LUH2 v2h

1 OVERVIEW OF LAND USE FORCING DATA (850-2100)

In preparation for sixth phase of the Coupled Model Intercomparison Project (CMIP6), a new set of global gridded land-use forcing datasets are being developed to link historical land-use data and future projections in a standard format required by climate models. This new generation of "land use harmonization" (LUH2) builds upon past work from CMIP5, and includes updated inputs, higher spatial resolution, more detailed land-use transitions, and the addition of important agricultural management layers. The major attributes of the dataset will include:

- Global domain
- 850-2100 annual land-use states, transitions, and gridded mgt layers
- Common history
- Official CMIP6 future scenarios
- 0.25 x 0.25 degree spatial resolution
- 12 possible land-use states including separation of Primary and Secondary natural vegetation into Forest and Non-forest sub-types, Pasture into Managed Pasture and Rangeland, and Cropland into multiple crop functional types
- >100 possible transitions per grid cell per year, including crop rotations
- Agriculture management layers including irrigation, synthetic nitrogen fertilizer, and biofuel management

These datasets are being developed as a contribution of the Land-Use Model Intercomparison Project (LUMIP) to the Forcings Group for CMIP6. The primary points of contact for these data are:

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2 DESCRIPTION OF HISTORICAL DATA (850-2015)

LUH2 v2h is an updated release of the historical land-use forcing dataset, and covers the period 850-2015. This product is the result of a series of prototypes released previously, uses the established data format, and will connect smoothly to gridded products for the future. A DOI is planned for this dataset.

LUH2 v2h is an update to the previously released historical land-use dataset LUH2 v1.0h and includes the following updates/features to address known issues and notices:

- Updated historical HYDE land-use inputs
- Updated static maps including: biomass, recovery rate, country codes, and lat/lon coordinates
- Updated spatial patterns of nitrogen-fixing crops
- Updated spatial patterns of biofuel crops
- New labeling of the time dimension in netCDF files to ensure software packages like panoply and ArcGIS can read the time metadata properly
- Added lat and lon bounds to address netCDF compliance issues

In addition to the updated attributes listed above, major attributes of the new historical dataset continue to include:

- Agriculture and urban land-use based on HYDE 3.2
- Wood harvest reconstruction based on FAO and other sources
- Spatial pattern of wood harvesting constrained by Landsat data
- Updated shifting cultivation estimates
- Crop rotations
- Fraction of crop biomass harvested
- Fraction of crops grown as biofuels
- Fraction of cropland flooded
- Fate of wood harvest (traditional fuelwood, commercial biofuels, and industrial roundwood)
- NetCDFs are CF (climate and forecast) convention compliant

2.1 Files

Files can be downloaded from:

http://luh.umd.edu

The datasets are comprised of several netCDF files:

- states.nc
- transitions.nc
- management.nc
- staticData_quarterdeg.nc

2.2 Variable Names and Units

2.2.1 States: (units fraction of grid cell unless otherwise specified)
```
primf: forested primary land
primn: non-forested primary land
secdf: potentially forested secondary land
secdn: potentially non-forested secondary land
pastr: managed pasture
range: rangeland
urban: urban land
c3ann: C3 annual crops
c3per: C3 perennial crops
c4ann: C4 annual crops
c4per: C4 perennial crops
c3nfx: C3 nitrogen-fixing crops
secma: secondary mean age (units: years)
secmb: secondary mean biomass density (units: kg C/m^2)
```

2.2.2 Transitions:
Transitions between land use states (units fraction of grid cell per year)
All in format <state1_to_state2>

Wood harvest: (units fraction of grid cell)
```
primf_harv: wood harvest area from primary forest
primn_harv: wood harvest area from primary non-forest
secmf_harv: wood harvest area from secondary mature forest
secyf_harv: wood harvest area from secondary young forest
secnf_harv: wood harvest area from secondary non-forest
```

Wood harvest: (units kg C)
```
primf_bioh: wood harvest biomass from primary forest
primn_bioh: wood harvest biomass from primary non-forest
secmf_bioh: wood harvest biomass from secondary mature
forest
secyf_bioh: wood harvest biomass from secondary young
forest
secnf_bioh: wood harvest biomass from secondary non-forest
```

2.2.3 Management:

Irrigation: (units fraction of crop area)
```
irrig_c3ann: irrigated fraction of C3 annual area
irrig_c3per: irrigated fraction of C3 perennial area
irrig_c4ann: irrigated fraction of C4 annual area
irrig_c4per: irrigated fraction of C4 perennial area
irrig_c3nfx: irrigated fraction of C3 N-fixing area
```

```
flood: flooded fraction of C3 annual crop area
```

Nitrogen Fertilizer: (units kg N/ha/crop season; (per year for single cropping))
```
fertl_c3ann: N. fertilizer rate for C3 annual crops
fertl_c4ann: N. fertilizer rate for C4 annual crops
fertl_c3per: N. fertilizer rate for C3 perennial crops
fertl_c4per: N. fertilizer rate for C4 perennial crops
fertl_c3nfx: N. fertilizer rate for C3 N-fixing crops
```

Biofuel crops (fraction of crop type area occupied by biofuel crops)
```
crpbf_c3ann: C3 annual crops grown as biofuels
crpbf_c4ann: C4 annual crops grown as biofuels
crpbf_c3per: C3 perennial crops grown as biofuels
crpbf_c4per: C4 perennial crops grown as biofuels
crpbf_c3nfx: C3 N-fixing crops grown as biofuels
```

Wood harvest product split (units: fraction of wood harvest biomass)
```
rndwd: industrial roundwood fraction of wood harvest
fulwd: traditional fuelwood fraction of wood harvest
combf: commercial biofuels fraction of wood harvest
```

Harvest (units of fraction of biomass harvested annually)
```
fharv_c3per: fraction of C3 perennial crops harvested
annually
fharv_c4per: fraction of C4 perennial crops harvested
annually
```

2.2.4 Static:
```
ptbio: potential biomass density of natural vegetation (units:
```
kg C / m^2)
```
fstnf: forest/non-forest mark (units: binary flag for forest (1) or non-
```
forest (0))
```
carea: area of grid cell (units: km^2)
ccode: country codes (units: ISO 3166-1 numeric code)
icwtr: icew/water fraction (units: fraction of grid cell area)
```