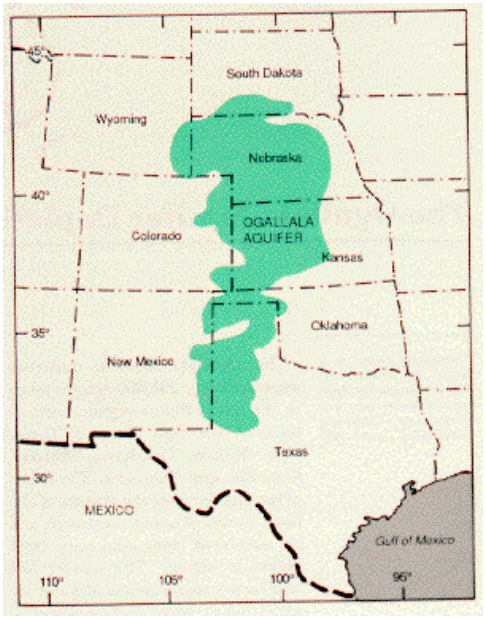
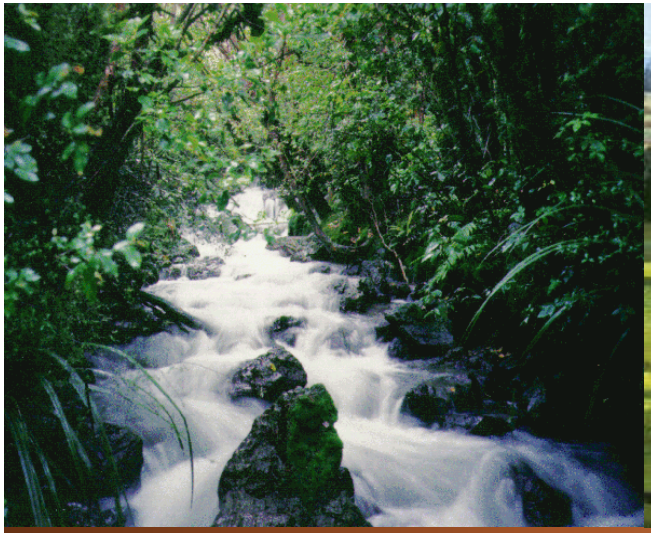
Climate Change and Water Management? Why?



Adel Shirmohammadi

Professor & Associate Dean for Research
AGNR, University of Maryland College Park, MD

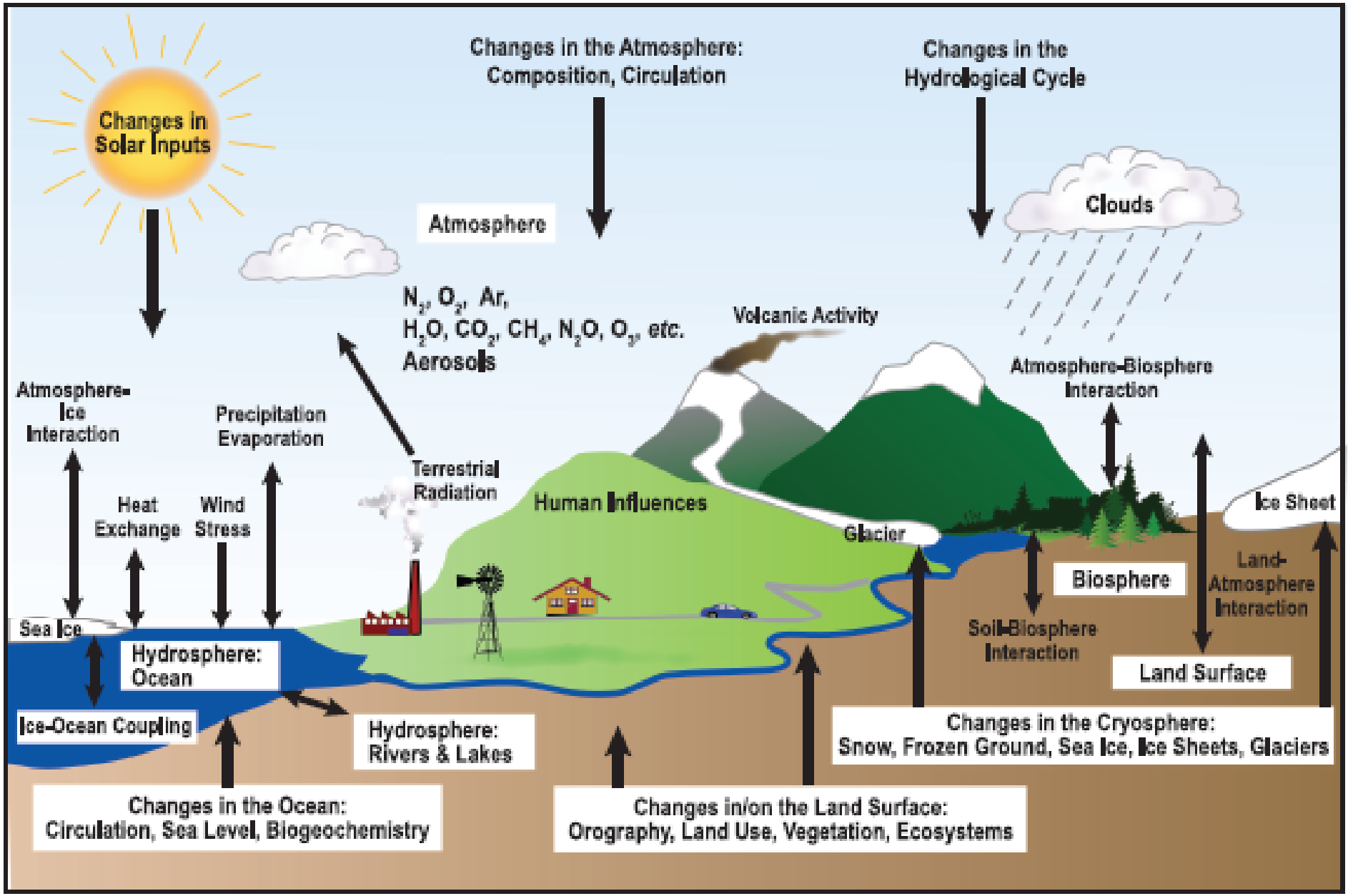
We are communicating Climate Change!

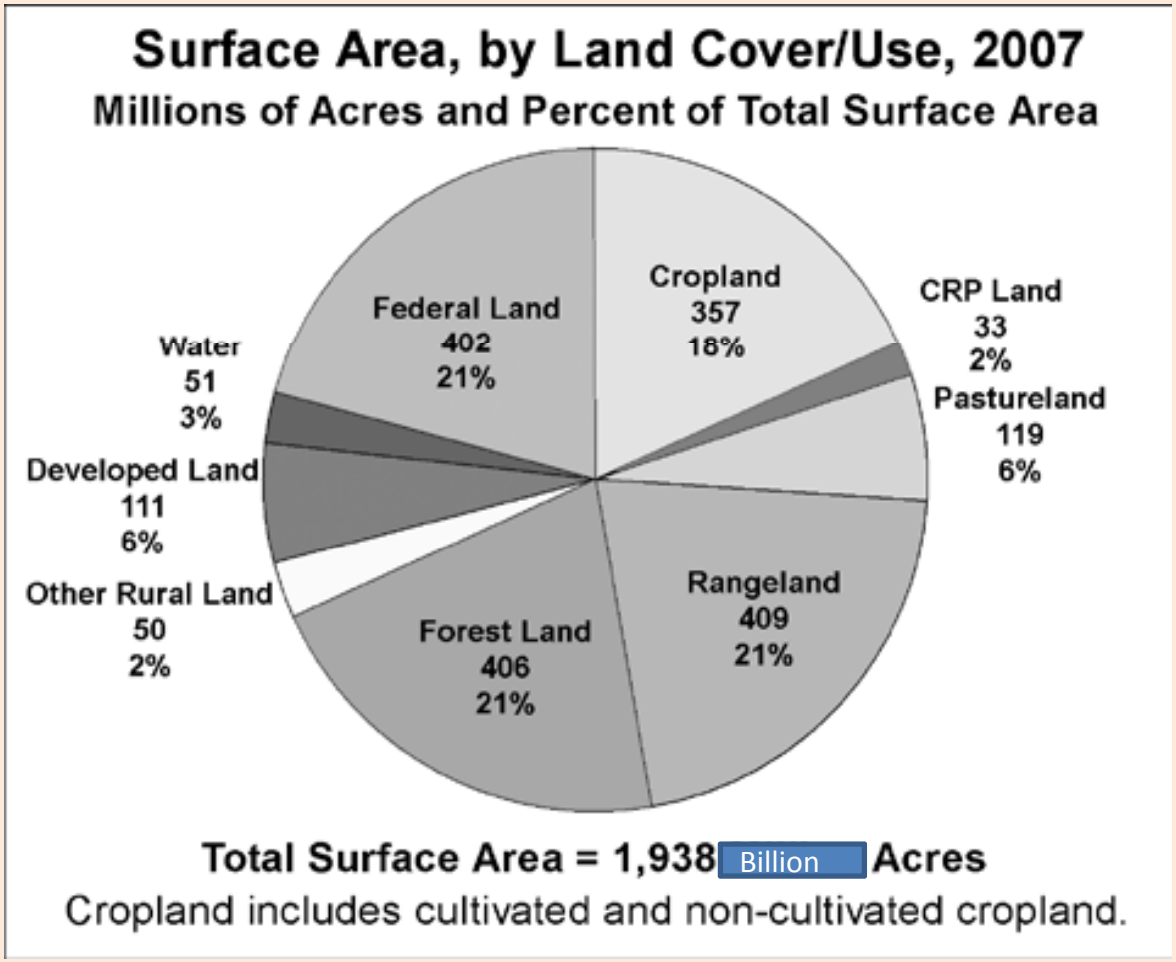


Pollution

Pollution caused by man results in an undesirable or harmful change in the quality of the resource (water, soil, and air).

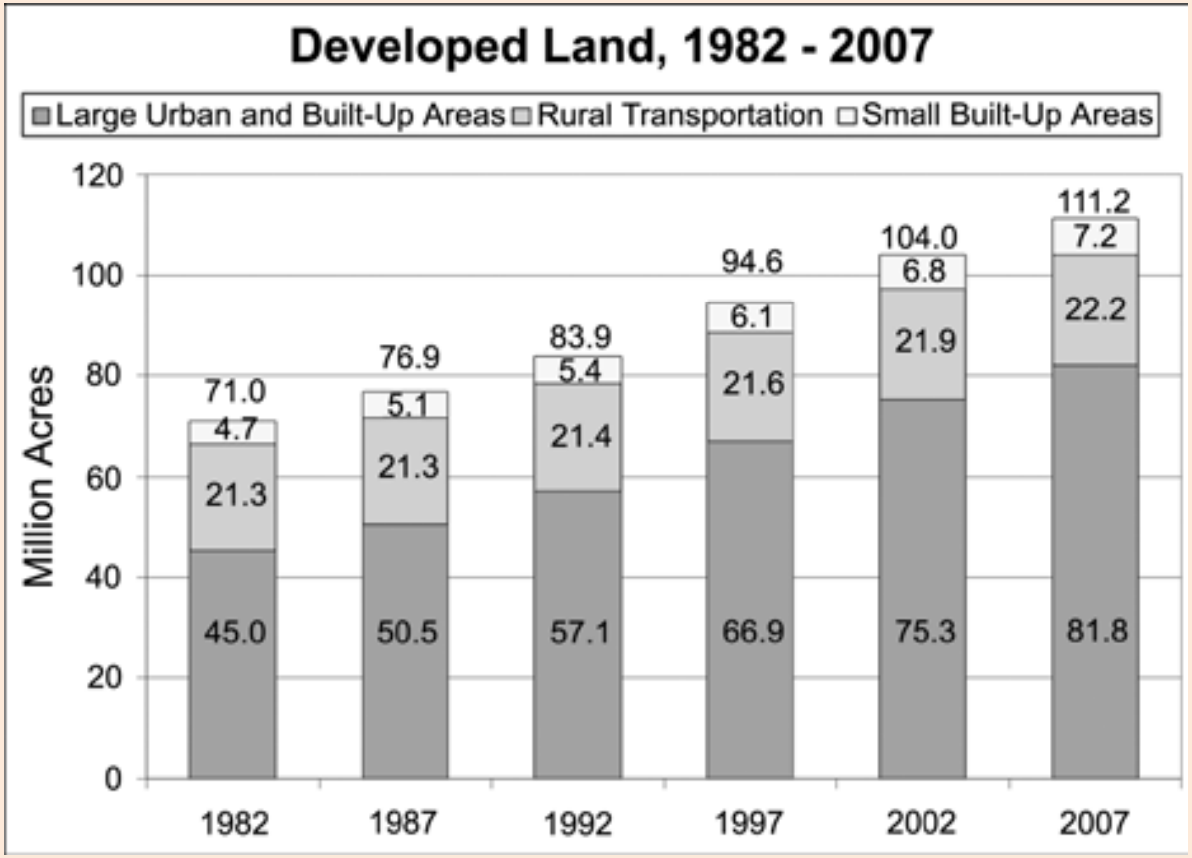

Climate System Components, their Processes and Interactions (U. Cubasch et al., 2007)





(NRI, 2009)

http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1041379.pdf

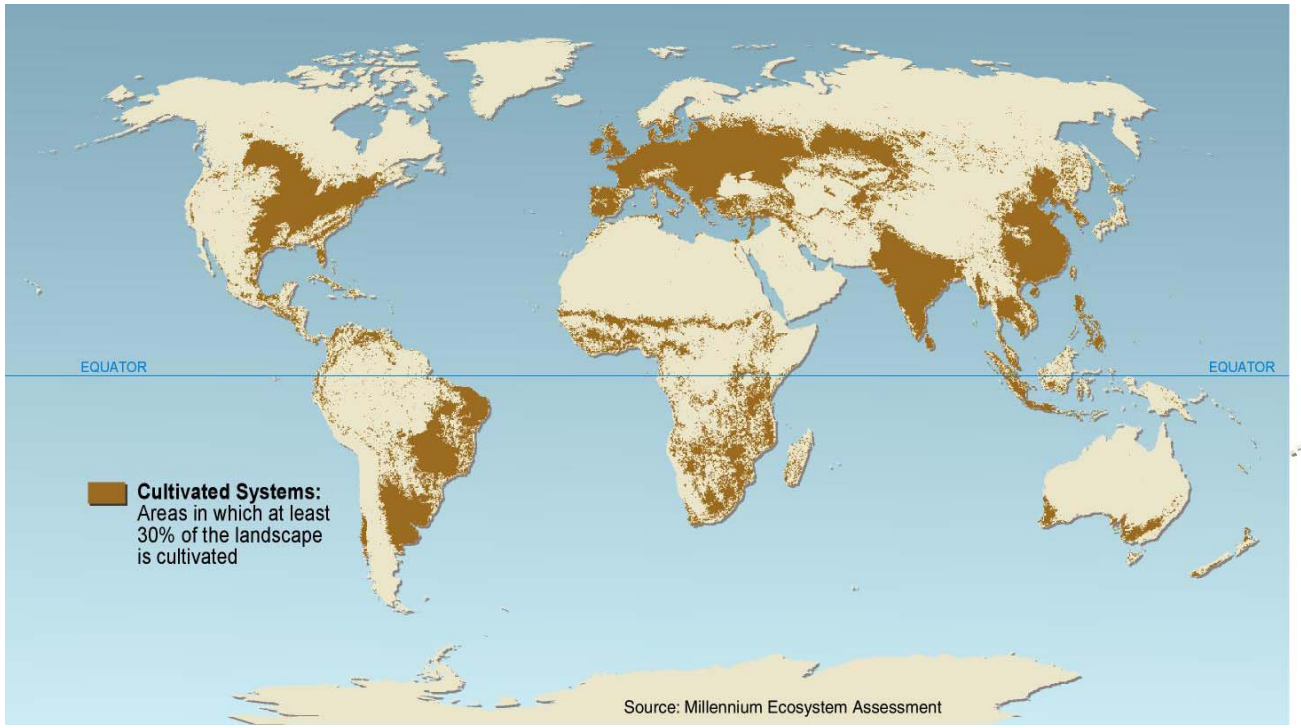


About 40 million acres of land were newly developed between 1982 and 2007, bringing the total to about 111 million acres; that represents a 56 percent increase. This means that more than one-third of all land that has ever been developed in the 48 states was developed during the last quarter century. (NRI, 2009). http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1041379.pdf

Millennium Ecosystem Assessment

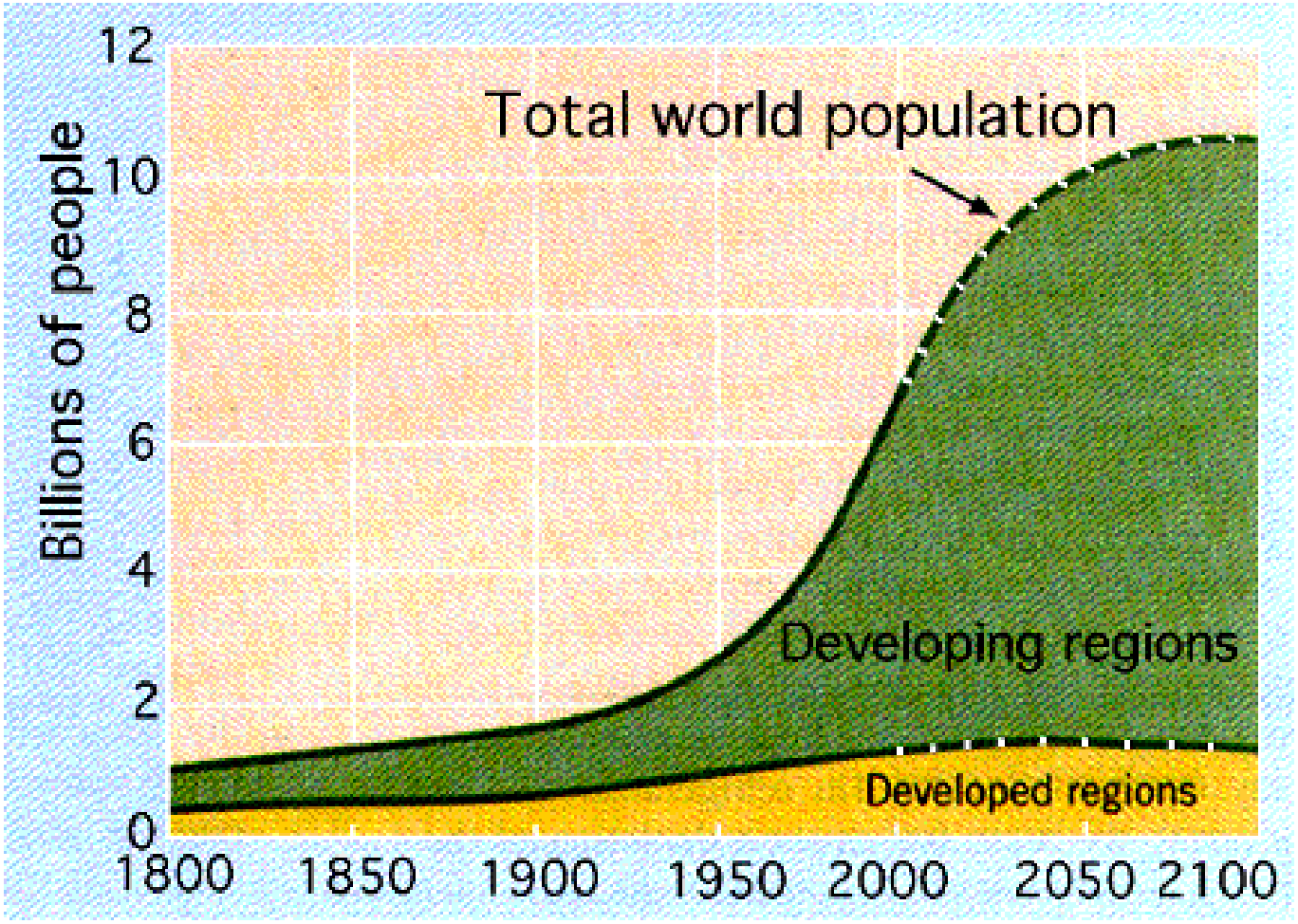
Unprecedented change in structure and function of ecosystems

More land was converted to cropland in the 30 years after 1950 than in the 150 years between 1700 and 1850.



Cultivated Systems in 2000 cover 25% of Earth's terrestrial surface

(Defined as areas where at least 30% of the landscape is in croplands, shifting cultivation, confined livestock production, or freshwater aquaculture)- (MEA, 2005)



Population Growth: 10,000 years ago – 10 M; 1850 – 1B; 1930 – 2B
1975 – 4B; 1987 – 5B; 1999 – 5B; 2020 – 8B
Current Growth Rate: 0.25M Per Day

http://saferenvironment.wordpress.com/2008/08/19/explosive-population-growth-affects-world-food-supplies-and-environment/

Facts On Water

a) 10 Gal for 1 slice of bread; 35 Gal for 1 cup of Coffee; 635 Gal for one hamburger

b) Global population will increase by 30% by 2050, thus increased demand for water, water shortage!

d) Only 2.5% of world's water supply is fresh. Less than 1% is surface water
(http://ga.water.usgs.gov/edu/earthwherewater.html)

e) North America has 15% of World's Fresh Water, but 8% of population; China has 7% of fresh water, but 21% of population.

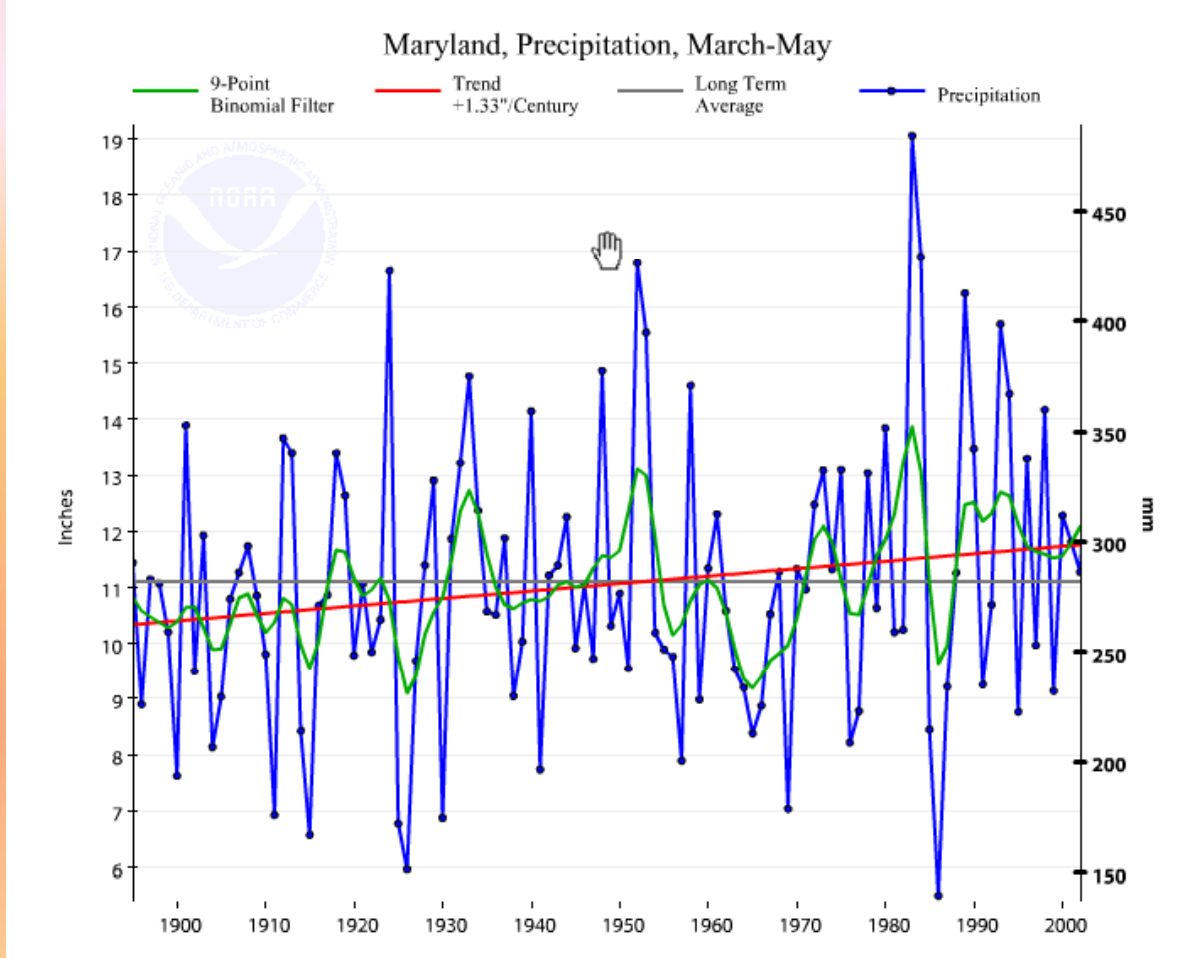
f) Today, >1 B people do not have access to fresh water. Unsanitary living conditions account for more than 5 million deaths/y, of which more than half are children (David Pimental, Cornell University) http://www.news.cornell.edu/stories/Aug07/moreDiseases.sl.html

g)Global water use is expected to increase by 40% by 2050. More than half of the world population will live under water stress! Water constraints will cause rise in food cost.

h) Agriculture consumes about 70% of fresh water.
http://saferenvironment.wordpress.com/?ref=spelling/(Partha Das Sharma – Consulting Engineer)

We have to rely on high cost technologies such as desalinization, reuse, and conservation.

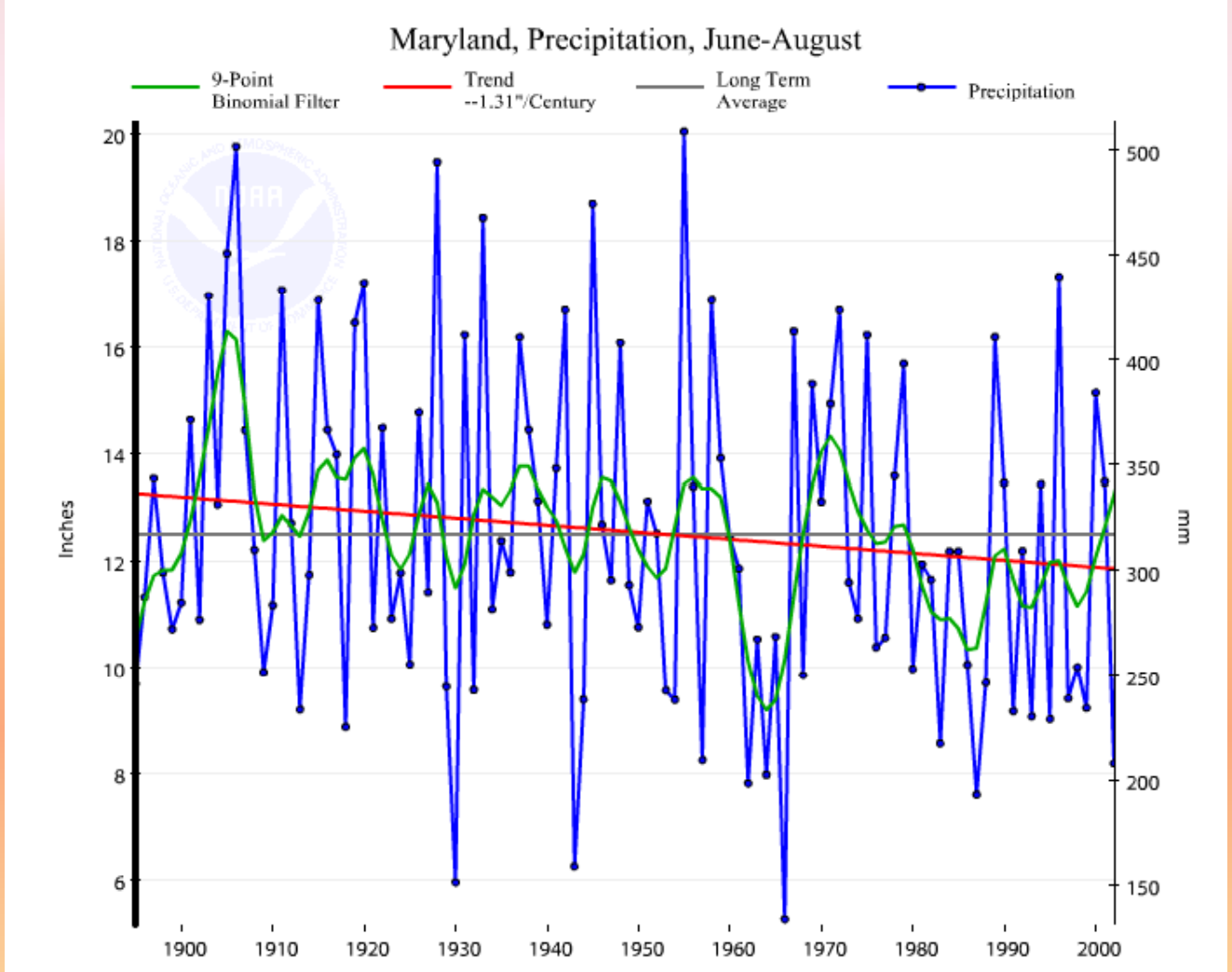
NOAA – National Climate Date Center



Cum. Change in Precipitation for March-May = 1.33” [March (0.47), April (0.18), May (0.67)] per Century

http://www.ncdc.noaa.gov/temp-and-precip/time-series/index.php?parameter=pcp&month=8&year=2002&filter=3&state=18&div=0

NOAA – National Climate Date Center



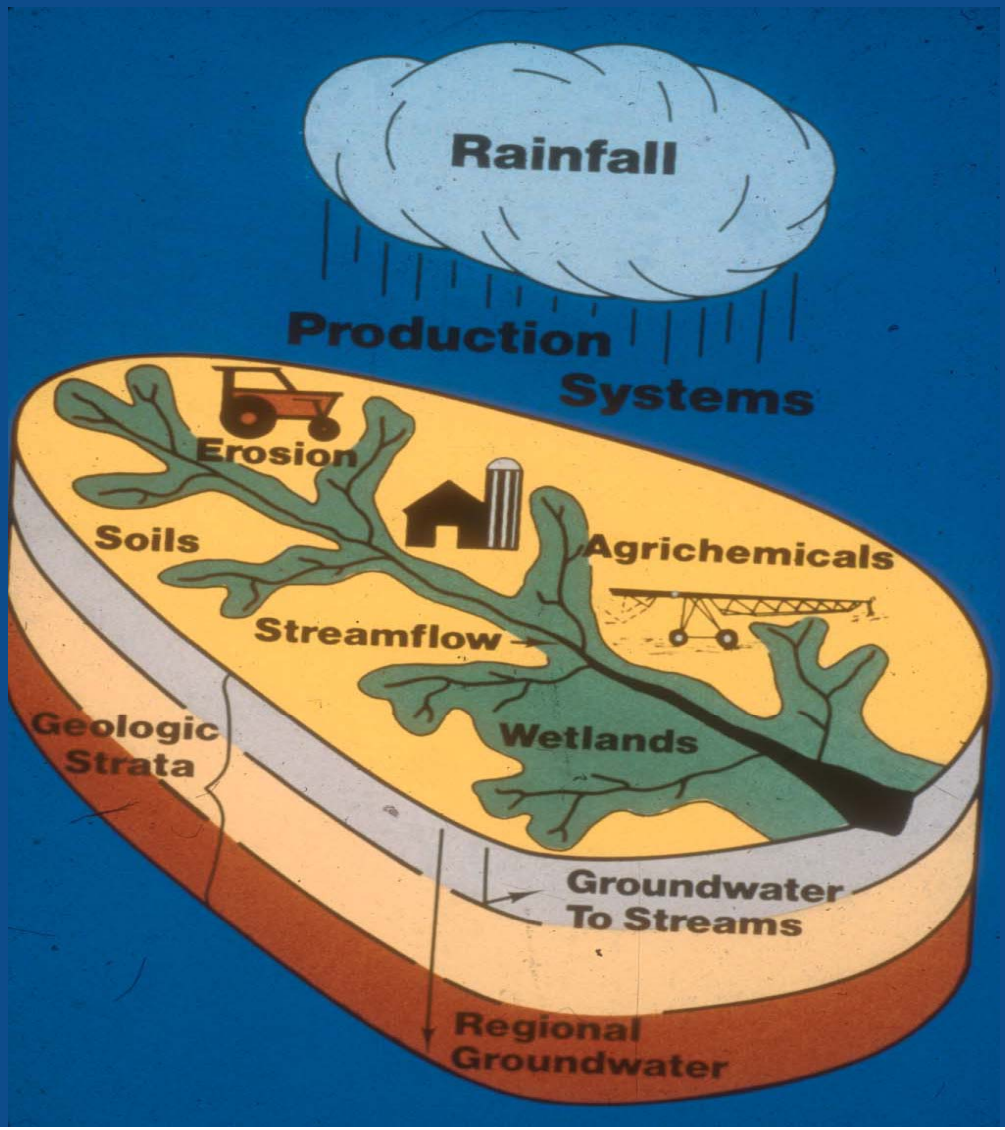
Cum. Change in Precipitation for June-August= -1.31" [June (-0.18), July (-0.49), August (-0.65)] per Century

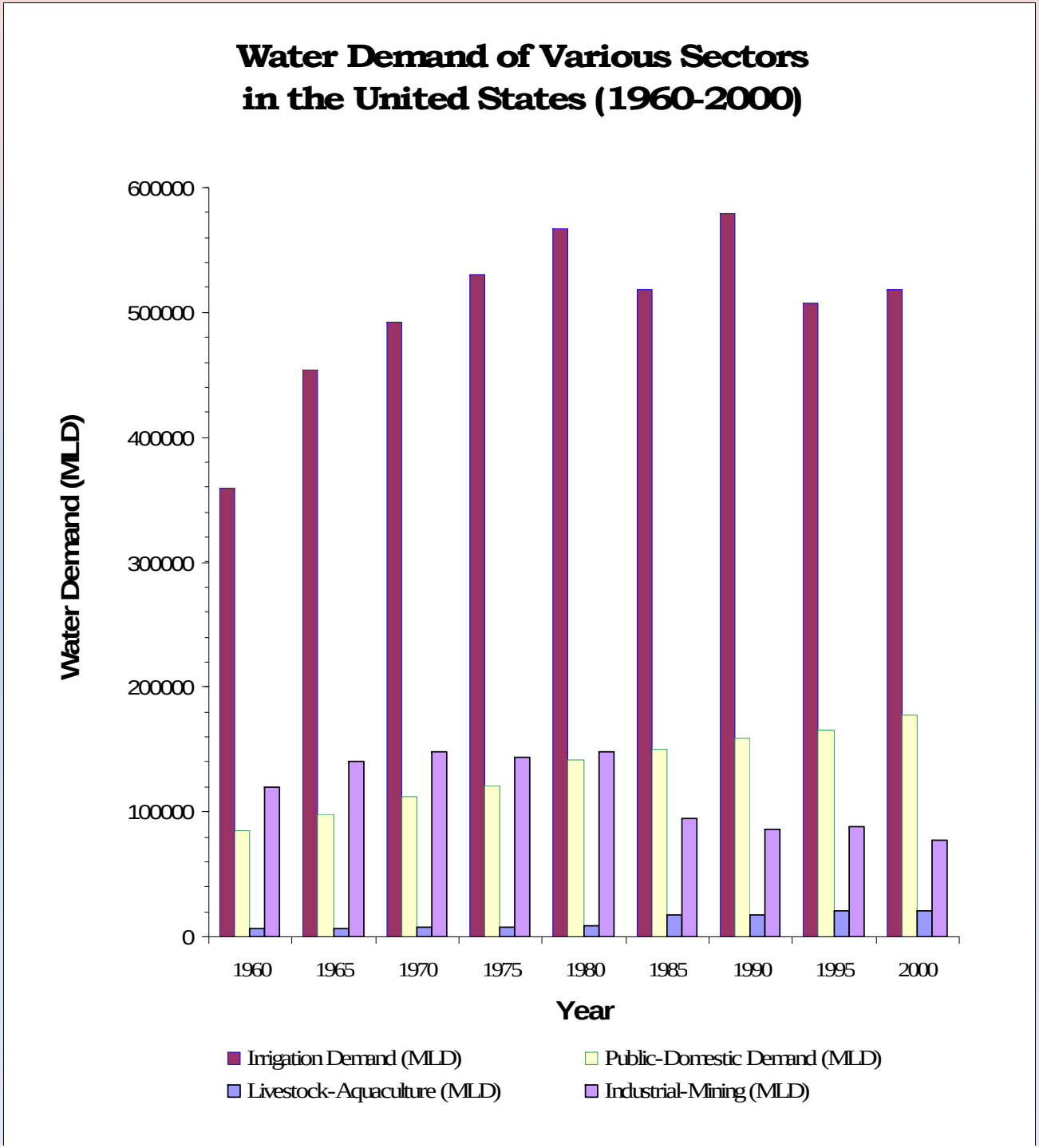
http://www.ncdc.noaa.gov/temp-and-precip/time-series/index.php?parameter=pcp&month=8&year=2002&filter=3&state=18&div=0

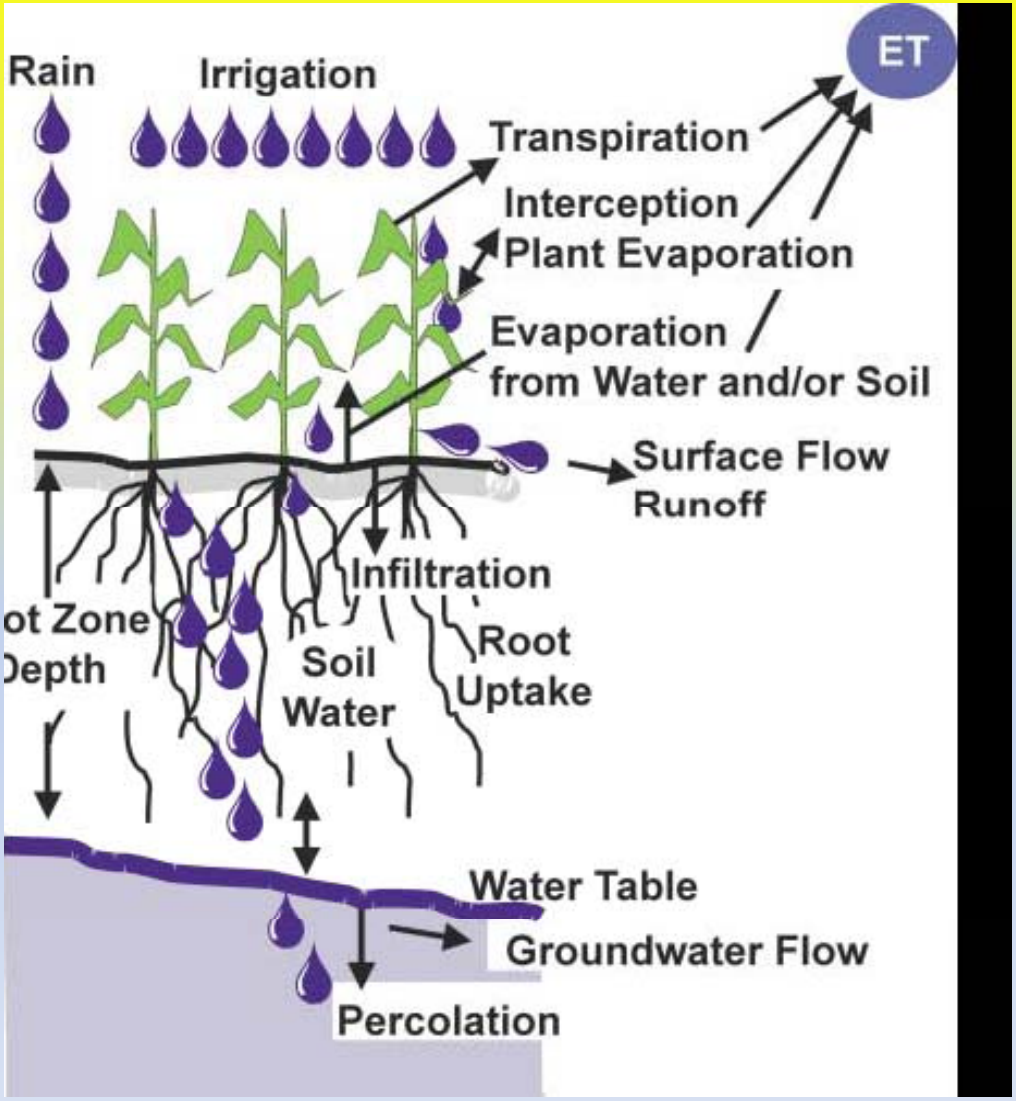
Per Century (Data for 1900- 2010, NOAA) Changes in Temperature and Precipitation

Month	Δ Temperature	Δ Precipitation
January	0.5	- 0.14
February	4.0	- 0.41
March	1.7	0.47
April	2.9	0.18
May	0.6	0.67
June	1.6	- 0.18
July	1.1	- 0.49
August	1.7	- 0.65
September	0.4	0.97
October	0.4	0.76
November	2.7	1.07
December	2.8	0.33
12 Month Average	1.7	2.56

Hydrology Within the Context of Watershed/Ecosystem Management




Water Demand of Various Sectors in the United States (1960-2000)
Water Demand (MLD)
600000
500000
400000
300000
200000
100000
0
1960
1965
1970
1975
1980
1985
1990
1995
2000
Year
Irrigation Demand (MLD)
Public-Domestic Demand (MLD)
Livestock-Aquaculture (MLD)
Industrial-Mining (MLD)



For Irrigation Water Use Efficiency (WUE) is very important.

WUE = Yg/ET

Yg: Economic Yield (gm^{-2})
ET: Crop Water Use (mm)

- Conveyance Efficiency
- Application Efficiency

Illustration of the various water transport components needed to characterize irrigation efficiency. (T. Howell, USDA-ARS, 2003)

Irrigation Economics

Mannocchi and Mecarelli, 1994 and
Hanna and Shirmohammadi, 2006:

$$NB = P_s Y_a - \left[C_0 + (C_1 Y_a) + \left(C_2 \frac{V_a}{EFI} \right) + \left(C_3 \frac{V_a}{EFI} \right) + (C_4 N_w) \right]$$

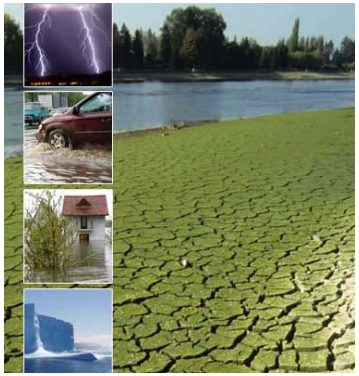
Center-pivot sprinkler irrigation in Nebraska.
Credit: USGS

NB : Net Benefit ($@/ha)
P_s: Sale Price of Yield ($/ton)
Y_a: Actual Crop Yield ($/ton)
C_0: Fixed Costs of Production ($/ha)
C_1: Costs of Production Varying with Crop Yield ($/ha)
C_2: Cost of Irrigation Water ($/$m_3$)
C_3: Cost of Distributing Irrigation Water ($/ha)
C_4: Fixed Cost of each Irrigation ($/number. ha)
V_a: Net Available Irrigation Water (m_3/ha)
N_w: Number of Irrigation Events (number)
EFI: Total Irrigation Efficiency (e.g., 0.8)

Sustainability **is generally referred to as the ability of a system to maintain balance of certain processes or states.**

In ecological terms, it is the ability of an ecosystem to maintain ecological processes, functions, biodiversity and productivity into the future (O'Riordan and Stoll-Kleemann, 2002).

Considering the status of today's world regarding poverty, inequality, global warming, lack of ecosystem/human health in many parts of the world, and water scarcity, sustainability loses its dictionary meaning. More than one billion people in the world are without water and proper sanitation (UNDP, 2002), which is a clear failure of the meaning of sustainability.



NERA's Climate Change Activities

1. Baltimore Summit (July 11-13, 2010) – NERA, NEED, CARET
2. Eastern US-Canada Climate Change Meeting (August 18-19, 2010), Syracuse, NY
3. Multiple CORE Committee Tele-Conferences for both of the Groups Above
4. Beltsville Forum (March 22-23, 2011), Beltsville, MD (Faculty/Scientists from Multiple Institutions and Diverse Fields interested in "Climate Change in Northeast-- ***Water Quantity and Quality Challenges for Agricultural and Natural Systems***
5. Eastern US – Canada "Think Tank" Committee Meeting (Montreal)-June 27-28, 2011)
6. Climate Change Forum--Mystic, Connecticut (July 10-12, 2011)
7. BARC-UMD Symposium ---January 23, 2014
8. ASABE Sponsored Climate Change Symposium --- April/May 2015

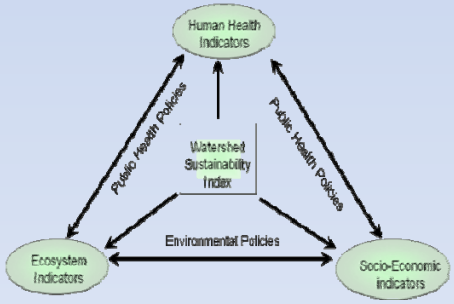
Research Needs

1) Collection and synthesis of climate, hydrologic, and land use data for:

a) understanding of the state of interaction between Atmosphere, Hydrosphere, Cryosphere, and Lithosphere
b) determination of the path, usage, and storage of water within and through each of the spheres
c) determination of the value of water both locally, regionally, nationally, and globally
d) determination of the cause of declining freshwater (Is it overuse? Is it Pollution? Or both?)
e) devising adaptation strategies to cope with the impact of climate Change on Water Resources
f) identifying Climate Change mitigation strategies that is suitable within each ecosystem
g) devising legislative agenda that is science based and works to create a sustainable ecosystem

2) Building proper models to interface the spheres listed under item 1.a above and be able to:

a) forecast time sensitive climate and hydrologic functions on manageable scales
b) simulate adaptation and mitigation strategies and their impacts on water resources
c) simulate economic, biosystems, environmental, social, and ecosystem health impacts of the climate change using water as the principle vector
d) develop a sustainability Index for each ecosystem in light of climate change and implement the strategies that will guarantee the achievement of the required index.



3) ***For Climate and Agriculture***, Research needs identified by USDA-ARS in Technical Bulletin 1935 titled "***Climate Change and Agriculture in the United States: Effects and Adaptation***", 2012 should be supported and followed.

“Let there be work, bread, **water** and salt for all.”
Nelson Mandela

H_2O

Quantity

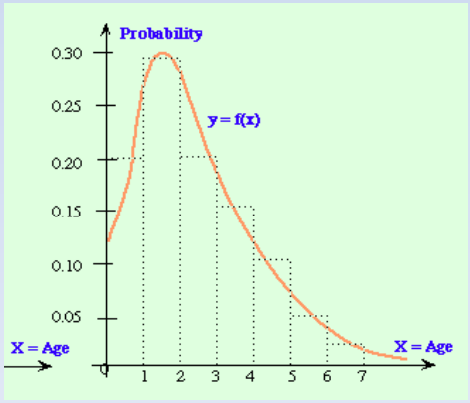
Quality

Monitoring & Modeling

$$\frac{\partial}{\partial t}(\theta C) = D_x \frac{\partial^2}{\partial x^2}(\theta C) + D_z \frac{\partial^2}{\partial z^2}(\theta C) - \frac{\partial}{\partial z}\left(\overline{v_z}\ C\right)$$

“Water is the driving force of all nature.”
Leonardo da Vinci

Water, taken in moderation, cannot hurt anybody.
Mark Twain



Under Changing Climate and Policy!

“The nation behaves well if it treats the natural resources as assets, which it must turn over to the next generation increased and not impaired in value.”

President Theodore Roosevelt (1901-1909)

"Speed is irrelevant if you are going in the wrong direction." - M. Gandhi