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RISKY BUSINESS

The Art and Science of Safe Water

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Study finds 43% of Michigan beaches were likely contaminated with poop in 2022

Tucson, Saturday, August 28, 1999



search text ...



HOME UNITED STATES WORLD TECHNOLOGY SCIENCE & HEALTH @VOA STUDENTU VOA NEWS ON IRAN VOA CONNECT



Search

Cholera outbreak in Zimbabwe Turns

CHOLERA OUTBREAK

AFRICA FACES WORST CHOLERA OUTBREAK IN 25 YEARS, SAYS AFRICA CDC

Play K

0:03 / 1:11

africa news.





Risks to Water Safety are Immense

News on drinking water problems for 2026 have highlighted severe contamination, infrastructure failure, and water scarcity impacted by climate. Recent reports reveal deadly, water-borne disease outbreaks in India due to contaminated supplies, toxic mining pollution in the Mekong region and global PFAS contamination.

How is Risk Defined?

Probability



What are the odds?

Exposure* Hazard
chance*hazard*
exposure*consequence



Estimation of potential adverse effects associated with exposure of individuals or populations to hazards

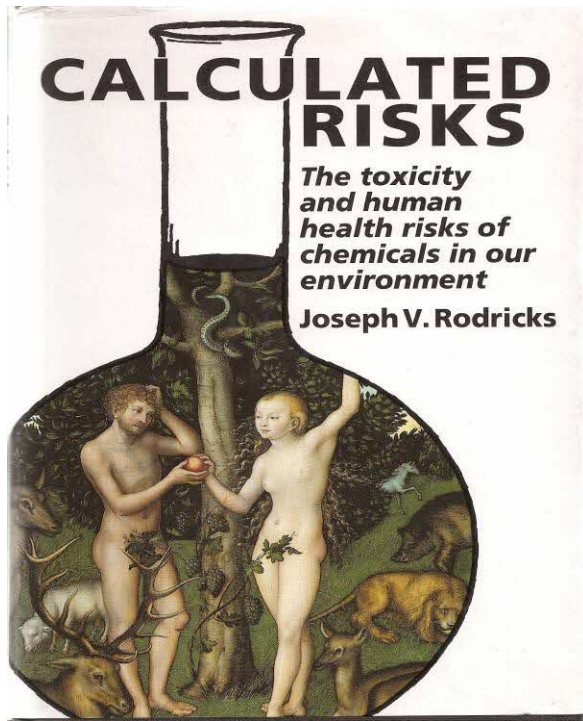
Unknown Hazards



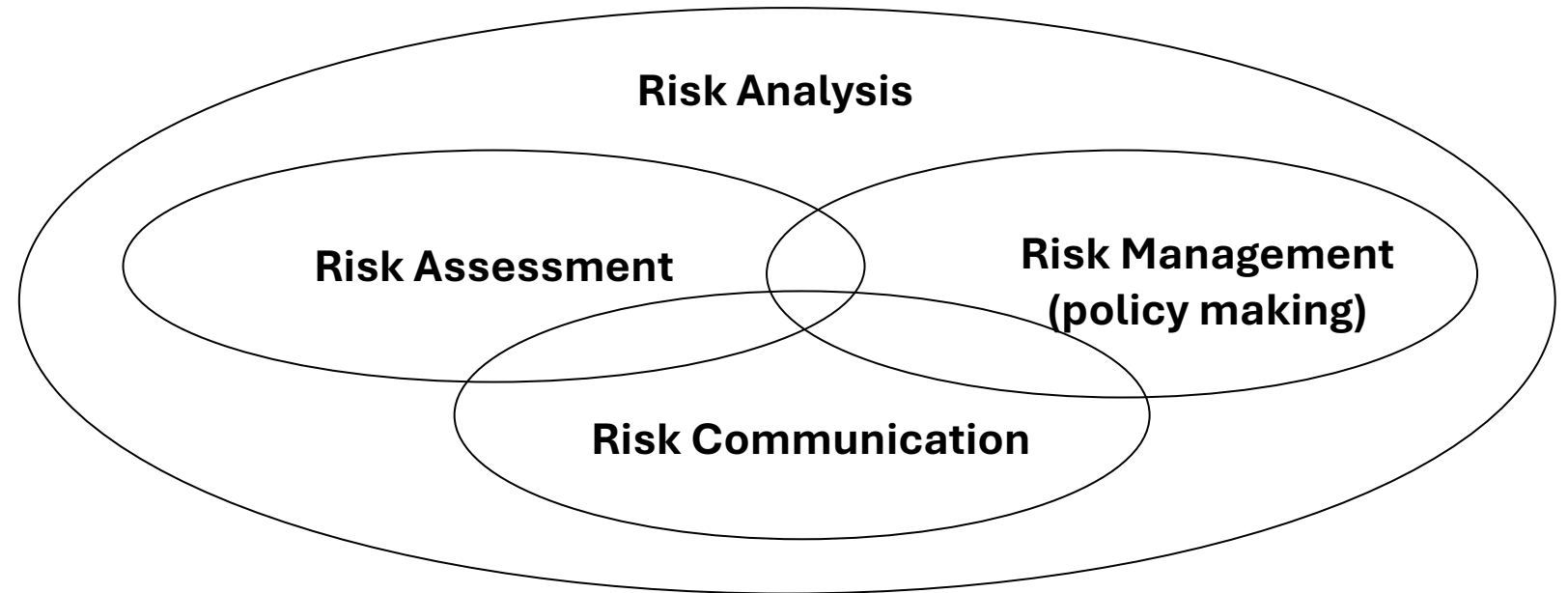
‘What is the frequency or probability?’ and ‘What are the consequences?’
(Kaplan 1997)

Risk Assessment

- Early on used by insurance companies to determine premium costs
- 1960-1970's used to assess the safety of nuclear power plants
- 1983 the National Academy of Sciences published a process for conducting formal risk assessments for chemical hazards- "Red Book"
- 1988-1991 the risk assessment process evolved for microbial hazards in drinking water in part by the USEPA



The National Academy of Sciences “Red Book” Approach



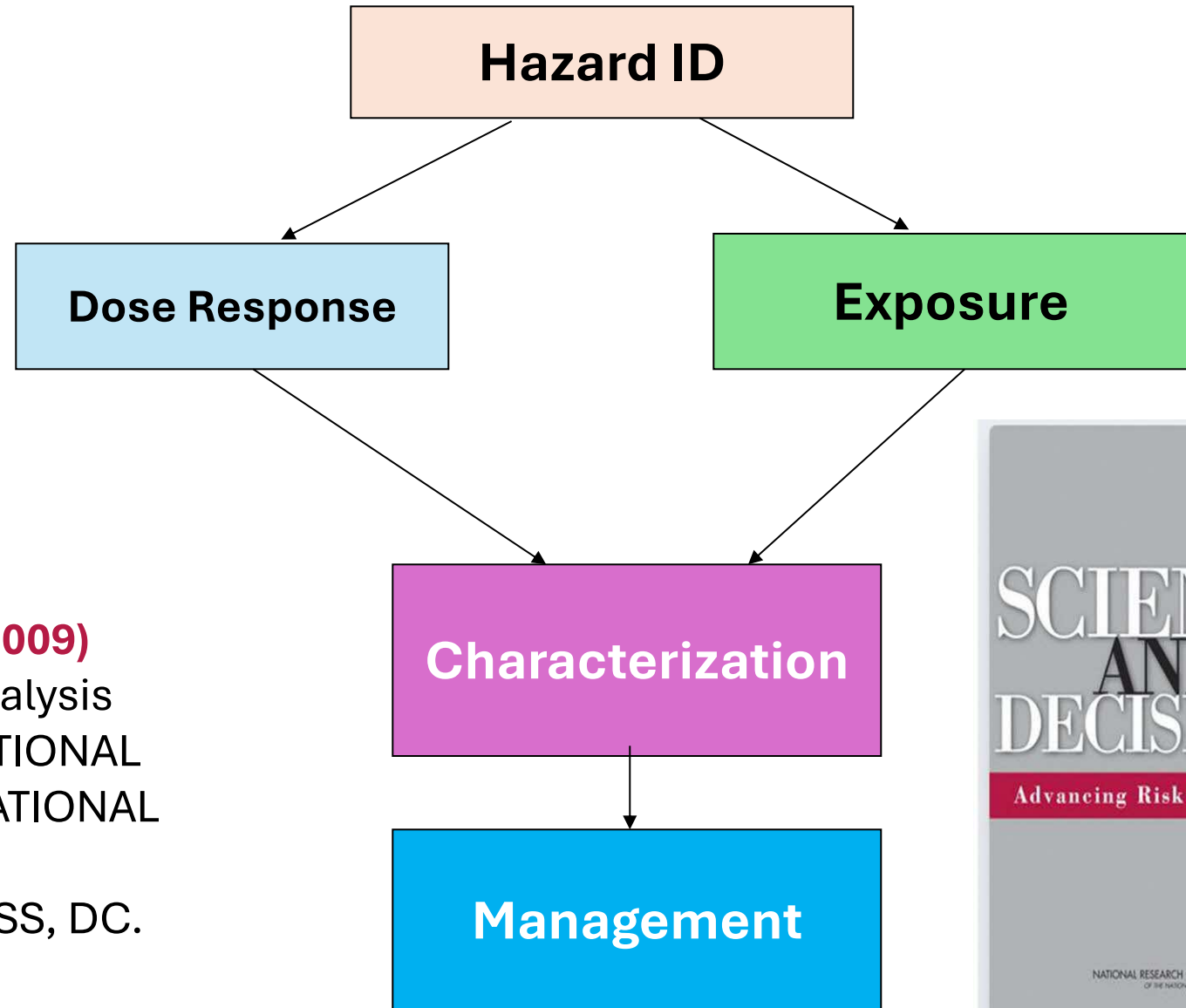
- The “Red Book” which was released in 1983 set the formal approach for assessing the risks from environmental chemical hazards in the environment

Definitions used in risk analysis

Risk assessment	The qualitative or quantitative characterization and estimation of potential adverse health effects associated with exposure of individuals or populations to hazards (materials or situations, physical, chemical and or microbial agents).
Risk management	The process for controlling risks, weighing alternatives, selecting appropriate action, taking into account risk assessment, values, engineering, economics, legal and political issues.
Risk communication	The communication of risks to managers, stakeholders, public officials, and the public, includes public perception and ability to exchange scientific information.

The QMRA PROCESS

Quantitative Microbial Risk Assessment



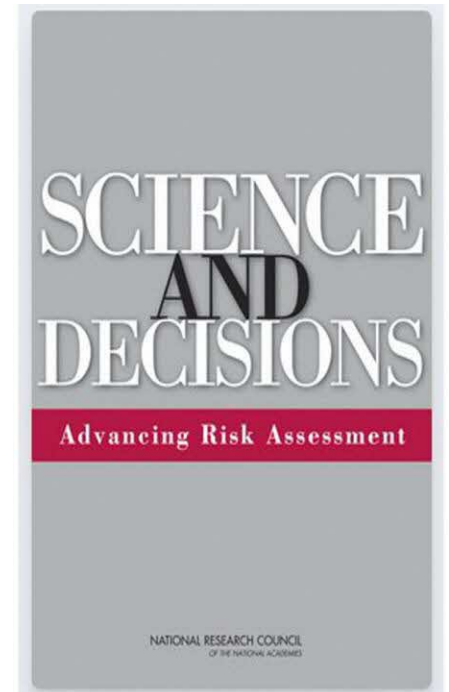
SCIENCE AND DECISIONS:

Advancing Risk Assessment, (2009)

Committee on Improving Risk Analysis
Approaches Used by the EPA NATIONAL
RESEARCH COUNCIL OF THE NATIONAL
ACADEMIES

THE NATIONAL ACADEMIES PRESS, DC.

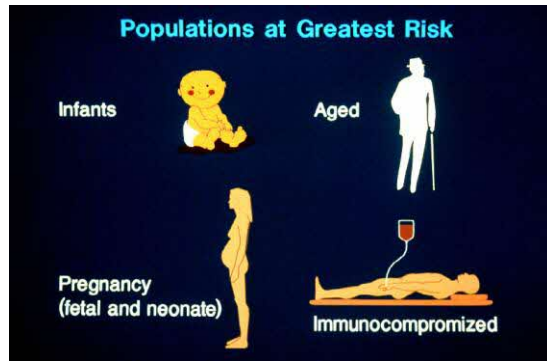
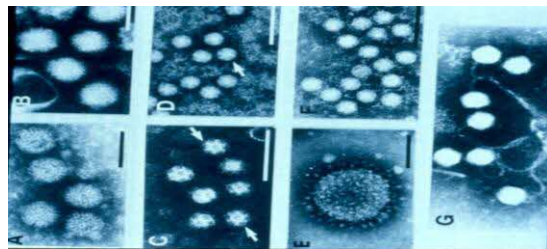
www.nap.edu



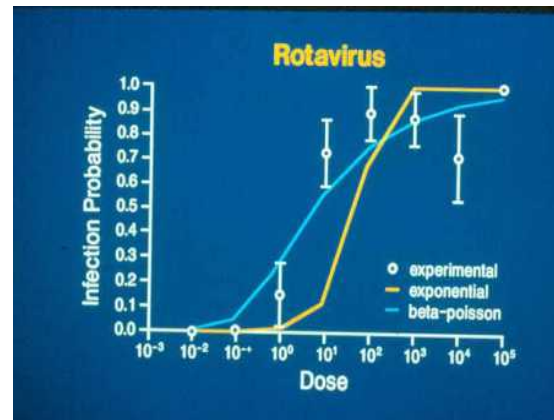
Quantitative Microbial Risk Assessment

- **HAZARD IDENTIFICATION** : Types of microorganisms and disease endpoints
- **DOSE-RESPONSE** : Human feeding studies, clinical studies, less virulent microbes and healthy adults
- **EXPOSURE**: Monitoring data, indicators and modeling used to address exposure
- **RISK CHARACTERIZATION**: Magnitude of the risk, uncertainty and variability
- **RISK MANAGEMENT**: How are the microbial risks mitigated via water treatment technologies? Why 99.99% reduction may not be enough.

Convergent of Experimental; Observational Data and Modeling

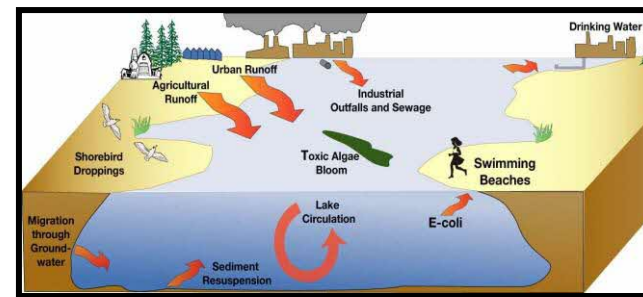


Hazard Identification

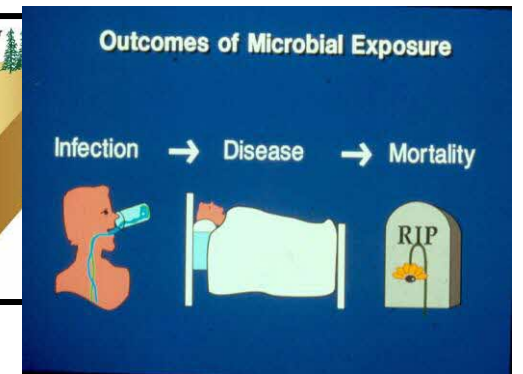


Dose-Response

$$p = 1 - \left[1 + \frac{d(2^{1/\alpha} - 1)}{N_{50}} \right]^{-\alpha}$$



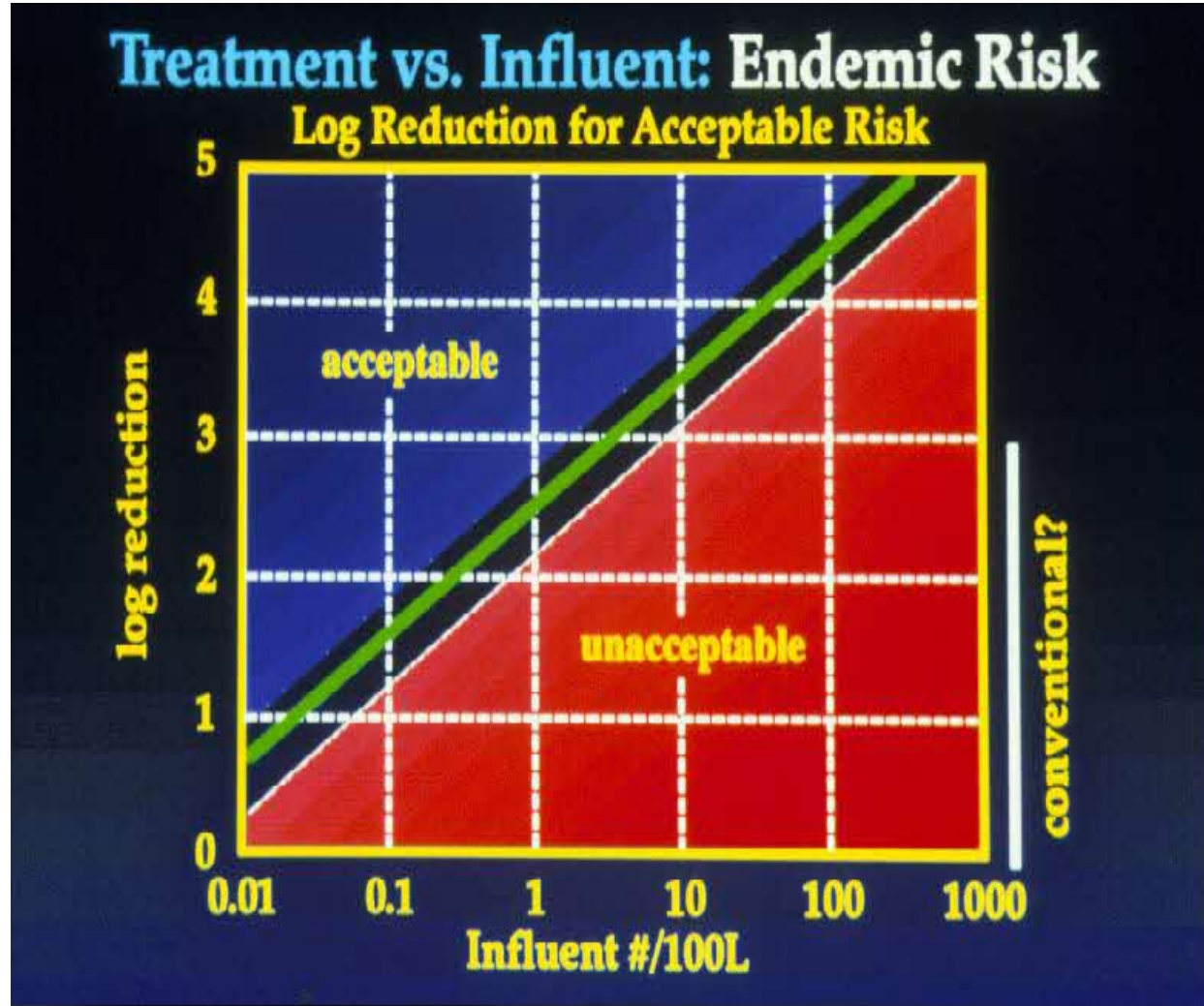
Exposure Assessment



Characterization

Engineers, computer scientists, microbiologists, clinicians, public health professionals and social scientists working together to create innovative solutions and manage the risks

How do we use QMRA?



Development of treatment standards for log reductions of pathogens by drinking water technologies

Need to identify *Acceptable Risk*:
What is safe?

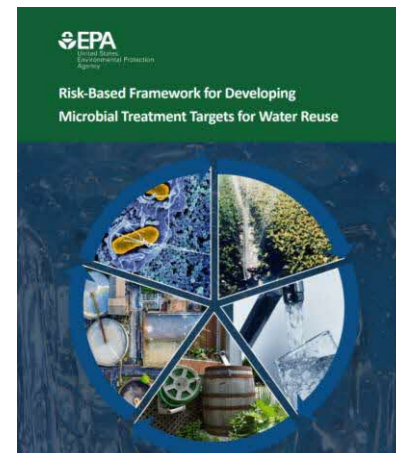
Is 1 infection /10,000 the goal?

Engagement and communications are critical

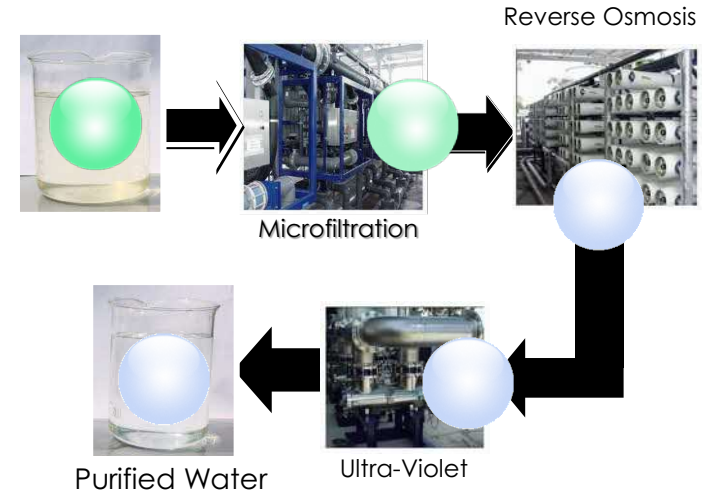
Understanding Regulations for Risk Reduction for Potable Reuse

- More multiple barriers for more contaminants
- Will include membranes, other advanced technologies
- Greater removals/greater reliability
- Enhanced monitoring of receiving water supplies
- More monitoring for contaminants (emerging)
- Public oversight

Indirect Potable and Direct Potable Reuse: regulations for reuse require 12-10-10 log and 20-14-15 log removals of virus, *Cryptosporidium*, and *Giardia*, respectively in Calif



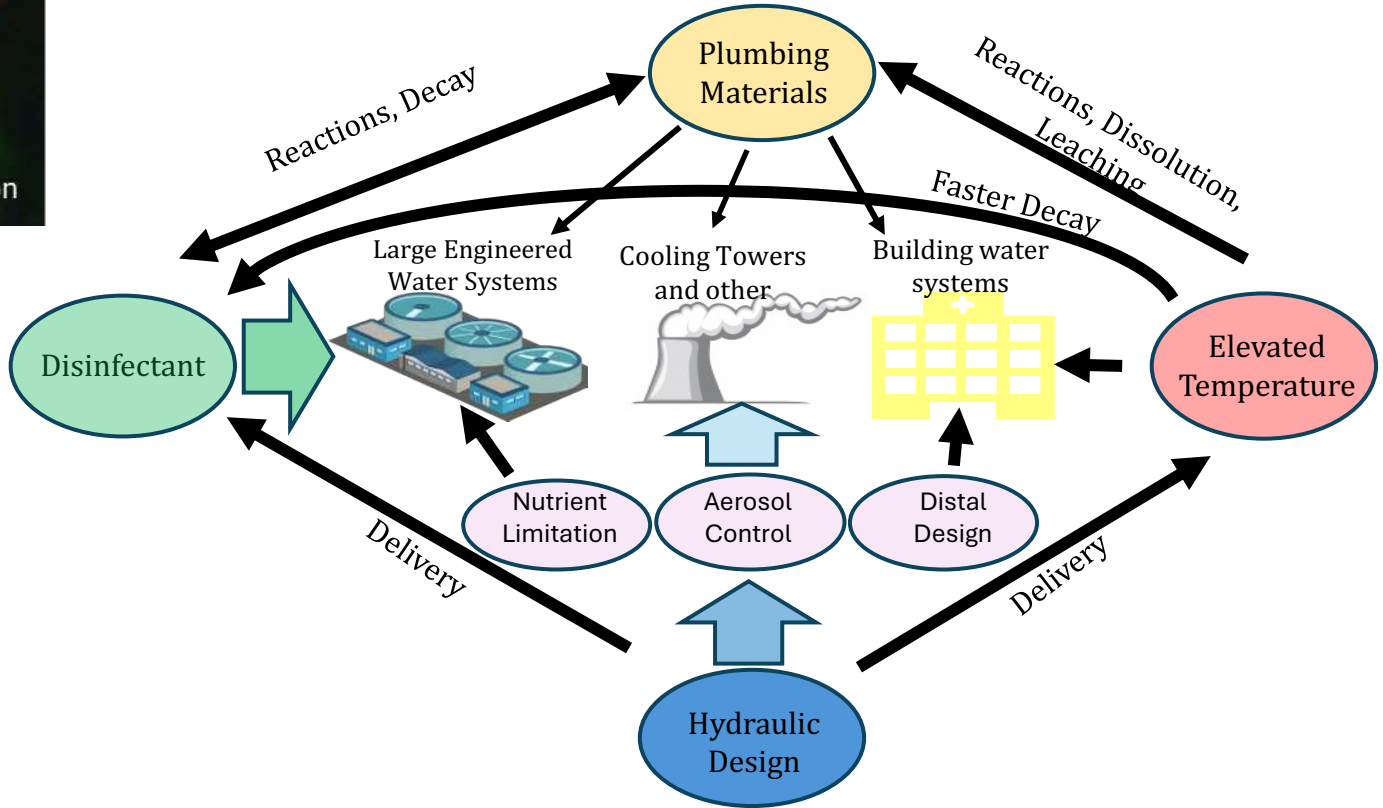
Advance Treatment Process



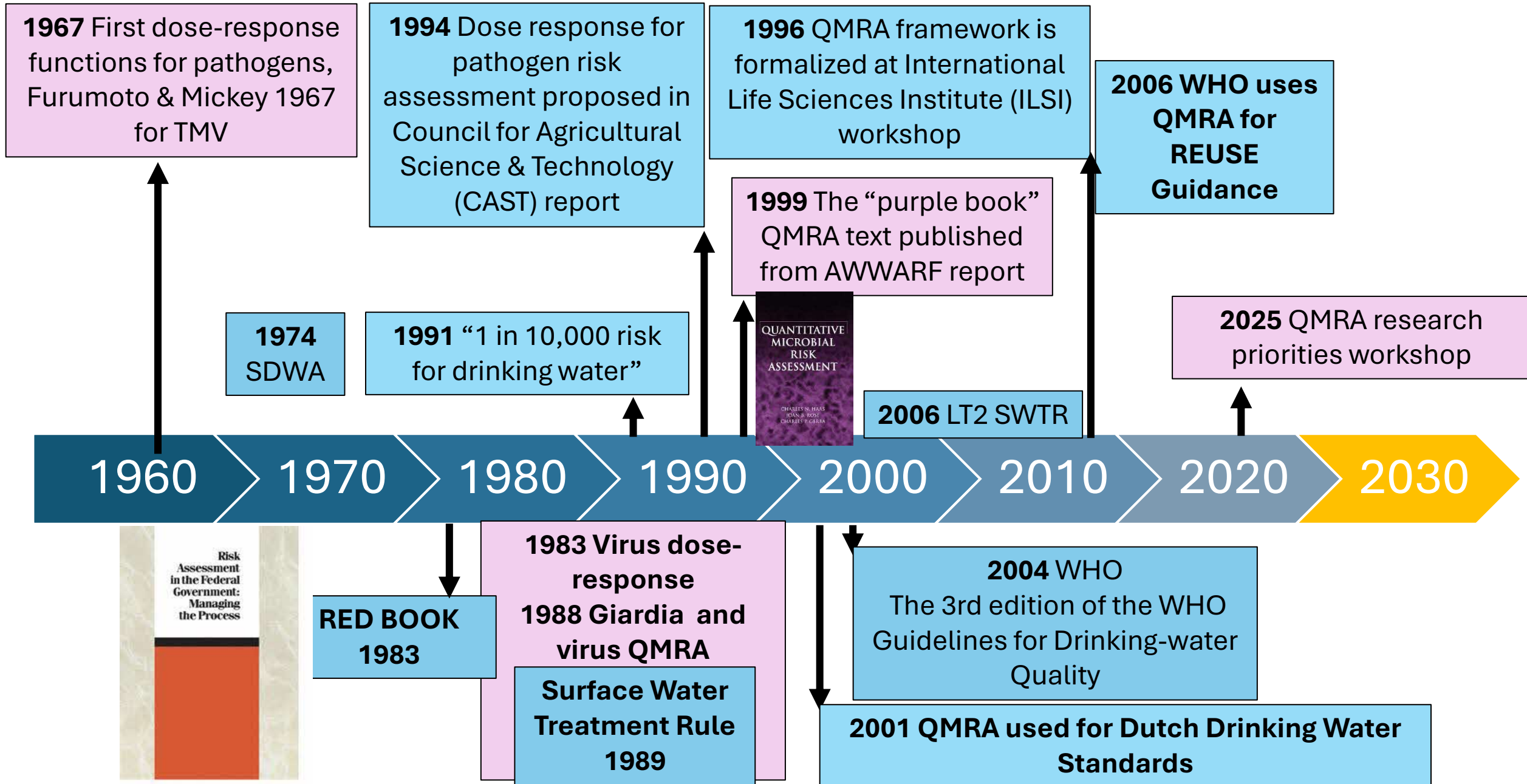


Management strategies require integration of knowledge on biology, plumbing environment, chemistry and engineering systems.

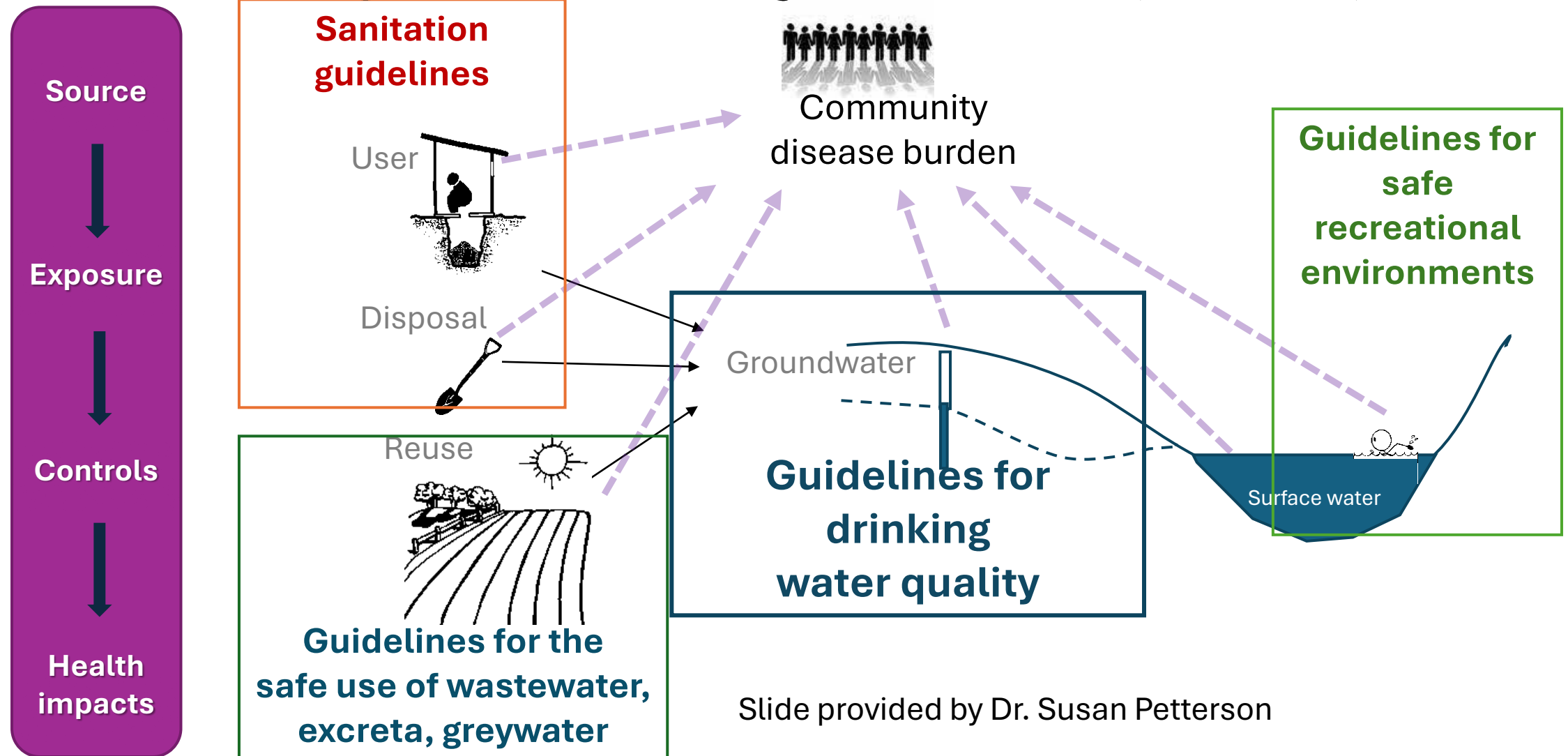
QMRA found improvements needed in exposure assessment for Opportunistic Pathogens in Drinking Water



Linking Science and Policy using QMRA



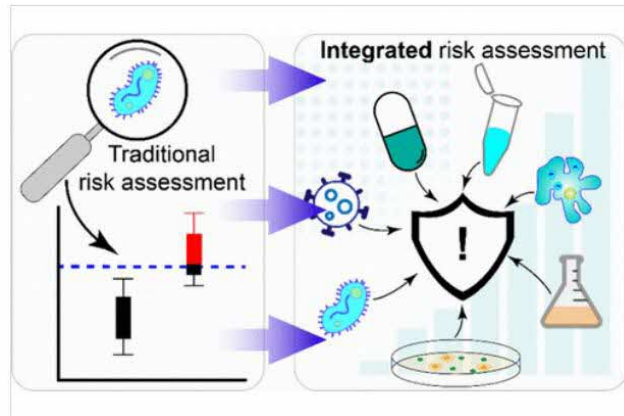
Global and Harmonized Approaches and Knowledge for Policy Makers (WHO)



Slide provided by Dr. Susan Petterson

Future Focus Areas for QMRA

Integration of Omics into QMRA



- Rapid, Actionable QMRA
- Improving Hazard and Exposure Assessments

Next Generation Quantitative Microbial Risk Assessment (QMRA): Bigger, Better, Faster
Hamilton et al., 2025

Recalcitrant One Health issues: hazardous algal blooms and antibiotic



- Addressing Water insecurity
- Managing contaminants

Key Research Needs

- Calibrating and/or validating QMRA models
- Modeling co-exposures and mixtures
- Improving Exposure assessment
- Standardizing practices for incorporating variability and uncertainty throughout the source-to-outcome continuum.

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Research gaps and priorities for quantitative microbial risk assessment (QMRA)

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Abstract

The coronavirus disease 2019 pandemic highlighted the need for more rapid and routine application of modeling approaches such as quantitative microbial risk assessment (QMRA) for protecting public health. QMRA is a transdisciplinary science dedicated to understanding, predicting, and mitigating infectious disease risks. To better equip QMRA researchers to inform policy and public health management, an Advances in Research for QMRA workshop was held to synthesize a path forward for QMRA research. We summarize insights from 41 QMRA researchers and experts to clarify the role of QMRA in risk analysis by (1) identifying key research needs, (2) highlighting emerging applications of QMRA, and (3) describing data needs and key scientific efforts to improve the science

An International Community has been built



QMRA is about collaboration: bringing science and information from many disciplines together

Dr Chuck Haas, Dr. Joan Rose and Dr. Chuck Gerba working together as a team since 1988

- Dr. Kerry Hamilton
- Dr. Jade Mitchell
- Dr. Marc Verhougstraete



And training the next generation who now have emerged as the leaders.

Thank You



Photo credit: Asli Aslan

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