



# Unlocking the Potential of Land Cover: From Land Continuum to Crop Mapping and Applications in Agriculture

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# Introduction

Effective management of land use plays a pivotal role in ensuring sustainable and resilient agriculture by leveraging natural resources efficiently.

Land Cover information and its changes over time serve multiple purposes, from local to global levels, such as for agriculture, food security, ecosystem conservation, sustainable land management, humanitarian response programs, climate change mitigation, and adaptation.

Land cover is a key source of baseline information to support multilateral environmental agreements and the implementation of the United Nations Sustainable Development Goals (UN SDGs indicators) including 2.4, 6.6, 13.3, 14.4, and 15.3.1



↘  
Land cover  
& Crop monitoring



↘  
Agro-ecological zoning  
& Land evaluation



↘  
Land and water resources  
assessment and management



↘  
Ecosystem restoration  
& Land degradation monitoring



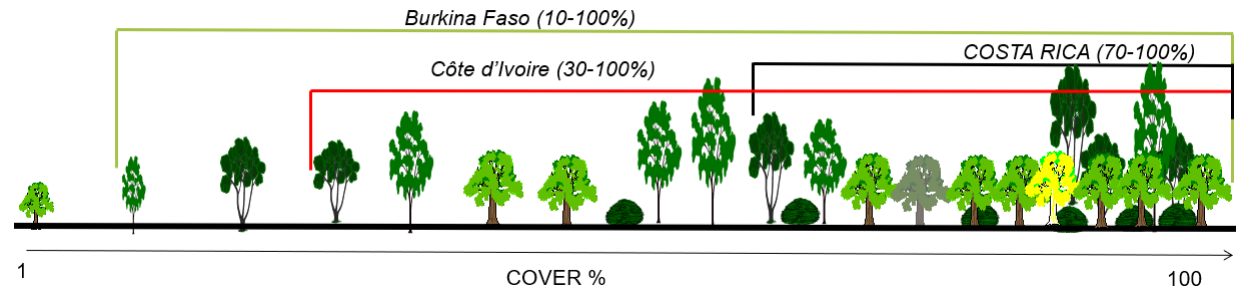
↘  
Green cities  
& Nature-based solutions



↘  
Emergency &  
Resilience

# Land as a continuum

Several national, regional, and global datasets and Land Cover maps have been produced by different organizations for different purposes over the years, and the methods for representing and defining classes of land characteristics are as diverse as the land heterogeneity itself.

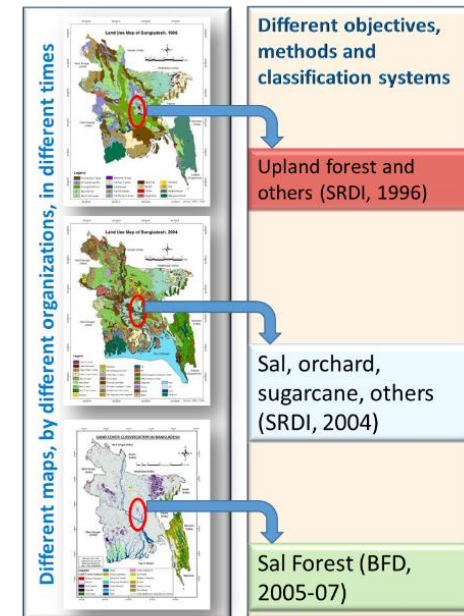


## Limitations:

- Fixed number of land cover classes
- Classes are too general
- Missing information (documentation, metadata, definitions, field information, etc.)
- Different terms used for same concepts (**Synonymy**)
- Different understanding of homonymous concepts (**Polysemy**)

Land is a continuum managed under different ministries with different mandates

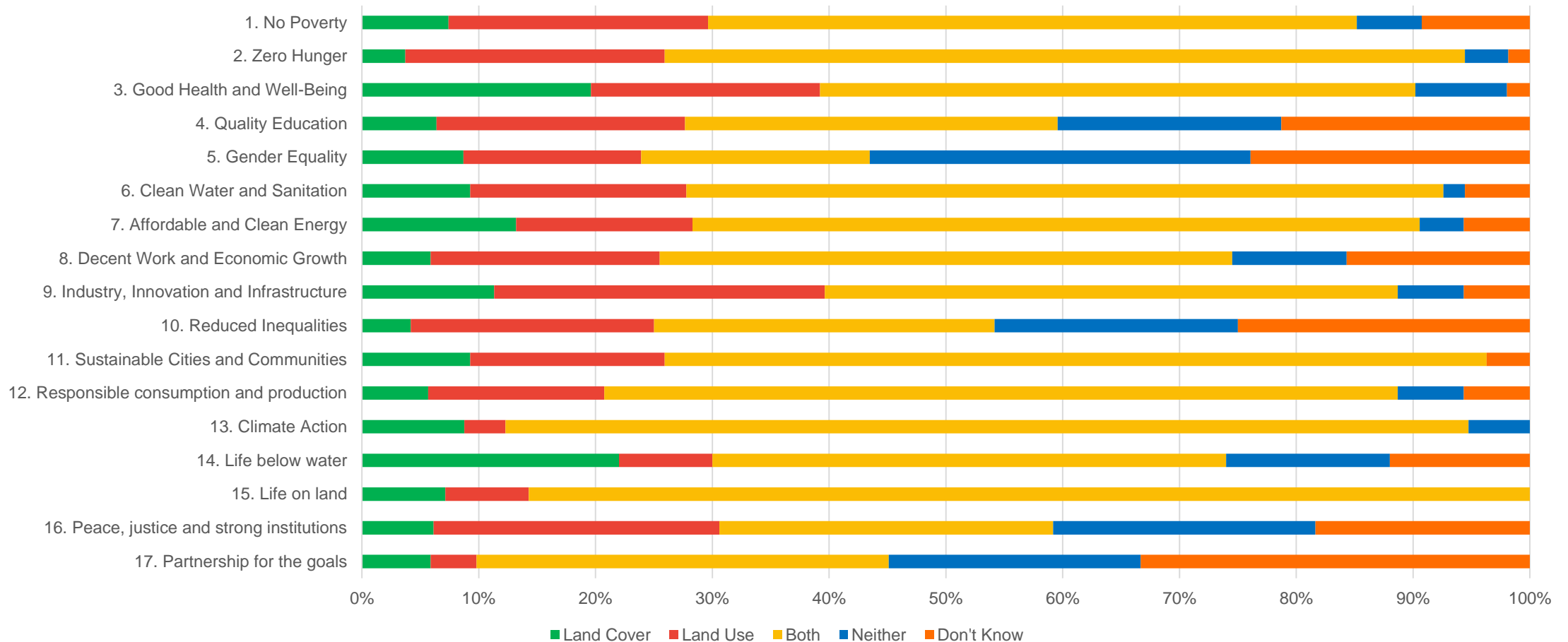
Land cover and natural resources information are NOT comparable over time, space and organizations





# Land cover for the SDGs

Consideration of land cover data across various Sustainable Development Goals (SDGs):



Source: An International Library for Land Cover Legends: The Land Cover Legend Registry

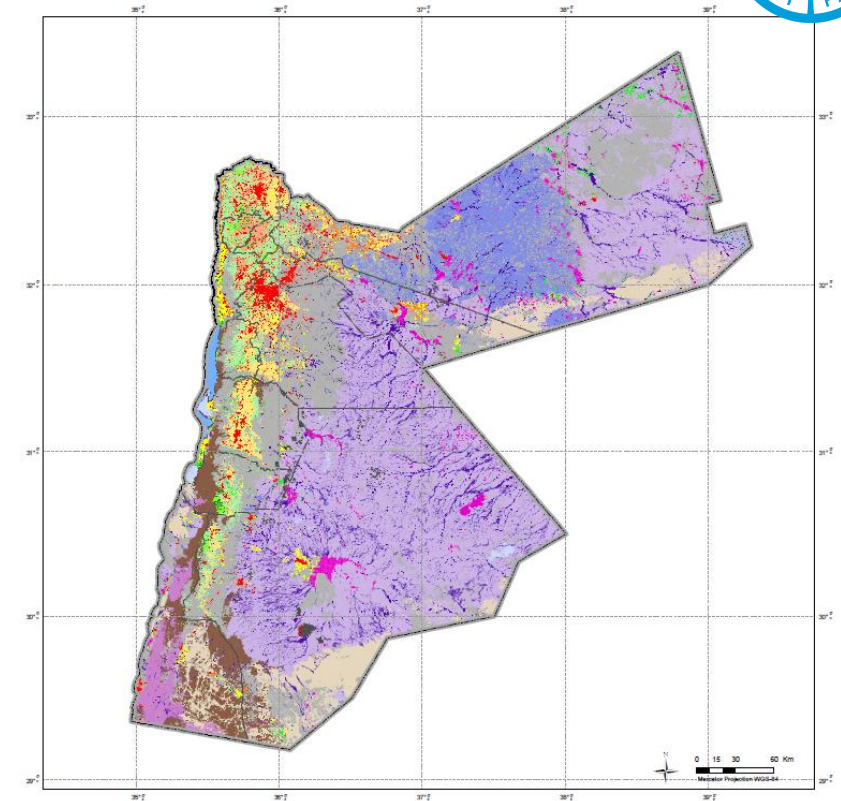
[https://www.mdpi.com/2073-445X/11/7/1083?type=check\\_update&version=3](https://www.mdpi.com/2073-445X/11/7/1083?type=check_update&version=3)



# Land Cover Legend Registry (LCLR)

- Land Cover Legend Registry is a database established and maintained by FAO for accessing land cover legend, legend class, datasets and related reference documents.
- It follows international standards (19144-1 & 2)
- The legends are available in different file formats (.csv, .ea, .hdx, .html)
- And different level (global, regional, national, local)
- Metadata for this registry can be accessed from CKAN platform.
- It also supports legends developed for various purpose in various sectors to support national monitoring programs etc. (e.g., agriculture sector, water management, disaster management, rapid risk assessment etc.)

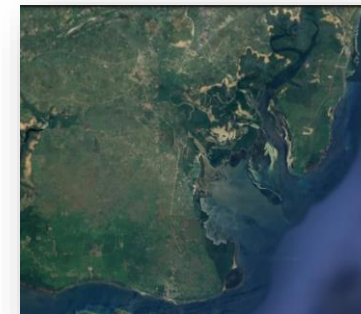
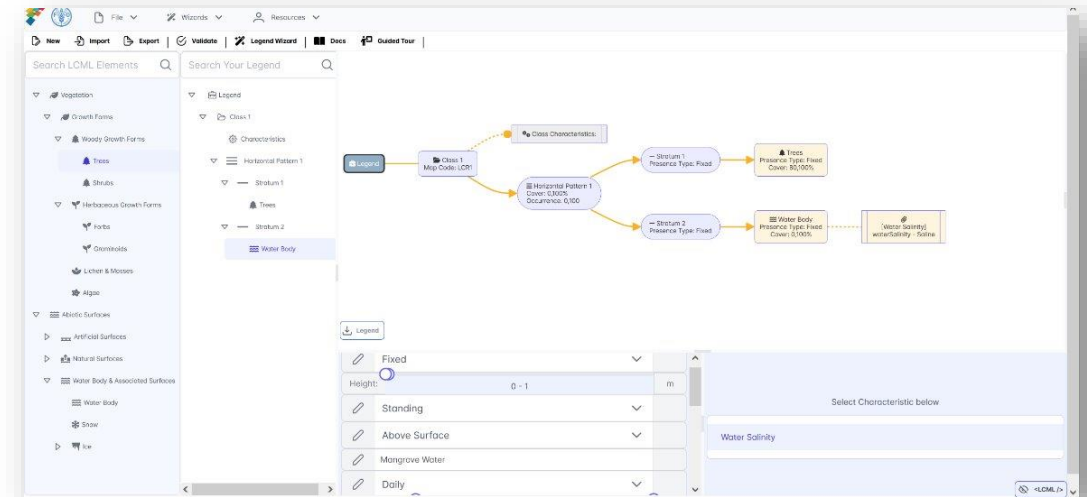
Id	Alpha Code	Name	Country	Country Code (M49)	Legend Type	Year	Files	Source Reference	Status
1	L1	Globcover legend	Global	1	LCCS3	2009		REF-1	VALID
2	L2	Himalaya region land cover legend	Regional	35	LCCS3	2005		REF-2	VALID
3	L3	Land cover legend for Zanjan Province	Islamic Republic of Iran	364	LCCS3	2019		REF-3	VALID
8	L8	Land cover legend for Bangladesh	Bangladesh	50	LCCS3	2015		REF-9	VALID



<https://data.apps.fao.org/lclr-tool/en>

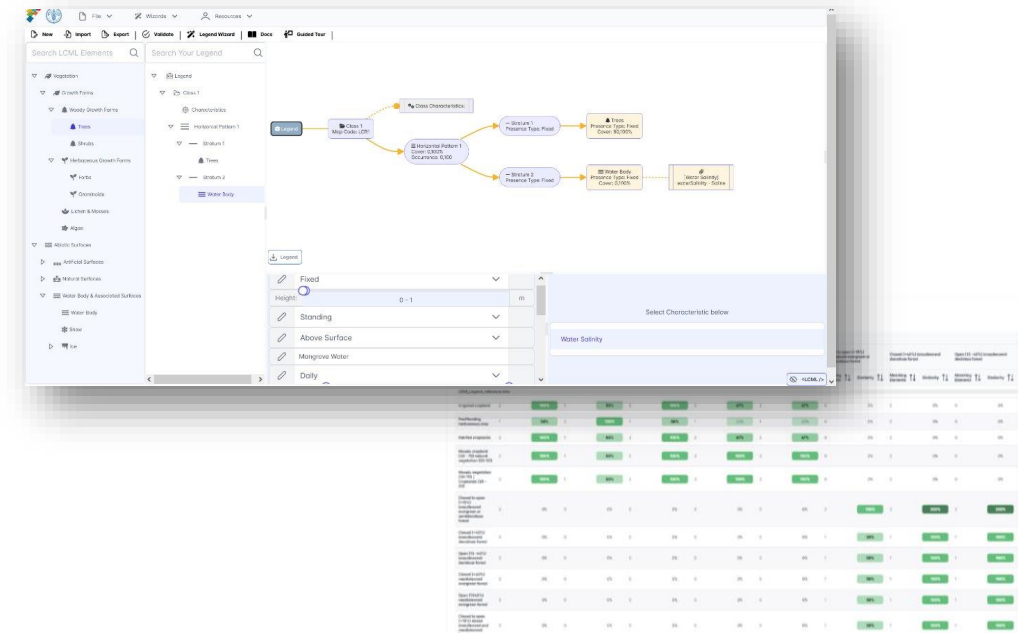
# Land Cover Meta Language (LCML)

- LCML is a tool that can be used to create and describe land cover classes in a standardized and consistent way.
- It is based on a set of basic objects and their properties and characteristics, which can be combined to represent a wide range of land cover features.
- LCCS & LChS languages are based on LCML.



# Land Characterization System Software (LCHS)

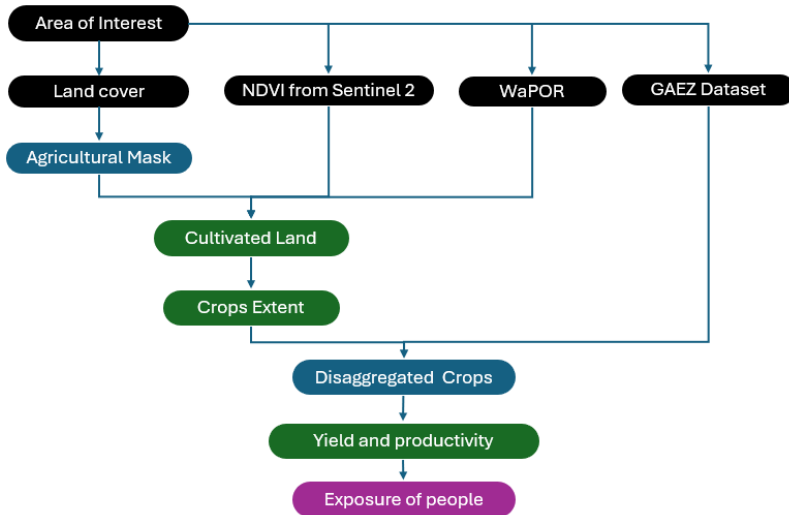
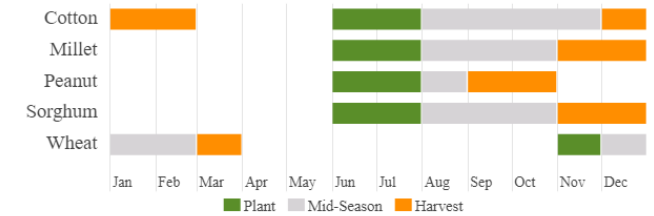
To overcome inconsistencies between legends and to integrate the different Land Cover products and development of consistent approaches, a method is needed that can automatically measure the similarity between different classification systems.



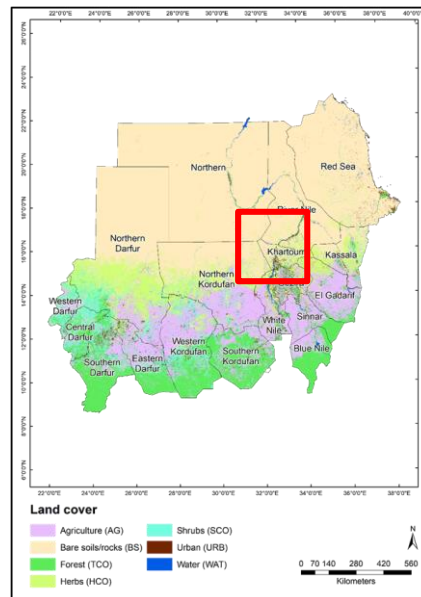
# Crop type mapping

- Utilize land cover data to focus on agricultural land.
- Analyze the data to identify cultivated areas.
- Employ collected data or a specific methodology.
- Incorporate the FAO crop calendar (or any others when available).
- Generate crop type maps based on the analysis.

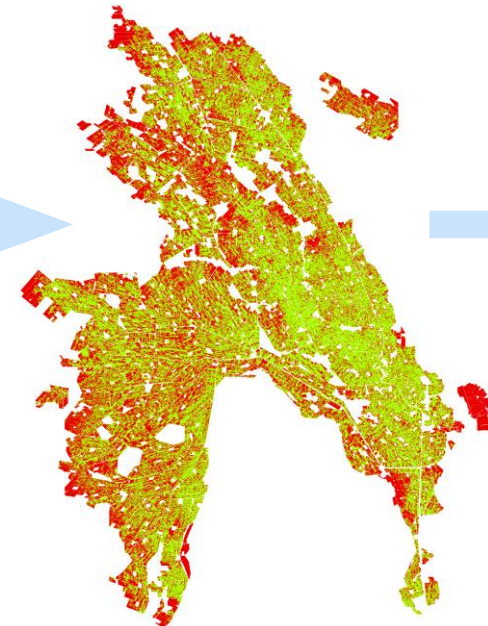
Sudan – Crop Calendar



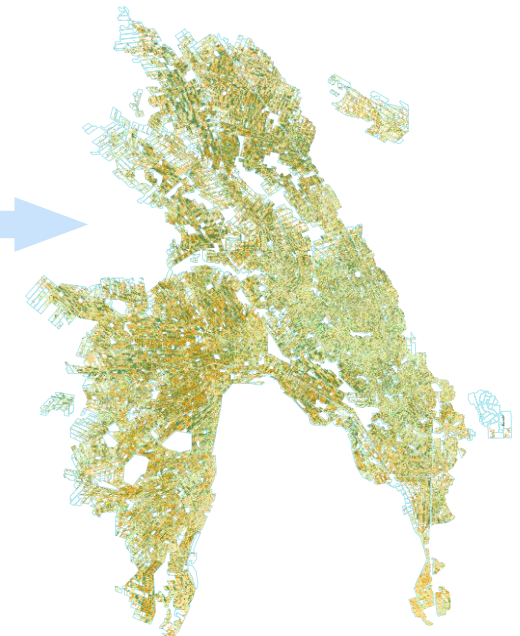
Land cover map of Sudan



Cultivated area in selected Aol



Crop Type map in selected Aol

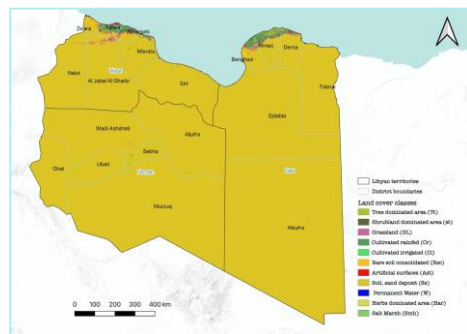




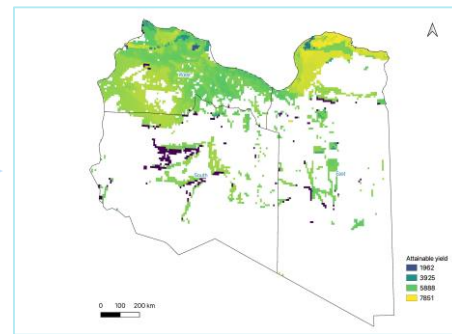
# Crop type mapping and yield estimation

Croplands cover 10% of Earth's land surface and are crucial for food, fiber, and fuel production. Understanding crop yield dynamics is vital for global food security and sustainable development.

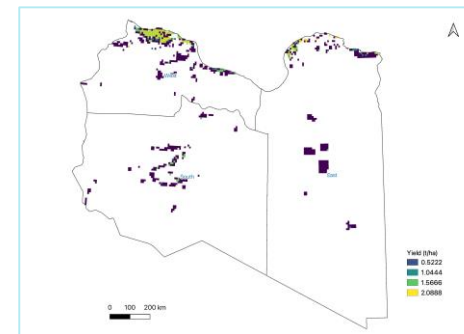
1. Land cover for the area of interest (e.g. Libya)
2. Obtain the actual yield from GAEZ dataset
3. Mask cropland and actual yield to obtain yield in cropland area
4. Run zonal statistics on sub-national administration levels to obtain potential yield by district



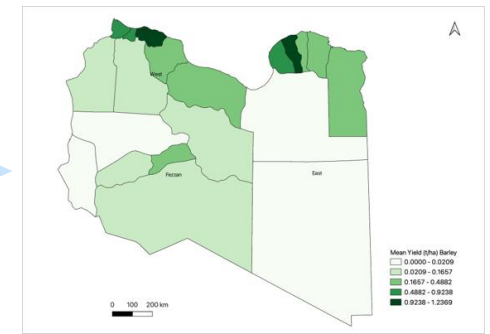
Landcover Libya



Attainable yield from GAEZ for Barley



Attainable yield from GAEZ on croplands and very suitable areas



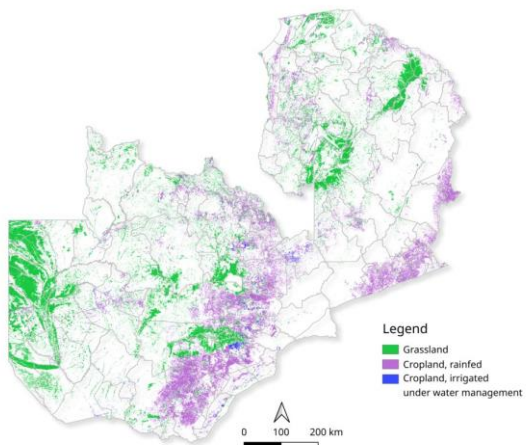
Zonal statistics of yield statistics

# Agricultural monitoring and indices

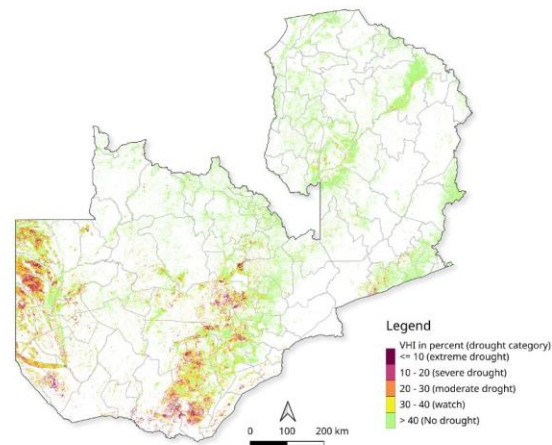
This example demonstrate using the land cover for analyzing the impact of drought on agricultural and grassland areas, as well as assessing the exposure of people and livestock to the drought conditions

Assessing drought impact on agriculture in Zambia – March 2024:

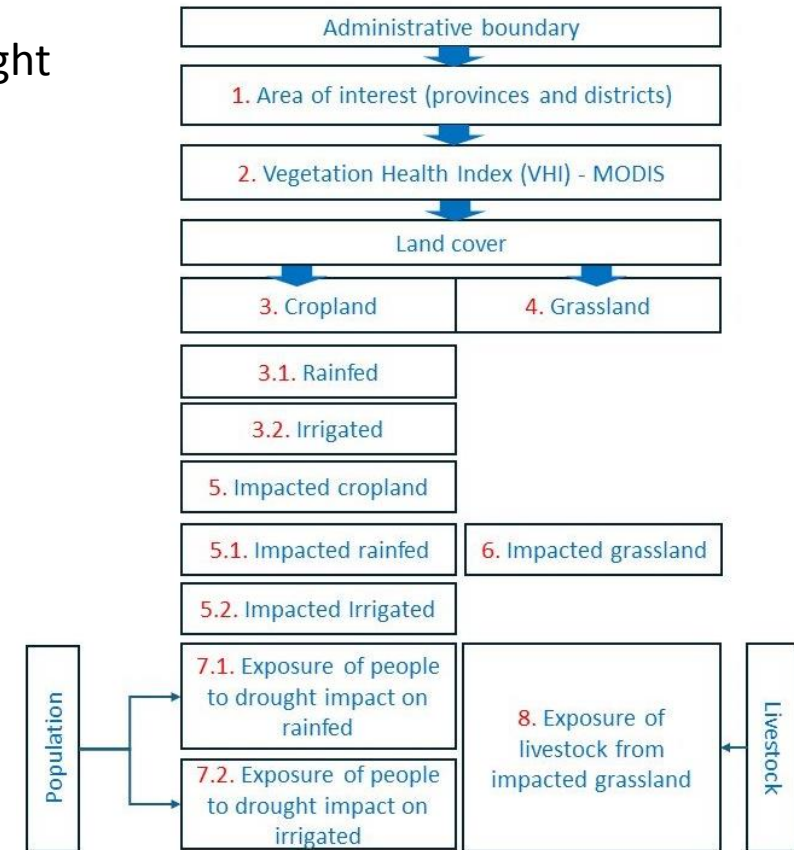
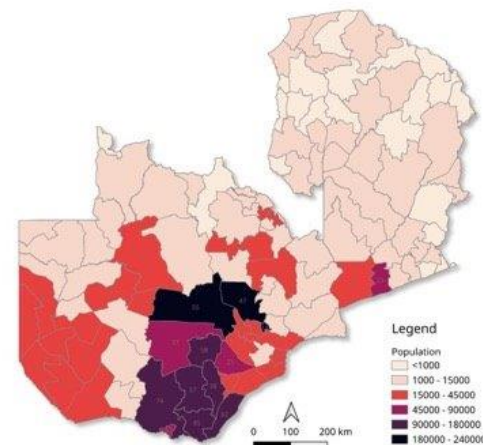
Crop land and grassland area



Drought analysis



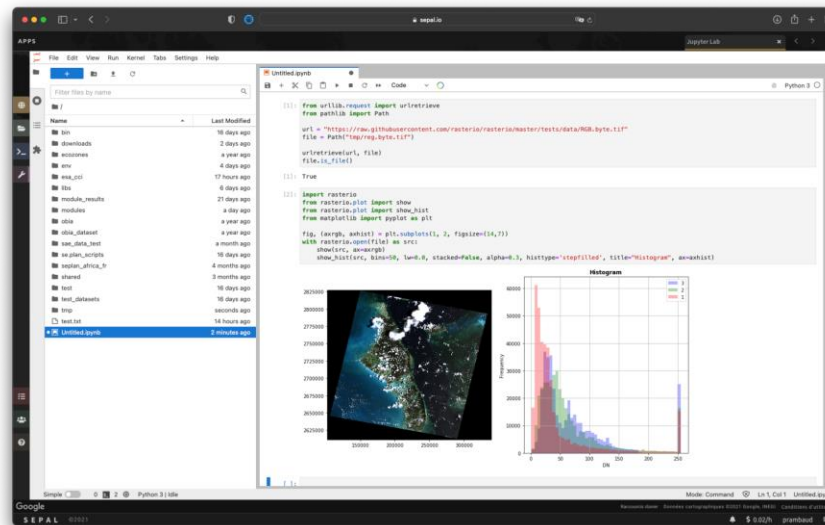
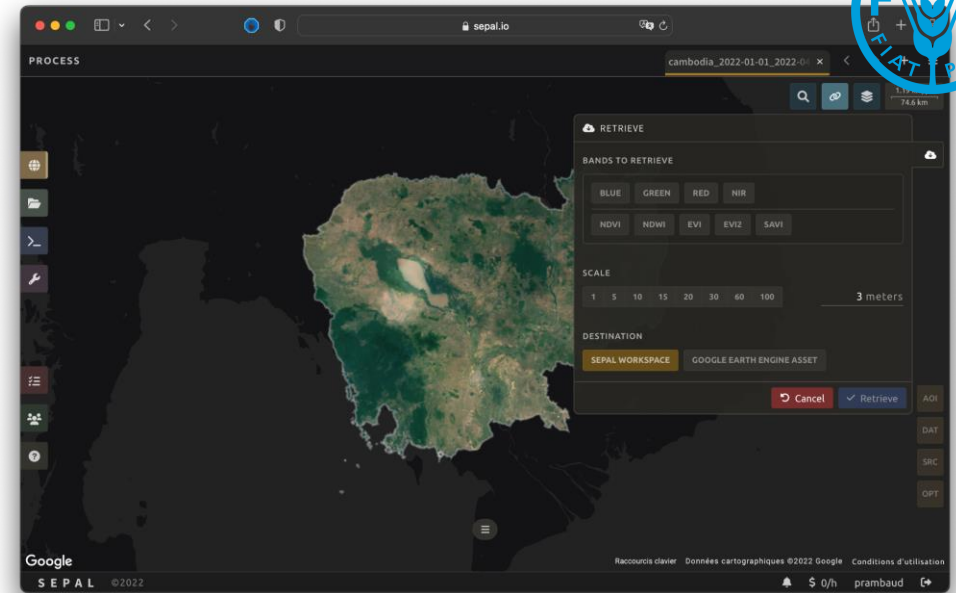
Exposure of people to impacted rainfed agriculture







# SEPAL


- SEPAL is a cloud platform for accessing, processing and analyzing geospatial data for land monitoring.
- The platform is free and open: anyone can register for access to its features
- All you need is an Internet connection to access SEPAL website




<https://sepal.io>


 Aoi selector

 Parameters


 Results

 Customize LC


 About

 Source code

 Wiki

 Bug report

## SDG 15.3.1: Proportion of land that is degraded over total land area

 EN 

### Computation parameters

This process tile will allow you to compute the value of the sdg indicator 15.3.1 and its sub-indicators (land cover, soil organic carbon and productivity)

Starting year  
2000

Ending year  
2015

Select sensor

MODIS MOD13Q1 ×

Select Vegetation Index

Normalised Difference Vegetation Index (NDVI)

Select trajectory

Productivity (VI) trend

Select Land cover ecosystem functional units


Global Agro-Environmental Stratification

Climate regime options

Per pixel based on global climate data

### Advanced Parameters ▼

LOAD THE INDICATORS

 You have changed your transition matrix

- Aoi selector
- Parameters
- Results**
- Customize LC
- About
- Source code
- Wiki
- Bug report

## SDG 15.3.1: Proportion of land that is degraded over total land area

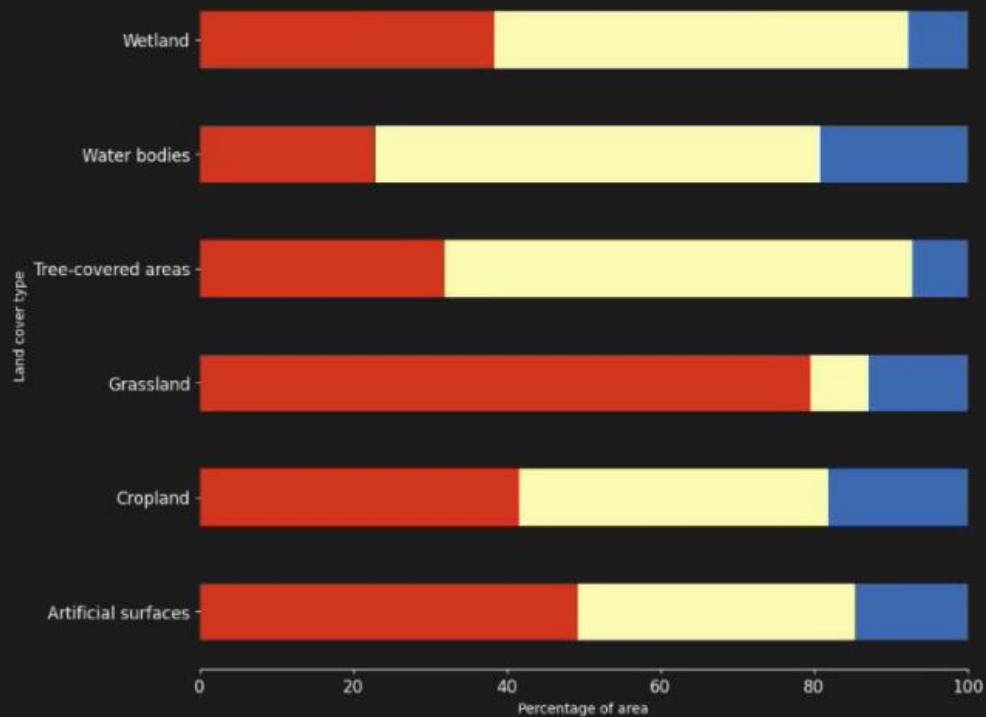
### Spatial results

Once the layers are loaded on the map, click on the "download" button to download the indicators **.tif** files to your SEPAL folders

#### TRANSITIONS

#### DISTRIBUTION

Distribution of area by land cover (2000)



**Indicator state**

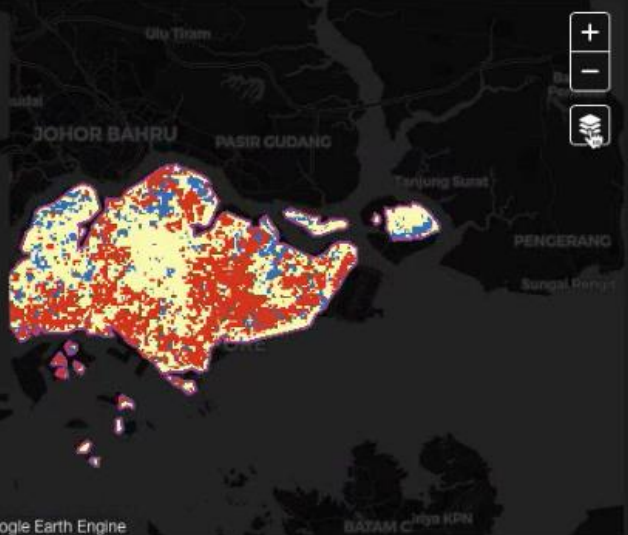
- Degraded
- Stable
- Improved

**LC classes**

- Tree-covered areas
- Grassland
- Cropland
- Wetland
- Artificial surfaces
- Other land
- Water bodies

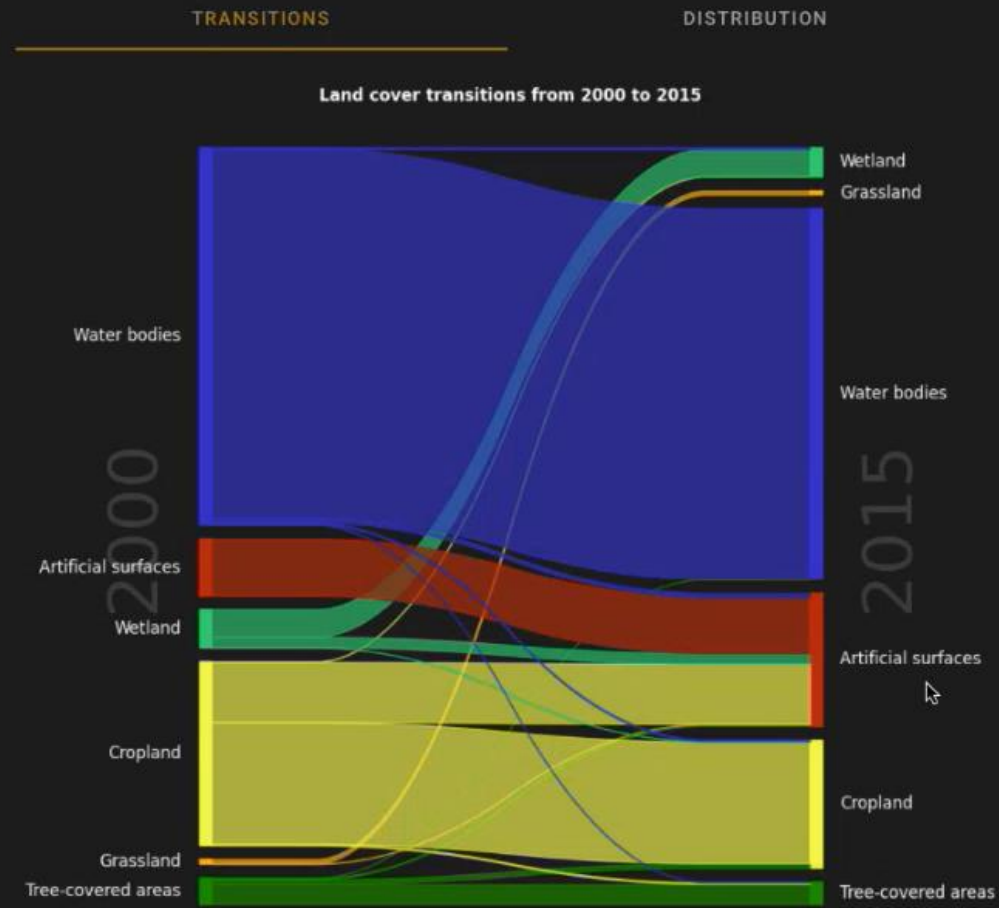
10 km

SEPAL | (C) OpenStreetMap contributors (C) CARTO, Google Earth Engine



- Aoi selector
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## SDG 15.3.1: Proportion of land that is degraded over total land area



**Degraded** (Red)  
**Stable** (Yellow)  
**Improved** (Blue)

**LC classes**

- Tree-covered areas (Green)
- Grassland (Orange)
- Cropland (Yellow)
- Wetland (Light Green)
- Artificial surfaces (Red)
- Other land (Light Yellow)
- Water bodies (Blue)

10000 km

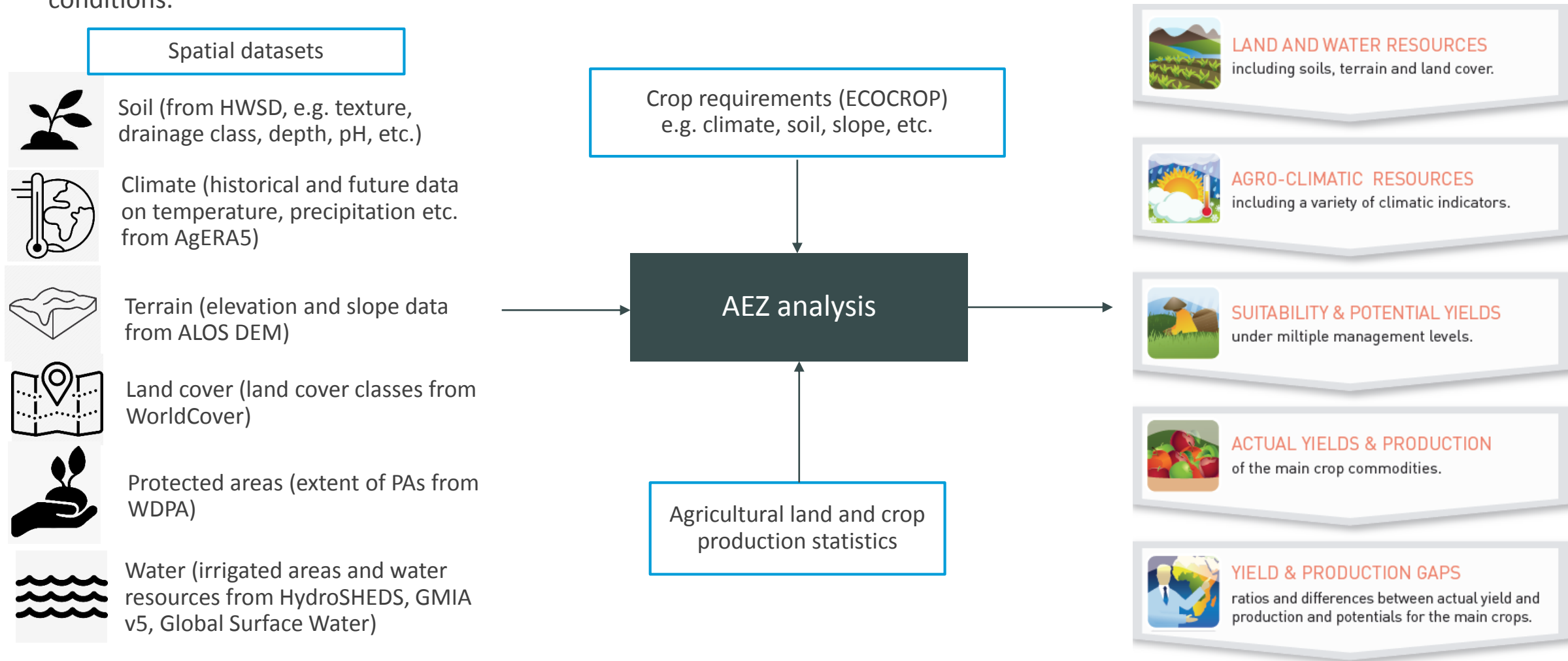
SEPAL | (C) OpenStreetMap contributors (C) CARTO, Google Earth Engine

DOWNLOAD MAPS AS .TIF IN SEPAL

# Agro-Ecological Zoning



AEZ makes use of best available global/national spatial databases to estimate the biophysical crop production potential. The estimation procedures consecutively consider factors relevant for crop production over time and for different management conditions.

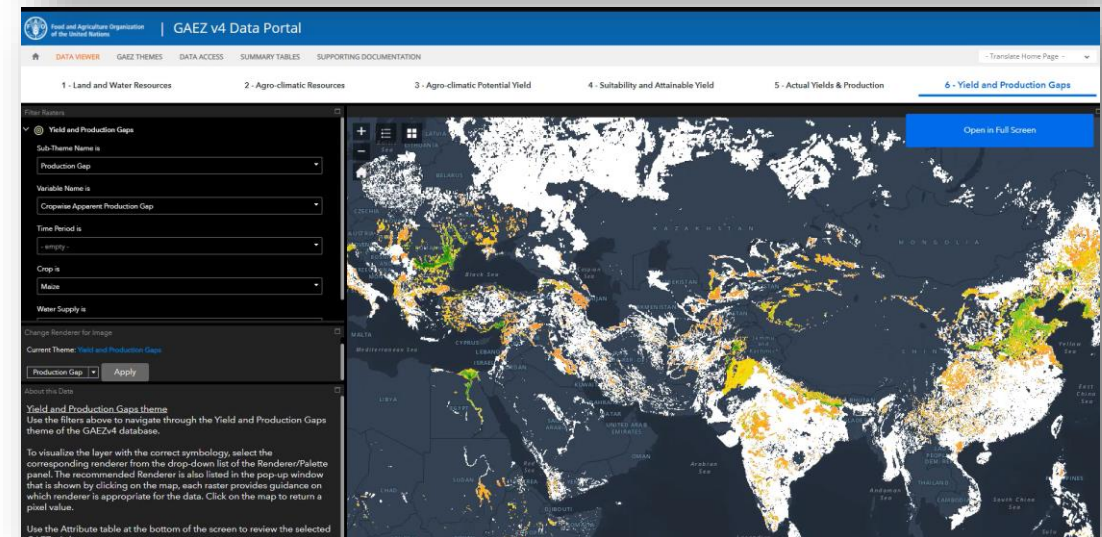
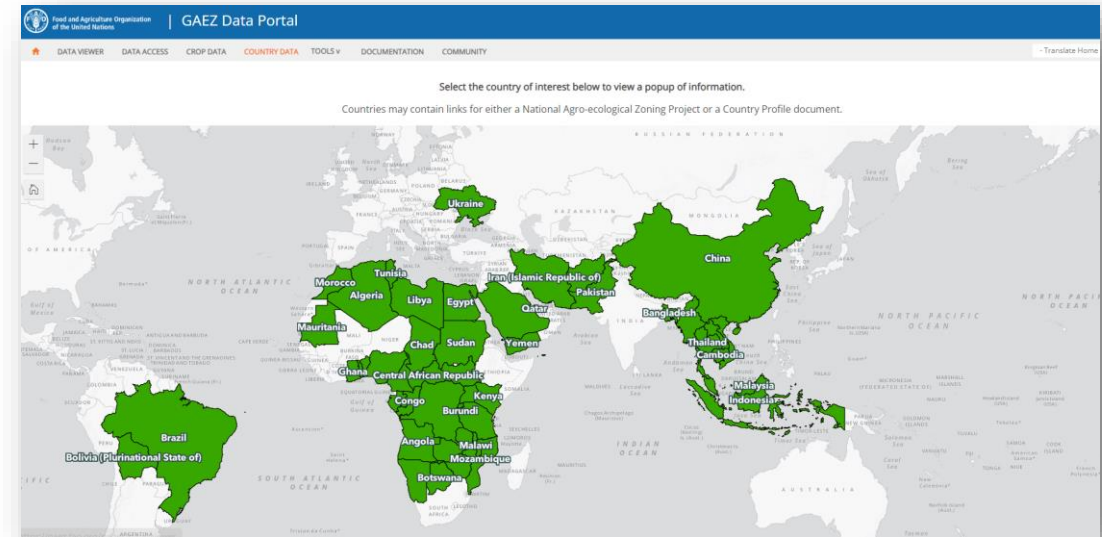


# GAEZ (Global Agro-Ecological Zoning)

It provides detailed crop yield and production information, aiding in understanding biogeochemical cycles and enhancing global to local analysis capabilities, particularly in areas with limited information access.

1. Land & Water Resources
2. Agro-Climatic Resources
3. Agro-Climatic Potential
4. Suitability and Attainable Yield
5. Actual Yields & Production
6. Yield and Production Gaps

Providing globally crop suitability map for 50 crops at 10 km scale

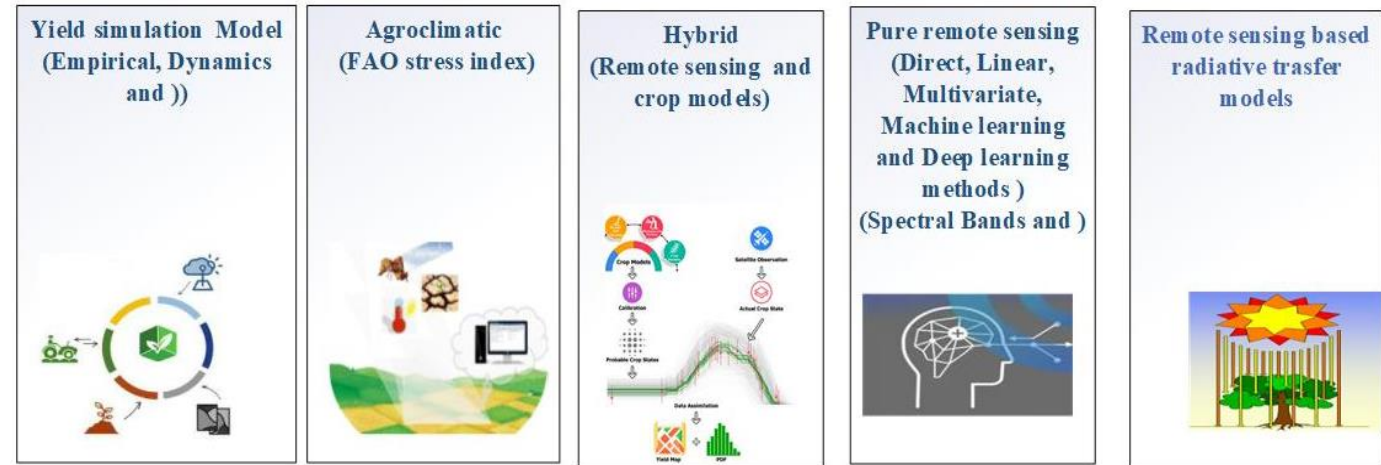


<https://gaez.fao.org/pages/data-viewer>

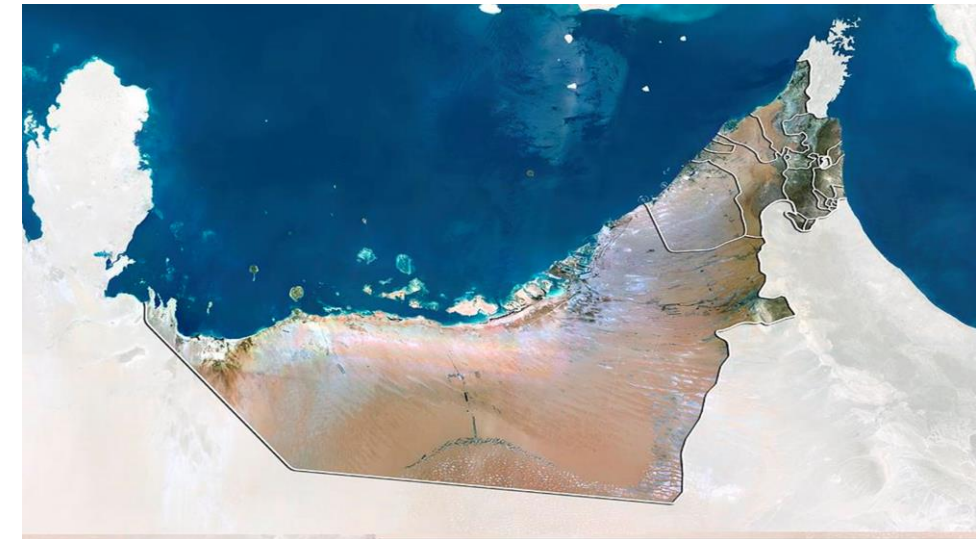


# Crop Suitability

Beside GAEZ, different approach may be used for yield estimation and crop suitability mapping such as crop models, or integration of RS and crop models, or only RS applying AI and deep learning algorithms



Improving Crop Suitability Maps Through Advanced Modeling and Parcel-Level Analysis, we're refining crop suitability mapping by integrating outputs from crop models at the parcel level. This involves constructing reduction factor functions for each crop relative to key variables and updating mapping algorithms based on parcel-level simulations – UAE project.



# Geospatial unit in the Land and Water Division

- FAO's Geospatial Unit: providing geospatial data, information, and services
- Supporting food security and monitoring natural resource use
- Proposing policy-relevant solutions through remote sensing

## Our Contributions

- Define standards and indicators for regular monitoring
- Conduct qualitative and quantitative assessment of natural resources
- Develop methodologies and tools for governments and institutions

## Impact

- Supports development plans, growth strategies, and decision-making processes
- Key issues addressed: land cover mapping, crop monitoring, disaster risk reduction, food security mapping, spatial planning, and environmental sustainability

<https://www.fao.org/geospatial/our-work/what-we-do/en/>



## Geospatial information for sustainable food systems

Our work Projects News Events Resources



### What we do

Crop and Agricultural monitoring  
Climate Change impact on Agriculture production  
Risk and Disaster management  
Land Cover and Land Use  
Natural Resources and Ecosystems  
Land evaluation and Suitability

### Partnerships

### Geospatial activities in FAO

Geospatial technology plays a fundamental supporting role in the quest for food security by identifying and monitoring natural resource use and propose adequate information for policy relevant solutions. Through remote sensing, we define:

- standards and indicators for the assessment and regular monitoring, qualitative and quantitative, of natural resources,
- methodologies and tools that support governments and institutions in the study and assessment of innovative and effective plans for production, management, safeguarding and building resilience of natural resources;
- develop serious games that utilize real data and information to support relevant stakeholders in making evidence-based decision-making throughout the project cycle.

Our work supports development plans, growth strategies and decision-making processes in countries, on issues such as:

-  Agriculture production
-  Water governance
-  Forests management
-  Climate Changes monitoring
-  Ecosystems and Biodiversity protection
-  Emergencies and Disasters management

### Topics

- LAND
  - 1 Soil Portals
  - 2 LADA
  - 3 SWALIM
- WATER
  - 1 Aquasat
  - 2 Aquamaps
  - 3 Wapor Beta Portal
- CLIMATE
  - 1 GIEWS
- FORESTRY
  - 1 National Forests Monitoring System
  - 2 Global Forest Resources Assessment
- FISHERY
  - 1 Fisheries Resources Monitoring Systems (FIRMS)
  - 2 GISFish
- CROSSCUTTING ACTIVITIES
  - 1 LRIMS
  - 2 GAEZ
  - 3 GeoNetwork
  - 4 Land Cover Mapping

### Related links

- 1 RIO 20+
- 2 FAO SDG
- 3 GEOSS



**Thank you**

**[GIS-Manager@fao.org](mailto:GIS-Manager@fao.org)**

