2023

INTER-REGIONAL WORKSHOP FOR DESERT LOCUST INFORMATION OFFICERS

(DESERT LOCUST INFORMATION MANAGEMENT AND USE OF GOOGLE EARTH ENGINE)

NO. 2

21–27 MAY 2023

SHARM EL SHEIKH (EGYPT)

COMMISSION FOR CONTROLLING THE DESERT LOCUST IN THE WESTERN REGION (CLCPRO)
COMMISSION FOR CONTROLLING THE DESERT LOCUST IN THE CENTRAL REGION (CRC)
COMMISSION FOR CONTROLLING THE DESERT LOCUST IN SOUTH-WEST ASIA (SWAC)
DESERT LOCUST INFORMATION SERVICE (DLIS)

Food and Agriculture Organization of the United Nations

CLCPRO/CRC/SWAC

Inter-regional Workshop
for Desert Locust Information Officers
(Desert Locust information management
and use of Google Earth Engine)

21–27 May 2023, Sharm El Sheikh (Egypt)

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

- 2023 -

Participants to the Inter-regional Workshop for Desert Locust Information Officers

(Desert Locust information management and use of Google Earth Engine)

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Inter-regional Workshop for Desert Locust Information Officers

(Desert Locust information management and use of Google Earth Engine)

21-27 May 2023, Sharm El Sheikh (Egypt)

1. Introduction

For the second time since 2014, an inter-regional workshop for Desert Locust information officers were organized with more than 23 countries (ALGERIA, BAHRAIN, BURKINA FASO, CHAD, EGYPT, ERITREA, ETHIOPIA, IRAN, IRAQ, JORDAN, KENYA, LIBYA, MAURITANIA, NIGER, OMAN, QATAR, SAUDI ARABIA, SENEGAL, SOMALIA, TUNISIA, UAE, and YEMEN) adding to the Desert Locust Control Organization for Eastern Africa (DLCO-EA). The other countries did not attend the workshop due to the non-deliverance of visas on time (Mali, Morocco, Pakistan, and India) knowing that the last regional workshops were organized in 2019 (Tunis in April 2019, Addis Ababa in June 2019, and Tehran in November 2019) due to the COVID-19 pandemic and the non-possibility to have face to face workshops. The workshop used three languages: Arabic, French and English. The Commission for Controlling the Desert Locust in the Central Region (CRC) staff organized the workshop and the Egyptian General Department for Locust and Agro-aviation Affairs provided logistics and support. The workshop was supervising remotely by FAO Senior Locust Forecasting Officer, Keith Cressman (online, via Zoom), Hichem Dridi (FAO/CLCPRO), Osama Rabie (FAO/Yemen), Nasser Al-Harthy (Oman) and supported by Mehdi Ghaemian (RAMSES developer). The workshop was held at the Parrotel Hotel in Sharm El Sheikh, Egypt during 21–27 May 2023.

The opening ceremony was done by Mamoon Al Alawi, the Executive Secretary of CRC, Shoki Al Dobai, Team Leader of the Locusts and Transboundary Plant Pests and Diseases (FAO Plant Production and Protection Division), Mohamed Lemine Hamouny, Executive Secretary (CLCPRO), and Khaled Abderabo, the Director of the Egyptian General Department for Locust and Agro-aviation Affairs.

The workshop wished to express his sincere thanks to the Egyptian Government for kindly hosting the workshop and for all the facilities granted to the participants to make their stay pleasant. There were several highlights about the progress made in DL information management with member countries contributions through the implementation of numerous mechanisms and tools developed by FAO, aimed to the reinforcement of sustainability of the preventive control strategy and the early warning system. The Director of the Egyptian General Department for Locust and Agro-aviation Affairs officially opened the workshop.

2. Program

The workshop started as indicated in the agenda (Annex 1) by a one-day brainstorming to allow to collect from the participants all feed-back, ideas and inquiries on the different themes of the Desert Locust information management (RAMSES, data transmission, eLocust3, eLocust3m (Pro), eLocust3w, eLocust3g, maps, layers, drones, and Locust Hub). This was followed by a presentation and discussions on data transmission tools from the field and the different faced problems. A presentation on RAMSES v4 and the management of the collected data followed by brief of the GIS systems (Geographic Information System) to facilitate the introduction to QGIS and RAMSES v5 which is under development. After the four training days intended for the DL management purposes, three days were dedicated for the initiation to the use of Google Earth Engine (GEE) where a trainer from the African Regional Institute for Geospatial Information Science and Technology (AFRIGIST) presented remotely via Zoom the introduction to GEE platform followed by exercises applied by the participants to allow them to be more familiar with GEE.

3. Brainstorming

Before starting the brainstorming session, which is a form of thinking in which ideas are first collected without judgment or censorship, presentation was provided to the participants describing the recommended rules to respect to reach the expected results, the main rules to respect to make this exercise fruitful are:

Defer judgment: creative spaces are judgment-free zones – they let ideas flow so people can build from each other's great ideas.

Encourage wild ideas: embrace the most out-of-the-box notions.

Build on the ideas of others: try to use “and” instead of “but," it encourages positivity and inclusivity and leads to tons of ideas.

Stay focused on the Topic: try to keep the discussion on target.

One conversation at a time: this can be difficult, especially with lots of creative people in a single room, but always think about the challenge topic and how to stay on track.

Be visual: write your ideas and make it visible.

Go for quantity: crank your ideas out quickly. For any 60-minute session, you should try to generate 100 ideas.

The brainstorming storming day is represented in the below table and was followed by a multiple discussion. During this brainstorming, the participants indicated what they expect from the workshop and some ideas that need to be achieved and some faced problems and difficulties they faced in their daily work as DLIOs. This information was used during the workshop discussions and to formulate some recommendations to the Commissions, DLIS and FAO-HQ:

Themes	Ideas	Problems
RAMSES v4.1	• The Regional Commission (CRC) should have the possibility to exchange and access to the countries’ locust data • To have a summary for data in Rv4 • To download the soil moisture and greenness map directly • Not to change the period manually every time when changing the different queries • Need urgent update with new devices with new technologies	1. Difficulty in installation 2. The processing is slow?

Themes	Ideas	Problems
	• Propose to have one platform for all transmission devices • To have possibility to make a legend in the same Rv4 map • To make map directly from the Rv4.1/Open street map • Easy way to download and install the application • To have new background maps 3D; and have it in Arabic • To have features similar to SWARMS application to make forecast at the country level • Options to make copy paste of regional names • Not to change the period manually every time when changing the different queries • Comparison of different layers at the same time	
Data transmission	• To send DL survey reports and data only through the Desert Locust Control Centers of the country • Any eL3m user should need username and password from the country information office before using the application	Some DL reports are not sent by email only available in the platform
eLocust3	Need urgent update with new devices with new technologies	
eL3m	eL3m Basic to have option to send report without mandatory photo attached	Difficulties to send heavy files and transmission cost

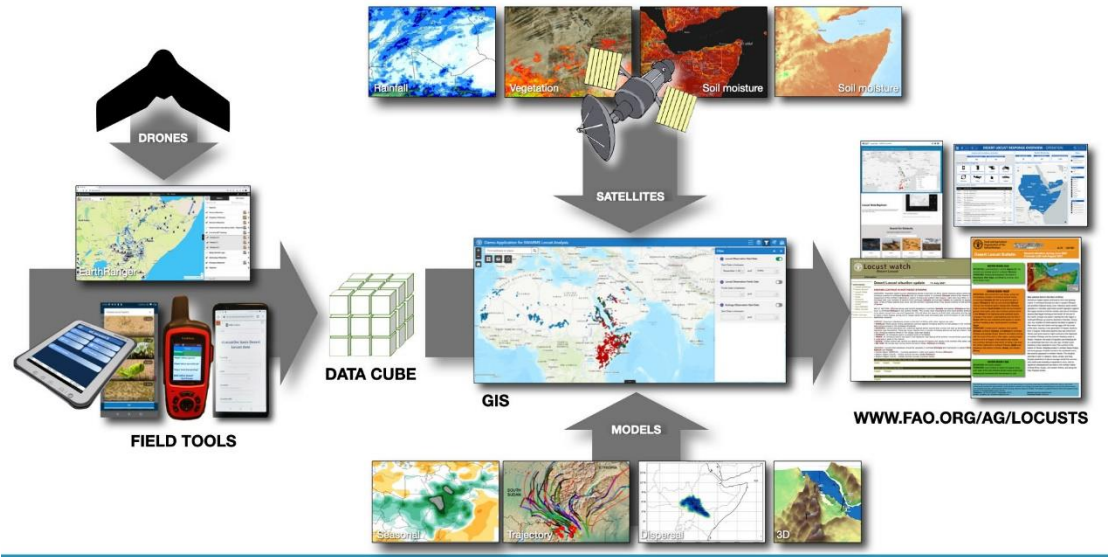
Themes	Ideas	Problems
eL3m PRO	• To have the possibility to retrieve the coordinates of any point on the map in the application • No administrative regions in iPhone version • Need more visual options • Addition aerial to stronger the coverage • Need to use the device out of the user's country • To provide devices to the survey officers • Propose to have one platform for all transmission devices	1. One platform to access the data for all devices 2. Any process to the development should be shared with Commissions
eL3g	• Expensive and can't be find quantity need from market • Expensive to send data	
Locust Hub	Data shouldn't be open for public, should be restricted and accessed upon permission	1. Data section shouldn't be open for all 2. Access should be subject to Commissions and country authorization 3. To be restricted login by username and password

Nobody had anything about eL3w, maps, layers or drones.

4. Data collection tools

A presentation was provided by the trainers describing information flow and the principal of data collection and transmission from the field using the different tools developed to collect and transmit data, namely eL3, eL3m, eL3g and eL3w to make clear how the information is sent from the field by the survey officers and which information is collected by the devices before transmitting the messages until the receiving from the DLIO.

As some participants from invasion countries were not familiar with the data collection tools the global early warning schema was presented.



This schema raised questions from some participants regarding the access to the platforms and the models, the trainers indicated the different links to access to the mentioned resources:

Field tools platforms:

- **Novacom Geoflex** – https://web-humanav.novacom-services.com
- **PlantVillage** – https://plantvillage.psu.edu/users/sign_in
- **Garmin explorer** – https://explore.garmin.com/Account/LogOn?stage=2
- **Kobo Tools** – https://kf.kobotoolbox.org/accounts/login/

5. RAMSES & countries bulletins

The trainers presented a summary of the use of the common features of RAMSESv4, starting by the importation of the collected data, its correction and plotting on the country map, before to import them into the Postgresql locust database. Manual data entry to Rv4 was also explained. After these steps, querying the database for locust data was done and the importation of the different remote sensing layers (precipitations and vegetation) was done, and the customization of the different legends and labels. The resulted map was imported into Keynote to be improved with the different shapes to make it easy for the readers.

These steps were followed by a session dedicated to the exercises, where the trainers were divided on the different group to support and help the DLIOs to produce a map which were

imported into the country bulletins. The exercises were very benefit to the DLIO as some of them still not using the recommended methods and tools.

The exercises were followed by a presentation to discuss and analysis the content of the monthly Desert Locust bulletins of some countries from the three regions, and advise on the recommended sections which need to be completed: map of the country and the summary of the country situation, ecology, situation summary, and analysis of DL, maps, forecasting, other information, resources, and distribution list.

6. Introduction to GIS and QGIS

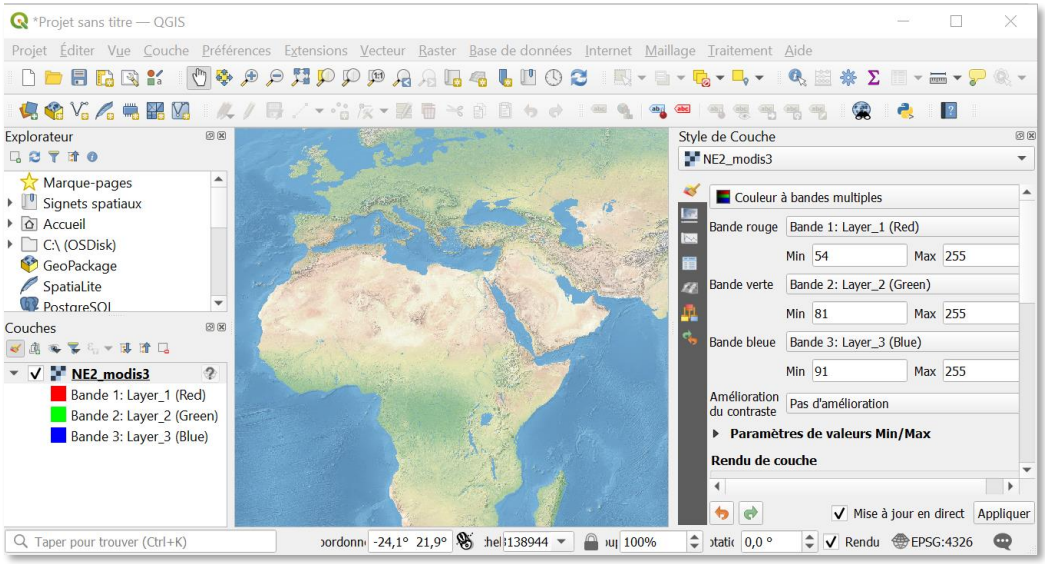
1. **Introduction to GIS:** The definition of GIS was presented as a system of integrated computer-based tools for end-to-end processing (capture, storage, retrieval, analysis, display) of data using location on the earth's surface for interrelation in support of operations management, decision making, and science.

   As most of the analysis uses GIS (Geographic Information System) to manipulate and interpret the georeferenced data, a presentation on the principles of GIS was presented to allow to DLIO to well understand the concept and as the philosophy. Locust data analysis and forecasting needs spatial information system as in GIS so you can visualize the data and notice the relations between the environment and Desert Locust. To understand the custom GIS, it's important to know the basics of the GIS, and composed by application or software (to use for analysis), spatial database (to store your locust geo-referenced data), data (that comes from surveys or control teams), and user (who should be trained well). Also, the definition of the spatial data, the attributes, difference between raster layer and vector one to represent the features, the definition of projection, scale, accuracy and resolution, maps, representing data with raster and vector models adding to some oral exercises to confirm the well understanding by the participants.

2. **Introduction to QGIS:** In order to prepare the DLIO to the next version of RAMSES (Rv5) that use QGIS as GIS software, it was presented to the participants to give them an overview of the main features and functionalities.

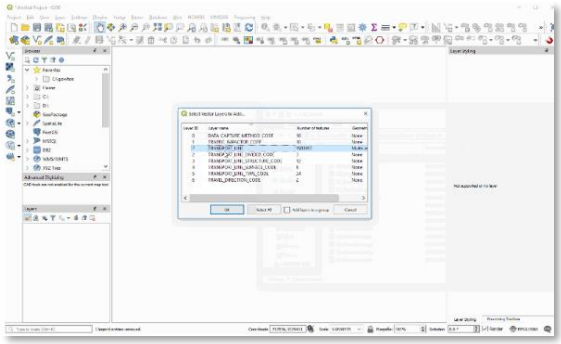
   QGIS is software distributed under an "open-source" license, this means that its open-source code, therefore available. Thus, anyone can have access to the source code of QGIS, improve it or redistribute it. QGIS is free cross-platform GIS software released under the GPL license. Development started in May 2002 and was released as a project on Source Forge in June 2002. It was also called Quantum GIS until September 2013.

   QGIS offers an ever-increasing number of possibilities, through its internal functions and its extensions. We can view, manage, edit, analyze data, and compose maps for printing.

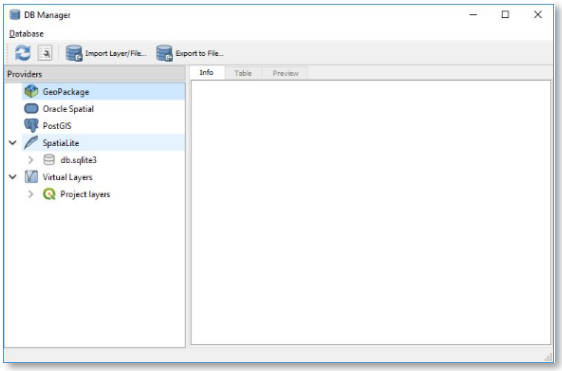


The main features of QGIS:

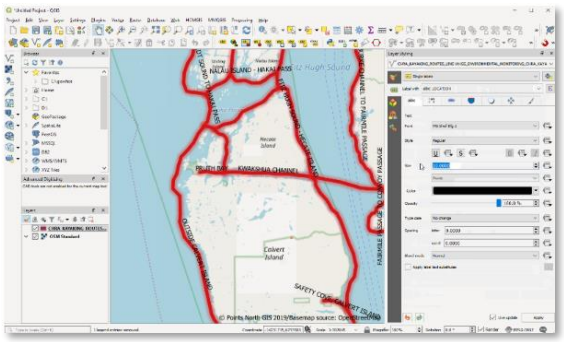
- **Drag and Drop**



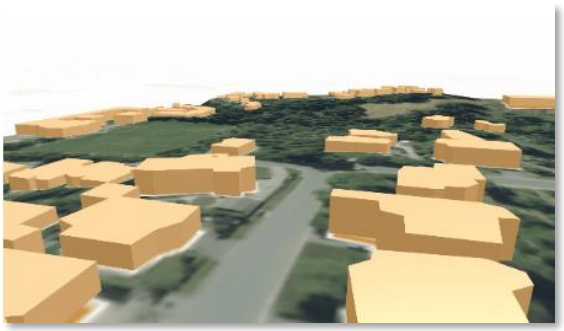
- **Relational Database Connectivity**



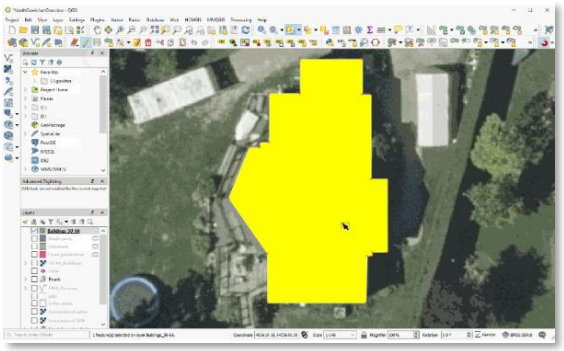
- **Symbology Interface**



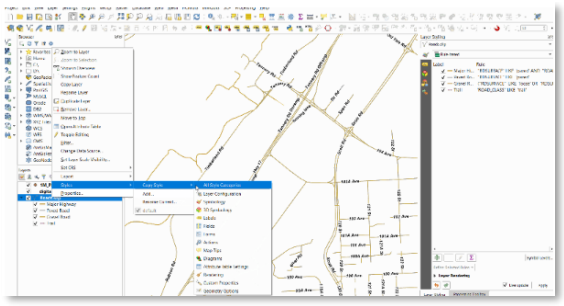
- **3D Visualization/Modeling**



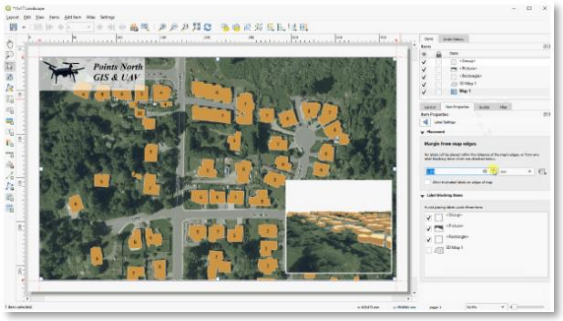
- **Digitizing Interface**



- **Extensibility with Plugins**
- **Python Integration**
- **Basemaps**
- **Layer Styling**



- **Map Layouts**

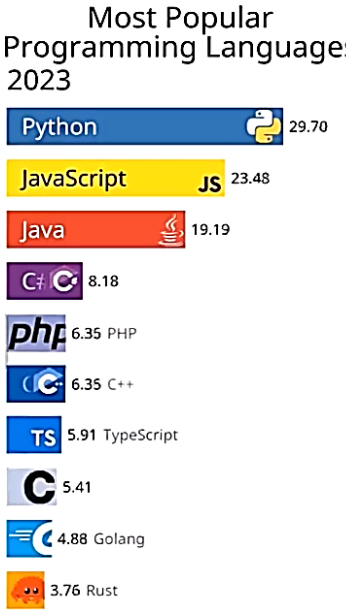


7. RAMSES v5

RAMSES custom application is the most essential tool for national locust units of the locust affected countries. It stores all related data and help locust information officers of the countries to manage data, create reports (both at national and international levels), current locust situation, and forecast. Therefore, it must be using latest technologies and always maintenance to be sure it is working properly.

RAMSES v4 is operated since 2015 and it is time to use better technologies as far as GIS engine, updated PostgreSQL as database engine. RAMSES should be updated based on current computer science to make more functionality available for locust affected countries.

RAMSES v5 will be launched based on following properties:



- **Database engine**:

PostgreSQL® (https://www.postgresql.org) (version 15.2 and upper) and PostGIS (latest version at release time)

- GIS engine:

QGIS® (https://qgis.org) (latest version at release time)

- Develop language:

Python® better background map display, possible to have printable reports, users can create custom queries, layouts, plugins with faster performances (C++). More meet end users need (users just need to input parameters one time, then parameters will used in a series of related queries). Better user-friendly interface, better managing layers by using categories layers and sublayers plugins repository for updates user interfaces in English, French and Arabic.

8. Other: usage of drone as data collection tool

The usage of drones as a new tool for the data collection in the field. This is one of the important tools in the early warning system components as it can allow the teams to carry out the extensive and intensive survey to detect the suitable area for the breeding and survival of DL adding to the detection of hopper bands and DL swarms. Since 2015, a long process of research, improvements and field testing was conducted to reach the actual model, which was used in 2022 for the first time by the survey teams without any assistance to detect the green vegetation and guide the field teams to the most interesting area that contains the suitable conditions. A presentation was presented to give to the participants the actual situation of the usage of drones in the field, adding to an overview of the components of the used drone for survey, the software used to the planning of the missions, to retrieve the results collected by the drones, and following the onboard data processing performed by the embed computer.

An overview of the platform called DOMA (Drone Operations Management Application) is to manage the drone operations. DOMA is a web application platform in real-time to monitor the drone missions and flights results data analysis. With this application, the status of all flying drones will be known and once the flight results are downloaded, the results will be analyzed.

9. Introduction to the use of Google Earth Engine (GEE)

In the framework of the collaboration between CLCPRO and the Regional Center for Training and Application in Agro Meteorology and Operational Hydrology (Niamey, Niger), and with support of the African Regional Institute for Geospatial Information Science and Technology (AFRIGIST), three days training was organized after the DLIO training, from 25 to 27 May 2023 to initiate the participants to the use of the platform of GEE (**program in annex 1**). The workshop was conducted remotely using Zoom by Glory Enaruvbe from AFRIGIS.

1. Objectives of the workshop

- Understand the GEE scripting language;
- Use pre-programmed scripts;

- Find the source of the image data (wind, vegetation, soil humidity), their periodicities and their resolutions as well as the indices used in remote sensing (NDVI, NDWI, etc.), in order to import them and perfect their interpretations;
- Find the method of extracting useful information for a given area;
- Find the method of classifying the images obtained;
- Optimize the use of indices in remote sensing (NDVI, NDWI, etc.);
- View, download and interpret GEE images.

2. Introduction to GEE

Google Earth Engine is a cloud-based platform that enables large-scale processing of satellite imagery to detect changes, map trends, and quantify differences on the Earth's surface.

The advantages offered by the platform are numerous, in particular:

- Free cloud-based images;
- The image analysis tool facilitating the analysis and sharing of information via an interactive development platform-Cloud computing;
- The vast archive of Earth observation images available to the public (data available from 1984 to the present);
- Acquisition of 4,000 new images daily;
- Seven (7) petabytes of data available.

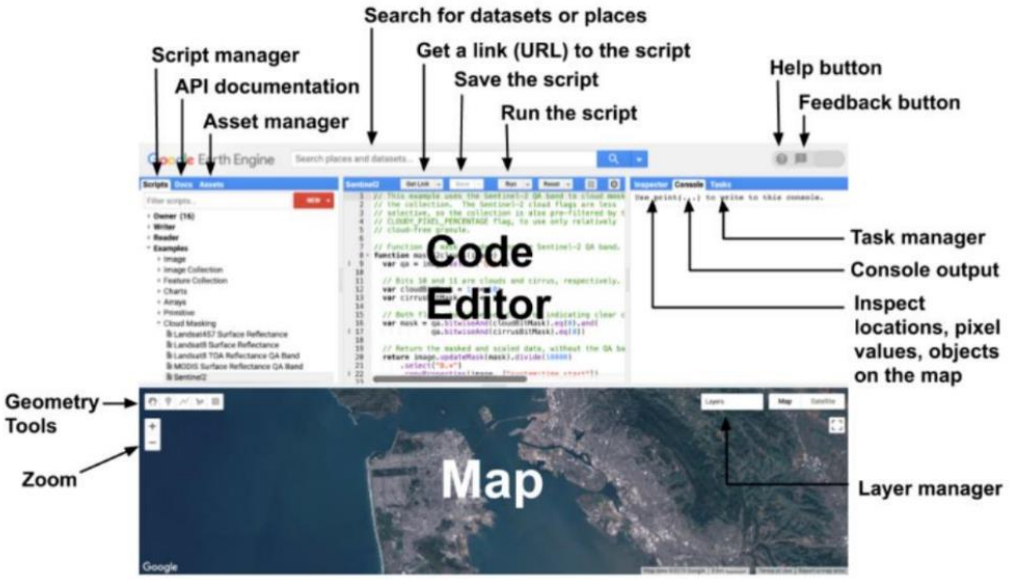
Data catalog:

The first step during this training was the presentation of the code editor which represents the development environment.

The Earth Engine (EE) Code Editor (code.earthengine.google.com) is a web-based IDE (**integrated development environment**) for the Earth Engine JavaScript API

(Application Programming Interface). Code Editor features are designed to make developing complex geospatial workflows fast and easy. The Code Editor has the following elements:

- JavaScript code editor
- Map display for visualizing geospatial datasets
- API reference documentation (Docs tab)
- Git-based Script Manager (Scripts tab)
- Console output (Console tab)
- Task Manager (Tasks tab) to handle long-running queries
- Interactive map query (Inspector tab)
- Search of the data archive or saved scripts
- Geometry drawing tools

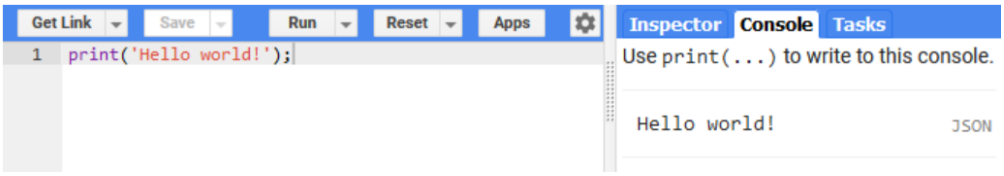


This step was followed by the explanation of the syntax of the scripts and how we can write and run a script.

The first script was the printing of "Hello world !"

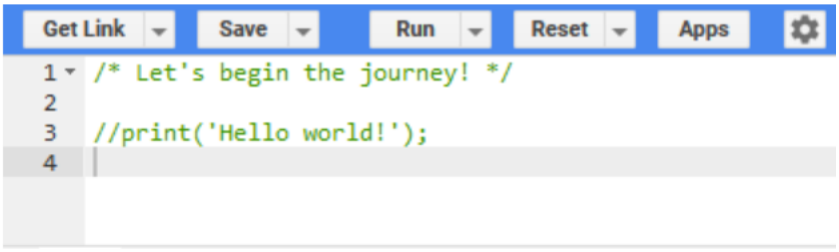
```
print ( 'Hello world!' );
```

By clicking the "*Run*" button and the "*Hello world* !" will be printed in the "Console" tab of the right panel

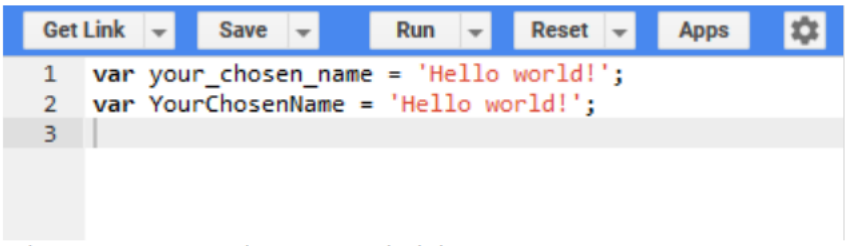


The usage of comment that will not run when you press the "Run" button is also possible. The comment is used to prevent the execution of a line of code without having to delete it. It is therefore very useful for tests or to keep track of developments and ideas during programming. There are three ways to write a comment or comment out lines of code on the script:

1. By placing two slashes // in front of the code,
2. By using the "Ctrl + /" shortcut,
3. To comment on multiple lines, instead of putting // at the beginning of each line, you can put a /* before the first line and complete it by putting a */ at the end of the last line.



Explanation of the variables: variables are used to store objects that can be re-used during code execution. They are used as inputs for methods and specialized specific scripts. They are defined with the keyword "var" and by typing the name you have chosen for the variable.



Exercises: the trainer asked the participant to practice the use of GEE through eight exercises in their GEE session and running the scripts to show the results (**annex 3**).

11.Recommendations

RAMSES v4.1	- Have Rv5 in Arabic, French and English. - Have advanced functionalities like those in SWARMS. - Any process to the development should be expressed by countries through commission and development shared with Commissions. - Rv5 should be ready for the first test by the end of December 2023.
Data transmission	- To send DL reports and data only from the DL Center of the country to the Commissions and to DLIS. - To restrict the use to identified users. - The DLCO-EA to have access to data of member countries (DJI - ETH - ERI - SUD - South Sudan - SOM).
eL3m	- Any development suggestion should be agreed and made jointly with commissions secretariats.
eL3g	- Any process to the development should be shared with commissions.
eL3w	- Any process to the development should be shared with commissions.
Locust Hub	- Data section shouldn't be open for public, to be restricted using login by username and password and upon approval from concerned countries and commissions.
GEE	- Take advantage of the DLIO monthly zoom meeting to continue the training on GEE with the participation of a trainer from AFRIGIST or AGRHYMT.

12.Conclusion

The second inter-regional workshop of the DLIO was very successful following the general feedbacks from the participants and was an opportunity to the DLIO from 23 countries and DLCO-EA to get together to exchange experiences and share knowledge exchange their experiences and to learn from the trainers and from their colleagues was good, specially from those who carry out their activities on annual basis (breeding countries). The DLIO from invasion countries were very happy to have been invited to this workshop because they learned about a lot of thoughts related to DL data management, which they were not familiar about and expressed their hope to continue to participate to such workshop. Everyone reaffirmed the importance and the need to continue to organize such workshops. The workshop contributes directly to the strengthening of the Desert Locust early warning system, which is the basis for preventive control to reduce the frequency, duration, and intensity of Desert Locust plagues. Participants were presented with a Certificate of Attendance at the end of the workshop.

Annexes

Annex 1. Workshop agenda

Date and Time	Session	Note
Sunday 21 May	**Morning**	**DLIO**
8.00 - 09.00 09.00 - 10.30 (break) 11.00 - 12.30 (lunch)	**Official opening**	Host country /FAO
	Break	
	Workshop introduction	• Presentation of the participants • Workshop objectives • Participants expectations • Review of workshop program
	Brainstorming on improvement of tools and methods	• Data collection tools: eLocust3, eLocust3m, eLocust3g, eLocust3w, Drones
	Afternoon	
14.00 – 15.30 (break) 16.00 – 17.00	**Brainstorming on improvement of tools and methods**	• Data management tools: RAMSES, Maps, additional layers, Reporting, Data dissemination • Development New tools
Monday 22 May	**Morning**	**DLIO**
08.30 - 10.00 (break) 10.30 - 12.30 (lunch)	**eLocust3, eLocust3m and eLocust3g, eLocust3w Data**	• Review of el3, el3m, el3g, el3w • Retrieving the collected data from emails and platforms • Check the received data from the field
	Afternoon	
14.00 – 15.30 (break) 16.00 – 17.00	**eLocust3, eLocust3m and eLocust3g, eL3W Data**	• Exercises
Tuesday 23 May	**Morning**	**DLIO**
08.30 - 10.00 (break) 10.30 - 12.00 (lunch)	**Ramses V4**	• Review the practice functionalities. • Importing and correction of the collected data • Data analysis
	Afternoon	
14.00 – 15.30 (break) 16.00 – 17.00	**Ramses V4**	• Maps making in Rv4 • Using of Mac tools to improve the maps

Date and Time	Session	Note
Wednesday 24 May	**Morning**	**DLIO**
08.30 - 10.00 (break) 10.30 - 12.00 (lunch)	**GIS for locust data management** **Reporting and data Management**	• Presentation on the principles of GIS for locust management • Introduction to QGIS • Using QGIS to manage the DL data • Review of countries DL bulletins • Making a DL bulletins following the standard and recommended practices • Exercises
	Afternoon	
14.00 – 15.30 (break) 16.00 – 17.00	**Other**	• Collaboration tools • Next steps • Workshop evaluation • **Closing**
Thursday 25 May	**Morning**	**GOOGLE EARTH ENGINE**
08.30 - 10.00 (break) 10.30 - 12.30 (lunch)	**Official opening** **General information and reminders**	• Reminder on GEE scripts, documents and resources • Loading of images, calculations, spectral indices, visualization, etc. • List the relevant GEE resources for locust monitoring and the production of locust information • Exercises
	Afternoon	
14.00 – 15.30 (break) 16.00 – 17.00	**Processing and interpretation of GEE resources for locust monitoring and information production**	• Research of satellite images (Landsat, NOAA, Sentinel, Modis, SAR, etc.) and their metadata / information to identify satellite data relevant to the locust service • Use of mathematical operators, calculation of bands (NDVI, NDWI, slopes, etc.), use of reducers, cartographic and spatial analysis in specific regions, analysis and interpretation of data and images. • Generation of parameters for characterization of biotopes and visualization of outputs

Date and Time	Session	Note
Friday 26 May	**Morning**	**GOOGLE EARTH ENGINE**
08.30 - 10.00 (break) 10.30 - 12.30 (lunch)	**Processing and interpretation of GEE resources for locust monitoring and information production**	• Use of the scripts available in the different directories • Practical exercises on data : import/export, processing, analysis and interpretation
	Afternoon	
14.30	**Cultural visit**	
Saturday 27 May	**Morning**	**GOOGLE EARTH ENGINE**
08.30 - 10.00 (break) 10.30 - 12.30 (lunch)	**GEE Desert Locust interface**	• Presentation and usage of GEE Desert Locust interface • Practical exercises on data: import/export, processing
	Afternoon	
14.00 – 15.30 (break) 16.00 – 17.00	**GEE Desert Locust interface**	• Analysis and interpretation and usage in the DL bulletins • Distribution of Certificates • **Closing**

Annex 2. Workshop participants

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Annex 3. Exercises

Exercise 1

1. Create a list named 'visitedCities'

2. The list should have names of 5 cities you have visited or wish to visit soon

3. Print the list

```
//In-built functions example:print function
print('Hello World');

// Variables and variable declaration
var city = 'Cairo';
var country = 'Egypt';
print(city, country);

var population = 10000000;
print(population);

// List of items
var majorCities = ['Alexandria', 'Giza', 'Aswan', 'Cairo'];
print(majorCities);

// Dictionary
var cityData = {
  'city': city,
  'population': 1000000,
```

```
  'elevation': 23
};
print(cityData);


// Function
var greet = function(name) {
   return 'Hello ' + name;
};
print(greet('World'));
```

Exercise 2

1. Find the 'Sentinel-2 Level-1C' dataset page https://developers.google.com/earth-engine/datasets
2. Copy/page the code snippet
3. Change the code to display images for your home city

```
/**
 * Function to mask clouds using the Sentinel-2 QA band
 * @param {ee.Image} image Sentinel-2 image
 * @return {ee.Image} cloud masked Sentinel-2 image
 */
function maskS2clouds(image) {
  var qa = image.select('QA60');

  // Bits 10 and 11 are clouds and cirrus, respectively.
  var cloudBitMask = 1 << 10;
  var cirrusBitMask = 1 << 11;
```

```
  // Both flags should be set to zero, indicating clear conditions.
  var mask = qa.bitwiseAnd(cloudBitMask).eq(0)
      .and(qa.bitwiseAnd(cirrusBitMask).eq(0));

  return image.updateMask(mask).divide(10000);
}

// Map the function over a month of data and take the median.
// Load Sentinel-2 TOA reflectance data (adjusted for processing changes
// that occurred after 2022-01-25).
var dataset = ee.ImageCollection('COPERNICUS/S2_HARMONIZED')
                  .filterDate('2022-01-01', '2022-01-31')
                  // Pre-filter to get less cloudy granules.
                  .filter(ee.Filter.lt('CLOUDY_PIXEL_PERCENTAGE', 20))
                  .map(maskS2clouds);

var rgbVis = {
  min: 0.0,
  max: 0.3,
  bands: ['B4', 'B3', 'B2'],
};

Map.setCenter(-9.1695, 38.6917, 12);
Map.addLayer(dataset.median(), rgbVis, 'RGB');
```

Exercise 3

What is the filter size?

Add one more filter in the script below to select images from only one of the satellites - Sentinel-2A

- from the Sentinel-2 constellation

```
var geometry = ee.Geometry.Point([77.60412933051538, 12.952912912328241])

Map.centerObject(geometry, 10)


var s2 = ee.ImageCollection('COPERNICUS/S2_HARMONIZED');


// Filter by metadata

var filtered = s2.filter(ee.Filter.lt('CLOUDY_PIXEL_PERCENTAGE', 30));


// Filter by date

var filtered = s2.filter(ee.Filter.date('2019-01-01', '2020-01-01'));


// Filter by location

var filtered = s2.filter(ee.Filter.bounds(geometry));


// Let's apply all the 3 filters together on the collection


// First apply metadata fileter

var filtered1 = s2.filter(ee.Filter.eq('SPACECRAFT_NAME', "Sentinel-2A"));

// Apply date filter on the results

var filtered2 = filtered1.filter(

  ee.Filter.date('2019-01-01', '2020-01-01'));
```

```
// Lastly apply the location filter
var filtered3 = filtered2.filter(ee.Filter.bounds(geometry));

// Instead of applying filters one after the other, we can 'chain' them
// Use the . notation to apply all the filters together
var filtered = s2.filter(ee.Filter.lt('CLOUDY_PIXEL_PERCENTAGE', 30))
  .filter(ee.Filter.date('2019-01-01', '2020-01-01'))
  .filter(ee.Filter.bounds(geometry));

print(filtered.size());
```

Exercise

Add one more filter in the script below to select images

from only one of the satellites - Sentinel-2A - from the

Sentinel-2 constellation

*Hint1: Use the 'SPACECRAFT_NAME' property

*Hint2: Use the ee.Filter.eq() filter

Exercise 4

Reduce cloud percentage

```
var geometry = ee.Geometry.Point([30.92, 31.13]);
var s2 = ee.ImageCollection('COPERNICUS/S2_HARMONIZED');

var rgbVis = {
  min: 0.0,
```

```
  max: 3000,
  bands: ['B4', 'B3', 'B2'],
};
var filtered = s2.filter(ee.Filter.lt('CLOUDY_PIXEL_PERCENTAGE',
30))
  .filter(ee.Filter.date('2019-01-01', '2020-01-01'))
  .filter(ee.Filter.bounds(geometry));

var mosaic = filtered.mosaic();

var medianComposite = filtered.median();

Map.addLayer(filtered, rgbVis, 'Filtered Collection');
Map.addLayer(mosaic, rgbVis, 'Mosaic');
Map.addLayer(medianComposite, rgbVis, 'Median Composite');
```

Exercise 5

```
// Apply a filter to select only the any country eg 'Egypy'
// Display only the selected country
// Hint: The country names are in ADM0_NAME property
var country = ee.FeatureCollection('FAO/GAUL_SIMPLIFIED_500m/2015/level0');
var egypt = country.filter(ee.Filter.eq('ADM0_NAME', 'Egypt'));
var visParams = {'color': 'red'};
//You can use any color of your choice in place of red
Map.addLayer(egypt, visParams)
```

Exercise 6

```
Search and import the image and features of interest
var s2 = ee.ImageCollection('COPERNICUS/S2_HARMONIZED');
var admin = ee.FeatureCollection('FAO/GAUL_SIMPLIFIED_500m/2015/level0');
//Identify the roi
var egypt = admin.filter(ee.Filter.eq('ADM0_NAME', 'Egypt'));
var geometry = egypt.geometry();
var filtered = s2.filter(ee.Filter.lt('CLOUDY_PIXEL_PERCENTAGE', 30))
  .filter(ee.Filter.date('2019-01-01', '2020-01-01'))
  .filter(ee.Filter.bounds(geometry));
var image = filtered.median();
// Calculate Normalized Difference Vegetation Index (NDVI)
// 'NIR' (B8) and 'RED' (B4)
var ndvi = image.normalizedDifference(['B8', 'B4']).rename(['ndvi']);
// Calculate Modified Normalized Difference Water Index (MNDWI)
// 'GREEN' (B3) and 'SWIR1' (B11)
var mndwi = image.normalizedDifference(['B3', 'B11']).rename(['mndwi']);
// Calculate Soil-adjusted Vegetation Index (SAVI)
// 1.5 * ((NIR - RED) / (NIR + RED + 0.5))
// For more complex indices, you can use the expression () function
// Note:
// For the SAVI formula, the pixel values need to converted to reflectances
// Multiplyng the pixel values by 'scale' gives us the reflectance value
// The scale value is 0.0001 for Sentinel-2 dataset
var savi = image.expression(
    '1.5 * ((NIR - RED) / (NIR + RED + 0.5))', {
      'NIR': image.select('B8').multiply(0.0001),
      'RED': image.select('B4').multiply(0.0001),
```

```
}).rename('savi');

var rgbVis = {min: 0.0, max: 3000, bands: ['B4', 'B3', 'B2']};

var ndviVis = {min:0, max:1, palette: ['white', 'green']};

var ndwiVis = {min:0, max:0.5, palette: ['white', 'blue']};

Map.addLayer(image.clip(geometry), rgbVis, 'Image');

Map.addLayer(mndwi.clip(geometry), ndwiVis, 'mndwi');

Map.addLayer(savi.clip(geometry), ndviVis, 'savi');

Map.addLayer(ndvi.clip(geometry), ndviVis, 'ndvi');
```

Exercise 7

```
// Load a Landsat 8 TOA collection.

var collection = ee.ImageCollection('LANDSAT/LC08/C02/T1_TOA')

  // Filter by date and location.

  .filterBounds(ee.Geometry.Point(-122.262, 37.8719))

  .filterDate('2014-01-01', '2014-12-31')

  // Sort by increasing cloudiness.

  .sort('CLOUD_COVER');

// Compute the median of each pixel for each band of the 5 least
cloudy scenes.

var median = collection.limit(5).reduce(ee.Reducer.median());
```

Exercise 8

```
// Load and display a Landsat TOA image.

var image =
ee.Image('LANDSAT/LC08/C02/T1_TOA/LC08_044034_20140318');

Map.addLayer(image, {bands: ['B4', 'B3', 'B2'], max: 0.3});

// Create an arbitrary rectangle as a region and display it.

var region = ee.Geometry.Rectangle(-122.2806, 37.1209, -
122.0554, 37.2413);

Map.addLayer(region);
```

```
// Get a dictionary of means in the region.  Keys are bandnames.
var mean = image.reduceRegion({
  reducer: ee.Reducer.mean(),
  geometry: region,
  scale: 30
});
```

Annex 4. GEE sessions Zoom recordings

- https://fao.zoom.us/rec/share/nfu1rLRwyVNE6obiDgo14laUDRi29_WjliBxIXusNGg1wldPNK610mgUUHpEYNHf.-FPFCEm1zV45RNgE

- https://fao.zoom.us/rec/share/7l9tCg1CWgD4l1QvJVTNrdMK_Qtj4daFdxYFyT_VQRDLi6pDHvQfVh_RADLGc0ce.6V_7ONICMrGL4LFm

- https://fao.zoom.us/rec/share/aynAJAriuQ-IF3SL8mhlaOwsLk2jzbkAc1OlnI6DFWAS1pPoxS_o59s2FFo1KVgH.fSV-FjYAU_Vrr_s1

- https://fao.zoom.us/rec/share/dK_3Tdvrg0_gQdx4YhRZkPBEKY-ayK2vprzzijckUthSsX3L5UB_O7rtzgvIClvx.orTpp5Jfw1bP_59z