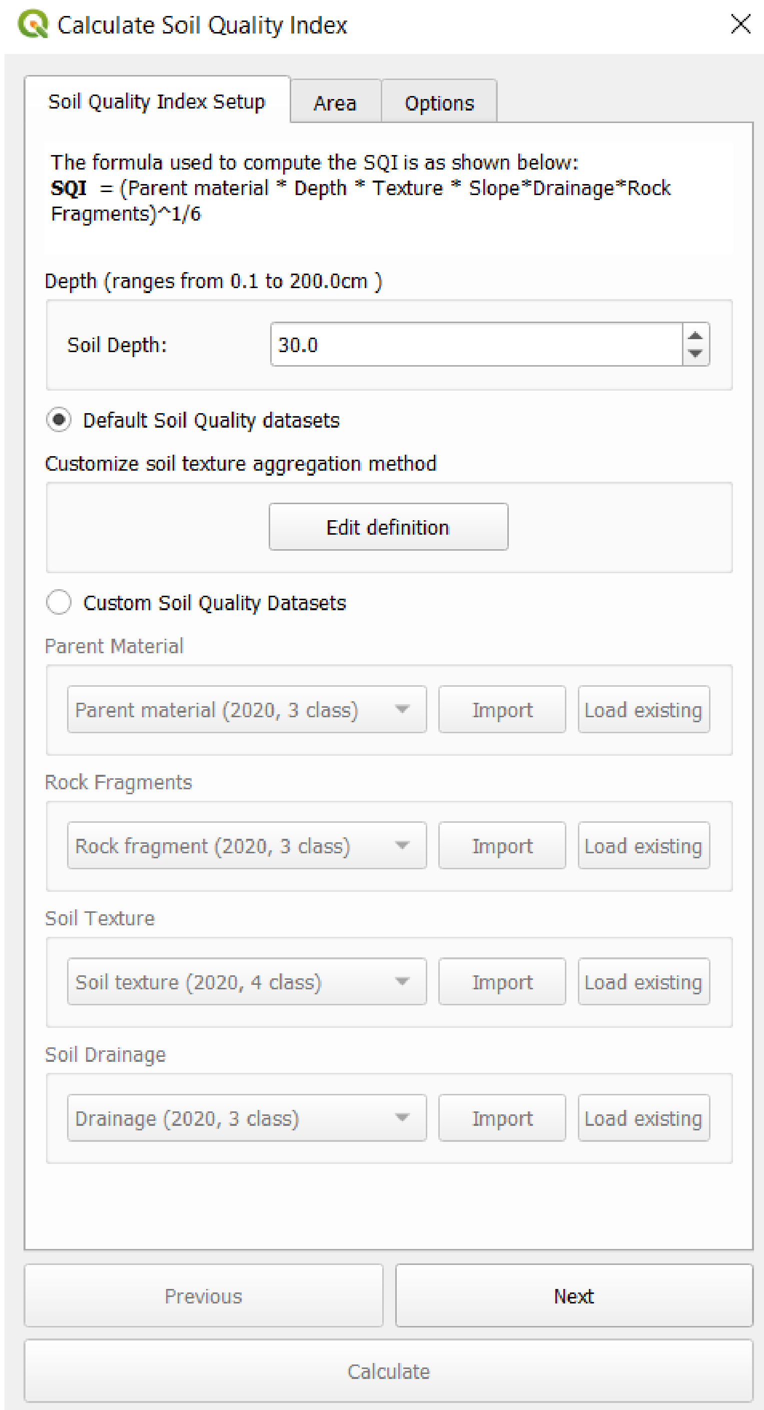
Inorder to compute Soil Quality Index using default data use the following steps.

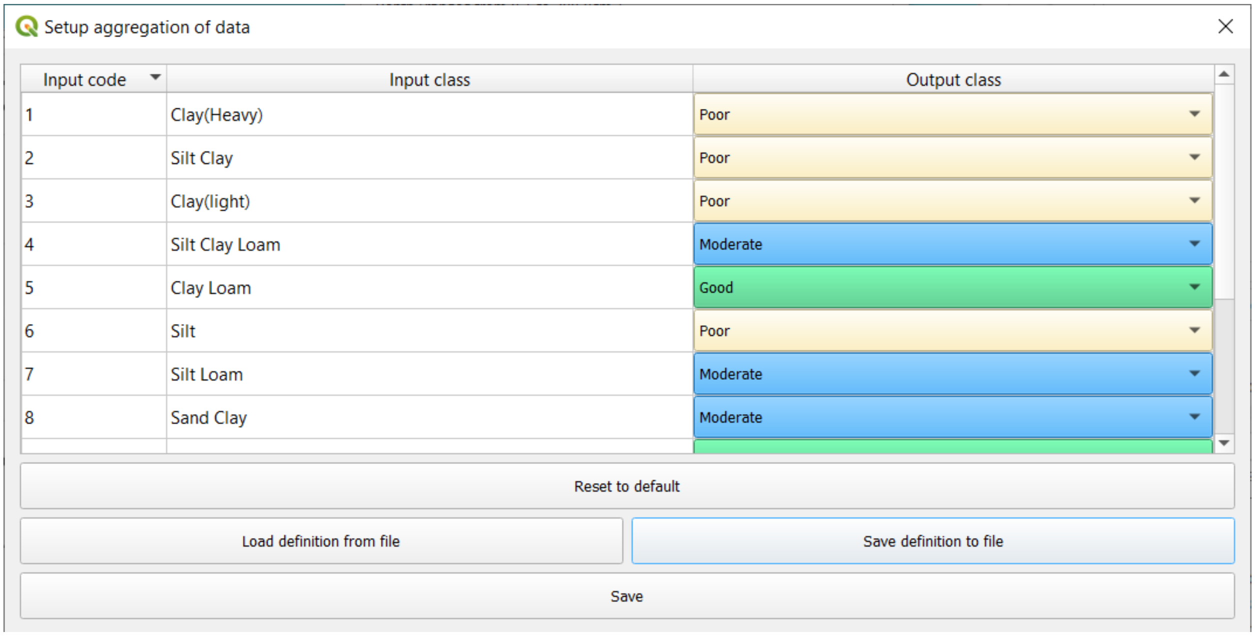
First open the calculate indicators toolbox and select MEDALUS then select the Soil Quality Index option as shown.





Input soil depth (cm) and edit soil texture aggregation method according to case study as shown. This will reclassify soil depth values according to the definition selected.


Calculate Soil Quality Index
Soil Quality Index Setup
Area
Options
The formula used to compute the SQI is as shown below:
SQI = (Parent material * Depth * Texture * Slope*Drainage*Rock Fragments)^1/6
Depth (ranges from 0.1 to 200.0cm)
Soil Depth:
30.0
Default Soil Quality datasets
Customize soil texture aggregation method
Edit definition
Custom Soil Quality Datasets
Parent Material
Parent material (2020, 3 class)
Import
Load existing
Rock Fragments
Rock fragment (2020, 3 class)
Import
Load existing
Soil Texture
Soil texture (2020, 4 class)
Import
Load existing
Soil Drainage
Drainage (2020, 3 class)
Import
Load existing
Previous
Next
Calculate



Proceed to select an area of interest and run the computation.

23.1.2 b. Using Custom data (Computed locally on device)

This step requires the data to be available locally.

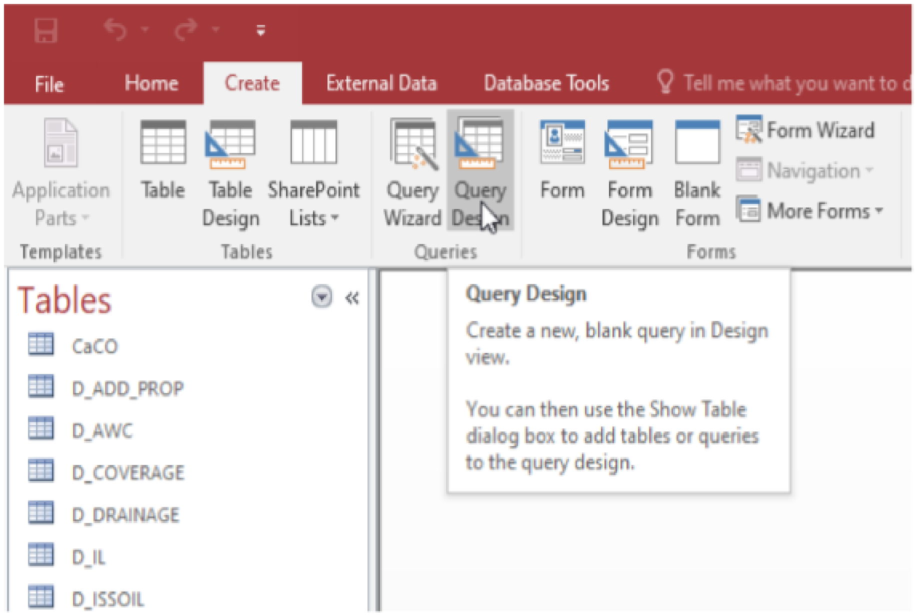
Raw Data Download

Inorder to prepare local data, `Harmonized World Soil Database`

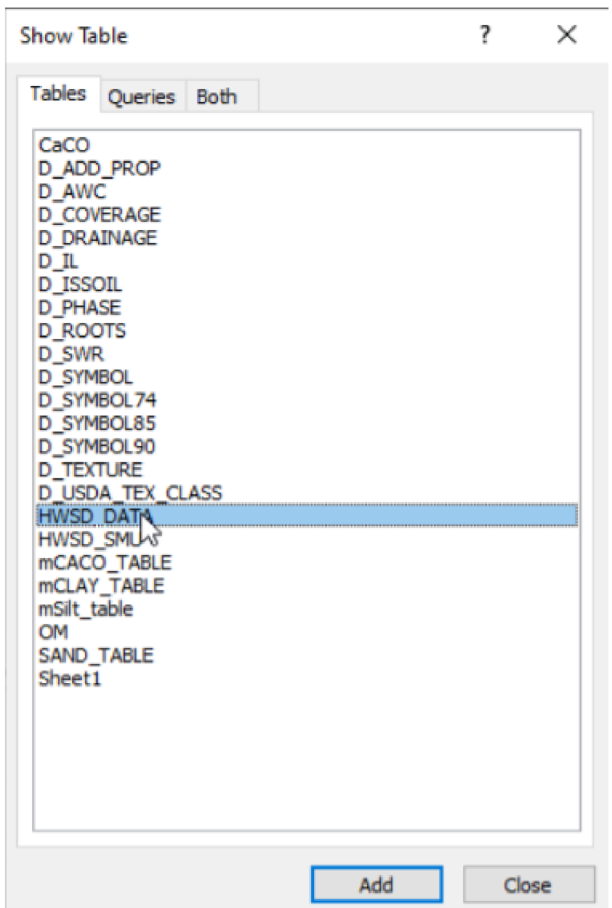
Extracting Soil Drainage, Soil Texture and Rock Fragment Layers from HWSD DATA

To extract the drainage, texture and soil group variables from the HWSD data follow these simple steps:

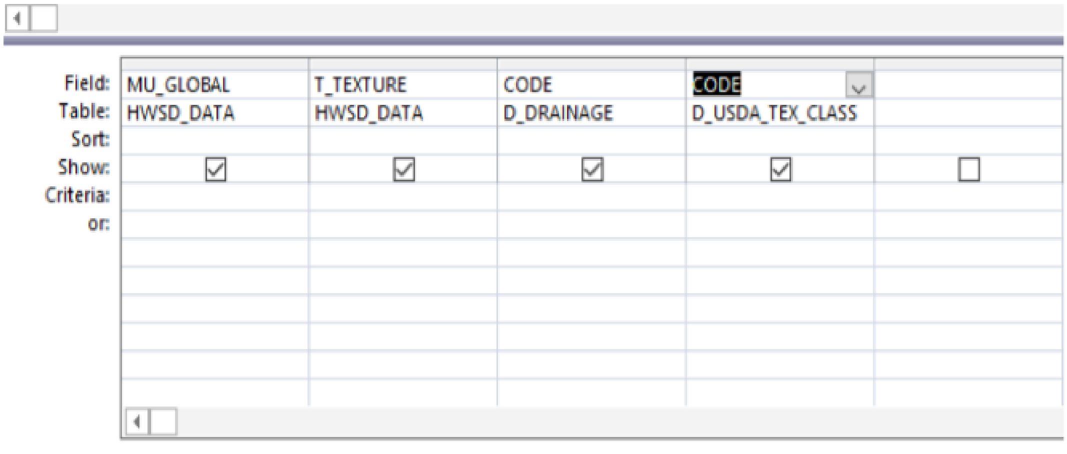
1. Open the HWSD data table on Microsoft Access. The variable to be extracted are D DRAINAGE(code), D USDA TEX CLASS(code), and T GRAVEL. To initiate the extraction, create a query design in the 'show table' dialogue that pops up select HWSD DATA, D DRAINAGE and D USDA TEX CLASS tables.



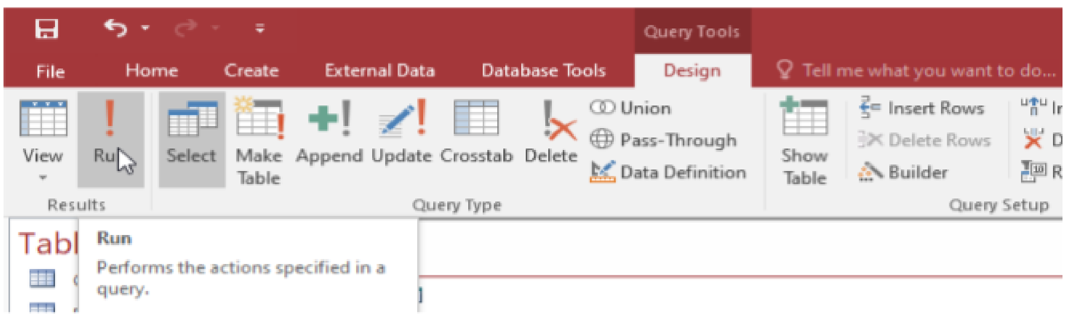
In the 'show table' dialogue that pops up select HWSD DATA, D DRAINAGE and D USDA TEX CLASS tables

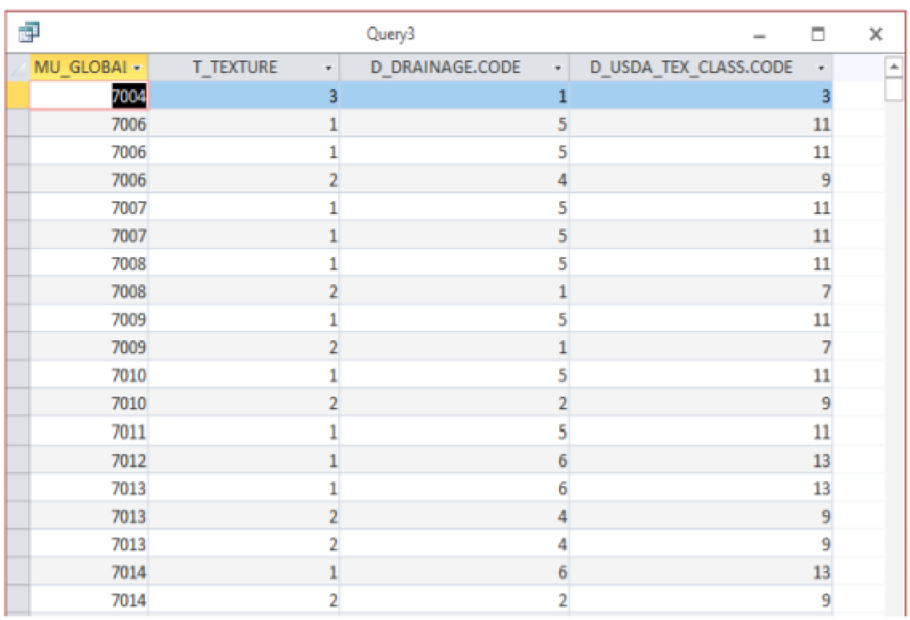


2. From the HWSD DATA select the MU GLOBAL and T GRAVEL variables. From the D DRAINAGE and D USDA TEX CLASS tables select the CODE variable. The resulting query design should have the Fields row populated with the selected variables for their respective table on the Table row



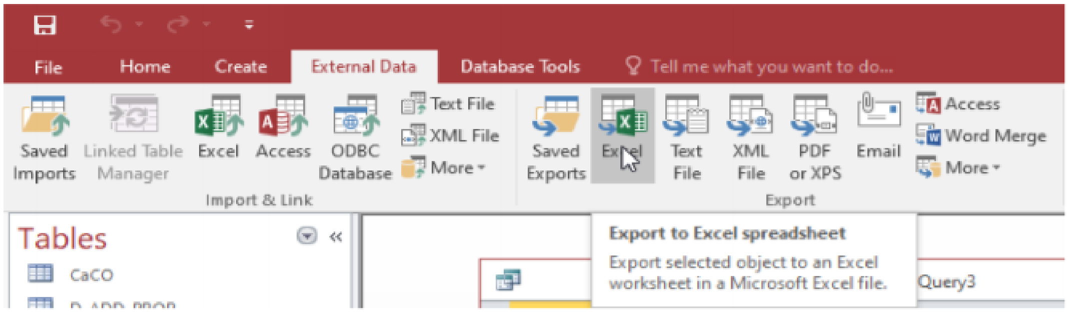
3. Click run and the resulting table should have 4 columns populated with data from the selected variables

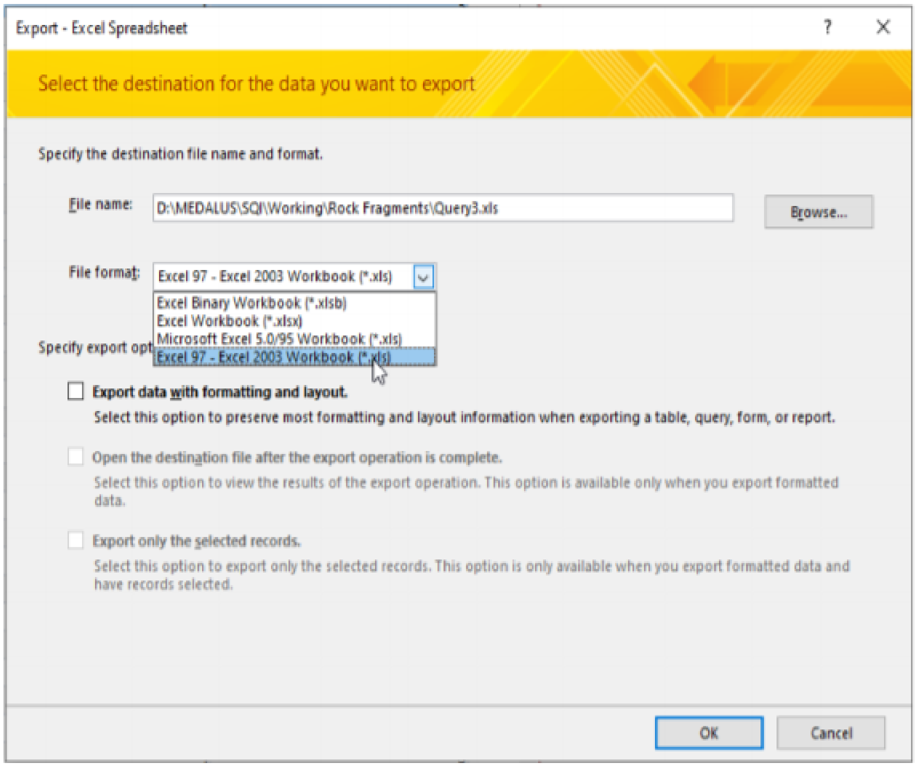



Query3

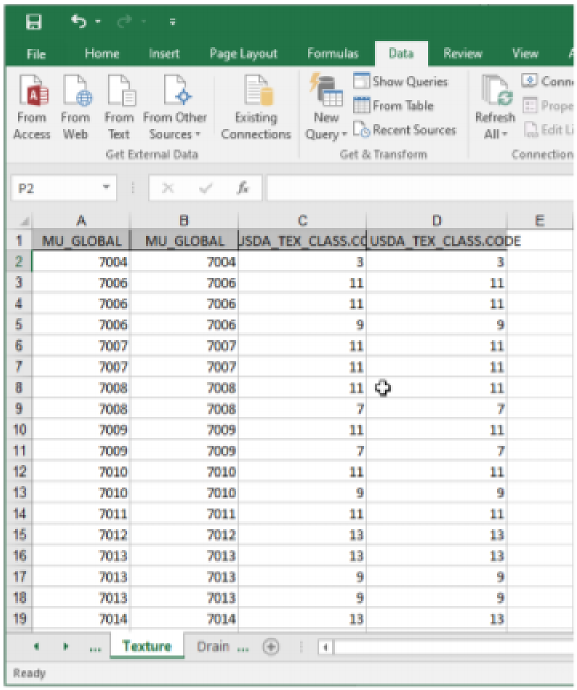
MU_GLOBAL	T_TEXTURE	D_DRAINAGE.CODE	D_USDA_TEX_CLASS.CODE
7004	3	1	3
7006	1	5	11
7006	1	5	11
7006	2	4	9
7007	1	5	11
7007	1	5	11
7008	1	5	11
7008	2	1	7
7009	1	5	11
7009	2	1	7
7010	1	5	11
7010	2	2	9
7011	1	5	11
7012	1	6	13
7013	1	6	13
7013	2	4	9
7013	2	4	9
7014	1	6	13
7014	2	2	9

4. Export the table to MS Excel under the 'External Data' tab as shown below. On the dialogue that pops up, give the export table an appropriate name and select 'Excel 97 - Excel 2003 Workbook' as the export file format

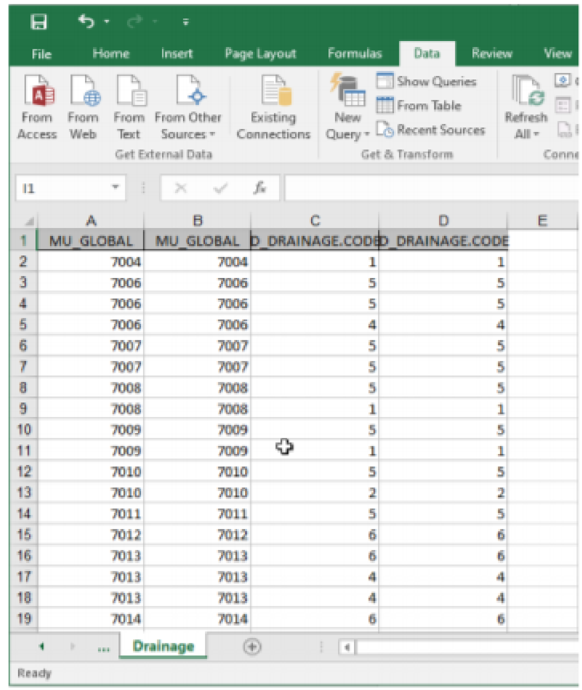




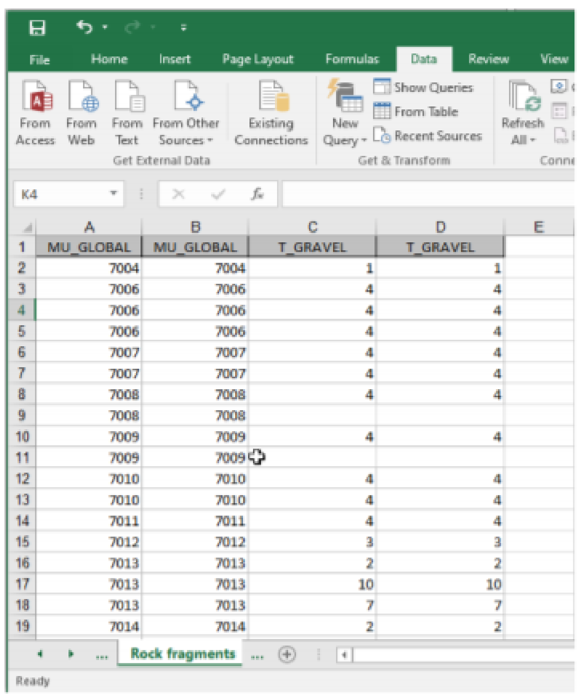
5. In MS Excel, open the just exported sheet and in separate sheets copy the MU Global field alongside the 3 variables of interest (Drainage, Gravel, Texture class); Paste the variables separately as shown below to facilitate joining them to the raster dataset in Q-GIS software.



	A	B	C	D	E
1	MU_GLOBAL	MU_GLOBAL	JSDA_TEX_CLASS.CC	USDA_TEX_CLASS.CODE	
2	7004	7004	3	3	
3	7006	7006	11	11	
4	7006	7006	11	11	
5	7006	7006	9	9	
6	7007	7007	11	11	
7	7007	7007	11	11	
8	7008	7008	11	11	
9	7008	7008	7	7	
10	7009	7009	11	11	
11	7009	7009	7	7	
12	7010	7010	11	11	
13	7010	7010	9	9	
14	7011	7011	11	11	
15	7012	7012	13	13	
16	7013	7013	13	13	
17	7013	7013	9	9	
18	7013	7013	9	9	
19	7014	7014	13	13	

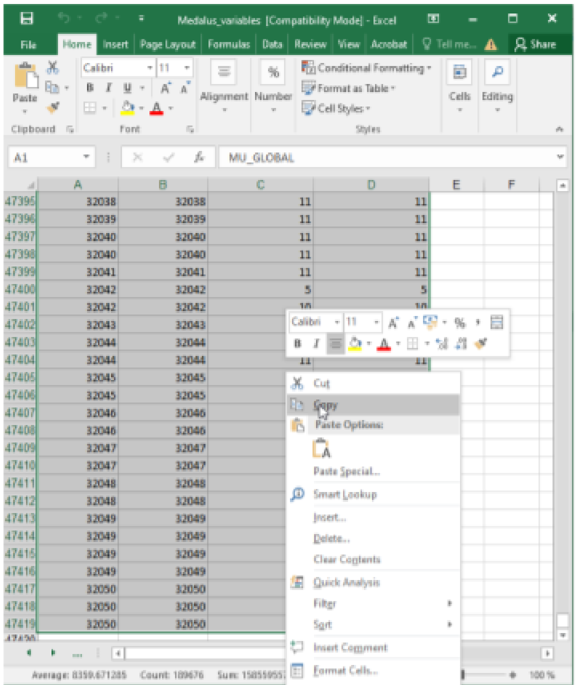


	A	B	C	D	E
1	MU_GLOBAL	MU_GLOBAL	D_DRAINAGE.COD	D_DRAINAGE.CODE	
2	7004	7004	1	1	
3	7006	7006	5	5	
4	7006	7006	5	5	
5	7006	7006	4	4	
6	7007	7007	5	5	
7	7007	7007	5	5	
8	7008	7008	5	5	
9	7008	7008	1	1	
10	7009	7009	5	5	
11	7009	7009	1	1	
12	7010	7010	5	5	
13	7010	7010	2	2	
14	7011	7011	5	5	
15	7012	7012	6	6	
16	7013	7013	6	6	
17	7013	7013	4	4	
18	7013	7013	4	4	
19	7014	7014	6	6	



	A	B	C	D	E
1	MU_GLOBAL	MU_GLOBAL	T_GRAVEL	T_GRAVEL	
2	7004	7004	1	1	
3	7006	7006	4	4	
4	7006	7006	4	4	
5	7006	7006	4	4	
6	7007	7007	4	4	
7	7007	7007	4	4	
8	7008	7008	4	4	
9	7008	7008			
10	7009	7009	4	4	
11	7009	7009			
12	7010	7010	4	4	
13	7010	7010	4	4	
14	7011	7011	4	4	
15	7012	7012	3	3	
16	7013	7013	2	2	
17	7013	7013	10	10	
18	7013	7013	7	7	
19	7014	7014	2	2	

6. For each of the newly created sheets, copy the tables in MS Excel and paste to MS Access



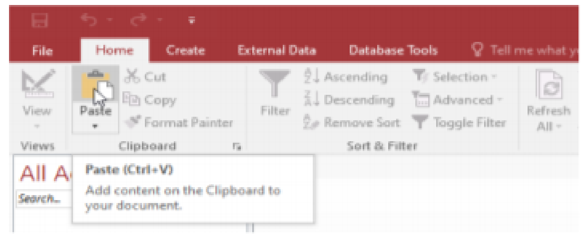
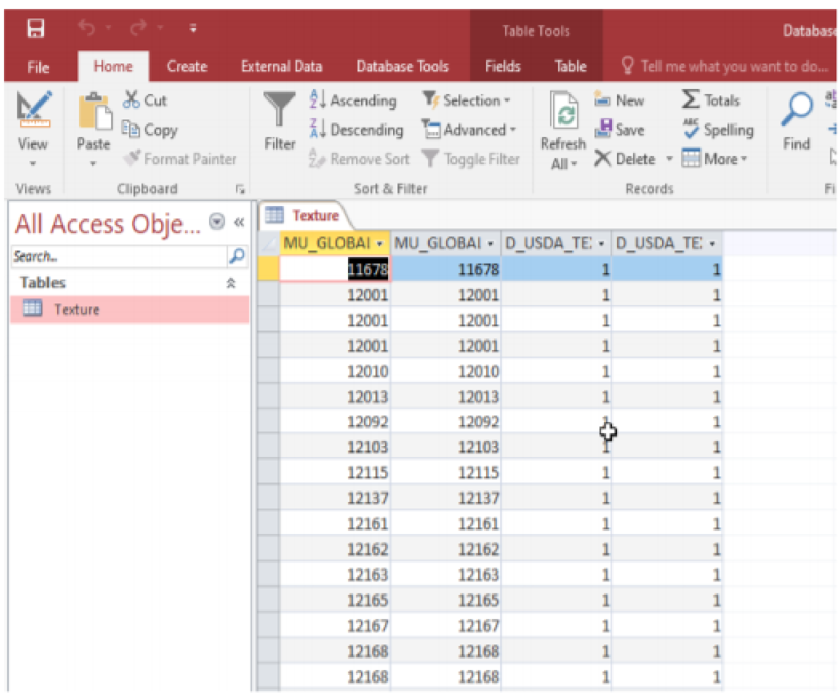
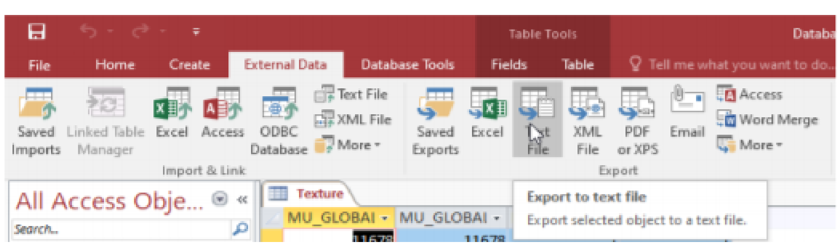


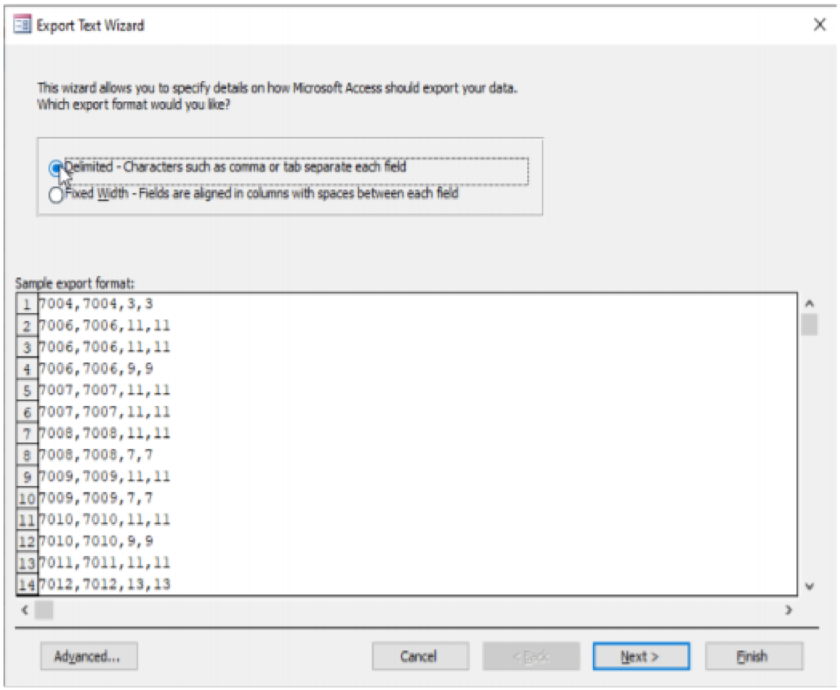
Figure 2.12: Pasting on MS Access



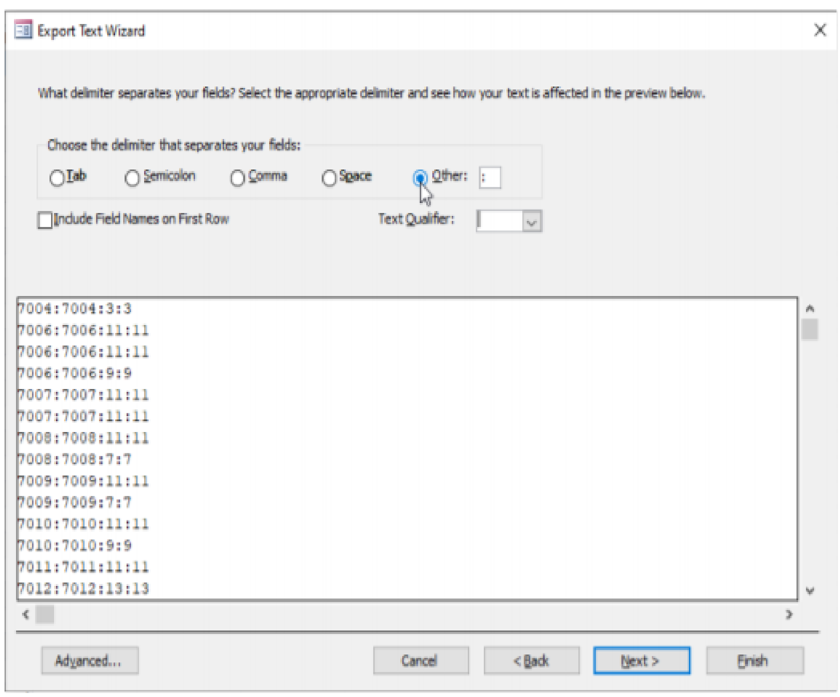
7. Under the Export data tab, select the Export to text file option as shown below.



8. On the Export text wizard that pops us set the export text as delimited text by checking the Delimited options then click next.

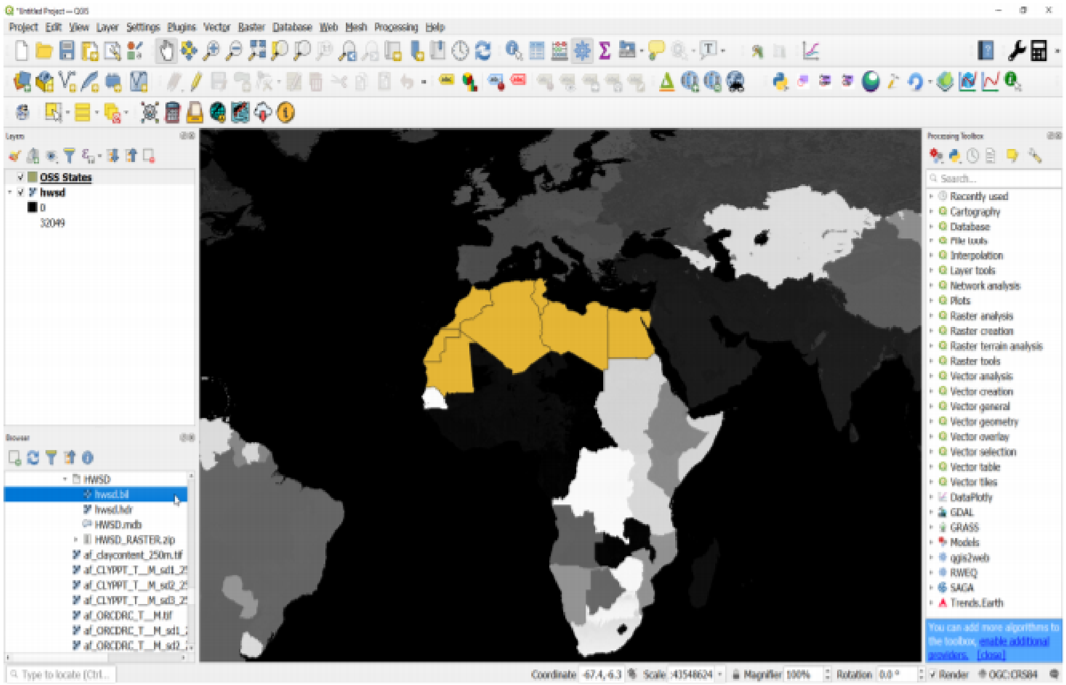


9. On the Export text wizard that pops us set the export text as delimited text by checking the Delimited options fig. 2.15 then click next.

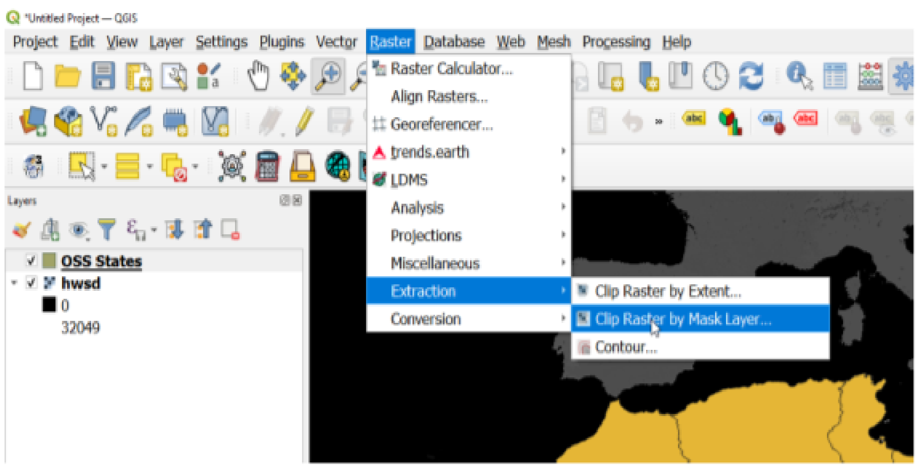


Click on next to finish the export. Repeat steps 6 to 9 for all the other remaining variables and save the text files. The text files are used to assign pixel values to the HWSD.bil raster in Q-GIS.

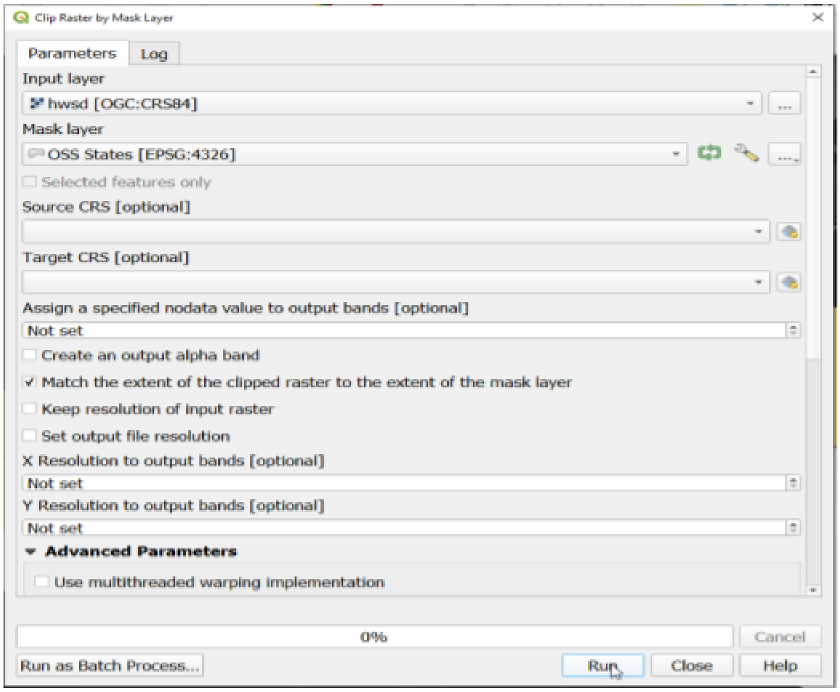
10. Open the HWSD.bil raster file on Qgis together with the vector data for the OSS North Africa States in Q-GIS



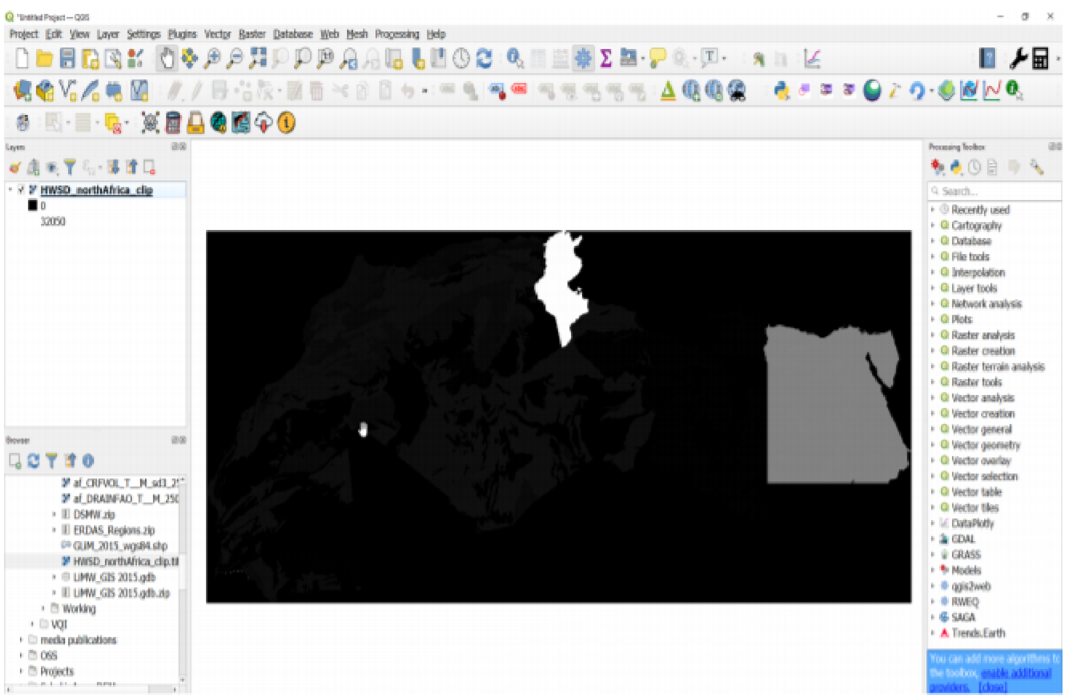
11. Under the raster tab on the Q-GIS menu bar navigate to 'Extraction' > 'Extract by Mask Layer'



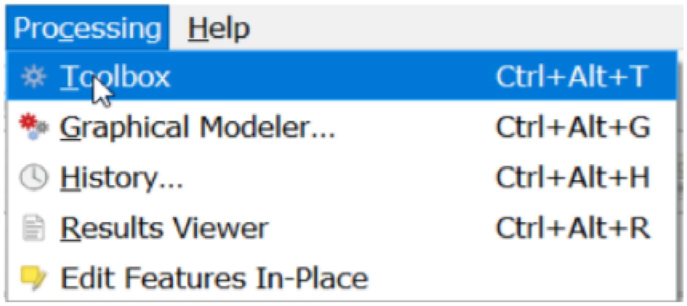
12. In the Clip Raster by Mask Layer dialogue box, select hwsd raster as the input layer and the Vector layer as your Mask Layer. Save the output with the desired name to your desired location.



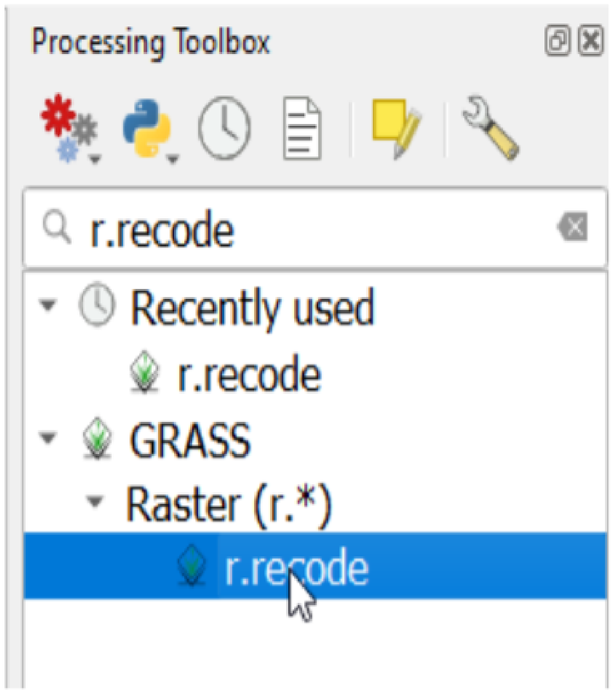
The clipped raster should is as shown below:



13. On the Q-GIS Menu bar, click on Processing and select the toolbox (or use keyboard shortcut Ctrl+Alt+T) to open the processing toolbox.

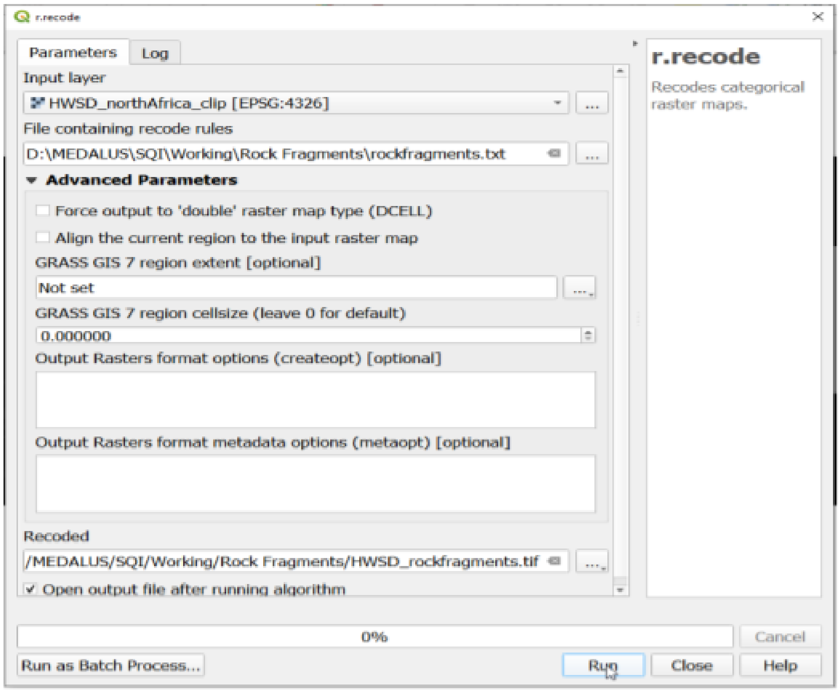


14. On the processing toolbox, search for the GRASS-GIS r.recode tool

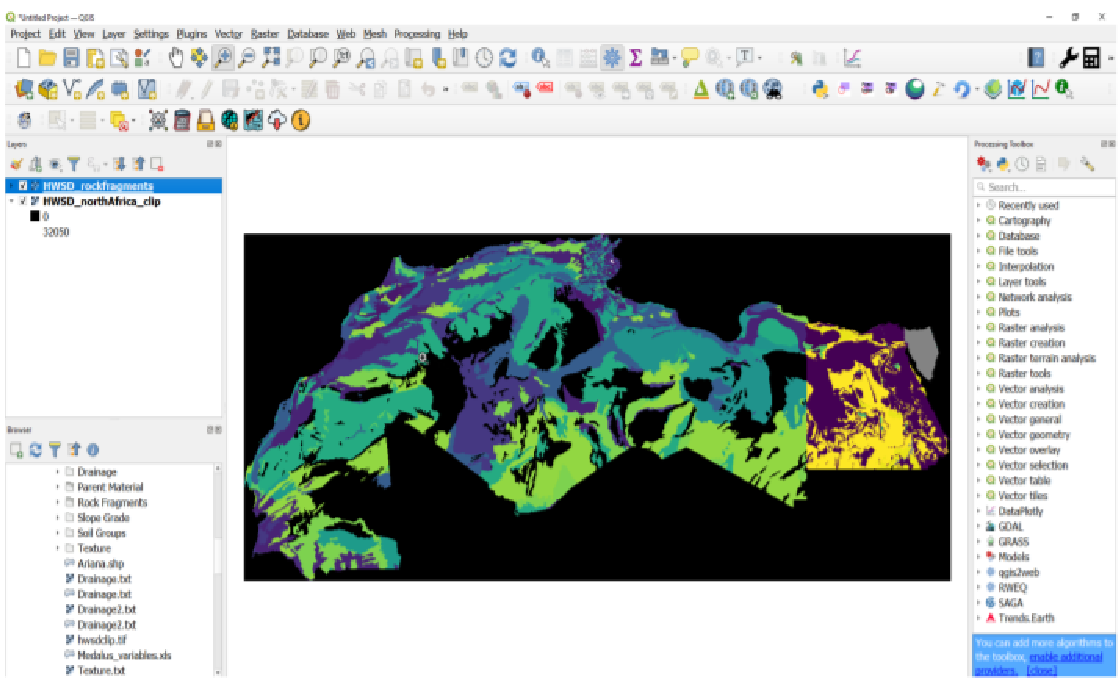


15. On the r.recode dialogue, select the clipped HWSD data as the input layer and the .txt

    file previously prepared as the file containing the recode rules(for this example we will use the rock fragment). Save the output to your desired location and click run.

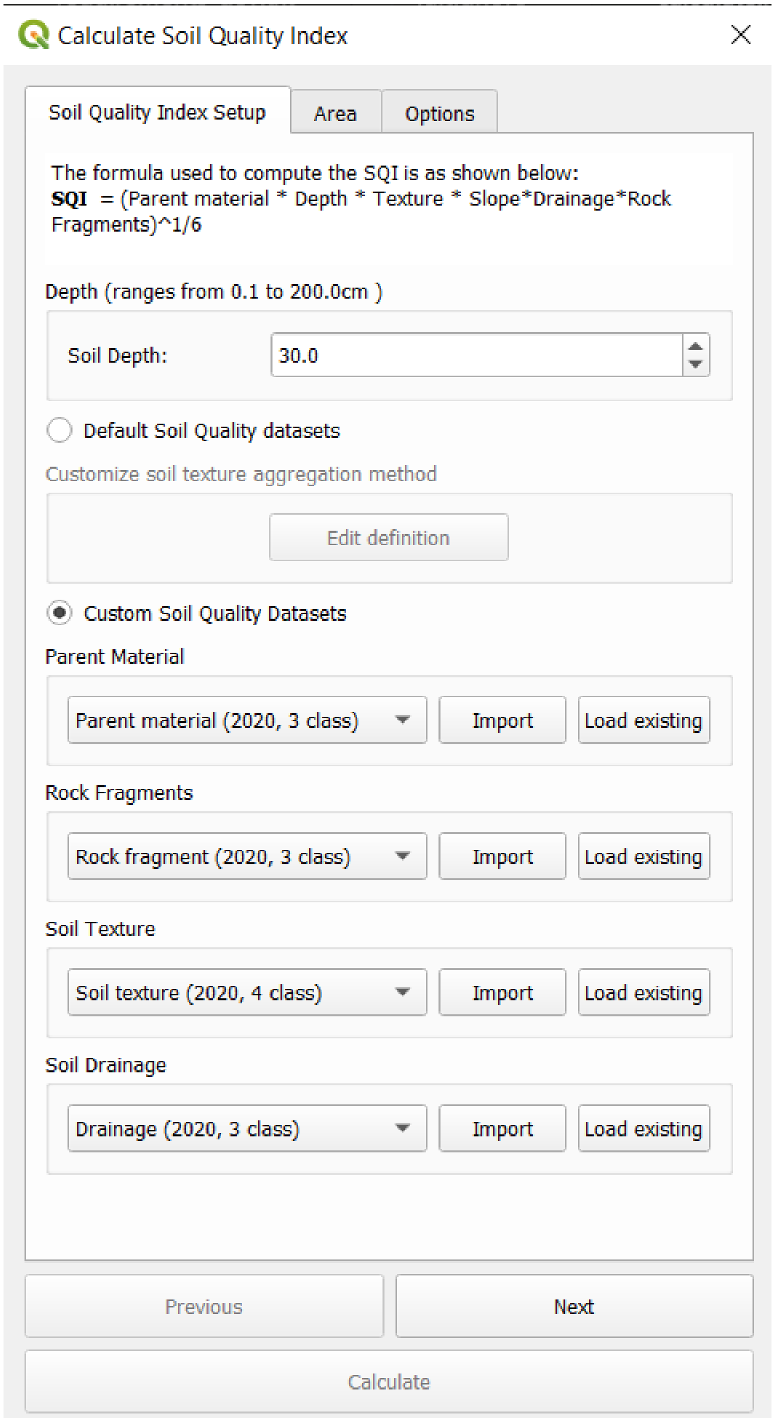


Using the HWSD cliped raster as input layer, repeat the step 14 and 15 with the appropriate recoding rules to extract the remaining variables and save the outputs for the other datasets.

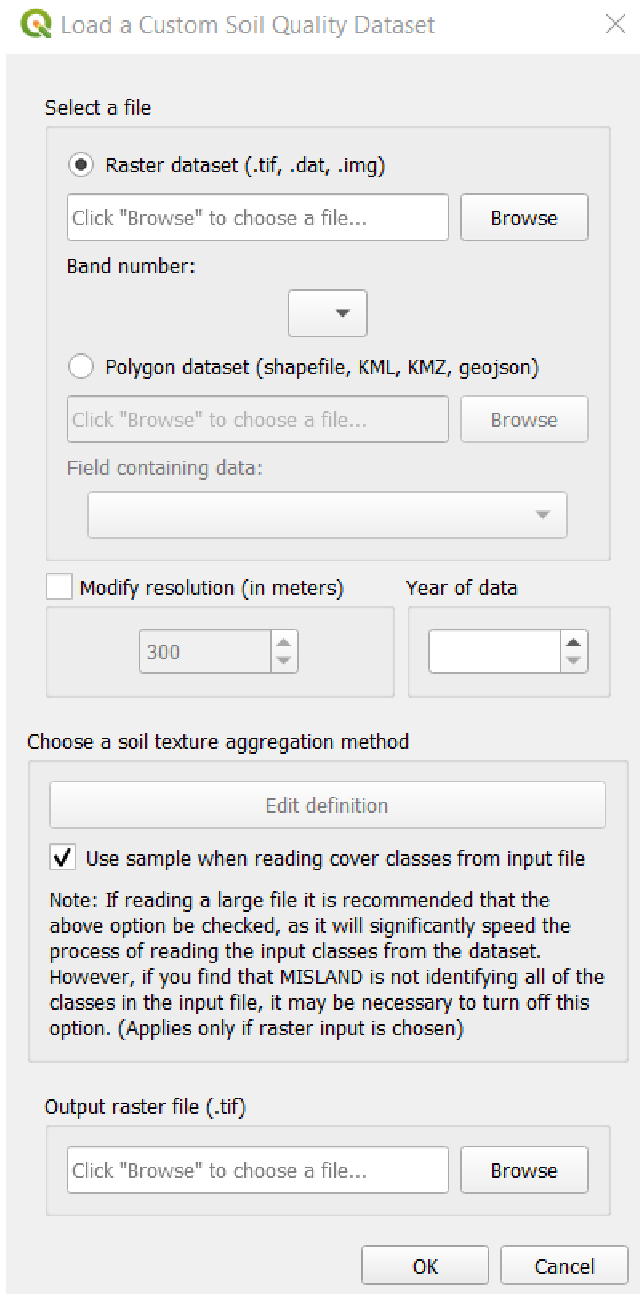


Compute Soil Quality Index

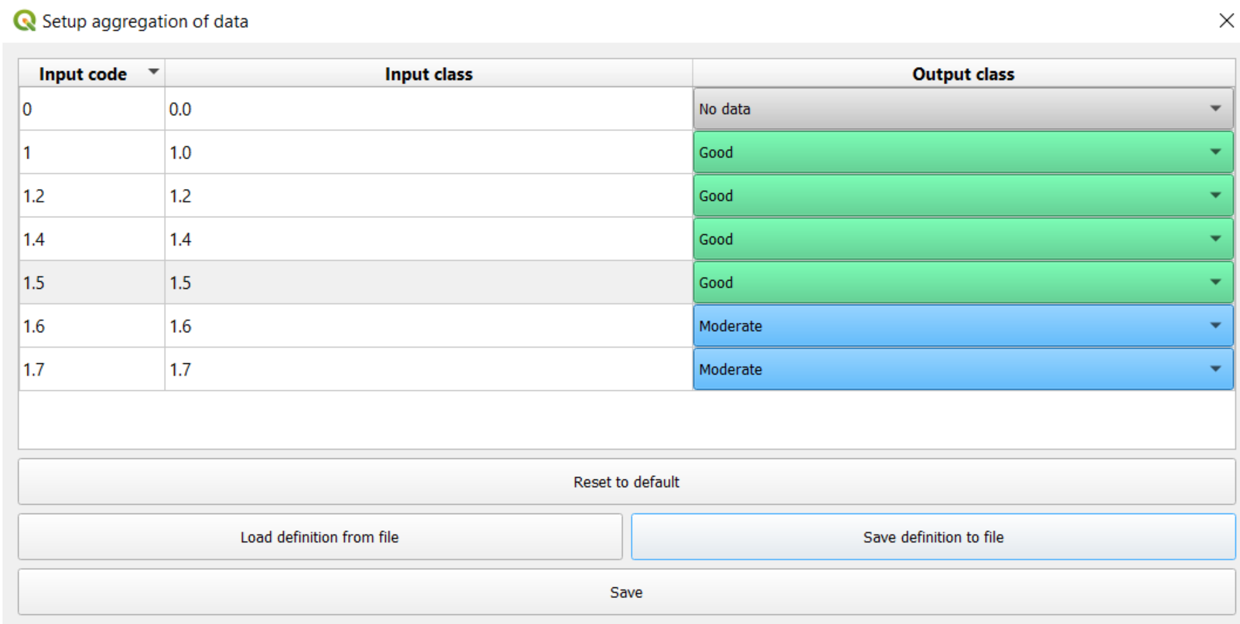
First Input soil depth (cm) then Select Custom soil quality datasets instead of default and import sqi datasets as below.



Select import and select a raster or vector dataset of interest. Select the band number for the raster dataset. Input the aggregation definition, study year and the reclassified output destination file as shown:



Ensure to reclassifiy values correctly according to case study. Once all 4 datasets are imported proceed to select an area of interest and run the computation. You will be required to select a destination for your output file.



23.2 2. Vegetation Quality Index (VQI)

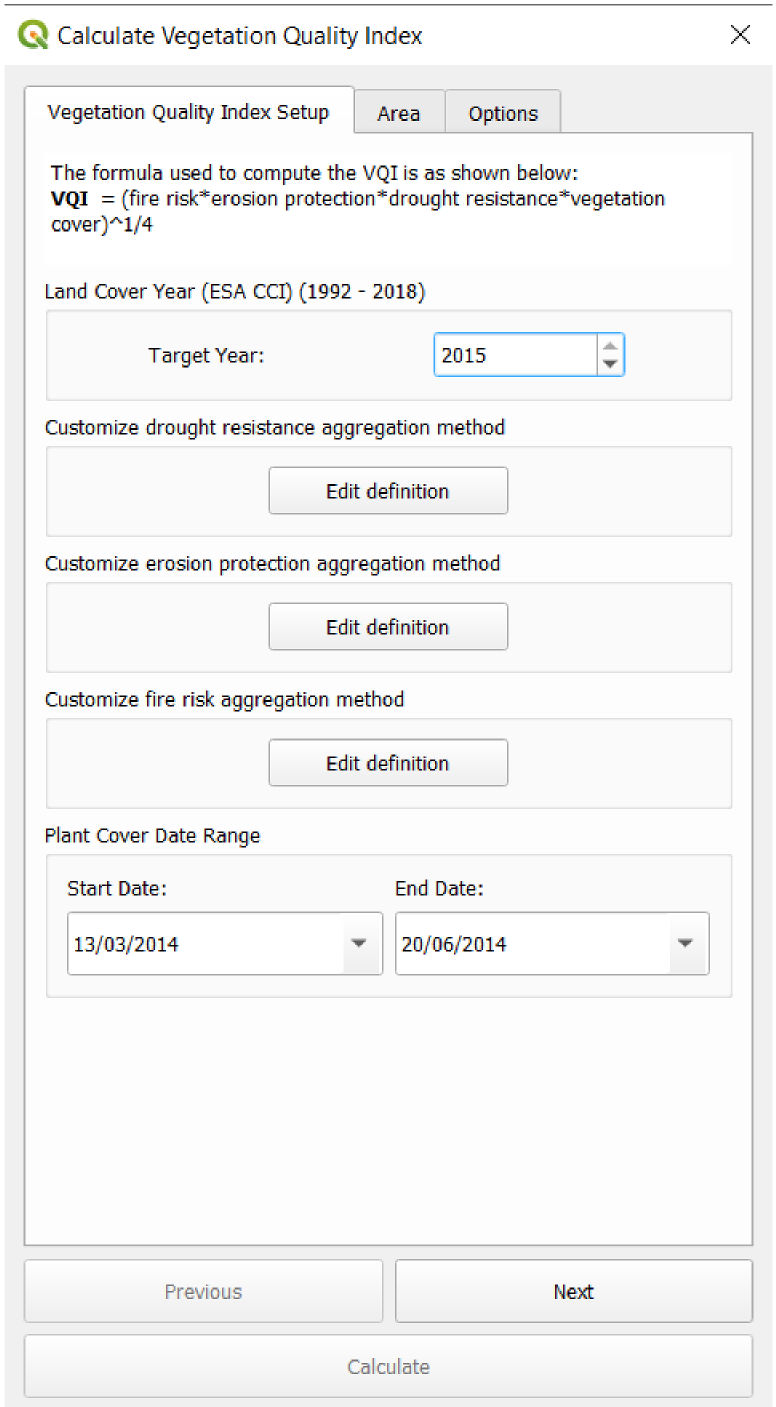
The Vegetation Quality index is derived as the geometric mean of the characteristics of the vegetation. Fire Hazard layers (RI), Fire Resistance (FR), drought (RS), vegetation erosion protection (PE) and cover plant (CV) according to the following formula:

VQI = (RI x PE x RS x CV) ^ ¼

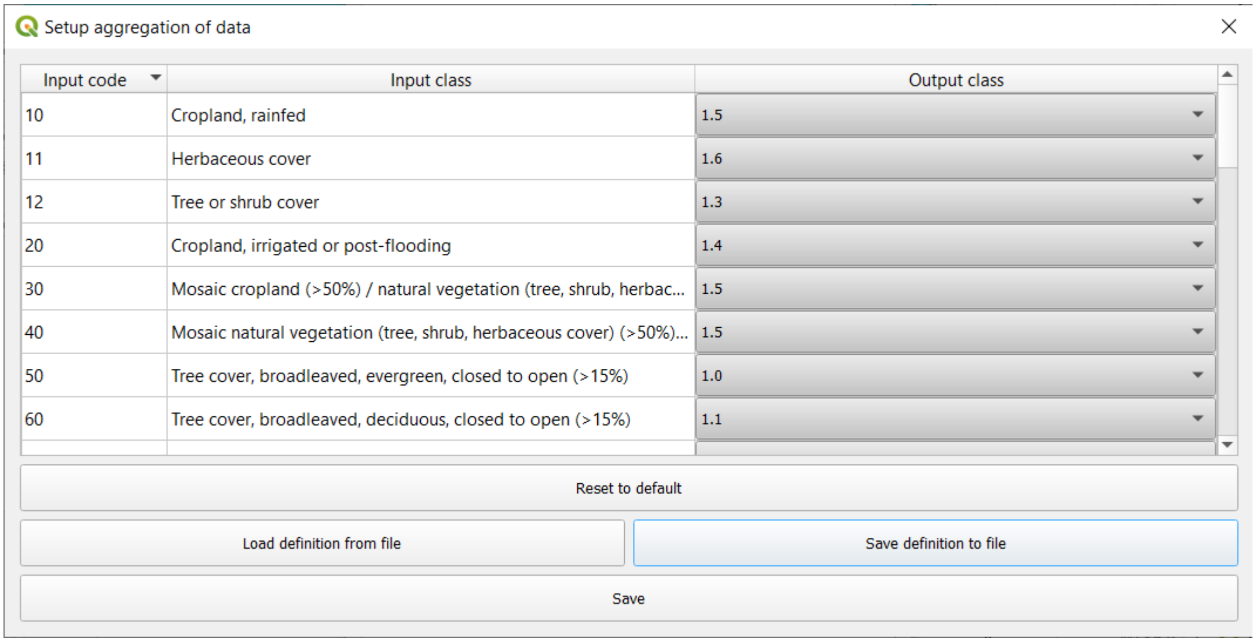
Default datasets used for vqi are as shown below:

Indicator	Variables	Data Source
Vegetation Quality Index	Fire Risk	ESA CCI–land cover map v2.0.7–2015
	Drought Resistance	ESA CCI–land cover map v2.0.7–2015
	Erosion Protection	ESA CCI–land cover map v2.0.7–2015
	Plant Cover	PROBA-V C1 Top Of Canopy Daily Synthesis 100m

To compute vegetation quality index, select Vegetation Quality Index option under the MEDALUS toolbar. For each of the 3 datasets, i.e - Fire Risk - Drought Resistance - Erosion Protection



Select the land cover year and an aggregation definition or use default set aggregation. This will reclassify land cover classes based on definition provided.



For Plant cover, select a start and end date. Proceed to select an area of interest and run the computation.

23.3 3. Climate Quality Index (CQI)

Climate quality is assessed on the basis of how it influences water availability to the plants. The climate quality index, according to the MEDALUS approach, is obtained by cross-referencing the three layers of information namely precipitation and aridity index using the following equation:

CQI = (precipitation x aridity index) ^ 1/2

Default datasets used for CQI are:

Indicator	Variables	Data Source
Climate Quality Index	Precipitation	TerraClimate Monthly Climate and Climatic Water Balance for Global Terrestrial Surfaces
	Potential Evapotranspiration	TerraClimate Monthly Climate and Climatic Water Balance for Global Terrestrial Surfaces

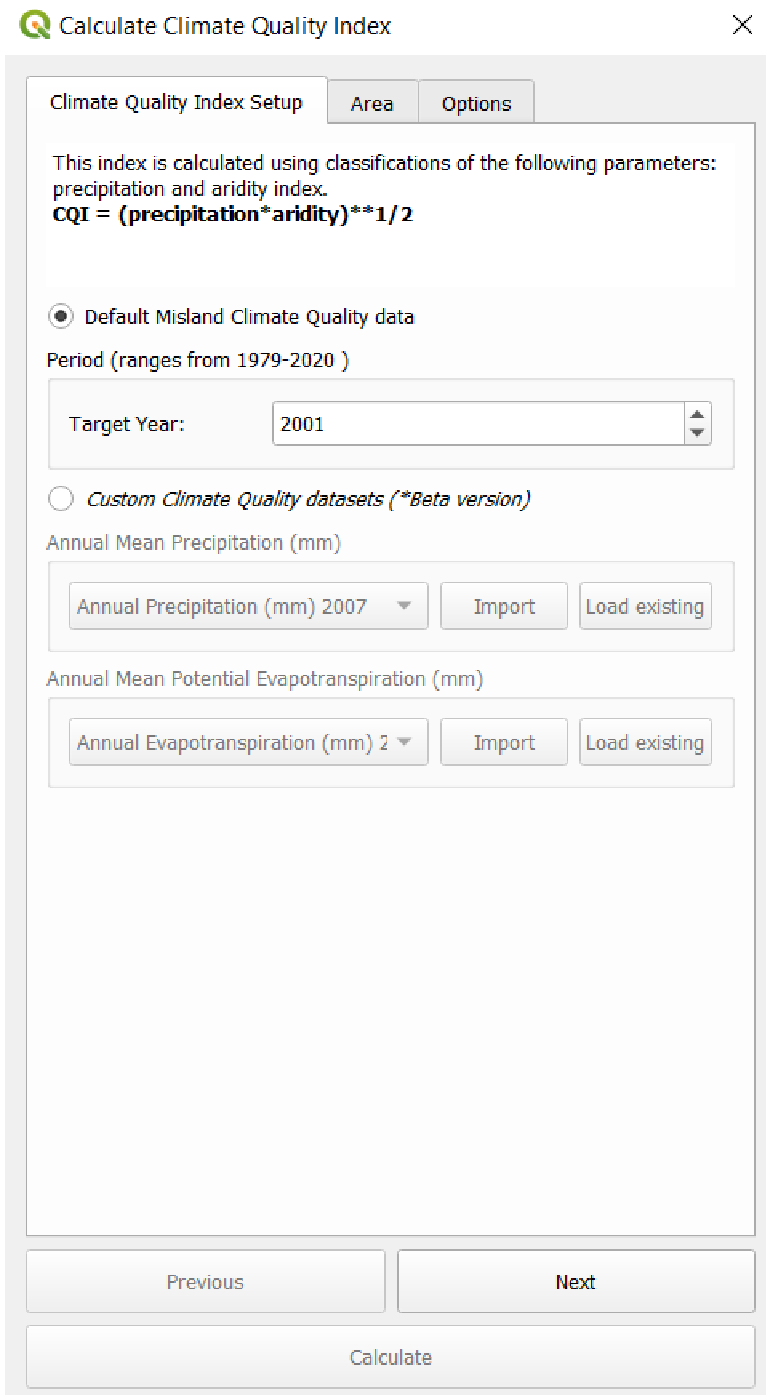
Climate Quality Index can be calculated in two ways:

a. Using default data (Computed on Google Earth Engine)

b. Using Custom data (Computed locally on device)

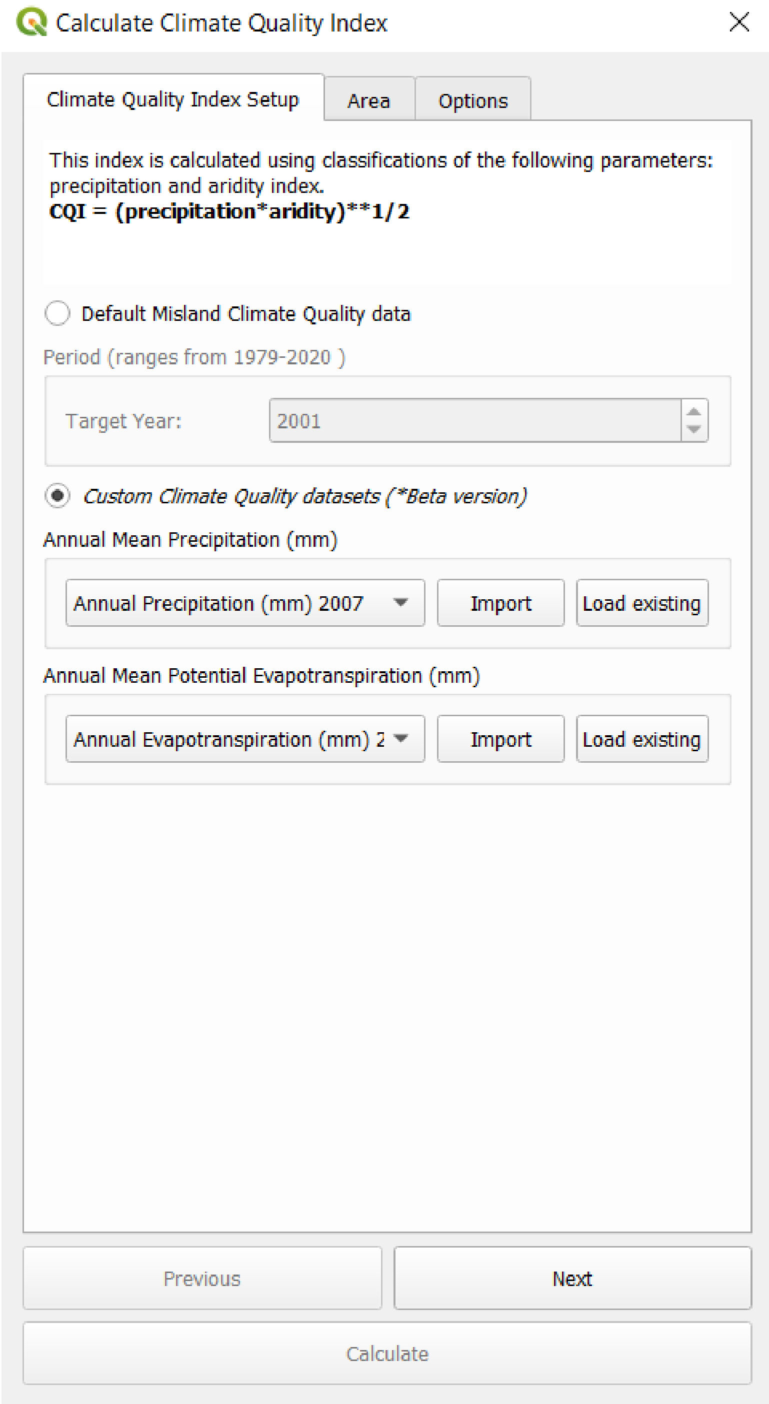
23.3.1 a. Using default data (Computed on Google Earth Engine)

Select a year of study between 1979-2020. Proceed to select and area of interest and run the computation.



23.3.2 b. Using Custom data (Computed locally on device)

This step requires the data to be available locally. Load both a potential evapotranspiration and precipitation dataset to the plugin as shown below.



Proceed to select an area of interest and run the computation. You will be required to select a destination for your output file.

23.4 4. Management Quality Index (MQI)

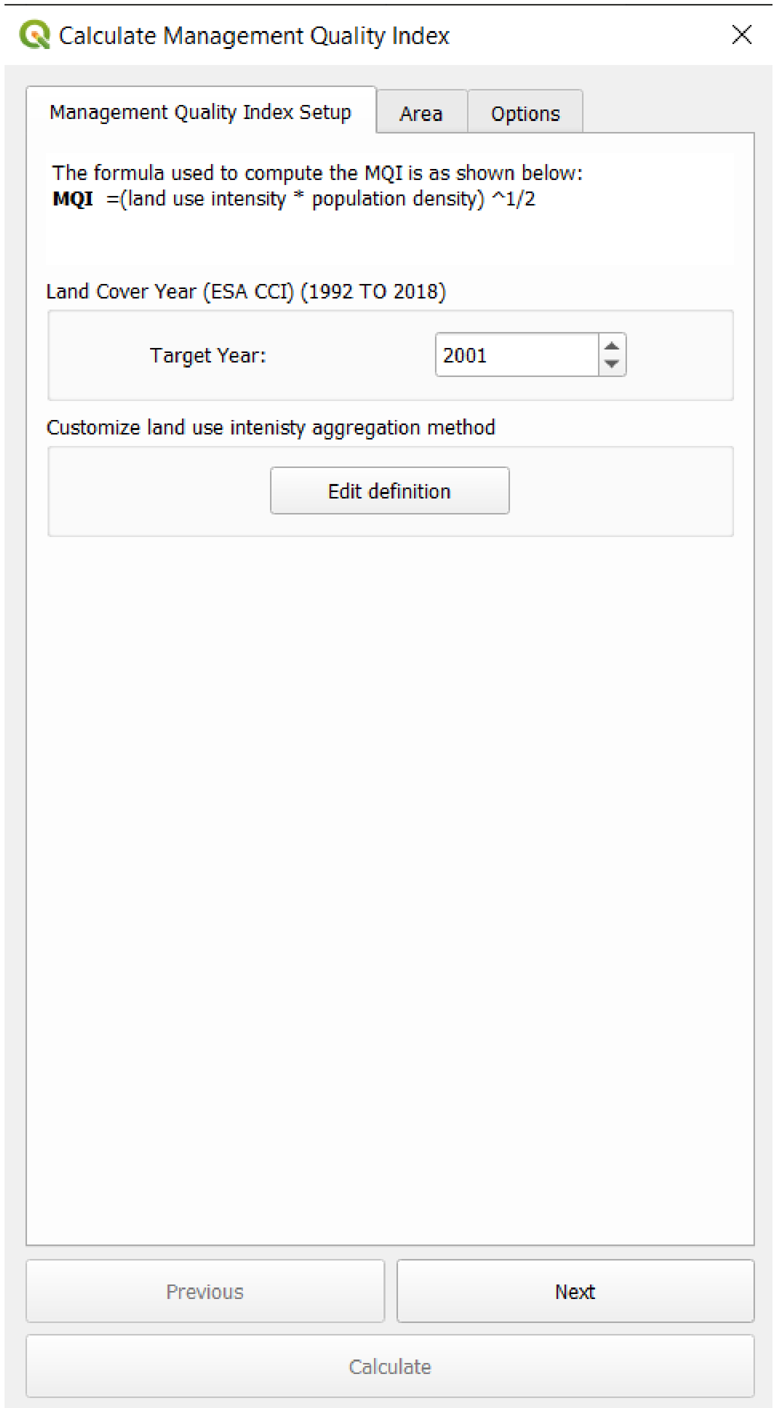
The Management quality index, according to the MEDALUS approach, is obtained by cross-referencing the two layers of information namely Land-Use intensity (LU) and Population Density (PD) using the following equation:

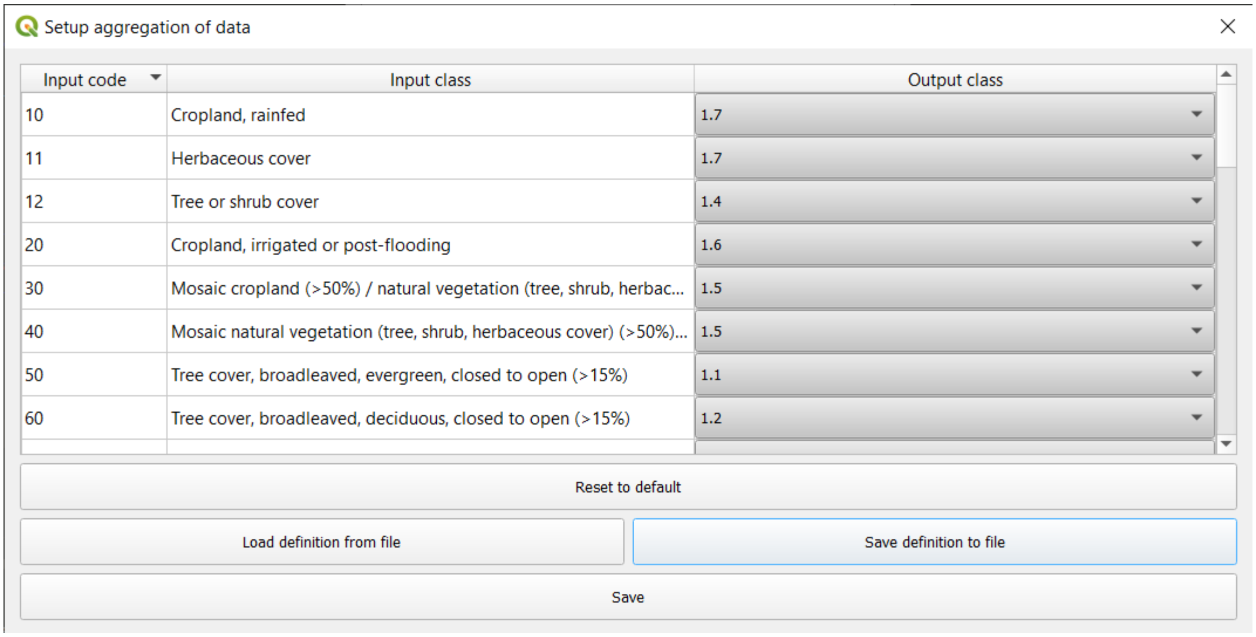
MQI = (LU X PD)^1/2

Default datasets used for MQI are:

Indicator	Variables	Data Source
Management Quality Index	Land Use Intensity	ESA CCI–land cover map v2.0.7–2015
	Population Density	GPWv411: Population Density (Gridded Population of the World Version 4.11)

To compute vegetation quality index, select Management Quality Index option under the MEDALUS toolbar. Select the land cover year an and set aggregation definition for Land Use Intensity. This will reclassify land cover classes based on definition provided.


Calculate Management Quality Index
Management Quality Index Setup
Area
Options
The formula used to compute the MQI is as shown below:
MQI =(land use intensity * population density) ^1/2
Land Cover Year (ESA CCI) (1992 TO 2018)
Target Year:
2001
Customize land use intenisty aggregation method
Edit definition
Previous
Next
Calculate



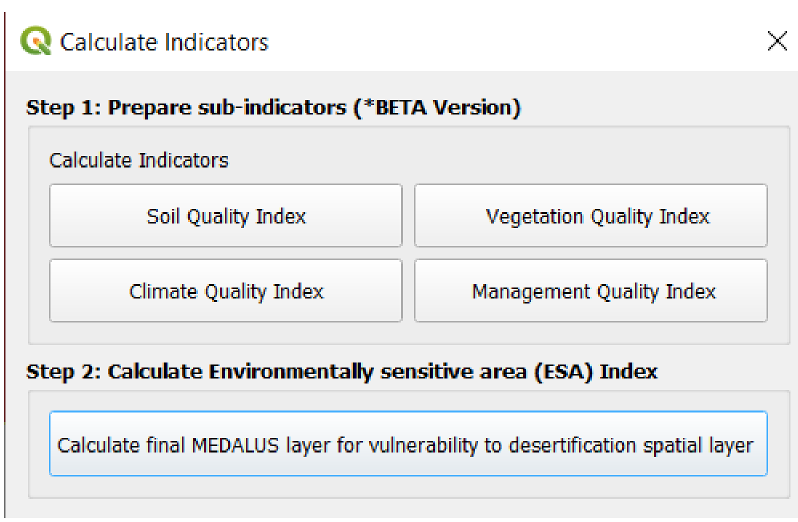
Proceed to select an area of interest and run the computation. You will be required to select a destination for your output file.

23.5 Environmentally sensitive area (ESA) Index (Combined Desertification Layer)

The environmentally sensitive area (ESA) index (ESAI) is computed according to the original procedure as a geometric mean of the four quality values recorded at each location (i.e., in each elementary pixel; Equation 2):

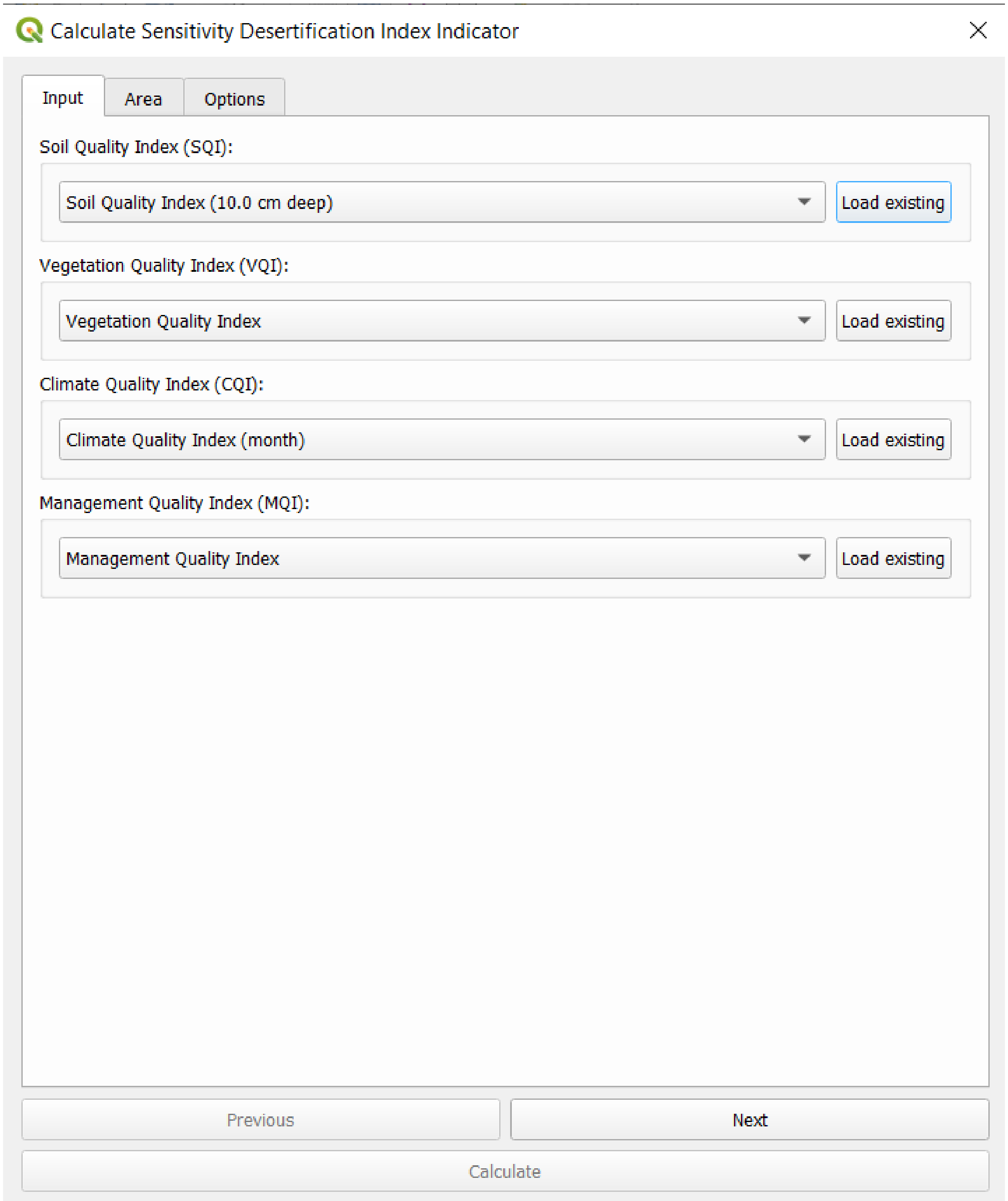
ESAI = (SQI x VQI x CQI x MQI) ^ 1/4

To compute the final desertification layer all MEDALUS subindicator must be already computed i.e SQI, VQI, CQI, MQI. In the MEDALUS toolbox select Calculate **final MEDALUS option** as shown below:



Load all 4 layers to the plugin, select the area of interest and compute the ESAI. You will be required to select a destination for your output file.

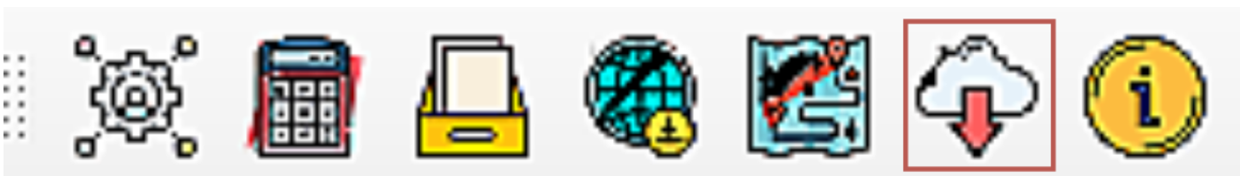
Note: All layers will be automatically loaded into the plugin if they are available and loaded within QGIS.



CHAPTER

TWENTYFOUR

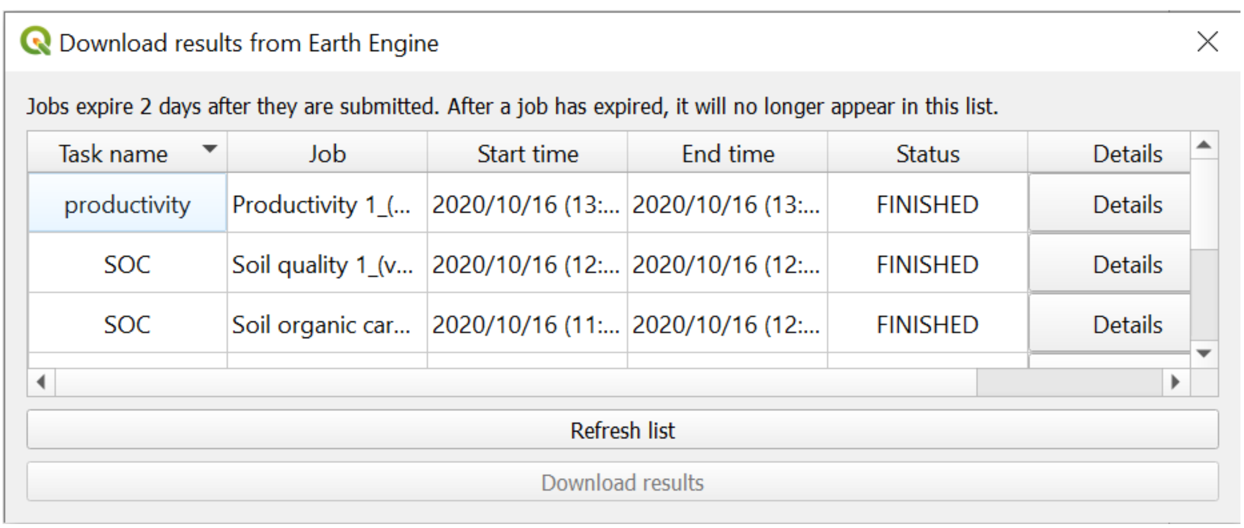
VIEW AND DOWNLOAD RESULTS



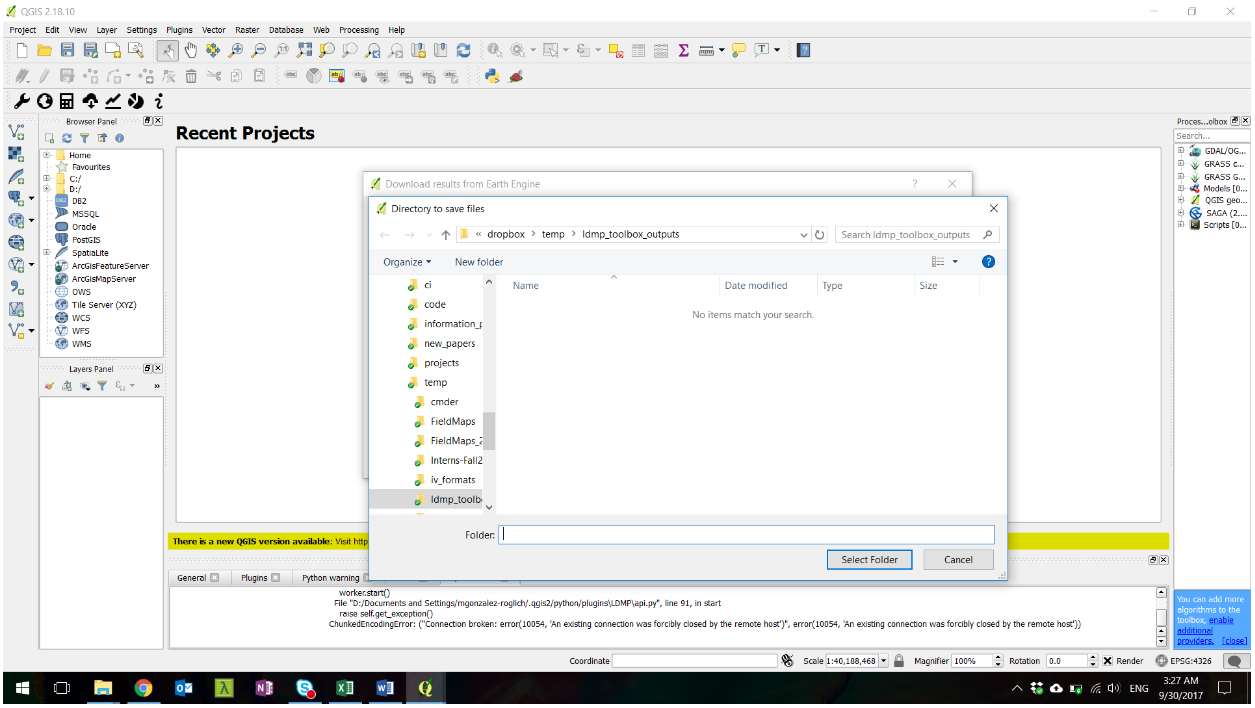
Once you have submitted a calculation using MISLAND, it is sent to Google Earth Engine to run the calculations in the cloud. To view the Google Earth Engine (GEE) tasks you have running, and to download your results, select the cloud with the arrow facing down icon highlighted above. This will open up the *Download results from Earth Engine* dialog box.

Click *Refresh List* to show all the tasks you have submitted and their status.

Users can view their current and previous tasks here. the table shows the task name provided by the user, which analysis is running (job), the start time and end time of when the task was started and completed and whether or not the task was successful. The Details page outlines the different options the user chose for each task.



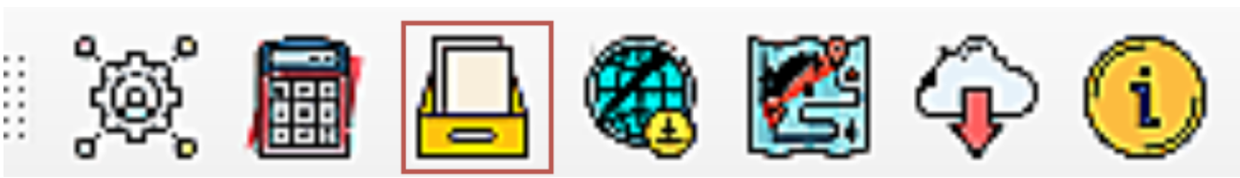
To download results to the computer once a task has finished, click on the task you are interested in downloading results for, then click *Download results*. In the window that appears, choose the location in which to save the download. Note that some downloads might consist of multiple files - all of these files need to be kept together if the results are moved to a different location on the computer (or saved to a USB stick).


QGIS 2.18.10
Recent Projects
Download results from Earth Engine
Directory to save files
dropbox > temp > ldmp_toolbox_outputs
Organize
New folder
Name
Date modified
Type
Size
No items match your search.
Folder:
Select Folder
Cancel
There is a new QGIS version available: Visit http
worker.start()
File "D:/Documents and Settings/mgonzalez-roglich/.qgis2/python/plugins\LDMP\api.py", line 91, in start
raise self.get_exception()
ChunkedEncodingError: ("Connection broken: error(10054, 'An existing connection was forcibly closed by the remote host')", error(10054, 'An existing connection was forcibly closed by the remote host'))

CHAPTER

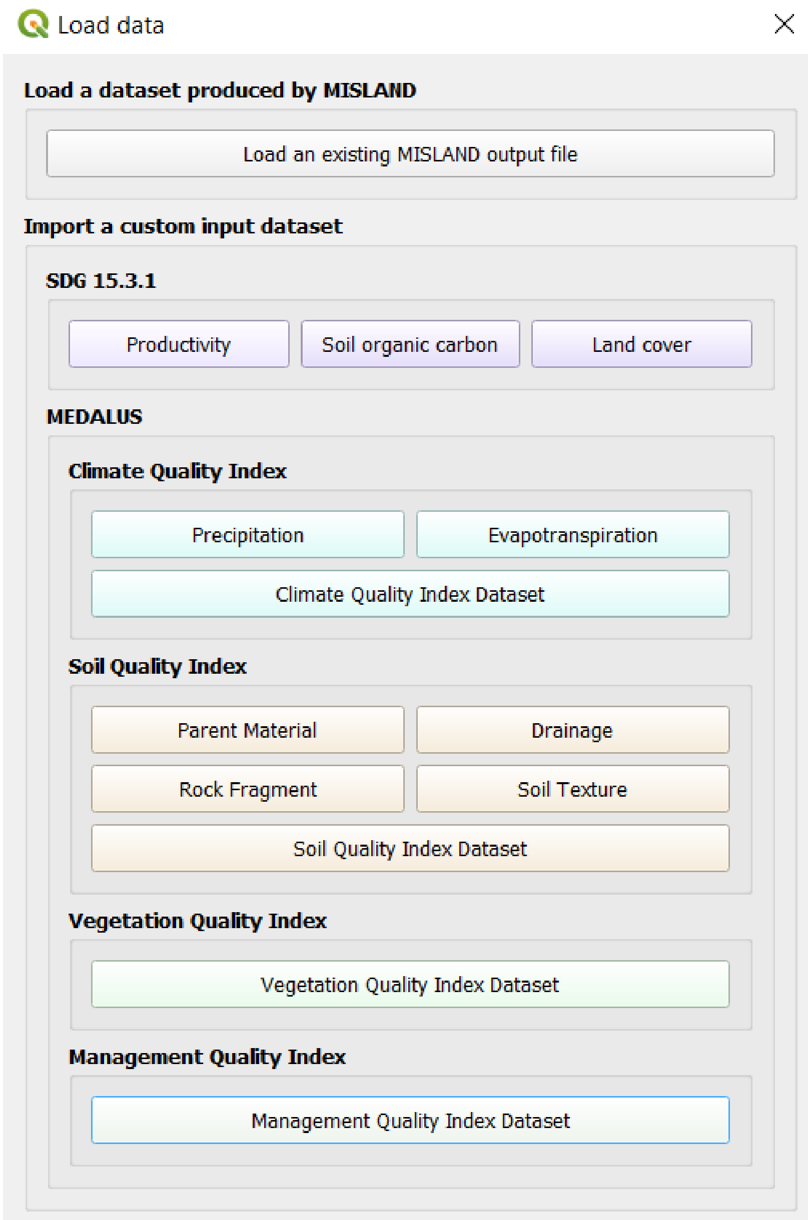
TWENTYFIVE

LOAD CUSTOM DATA



The “Load data” function allows the user to load data into QGIS and MISLAND for analysis.

There are two options, to load results of MISLAND analysis or to load custom datasets which will be used to compute the indicators.



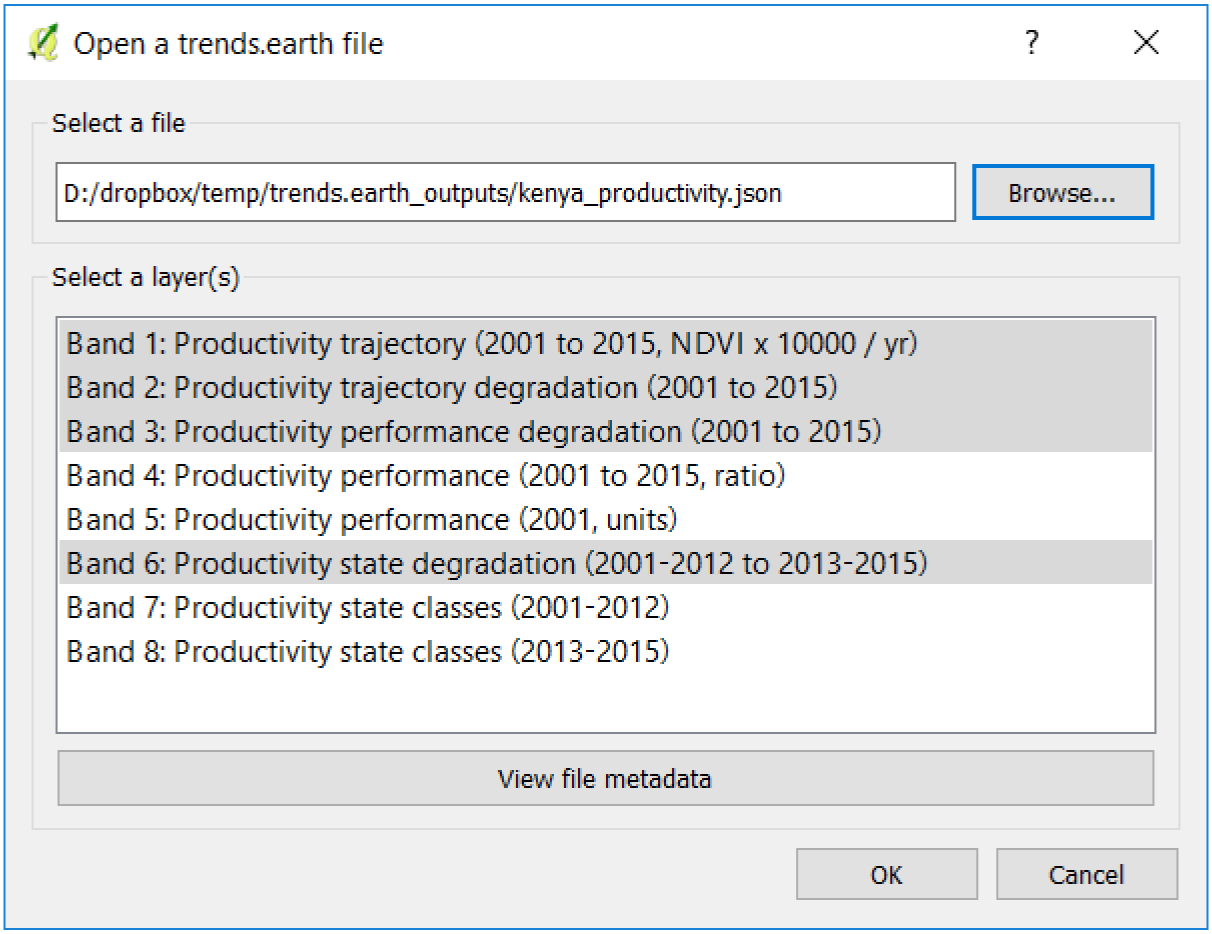
25.1 Load a dataset produced by MISLAND

This option lets you load already downloaded results from MISLAND. eg Productivity, Land Cover, Soil Organic Carbon, Forest Fires, Soil Quality Index, Vegetation Quality Index, Climate Quality Index, Management Quality Index, etc.

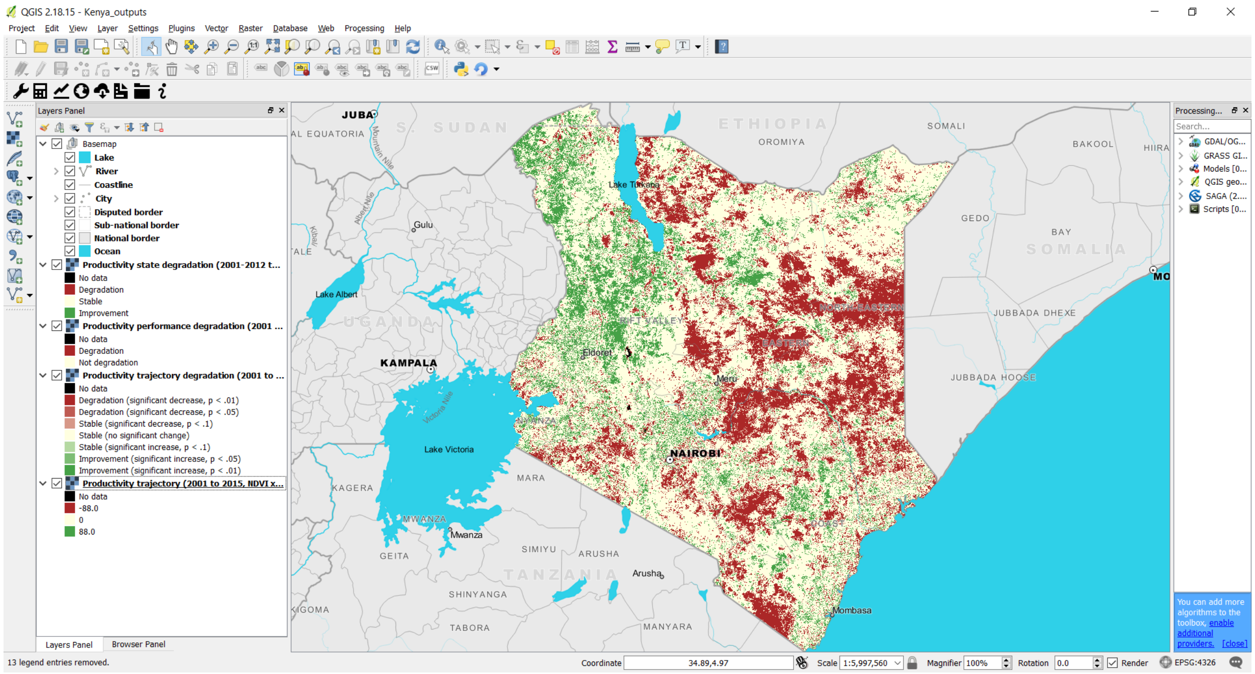
25.1.1 Productivity

Use this function to load into the QGIS map pre-computed productivity indicators which had been processed to identify land degradation.

Navigate to the folder where you stored the downloaded file and select it. The downloaded file is an 8 band raster, with each band representing the three subindicators (trajectory, performance and state) plus other information which may help you interpret the trends identified. The layers to be loaded into the QGIS maps are the ones highlighted in gray. By default: trajectory (degradation and slope), performance and state. If you want to load the other layers, simply select them and click OK.



The layers will be loaded in the QGIS map with its corresponding symbology.

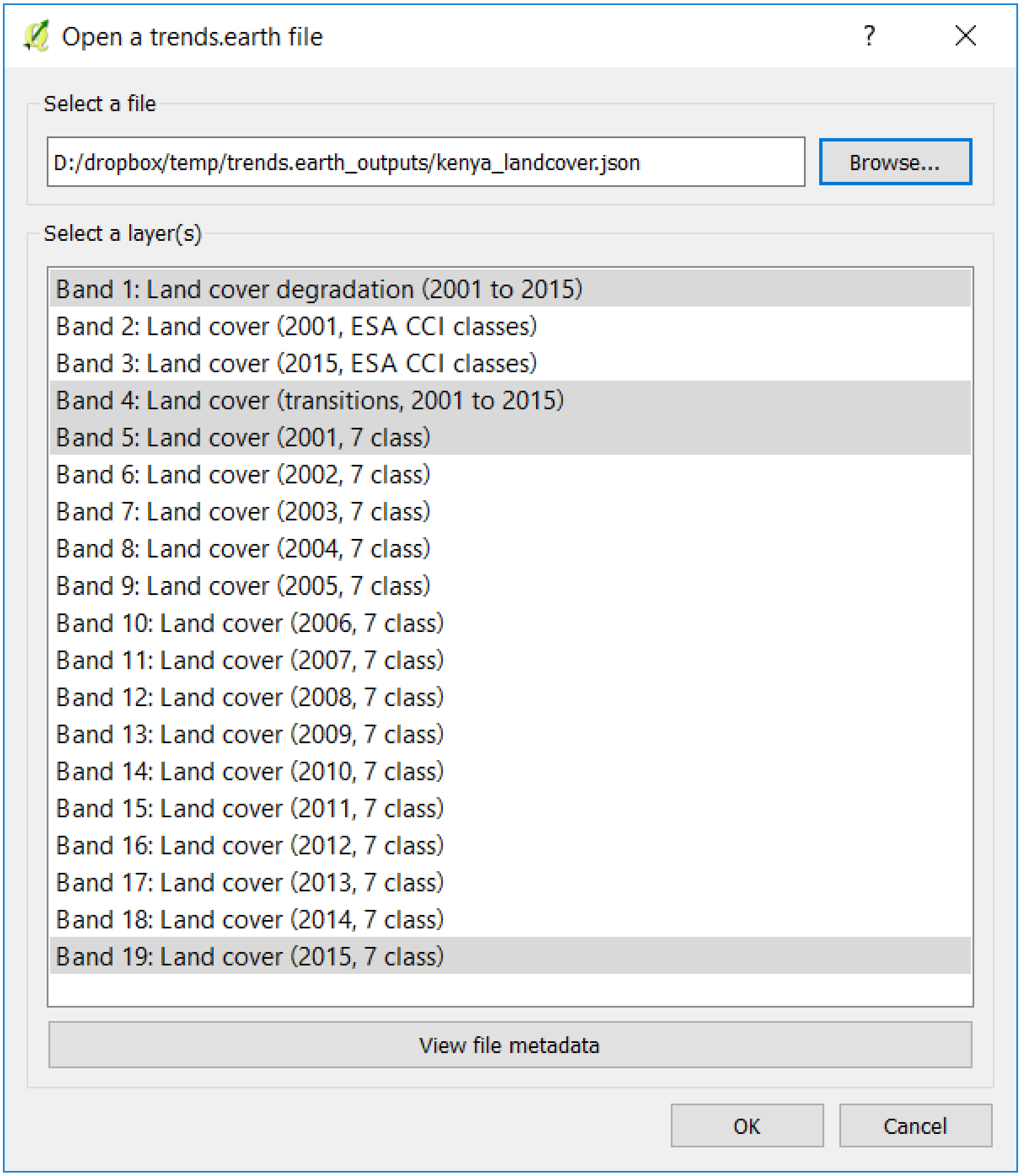


25.1.2 Land cover

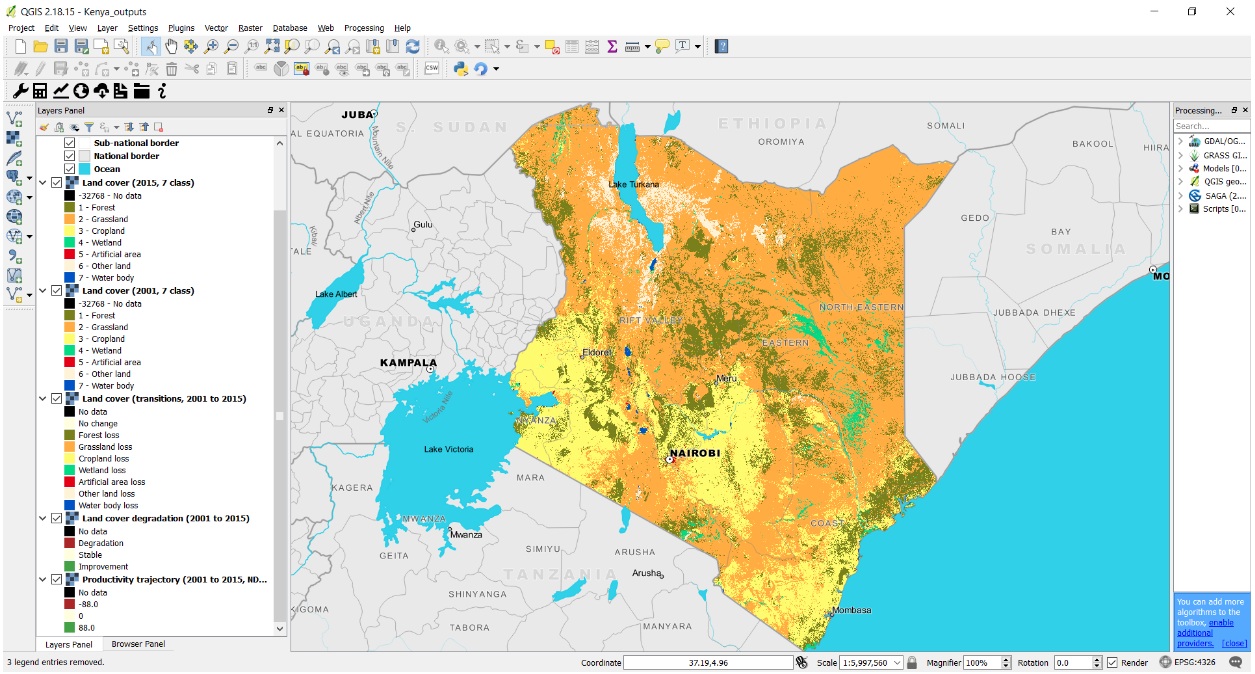
This option lets you load pre-computed land cover indicators which had been processed to identify land degradation.

Navigate to the folder where you stored the downloaded file and select it. The downloaded file is a multi band raster. The number of bands will depend on the period of analysis selected and the data source used. If the default ESA CCI land cover was used, for example, annual land cover maps will be downloaded.

The bands in the stack represent: initial and final land cover (annual if available) both in the original classification scheme and using the UNCCD 7 class land cover table, land cover transitions and land cover degradation as identified by this subindicator. If you want to load the other layers not selected by default, simply select them and click OK.



The layers will be loaded in the QGIS map with its corresponding symbology.

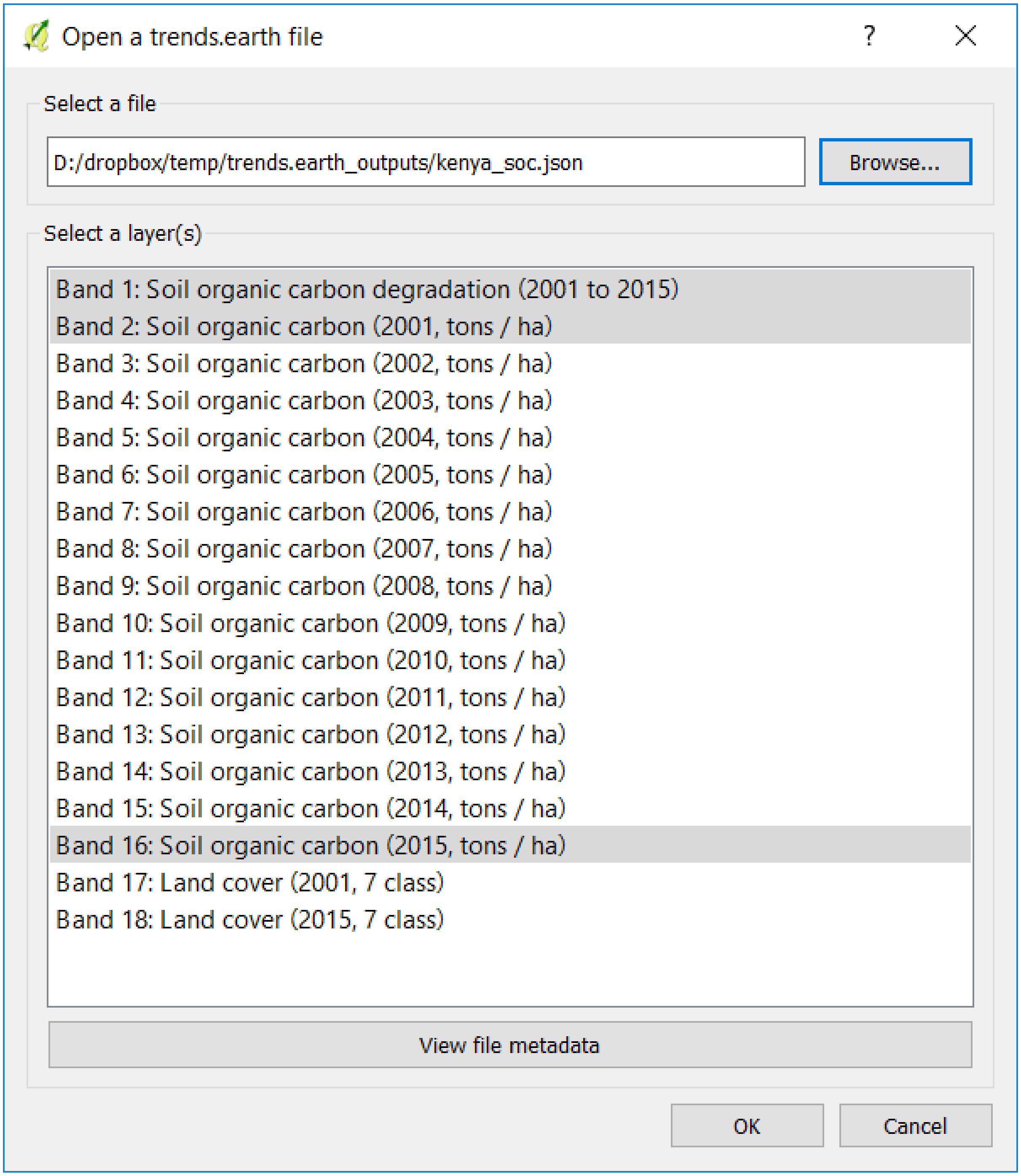


25.1.3 Soil organic carbon

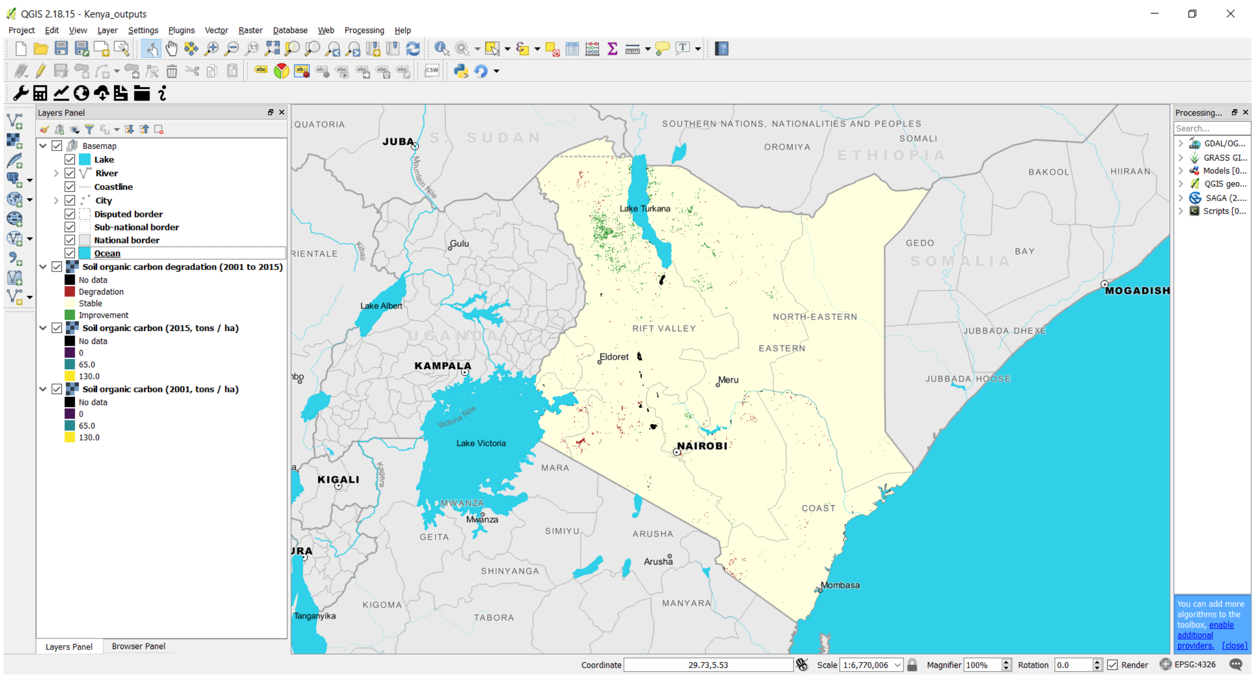
This option lets you load pre-computed soil organic carbon indicators which had been processed to identify land degradation.

Navigate to the folder where you stored the downloaded file and select it. The downloaded file is a multi band raster. The number of bands will depend on the period of analysis selected and the data source used. If the default ESA CCI land cover was used, for example, annual soil organic carbon maps will be downloaded.

The bands in the stack represent: initial and final soil organic carbon stocks (annual soc if annual land data is available), initial and final land cover maps using the UNCCD 7 class land cover classification,and degradation as identified by this subindicator. The units of the degradation layer are "% change", if changes are larger than 10% for the period, they will be considered as improvement or degradation depending on the sign of the change. If you want to load the other layers not selected by default, simply select them and click OK.



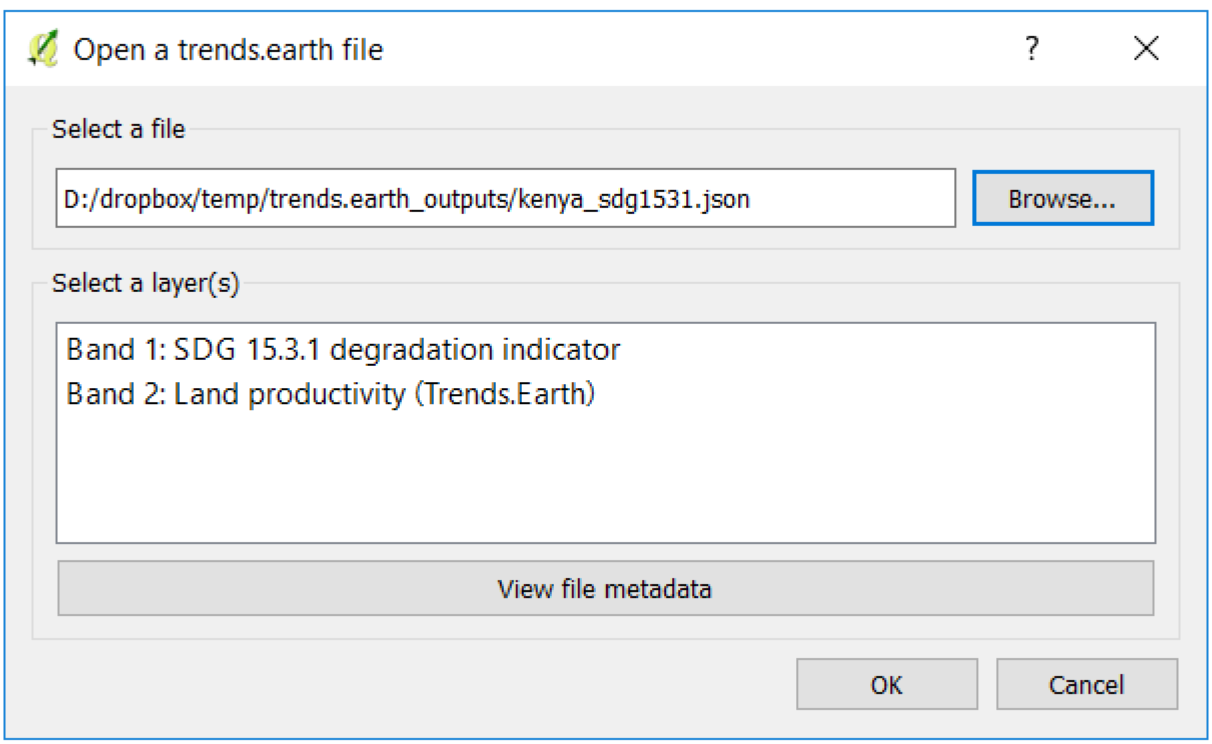
The layers will be loaded in the QGIS map with its corresponding symbology.



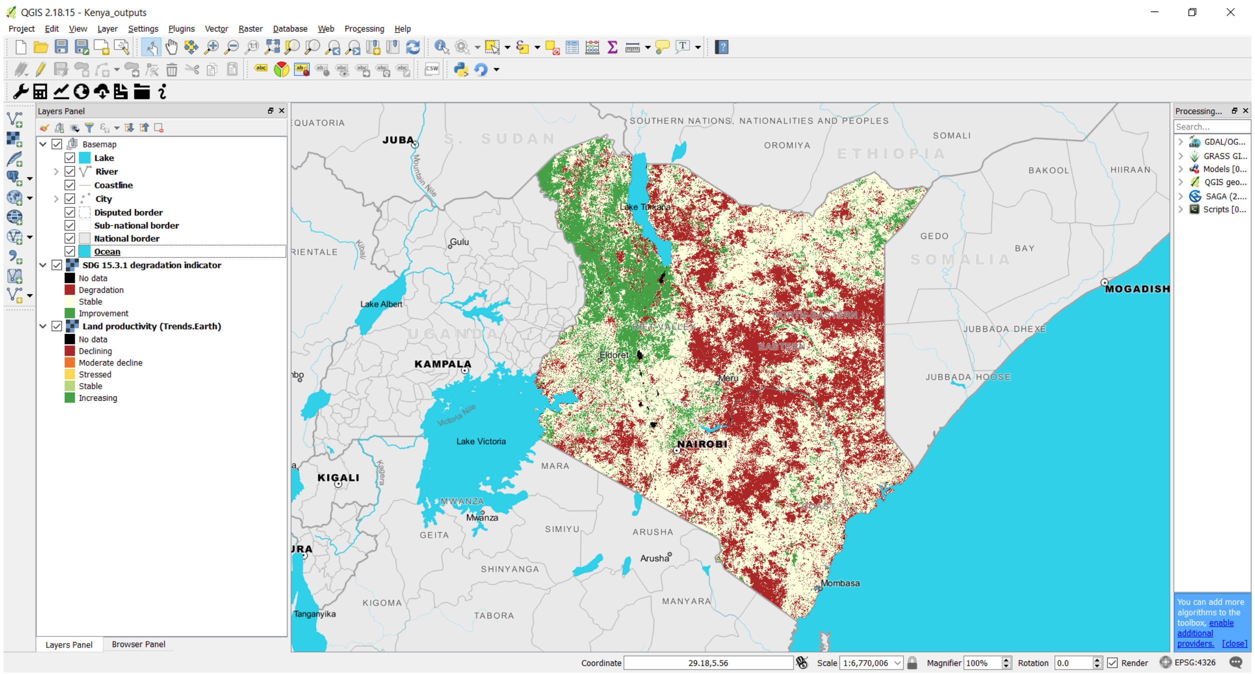
25.1.4 SDG 15.3.1 indicator

This option lets you load pre-computed productivity subindicator (the integration of trajectory, performance and state) as well as the final SDG 15.3.1 (the integration of productivity, land cover and soil organic carbon)

Navigate to the folder where you stored the downloaded file and select it. The downloaded file is an 2 band raster, the first one containing information on the SDG and the second on the 5 classes productivity subindicator.



The layers will be loaded in the QGIS map with its corresponding symbology.



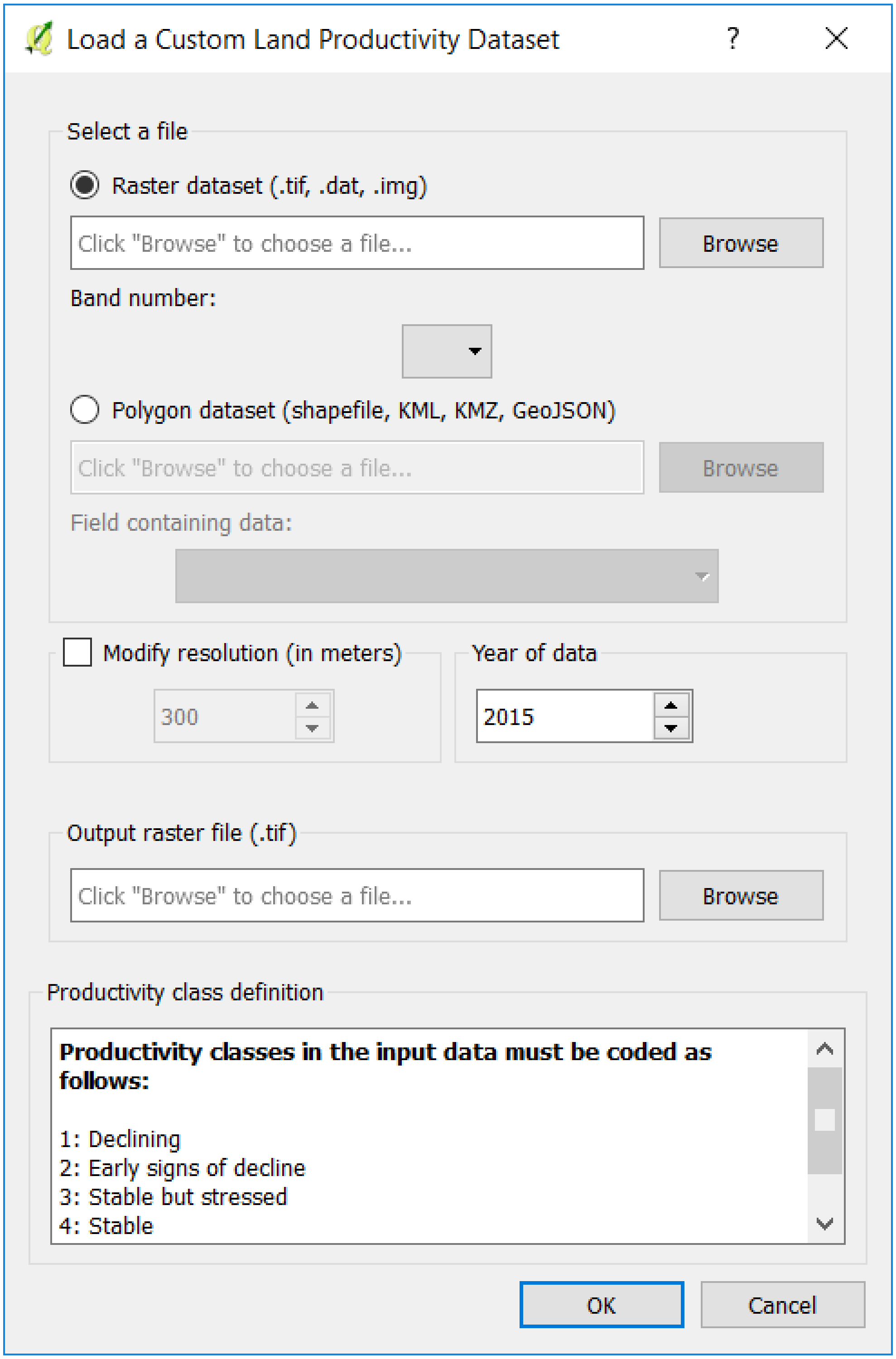
25.2 Load a custom input dataset

25.2.1 Productivity

Use this option to load productivity datasets which have already been generated outside of MISLAND.

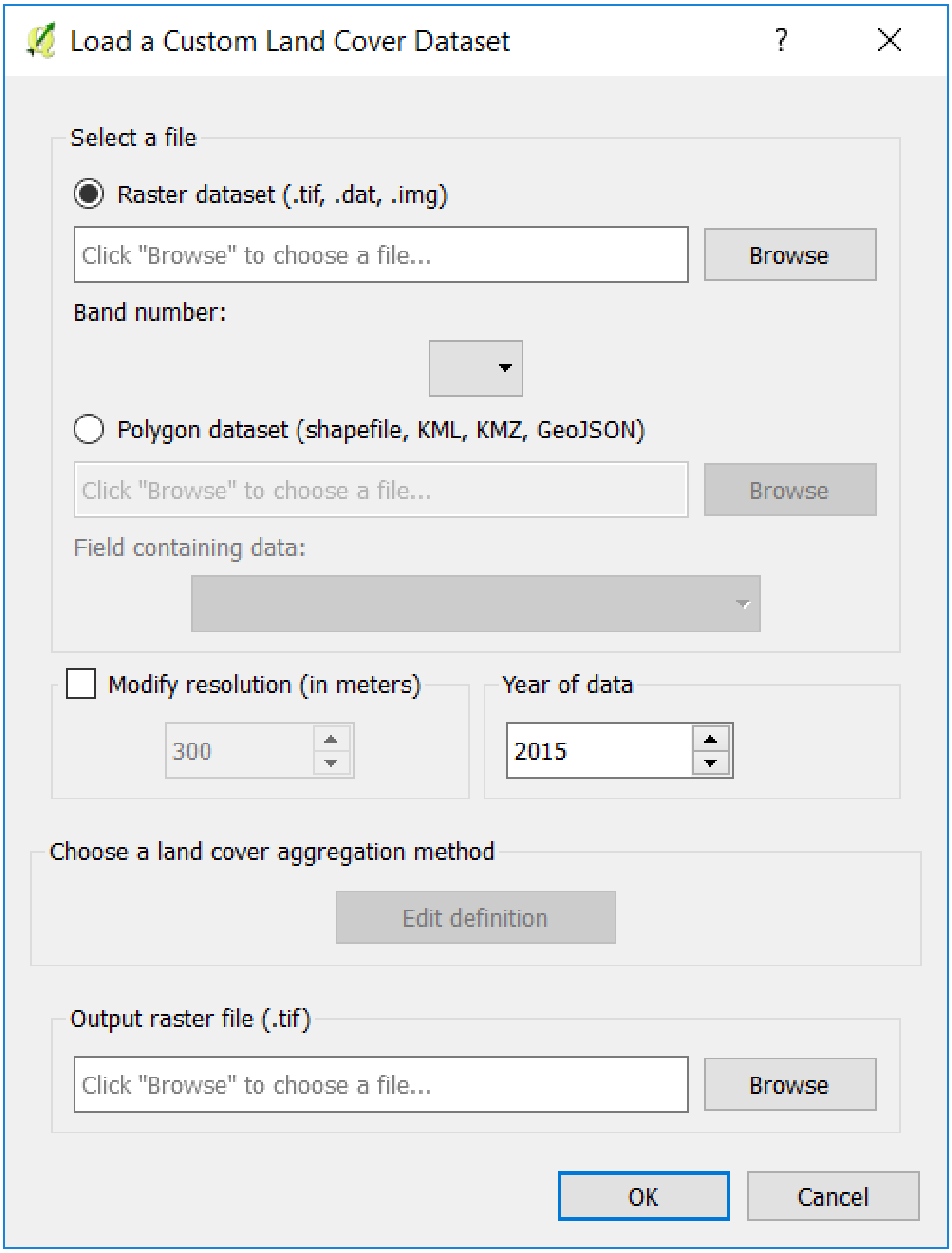
Productivity classes in the input data must be coded as follows:

1: Declining 2: Early signs of decline 3: Stable but stressed 4: Stable 5: Increasing 0 or -32768: No data


Load a Custom Land Productivity Dataset
Select a file
Raster dataset (.tif, .dat, .img)
Click "Browse" to choose a file...
Browse
Band number:
Polygon dataset (shapefile, KML, KMZ, GeoJSON)
Click "Browse" to choose a file...
Browse
Field containing data:
Modify resolution (in meters)
300
Year of data
2015
Output raster file (.tif)
Click "Browse" to choose a file...
Browse
Productivity class definition
Productivity classes in the input data must be coded as follows:
1: Declining
2: Early signs of decline
3: Stable but stressed
4: Stable
OK
Cancel

25.2.2 Land cover

Use this option to load land cover datasets which will then be used for land cover change analysis and/or soil organic carbon change analysis.



Note: If you'll be using the CORINE land cover data , you can use this definition file to pre-load a suggested aggregation of the land cover classes in Corine to convert them to the 7 UNCCD land cover classes.

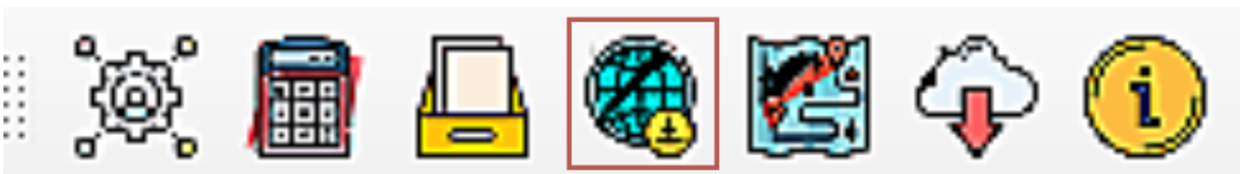
25.2.3 Soil organic carbon

Processing of custom soil organic carbon data can be handled using this tool.

Note: This tool assumes that the units of the raster layer to be imported are **Metrics Tons of organic carbon per hectare**. If your layer is in different units, please make the necessary conversions before using it in MISLAND.

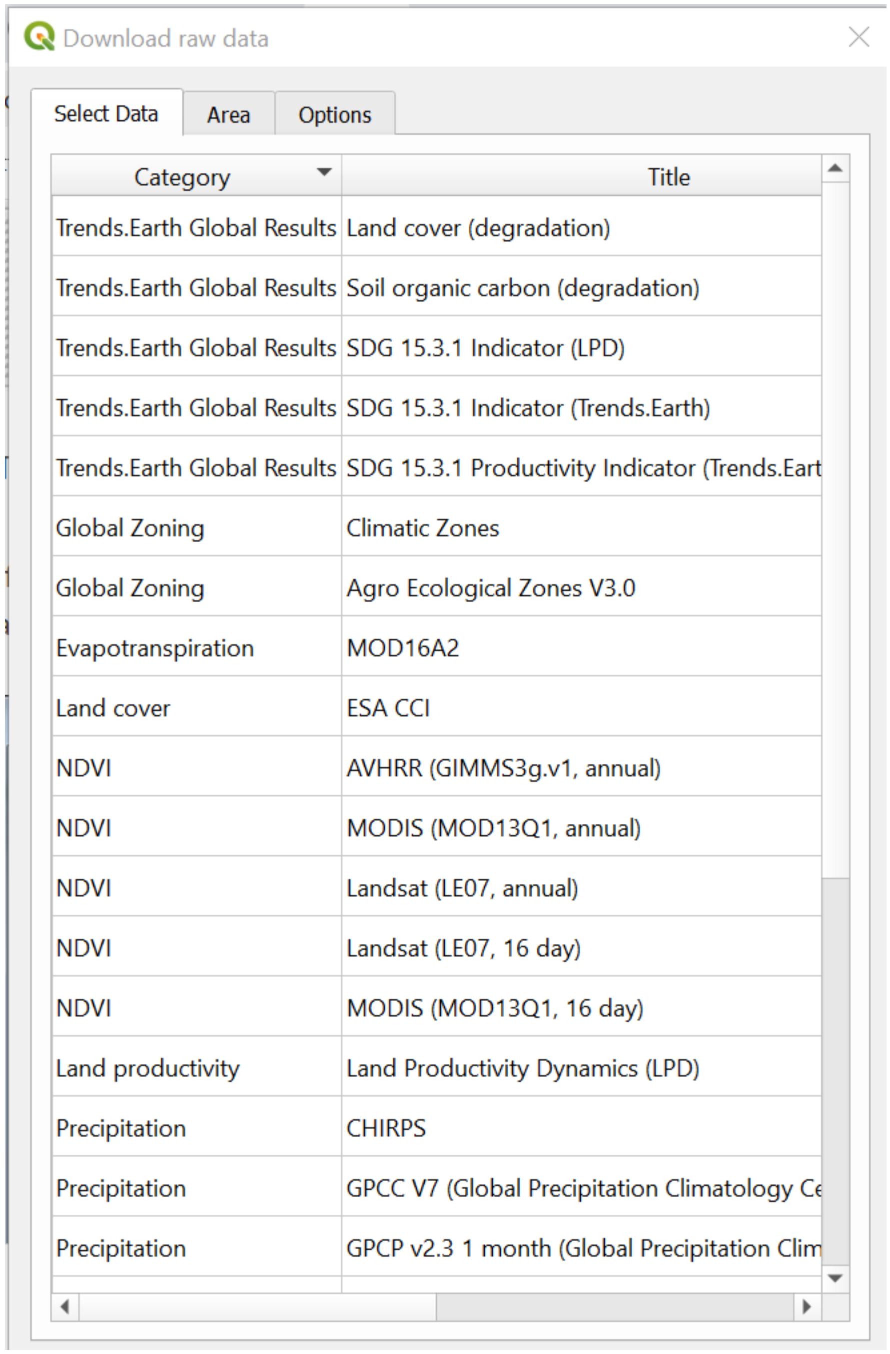
CHAPTER TWENTYSIX

DOWNLOAD RAW DATA



To download data, select the download icon highlighted above. This will open up the “Download Data” dialog box:

If you would like to work with the original raw data used in LDMS, you can select select an area of interest and download the desired data for further analysis.

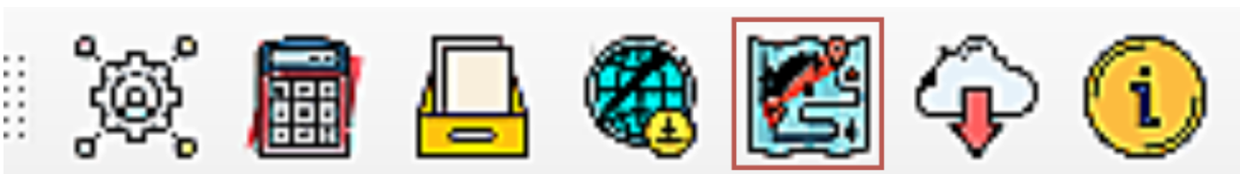


The table below describes all the data available through the toolbox. It specifies data sources, resolutions, coverage and the different indicators for which each data set is used.

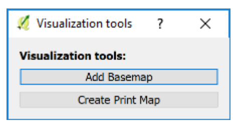
CHAPTER

TWENTYSEVEN

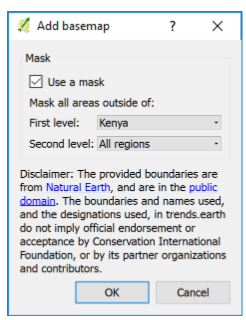
VISUALIZATION TOOLS



To view the "Visualization Tools", select the report icon highlighted above. This will open up the "Visualization tools" dialog box:



Here there are two options: "Add Basemap" or "Create Print Map". The first allows users to add a Basemap for a first or second level administrative boundary. The second option brings up the Composer window in QGIS to design and export a static map.



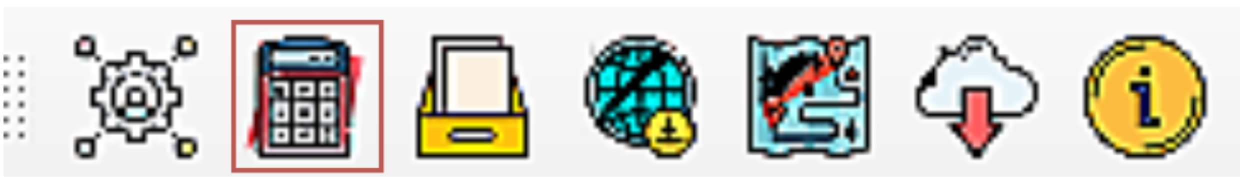
By selecting "Add Basemap", the user can select the first or second level administrative boundary. The first level is the country boundary. The second level will be the first sub-division that the country is divided into and will be dependent on the country selected. For example, in the United States of America, the second level will provide a drop down of states. In Kenya, the second level will display provinces. Please note the disclaimer in the window. Natural Earth provides the spatial layers contained within the dropdown. These boundaries are not official endorsed by CI or other partner organizations and contributors. After selecting the dropdown, for the first level and second level if applicable, select "Ok".

After submitting the above message will appear within the QGIS Desktop window. This shows that the Basemap is loading. DO NOT select cancel or attempt another function in QGIS until the Basemap has loaded. The time it takes to load will depend on your Internet connection and computer processor.

If you have a map layer within your QGIS Desktop window, you will now see the Basemap with the administrative level selected clipped out to view the underlying map layer.

CHAPTER TWENTYEIGHT

CALCULATE SDG 15.3.1



Sustainable Development Goal 15.3 intends to combat desertification, restore degraded land and soil, including land affected by desertification, drought and floods, and strive to achieve a land degradation-neutral world by 2030. In order to assess the progress to this goal, the agreed-upon indicator for SDG 15.3 (proportion of land area degraded) is a combination of three sub-indicators: change in land productivity, change in land cover and change in soil organic carbon.

Watch the video below for an introduction to SDG 15.3.1 monitoring using MISLAND QGIS Plugin.

CHAPTER

TWENTYNINE

CALCULATE VEGETATION/FOREST DEGRADATION

Contents

Watch the video below for an introduction to Vegetation/ Forest degradation monitoring using MISLAND QGIS Plugin.

29.1 Compute Vegatation Indices

Land degradation hotspots (LDH) are produced via the analysis of time-series vegetation indices data and are used to characterize areas of different sizes, where the vegetation cover and the soil types are severely degraded. Vegetation loss/gain hotspots will be calculated based on time series observation of selected suit of vegetation indices depending on the climatic zones and terrain morphology of the North African countries

Vegation Indices computed from Landsat 7 ETM+ include:

1. **NDVI (humid, sub-humid and semi-arid zones)**

   DVI is preferable for global vegetation monitoring since it helps to compensate for changes in lighting conditions, surface slope, exposure, and other external factors. NDVI is calculated in accordance with the formula:

   $$NDVI = \frac{NIR - RED}{NIR + RED}$$

   NIR – reflection in the near-infrared spectrum RED – reflection in the red range of the spectrum

   According to this formula, the density of vegetation (NDVI) at a certain point of the image is equal to the difference in the intensities of reflected light in the red and infrared range divided by the sum of these intensities.

   This index defines values from -1.0 to 1.0, basically representing greens, where negative values are mainly formed from clouds, water and snow, and values close to zero are primarily formed from rocks and bare soil. Very small values (0.1 or less) of the NDVI function correspond to empty areas of rocks, sand or snow. Moderate values (from 0.2 to 0.3) represent shrubs and meadows, while large values (from 0.6 to 0.8) indicate temperate and tropical forests.

2. **MSAVI2 (arid and stepic zones)**

MSAVI2 is soil adjusted vegetation indices that seek to address some of the limitation of NDVI when applied to areas with a high degree of exposed soil surface.It eliminates the need to find the soil line from a feature-space plot or even explicitly specify the soil brightness correction factor:

$$MSAVI2 = \frac{\left(2 * NIR + 1 - \sqrt{(2 * NIR + 1)^2 - 8 * (NIR - RED)}\right)}{2}$$

3. **SAVI (desert areas)**

   SAVI is used to correct Normalized Difference Vegetation Index (NDVI) for the influence of soil brightness in areas where vegetative cover is low. Landsat Surface Reflectance-derived SAVI is calculated as a ratio between the R and NIR values with a soil brightness correction factor (L) defined as 0.5 to accommodate most land cover types.

   $$SAVI = ((NIR - R) / (NIR + R + L)) * (1 + L)$$

29.2 Compute Forest Fires

Burnt areas and forest fires are be highlighted and mapped out form remotely sensed **Landsat 8 /Sentinel 2** data using the Normalized Burn Ratio (NBR). NBR is designed to highlight burned areas and estimate burn severity. It uses near-infrared (NIR) and shortwave-infrared (SWIR) wavelengths. Before fire events, healthy vegetation has very high NIR reflectance and a low SWIR reflectance. In contrast, recently burned areas show low reflectance in the NIR and high reflectance in the SWIR band.

The NBR is be calculated for Landsat/Sentinel images before the fire (pre-fire NBR) and after the fire (post-fire NBR). The **difference between the pre-fire NBR and the post-fire NBR** referred to as **delta NBR (dNBR)** is computed to highlight the areas of forest disturbance by fire event.

Classification of the dNBR is be used for burn severity assessment, as areas with higher dNBR values indicate more severe damage whereas areas with negative dNBR values might show increased vegetation productivity. dNBR is classified according to burn severity ranges proposed by the United States Geological Survey(USGS)

29.3 Compute Forest Change and Total Carbon & Summary

The quantification of the forest gain/loss hotspots will be based on pre-existing high-resolution global maps derived from Hansen Global Forest change dataset that can be accessed using Google Earth Engine API. The maps are produced from time-series analysis of Landsat images characterizing forest extent and change over time.

CHAPTER

THIRTY

INDICES AND TABLES

- genindex
- modindex
- search