Food Security and Sustainable Agriculture

Bridging Remote Sensing and Ground Information for National and International Policy Actions

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IIASA, Laxenburg, Austria

Fifty-first session of the
Committee on the Peaceful Uses of Outer Space
13th June 2008
Vienna International Center, Austria

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Human Rights and Human Security

Food
Water
Health
Education
Social Security
Sustainable Environment
Freedom form Harassment
Freedom from Discrimination
Opportunities for Participation

International Commitments in a World of Disparities

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Information Gathering: Utility and Actions

From Information to Knowledge

(Information for Understanding the System)

From Knowledge to Policy Making

(Information for Interdisciplinary Scientific Analysis)

From Policy Making to Policy Actions

(Information for Policy Prioritization and Resource Commitments)

Implementation, Monitoring, Evaluation

(Information for Timely and Spatial Adaptation)

World Food System: Persistent Hunger in a World of Abundance

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Towards world-wide Food Security

- Who are the food insecure ?
  - Where are the they ?
- What makes them vulnerable ?
  - When are they in need ?
  - What needs to be done ?

Bridging Remote Sensing & Ground Information for National & International Policy Actions

Natural Resources, Technology, Human Capital, Finance,……

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Food Security

Sustained access to food
at all times in socially acceptable ways
and adequate in quantity and quality
to maintain a healthy life

Food Systems
Availability: Production, Storage and Processing
Access: Marketing and Trade
Health: Consumption and Nutrition

Sub-national, national, regional, global

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Food Security: 100 Years of Promises

- 1905 International Institute of Agriculture
- 1941 US Conference for Defence
- 1943 Hot Springs Conference Food and Agriculture
- 1948 United Nations Human Right
- 1972 Stockholm: Preserving and Enhancing the Environment
- **1973 First World Food summit**
- 1992 Rio Earth Summit
- **1996 Second World Food summit**
- **2000 Millennium Summit**
- **2002 Third World Food summit**
- **2008 FAO Food, Biofuels and Climate Change**

Hunger in a World of Plenty

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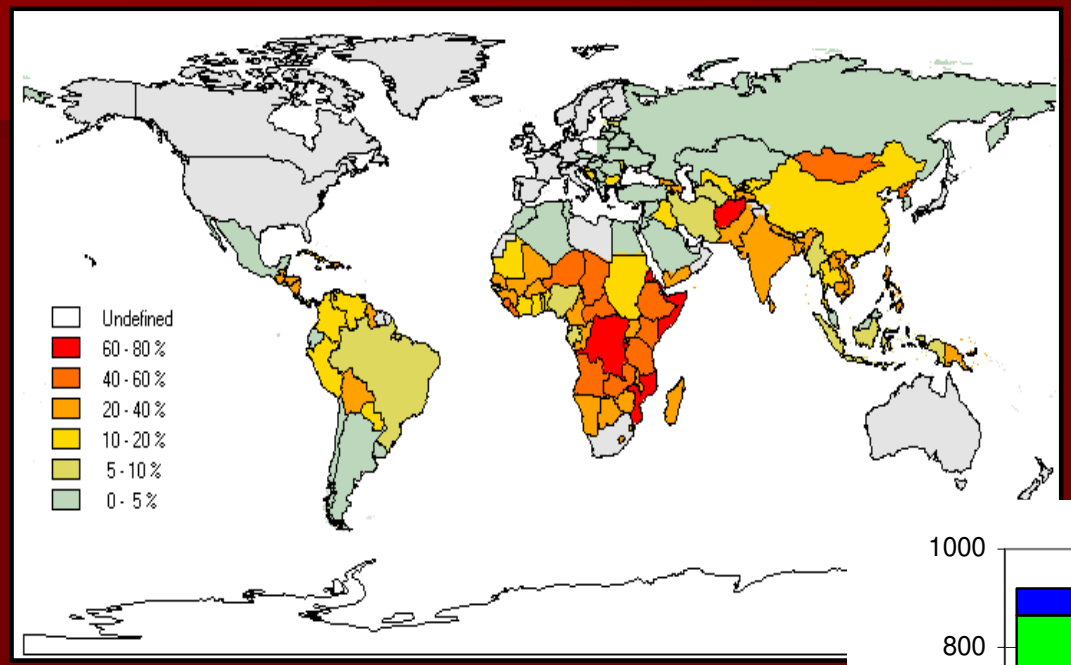
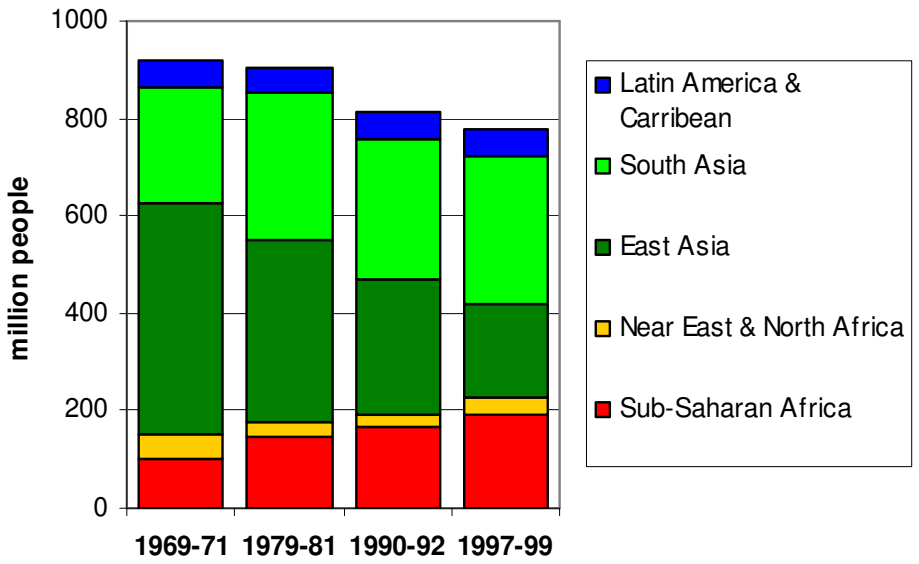
Hunger in a World of Plenty



World Food Summits
1974, 1996, 2002

MDGs 2000

34 Years of Failure to Deliver



The debilitating pain of hunger: Not Just Numbers but real Faces and Voices

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The faces and voices of Hunger

Fatima and Jabil

Rural Ethiopia

Naigzy and Tesfai

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Security of Growing Up ?

Esposito, Urban Brazil

Yearning a Life Time for a Secured Future

Mira, Afghanistan

Farida, Afghan Refugees

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The 21st Century Challenges

Food Security and Sustainable Agriculture

Population and Demographic Change
Natural Resources Exploitation
Science and Technology Barriers
Globalization and Development Disparities
Governance and Societal Conflicts
Climate Change Risks and Justice

Unprecedented Challenges in an Interdependent World

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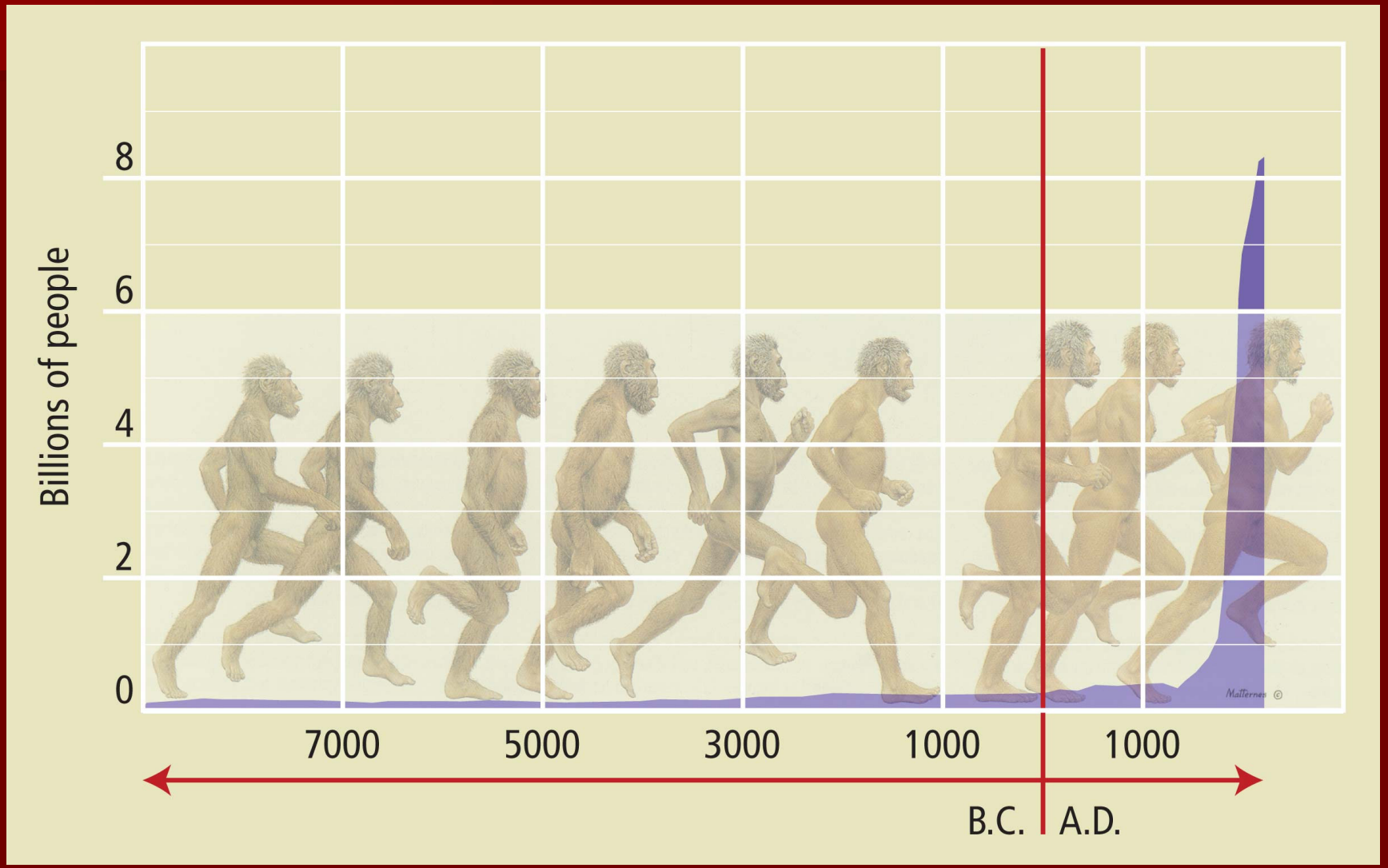
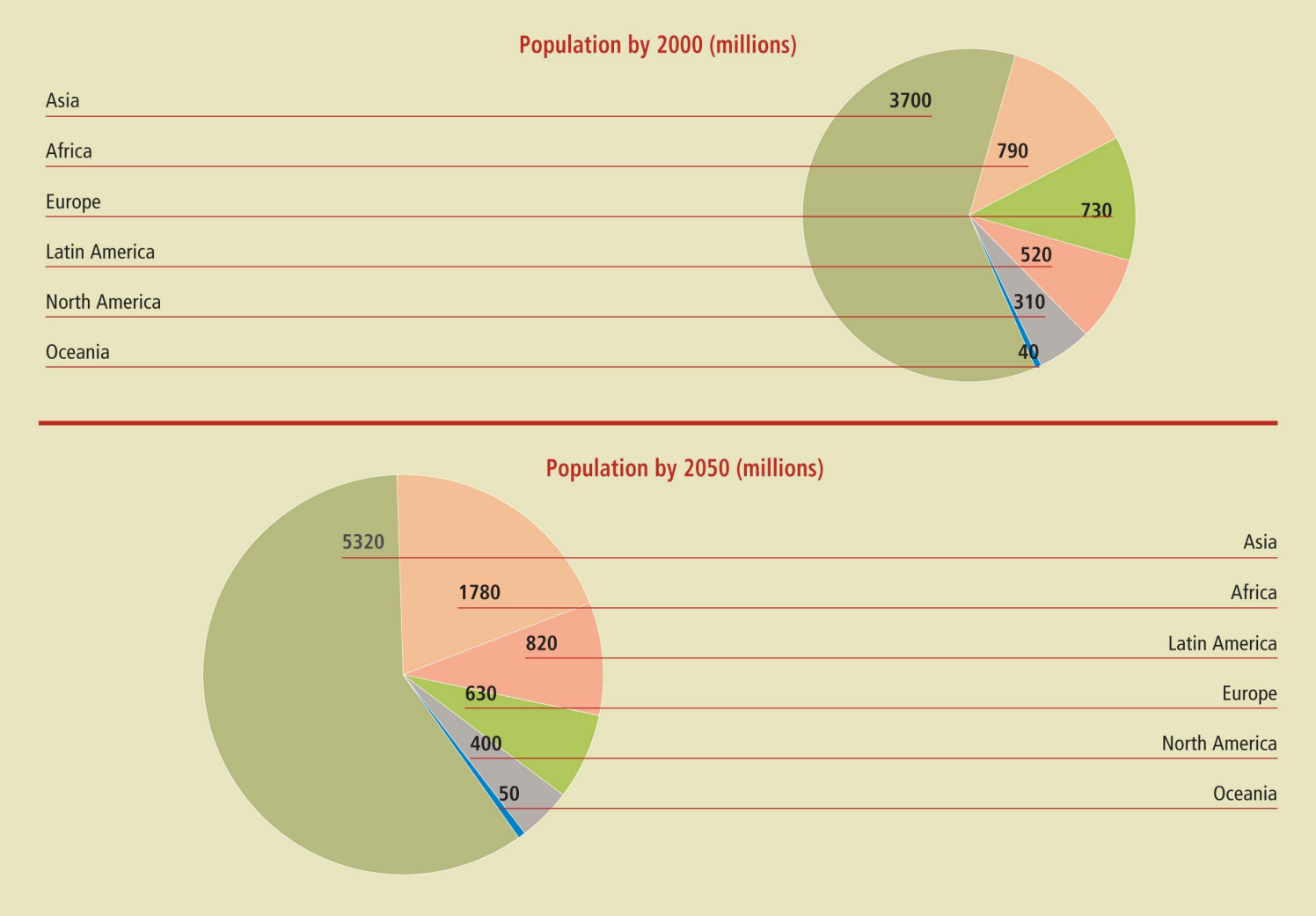
Population Growth
9000 BC to 2050 AD

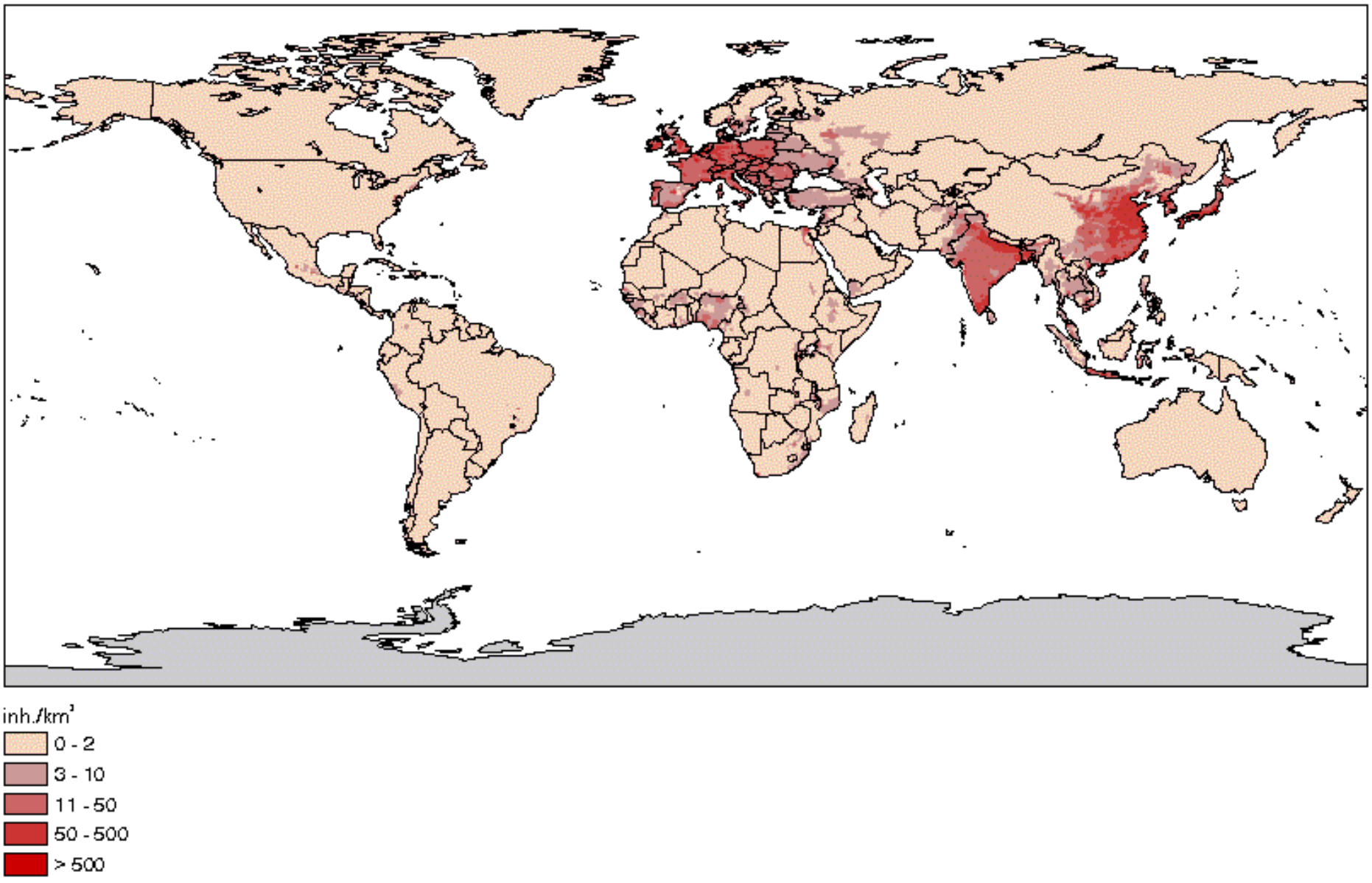


Demographic Transition 2000-2050

Population 2000, 2050 regional distribution

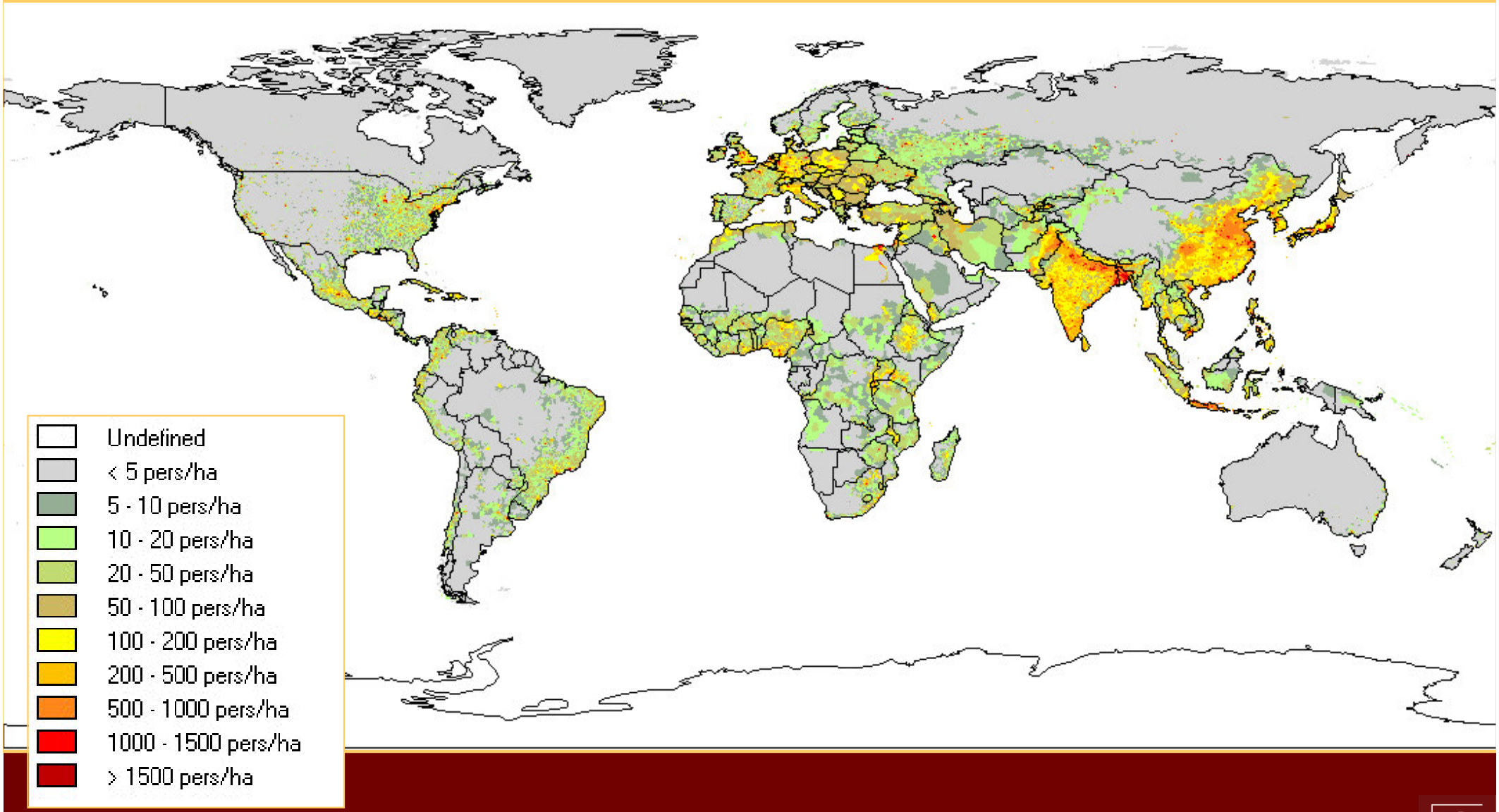


Regional Diversity and Demography, 1700 – 1990




City Lights from night time images
(Chris Elvidge NOAA)

Global gridded population distribution data of 1995; CIESIN; at 2.5 arc-min. latitude/longitude resolution



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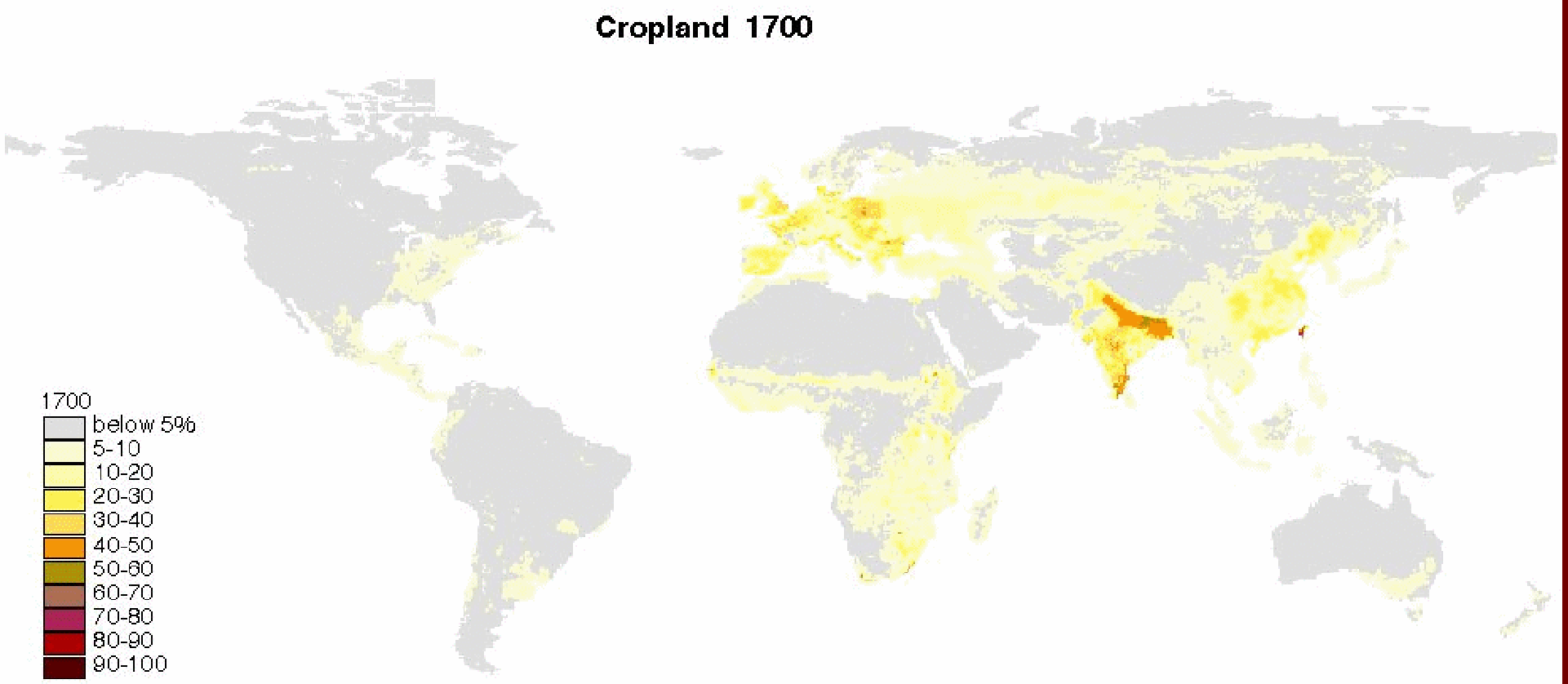
Expanding Cropland 1700-1990

Fraction of grid cell in croplands



1970s : Green Revolution

2000s Next Biological Revolution

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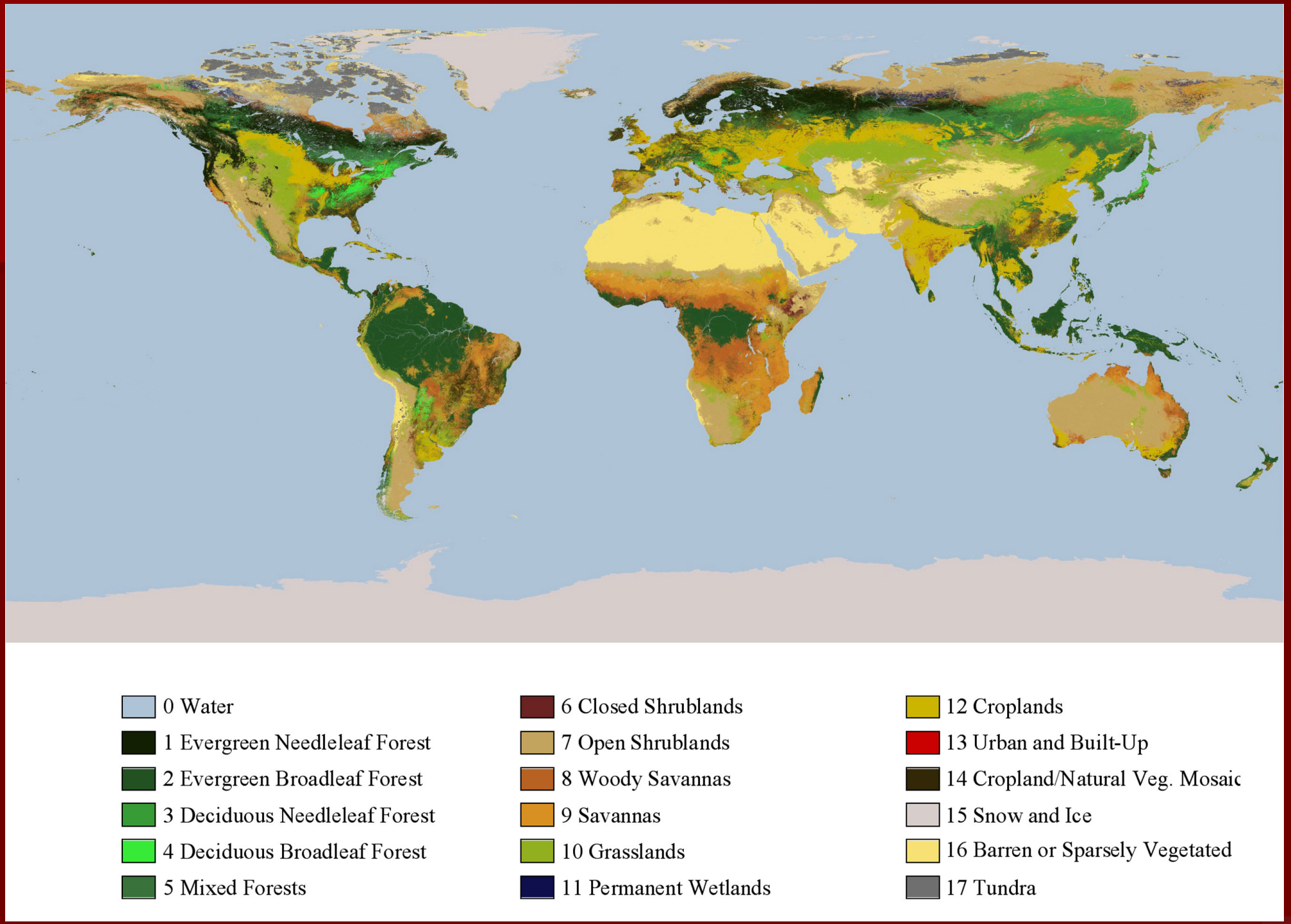

NASA Remote Sensing : Global Land Cover Map

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Towards world-wide Food Security Information – Knowledge – Agenda-Actions

- Earth-based Information
- Ground Assessment, Household Surveys, Market Information
- Information Processing, Science and technology, Traditional Knowledge…
  .....
- Space-based Information
- IGOS : Integrated Global Observing Strategy
- GISD : Global Information for Sustainable Development
- .....
- Harmonizing Earth-based and Space-based Information
- Integrated analytical tools : Systems Modeling and Policy Analysis
- National Policy making and implementation actions
- International negotiations, agreements and partnerships
- .....
- Developing Country Capacity Building
- Sustainable Agricultural Development and Food security
  .....

Integrating Remote Sensing Observations & Ground-based Information for Decision-Making & Actions

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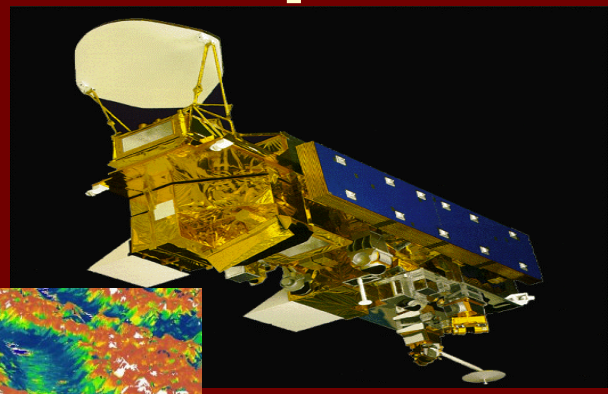
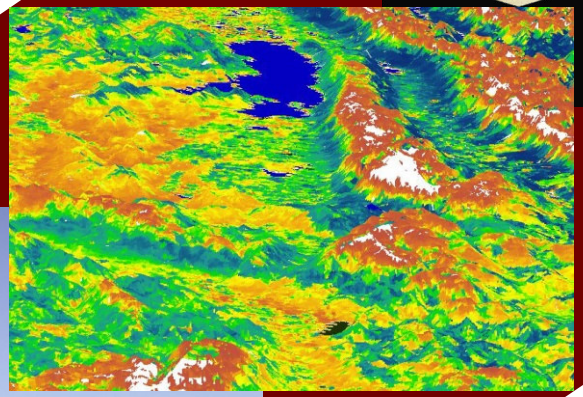
Integrated, Multiple Constraints on the Biosphere

Source: S. W. Dunning



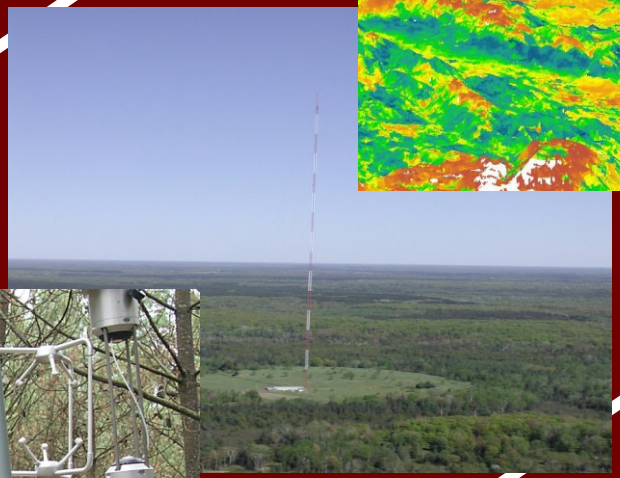
1000 km

10 km



Upscaling Prediction

1km



1ha

1m

Downscaling & Verification

FAO and USDA Famine Early Warning Systems
Remote Sensing Success
but Ground Action Constraints

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Driving ecosystem models with satellite data, concept for NASA Global Habitability, 1983

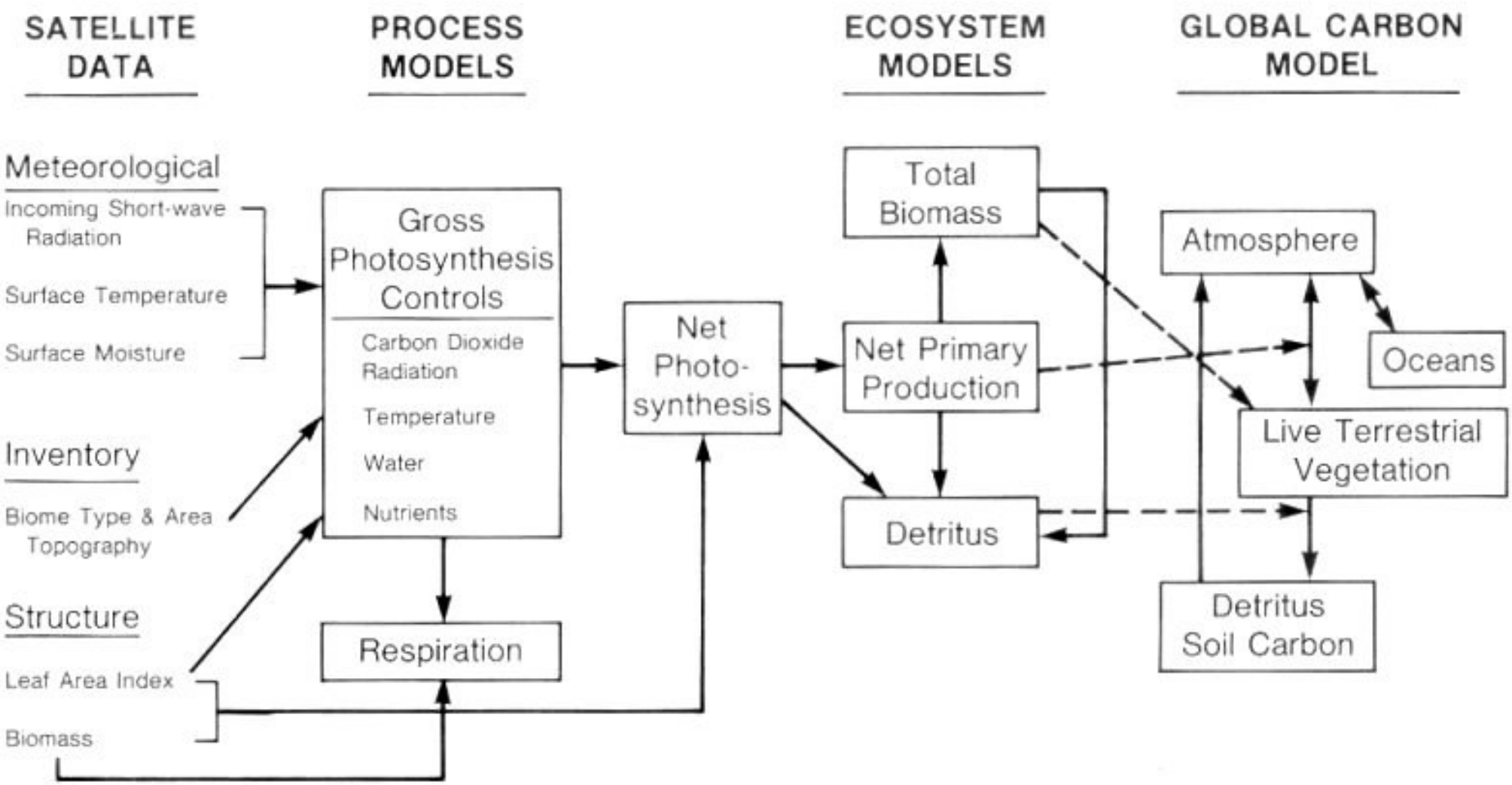

Figure 2. Organizational diagram of a proposed model of net primary production for a coniferous forest. All driving variables are derived from satellite data. Potential linkages to a global carbon model are shown by dashed lines (Running, 1984).

Source: S. W. Dunning

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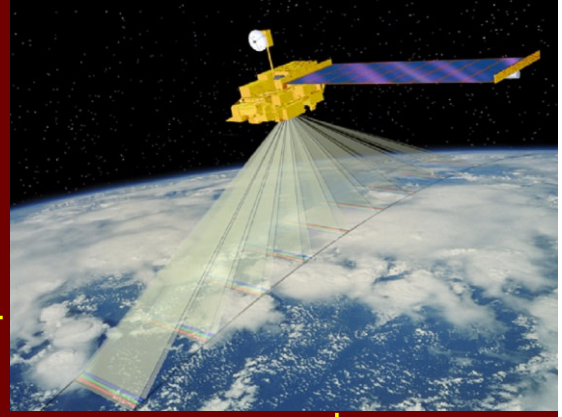
MODIS LAND PRODUCTS



- MOD 09 Surface Reflectance
- MOD 11 Land Surf. Temp. / Emissivity
- MOD 12 Land Cover / Change
- MOD 13 Vegetation Indices
- MOD 14 Thermal Anomalies / Fire
- MOD 15 Leaf Area Index / FPAR
- MOD 16 Evapotranspiration/SR
- MOD 17 Primary Production
- MOD 43 BRDF / Albedo
- MOD 44 Vegetation Continuous Fields

Source: S. W. Dunning

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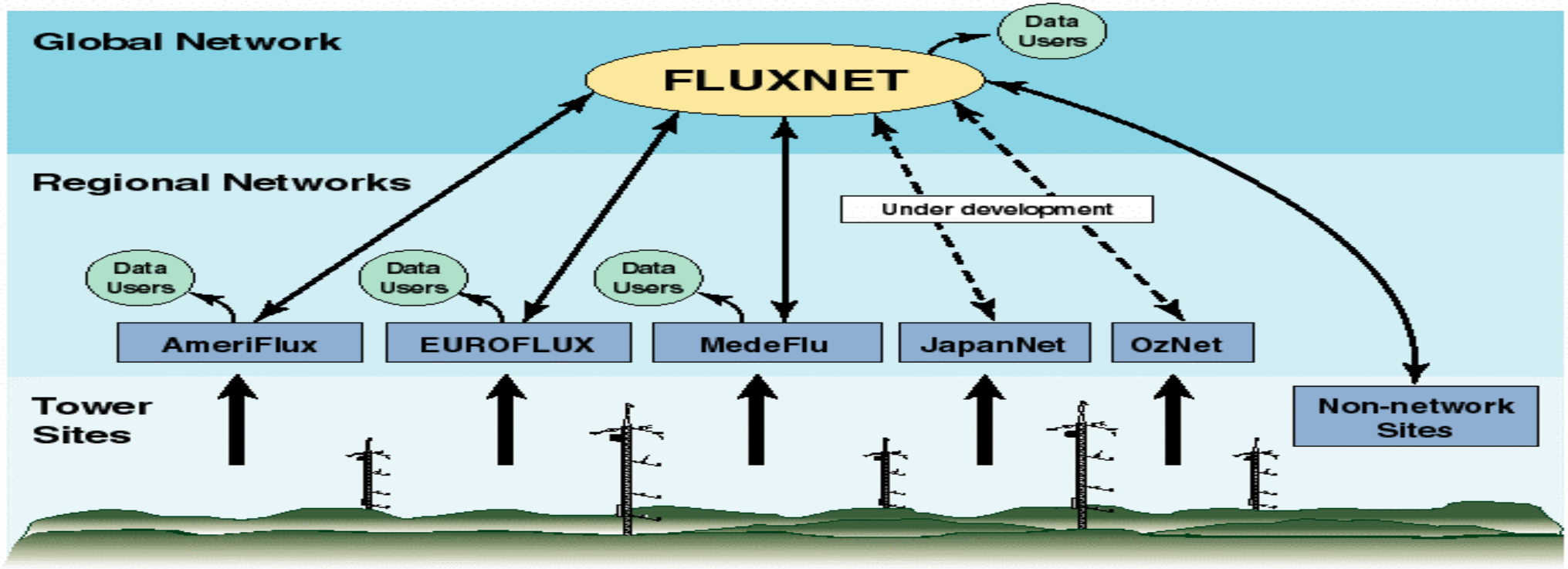
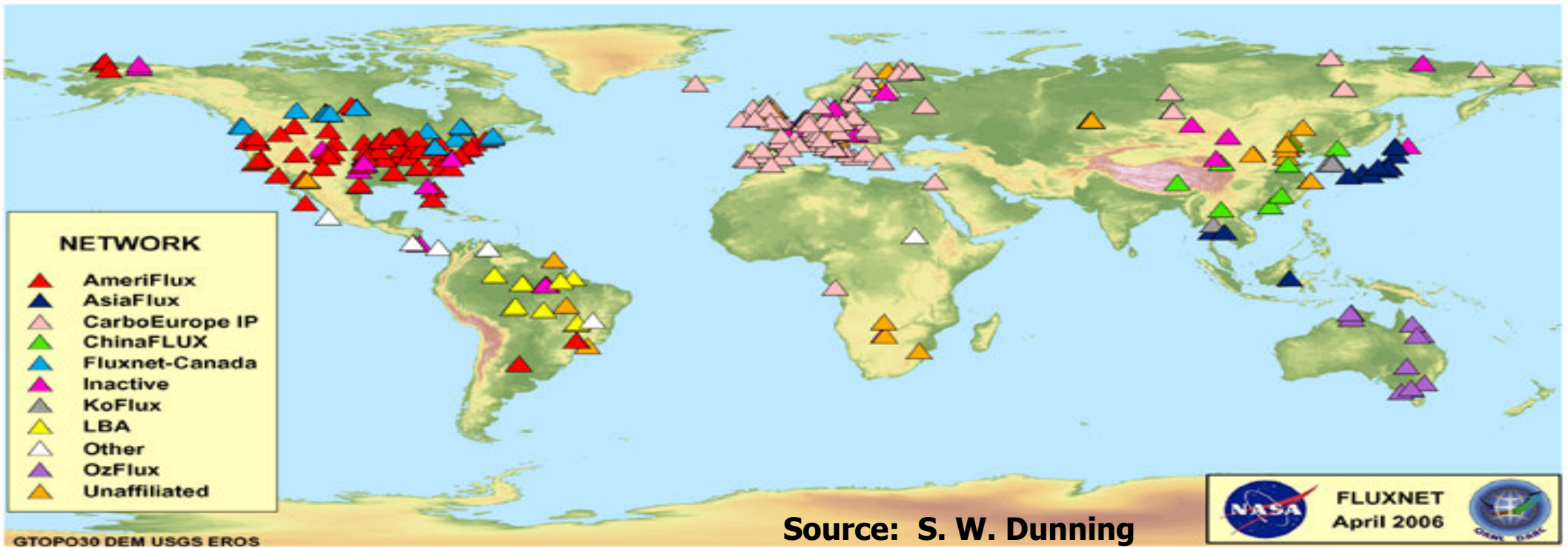
Architecture of Global/Regional Flux Networks





Source: S. W. Dunning

Bridging Remote Sensing and Ground Information

Relevance, Comprehensiveness, Timeliness, Credibility,...
Policy Analysis, Communication, Decision-making, Implementation…

- Problem, Issues and Goals
- Information – Remote Sensing and Ground
- Interdisciplinary Methodology and Modeling
- Policy Analysis and Options
- Policy Choice and Implementation Actions
- Monitoring and Evaluation

IIASA and FAO
AEZ-BLS Methodology: Integrated Decision-making
Food security and Sustainable Agriculture Development

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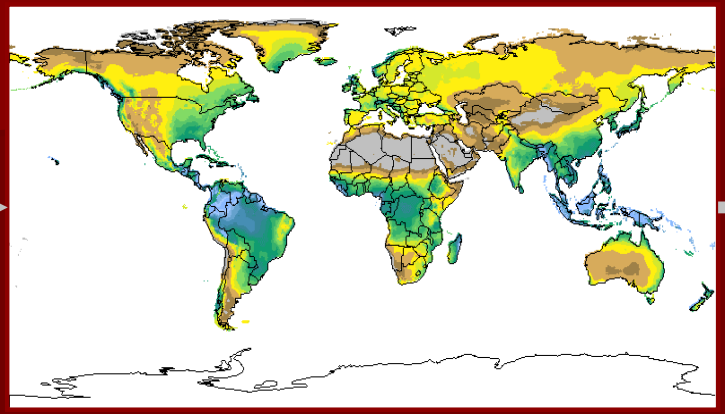
Land Resources and Food Security
Ecological - Economic Analysis



3

2

Climate model

1

GGI scenario

Climate impact response relations

4

Production

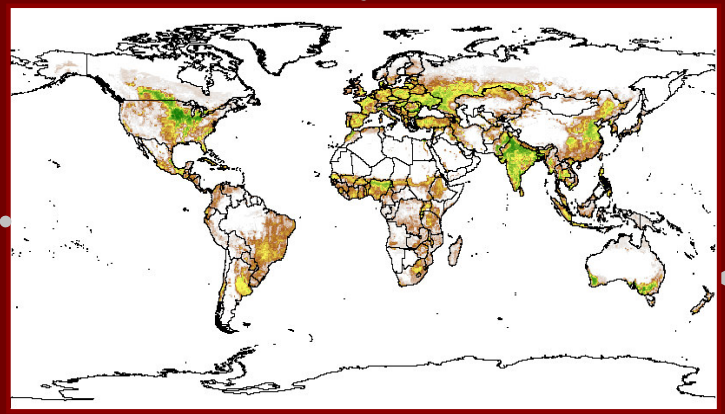
Demand

Trade

Global Food System

World Market

5



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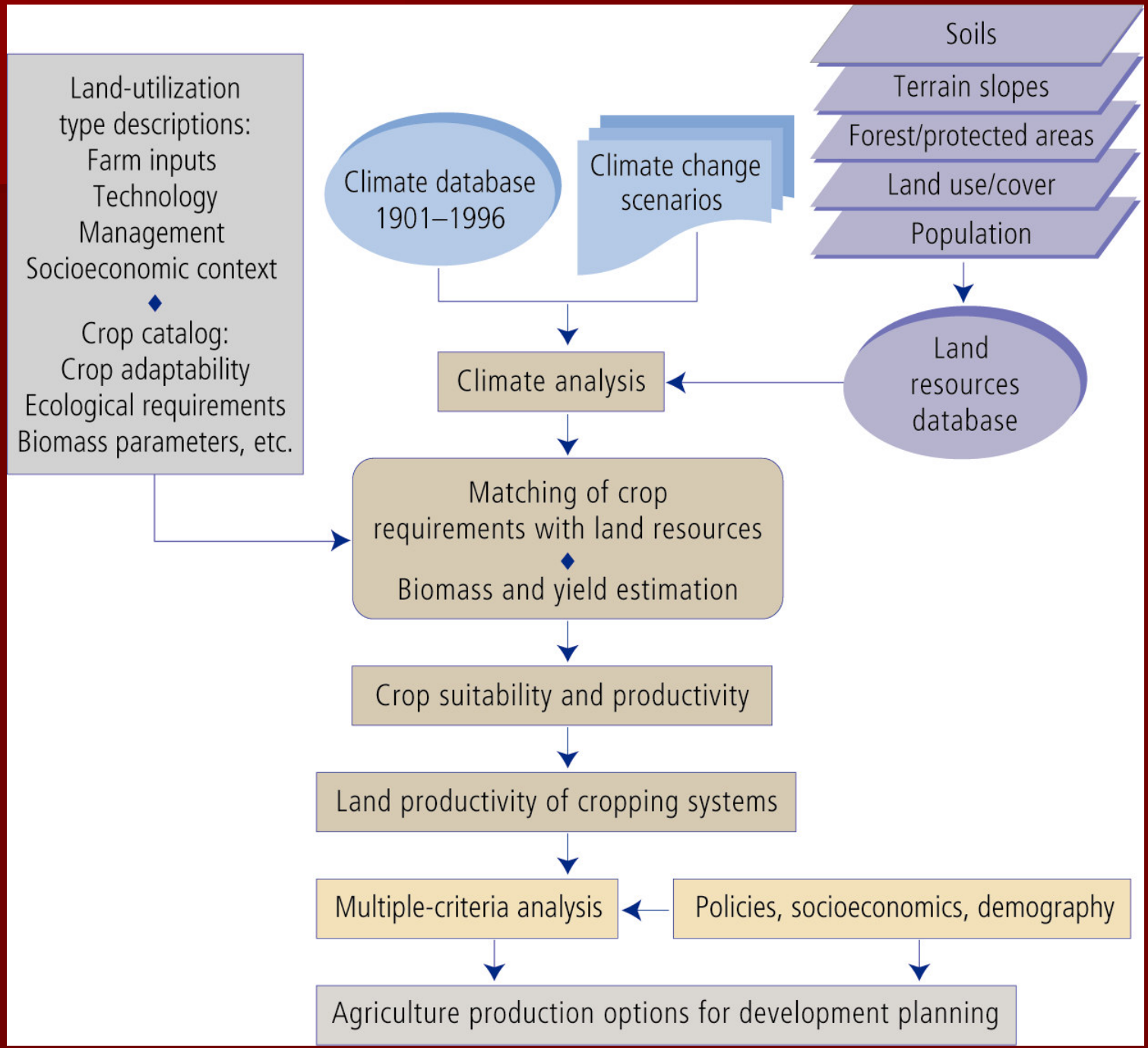
Agro-ecological Zones Methodology



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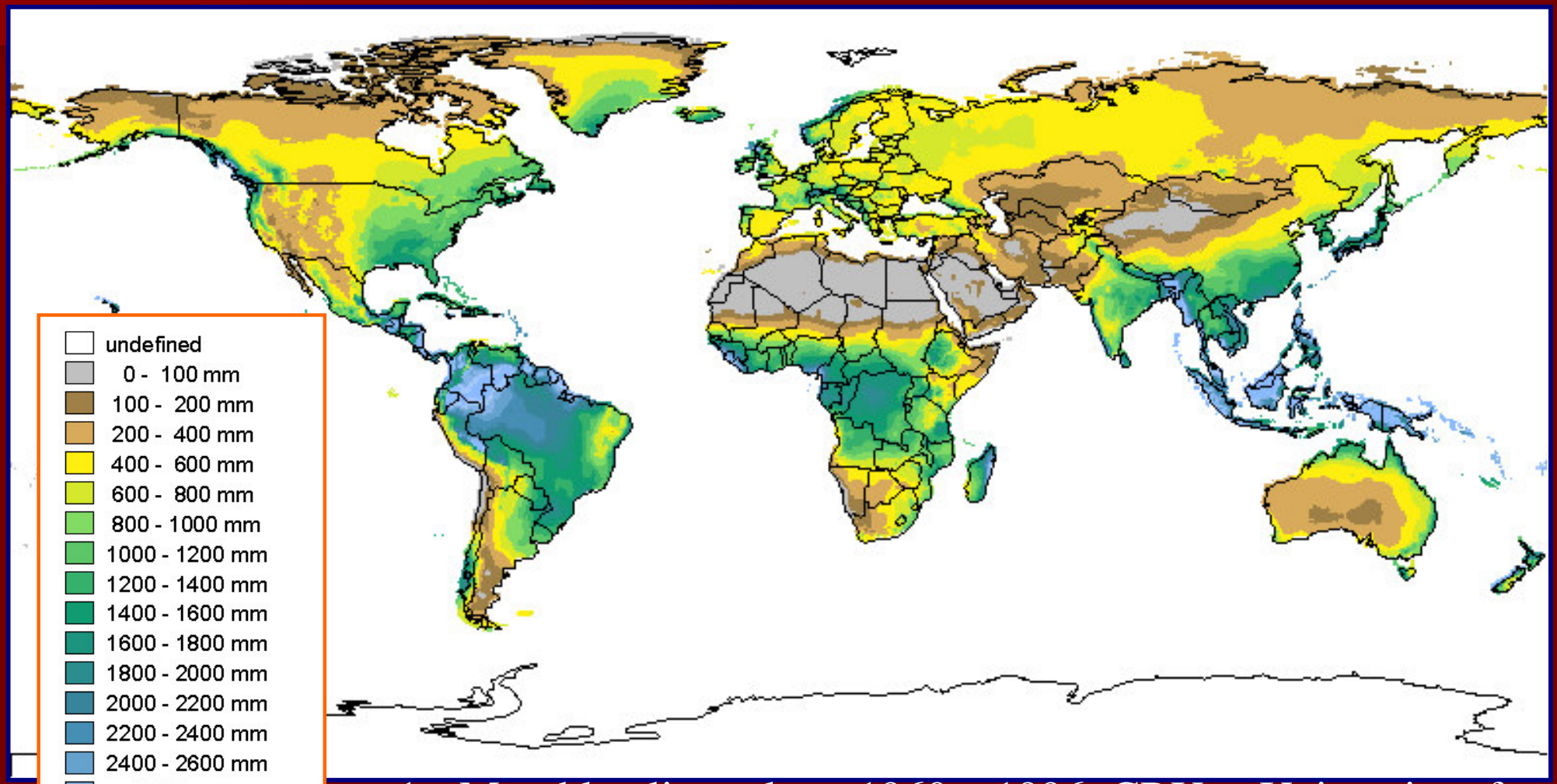
Agro-ecological Zones Methodology
Geographical Data Layers



1. Monthly climatology 1960 – 1996; CRU at University of East Anglia; at 0.5 deg. latitude/longitude

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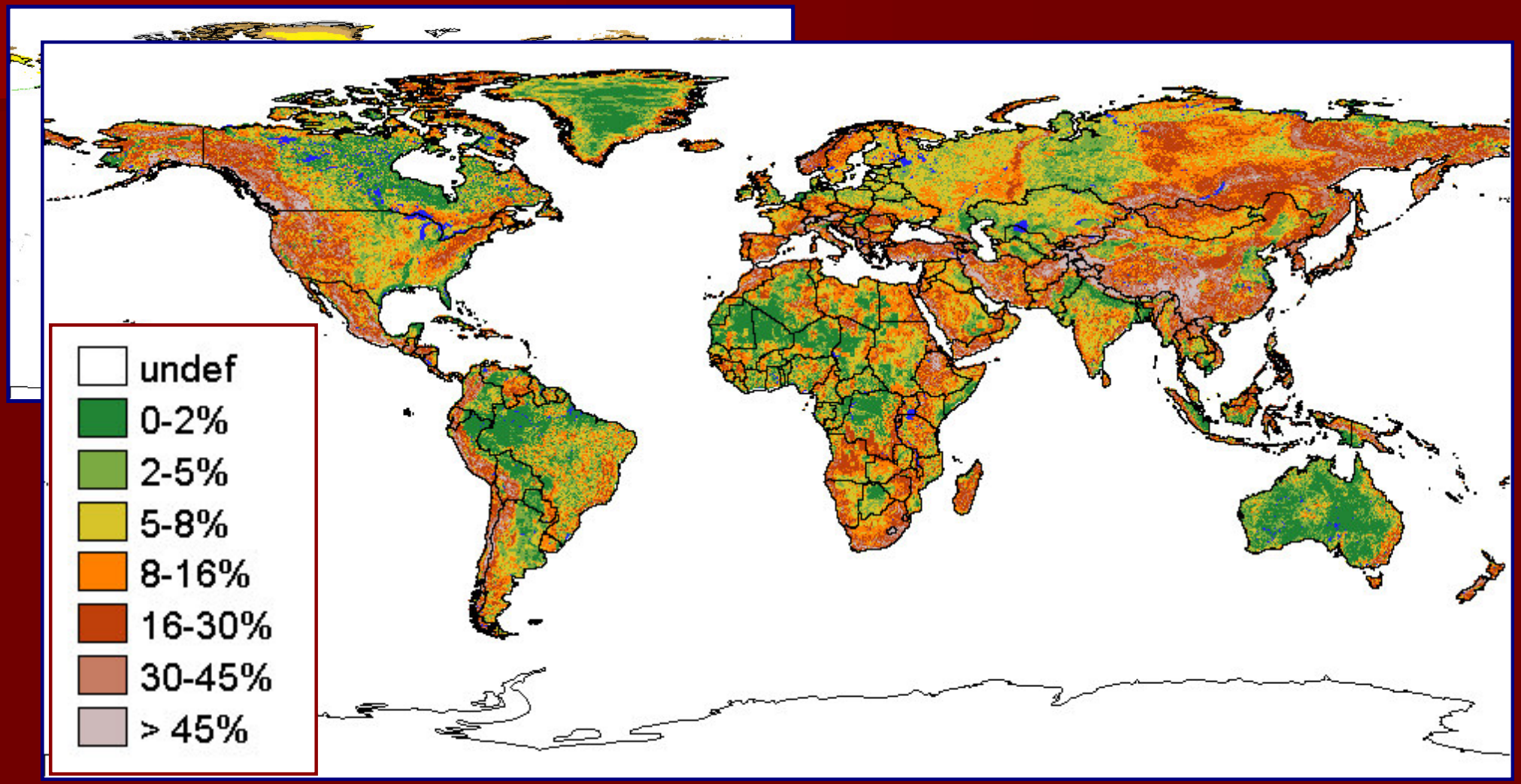
Agro-ecological Zones Methodology
Geographical Data Layers



2. Terrain slope database; USGS Eros Data Center; digital elevation at 30 arc-seconds latitude/longitude

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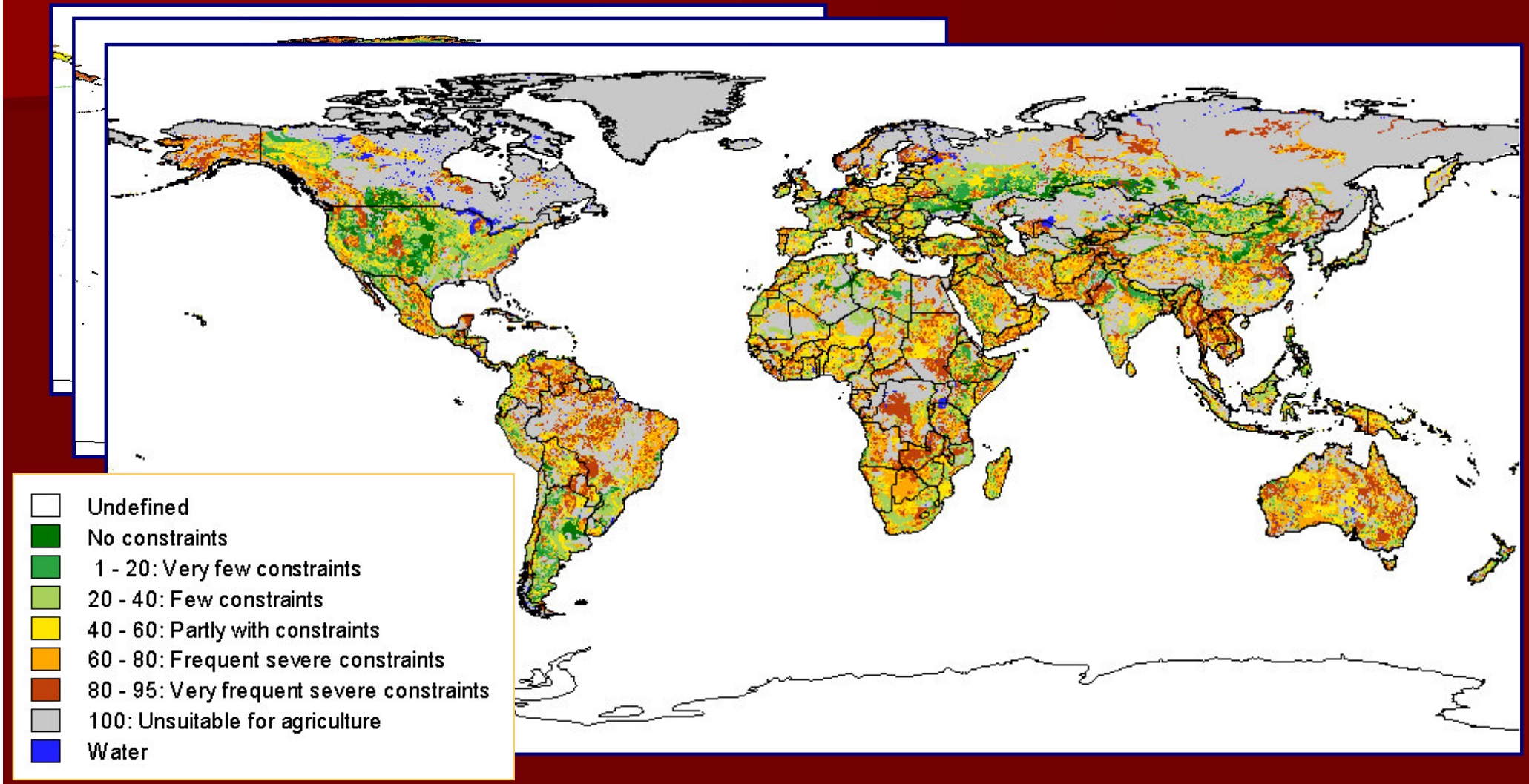
Agro-ecological Zones Methodology
Geographical Data Layers



3. FAO/Unesco digital Soil Map of the World; UN Food and Agriculture Organization; at 5 arc-min. latitude/longitude

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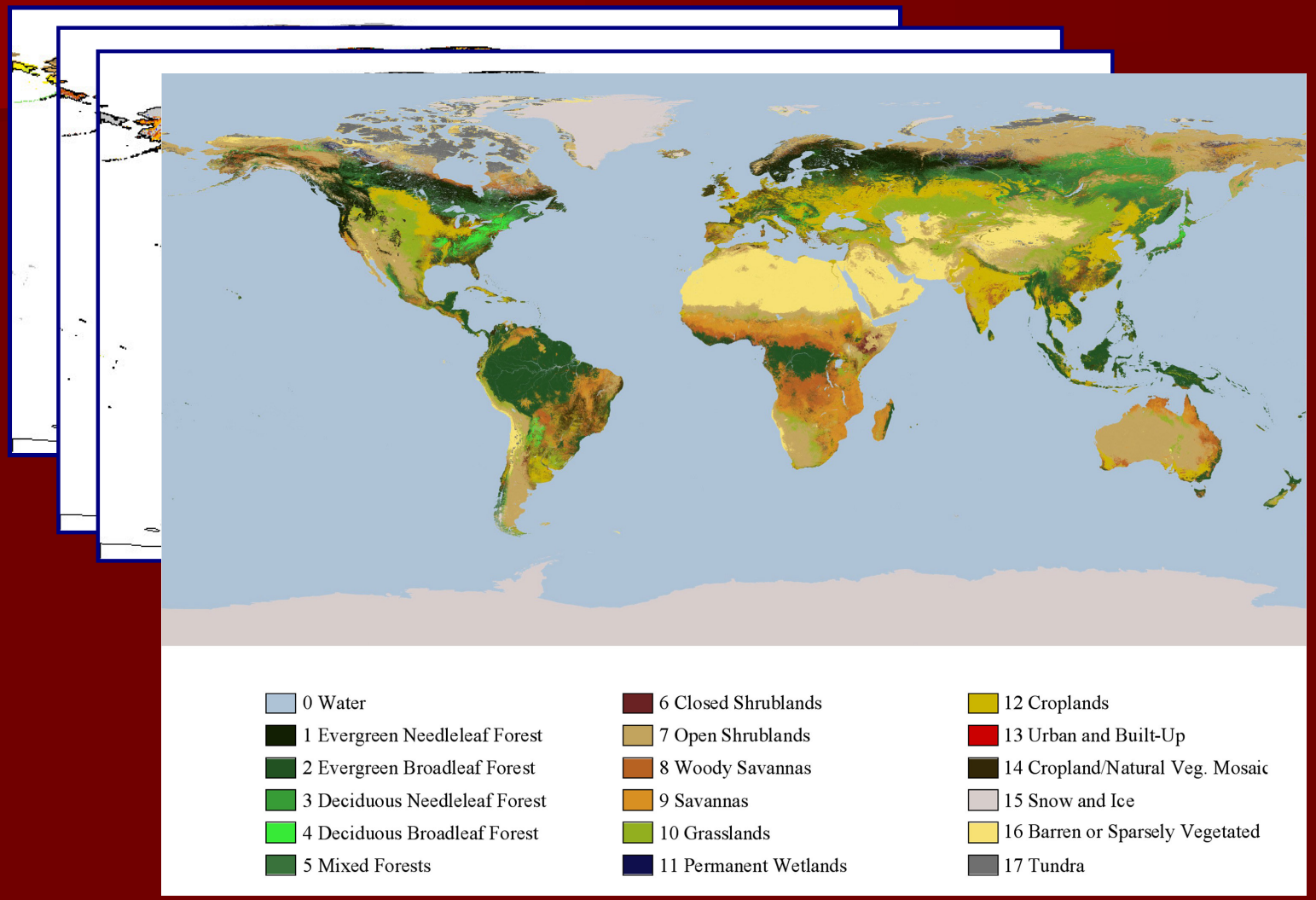
Agro-ecological Zones Methodology
Geographical Data Layers



4. Global land cover characteristics database; NASA

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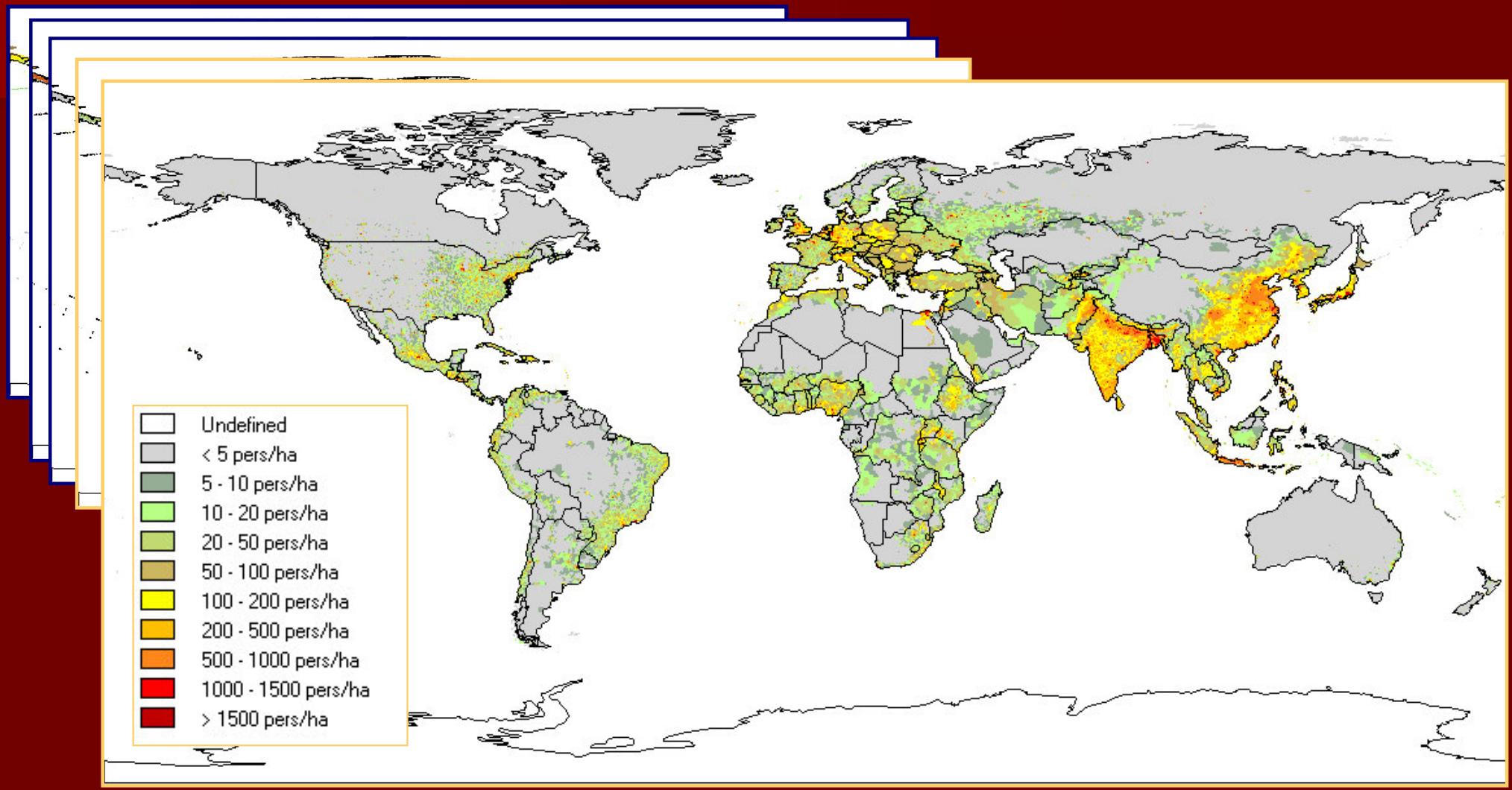
Agro-ecological Zones Methodology
Geographical Data Layers



5. Global gridded population distribution data of 1995; CIESIN; at 2.5 arc-min. latitude/longitude resolution.

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Global Agro-ecological Zones

Environmental resources database

including climate, soil, terrain, and land cover

comprising 2.2 million grid cells,

assessing the agricultural potential

of Crops, pastures, trees, shrubs

at three levels of farming technology.

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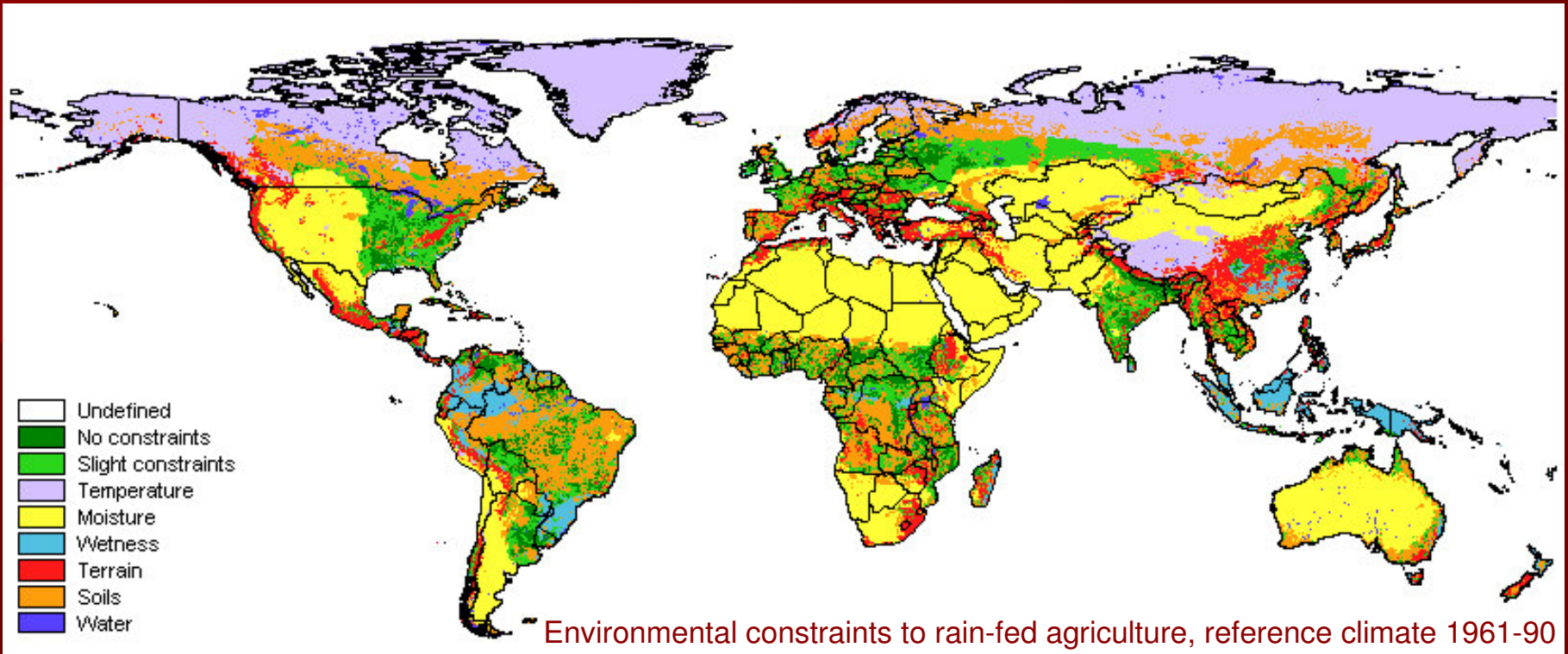
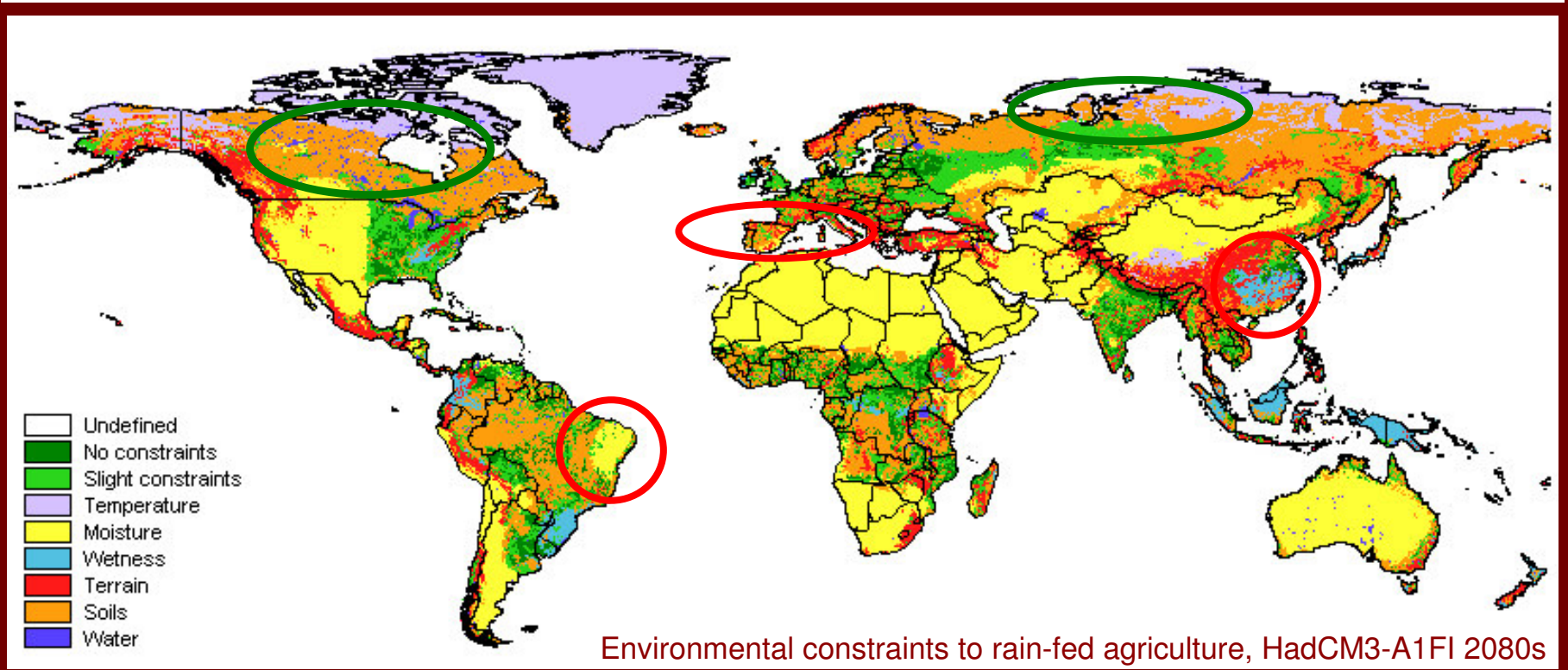


Environmental constraints to rain-fed agriculture, reference climate 1961-90

3.7



Environmental constraints to rain-fed agriculture, HadCM3-A1FI 2080s

3.8

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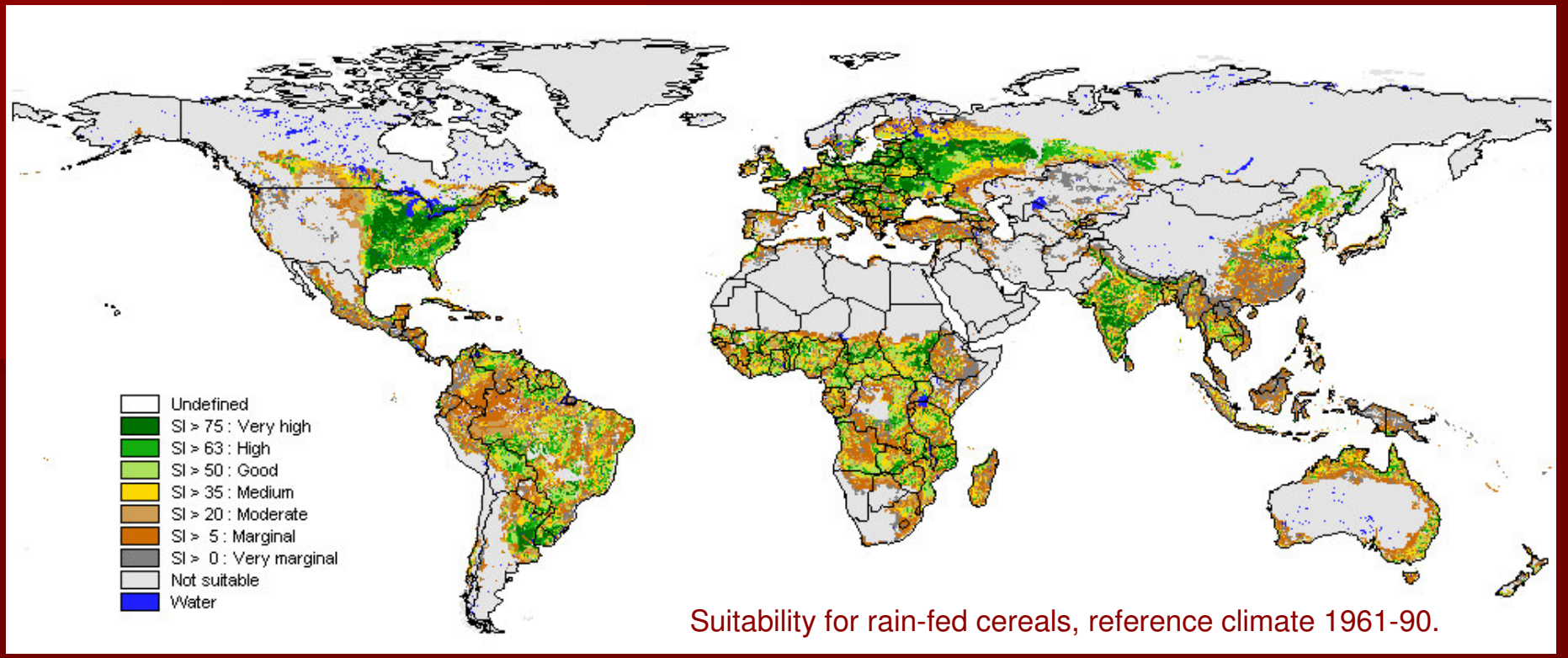
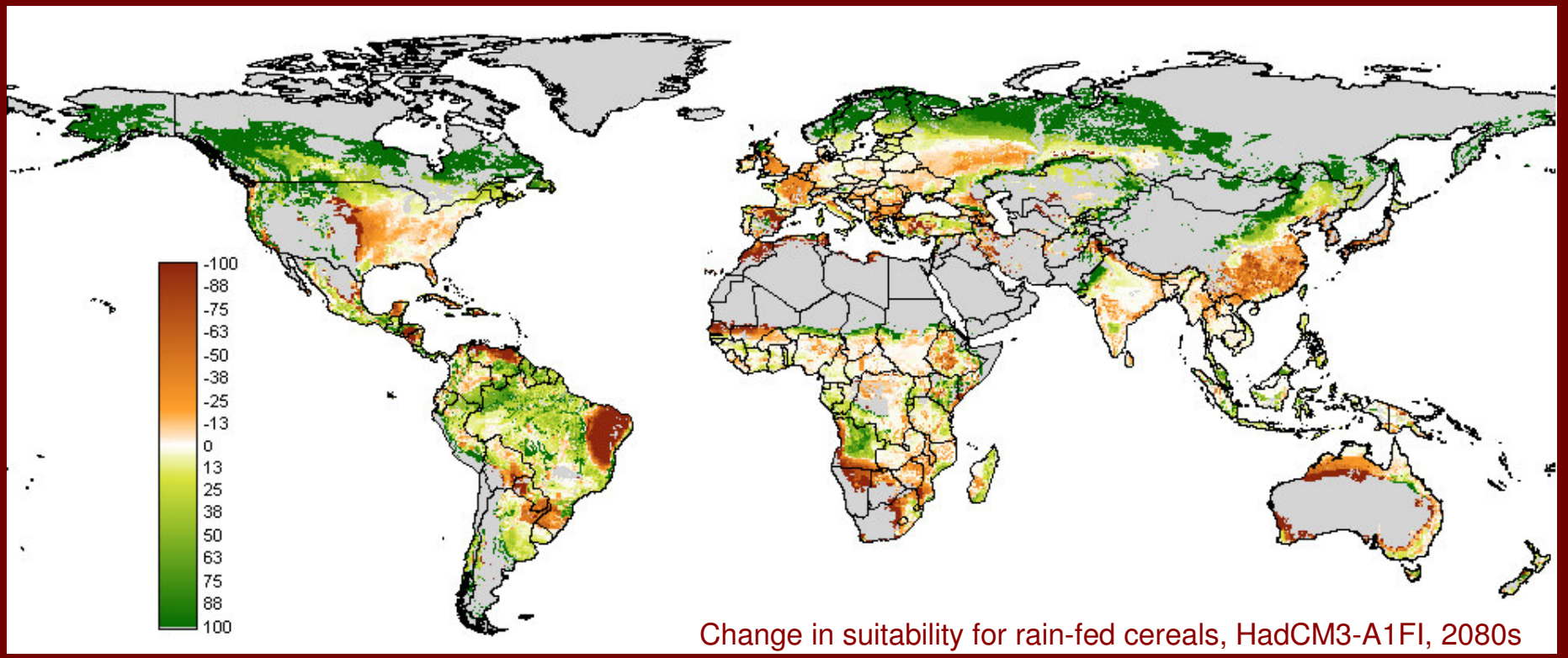


Suitability for rain-fed cereals, reference climate 1961-90.

3.12a



Change in suitability for rain-fed cereals, HadCM3-A1FI, 2080s

3.12b

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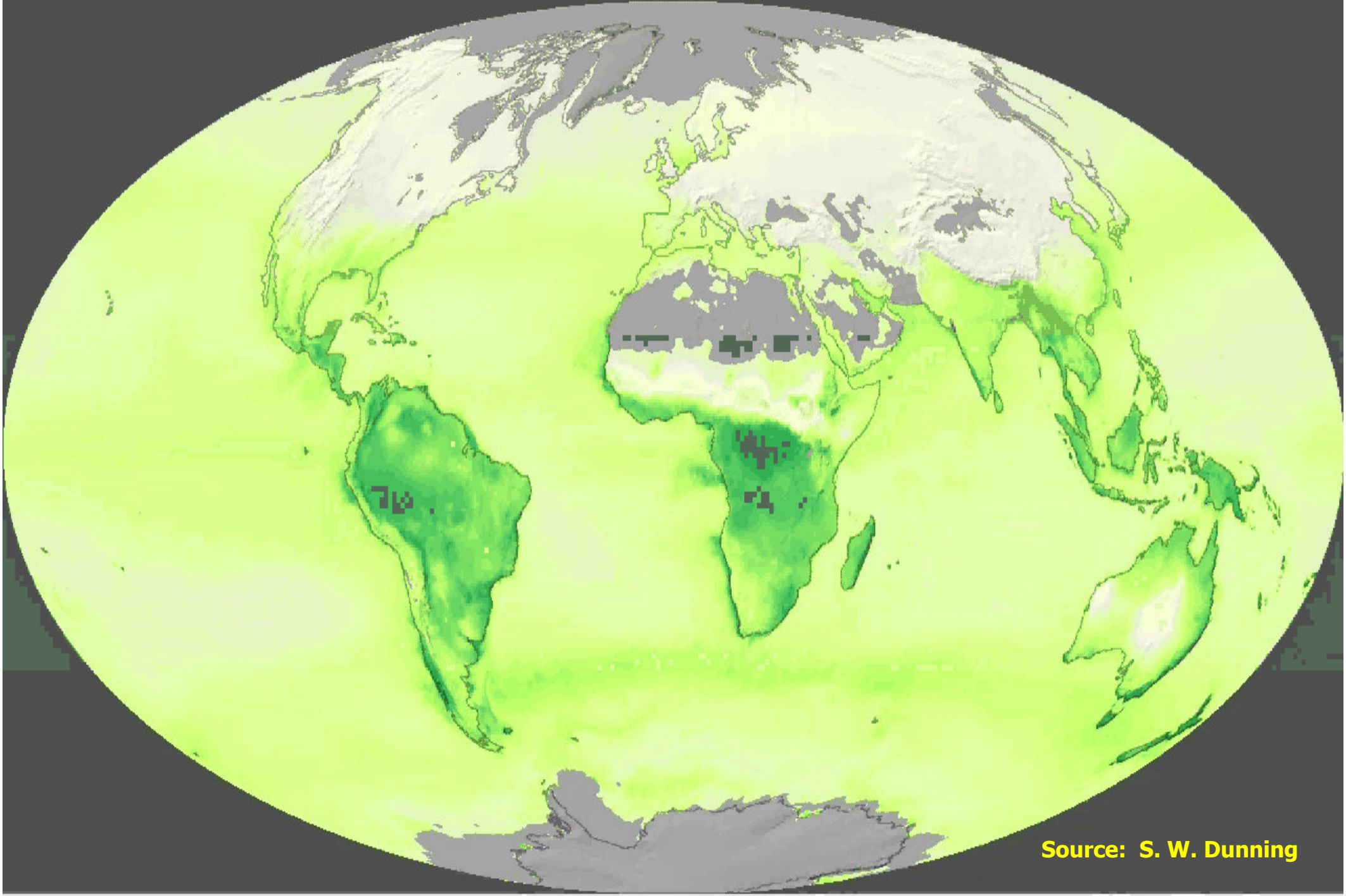
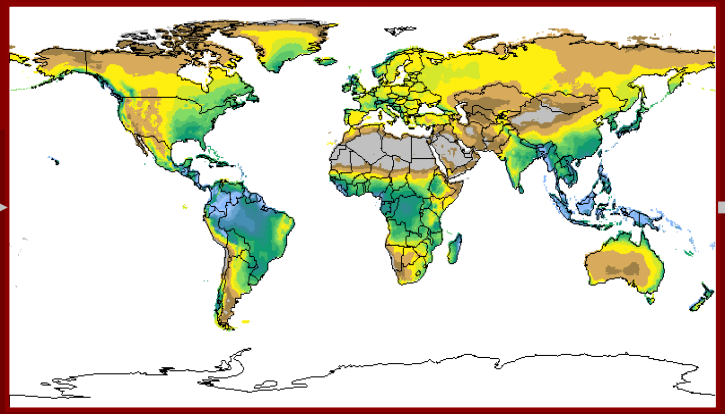

Source: S. W. Dunning
Ocean Data: M.J. Behrenfeld (Oregon State Univ.)
Land Data: S.W. Running (Univ. of Montana)
Movie: R. Stöckli (NASA Earth Observatory)
Net Primary Productivity [kgC/m2/year]
-0.5
0.0
0.5
1.0
1.5
2.0
2.5
JAN 2000
MODIS
NASA

Land Resources and Food Security
Ecological - Economic Analysis



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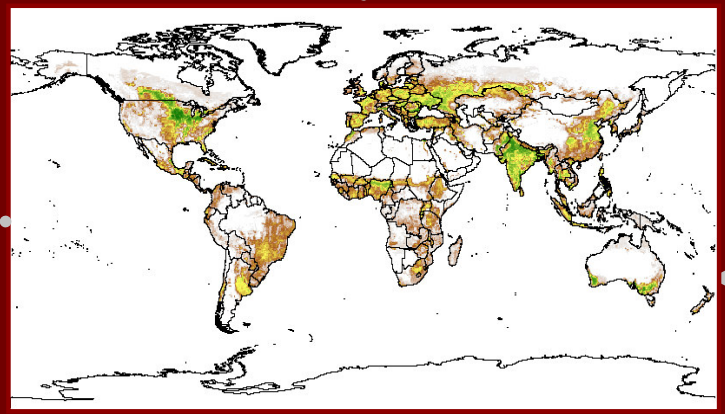

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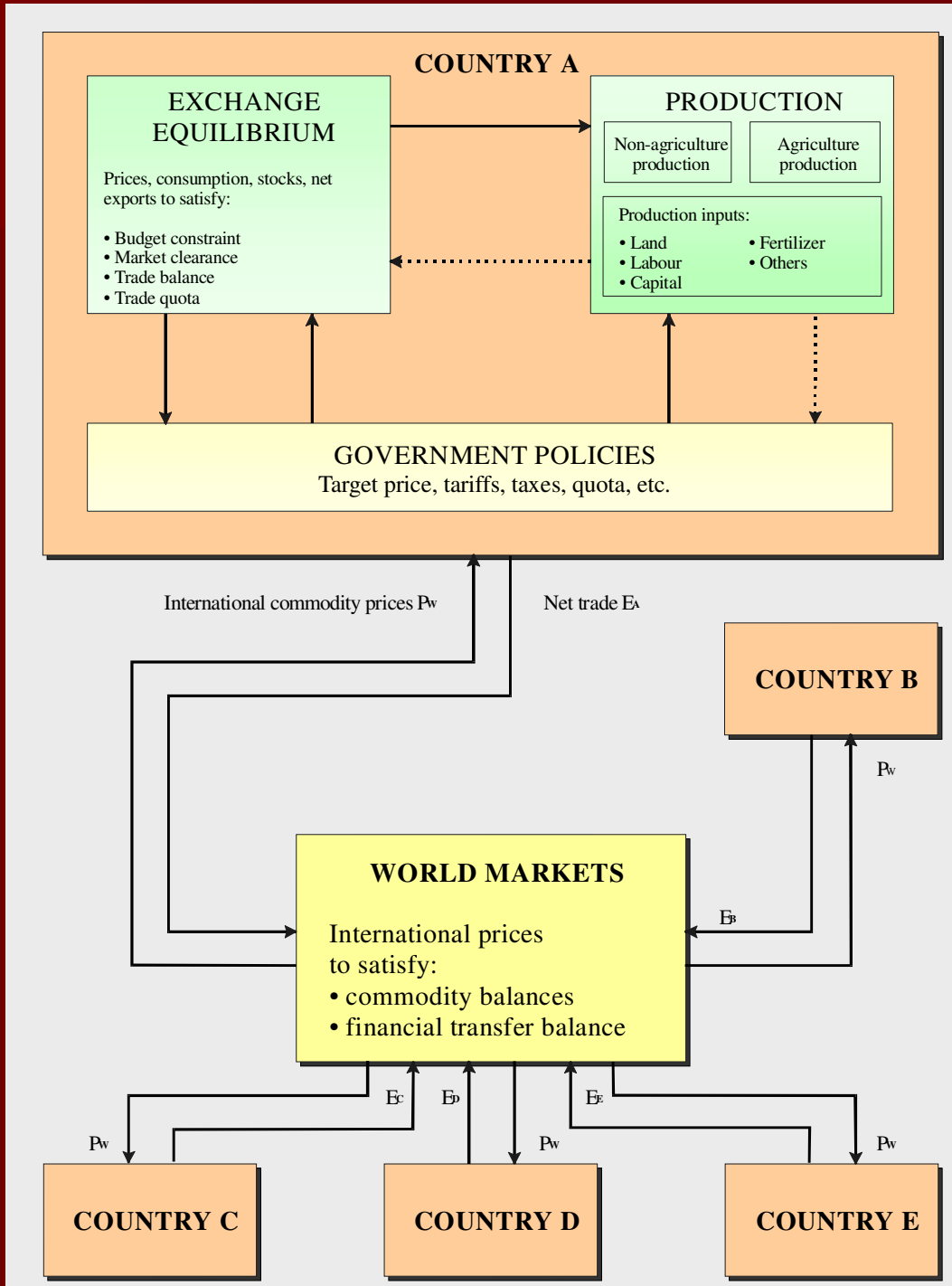
The International Linkage in the World Food System Model

18 national models,
2 country-group models,
14 regional models

Commodities: wheat, rice, coarse grains, protein feed, bovine & ovine meat, dairy products, other animal products, other food, non-food agriculture, non-agriculture.

Linkage: trade, world market prices and financial flows



Economic Impacts of Climate Change Hadley A1F1 Scenario 2080

	% AgGDP	% Cereal Prdn
World	-1.5	-1.4
Developed	-0.5	2.8
North America	7.5	1.3
Europe	-14.7	-3.4
Devloping	-1.9	-3.9
Africa	-4.9	-0.6
Latin america	3.7	15.9
Asia	-4.3	-8.6

World Market prices(% change from Ref Scenario)

Cereals 19.5% All crops 10.5%

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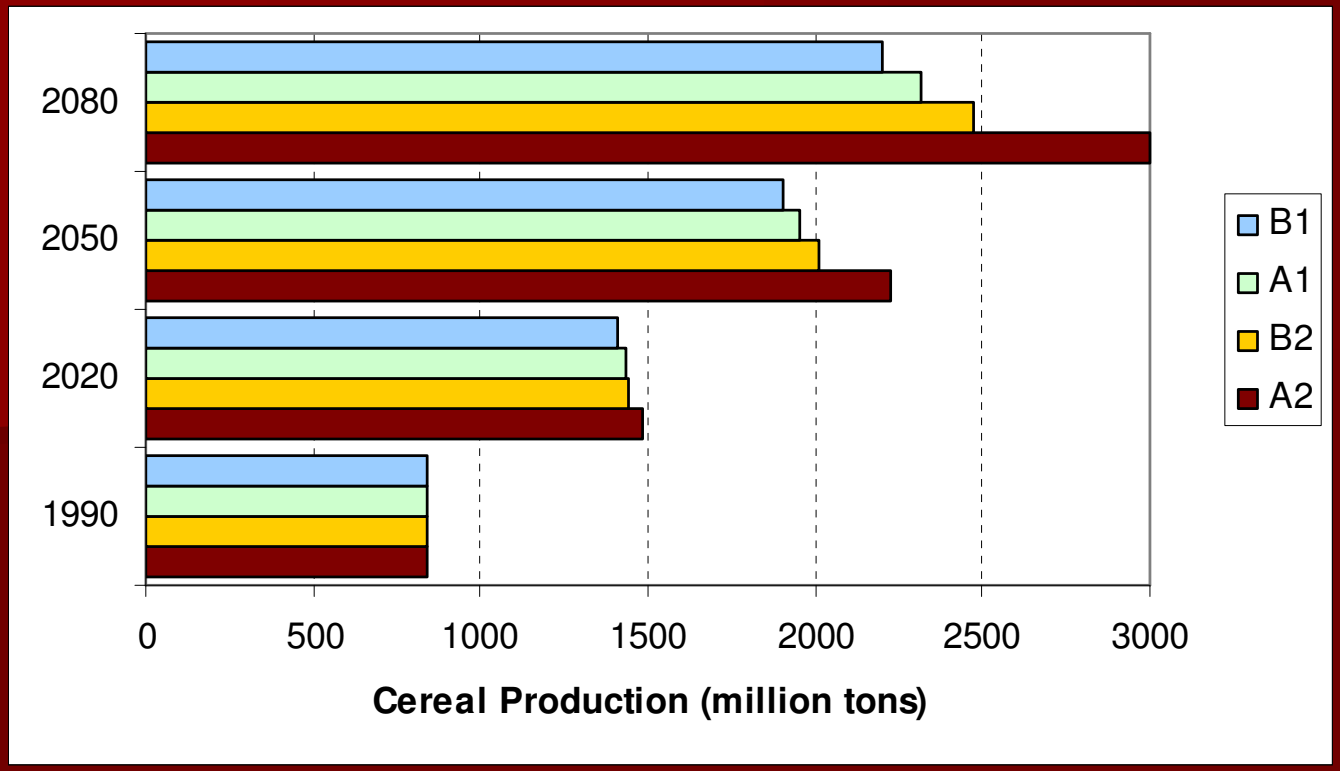
Cereal Production, Net Imports of Developing Countries

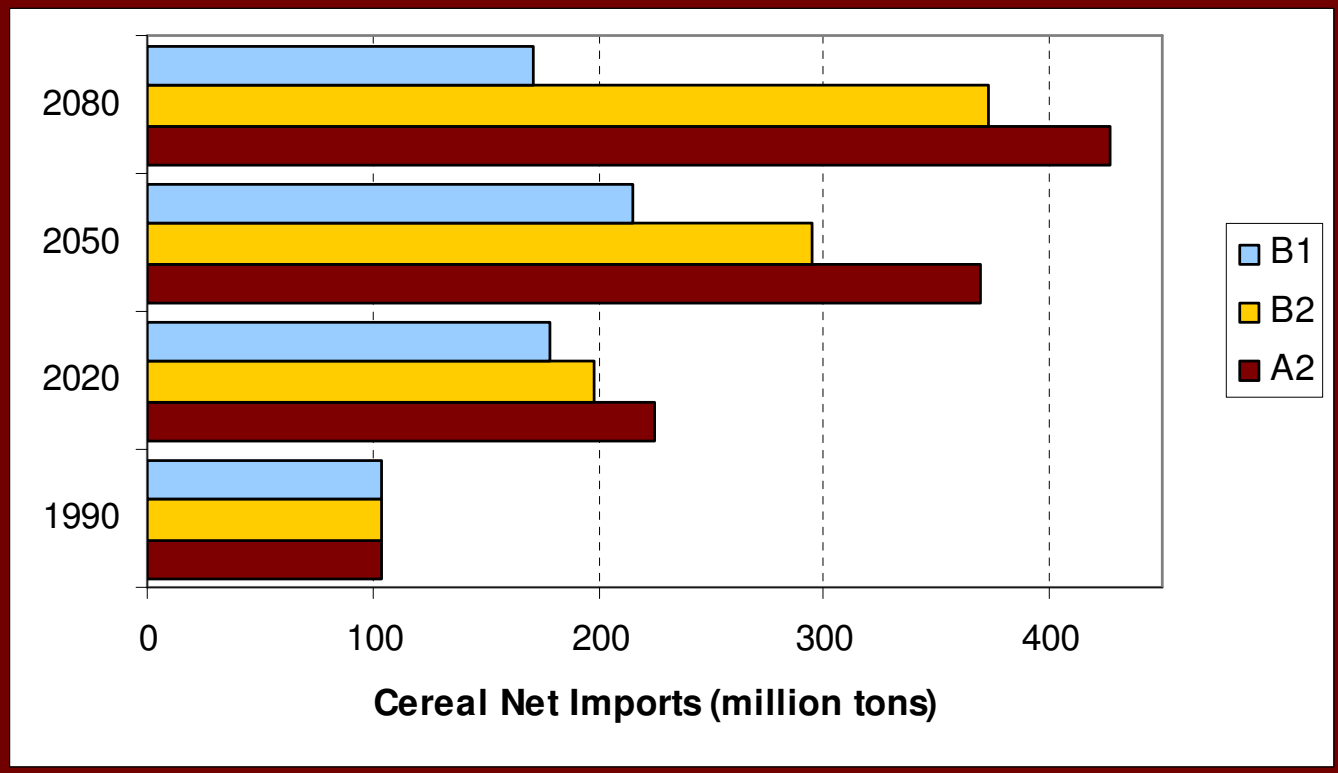
projected for different IPCC economic development paths



PRODUCTION

Source: Fischer et al., 2002

NET IMPORTS, CEREALS



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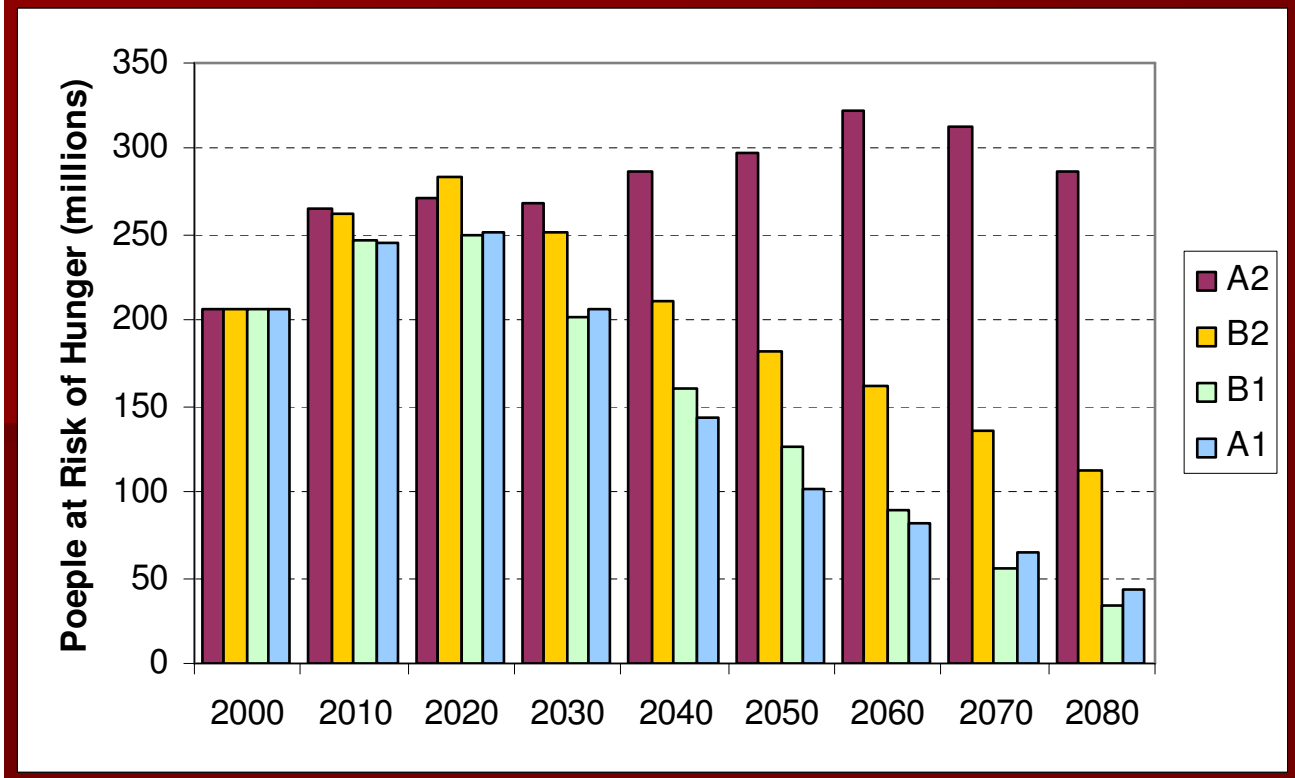
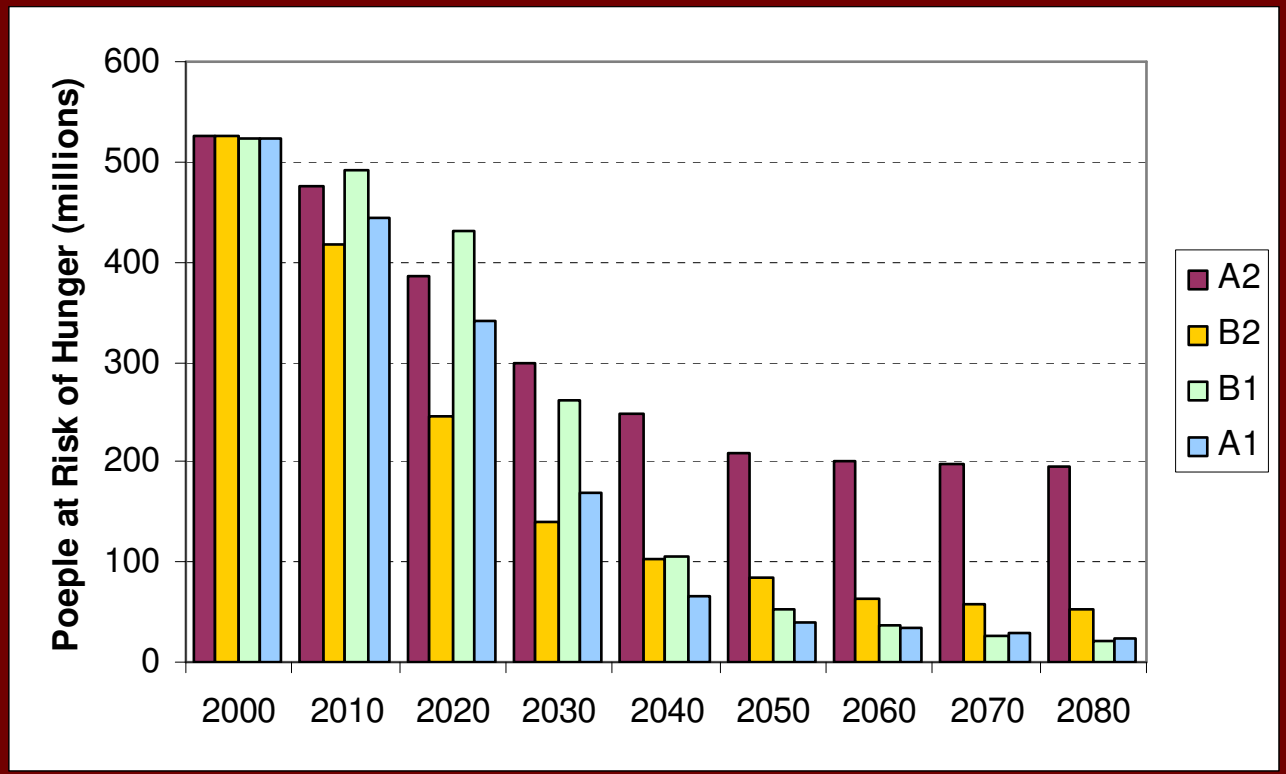
Number of People at Risk of Hunger

projected for different IPCC economic development paths



AFRICA

Source: Fischer et al., 2002



SOUTH, SOUTEAST and EAST ASIA

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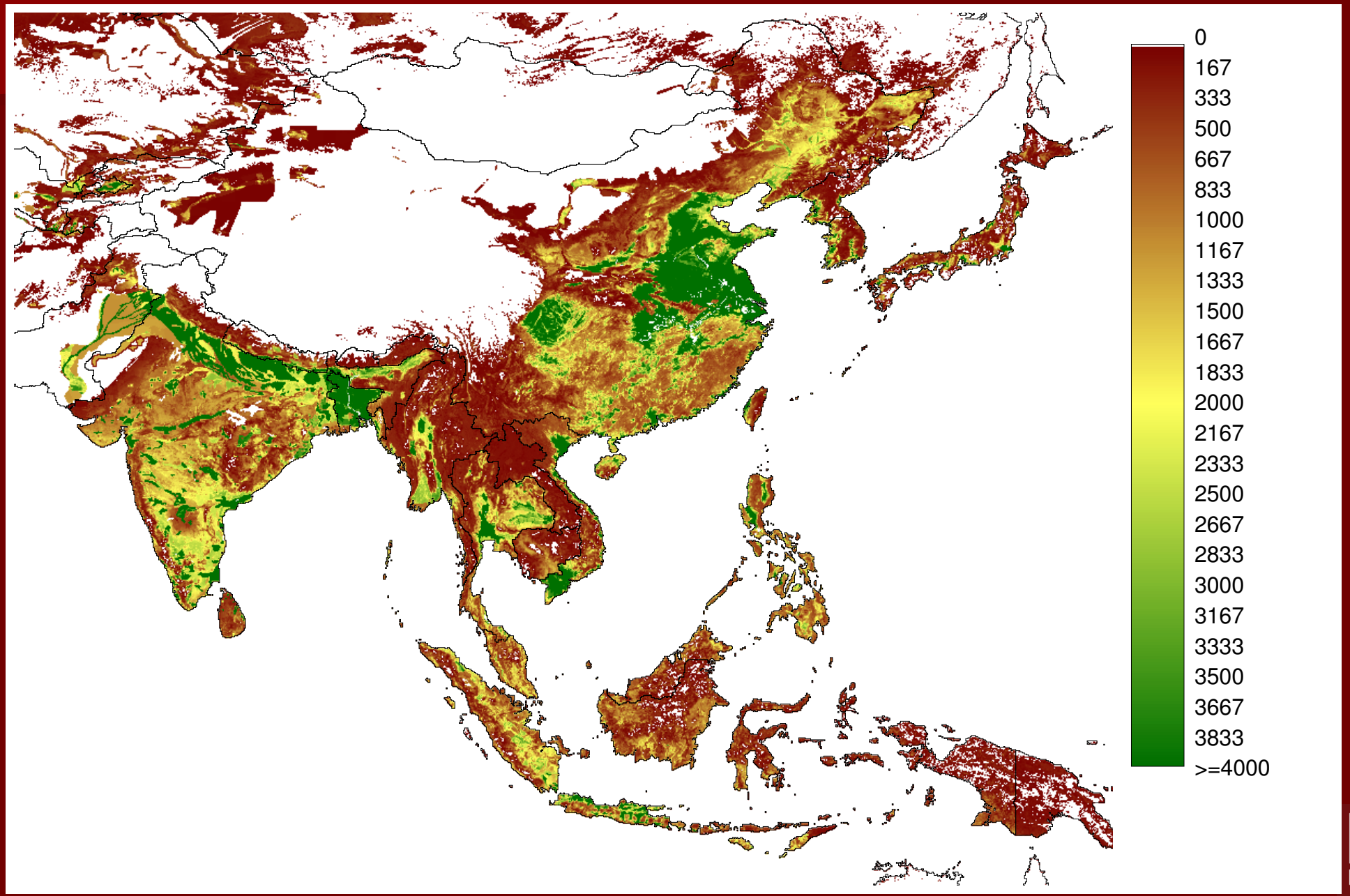
Spatial Results: Agriculture and Rural Poverty
Value of Agricultural Output per Grid-cell



India : Impact of Climate Change on Agriculture – 2080s

	Cereal Production	GDP Agriculture	Cereal Consumption
H3A1f	-15.7	-4.8	-7.5
H3A2	-15.9	-7.9	-6.4
H3B2	-9.8	-4.4	-4.4
H3B1	-5.7	-1.0	-3.8
CSA1b	-9.6	-1.8	-4.6
CSA2	-10.4	-3.9	-4.1
CSB2	-8.2	-2.8	-4.9
CSB1	-7.5	-2.7	-5.0
CSA2	-5.7	1.0	-2.2
CSB2	-5.4	2.5	-1.2
NCA2	-10.3	0.9	-0.4
NCB2	-5.7	1.9	0.1

Note: percent change relative to respective reference projection without climate change

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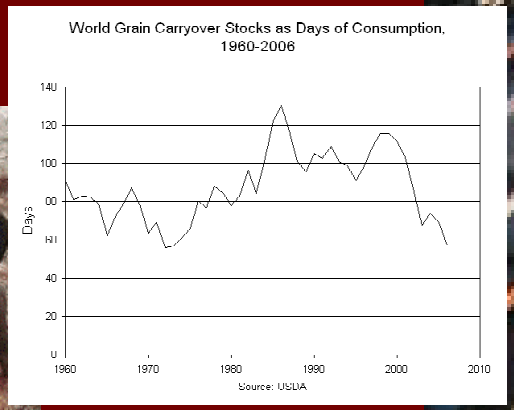
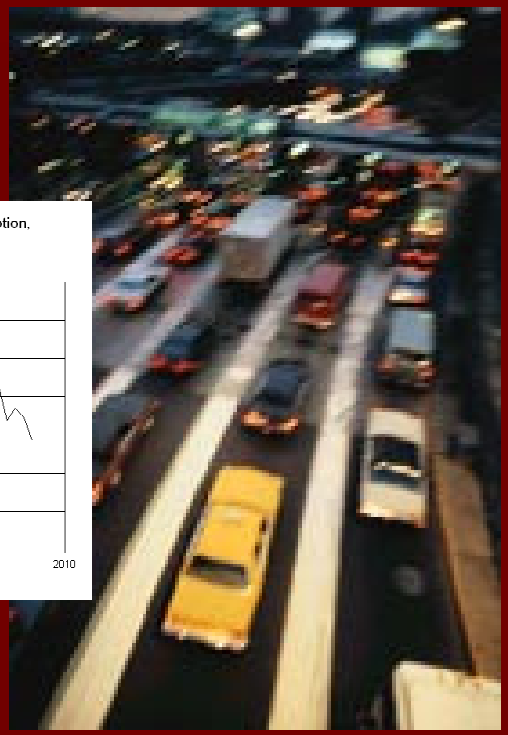
2008 World Food Crisis
Bloodfuels and Biofuels

- Corn - Tortilla Price Riots in Mexico
- Land for Palm Oil and farmer's deaths in Colombia
- Doubling of corn prices and export cutbacks
- World Food Stocks Lowest in History
- +200 Million more are food-insecure





Biofuel Targets 10 to 20% of Transport Fuel
From Food crops for Livestock to Food crops for Cars

5% of World Food Production Traded
Disproportionate Impact: Exporters Diversification of First Generation Biofuels

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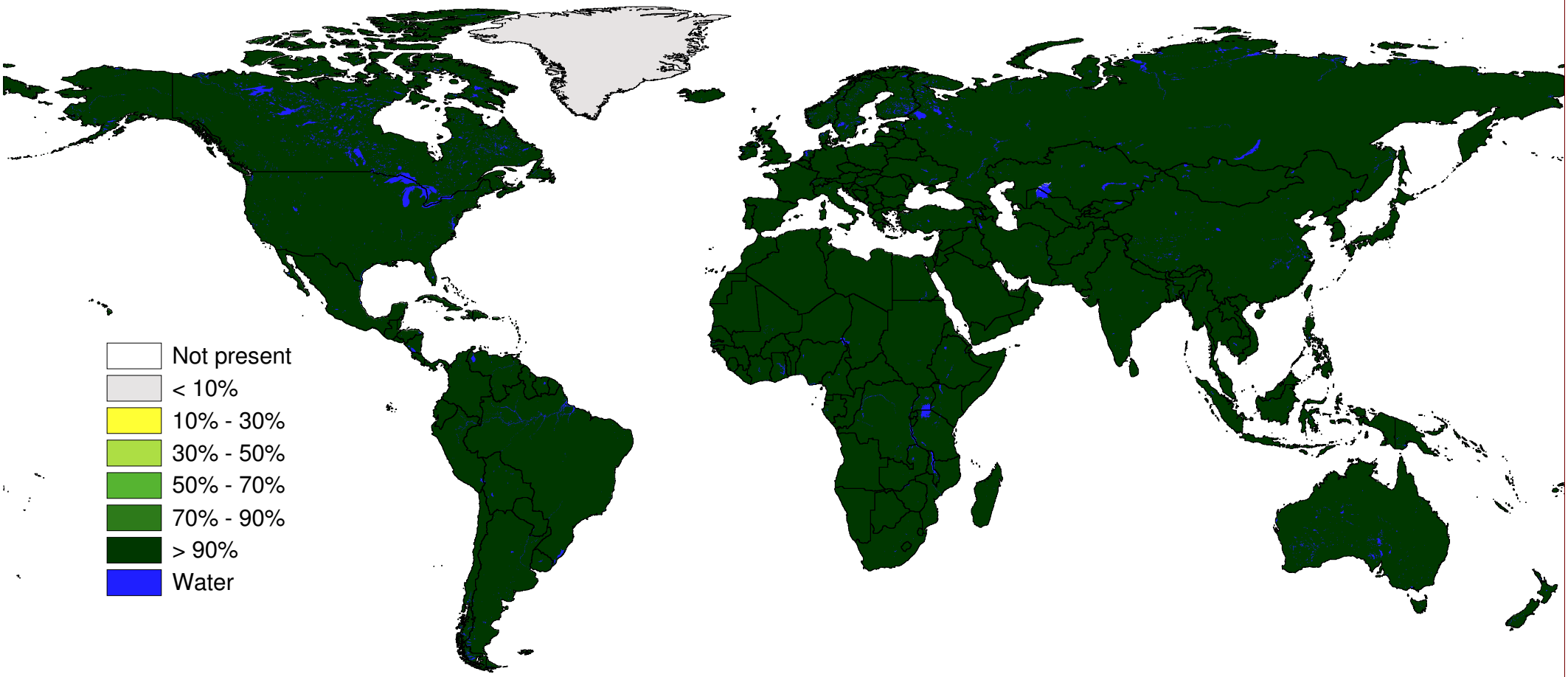
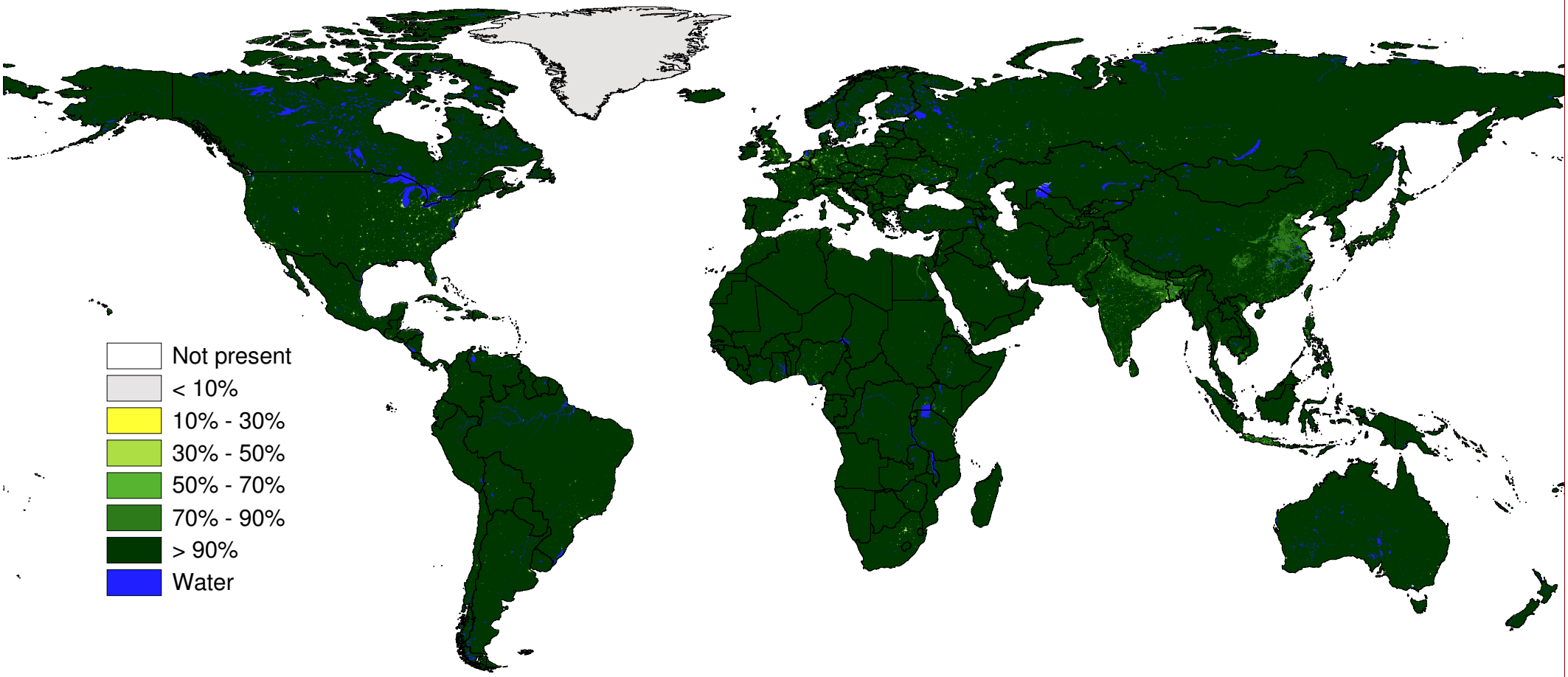
Remote Sensing and Ground Information

Total land ...



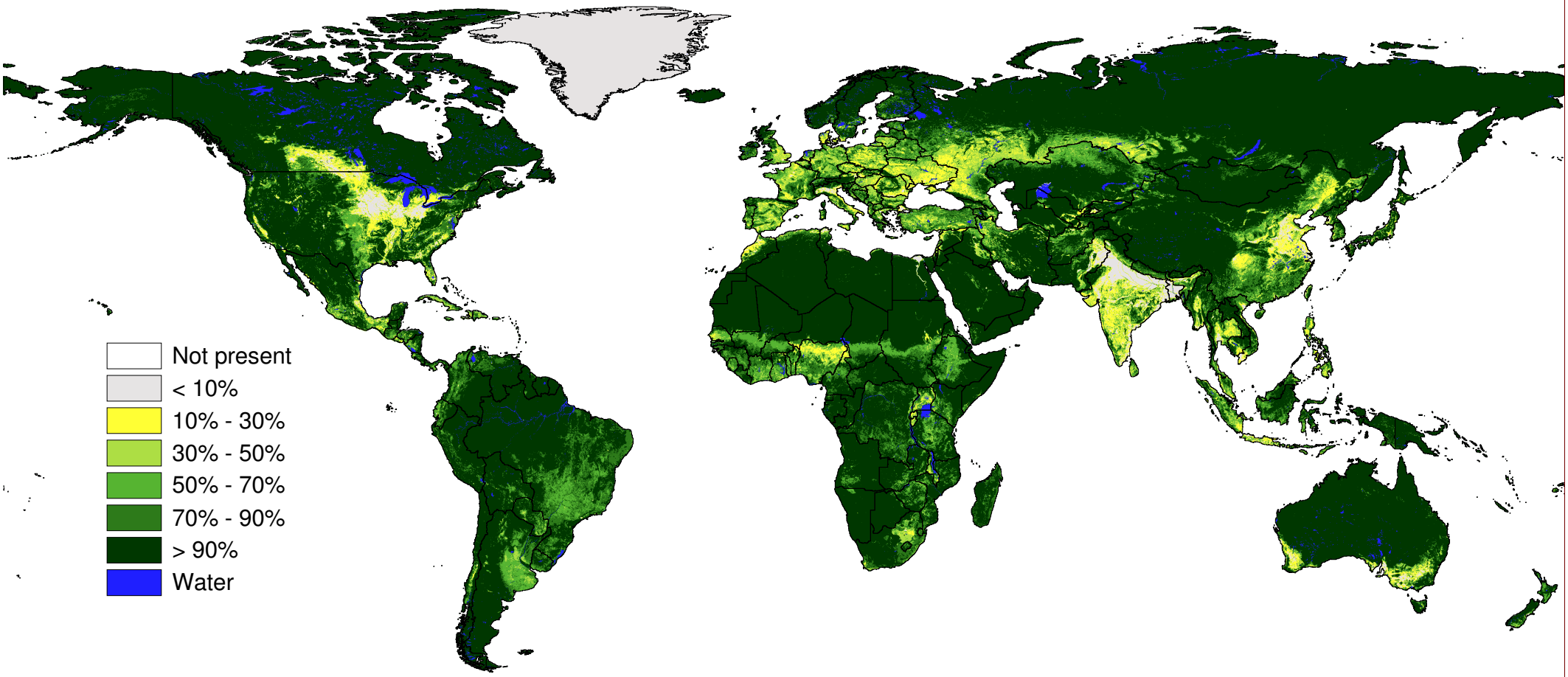
Remote Sensing and Ground Information

... subtracting built-up areas



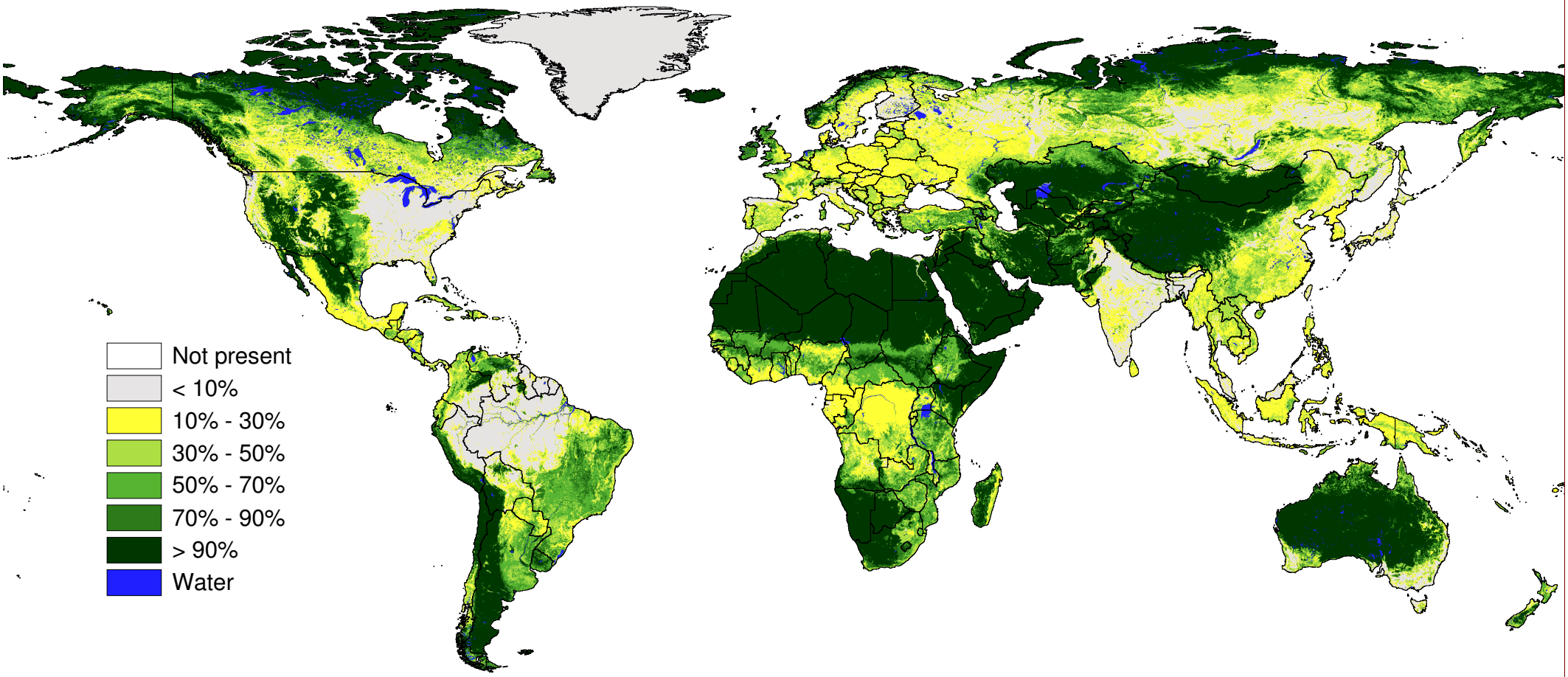
Remote Sensing and Ground Information

... subtracting cultivated land



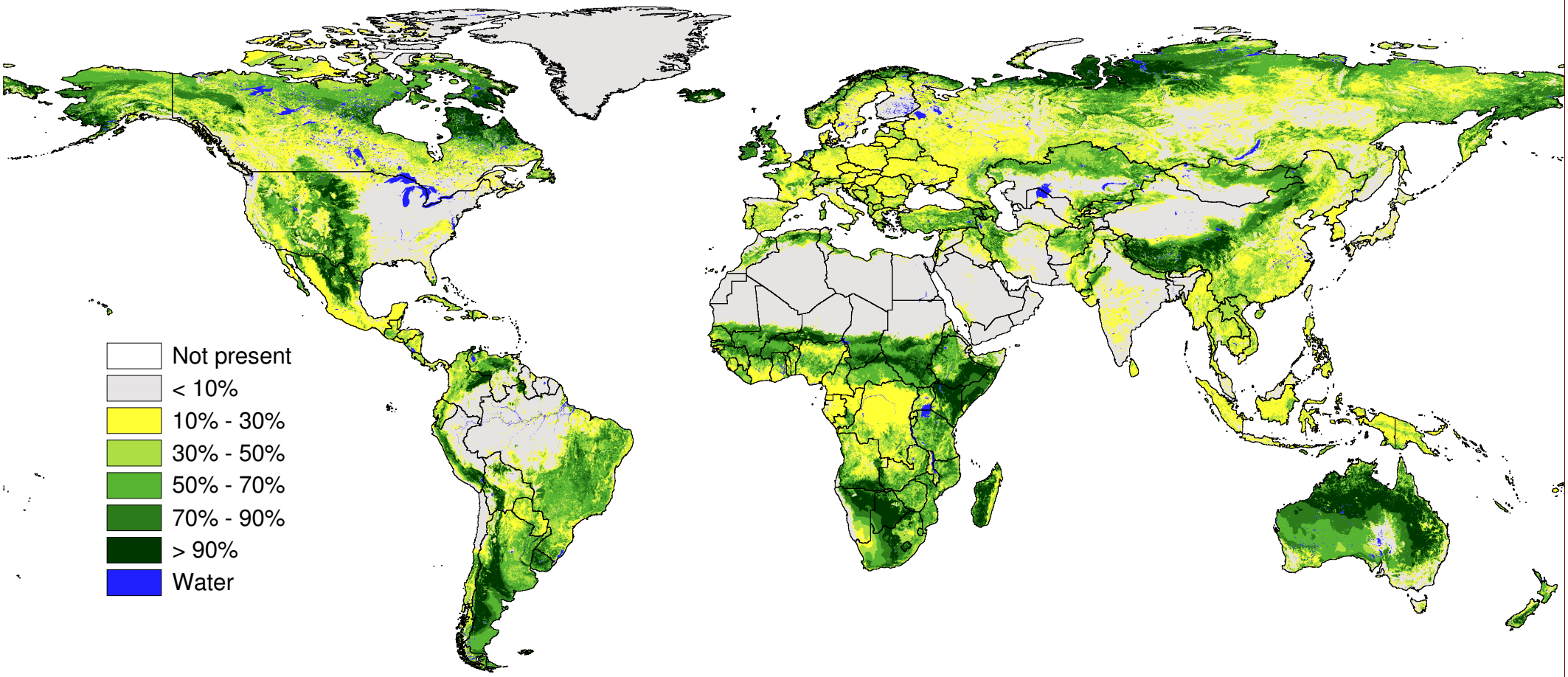
Remote Sensing and Ground Information

... subtracting forest areas



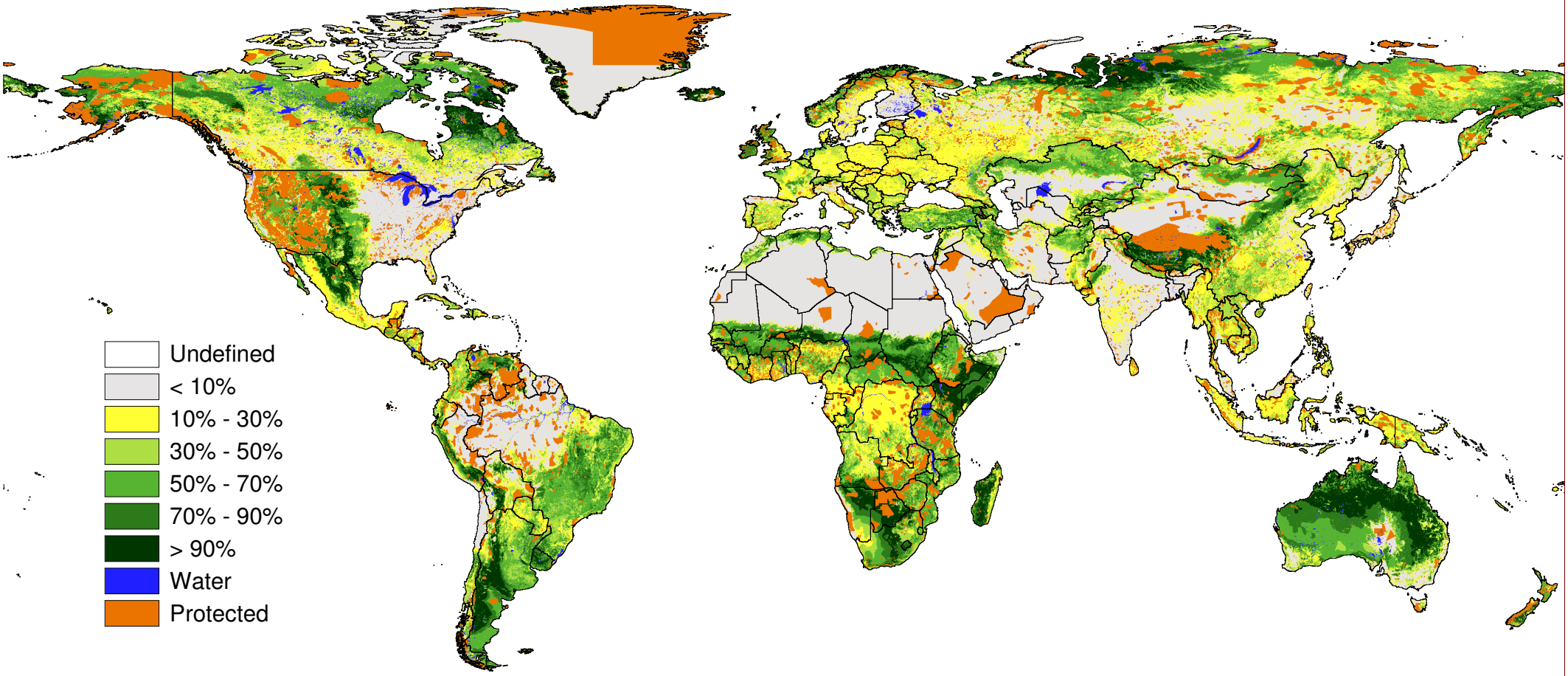
Remote Sensing and Ground Information

... excluding non-vegetated areas



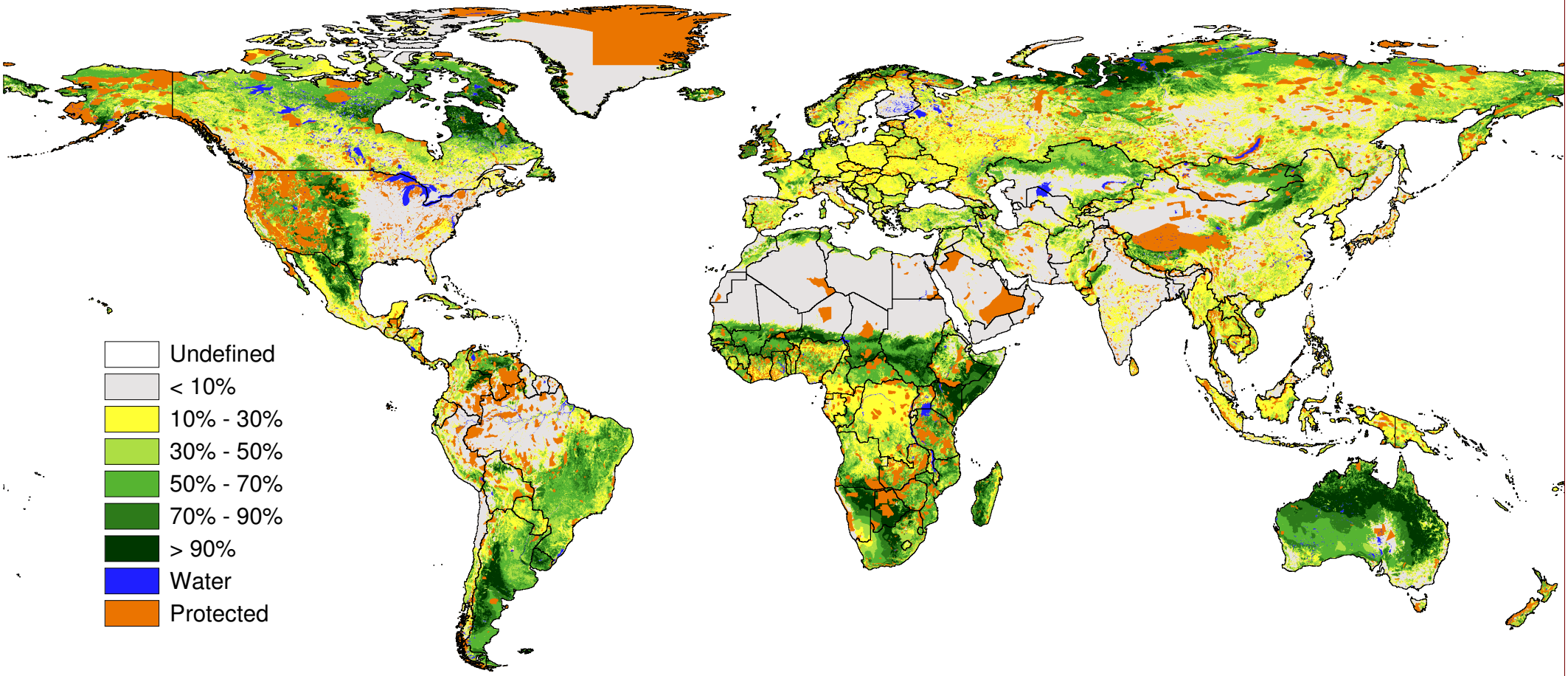
Remote Sensing and Ground Information

... excluding protected areas



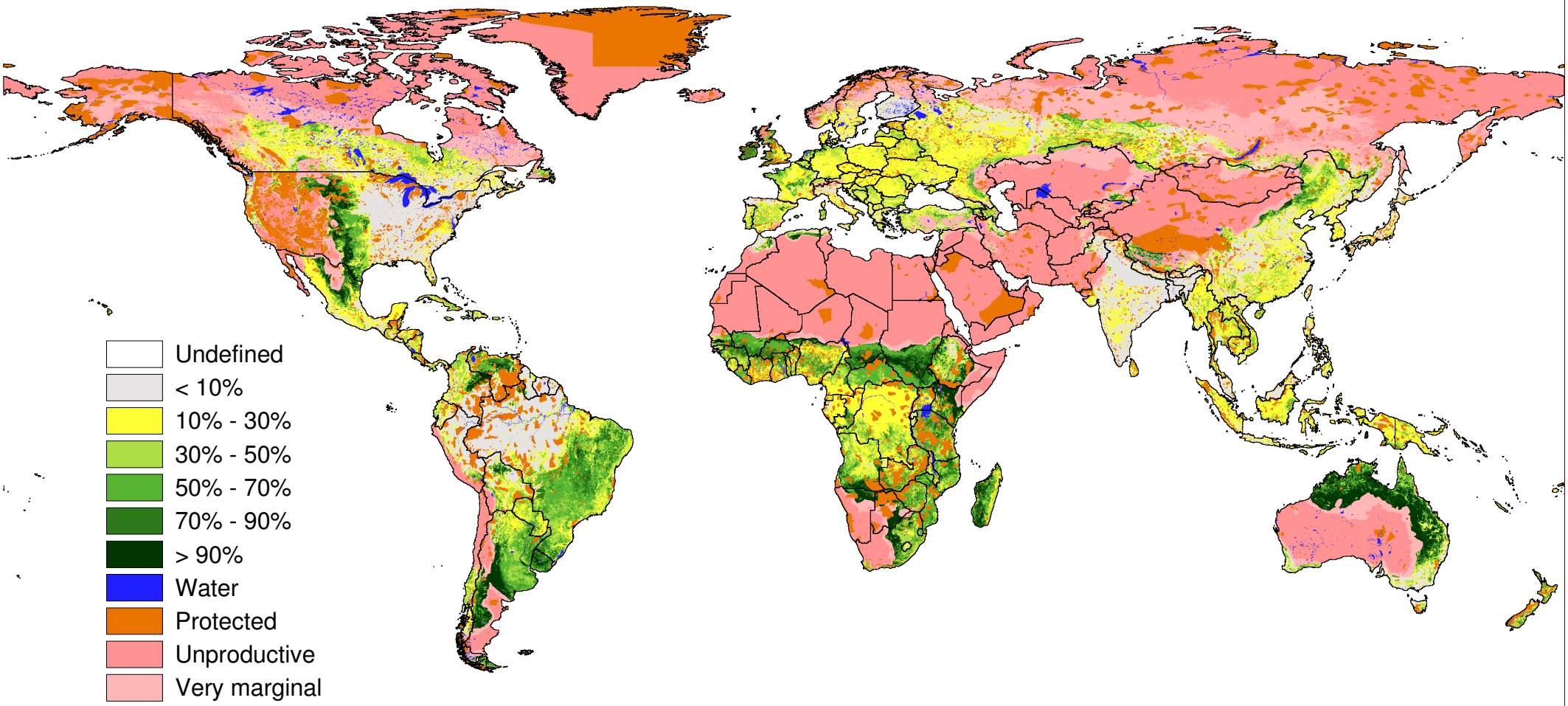
Remote Sensing and Ground Information

... subtracting land with steep slopes

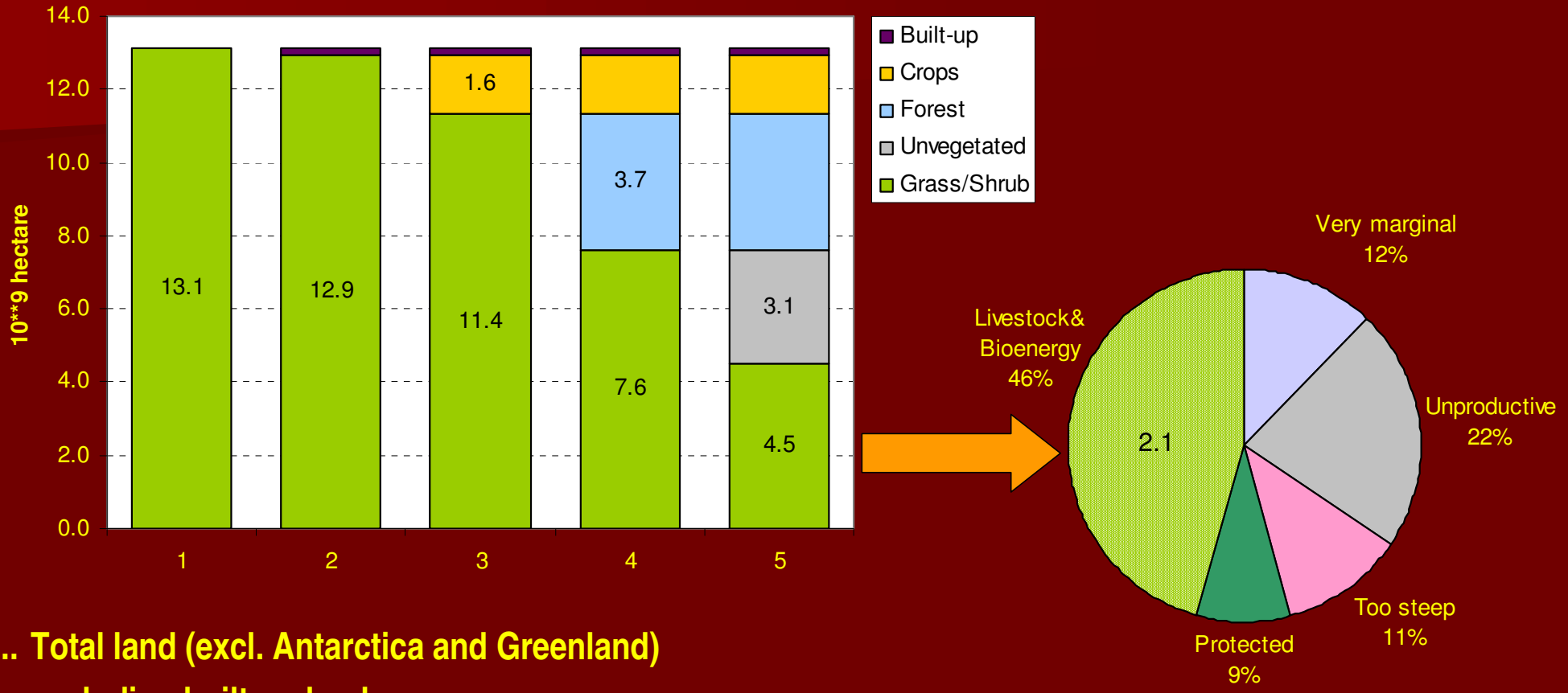


Remote Sensing and Ground Information

... excluding climatically unsuitable or very marginal areas



How much land is available for Biofuels?



1 ... Total land (excl. Antarctica and Greenland)

2 ... excluding built-up land

3 ... excluding arable and perennial cropland

4 ... excluding forests

5 ... excluding barren land & water

Pasture land in use for livestock feeding: ~1.4 Billion ha

Potential land for biofuels : ~0.7 Billion ha

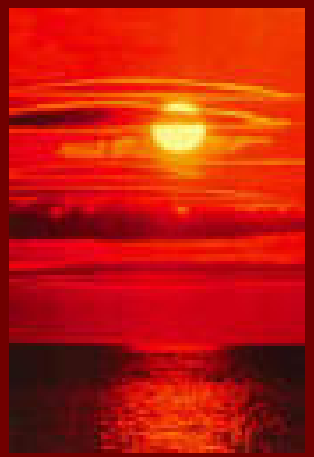
Source: IIASA-LUC, 2007

IIASA

Climate Change and Human Wellbeing





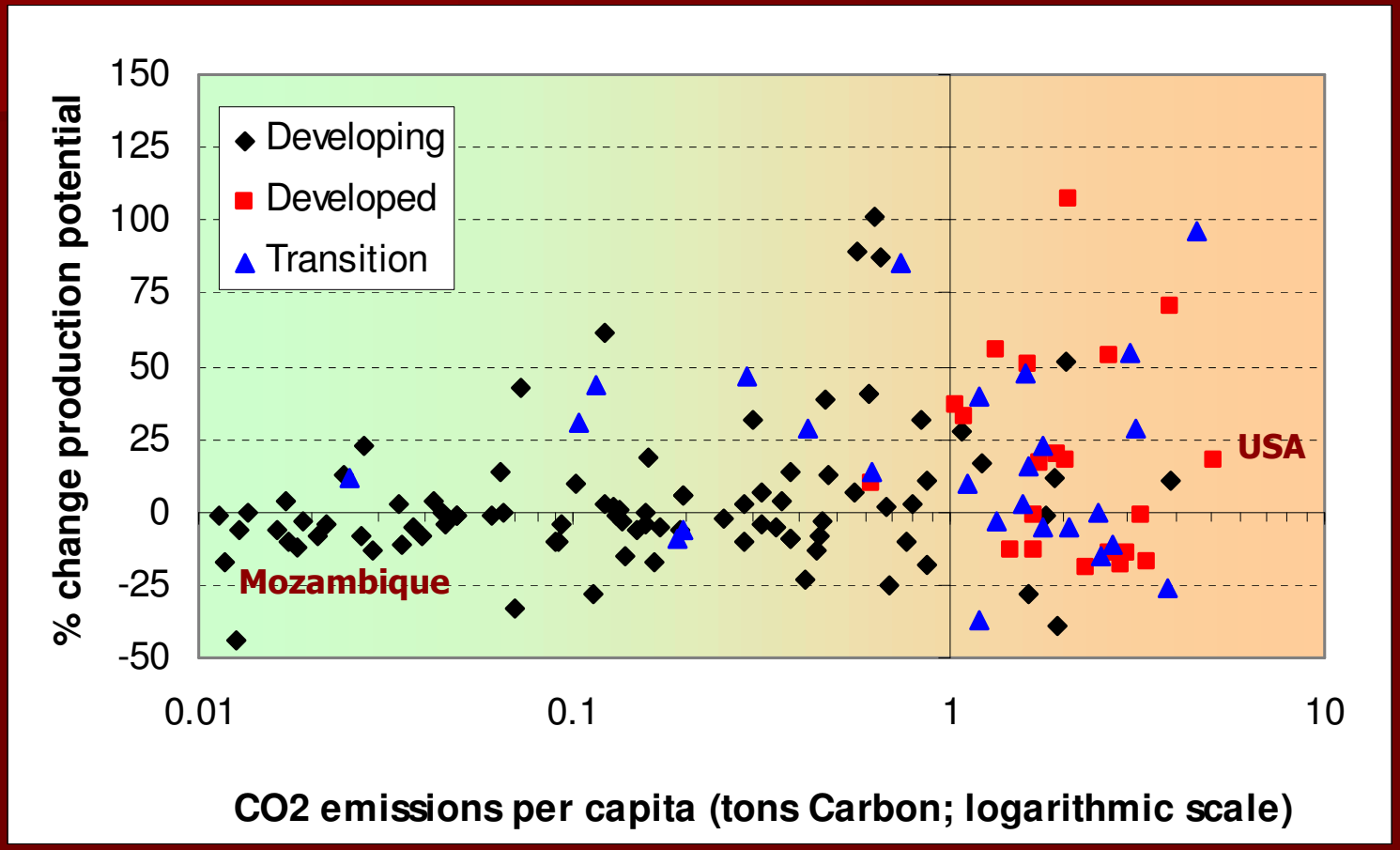



A global & inter-generational risk to security and survival

IIASA

Climate Change Impacts and Carbon Dioxide Emissions

ECHAM4, 2080s



Fairness and Equity?

Cumulative Greenhouse Gas Emissions since 1950s:

75% from developed countries, 25% from developing countries

IIASA

Mozambique

Population: 18 million (Year 2050: 28 million)
Undernourished: 14 million
Depth of Hunger: 420 calories per capita per day

GDP per capita: $ 105
30% of GDP from Agriculture
75% of Population in Agriculture

1997 CO2 Emissions per capita
Mozambique 0.1 tons
Developing Countries 1.9 tons
OECD 11 tons

Climate Change projected to cause 25% loss in cereal production

EU is giving consideration to producing Biofuels in Mozambique

IIASA

Bridging Remote Sensing Data and Ground Based Information for Food Security and Sustainable Agriculture Policy Actions

Source: S. W. Dunning

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THANK YOU

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