BIOENERGY IN WATER- SCARCE COUNTRIES

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WELCOME TO PLANET "OCEAN"

- 70% of the Earth's surface is water
- 97.5% of the Earth's water is salt water
- 2.5% is fresh water
- 70% of fresh water is ice
- 29% of fresh water is in the soil or deep aquifers
- <1% of fresh water is accessible
  (<0.007%) of all water on earth
- We live "On the Edge"
-

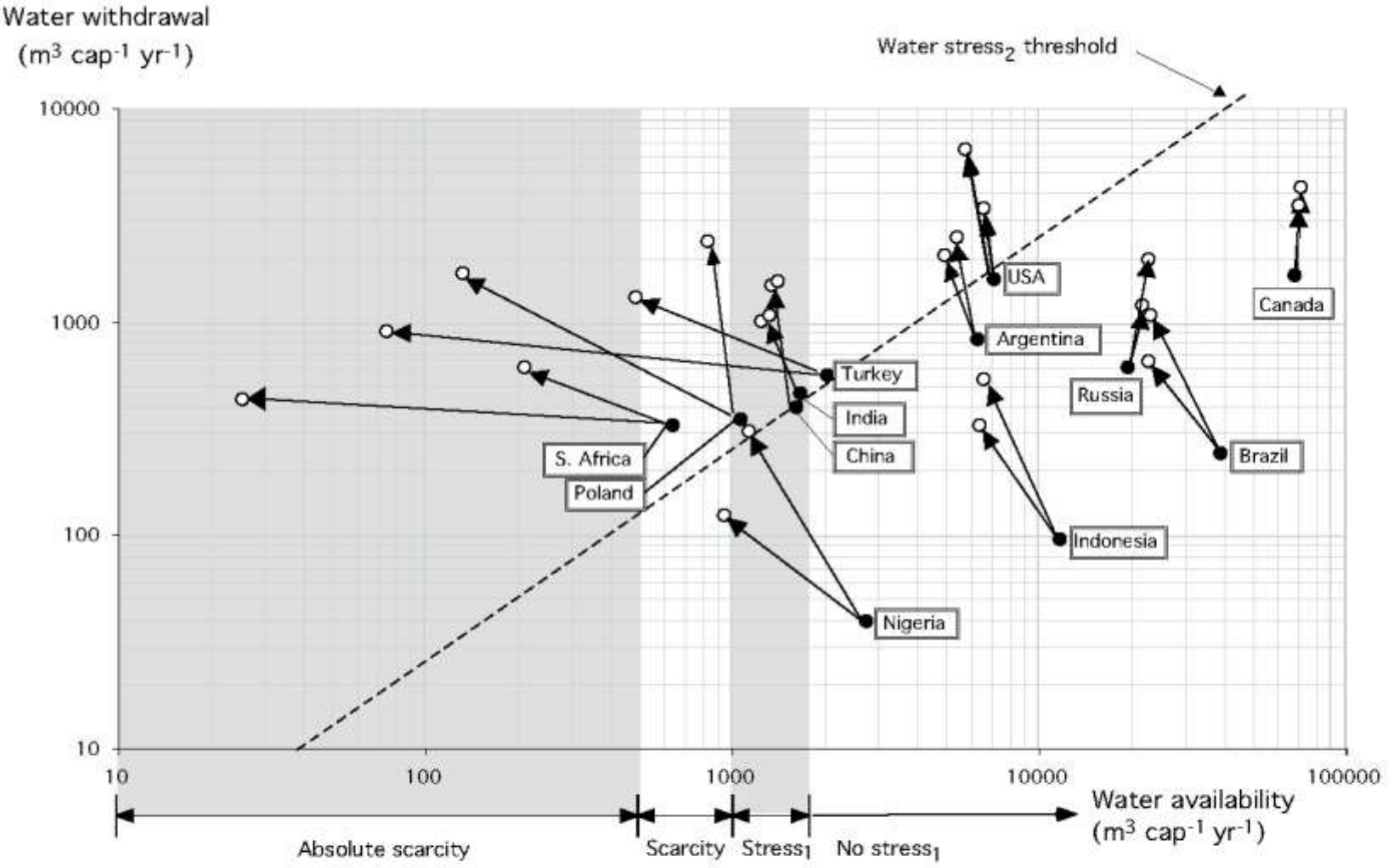
WATER DECISIONS

DOMESTIC &
INDUSTRIAL USE

20-92%

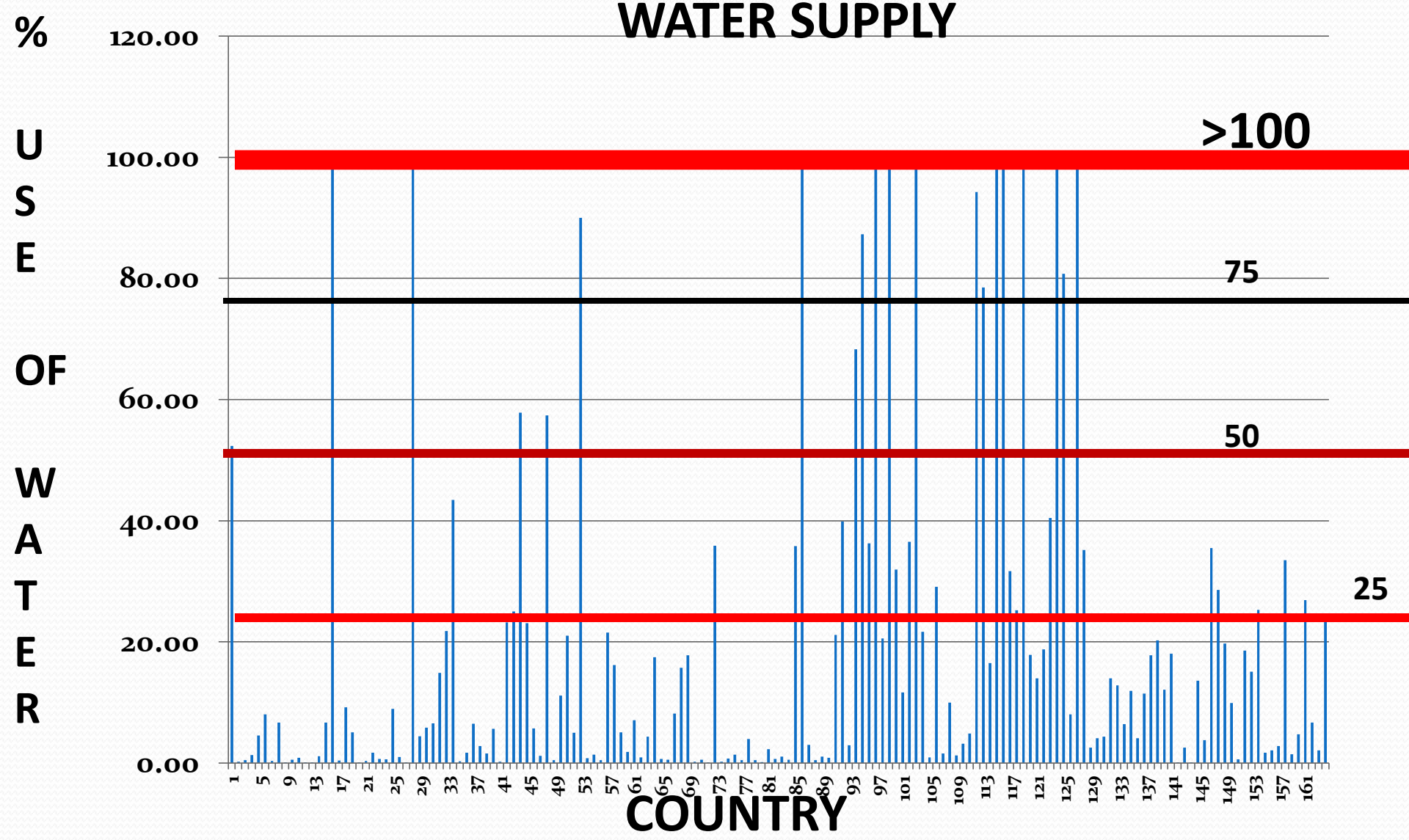
ENERGY CROPS

FOOD CROPS



Berndes 2002

WORLD WATER USE AS A PERCENT OF RENEWABLE WATER SUPPLY



OBJECTIVES

1. EXAMINE TO TOPIC OF “WATER SCARCITY”
2. PRESENT SOME EXAMPLES OF BIOENERGY IN WATER SCARCE COUNTRIES

WATER SCARCITY

WATER SCARCITY DEFINED BY THE FOLLOWING:

- Arid or semi-arid climates
- Prolonged drought
- Withdrawals exceed supply
- Poor geographic distribution
- Exploding human population
- Poor water quality

WATER- SCARCE COUNTRIES

FALKENMARK 1989; RASKIN et al. 1995

ABSOLUTE WATER SCARCITY = 18 (<500 m^3/p)
WATER SCARCITY = 7 (500-1000 m^3/p)
WATER STRESS = 13 (1000-1700 m^3/p)

ARID AND SEMI-ARID CLIMATES

SEMI-ARID AND ARID COUNTRIES

- 35 COUNTRIES
- 70 to 700 mm PPT (179 mm)
- 41 TO 99% WATER USE FOR AGRICULTURE
- CRITICAL WATER SCARCITY
- % FOREST 0.0 TO 13.5
- POPULATION 0.8 TO 84.5 M

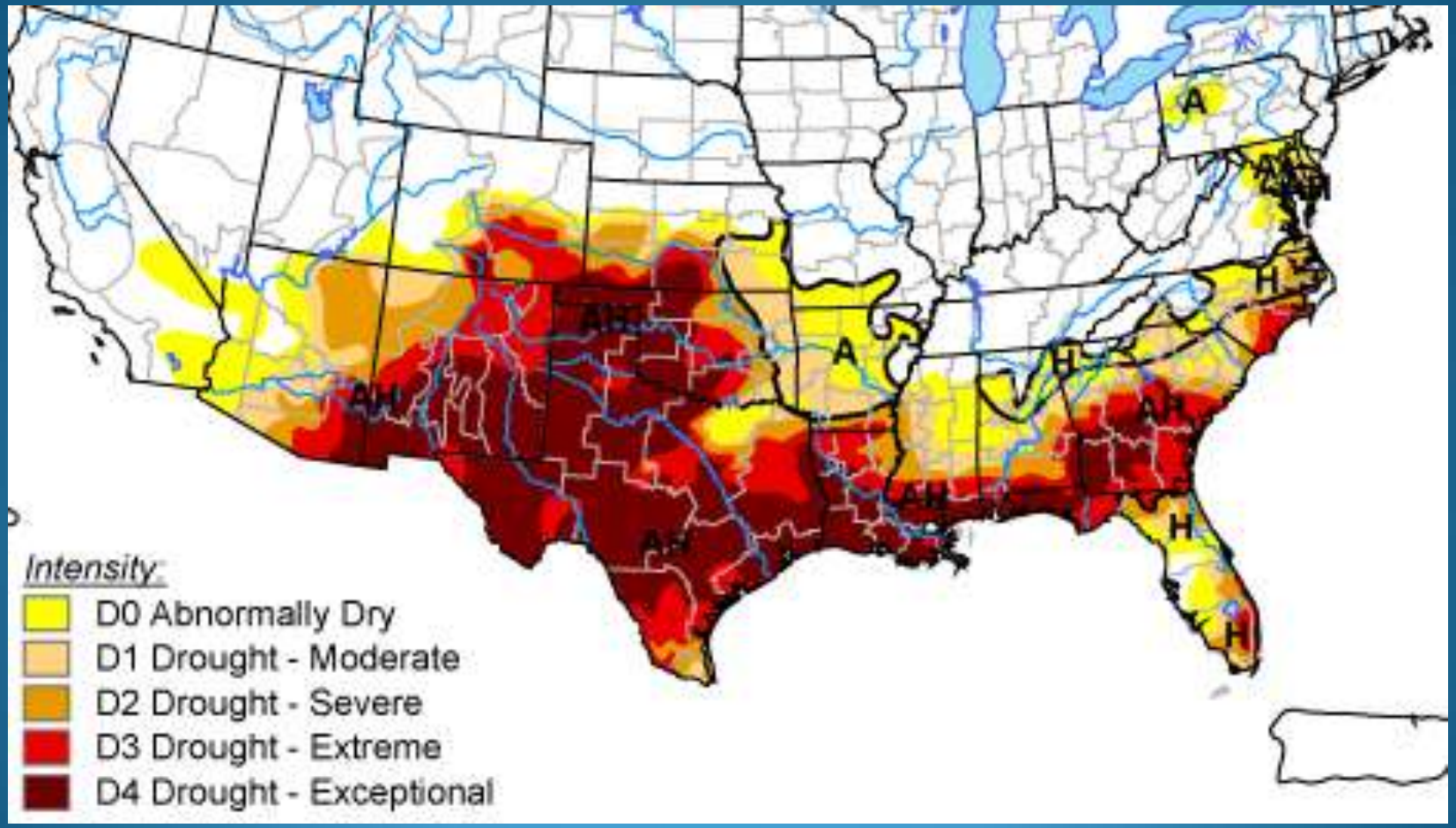
  TOTAL OF 726.4 M PEOPLE

MIXTURE OF CLIMATES
DESERT TO HUMID

- CHINA
- USA
- AUSTRALIA
- MEXICO
- INDIA
- PAKISTAN
- CHILE
- PERU
- OTHERS

PROLONGED DROUGHT

USA DROUGHT 2011



TEXAS WATER NEEDS

CURRENT NEEDS = 22.2 km^3

CURRENT SUPPLY = 20.1 km^3

2060 ESTIMATE =27.1 km^3

PROJECTED 2060 SHORTFALL = 10.2 km^3

WITHDRAWALS EXCEED SUPPLY

THE WORLD'S WATER

- SOURCE: http:www.worldwater.org/data.html

- BERNDES 2002 *Bioenergy and water – the implications of large-scale bioenergy production for water use and supply*

- COUNTRIES > 25 % WATER STRESS THRESHOLD = 36
- COUNTRIES > 50% = 20
- COUNTRIES > 75% = 17

- **COUNTRIES IN ABSOLUTE DEFICIT = 10**

COUNTRIES IN ABSOLUTE DEFICIT
(WITHDRAWALS > RENEWABLE SUPPLY)

- ALGERIA
- EGYPT
- LIBYA***
- BAHRAIN***
- ISRAEL
- JORDAN
- KUWAIT***
- QATAR***
- SAUDI ARABIA***
- YEMEN

*** = SIGNIFICNANT OIL RESERVES

POOR GEOGRAPHIC DISTRIBUTION

CHILE

ATACAMA DESERT

PATAGONIA

SOUTHWEST USA

SONORAN DESERT

SALT RIVER PROJECT

- SALT & VERDE RIVERS
- STARTED 1903
- WS AREA: 33,699 km^2
- 6 DAMS
- 232 Mw HYDROPOWER
- FLOW: 1.2 km^3
- RANGE: 30% OF MEAN TO 3,000%

Lake Roosevelt, Arizona

1st Western USA Water Supply Dam

RESERVOIRS + & -

Glen Canyon Dam

Colorado River

- + STORE WATER DURING DROUGHT
- - EPISODIC FLOODS, CAN'T STORE IT ALL
- + GENERATE CLEAN POWER
- - EXPENSIVE $$$ €€€ £££
- - ALTER ECOLOGICAL FLOWS
- - RAPID SEDIMENTATION
- - CATASTROPHIC FAILURES
- + & - RIPARIAN HABITAT CHANGES
- - HUMAN DISPLACEMENT

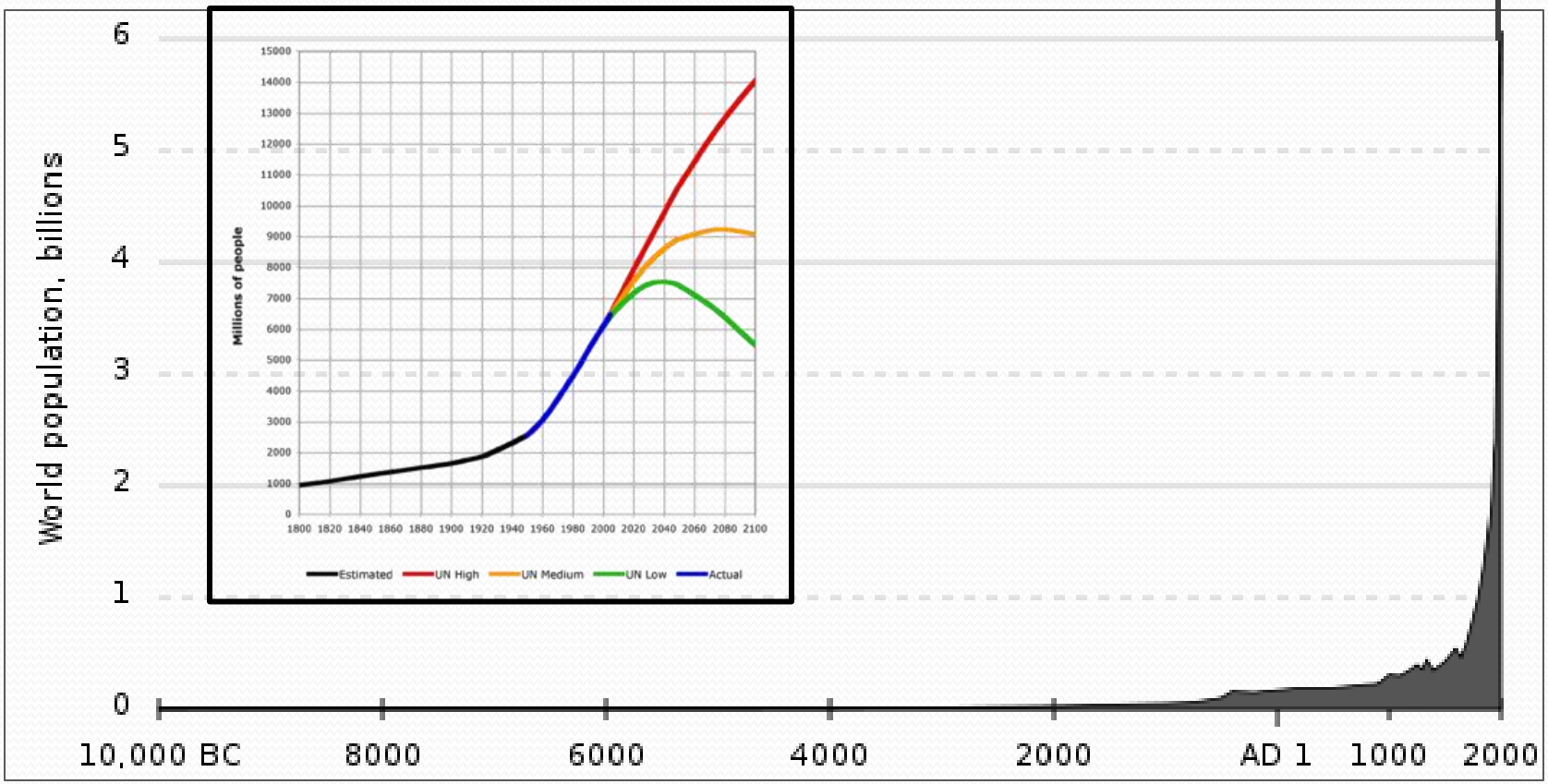
AQUADUCTS

- **COLORADO RIVER AQUADUCT**
- **292 km Canal**
- **Colorado River to Los Angeles California**
- **1.6 km^3 Volume Delivery**
- **High Evapotranspiration Losses**
- **Interbasin Water Diversion**
- **Salinity Problems**
- **Leaks**

ARAL SEA DISASTER

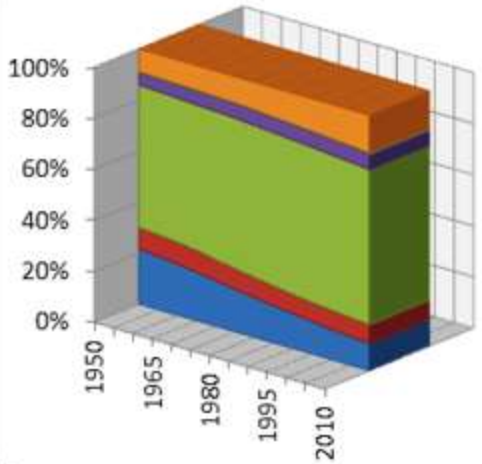
POPULATION GROWTH

OCTOBER 31, 2011 = 7 B



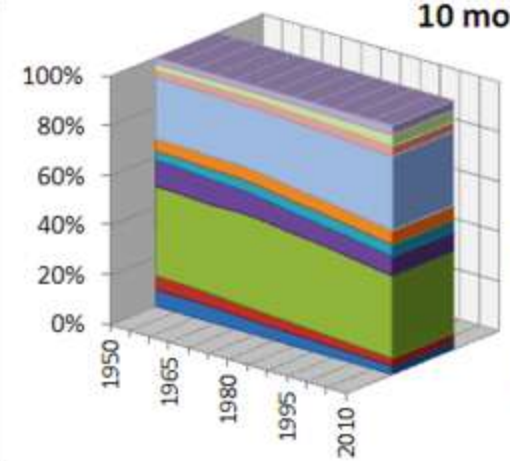
POPULATION GROWTH = INCREASED DEMAND FOR WATER, FOOD, & ENERGY

Share of Population from 1950 to 2010 & Population Growth in the 2000-2010 Decade



Continents

- (26.1%) #2 Africa
- (15.0%) #6 Oceania
- (13.2%) #5 South America
- (12.7%) #1 Asia
- (10.4%) #4 North America
- (00.8%) #3 Europe

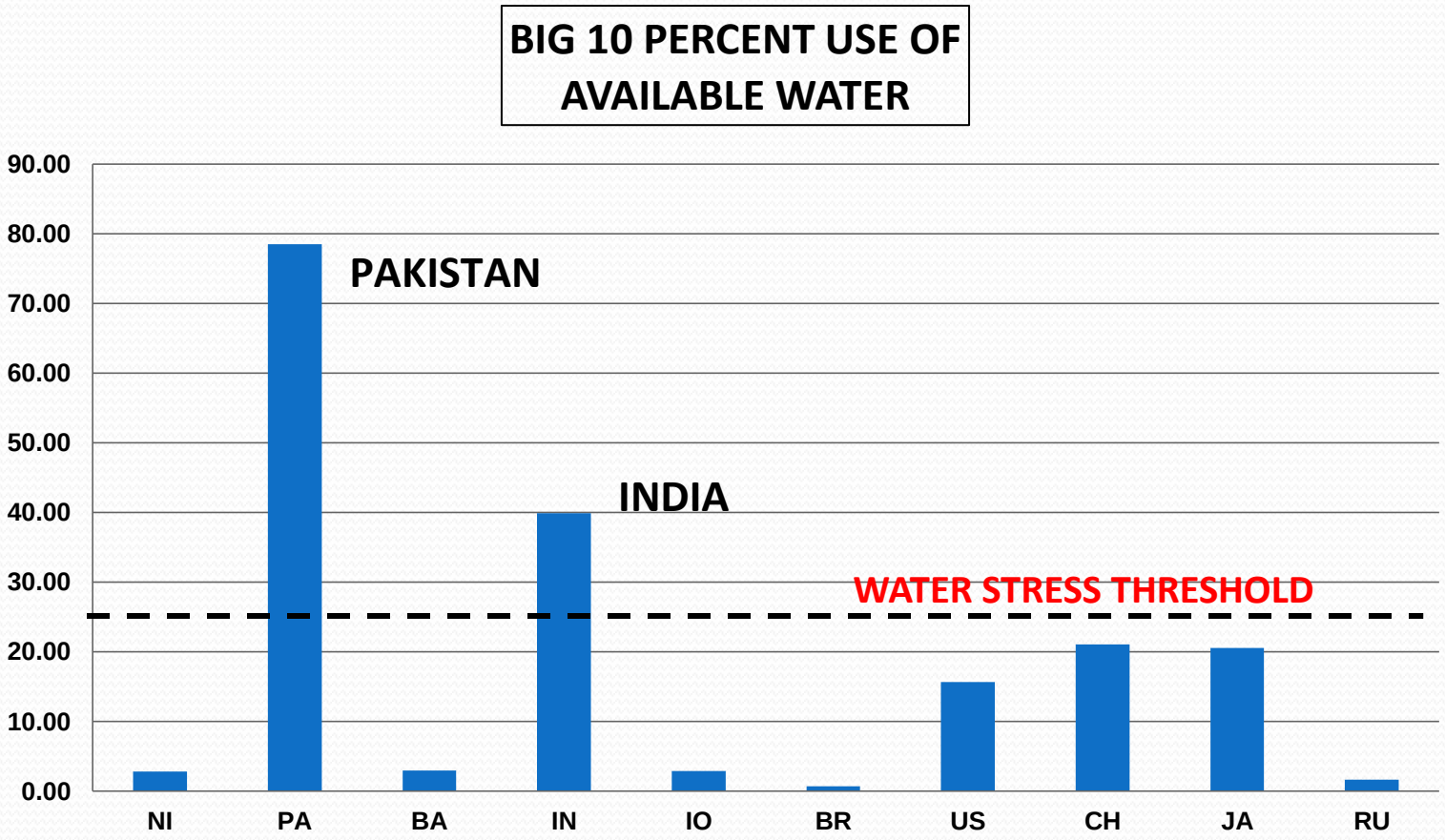


10 most populated countries

- (26.8%) #8 Nigeria
- (24.7%) #6 Pakistan
- (16.8%) #7 Bangladesh
- (16.5%) #2 India
- (13.3%) #4 Indonesia
- (12.2%) #5 Brazil
- (10.4%) #3 United States
- (06.9%) #1 China
- (00.2%) #10 Japan
- (-4.3%) #9 Russia

Source: Department of Economic and Social Affairs, United Nations Population Division (UNPD). 2010. Available on-line at: http://esa.un.org/unpp/

POPULATION GROWTH

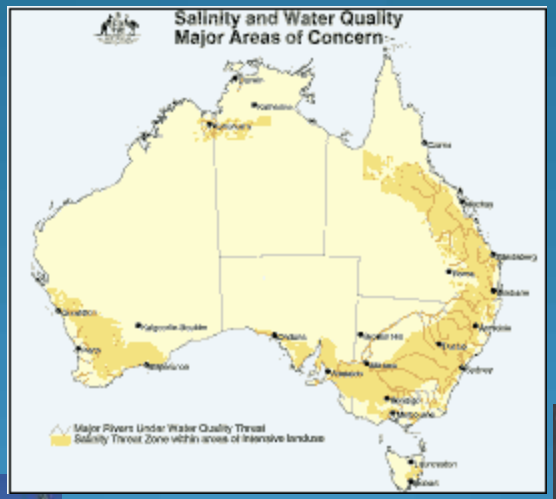


KHAN & HANJRA 2009

POOR WATER QUALITY

WATER QUALITY

- **MAJOR ISSUES**
  - **SALINITY**
  - **NUTRIENTS**
    - **NITROGEN**
    - **PHOSPHORUS**
  - **TURBIDITY**


Salinity and Water Quality
Major Areas of Concern
Major Rivers Under Water Quality Threat
Salinity Threat Zone within areas of intensive landuse

SALINITY


National Library of Australia

WATER QUALITY

- **SALINITY**
  - Major Problem in Western Australia
  - Conversion of Malee to Wheat
  - Precipitation Decline
  - Natural Salt Loading

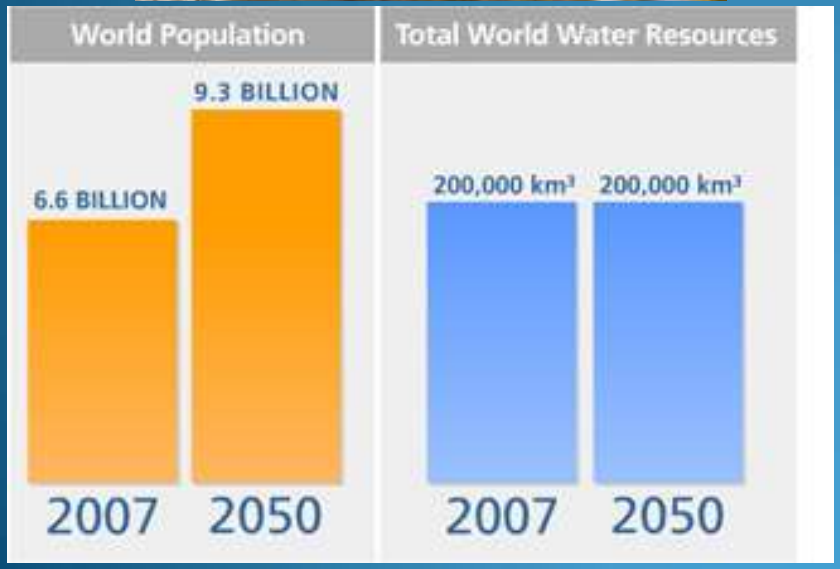
WATER QUALITY

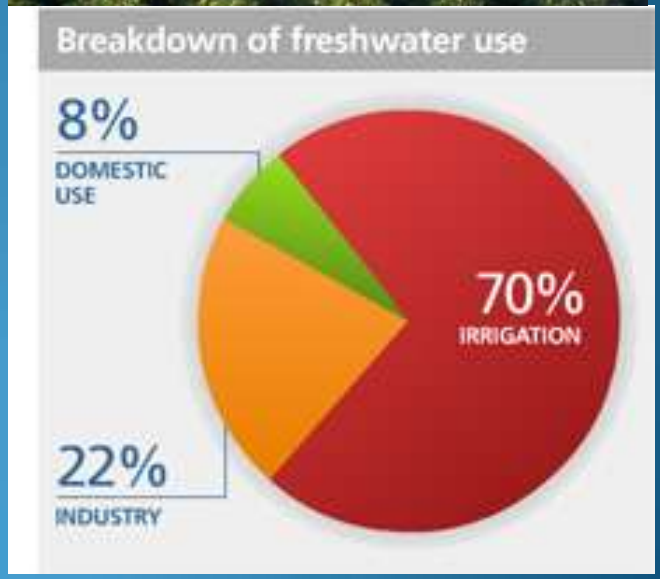
- Turbidity
  - Overgrazing a Problem During Droughts

RESPONSE TO WATER SCARCITY

- Groundwater mining
- Reservoir construction
- Increasing irrigation efficiency
- Inter-basin transfers
- Water reuse
- Desalinization
- Fixing leaks

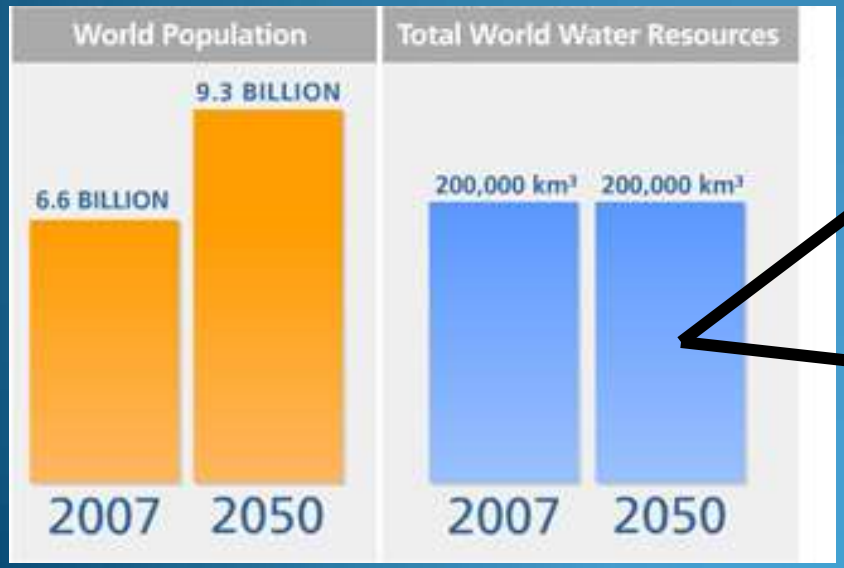
WATER IN THE 21ST CENTURY





CLIMATE CHANGE & WATER DISTRIBUTION

DRIER DRYS & WETTER WETS



BIOENERGY IN WATER SCARCE COUNTRIES

ARID & SEMI-ARID FOCUS

BACKGROUND

- Many Middle East countries that are water scarce have a dominant role in global petroleum energy supplies.

- But fuelwood and charcoal are also a major source of energy in their rural households (>50%)

- About 66% of the wood in the region is used for fuel, compared to the global average of 40%

- Forests in semi-arid & arid countries range from 0.0 (Bahrain) to 21% (Iran) with an average of 6.4%

BACKGROUND

- **RENEWABLE ENERGY SOURCES IN PERCENT**

Yemen	**1.1**
Egypt	**2.2**
Morocco	**3.1**
Turkey	**5.1**
Tunisia	**13.6**
Pakistan	**33.9**
Sudan	**72.8**

SOURCE: WORLD BANK 2010

BACKGROUND

- In water scarce countries, combustible renewable and waste use amounts to 1.1 to 72.8% with most <10%. Emphasis on agricultural, industrial, & municipal wastes.

- Bagasse potential availability, thousand dry tonnes

Egypt	1,902
Morocco	138
Sudan	1,063
Pakistan	8,135
Iran	660

BIOENERGY

- **EGYPT: Potential**

Municipal solid waste = 2.4 million tonnes
Sugar cane bagasse = 1.4 million tones
Ethanol production capacity = 456.25 TJ/yr
Biodiesel production capacity = 22.83 TJ/yr
Forestry/wood processing = 1.2 million tonnes
Cotton stalks = 1.2 million tonnes

- SOURCE: *World Energy Council 2010*

BIOENERGY

- **EGYPT: Potential**

Rice straw = 3.4 million tonnes
Food processing waste =2 million tonnes
Animal dung = 6 million tonnes
Biogas production capacity = 40 TJ/yr
Sewage sludge = 2.4 million tonnes
Industrial waste = 3 million tonnes

- SOURCE: *World Energy Council 2010*

BIOENERGY

- **JORDAN: Evaluating municipal wastes, sewage sludge, animal manure, crop residues, & oil tree/shrubs (*Jatropha*)**

Potential

Municipal solid waste = 2 million tonnes
Biogas production = 3.6 million cum
Electricity generating capacity = 1 000 kW
Electricity generation = 5 142 MWh

Source: World Energy Council 2010

BIOENERGY

- **OMAN:** Evaluating palm dates for production of 90,000 L/day of ethanol for biofuel

- SOURCE: FAO 2011

BIOENERGY

- **SYRIA:** Evaluating municipal wastes, wood and wood wastes, trees including & oil tree/shrubs (*Jatropha*)

Potential

Municipal solid waste = 4.0 million tonnes

Wood = 0.5 million tonnes

Forestry /wood processing = 0.2 million tonnes

- ***Source: World Energy Council 2010***

BIOENERGY

- **ALGERIA:** **Evaluating municipal wastes, wood & wood waste, urban & agricultural wastes, palm dates**

Municipal solid waste = 5 million tonnes

Forestry/wood processing = 3.7 million tonnes

Urban agricultural wastes = 1.33 million tones

- ***Source: World Energy Council 2010***

BIOENERGY

- **MOROCCO: Evaluating municipal wastes & animal manure**

Potential

Animal dung = 4.00 TJ/yr
Yield of biogas = 0.56 GJ/tonne
Biogas production = 4.00 TJ

***Source: World Energy Council 2010* & FAO 2011**

BIOENERGY

- **ISRAEL:** Approved in 2011 a plan to meet 10% of the nation's energy from renewables

---

210 MW from biogas, biomass, and waste materials by 2014

- *SOURCE: BIOENERGY INSIGHT 2001*

BIOENERGY

- **TUNISIA: Establishing a 500,000 ha oil tree/shrub plantation (*Jatropha curcas & Simmondsia chinensis*) to produce a bio-oil to power cement plants**

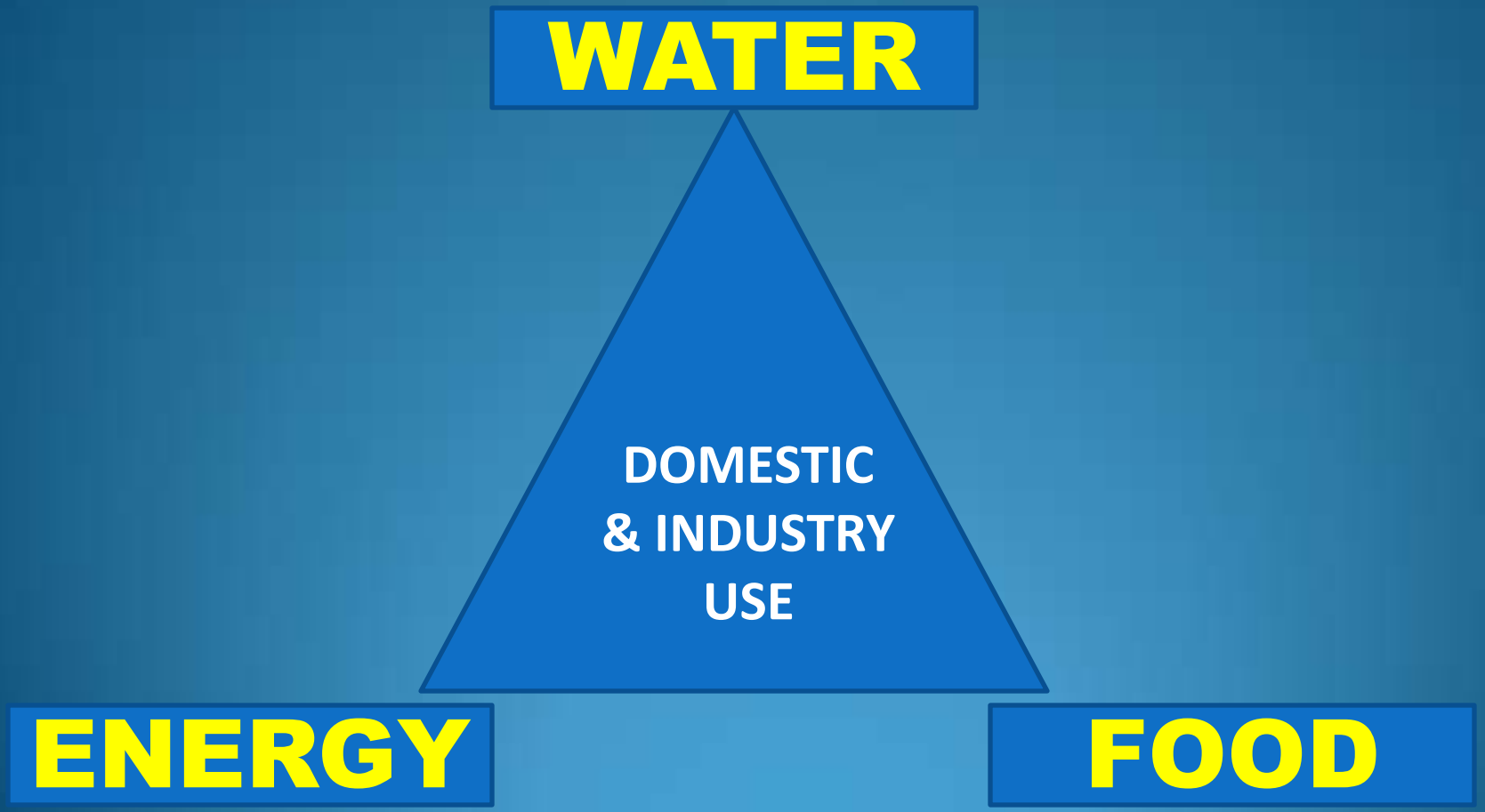
- ***SOURCE: FAO 2011***

BIOENERGY

- **INDIA: Diverse portfolio of fuelwood, agriwaste, forest residues, bio-pellets, bio-diesel, bio-ethanol, bio-oil, & bio-gas**

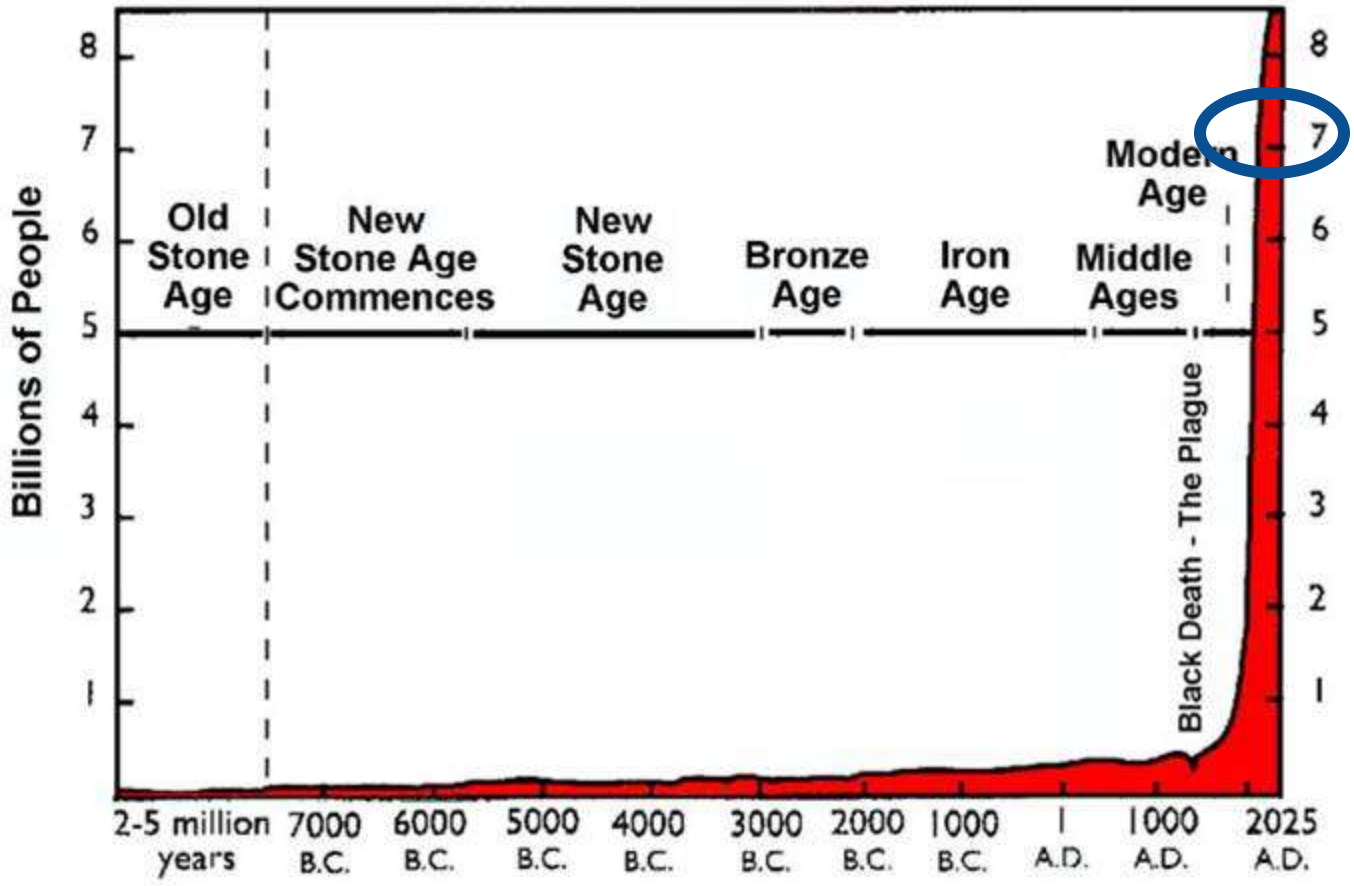
- **7th in the world in energy demand**
- **Imports 70% of its petroleum needs**
- **1,214 M people & growing**
- *SOURCE: FAO 2011*

SUMMARY & CONCLUSIONS



WATER SCARCITY

World Population Growth Through History



From "World Population: Toward the Next Century," copyright 1994 by the Population Reference Bureau

BIOENERGY IN WATER SCARCE COUNTRIES

WATER: THE FUTURE

GREAT LAKE TASMANIA

DARLING RIVER NEW SOUTH WALES

- 47% OF THE WORLD'S POPULATION WILL FACE SEVERE WATER SHORTAGES BY 2030
  "*OECD*"

- WATER IS THE NEW OIL

  "*T. BOONE PICKENS*"

  BUSINESS WEEK 6/23/08

SIDEBAR TRIVIA QUESTION

- **WHAT CAUSES THE MOST MORTALITY OF CHILDREN WORLD-WIDE?**
  - **Crocodiles**
  - **Communicable Disease**
  - **AIDS**
  - **War**
  - **Trauma**
  - **Dirty Water**

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THE END