This presentation premiered at WaterSmart Innovations

watersmartinnovations.com

watersmart
INNOVATIONS

Water Resource Management Beyond Climate Change: Welcome to the Anthropocene

Michael Davidson

Spec Management Group

With Thanks

- With thanks and homage and debt to:

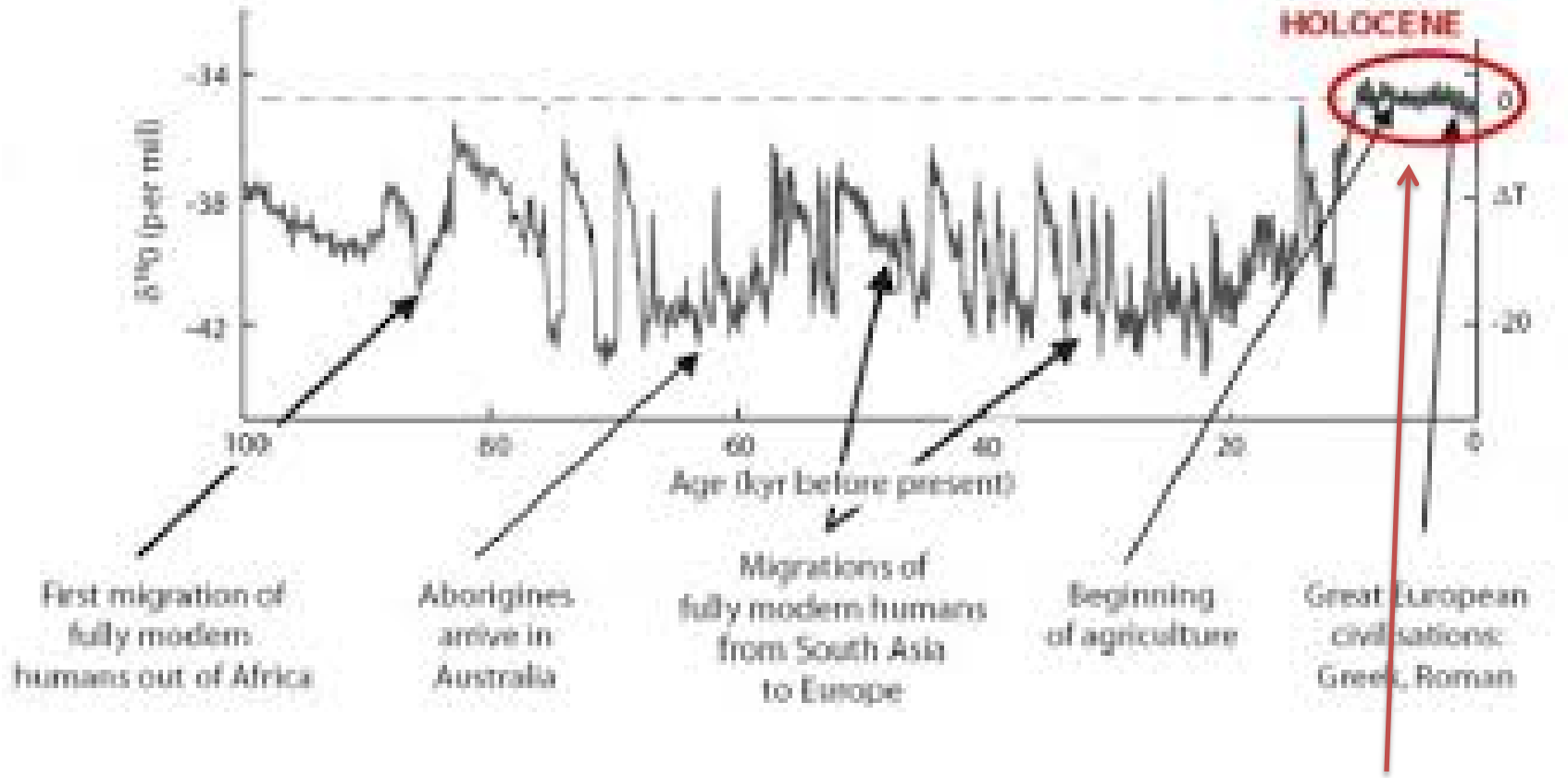
Johan Rockstrom

Stockholm Environment Institute, Stockholm Resilience Centre, Department of Water and Environmental Studies at Linkoping University, and the Stockholm International Water Institute

Outline

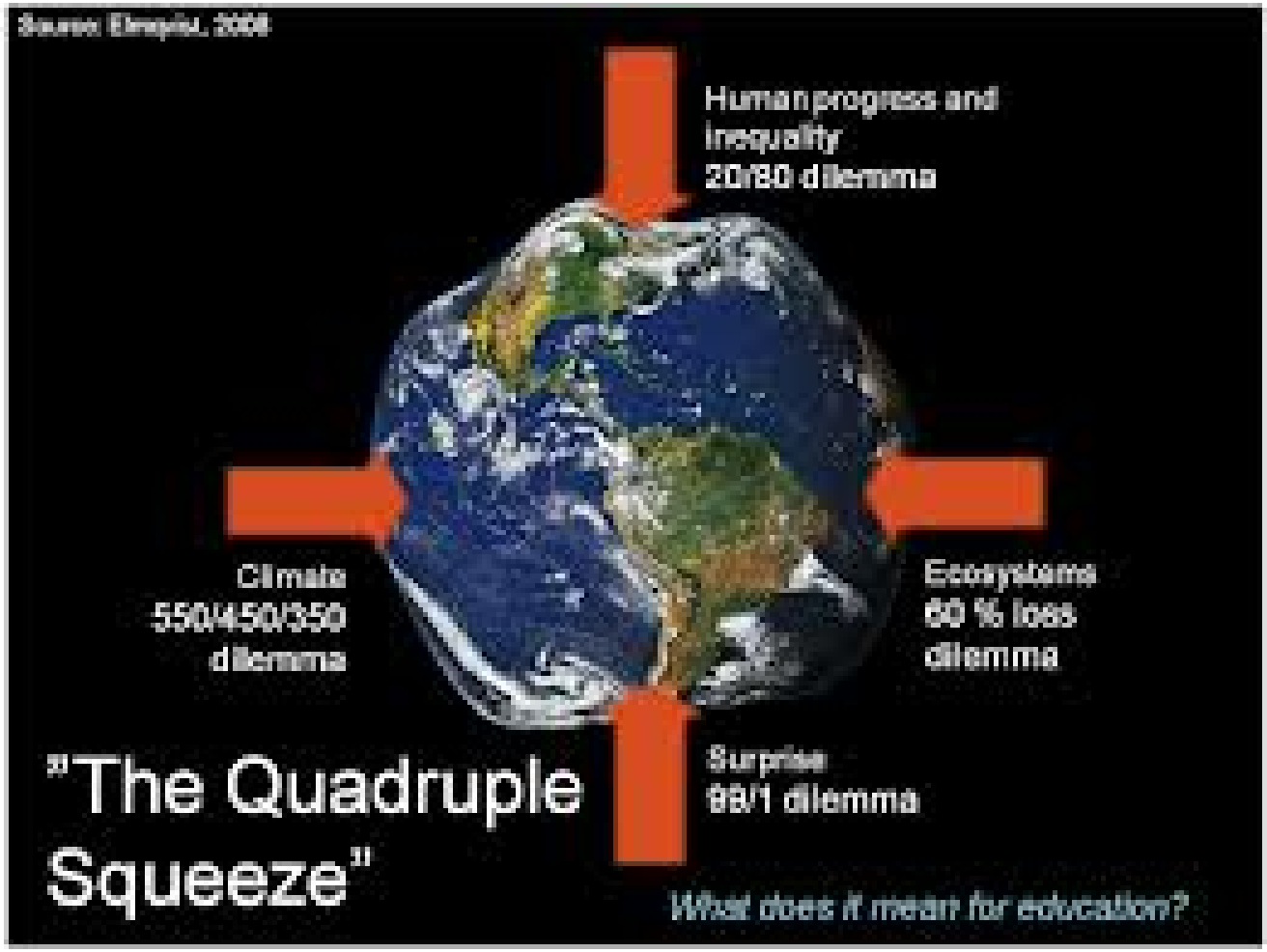
- The Anthropocene
  - Indicators
  - Quantification
- The Dual Challenge
  - Increase food security
  - Increase environmental security
- Constraints to Sustainability
- Correcting Course

Human Development

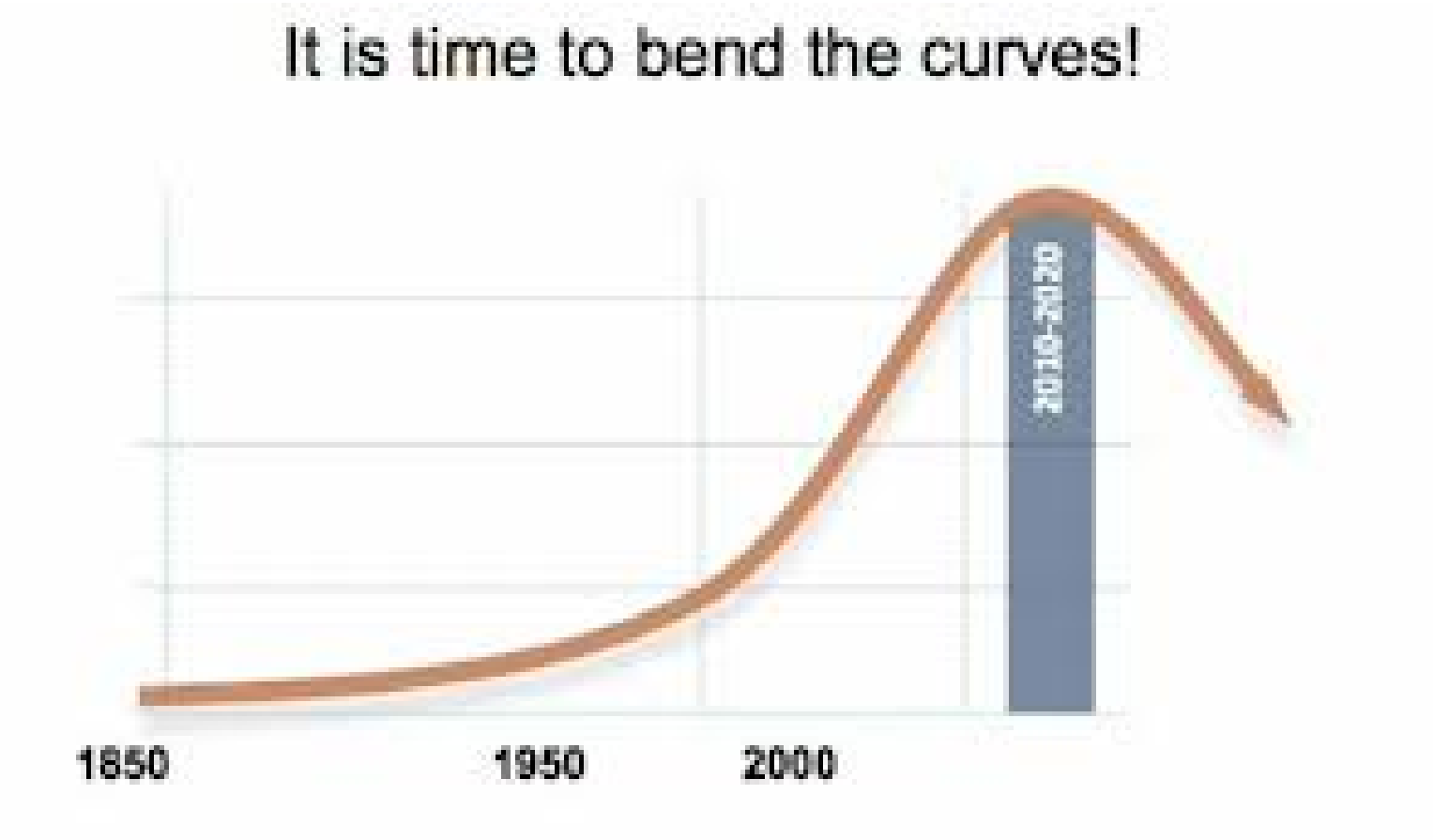


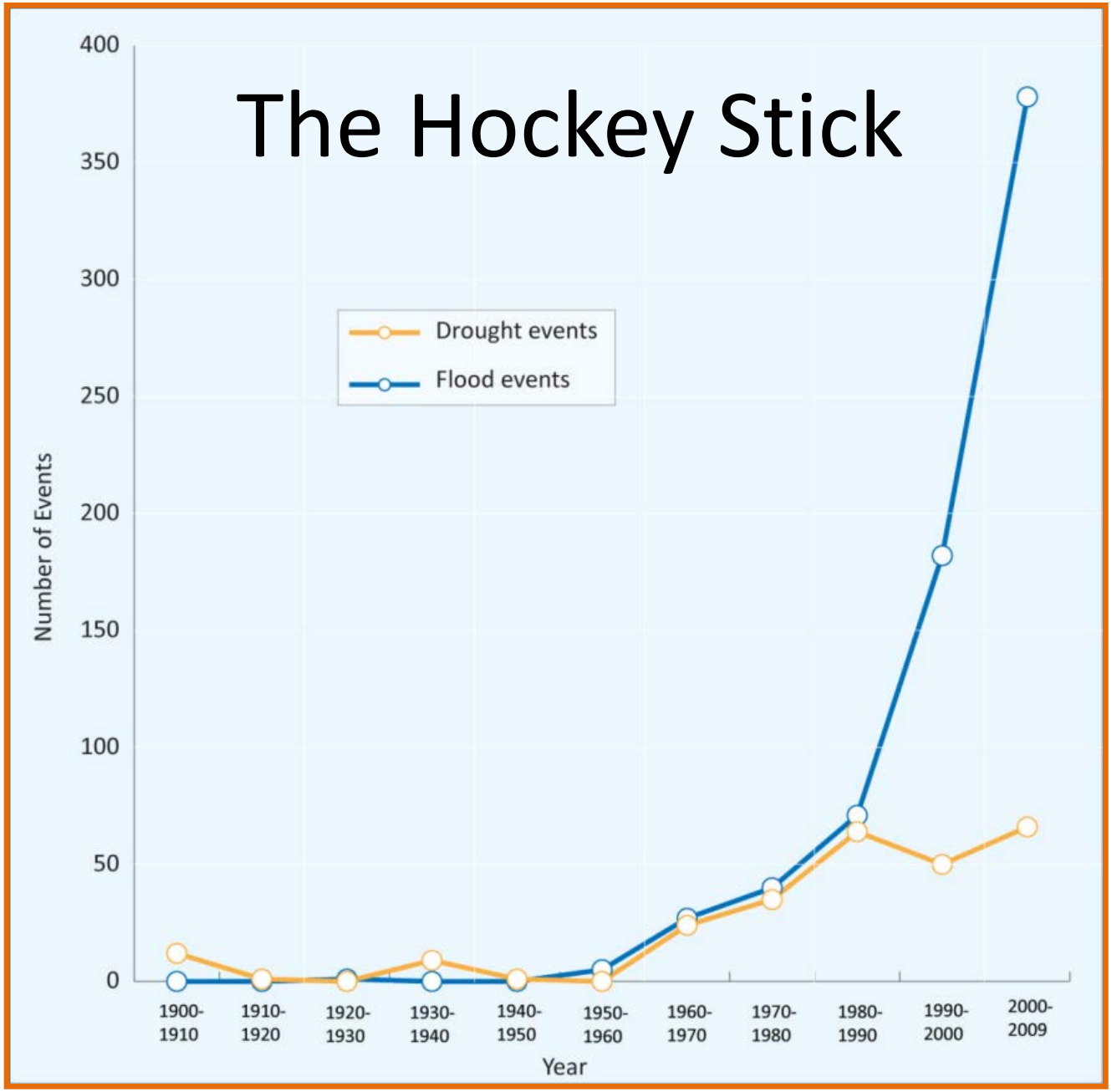
Last 10,000 years of unparalleled stability

The Quadruple Squeeze



It’s All About the Curve





Trend in the number of recorded flood and drought events in Africa

Global Environmental Change

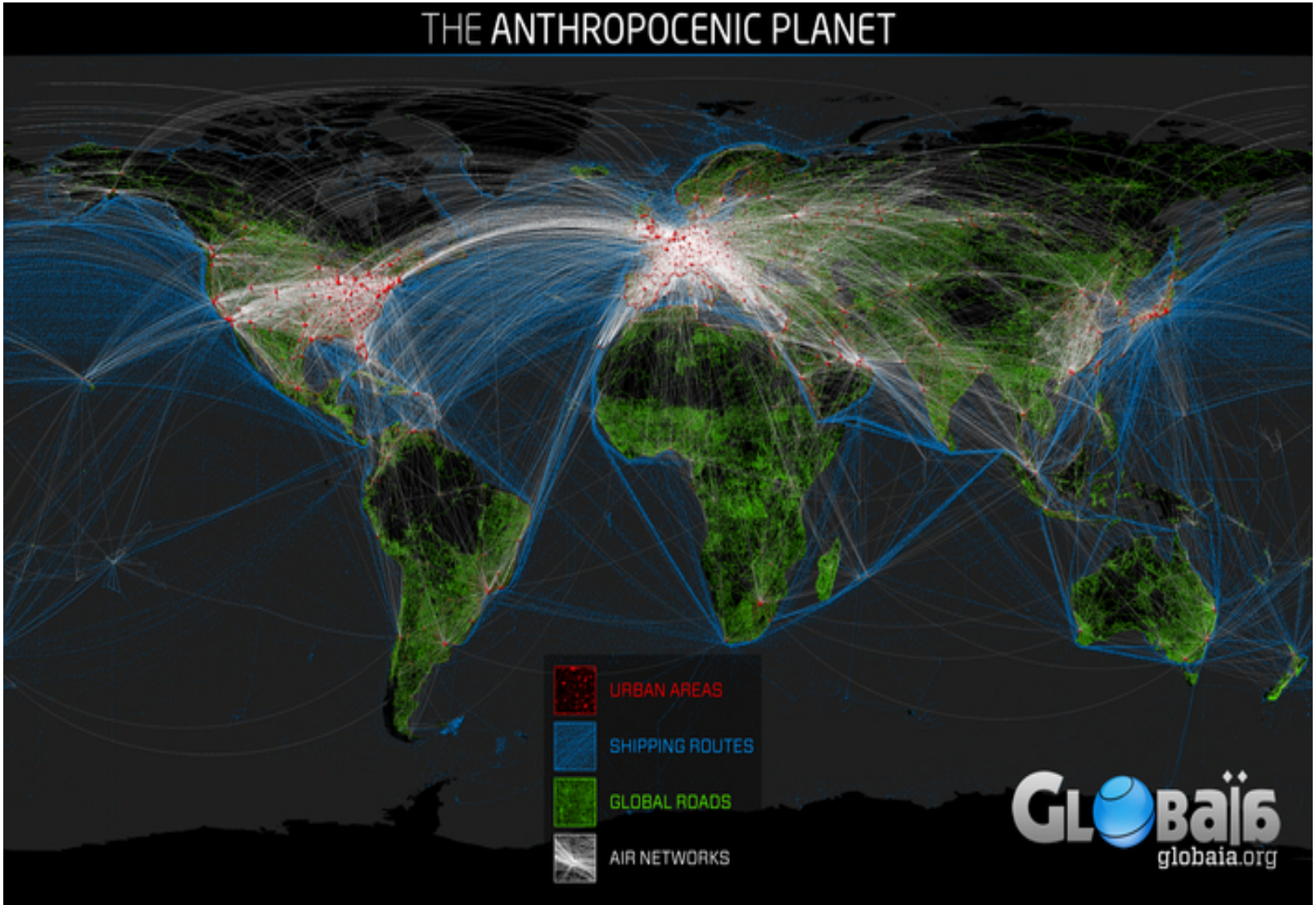
We're not in the Holocene any more!

The New Epoch

The Anthropocene

Welcome to the Anthropocene

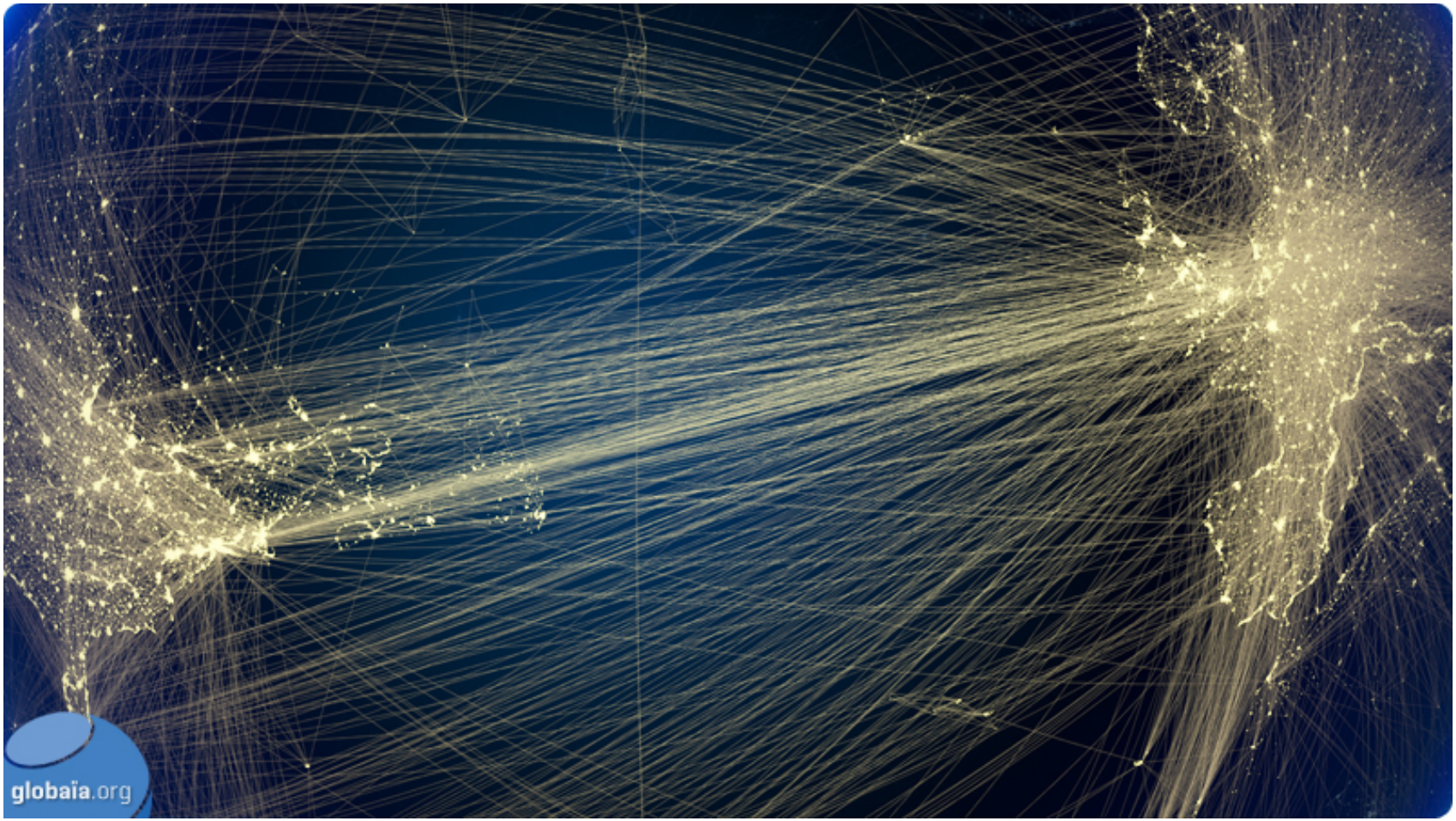
The Anthropogenic Impact on the Planet Earth



Cities, roads, railways and cables in Europe

Air routes between Europe and North America

Moderate Resolution Imaging Spectroradiomter (MODIS)



https://earthdata.nasa.gov/data/near-real-time-data/rapid-response/modis-subsets

Population Growth and Movement (Mexico City)

In 1800 3% of the world's population lived in cities.. Today it's 50%

Cle Elum
Keechelus
Easton Diversion
Kachess
Bumping Lake
French Canyon
Tieton
Clear Creek
Scoggins
Wasco
Haystack
Ochoco
Arthur R. Bowman
Crane Prairie
Wickiup
Crescent Lake
Fourmile Lake
Savage Rapids Diversion
OR
Agate
Emigrant
WA
Big Falls
Conconully
Salmon Lake
Grand Coulee
North
Hungry Horse
Pinto
O'Sullivan
Cold Springs
Reservoir A
Soldiers Meadow
MT
Como
Island Park
McKay
Unity
Thief Valley
Mason
Cascade
Deadwood
Grassy Lake
Mann Creek
Warm Springs
Agency Valley
Black Canyon (Diversion)
Little Wood River
Jackson Lake
Bully Creek
Owyhee
Deer Flat
Anderson Ranch
Ririe
Fish Lake
Palisades
CA
Hubbard
Boise River (Diversion)
ID
WY
Arrowrock
American Falls
NV
UT
Minidoka

Swift
Fresno
Nelson Dikes
Tiber
MT
Pishkun Dikes
Willow Creek
Gibson
Canyon Ferry
Helena Valley
Clark Canyon
Anita
ND
Dickinson
Jamestown
Heart Butte
Yellowtail Afterbay
Shadehill
Yellowtail
Belle Fourche
Deaver
Keyhole
SD
Buffalo Bill
Anchor
Bull Lake
Pilot Butte
Glendo
Boysen
Pathfinder
Pactola
Deerfield
Angostura
Merritt
WY
Box Butte
Virginia Smith (Calamus)
Minatare
Lake Alice
Davis Creek
Sherman
Seminoe
Red Willow
Medicine Creek
GREAT PLAINS
REGION (NORTH)
Alcova
Guernsey
NE
Enders
Trenton

Hoover
NV
COLORADO
REGION
New Waddell
Horseshoe
Bartlett
UT
Theodore Roosevelt
Davis
Parker
CA
AZ
NM
Horse Mesa
Mormon Flat
Stewart Mountain
Granite Reef
Imperial (Diversion)
Senator Wash
Squaw Lake Dike
Palo Verde (Diversion)

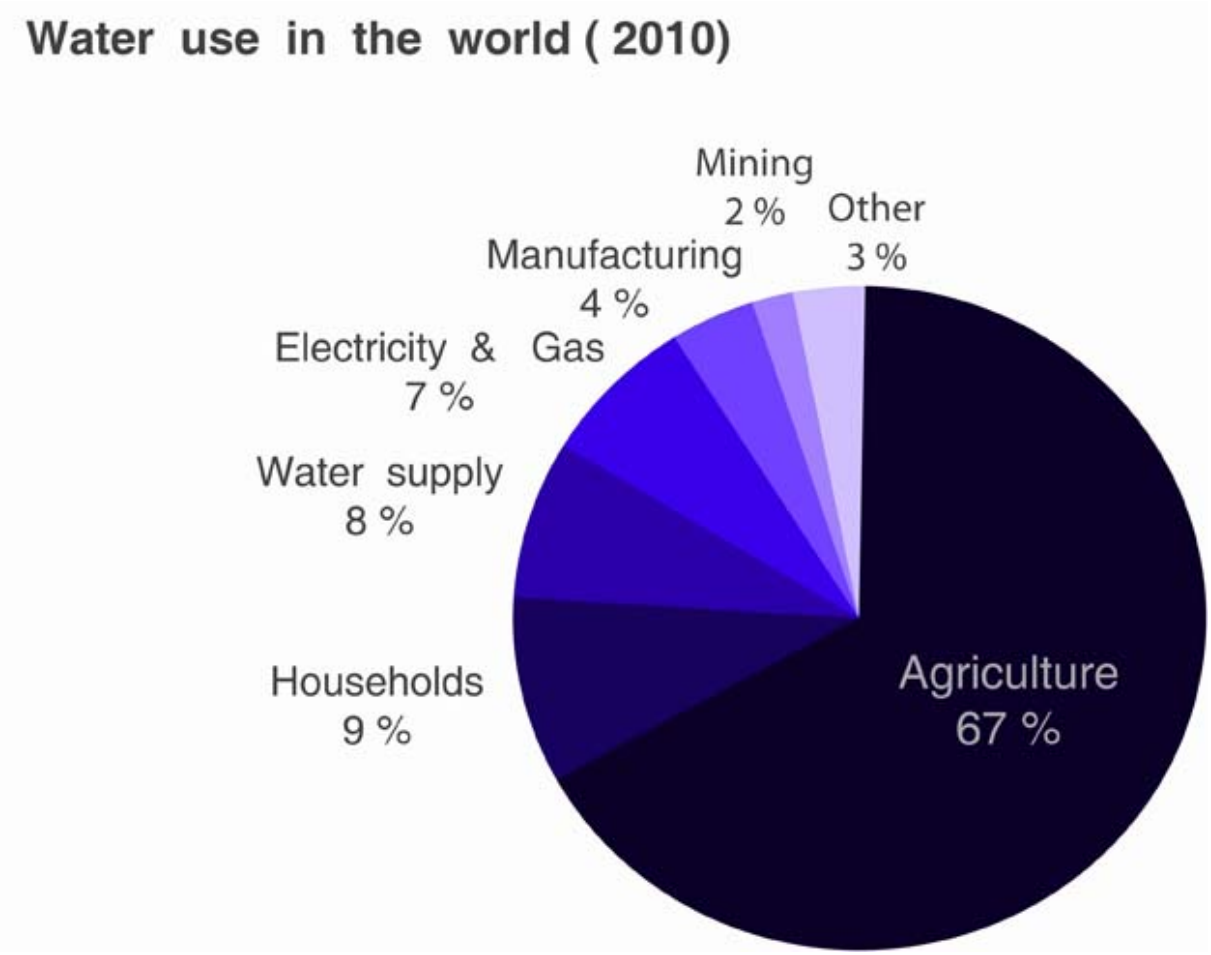
nake
ooth
us

1-11
CO
Norton
Kirwin
Lovewell
Glen Elder
KS
Webster
Cedar Bluff
Bonny
Cheney
Pueblo
Foss
OK
Fort Cobb
Sanford
Norman
Arbuckle
McGee Creek
GREAT PLAINS
REGION (SOUTH)
Altus
Mountain Park
Twin Buttes
TX
Marshall Ford
Palmetto Bend
Choke Canyon

5 Dixon Canyon
6 Satanka Dikes
7 Spring Canyon
8 Soldier Canyon
9 Mary's Lake Dike
10 Shadow Mountain
11 Carter Lake & Dikes

Howard Prairie
Hyatt Prairie
Keene Creek
Lewiston
Trinity
Keswick
Shasta
Spring Creek Debris Dam
Whiskeytown
Red Bluff (Diversion)
Stony Gorge
East Park
Monticello
Folsom
Mormon Island Auxiliary Dam
Martinez
Contra Loma
San Justo Dike
San Justo
Little Panoche (Detention)
Twitchell
Bradbury
Glen Annie
Lauro
Carpinteria
Ortega
Link River
Gerber
OR
Clear Lake
Buckhorn
Rye Patch
NV
Stampede
Boca
Prosser Creek
Lake Tahoe
Lahontan
Sugar Pine
New Melones
O'Neill
San Luis
Los Banos (Detention)
CA
Friant
Casitas

Water Use in the World



Water withdrawals by sector

95% of available water used in agriculture

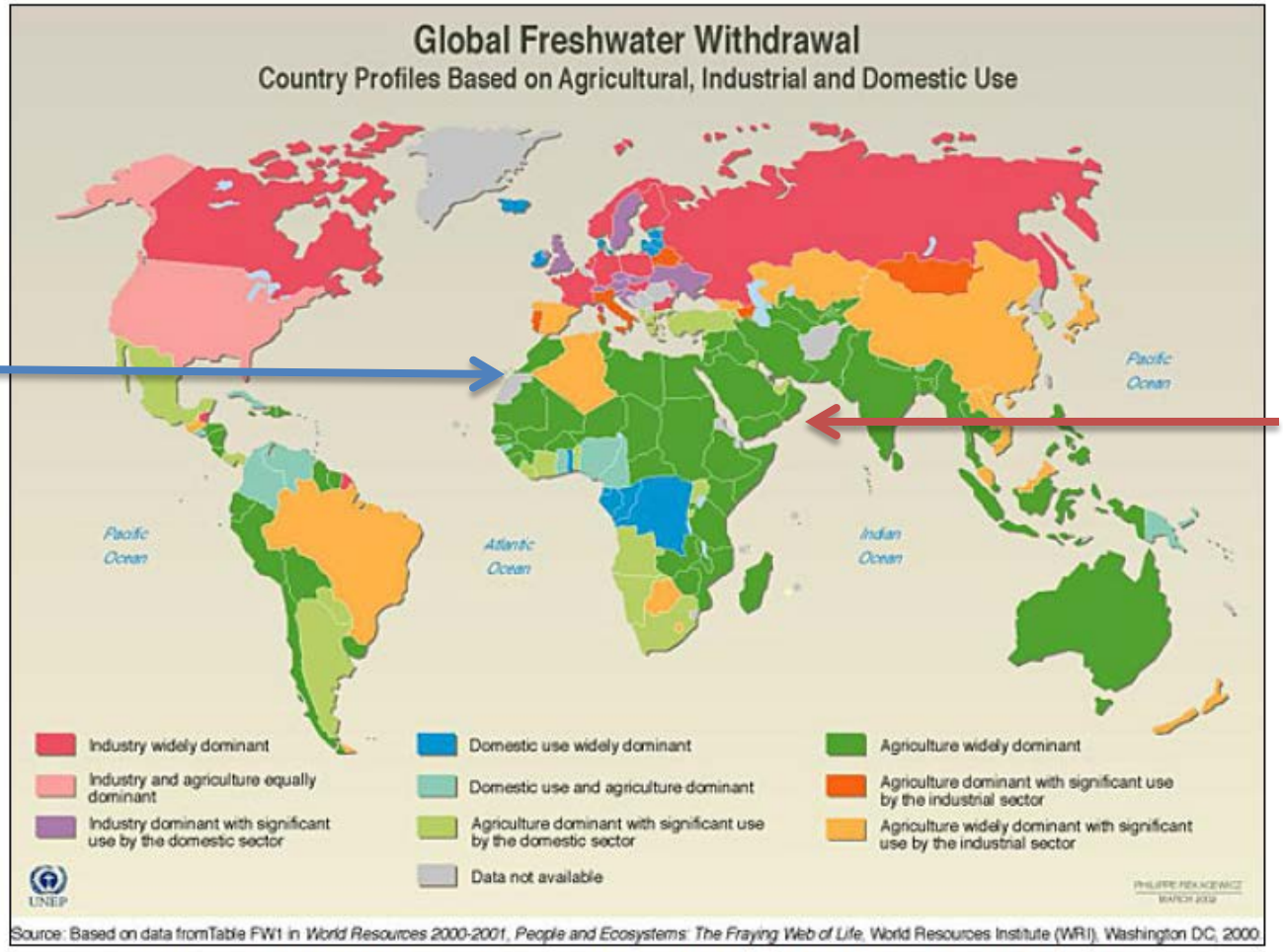
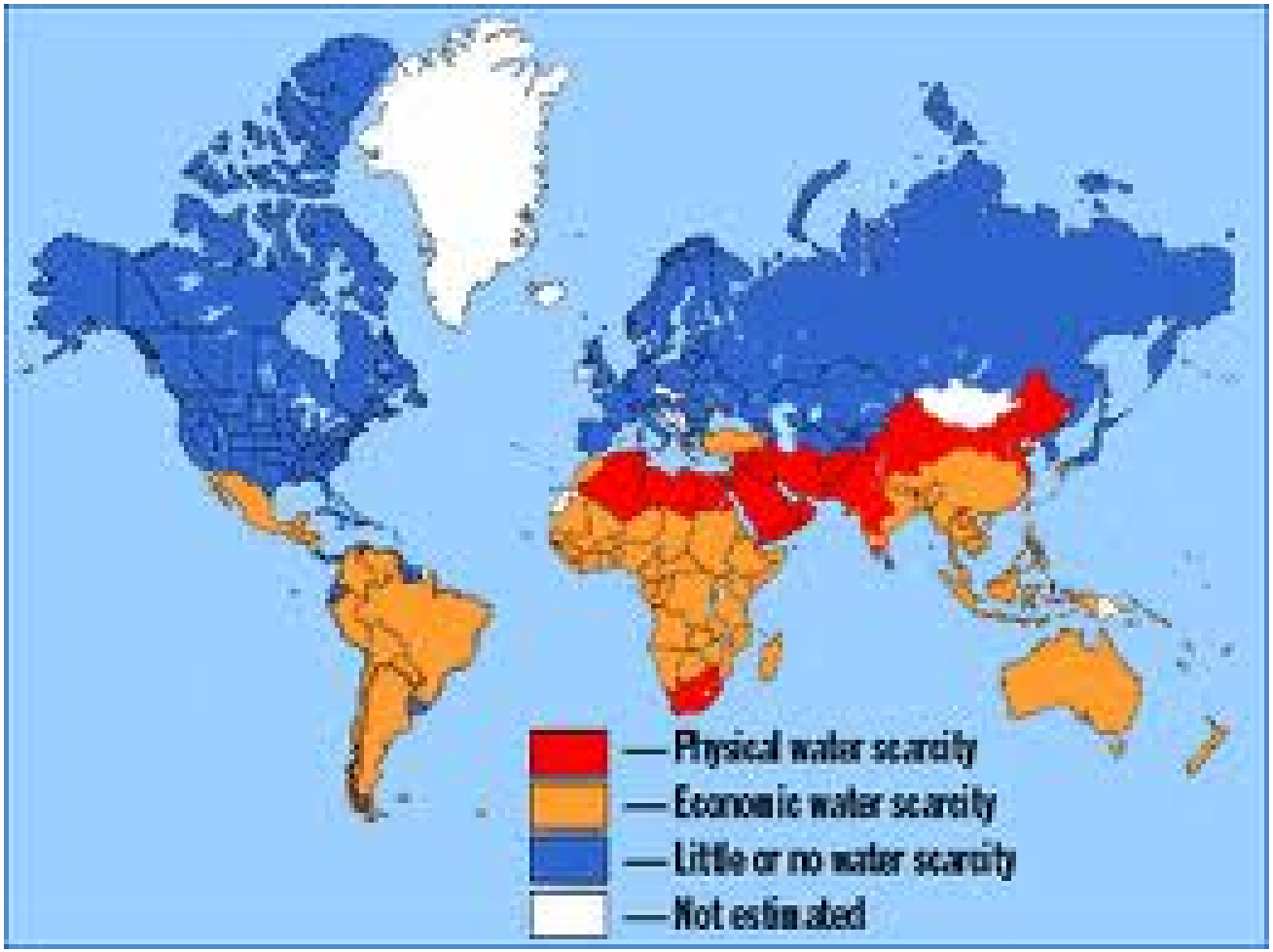


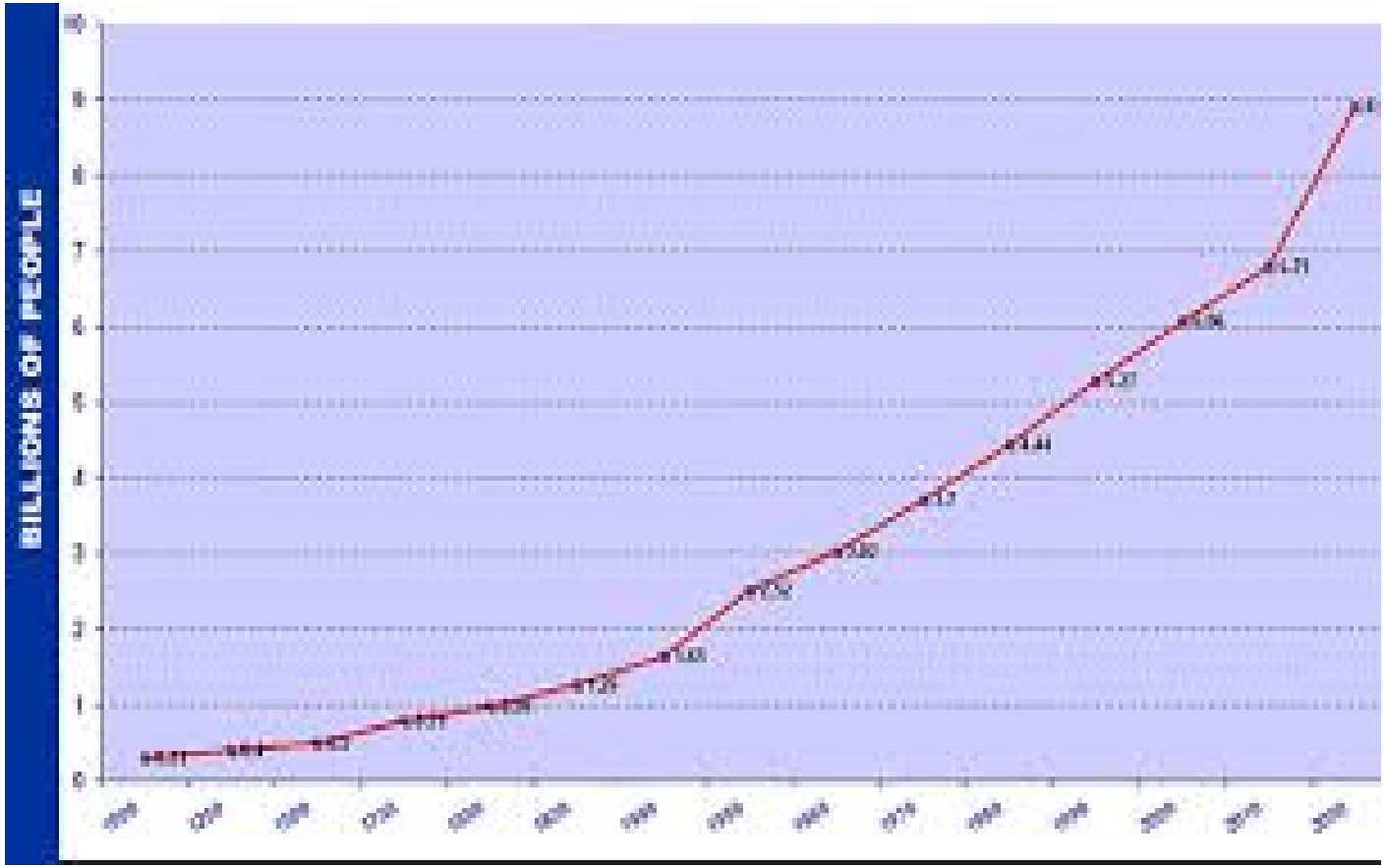
Fig. 6: Global freshwater withdrawal (World Resources Institute)

4% of land under irrigation

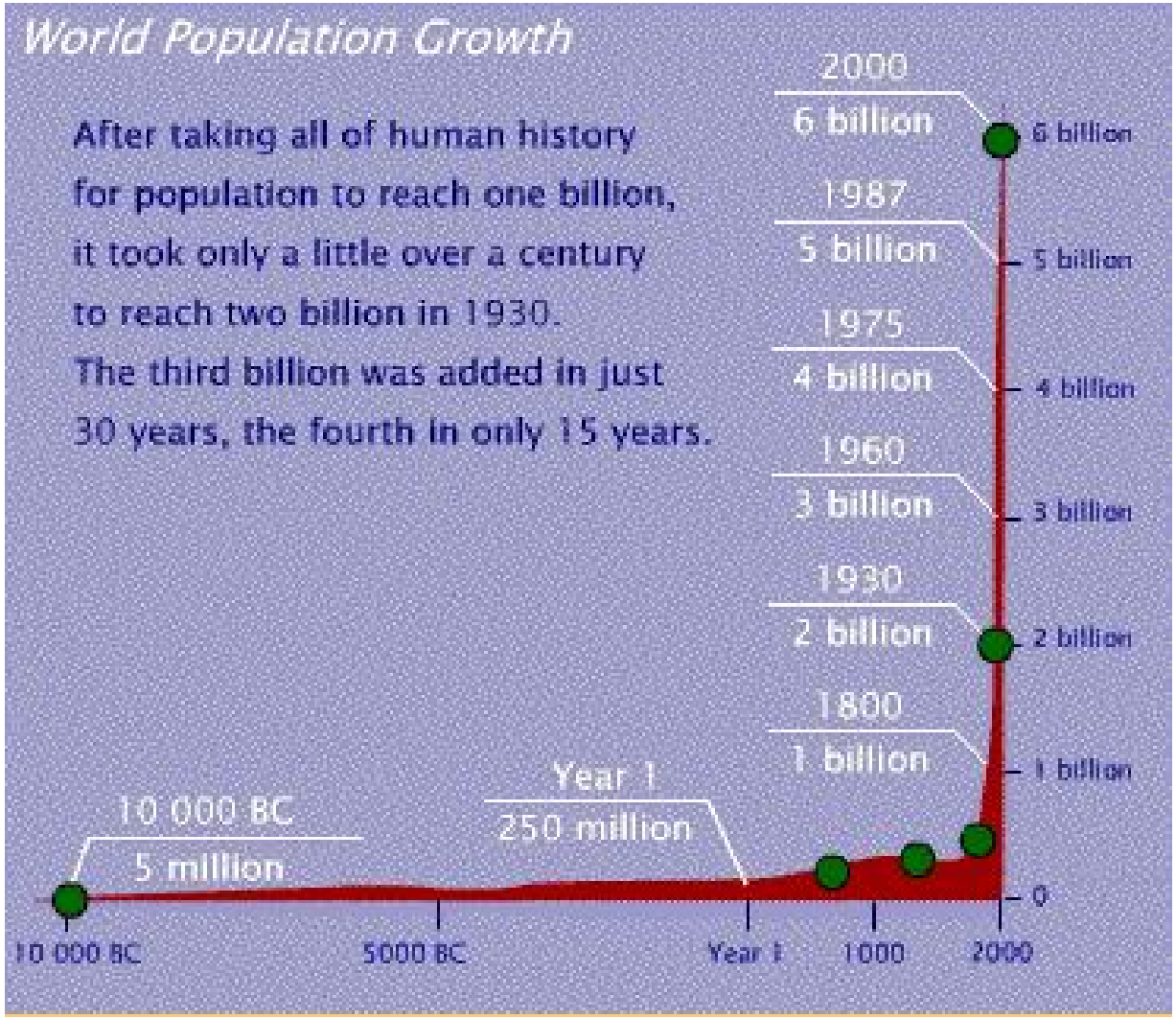
Water Scarcity



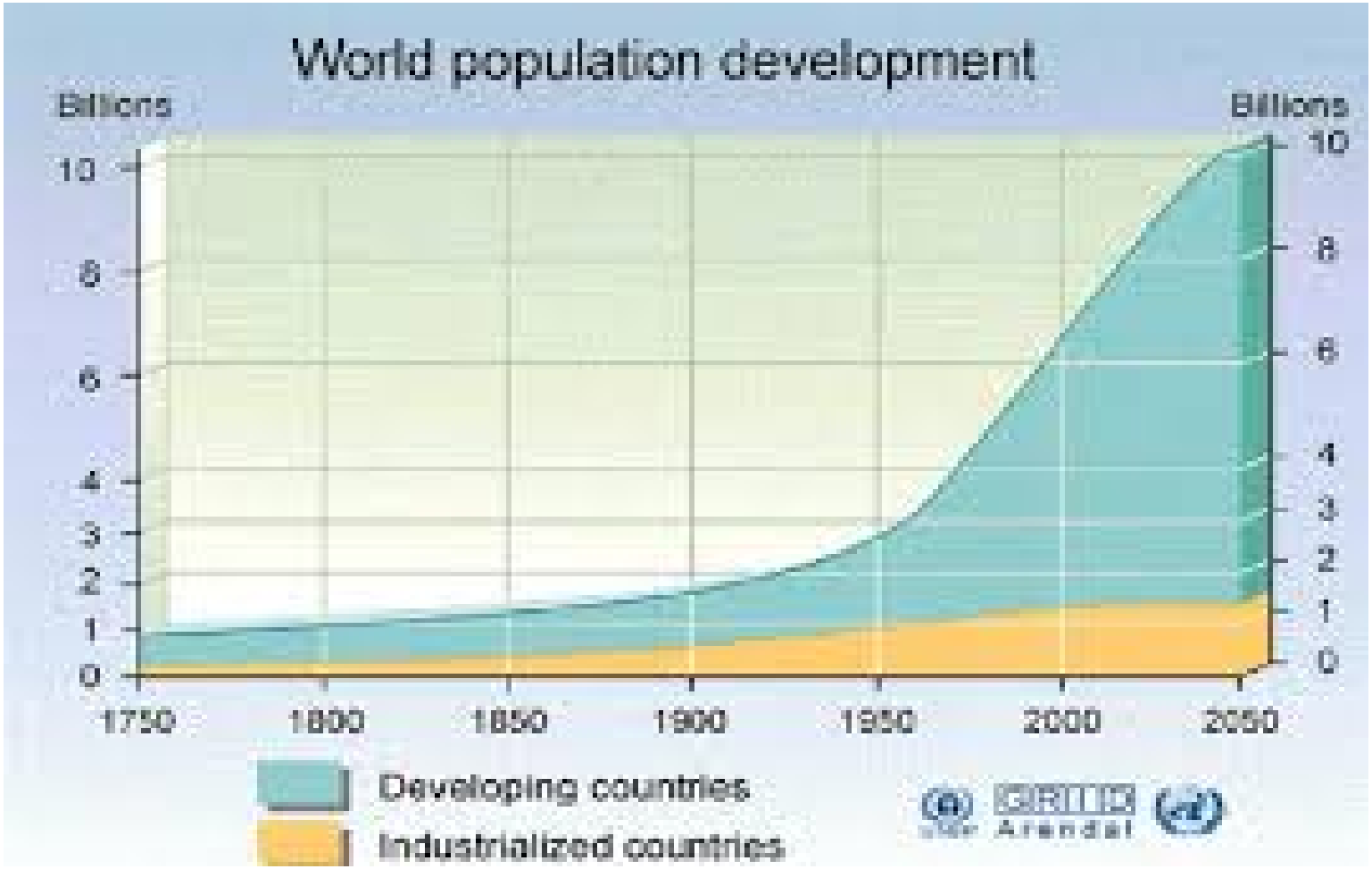
Global Population Growth from 6.5 billion to 9.5 billion in 30



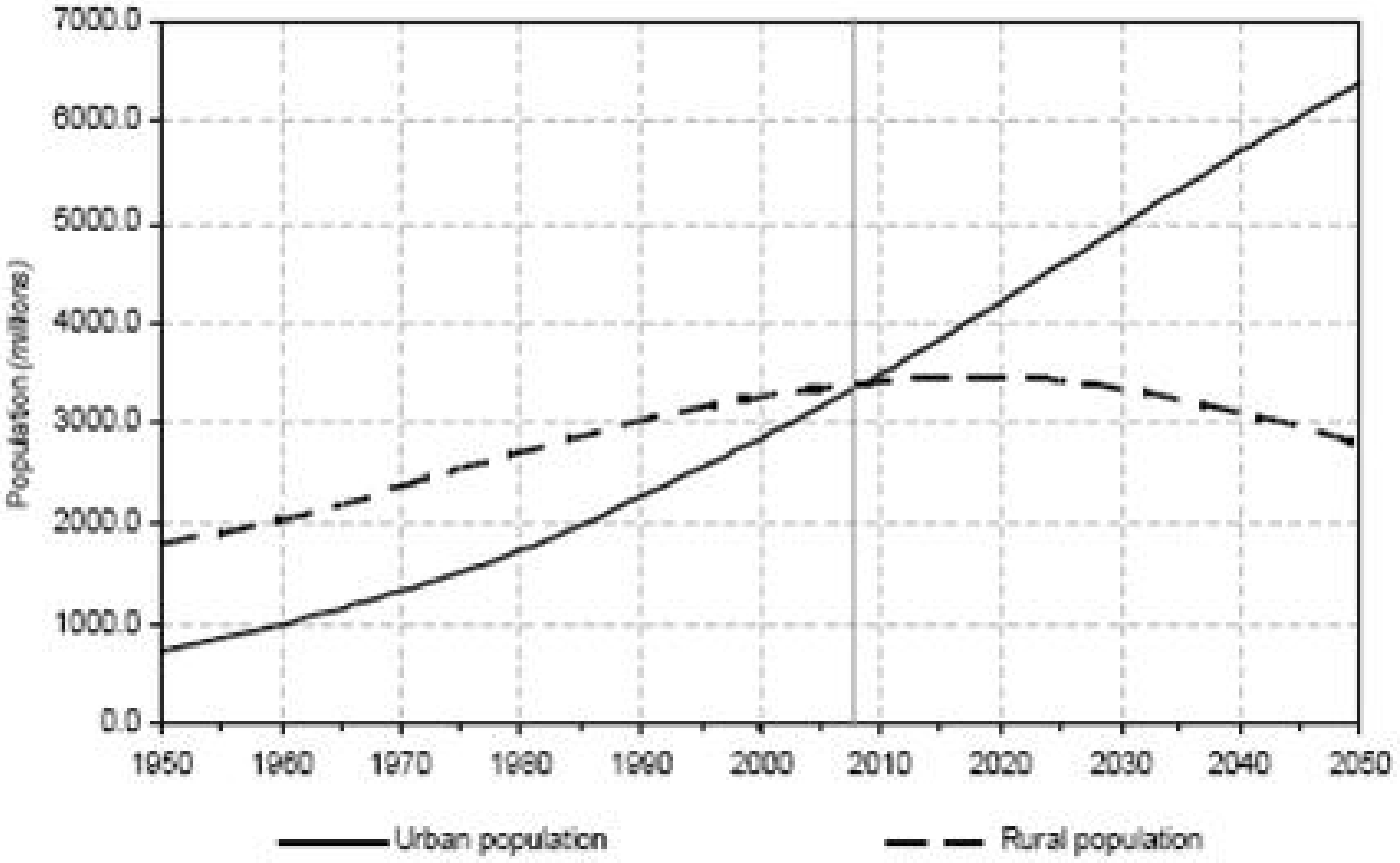
Rate of Population Growth



Population Growth
By Sectors

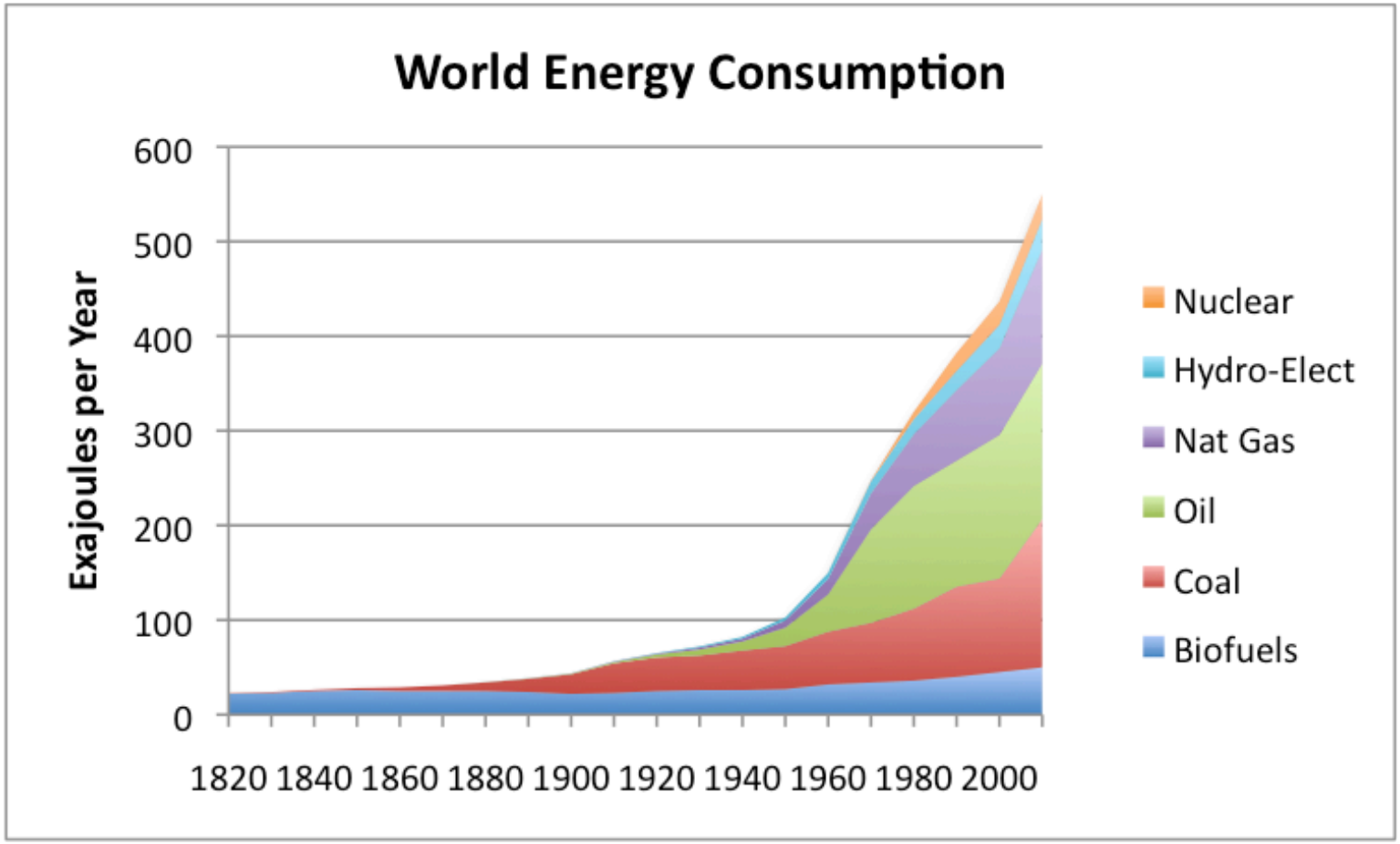


Urban Growth



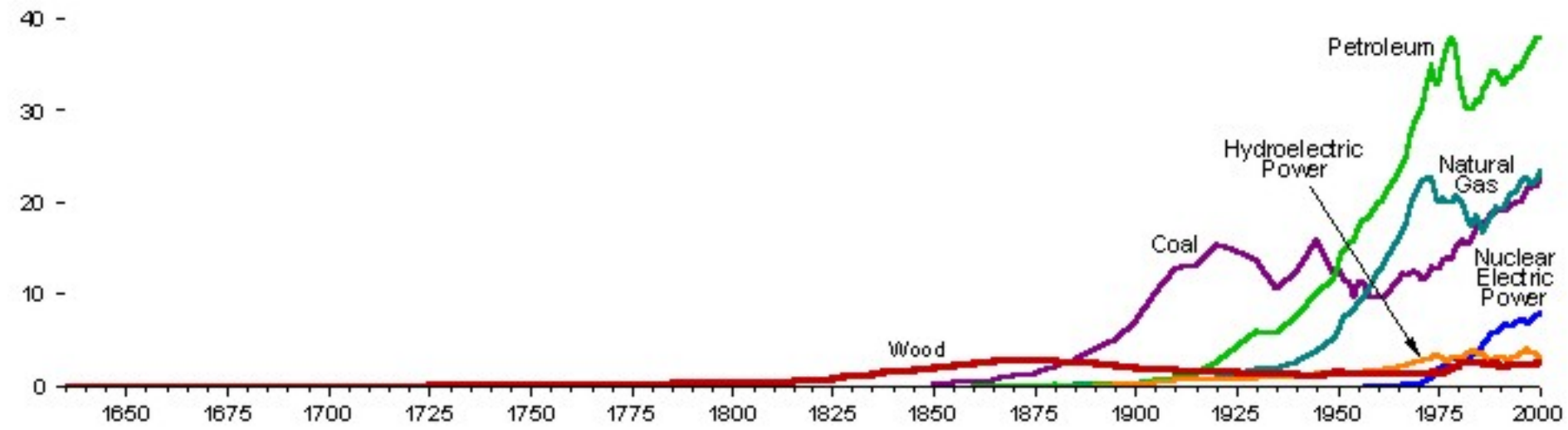
World Energy Consumption

(ourfiniteworld.com)

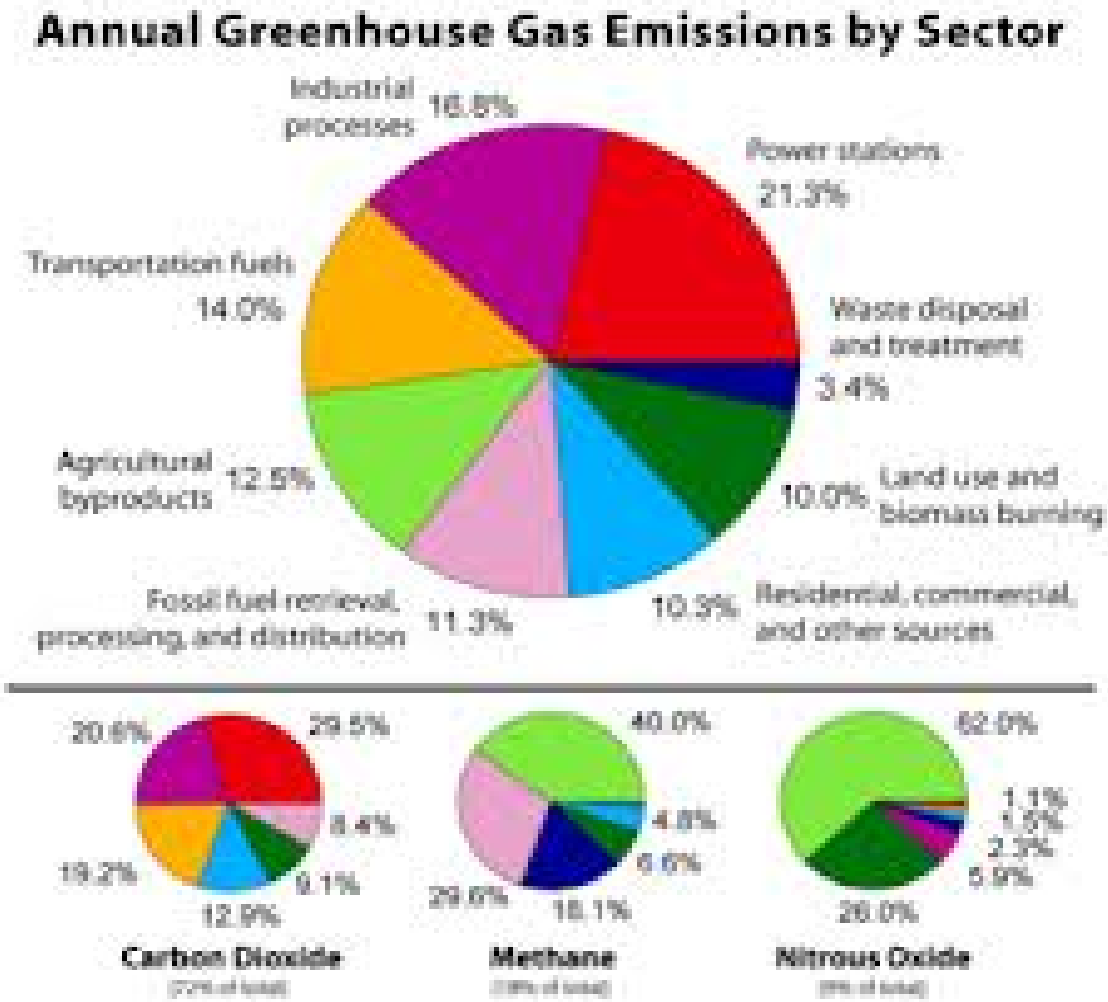


Energy Consumption by Source

(US Department of Energy: Energy Information Agency)

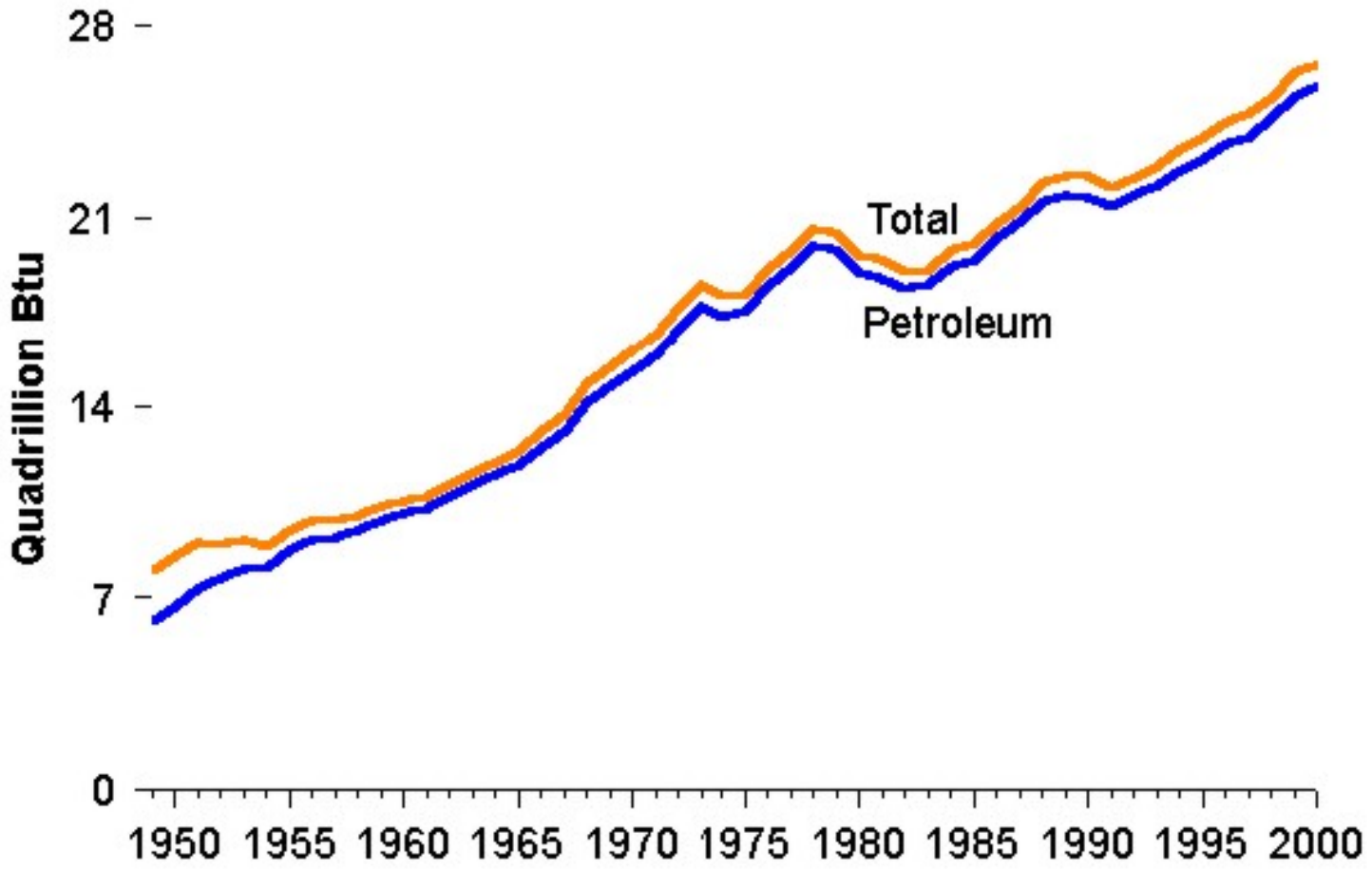


GHG emissions by sector

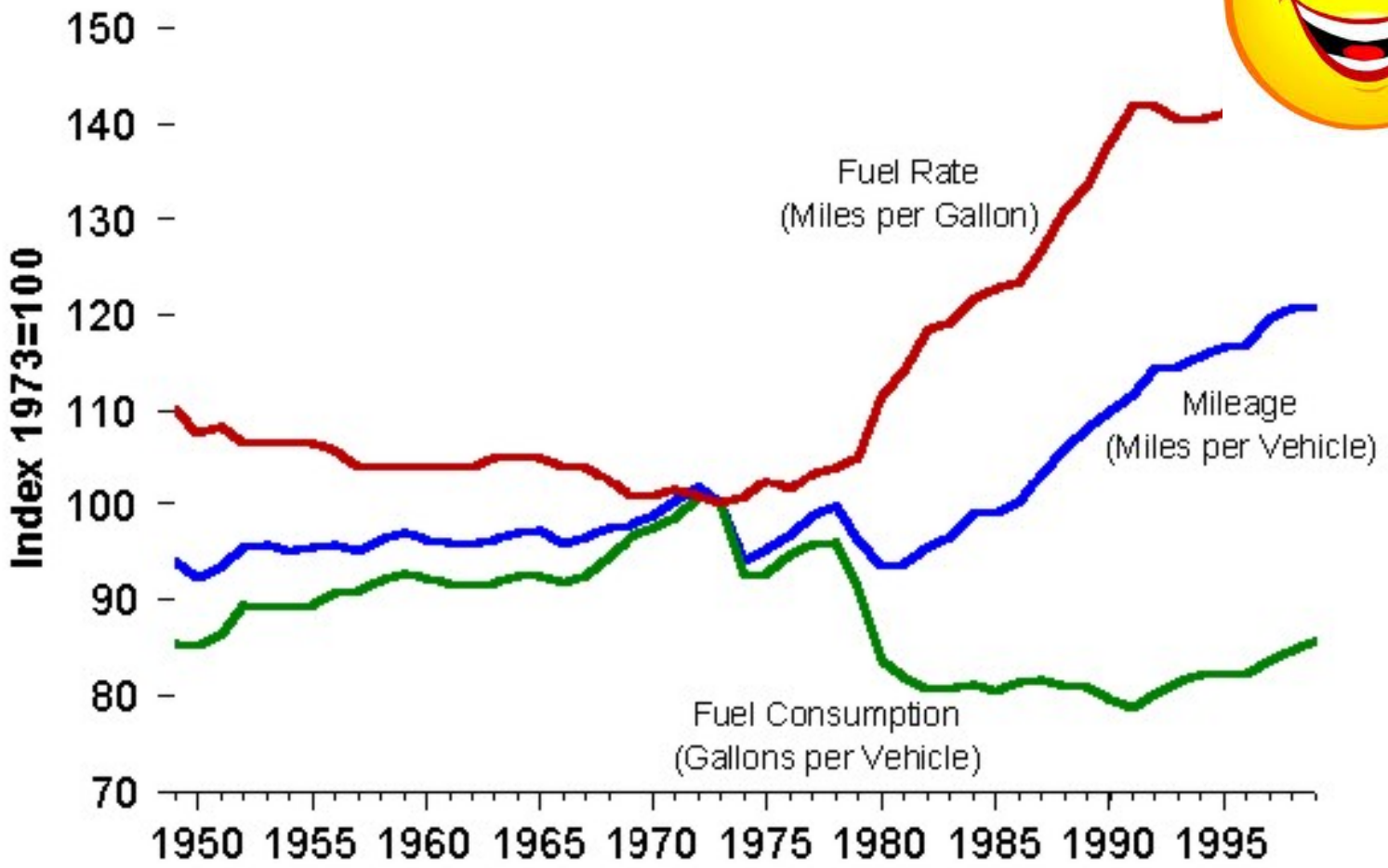


Traffic patterns

Transportation Energy Consumption



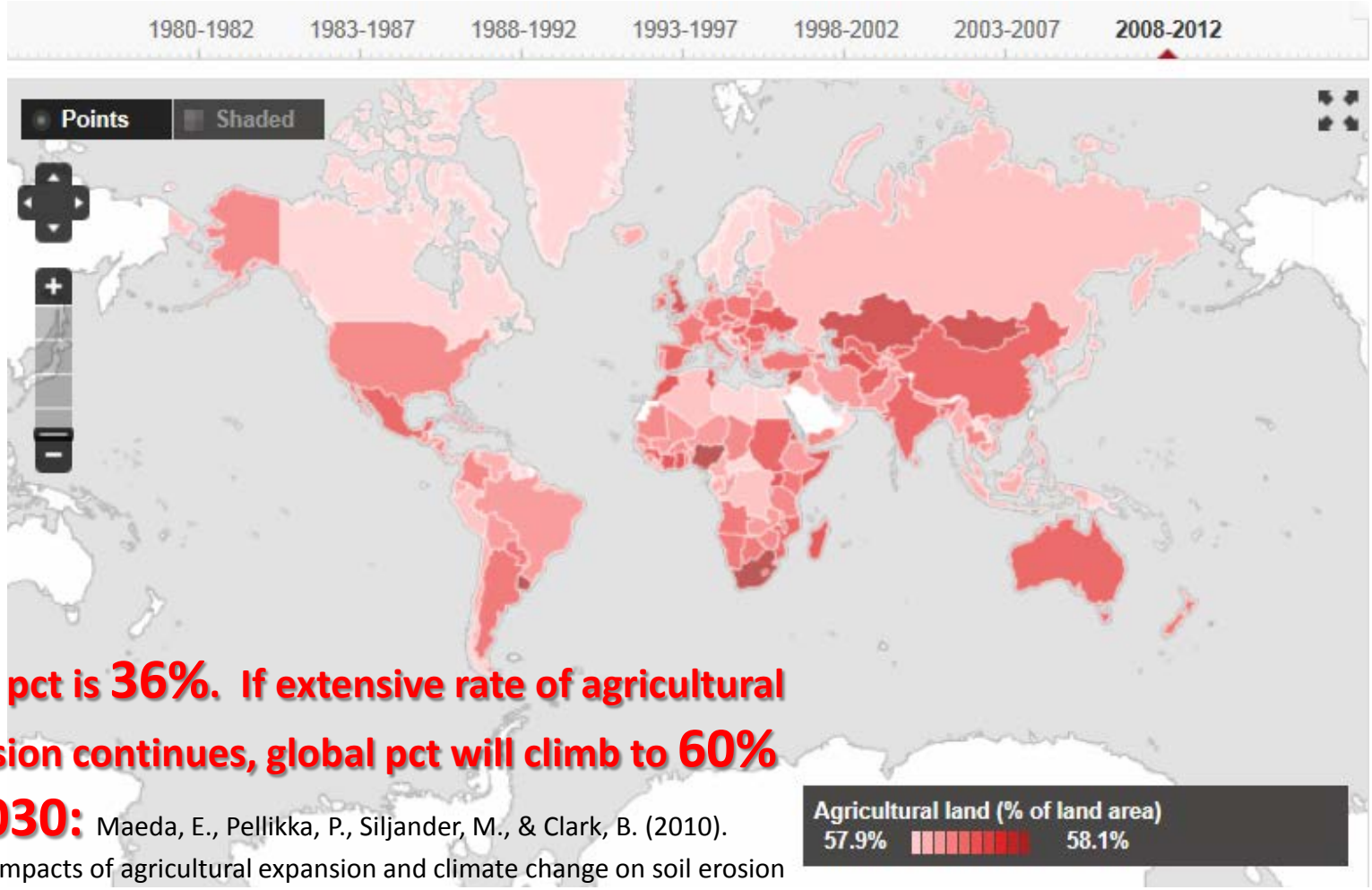
Motor Vehicle Energy Consumption in the US



Land Use

Agricultural Land/% of total

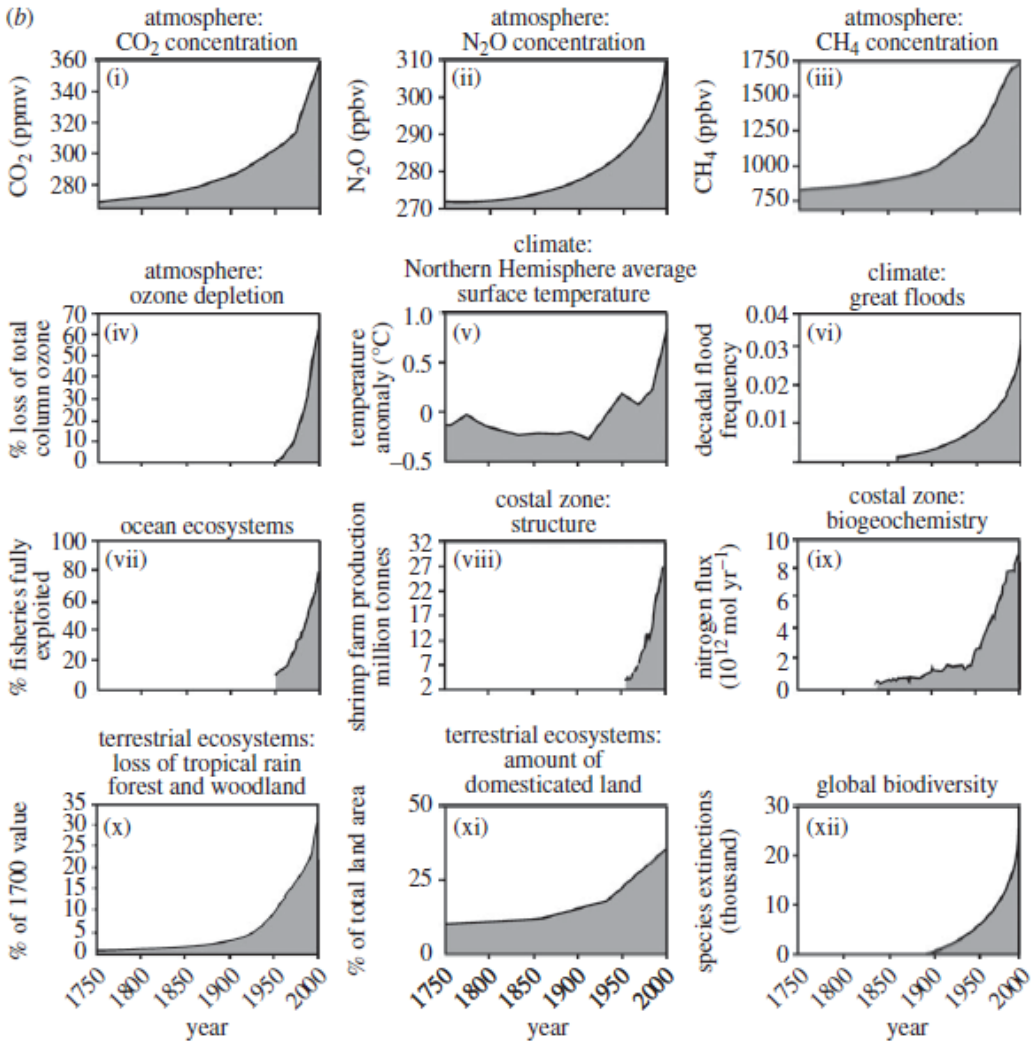
(World Bank, 2012)



Global pct is 36%. If extensive rate of agricultural expansion continues, global pct will climb to 60% by 2030: Maeda, E., Pellikka, P., Siljander, M., & Clark, B. (2010). Potential impacts of agricultural expansion and climate change on soil erosion in the Eastern Arc Mountains of Kenya. *Geomorphology , 123*, 279-289.

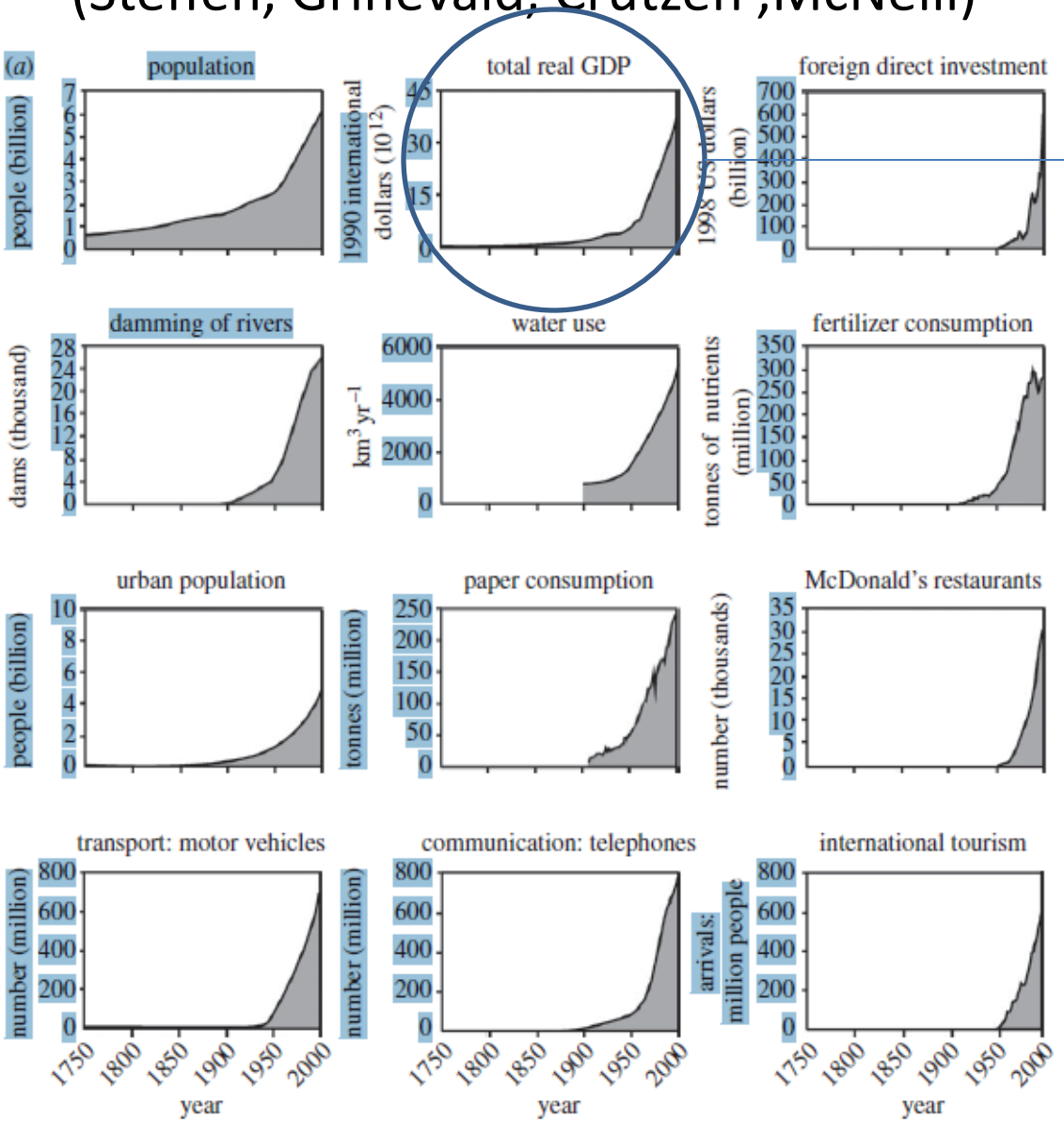
Emergence of the Anthropocene

(Steffen, Grinevald, Crutzen ,McNeill)



Development of the Anthropocene

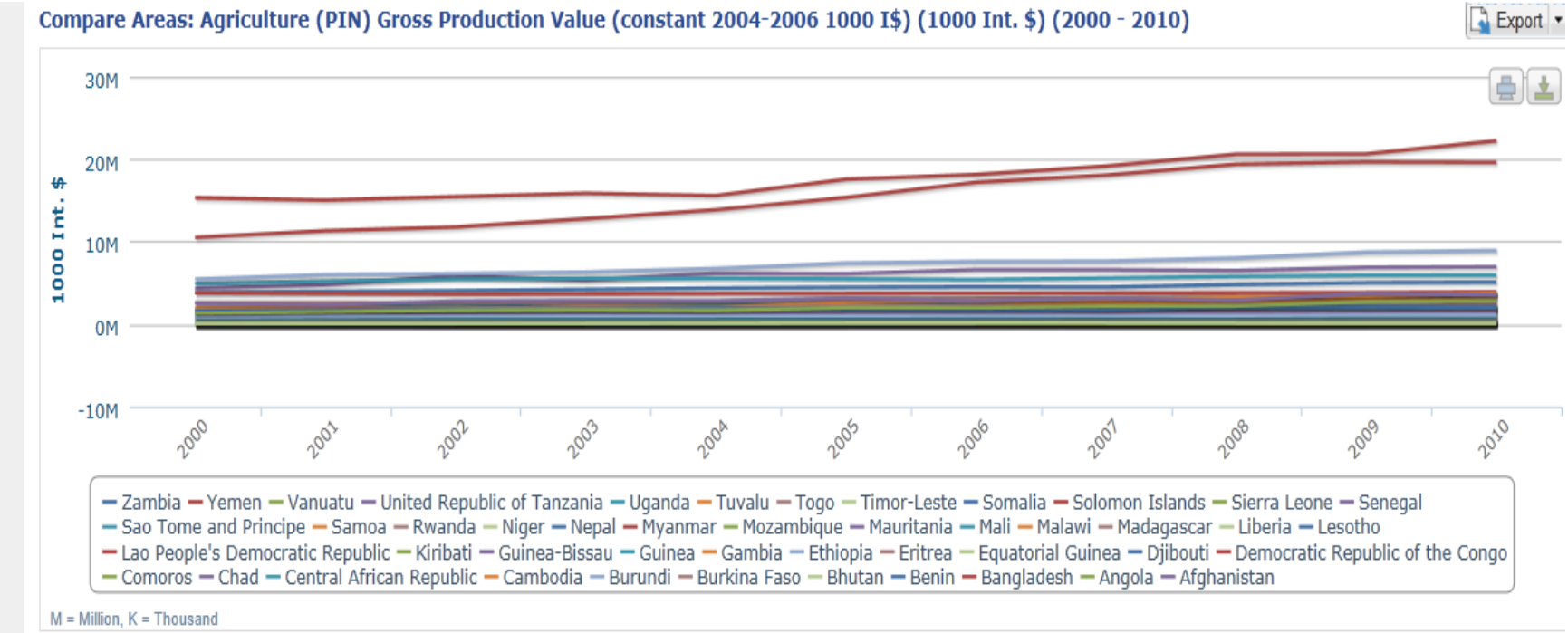
(Steffen, Grinevald, Crutzen ,McNeill)



The emerging critical driver

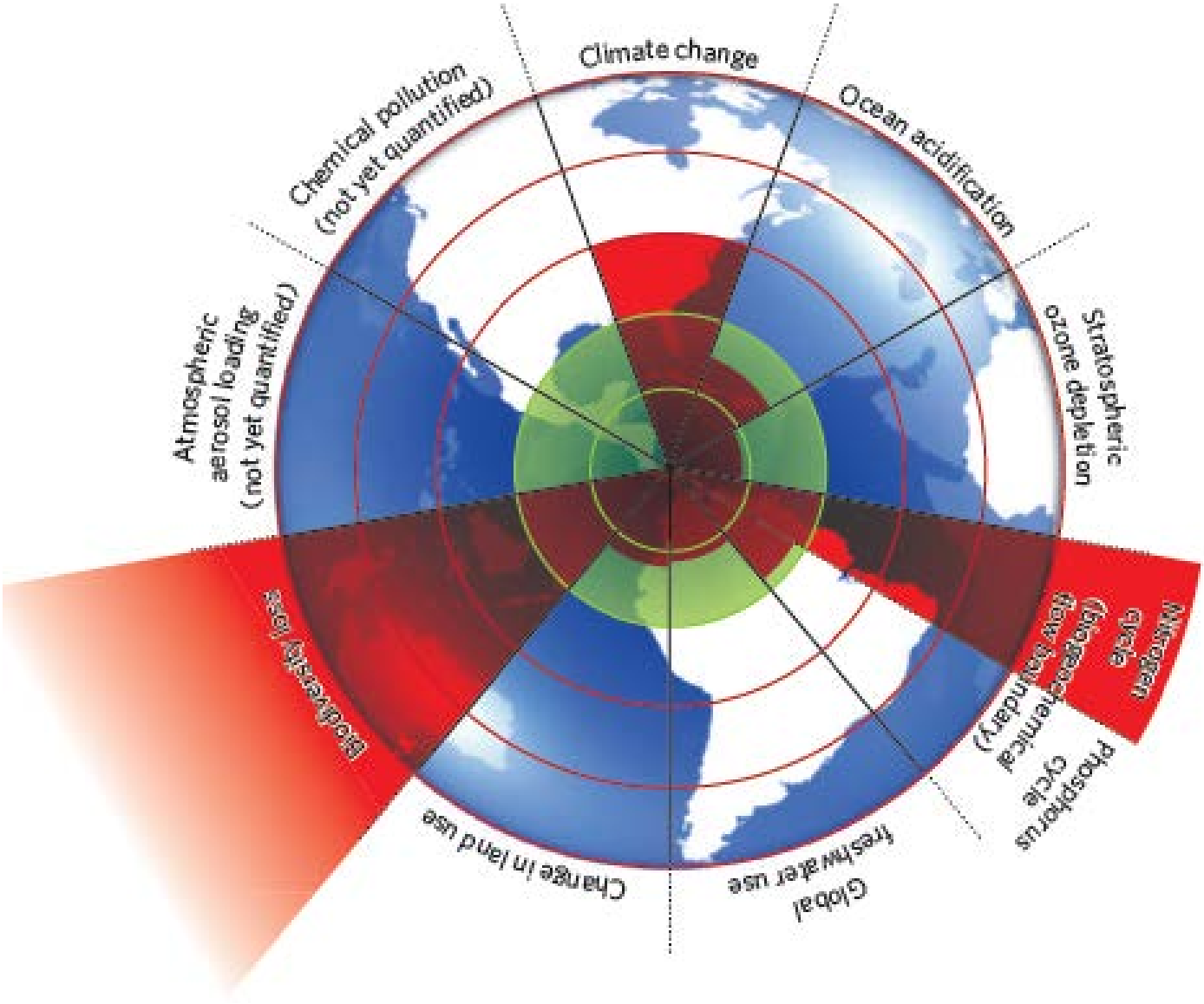
Agricultural Growth in Developing Countries from 2000-2010

(FAO)



Earth system process	Parameter	Proposed boundary	Current status	Pre-Industrial status
Climate change	•Atmospheric carbon dioxide concentration (PPM) •Change in radiative forcing (watts per meter sq)	350 1	387 1.5	250 0
Rate of biodiversity loss	Extinction rate (number of species per million number of species)	10	>100	0.1-1.0
Nitrogen Cycle	Amount of N removed from the atmosphere for human use (millions of tons per year)	35	121	0
Phosphorus Cycle	Amount of P flowing into the ocean (millions of tons per year)	11	8.5-9.5	-1
Stratospheric Ozone depletion	Concentration of Ozone (Dobson units)	276	283	290`
Ocean acidification	Global mean saturation state of aragonite in surface sea water	2.75	2.90	3.44
Global freshwater use	Consumption of freshwater by humans (km^3 year)	4000	2600	415
Land use	Percentage of global land converted to cropland	15	11.7	Low
Atmospheric aerosol loading		To be determined		

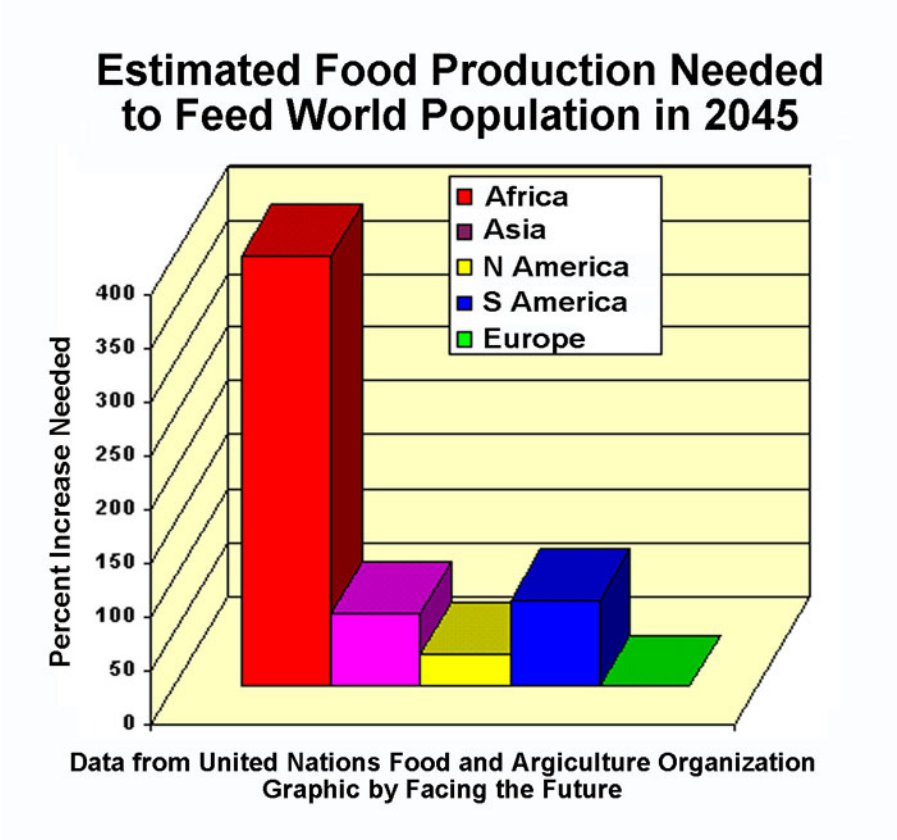
Beyond the boundary (Rockstrom)



The Challenge of Uncertainty

"No amount of sophistication is going to allay the fact that all your knowledge is about the past and all your decisions are about the future" -Ian Wilson, former Chairman of G.E.

Estimated Food Production



The Good News

- Sustainable Agricultural Production produces a win/win:

1. Greater yields increased profitability for growers in least developed countries
2. Mitigation of global environmental change

Water productivity gains

(World Bank report; 2006)

Table 4.4. More from Less: Water Productivity Gains from Shifting to Drip from Conventional Surface Irrigation in India

Crop	*Change in yield/ha (percent)*	*Change in water use/ha (percent)*	*Change in water productivity (percent)*
Bananas	+52	–45	+173
Cotton	+27	–53	+169
Grapes	+23	–48	+134
Sweet potatoes	+39	–60	+243
Tomatoes	+50	–39	+145

What is Sustainable Agriculture Production?
A tool Kit

Water Harvesting

ET Based Irrigation

Conservation Tillage

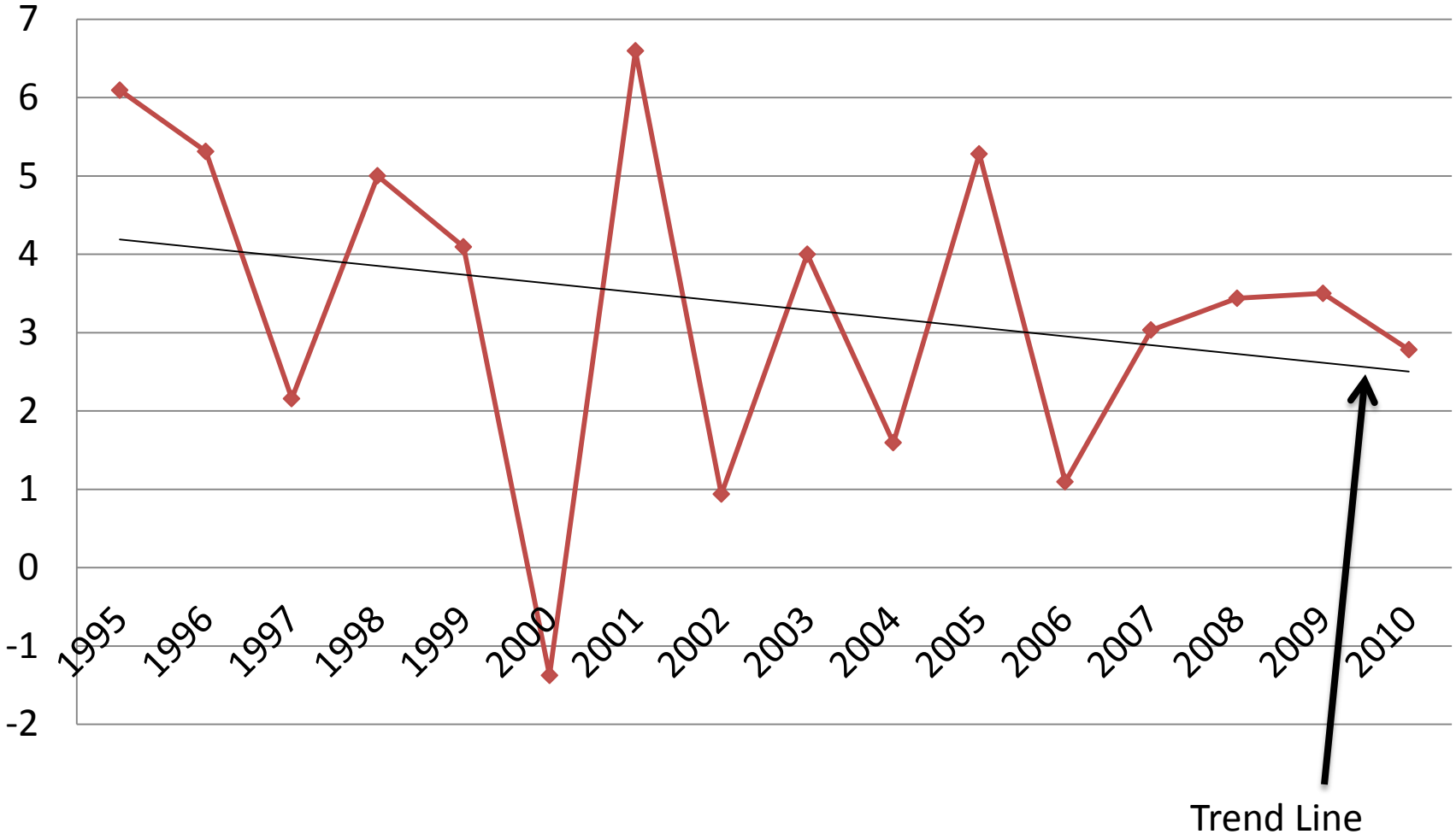
Run-Off Control

Intensive Production

Low Volume/High Uniformity Irrigation

Integrated Pest and Nutrient Mgt

LDC Annual growth from Ag 1995-2010 in pct



Prevalence of Stunting

(FAO)

Region	1980	1985	1990	1995	2000	2005
Africa	40.5	39.2	37.8	36.5	35.2	33.8
Eastern Africa	46.5	46.9	47.3	47.7	48.1	48.5
Northern Africa	32.7	29.6	26.5	23.3	20.2	17.0
Western Africa	36.2	35.8	35.5	35.2	34.9	34.6

The Failure of Current Models

Development Model

The Constraints and Inputs to Agricultural Production

Constraints

- **Institutional:** Capacity, corruption
- **Social:** gender, health
- **Governance:** statutory v traditional law, land tenure
- **Finance:** credit, loans
- **Weather:** vulnerability
- **Knowledge:** lack of training

Inputs

- Labor
- Water
- Land
- Seeds
- Cultivars
- Fertilizers
- Irrigation
- Credit
- Mechanization
- Knowledge

Solving for the constraints is important but insufficient

Sustainability

*"Sustainability, is better seen as a measure of the **relationship between the community as learners and their environments**, rather than an externally designed goal to be achieved" (Sriskandarajah et al, 1991).*

The Disconnect

The Development Community

The Professional Agricultural Community

Local Institutions

Scientific Community

All Irrigation Research Determines When and How Much We Water

Of the 6 million ha equipped for irrigation 1 million need rehabilitation (You, 2008)

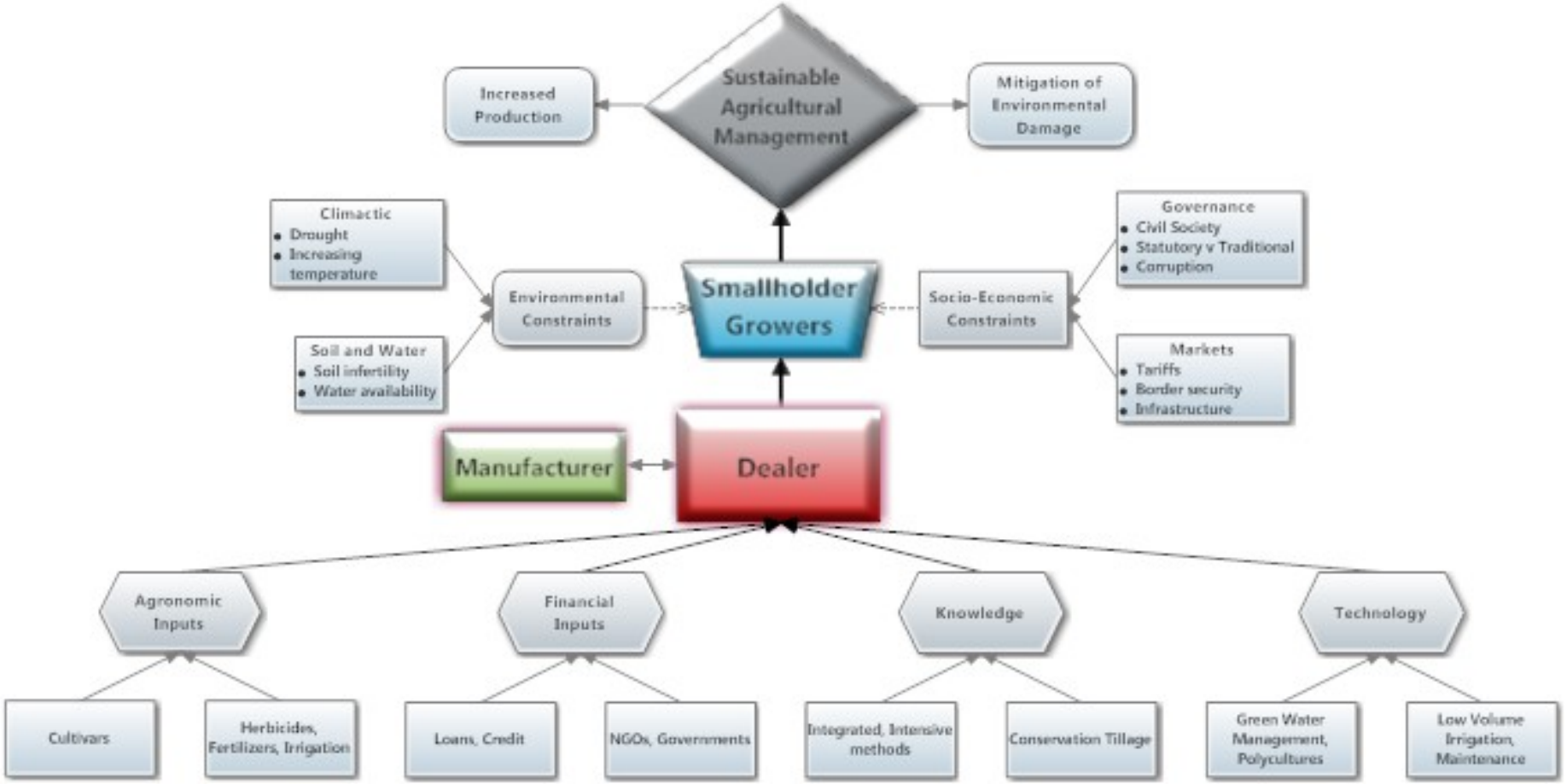
Off all the drip kits distributed in Africa over the last three years, 84% have been abandoned (Burney and Naylor, 2011)

Estimates vary from 20-40% of all irrigation systems are 'down' in LDCs at any one time (interview with Minister of Ghana, Stockholm 2012)

For lack of a connector

SAM MODEL

“Make it simple, but not simpler”- Einstein



The Triple Nexus
Manufacturer, Distributor, Smallholder

The Key Actors in the new Model

In the same interdependent and interlinked Financial boat

Who is the most important person on a daily basis for the smallholder farmer?

This is the model used in the developed world. Is this model transferable?


CFA

THANK YOU

Questions?