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# The Challenges Ahead in Feeding the World

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# Projected Population Growth

| Region | 2011 | 2050 | Change | Percent |
|---|---|---|---|---|
| World | 6,987 | 9,587 | +2,600 | + 38 |
| High Income | 1,242 | 1,333 | + 91 | + 7 |
| Low Income | 5,745 | 8,254 | +2,509 | + 44 |
| East & S.E. Asia | 2,183 | 2,308 | + 125 | + 6 |
| South Central Asia | 1,795 | 2,574 | + 779 | + 43 |
| Sub-Saharan Africa | 883 | 2,069 | +1,186 | +134 |
| Lat. America/Carib | 596 | 746 | + 150 | + 25 |
| N. Africa & W. Asia | 451 | 725 | + 274 | + 61 |

Source: Population Reference Bureau. 2011 World Population Data Sheet.

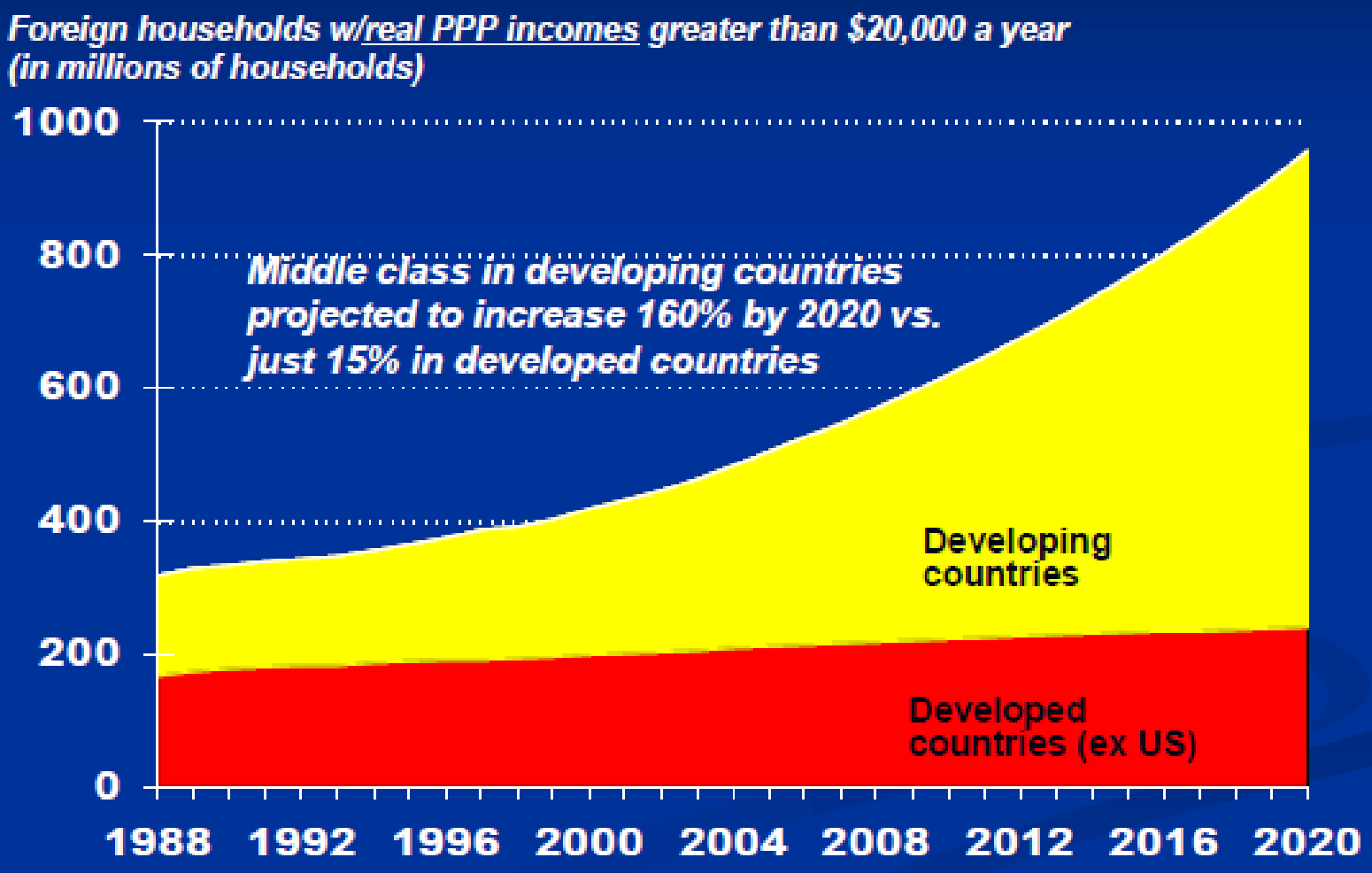
# Dynamics of Food Demand Growth

- 1.4 billion people live on less that $1.25/day
  - 1 billion cannot afford 1,800 calories per day.
- 2.6 billion people live on less than $2.00/day
  - At $2.00 per day most hunger (calorie) problems solved, but 1 billion still suffer nutritional deficiencies.
- As their incomes rise from about $2 to $10 per day, people eat more meat, dairy products, eggs, edible oils, fruits & vegetables causing rapid growth in raw ag commodity demand.
- After about $10 per day, people buy more processing, services, packaging, variety, and luxury forms, but not more raw ag commodities.

# Projected World Food Demand

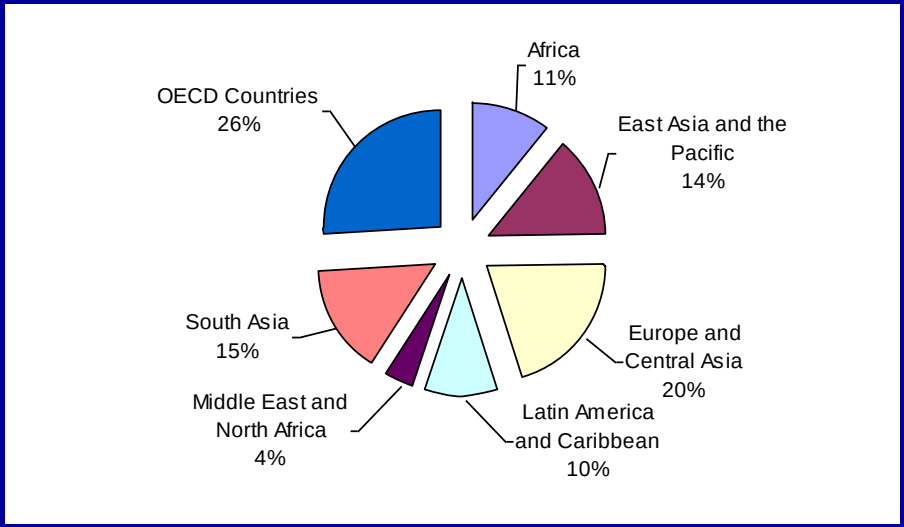
- World food demand to grow 70-80% by 2050
  - 40% increase from world population growth – from 7.0 to 9.6 billion – almost all in developing countries
  - 30-40% increase from broad-based economic growth in low income countries
- The World Bank has estimated the number of people in developing countries in households with incomes >$16,000/year will rise from 352 million in 2000 to 2.1 billion by 2030.
- How many presently low income consumers escape from poverty is the *most important* uncertainty re future global demand for food.
- Policies that accelerate broad-based economic growth in LDCs reduce hunger, but unleash rapid growth in demand for agric. products.

# "Middle Class" *Outside the U.S.* Expected to Double By 2020 – Approaching 1 Billion Households

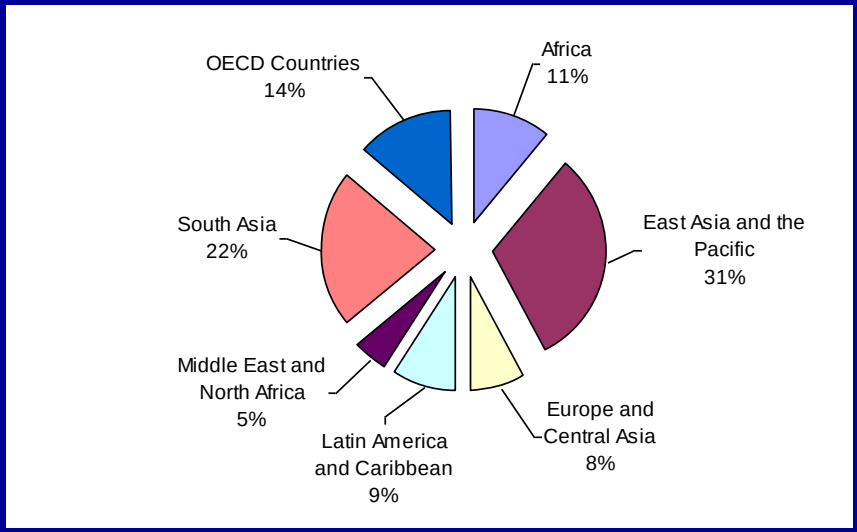



Source: Global Insight's Global Consumer Markets data as analyzed by OGA/FAS/USDA

# Larger Fraction of Ag Production to Move Through Trade




Distribution of Arable Land




Distribution of World Population

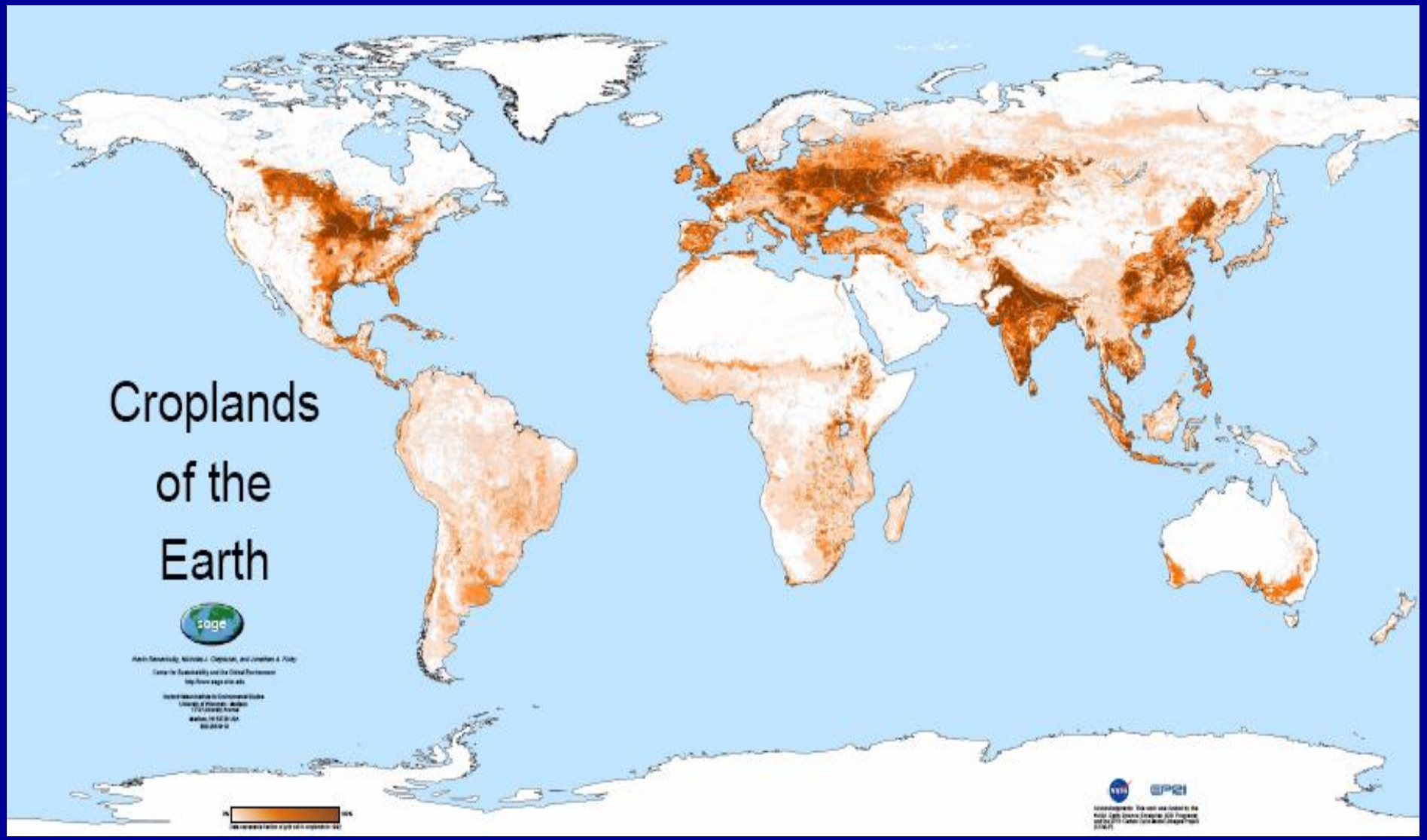
- With population growth, urbanization and broad-based economic development, many low-income countries' food consumption will outstrip their production capacity, and they will become larger net importers.

# The Land Constraint

- There is at most 12% more arable land available worldwide that isn't presently forested or subject to erosion or desertification, and…
- Loss and degradation of many soils continues:
  - Urbanization & infrastructure construction
  - Nutrient mining
  - Erosion
  - Desertification
  - Natural reserves
  - Reforestation

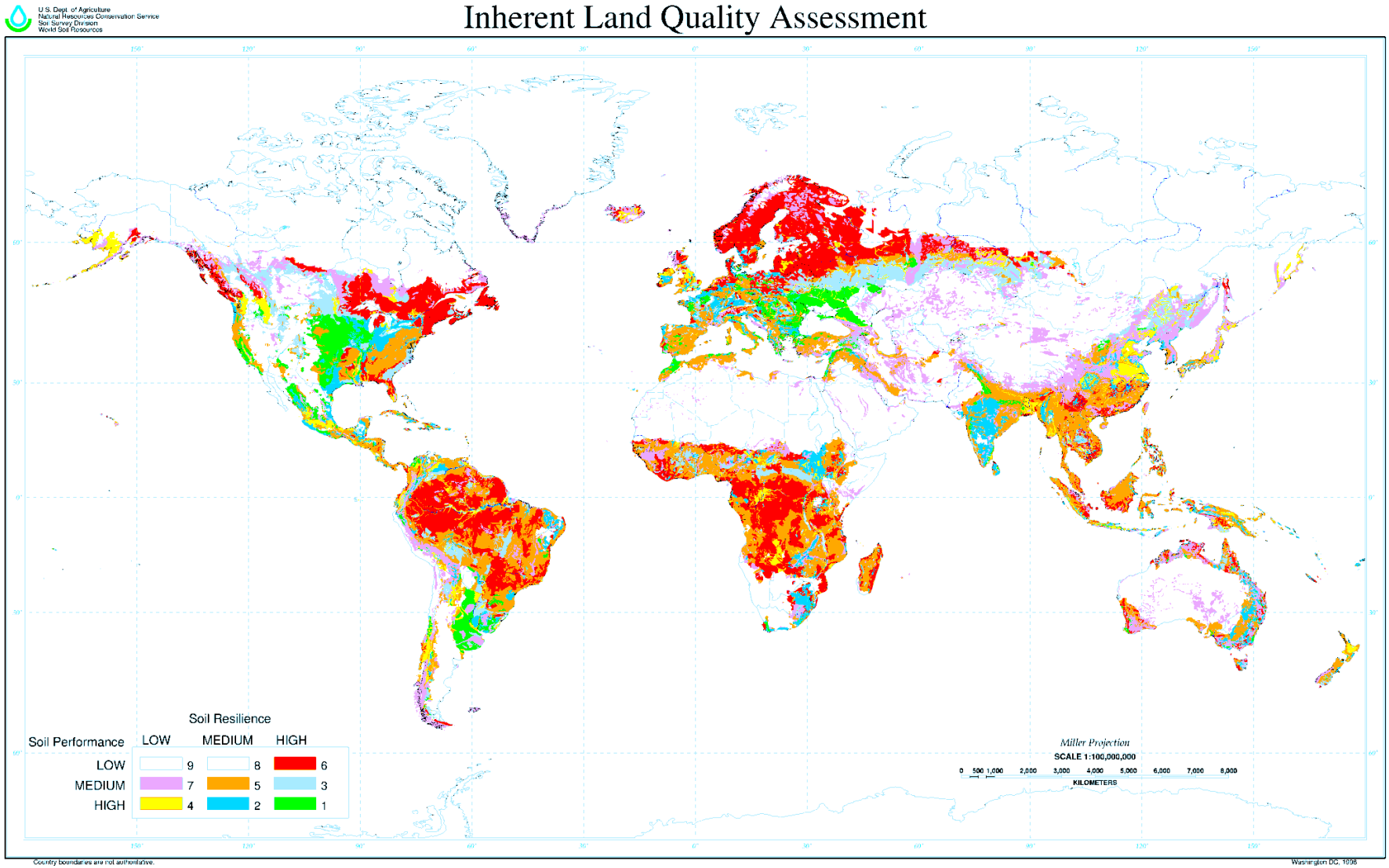
# The Land Constraint (cont'd.)

- The area of land in farm production could be doubled…
  - But only by massive destruction of forests and loss of wildlife habitat, biodiversity and carbon sequestration capacity
- The only environmentally sustainable alternative is to double productivity on the fertile, non-erodible soils already in crop production.
- Most available cropland is in remote areas of South America and Sub-Saharan Africa where infrastructure is minimal and soils are inferior in quality to many already in production.




Source: Center for Sustainability and the Global Environment (SAGE), University of Wisconsin.

# Inherent Land Quality



# Climate Constraints

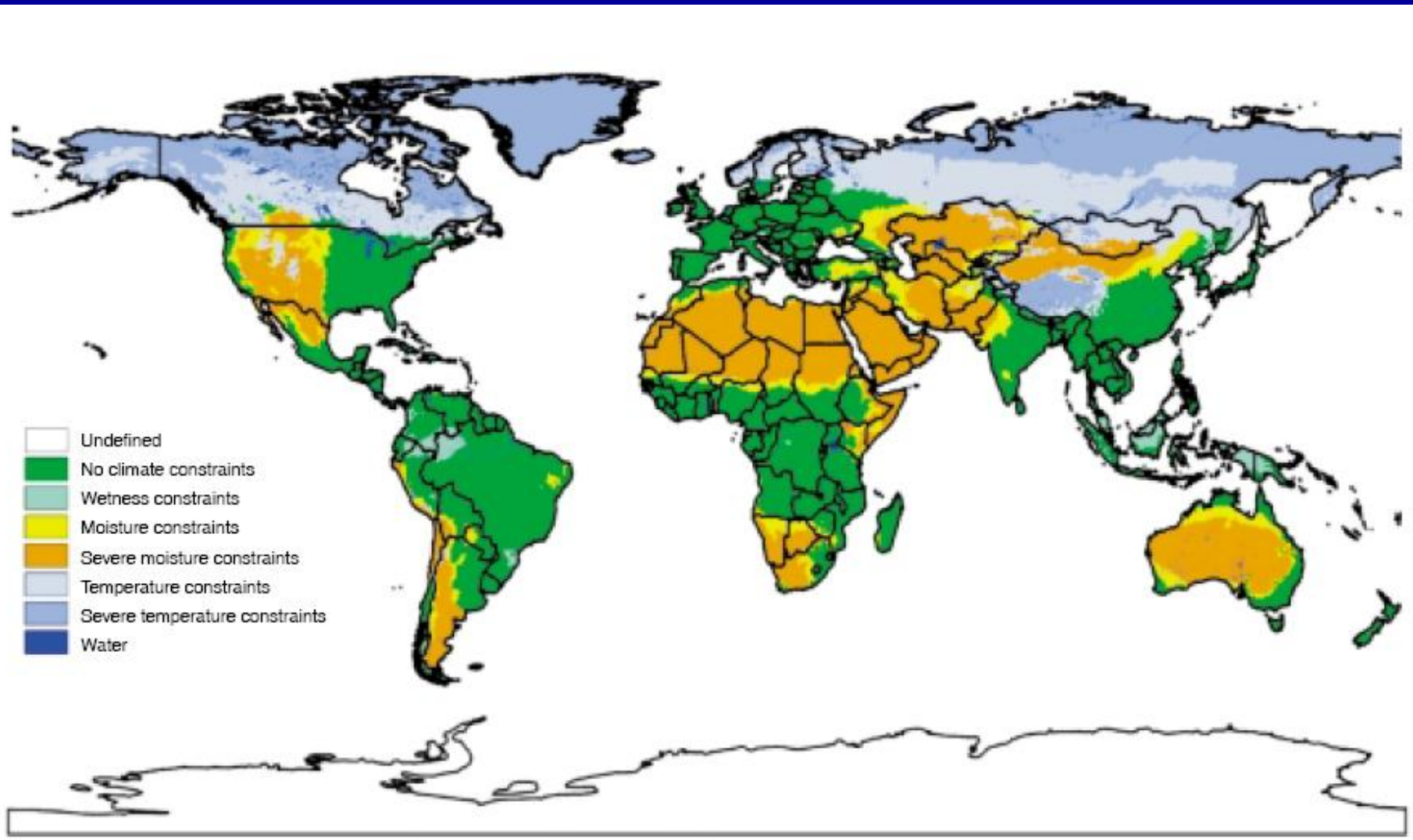



**Plate E.** Climate constraints.

Source: International Institute for Applied Systems Analysis

# Agriculturally Important Effects of Climate Change

- Warming greater over land than over water and greatest at higher latitudes.
- Increases spatial distribution of precipitation
  - Largest reduction in subtropics (especially on their poleward edges)
  - Largest increases in higher latitudes
  - Increase under monsoons
- Increased frequency of extreme events, such as droughts and flooding.

# Adaptations Will be Required Due to Global Climate Change

- As all agro-ecosystems shift with climate change, need larger public and private investments in adaptive plant and animal breeding just to sustain present productivity levels.
  - e.g. introduce more drought or heat tolerance.
- Change the mix of what crops are produced in a some geographic locations.
- Rely more on international trade.

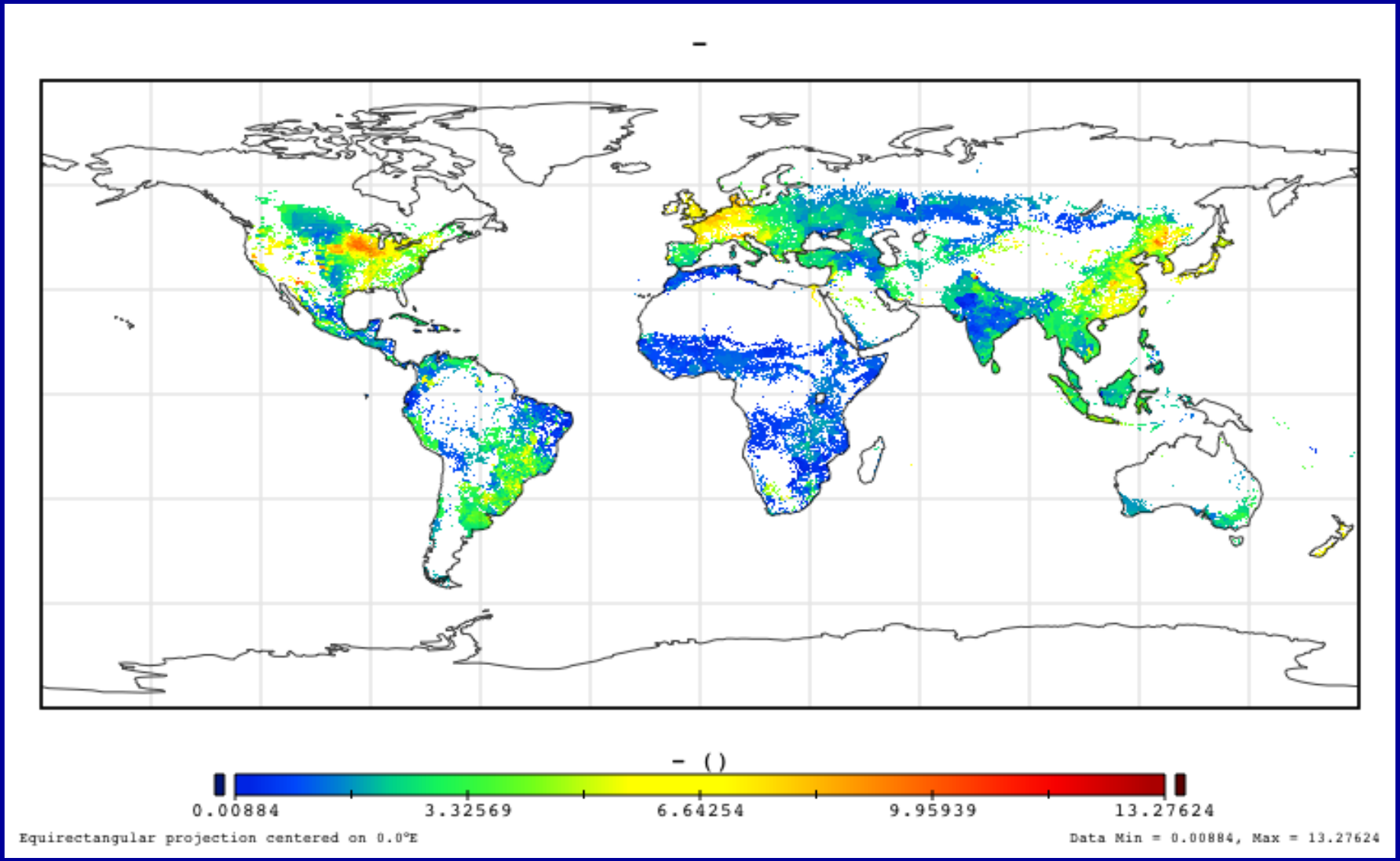
# Water--A Growing Constraint

- Farmers account for 70% of the world's fresh water use.
- With the rapid urbanization underway, cities will outbid agriculture for available fresh water.
- The world's farmers, who are being called on to double food production, will have to do it using less fresh water than they are using today.
  - i.e., they will have to more than double the "crop per drop," the average productivity of the water they use.
- This will require investments in research to develop water saving technologies and to increase the drought tolerance and water use efficiency of the crop varieties being grown.

# Need to Almost Double the Global Food System Productivity by 2050

- Make presently unusable soils productive
- Increase genetic potential (of individual crops and/or farming system) (ditto for farm animals)
- Achieve as much of that potential as possible by:
  - Improving nutrition of that crop
  - Increasing water availability and control
  - Reducing competition from weeds for water, nutrients and sunlight
  - Reducing losses from disease and insects
- Reduce post-harvest losses

# Grain Yields Around the World

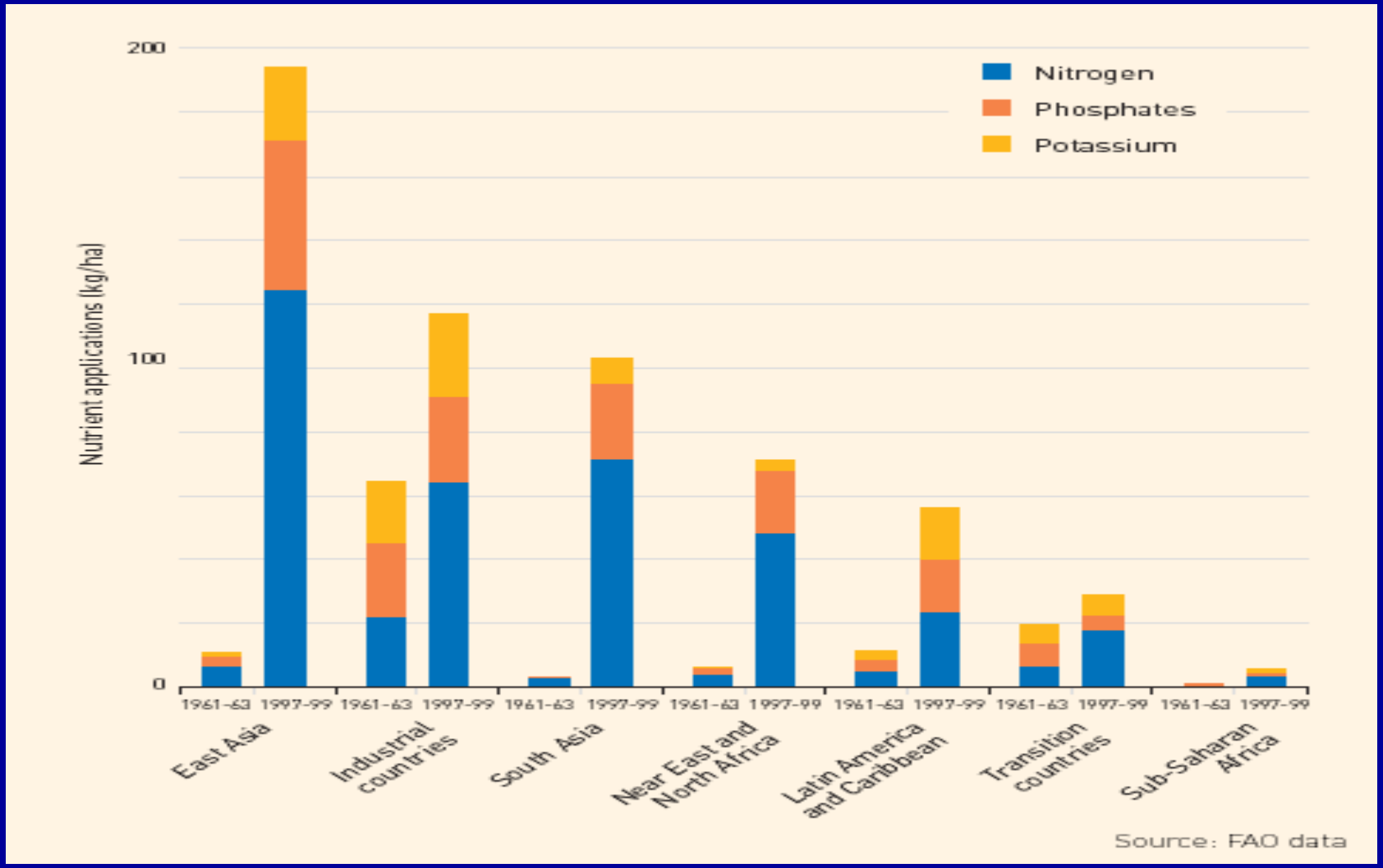



Interpretation: Grain yields (in metric tons per hectare) rise from lowest (dark blue) to highest (dark red)
Source: Center for Sustainability and the Global Environment (SAGE), University of Wisconsin.

# Sources of Observed Differences in Crop Yields in Different Locations

- Genetic potential embodied in the seeds of the crop being grown.
- Climatic conditions (level and variation in temperature and precipitation)
- Quality of soil (fertility, water holding capacity; resilience)
- Supplementation of soil fertility and precipitation with fertilizer and irrigation.
- Losses of yield potential from disease and insect infestations and competition from weeds.

# Fertilizer Use



# More Sources of Observed Differences in Grain Yield in Different Locations

- Existence of markets to supply farmers inputs that embody improved technologies (and available credit) and buy their outputs
  - Requires a business friendly investment climate
- Remunerative input and output prices
  - Reflect public policy and state of transport and communications infrastructure.
- Knowledge and skill of farmers.

# Agricultural Research Potential

- There remains more productivity enhancement potential from classical plant and animal breeding, especially with modern genomics, and genetic engineering opens new frontiers:, e.g.
  - Improve nutritional content of grains, etc.
  - Increase tolerance to drought, wetness, temperature, salt, aluminum toxicity, …. (to increase yields and/or planted area under adverse or variable conditions)
  - Internalize resistance to diseases; viruses
  - Reduce pesticide use, esp. insecticides
  - Herbicide-resistant varieties
  - Slow down product deterioration

# Decline in Investments in Agriculture Development

- Between 1980 to 2005, foreign aid to LDCs for ag development dropped from $8 billion to $3.4 bill./yr (from 17 to 3% of the whole)
- In the 1980s, 25% of US foreign aid went to agriculture; dropped to 6% by 1990 and 1% last year.
- Share of World Bank lending going to agriculture fell from 30% in 1978 to 16% in 1988 to 8% in 2006.

# Long-Run Prospects

- Since Malthus, prophets of doom have argued population growth will increase food demand faster than agricultural production can grow.
- Public and private sector investments in agricultural research have increased productivity faster than demand growth, with resulting 150-year downward trend in real price of grains.
- Need big increase in world food production by 2050 using less water and little more land than today and also produce biofuels feedstocks.
- Future world market price trends will depend on whether land and water productivity rise faster or slower than world demand grows.