

Simultaneous Global Modeling of Agriculture and Forestry: New Developments

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**The views expressed herein do not necessarily reflect
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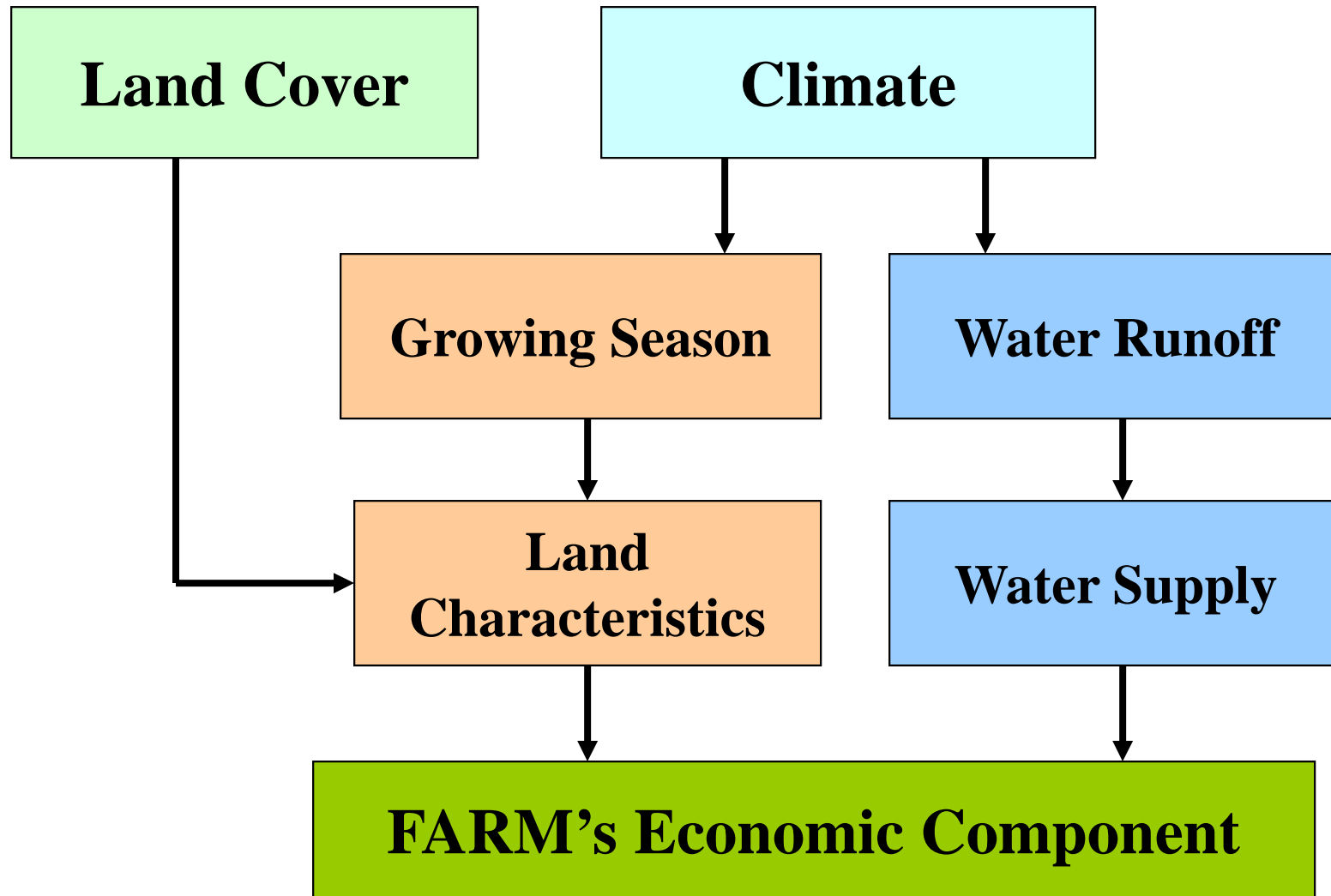
Outline

- Future Agricultural Resources Model
- Database Developments
- Simulating Land-Use Change

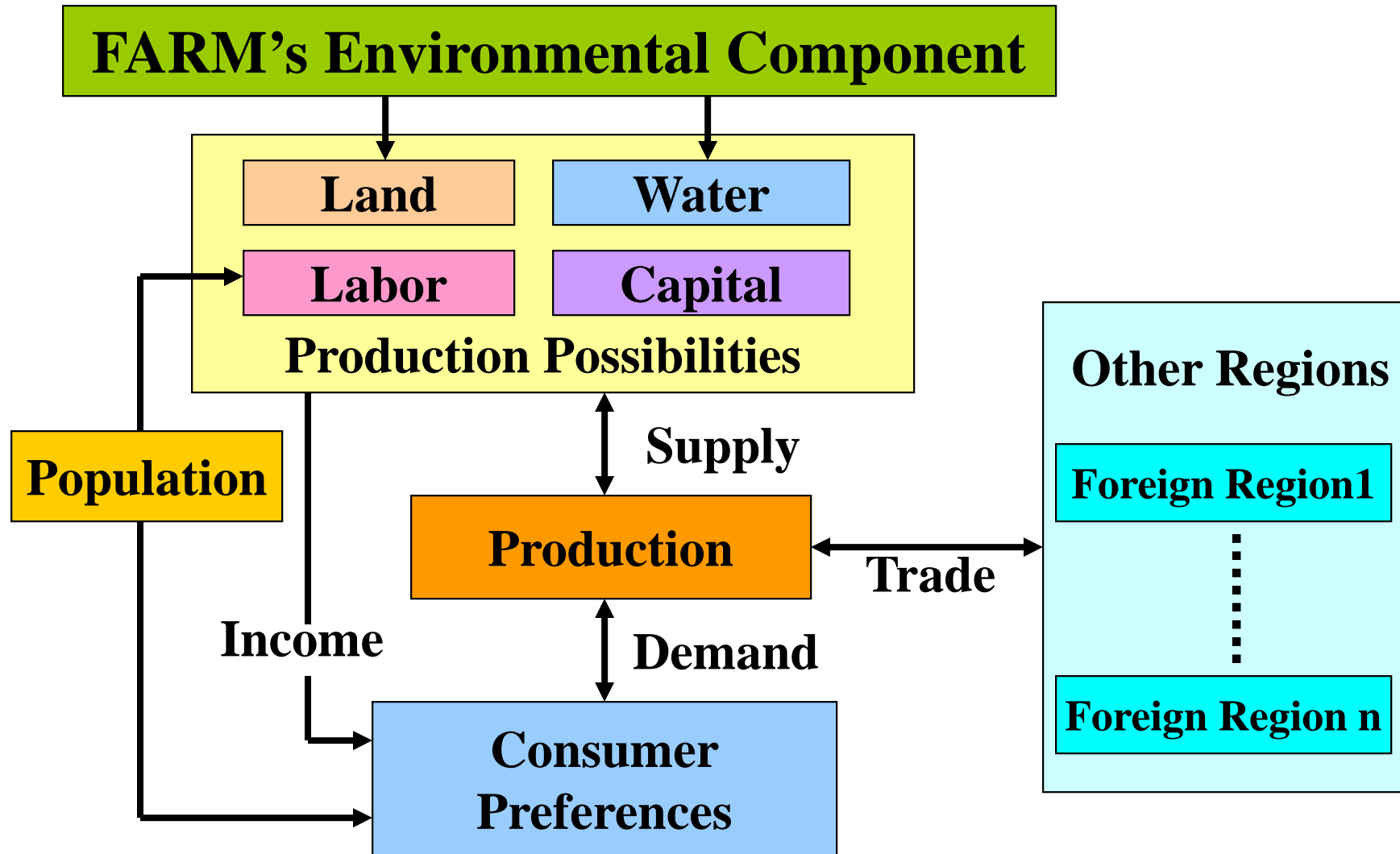
Future Agricultural Resources Model

- FARM is an integrated modeling framework specifically designed for analyzing global changes
- ERS has used FARM primarily to analyze the impacts of greenhouse gas emissions on agriculture
- Some of these analyses estimated impacts on forestry as well
- It has also been used to estimate costs of sea level rise
- Other topics include: the effects of trade deregulation and population growth on tropical forests, the costs of protecting global ecosystem diversity, and the impacts of technological advance in agriculture on land use

FARM's Environmental Component



FARM's Economic Component



Database Components

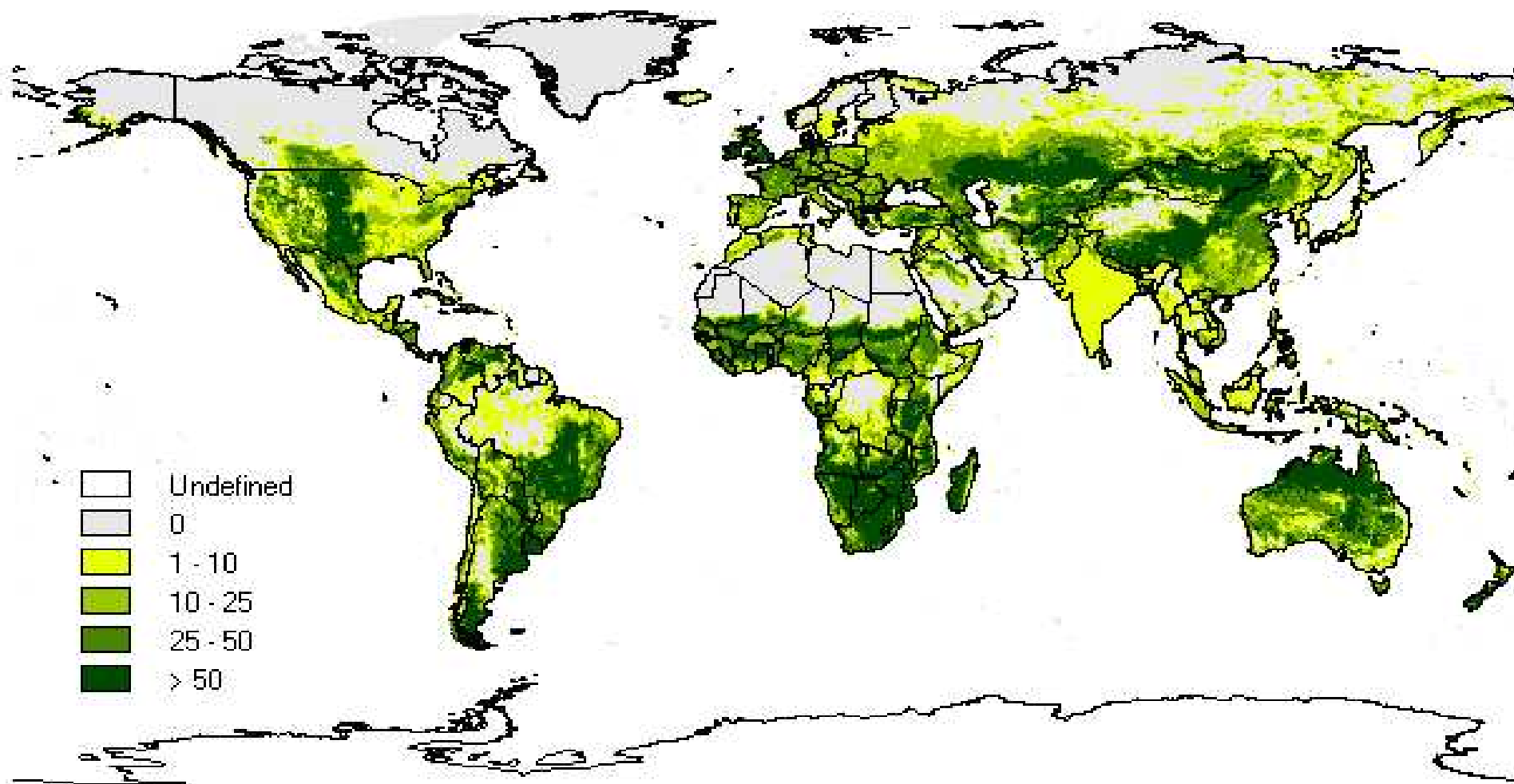
- Land cover
- Agro-ecological zones
- Production
- Production distribution
- GTAP allocation

Land Cover Component

- The land-cover component organizes data on land cover characteristics
- The main data source is a 1-km resolution global land cover characteristics database
- These data are organized by 0.5° grid and second order political unit
- The original category codes were normalized, disaggregated, and reaggregated into 10 general land-cover categories

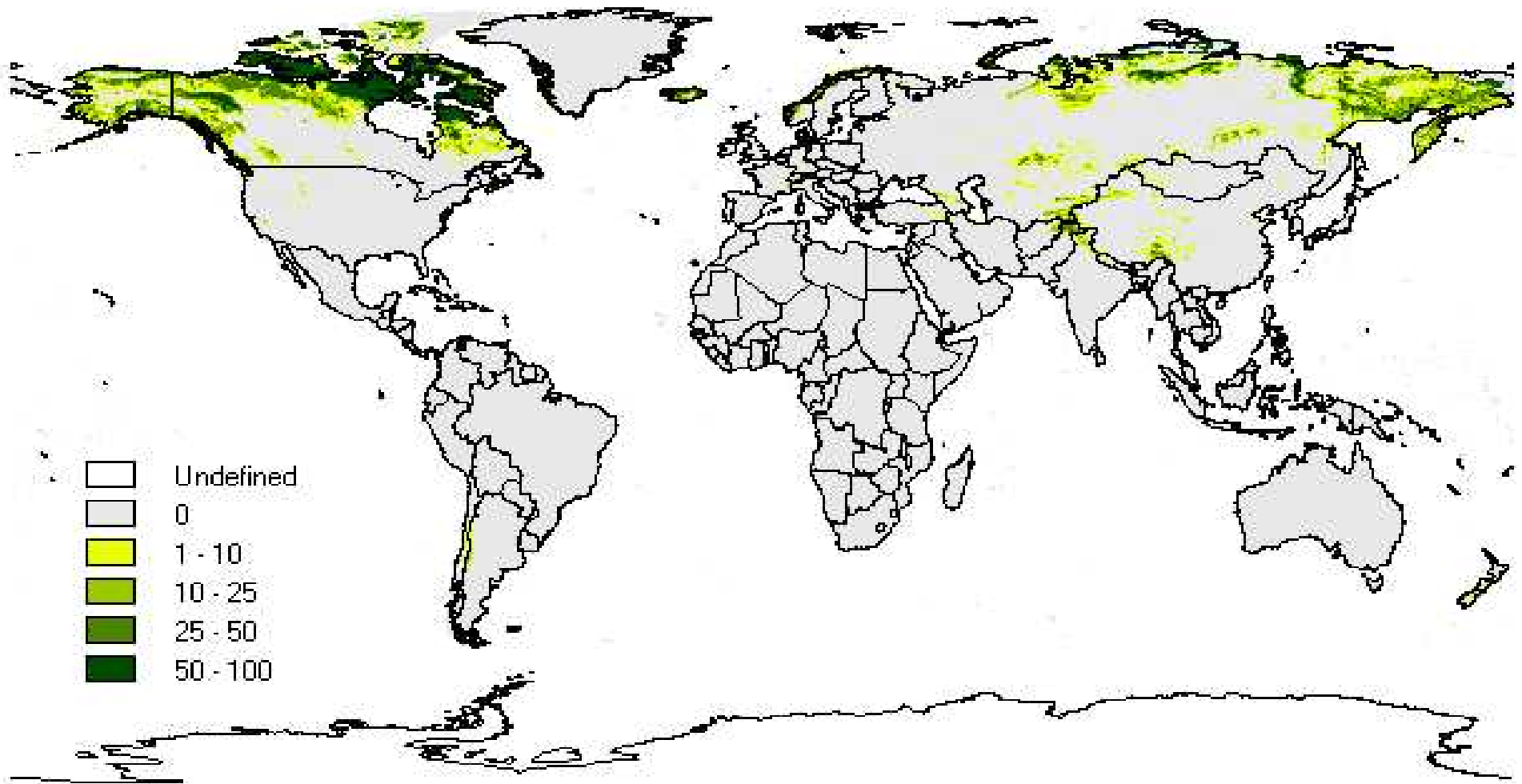
Percent Grassland

Derived from: U.S. Geological Survey. EROS Data Center. *Global Land Cover Characteristics Data Base Version 2.0.* , 2001.



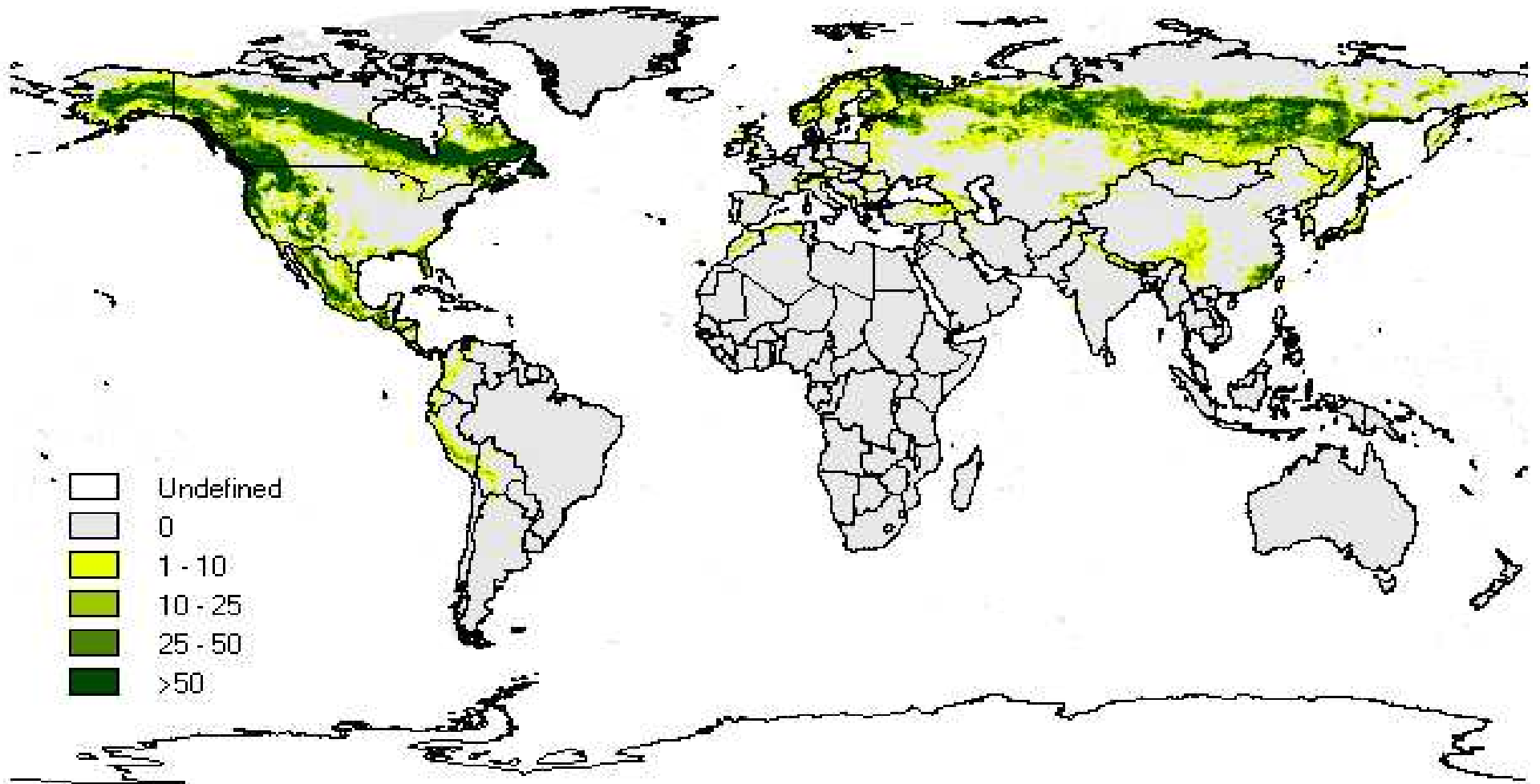
Percent Tundra

Derived from: U.S. Geological Survey. EROS Data Center. *Global Land Cover Characteristics Data Base Version 2.0.* , 2001.



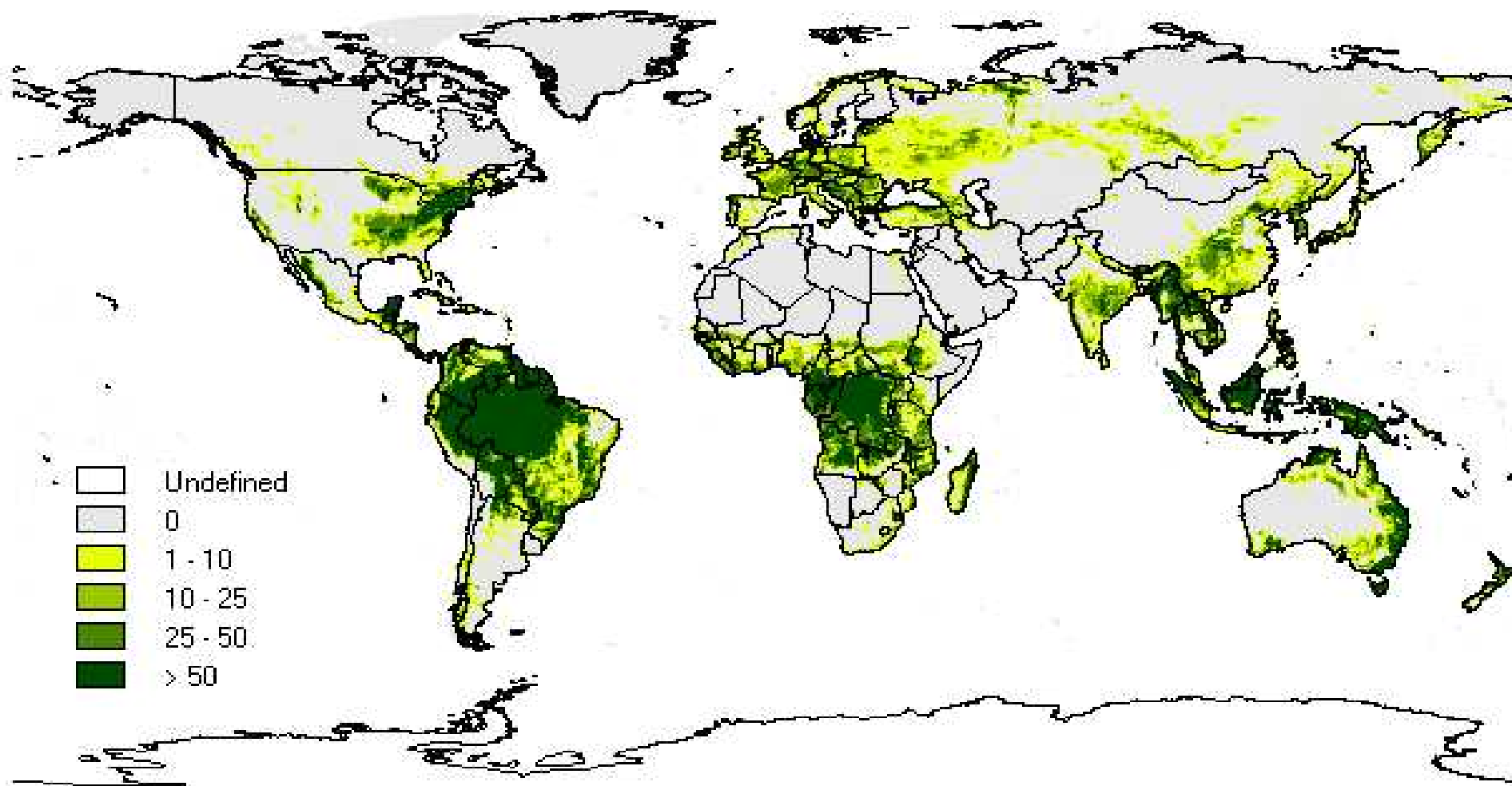
Percent Coniferous Forestland

Derived from: U.S. Geological Survey. EROS Data Center. *Global Land Cover Characteristics Data Base Version 2.0.* , 2001.



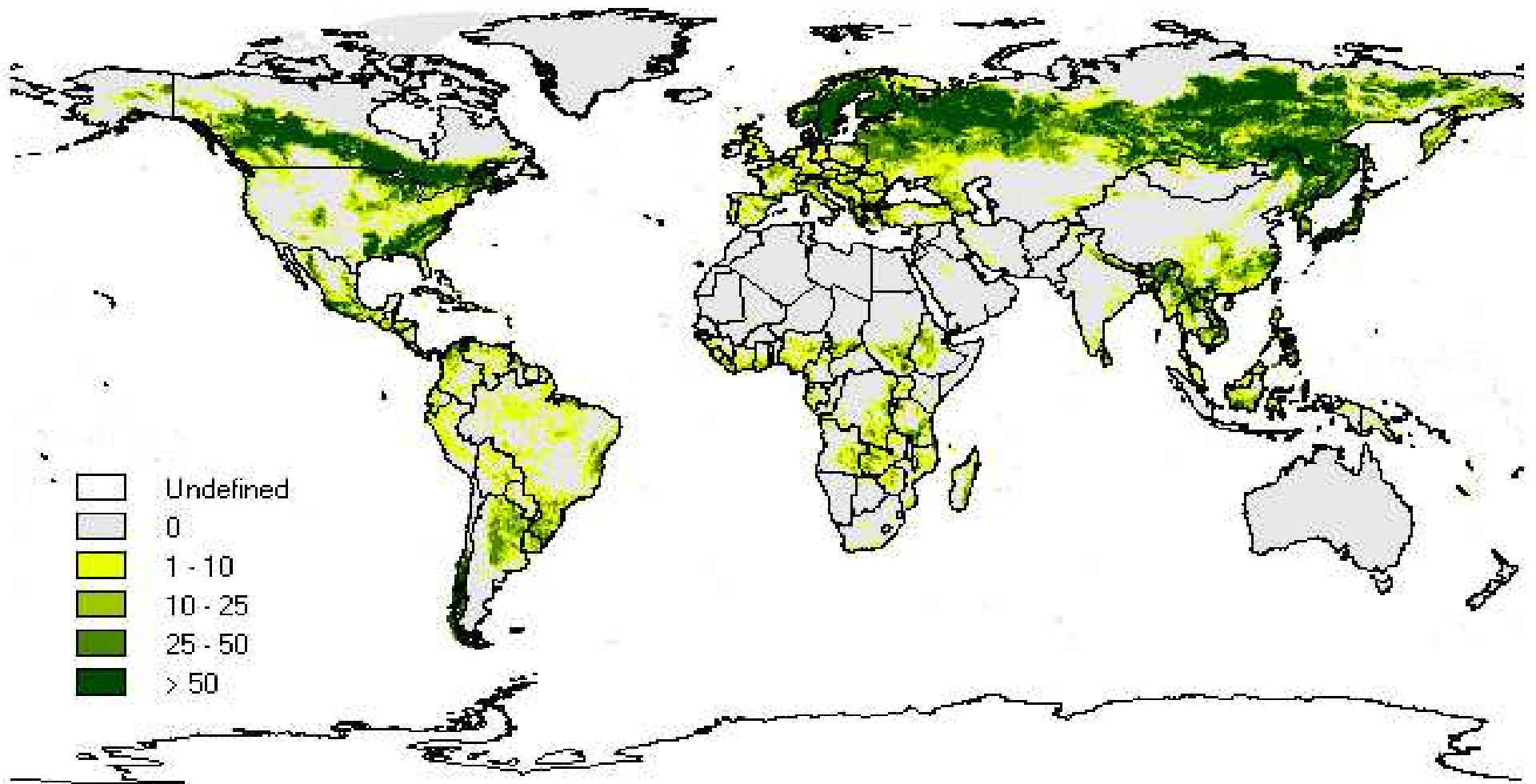
Percent Nonconiferous Forestland

Derived from: U.S. Geological Survey. EROS Data Center. *Global Land Cover Characteristics Data Base Version 2.0.* , 2001.



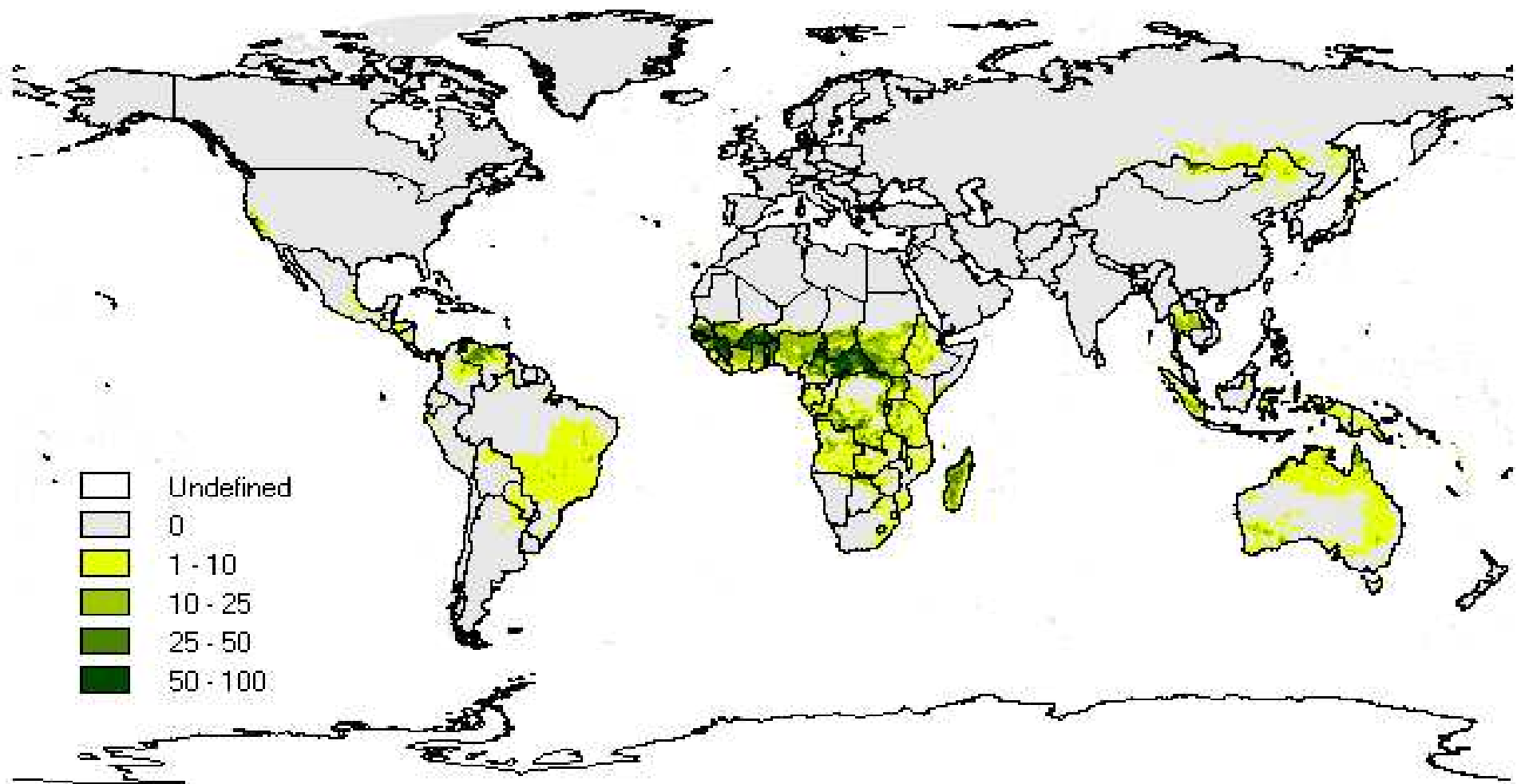
Percent Mixed Forestland

Derived from: U.S. Geological Survey. EROS Data Center. *Global Land Cover Characteristics Data Base Version 2.0.* , 2001.



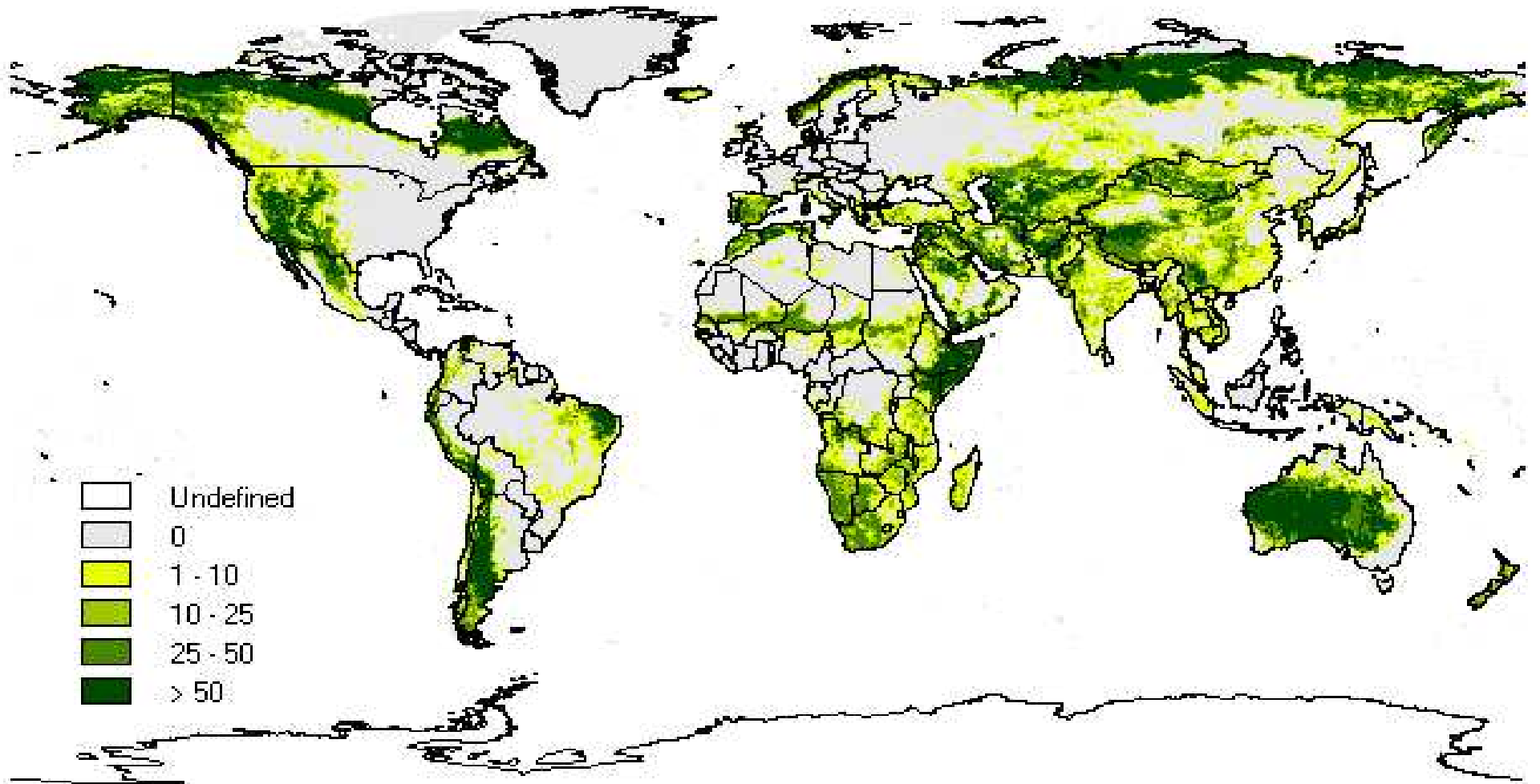
Percent Open Woodland and Scattered Trees

Derived from: U.S. Geological Survey. EROS Data Center. *Global Land Cover Characteristics Data Base Version 2.0.* , 2001.



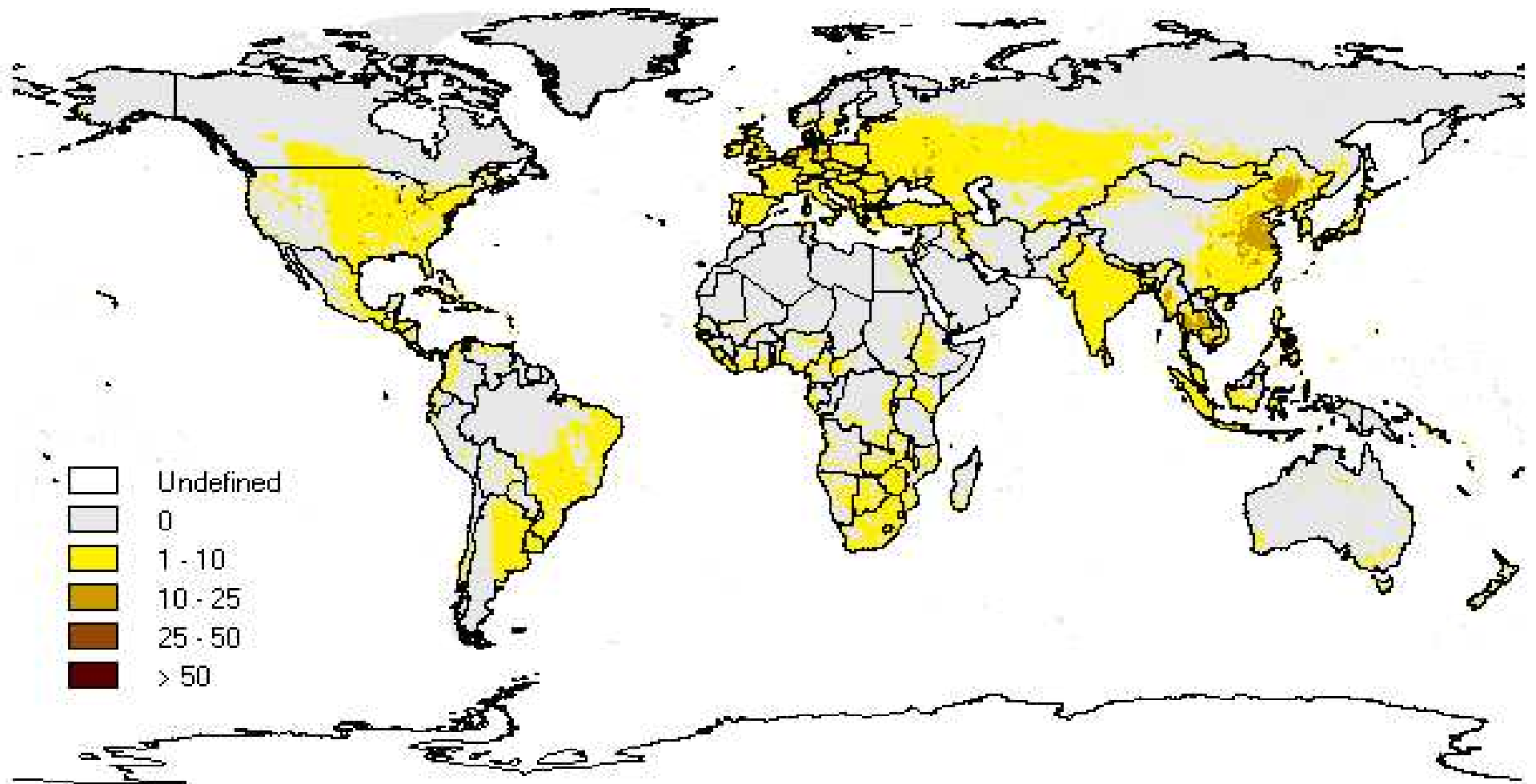
Percent Shrubland

Derived from: U.S. Geological Survey. EROS Data Center. *Global Land Cover Characteristics Data Base Version 2.0.* , 2001.



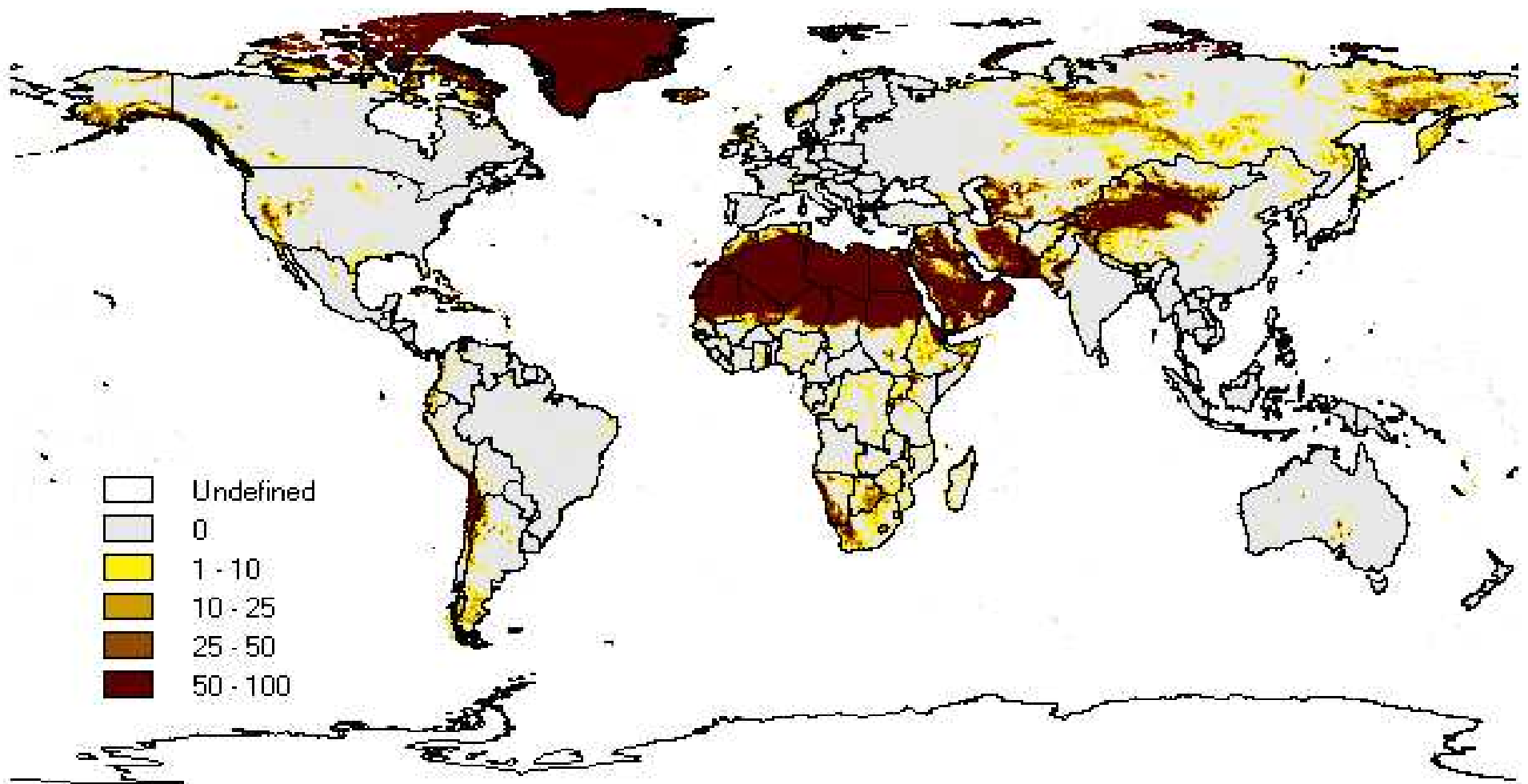
Percent Built-Up Land

Derived from: U.S. Geological Survey. EROS Data Center. *Global Land Cover Characteristics Data Base Version 2.0.* , 2001.



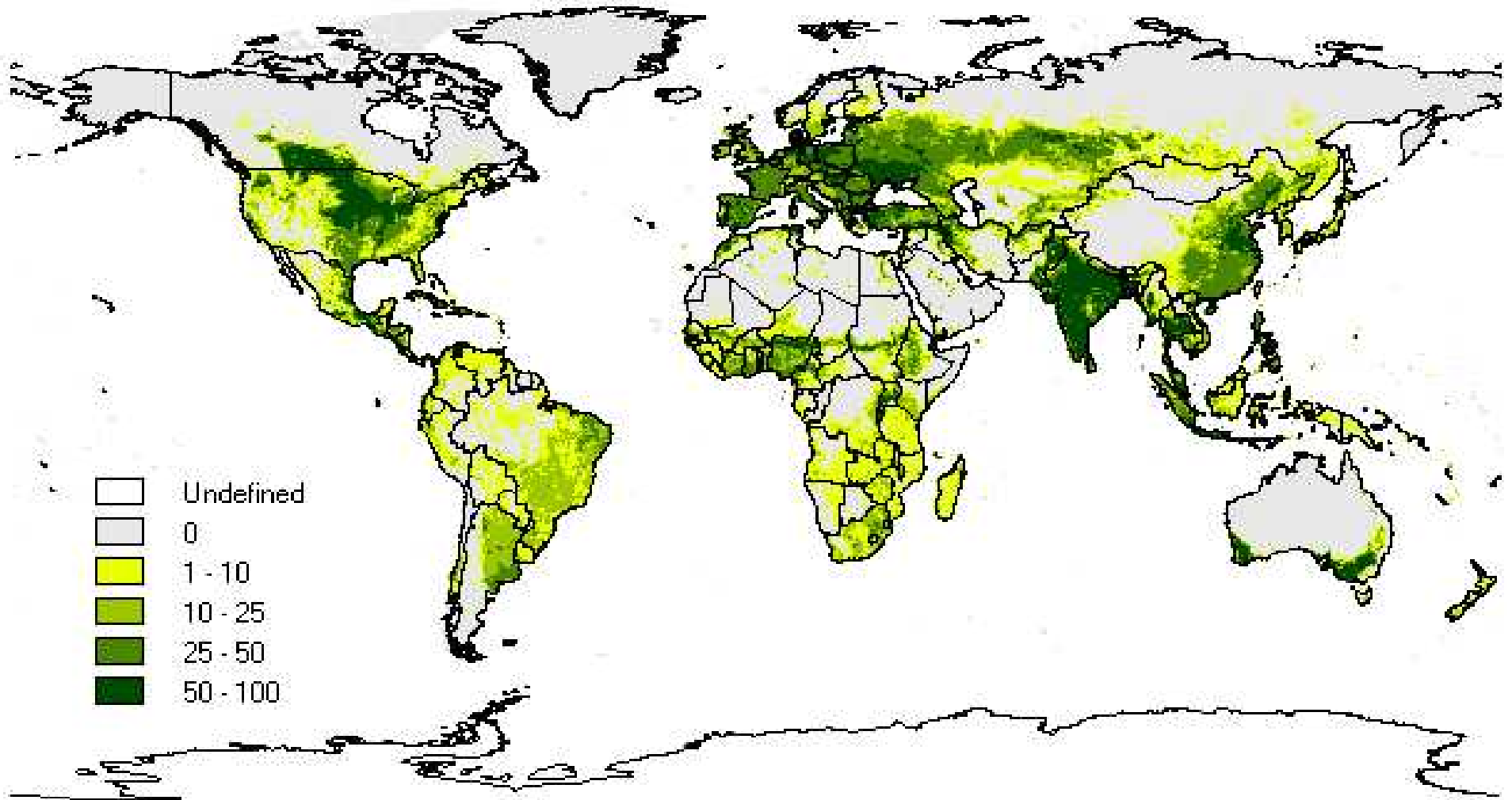
Percent Other Land

Derived from: U.S. Geological Survey. EROS Data Center. *Global Land Cover Characteristics Data Base Version 2.0.* , 2001.



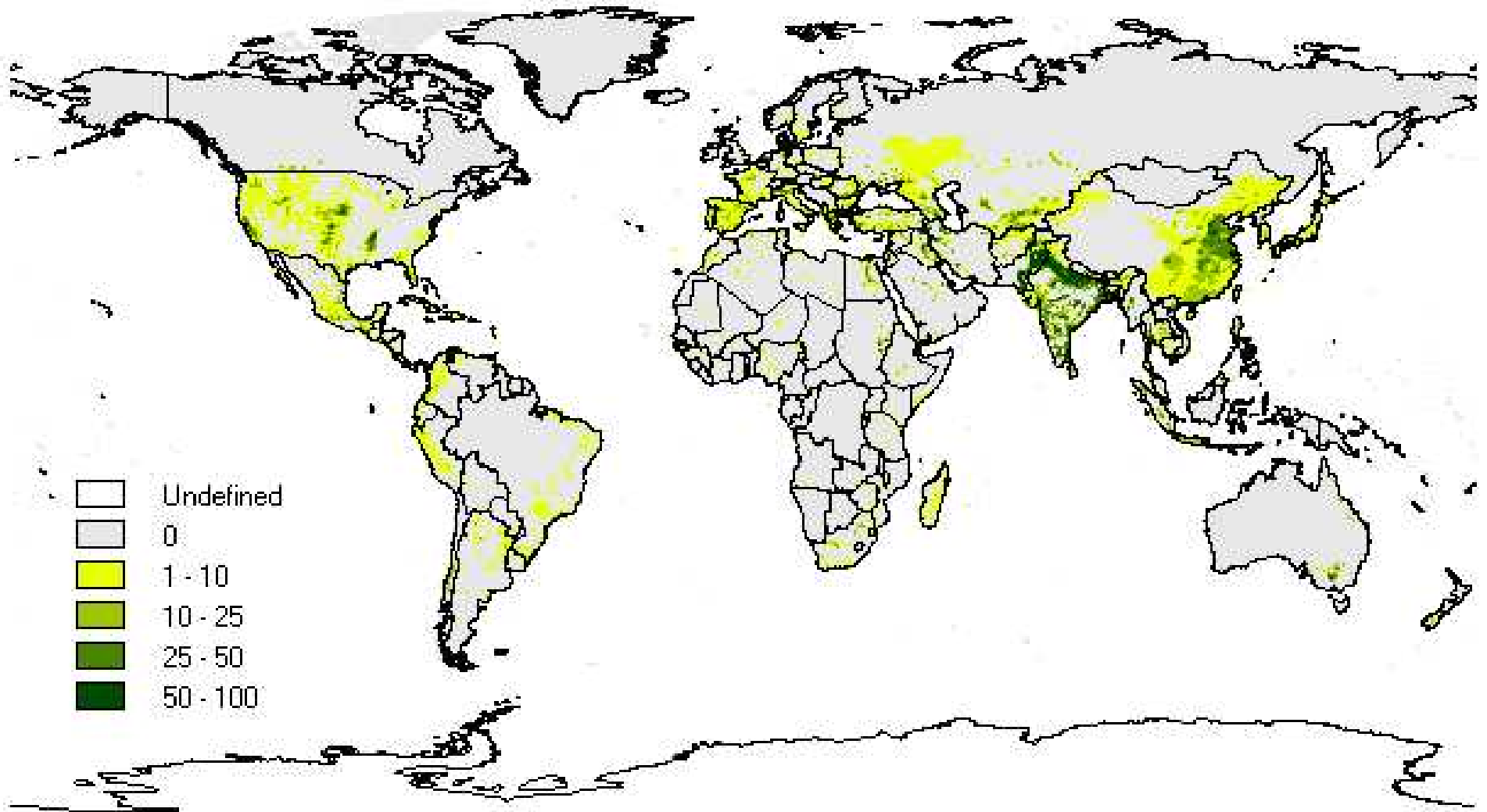
Percent Cropland in 1997

Derived from: U.S. Geological Survey. EROS Data Center. *Global Land Cover Characteristics Data Base Version 2.0.* , 2001; Food and Agriculture Organization of the United Nations. *FAOSTAT Agriculture Data.* 2001; Döll, P. and S. Siebert. *A digital global map of irrigated areas.* 2000; Siebert, S. and P. Döll. *A digital global map of irrigated areas—An update for Latin America and Europe.* 2001.



Percent Irrigated Land in 1997

Derived from: Döll, P. and S. Siebert. *A digital global map of irrigated areas*. 2000; Siebert, S. and P. Döll. *A digital global map of irrigated areas—An update for Latin America and Europe*. 2001; U.S. Geological Survey. EROS Data Center. *Global Land Cover Characteristics Data Base Version 2.0*. 2001; Food and Agriculture Organization of the United Nations. *FAOSTAT Agriculture Data*. 2001.

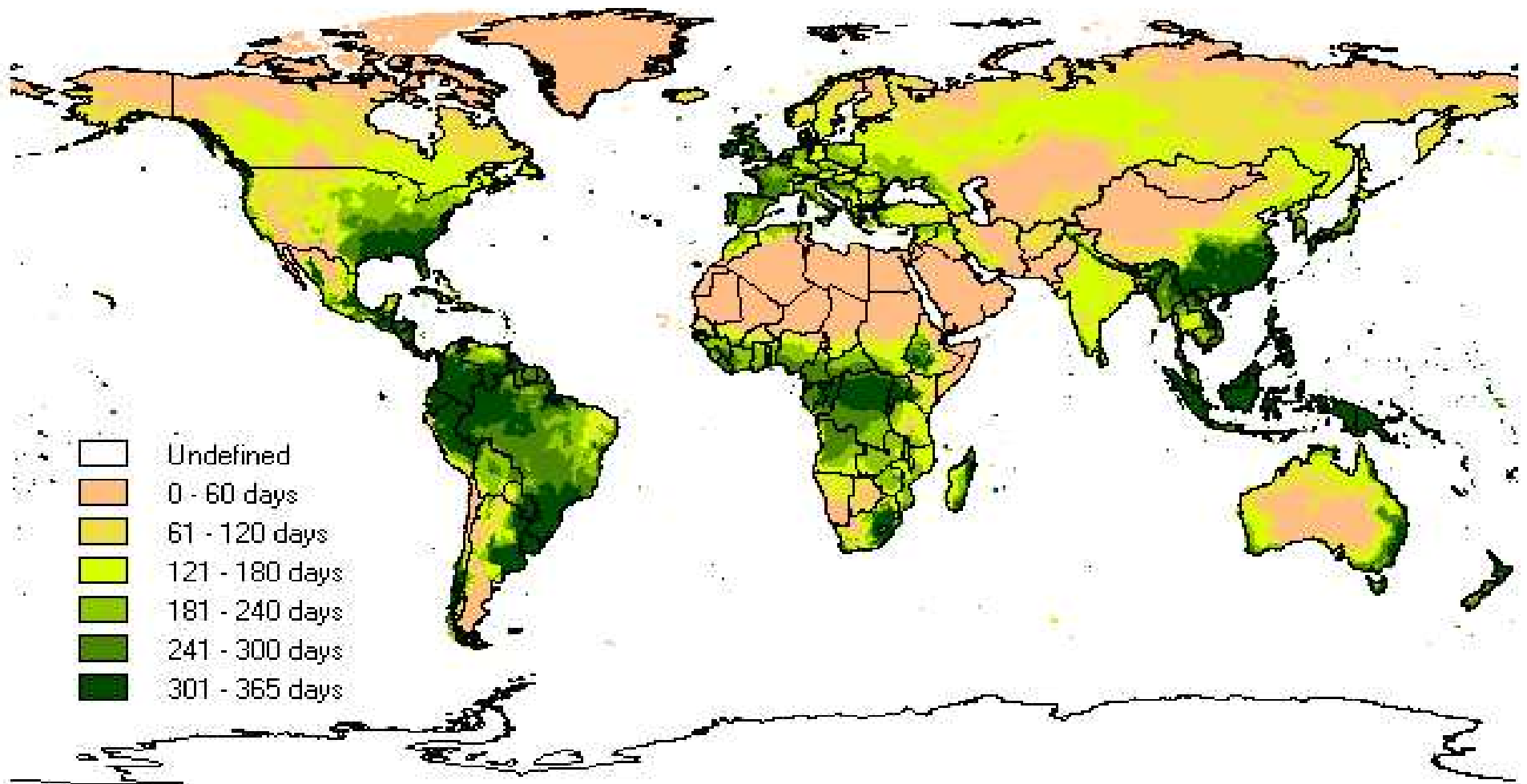


Agro-Ecological Zone Component

- Agro-ecological zones (AEZs) replace land classes in the current version of FARM
- The AEZ component constructs AEZs based on length of growing season and thermal regime
- Growing season and thermal regime are calculated from meteorological data with a soil temperature and moisture algorithm
- The meteorological data are monthly temperature and precipitation at 0.5-degree grid, 1901-1998

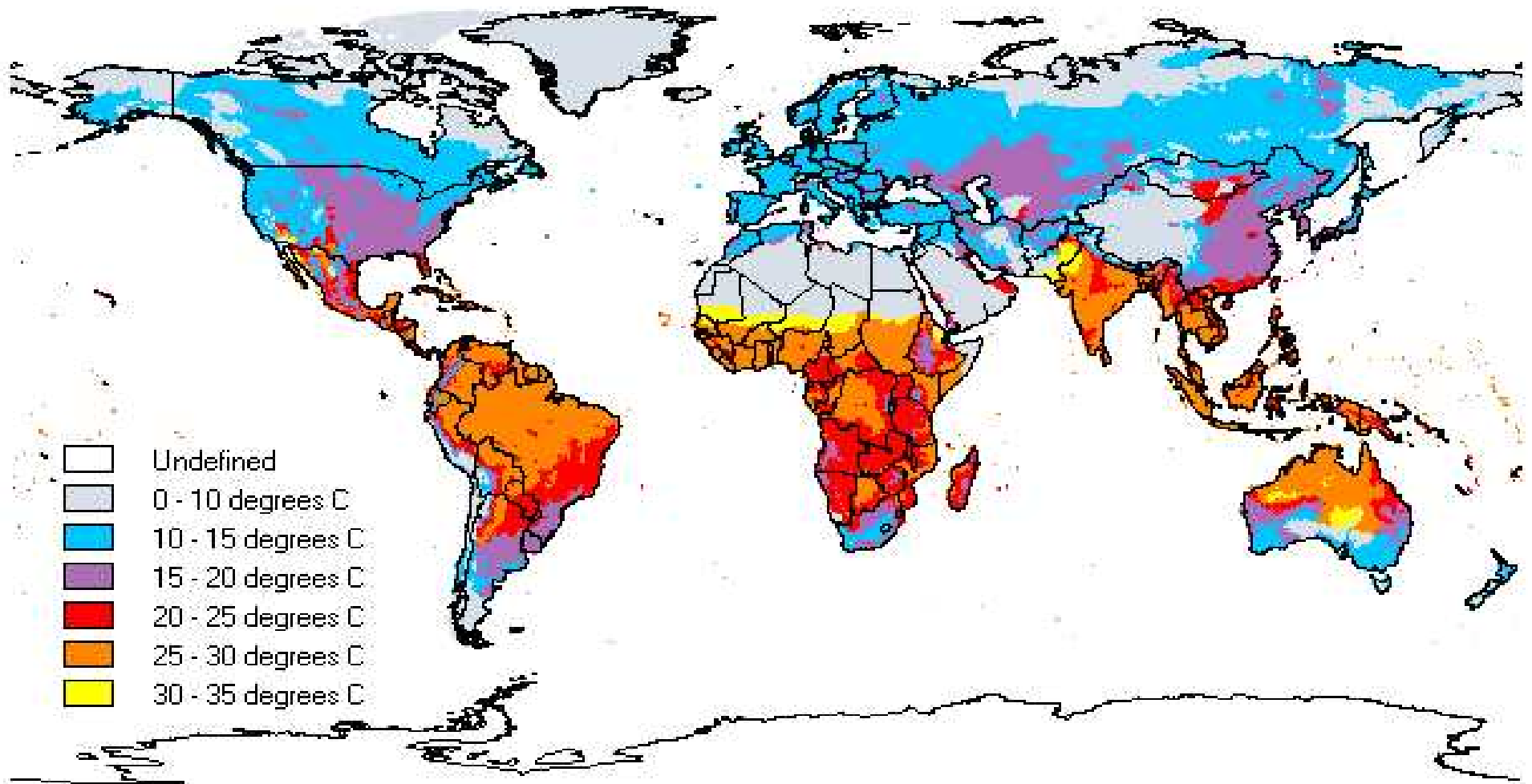
Rainfed Agro-Ecological Zones in 1997

Derived from: University of East Anglia. Climate Research Unit. *CRU05 0.5 Degree 1901-1995 Monthly Climate Time-Series*. East Anglia, Great Britain.



Rainfed Thermal Regimes in 1997

Derived from: University of East Anglia. Climate Research Unit. *CRU05 0.5 Degree 1901-1995 Monthly Climate Time-Series*. East Anglia, Great Britain.



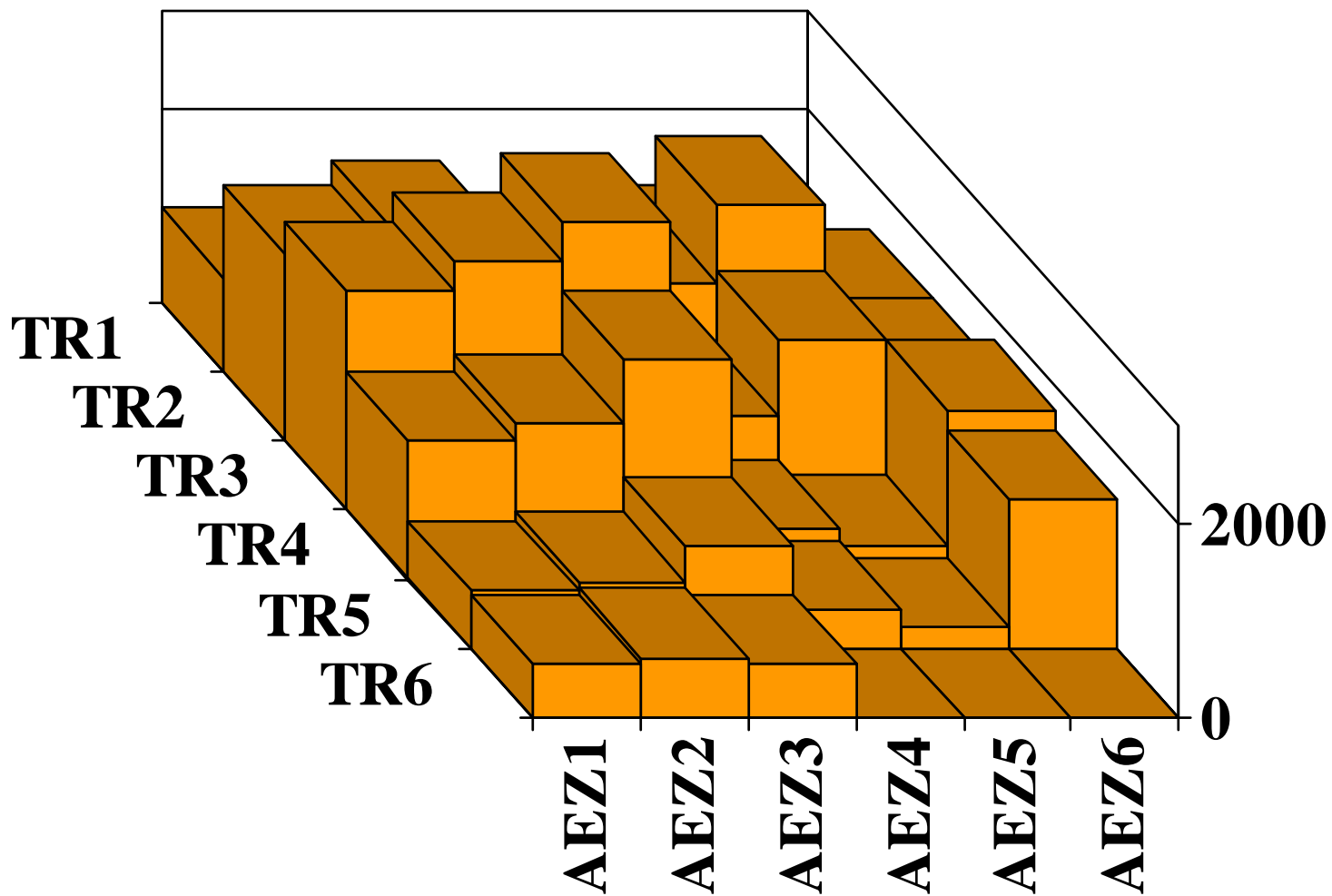
Production Component

- The production component organizes price and quantity data for agricultural and forestry commodities
- It tracks production of 173 crops by country
- It tracks 37 primary livestock commodities
- It tracks 6 categories of timber products
- It also tracks 18 categories of live animals

Production Distribution Component

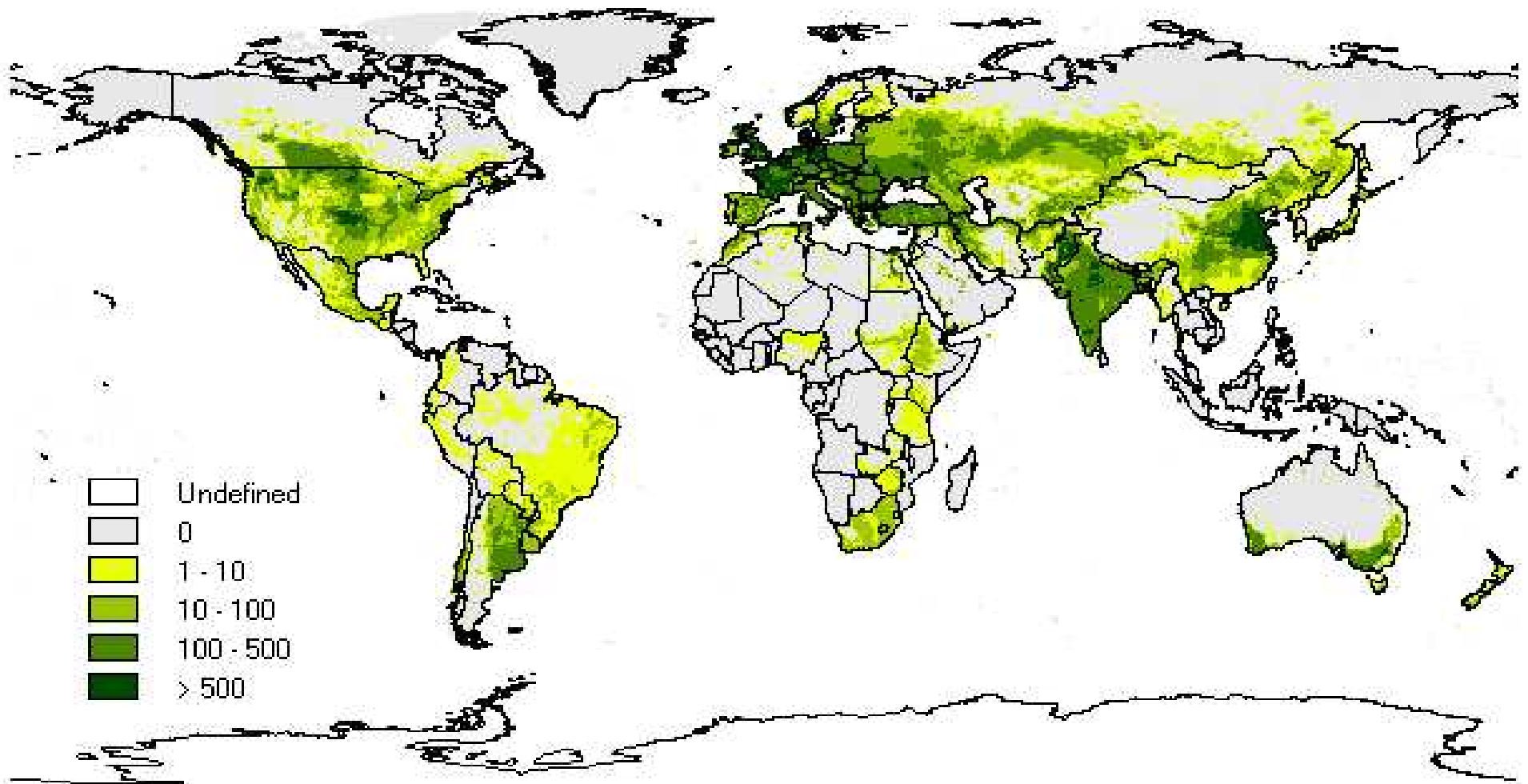
- The production distribution component links production to land covers by AEZ
- Commodities are distributed to appropriate land covers
- Average production for each AEZ in the appropriate land cover is estimated with regression analysis
- Commodities are distributed by AEZ and calibrated to official levels

Estimated Average Wheat Production by AEZxTR (mt/1000ha)



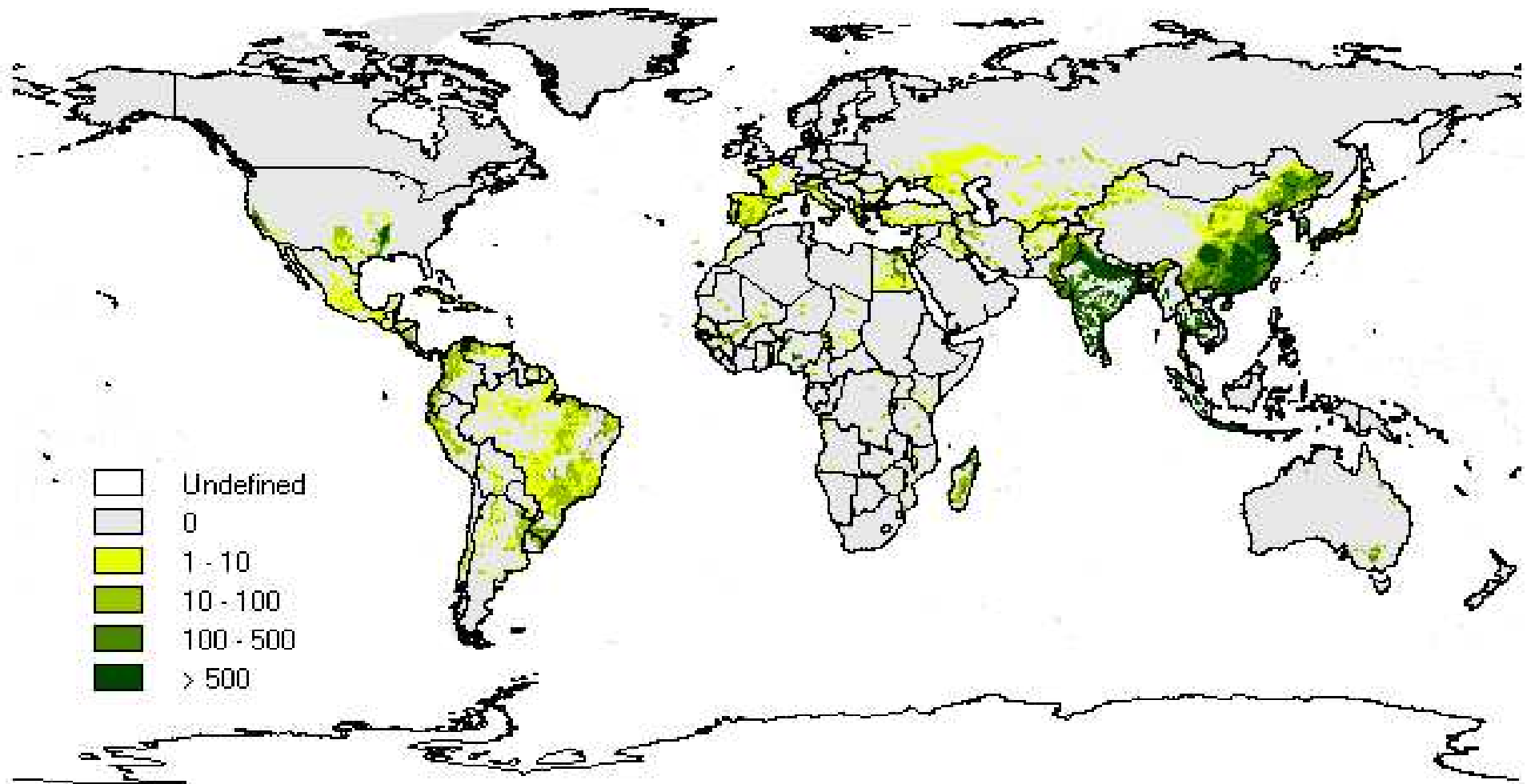
Wheat Production in 1997 (mt/1000ha land)

Interpolated from country or state level data



Paddy Rice Production in 1997 (mt/1000ha land)

Interpolated from country or state level data

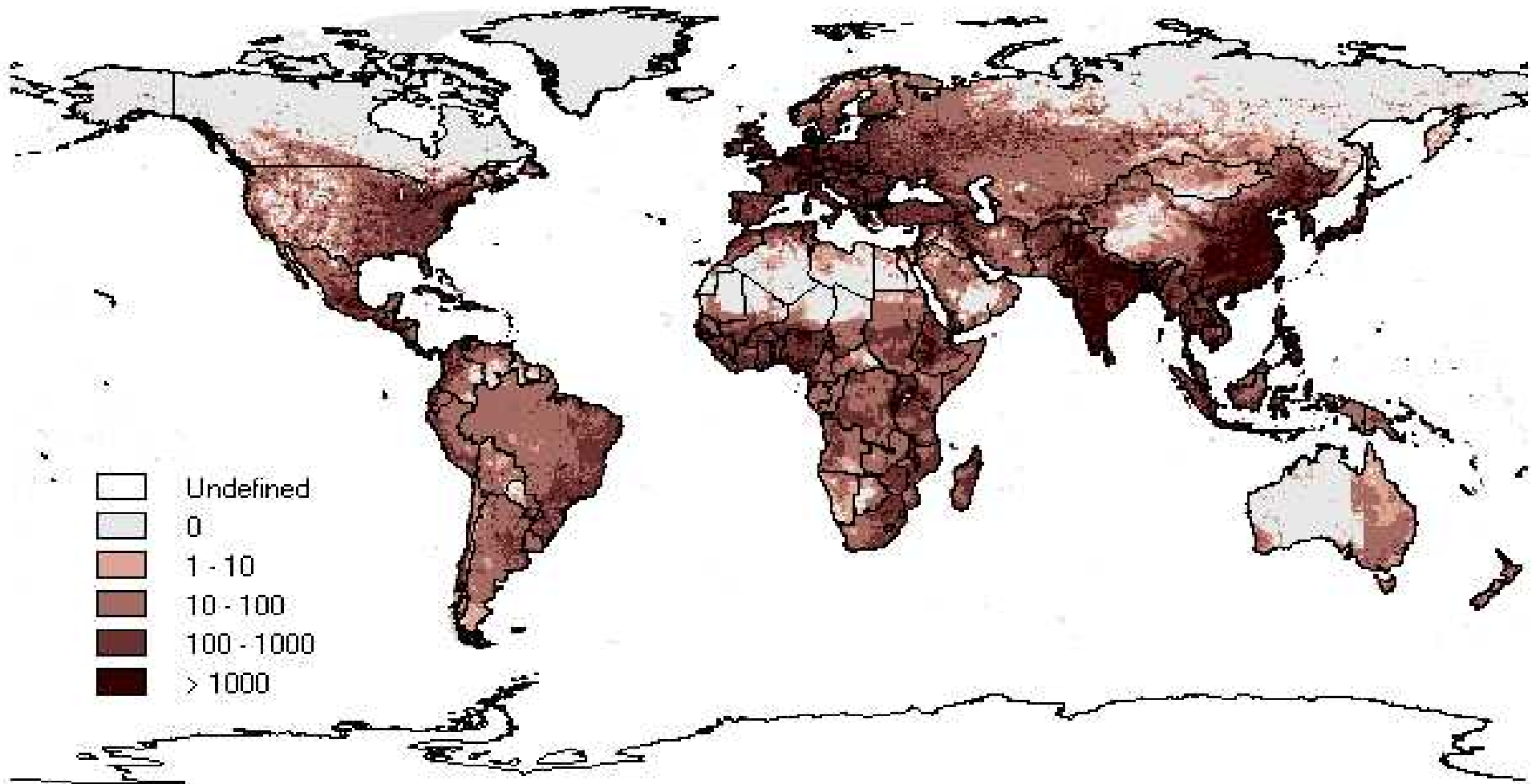


Distributing Livestock and Forest Products

- Many grasslands or forestlands do not provide livestock or forest products because people do not live there
- A particular livestock animal, livestock commodity, or forest product may be associated with more than one land cover
- Consistency between live animals and livestock commodities must be maintained

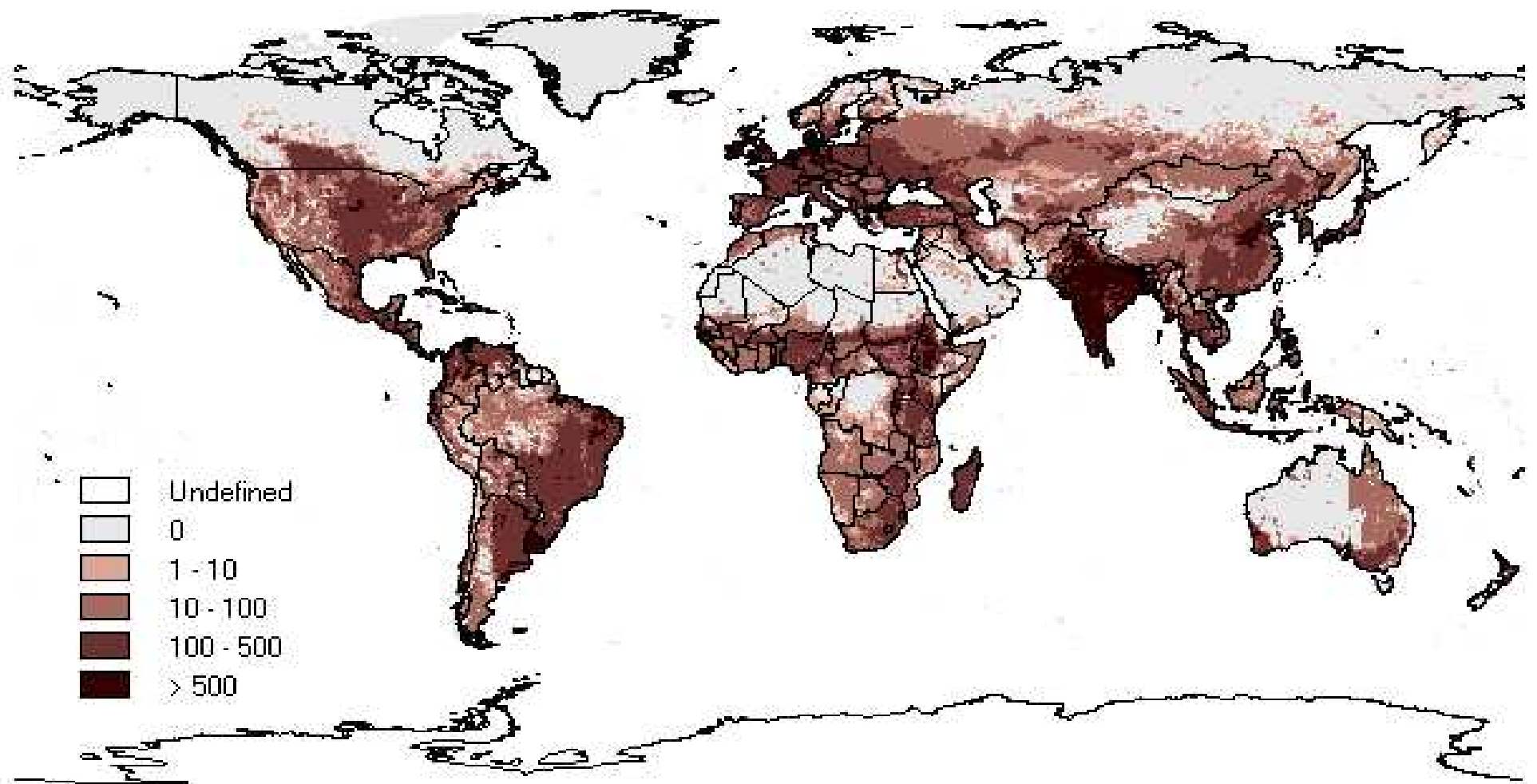
Population Density in 1998 (no/1000ha land)

Derived from Oak Ridge National Laboratory. *LandScan Global Population 1998 Database*, Oak Ridge, Tennessee.



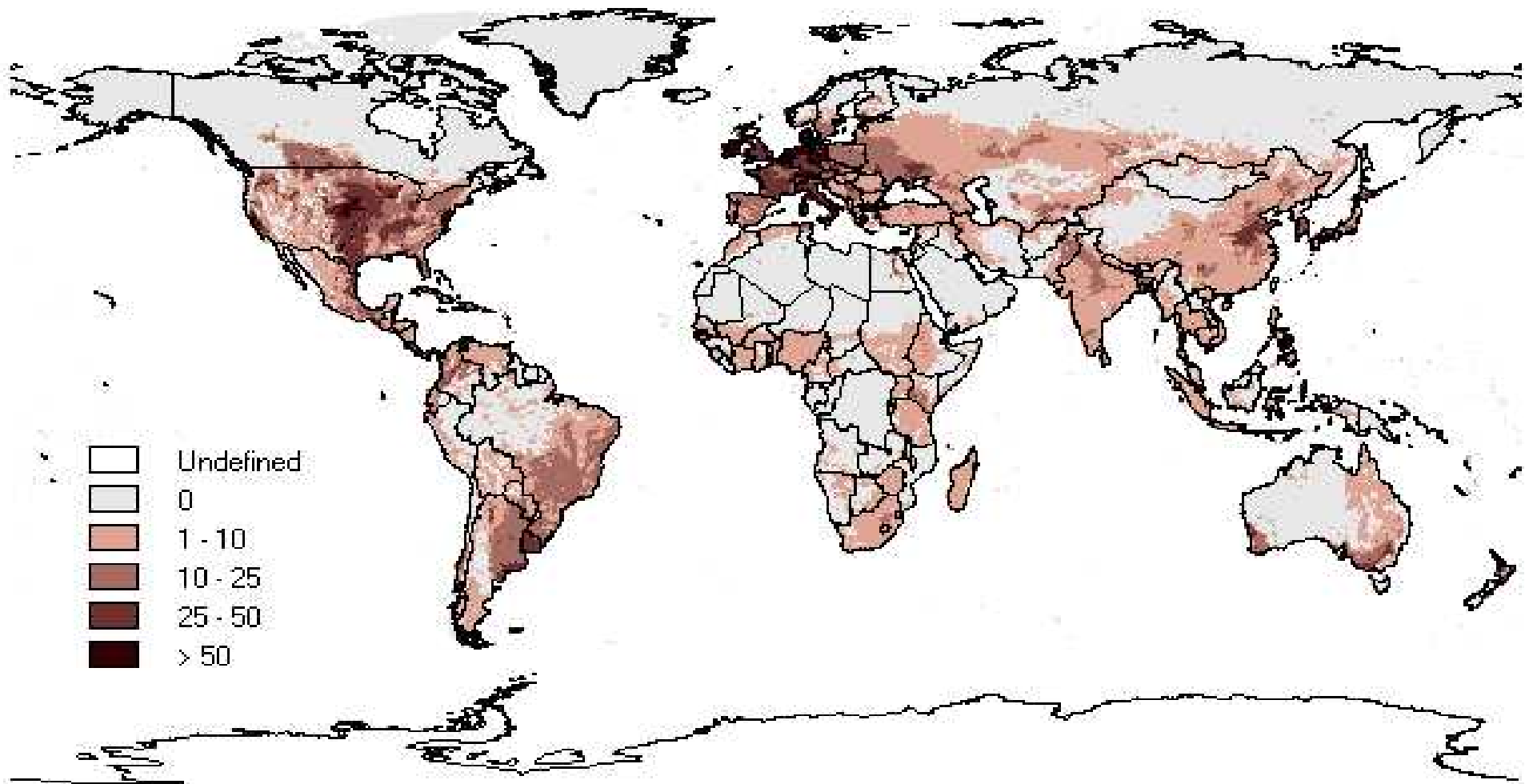
Cattle Inventory in 1997 (head/1000 ha land)

Interpolated from country and state level data



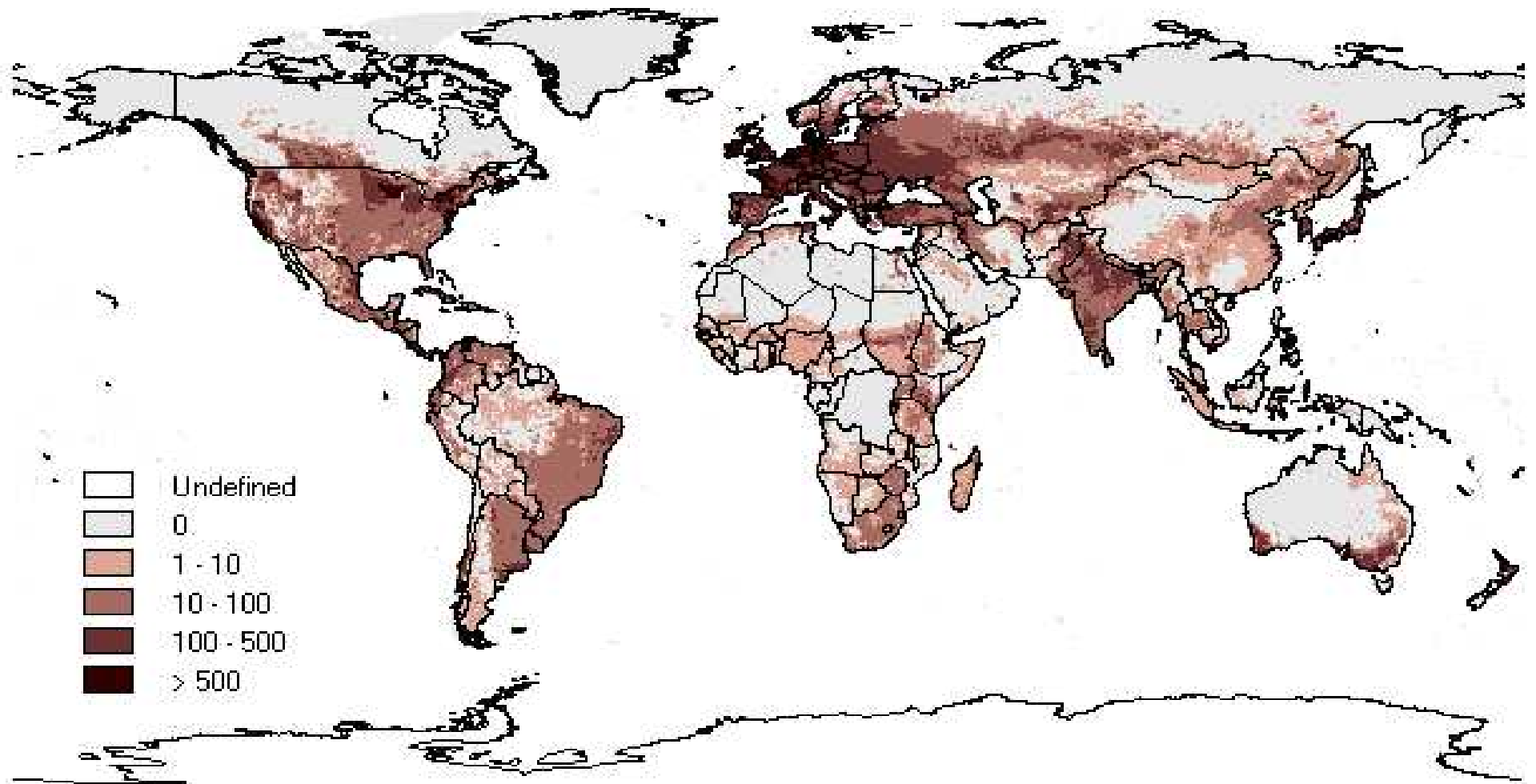
Beef, Veal, and Cattle Hide Production in 1997 (mt/1000ha land)

Interpolated from country and state level data



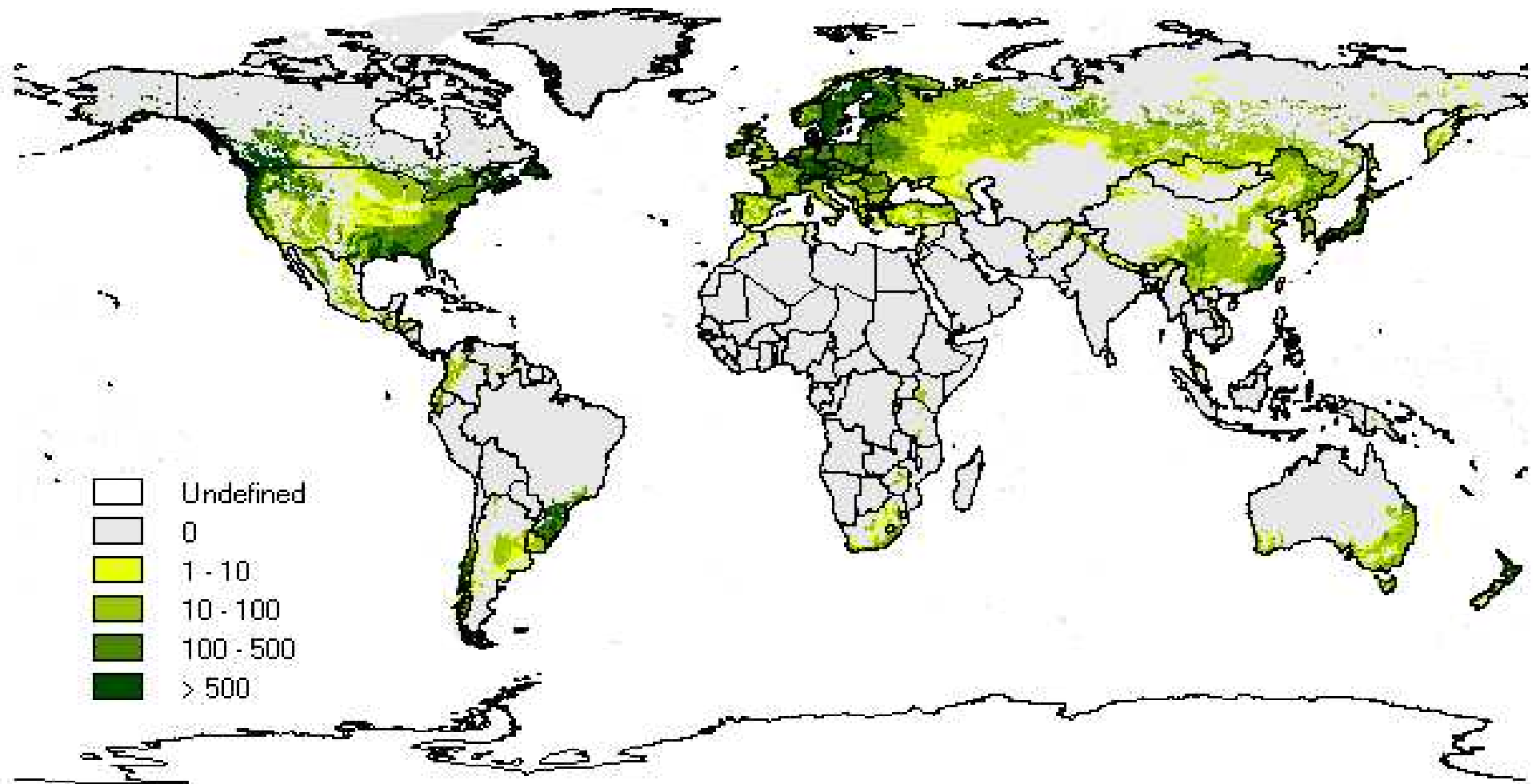
Cow Milk Production in 1997 (mt/1000ha land)

Interpolated from country and state level data



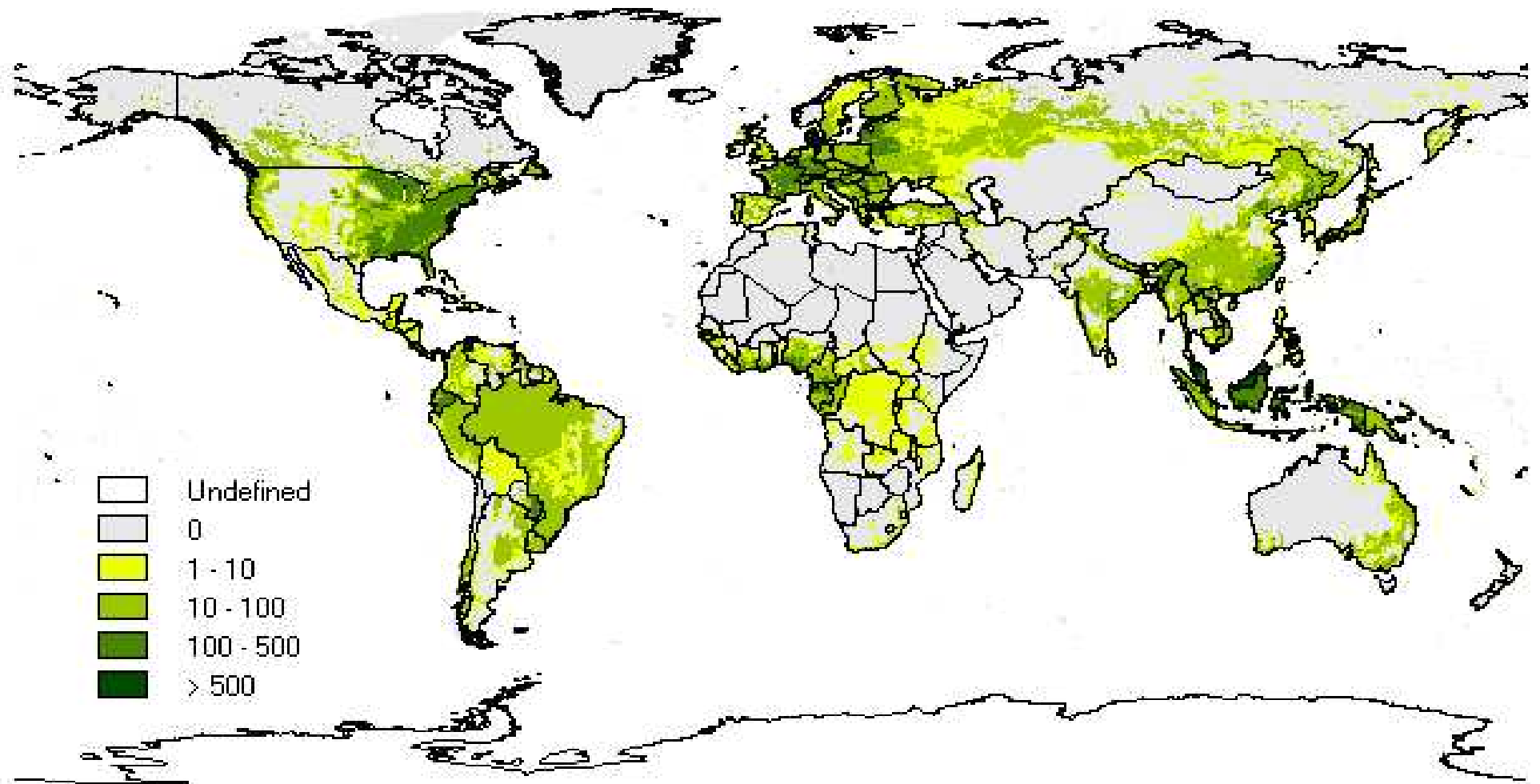
Conifer Sawlog Production in 1997 (m³/1000ha land)

Interpolated from country and U.S. regional level data



Nonconifer Sawlog Production in 1997 (m³/1000ha land)

Interpolated from country and U.S. regional level data



GTAP Allocation Component

- The GTAP allocation component calculates value shares for distributing GTAP V5 commodity values to AEZs
- Once commodities are allocated to the AEZs, dollar values of production are calculated by AEZ, by GTAP V5 commodity, and by GTAP V5 region
- Then these values are used to estimate value shares with which to distribute GTAP V5's commodity values to AEZs within GTAP V5 regions

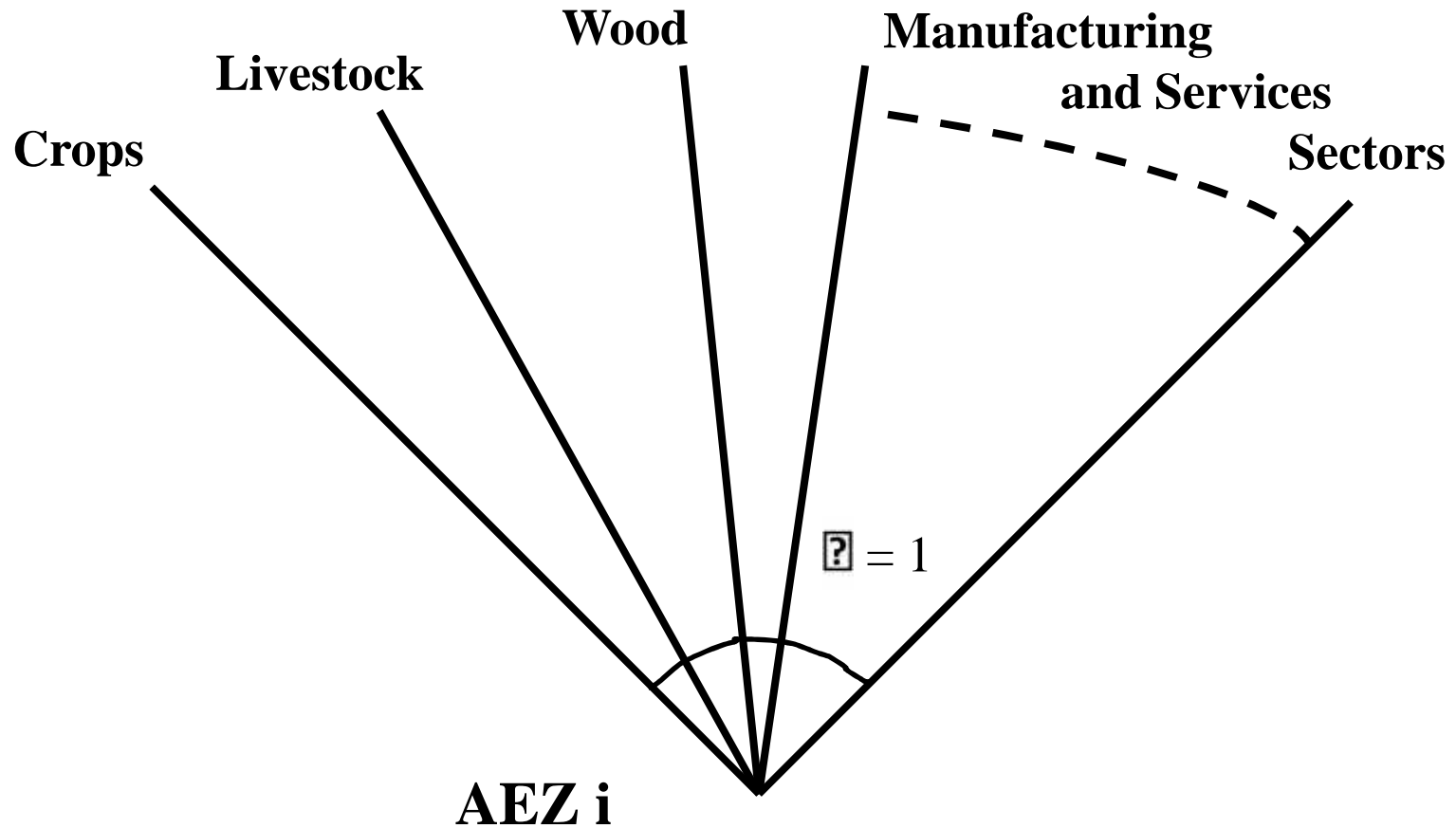
Status of New Database

- Crop and livestock commodities are being allocated to AEZs within countries and U.S. states
- Forest products are being allocated to AEZs within countries and U.S. timber regions
- We hope to obtain and include production data for states or provinces in other countries in the future
- Data will be made available through GTAP

Simulating Land-Use Change

- Simulating land-use change in FARM depends on two unique features
- First, within each region land is treated as a heterogeneous input
- Second, all economic sectors in FARM use land as a factor of production

Land Services Supply



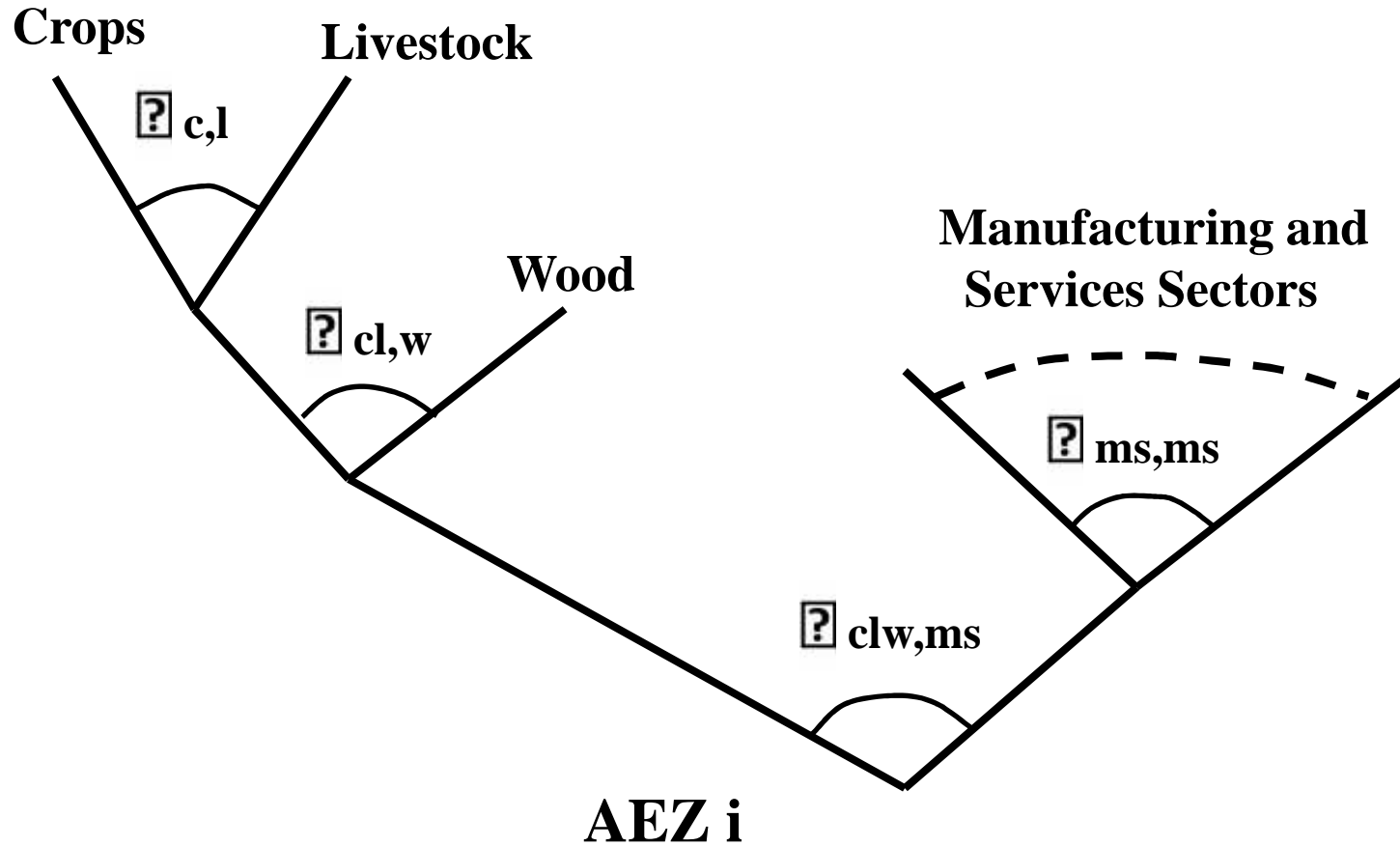
Limitations of Land Services Supply

- Empirical estimates of σ are not readily available
- The difficulty of converting from one land use to another is similar for all changes
- Mapping changes in land services to changes in land area is difficult

Revising Land Services Supply

- Impose a nested CET structure on land services supply
- Add a separate economic sector that differentiates costs among various land conversion activities
- Calibrate the elasticities of transformation

Nested Land Services Supply



Summary and Conclusions

- FARM can simultaneously analyze global changes in agriculture and forestry
- ERS is currently updating FARM to be compatible with the 5th GTAP model
- Major updates include a new land resources database and a revised method for simulating changes in land use