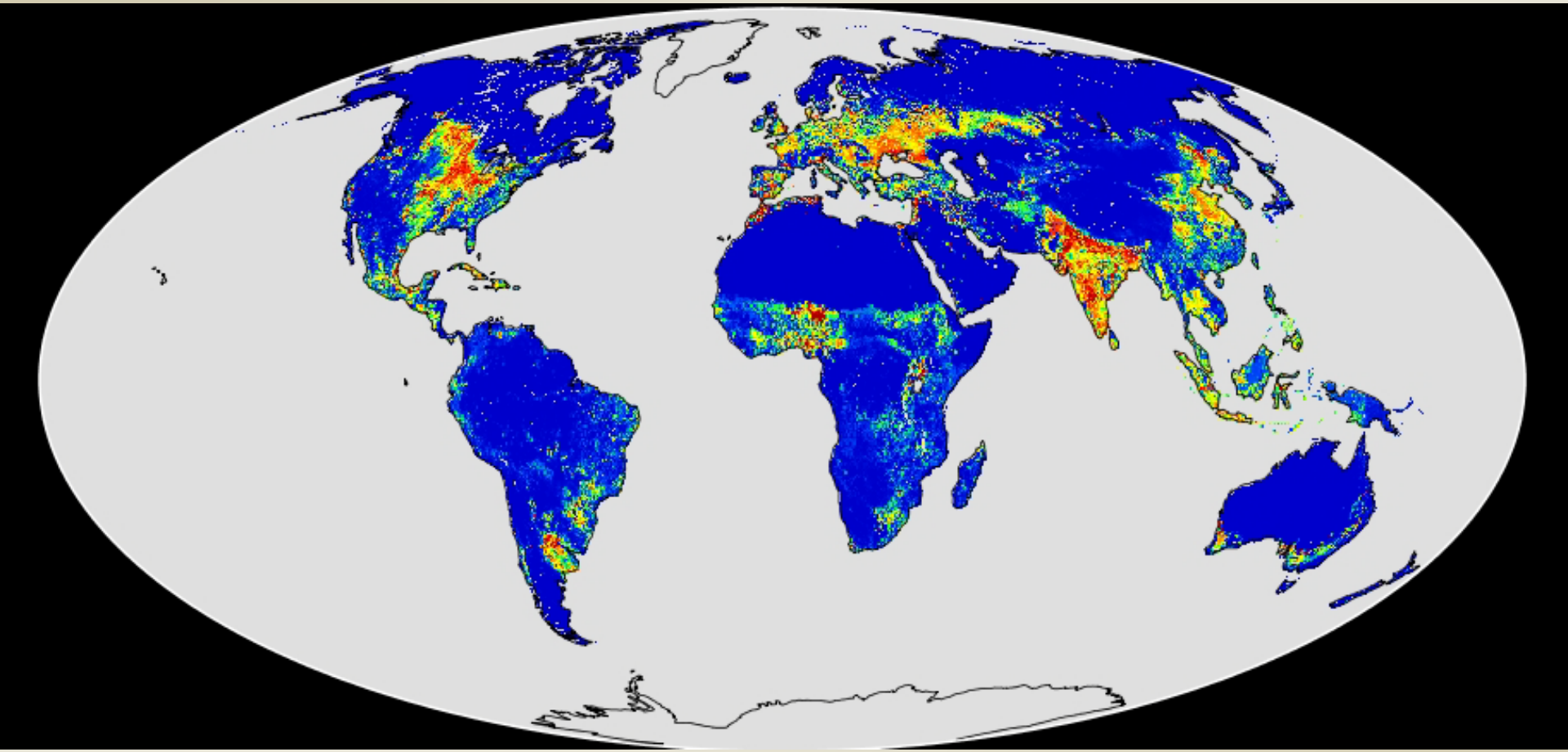
Global Agricultural Land Cover and Use: Data and Applications



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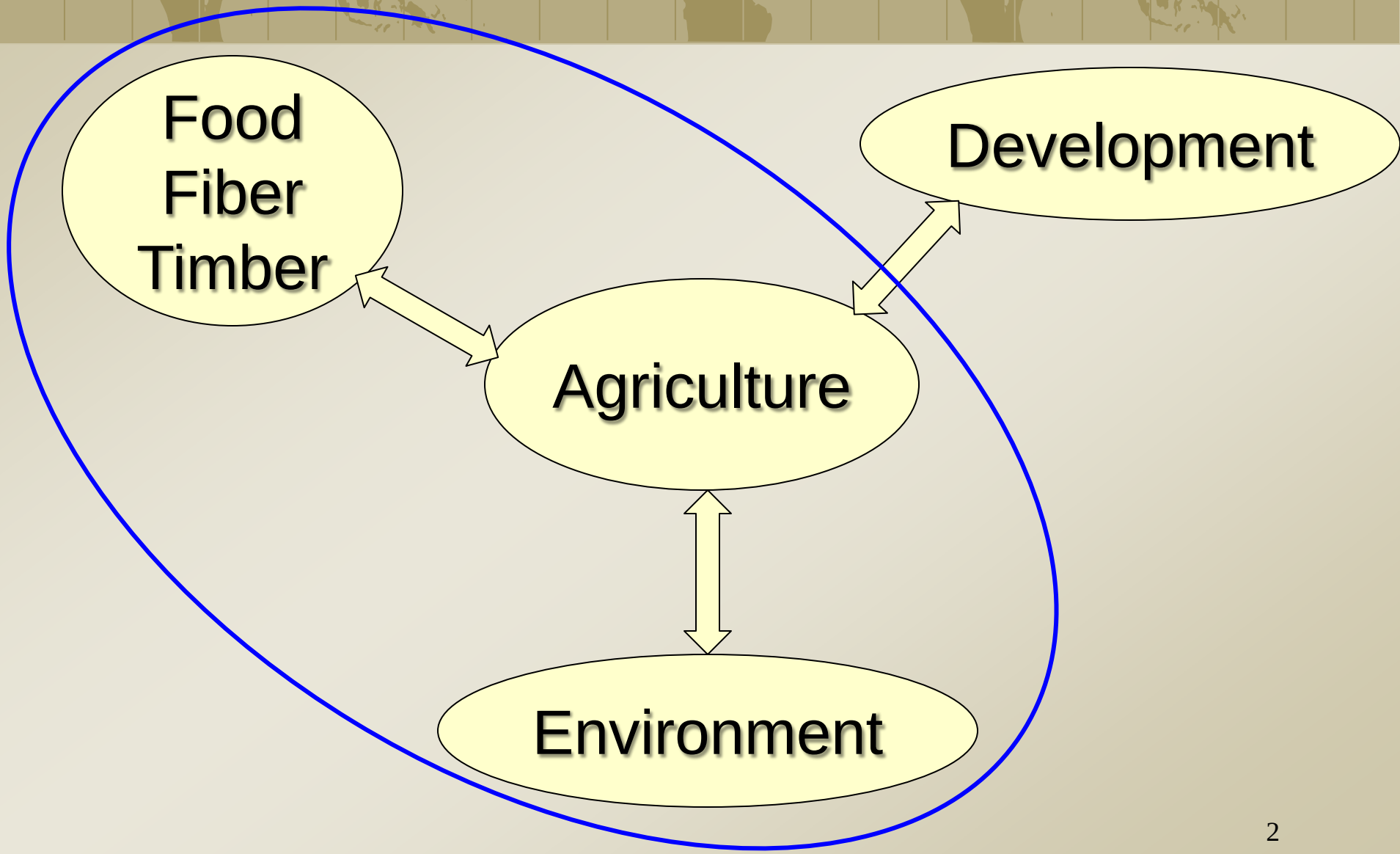
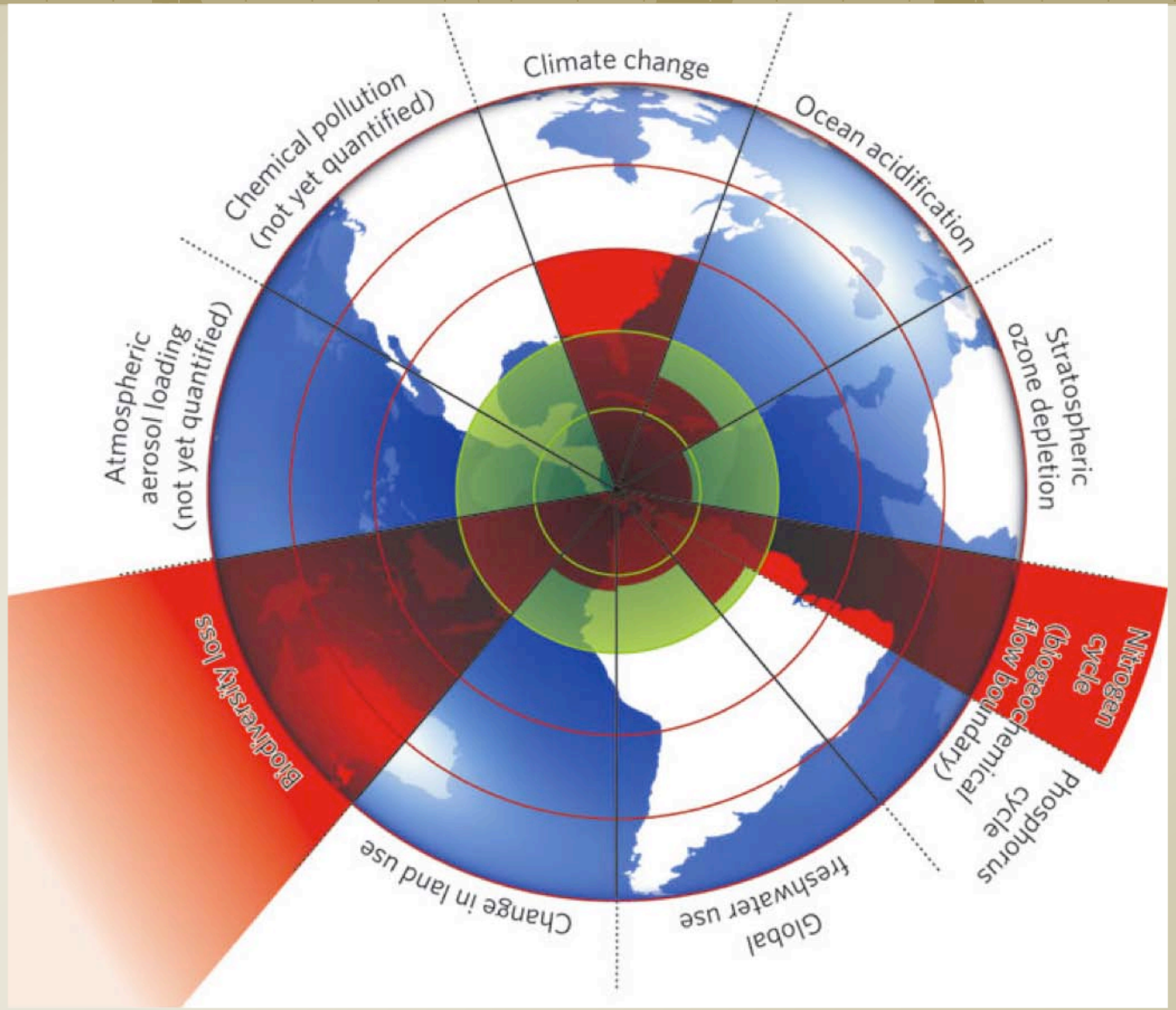
Critical role of agriculture



Planetary Boundaries
(Rockstrom et al. 2009)



Planetary Boundaries

Planetary Boundary	Role of Agriculture
Climate change	20-30% of GHG
Biodiversity loss	Biggest driver (37% for birds)
Nitrogen & Phosphorus cycle	Biggest driver
Global freshwater use	70% of withdrawals
Change in land use	Biggest driver (34% of land)
Ocean acidification	9-15% of CO_2
Chemical pollution	? (Pesticides)
Atmospheric aerosol loading	? (Biomass burning)
Stratospheric ozone depletion	

- Agriculture is a major driver!

Spatial databases

- Spatially explicit data are key for understanding the global role of agriculture
  - Location matters for understanding the food-environment-development tradeoffs
  - Impacts: GHGs, poverty, water quality, …
  - Policies: production, development, conservation…
- Need to move beyond national statistics
- Global Earth observations need grounding

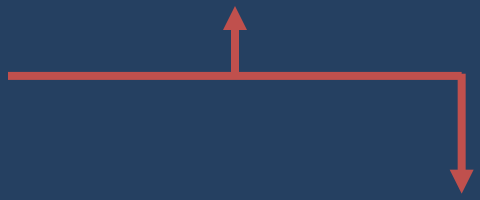
Data needed to understand tradeoffs between agriculture and the environment

Resources:
- Climate
- Population
- Land (soil)
- Water
- Cultivars
- Livestock
- Energy
- Other Assets

Economic and institutional factors:
- Land tenure
- Market Access
- Credit Availability

Environmental and socio-economic variables:
- Poverty
- Greenhouse gas fluxes
- Biodiversity
- Water quality
- Soil degradation

Agriculture and Forestry sectors



Management:
- Planting/harvest dates/cropping intensity
- Irrigation
- Fertilization
- Plant protection
- Labor
- Other management practices

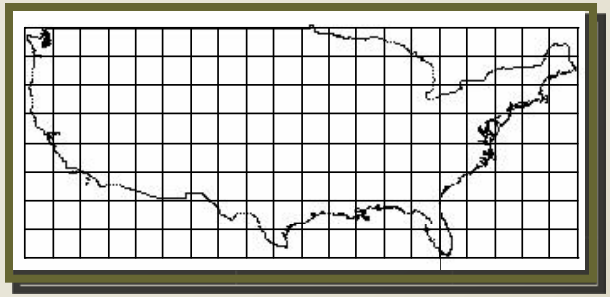
Marketed products:
- Food
- Fiber
- Fuel
- Timber
- Carbon credits

Earth observations

1. Interpolate between point observations
   - Historical climate (CRU)
   - Ecological (NPP)
2. Remote sensing
   - Land cover/Forest cover & change (GLC2000, SDSU/UMD)
   - Topography (SRTM, Aster)
   - Irrigation (IWMI)
3. Census data
   - Population (CIESIN)
   - Irrigation (Bonn/FAO)
4. Data fusion/models
   - Population (Landscan)
   - Urban areas (SAGE, GRUMP)
   - Agricultural land use/cover (M3, SPAM)

Sources of Global Land Data

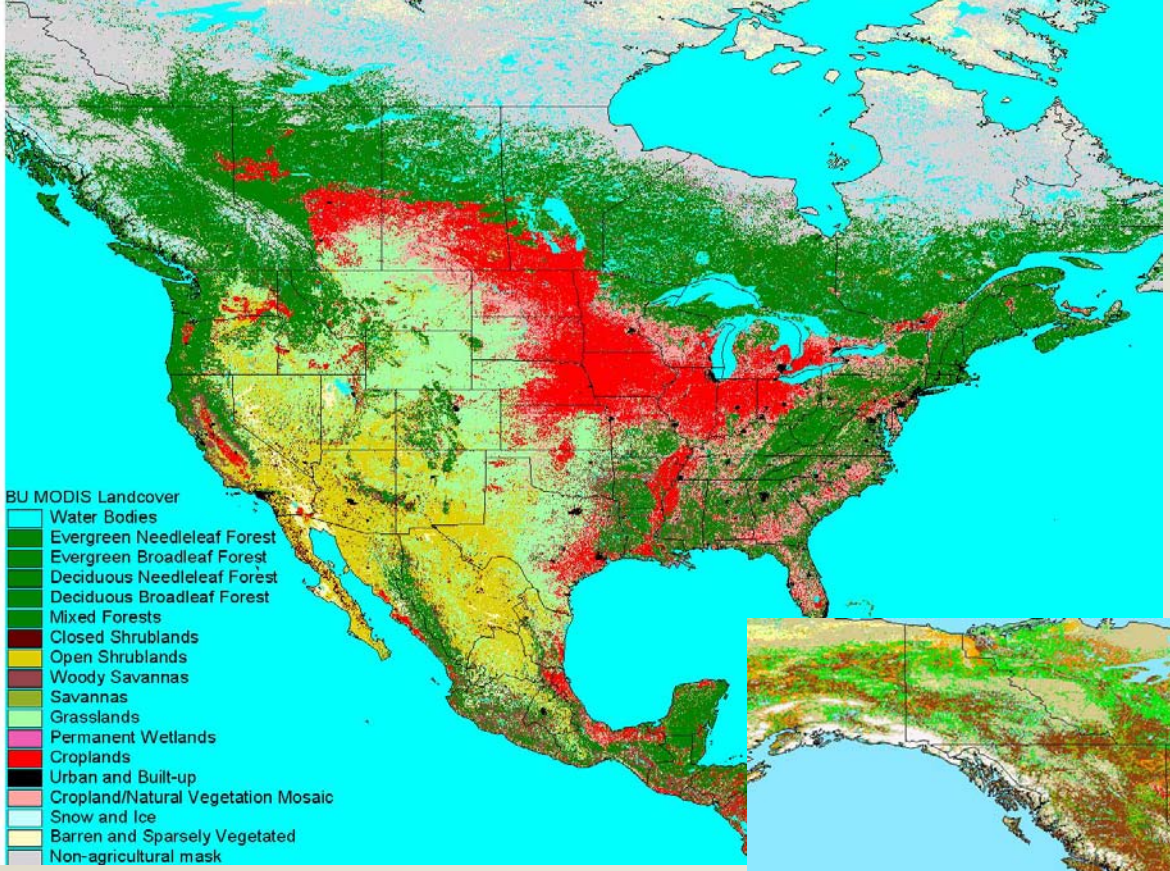
- Satellite Data
  - Spatially-explicit
  - Consistent
  - Only for the last ~40 yrs



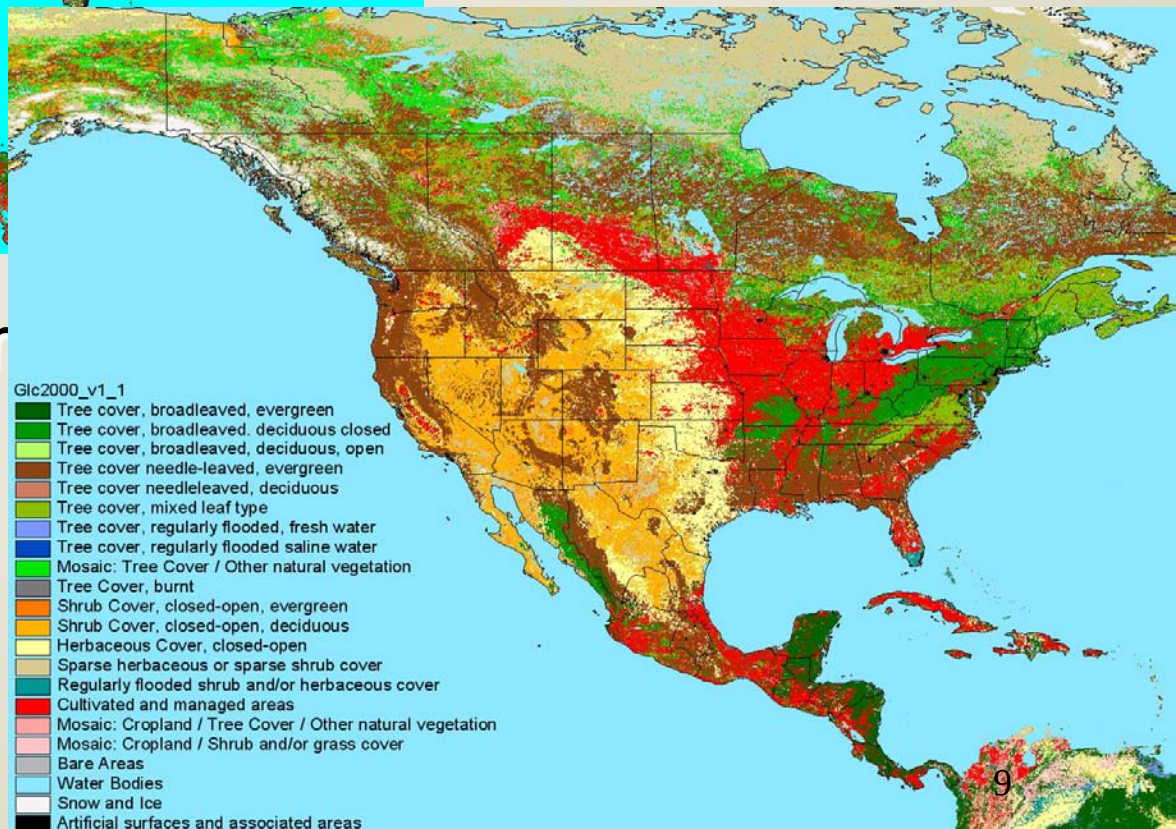
- Inventory/census Data
  - Available for the last few centuries
  - Collected at “administrative unit” level
    (countries, states, etc,...)
  - Inconsistent

Statistical Data Fusion

Satellite Data

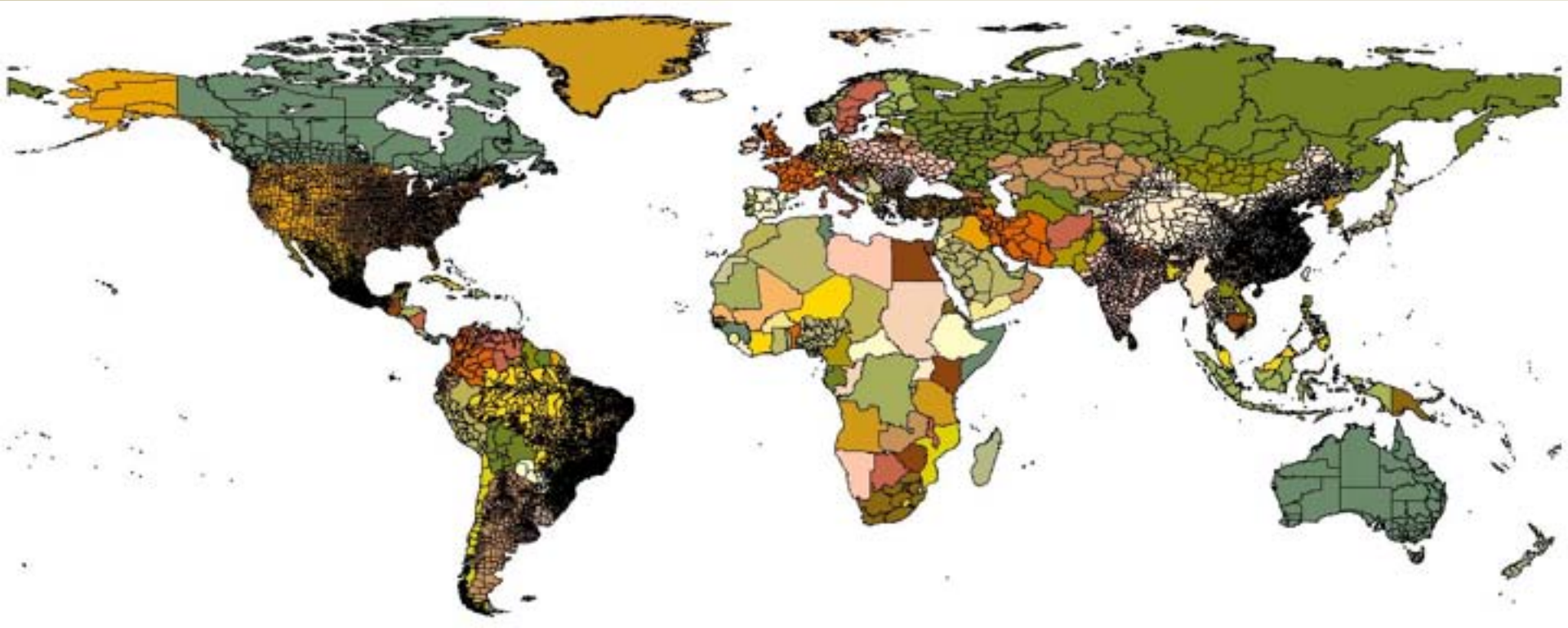


BU MODIS land cover



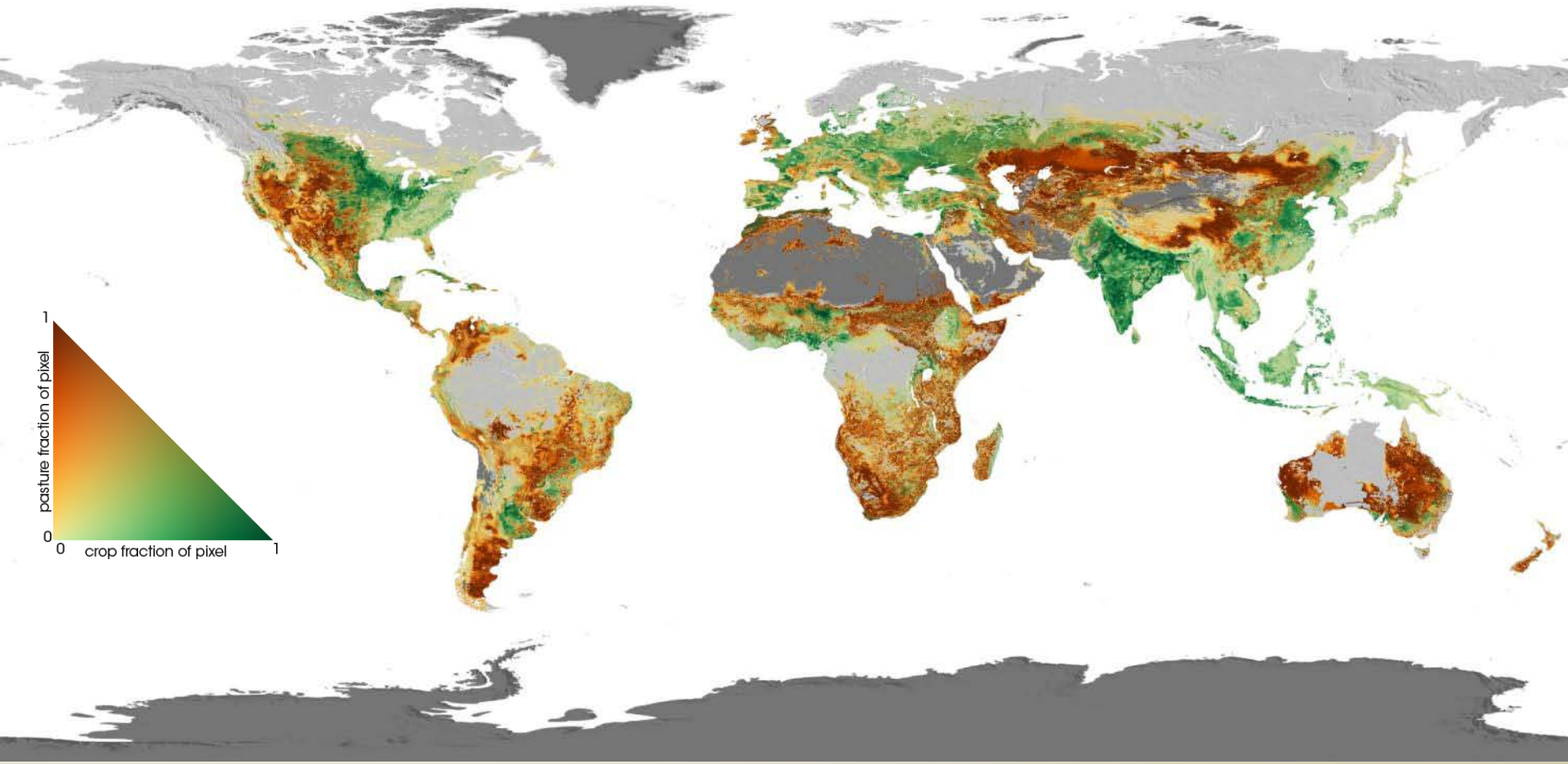
GLC2000

Global Census Data for Year 2000



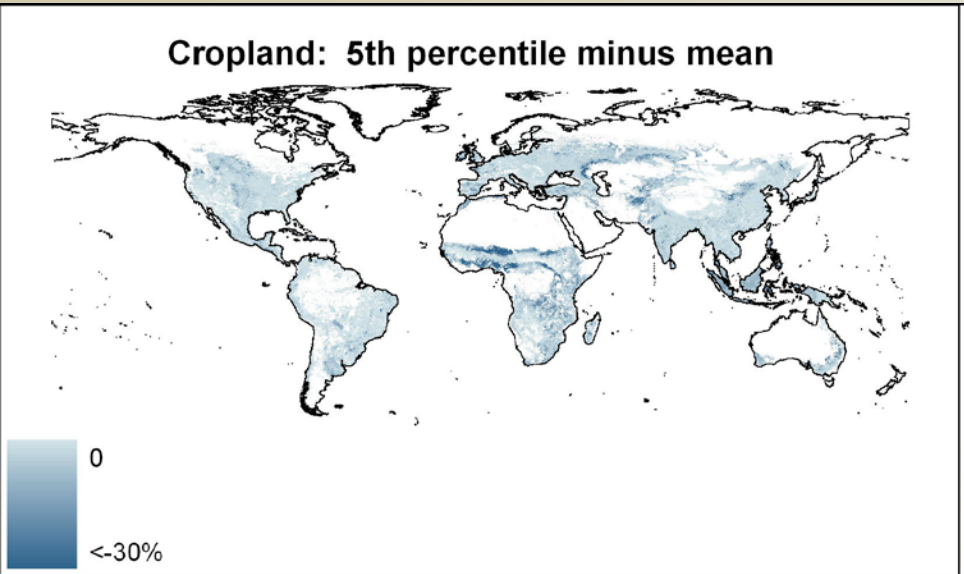
Ramankutty *et al.*, 2008

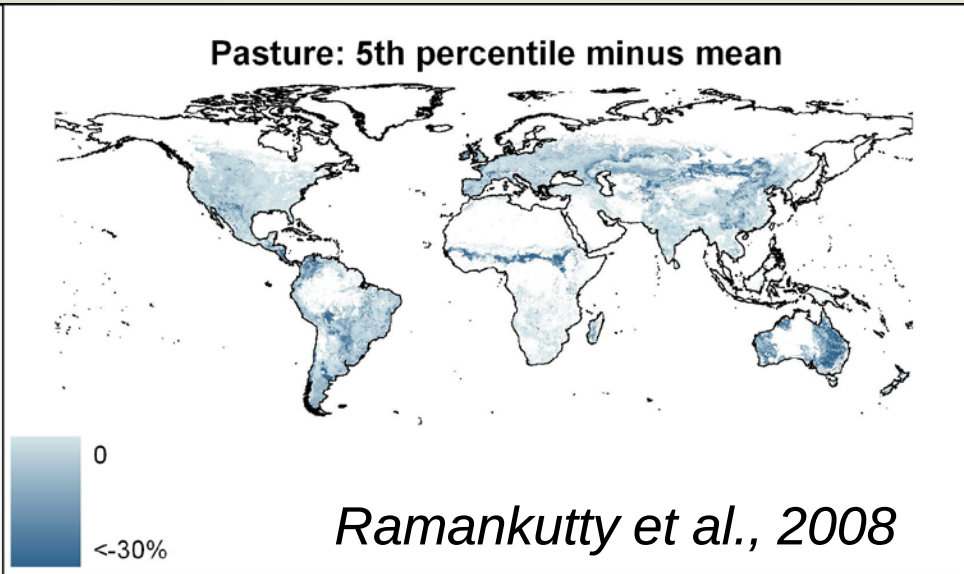
M3LAND (Cropland, Pasture in Yr 2000)



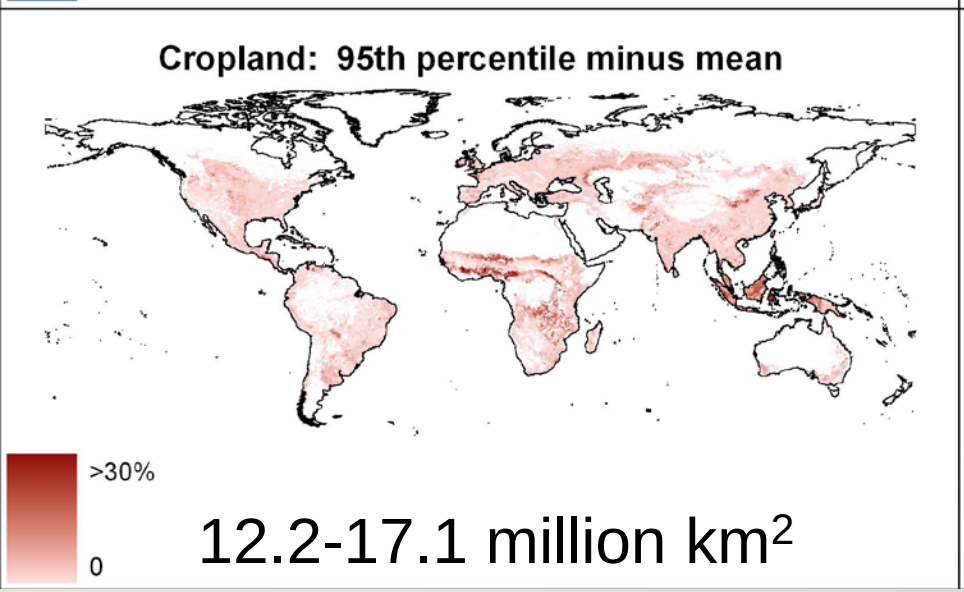
Ramankutty et al., 2008

Uncertainty (Confidence Intervals)

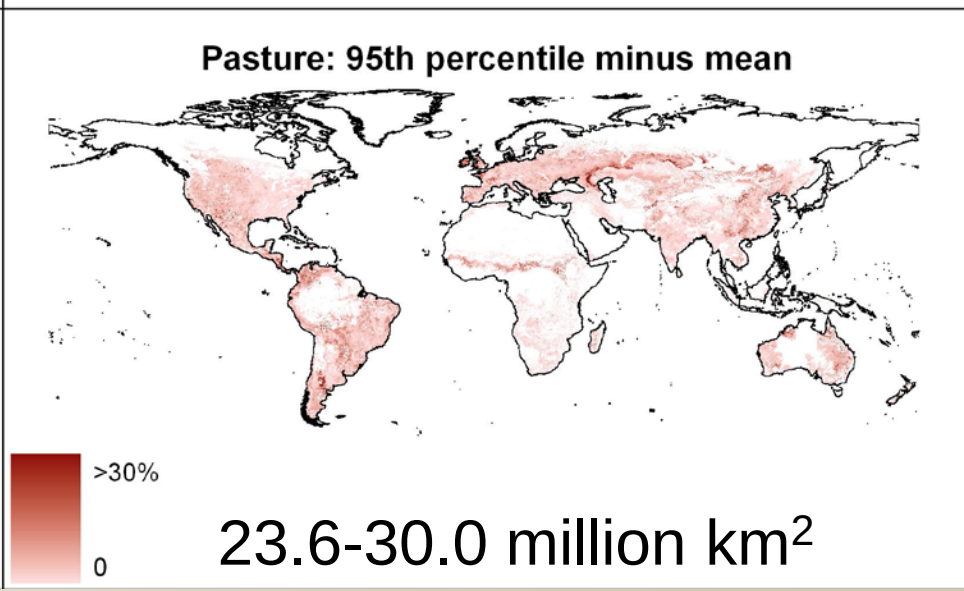




Ramankutty et al., 2008

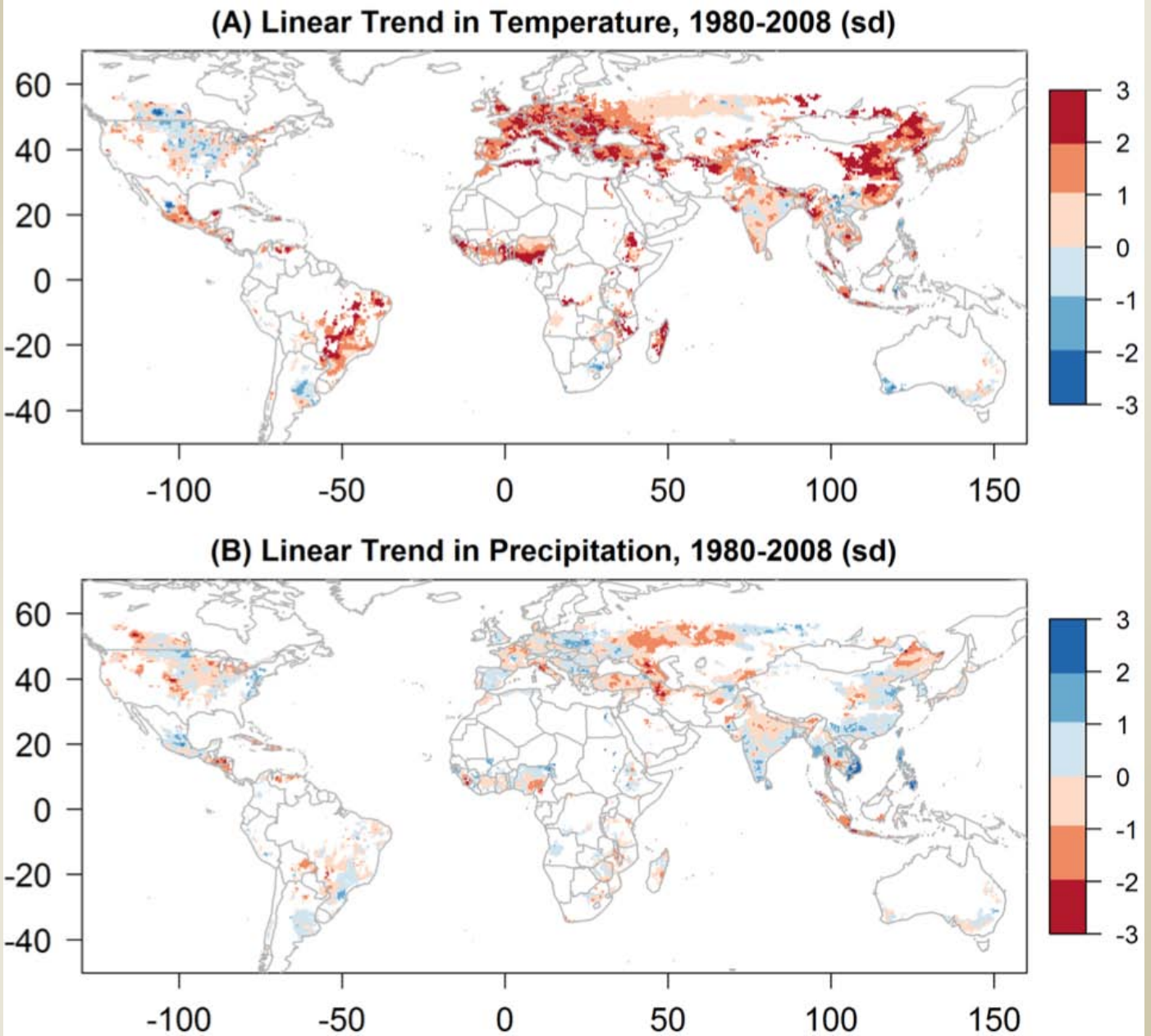


12.2-17.1 million km^2
(33% uncertainty)



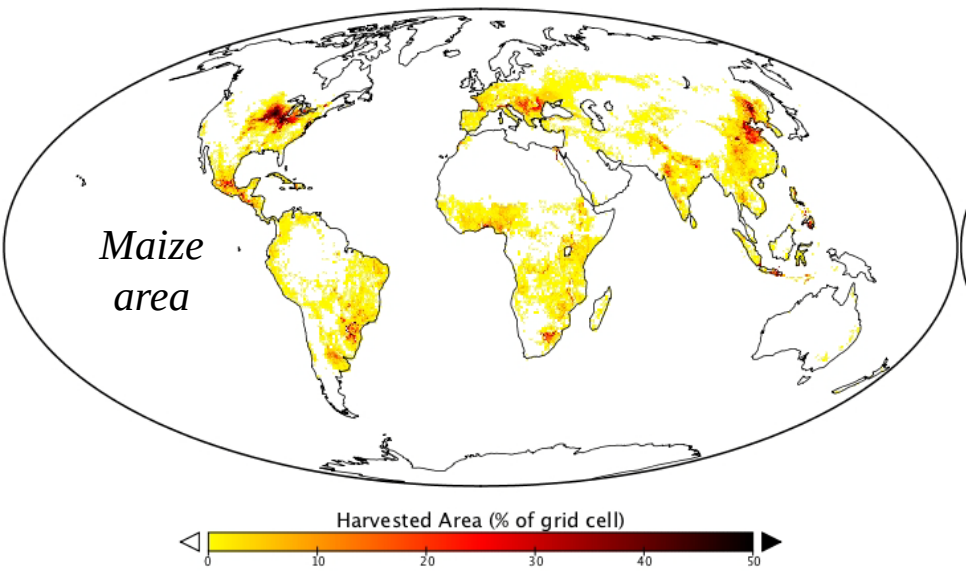
23.6-30.0 million km^2
(23% uncertainty)

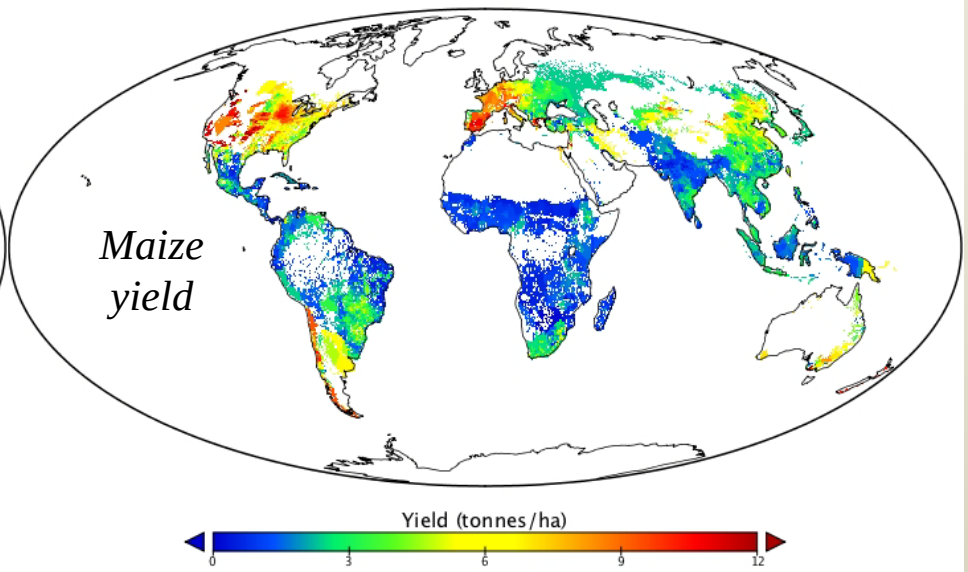
Application: Climate impact on crop yields

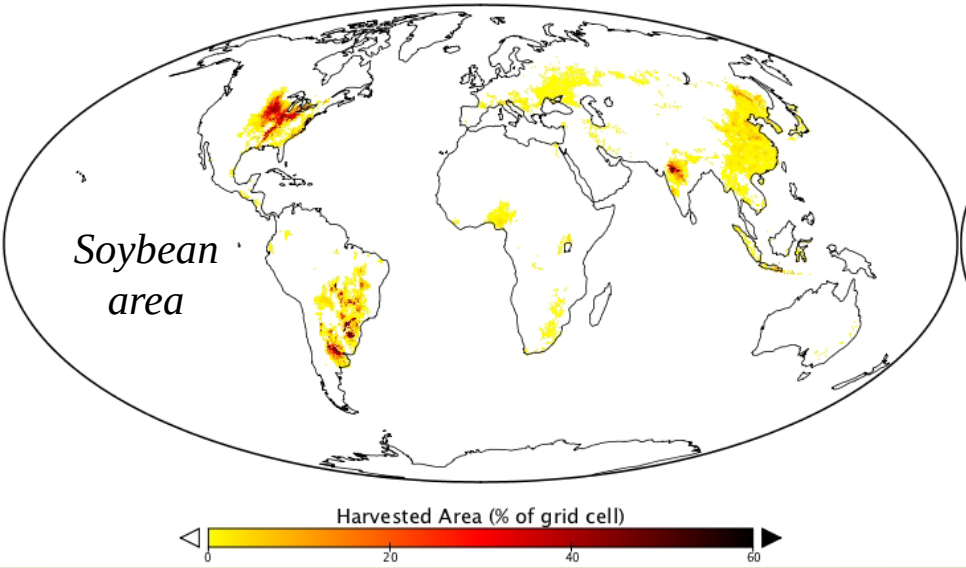


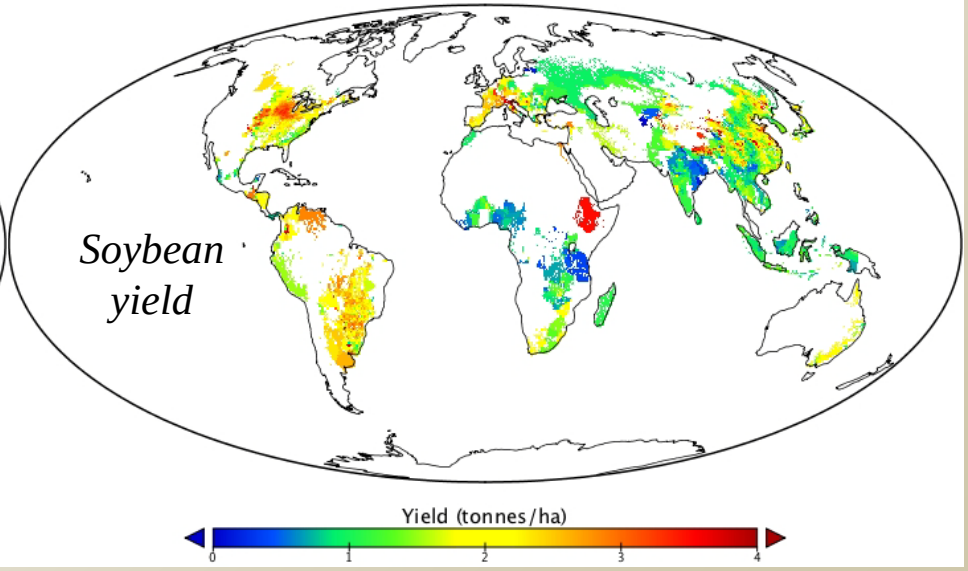
Lobell et al. 2011

M3CROPS (Crop Area/Yield in Yr 2000 for 175 crops)





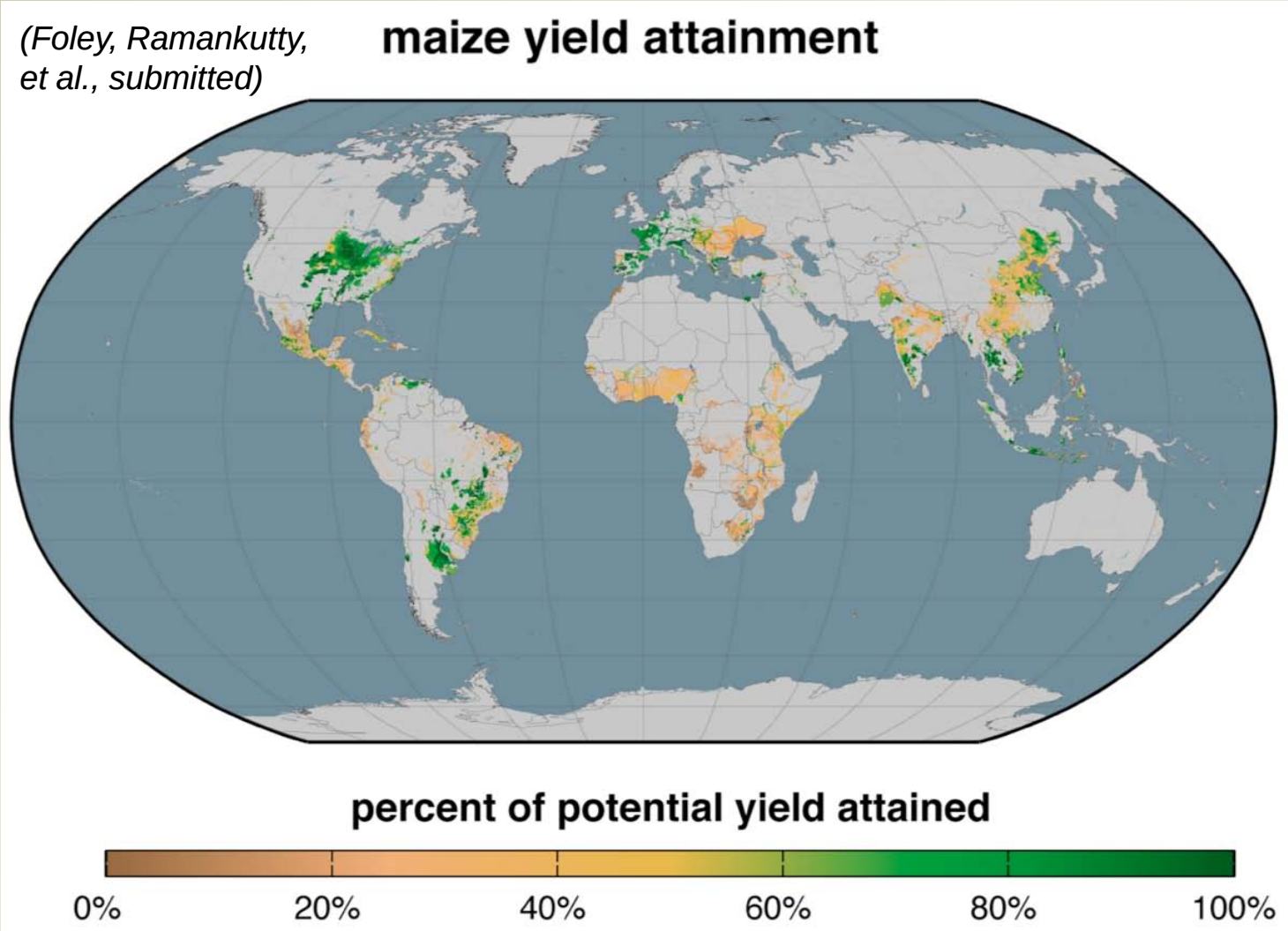




Monfreda, Ramankutty and Foley, 2008

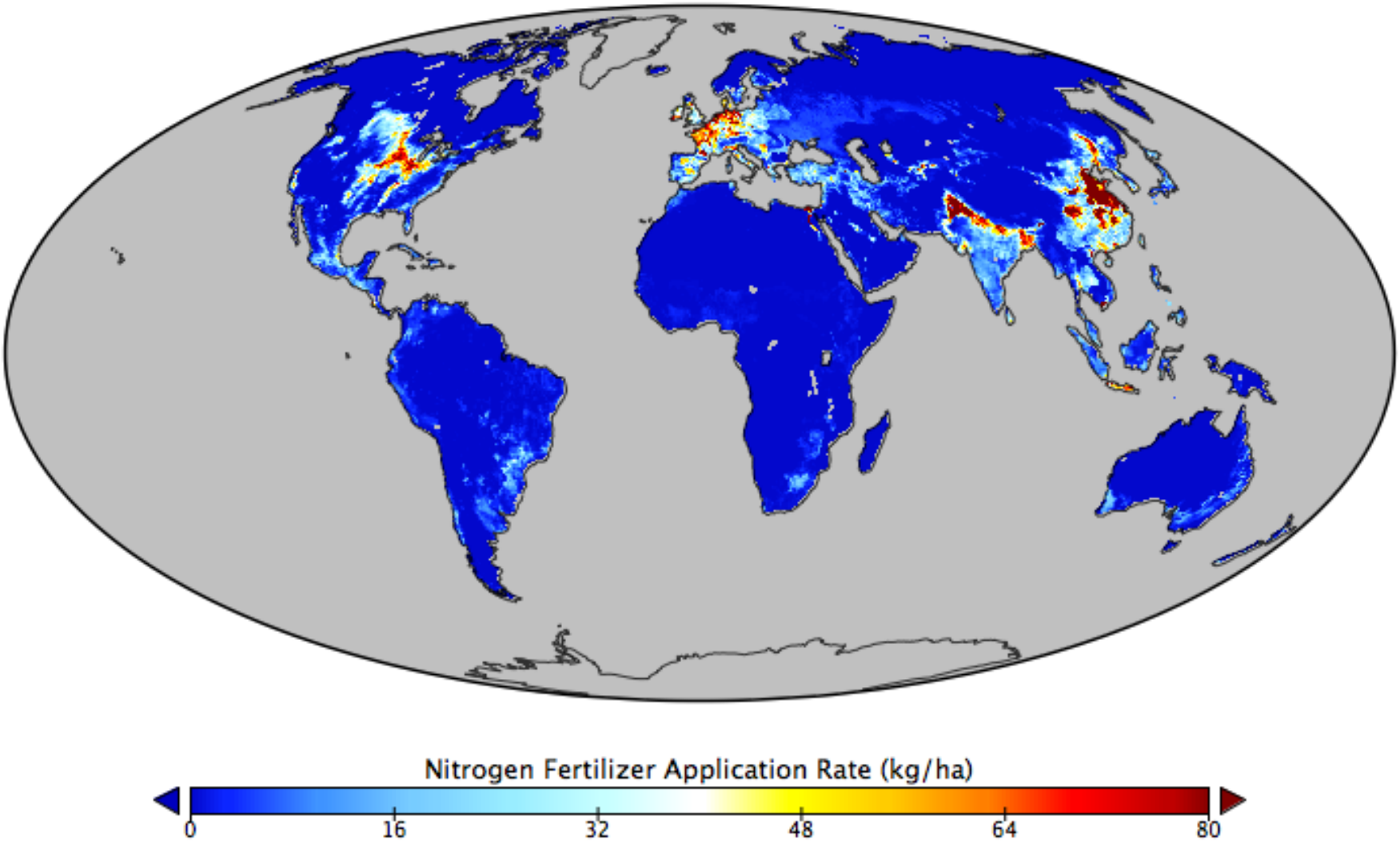
Application: Close yield gaps

(Foley, Ramankutty, et al., submitted)



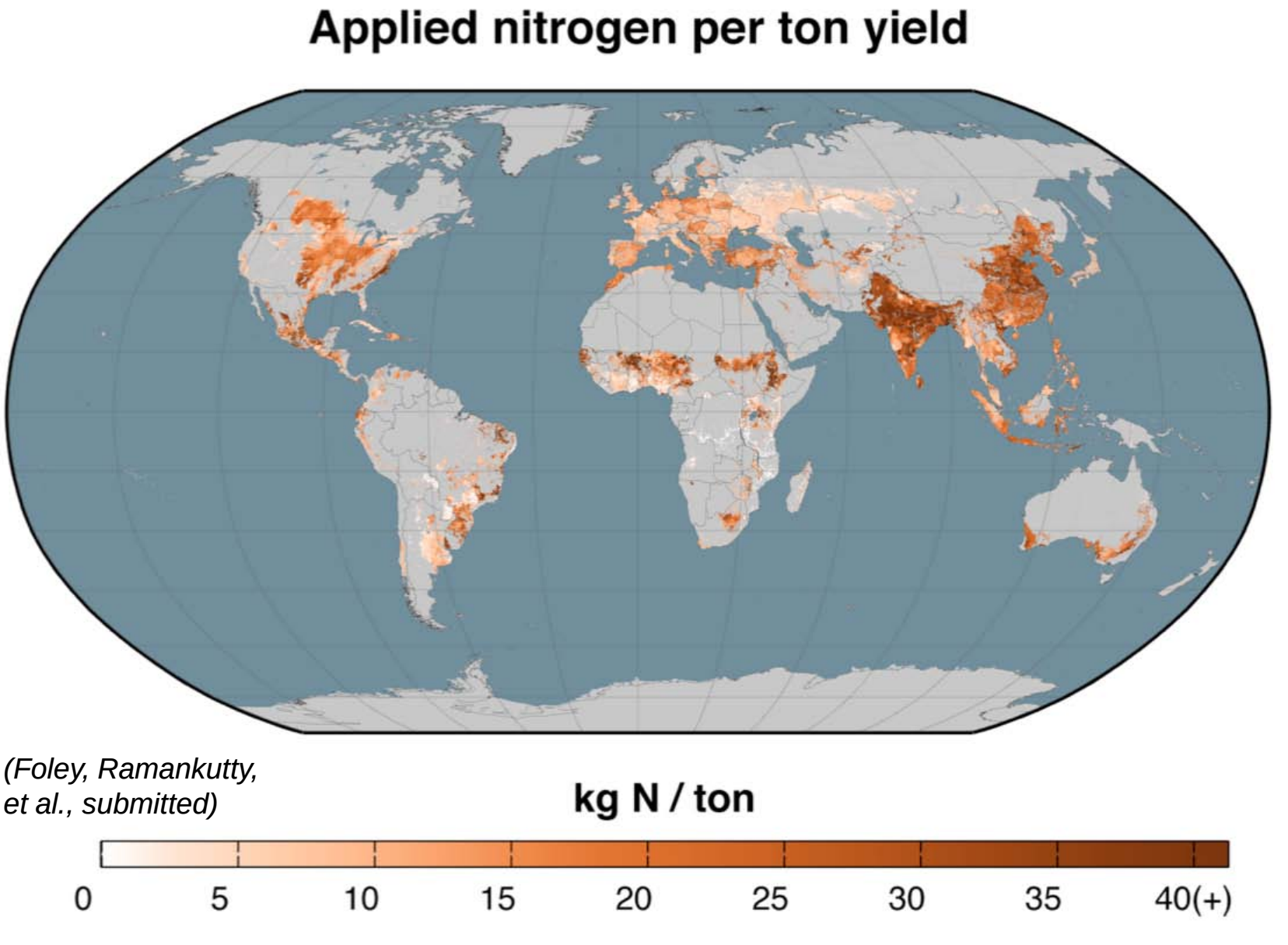
- Bringing yields of 16 crops to 75th %ile (95th) of potential would increase production by 28% (58%).

M3FERT (N/P/K Fertilizer application rates in Yr 2000)



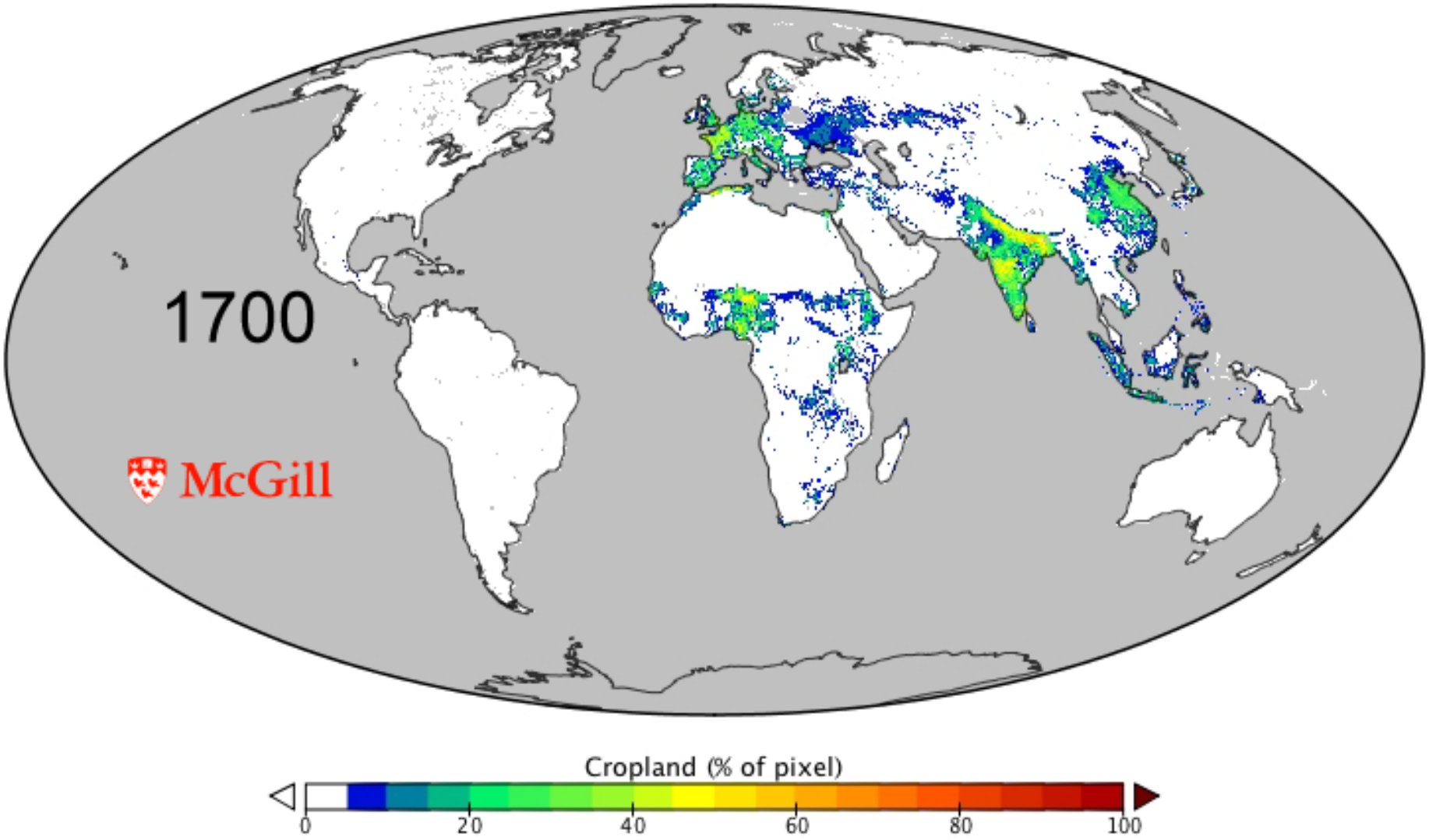
Potter et al., 2010

Application: Nutrient-use efficiency



(Foley, Ramankutty, et al., submitted)

Historical changes



Ramankutty and Foley, 1999; Ramankutty et al., in prep.

Why fund this project?

- Everyone loves data, but no one wants to pay for it.
- Gathering, reconciling, filling gaps in, data is tedious, often thankless, task
- Data development is not considered ‘science’.
- We have a group of key players today, who have contributed in the past, and are excited about the opportunity to be funded to work together.

Experience working together

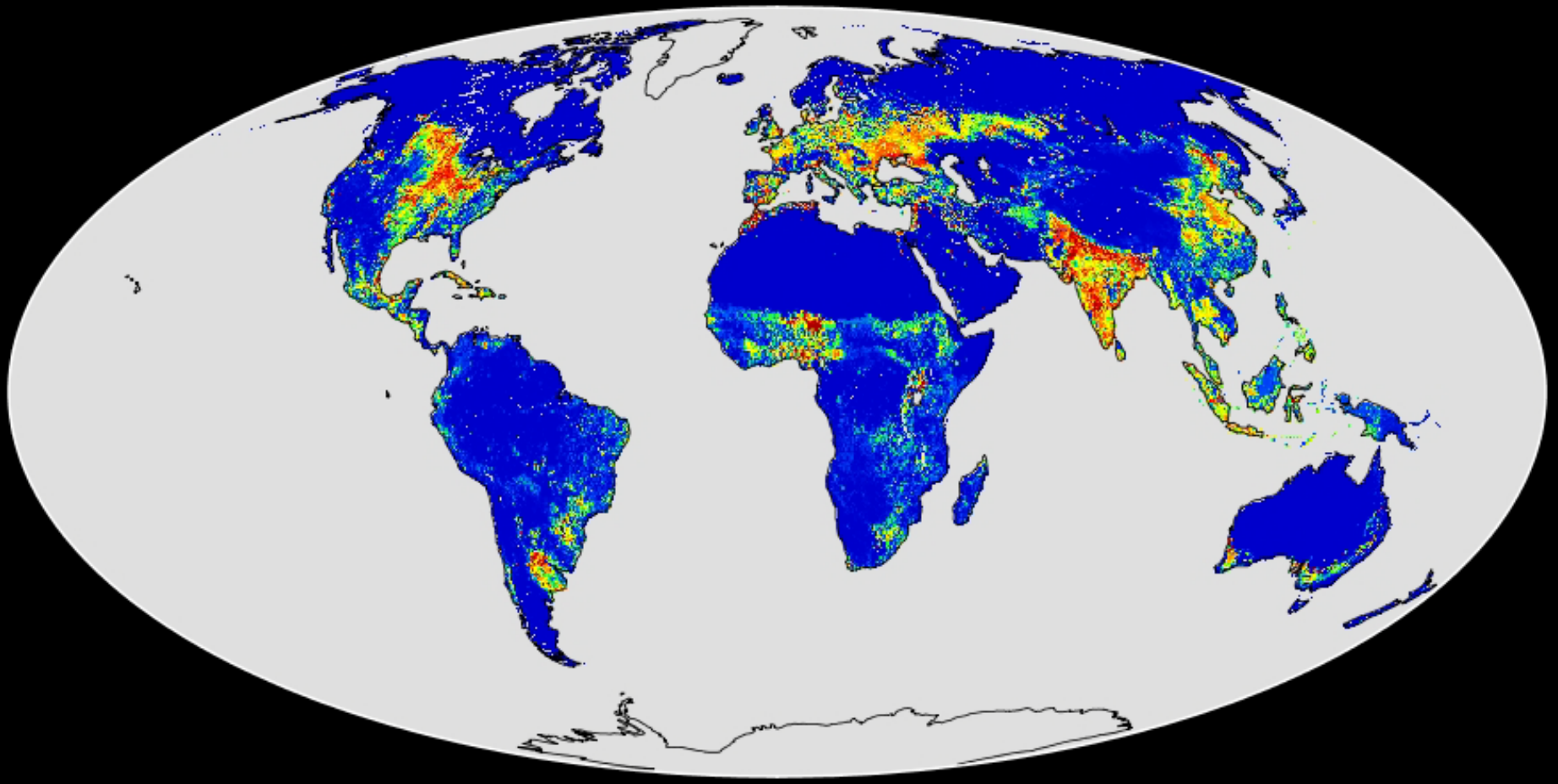
- AgroMAPS: Collaboration between FAO, IFPRI, CIAT, and SAGE (currently M3 @ Montreal-Minnesota-Madison).
  - Further led to development of M3CROPS, SPAM, MIRCA2000

- McGill and CIAT collaborated on a project showing that soybean expansion in Brazil was causing indirect deforestation (Barona et al. 2010).

- Bonn and McGill are collaborating to develop historical irrigation time series.

- Purdue and McGill have collaborated to enhance land use by AEZ into GTAP database.

THANK YOU!



Future Database Needs

Data Needs	Purpose
Disentangle arable land from harvested area (Fallow, multiple cropping, crop rotations, crop failure,...)	Productivity change, Climate impacts
Pasture versus Grazing land; Landless livestock	Climate change (biophysical, CH4 emissions)
Land cover transitions (forest <-> cropland; forest <-> pasture, etc.)	Climate change (CO2 emissions)
Historical crop area and yield data	Productivity change, Climate impacts
Crop-specific irrigation, fertilizer use, pesticide use, mechanization	Productivity change, Water quantity & quality