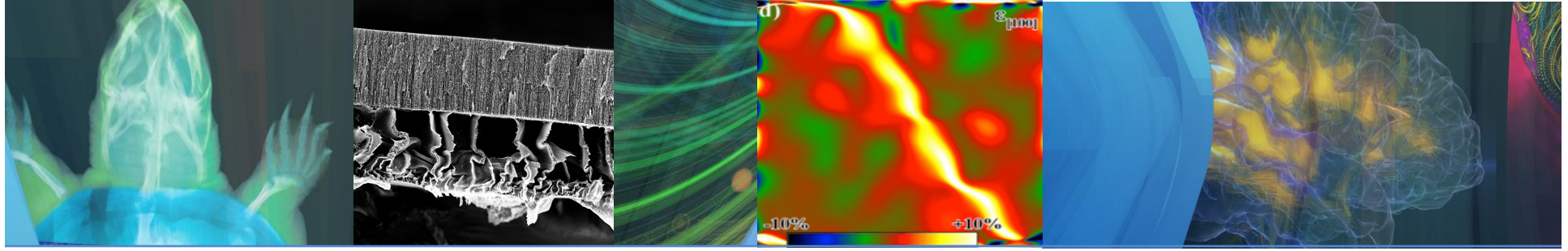


American Academy of Environmental Engineers and Scientists
Excellence in Environmental Engineering and Science Awards Luncheon

The Engineering Grand Challenges – Where Environmental Engineering fits into the Landscape of Transformative Research

National Press Club

April 19, 2018

Washington DC

Karl Rockne, PhD, PE, BCEE: Environmental Engineering Program Director

Chemical, Bioengineering, Environmental and Transport Processes

National Science Foundation

Overview

1. Two Questions
2. NSF Mission, Vision Statement, and 1440 Program Overview
3. The “Standard Model” of Environmental Engineering:

   Inspiration, Concerns, Responses, Successes, and Challenges
4. Grand Challenges for the 21st Century
5. Is past prologue?
6. Q&A

Two questions to ponder…

1. What is the best ROI you have ever heard of?

2. Which profession has saved the most lives?

II) NSF Mission and Vision

NSF Statutory Mission

- To promote the **progress of science**; to advance the national **health, prosperity, and welfare**; and to secure the national defense; and for other purposes.

  —From The National Science Foundation Act of 1950 (P.L. 81-507)

NSF Vision Statement

- NSF envisions a nation that **capitalizes** on new concepts in science and engineering and provides **global leadership** in **advancing research and education**.

  —From "Empowering the Nation Through Discovery and Innovation, NSF Strategic Plan for Fiscal Years 2011-2016"

- NSF-funded research must have **Intellectual Merit *and* Broader Impacts**

National Science Foundation | Directorate for Engineering

Chemical, Bioengineering, Environmental, and Transport Systems Division (CBET)

Division Director
Richard Dickinson

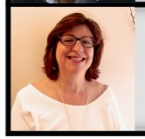
Deputy Division Director
(Acting)
Timothy Patten

Chemical Process Systems

1401
Catalysis
Robert McCabe

1417
Process Separations
Angela Lueking

1403 Process Systems, Reaction Engineering, & Molecular Thermodynamics
Triantafillos Mountziaris

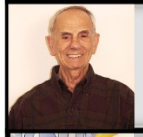


7644
Energy for Sustainability
Carole Read

Engineering Biology & Health

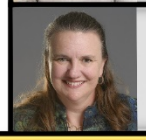
1491 Cellular & Biochemical Engineering
Steven Peretti

5345
Engineering of Biomedical Systems
Michele Grimm



7236
Biophotonics
Leon Esterowitz

7909
Nano-Biosensing
Chenzhong Li



5342 Disability & Rehabilitation Engineering
Michele Grimm

Environmental Engineering & Sustainability

1440
Environmental Engineering
Karl Rockne

1179 Biological & Environmental Interactions of Nanoscale Materials
Nora Savage

7643
Environmental Sustainability
Bruce Hamilton

022Y
INFEWS
James Jones

Transport Phenomena

1407
Combustion & Fire Systems
Song-Charng Kong

1443
Fluid Dynamics
Ronald Joslin

1415 Particulate & Multiphase Processes
Susan Muller

1406
Thermal Transport Processes
José Lage

Associate Program Directors

Chemical Process Systems Cluster
VACANT

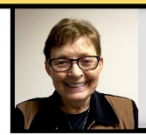
Engineering Biology & Health Cluster
Christina Payne

Environmental Engineering & Sustainability Cluster
Brandi Schottel

Transport Phenomena Cluster
VACANT

Division Experts and AAAS Science & Technology Policy Fellows

Multiple Programs Expert
Geoffrey Prentice



Engineering of Biomedical Systems Expert
Carol Lucas

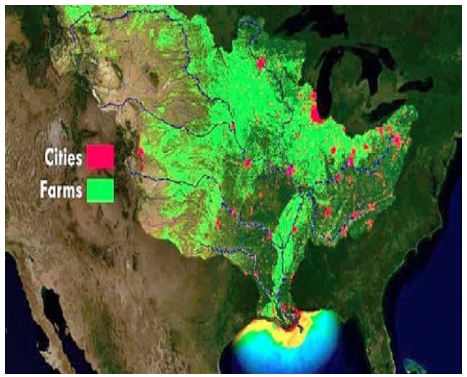
AAAS S&T Policy Fellow
Gregory Meyer

AAAS S&T Policy Fellow
Emily Aurand

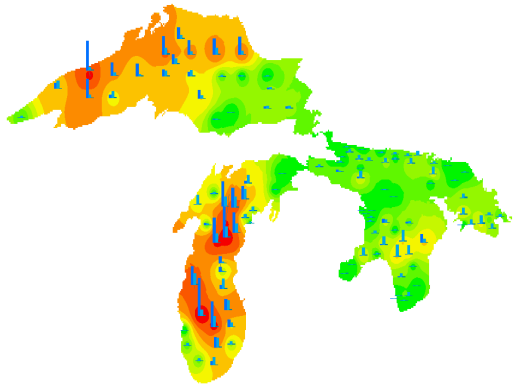
CBET Environmental Engineering: Program Emphasis Areas (1440)

Program Goal: Fund **transformational** and high risk/high reward research to:

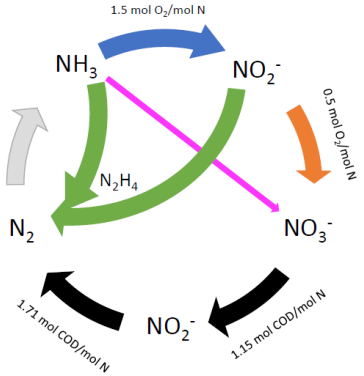
- **Prevent/minimize release** of pollution to **soil**, **water,** and **air**
- **Mitigate:** Ecological and human health impacts of such releases by smart/ adaptive manipulation of the environment
- **Remediate** polluted environments through engineered **chemical**, **biological,** and **geo/physical** processes
- Integral to achieving these goals is the **fundamental understanding of pollutant transport** in the environment and **how to harness and control their biological, chemical, and geo/physical reactions**



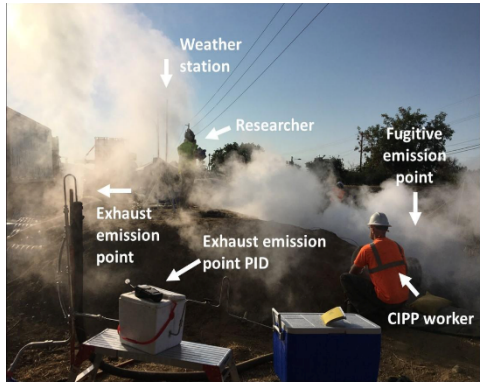
USGS (2007)



Guo et al. (2017)



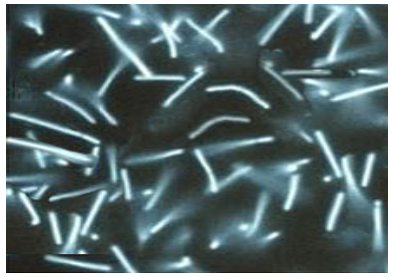
Chandran et al. (2017)



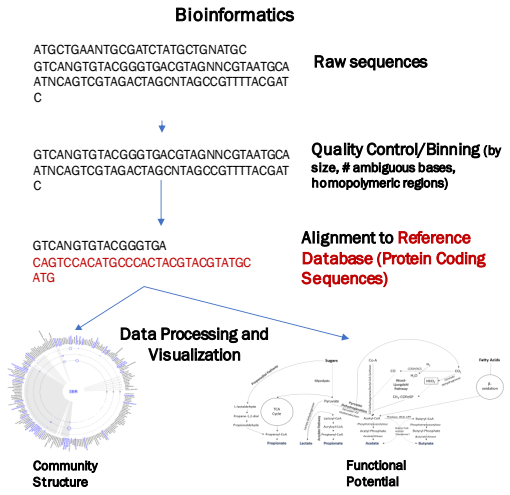
Whelton, Purdue Univ (*2017)*

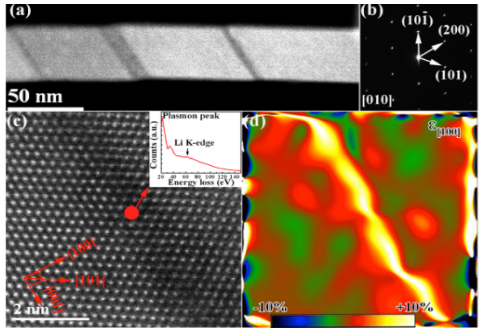
CBET Environmental Engineering (1440)

Program Emphasis Areas

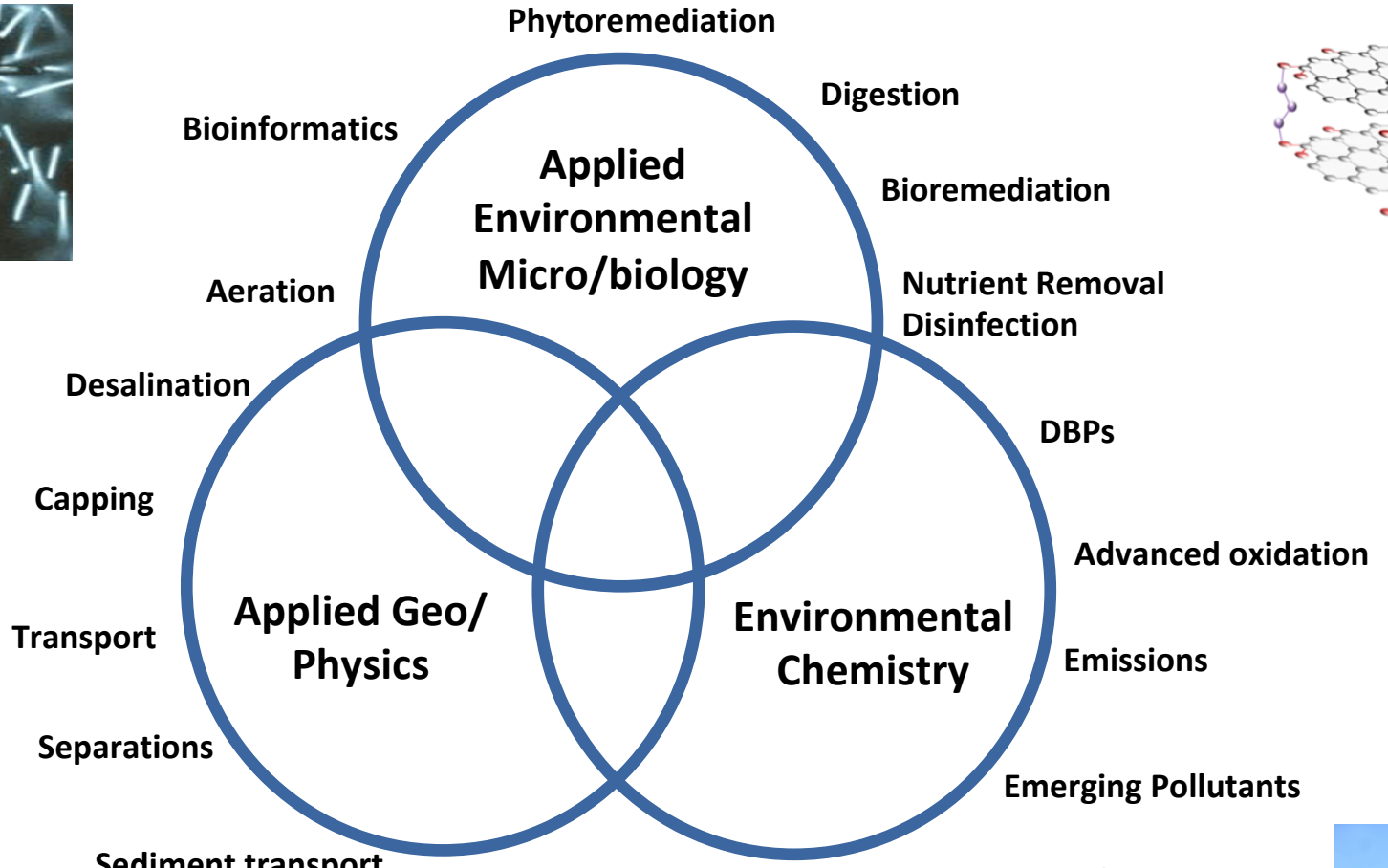


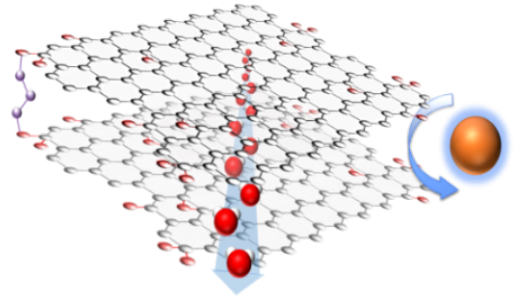
Chandran et al. (2017)

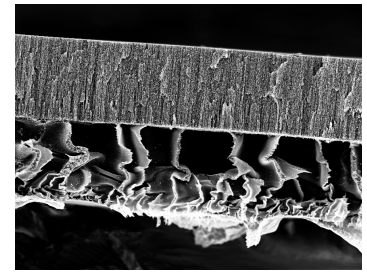




Chaplin (2017)







Chaplin (2017)

Li (2008)

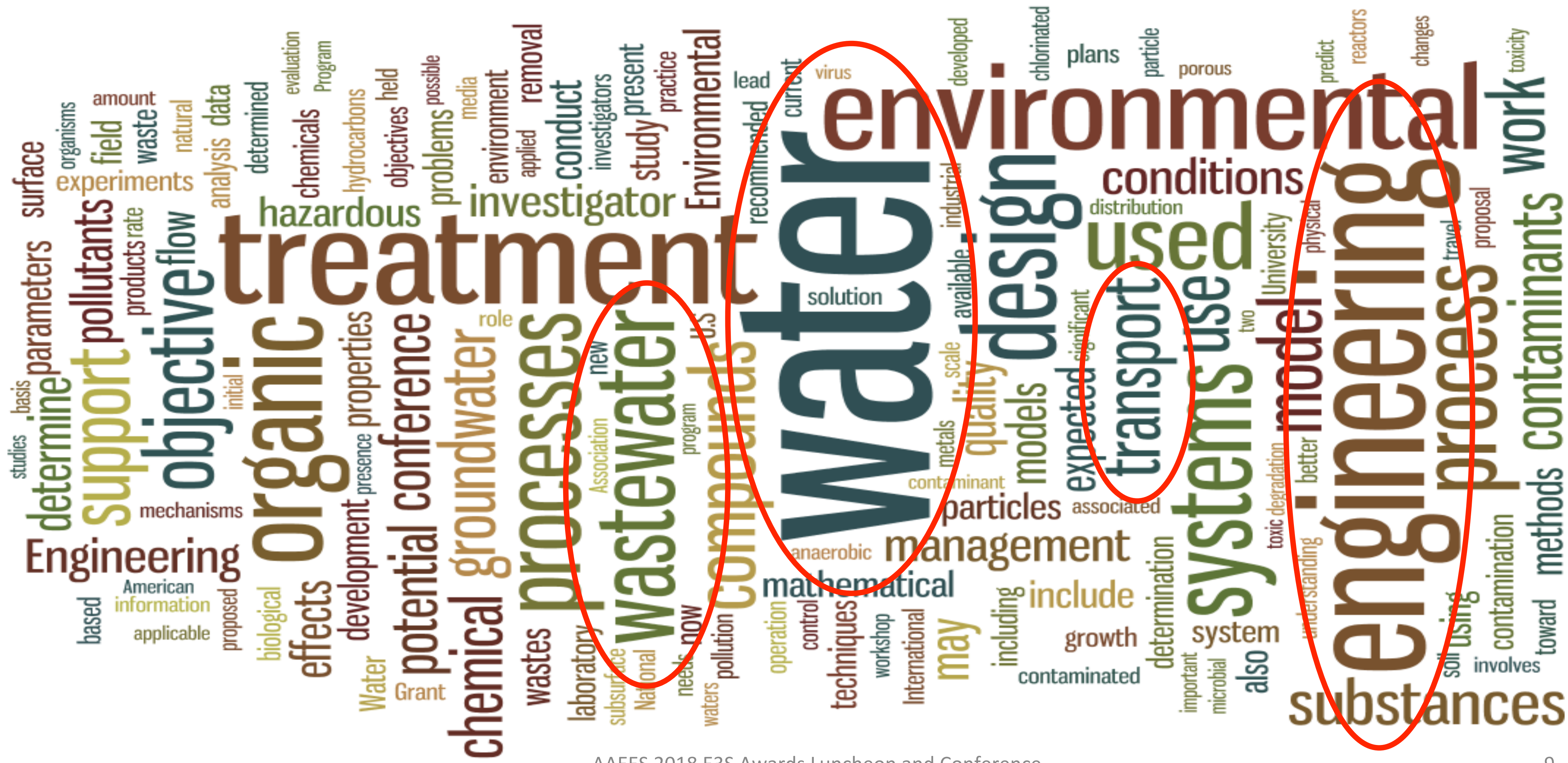
“The words you speak become the house you live in”

-Hafez (1315-1390)

A trip through the Environmental Engineering program abstracts

http://www.iub.edu/~iuam/online_modules/islamic_book_arts/exhibit/manuscripts/divan_hafiz.html

Pre-1990s



water
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pollutants
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parameters
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flow
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investigator
Environmental
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present
study
practice
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problems
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held
possible
media
applied
investigators
chemicals
hydrocarbons
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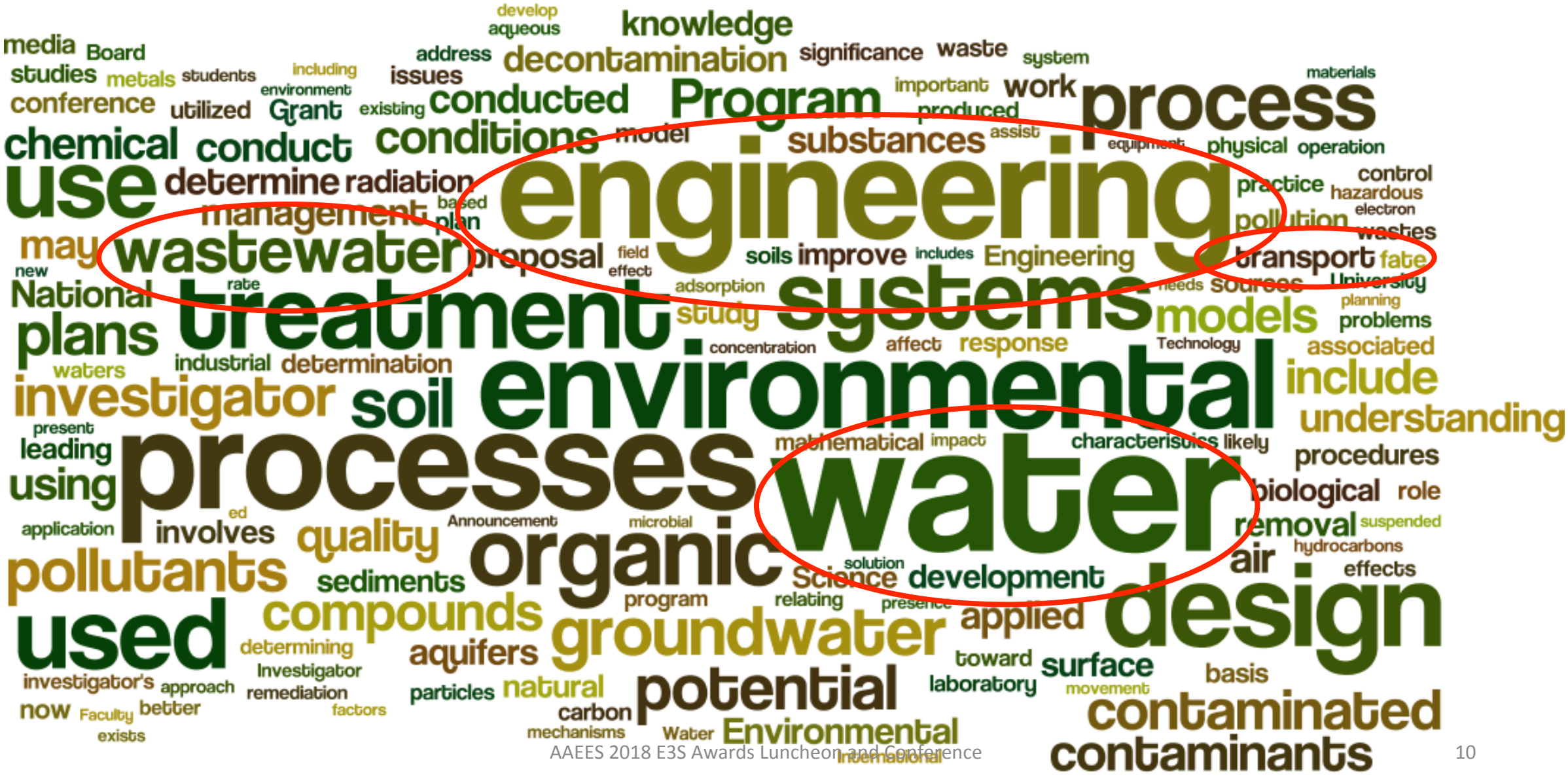
1990s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2000-2005


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2005-2010


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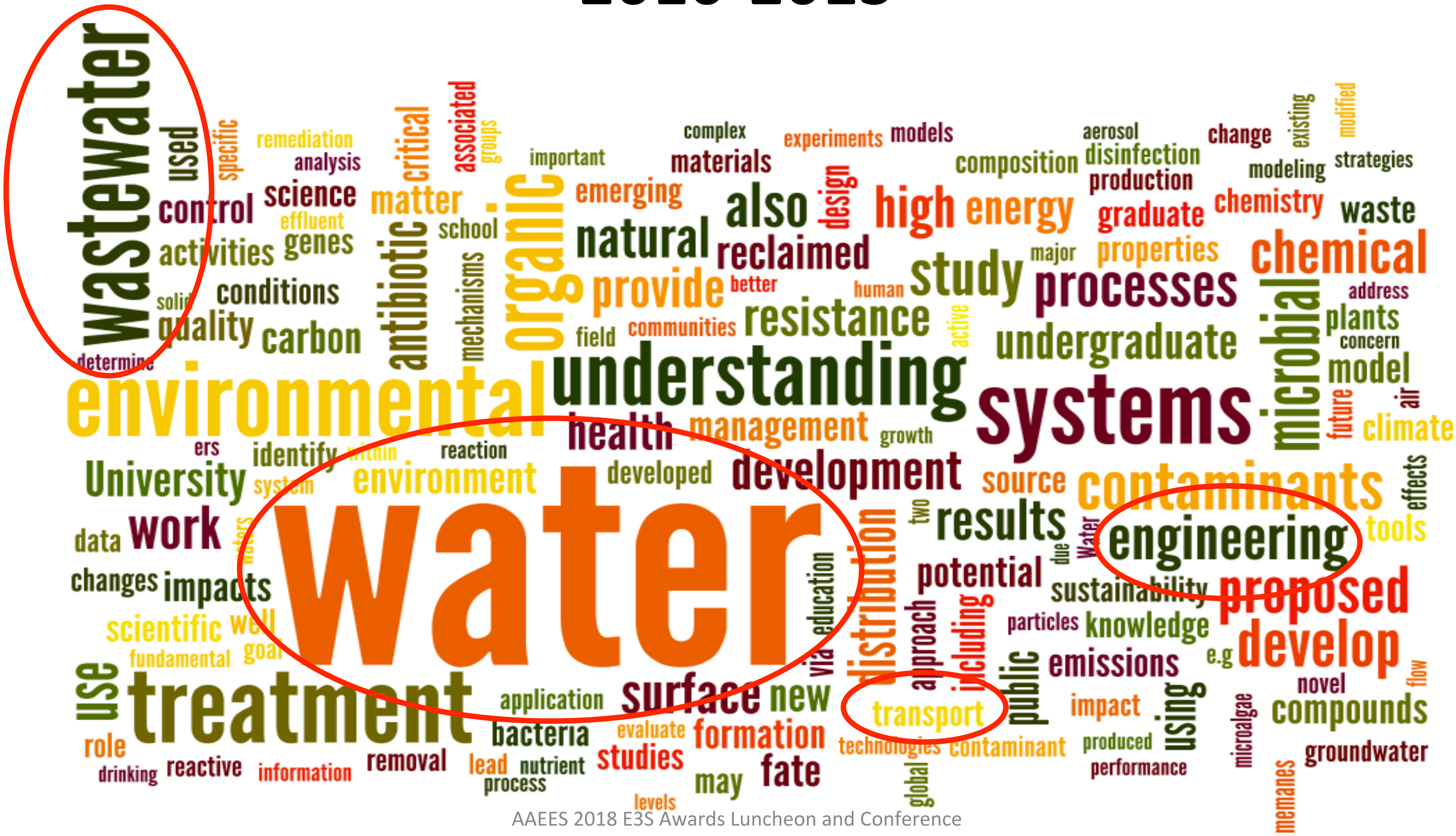
2010-2015


wastewater
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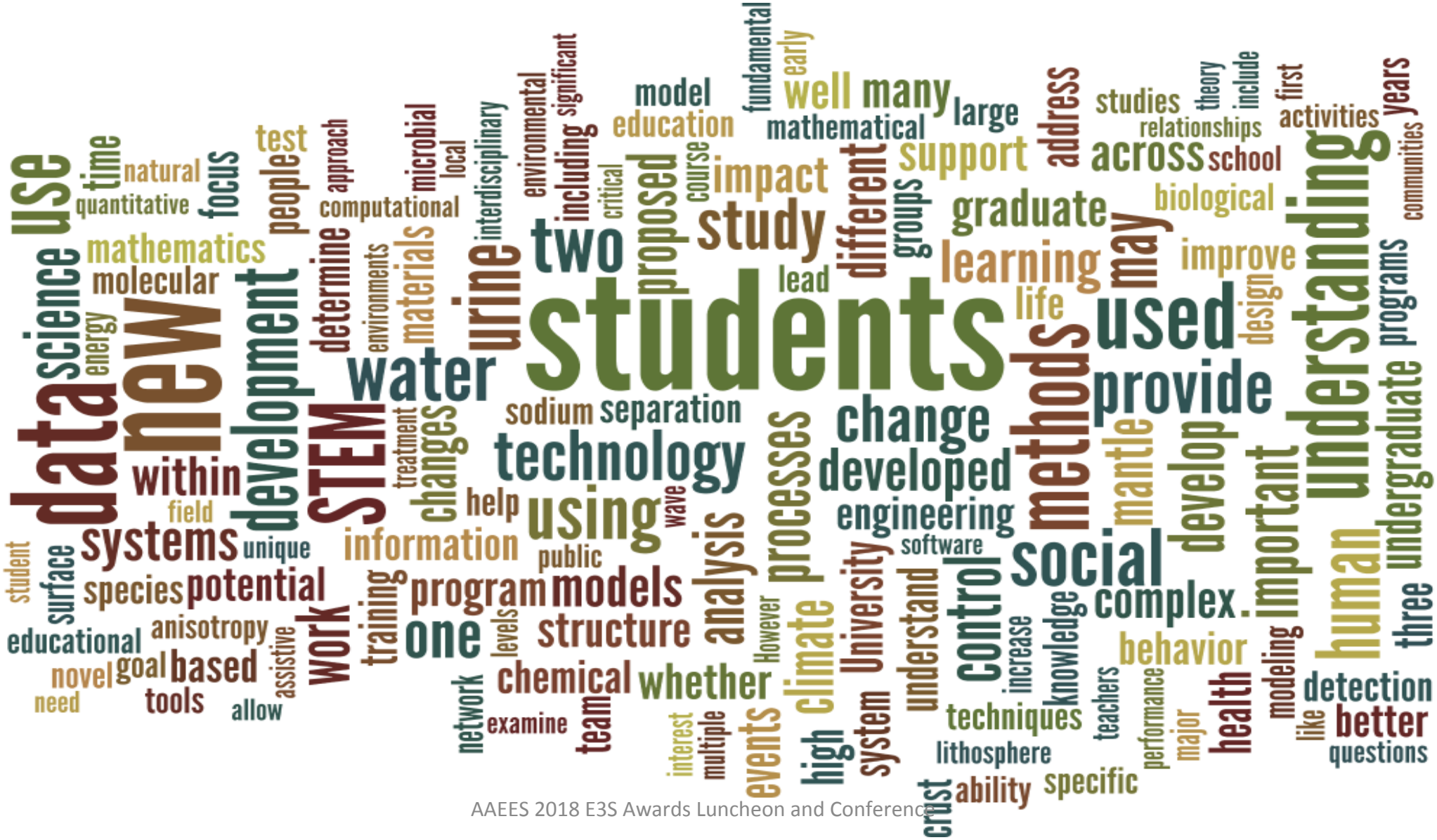
2015-present (minus one word)

2015-present



III) The “Standard Model” of Environmental Engineering

INSPIRATION

CONCERNS

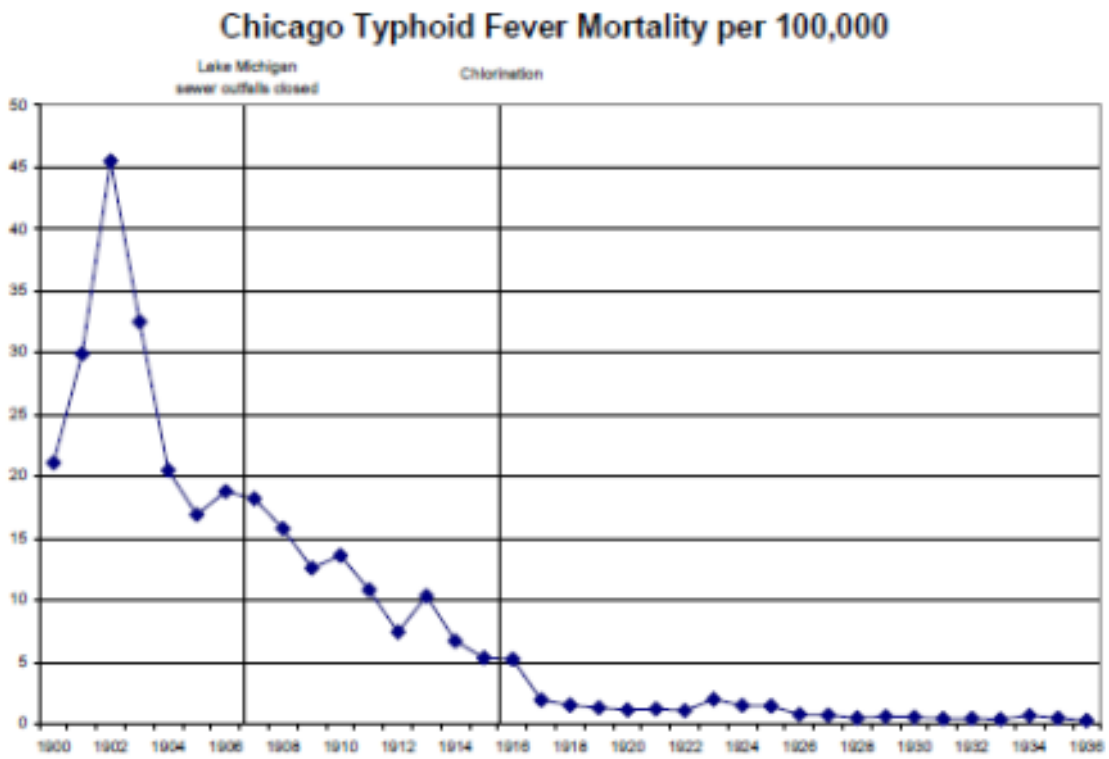
RESPONSES

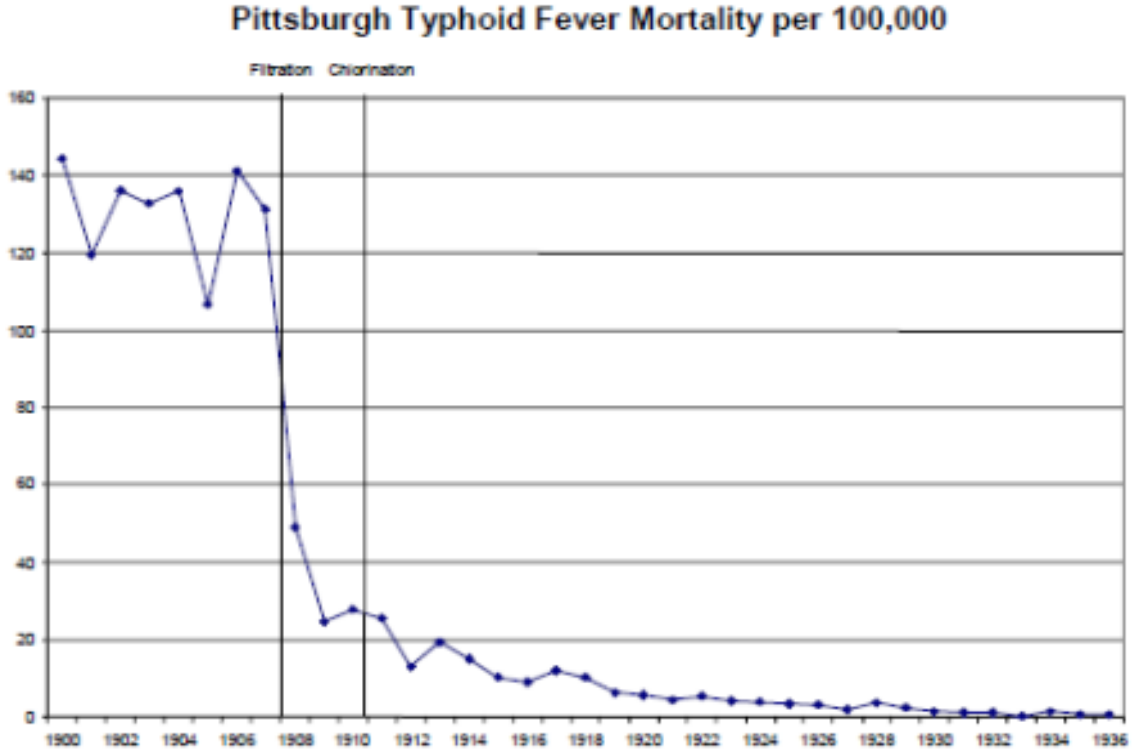
Legislation

- SDWA
- CWA
- CAA
- GLWPA
- CERCLA
- RCRA
- Etc…

SUCCESSES

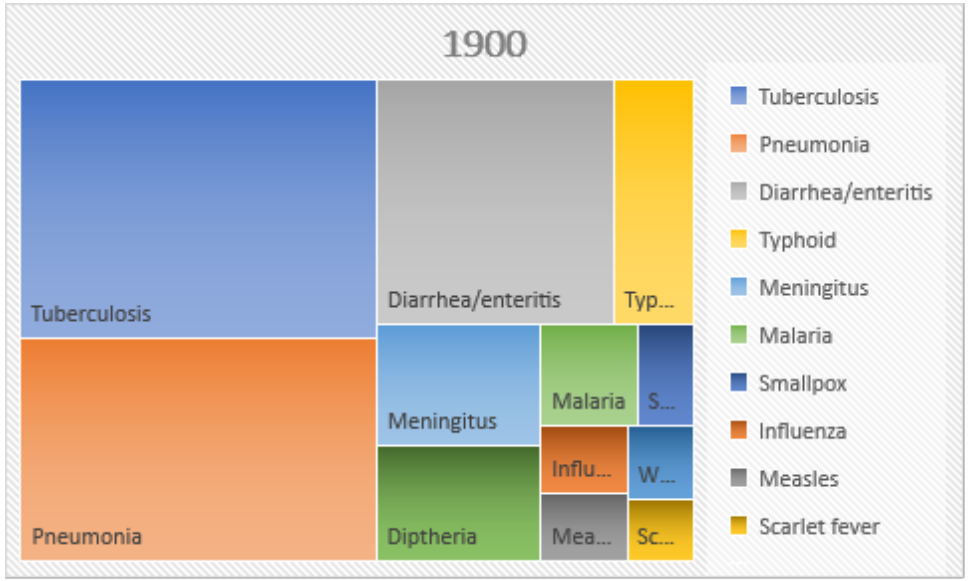
…But some of our greatest successes were <u>well before</u> the modern environmental movement

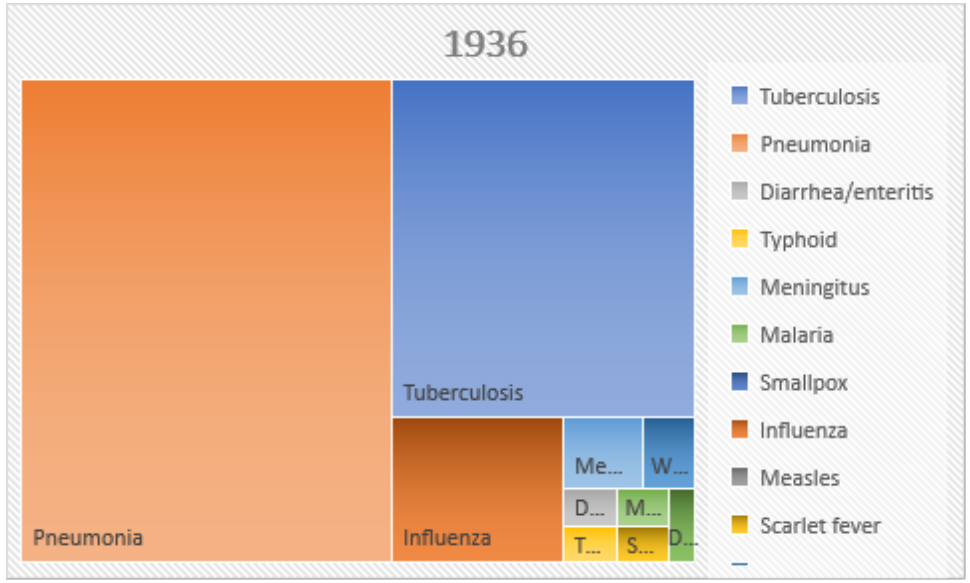




Figures from Cutler and Miller (*2004)*
National Bureau of Economic Research

Early “Environmental Engineers” helped save millions and increased US lifespan

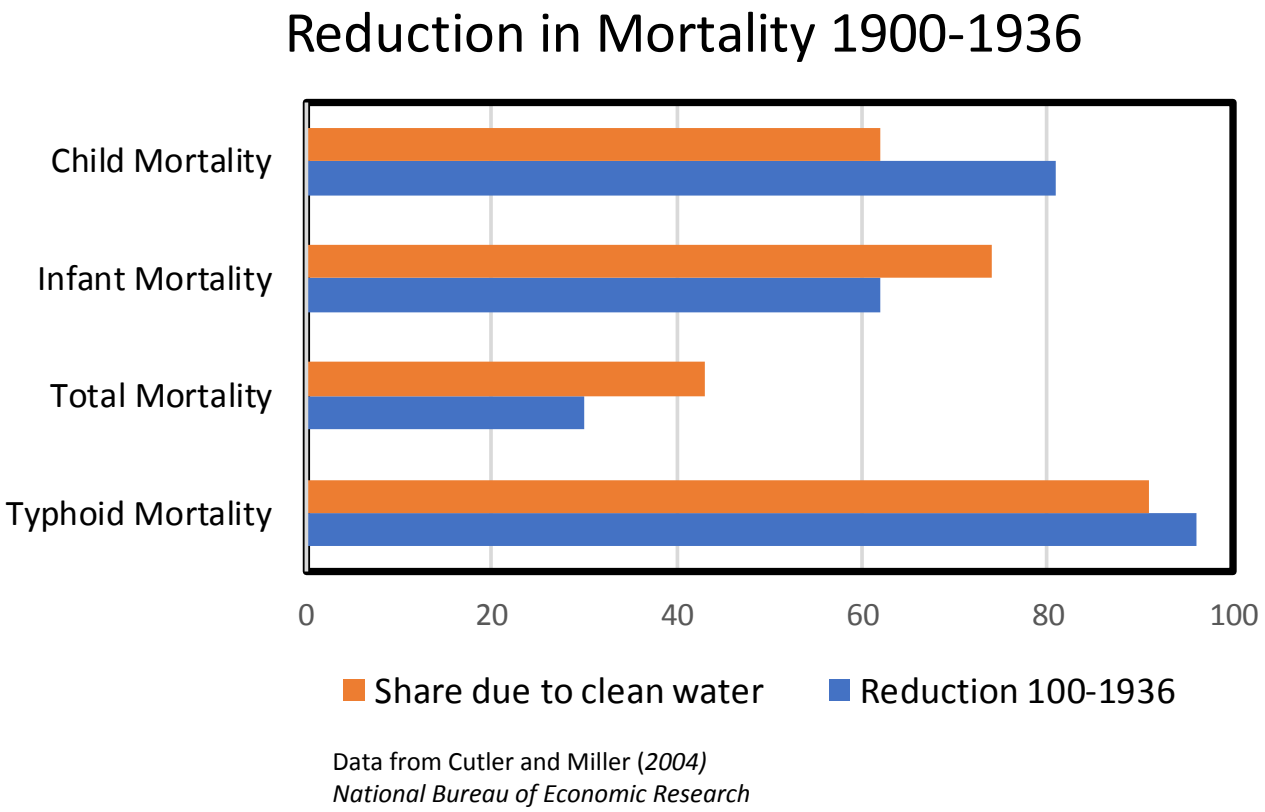




Data from Cutler and Miller (*2004)*
National Bureau of Economic Research

Completely changed the shape of childhood disease in a few decades

The social ROI: $23 per $1 spent on water infrastructure



Data from Cutler and Miller (*2004)*
National Bureau of Economic Research

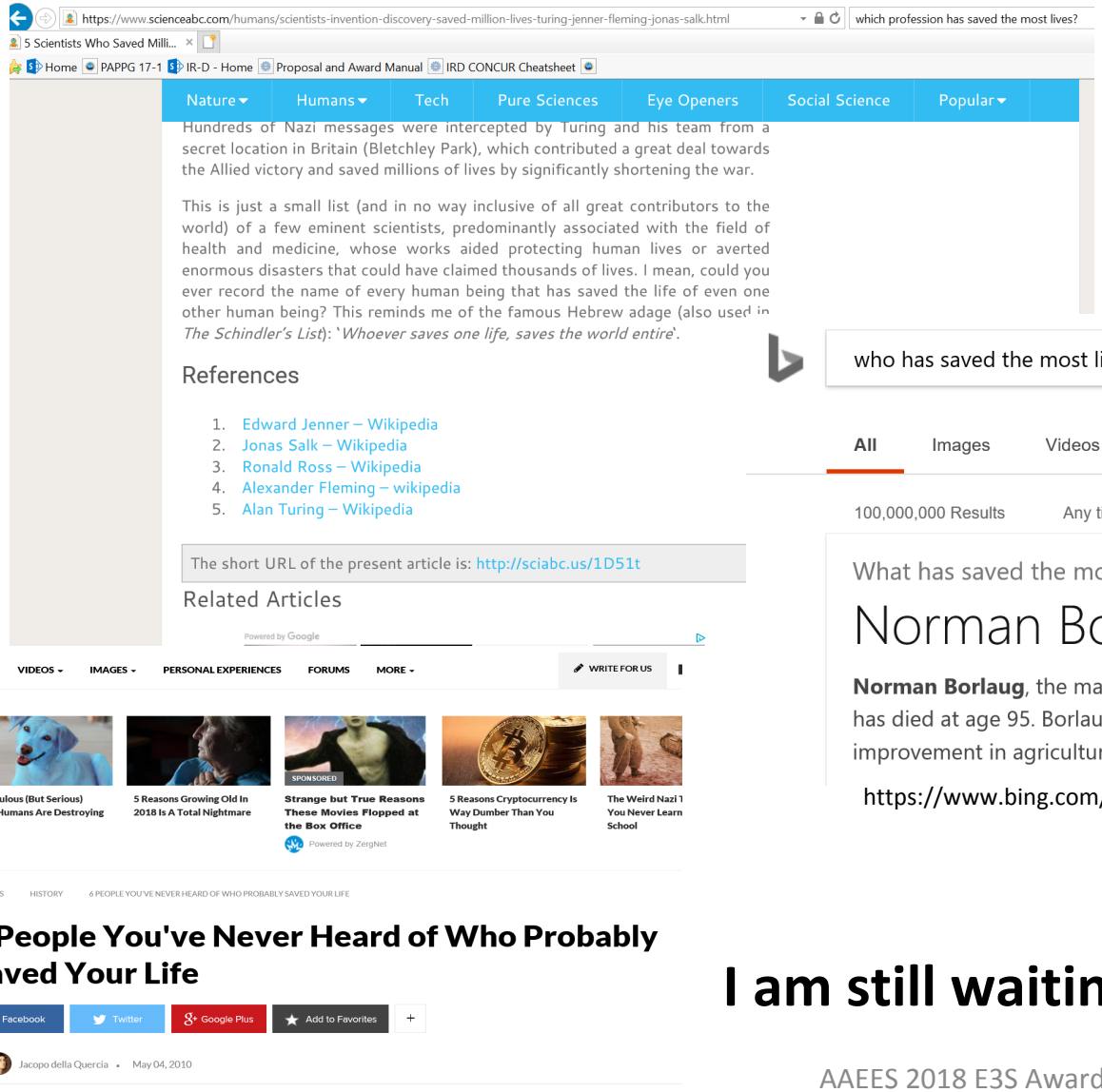
Annual US deaths prevented
1500/100,000

Person-years saved
58,000

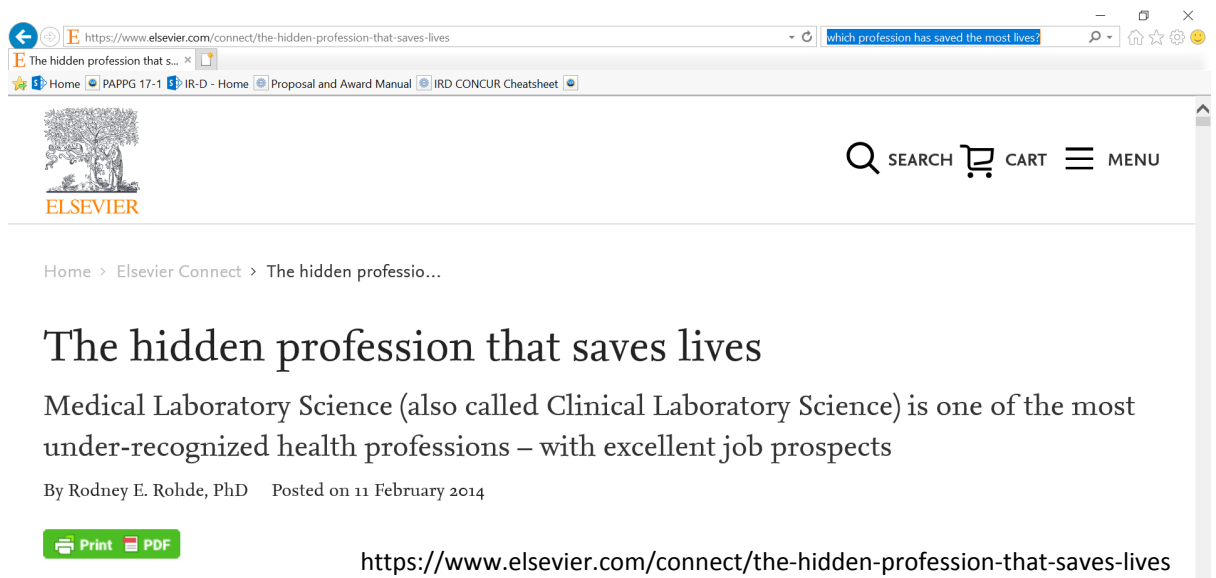
Annual benefits (2018 $)
$920M

So where is the love?

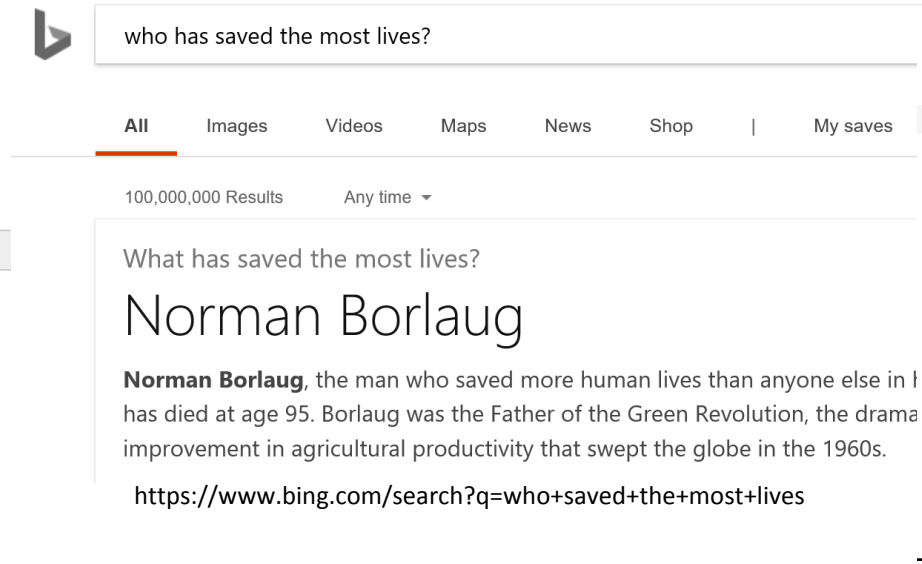
https://www.scienceabc.com/



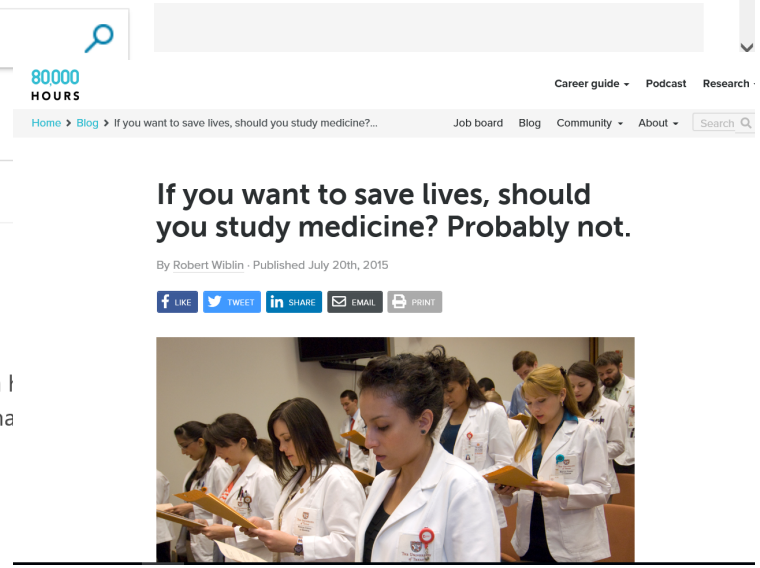
http://www.cracked.com/article_18519_6-people-youve-never-heard-who-probably-saved-your-life.html



https://www.elsevier.com/connect/the-hidden-profession-that-saves-lives



https://www.bing.com/search?q=who+saved+the+most+lives



https://80000hours.org/2015/07/if-you-want-to-save-lives-should-you-study-medicine-probably-not/

I am still waiting for the Environmental Engineer TV show!

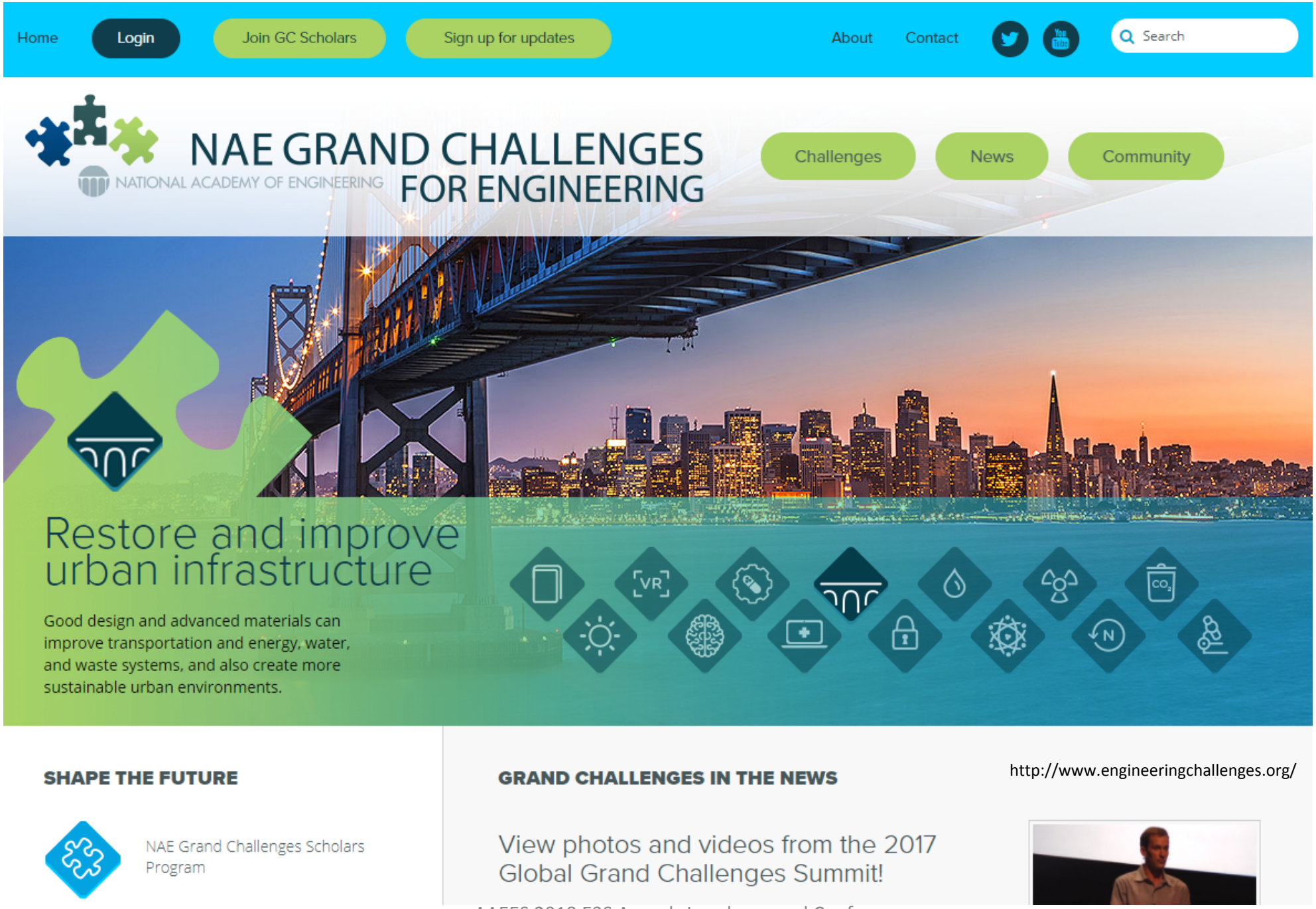
IV) Grand Challenges for Environmental Engineers and Scientists in the 21st Century

http://nas-sites.org/dels/eechallenges/

The National Academies of
SCIENCES · ENGINEERING · MEDICINE

Grand Challenges for Environmental Engineering and Science in the 21st Century

www.nas-sites.org/dels/eeschallenges #GrandChallenges



http://www.engineeringchallenges.org/

NAE GRAND CHALLENGES FOR ENGINEERING

1. Advance Personalized Learning
2. Make Solar Energy Economical
3. Enhance Virtual Reality
4. Reverse-Engineer the Brain
5. Engineer Better Medicines
6. Advance Health Informatics
7. **Restore and Improve Urban Infrastructure**
8. Secure Cyberspace
9. **Provide Access to Clean Water**
10. Provide Energy from Fusion
11. Prevent Nuclear Terror
12. **Manage the Nitrogen Cycle**
13. **Develop Carbon Sequestration Methods**
14. Engineer the Tools of Scientific Discovery

Study charge

- Identify high priority challenges and opportunities for the broad field of environmental engineering for the next several decades

http://nas-sites.org/dels/eechallenges/

- Identify key questions that **require the expertise of environmental engineering & science** to address;
- Identify **areas where knowledge and practice need to advance** to address these challenges

Committee Membership

Domenico Grasso – University of Delaware

Craig H. Benson (NAE) – University of Virginia

Amanda Carrico – University of Colorado,

Kartik Chandran – Columbia University,

Wayne Clough (NAE) – Emeritus, Smithsonian Institution; Georgia Institute of Technology

John C. Crittenden (NAE) – Georgia Institute of Technology

Daniel S. Greenbaum – Health Effects Institute

Steven P. Hamburg – Environmental Defense Fund

Thomas C. Harmon – University of California, Merced

James M. Hughes (NAM) – Emory University School of Medicine

Kimberly L. Jones – Howard University

Linsey C. Marr – Virginia Polytechnic Institute

Robert Perciasepe – Center for Climate and Energy Solutions

Stephen Polasky (NAS) – University of Minnesota

Maxine L. Savitz (NAE) – Honeywell, Inc.

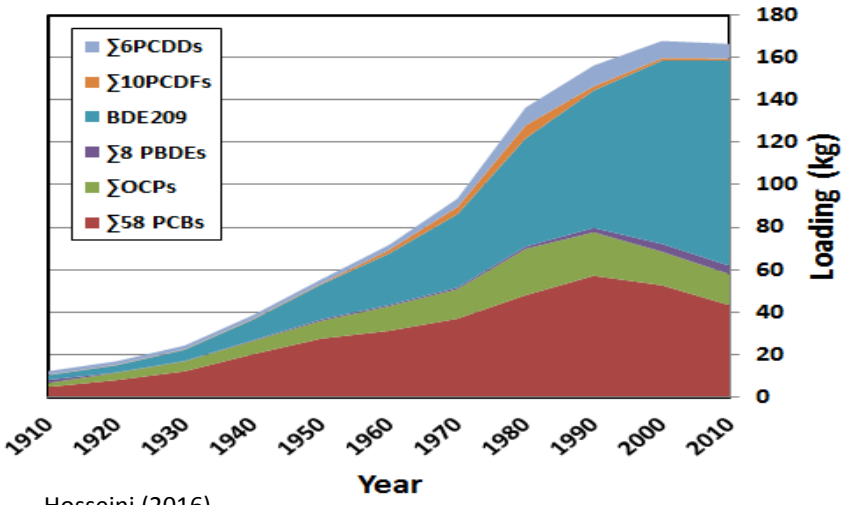
Norman R. Scott (NAE) – Cornell University

Rhodes Trussell (NAE) – Trussell Technologies, Inc.

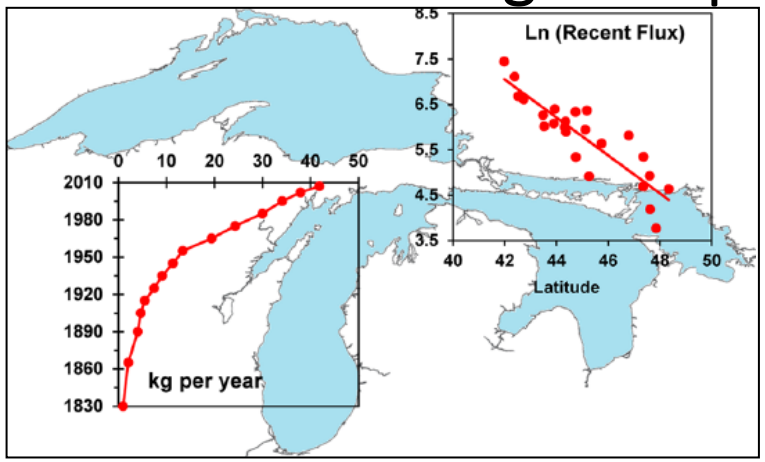
Julie Zimmerman – Yale University

Emerging Pollutants

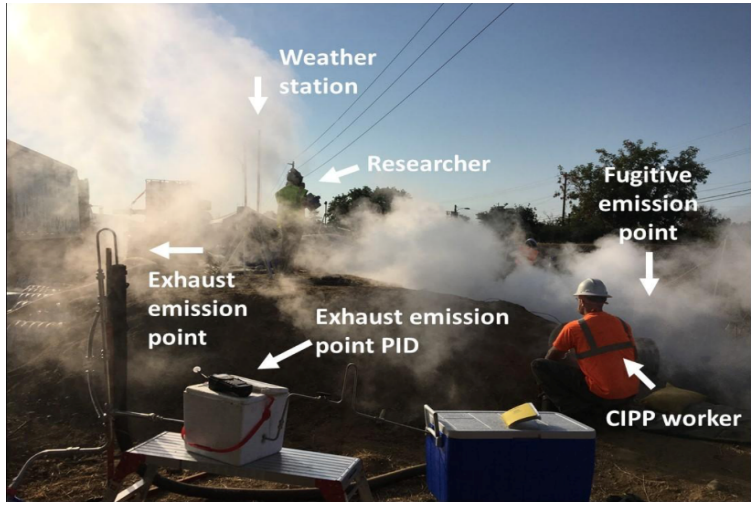
While legacy pollutants decrease others are taking their place



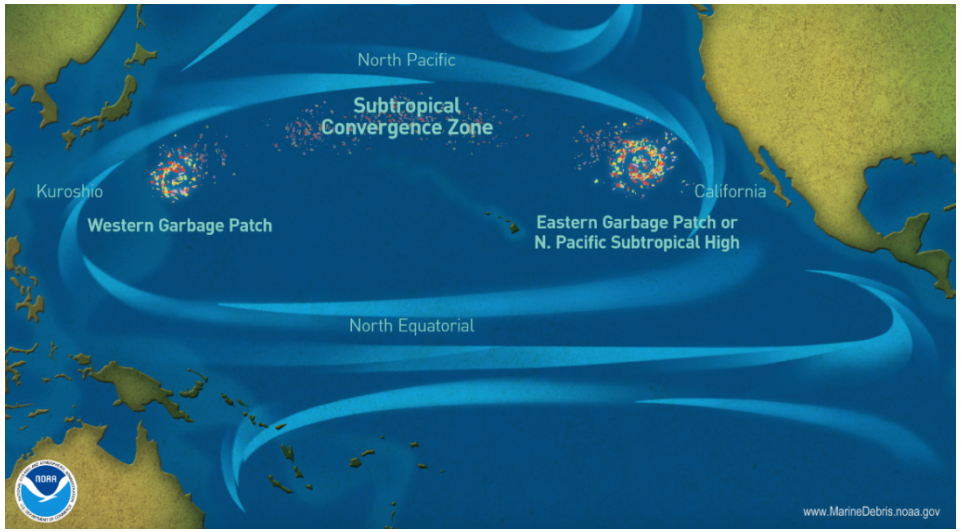
Hosseini (2016)



Guo et al (2016) *Environ. Sci. Technol.*



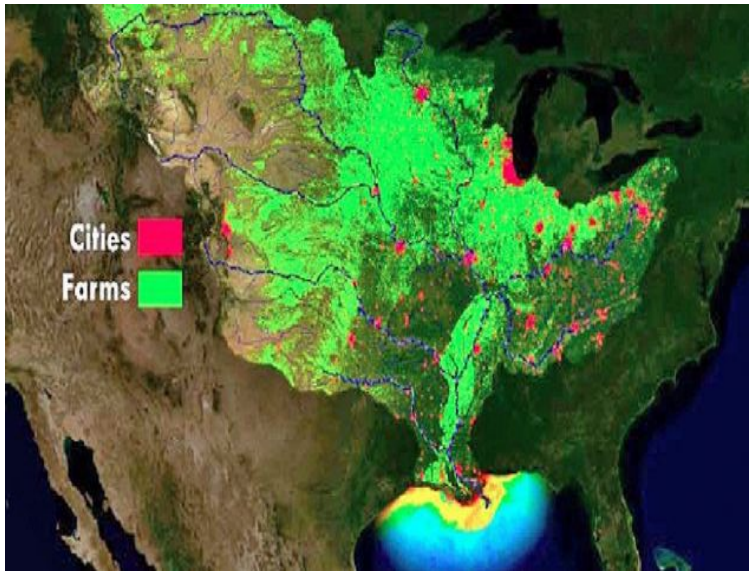
Andy Whelton, Purdue Univ (*2017)*



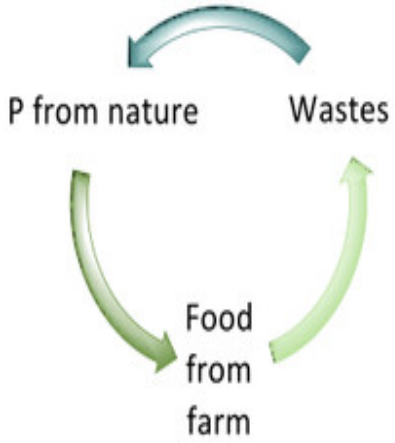
https://marinedebris.noaa.gov/info/patch.html

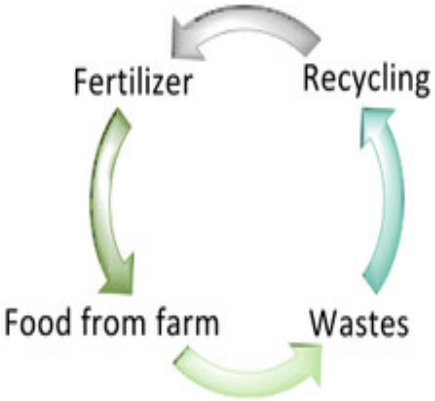
Food

How to mitigate food production impacts on the environment

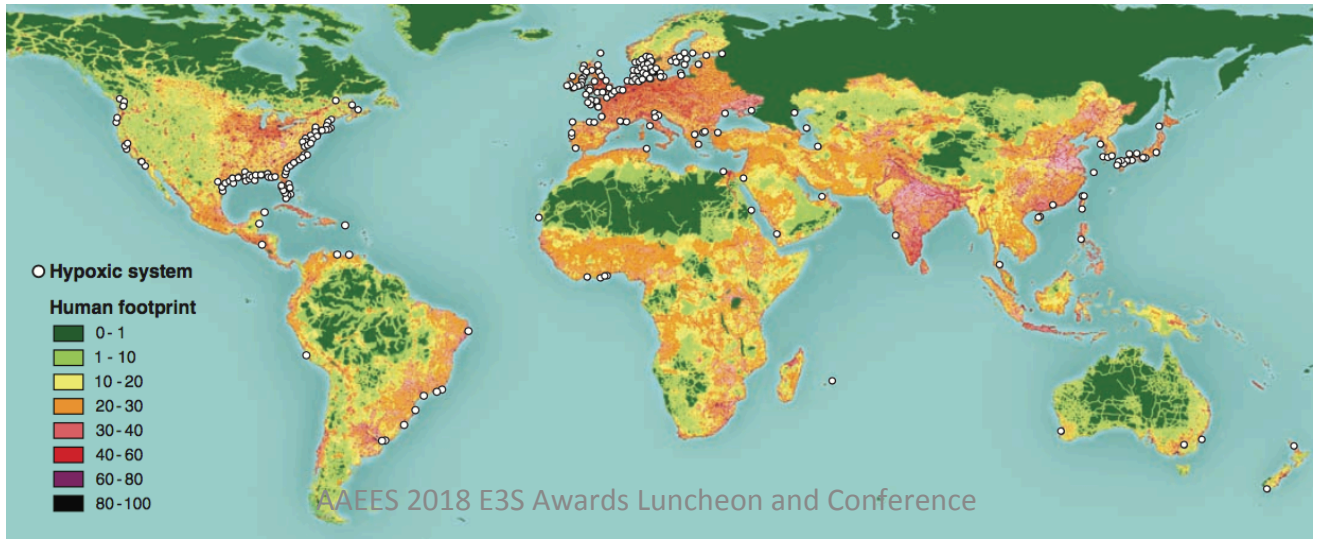


USGS (2007) Environ. Sci. Technol.





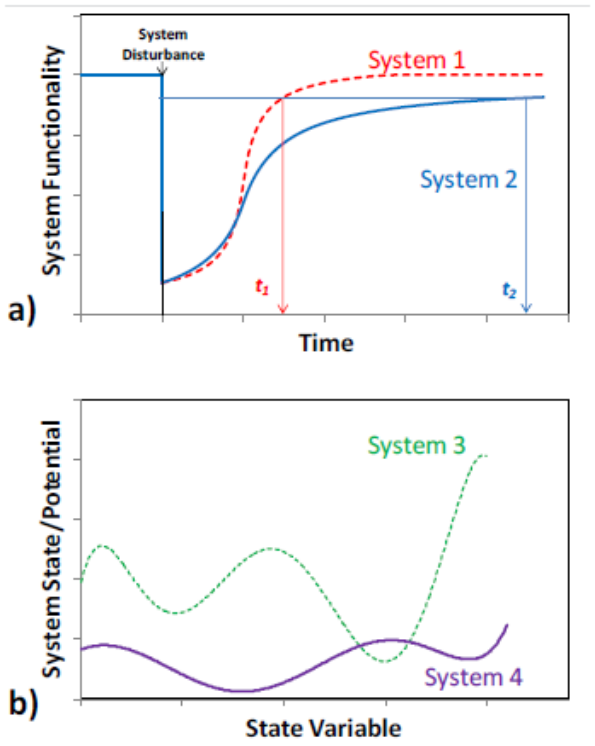
Faradji and de Boer (*2016)*

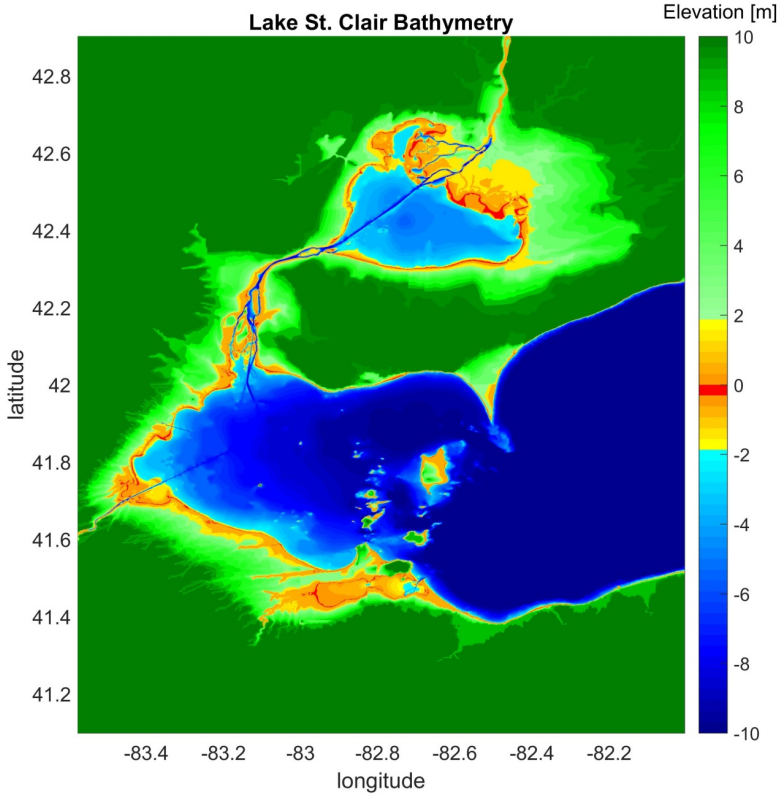


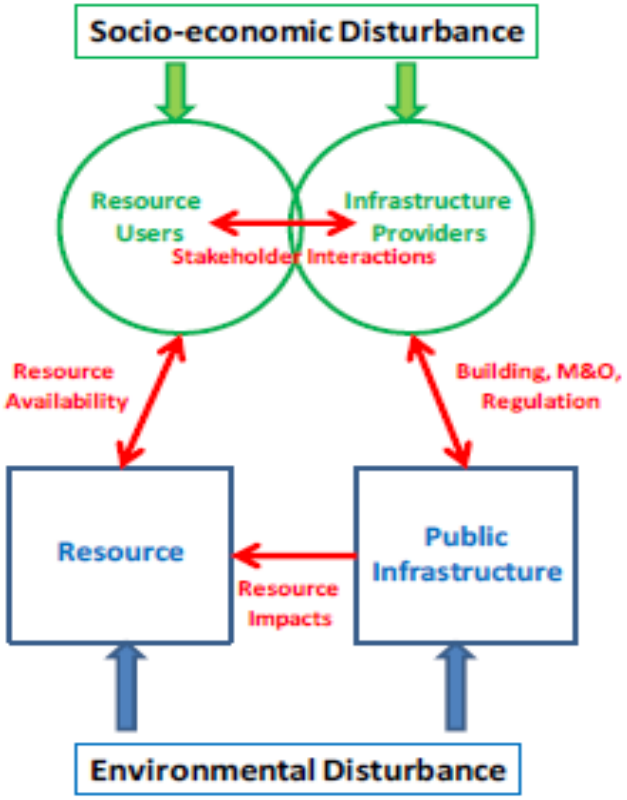
Diaz et al (*2008)*

Climate Change
Not just seas, not just rise!

- Unlike the oceans, Great Lakes **water levels are expected to decrease** due to climate change
- **Societal Impacts:** Changing lake levels impact **infrastructure**, **resources**, and **transportation**





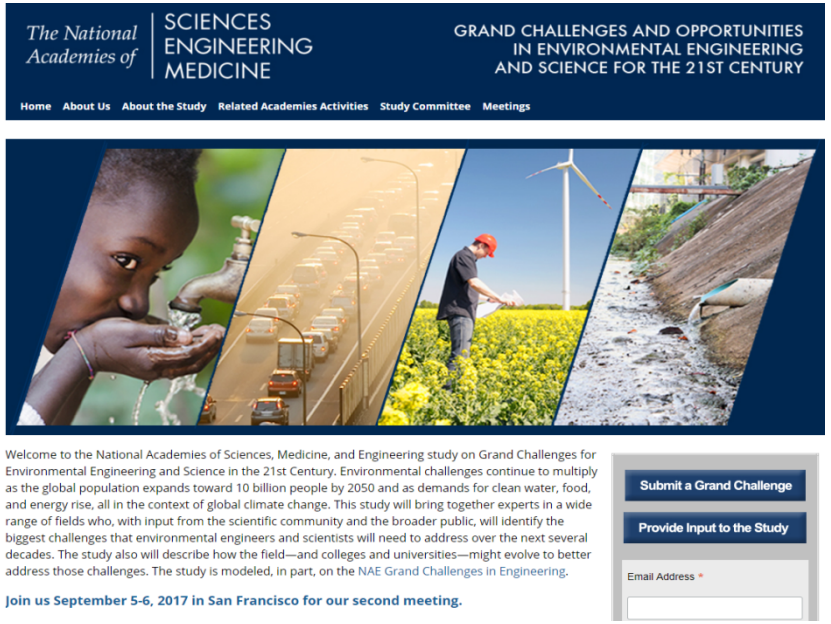


Noruzoliaee et al (*2018*)

Study Impacts

Advancing the Progress of EE&S

- Create new opportunities for **relevant education** and **training**
- Identify **research gaps** to guide fruitful areas of research
- ID ways to **integrate social/behavioral aspects** for **effective solutions** (Bluespace, learning from history!)
- **<u>Inspire</u> a new generation** of EES to **"make a difference"**
  - Infrastructure vs "earth systems engineer"
  - **Developing nations**
- Guide educational development to **train the profession**



http://nas-sites.org/dels/eechallenges/ (*2018*)

Stay tuned for **August** release

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
AUGUST 2018						
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	

Other Current National Challenges

- **Opioids:**
  - Pharmaceutical capture, fate, and transport
  - Urine separation

- **Disaster Response:**
  - **RAPIDs**: Health effects, pollution, water supply
  - Natural Hazards Workshop (U of Colorado in July) w/NIH-NIEHS
  - Resilient Environmental Infrastructure

- **WW Omics for Integrated Public Health Assessment:**
  - Utilize the integrated capture of molecular data in the WW stream to **assess human health through –omics technologies**

These and many other challenges await…

If “past is prologue”, I have every confidence that the profession is up to the task!

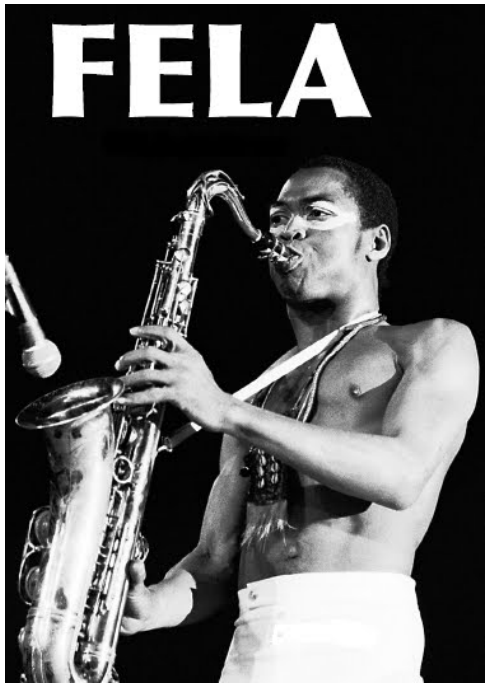
From Cutler and Miller (*2004) National Bureau of Economic Research*

Cartoon by Zim, 1919

Q & A

“Water no get enemy”

-Fela Ransome Kuti (1938-1997)



https://egregores.files.wordpress.com/2010/02/felasax1.jpg

Chem. Engr. News. (2015)