Human Health & Water Issues
Micro & Macro: Harmful Algal Blooms, Climate Change & Infectious Diseases
Disaster-Related H₂O Injuries, Illnesses

SC Water Resources Conference
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SC Department of Health & Environmental Control
Human Health Impact of...

SHOE By Chris Cassatt & Gary Brookins

GLOBAL WARMING, WAR, FAMINE, ANTIBIOTIC-RESISTANT DISEASE...

WATER SUPPLY & QUALITY PROBLEMS

IT SEEMS LIKE THE WORLD IS AT A TIPPING POINT.
Human Health, Coastal Populations, & Climate Change: *Micro Issues*

1. Emerging Infectious Diseases

2. Mosquito/ pest-borne diseases

3. Others: ie, Harmful Algal Blooms (HABs)

4. Food safety & quality (eg, flooding, droughts, environmental contamination, foodborne illnesses, infectious diseases)
HARMFUL ALGAL BLOOMS:
Some Effects on Human Health

so-called "FISH POISONINGS"

- Ciguatera - ingestion: Gamber. toxicus/ neuro Sx
- Paralytic shellfish poisoning: Alex. sp/ neuro, paral.*
- Neurotoxic shellfish poisoning: G. breve/ neuro, GI*
- Diarrhetic s.p.: Dinophysis/ GI Sx – okadoic acid
- Amnesic s.p.: Ps. pungens/ amnesia, neuro Sx – domoic acid (found in many marine animal events)
  (Scombroid - ↑ histamine ingestion → neuro Sx)

MOST ARE INGESTION-RELATED, from HABs 2° ↑ water temps & pollution.
* "red tides"
The temperatures of the northern Caribbean and extreme southeastern Gulf of Mexico have been predicted to increase 4.5°F–6.3°F (2.5°C–3.5°C) during the twenty-first century, with greater temperature increases in higher latitudes (7). Higher temperatures favor *G. toxicus* growth (8) and are likely to alter fish migration patterns. Ciguatera outbreaks previously have been correlated with sea-surface temperature increases in the south Pacific Ocean (9) and Tahiti (10). These data suggest *G. toxicus* proliferation likely will continue and perhaps increase in the Gulf of Mexico (2) and along the southern Atlantic coastline.
Harmful Algal Blooms in South Carolina

Kiawah Island
Hilton Head Island

\( \text{Kryptoperidinium sp.} \)
\( \text{Karlodinium micrum Heterosigma akashiwo Chattonella cf. verruculosa} \)
\( \text{C. subsalsa} \)
\( \text{Fibrocapsa japonica Prymnesium parvum} \)
\( \text{Microcystis Gyrodinium instriatum Gyrodinium pinque Katodinium rotundatum Heterocapsa triquetra Akashiwo sanguinea} \)
\( \text{Synechococcus Prorocentrum minimum Anabaenopsis sp.} \)
\( \text{Aphanizomenon sp.} \)
\( \text{Scrippsiella sp.} \)
\( \text{Anabaena sp.} \)

Thanks to Dr. Alan Lewitus & colleagues for these data 2005

N = 19 genera, mostly in residential & recreational coastal ponds
Case report: Blue-green Algal Bloom - James Island, SC 2000

- Blue-green algal bloom: residential pond
- June 2000: 7 yo girl waded briefly in water < 2’ deep → immed. dev. severe body rash, respir. & constitutional Sx
- LMD provided emerg. care, Sx cleared
- DHEC: high # Anabaena & Microcystis algal forms (LM only) in pond water
## COMPARATIVE LETHALITY OF TOP 23 SELECTED TOXINS AND CHEMICAL AGENTS (LD$_{50}$ in laboratory mice) - USAMRIID, Blue Book 2001

<table>
<thead>
<tr>
<th>AGENTS 1-12</th>
<th>LD50 (µg/kg)</th>
<th>SOURCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>C. botulinum Toxin</td>
<td>0.001</td>
<td>Bacterium</td>
</tr>
<tr>
<td>Shiga Toxin</td>
<td>0.002</td>
<td>Bacterium</td>
</tr>
<tr>
<td>Tetanus Toxin</td>
<td>0.002</td>
<td>Bacterium</td>
</tr>
<tr>
<td>Abrin</td>
<td>0.04</td>
<td>Plant (Rosay Pea)</td>
</tr>
<tr>
<td>Diphtheria Toxin</td>
<td>0.10</td>
<td>Bacterium</td>
</tr>
<tr>
<td><strong>Maitotoxin</strong></td>
<td><strong>0.10</strong></td>
<td><strong>Marine Dinoflagellate</strong></td>
</tr>
<tr>
<td>Palytoxin</td>
<td>0.15</td>
<td>Marine Soft Coral</td>
</tr>
<tr>
<td><strong>Ciguatoxin</strong></td>
<td><strong>0.40</strong></td>
<td><strong>Fish-Marine Dinoflagellate</strong></td>
</tr>
<tr>
<td>Textilotoxin</td>
<td>0.60</td>
<td>Elapid Snake</td>
</tr>
<tr>
<td>C. perfringens toxins</td>
<td>0.1-0.5</td>
<td>Bacterium</td>
</tr>
<tr>
<td>Batrachotoxin</td>
<td>2.0</td>
<td>Arrow-Poison Frog</td>
</tr>
<tr>
<td>Ricin</td>
<td>3.0</td>
<td>Plant (Castor Bean)</td>
</tr>
</tbody>
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### COMPARATIVE LETHALITY OF TOP 23 SELECTED TOXINS AND CHEMICAL AGENTS

*LD<sub>50</sub> in laboratory mice* - USAMRIID, Blue Book 2001

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<th>AGENTS</th>
<th>LD&lt;sub&gt;50&lt;/sub&gt; (µg/kg)</th>
<th>SOURCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conotoxin</td>
<td>5.0</td>
<td>Cone Snail</td>
</tr>
<tr>
<td>Taipoxin</td>
<td>5.0</td>
<td>Elapid Snake</td>
</tr>
<tr>
<td>Tetrodotoxin</td>
<td>8.0</td>
<td>Puffer Fish</td>
</tr>
<tr>
<td>Tityustoxin</td>
<td>9.0</td>
<td>Scorpion</td>
</tr>
<tr>
<td>Saxitoxin</td>
<td>10.0 (inhal, 2.0)</td>
<td>Marine Dinoflagellate</td>
</tr>
<tr>
<td>VX</td>
<td>15.0</td>
<td>Chemical Agent</td>
</tr>
<tr>
<td>SEB (Rhesus/aerosol)</td>
<td>27.0</td>
<td>Bacterium</td>
</tr>
<tr>
<td>Anatoxin-A(s)</td>
<td>50.0</td>
<td><strong>Blue-Green Alga (found in SC)</strong></td>
</tr>
<tr>
<td>Microcystin</td>
<td>50.0</td>
<td><strong>Blue-Green Alga (found in SC)</strong></td>
</tr>
<tr>
<td>Soman (GD)</td>
<td>64.0</td>
<td>Chemical Agent</td>
</tr>
<tr>
<td>Sarin (GB)</td>
<td>100</td>
<td>Chemical Agent</td>
</tr>
</tbody>
</table>

*note: Brevitoxin & Domoic acid LD<sub>50</sub> average ~ 200-300 µg/kg*
Blue-green Algae: Anabaena & Microcystis

- Anabaena & Microcystis to toxins with known adverse human health effects
  - Neurotoxicity, hepatotoxicity, dermatotoxicity, other toxicities
  - Rapid death in livestock drinking H₂O
  - Case reports in humans
Toxic bloom

High levels of the algae-produced toxin domoic acid have been found off the mouths of the Los Angeles and San Gabriel rivers. USC researchers are trying to determine whether the river discharges cause the toxic bloom that poisons sea life.

Source: USC department of biological sciences. Graphic by Leslie Carlson
Los Angeles Times
HABs & Health Impacts: Marine Life as “Ocean Canaries” espec. re: Domoic Acid Outbreaks

- California: ↑ in 2006, ↑↑ April 2007
- Birds (“seizing pelicans”) & mammals
- Hundreds sickened and dead
- Domoic acid found in many marine animals (incl. sea lions & whales)
- $2^0$ to $↑$ Harmful Algal Blooms (pseudonitzschia) $2^0$ to warmer water temps, $↑$ pollution, runoff, etc
- Citizens warned against eating finfish or shellfish from affected areas

Source: www.ibrrc.org 10.07
How to Document Health Impact?

We need Novel Surveillance Systems

HABISS
Harmful Algal Bloom-related Illness Surveillance System

August 28, 2007
World population growth may escalate rates of infectious diseases

BETHESDA, Md. – By 2015, more than 90% of the world’s population growth is estimated to occur in developing nations. But many of these nations may lack the public health infrastructure to thwart zoonotic and foodborne diseases.

“These nations are potential hotspots for new emerging diseases,” said Lonnie J. King, DVM, MS, MPA, director of the CDC’s National Center for Zoonotic, Vector-Borne and Enteric Diseases. King presented an outline about the concerns rising from the convergence of animal and human health from 10,000 years ago to more than 20 years in the future at the 2007 Annual Conference on Antimicrobial Resistance, held here recently.

King noted that one factor that may further facilitate the spread of zoonotic diseases is the shift from rural farming to urban farming. By 2030, an estimated 60% of people are expected to live in urban areas. King said that infectious and zoonotic diseases may be more difficult to control because livestock farming is predicted to move to the edge of these urban areas and closer to large population centers. Many of these areas may lack sufficient public health services.

For more, see page 44.
Emerging Infectious Diseases: *related to climate, water changes*
Dengue fever surging in Puerto Rico

Mosquito-borne disease reaches worst levels since 1994 epidemic

Telemundo and MSNBC.com Updated: 8:11 p.m. ET Aug 6, 2007

SAN JUAN, Puerto Rico — Puerto Rican health authorities warned Wednesday that the potentially deadly disease dengue fever was reaching epidemic proportions and called for a territory-wide campaign to eliminate breeding grounds of disease-carrying mosquitoes.

Enid García-Rivera, the U.S. territory’s secretary of health and epidemiology, said 2,343 confirmed cases of dengue had been reported since the beginning of the year, more than double the number of cases reported in the same period last year and the most since the dengue epidemic of 1994.

While no deaths have yet been confirmed, the disease is spreading rapidly, with more than 300 cases reported last week alone. Because milder forms can be mistaken for common illnesses like influenza, many victims may not seek medical attention, and the true number of infections could be five to 10 times greater, the U.S. Centers for Disease Control and Prevention said.

Malaria in the Bahamas: Recommendations for Travelers

The Centers for Disease Control and Prevention (CDC) has received official reports of two confirmed malaria cases in Great Exuma, Bahamas. Malaria transmission had not previously been reported from this area, until an outbreak was reported in late spring and summer 2006. One of the confirmed cases occurred in a U.S. citizen who traveled to Great Exuma in late July 2007. This patient’s illness has been confirmed as malaria caused by Plasmodium falciparum. Malaria is not considered endemic on the islands of the Bahamas.

Recommendations for Travelers

Antimalarial Medication

At this time, CDC is recommending chloroquine as an antimalarial medication for travelers to Great Exuma. This recommendation is expected to be temporary and does not
Outbreaks of infectious diseases carried by mosquitoes, rodents and water often “cluster” following storms and floods. Droughts also lead to water-borne diseases and disease from fires. The events above occurred in 1997-1998, during the century’s largest El Niño.

Image: Bryan Christie/Scientific American August 2000

Sources: Climate Change Futures- Health Ecologic & Economic Dimensions- Harvard Center Health & Global Environment- Paul Epstein 10.06
Human Health, Coastal Populations, & Climate Change: Macro Issues

5. Coastal overpopulation, overdevelopment in face of slowly rising sea levels

6. Beach/ocean water quality ↓ (adversely impacts both recreational & commercial)

7. ↑ Hurricane impacts (costs > lifestyles > human health toll, ↓ quality of life)

8. ↑ Air pollution (particulates & subpartic’s)
Human Health Impact: \(\uparrow\) Floods

Millions face flood disease threat

CNN 8.7.07

>30 million persons

“this year - particularly intense”

STORY HIGHLIGHTS

- United Nations warns of major health crisis in wake of monsoon floods
- 30 million affected by rising waters in India, Bangladesh, Pakistan and Nepal
- Stagnant flood waters are lethal breeding grounds for disease and infection

(CNN) -- The United Nations is warning of a massive "health emergency" in Asia as heavy monsoon rains flood millions of people in India and Bangladesh.

(Dartmouth Flood Observatory)

www.dartmouth.edu/~floods
Potential Storm Surges: SC coastal areas: now ~25 mi inland

↑↑ Insurance rates >2x/ last 5 yrs.
Hurricanes 2008: Update
September 26, 2008

CDC is working with state and local governments and other federal agencies to help communities recover from Ike.

Learn more

Protect Yourself and Others

Prevent illness & Injuries
Food, water, carbon monoxide, & other hazards.

Generator Safety
Prevent carbon monoxide poisoning.

Return Home Safely
Stay safe from hazards a storm may leave in your home.

Clean Up
Learn how fluids, activities, & clothing affect your safety.

Stay Safe in the Heat
Changes in your fluid intake, activities, and clothing can help you remain safe.

Learn About Hurricane Preparedness
Prepare yourself for future storms.

Information for You
Evacuation Centers

Audio, Video, Etc.
Podcasts, public service
Local Problems & Solutions

SPECIAL REPORT: The Environmental Connection to Public Health Protection

In this special report, The Environmental Connection to Public Health Protection, we examine such topics as the rising rates of asthma, lung cancer, obesity and other chronic diseases in South Carolina, the issue of uncontrolled port pollution, the dangers of coal fired power plants, the links between urban sprawl and obesity, and most importantly, what we can do to ensure a healthy South Carolina now and in the future. Click here to read the report.
Contaminated Flood Waters: Human Health Impact

- Surface waters, wells, other drinking water supplies
- Injuries (electrical, mechanical, other)
- Illnesses (infectious diseases)
  - Diarrheal Illnesses (eg, viral, bacterial, parasitic)
  - Other (eg, hepatitis A, injury-related wound inf’s.)
- Chemical contamination, exposures
Prevent Illness and Injuries After a Hurricane or Flood

Prevent Illness From Food and Water
Special precautions for food and water are important after a storm.

Prevent Other Illnesses and Injuries
Carbon monoxide poisoning, mold, and other hazards can be avoided by taking the proper steps.

Stay Safe in the Heat
Changes in your fluid intake, activities, and clothing can help you remain safe.

Content Source: National Center for Environmental Health (NCEH)
Useful Links for Flood Preparedness and Response
(Floods, Potable Water, and Preventing Waterborne Disease)

Topics:

I. → General Flood Preparedness and Response
II. → Preparation Before the Flooding Occurs
III. → Water Storage - Bottled Water and Home Containers
IV. → Drinking Water after a Disaster - Emergency Disinfection of Drinking Water
V. → Drinking Water Advisories
VI. → Inspecting and Disinfecting Wells
VII. → Sewage and Septic Tanks
VIII. → After the Flood - Cleanup after the Flood
IX. → Hand-washing, Sanitation, and Hygiene
X. → Hauled Water or Bulk Water Delivery
XI. → Water-related Diseases and Illnesses
XII. → Education Materials - Posters and Flyers
XIII. → Additional Resources

I. General Flood Preparedness and Response

- → CDC - Floods
  Guidance for protecting personal health and safety during and in the aftermath of a flood
  (http://www.bt.cdc.gov/disasters/floods/)

- → CDC - Key Facts about Hurricane and Flood Recovery
  Information about preventing illness from food and water, and preventing other types of illnesses and injuries during a flood
  (http://emergency.cdc.gov/disasters/hurricanes/recovery.asp)

- → FoodSafety.gov - Consumer Advice - Disaster Assistance
  A gateway to federal, state, and local government websites that address food and water safety during disasters.
DISASTER RECOVERY FACT SHEET

**Vibrio vulnificus After a Disaster**

What is *Vibrio vulnificus*?

*Vibrio vulnificus* is a bacterium that is a rare cause of illness in the United States. The illness is very different from cholera, which is caused by different bacteria, called *Vibrio cholerae*. *V. vulnificus* infections do not spread directly from one person to another and are a serious health threat predominantly to persons with underlying illness, such as liver disease, or a compromised immune system. The organism is a natural inhabitant of warm coastal waters. Infection can occur after a wound is exposed to warm coastal waters where the *V. vulnificus* organism is growing. Infection may also be acquired by eating raw or undercooked seafood from those waters.

CDC receives reports of over 400 Vibrio illnesses each year. Of those, about 90 per year are due to *V. vulnificus*. Most *V. vulnificus* illness occurs during warm-weather months.

**Symptoms of infection with *V. vulnificus***

- Acute illness, with a rapid decline in health following exposure
- If exposed by contamination of an open wound, increasing swelling, redness, and pain at the site of the wound
- Illness typically begins within 1-3 days of exposure, but begins as late as 7 days after exposure for a small percentage of cases
Human Health Impact:

↑Drought: 2007-08 Ongoing in US West & SE, spreads to Mid-Atlantic

As Lake Lanier dried up, ~4 million persons in Georgia alone struggled with severe water shortage in 2008

SE States' AGs, Governors seeking remedies, federal court relief
“The voting public will do little until their financial or personal health is adversely impacted.”

Action Steps: mobilize public
Those who carry on great public schemes must be proof against the most fatiguing delays, the most mortifying disappointments, the most shocking insults, and what is worst of all, the presumptuous judgments of the ignorant.”

- Edmund Burke (1729 - 1797)