

# A Secure Water Future

Stacy Hutchinson, Ph.D.



**Biological & Agricultural Engineering**  
**Kansas State University**

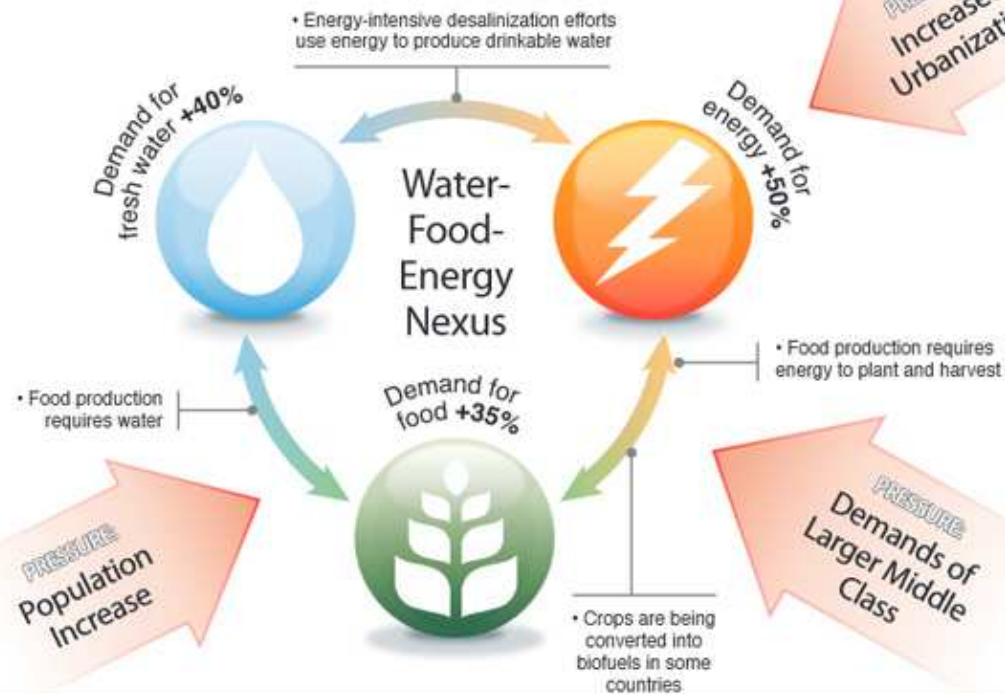
Voice: 785-532-2943 Fax: 785-532-5825  
sllhutch@ksu.edu



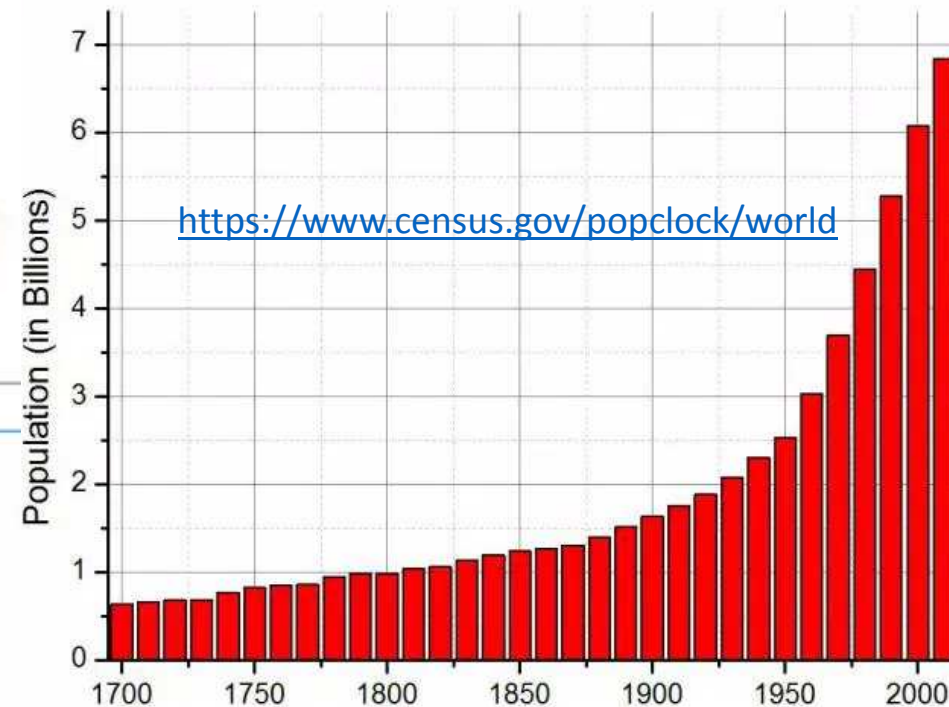
# As population grows, pressures mount

And the relationships between food, water, and energy supplies become critical

Because of growth in global population and the consumption patterns of an expanding middle class, in less than two decades three key demands will sharply increase ...



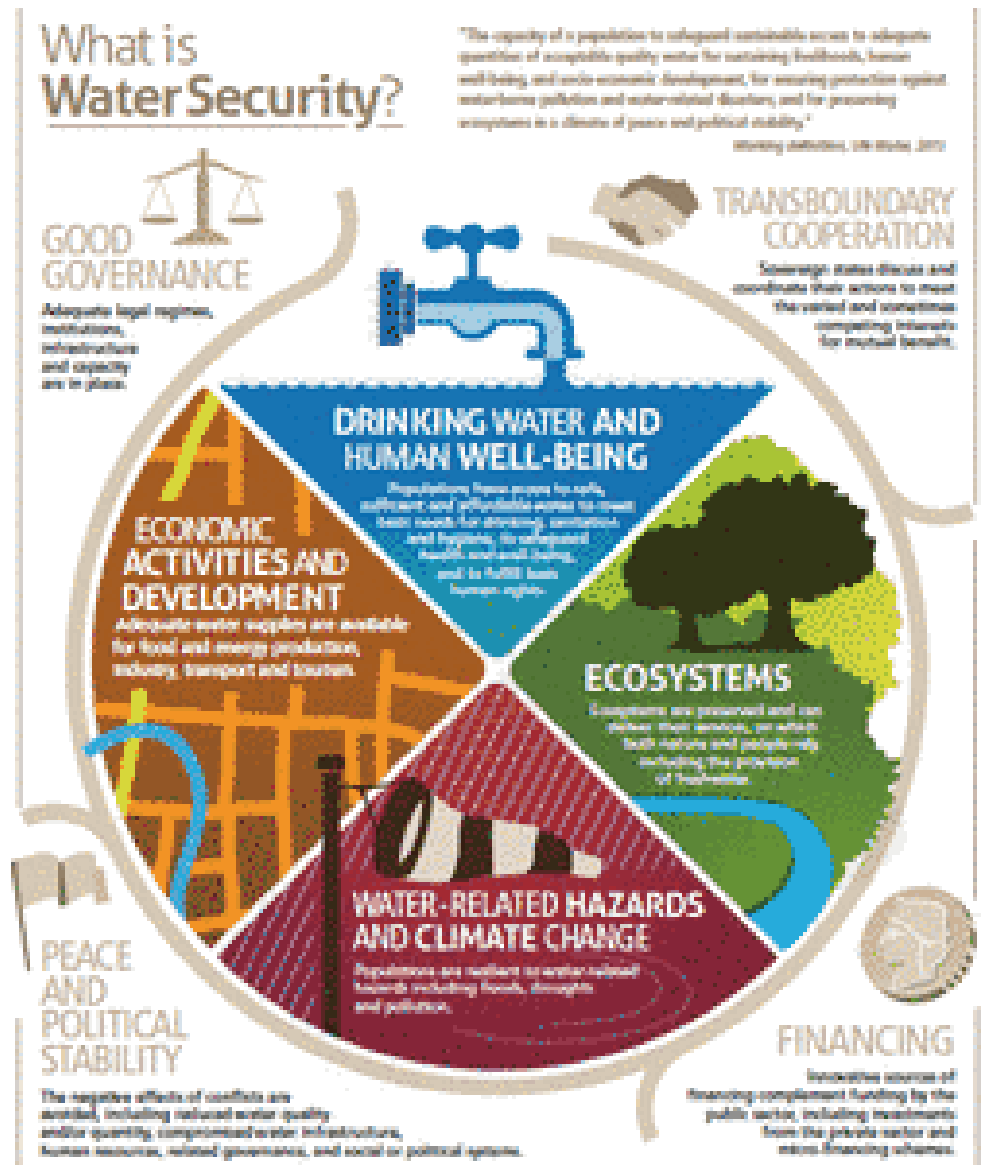
<https://www.westarenergy.com/coal>





# Water Security....

<http://www.unwater.org/topics/water-security/en/>



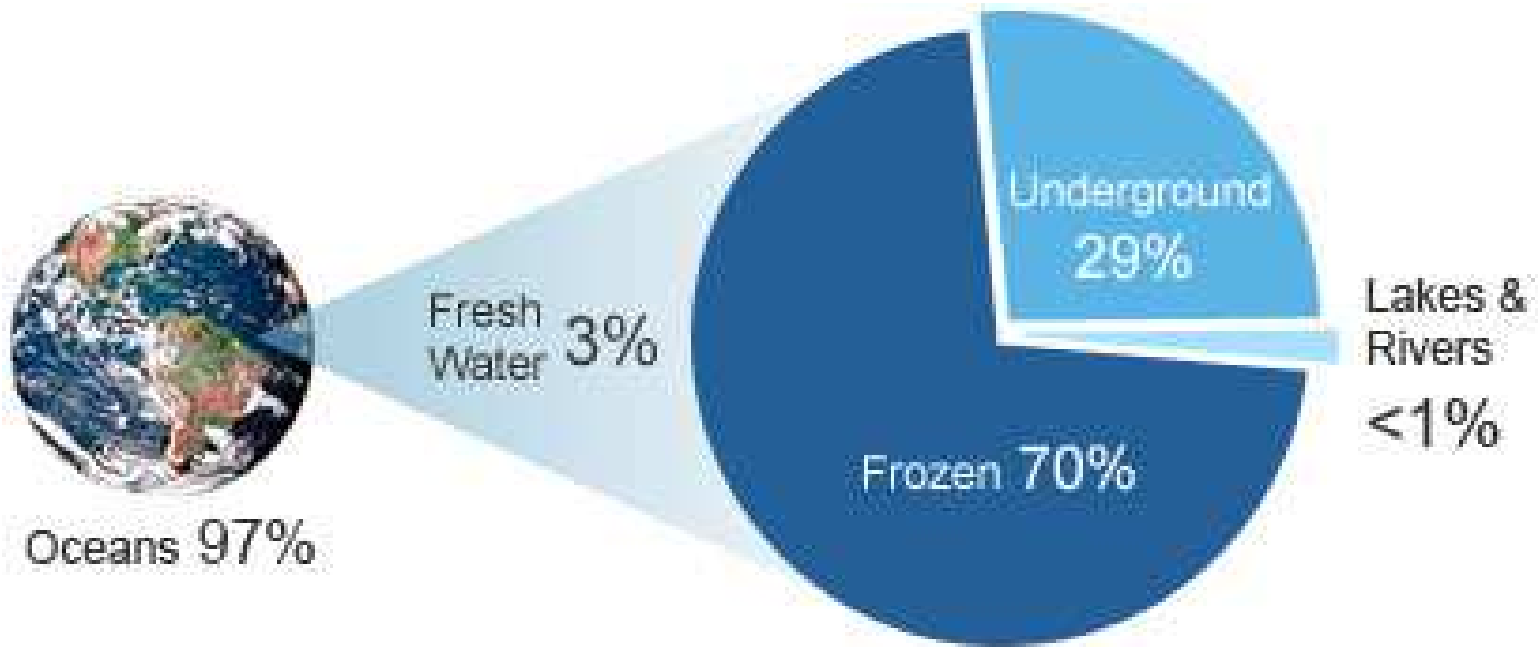
## Water Security....

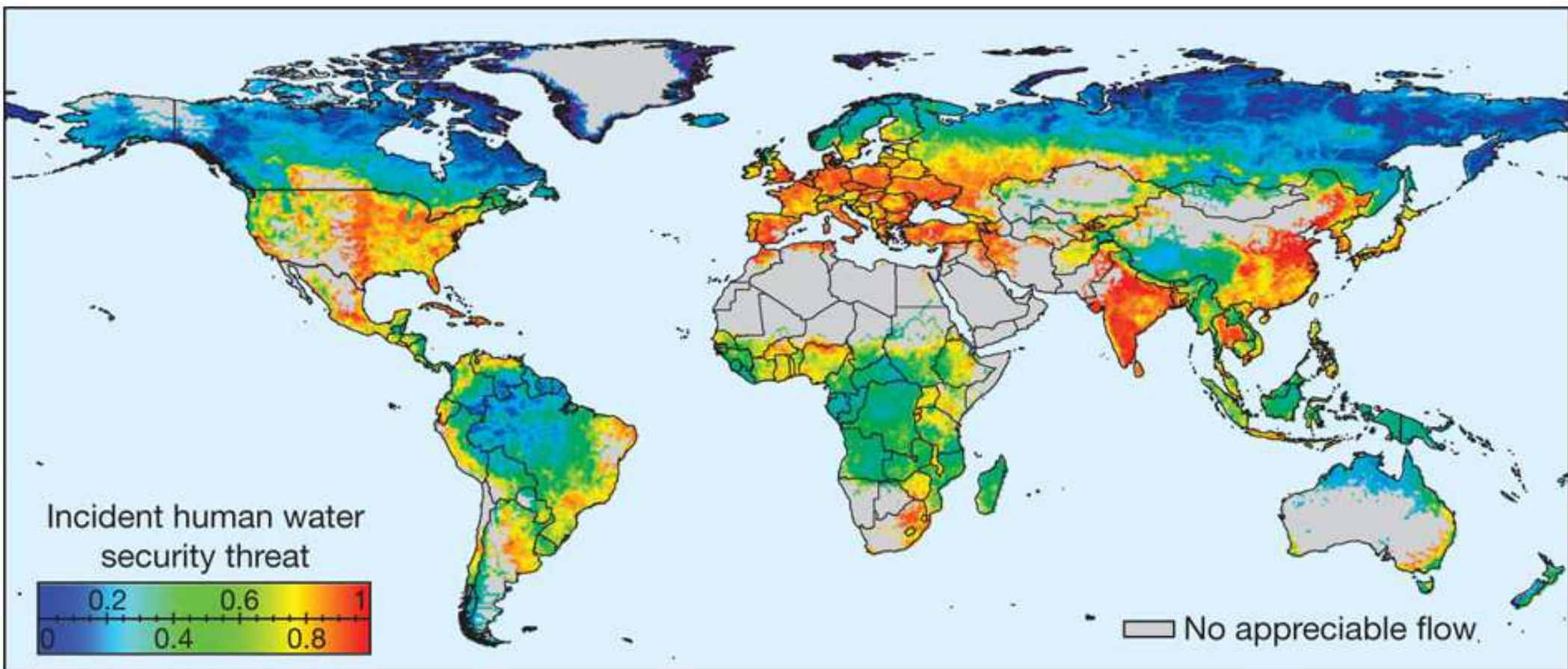
- As defined by the United Nations, water security is “the capacity of a population to safeguard **sustainable** access to adequate quantities of acceptable quality water for **sustaining** livelihoods, human well-being, and socio-economic development, for ensuring protection against water-borne pollution and water-related disasters, and for preserving ecosystems in a climate of peace and political stability”.

<http://www.unwater.org/topics/water-security/en/>



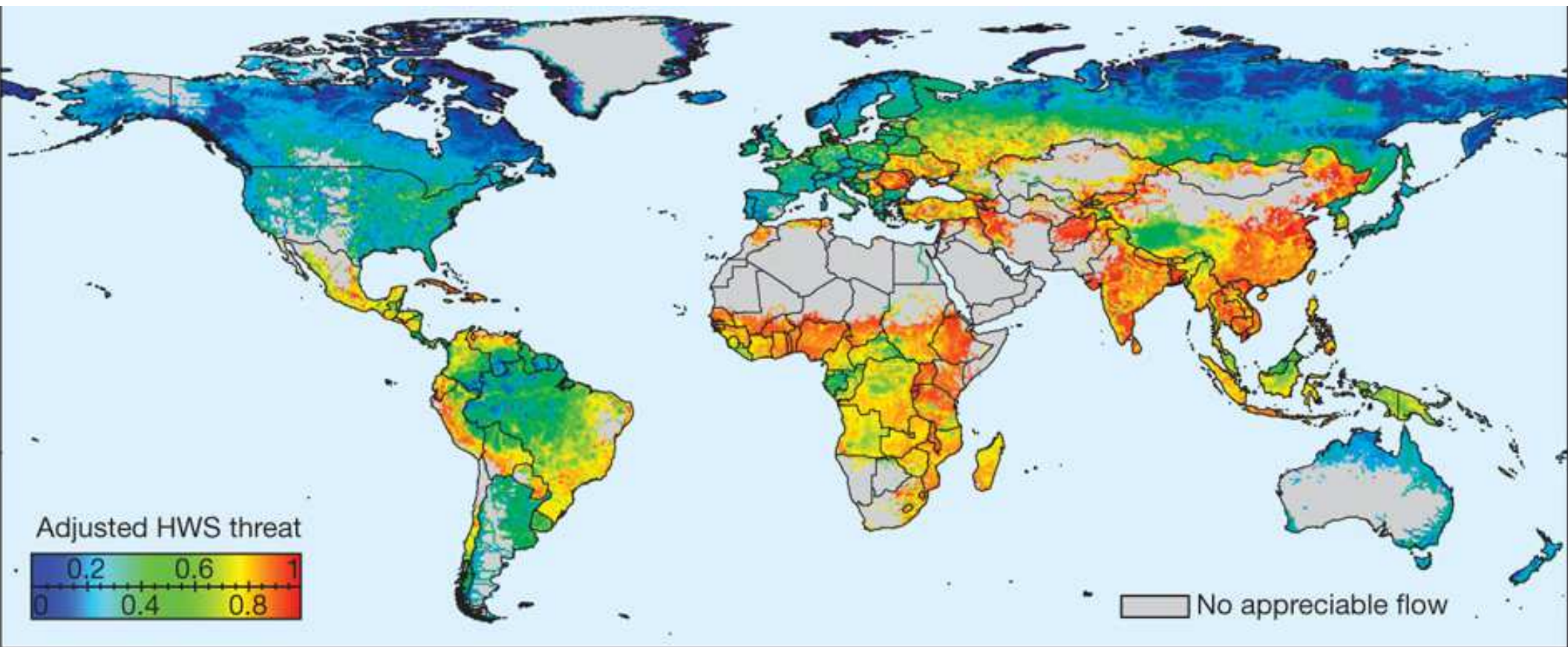
## Available Water





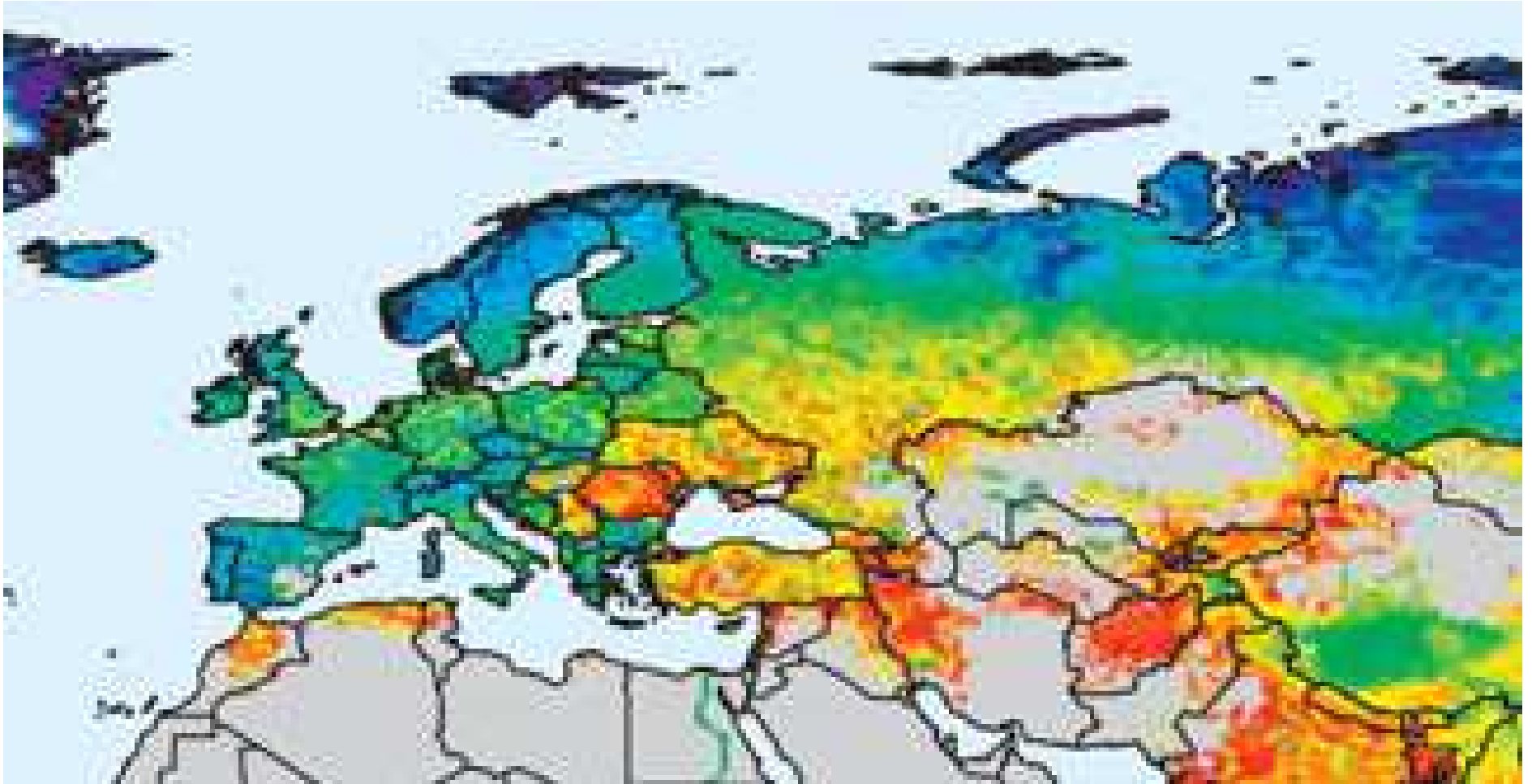
CJ Vörösmarty *et al.* *Nature* **467**, 555-561 (2010) doi:10.1038/nature09440





CJ Vörösmarty *et al.* *Nature* **467**, 555-561 (2010) doi:10.1038/nature09440





CJ Vörösmarty *et al.* *Nature* **467**, 555-561 (2010) doi:10.1038/nature09440

# The Challenge:

- Increasing global population
  - World population is expected to reach 9B by 2050
  - The number of people living in cities will double during the next century (A. Townsend, *Smart Cities*, 2013).
- Increasing land and water use
  - Human/animal food and water consumption
- Climate Change
  - Extreme weather
    - Floods and drought

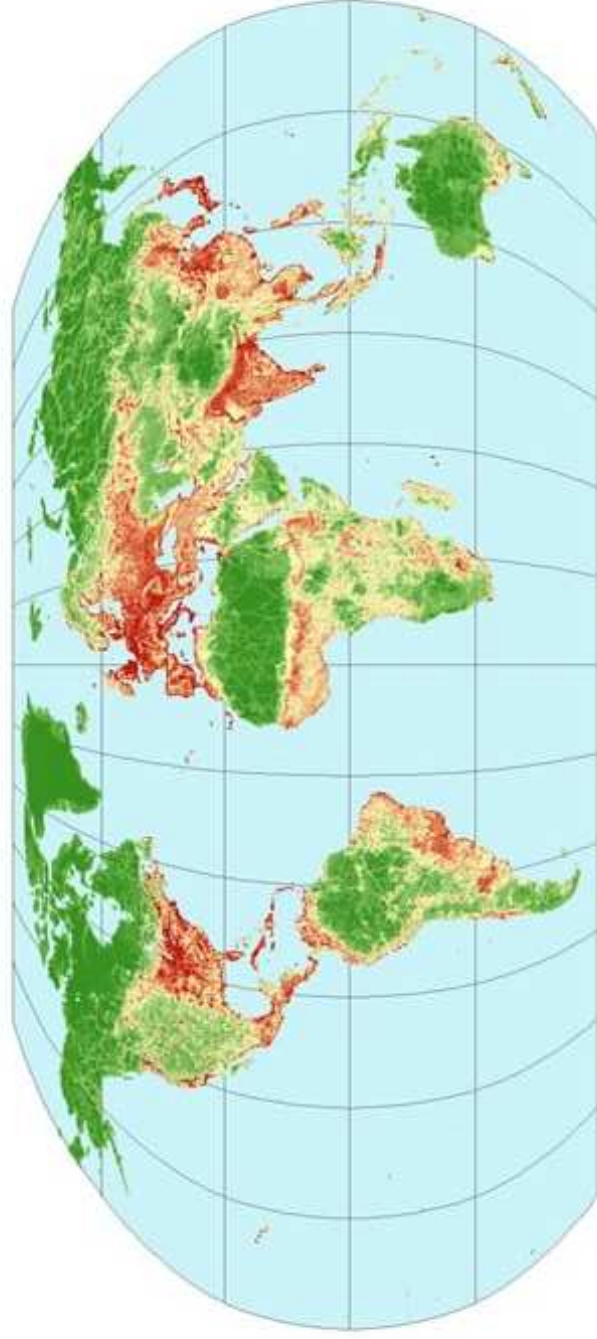
# The World is Changing...

- **Landcover Change:**
  - **Conversion of natural lands for anthropogenic uses (e.g. agriculture and economic centers)**
    - **Change in runoff rates and volumes**
    - **Change in surface temperatures**
    - **Change in erosion potential**
- **Climate Change:**
  - **More extreme weather events across the globe**



# The Human Influence Index ver. 2

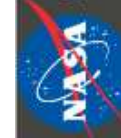
Global



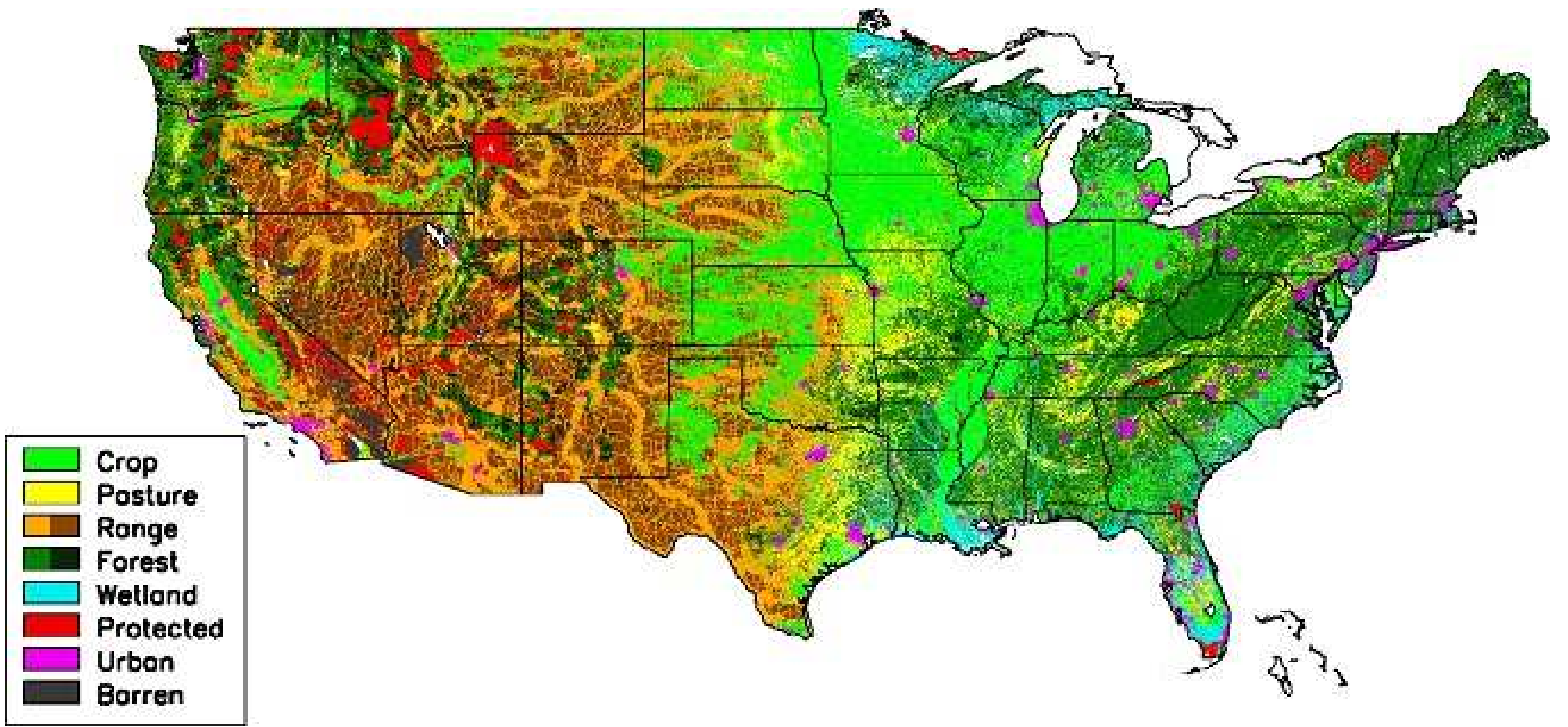
## The Human Influence Index

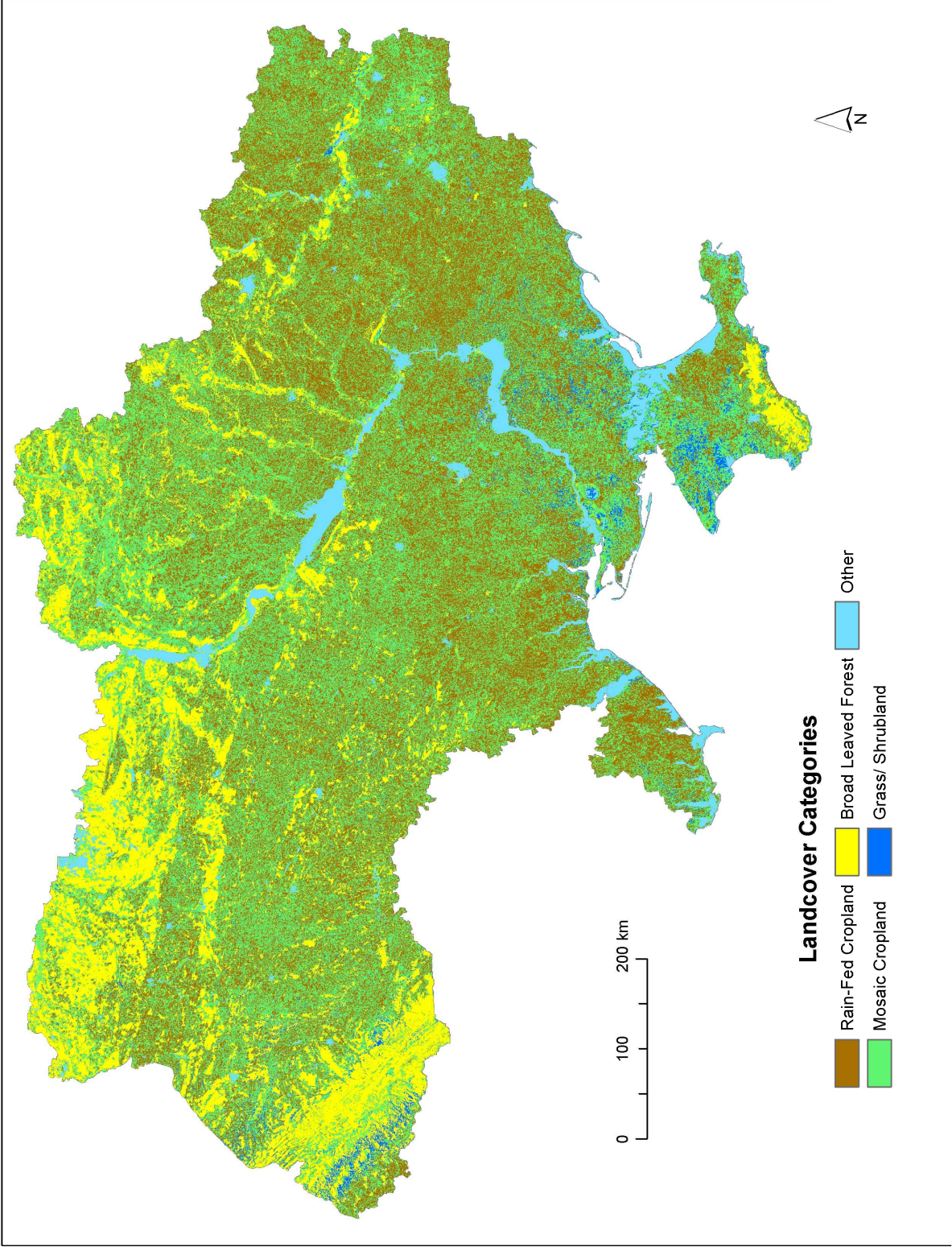
The Human Influence Index (HII) is a measure of direct human influence on terrestrial ecosystems using the best available data sets on human settlement (population density, built-up areas), access (roads, railroads, navigable rivers, coastline), landscape transformation (land use/land cover) and electric power infrastructure (nighttime lights). HII values range from 0 to 64. Zero value represents no human influence and 64 represents maximum human influence possible using all 8 measures of human presence.

Copyright 2008, The Trustees of Columbia University in the City of New York, Center for International Earth Science Information Systems (CIESIS) University and Woods Hole Oceanographic Institution, the Bronx Zoo, New York Zoological Garden, and the American Museum of Natural History. Data set available at <http://www.earthsci.columbia.edu/hii/>



SOCIOECONOMIC DATA AND APPLICATIONS CENTER (SEDAC)

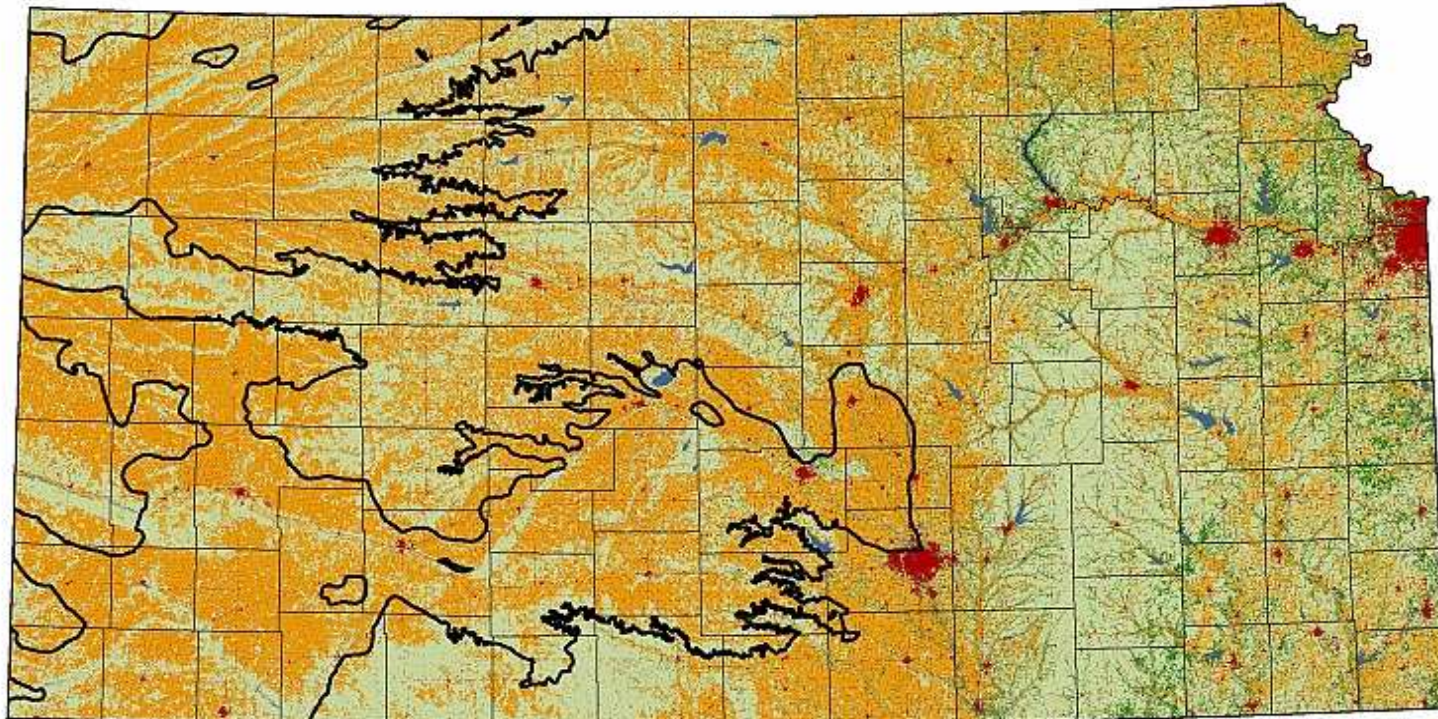






Ka

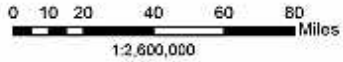
### Kansas Land Use: 2010



#### Legend

Land Use

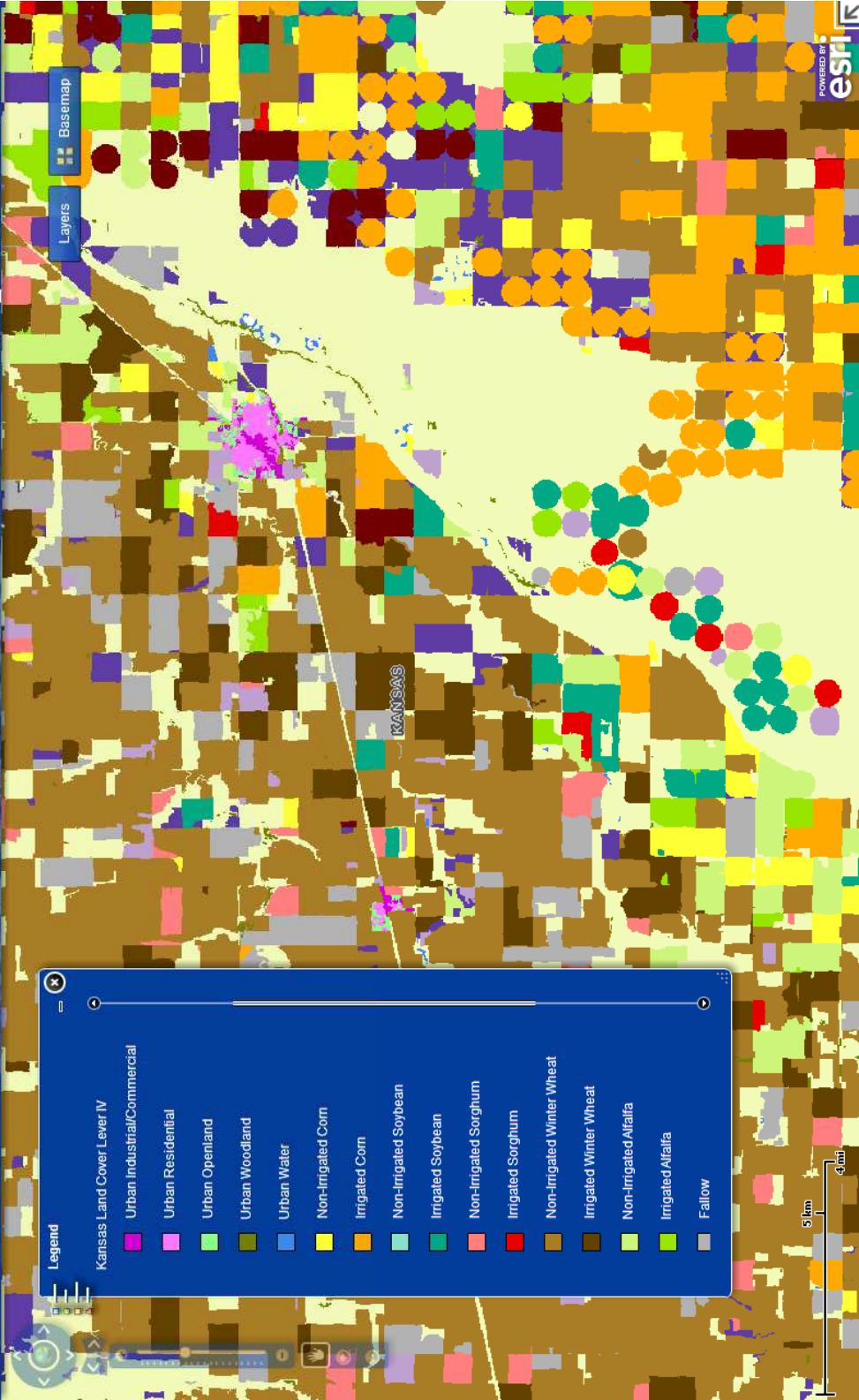
-  Grassland
-  Cropland
-  Urban Area
-  Forested
-  Water/Wetland
-  High Plains Aquifer



**KU** KANSAS  
GEOLOGICAL  
SURVEY  
The University of Kansas  
Kansas Geological Survey – Geohydrology  
University of Kansas – Lawrence, KS  
USDA NASS 2010 Cropland Data Layer  
NAD 1983 UTM Zone 14 02 May 2012

## 2005 Kansas Land Cover Patterns Map

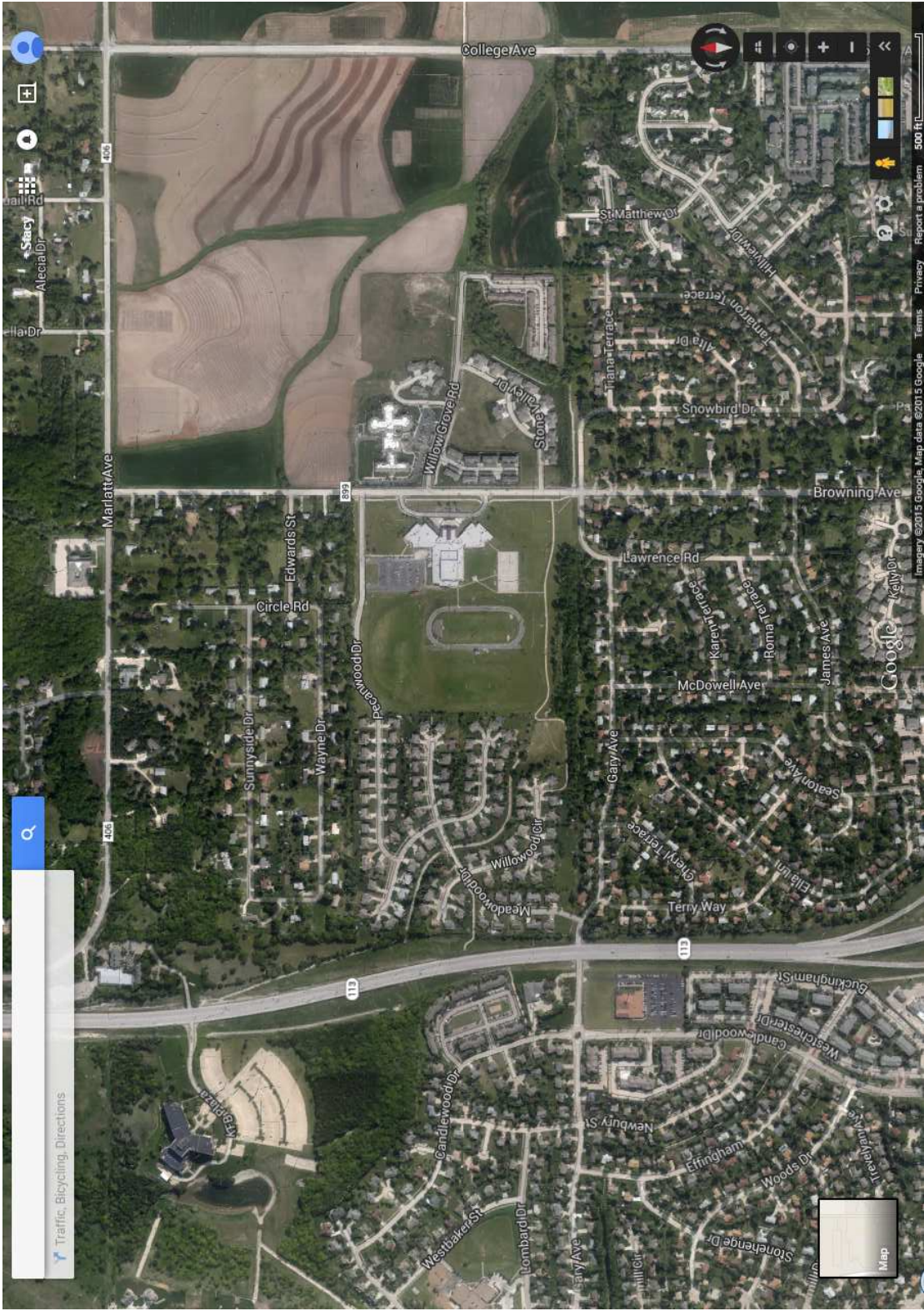
More Information about KLCIP 2005 | Kansas Biological Survey | Kansas Applied Remote Sensing (KARS)

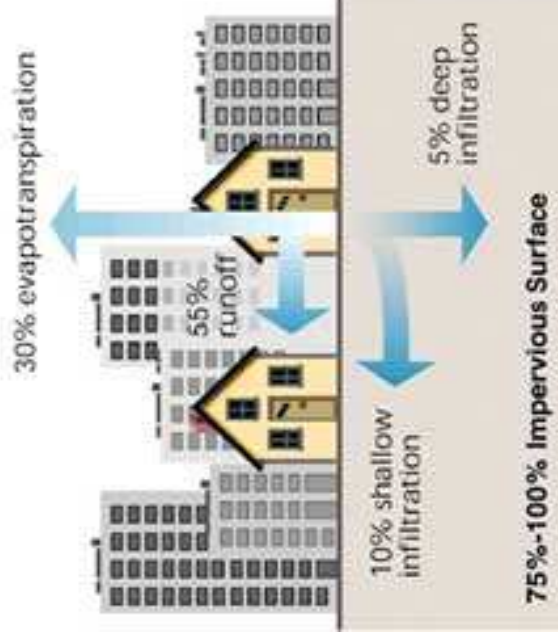
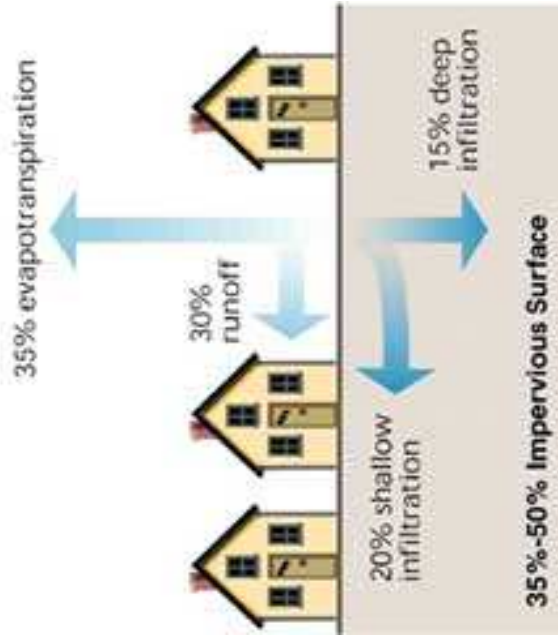
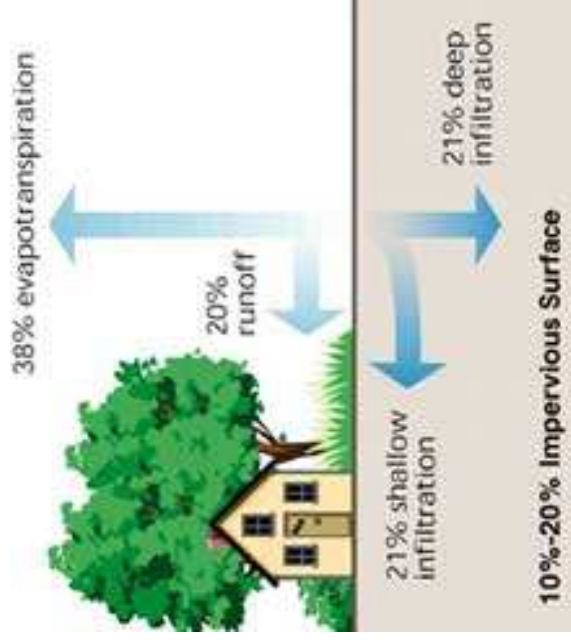
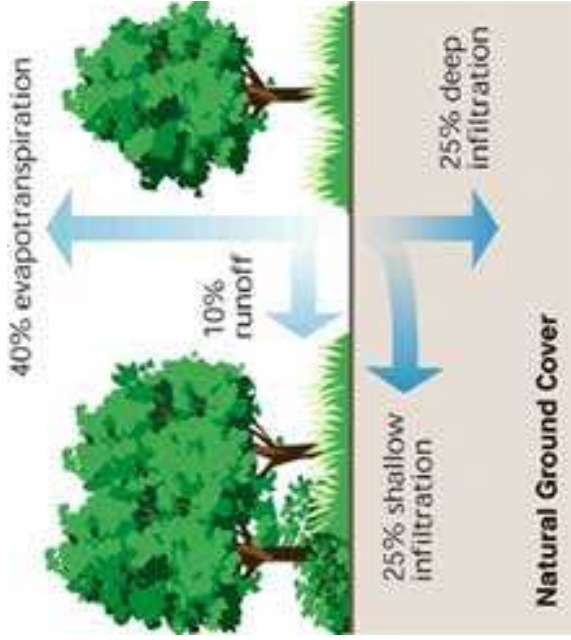


# Northwest Manhattan 1991







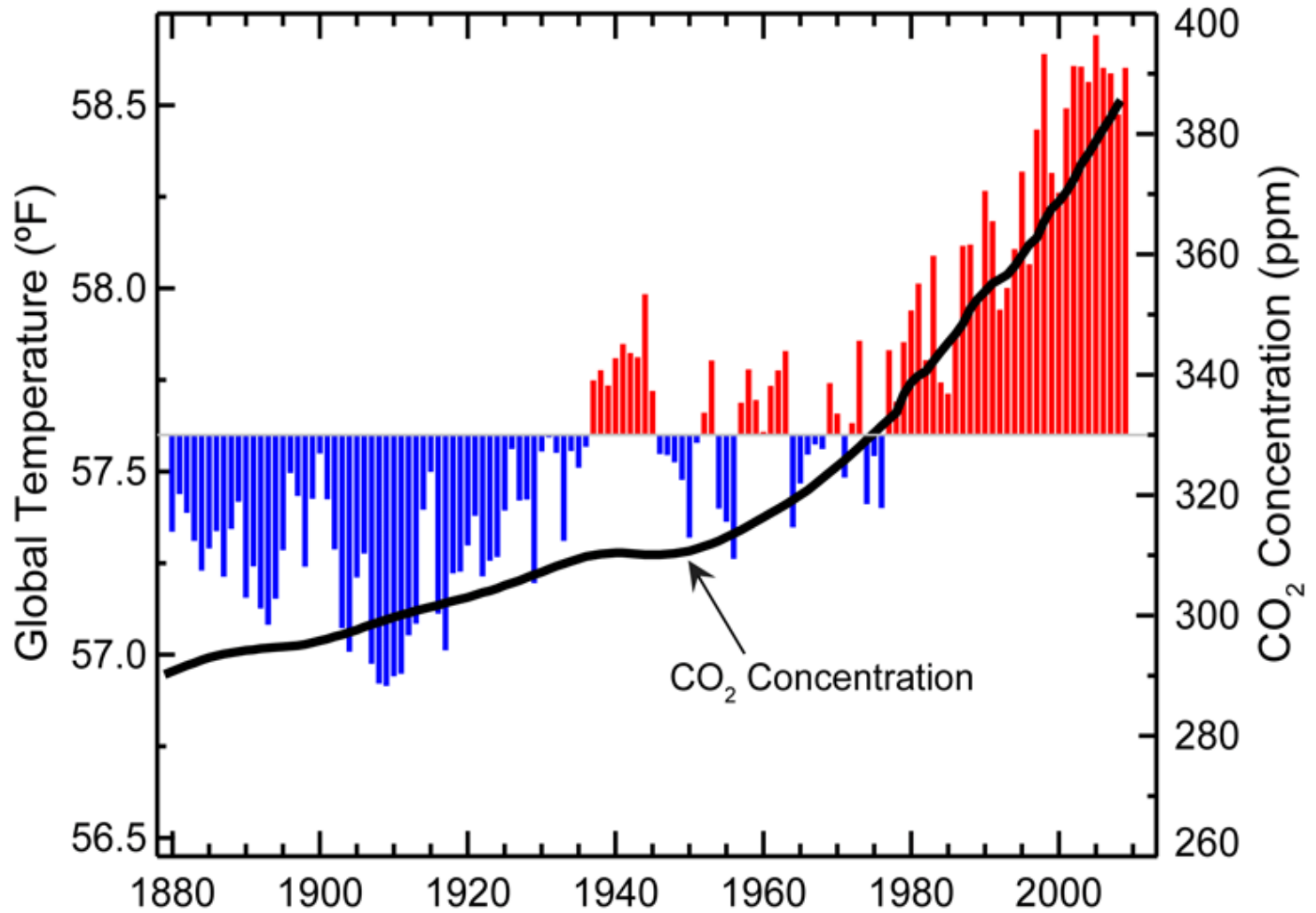


# The World is Changing...

- Landcover Change:
  - Conversion of natural lands for anthropogenic uses (e.g. agriculture and economic centers)
    - Change in runoff rates and volumes
    - Change in surface temperatures
    - Change in erosion potential
- **Climate Change:**
  - **More extreme weather events across the globe**



# Global Temperature and Carbon Dioxide



Year <http://www.isws.illinois.edu/atmos/statecli/climate-change/gtrends.htm>

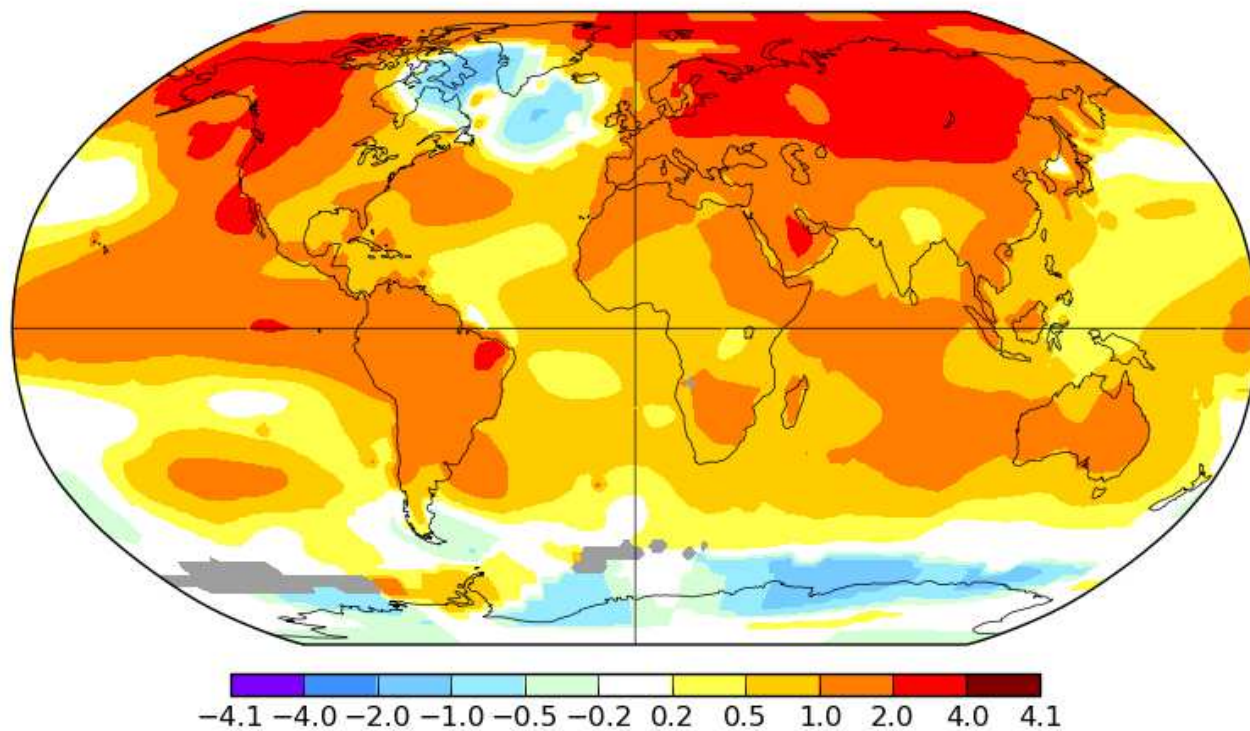


## Change in 2015 annual temperature relative to 1951-1980

Annual J-D 2015

L-OTI(°C) Anomaly vs 1951-1980

0.86



<http://data.giss.nasa.gov/gistemp/maps/>



# ClimateWizard



About Us    FAQ's    Contact Us

Follow @climatewizard

**Analysis Area**

United States  Global

Global

**Future Climate Model**  
IPCC Fourth Assessment  
Emission Scenario  
High A2

General Circulation Model  
Ensemble Average

**Time Period**

Past 50 Years  
 Mid Century (2050s)  
 End Century (2080s)

**Map Options**

Map of Average  
 Map of Change

Compare & Animate Models

**Measurement**

Average Temperature  
 Precipitation

Annual

**Resources**

[Case Studies](#)  
[Documentation](#) | [Developer Data and Map Image Download](#)  
[ClimateWizard Custom Analysis](#)  
[Printer Friendly Version](#)

## Change in Annual Precipitation by the 2080s

Model: Ensemble Average, SRES emission scenario: A2

50%: This map shows the precipitation change projected by the middle model. Areas that are blue are projected to increase by at least half of the model, and areas that are yellow to red are projected to decrease in precipitation by at least half of the models.

Map data Sources: Esri, HERE, DeLorme, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, Geobase, IGN, Kasaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), Swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

Lat: 46.26° Lon: -132.19°

Data Source: Historical Global 50km: Climatic Research Unit and the Tynsall Centre, Mitchell et. al. <http://clu.es.gar.org/PDF/mitchellones.pdf>

**Analysis Area**

United States     Global

Global

**Time Period**

Past 50 Years     Mid Century (2050s)     End Century (2080s)

**Map Options**

Map of Average     Map of Change

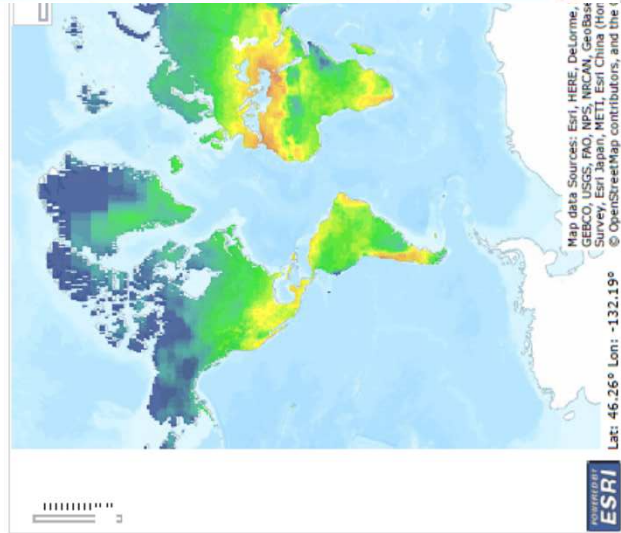
Compare & Animate Models

**Measurement**

Average Temperature     Precipitation

Annual

**Change in Annual Precipitation by**  
Model: Ensemble Average, SRES emission s



Data Source: Historical Global 50km: Climatic Research Unit and the Tyndall Centre. Mitchell et al. <http://rcs.org.org/PDF/mitchellones.pdf>

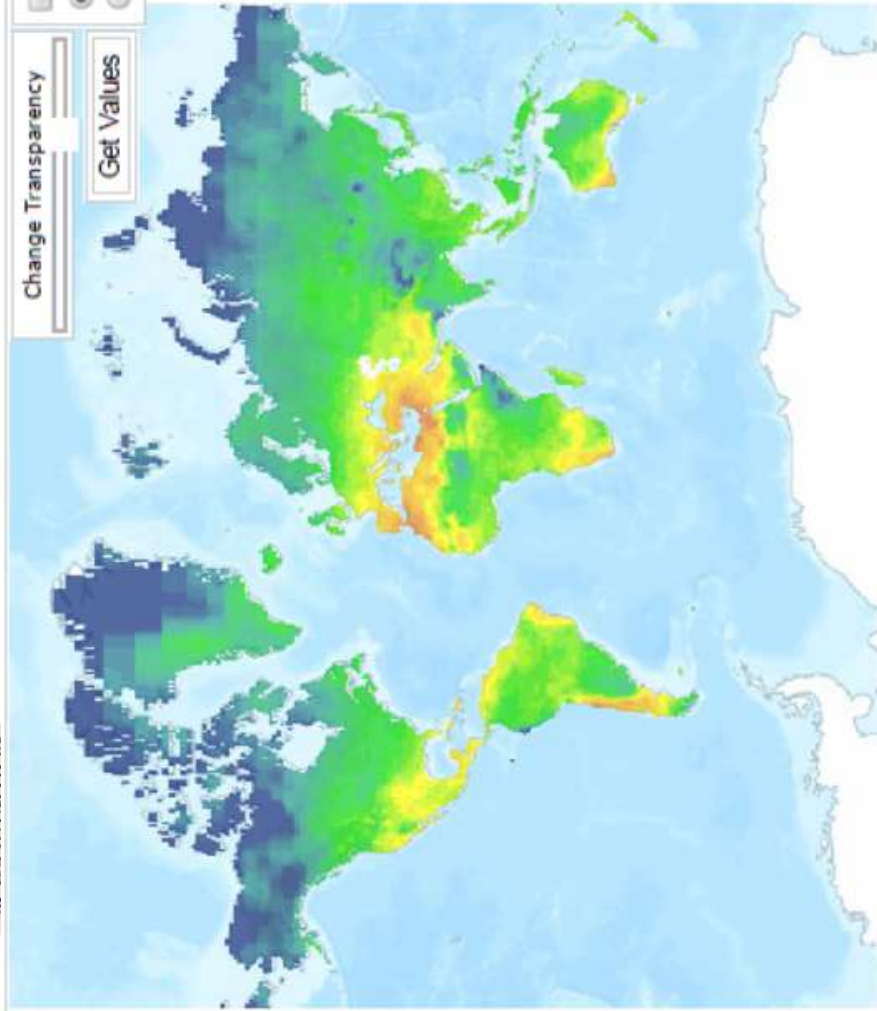
50%: This map shows the precipitation change projected by the middle model. Areas that are blue are projected to increase by at least half of the models, and areas that are yellow to red are projected to decrease precipitation by at least half of the models.

Change Transparency

Get Values

Factoids

Topo     World



Map data Sources: Esri, HERE, DeLorme, Intermap, Increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

Lat: 46.26° Lon: -132.19°

Historical Global 50km: Climatic Research Unit and the Tyndall Centre. Mitchell et al.

<http://rcs.org.org/PDF/mitchellones.pdf>




HOME PAGE | TODAY'S PAPER | VIDEO | MOST POPULAR | TIMES TOPICS | [Subscribe: Digital / Home Delivery](#) | [Log In](#) | [Register Now](#) | [Help](#)


**The New York Times** **Environment**  [Go](#) [ING DIRECT](#)

WORLD | U.S. | N.Y. / REGION | BUSINESS | TECHNOLOGY | SCIENCE | HEALTH | SPORTS | OPINION | ARTS | STYLE | TRAVEL | JOBS | REAL ESTATE

ENVIRONMENT | SPACE & COSMOS

[www.cia.gov](#) **NATIONAL CLANDESTINE SERVICE CAREERS** 

**CHANGES IN THE AIR**  
**A City Prepares for a Warm Long-Term Forecast**



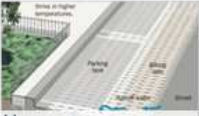
Leroy Leobetter tending a rooftop garden created to reduce energy use by Chicago's City Hall. Sally Kohn for The New York Times

By LESLIE KAUFMAN  
 Published: May 22, 2011



**CHICAGO —** The Windy City is preparing for a heat wave — a permanent one.


**Changes in the Air**  
 This is the first article in a series on strategies for adapting to climate change.

Climate scientists have told city planners that based on current trends, Chicago will feel more like Baton Rouge than a Northern metropolis before the end of this century.

**Multimedia**  

 So, Chicago is getting ready for a wetter, steamier future. Public alleyways are being repaved with materials that are permeable to water. The white oak, the state tree of Illinois, has been banned from city planting lists, and swamp oaks and sweet gum

**What's Popular Now**





- Strauss-Kahn Case Seen as in Jeopardy 
- To the Limit 

**THE JAMES WEBB SPACE TELESCOPE - USHERING IN THE NEXT ERA OF SPACE DISCOVERY.**  
[LEARN MORE](#)  
  
 Photo Credit: NASA/ESA  
**NORTHROP GRUMMAN**

**RECOMMEND** | **TWITTER** | **COMMENTS (134)** | **SIGN IN TO E-MAIL** | **PRINT** | **SINGLE PAGE** | **REPRINTS** | **SHARE**

**SNOW FLOWER and the SECRET FAN**  
**WATCH THE TRAILER**

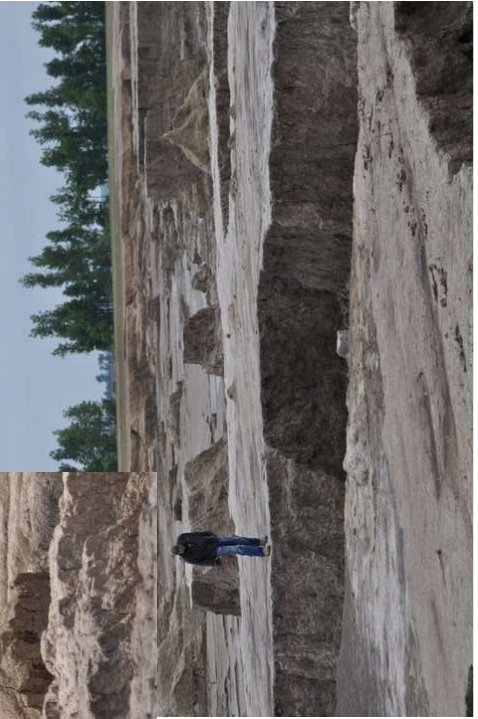
**MOST E-MAILED** | **MOST VIEWED**

1. Married, With Infidelities 
2. Strauss-Kahn Case Faces Test in Hearing 
3. OP-ED COLUMNIST: To the Limit 
4. OP-ED CONTRIBUTOR: Practicing Medicine Can Be Grimm Work 

New York Times  
 May 22, 2011

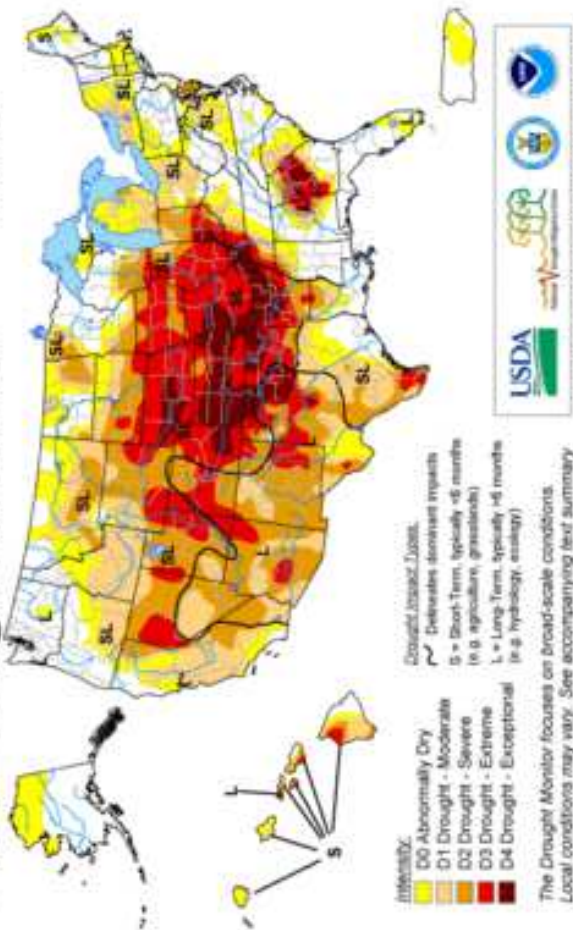
“Chicago- The windy city is preparing for a heat wave- a permanent one...”





# U.S. Drought Monitor

August 21, 2012  
Valid 7 a.m. EDT



Released Thursday, August 23, 2012

Author: Michael Brewer, LL

<http://droughtmonitor.unl.edu/>



## Greatest Percent Area of Lower 48 States in Drought, Since 1895



# Water security issues related to change....

- Water Quantity
  - Is there enough water?
  - Is there too much water?
- Water Quality
  - Is the water safe to:
    - Drink?
    - Bath?
    - Grow food?