SSP-RCP Scenario-based Future Land Use Change Projection over Ethiopia

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Introduction

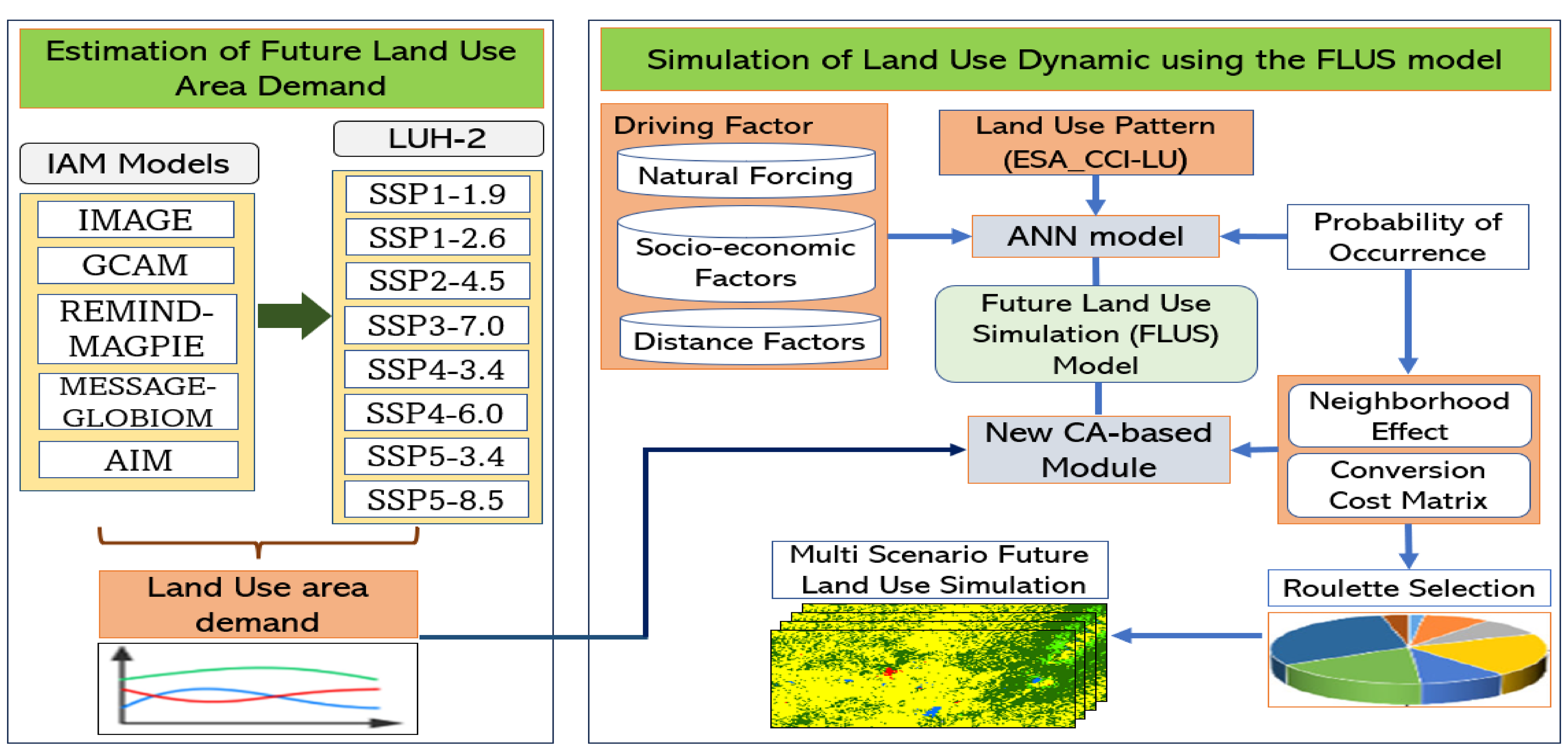
Main objective

- ❑ Produce/generate a set of high-resolution land use change projections for regional research in Ethiopia using the new integrated scenarios of SSPs-RCPs.

Specific objectives/purposes

- ❑ Link the land projection dataset to the latest group of climate research scenarios, SSP-RCPs, and
- ❑ Improve the resolution of the global land projection dataset (LUH2) under the latest scenario

Therefore, this study used the Future Land Use Simulation (FLUS) model to produce a 1-km future land use land cover (LULC) dataset in Ethiopia, comprising six broad land use types at 10-year intervals from 2020 to 2100 with eight SSP-RCP scenarios



Methodology

The methodological framework for producing/generating a high-resolution future LULC dataset under SSPs-RCPs scenario in Ethiopia (study area).

1. Estimation of future land use demand based on LUH2 datasets
   → estimation of the future land use area demands for different land use types under eight SSPs-RCPs scenarios.
2. Simulation of future land use dynamic with the FLUS model
   → conducts a 1-km spatial land simulation using the future land use simulation (FLUS) model.

Estimation of future land use demand

- ❑ Land-Use Harmonization² (LUH2) (http://luh.umd.edu/index.shtml)
- ❑ LUH2 v2f Release
- ❑ 12 LULC state layers (supplementary material)
- ❑ annual resolution from 2015 to 2100, eight SSP-RCP scenarios
- ❑ 0.25° resolution (approximately 25 km at the equator).

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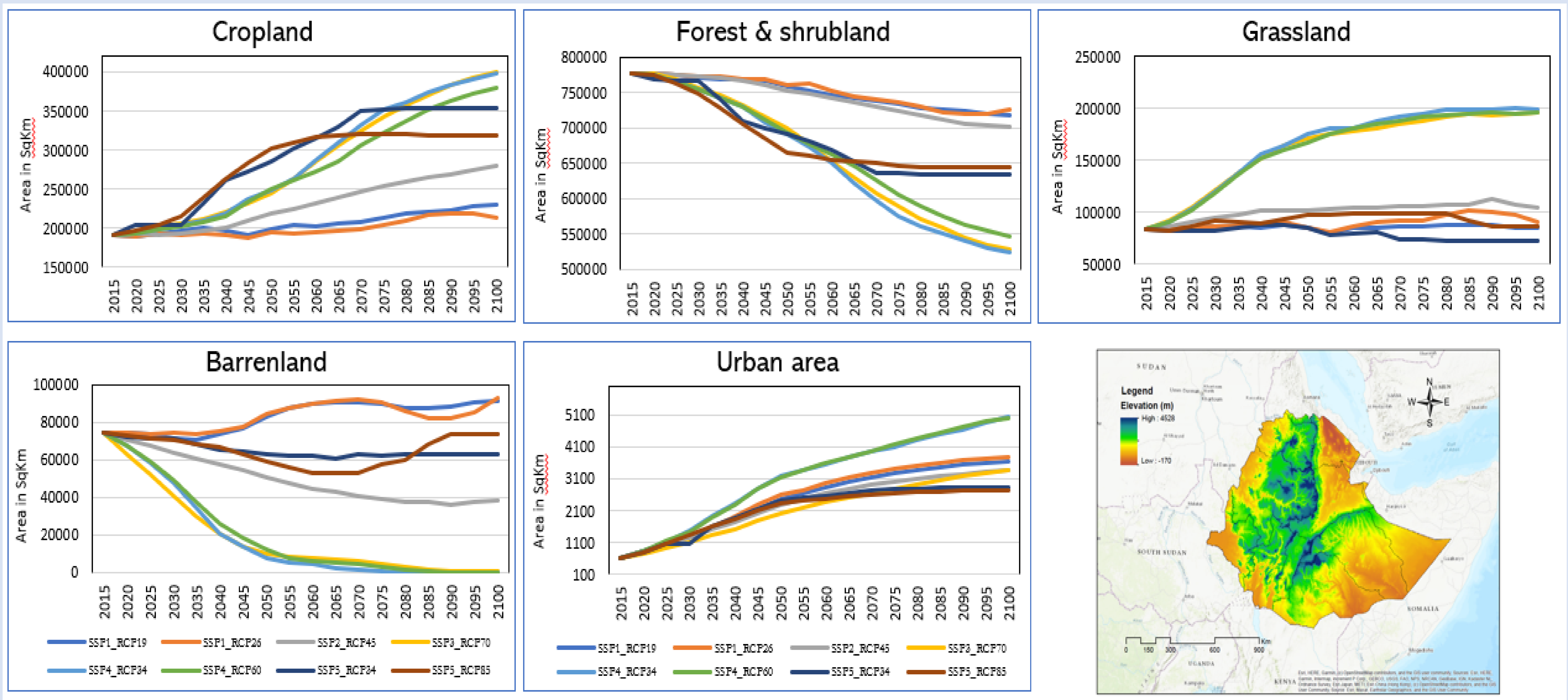
Figure. Projection of land use demands under different scenarios in Ethiopia from 2015 to 2100.



FLUS (Future Land Use Simulation) model

- A new CA-based model, which couples "top-down" socio-economic modeling and "bottom-up" spatial simulation (Li et al., 2017).

The major mechanisms involved in the FLUS model

1) ANN-based probability of occurrence estimation module and
2) The self-adaptive inertial and competition mechanism CA of roulette selection

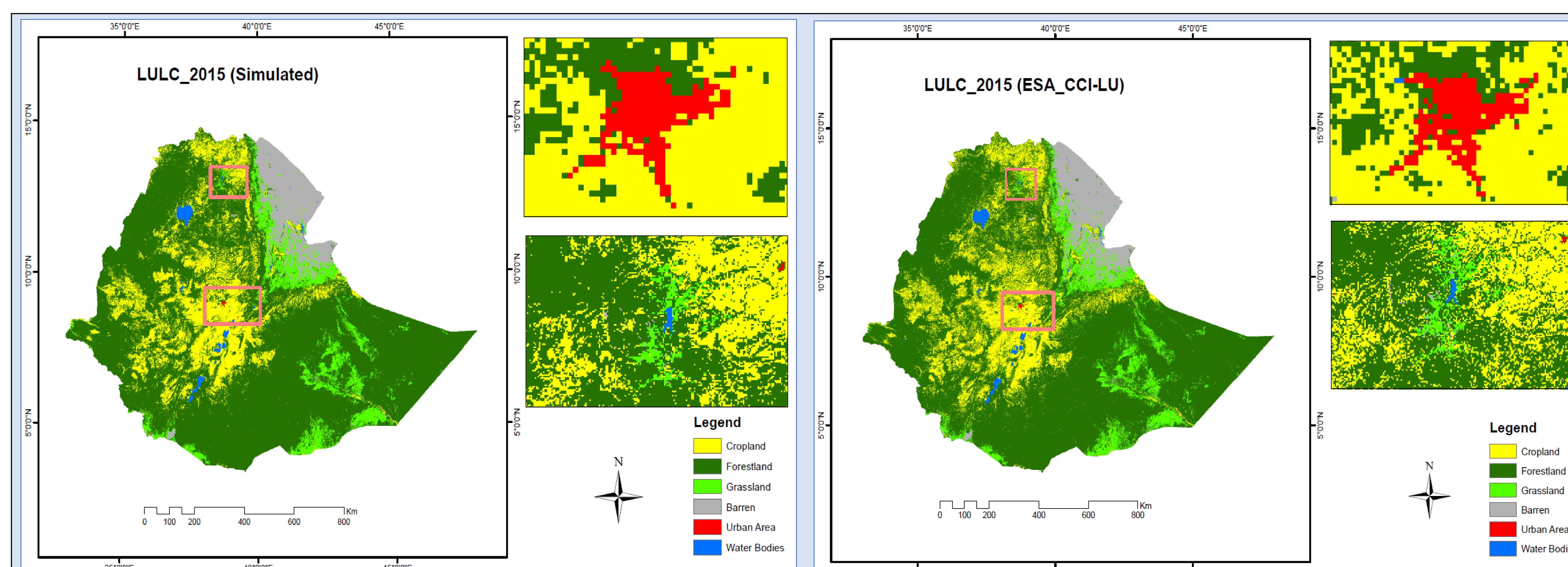
Data and Spatial Variables

- The dataset used to build and train the FLUS model includes the LULC data and spatially explicit biophysical and socioeconomic variables at each grid cell.
- 18 spatial variables/input (listed in the table) are assumed to represent the driving forces of land use change, as commonly used in the global LULC simulation models (Li et al., 2017).

Figure: Spatial driving factors used in this study

Data	Resolution	Year	Source
Land use	300m (raster)	1992-2020	European Space Agency Climate Change Initiative (ESA-CCI) (http://esa-landcover-cci.org/)
	0.25°*0.25° (raster)	2015-2100	Land-Use Harmonization2 (LUH2) (http://luh.umd.edu/)

Spatial Variable	Year	Resolution	Data Source
Annual mean temperature Minimum and Maximum Temperature Annual precipitation	1991-2020	0.5'	Climatic Research Unit gridded Time Series (CRU TS v. 4.06)
Soil quality (Oxygen availability to roots; Excess salts; Workability and Nutrient availability)	2008	5'	Harmonized World Soil Database (http://webarchive.iiasa.ac.at/Research/LUC/External-World-soil-database/HTML/SoilQuality.html?sb=10)
DEM		30m (Raster)	ASTER Global Digital Elevation Model v3 (https://earthdata.nasa.gov/)
Slope, Aspect and Hillshade			Retrieved from DEM
Gross Domestic Product (GDP)	2010	1 km (Raster)	Chen et al., 2022
Population Density	2010	1 km (Raster)	WorldPop and Center for International Earth Science Information Network (CIESIN) (https://dx.doi.org/10.5258/SOTON/WP00674)
Distance to road	1980-2010	1 km	NASA, Socioeconomic Data and Applications Center, Global Roads Open Access Data Set, version 1 (gROADSv1)
Distance to river		Shapefile	RCMRD GeoPortal (https://geoportal.rcmrd.org/)
Distance to city/sub city/etc.	2014	Shapefile	United Nations, Department of Economic & Social Affairs, Population Division (2014)
Restricted Area Maps		Shapefile	World Database on Protected Areas (WDPA)



Year	Overall accuracy (OA)	Kappa coefficient	Figure of merits (FoM)
1992	0.894	0.912	0.11
1995	0.923	0.890	0. 21
2000	0.839	0.760	0.17
2005	0.854	0.841	0.15
2010	0.880	0.837	0.42
2015	0.892	0.841	0.14
2020	0.818	0.860	0.19

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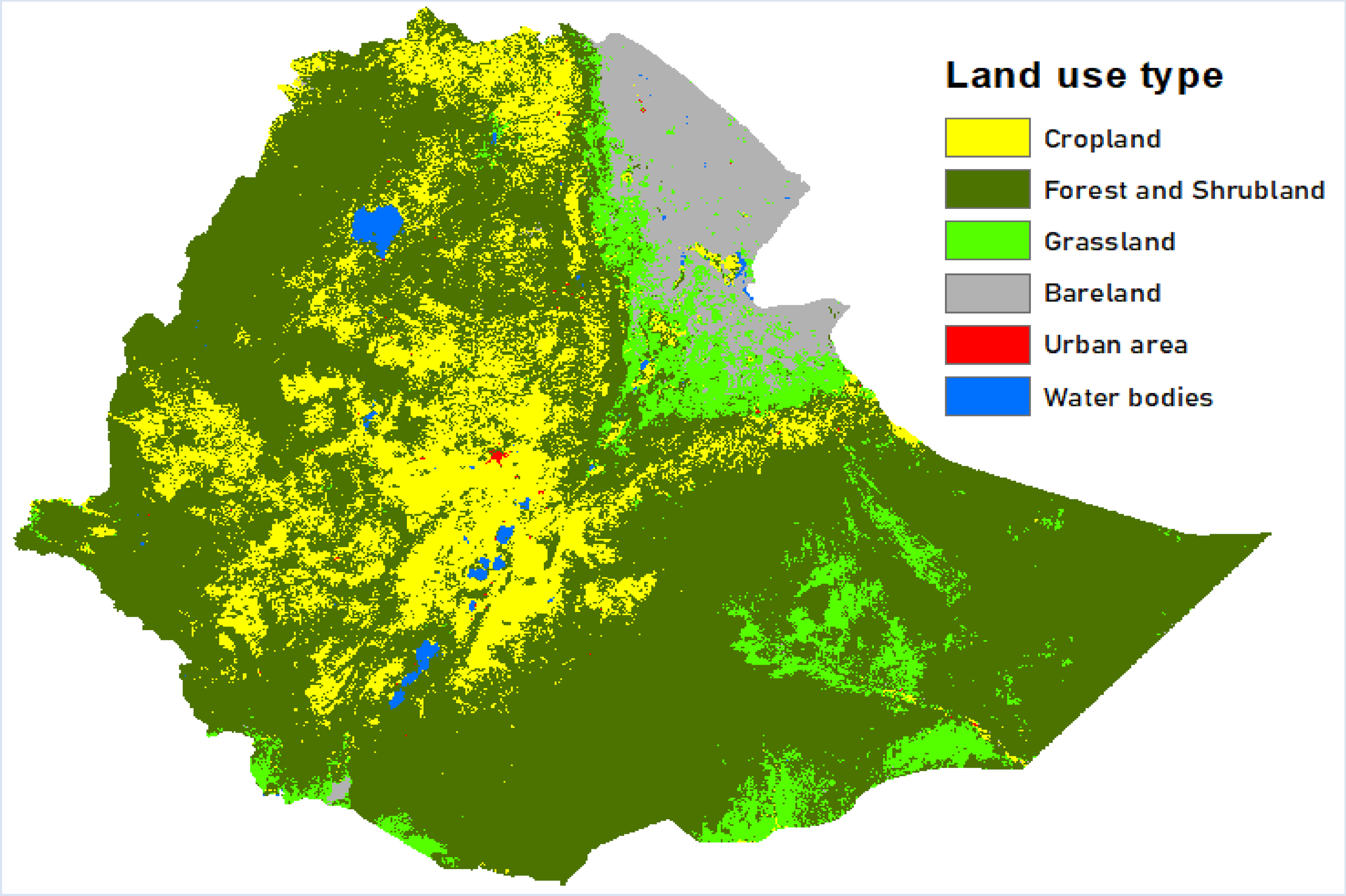
Result/Main Finding

- The FLUS model is used to simulate multiple land use changes in Ethiopia
- Land use datasets for Ethiopia
  - → 2020 to 2100 with 10-year intervals
  - → the eight SSP-RCP scenarios:
  - → 1 km spatial resolution
  - → Six land use types

(i.e., cropland, forest and shrubland, grassland, barren, urban area, and water bodies)

- All files in the datasets are in single-band GeoTIFF format.
- Future land-use simulations showed that forestland degradation and cropland and urban expansion will be the main forms of land-use change in Ethiopia.



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