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CLIMATE CHANGE AND FOOD SECURITY: THE VIEW FROM SPACE



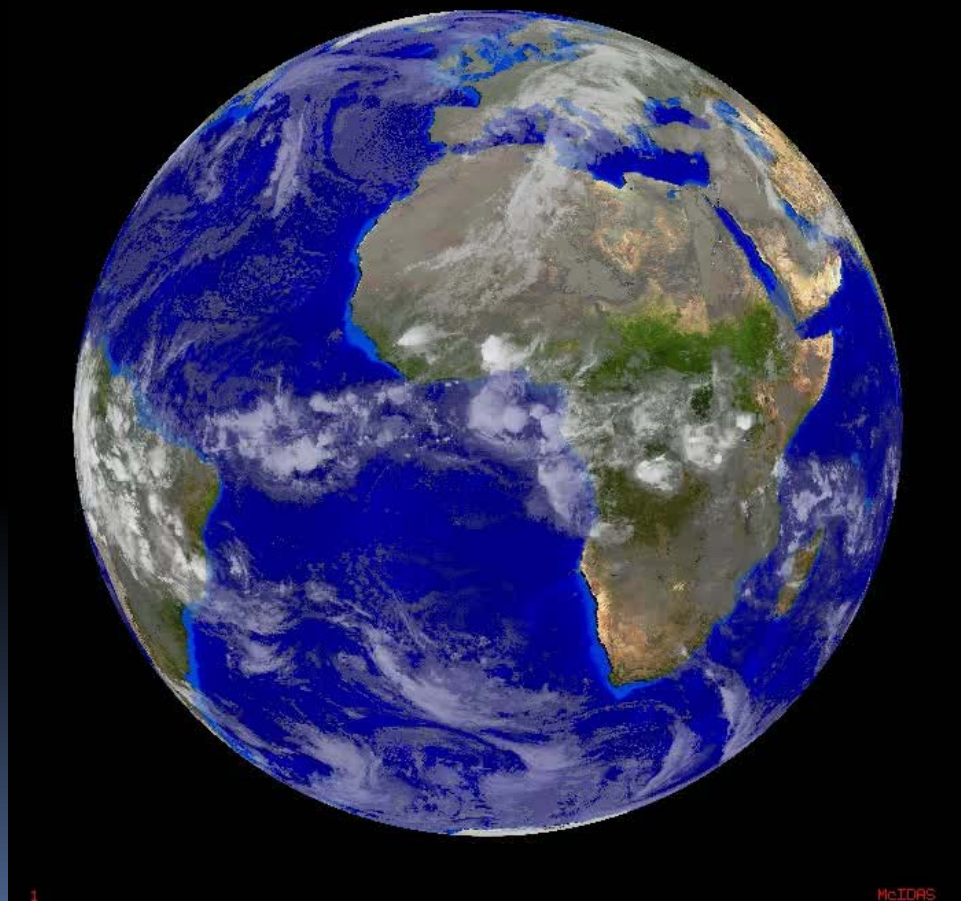
The Environment matters...

- Global food system is changing
 - Stronger links between food and fuel
 - Changing agriculture policies and fiscal uncertainty in the West
- Climate change reduces predictability and increases the likelihood of extreme events
 - Risk of weather-related agricultural impacts is growing
 - The need for information that is comparable, timely and global is increasing
- Satellite remote sensing of the Earth is a starting point for information systems that can warn of shocks
- External shocks from commodity prices, extreme weather events can have significant negative impact on agriculture and societal well being



What can we see with remote sensing?

Rainfall
Clouds
Humidity
Soil Moisture
Floods
Biomass
Photosynthetic Activity
Land use
... and many others



Earth Observing Constellations

Morning Constellation

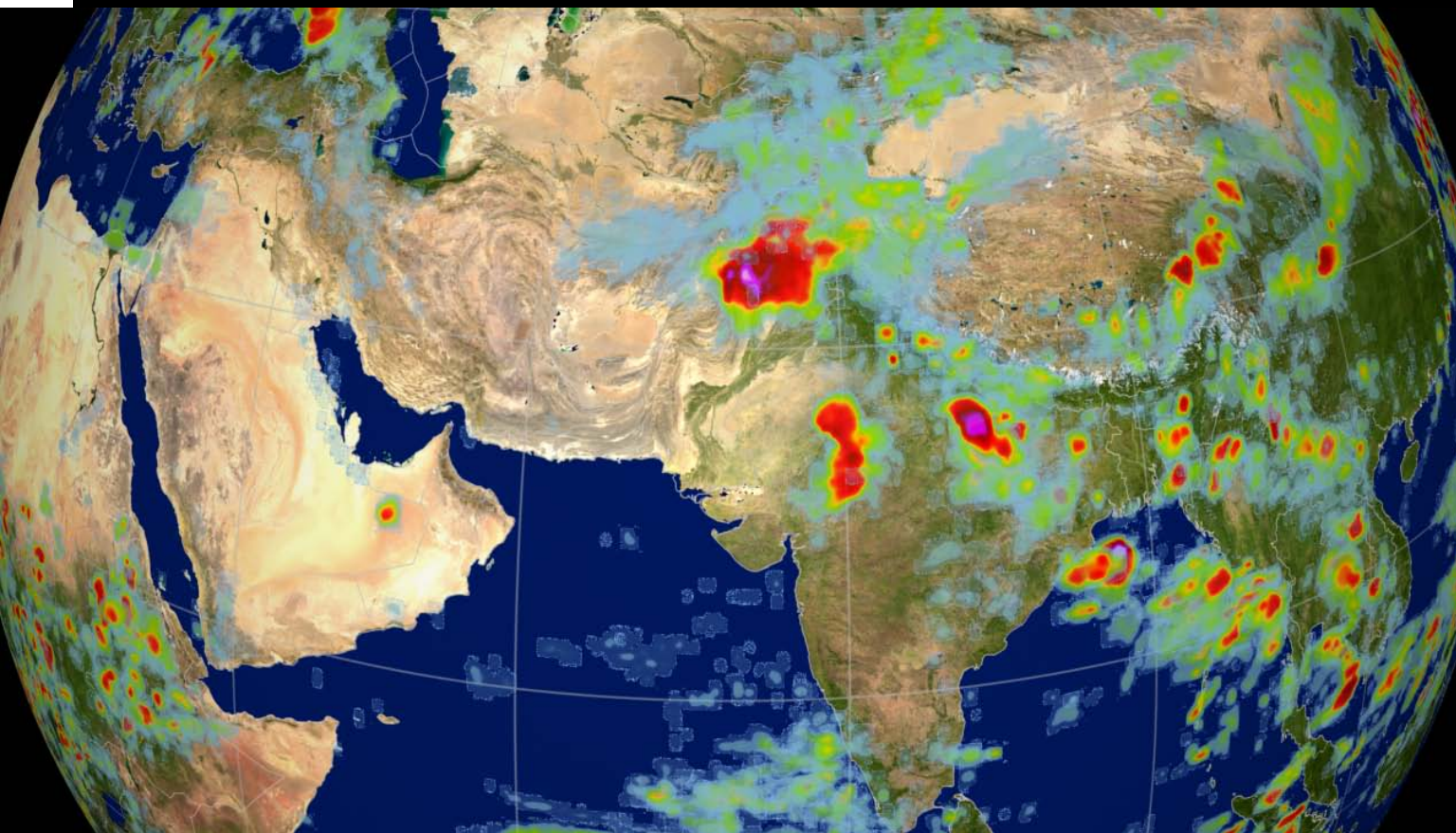
Afternoon Constellation





Rainfall data from satellites

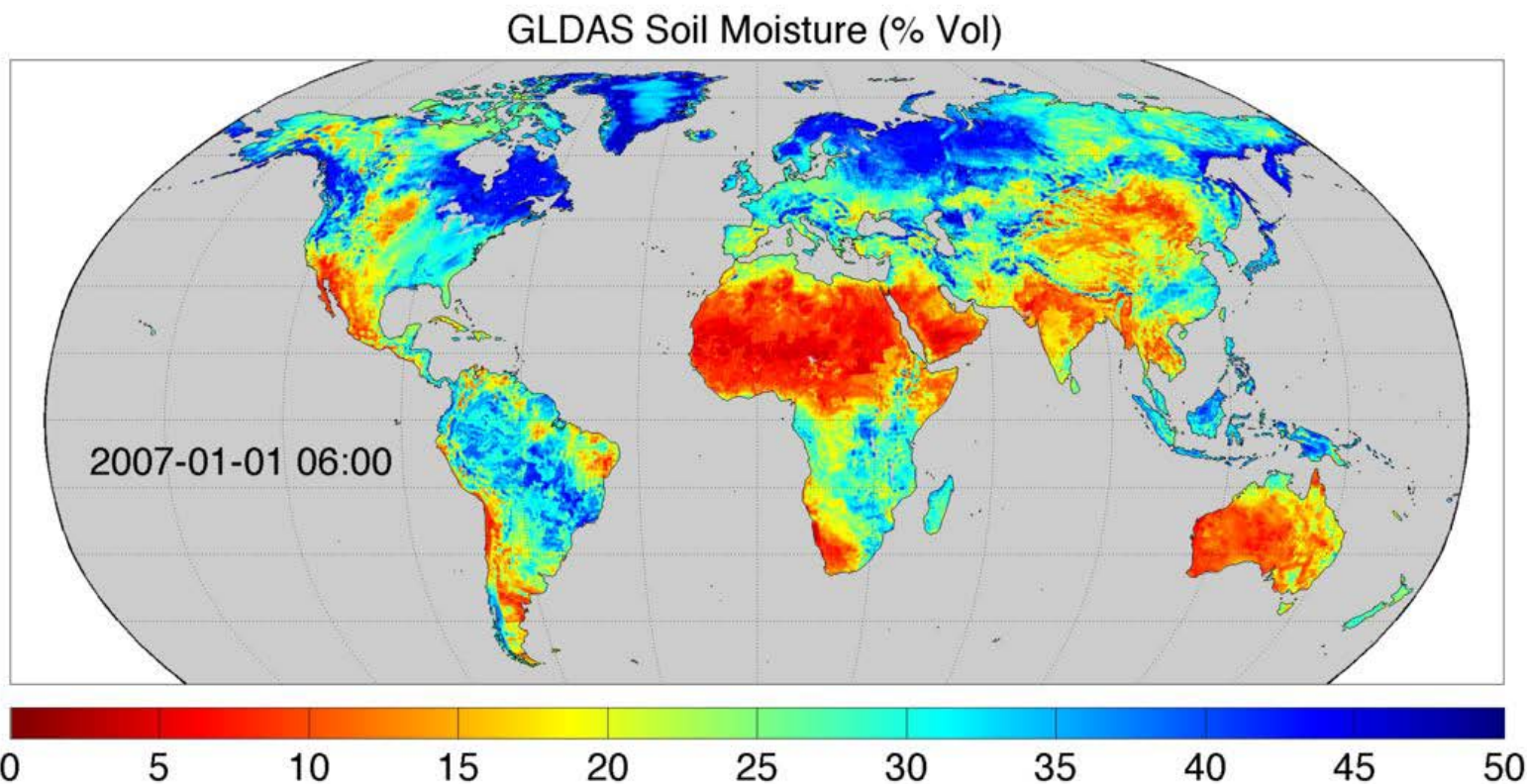
Real-time rainfall data are being used for flood forecasting, but in many developing countries rain gauging stations are either not available or are too sparsely available to develop representative aerial samples. Satellite-derived rainfall products are useful for flood forecasting.



Flooding
event in
Pakistan,
India, and
Thailand
2004



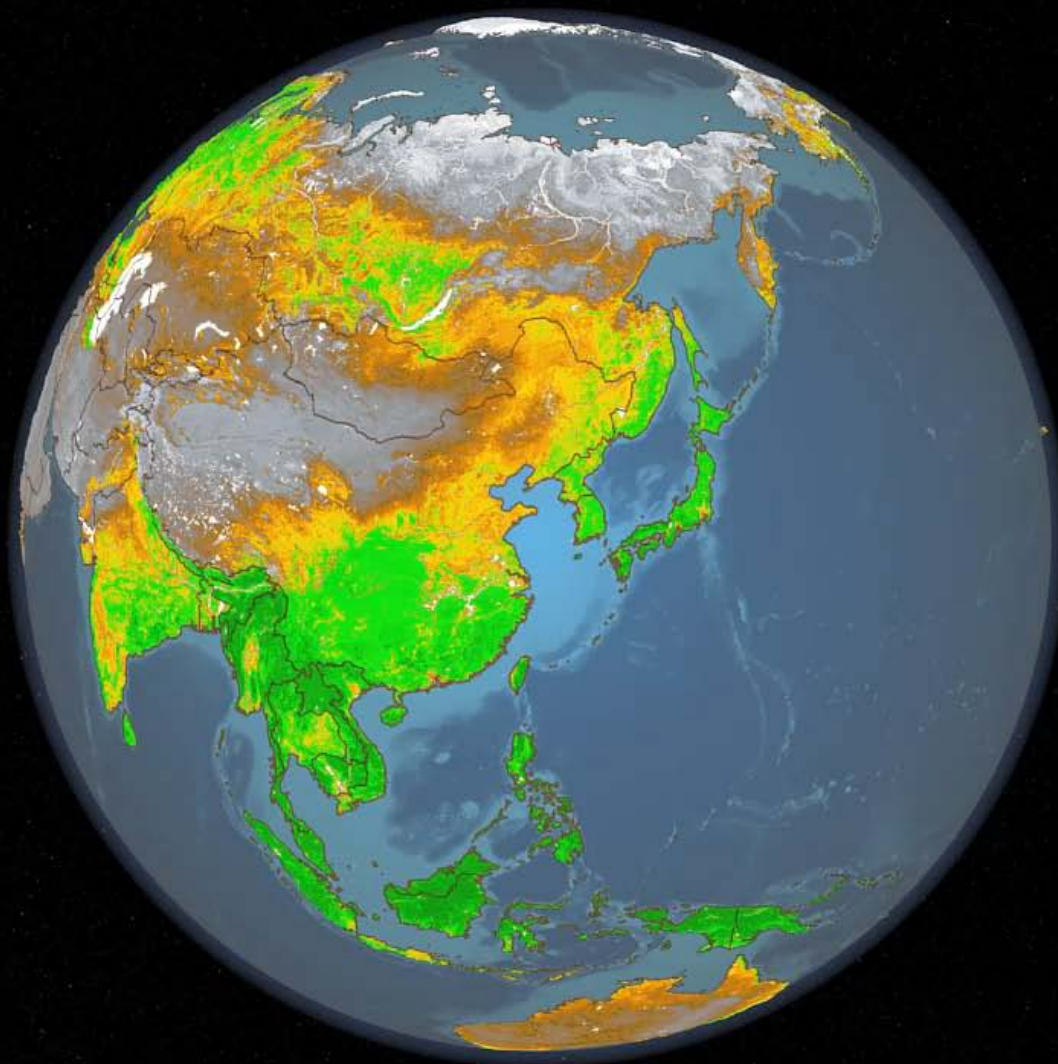
Soil Moisture products



Soil Moisture Active Passive (SMAP) mission planned for 2014

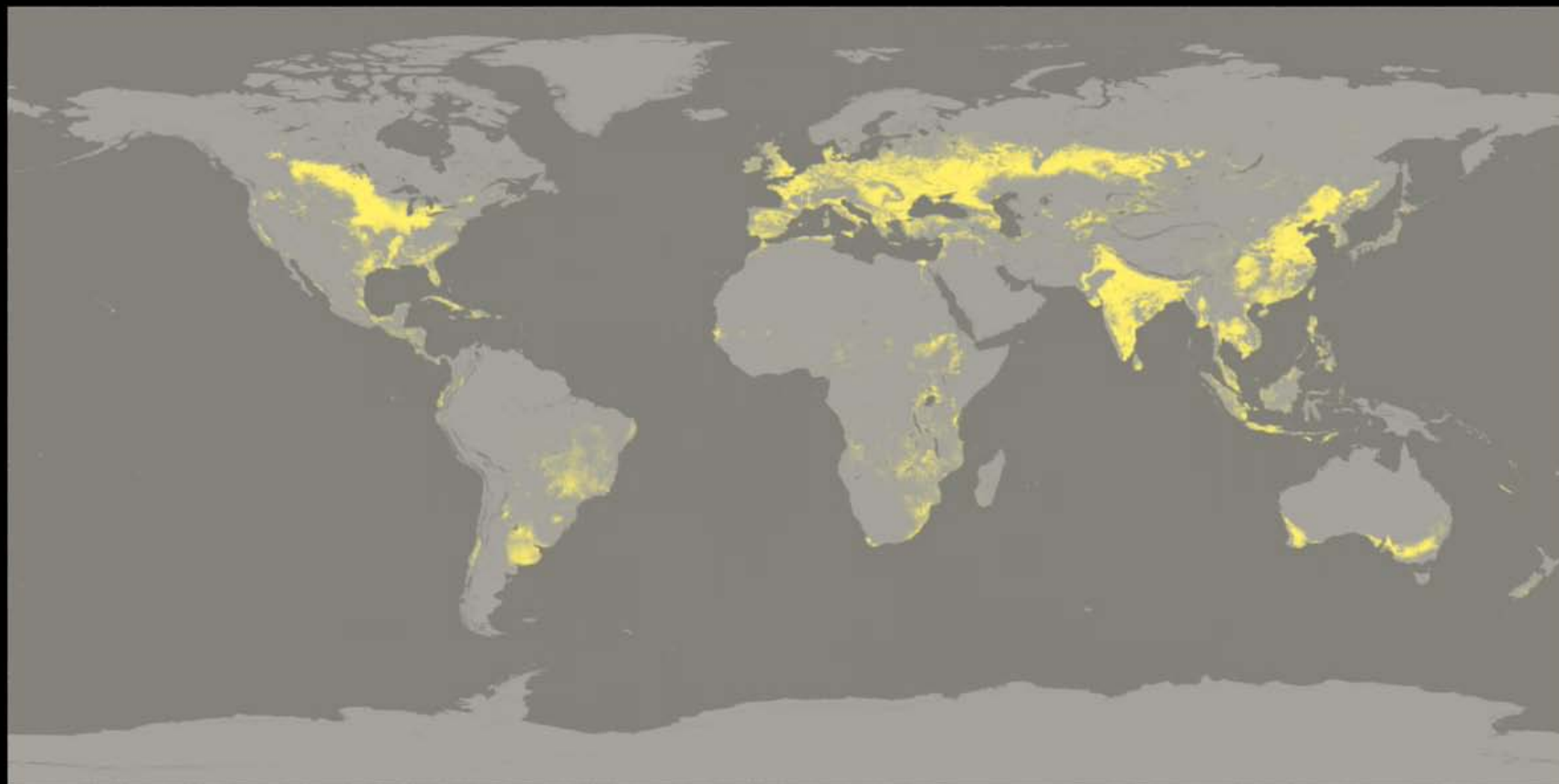


Vegetation Index Seasonality





Monitoring production- wheat





Increasing the Usefulness of these data products...

- Integrated management products that bring economics and supply concerns together with weather
 - Early warning systems for food security
 - Global Drought Information systems
- Understanding Risk – estimating the impact within a structure that links causes to consequences
- Detecting and responding to trends



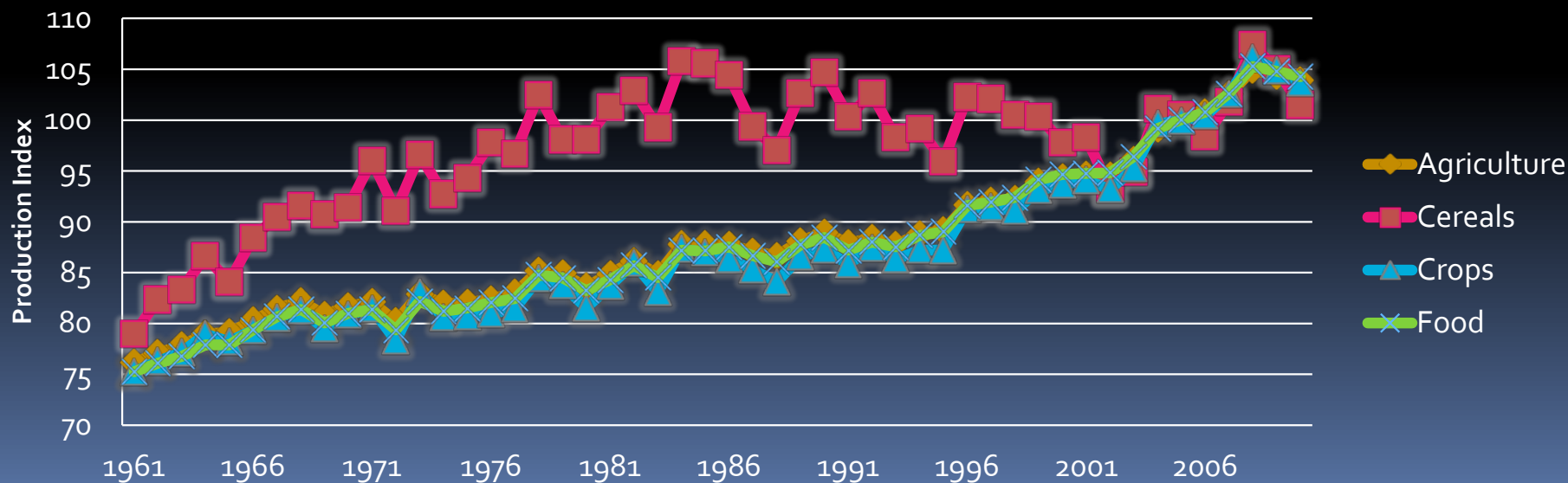
Increases in Agricultural Production

Increase in world food production and agricultural inputs from 1961 to 1996 based on FAO data

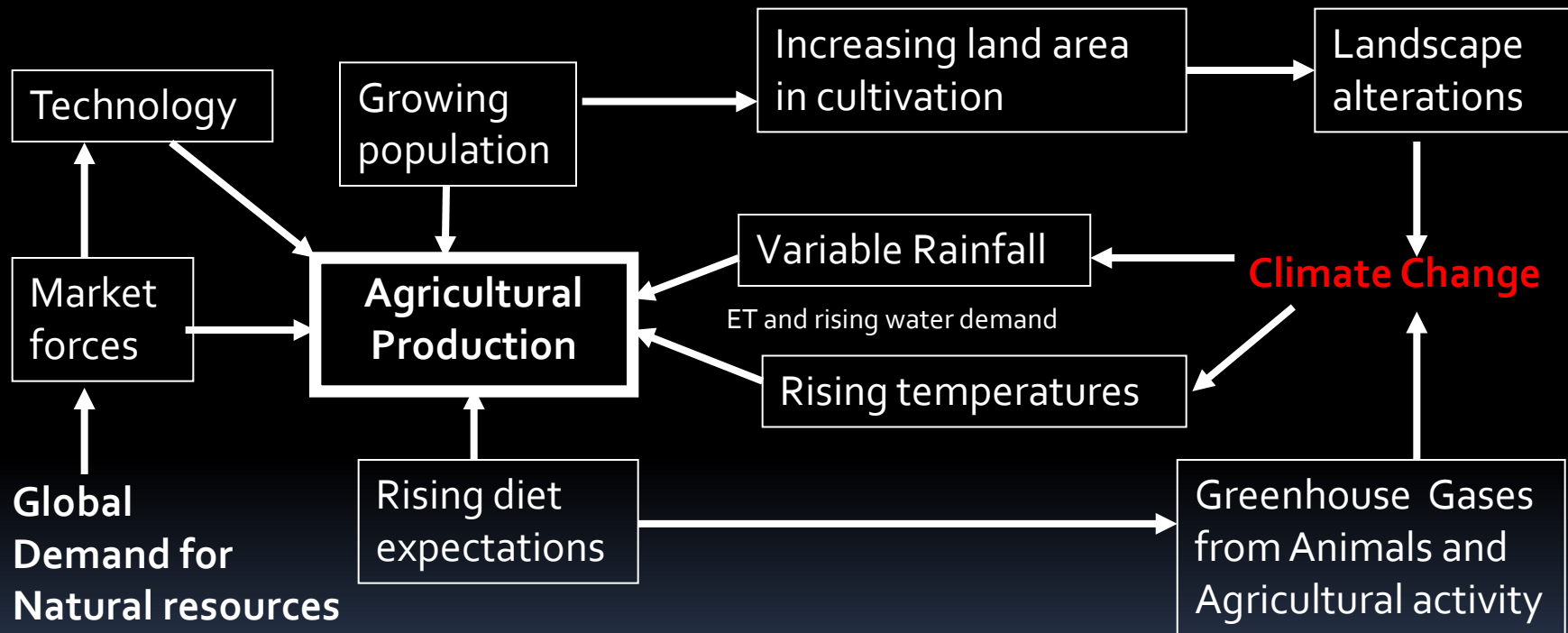
	Number-fold increase in 135 years (1861-1996)
World food production	1.97
Land under cultivation	1.098
Proportion of irrigated land	1.68
Nitrogen Fertilization	6.87
Phosphorus Fertilization	3.48

Lambin et al (2003) Annual Rev. Environ. Resour.

Gross per Capita Production Index Number (2004-2006 = 100)



Food Demand, Markets and Ecosystems: influence of Climate Change



As populations and incomes rise, the global demand for food will also grow – probably roughly doubling by 2050 and shifting towards more water-demanding diets.



Poverty Is the Root of Household Food Insecurity and Hunger

- 925 million people suffer under-nutrition or hunger.
- 1.4 billion people live on less than \$1.25 per day; 70% of them are rural, and most of these depend on farming for their incomes
- 40% of the world's population live on less than \$2.00 per day.
- Hunger is due mainly to poverty except in times of war, natural disaster or politically-imposed famine.
- The rich in no country go hungry.
- To solve the world's hunger problem, the world poverty problem must be solved.



Where are the Extremely Poor?

Region	<\$1.25/day	<\$2.00/day
South Asia	43%	43%
Sub-Saharan Africa	28%	22%
East Asia & Pacific	23%	28%
Latin America & Carib	3%	4%
E. Europe & Central Asia	1%	2%
Middle East & N. Africa	1%	2%
Total	1,374	2,562

Source: World Bank, World Development Indicators 2008.

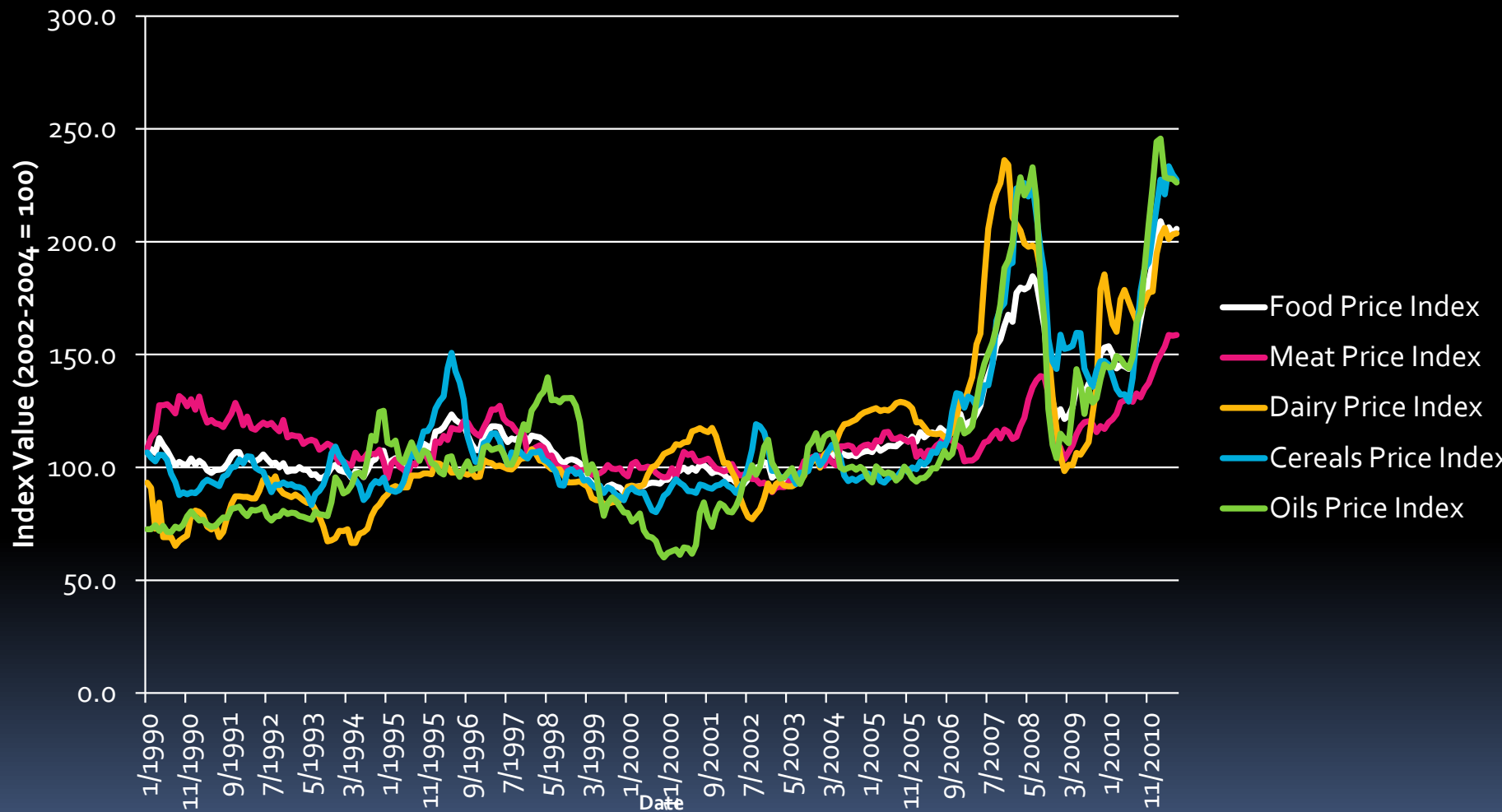


Higher Food Prices Increase the Incidence of Hunger

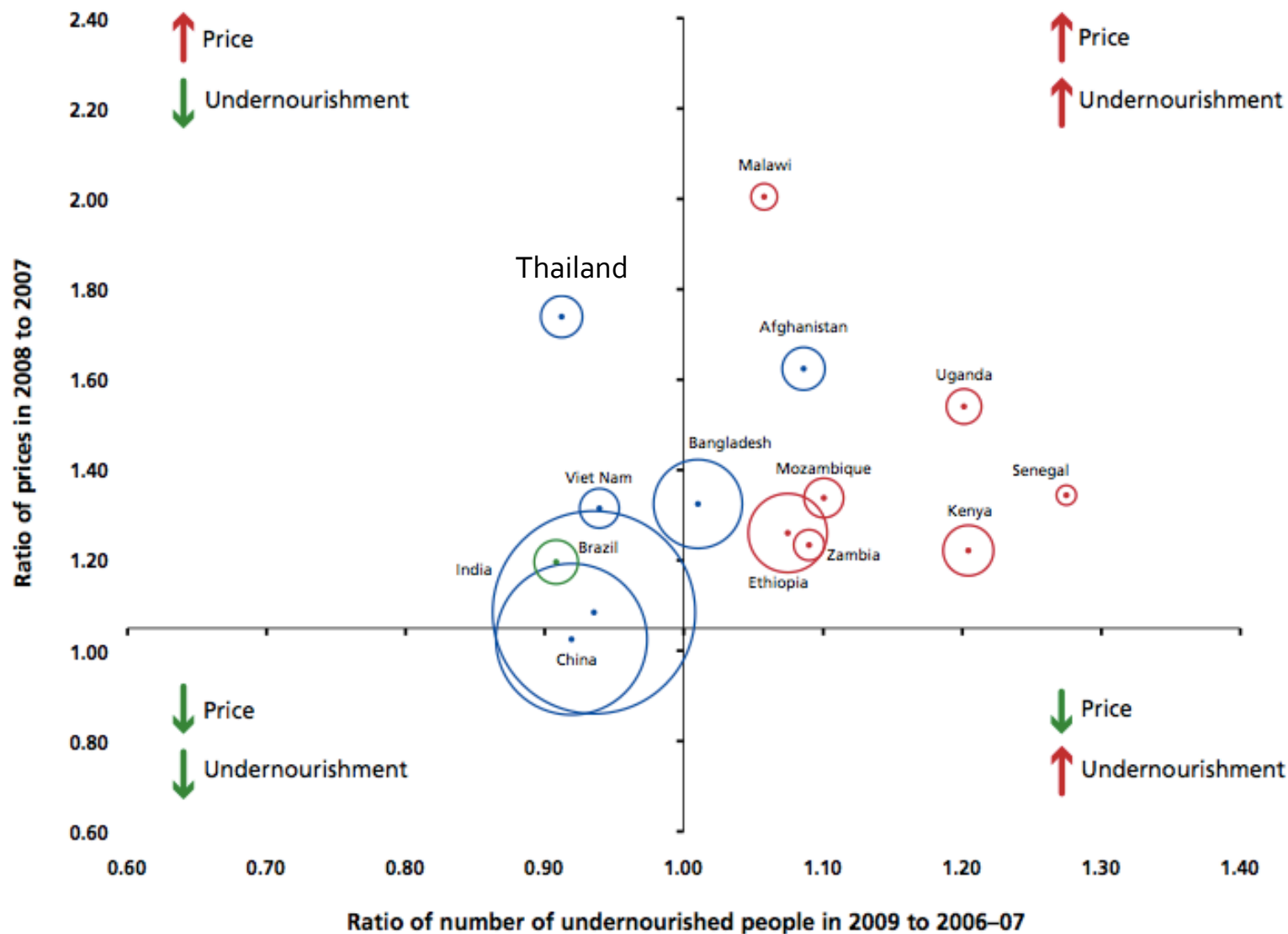
- Low income people spend a large fraction of their incomes on food, so higher food prices reduce their purchasing power
- The 2008 and 2010-12 price spike increased number of people suffering hunger to over 1 billion and precipitated political crises in many countries.
 - When international prices are high, local food production becomes more important
 - Providing early and accurate information about the impacts of weather on production can reduce food security crises



Global Indices of Food and Fuel



Impact of price volatility



From FAO Report 2011 State of food Insecurity

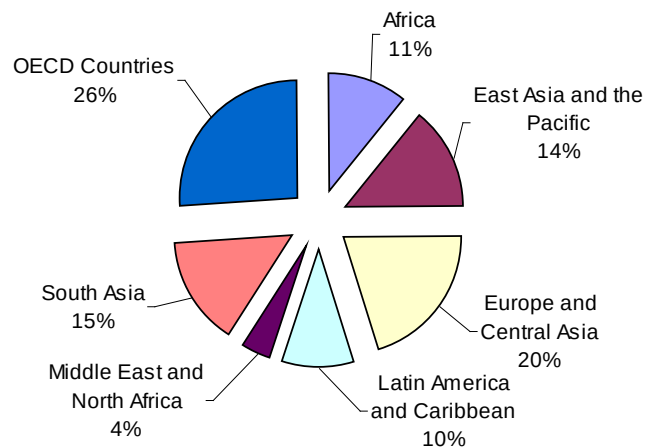


Projected World Food Demand

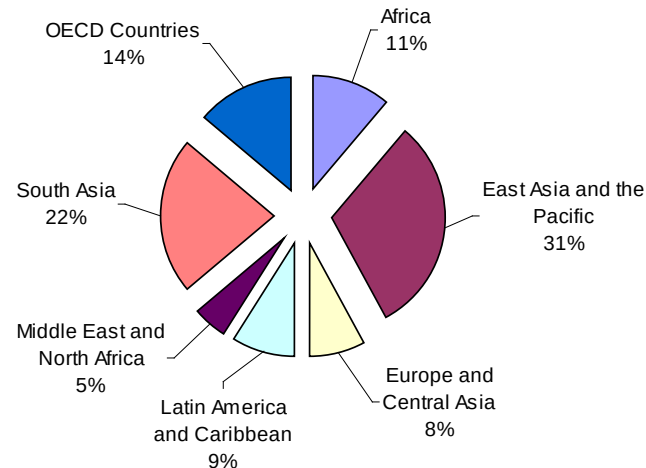
- World food demand could double in first half of 21st century:
 - 50% increase from world population growth – from 6 to 9 billion – almost all in LDCs.
 - 50% increase from broad-based economic growth in low income countries
- The World Bank has estimated the number of people in developing countries 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* determinant of future global demand for food.**



Larger Fraction of Agricultural Production to Move Through Trade



Distribution of Arable Land

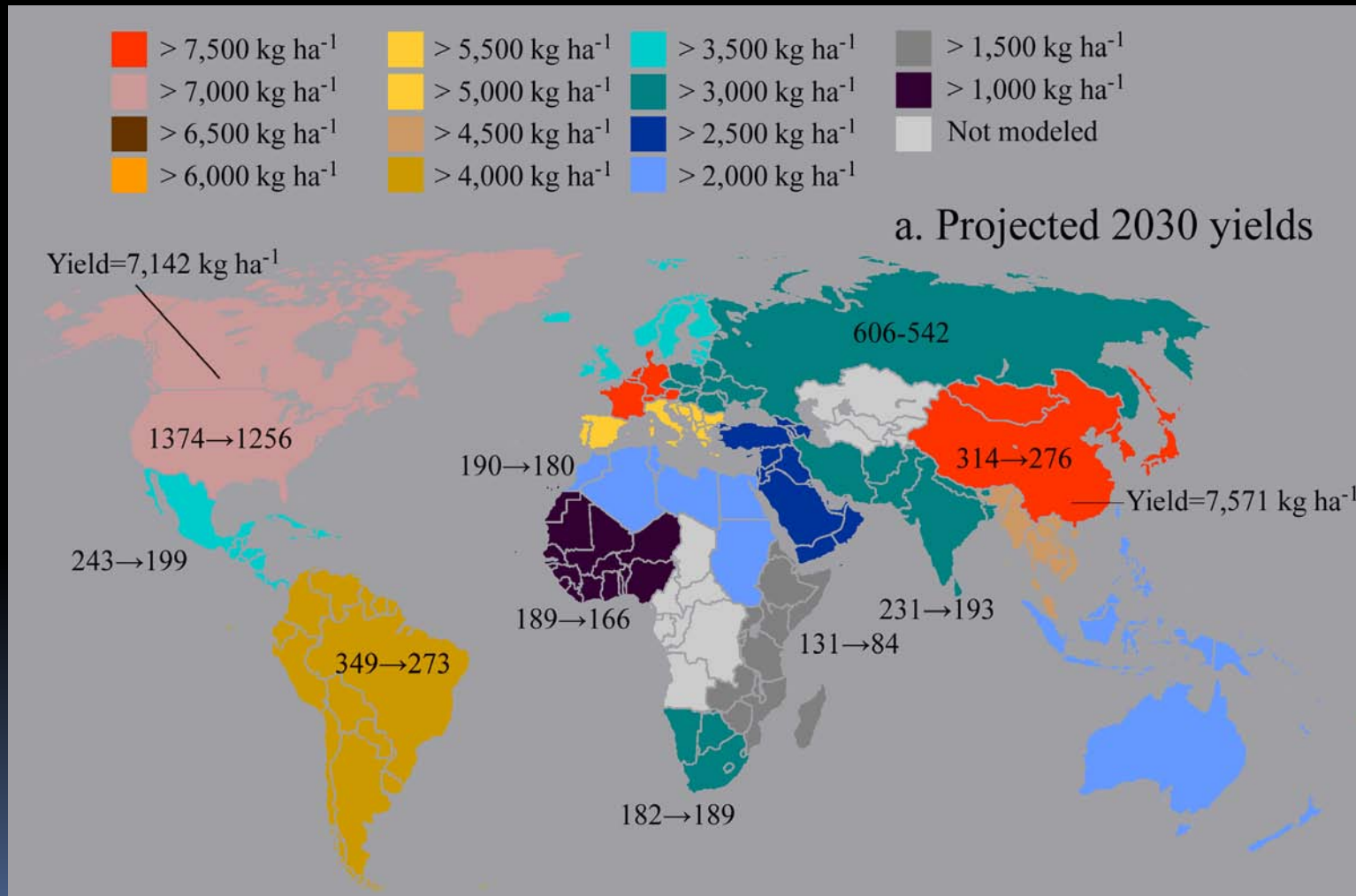


Distribution of World Population

- 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.



Yield growth is projected to decline due to a changing climate





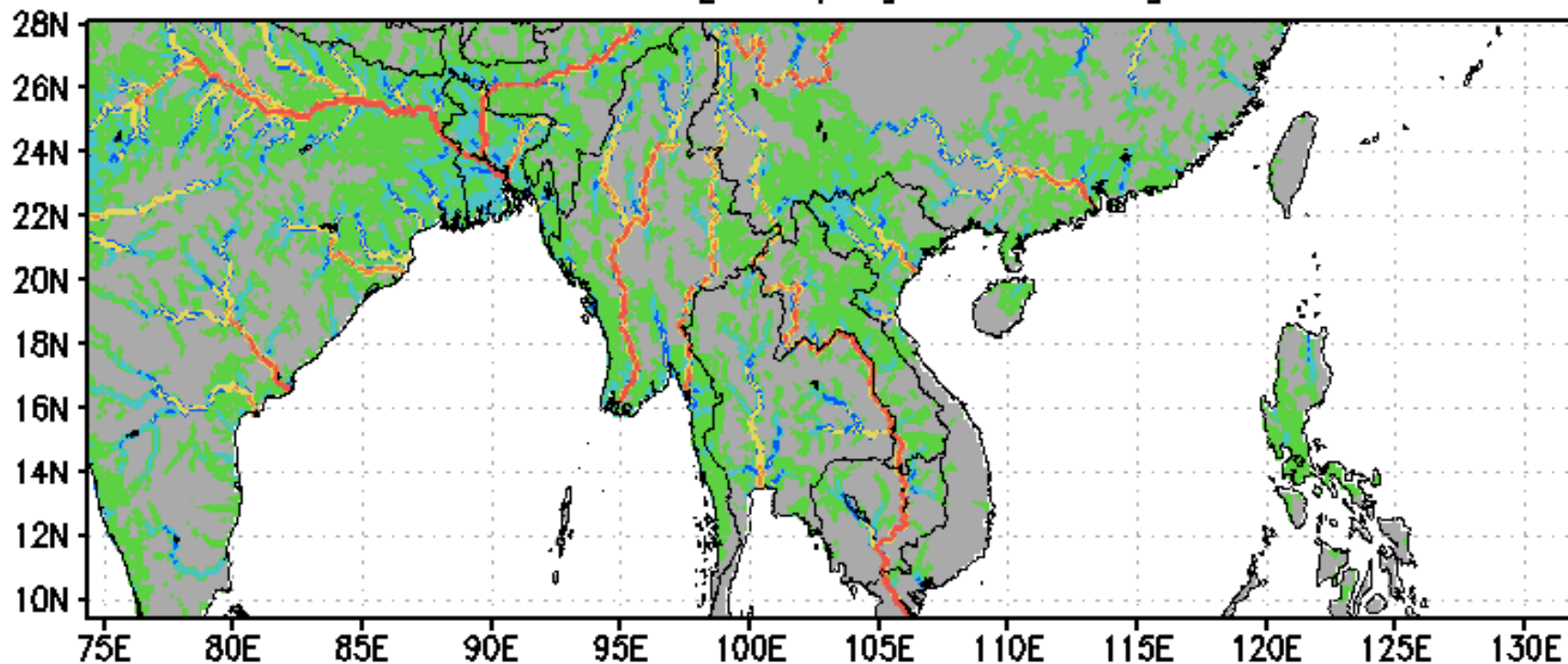
Investment in Information...

- For improved water management to ensure
 - ▣ all needs are met, domestic, agricultural, industrial
 - ▣ risks of negative impacts of extreme events reduced
- To boost yields in good years in places with low productivity
- To provide support to the poor to ensure minimum consumption
- To invest in infrastructure to reduce transaction costs, facilitate trade
 - ▣ **Poverty** causes food insecurity, not lack of food



Global Flood Monitoring System (GFMS)

Stream flow [m^3/s] 06Z13Aug2012





Summary

- Information on environment
 - Global satellite data provides information on land use, rainfall, soil moisture, vegetation vigor and crop yields
 - Process-based products allows transformation of these data into information that can be used to assess impact of weather on commodity prices and local economic health
 - Trends and impact of climate change
- Linking yields, weather and prices is critical to ensure food security for all