VICAL Guide: VEGETATION INDICES CALCULATOR

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Contents

Welcome

This site is a guide to use the **VICAL** tool developed within Google Earth Engine (GEE). VICAL calculates **online** 23 vegetation indices (commonly used in agricultural applications) of any polygon(s) in the world (digitized by the user or vector file) using LandSat and Sentinel-2 images. This is done without the user downloading/uploading satellite images of writing a single line of code, they just need to have an internet connection.

A web application is also available https://inifapcenidraspa.users.earthengine.app/view/vical.

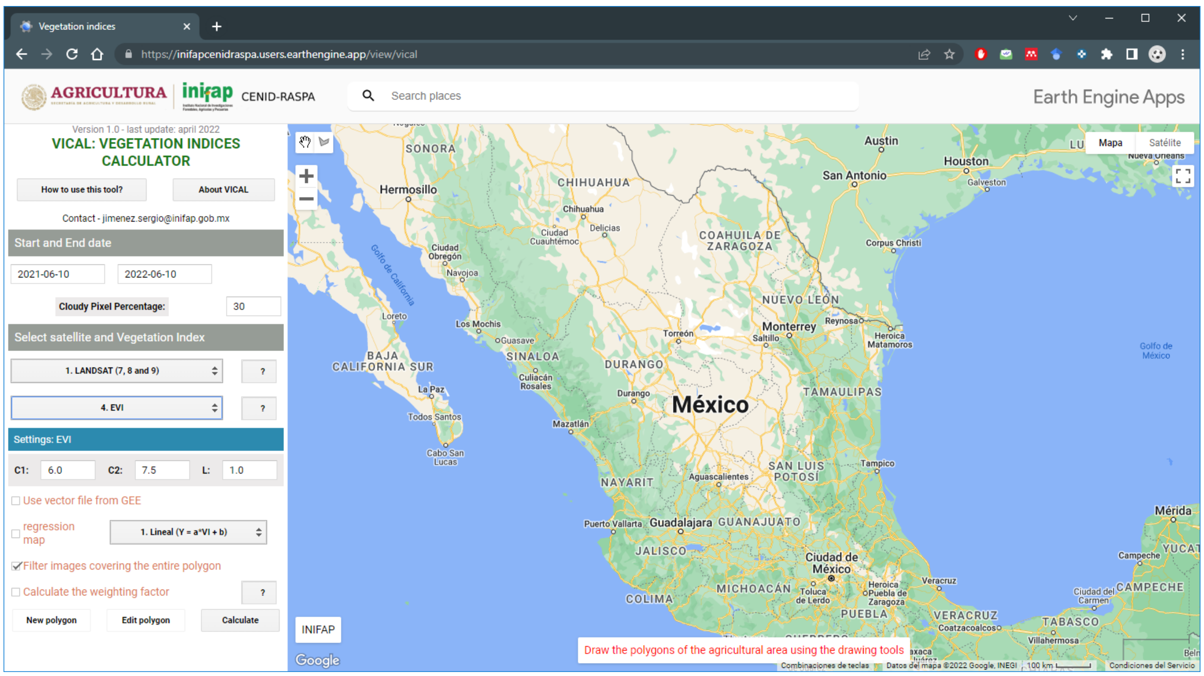

Figure 1: Vista principal de VICAL

This work was developed by researchers from **INIFAP CENID-RASPA** and **CEVAF**. Among the improvements planned for VICAL is that are intended for VICAL is that through experimentation the calibration of biophysical variables of interest for various crops is achieved using *vegetation indices (IV)*; and these results are available in **VICAL** to be useful to other people and thus they can easily monitor variables related to irrigation engineering.

Please check back occasionally for new GEE applications, example scripts, and VICAL updates. You might try doing a hard refresh on the site to make sure you see recent changes (what you're looking at might be a previously cached version of the site)

*If you have any questions or suggestions or wish to participate in the project, you can write to the email **jimenez.sergio@inifap.gob.mx***

Chapter 1

Introduction

This guide is intended to introduce the basics of running VICA and how to implement the libraries in any GEE Script. It describes the VICAL conceptual framework, the vegetation indices (VIs) considered and the images collections used to calculate it, how to run it, what the outputs are, and how they are formatted.

VICAL was developed within the GEE platform https://earthengine.google.com/ and was coded in JavaScript from the Earth Engine Code Editor https://code.earthengine.google.com/.

1.1 Scopes

The design principles for **VICAL** were that it should provide for any area (defined by the user) where there is a Landsat or Sentinel-2 image, the estimation of different VIs applied in agriculture. In addition, to graph the VI time series for that area in the date range established by the user. **All without the user writing a single line of code within the GEE platform or performing image pre-processing.**

The VICAL tool has three main functions::

1.- calculation of 23 VIs with images (cloud-free) from Landsat (4, 5, 7, 8 and 9) and Sentinel-2 data from any user-defined area.

2.- VI time series plot for each polygon drawn by the user with Landsat and Sentinel-2 or both satellites.

3.- Regression maps (linear, quadratic, potential or exponential function) or weighting factor using VIs values.

In this tool, you can configure some VI coefficients such as EVI, SAVI, among others.

We believe that the **VICAL** tool saves time and avoids the trivial repetitive procedure associated with “manual” VI calculations (image download, processing, etc.), which requires different types of software, which can lead to human error.

VICAL can be used to quickly extract VIs values for calibration in agricultural biophysical variables.

Chapter 2

Satellites - Image Collection

VICAL used the atmospherically corrected land surface reflectance images from Landsat (missions 4, 5, 7, 8 and 9, with images from 1982 to present) and Sentinel-2. Table 2.1 shows the properties of these image collections in the GEE.

The location of the different spectral bands of these sensors is shown in Figure 2.1.

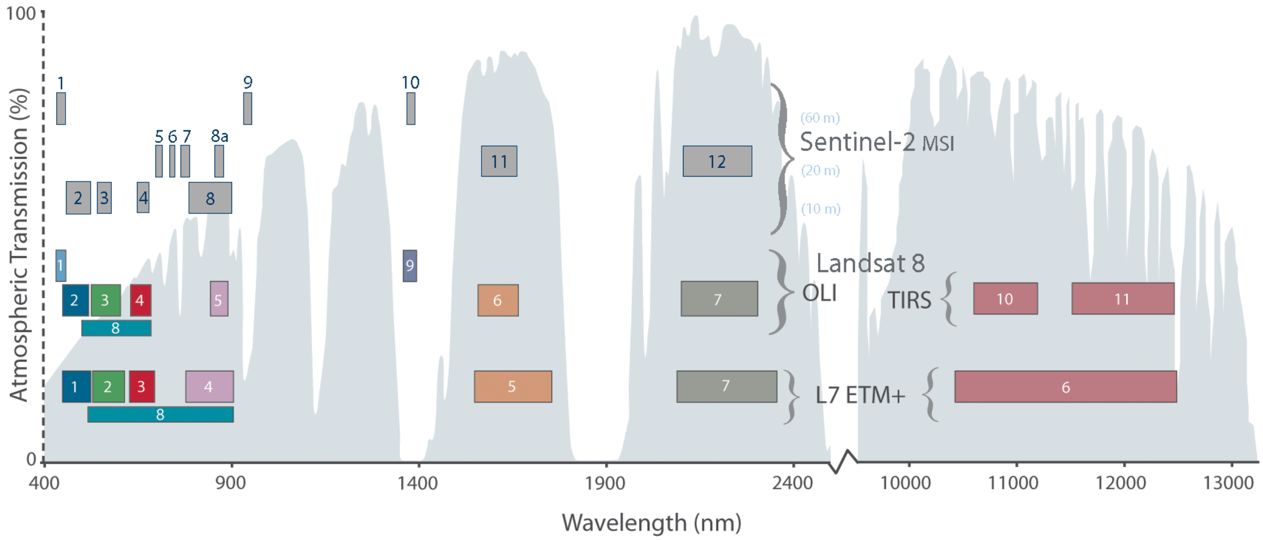

Figure 2.1: Comparison of Landsat and Sentinel-2 and location of the spectral bands. The numbers indicate the number of spectral bands considered in each sensor [@NASA2021]

In VICAL, there are four calculation options in VICAL with these image collections: **(i) Landsat (7, 8 and 9), (ii) Sentinel-2, (iii) Landsat (7, 8 and 9) and Sentinel-2 and (iv) Landsat (4 and 5)**.

Table 2.1: Image collection of Landsat and Sentinel-2 within the Google Earth Engine (GEE)

Sensor	Dataset.availability	Collection.ID
Landsat-4 TM	22/08/1982 - 24/06/1993	LANDSAT/LT04/C02/T1_L2
Landsat-5 TM	16/03/1993 – 05/05/2012	LANDSAT/LT05/C02/T1_L2
Landsat-7 ETM+	01/01/1999-present	LANDSAT/ LC08 /C02/T1_L2
Landsat-8 OLI	11/04/2013- present	LANDSAT/LE07/C02/T1_L2
Landsat-9 OLI-2	31/10/2021- present	LANDSAT/LC09/C02/T1_L2
Sentinel-2 (MSI)	28/03/2017-present	COPERNICUS/S2_SR_HARMONIZED

Chapter 3

Vegetation Indices

The VIs allow the quantitative and functional relationship with different parameters or variables of the vegetation. There are 23 VIs considered in VICAL, these VIs are commonly used in agricultural applications (Bannari, 2009),(Xue, 2017).

The names of these VIs, their mathematical expression as well as their abbreviation are shown in the following list:

1: ARVI: Atmospherically resistant vegetation index*

$$ARVI = \frac{p(NIR - rb)}{NIR + rb};$$

$$rb = R - \gamma(B - R);\ Default\,value:\ \gamma = 1.0$$

2: ATSAVI: Adjusted transformed soil-adjusted vegetation index

$$ATSAVI = \frac{a(NIR - aR - b)}{(R + aNIR - ab + X(1 + a^2))};$$

$$Default\,value:\ a = 1;\ b = 0;\ X = 0.08$$

3: DVI: *Difference vegetation index*

$$DVI = (NIR - R);$$

4: EVI: Enhanced vegetation index

$$EVI = \frac{2.5 * (NIR - R)}{NIR + C_1 R - C_2 B + L};$$

$$Default\,value:\ C_1 = 6.0;\ C_2 = 7.5;\ L = 1.0$$

5: EVI2*: Enhanced vegetation index

$$EVI2 = \frac{2.5 * (NIR - R)}{NIR + C_1 R + 1};\ Default\,value:\ C_1 = 2.4$$

6: GNDVI: Green normalized difference vegetation index

$$GNDVI = \frac{NIR - G}{NIR + G};$$

7: MSAVI2: Modified soil adjusted vegetation index

$$MSAVI2 = \frac{(2NIR + 1) - \sqrt{((2NIR + 1)^2 - 8(NIR - R))}}{2};$$

8: MSI: Moisture stress index

$$MSI = \frac{SWIR_1}{NIR};$$

9: MTVI: Modified triangular vegetation index

$$MTVI = 1.2[1.2 * (NIR - G) - 2.5 * (R - G)];$$

10: MTVI2: Modified triangular vegetation index-2

$$MTVI2 = \frac{1.2[1.2 * (NIR - G) - 2.5 * (R - G)]}{\sqrt{((2NIR + 1)^2 - (6NIR - 5\sqrt{(R)}) - 0.5)}};$$

11: NDTI: Normalized difference tillage index (NDTI)

$$NDTI = \frac{SWIR_1 - SWIR_2}{SWIR_1 + SWIR_2};$$

12: NDVI: Normalized difference vegetation index

$$NDVI = \frac{NIR - R}{NIR + R};$$

13: NDWI: Normalized difference water index

$$NDWI = \frac{NIR - SWIR_1}{NIR + SWIR_1};$$

14: OSAVI: Optimized soil adjusted vegetation index

$$OSAVI = \frac{1.16 * (NIR - R)}{NIR + R + X};\ Default\,value:\ X = 0.16$$

***15: RDVI**: Renormalized difference vegetation index*

$$RDVI = \frac{NIR - R}{\sqrt{(NIR + R)}};$$

***16: RI**: Redness index*

$$RI = \frac{p(NIR - G)}{NIR + G};$$

***17: RVI**: Ratio vegetation index*

$$RVI = \frac{R}{NIR};$$

18: SAVI: Soil adjusted vegetation index

$$SAVI = \frac{(NIR - R)}{NIR + R + L}(1 + L);\ Default\,value:\ L = 0.5$$

19: TVI: Triangular vegetation index

$$TVI = 0.5 * [120(NIR - G) - 200(R - G)];$$

20: TSAVI*: Transformed soil adjusted vegetation index*

$$TSAVI = \frac{a(NIR - aR - b)}{R + aNIR - ab};\ Default\,value:\ a = 1,\, b = 0.$$

***21: VARI**: Visible atmospherically resistant index*

$$VARI = \frac{G - R}{G + R - B};$$

***22: VIN**: Vegetation index number or simple ratio*

$$VIN = \frac{NIR}{R};$$

Table 3.1: Abbreviation of the spectral bands used in the VI equations

Abreviatura	Nombre
B	Azul/Blue
G	Verde/Green
R	Rojo/Red
RE	Borde Rojo/Red edge
NIR	Infrarrojo Cercano /Near infrared
SWIR1	Infrarrojo de onda corta 1/Shortwave infrared 1
SWIR2	Infrarrojo de onda corta 2/Shortwave infrared 2

23: WDRVI: Wide dynamic range vegetation index

$$WDRVI = \frac{\propto NIR - R}{\propto NIR + R)};\ Default\,value : \propto = 0.2$$

VICAL allows the user to configure some VIs coefficient such as in **ARVI, ATSAVI, EVI, EVI2, OSAVI, SAVI, ATSAVI**, and **WDRVI**, that is, all those VIs that need, in addition to the spectrum bands, some adjustment variable.

The name of the bands with their abbreviations that were used in the VIs equations is shown in Table 3.1.

If you want to add another VI you can write to us at jimenez.sergio@inifap.gob.mx

Chapter 4

Configuration

Before calculating the VIs in VICAL, a series of parameters that correspond to the configuration must be selected.

4.1 General configuration

When starting, to estimate the VI of any surface the user has two options: *i) digitize polygons or ii) Use a GEE vector file*. In addition, you need to configure other options, these are:

1). Date range: It is necessary to enter a start and end date, which corresponds to the interval in which you want to estimate the VIs (Figure 4.1). The date must have the following format: AAAA-MM-DD, *Four digits for the year, two for the month and two for the day.*

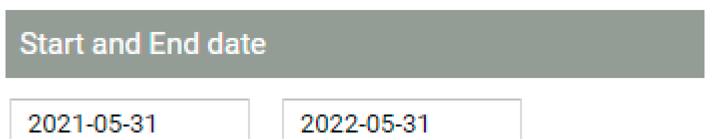

Figure 4.1: Date Range TextBox

VICAL uses this interval to search for available Landsat or sentinel-2 images, and with these images estimate VIs. VICAL by default sets the end date as the current date and the start date one year ago to the current date.

2) Cloud Percentage: A maximum cloud threshold must be entered, by default it is set to 30% (Figure 4.2).

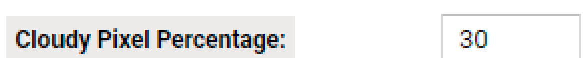

Figure 4.2: Cloud Percentage Threshold

3). Satellite: four available options are derived from landsat and sentinel-2 satellites (described in the section 2 **Satellites**) (Figure 4.3):

i) Landsat (7, 8 y 9): *returns Landsat images from sensors 7, 8 and 9 that are within the user-defined interval and with a maximum cloud threshold. Landsat 7 ETM+ data were spectrally fitted to Landsat 8 and 9 spectral bands (OLI and OLI-2) using the procedure recommended by (Roy, 2016) to generate a single set of harmonized data.*

ii) Sentinel-2: *returns Sentinel-2 images that are within the user-defined interval and with the maximum cloud threshold.*

iii) Landsat (7, 8 y 9) and Sentinel-2*: Returns both Landsat (7, 8 and 9) and Sentinel-2 images. Sentinel-2 MSI data are spectrally fit to Landsat-8 and 9 (OLI and OLI-2) spectral bands using the procedure recommended by*

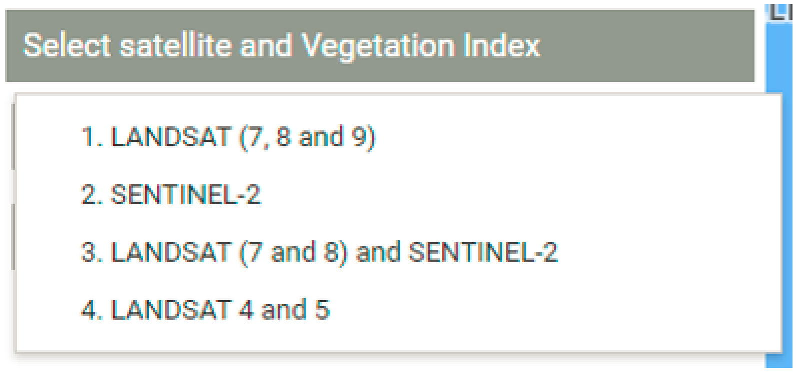

Figure 4.3: Satellites and sensors available at VICAL

(Claverie, 2018). Landsat 7 ETM+ data were spectrally fitted to Landsat 8 and 9 spectral bands (OLI and OLI-2) using the procedure recommended by (Roy, 2016). In this way a single set of harmonized data is generated.

iv) Landsat (4 y 5): *returns LandSat -4 and 5 images that are within the defined interval and with a maximum cloud threshold.*

4). Vegetation index: The user can select from 23 VIs commonly used in agricultural applications (Figure 4.4), The formulas for each vegetation index are found in the section 3 **Vegetation Indices**.

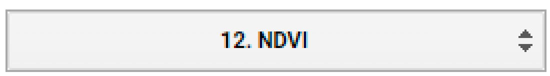

Figure 4.4: Vegetation Index Selector

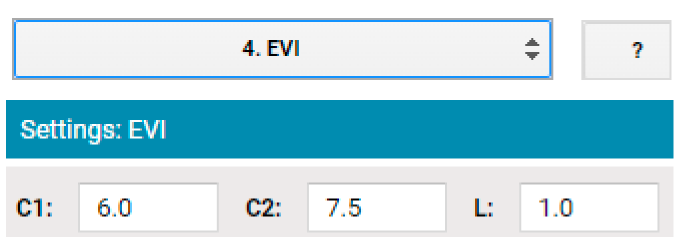

Figure 4.5: Coeficientes de IV

5) other additional functions: VICAL allows you to select additional options (Figure 4.6), for example:

i) Use a GEE vector file: *As indicated in the initial part of this chapter, the user can use a GEE vector file (polygon type). For this option, you must enter a URL address (Table ID) of the vector file that has been uploaded to GEE (Figure 4.7). in this way, even if there are digitized polygons, VICAL recognizes that the VIs must be calculated on the polygons of the vector file.*

ii) regression map: *The user obtains as a result a regression map based on the values of the calculated VIs. You can select between four types of functions: linear, quadratic, potential and exponential, and then you need to enter the adjustment coefficients for the selected function (Figure 4.8).*

iii) Filter images that cover the entire polygon: *Images that completely cover the polygon(s) are filtered, otherwise images are displayed even if they cover a certain percentage of the polygon. This option is useful for polygons that cover large surfaces (hundreds of hectares).*
iv) Calculate weighting factor (WF): *WF is the ratio of the VI value in a pixel to the average VI in the polygon (parcel). It is calculated for each digitized polygon. The WF in an agricultural parcel is a standardized indicator of the productive potential of each pixel of an image.*

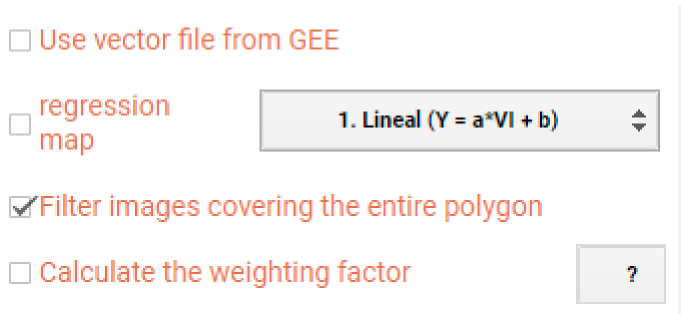

Figure 4.6: Optional configuration in VICAL

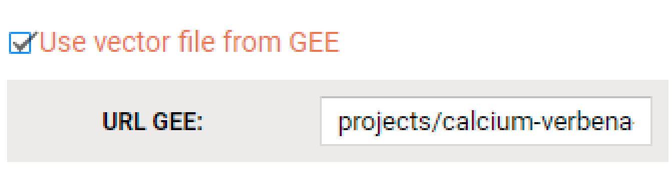

Figure 4.7: Table ID of the GEE vector file

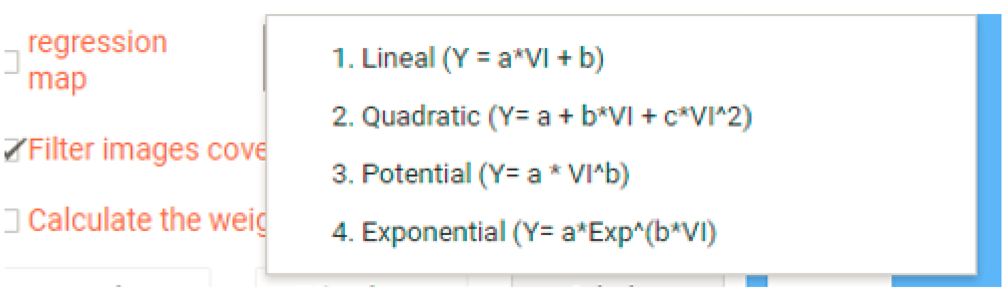

Figure 4.8: Functions considered

5) Calculate: : When the options have been configured, click on **calculate** and at least three layers will be shown on the map: ***i) RGB image of the first image found in the set interval, ii) VI map, iii) digitized polygons.***

4.2 Using digitized polygons

The user can digitize any parcel (polygons) using the drawing tools found in the upper left corner of the map (Figure 4.9). VICAL recognizes that VIs must be calculated on these polygons.

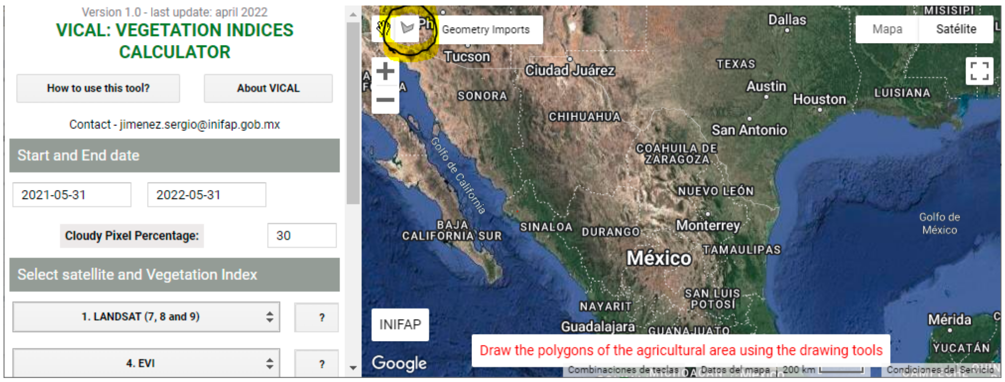

Figure 4.9: Drawing tools

This option is useful when there are few parcels where you want to estimate VIs (Figure 4.10). O bien, It is also useful when you want to download VIs for a particular area regardless of parcel boundaries. (Figure 4.11).

To edit the polygon or create a new polygon, click on the *"Edit and New Polygon"* buttons, respectively. These options are available after a calculation has been performed.

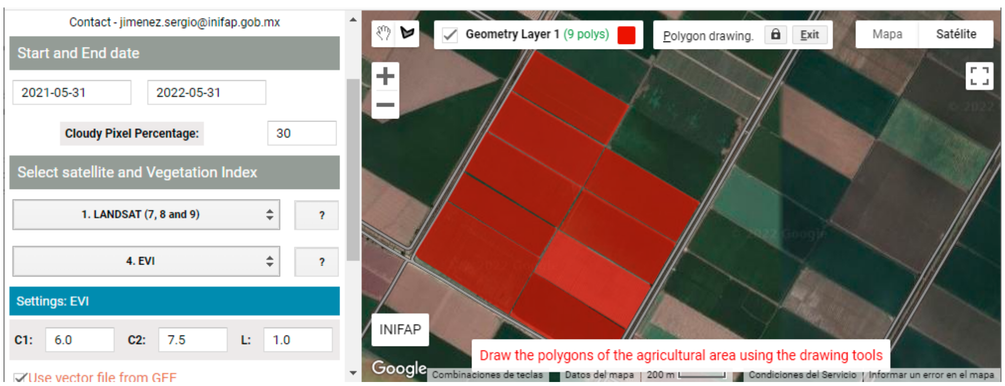

Figure 4.10: Digitized parcels

4.3 Using GEE vector file

For this option, the user must enter the **URL (Table ID)** of the vector file with which the calculations are to be performed; this indicates that you must have a GEE account and import a polygon-type vector file into your account.

The *Table ID **can be obtained by left clicking on the file found in the** Assets** tab of your GEE account (Figure 4.12).

So that the vector file can be used in **VICAL**, you must have the "Anyone can read" box activated (Figure 4.13).

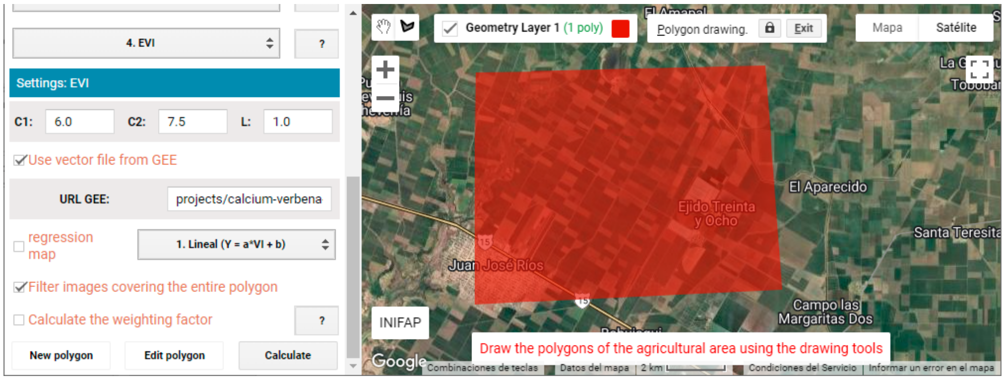

Figure 4.11: poligono digitalizados

Figure 4.12: vector file details

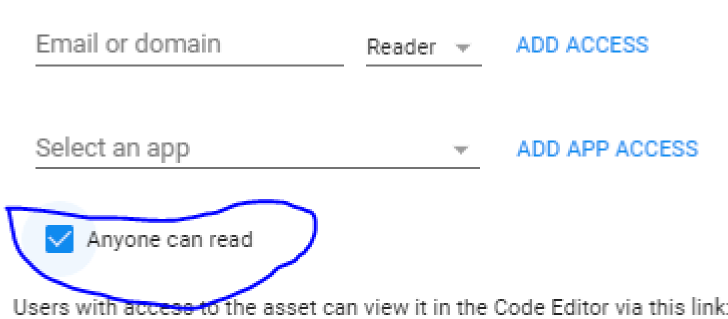

Figure 4.13: Share option view

Chapter 5

implementation

This section presents an example of how to navigate and how the VICAL results are displayed.

5.1 First views

When VIs are calculated using VICAL, a minimum of three mandatory and optional layers are shown on the map: (i) RGB combination *(Figure 5.1)*, (ii)the selected VI *(Figure 5.2)*, (iii) weighting factor (optional) calculated for each polygon *(Figure 5.3)*, (iv) the regression map (optional) *(Figure 5.4)* and (v) user drawn polygons. These maps, at first, are obtained from the first image found in the image collection..

The following images show some visualizations obtained from the URL that comes by default in VICAL (*"Use vector file from GEE"* was activated) and activating the linear regression option with coefficients of a=1.15 and b=0.17.

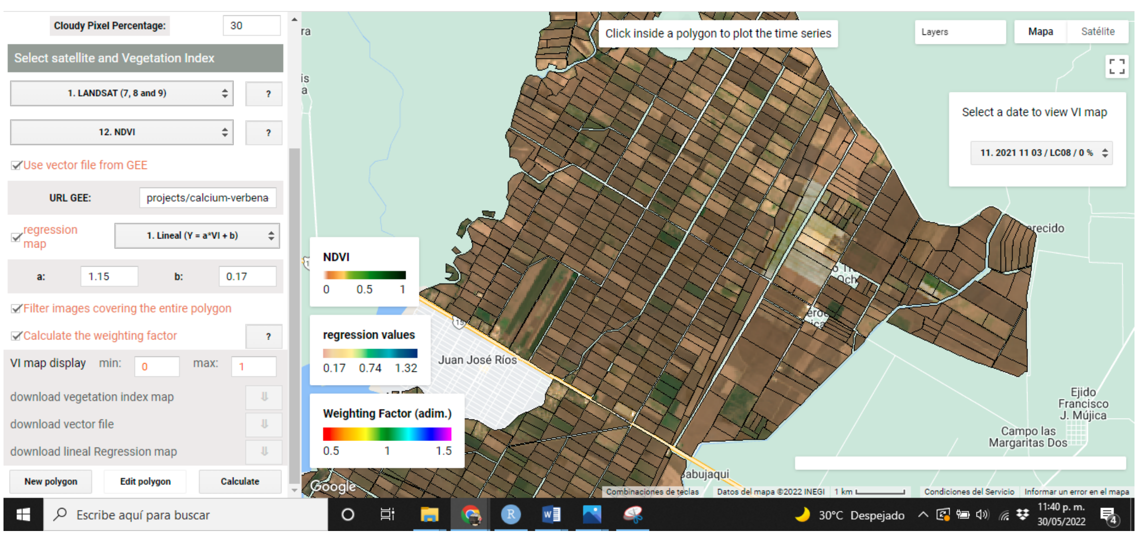

Figure 5.1: RGB Combination

5.2 Navigate between images

VICAL creates a images collection defined by the user's configuration; therefore, the user can navigate between the found images. To do this, a bar appears on the upper right side, where clicking on it displays a list where each row represents an image.

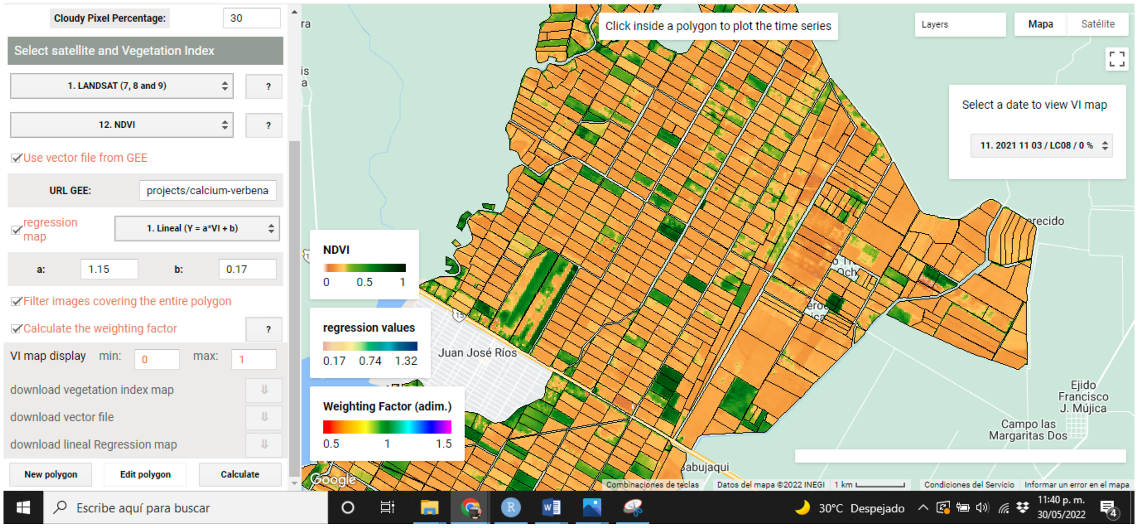

Figure 5.2: NDVI map

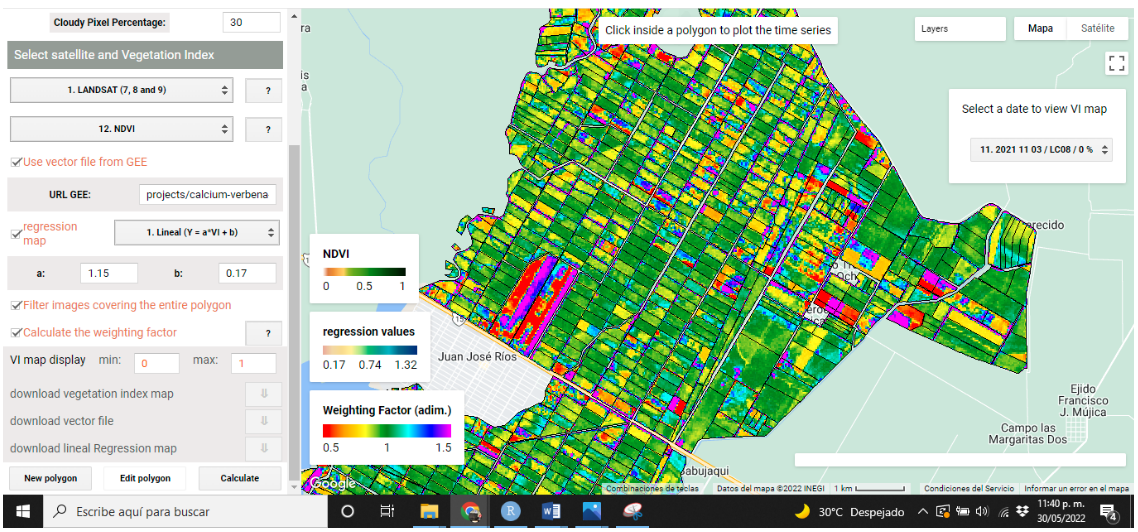

Figure 5.3: Weighting factor (optional)

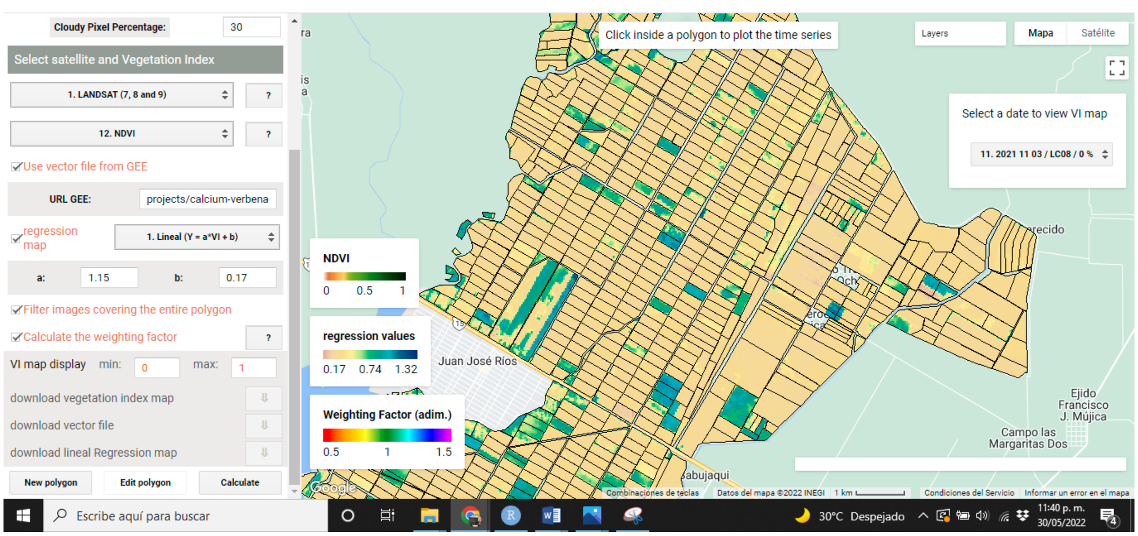

Figure 5.4: Regression Map (optional)

The short nomenclature used to name the images is: (Figure 5.5): *Image number found+ point + Image date (starting with year, month and day)+ / + Sensor + / + Cloud percentage in the image.*

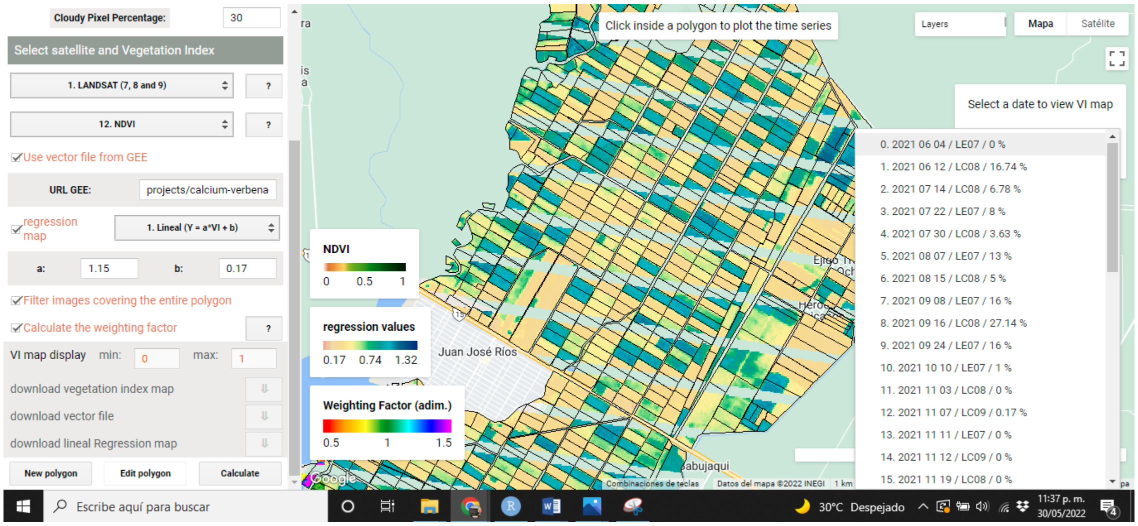

Figure 5.5: List of images found

Click on any row you want to view and the layers described in section 5.1 will appear (Figure 5.6).

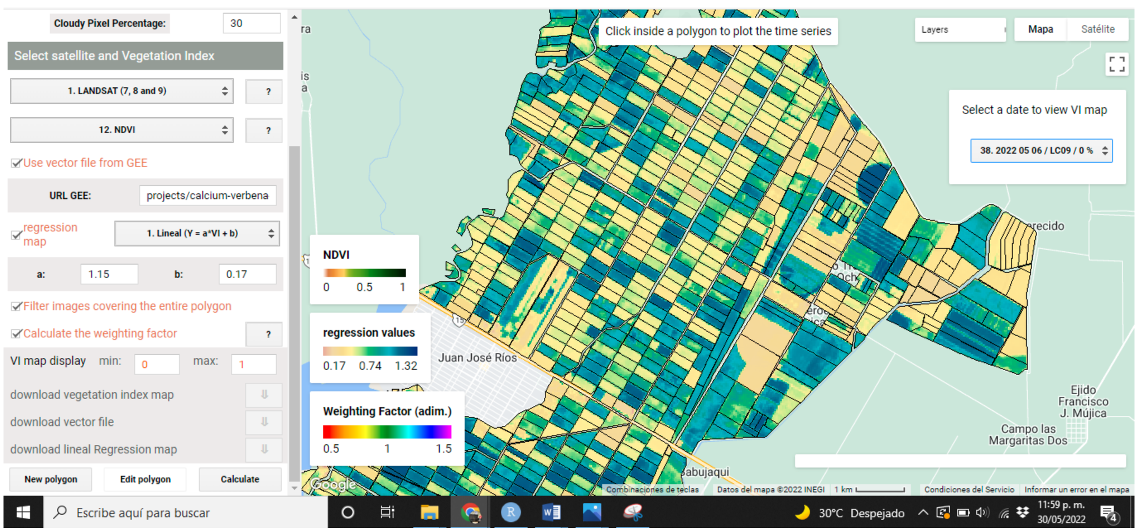

Figure 5.6: Maps for the selected date

5.3 VI map display

The user can change the display values of the VI map by changing the range in which the **maximum** and **minimum** value varies, for this, it is necessary to enter the values in the option *"VI map display"* (Figure 5.7) and press the Enter key with the keyboard.

The program recognizes when the value is changed and automatically creates the layer with the new display values (Figure 5.8). It is possible to change these display values after the user has navigated between images.

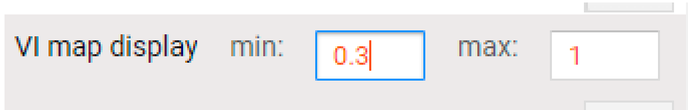

Figure 5.7: IV map display setting

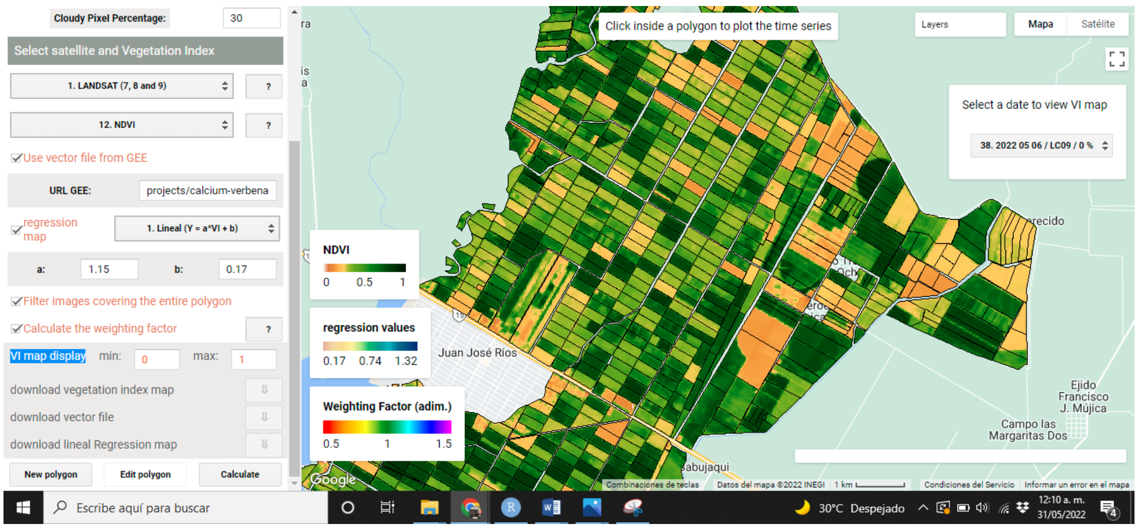

Figure 5.8: NDVI with values in the range [0,1]

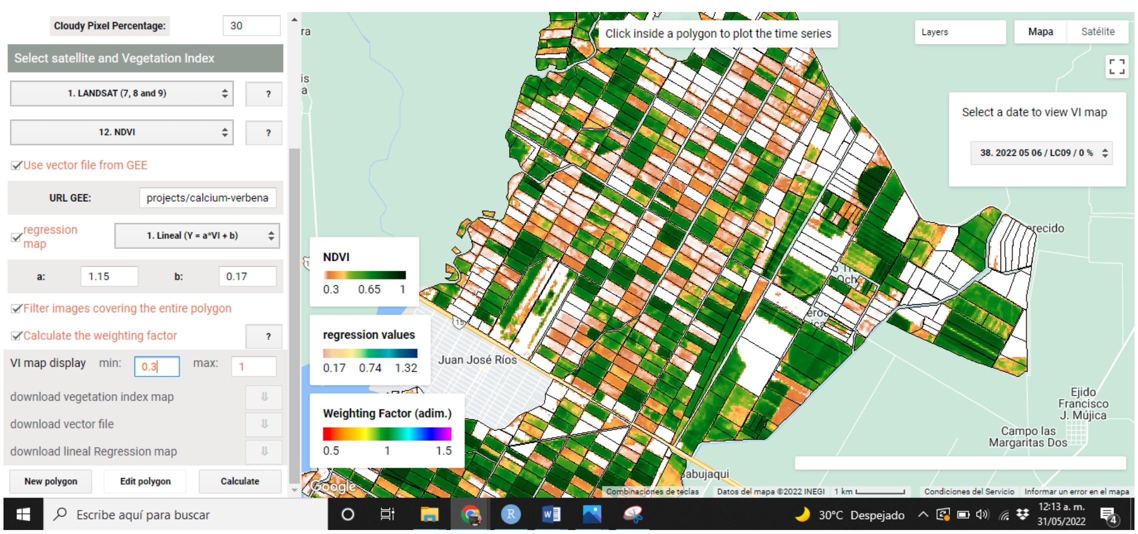

Figure 5.9: NDVI with values in the range [0.3,1]

5.4 Time series

The VI time series is obtained by clicking inside any polygon, therefore, the values are only for the selected polygon. The time series is shown in a graph where the average and standard deviation of the IV values are calculated. each point of the graph represents an image found according to the user's configuration (Figure 5.10 y (Figure 5.11)).

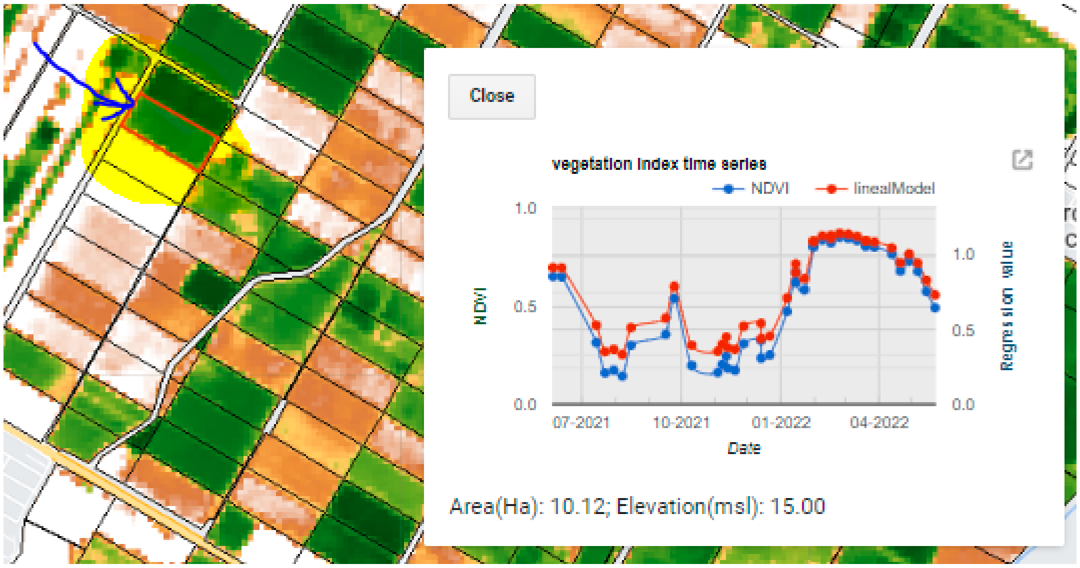

Figure 5.10: IV time series for the plot indicated

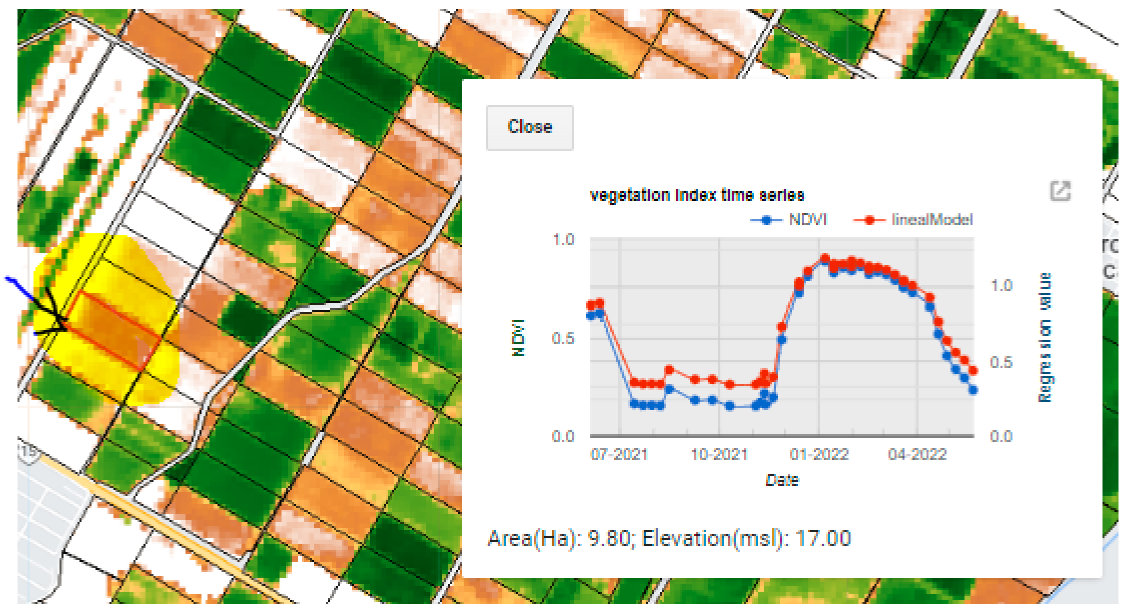

Figure 5.11: IV time series for the plot indicated

5.5 Download information

Three layers of the five shown on the map can be downloaded. Download buttons are displayed at the bottom of the configuration section (Figure 5.12). The layers that can be downloaded are:

i) VI map: The Raster image is downloaded with VI values calculated and cropped for the area of interest. The download is done in TIF format, which can be viewed, for example, in QGIS *(Figure 5.13)*.

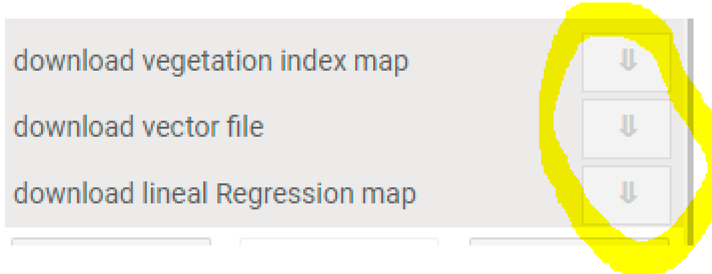

Figure 5.12: download options

ii) vector file: The digitized polygon is downloaded in kml format, which can be viewed, for example, in Google Earth.

iii) regression map: This option is available if “regression map” is activated; the raster image is downloaded with values of the regression map and cropped for the area of interest, the download is done in TIF format that can be viewed, for example, in QGIS.

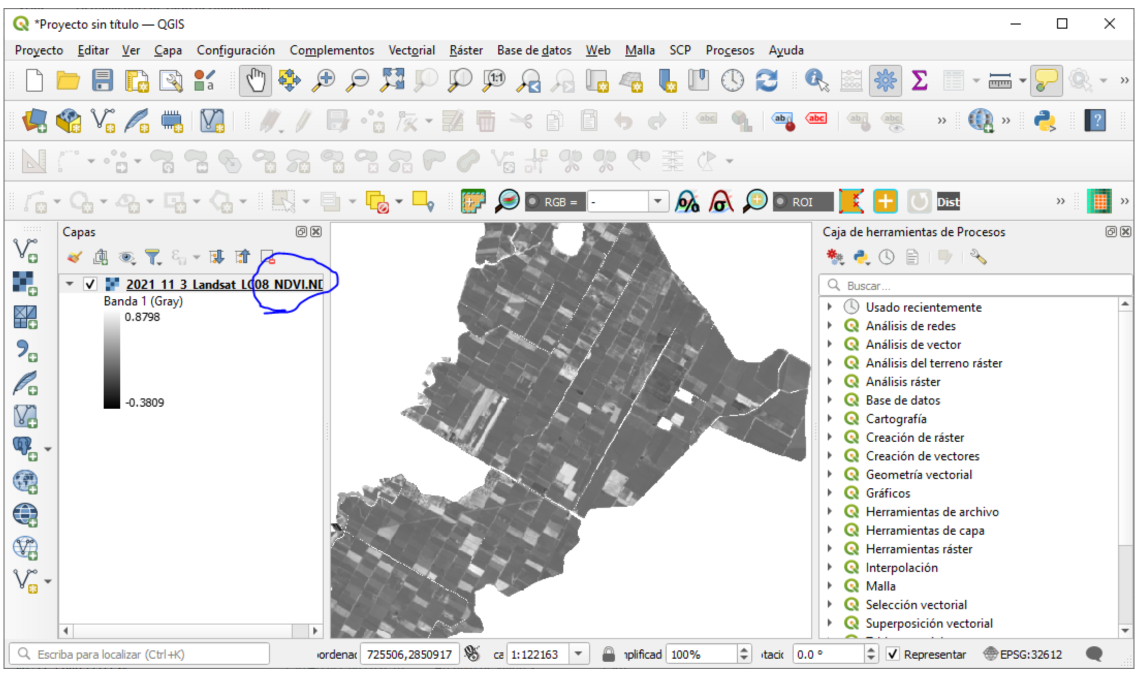

Figure 5.13: NDVI image displayed in QGIS

Chapter 6

VICAL in GEE

This section shows how to use the VICAL scripts to implement them in GEE.

VICAL has three main files that can be imported into a GEE Script, these are:

```
// Image collections
var imp = require('users/InifapCenidRaspa/VICAL:Exportaciones');
// Vegetation indices
var imp2= require('users/InifapCenidRaspa/VICAL:VegetationIndex');
// visualization styles
var St= require('users/InifapCenidRaspa/VICAL:Style');
```

6.1 Image collection

Before importing the image collections, some variables must be declared that are useful for filtering this collection: i) a point or polygon; ii) date range, and iii) cloud threshold value in images. These declarations are shown in the following code:

```
var fecha = ['2021-01-01', '2022-03-18']; //Start and end date
//polygon or point
var table = ee.FeatureCollection("projects/calcium-verbena-328905/assets/Bate");

var p_nubes= 30;//percentage of clouds
```

6.1.1 Landsat

If you want to use cloud-free atmospherically corrected LandSat images (4, 5, 7, 8 and 9), you can use the following code. A function is created to join the image collections. To do this, use the ***imp*** file.

```
function ColeccionImagenSR(fecha, recorte, umbral)
{
  // image collections are imported using the "imp" file
  var L9sr = imp.ColeccionLandsatSR(fecha, 'LC09', recorte, umbral);
  var L8sr = imp.ColeccionLandsatSR(fecha, 'LC08', recorte, umbral);
  var L7sr = imp.ColeccionLandsatSR(fecha, 'LE07', recorte, umbral);
  var L5sr = imp.ColeccionLandsatSR(fecha, 'LT05', recorte, umbral);
  var L4sr = imp.ColeccionLandsatSR(fecha, 'LT04', recorte, umbral);
  //ETM and ETM+ data are spectral fit to OLI and OLI-2
```

```
  var L7a = L7sr.map(imp.TMaOLI);
  var L5a = L5sr.map(imp.TMaOLI);
  var L4a = L4sr.map(imp.TMaOLI);
  // Join collections
  var serieT =L9sr.merge(L8sr).merge(L7a).merge(L5a).merge(L4a).sort('system:time_start');
    return serieT;
}
//The collection is imported using the previous function
var l8Sergio=ColeccionImagenSR(fecha, table, p_nubes);
//we can print the images using the print() function to see if the
//filtering of the image collection has been carried out (Figure 6.1)
print (l8Sergio);
```

With these image collections, time series of different vegetation indices can be calculated.

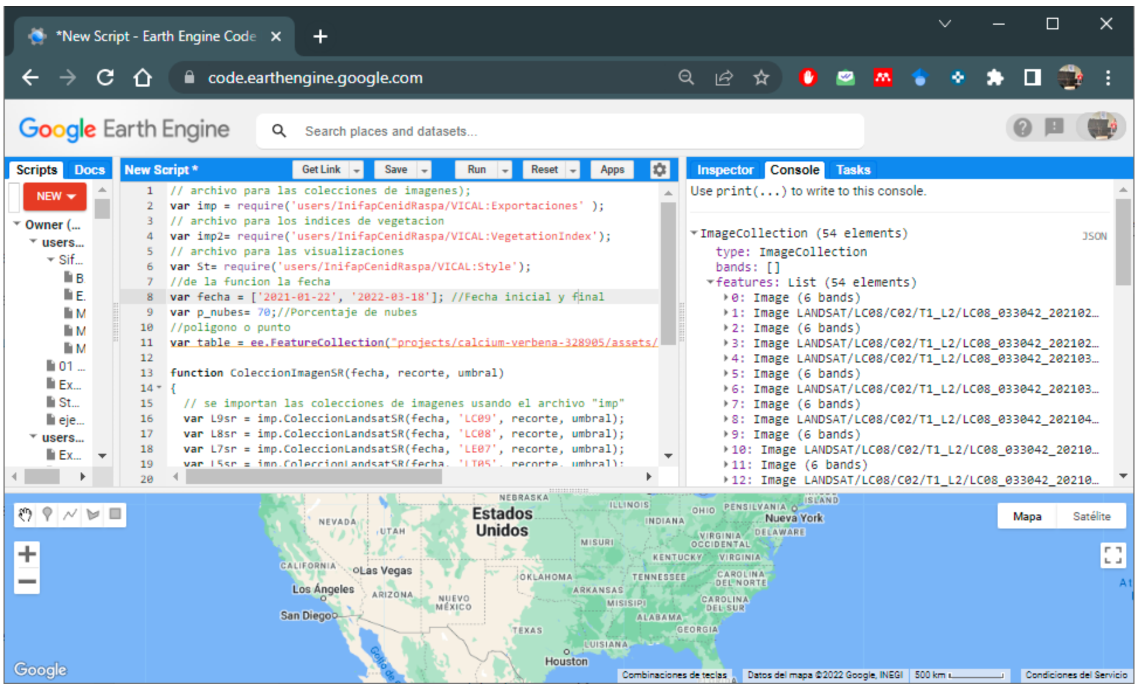

Figure 6.1: Landsat Image Collection

6.1.2 Sentinel-2

If you want to use cloud-free, atmospherically corrected Sentinel-2 images, you can use the following code.

```
//The collection of images is imported using the following code
var S2sr = imp.ColeccionImagenSentinelSR(fecha, table, p_nubes);
//we can print the images using the print() function to see if the
//filtering of the image collection has been carried out (Figure 6.2)
print (S2sr);
```

6.1.3 Landsat y Sentinel-2

If you want to use cloud-free, atmospherically corrected LandSat and Sentinel-2 images, you can use the following code, data were spectrally fit to Landsat 8 bands. The functions described in Section 6.1:

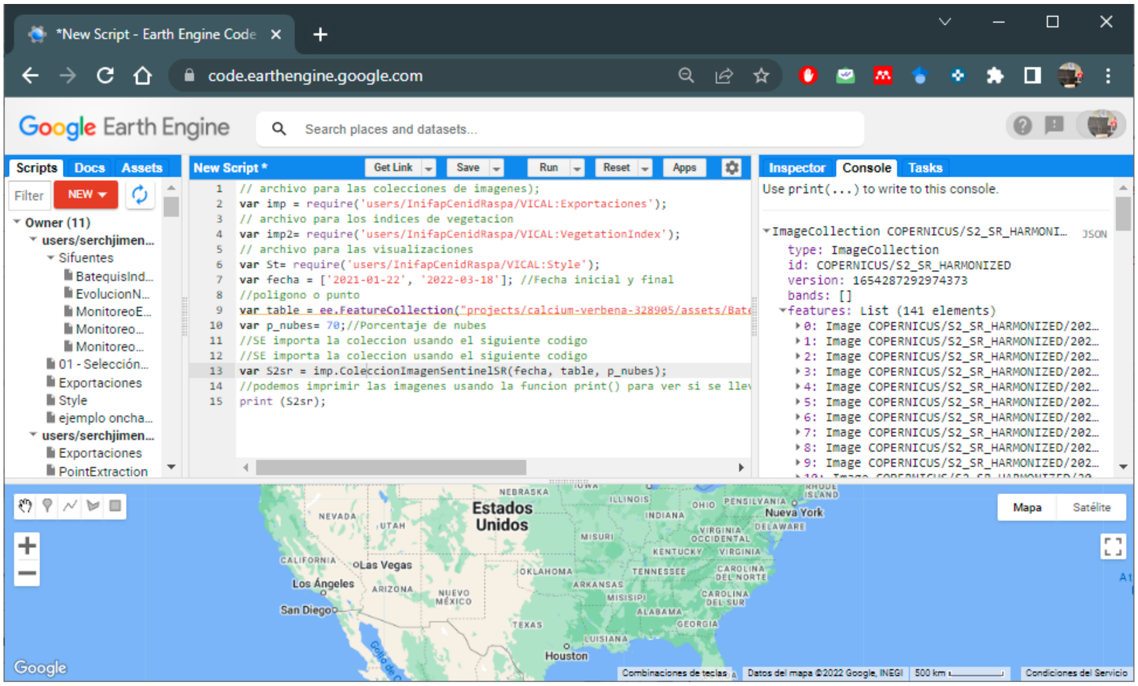

Figure 6.2: Sentinel-2 Image Collection

```
function ColeccionImagenAMBOS(fecha, recorte, umbral)
{
  //Function for Landsat images with spectral adjustment
  var L8Conjunto=ColeccionImagenSR(fecha, recorte, umbral)
  //Sentinel
  var S2sr = imp.ColeccionImagenSentinelSR(fecha, recorte, umbral);
  //Spectral matching of sentinel-2 to Landsat
  var S2a = S2sr.map(imp.MSIaOLI);
  var serieT = S2a.merge(L8Conjunto).sort('system:time_start');
    return serieT;
}

//The collection is imported
var S2B = ColeccionImagenAMBOS(fecha, table, p_nubes);
//we can print the images using the print() function to see if the
//filtering of the image collection has been carried out (Figure 6.3)
print (S2sr);
```

To view an example script click here

6.2 Vegetation indices

To calculate some of the VIs of **VICAL** you have to use the file **imp2**; and these VIs are imported using the names of the **ExpresionGEE** column that are shown in the **Table 6.1**.

For example, to calculate NDVI with LandSat and Sentinel-2 images from section 6.1.3, the following code would be used:

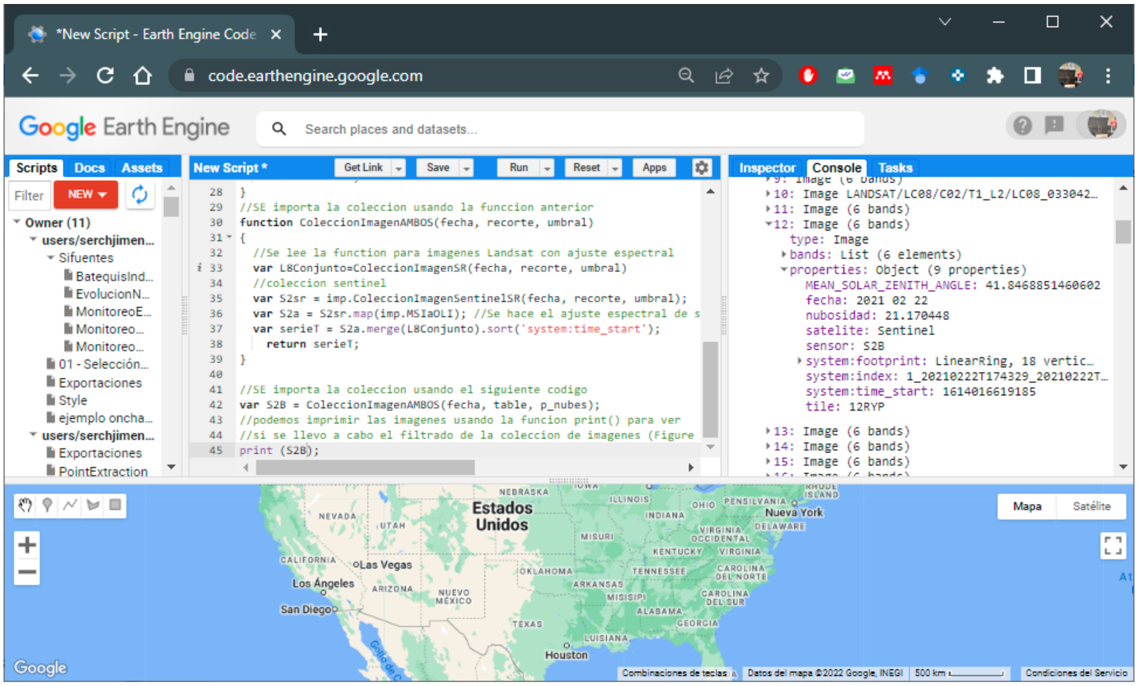

Figure 6.3: Landsat and Sentinel-2 imagery collection

```
//Normalized Difference Vegetation Index- NDVI
var ivs = ee.ImageCollection(S2B.map(imp2.NDVI));
//Print and view the NDVI band
print (ivs);
```

Figure 6.4 shows a single band called **NDVI**, calculated with the collection of images of the harmonized set

The following code shows an example to display on the map the **NDVI** of the first image of the collection and cropped for the area. The **st** file of ¨**VICAL** is used.

```
//NDVI from the first image in the collection
var iv = ivs.first();
//Color palette where 'st' file is used
var ivVis = {min :0, max : 1, palette : St.paletaIV};
Map.addLayer(iv.clip(table), ivVis,'NDVI'); //Indice
//the map is centered to the area
 Map.centerObject(table, 13);
```

Figure 6.5 shows the NDVI map for the area of interest

To view the sample code click here

If you want to display the NDVI of a particular image, you must convert it to a list.

6.3 GitHub repository

VICAL codes are written in JavaScript and are freely available on GitHub (https://www.github.com/CenidRaspaRiego/VICAL (accessed on 16 June 2022))

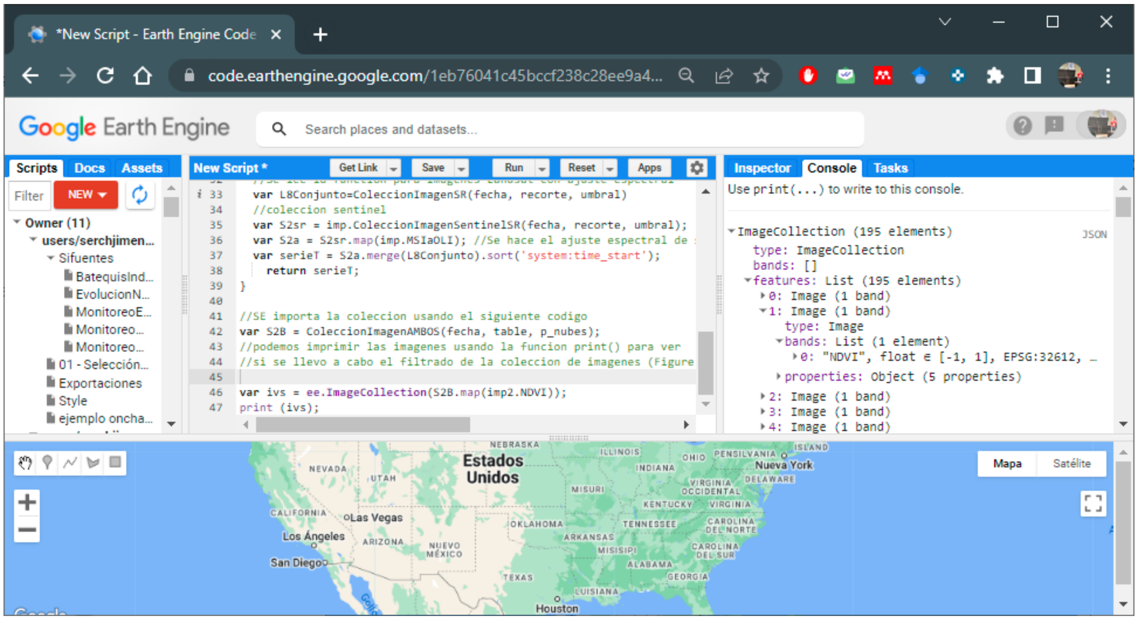

Figure 6.4: NDVI Band Image Collection

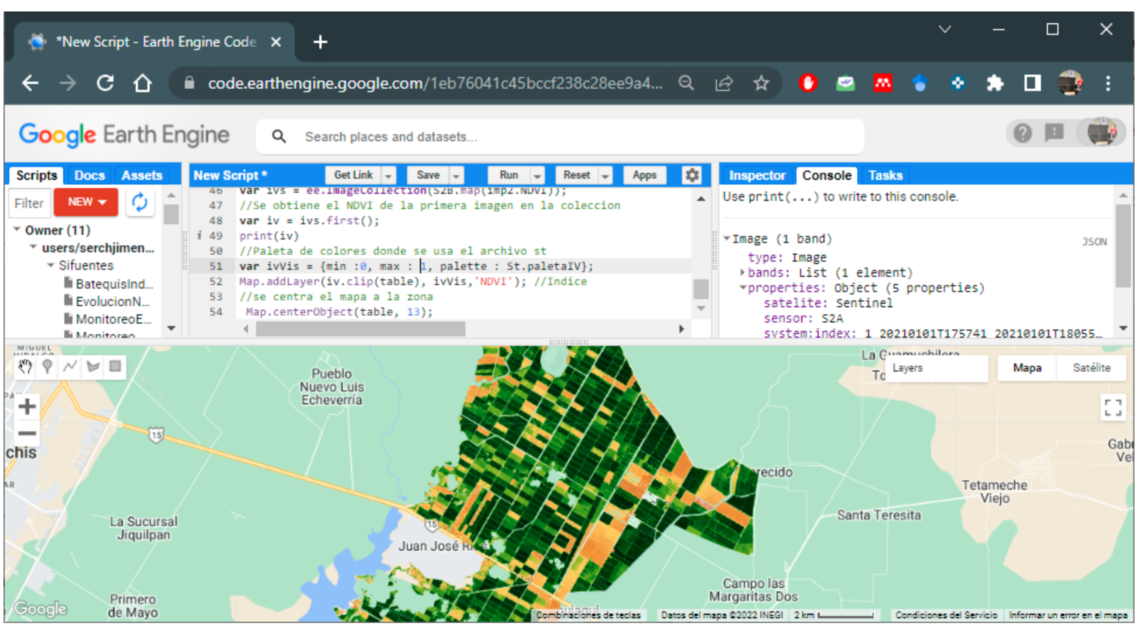

Figure 6.5: NDVI map for the area of interest

Table 6.1: Code of vegetation indices considered in VICAL

Number	Index	Abbreviation	ExpresionGEE	Coefficients
1	Atmospherically resistant vegetation index	ARVI*	ARVI	=1.0
2	Adjusted transformed soil-adjusted vegetation index	ATSAVI*	ATSAVI	
3	Difference vegetation index	DVI	DVI	
4	Enhanced vegetation index	EVI	EVI	C1=6.0, C2= 7.5; L=1.0
5	Enhanced vegetation index	EVI2*	EVI2	C1=2.4
6	Green normalized difference vegetation index	GNDVI	GNDVI	
7	Modified soil adjusted vegetation index	MSAVI2	MSAVI2	
8	Moisture stress index	MSI	MSI	
9	Modified triangular vegetation index	MTVI	MTVI	
10	Modified triangular vegetation index-2	MTVI2	MTVI2	
11	Normalized difference tillage index (NDTI)	NDTI	NDTI	
12	Normalized difference vegetation index	NDVI	NDVI	
13	Normalized difference water index	NDWI	NDWI	
14	Optimized soil adjusted vegetation index	OSAVI*	OSAVI	X=0.16
15	Renormalized difference vegetation index	RDVI	RDVI	
16	Redness index	RI	RI	
17	Ratio vegetation index	RVI	RVI	
18	Soil adjusted vegetation index	SAVI*	SAVI	L=0.5
19	Triangular vegetation index	TVI	TVI	
20	Transformed soil adjusted vegetation index	TSAVI*	TSAVI	a= 1 ; b=0;
21	Visible atmospherically resistant index	VARI	VARI	
22	Vegetation index number or simple ratio	VIN	VIN	
23	Wide dynamic range vegetation index	WDRVI*	WDRVI	=0.2

Chapter 7

Citation

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Chapter 8

Updates

f you have questions or find that updates introduce errors, please post an issue in the VICAL GitHub repository - if you don't have a GitHub account, email Sergio at: jimenez.sergio@inifap.gob.mx.

8.1 May 02, 2022

-The user can enter the **URL** (ID) of a vector file uploaded from GEE. -The digitized polygon can be exported in *.kml.* format

Bibliography

Bannari, Morin, B. . H. (2009). *A review of vegetation indices. Remote Sensing Reviews, 13(1–2), 95–120.*

Claverie, Ju, e. a. (2018). *The Harmonized Landsat and Sentinel-2 surface reflectance data set. Remote Sensing of Environment, 219, 145–161.*

Roy, Kovalskyy, e. a. (2016). *Characterization of Landsat-7 to Landsat-8 reflective wavelength and normalized difference vegetation index continuity. Remote Sensing of Environment, 185, 57–70.*

Xue, S. (2017). *Significant remote sensing vegetation indices: A review of developments and applications. Journal of Sensors.*