Building Capacity to Use Earth Observations in Addressing Environmental Challenges in Bhutan

Day 3 – Overview of Landcover Products

Objectives

By the end of this presentation, you will be able to:

- Describe global Land Cover (LC) products derived from remote sensing
- Utilize GEE to access and visualize the LC products in your region of interest

Outline

- Identify global Land Cover (LC) products derived from remote sensing
- Demonstration:
  - Global Forest Watch
  - Access LC products in GEE

Identifying Global Land Cover (LC) Products Derived from Remote Sensing

Global Landcover Products

- Satellite imagery provides the ideal vantage point to characterize land cover.
- Several LC products derived from optical and microwave Synthetic Aperture Radar (SAR) data are available.
- Existing LC products identify:
  - Multiple Classes (e.g., Water, Land, Forests, Shrubs, Grass, Crops, and Urban Areas)
  - Specific Classes (e.g., Forest and Non-Forest)

Global Landcover Products

Satellite & Sensor	LC Product Name	Spatial Resolution and Coverage	Temporal Resolution and Coverage
Terra & Aqua MODIS	MCD12Q1 Version 6.1	500 m, Global	Annual 2002–Present
Sentinel-2 MSI & Sentinel-1 SAR	ESA World Cover	10 m, Global	Annual 2020 and 2021
Sentinel-2 MSI	Dynamic World	10 m, Global	Near Real-Time 2015–Present
Landsat ETM, OLI, OLI2	Global Forest Watch	30 m, Global	Annual 2002–2023
Landsat, Sentinel-2	Global Land Analysis & Discovery	30 m, Global	2000–2020
ALOS & ALOS2 PALSAR & PALSAR-2	Forest/Non-Forest	25 m, Global	Annual 2007–Present (Except 2011–2014)

MODIS Land Cover

https://lpdaac.usgs.gov/news/release-of-modis-version-6-land-cover-data-products/

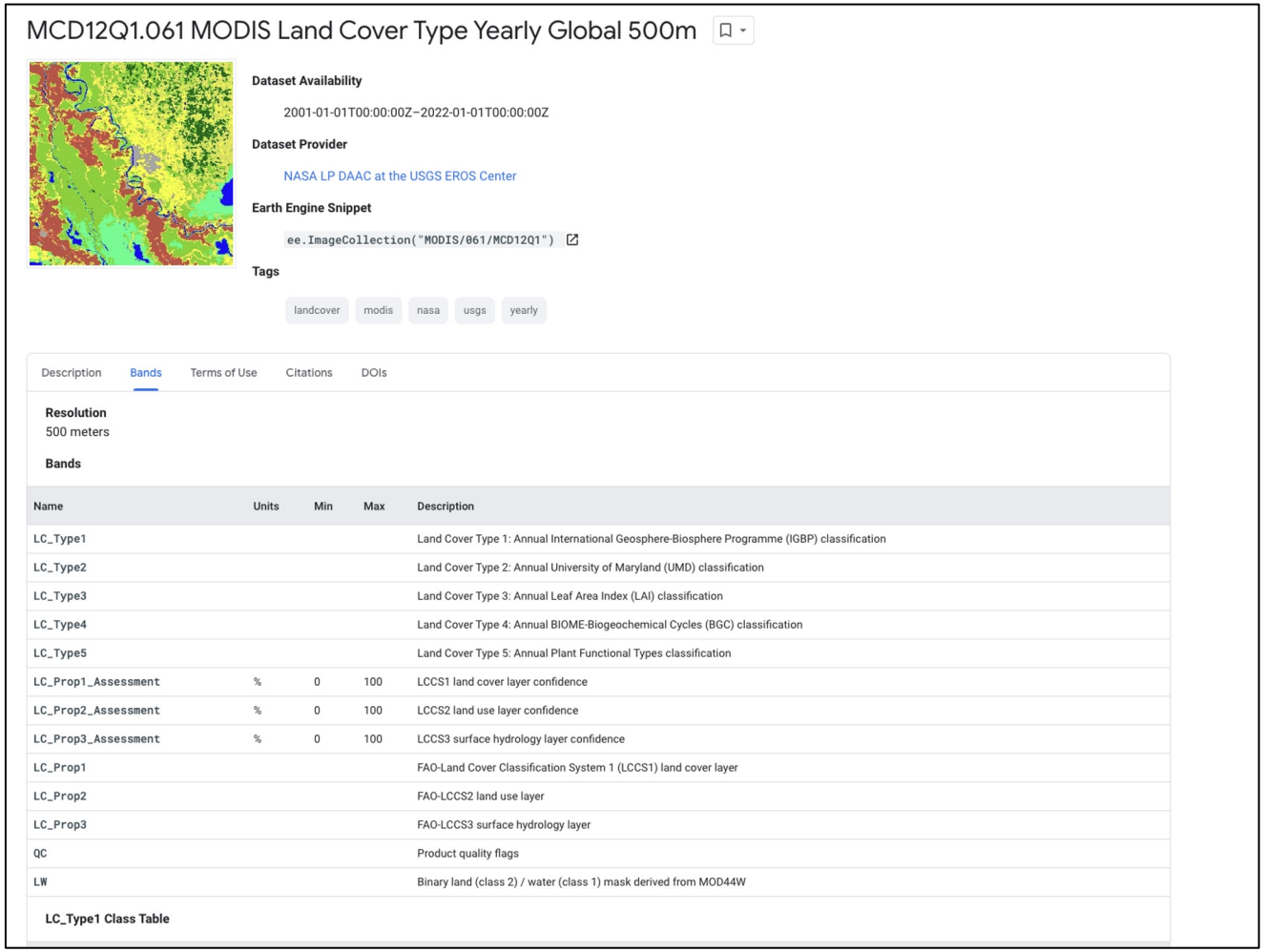
- Derived from combined Terra and Aqua MODIS observations
- Uses 1–7 MODIS spectral bands
- Derived using supervised classification methodology (Friedl et al. 2002, 2010)
- Six different classification schemes used

Band	Bandwidth[1]
1	620 - 670
2	841 - 876
3	459 - 479
4	545 - 565
5	1230 - 1250
6	1628 - 1652
7	2105 - 2155

MODIS Land Cover

https://developers.google.com/earth-engine/datasets/catalog/MODIS_061_MCD12Q1

- MODIS LC data are available in GEE and include multiple LCs, quality flags, and ancillary data.



MCD12Q1.061 MODIS Land Cover Type Yearly Global 500m

Dataset Availability

2001-01-01T00:00:00Z–2022-01-01T00:00:00Z

Dataset Provider

NASA LP DAAC at the USGS EROS Center

Earth Engine Snippet

```
ee.ImageCollection("MODIS/061/MCD12Q1")
```

Tags

landcover modis nasa usgs yearly

Description | Bands | Terms of Use | Citations | DOIs

Resolution
500 meters

Bands

Name	Units	Min	Max	Description
LC_Type1				Land Cover Type 1: Annual International Geosphere-Biosphere Programme (IGBP) classification
LC_Type2				Land Cover Type 2: Annual University of Maryland (UMD) classification
LC_Type3				Land Cover Type 3: Annual Leaf Area Index (LAI) classification
LC_Type4				Land Cover Type 4: Annual BIOME-Biogeochemical Cycles (BGC) classification
LC_Type5				Land Cover Type 5: Annual Plant Functional Types classification
LC_Prop1_Assessment	%	0	100	LCCS1 land cover layer confidence
LC_Prop2_Assessment	%	0	100	LCCS2 land use layer confidence
LC_Prop3_Assessment	%	0	100	LCCS3 surface hydrology layer confidence
LC_Prop1				FAO-Land Cover Classification System 1 (LCCS1) land cover layer
LC_Prop2				FAO-LCCS2 land use layer
LC_Prop3				FAO-LCCS3 surface hydrology layer
QC				Product quality flags
LW				Binary land (class 2) / water (class 1) mask derived from MOD44W

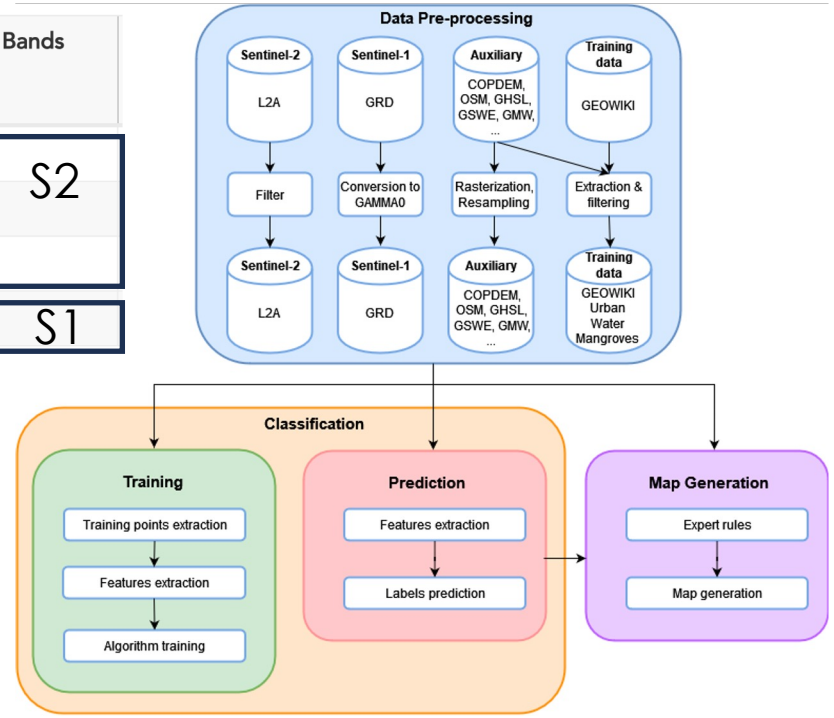
LC_Type1 Class Table

The European Space Agency (ESA) WorldCover

https://esa-worldcover.s3.eu-central-1.amazonaws.com/v200/2021/docs/WorldCover_PUM_V2.0.pdf

- **ESA WorldCover** is derived by using Sentinel-2 MSI optical reflectance, and Sentinel-1 SAR VV and VH backscatter data.
- Sentinel-1 and Sentinel-2 data, along with vegetation index from Sentinel-2, digital elevation, and meteorological information at training sites, are used to derive LC features based on the **Land Cover Classification System (LCCS)** developed by the United Nations (UN) Food and Agriculture Organization (FAO).

Product	Bands	
RGBNIR	4	S2
SWIR	2	
NDVI	3	
GAMMA0	3	S1

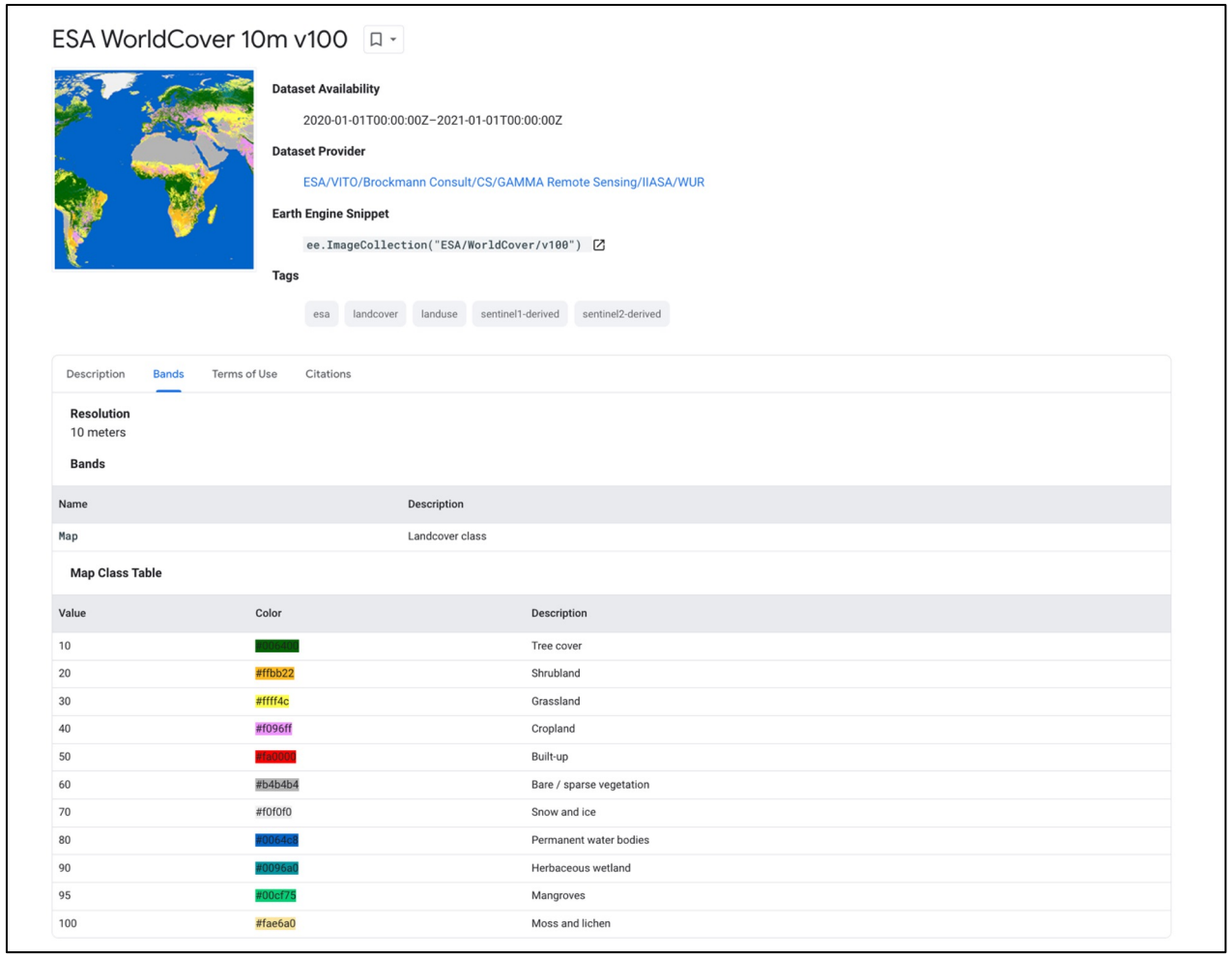


Combined Workflow to Generate the WorldCover Land Cover Product

The European Space Agency (ESA) WorldCover

https://developers.google.com/earth-engine/datasets/catalog/ESA_WorldCover_v100#bands

- ESA WorldCover is available from GEE



ESA WorldCover 10m v100

Dataset Availability

2020-01-01T00:00:00Z–2021-01-01T00:00:00Z

Dataset Provider

ESA/VITO/Brockmann Consult/CS/GAMMA Remote Sensing/IIASA/WUR

Earth Engine Snippet

```
ee.ImageCollection("ESA/WorldCover/v100")
```

Tags

esa landcover landuse sentinel1-derived sentinel2-derived

Description Bands Terms of Use Citations

Resolution
10 meters

Bands

Name	Description
Map	Landcover class

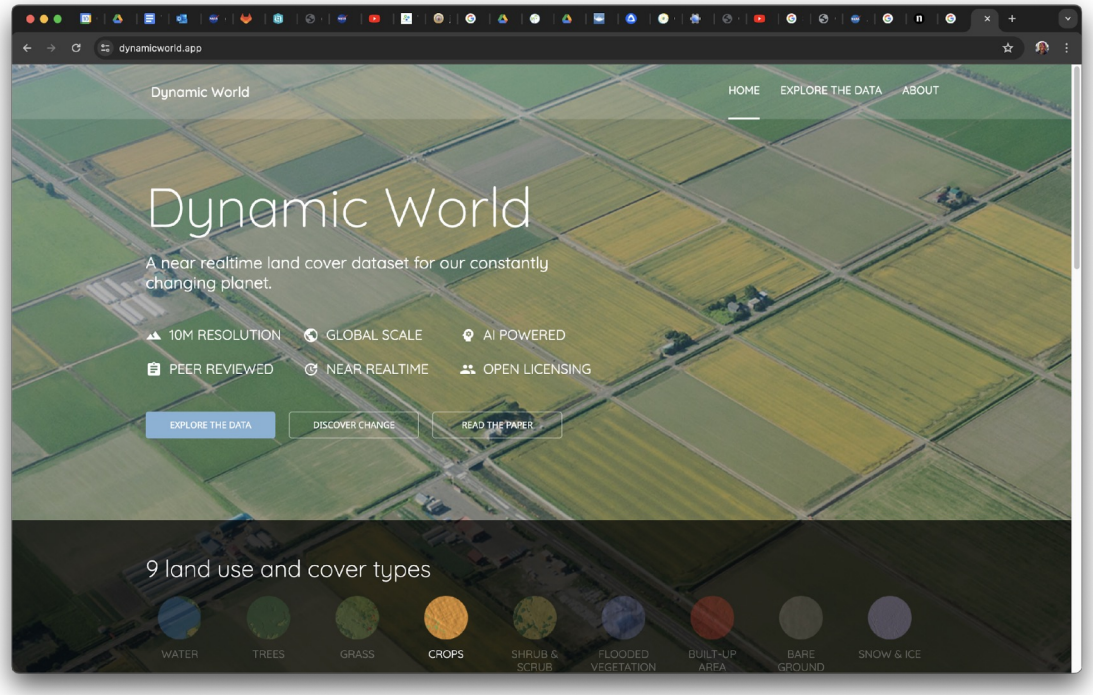
Map Class Table

Value	Color	Description
10	#006400	Tree cover
20	#ffbb22	Shrubland
30	#ffff4c	Grassland
40	#f096ff	Cropland
50	#fa0000	Built-up
60	#b4b4b4	Bare / sparse vegetation
70	#f0f0f0	Snow and ice
80	#0064c8	Permanent water bodies
90	#0096a0	Herbaceous wetland
95	#00cf75	Mangroves
100	#fae6a0	Moss and lichen

Dynamic World

https://www.nature.com/articles/s41597-022-01307-4

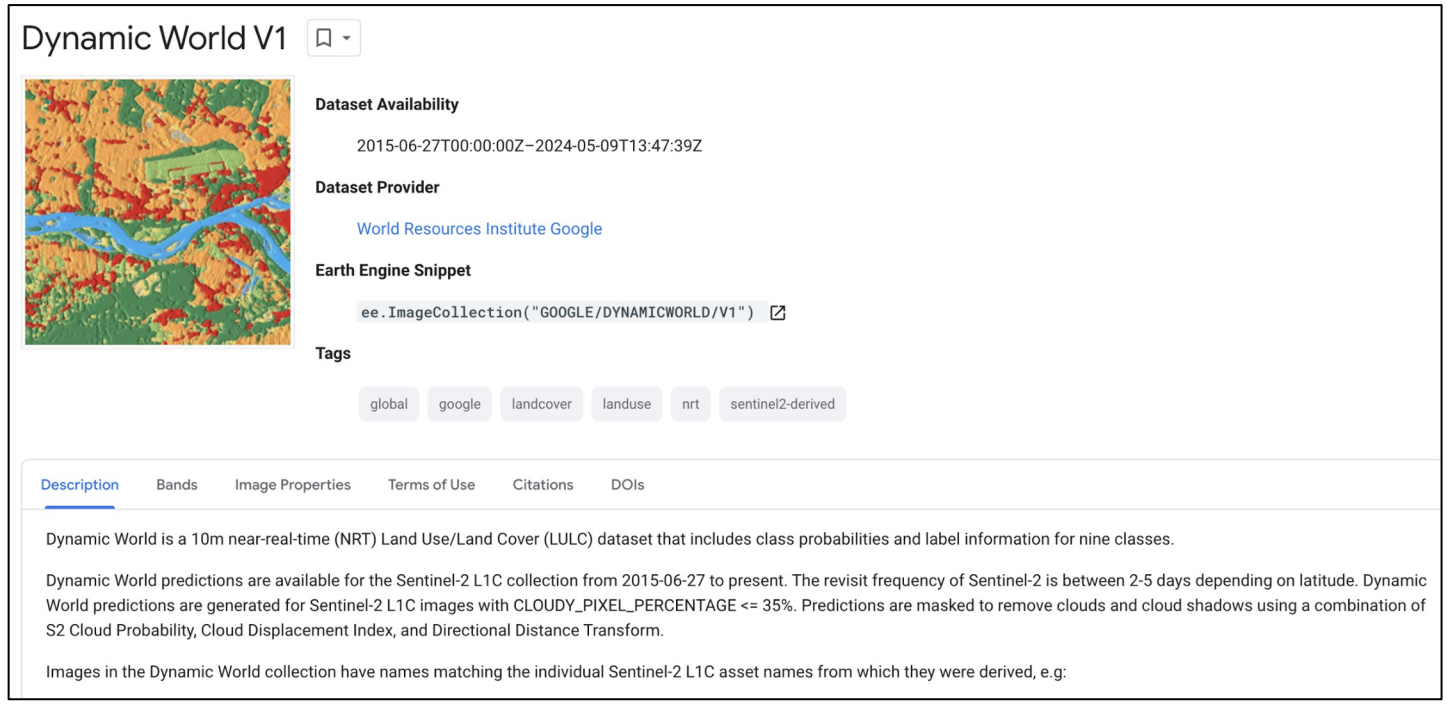
- Automated approach for globally consistent, high-resolution, Near Real-Time (NRT) Land Use Land Cover (LULC) classification leveraging deep learning on 10-meter Sentinel-2 imagery.
- Includes class probabilities and label information for nine classes.
- Predictions are available from 2015-06-27 to the present.
- Generated images with CLOUDY_PIXEL_PERCENTAGE <= 35%.



Brown, C.F., Brumby, S.P., Guzder-Williams, B. et al. Dynamic World, Near real-time global 10 m land use land cover mapping. Sci Data 9, 251 (2022).

Dynamic World

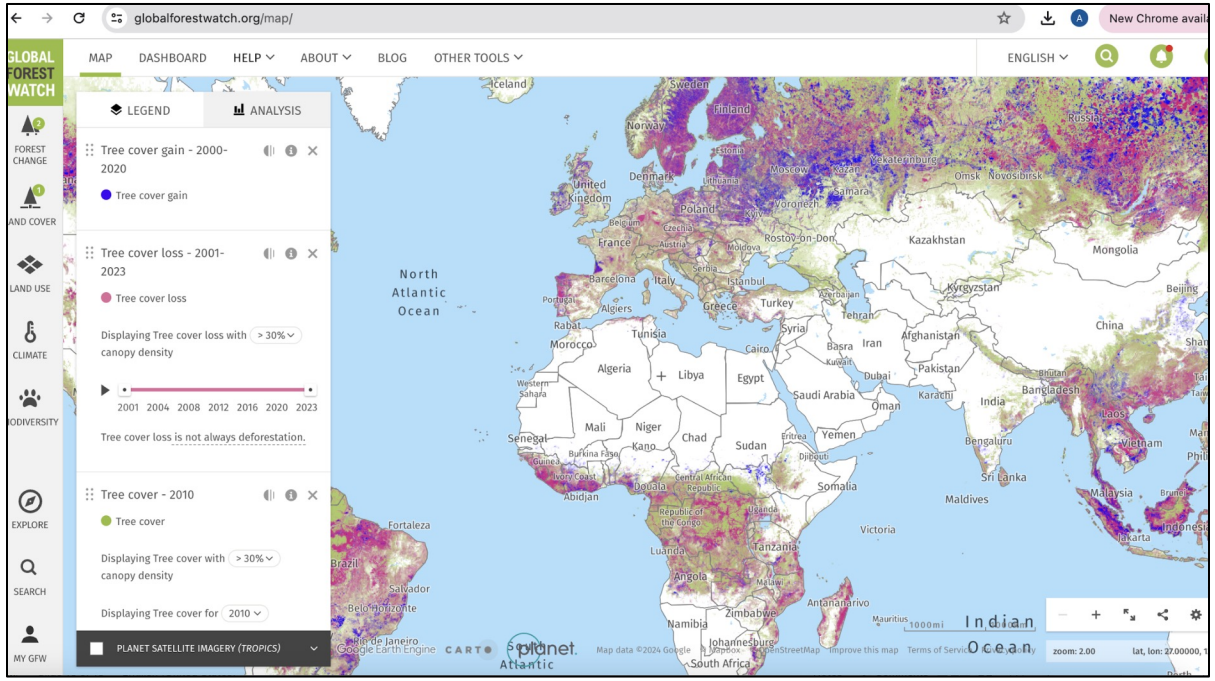
- Dynamic World is available from GEE.
- Google Earth Engine tutorial is available for working with the Dynamic World dataset.
- Links:
  - Website
  - GEE Dataset
  - Tutorials

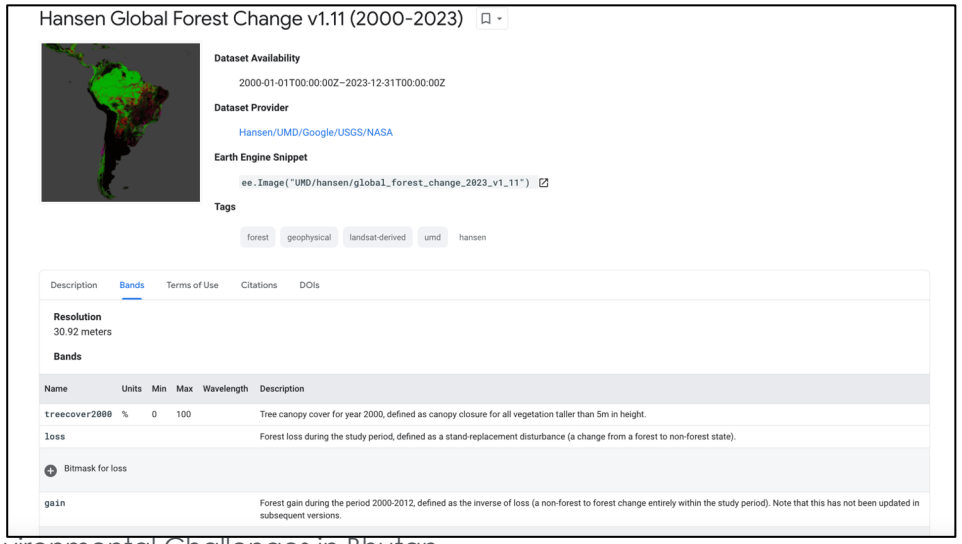


Global Forest Watch (GFW)

https://www.globalforestwatch.org/

- Focuses on **global tree cover** (tall woody vegetation with height > 5 m) identification based on Landsat 7 to 9 imagery.
- Uses **optical reflectance** from Landsat, and **supervised classification** methodology.
- Available from GFW interactive dashboard and from GEE.

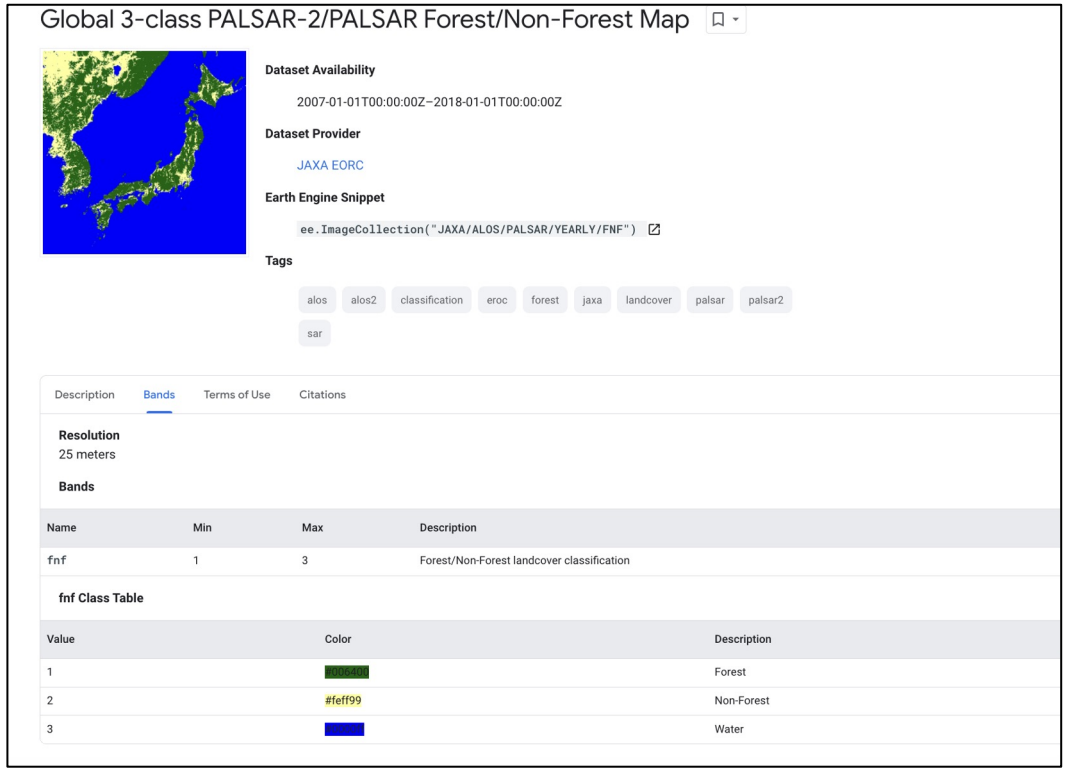




ALOS PALSAR Forest and Non-Forest

https://www.eorc.jaxa.jp/ALOS/en/dataset/fnf_e.htm

- PALSAR-2/PALSAR SAR annual mosaics are used to generate global **Forest/Non-Forest (FNF)** maps.
- SAR backscattering coefficient and region-dependent threshold for backscattering is used to classify **forest (high backscatter)** and **non-forest (low back scatter)** pixels.
- Area larger than **0.5 ha** and forest cover over **10%** is defined as **natural forest**.
- The classification accuracy is checked by using in-situ photos and high-resolution optical satellite images.



Available from GEE

Demonstration:
Global Forest Watch

Demonstration:
Land Cover Data Access in GEE

References

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