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

Note: The Land-Use Harmonization 2 (LUH2) datasets are made freely available for use by the scientific community, with attribution. Please use the following citation in any presentations or publications that result from, or include, the use of the LUH2 datasets:

G. Hurtt, L. Chini, R. Sahajpal, S. Frolking, et al. "Harmonization of global land-use change and management for the period 850-2100". Geoscientific Model Development (In prep).

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)
```