GLOBAL CHALLENGES IN WATER MANAGEMENT

The Canadian Context

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World Land Resources

Type of Land Use	Area in 1000 Sq Km	Area in M Ha	% of Total
Total Land Area	130,505	13,050	100
Perennial Crops	1,324	132	1
Permanent Pasture	34,590	3,459	26.5
Annual Crops	13,691	1,369	10.5
Total Agr. Lands	49,613	4,961	38.0
Forest and Woodlands	41,724	4,172	32.0
Non-Arable Lands	39,168	3,917	30.0

270 M ha Irrigated

World Land Use Data

	Land under irrigation (1000 ha)	Share of World Total, %	Share of Cropland that is Irrigated, %
Africa	**12879**	**5**	**6**
Asia	**193869**	**70**	**33**
Central and North America	**31408**	**11**	**12**
Europe	**25220**	**9**	**8**
South America	**10499**	**4**	**8**
Oceania	**2844**	**1**	**5**
WORLD	**276719**	**100**	**18**

Source: FAOSTAT, 2004.

Land Resources

Land use and food crops - Summary

- Most of irrigation is for rice, a wetland crop in Asia.
- Most other grain crops are grown in the semi arid climate.
- No food crops are grown in tropical forests.
- Negligible food crops are grown on wetlands.
- About one third of the lands on Earth is suitable for agriculture: crops and livestock grazing.
- One third is in forest with poor soils.

Water Productivity for Some Selected Cereal Producing Countries (SIWI, 2004).

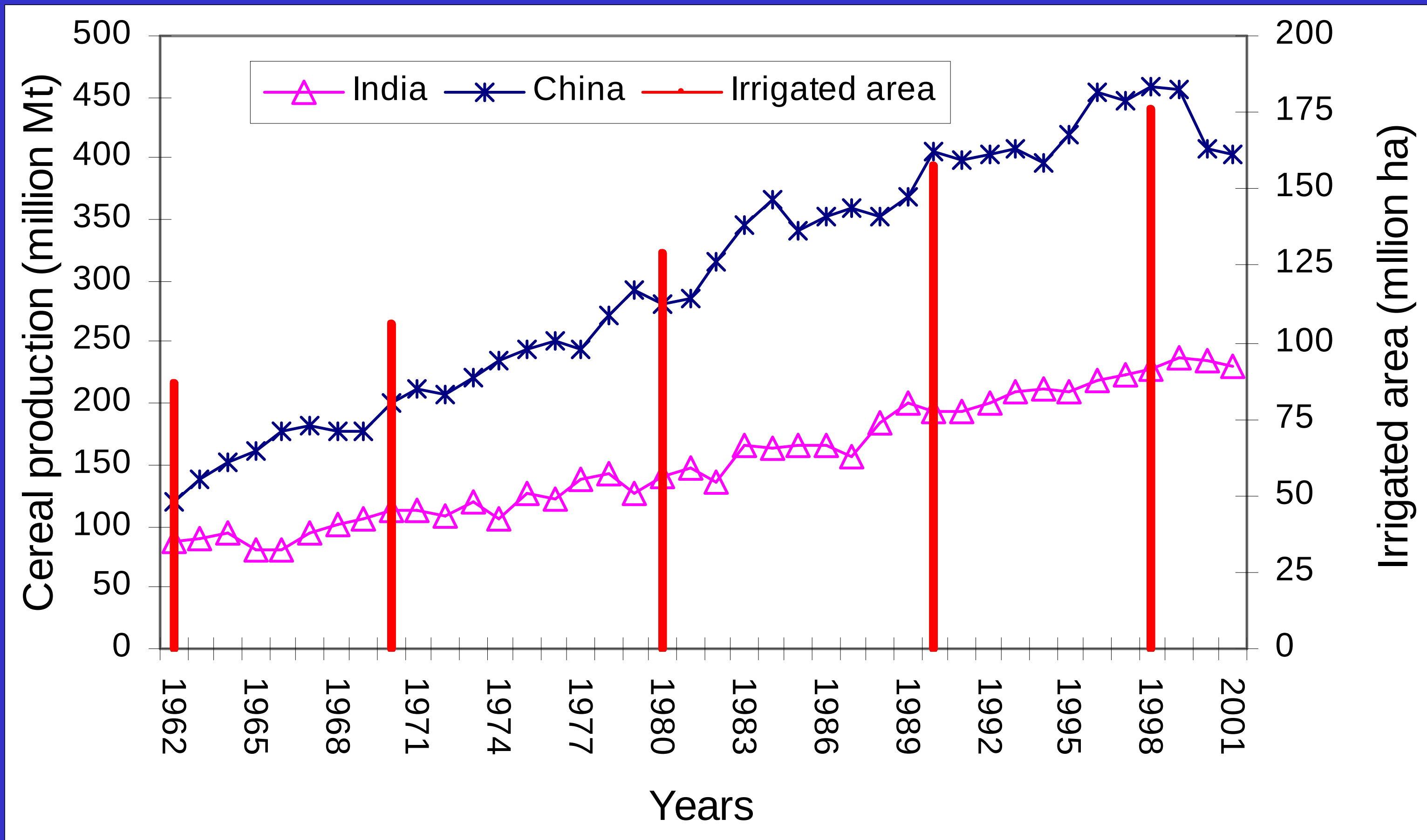
Exporters (1995)	Exports as % of world's total	Water productivity (Kg/cubic metre)	% met by irrigation
USA	48%	1.26	15%
Canada	10%	0.88	4%
W Europe	10%	1.59	5%
Argentina	7%	0.49	5%
Australia	5%	0.54	28%
India	3%	0.34	41%
Exporters Average		0.81	26%

World Food

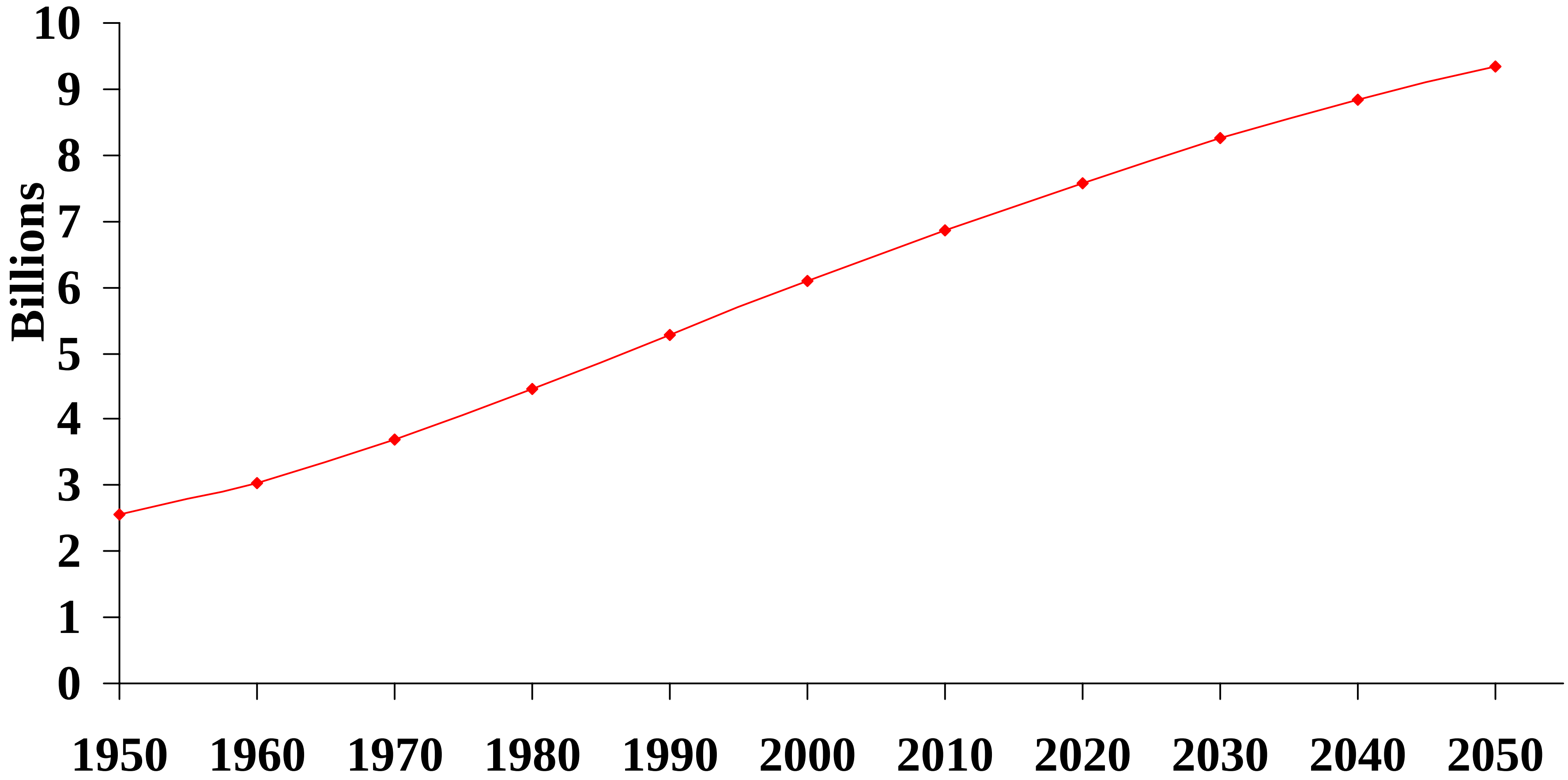
Facts and Figures

- ❖1 Billion are living on less than 1 $/Day.
- ❖2-3 Billion are living on less than 2 $/Day.
- ❖840 Million sleep hungry every night.
- ❖Only less than 8% of world cereal production is traded.
- ❖92% of cereals are consumed where they are produced.

Cereal Production and Irrigation Development in Asia Following the Green Revolution



Total World Population by Decade, 1950-2050



WORLD WATER CHALLENGES

Lack of accessibility

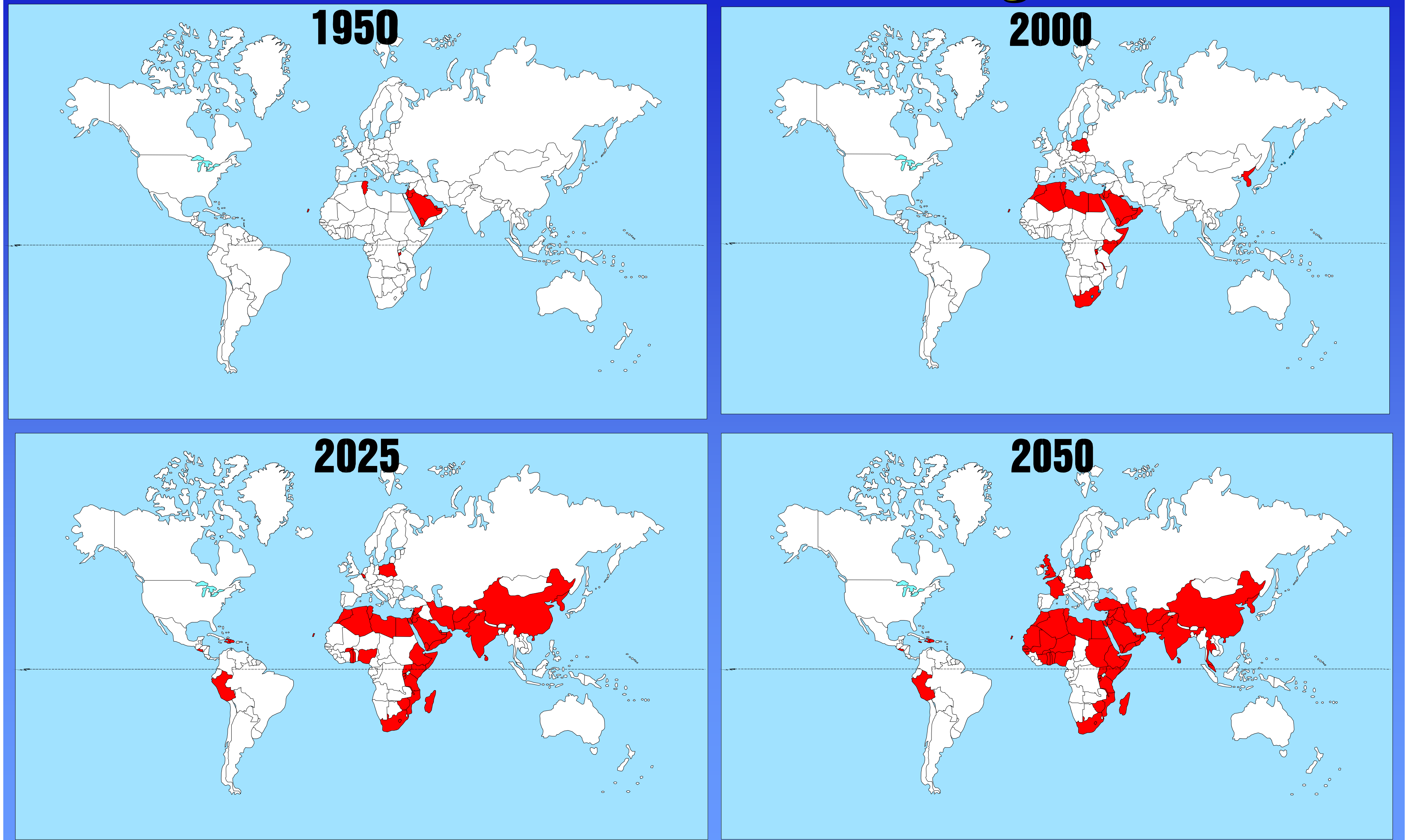
1.2 Billion lack access to clean drinking water

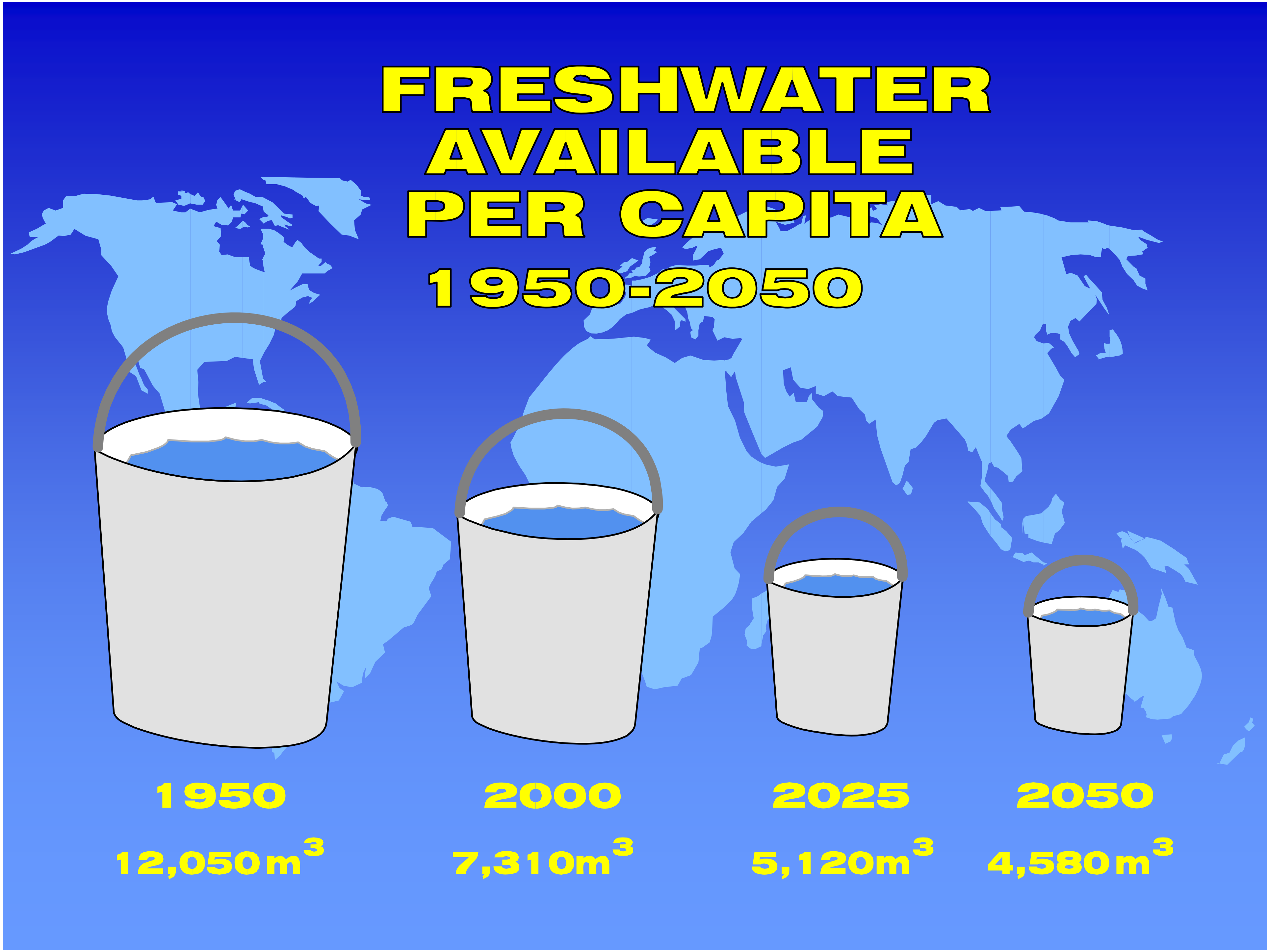
2-3 Billion lack adequate sanitation

4.0 Billion without sewerage service

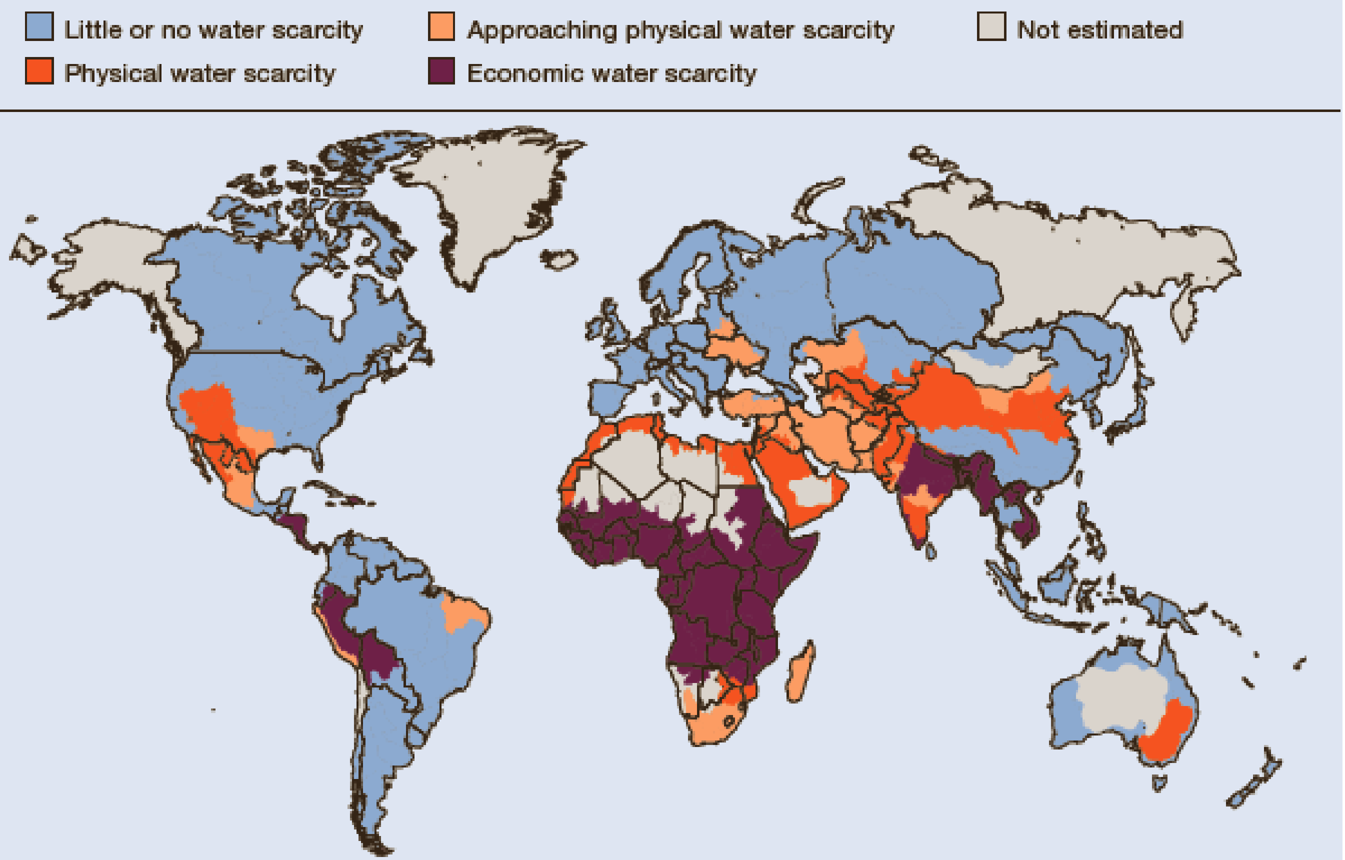
5-10 Million death per year

Evolution of World Water Shortage in 100 Years




FRESHWATER AVAILABLE PER CAPITA
1950-2050
1950
12,050 m^3
2000
7,310 m^3
2025
5,120 m^3
2050
4,580 m^3

map 2 | **Areas of physical and economic water scarcity**



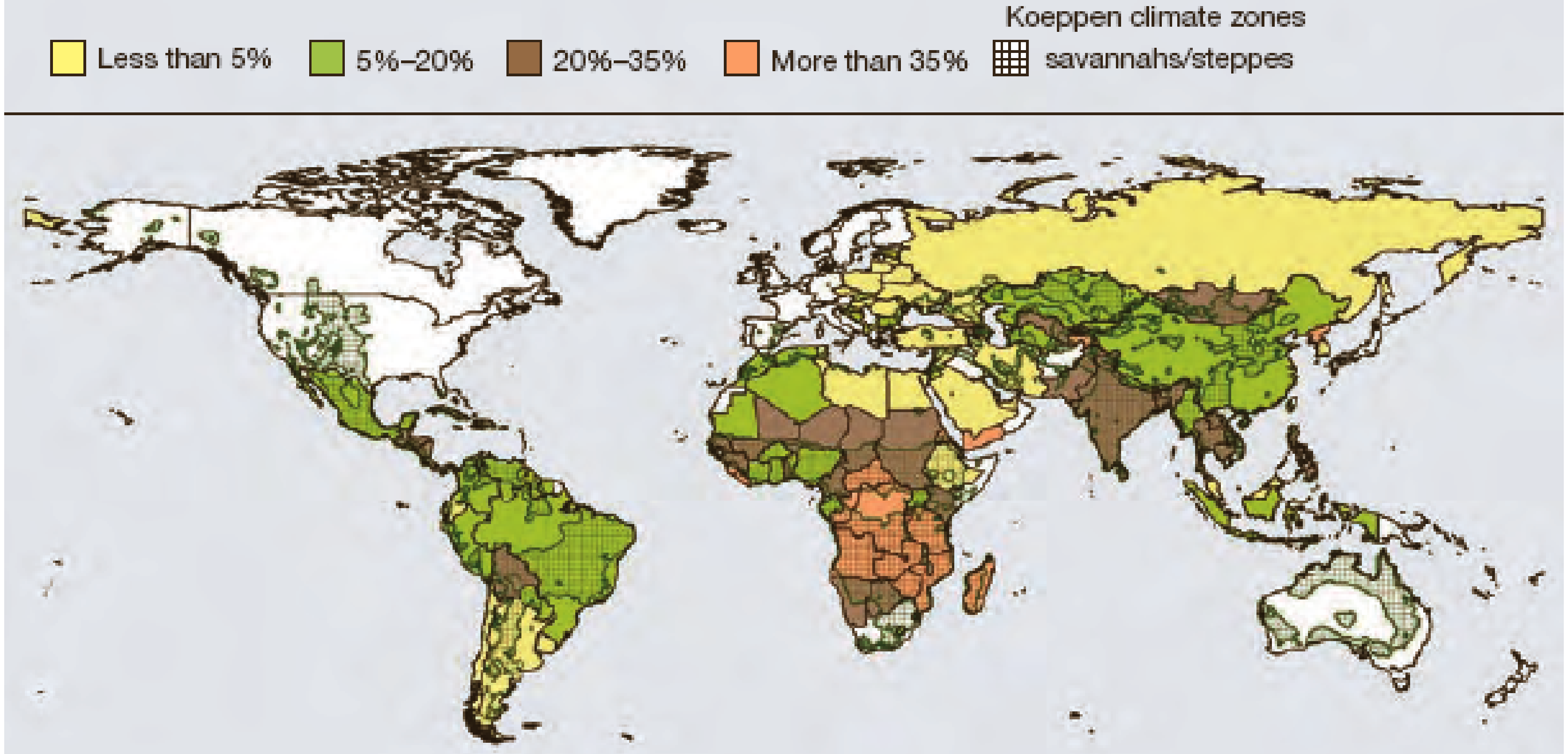
Definitions and indicators

- *Little or no water scarcity.* Abundant water resources relative to use, with less than 25% of water from rivers withdrawn for human purposes.
- *Physical water scarcity (water resources development is approaching or has exceeded sustainable limits).* More than 75% of river flows are withdrawn for agriculture, industry, and domestic purposes (accounting for recycling of return flows). This definition—relating water availability to water demand—implies that dry areas are not necessarily water scarce.
- *Approaching physical water scarcity.* More than 60% of river flows are withdrawn. These basins will experience physical water scarcity in the near future.
- *Economic water scarcity (human, institutional, and financial capital limit access to water even though water in nature is available locally to meet human demands).* Water resources are abundant relative to water use, with less than 25% of water from rivers withdrawn for human purposes, but malnutrition exists.

Source: International Water Management Institute analysis done for the Comprehensive Assessment of Water Management in Agriculture using the Watersim model; chapter 2.

map 3 | Undernutrition is high in semiarid and dry subhumid climates subject to variable rainfall, dry spells, and droughts

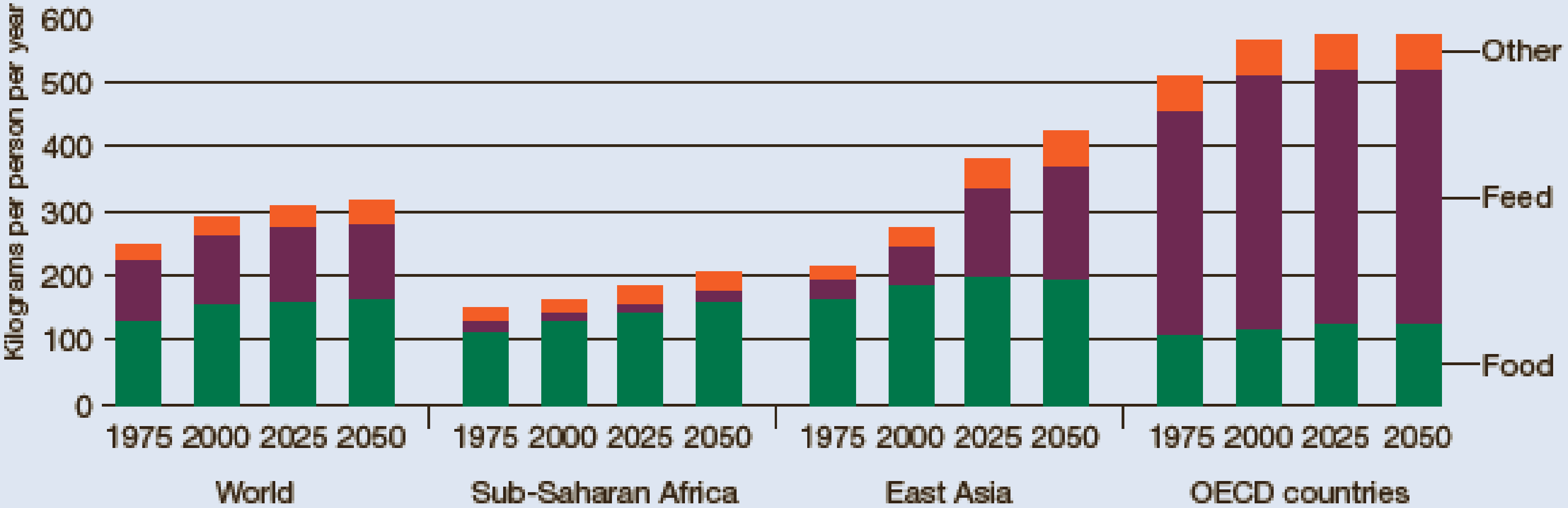
(Undernourished as share of total population, 2001/02)



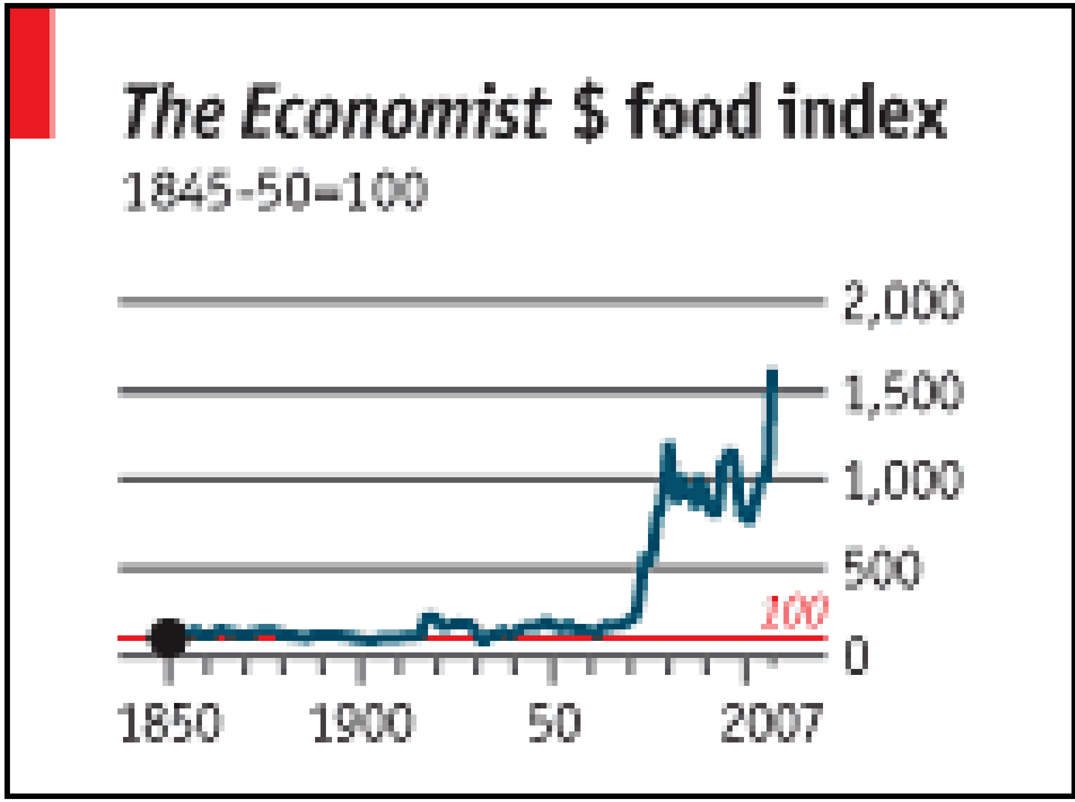
Note: Semiarid and dry subhumid hydroclimates include savannah and steppe agroecosystems. These regions are dominated by sedentary farming subject to the world's highest rainfall variability and occurrence of dry spells and droughts.

Source: UNStat database, 2005, United Nations Statistical Division, http://unstats.un.org/unsd/default.htm; chapter 8.

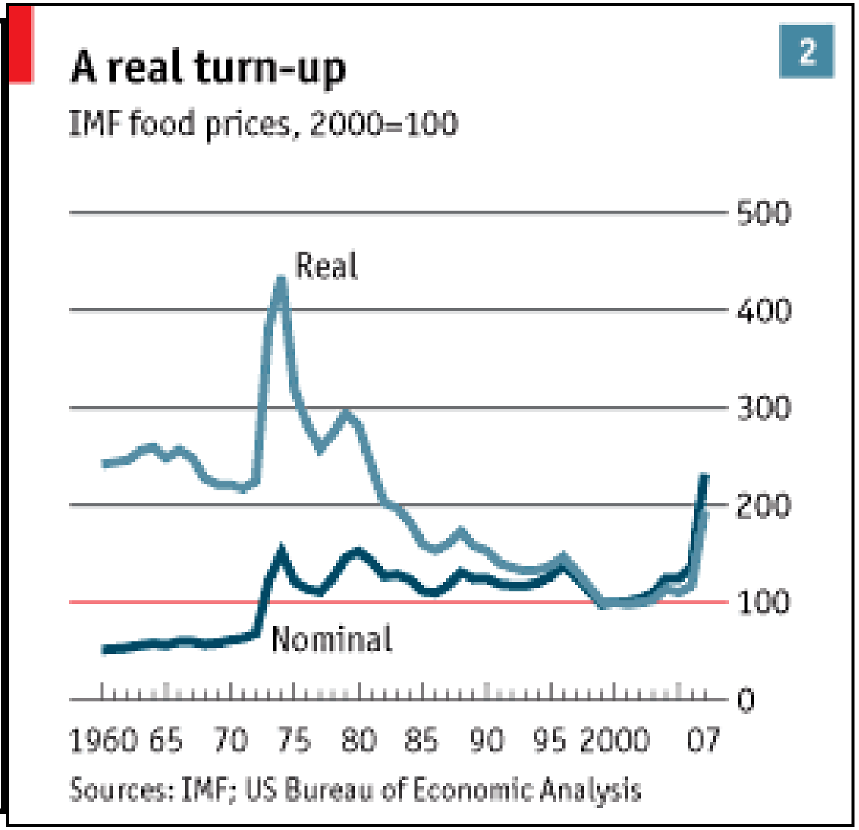
figure 3 | **Feed demand drives future demand for grains**



Source: for 1975 and 2000, FAOSTAT statistical database; for 2025 and 2050, International Water Management Institute analysis done for the Comprehensive Assessment of Water Management in Agriculture using the Watersim model; chapter 3.



The Economist $ food index
1845-50=100
2,000
1,500
1,000
500
100
0
1850
1900
50
2007

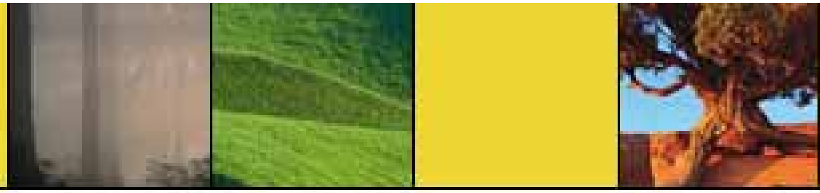


A real turn-up
2
IMF food prices, 2000=100
500
400
300
200
100
0
Real
Nominal
1960 65 70 75 80 85 90 95 2000 07
Sources: IMF; US Bureau of Economic Analysis

UN Millennium Development Goals (MDG)

By the year 2015, all 191 United Nations Member States have pledged to meet these goals

1. Eradicate extreme poverty and hunger.
2. Achieve universal primary education.
3. Promote gender equality and empower women.
4. Reduce child mortality.
5. Improve maternal health.
6. Combat HIV/AIDS, malaria and other diseases.
7. Ensure environmental sustainability.
8. Develop a global partnership for development.

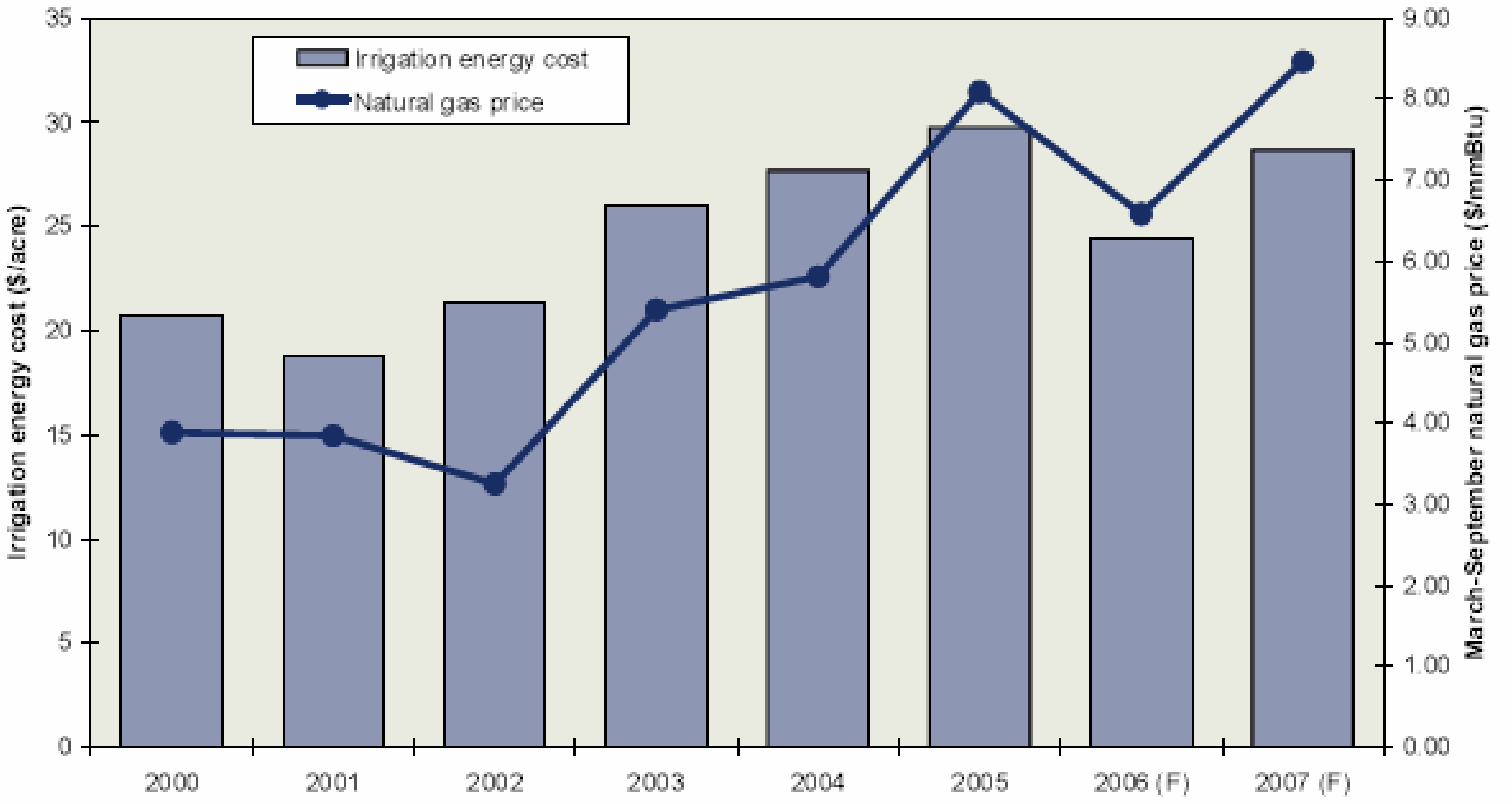



23 countries which have adopted biotech crops
Top ten producers, 2007
00.0 Production, hectares, m
+00 Increase, 2006-07, %
ARCTIC OCEAN
ATLANTIC OCEAN
PACIFIC OCEAN
PACIFIC OCEAN
INDIAN OCEAN
SOUTHERN OCEAN
CANADA
7.0
+15
UNITED STATES
57.7
+6
CHINA
3.8
+9
INDIA
6.2
+63
PHILIPPINES
0.3
+50
BRAZIL
15.0
+30
PARAGUAY
2.6
+30
URUGUAY
0.5
+25
ARGENTINA
19.1
+6
SOUTH AFRICA
1.8
+29

An Energy Crunch?
Energy use in agriculture

- 28 % fertilizer manufacturing
- 7 % irrigation
- 34 % fuel consumption by farm machinery
- 31 % pesticide production, grain drying

Irrigation Energy Costs for Irrigated Farms in Kansas Farm Management Association (KFMA), 2000-2007

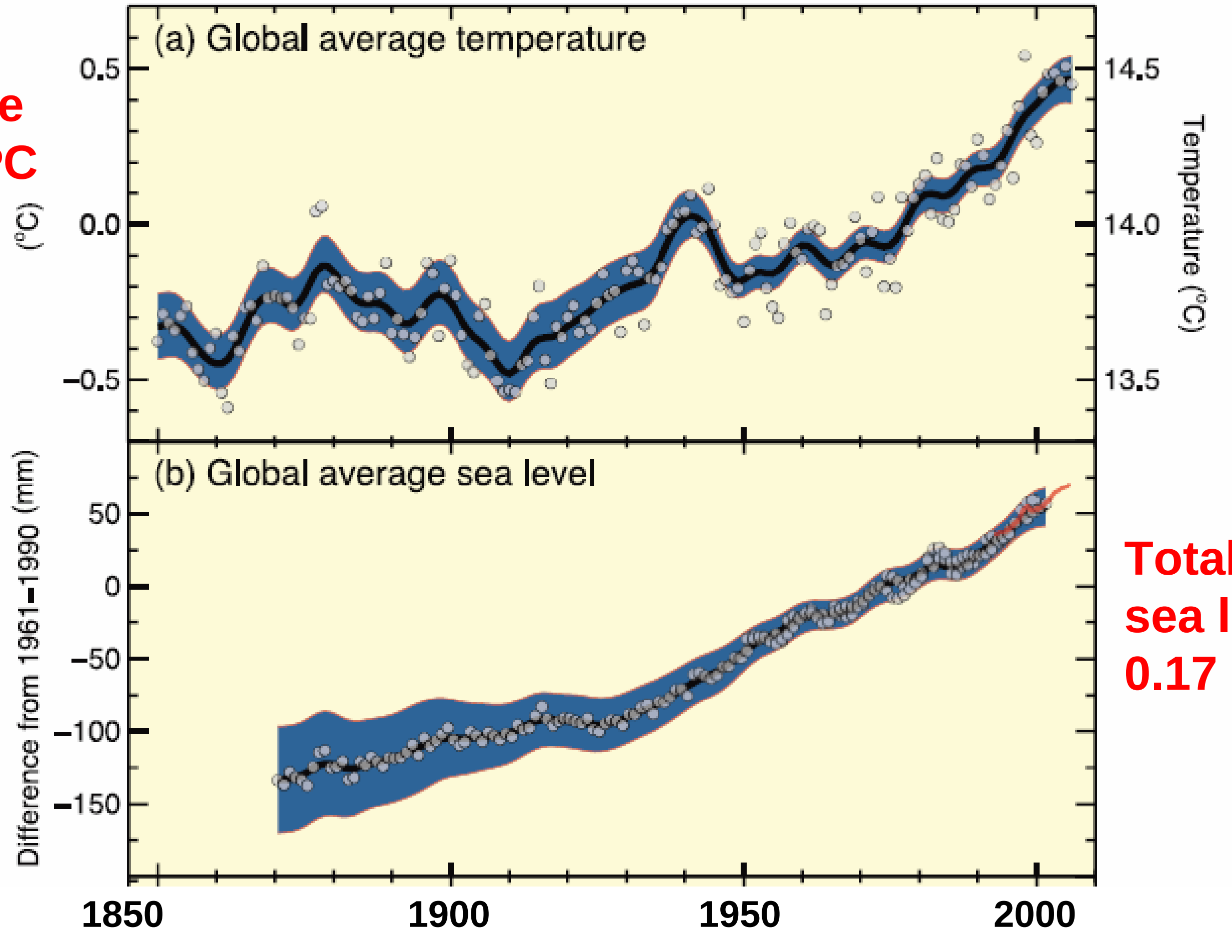


Source: Kastens et al., Energy Use in the Kansas Agricultural Sector: Report Submitted to the Kansas Energy Council, June 15, 2006 (available on the KEC web site: http://kec.kansas.gov/).

Solar powered pivots and mini pivots

Climate Change
Changes in temperature and sea level

T increase since 1850, 0.76 ±0.9°C



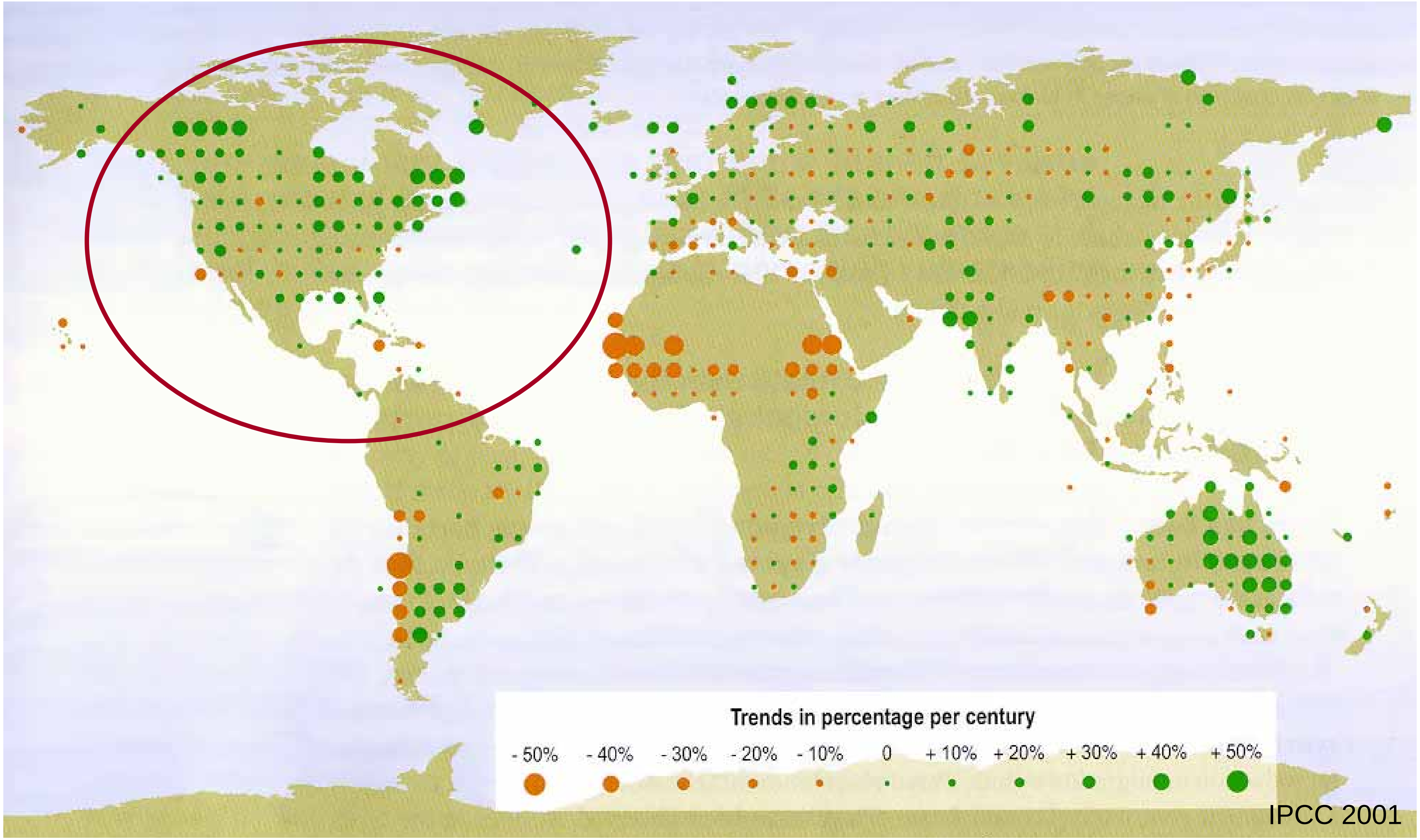
Total 20th century sea level rise is 0.17 m ±0.05m

Figure SPM.3. *Observed changes in (a) global average surface temperature, (b) global average sea level from tide gauge (blue) and satellite (red) data and (c) Northern Hemisphere snow cover for March-April. All changes are relative to corresponding averages for the period 1961–1990. Smoothed curves represent decadal average values while circles show yearly values. The shaded areas are the uncertainty intervals estimated from a comprehensive analysis of known uncertainties (a and b) and from the time series (c). {FAQ 3.1, Figure 1, Figure 4.2, Figure 5.13}*

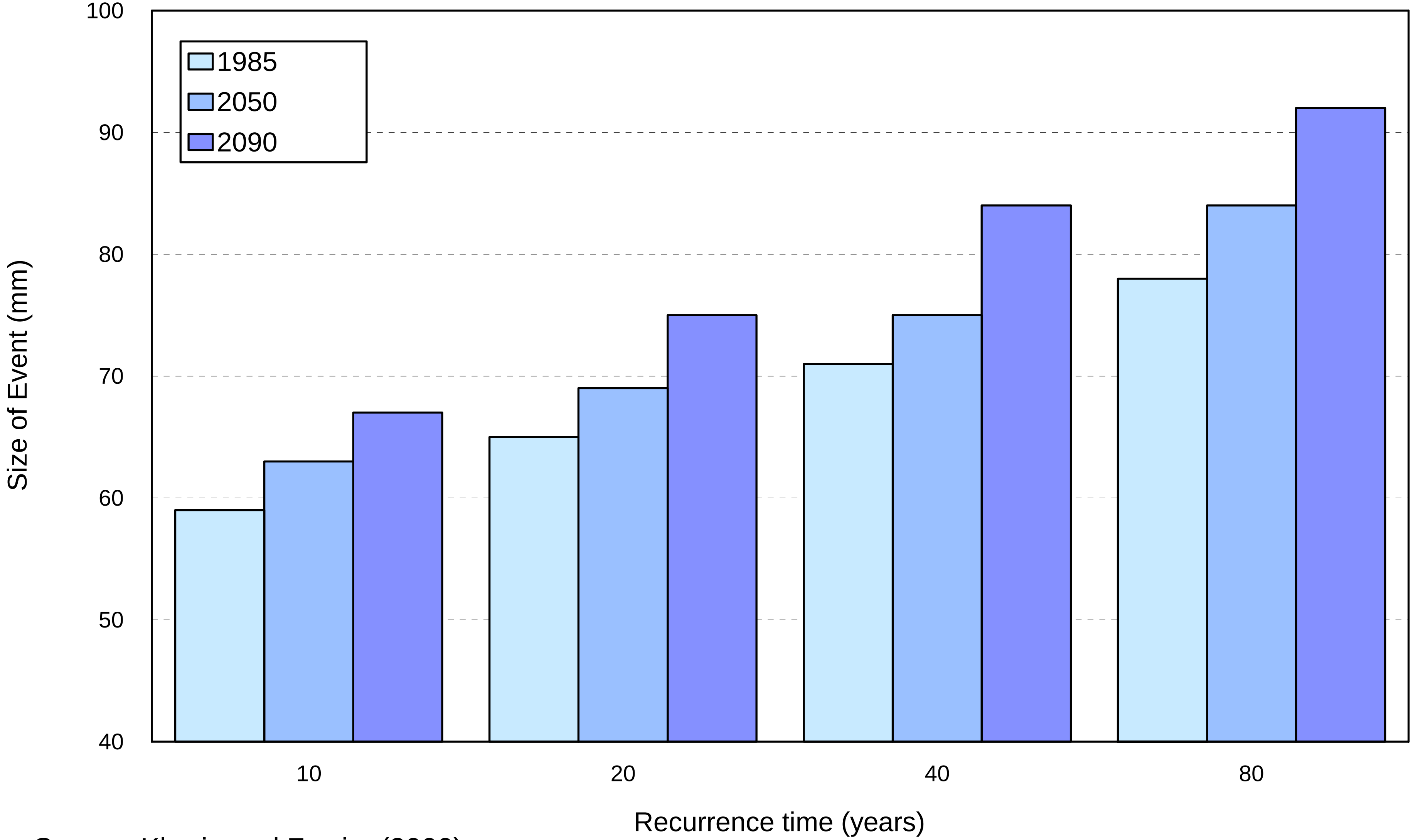
IPCC 2007: WG1-AR4

Precipitation has increased in some parts of the world and decreased in others

Trends (%/century) in annual precipitation for 1900-2000



Projected Changes in Extreme Precipitation

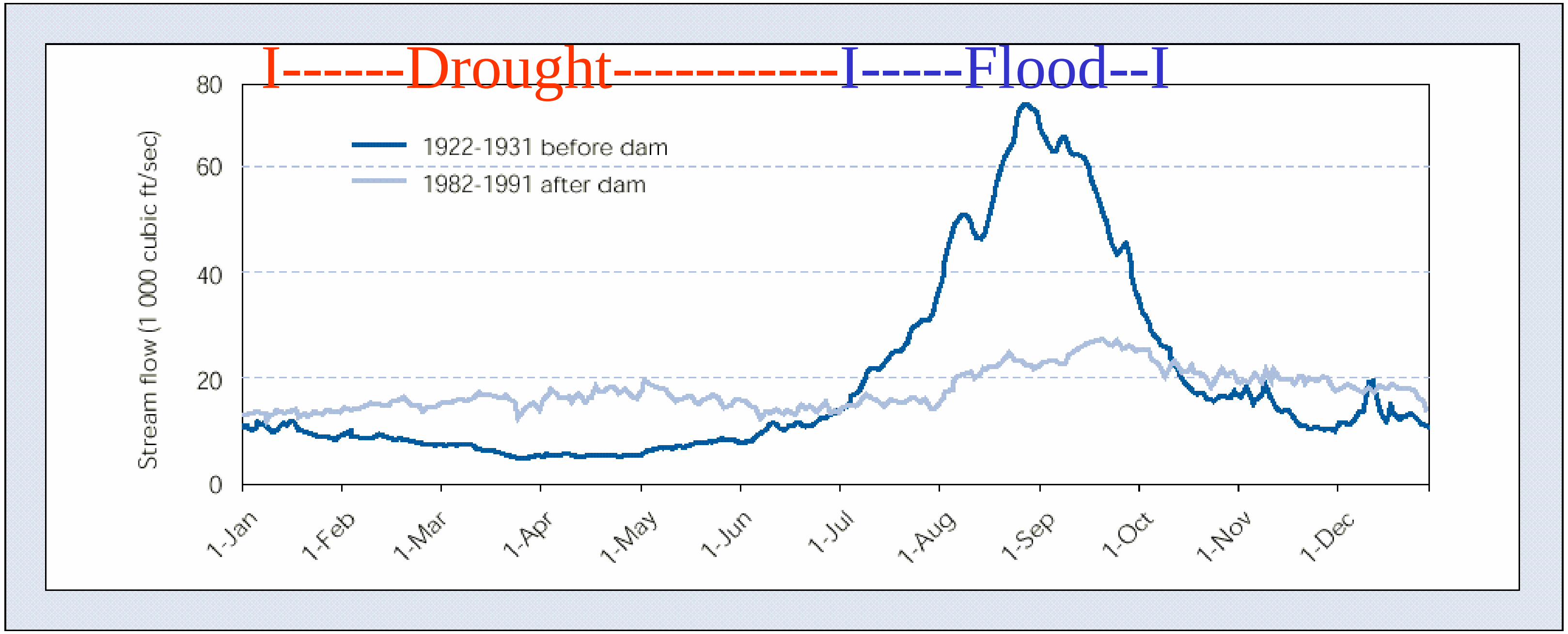


Source: Kharin and Zweirs (2000)

Needs for Water Storage

More than two thirds of the world water reservoirs are used for irrigation and food production to feed billions of the world poor and stamp out the starvation prevailed in 1950's.

Figure 3.3 Modification of annual flow regimes due to a hydropower dam, Colorado River at Lee's Ferry, United States



Source: Data from United States Geological Survey, 2000.

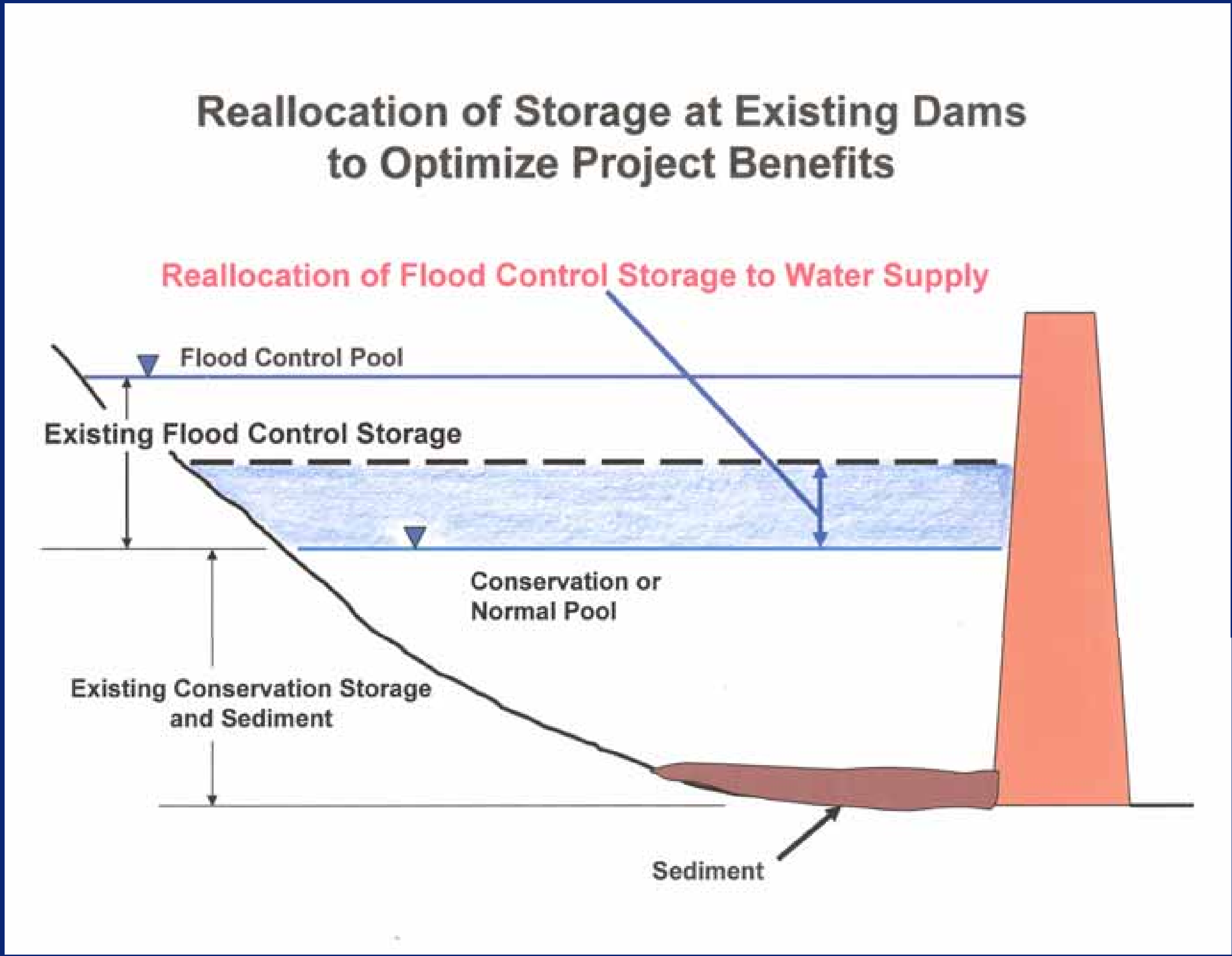
Dams are an Essential Part of our Infrastructures

For almost 5000 years, dams have been used successfully to collect and store water and manage discharges to provide the large quantities of water to sustain life and support growth and development.

Dams as the Tool for Water Management Irrigation, flood control, hydropower

Shonrweni Dam, South Africa

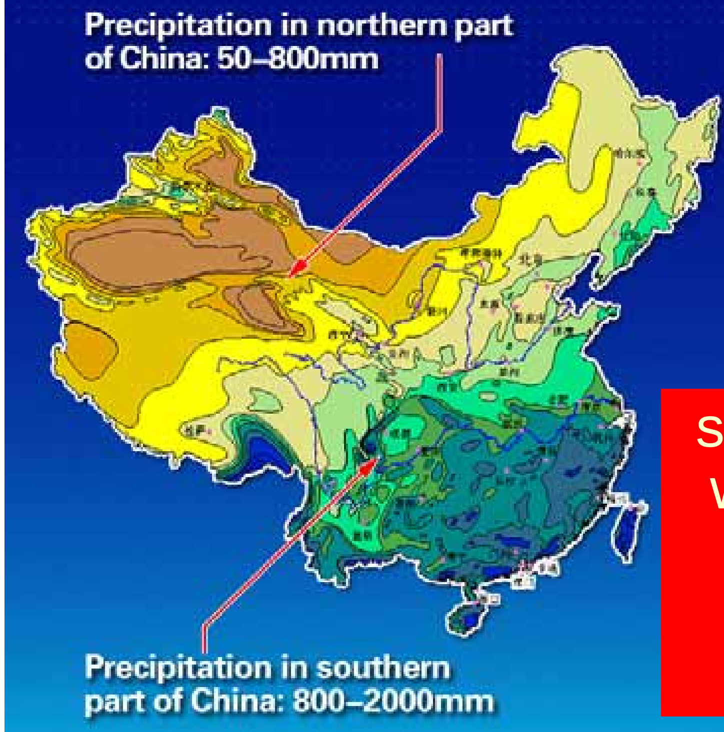
Reallocation of Existing Storage for Additional Water Supply



Interbasin Water Transfer

Moving water from the water-rich to the water-poor areas

China : Water is unevenly distributed in space.



Southern part of China:
Water resources: <u>81%</u>
population: <u>53%</u>
Cultivated land: <u>35%</u>
GDP: <u>55%</u>

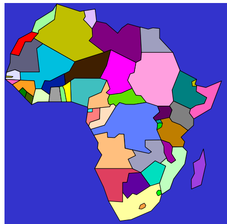
Northern part of China:
Water resources: <u>19%</u>
population: <u>47%</u>
Cultivated land: <u>64%</u>
GDP: <u>45%</u>

The Alternative :

Moving population from the water-poor to the water-rich areas

TRANSBOUNDARY COOPERATION

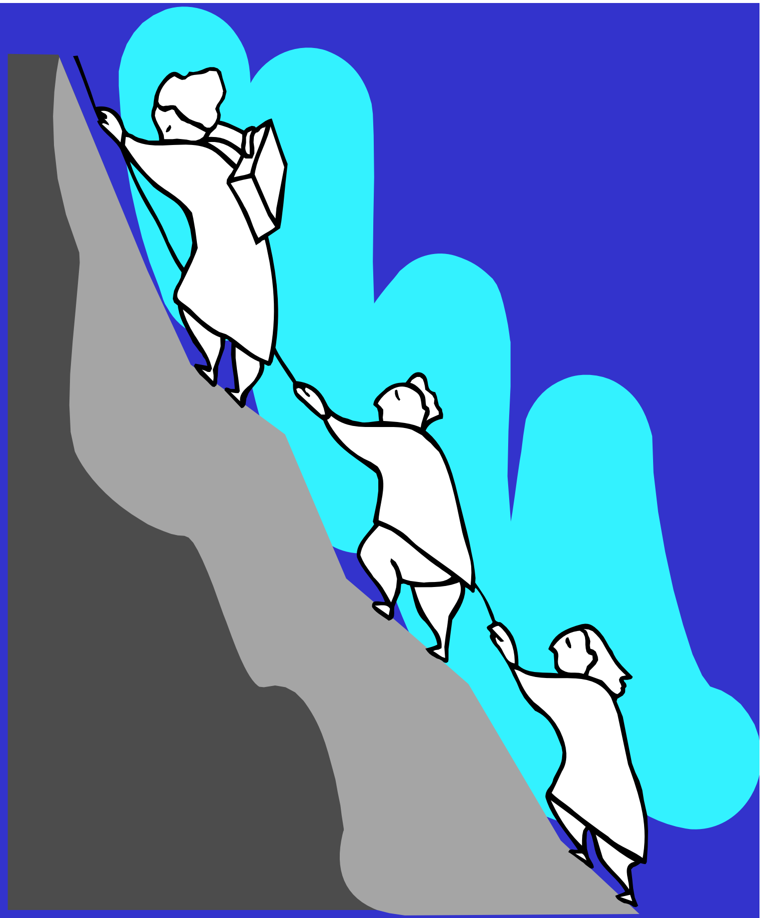
NILE COUNTRIES IN AFRICA



Main Features of the River Nile Basin

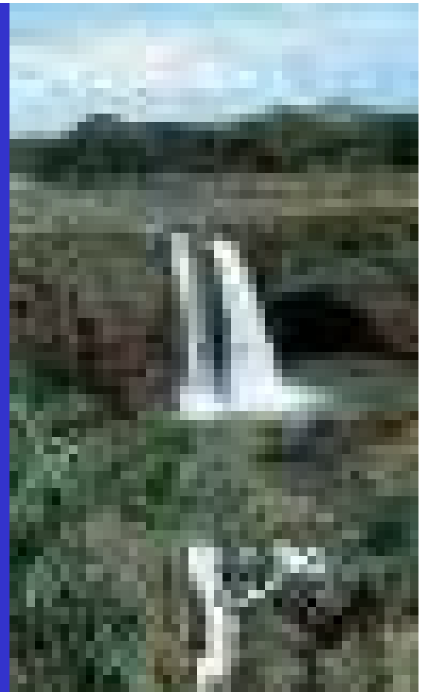
- ☞ Basin is about 3.0 million square km.
- ☞ Length is more than 6000 km.
- ☞ 10 Riparian States with 250 million people
- ☞ Area of Lakes is 81500 square km.
- ☞ Length of River and Tributaries is 37500 km.
- ☞ Area of swamps is 70000 square km.
- ☞ 5 States are among the Ten Poorest in World.

Nile Basin Challenges



- Extreme Poverty.
- Instability.
- Rapid Population Growth.
- Environmental degradation.
- Natural disasters (Floods, Droughts, ….etc.)
- Complicated hydrology of Basin.
- Low Specific Yield.
- Equitable Use and no harm Principle.

Nile Basin Opportunites



- River is least developed in upper reaches.
- Potential is great.

(Water saving, Agriculture, Power pooling, ….etc)

- Great chance for win-win solutions.
- Serious steps taken for cooperation is an incentive for donors.

Future Prospects.

- Build trust and confidence between governments.
- Strengthen the indigenous capacity of each region.
- Take advantage of new information technology.
- Policy reforms ,legal and institutional overhaul.
- Emergence of civil society and their active participation.
- Long term commitment , vision and political will.
- Facilitation and support by external support agencies.

Development and Cooperation Potential

- High Hydropower generation potential- Shared grid.
- High Irrigation potential – meet all Africa future food needs.
- Improved river navigation – trade and transport.
- Improved water quality – better health and high fresh water fisheries.
- Ecological conservation and stewardship.
- Poverty reduction.- Economic growth.

PARTICIPATION IN TRANSBOUNDARY WATER DEVELOPMENT

- **Participation in Transboundary Water development can contribute effectively to :**
  - **- economic growth,**
  - **- reduction of poverty**
  - **- improved health and nutrition**
  - **- promotion of peace and security**

INDIA

Transboundary Cooperation

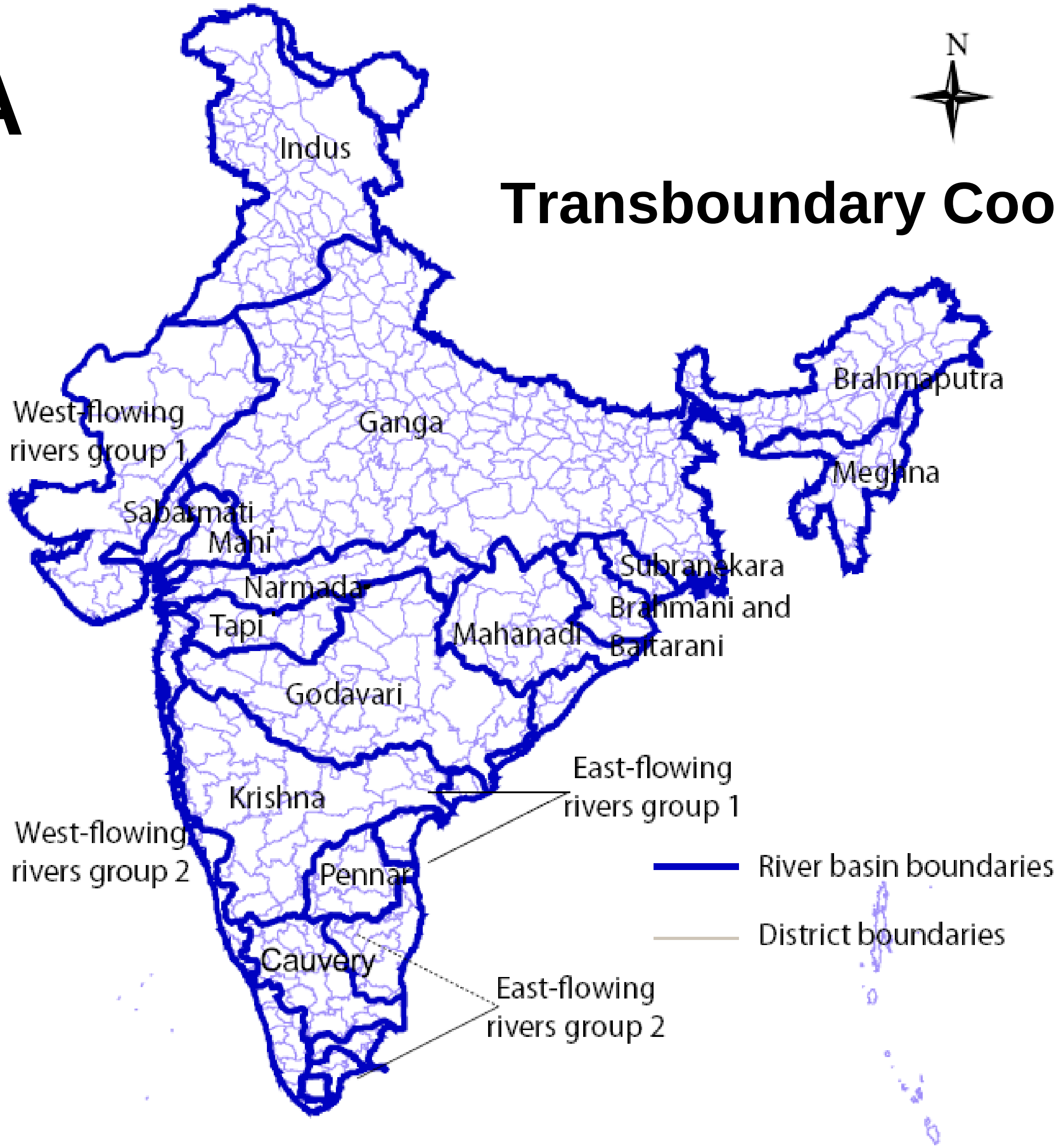
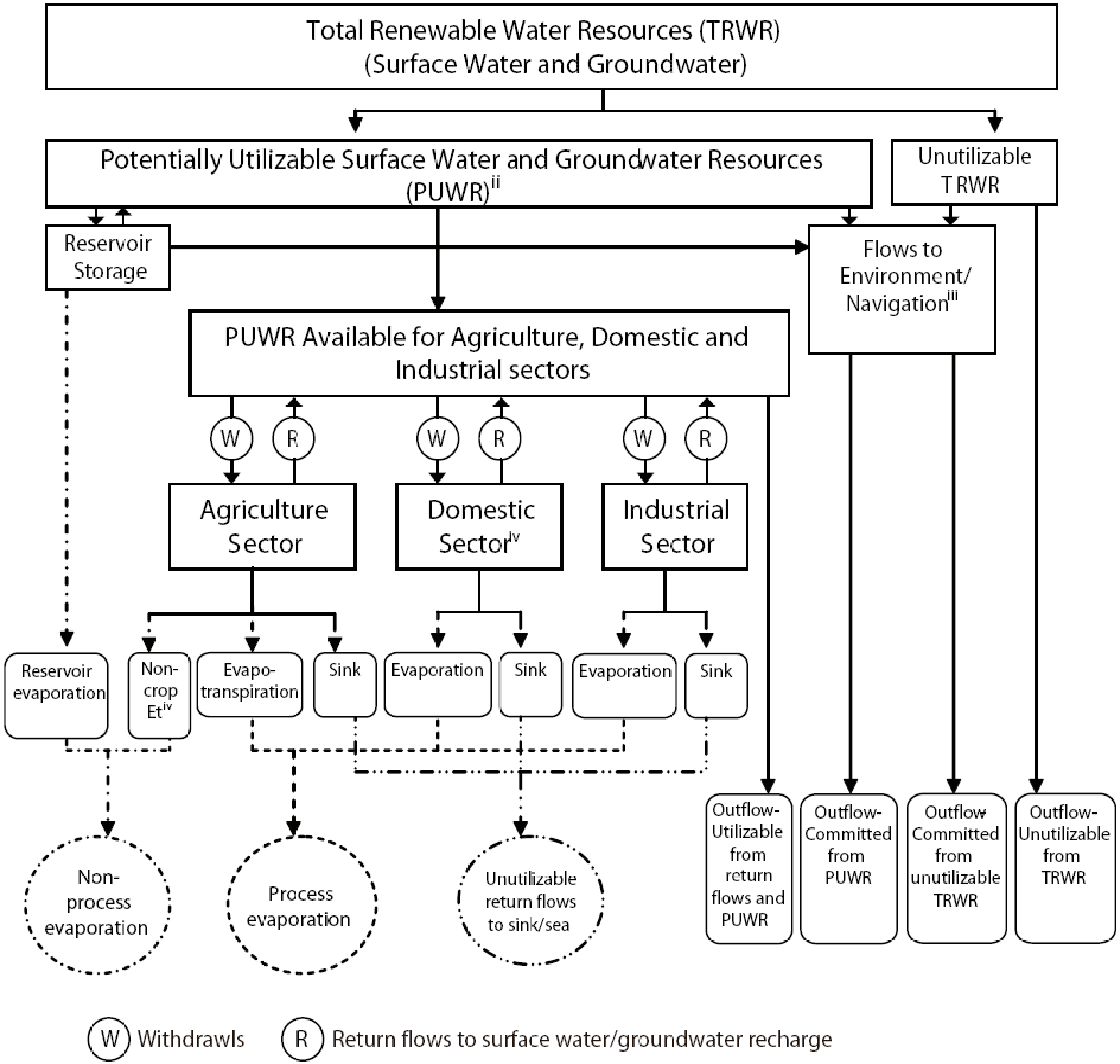


FIGURE 1. District and river basin boundaries of India.


DROUGHT AFFECTED STATES IN INDIA
Affected States
Most Affected States
125 Million People Affected (200 Million Unofficial)
1.1 Million Villages Affected
AFGHANISTAN
PAKISTAN
CHINA
NEPAL
BHUTAN
BANGLADESH
MYANMAR
SRI LANKA
Jammu & Kashmir
Himachal Pradesh
Punjab
Uttar Ranchal
Haryana
Delhi
New Delhi
Uttar Pradesh
Sikkim
Arunachal Pradesh
Assam
Nagaland
Meghalaya
Manipur
Tripura
Mizoram
Bihar
Jharkand
West Bengal
Jaipur
Rajasthan
Bhuj
Gujarat
Gandhinagar
Bhopal
Madhya Pradesh
Chhattisgarh
Raipur
Bhubaneshwar
Orissa
Diu
Daman
Dadra and Nagar Haveli
Maharashtra
Hyderabad
Andhra Pradesh
Yanam
Goa
Karnataka
Pondicherry
Mahe
Tamil Nadu
Karaikal
Kerala
Lakshadweep
Arabian Sea
Bay of Bengal
Andaman and Nicobar Islands
INDIAN OCEAN
N
W
E
S
USAID
USAID/OFDA
U.S. Agency for International Development (USAID)
Office of U.S. Foreign Disaster Assistance (OFDA)
June 2001

PODIUMSIM MODEL

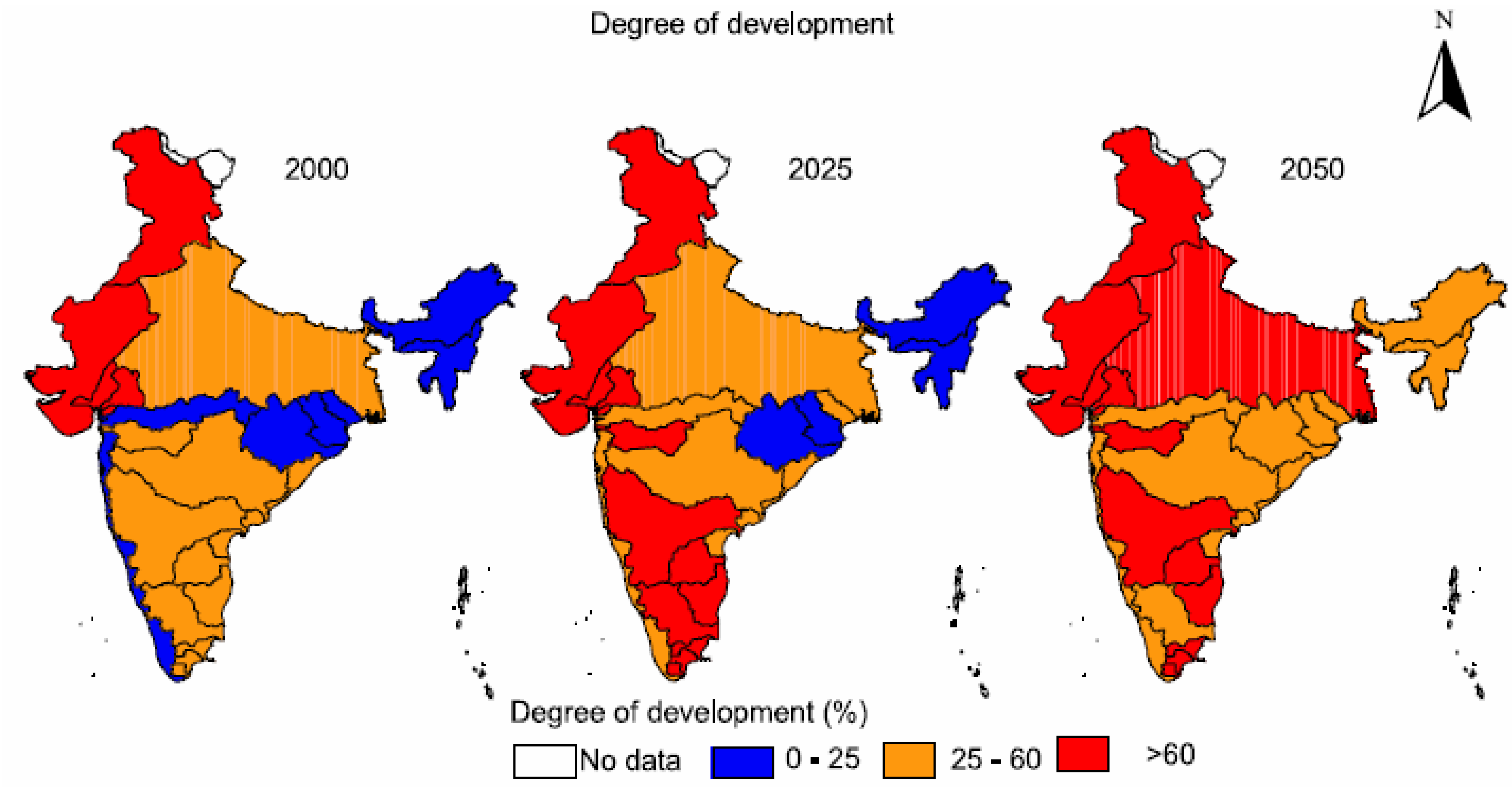


Drivers	Past trends			Projections	
	1979-1981	1989-1991	1999-2000	2025	2050
Demography					
Population (million)	689	851	1,007	1,389	1,583
Urban population (%)	23	25	28	37	51
Economic growth					
GDP growth ($1995 prices[1])	228	319	463	1,765	6,735
Nutritional intake					
Total calorie supply (kcal/person/day)	2,083	2,365	2,495	2,775	3,000
Contribution of grain crops (%)	71	69	65	57	48
Contribution from non-grain crops (%)	23	24	28	33	36
Contribution from animal products (%)	6	7	8	12	16

Drivers	Past trends			Projections	
	1979-1981	1989-1991	1999-2000	2025	2050
Crop area (million ha)					
Net sown area	141	142	141	142	142
Net irrigated area	38	46	55	74	81
Net groundwater area	18	25	34	43	50
Net canal and tank area	20	22	21	31	31
Gross irrigated area (GIA)	49	62	76	111	117
Gross crop area (GCA)	172	183	189	208	210
Grain crop area - % of GCA	74	69	65	58	57
Grain irrigated area - % of GIA	77	71	71	56	54
Crop yield (tons/ha)					
Average grain yield	1.0	1.4	1.7	2.4	3.1
Irrigated grain yield[i]	1.5	2.1	2.6	3.6	4.4
Rain-fed grain yield[i]	0.6	0.8	1.0	1.3	1.8

[i]Irrigated and rain-fed yields in 1979-1981 and 1990-1991 are estimated using the ratio of irrigated and rain-fed yields to the average yield in 1999-2001.

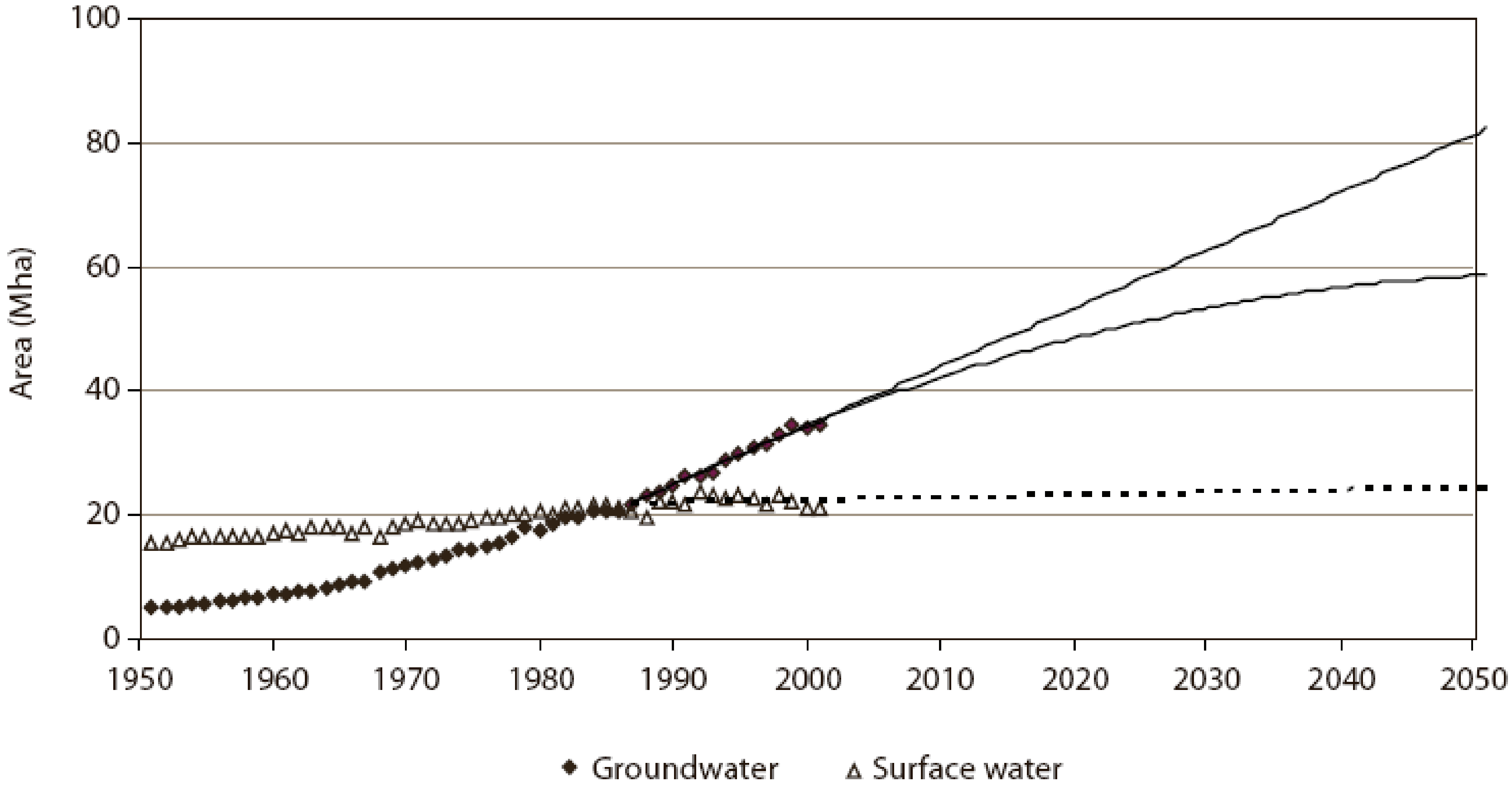
Drivers	2000	Projections	
		2025	2050
Project irrigation efficiency (%)			
Surface water	30-45	35-50	42-60
Groundwater	55-65	70	75
Domestic water demand			
Human water demand (m^3/person/year)	31	42	61
Livestock water demand (Bm^3)	2.3	2.8	3.2
Industrial water demand (m^3/person/year)	42	66	102
EWD			
Minimum river flow - % of mean annual runoff	-	6-45	6-45



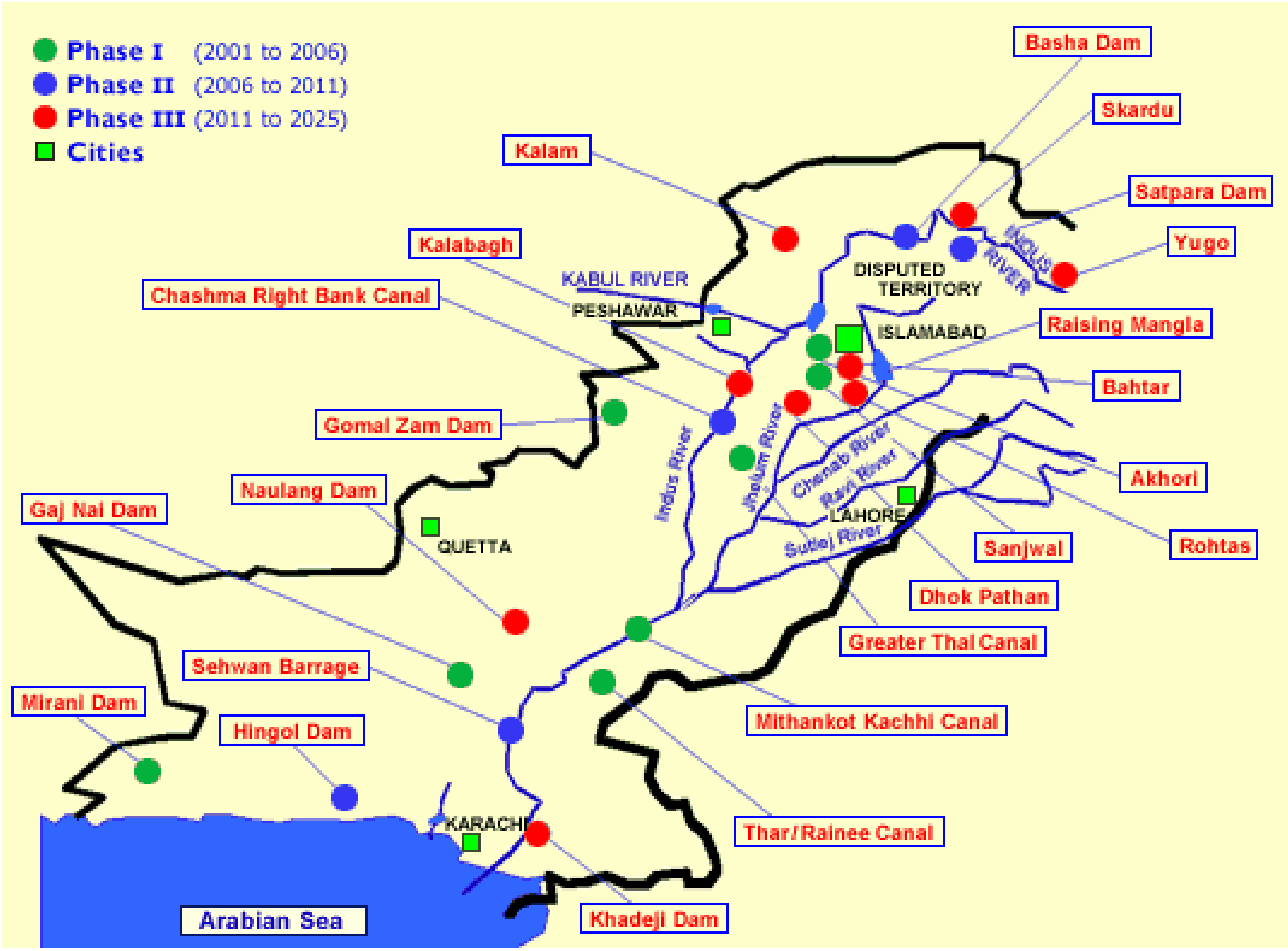
$$\text{Degree of development} = \frac{\text{Primary water supply}}{\text{PUWR - Environmental flows from PUWR}}$$

$$\text{Primary water supply} = \text{Process evaporation} + \text{non-process evaporation} + \text{unutilizable flows to the sea} + \text{utilizable return flows to the sea}$$

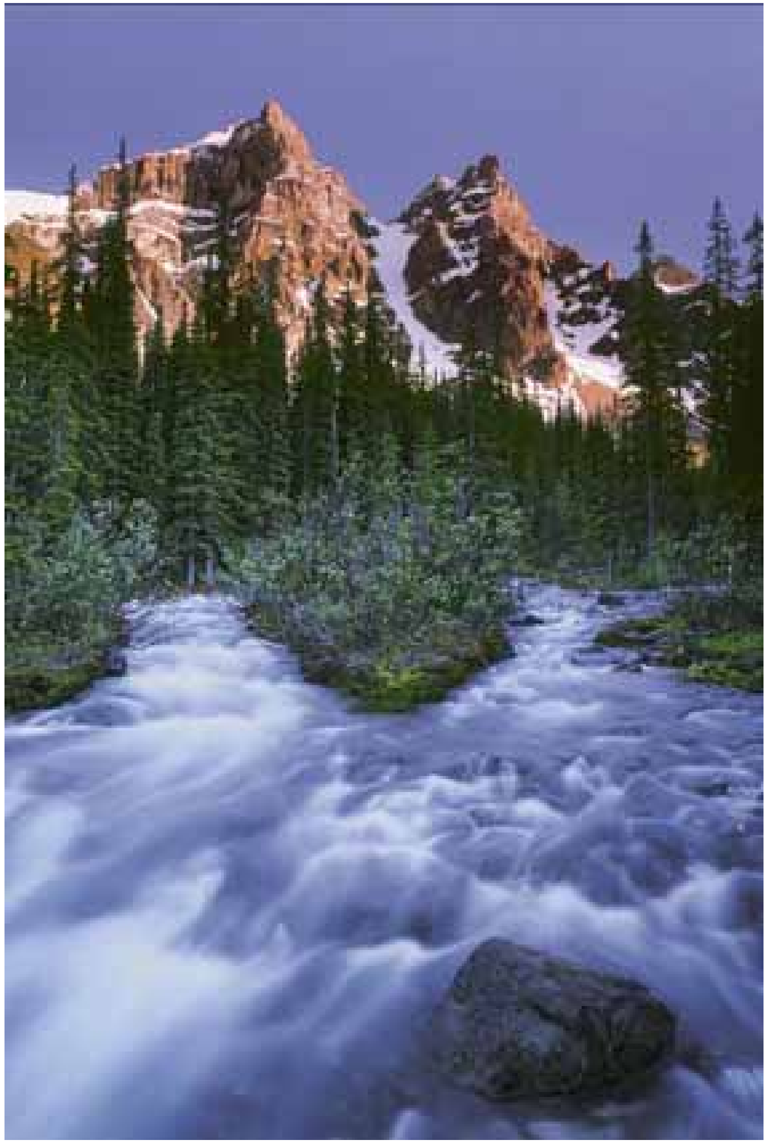
Net growth of surface water and groundwater irrigated area. *Source:* GOI 2004.

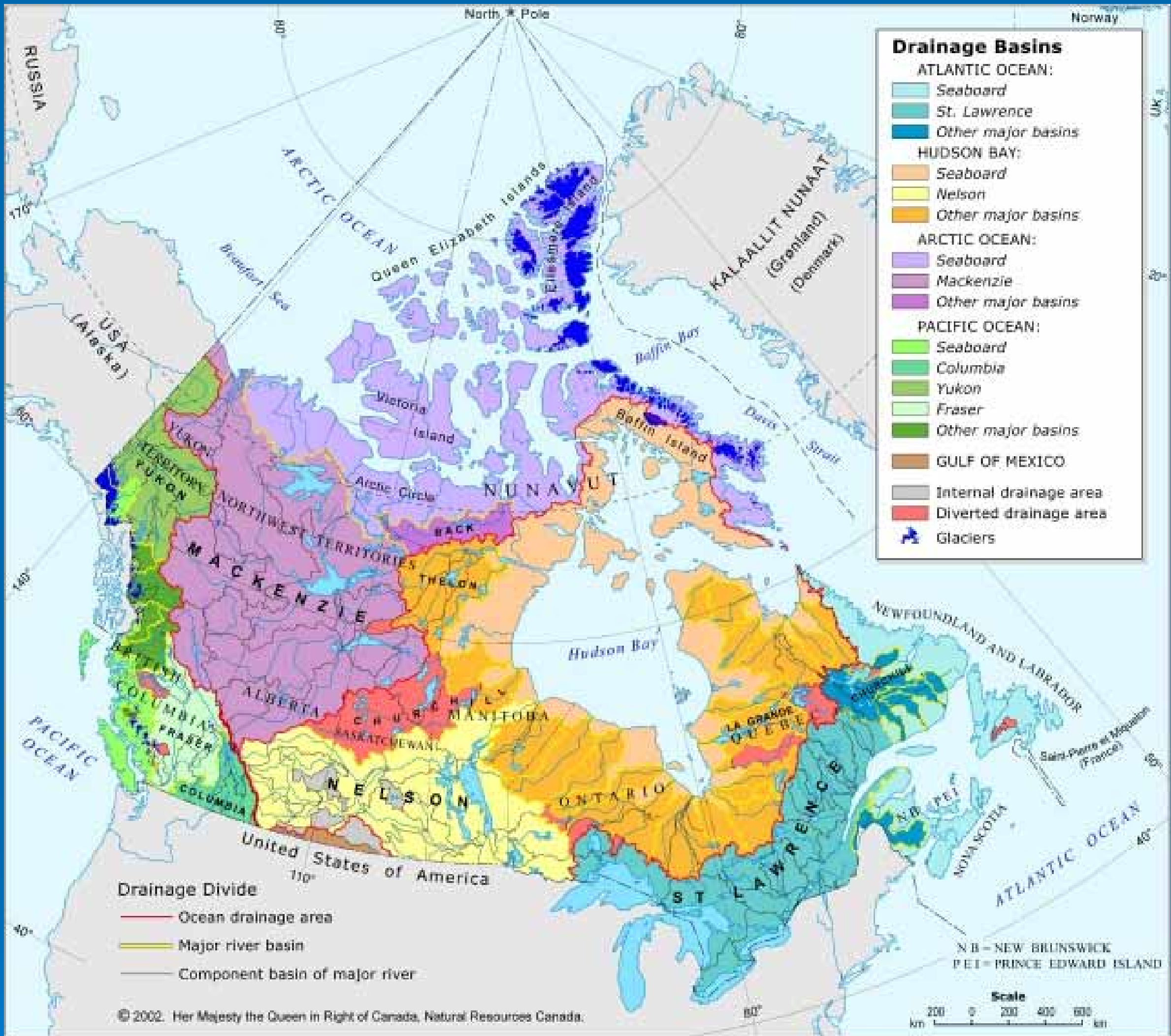


IMROVING WATER PRODUCTIVITY AT THE BASIN AND FIELD SCALES



CANADA'S WATER PICTURE





Annually, Canada's rivers discharge 105 000 m3/s, 7% of the world's renewable water supply.

Almost 9%, or 891 163 km2, of Canada's total area is covered by freshwater.

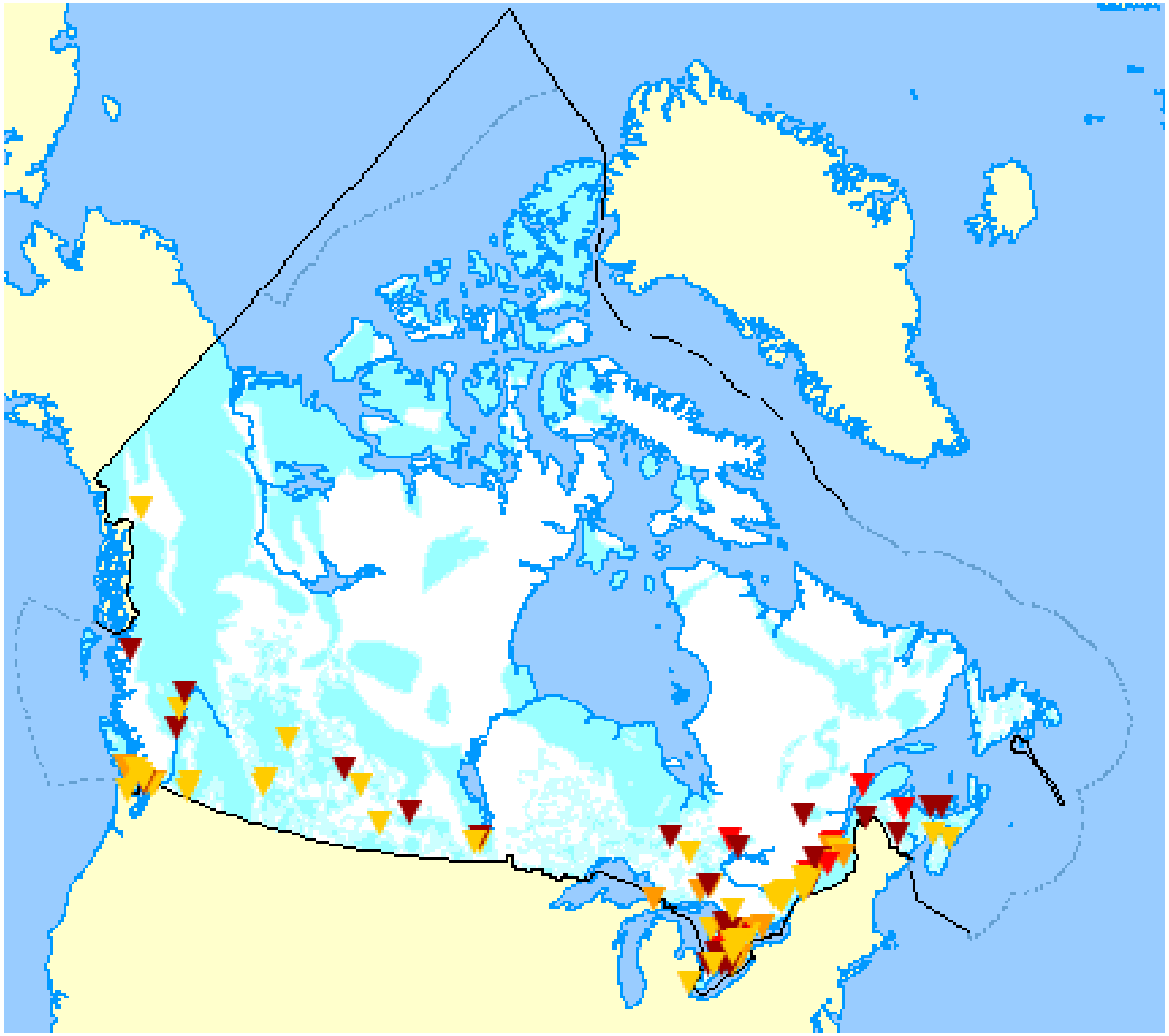
The Canadian portion of the Great Lakes occupies nearly 10%, or 7 500 km2, of the 891 163 km2 freshwater area in Canada.

Canada’s Drainage Areas

CANADIAN WATER FACTS

- Canada is the country with the third most renewable fresh water. Only Brazil and Russia have more
- Annually, Canada's rivers discharge 7% of the world's renewable water supply & 20% of the total fresh water
- Almost 9% of Canada's total area is covered by freshwater
- Approximately 60% of Canada's fresh water drains to the north, while 85% of the population lives along the southern border with the United States
- Canada has about 25% of the world's wetlands – the largest wetland area in the world.

Groundwater Distribution



Percentage of people using groundwater resources

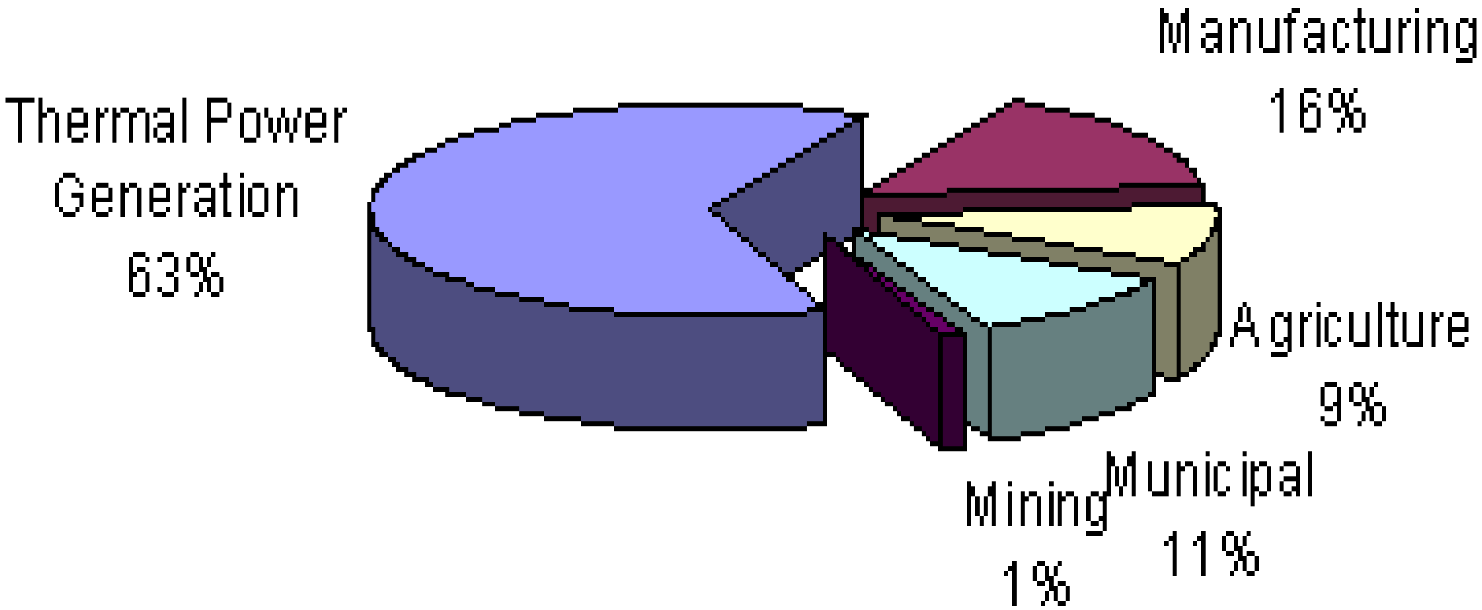
- 0-25%
- 26-50%
- 51-75%
- 76-100%

Canada's Water Governance

- Federal
- Provincial
- Municipal

- **Successful models of transboundary water management between provinces**
- **Canada – US IJC Boundary waters treaty**

Principal Water Uses in Canada, 2000



Source: Environment Canada

Canadian Annual Water Use by Sector

- Thermal power – 40,405 MCM (64%)
- Manufacturing – 12,996 MCM (14%)
- Municipal – 5,314 MCM (11%)
- Agriculture – 3,991 MCM (9%)
- Mining – 1,715 MCM (2%)

Irrigation
Prairies and BC

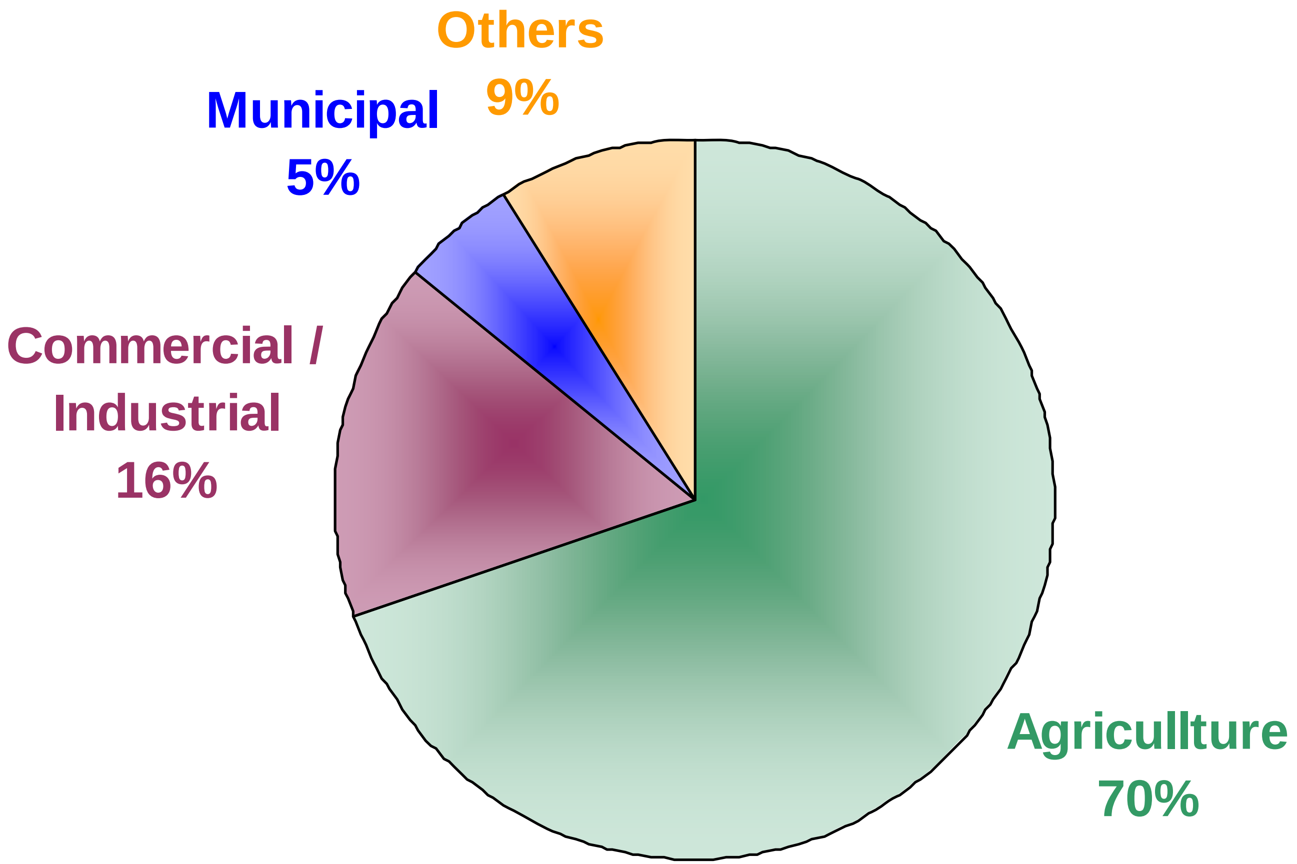
Close to 800,000ha

Estimates of Actual and Potential Irrigated Area in Canada

	Provincial Estimates (Ha)	Potential Irrigated Area (Ha)*	Potential Irrigated Area as % of Actual
British Columbia	121,408	182,113	150 %
Alberta	660,777	800,000**	121 %
Saskatchewan	80,939	404,694	500 %
Manitoba	30,352	60,704	200 %
Ontario	60,704	202,347	333 %
Quebec	25,000	35,000	140 %
New Brunswick	500	575	115 %
Nova Scotia	3642	7,285	200 %
Prince Edward Island	2023	4,047	200 %
Newfoundland	45	136	300 %
Total for Canada	985,390	1,696,901	172 %

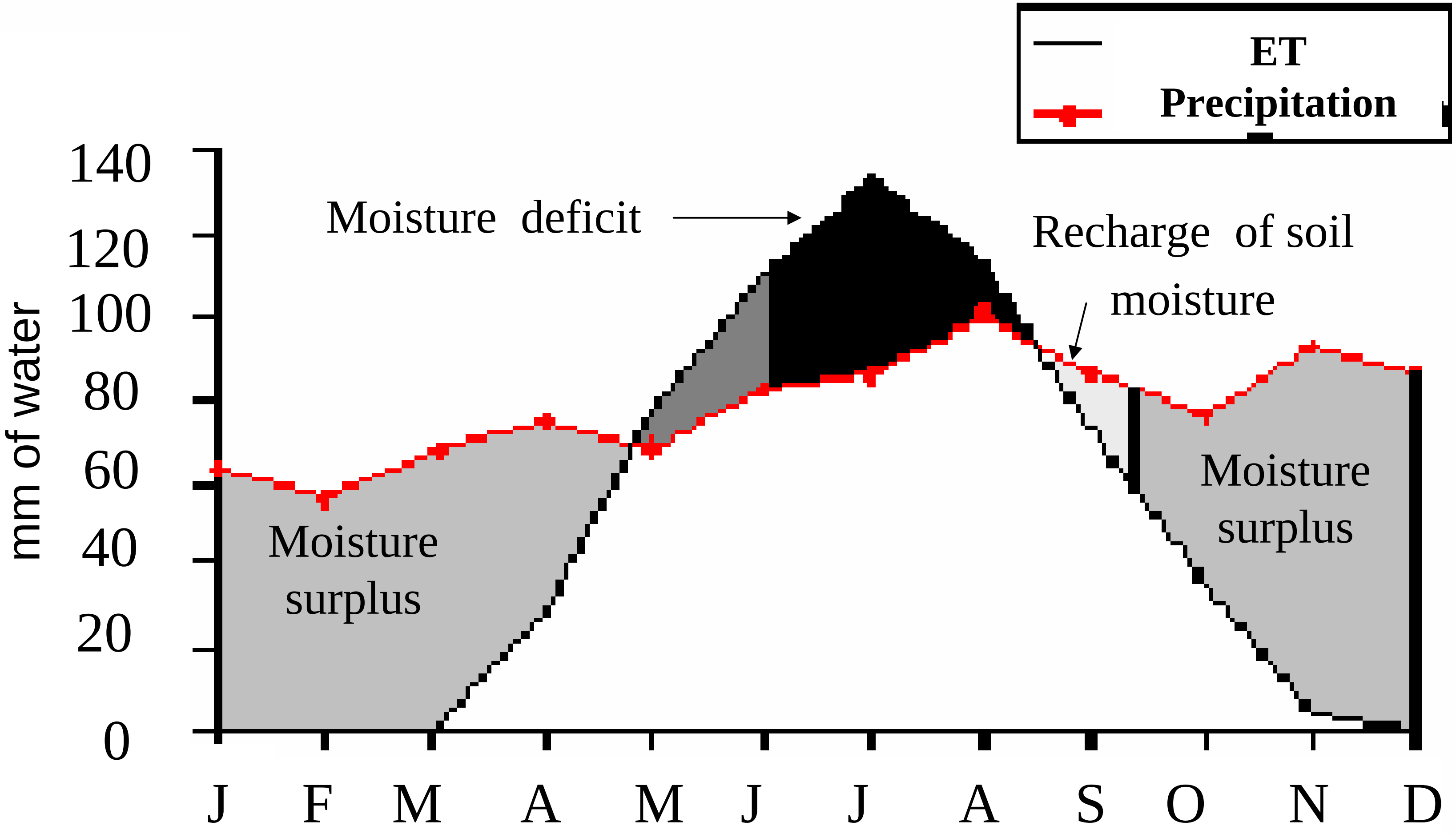
The Saskatchewan River Basin

Water Users in Alberta



http://www.keewatin.ca/Pages/Alberta_section.html

Soil Water Balance for Montreal



Eastern Canada

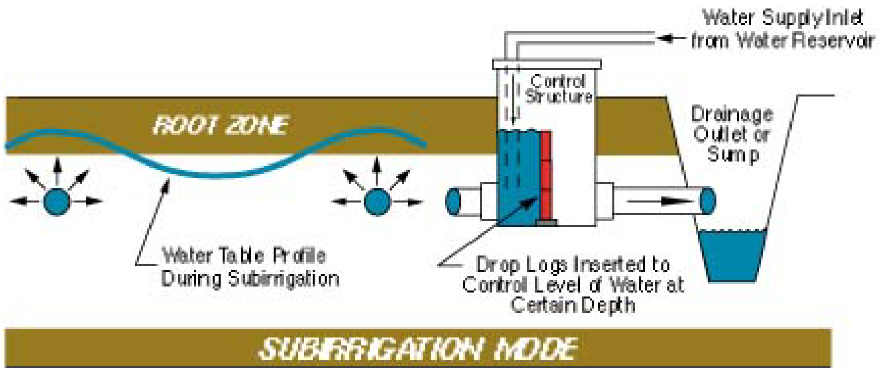
Spring field conditions

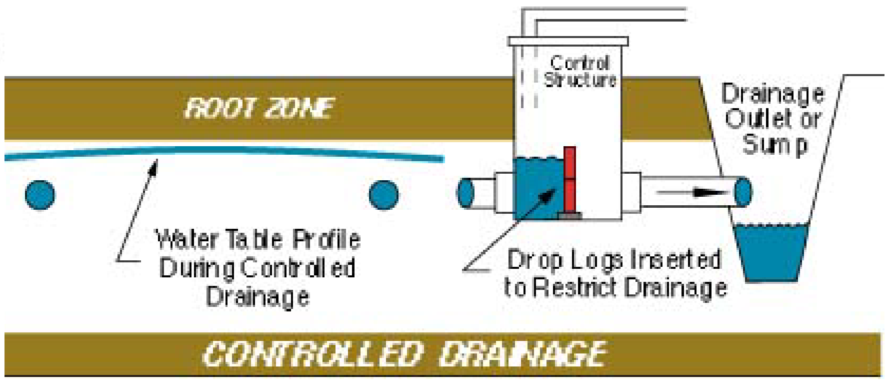

Flood damage – June 2002 Growing Season
NEED FOR DRAINAGE

Subsurface pipe drainage installation

Water table management

- Subirrigation
- Controlled drainage
- Water quality benefits
- Agronomic benefits



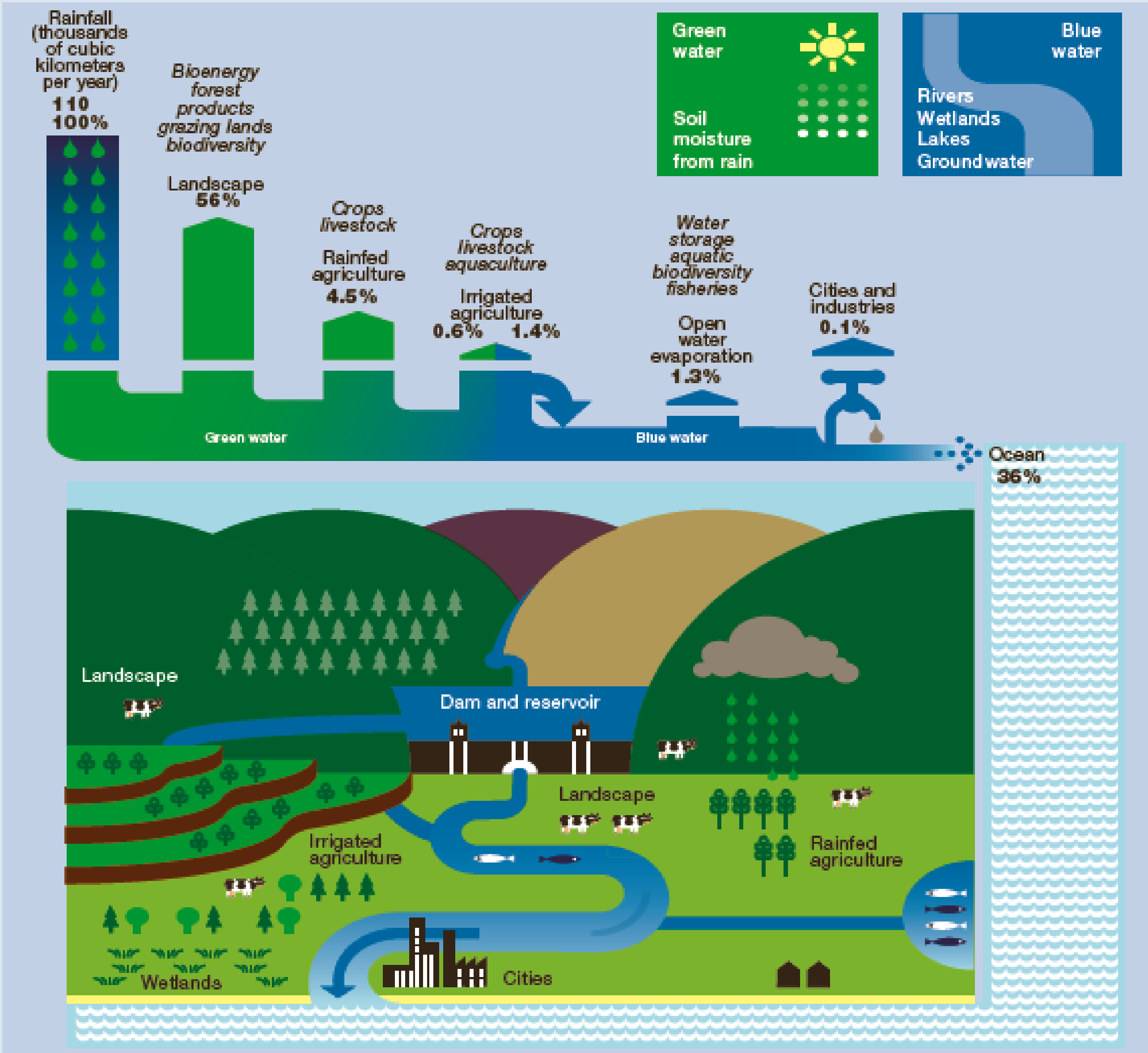


RESTRICTIONS ON IRRIGATION EXPANSION

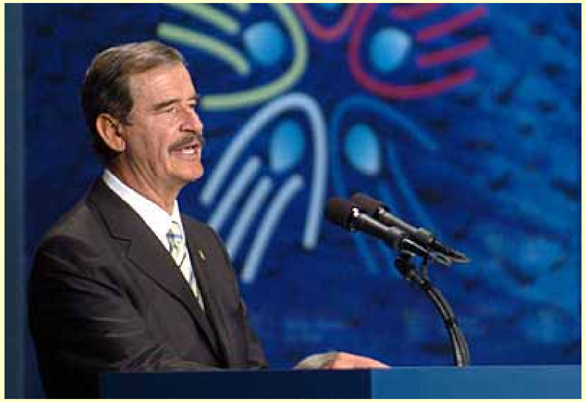
INCREASED COMPETITION FOR WATER

Irrigation Efficiency Gains

Global water use



Source: Calculations for the Comprehensive Assessment of Water Management in Agriculture based on data from T. Oki and S. Kanae, 2006, "Global Hydrological Cycles and World Water Resources," *Science* 313 (5790): 1068–72; UNESCO–UN World Water Assessment Programme, 2006, *Water: A Shared Responsiblity,* The United Nations World Water Development Report 2, New York, UNESCO and Berghahn Books.



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THANK YOU!