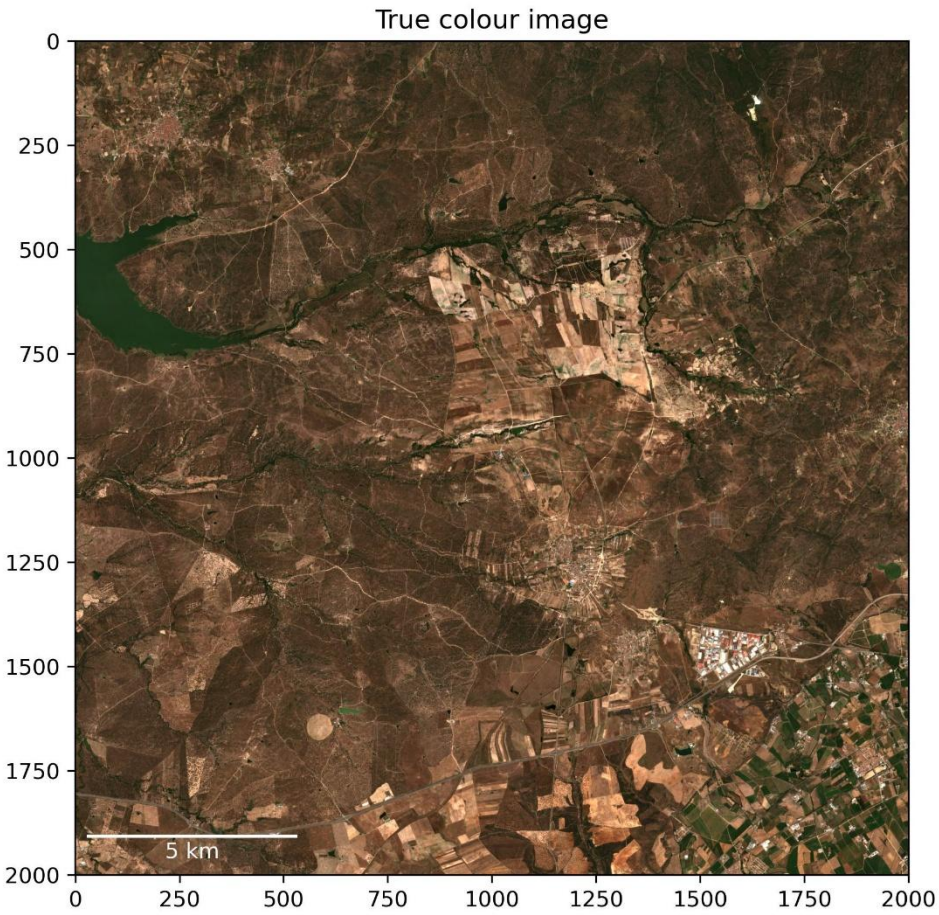
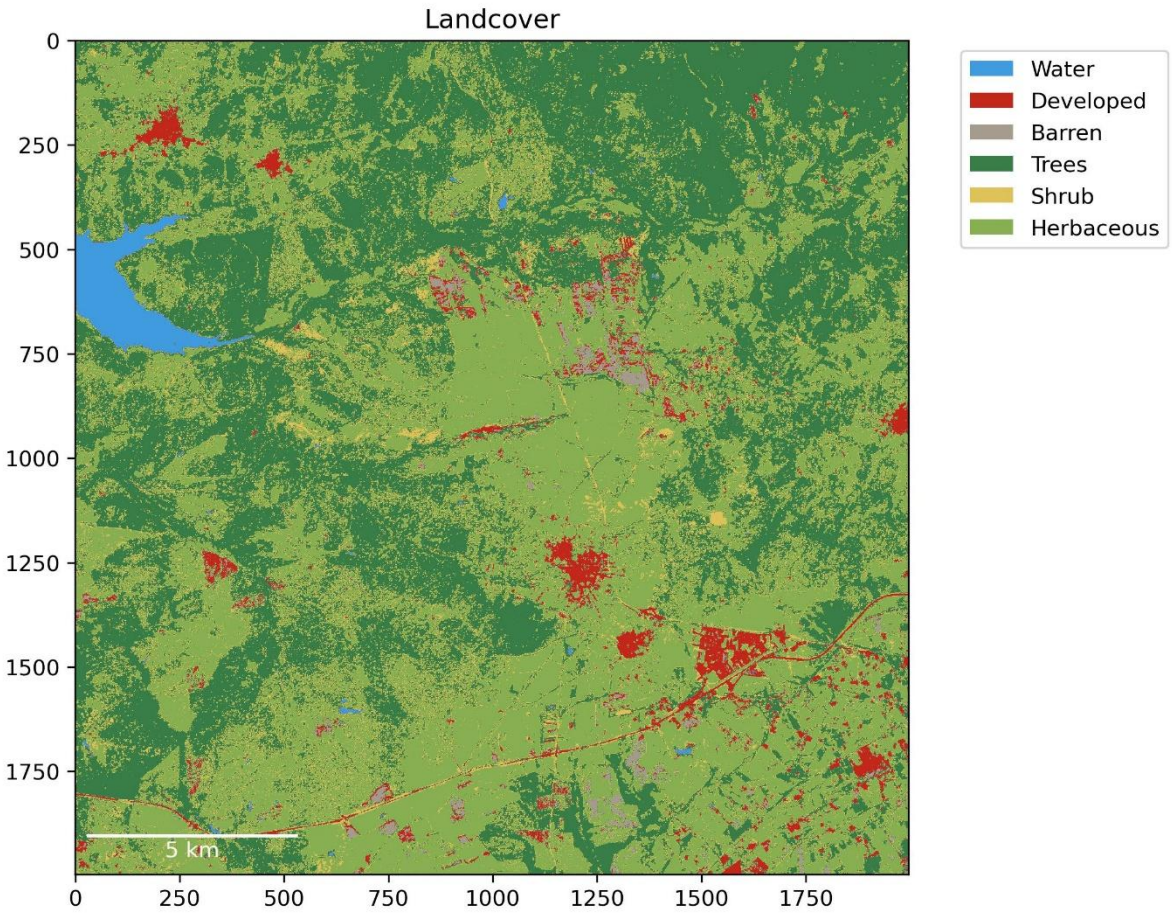
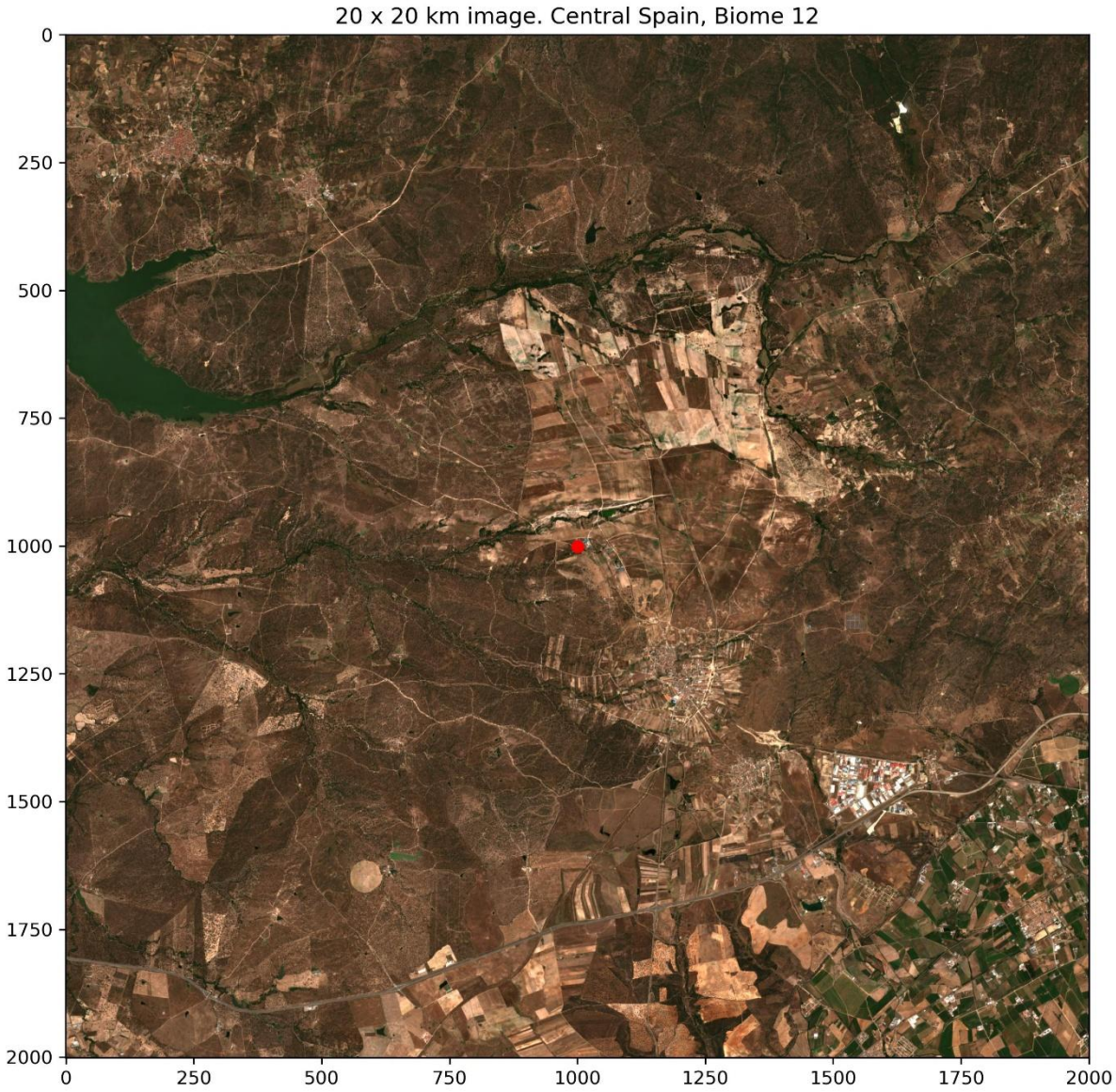
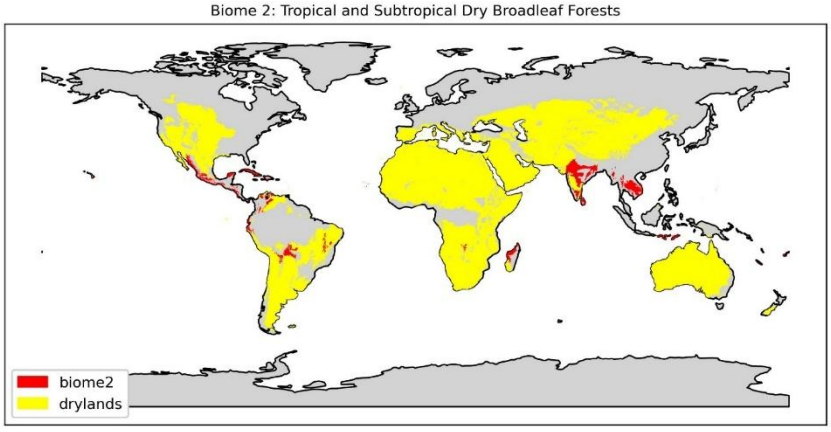

True colour image
0
250
500
750
1000
1250
1500
1750
2000
5 km

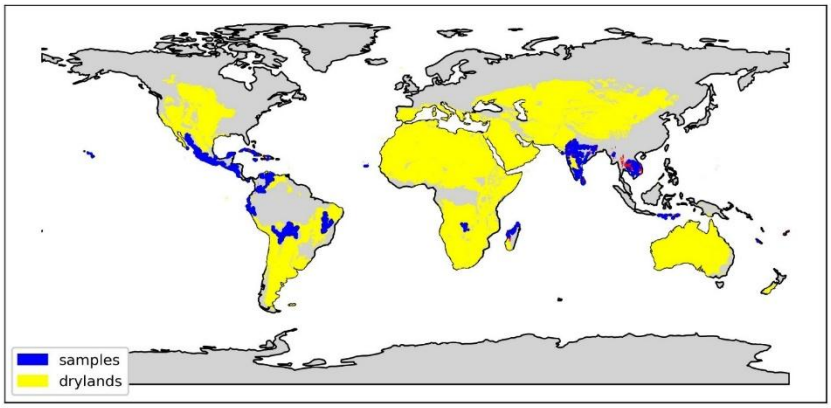

Landcover
0
250
500
750
1000
1250
1500
1750
5 km
Water
Developed
Barren
Trees
Shrub
Herbaceous


20 x 20 km image. Central Spain, Biome 12
0
250
500
750
1000
1250
1500
1750
2000

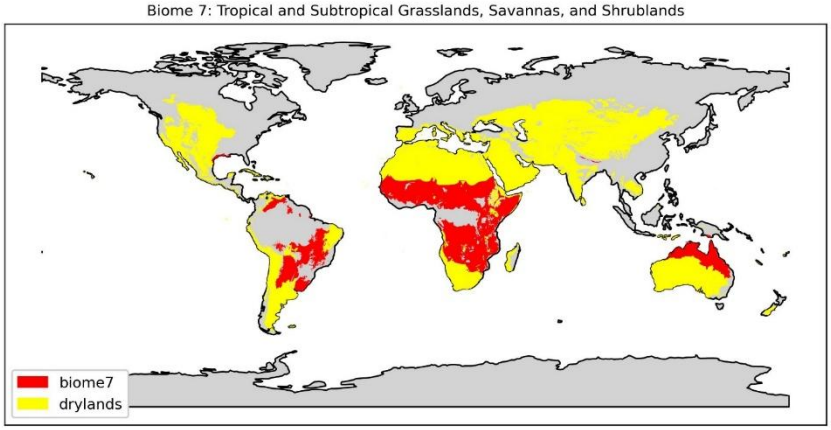
Biome shapefiles from WWF. With Glance samples filtered by biome (using geopandas).

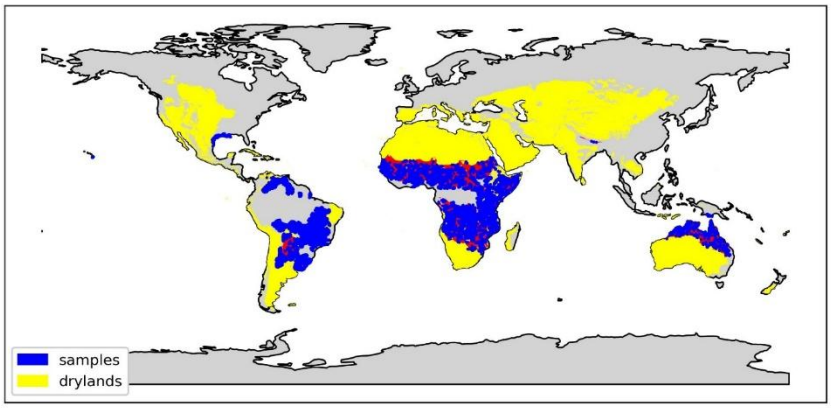
Biome 2: Tropical and Subtropical Dry Broadleaf Forests



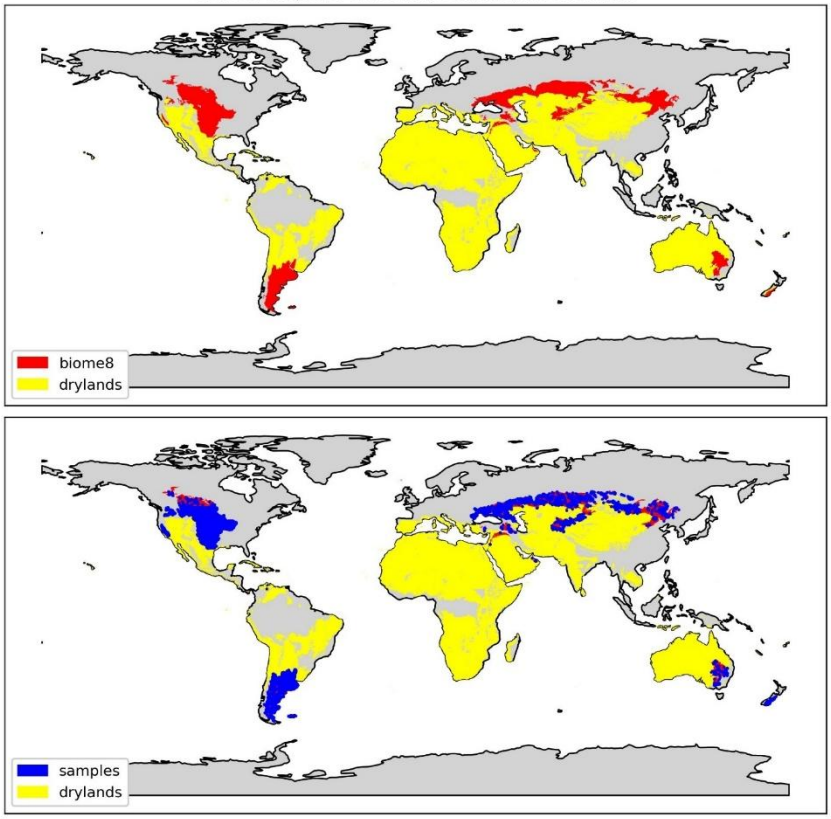


Biome 7: Tropical and Subtropical Grasslands, Savannas, and Shrublands

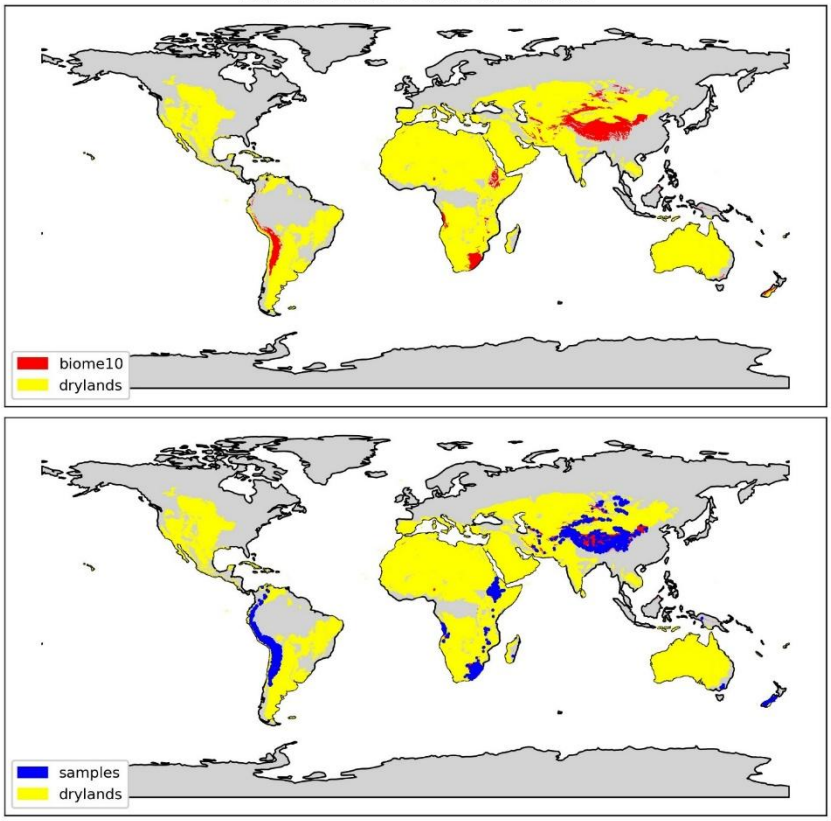




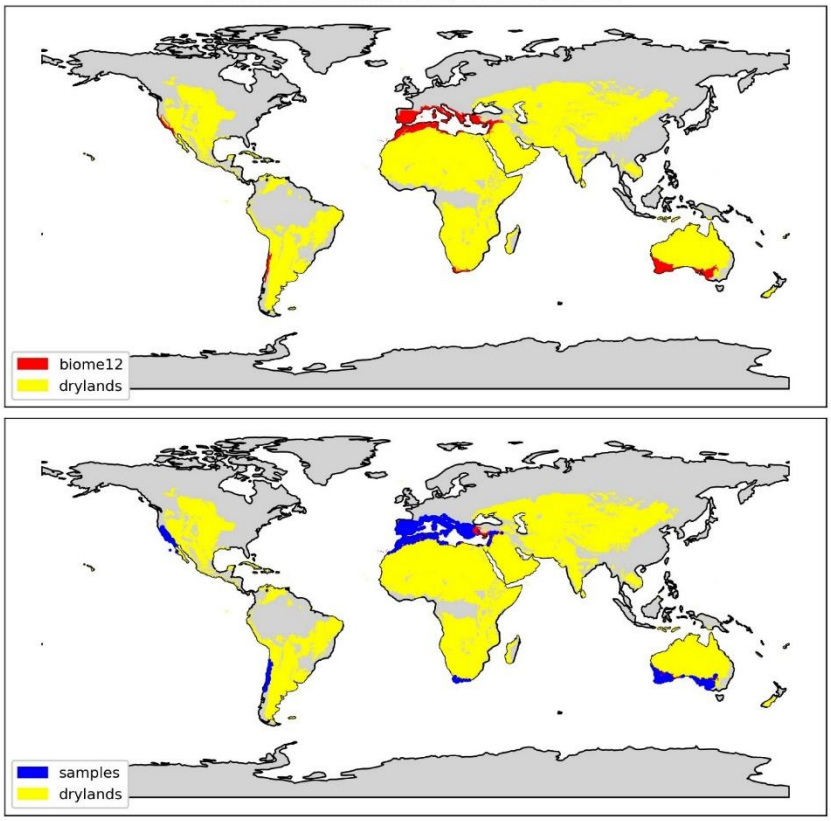
Biome 8: Temperate Grasslands, Savannas, and Shrublands



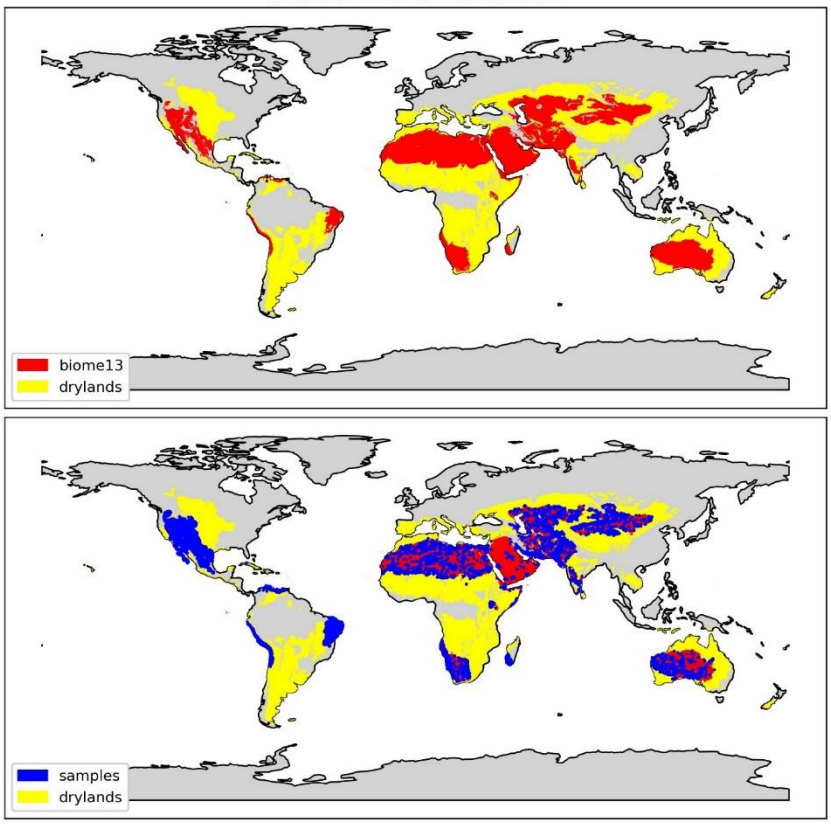
Biome 10: Montane Grasslands and Shrublands



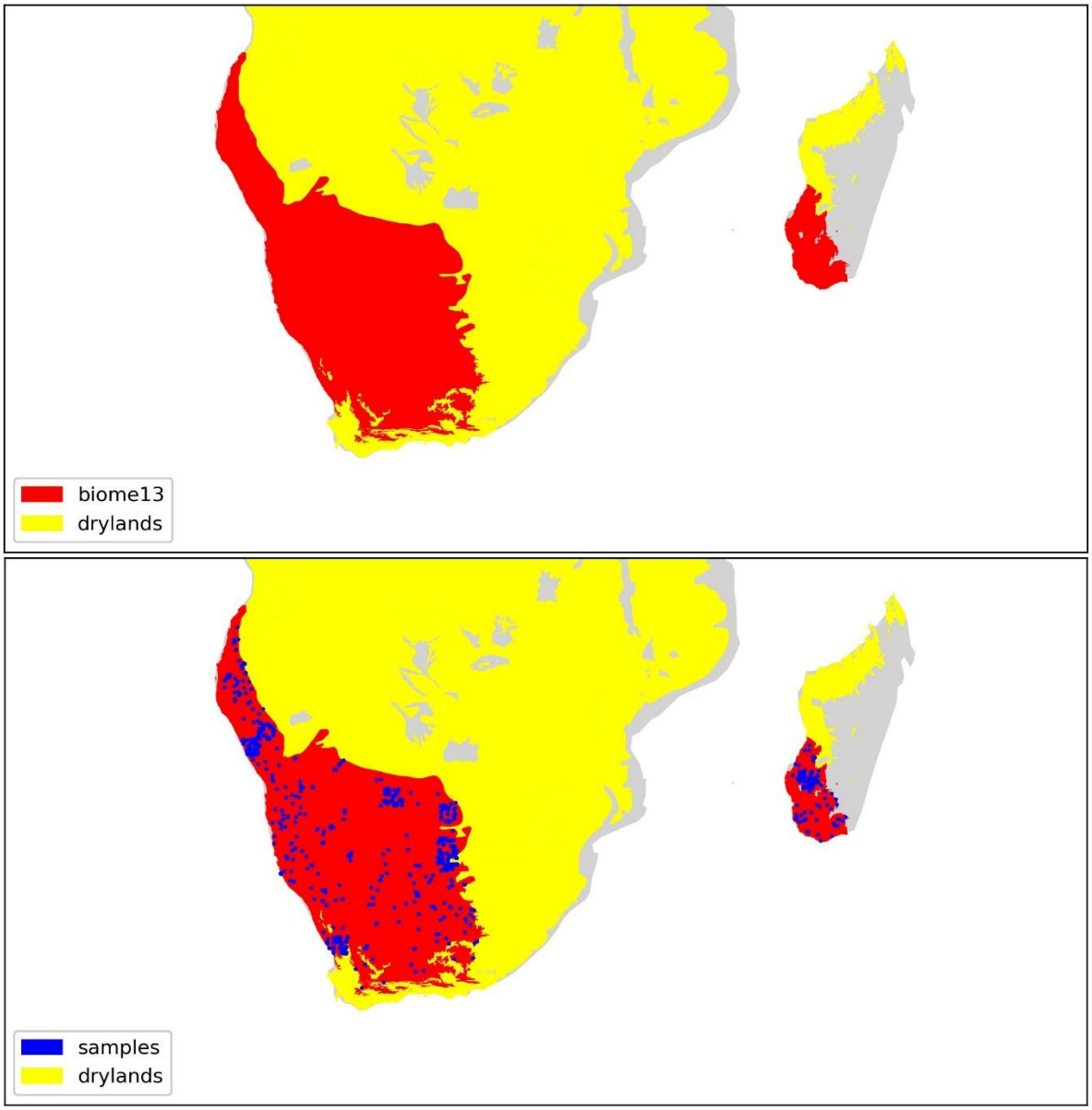
Biome 12: Mediterranean Forests, Woodlands, and Scrub



Biome 13: Deserts and Xeric Shrublands



Biome 13: Deserts and Xeric Shrublands



August 23rd

- Reply to FAO email to get more classes than simply 'Forest' or 'non-Forest'. –> done. waiting for response -> now have a positive second response
- ReRead FAO 2019 report and add notes -> done
- Also extract Level2 classes so we have grassland and agriculture...smaller dataset -> done
- In GlanCE: woody vegetation > 10% = shrubland, >30% = forest. >10% vegetated, <10% woody = herbaceous
- Use python / geopandas to extract points per biome (not QGIS) -> done

August 19th Supervisor Meeting with Arjan

Action Items/Points

- Separate Methodology from Application.
- WWF define 14 global biomes. Explain how I chose the six 'dryland' biomes.
- What are areas per biome. Samples per sqkm.
- I will be looking at landcover change within a biome rather than changes in biome extent.
- Stick with GlanCE Level 1 classes [Water, Developed, Barren, Trees, Shrub, Herbaceous]. At Level 2 Herbaceous is split into Agriculture & Grassland. Less accurate classification.
- Initially train the model on all dryland biomes rather than separate model per biome.
- For inference step start with a small area to test runtime and memory requirements.
- For benchmarking. Compare my predicted landcover classes with global landcover models (Dynamic World & ESRI). Take a random sample of points to test my model. Not every pixel. Look at Olofsson et al. 2014. (Good practices for estimating area and assessing accuracy of land change).

What is Novel about my project?

- There are only three global landcover datasets at 10m resolution. Two with annual coverage; ESRI Land Cover, Dynamic World. ESA World Cover is only 2020 & 2021. [30 m resolution: GlobeLand 30 from China, GLanCE Uni of Boston 2001-2019, Global Land Analysis and Discovery. 2000-2020. University of Maryland.]
- None focus on drylands. i.e. specifically trained on dryland environments. These are some of the most fragile ecosystems, open to degradation, impacted by human use, agriculture and grazing, climate change, and cover over 40% of land surface area.
- Using Geemap to pull over 100's thousands of (previously labelled) small patches of Sentinel-2 data in Google Earth Engine to Jupiter Notebook is innovative. These patches are also filtered according to Biome.
- The light convolutional neural network was introduced by Song in 2019. This approach has been optimised.

Work Plan – next six months

I have already filtered global GlanCE data by Biome. There are 1.8 million samples from 1984 to 2020. There are 1.28 million samples from 2016-2020. Of those, 330,000 are within dryland biomes. Sentinel-2 compete global coverage is from April 2017 (Sentinel-2a and 2b satellites).

By End September

- Include Biome 10; Montane Grasslands and Shrublands.
- Extract Sentinel-2 patches from the global dryland biomes. Correct year.
- Train the CNN with just this dryland data.
- Inference step. With the trained CNN predict 2024 landcover for specific dryland area. Start with a small area – memory / runtime.
- Initially train the model on all dryland biomes rather than separate model per biome.

End October

- Benchmarking. Compare my predicted landcover classes with global landcover models (Dynamic World & ESRI). Take a random sample of points to test my model.

End December

- Write-up Methodology section.

2026

- Apply the model
- Calculate landcover change over multi-year time period. - COPERNICUS/S2_SR_HARMONIZED available from 2017-03-28 to 2025-06-25.
- Take a look at ERA-5 dataset which contains global precipitation data (from ECMWF). Does this explain changes in Landcover seen ?
- Other factors for landcover change; urbanisation, agraiculture, climate change.

August 15th

Lidar data (GEDI) data only seems available for 2019? https://gedi.umd.edu/

August 14th

Most students take off the shelf model. I need to capture my time and effort.
Two papers - Methods and Applications.
Ann Grainger ?
email FAO

Plan for next 12 months

Main Global Land Cover maps at medium or high resolution:
ESRI Land Cover 2017-2024. Sentinel-2 data. 10 m res. 9 classes.
ESA WorldCover. 2020 and 2021. Sentinel-1 and Sentinel-2. 10 m res. 11 classes.
Dynamic World. Google and The World Resources Institute. Sentinel-2. 9 land cover classes. 2015-2024. 10 m res.
Global Land Analysis and Discovery. 2000-2020. University of Maryland. From Landsat. 30 m res.
GlanCE. Uni of Boston. Landsat 30 m resolution. 2001-2019.
Globe Land 30. From China. 10 classes. www.globeland30.org

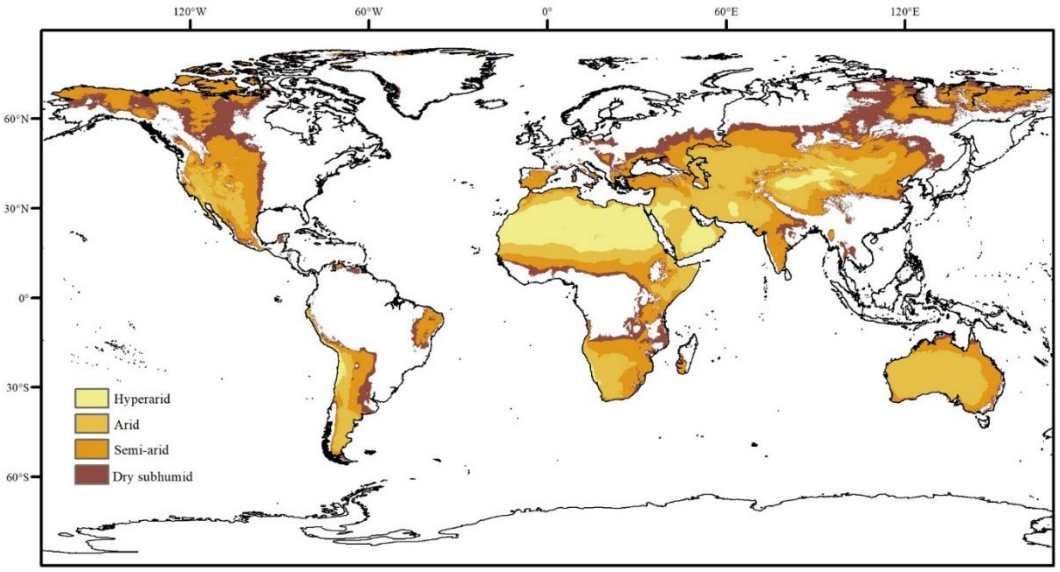
June 26th

I have filtered the dryland GLanCE points by Biome
These are in individual csv files and have been imported into Notepad
Next extract Sentinel-2 patches for each Biome Then re-train the model
Sentinel-2: The Sentinel-2 mission, which provides high-resolution optical imagery, began with the launch of Sentinel-2A in June 2015. Its twin satellite, Sentinel-2B, was launched in March 2017. Therefore, comprehensive global coverage and data availability in Google Earth Engine started around this period.

June 24th (from my First Formal Progress Review FFPR)

1. Extract Sentinel-2 patches from the global dryland biomes only.
2. Train the CNN with just this dryland data.
3. With the trained CNN predict 2024 landcover for specific dryland area.
4. Compare my predicted landcover classes with global landcover models (e.g. ESA World Cover map, Dynamic World, ESRI).
5. Calculate landcover change over multi-year time period. - COPERNICUS/S2_SR_HARMONIZED available from 2017-03-28 to 2025-06-25.
6. Take a look at ERA-5 dataset with contains global precipitation data (from ECMWF). Does this explain changes in Landcover seen in (5).
7. Can I get additional labelled landcover data ? (from FAO Global Drylands study).

Wang et al 2023. Land Cover Change in GlobalDrylands: A Review.



Olson et al 2001. Terrestrial Ecoregions of the World: A New Map of Life on Earth.

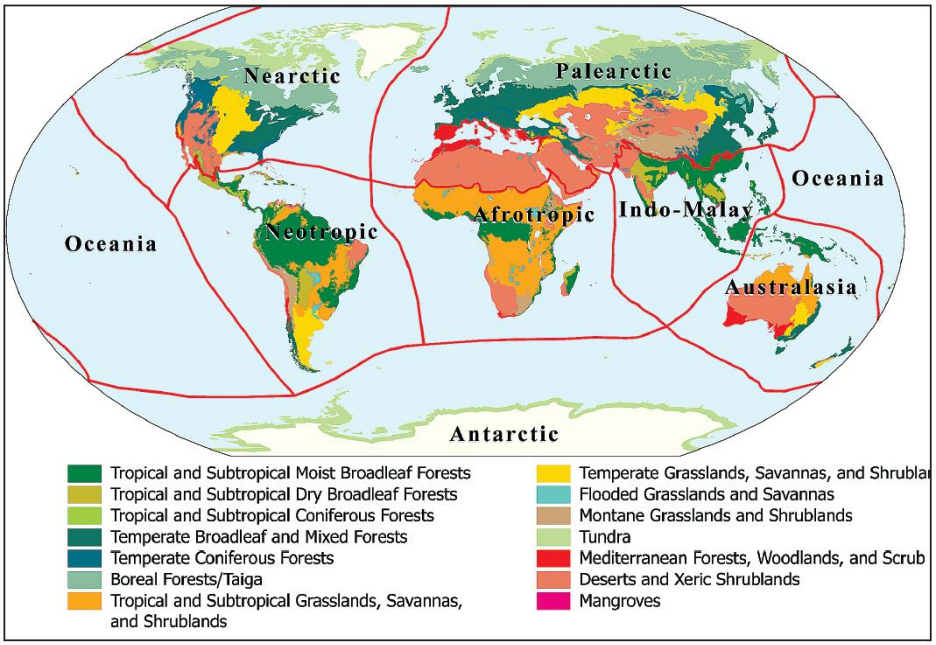


Figure 1. The ecoregions are categorized within 14 biomes and eight biogeographic realms to facilitate representation analyses.

1. Tropical and Subtropical Moist Broadleaf Forests
2. **Tropical and Subtropical Dry Broadleaf Forests** 29,053 global points
3. Tropical and Subtropical Coniferous Forests
4. Temperate Broadleaf and Mixed Forests
5. Temperate Coniferous Forest
6. Boreal Forest / Taiga
7. **Tropical and Subtropical Grasslands, Savannas, and Shrublands** 218,417 global points
8. **Temparate Grasslands, Savannas, and Shrublands** 24,555 global points
9. Flooded Grasslands and Savannas
10. **Montane Grasslands and Shrublands**
11. Tundra
12. **Mediterranean Forests, Woodlands, and Scrub** 27,145 global points
13. **Deserts and Xeric Shrublands** 29,973 global points
14. Mangroves

Realms in TEOW spreadsheet

1. AA. Australasia
2. AN. Antartic
3. AT. Afrotropic. Central and Southern Africa
4. IM. Indo-Malay
5. NE. Neartic. North America
6. NT. Neotropic. South America
7. OC. Oceania
8. PA. Paleartic. Europe, Asia, North Africa, Middle East