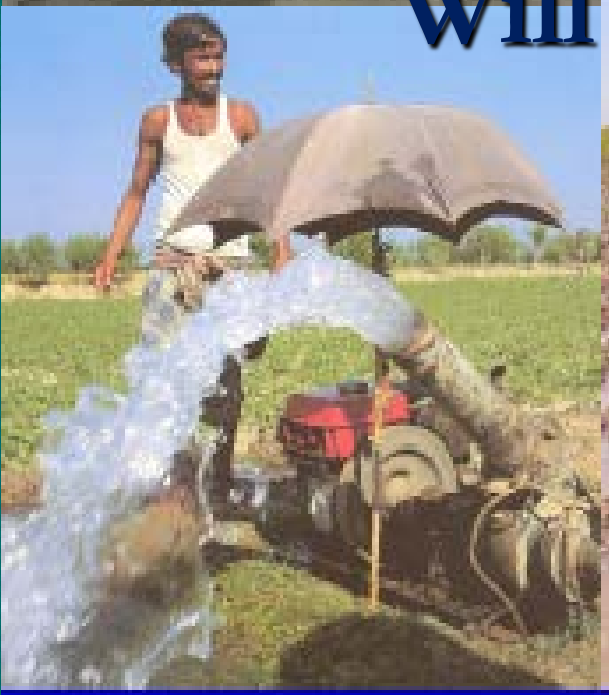
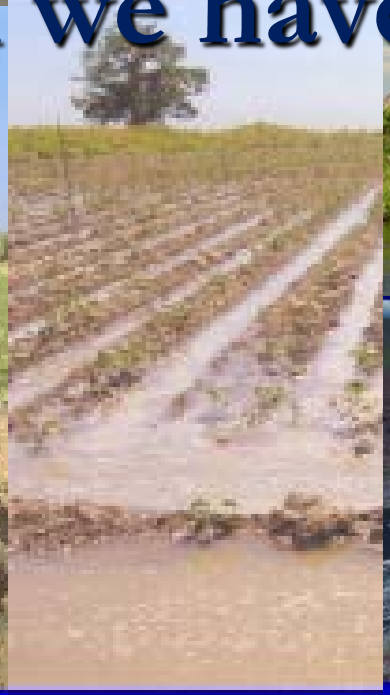
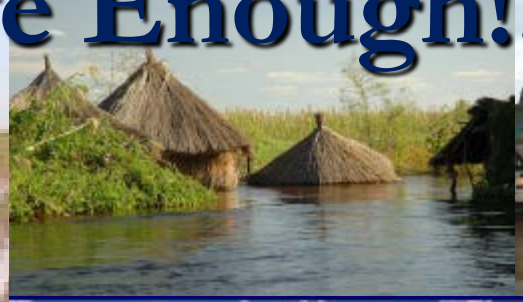
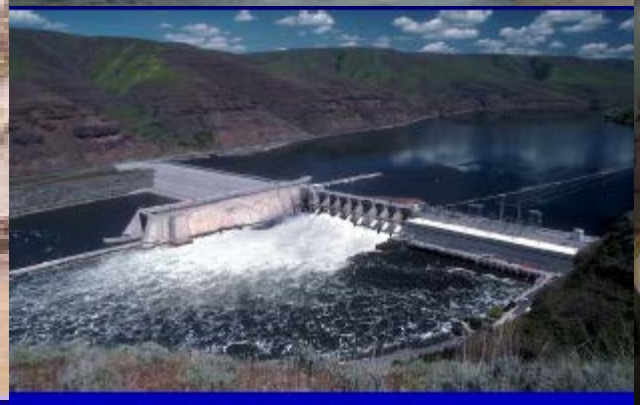
Global Water Resources

Will we have Enough!!!









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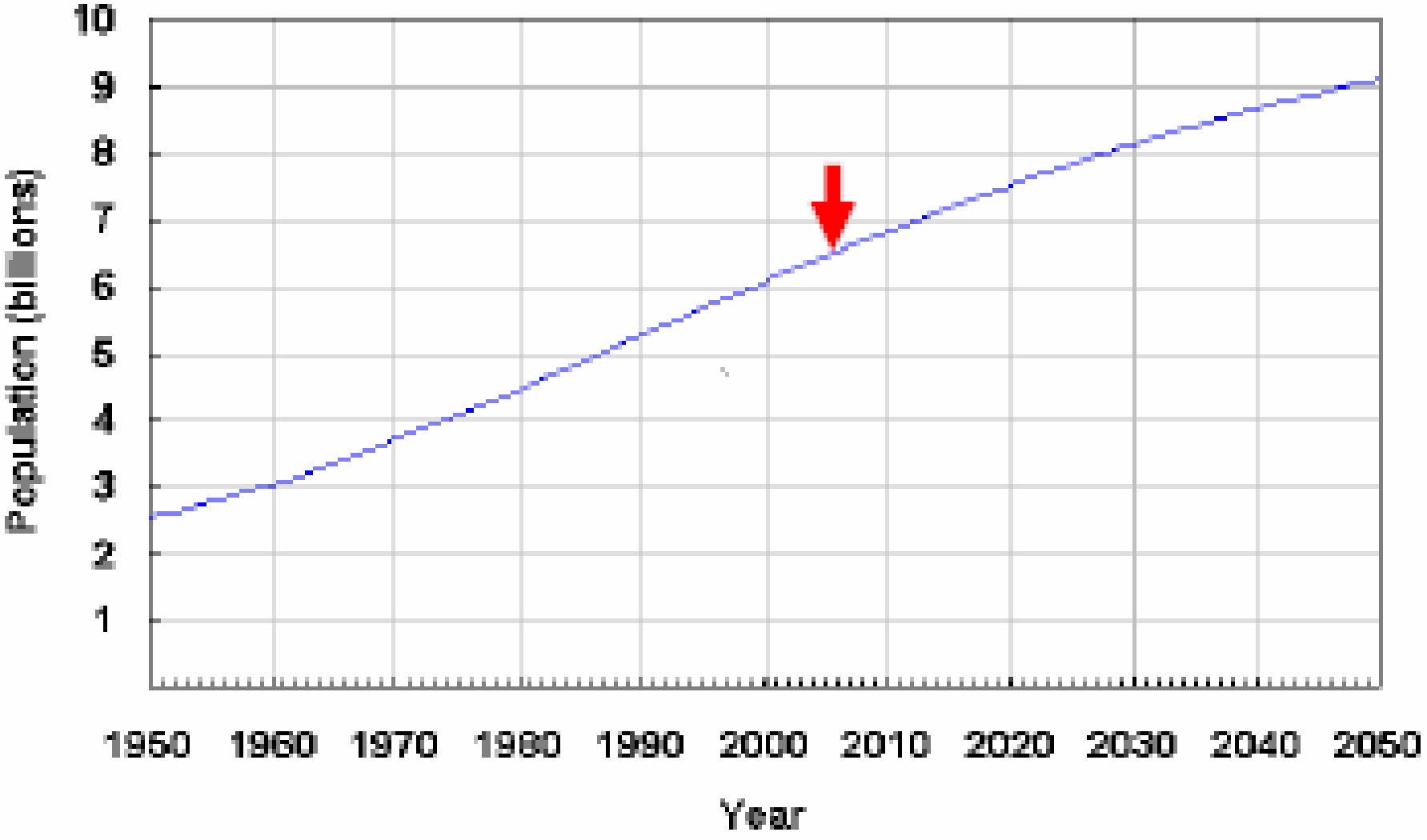
World Population: 1950-2050



Source: U.S. Census Bureau, International Data Base 5-10-00.

Huge needs

- Water-related disease kills 1 child every 8!
- 50% of people LDCs suffer from water-related diseases
- 50% of population lacks adequate sanitation
- 1 billion people without safe water,
- 2 billion w/o sanitation,
- 4 billion w/o sewage treatment
- contaminated water
  - causes 80% of developing world diseases
  - has pushed 20% of freshwater fish species to the edge of extinction
- Existing systems are run-down
- We need to provide sanitation for 1.2 millions and water for 600,000 additional persons/week for 15 years to meet MDG

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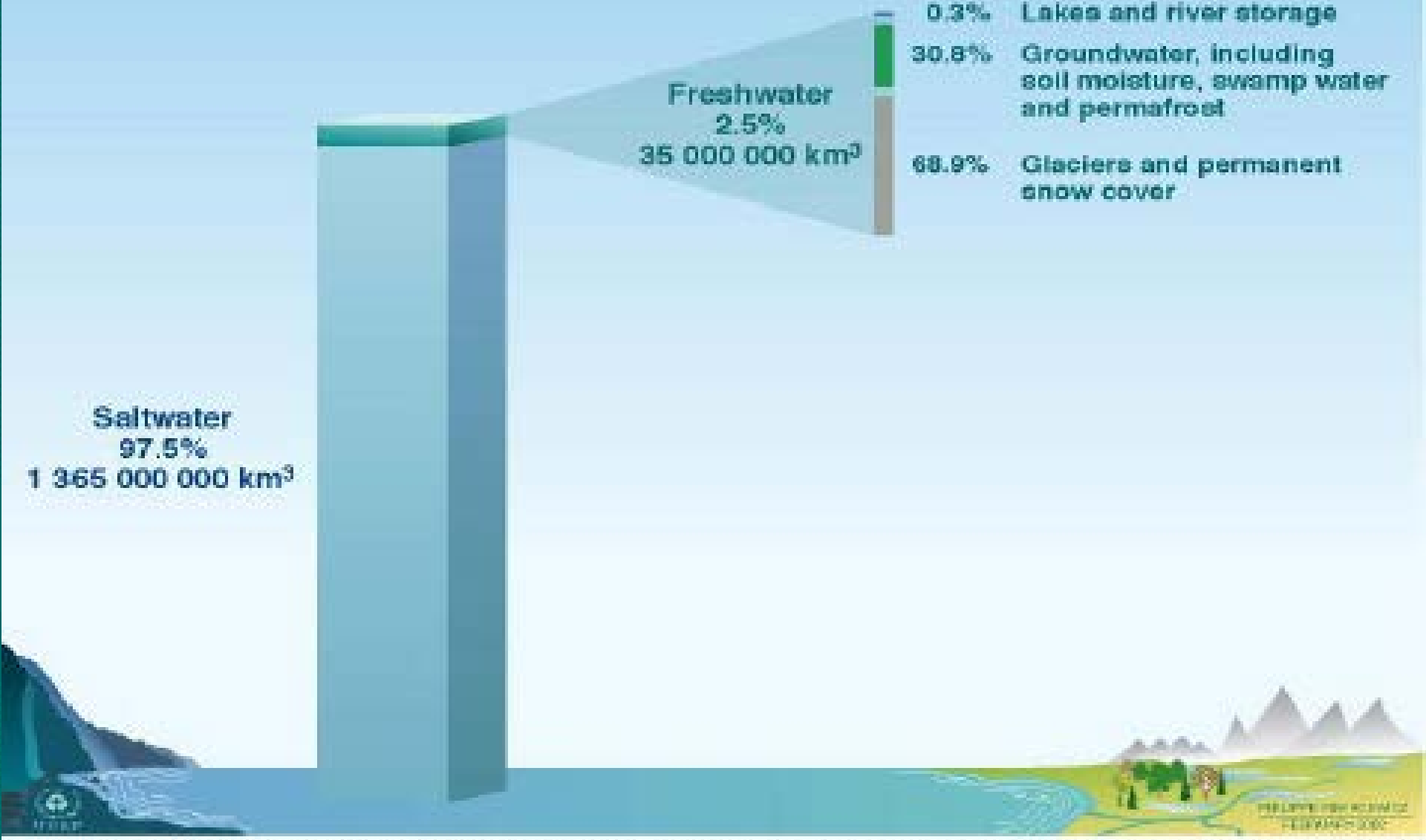
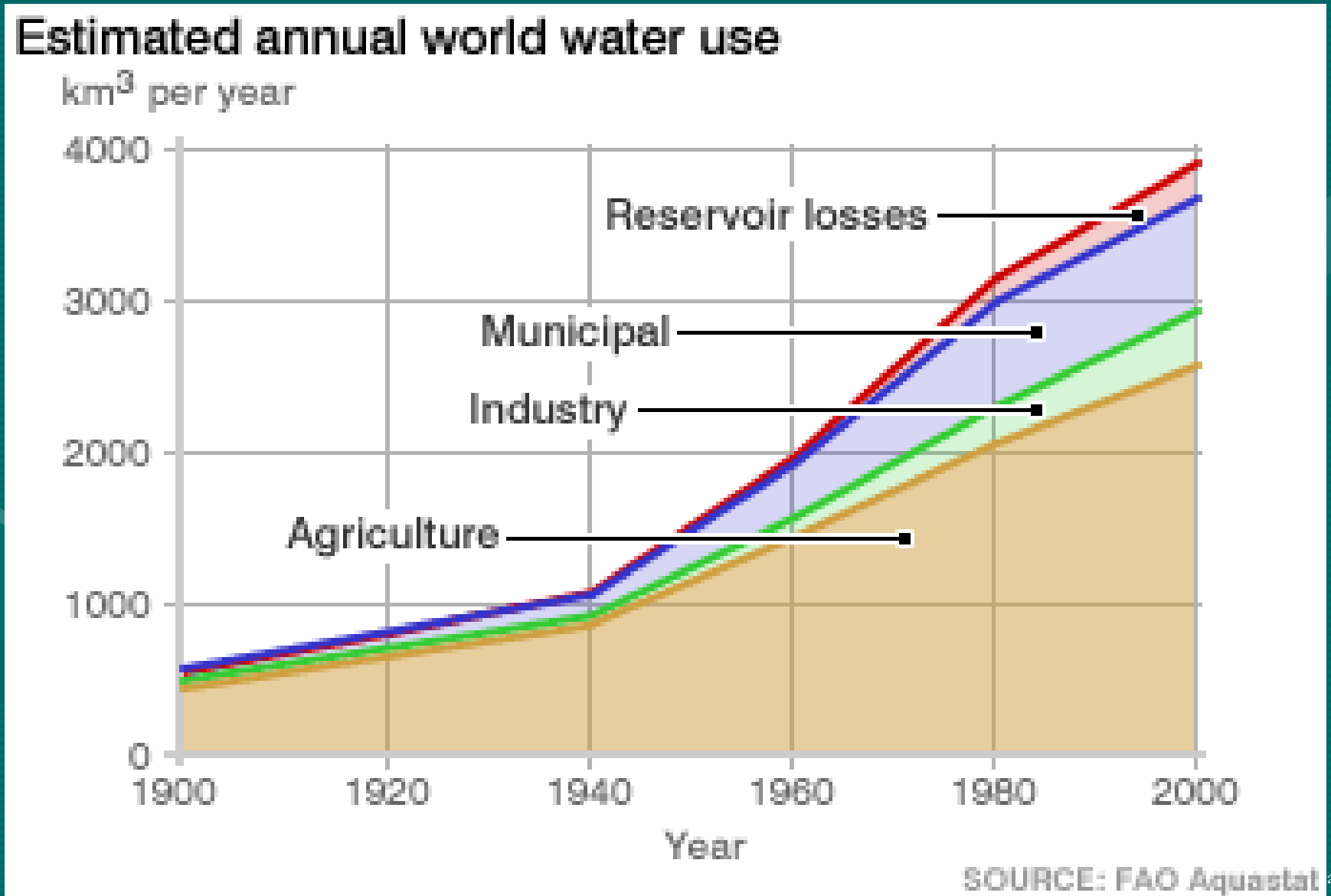
A World of Salt

Total Global Saltwater and Freshwater Estimates



Source: Igor A. Shiklomanov, State Hydrological Institute (SHI, St. Petersburg) and United Nations Educational, Scientific and Cultural Organisation (UNESCO, Paris), 1999.

Since 1900 global population has tripled
Water use has increased 6 times



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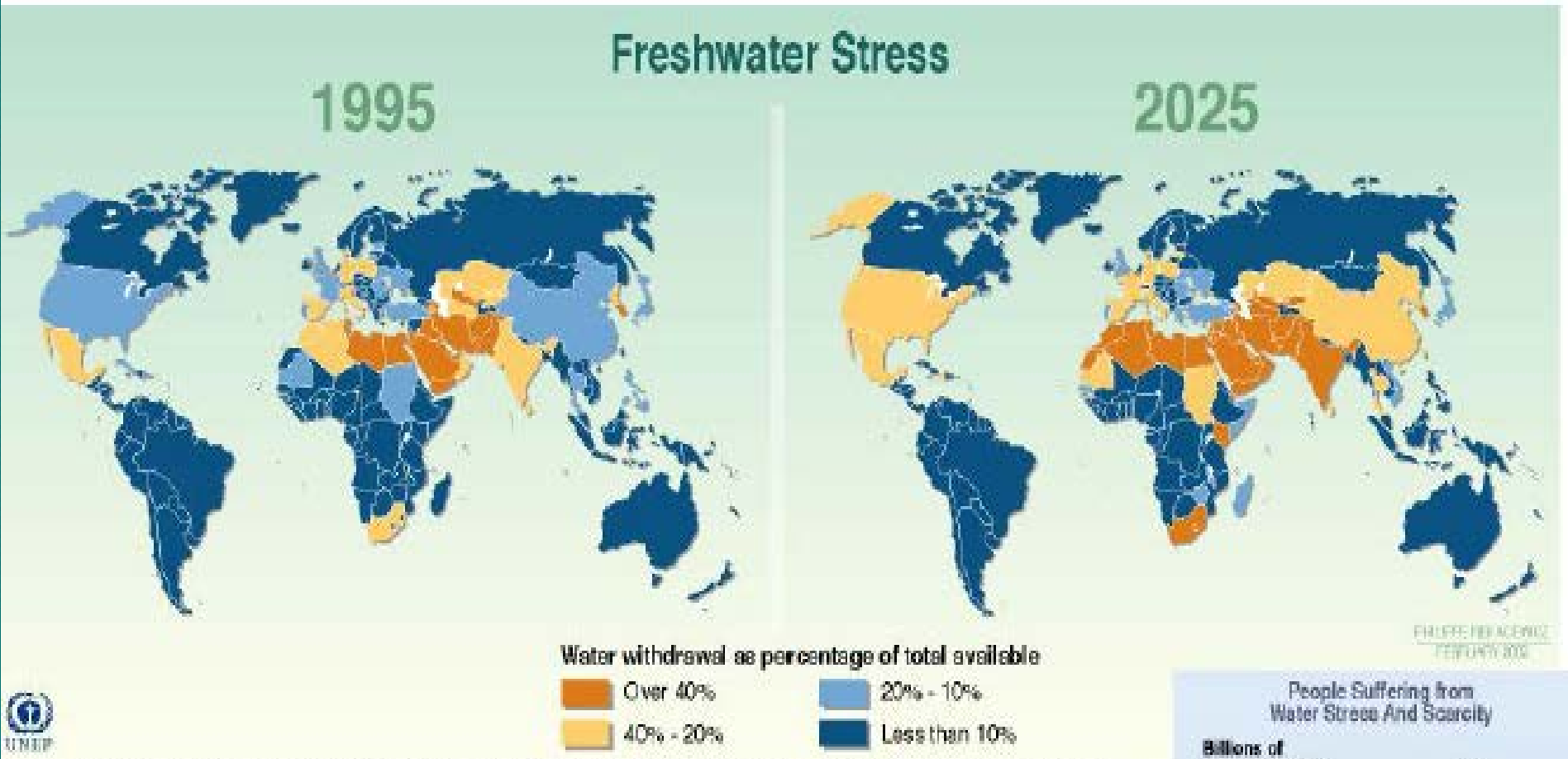
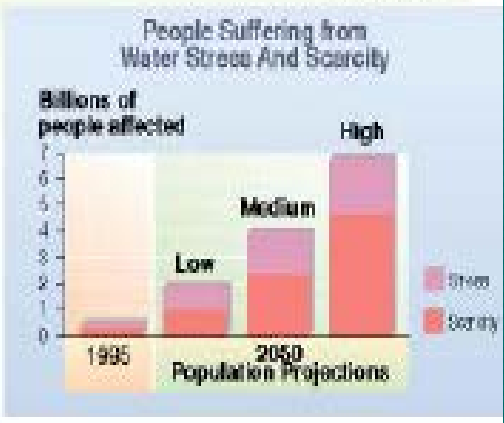
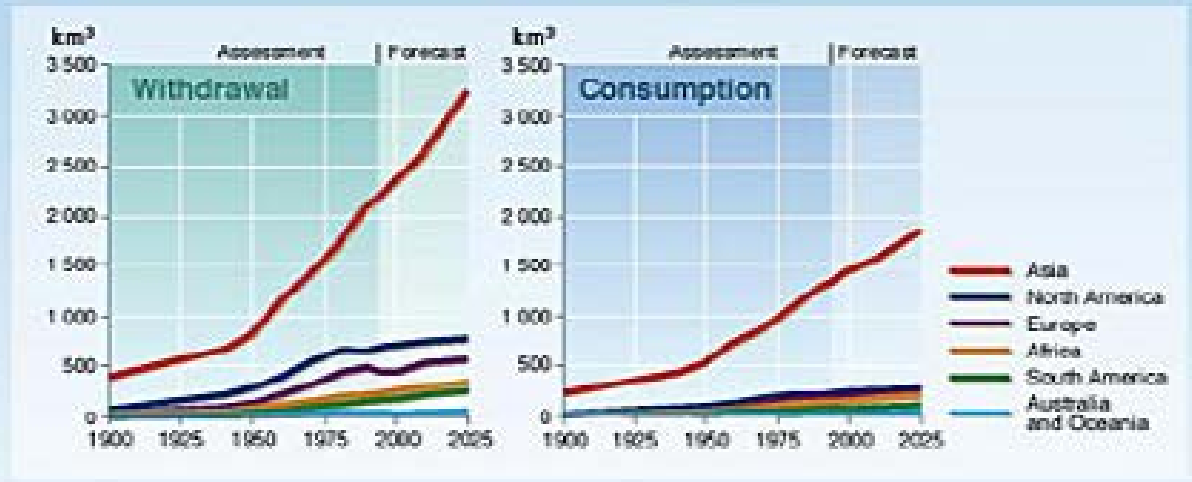
% Supply Withdrawn

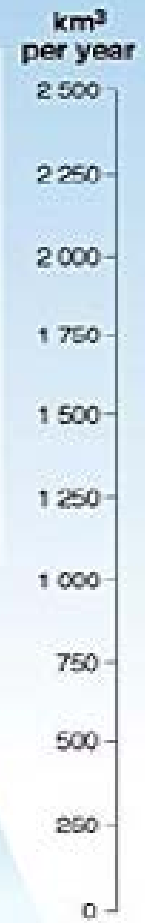


Source: World Meteorological Organisation (WMO), Geneva, 1996; Global Environment Outlook 2000 (GEO), UNEP, Earthscan, London, 1999.



Global Water Withdrawal and Consumption





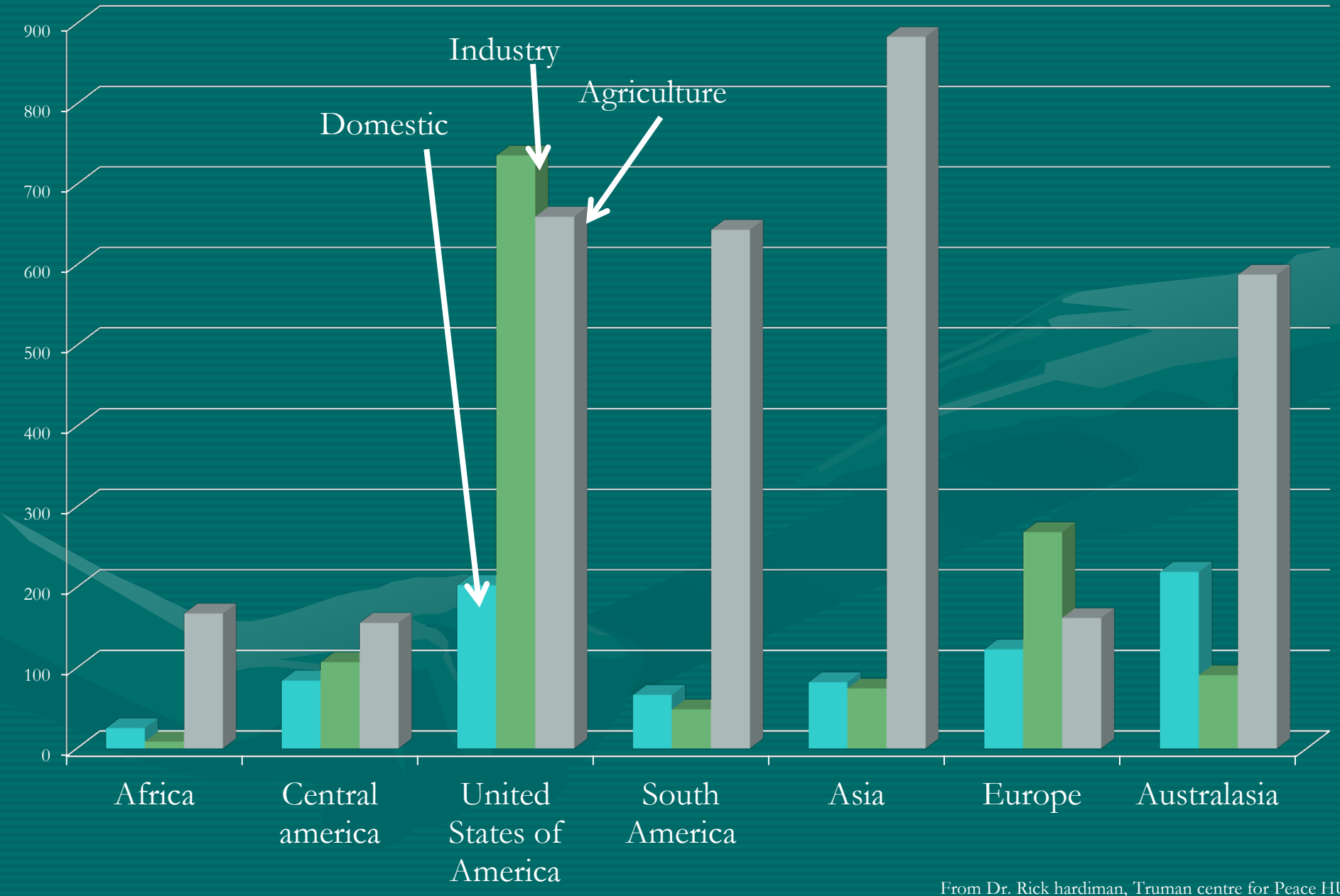
Source: Igor A. Shiklomanov, State Hydrological Institute (SHI, St. Petersburg) and United Nations Educational,Scientific and Cultural Organisation (UNESCO, Paris), 1999; *World Resources 2000-2001, People and Ecosystems: The Fraying Web of Life*, World Resources Institute (WRI), Washington DC, 2000; Paul Harrison and Fred Pearce, *AAAS Atlas of Population 2001*, American Association for the Advancement of Science, University of California Press, Berkeley

Per capita consumption of water/day

Continent/Region	Liter/day
Africa	70
South America	183
Asia	226
Central America	231
Israel	240
Europe	337
USA	556
(Australia/NZ)	601

Source FAO Statistics (2008-2009) (www.worldwater.org)

Domestic, Agriculture. Industrial consumption of water (m3/per capita/yr)



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Water Footprint in Agriculture

Table 3.3 Virtual Water Content of Selected Products

Product	Liters of water per kilo of crop
Wheat	1,150 **-1400**
Rice	2,656 **-3400**
Maize	450
Potatoes	160
Soybeans	2,300
Beef	15,977
Pork	5,906
Poultry	2,828
Eggs	4,657
Milk	865
Cheese	5,288

Source: Adapted from Hoekstra (2003)

No money

- Fiscal constraints
- Official aid stagnant (< $3bn/yr, WB $1bn)
- Public utilities unable to self-finance or to carry debt
- Private investment: a relative trickle so far

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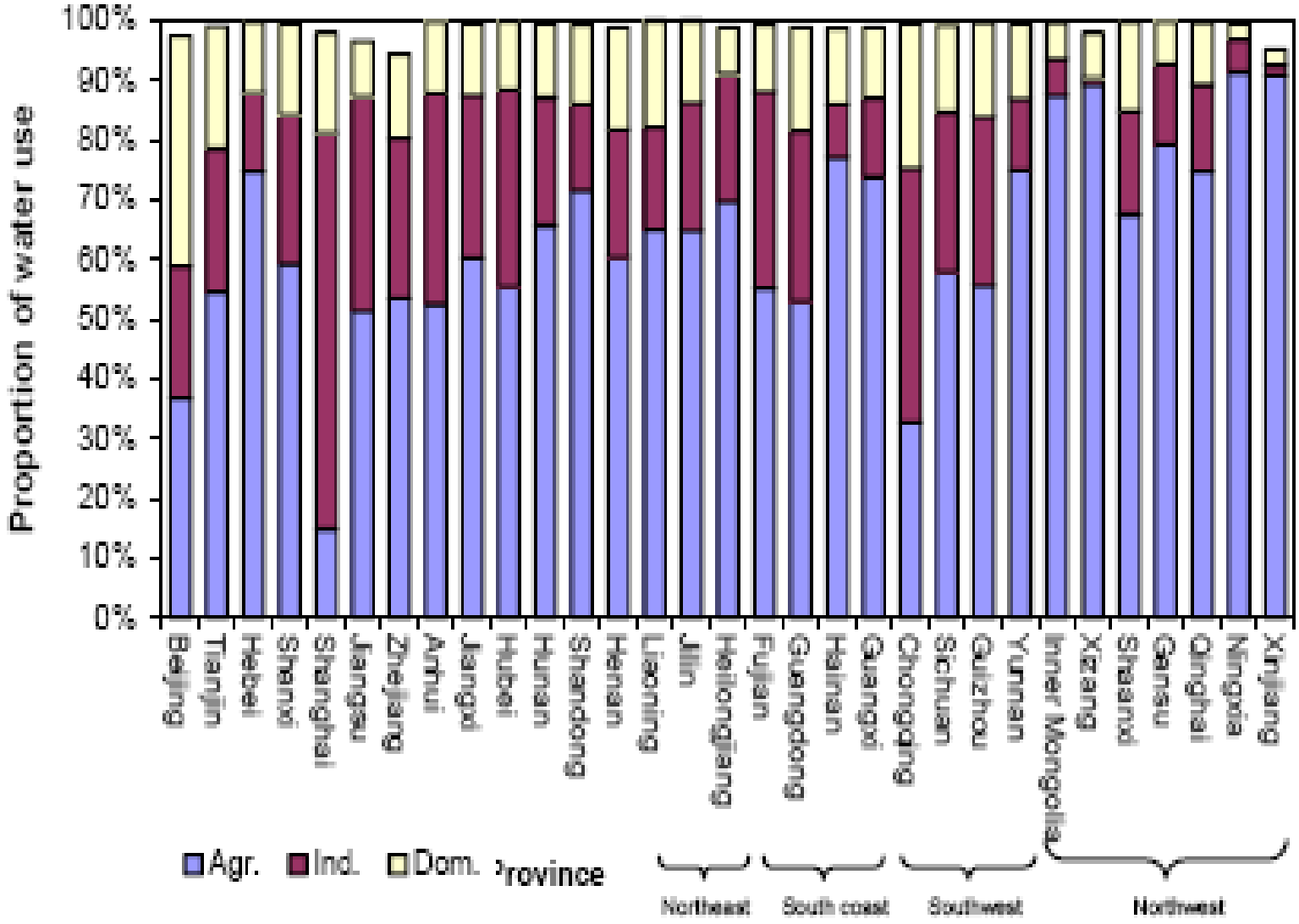
Water Wars

- "Population growth will make the problem worse. So will climate change. As the global economy grows, so will its thirst. Many more conflicts lie just over the horizon,"
- "This is not an issue of rich or poor, north or south," he said, pointing to examples of water problems in China, the United States, Spain, India, Pakistan, Bangladesh and the Republic of Korea. "All regions are experiencing the problem."

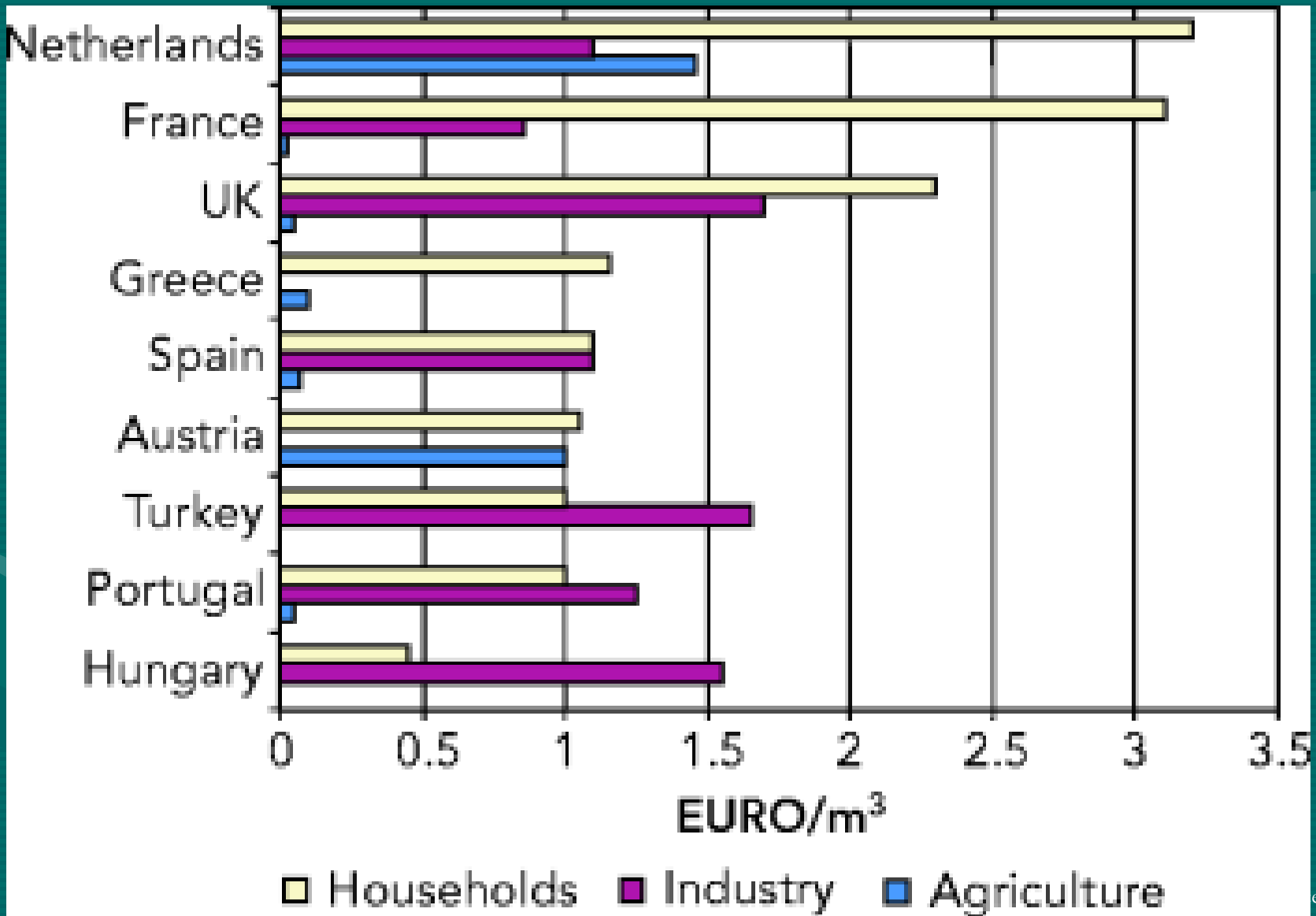
(Mr. Ban Ki-moon, the UN Secretary-General (World Economic Forum, Davos, January 2008)

The Economic Value of Water

% water use Agriculture, Industry Domestic



Indicative Water Pricing Comparisons in Europe



Pricing water

- Different water prices for:
  - Administrative Use
  - Domestic Use
  - Industrial Use
  - Business/service use
  - Special use (e.g. health clubs/spas)
  - Agricultural Use
- Considerations
  - Local situation (water availability and needs)
  - Socio-economic considerations (consider poor population)
  - Income difference (haves and have-not)

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Factors affecting industry water tariffs

- Low tariffs encourage local industrial investment
- Low tariffs provide market competition (local and national)

Economic Value of Water

E.g. Hai River (most polluted water source in China)

Drinking water production cost 0.75 USD/m3

- Average Economic Value: 6 USD/m3
- Industry 30.5 USD/m3
- Construction 26.5 USD/m3
- Agriculture 1-2 USD/m3)
  - Rice: 0.2 USD/m3
  - Vegetables: 1.8 USD/m3

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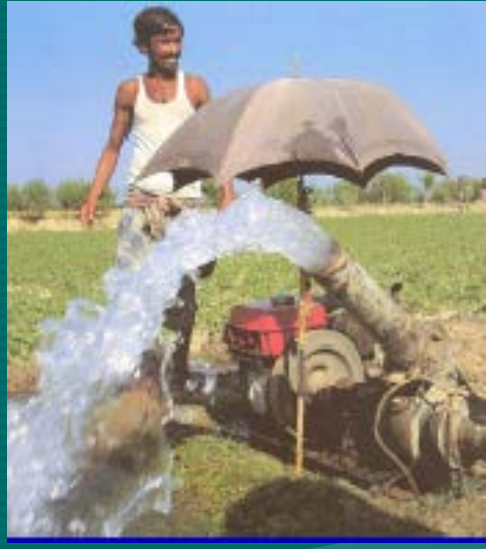
Agricultural tariffs



- Tariff very low, (0.1 USD/m3)
- based on area not volume,
- difficult to collect
- Socio-economic implications
- Water pollution – fertiliser efficiency
- Reliability of supply

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Agricultural Tariff – What happens if it increases?

Percentile of the Cost of Water	Depth of Water (m)	Average Cost of Water (CNY/m^3)	Water Use (m^3/ha)
Wheat			
1. Average	31	0.24	4,608
2. 0-25%	14	0.08	6,433
3. 26-50%	21	0.20	5,285
4. 51-75%	52	0.30	2,934
5. 76-100%	53	0.56	2,154
Maize			
1. Average	34	0.24	2,019
2. 0-25%	20	0.06	2,255
3. 26-50%	34	0.16	2,094
4. 51-75%	57	0.26	1,463
5. 76-100%	68	0.52	1,119
Cotton			
1. Average	51	0.29	1,241
2. 0-25%	41	0.14	2,322
3. 26-50%	46	0.23	931
4. 51-75%	47	0.33	994
5. 76-100%	108	0.51	978

Source: Huang et.al 2007

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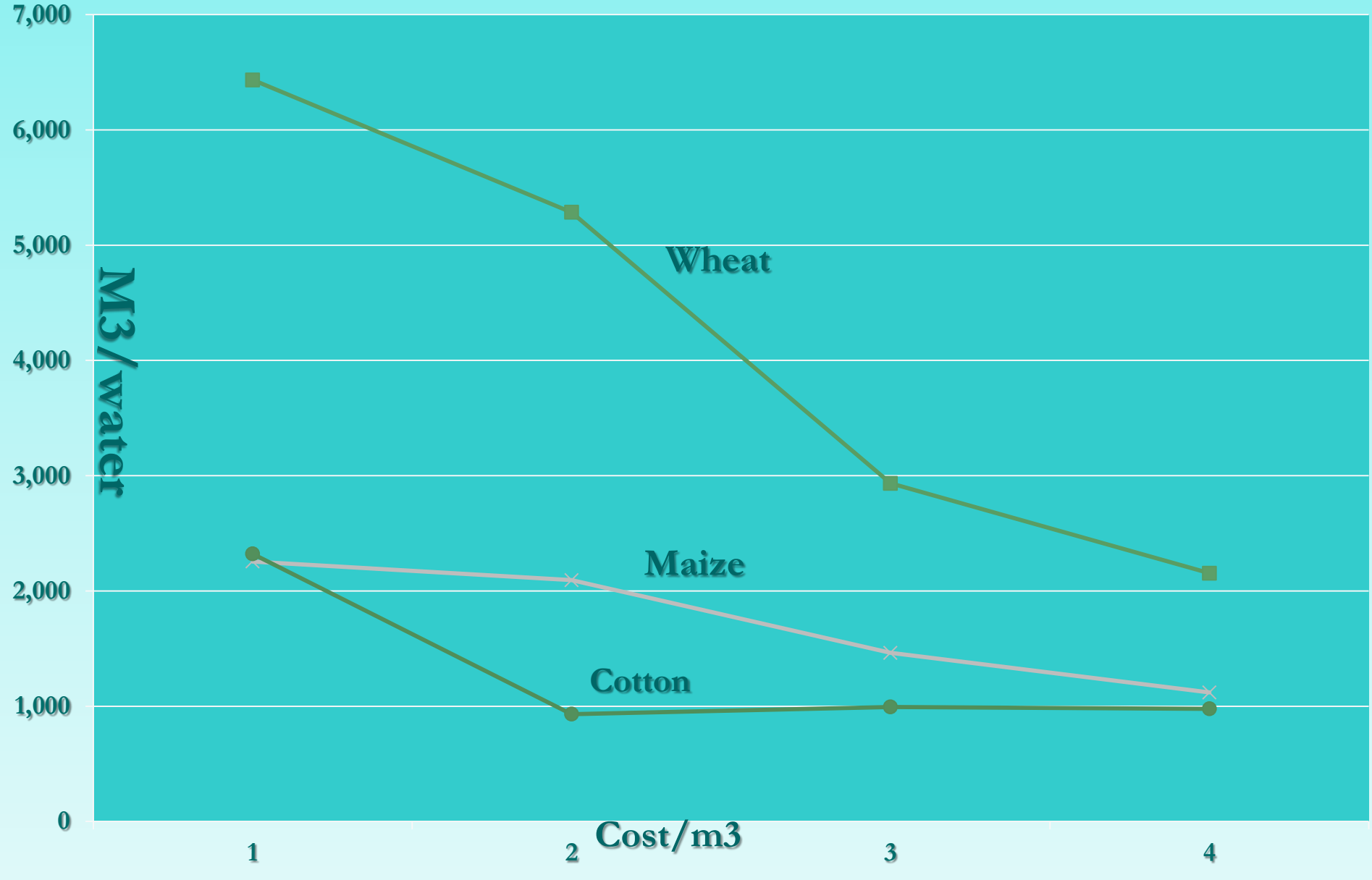
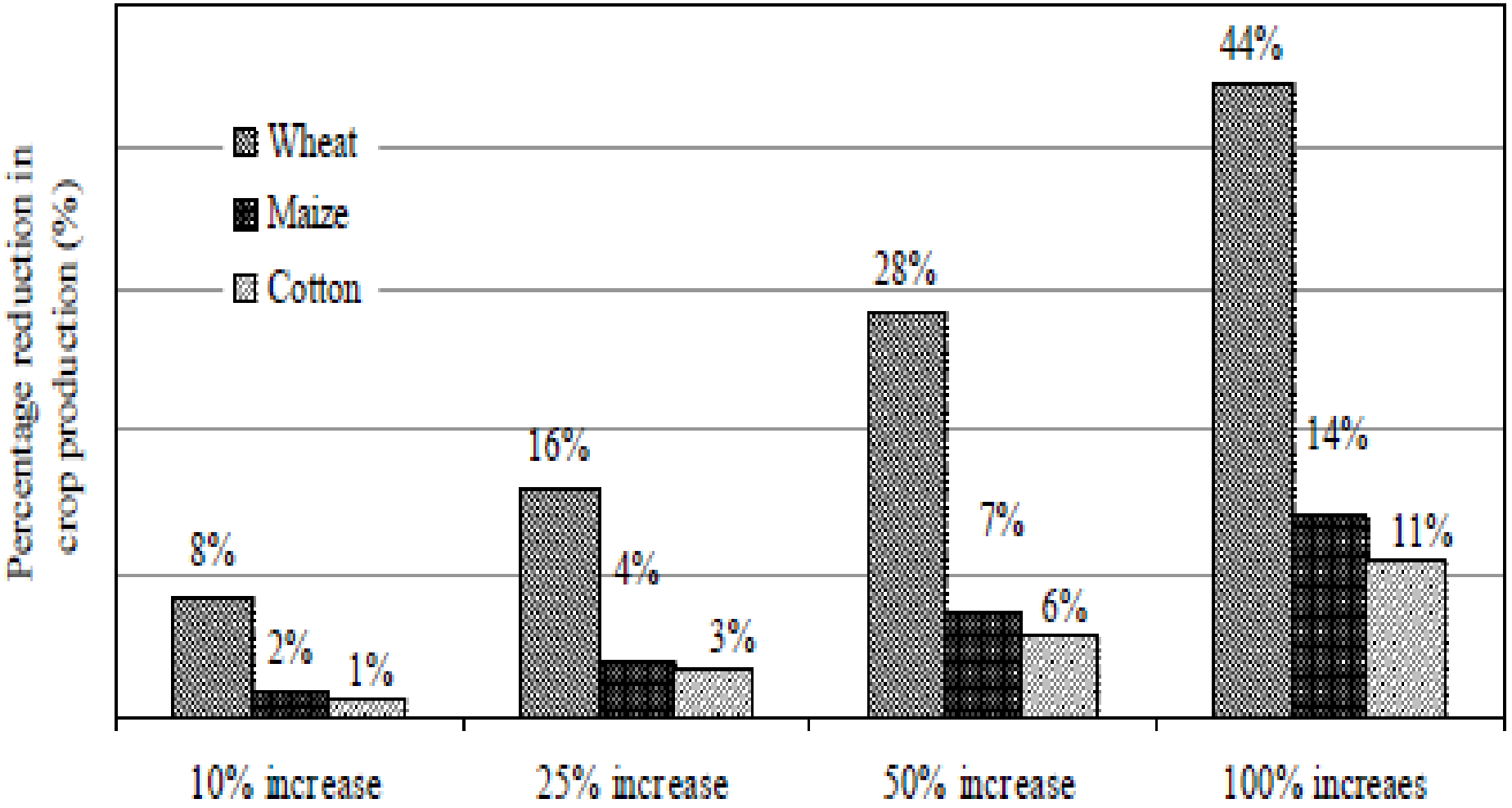
Agricultural Tariff – What happens if it increases?



Impact of higher water prices on crop production



Source: Huang *et.al* 2007)

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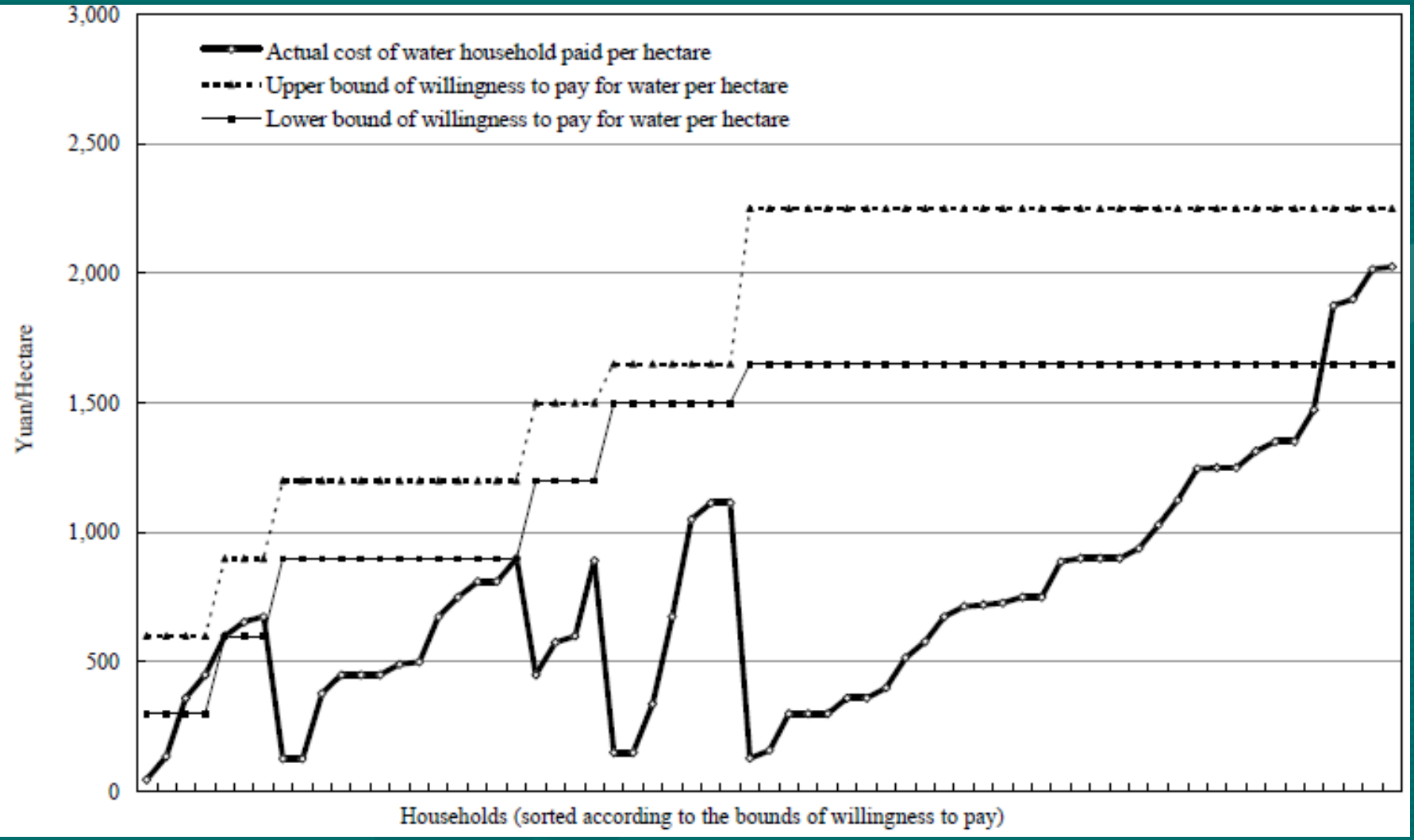
Amount Paid for Water and Willingness to Pay for Irrigation of Wheat



Source: Huang, Q., S. Rozelle, and R. Howitt, J. Wang J and J. Huang, 2007. *Irrigation Water Pricing in China*, University of California, Davis, Working Paper.

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Volumetric vs. Area based water measurement

- Volumetric at Main/lateral Canals

- Area based at sub-lateral and below

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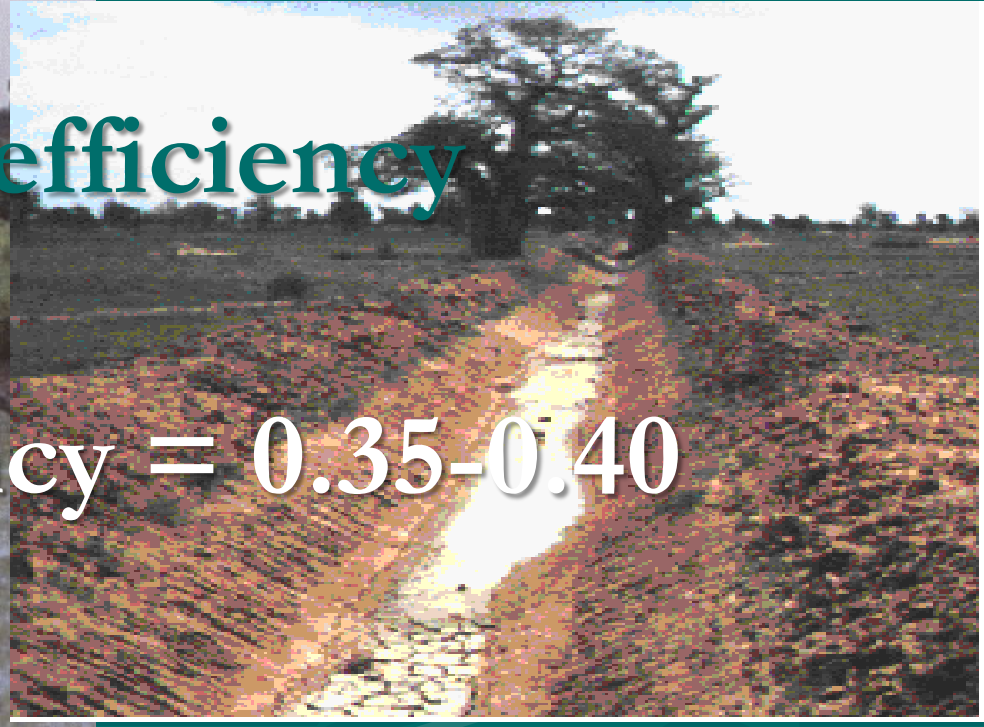
Irrigation efficiency

Irrigation efficiency = 0.35-0.40



Irrigation efficiency = 0.7-0.9

Agricultural Water Coupons and the Market Economy

- Allocation of fixed volume of water to Water User Associations and it members (farmers)
- Sell accordingly to Market price like stock exchange
- Funds channelled through bank
- Problem – will it create a desert?

Domestic Water Tariffs: Main issues

- Water and waste water tariffs still too low
  - Water price varies by county/municipality 70% of counties less than 0.2 USD/m3
  - 66% of water supply companies make a loss (2 million USD)
- Companies unable to make a profit
- Companies semi-government: accounts do not consider: amortization, salaries, depreciation of equipment, land costs, power costs,
- Cannot increase price because of income disparity
- Default of payment by poorer counties

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Domestic water and waste water tariffs vs. Income

Table 3: Comparison of economic development and water price among different small towns in Yunnan in 2004

Item	Shiping County	Luxi County	Ninglang County	Luchun County
GDP (10^4 Yuan)	120834	144857	57279	34989
Per capita GDP (Yuan)	4145	3848	2421	1699
Average salary (Yuan)	12546	13127	12489	10260
Domestic water price (Yuan/m^3)	2.00	1.84	0.7	0.7

Table 5: Proportion of water price and wastewater tariff in the household income in the demo sites and other cities

Proportion	Lijiang	Binchuan	Shangri-La	Western region		
				Chongqing	Fengjie	Puling
Water price (%)	1.5	2.5	1.0	1.5	1.71	1.4
Wastewater tariff (%)	0.3	--	0.1	1.0	0.37	1.4
Total (%)	1.8	2.5	1.1	2.6	2.1	2.9

- ADB/WB estimates tariff maximum is 3-5% of household income
- In Israel about 2% of income

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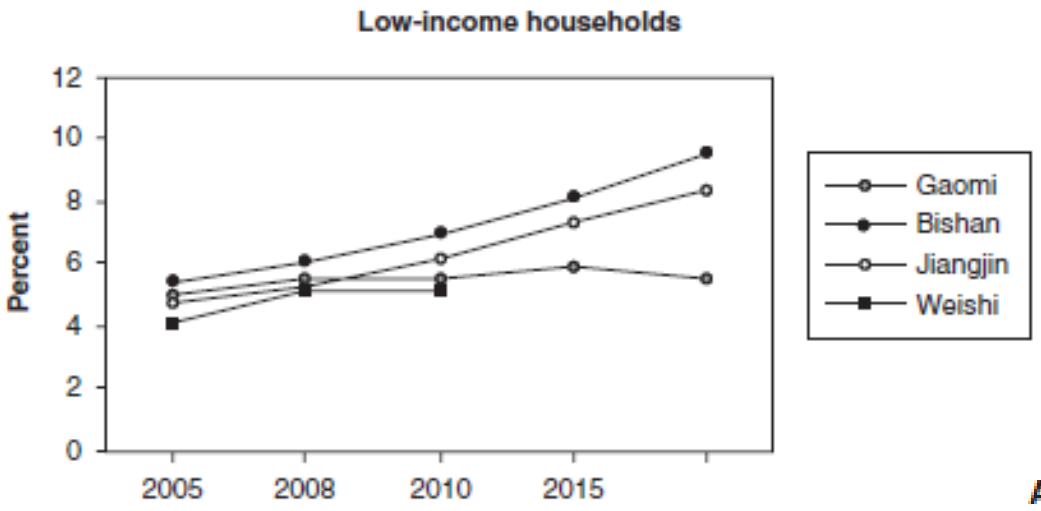
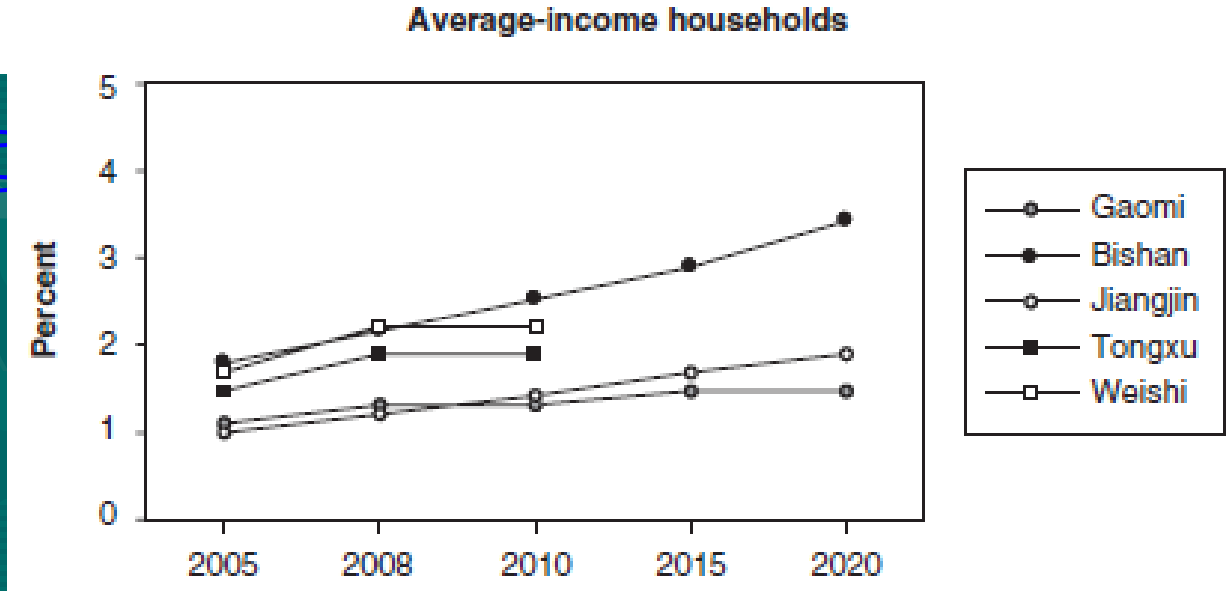
Percentage of income spent on domestic water supply +wastewater treatment for poor and average income households

Share of Water and Wastewater Services Expenses for Average and Low-Income Households





Tariffs and subsidies (Chongqing)

- Poor Family (100 USD/month) consume

8 m3/month, receive subsidy **5 USD/month**;

- Rich Family (1000 USD/month) consume

30 m3/month, receive subsidy 30 USD/month;

- Public spent more on bottled water than on water fee due to concerns of water quality
- Chongqing Water tariffs and the haves and have-nots
  - Unemployment 4-5%
  - Poor (under 80 USD/month) 28%

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Tiered Domestic water pricing/household

Lijiang

- 1st block: 25 m3 = 0.2 USD/m3*
- 2nd block: 26-35 m3 = 0.3 USD/m3
- 3rd block: ≥ 35 m3 = 0.4 USD/m3

*based on 40 l/person/day WHO

Israel

- 1st block: 8.5 m3/mth 1.5 USD/m3
- 2nd block: 9-18 m3/mth = 2.5 USD/m3
- + fine

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No money

- Fiscal constraints
- Official aid stagnant (< $3bn/yr, WB $1bn)
- Public utilities unable to self-finance or to carry debt
- Private investment: a relative trickle so far

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Foreign Investment in Water supply and waste water treatment

- Caution of foreign companies managing water resources
- BOT (Build Operate and Transfer, 20 years
- No guarantee of collecting fees hence contract with municipality
- Contract for Water Supply +piping network (every 1% leakage reduced = 1% profit)
- Main interest in large cities not in rural poor
- Will not invest in 3rd tier cities
- Investment slow due to:
  - (i) poor returns (tariff collection,
  - (ii) respect of contract agreement

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Privatisation of the water sector and Policy Considerations

- Access of public utilities to foreign companies
- Market-oriented
  - Reasonable price
  - Reasonable profit
- Privatization (Foreign and local investment)

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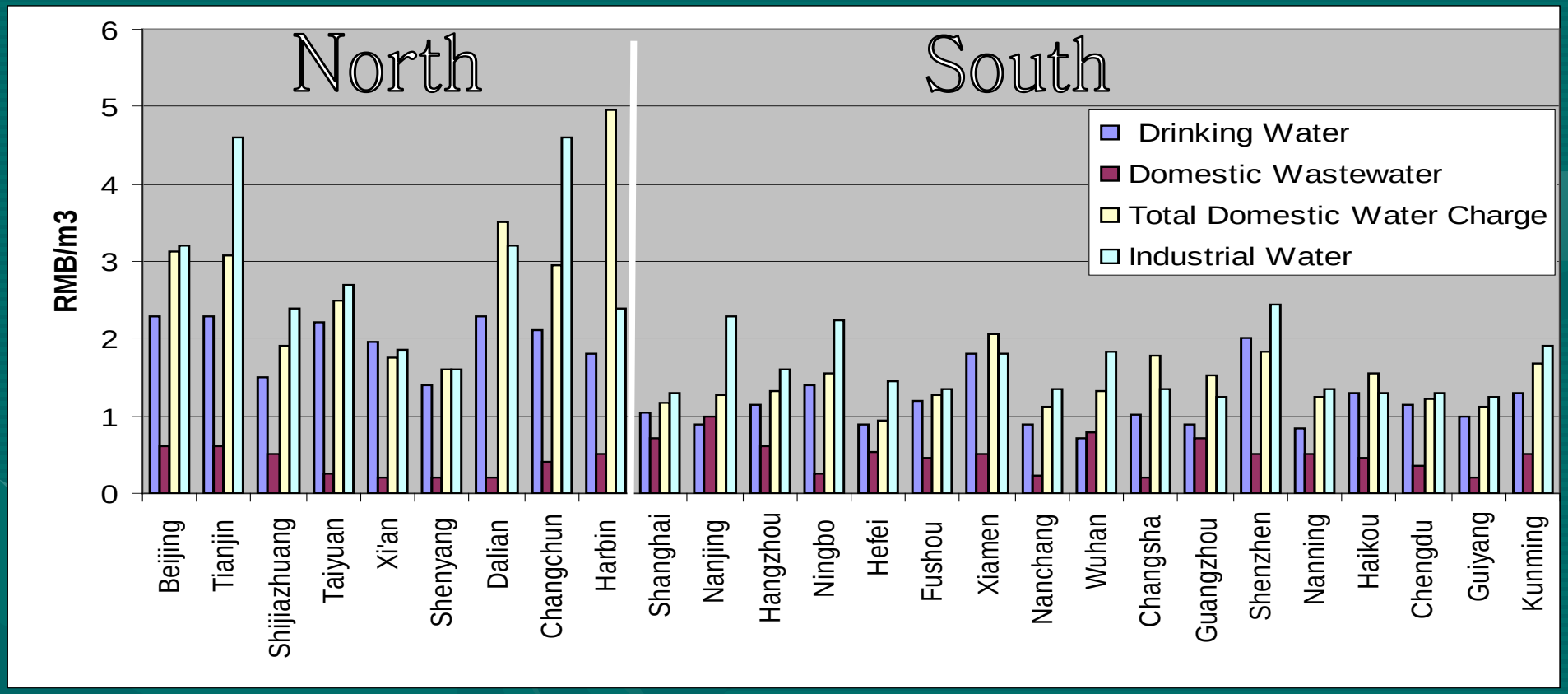
Industrial water Tariffs



Industrial: 0.7-0.35 USD/m3
Domestic: 0.3-0.15 USD/m3
Agricultural: 0.01 USD/m3

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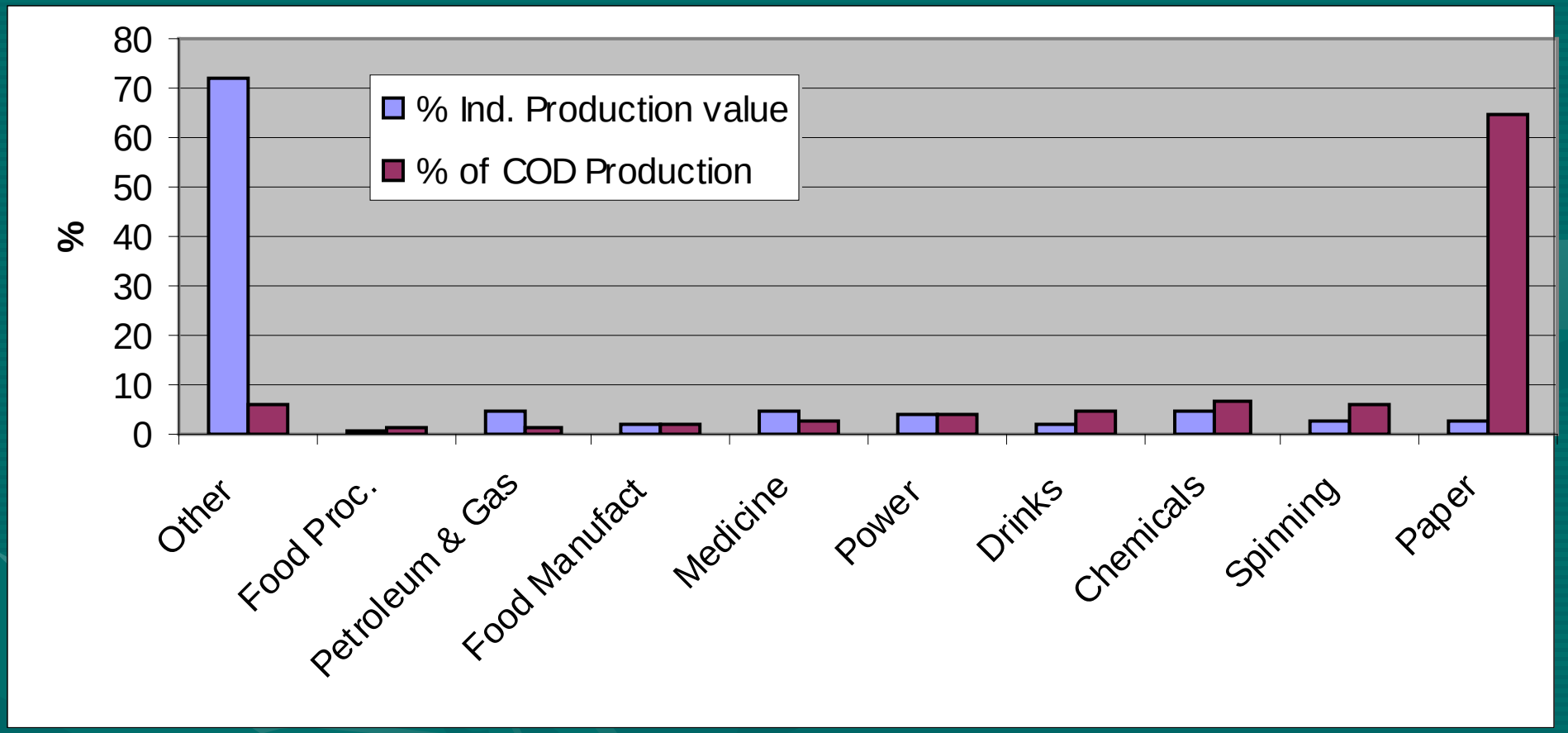
Industrial Production vs. Pollution – Shaanxi Province (2003)



Major water consumers: metallurgy, timber processing, paper and pulp, petroleum and chemical industries.

The value of water !!

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Table 3.2 Wastewater Treatment Cost for Major Industrial and Domestic Sectors

Sector	Treatment cost (yuan	USD/m3 Treatment Cost
Coal mining and washing	2.00	0.30
Food processing	3.20	0.40
Food manufacturing	1.95	0.30
Beverage manufacturing	1.65	0.25
Textile manufacturing	2.50	0.35
Paper and paper products manufacturing	2.50	0.35
Raw chemical materials and products	3.70	0.55
Petrochemicals	3. 80	0.60
Medicines manufacturing	1. 90	0.30
Chemicals manufacturing	3. 70	0.55
Chemical fibers manufacturing	2.80	0.35
Non-metallic mineral products	2.65	0.35
Iron and steel smelting and pressing	3. 50	0.50
Power generation and heating	2. 00	0.30

Water Entitlements and Trading WET (Australia)

From Dr. Rick hardiman, Truman centre for Peace HUJI

Water Entitlements and Trading WET

- Water rights are allocated to Administrative Areas (AAs)
- Certain amount of water must be reserved for 'Environmental Flow'
- Issue Water Extraction Permit
- Remaining water volume can be used or sold to other AAs
- **Funds collected can be used to invest in upgrading water distribution system e.g. irrigation, pollution etc and therefore save on water**
- Hence agric./household/industry will not suffer

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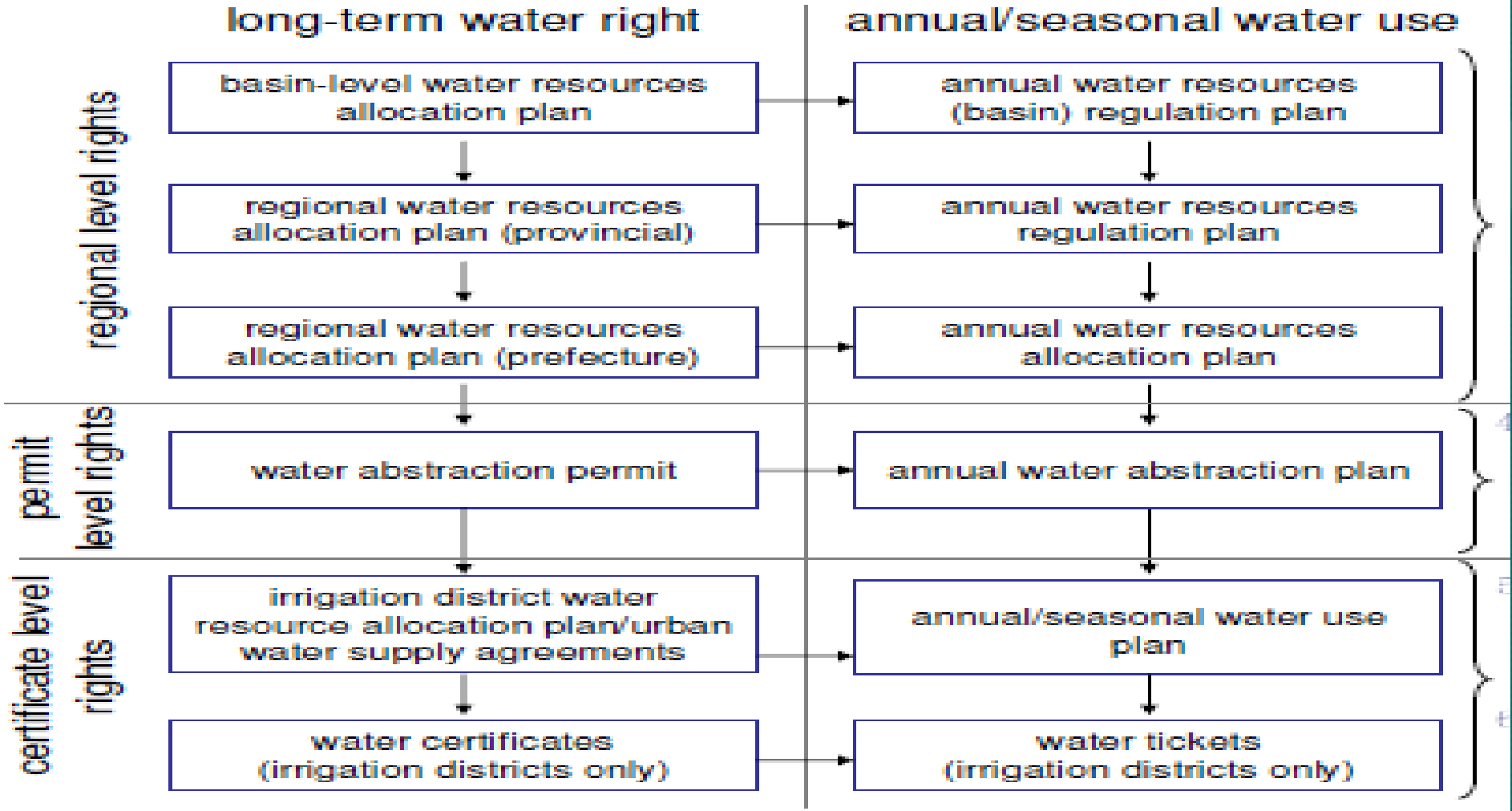
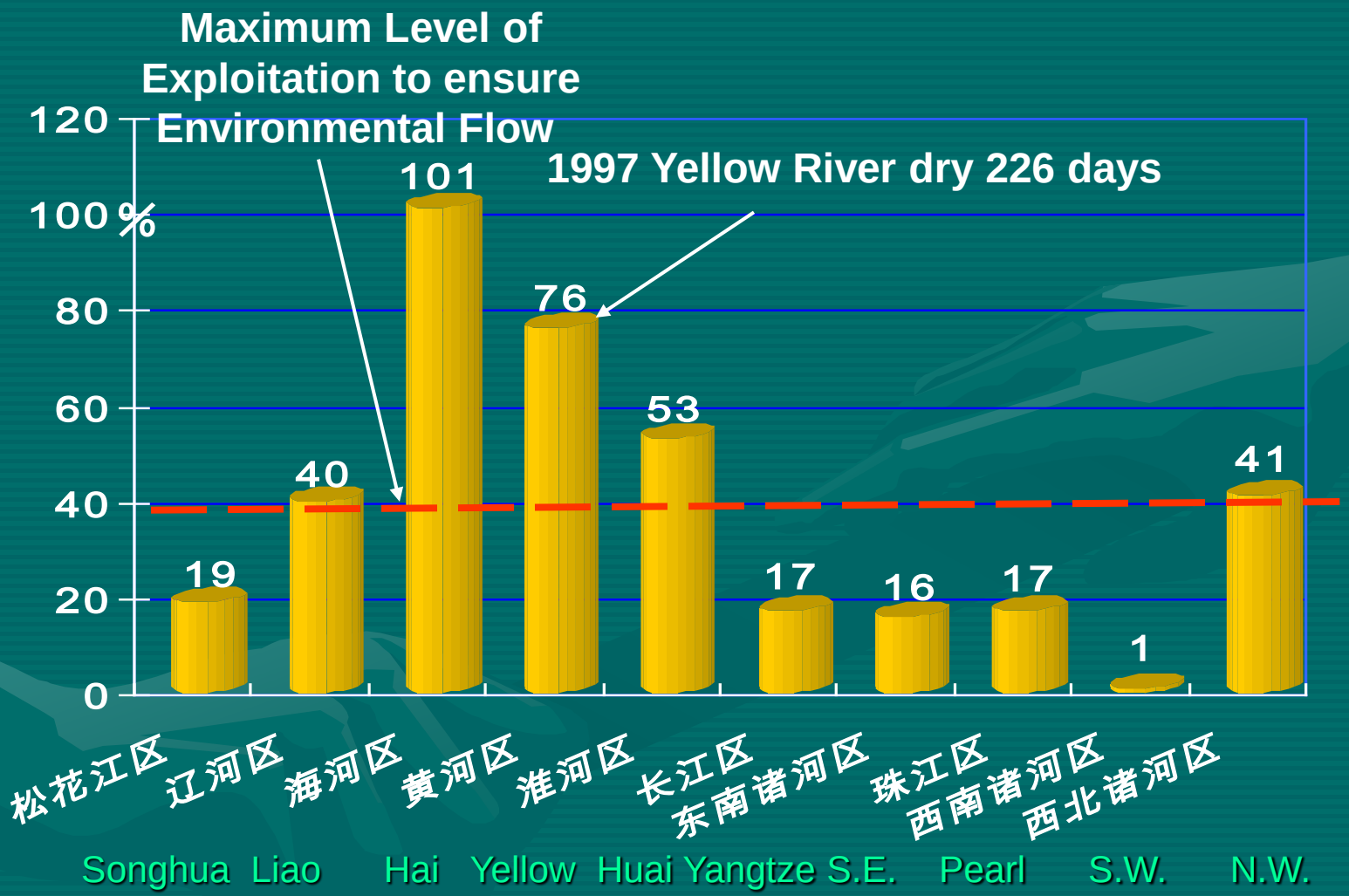
Availability for trade = Total volume of flow – Environmental flow – AA water demand



Environmental flow



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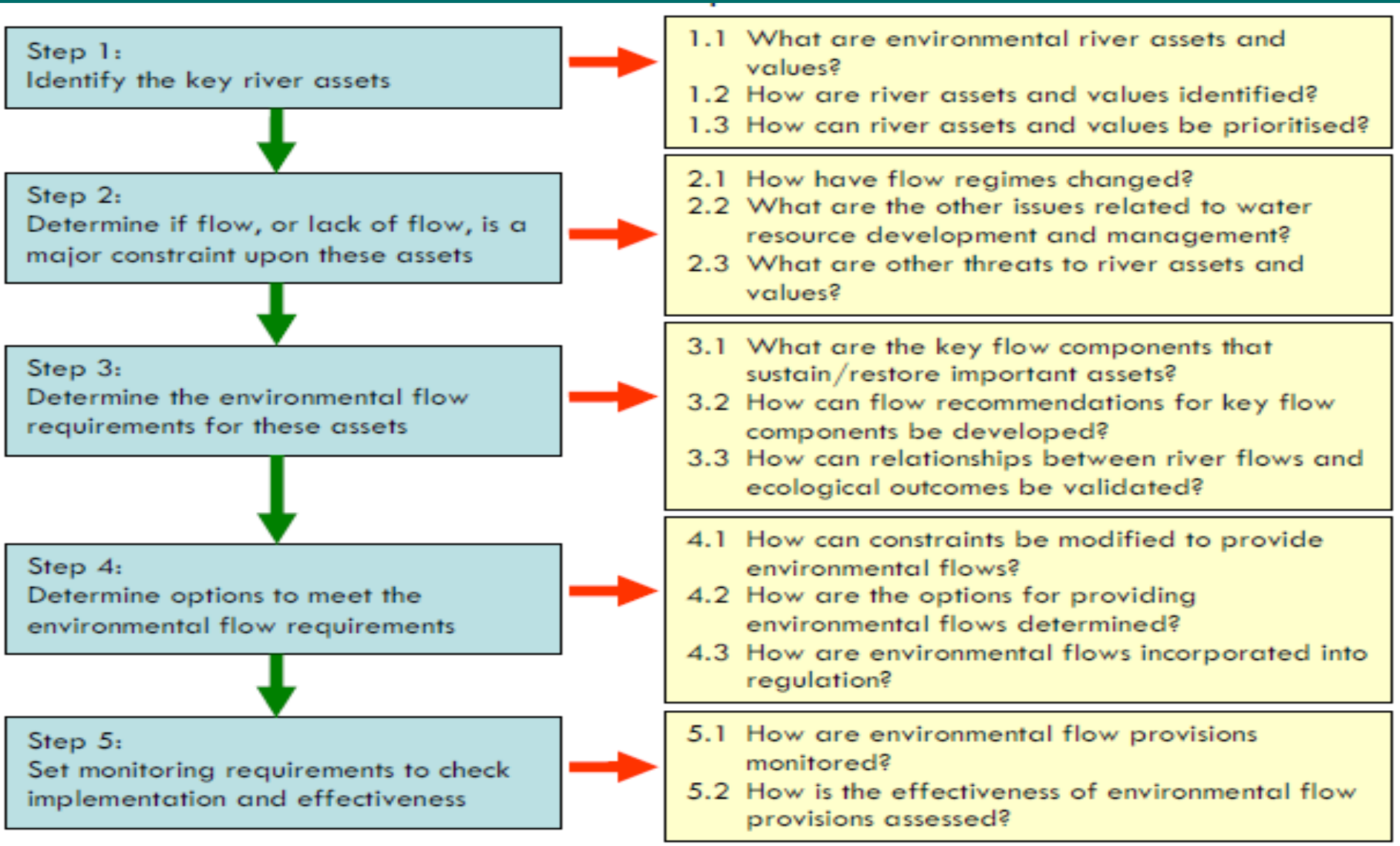
Environmental Flow



Environmental flow (40%)

Maintaining basic river function:

- drying-up,
- water for self-purification,
- flushing sediments
- survival of aquatic species
- flow to lakes and wetlands
- flow at river mouth (includes water demand for flushing, sediment, protect harbour, diluting salt water and preventing tide, protecting species at river month.

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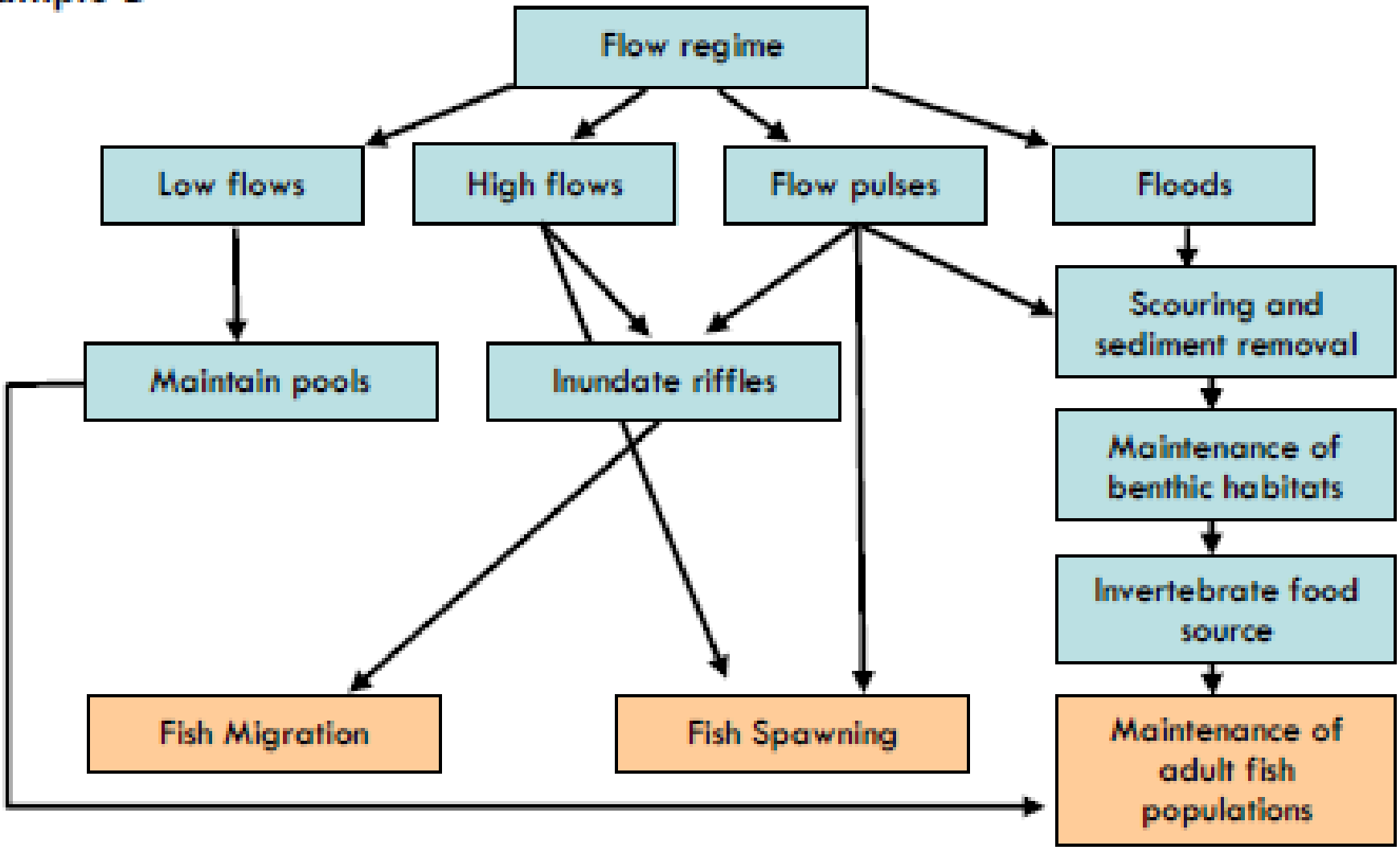
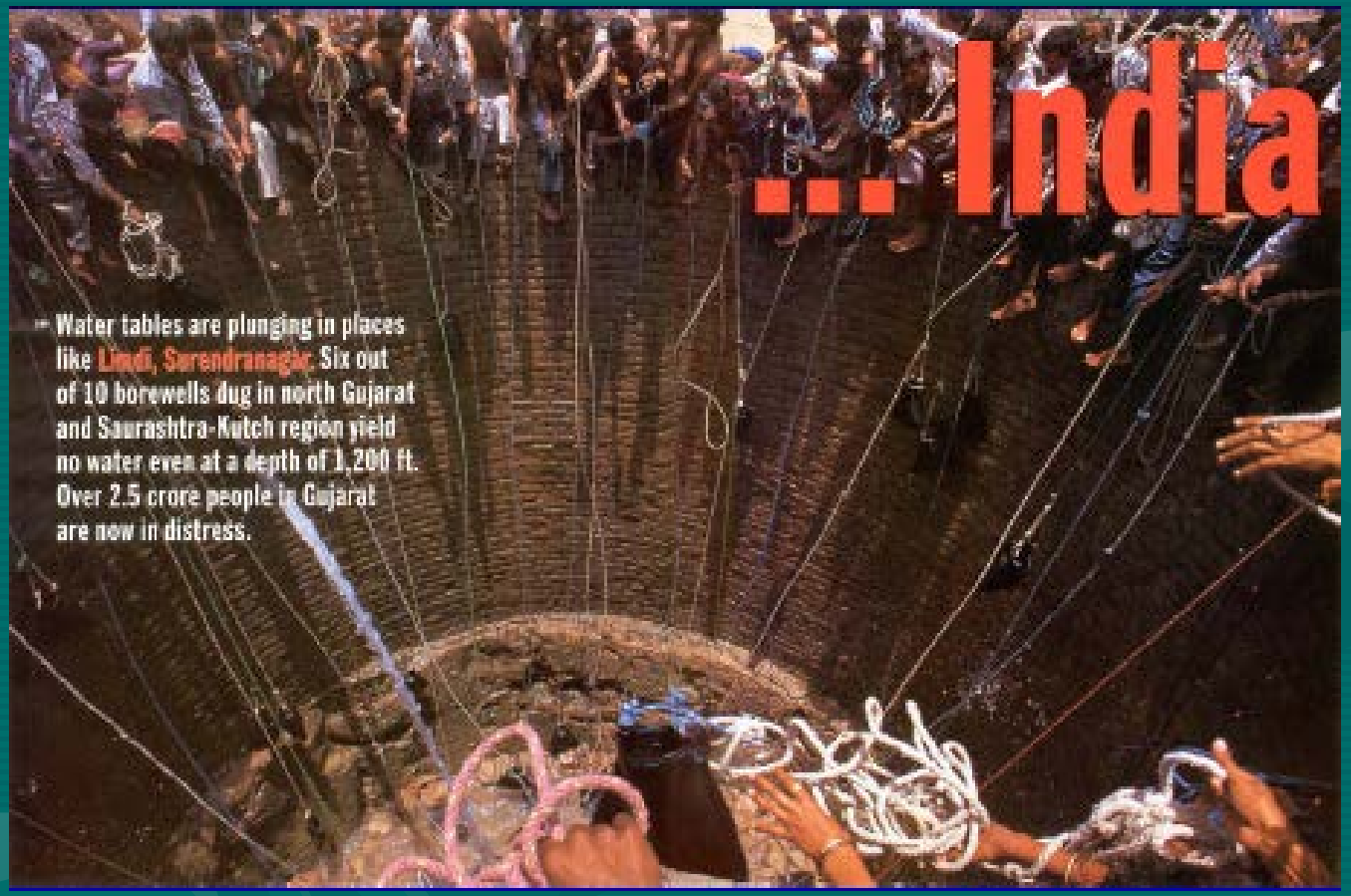
Example B



Conceptual flow diagram of the influence of flow on fish. Low flows maintain critical deep pool habitats for large bodied species during the dry season. High flows during the wet season maintain fish passage over riffles. High flow pulses trigger fish spawning and migration. Pulses and floods maintain river habitats and, scour and remove sediments for benthic invertebrates food sources.

Groundwater



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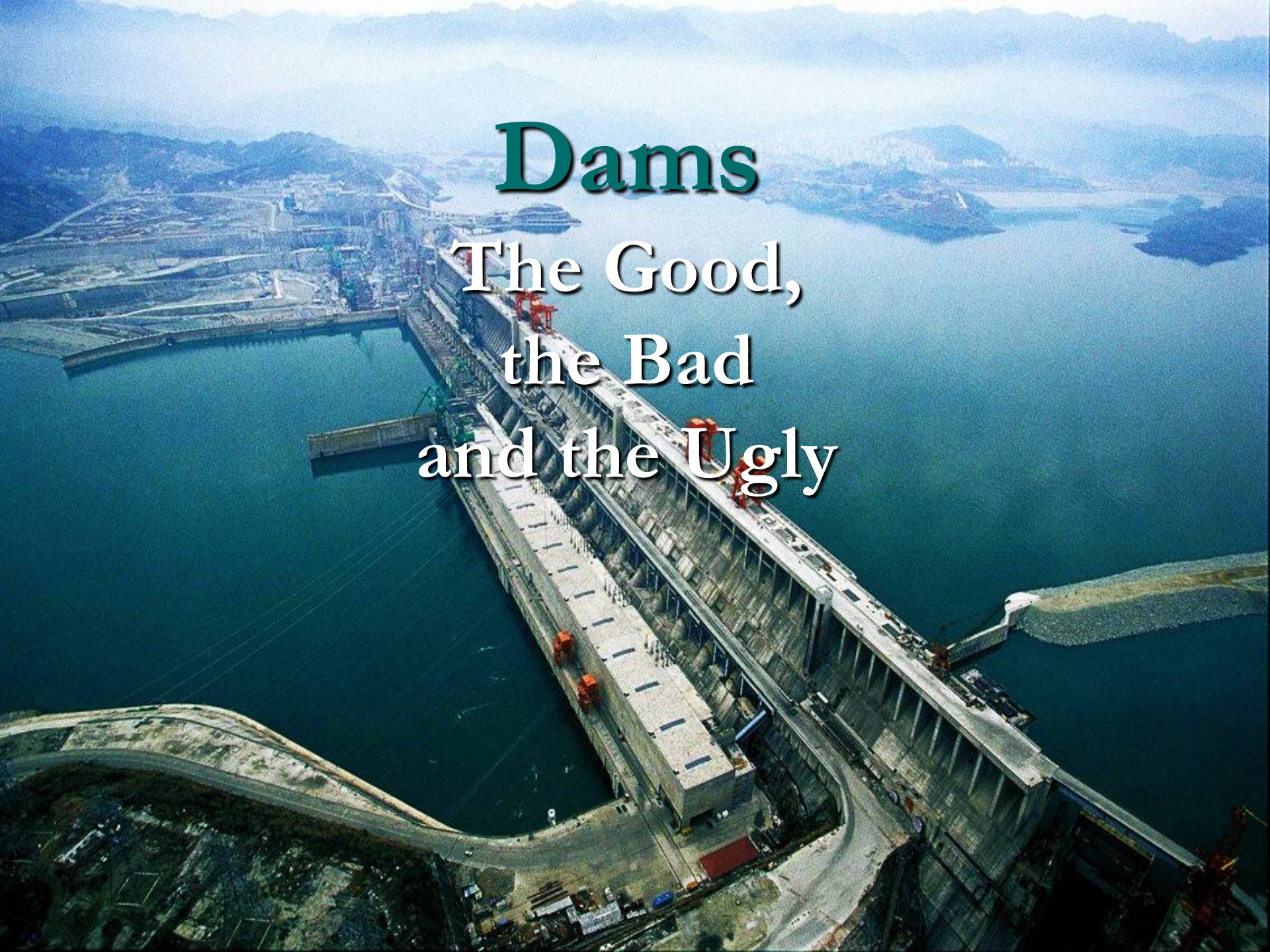
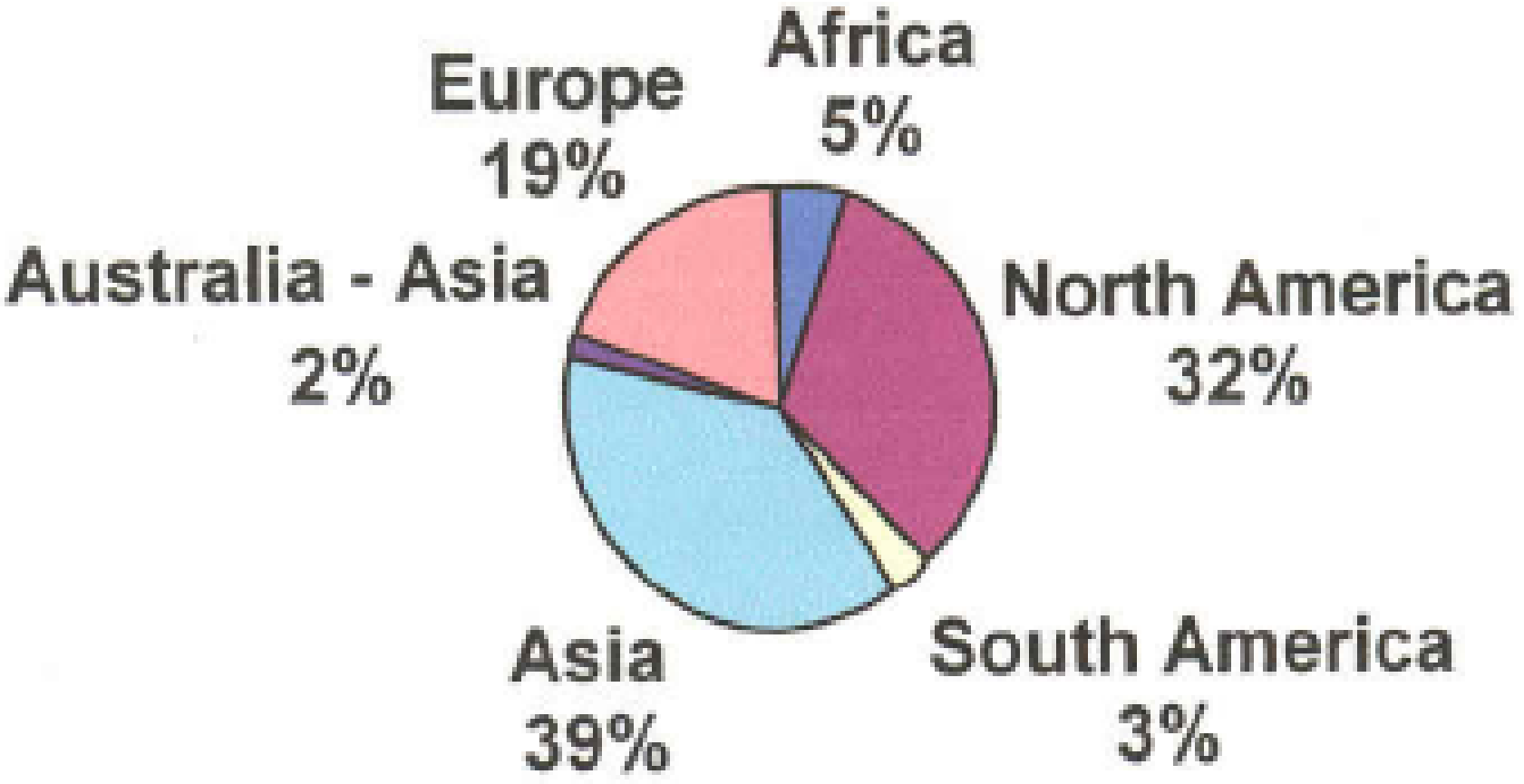
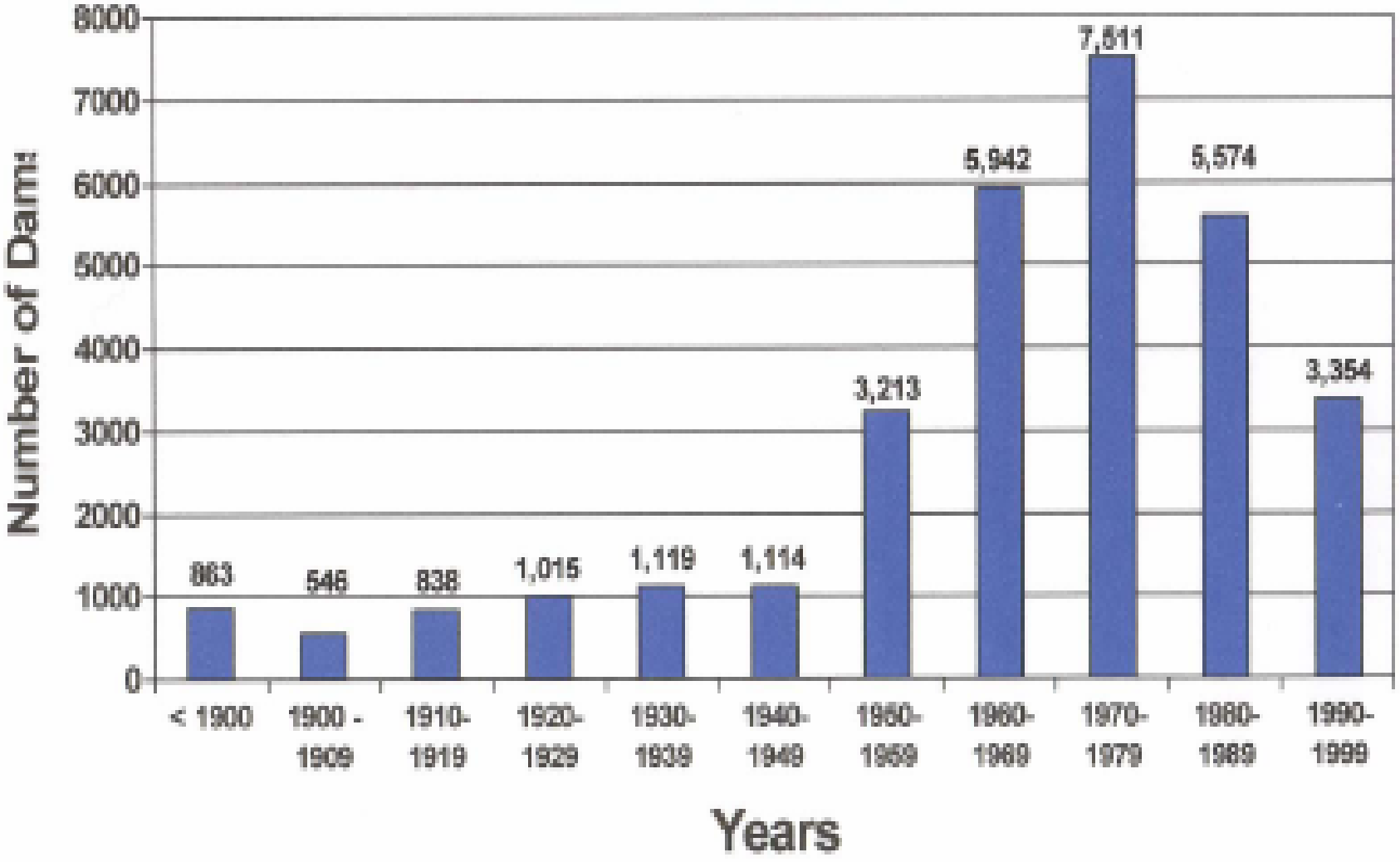

Dams
The Good,
the Bad
and the Ugly

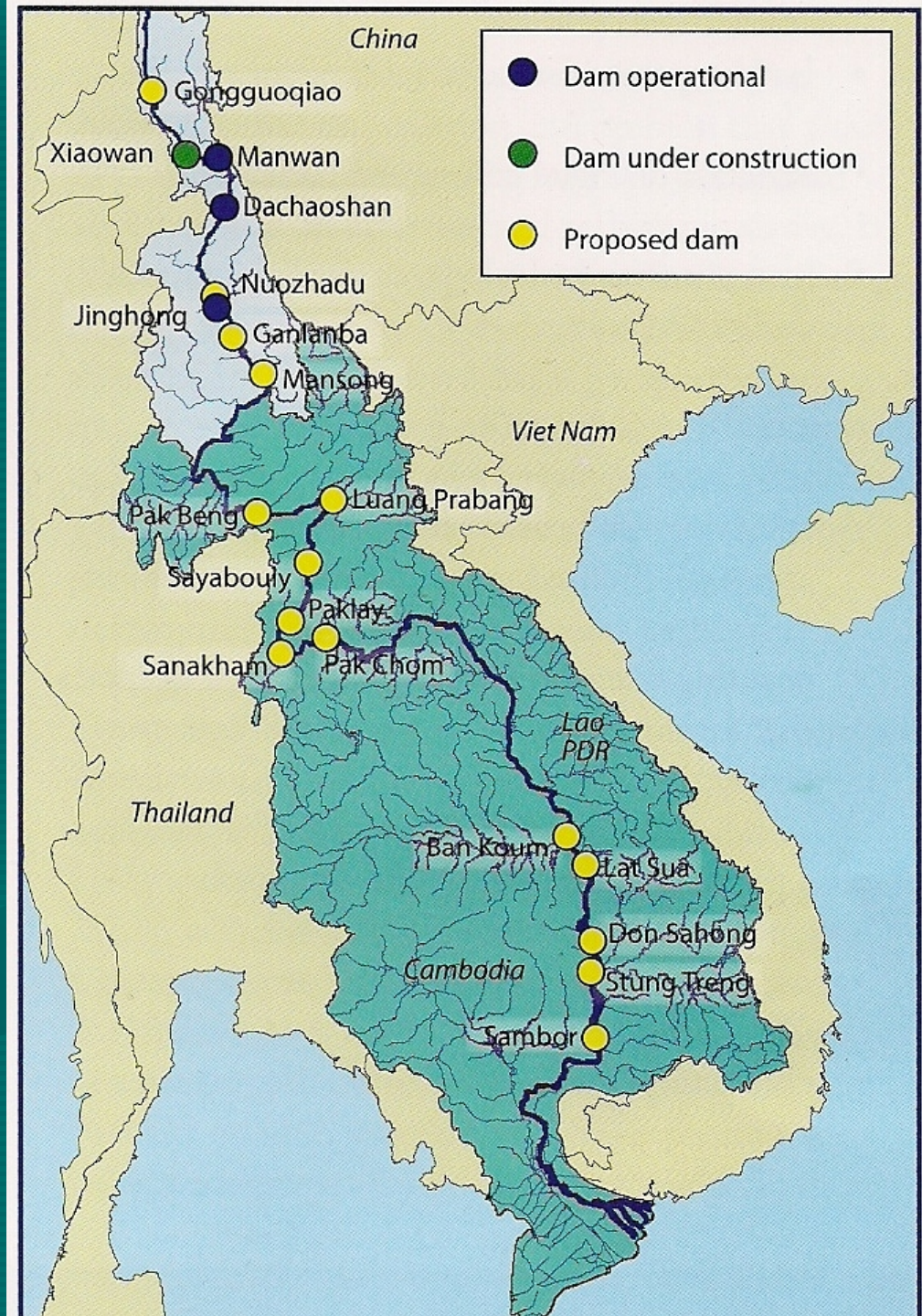
Distribution of Large Dams by Geographical Area

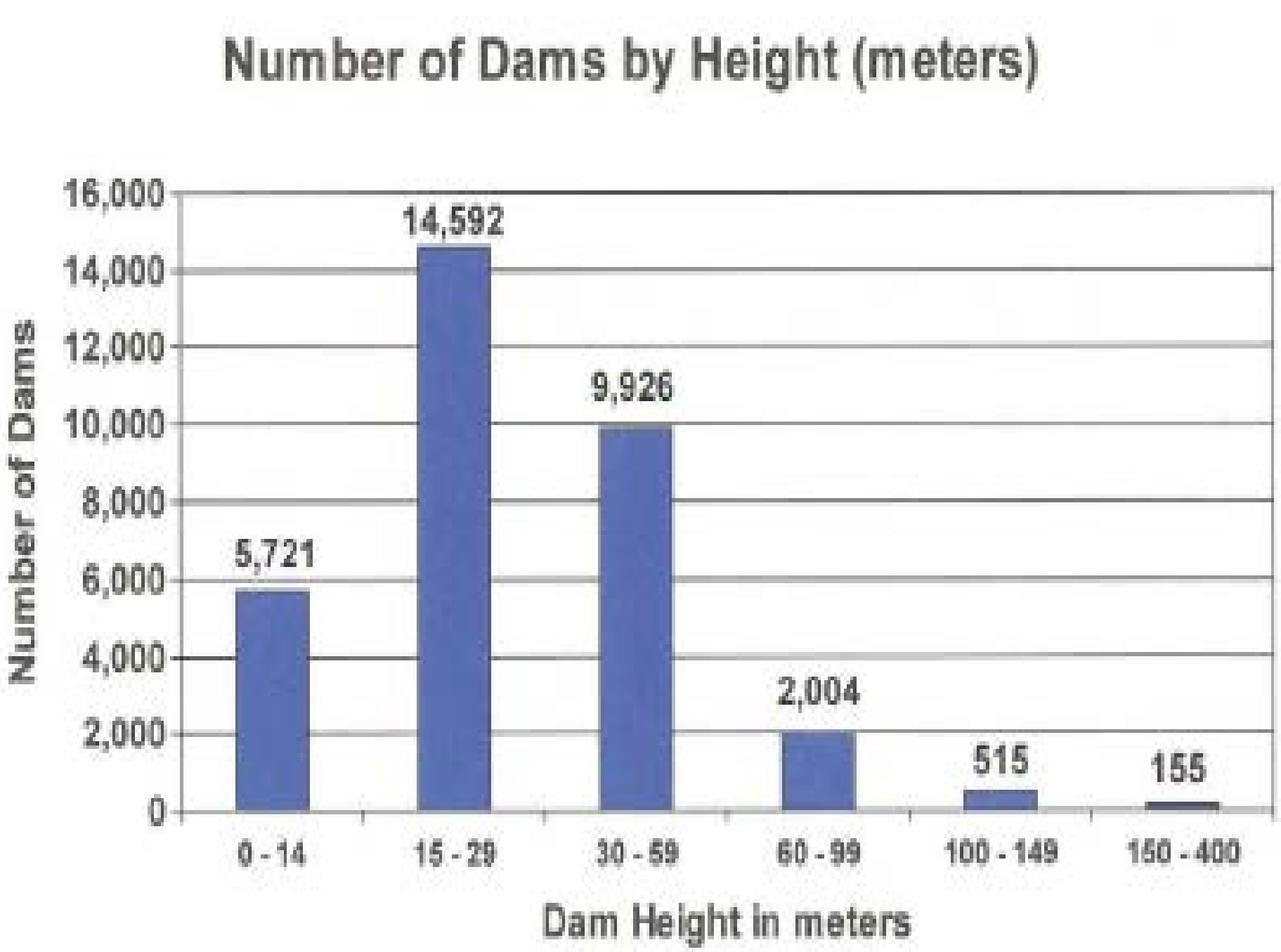


Dams Placed into Operation by Decade



Let's Dam the Mekong




Number of Dams by Height (meters)
Number of Dams
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
14,592
9,926
5,721
2,004
515
155
0 - 14
15 - 29
30 - 59
60 - 99
100 - 149
150 - 400
Dam Height in meters

The Benefits We Receive From Dams

- **Water supply** – domestic, agricultural & industrial
- **Flood control**
- **Hydropower**
- **Inland navigation**

Recreation is usually included in all projects

Miaohe village – leaving home

Dams and the Environment

"A balance is needed"

So… what to do??

- Use combination of policy, economics and technology
  - Agriculture – increase efficiency
  - Industry – reduce pollution
  - Use water tariffs and private enterprise
- Desalination??

From Dr. Rick hardiman, Truman centre for Peace HUJI