

September 25, 2011

# Climate Change and Growth: Will There Be Enough Water?

## **A. What do we know about likely impacts on water?**

1. Higher temperatures and faster evaporation
2. Drought periods and flooding events more likely
3. Less groundwater recharge (big storms)
4. Less glaciers storage of water (melting glaciers)
5. Growth in population and income mean increases in water demand (Figure 1)

# Figure 1

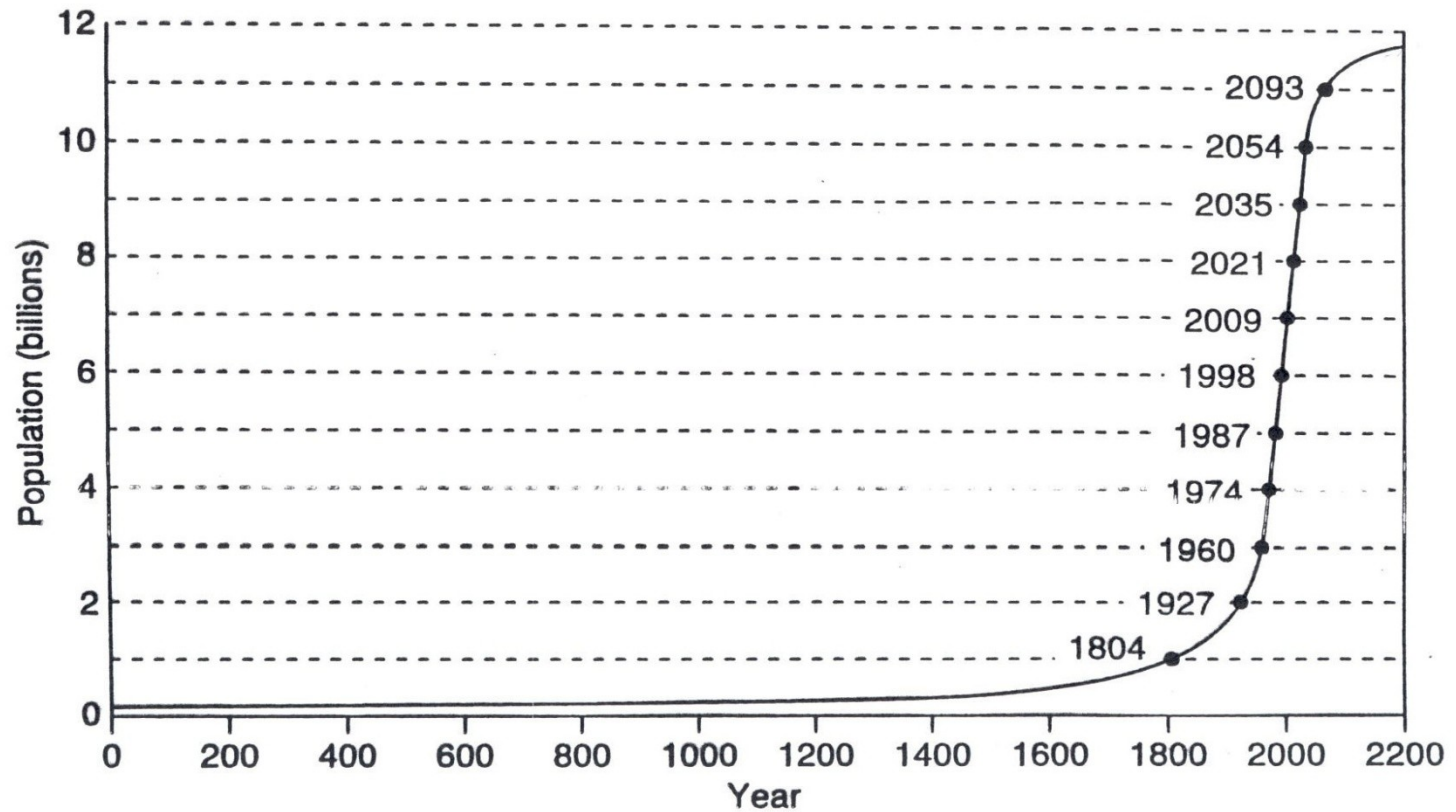


Fig .1 World population: actual and projected (source: Population Division of the United Nations Secretariat; graph adapted from one published in *The Independent* newspaper).

## **B. What problems does this raise**

1. This raises growing concerns about water security for domestic uses, food production, energy production and environmental protection.
2. Major water investments needed ranging from flood protection to stabilizing urban water supplies.
3. Need to reallocate water to its higher valued uses and encourage water conservation become critical.

## C. Water requirement to obtain more Energy

### 1. For cooling

#### a. Water used per unit of energy

Nuclear power 3,140 liters/mwh\*

Coal 2,840 liters/mwh

Natural gas 2,270 liters/mwh

#### c. Of total U.S. water withdraws 48% is for cooling (200 billion gallons per day)\*\*

\* megawatt hours

\*\* 2% is consumptive use

## C. Water requirement ...continued

2. For extraction of Natural gas from new sources

- a. Coal bed Methane: pumping groundwater to release methane gas
- b. Shale held natural gas: water plus chemicals forced underground to extract the natural gas

## C. Water requirement ...continued

### 3. Oil from shale

Green River Formation about 800 billion barrels of recoverable oil (western U.S.)

- a. Three barrels of water are needed per barrel of shale oil produced
- b. This puts stress on upper Colorado River basin where shale oil is located. (172.6 million m<sup>3</sup> of water required annually by 2040)
- c. This competes directly with agriculture and environmental services

## C. Water requirement ...continued

### 4. Water for biofuels

- 15 liters of water per liter of ethanol. U.S. may need 542.5 million m<sup>3</sup> of water annually by 2022\*.
- Biodiesel and cellulosic ethanol also will use large amounts of water

\* U.S. Target for biofuels is 20% of transport energy by 2022.



## C. Water requirement ...continued

5. Tar sands use is uncertain in U.S. but extraction in western Canada has contaminated large quantities of water.

- Hot water is used to wash the oil from the sand
- Canada has between 300 and 600 billion barrels of oil in tar sands and oil production is increasing from 2 to 3 million barrels/day\*
- About 25% of U.S. oil imports come from Canada

\* A 50% increase

## C. Water requirement ...continued

6. Hydropower – changes the quantity and timing of water flows.

- a. Can cause summer water shortages by storing water to produce electricity in winter
- b. Kyrgyzstan vs. Uzbekistan (upstream vs. downstream or hydropower vs. irrigation)
- c. In Chile non-consumptive water rights of owners of hydropower dams trump consumptive water rights of downstream irrigators.

# D. Impacts of climate change on agriculture

## 1. Likely to be mixed effects on crop yields

Effect of climate change on cereal production, in million tons, 2020, 2050, and 2080

Region	2020		2050		2080	
	Low Impact	High Impact	Low Impact	High Impact	Low Impact	High Impact
Developed countries	60	-20	120	-65	85	-175
Developing countries	30	-30	55	-115	-10	-250
World	75	-40	140	-155	65	-420

Source: International Institute for Applied Systems Analysis (2009/2010) Biofuels and Climate change: Challenge to food security in the twenty first century. Options winter, pp18-9. Laxenburg, Austria

## D. Impacts ... on Agriculture continued

2. Some relocation of production and crops grown
  - Cropping shifts away from drought prone areas
  - A number of rice producing areas will shift to other crops
3. Rise in uncertainty in yields and prices with some potentially large price increases
  - FAO reported that the food price index hit a historic high of 231 in Jan 2011.\*

\* Index was started in 1990

## D. Impacts ... on Agriculture continued

### 4. Larger impacts from future droughts and floods

- Prairie provinces in Canada lost \$4.5 billion in GDP due to 2001-2 drought
- The Mississippi River flood this year is the second largest in history
- Red River of the North in 2011 set a record number of days above flood stage
- Current drought in eastern Africa and Texas

### 5. Without trade some countries will face future food shortages

- Some countries will face food shortages because of poor transportation and storage facilities

## **E. Where do we get additional water for domestic and environmental uses?**

1. Irrigation is big consumptive water user (almost 70% worldwide): can we reallocate to other uses?
2. Increase storage for surface water?
3. Facilitate groundwater recharge by protecting recharge areas
4. Replace once - through cooling systems which account for 91% of cooling withdraws in U.S.
5. Develop effective demand management practices
  - Economic incentives can reduce climate change adaption costs, in Western Europe, by \$5 billion annually between 2010-50.

## F. How might we respond with water policies?

1. Have to improve efficiency in water use particularly for irrigation
  - a. Get serious about water pricing and water markets
  - b. Encourage water saving technology: drip and sprinkler irrigation
    - In Tamil Nadu, India drip irrigation increased water productivity by 50% to 200%\*
    - Yet much of the water saved was used to irrigate more
2. Develop crop varieties that use less water
3. Invest in and improve improved water infrastructure and management

\* Banana, grapes and coconut

## F. ...Water Policies continued

4. Markets can help in reallocating water
  - a. Australia, Chile, US west, South Africa and Spain have used water markets
  - b. Options markets
    - For drought management in cities
    - Used in California
  - c. Water as an economic good (irrigation and commercial uses)
    - Should water for domestic use be considered a basic right?
5. In most countries the consumer isn't charged enough to cover the cost of providing water
  - Should companies such as 3M receive subsidized water?



## **G. A default strategy has been to ration water**

1. Some large cities in India deliver water only for a few hours per day (2 to 5 hours)
  - Many U.S. cities during droughts ban activities such as car washing and lawn watering
2. For irrigation it creates a scarcity value for water
  - This has created informal water markets in some countries
  - Can also cause serious drops in production
3. In the commercial sector it has caused some firms to recycle their water and others to develop their own water sources.
  - The latter can cause rapid declines in groundwater (Bangkok)

## H. Conclusion

1. Uncertainty regarding water supply will increase
2. Our increased energy use will require even more water which will compete with other water uses
3. With more frequent droughts we must make more efficient use of our water particularly for irrigation and in the energy sector
4. We will have a difficult time meeting the growing demands for environmental water uses

## H. ...Conclusion continued

5. More areas will face water storages resulting in food shortages and price increases

6. Because of increased scarcity the value of water will rise like oil.

- Current price of oil \$90 to 100/barrel
- Current bottle water price \$30 to 300/barrel

7. Pressure will build to construct additional water storage capacity for irrigation, flood control, and urban supplies

## H. Conclusion continued

8. In the final analysis we need to modernize our water infrastructure and management
10. Desalination will help in a few coastal urban settings. However, energy requirements will be high
  - 3 to 16 kwh to obtain 1,000 liters of desalinated water