Developing good habits for public protection

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Evidence suggests a change in radiation protection

Be Cautious with the Precautionary Principle: Evidence from Fukushima Daiichi Nuclear Accident

APRIL 29, 2020 • RESEARCH BRIEFS IN ECONOMIC POLICY NO. 212

By Matthew J. Neidell, Shinsuke Uchida, and Marcella Veronesi

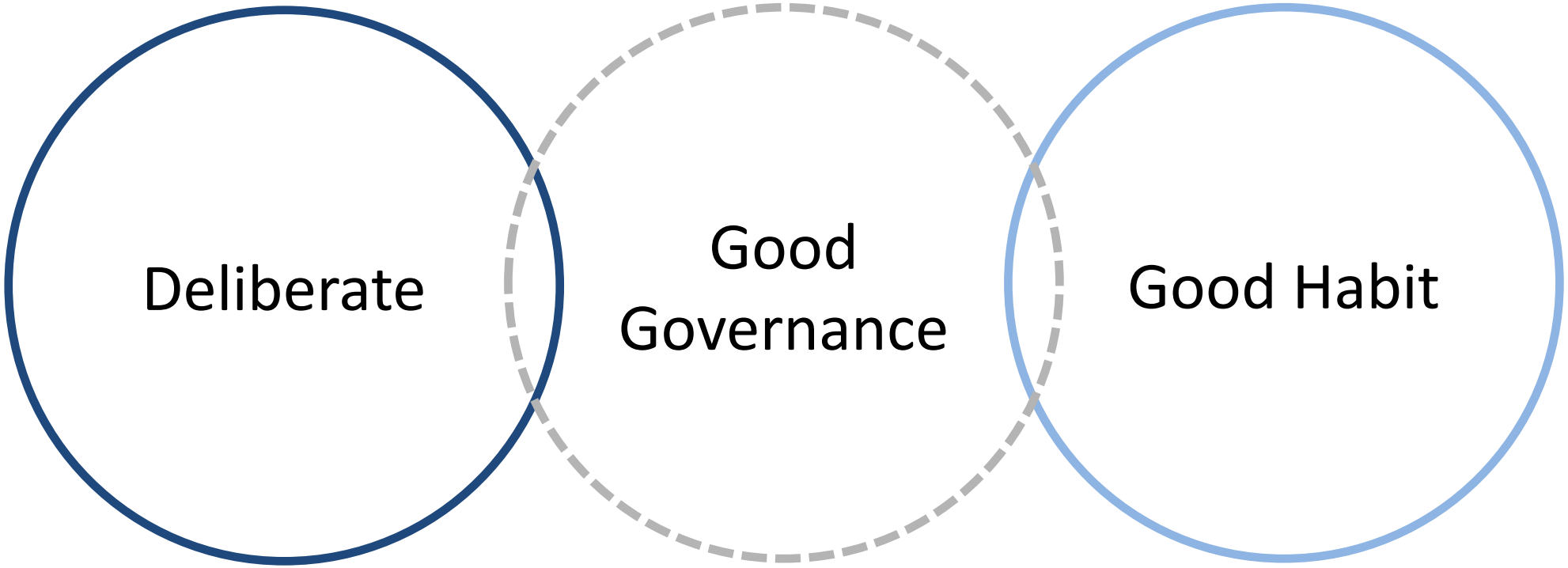
Fukushima's Evacuation May Have Done More Harm Than Good

By Philip Thomas
November 21, 2017

Saving Lives and Preventing Injuries From Unjustified Protective Actions–Method for Developing a Comprehensive Public Protective Action Strategy for a Severe NPP Emergency

J Callen, T McKenna

But how do we change?



Scarry, Elaine. *Thinking in an Emergency*, W.W Norton & Company, Inc, 2012.

We rely on habit in times of uncertainty

Crisis and Emergency Risk Communication (HHS, 2014)

Crises, by definition, create very high levels of uncertainty….During crisis situations, decision makers are often unable to collect and process information in a timely manner. They rely on established routines for situations that are, by definition, not routine.

U.S. Department of Health and Human Services (HHS). "Crisis Emergency Risk Communication: 2014 Edition," HHS/CDC, 2014.

Rather than emergency bringing about the end of thinking, thinking should bring about the end of emergency.

—Elain Scarry, Thinking in an Emergency

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Protective actions should do more benefit than harm

Stressors can disrupt the balance between protection and harm

The World Health Organization identified three such stressors:

- Stressor 1 – Radiation
- Stressor 2 – Protective Actions
- Stressor 3 – Stigmatization

How can good habits help protect the public?

World Health Organization. “A framework for mental health and psychological support in radiological and nuclear emergencies,” 2020.

Stressor 1: Radiation

Which communication habit is useful?

Habit 1: Radiation is invisible, its effects are uncertain, and the public fears it.

Habit 2: Radiation is detectable, predictable, protectable.

What we know and what the public understands

Radiation Risks in Perspective (2006)

We know more about the health effects of ionizing radiation than most other carcinogenic agents.

Strengths of Public Messages (U.S. CDC, 2012):

Participants felt another key message was that low exposures of radiation may result in minimal or no health effects.

- *Exposure to the radiation can be harmful.*
- *I guess that not all radiation is bad, depending on the dose.*

Mossman, Kenneth. *Radiation Risks in Perspective*, CRC Press, 2006.
U.S. Centers for Disease Control and Prevention (U.S. CDC). "Health Effects Message Testing: Detonation of Improvised Nuclear Device," Oak Ridge Institute for Science and Education (ORISE) and National Center for Environmental Health, Radiation Studies Branch, January 2012.

Develop habits of communicating what is known

Communicating During and After a Nuclear Power Plant Incident (2013)

How much radiation is safe?

According to radiation safety experts, radiation exposure between 5–10 rem (50-100 mSv) usually results in little to no harmful health effects.

It takes a large dose of radiation—more than 75 rem (750 mSv)—in a short amount of time (usually minutes) to cause immediate health effects like acute radiation sickness.

U.S. Federal Emergency Management Agency (FEMA). "Communicating During and After a Nuclear Power Plant Incident," June 2013.

Stressor 2: Protective Actions

Which response habit is useful?

Habit 1: Immediate evacuation out of an abundance of caution.

Habit 2: Go inside, stay inside, tune in.

Lessons from All-Hazards Risk Communication

Crisis and Emergency Risk Communication (U.S. HHS/CDC, 2014)

Give decision makers and others with influence in the community open access to complete scientific information.

Risk Communication Strategies for the Very Worst of Cases (Johns Hopkins, 2019)

"Our elected officials…don't really talk about these issues with any degree of urgency… Improving or increasing the knowledge of key leaders and decision makers will help."

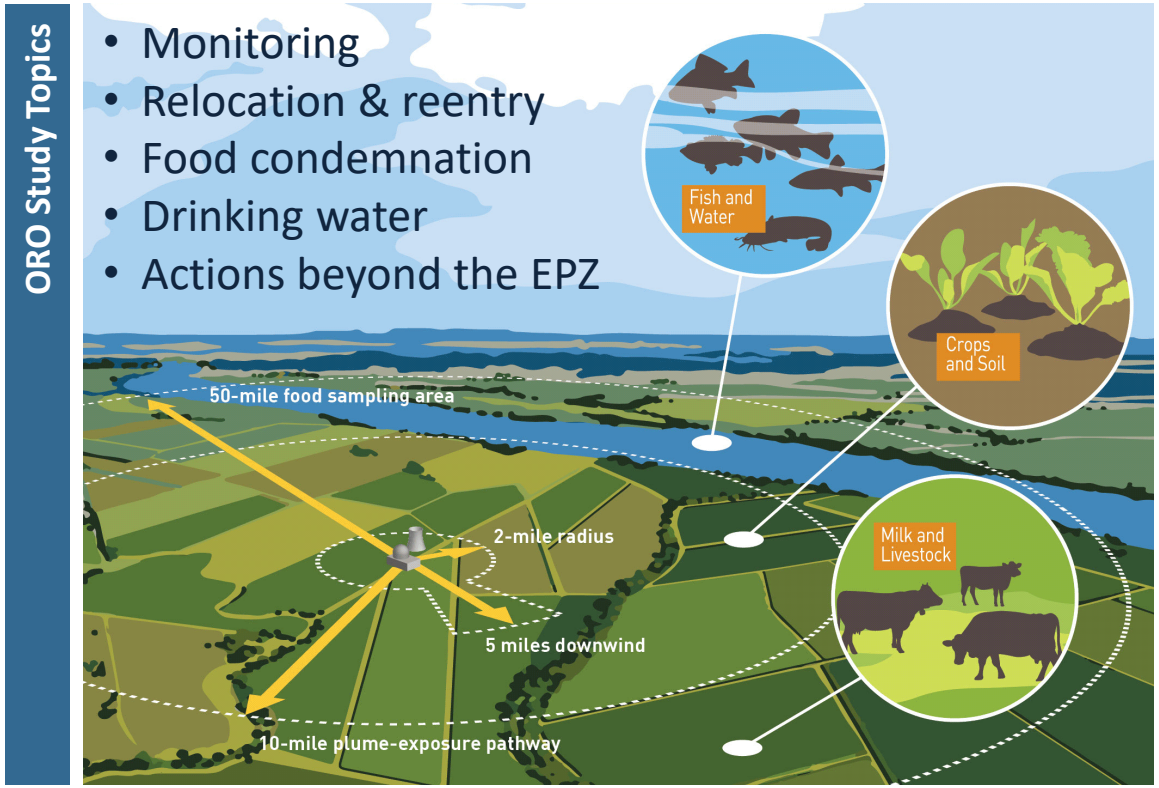
U.S. Department of Health and Human Services (HHS). "Crisis Emergency Risk Communication: 2014 Edition," HHS/CDC, 2014.
Johns Hopkins, "Risk Communication Strategies for the Very Worst of Cases: How to Issue a Call to Action on Global Catastrophic Biological Risks," Bloomberg School of Public Health, Center for Health Security, 2019.

The NRC supports public protection with evidence

- Protective Action Decision-Making in the Intermediate Phase (NUREG/CR-7248)
- Evacuation Time Estimate Study (NUREG/CR-7269)
- Emergency Planning Zone (EPZ) Size Methodology
- Sensitivity of Dose Projections to Weather
- Analysis of the Effectiveness of Sheltering-in-Place
- Use of Heating and Ventilation Systems during Sheltering-in-Place
- Dose Reduction Effectiveness of Masks
- Nonradiological Health Impacts of Evacuations and Relocations (NUREG/CR-7285)
- MACCS Consequence Model Improvements to Inform Protective Action Recommendations

Gathering and sharing best practices

Shared understanding of offsite response organization (ORO) capabilities and practices for protecting the public in the transition phase



Best Practices identified for:

- Communicating with the public
- Developing partnerships and sharing resources for monitoring
- Situation-dependent decisions based on science
- Leveraging technology
- Vulnerable populations, livestock and pets

U.S. NRC. NUREG/CR-7248, "Capabilities and Practices of Offsite Response Organizations for Protective Actions in the Intermediate Phase of a Radiological Emergency," June 2018.
https://www.nrc.gov/reading-rm/doc-collections/nuregs/contract/cr7248/index.html

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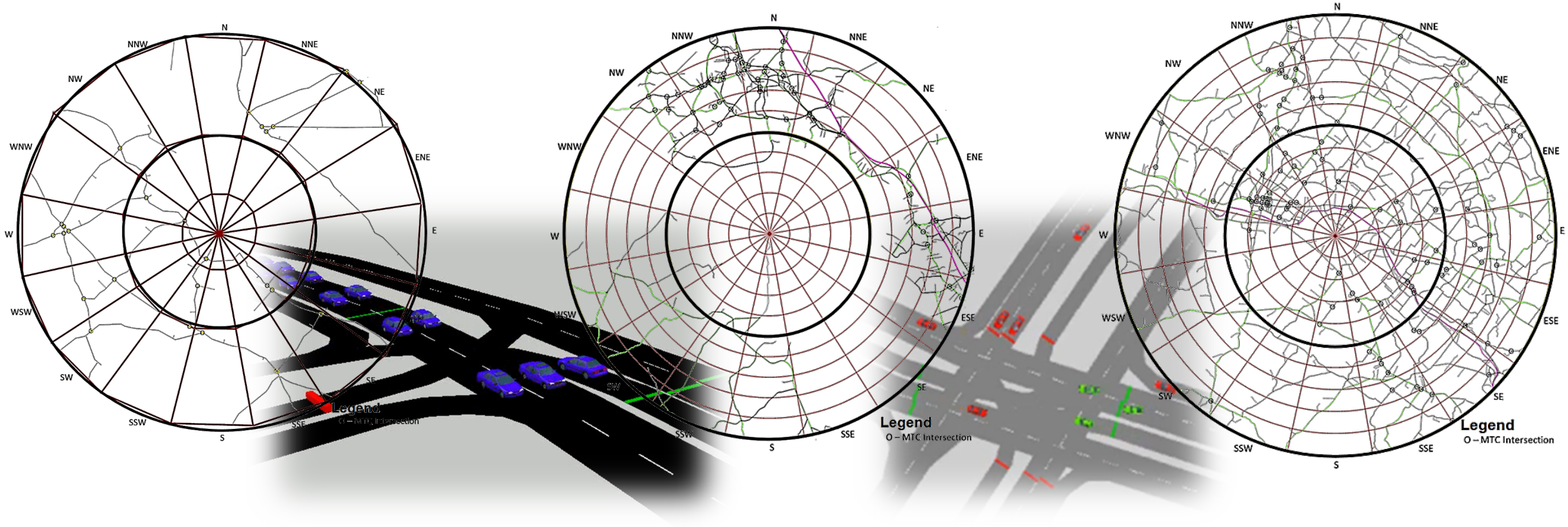
Providing insights into effective evacuation

State-of-the-art traffic simulation models used to better understand evacuation dynamics and to develop insights for protecting the public and first responders.



U.S. NRC. NUREG/CR-7269, "Enhancing Guidance for Evacuation Time Estimate Studies," January 2020.
https://www.nrc.gov/reading-rm/doc-collections/nuregs/contract/cr7269/index.html

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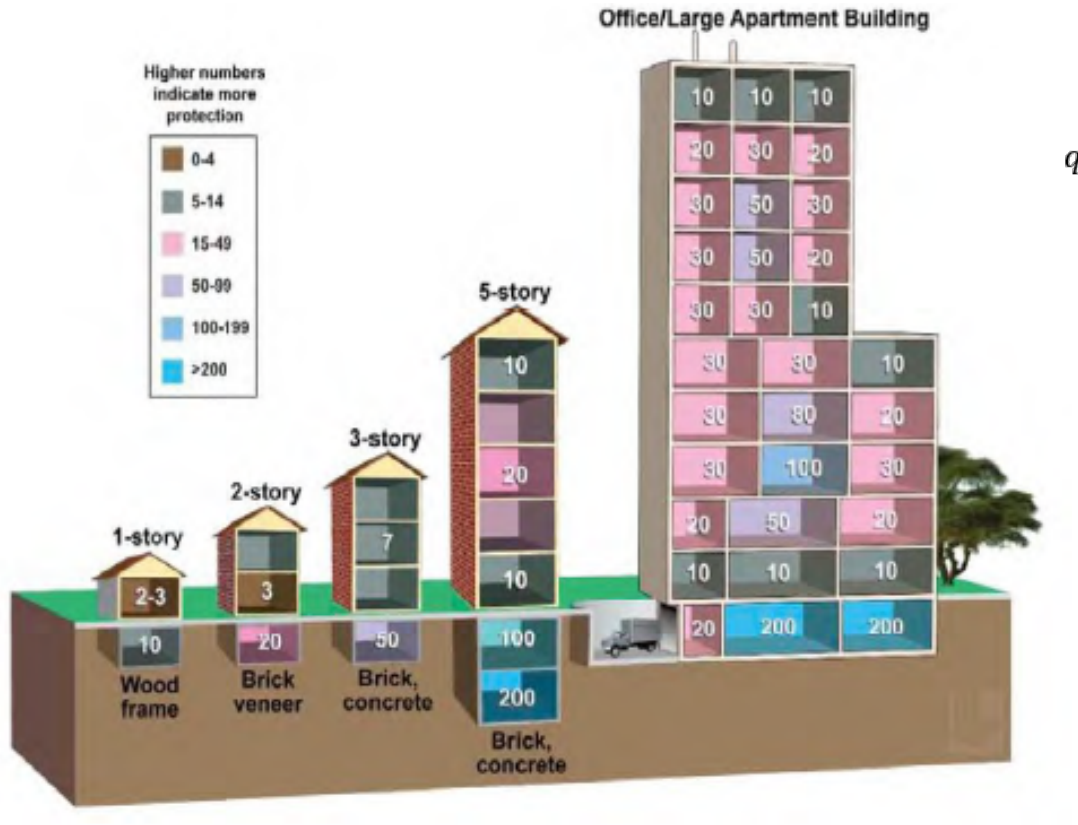
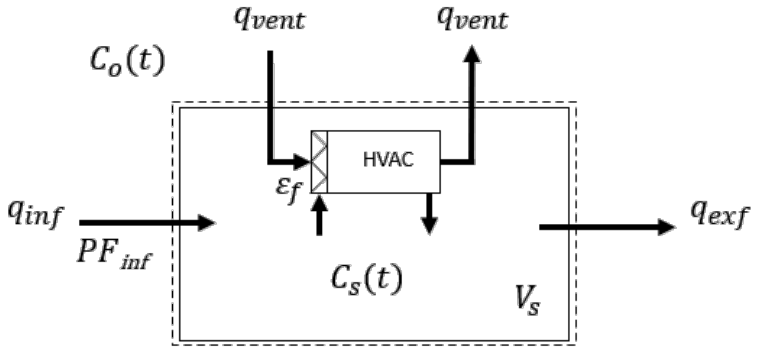
Analyzing the protection of shelters

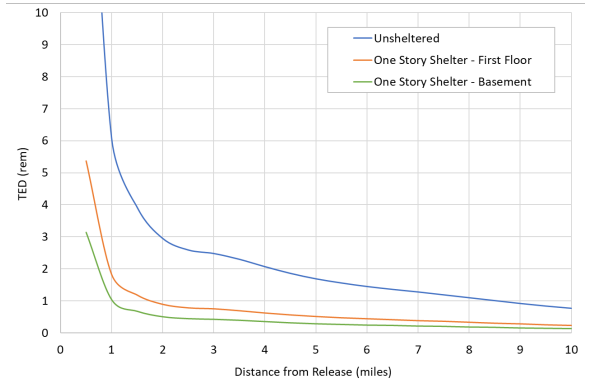


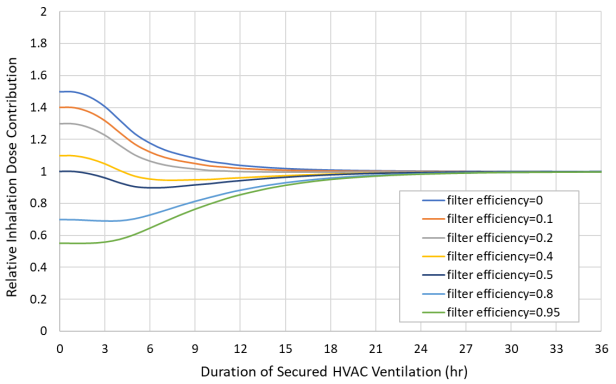
Dose Reduction Factors
(U.S. EPA, 2017)



$$V_s \frac{dC_s}{dt} = rate\ in - rate\ out$$

$$\Delta C_s(t_i) = \left(PF_{inf} q_{inf} C_o(t_i) + q_{vent}(1-\varepsilon_f) C_o(t_i) - q_{exf} C_s(t) - q_{vent} C_s(t_i)\right) \frac{\Delta t}{V_s}$$





Effectiveness of sheltering-in-place
(Smith, 2021)

U.S. EPA. EPA-400/R-17/001, "PAG Manual: Protective Action Guides and Planning Guidance for Radiological Incidents," Office of Radiation and Indoor Air, January 2017.

Smith, Todd R. *Transforming Protective Action Strategies for Radiological Emergencies—Exacting the Science of Sheltering-in-place.* Oregon State University, 2021.

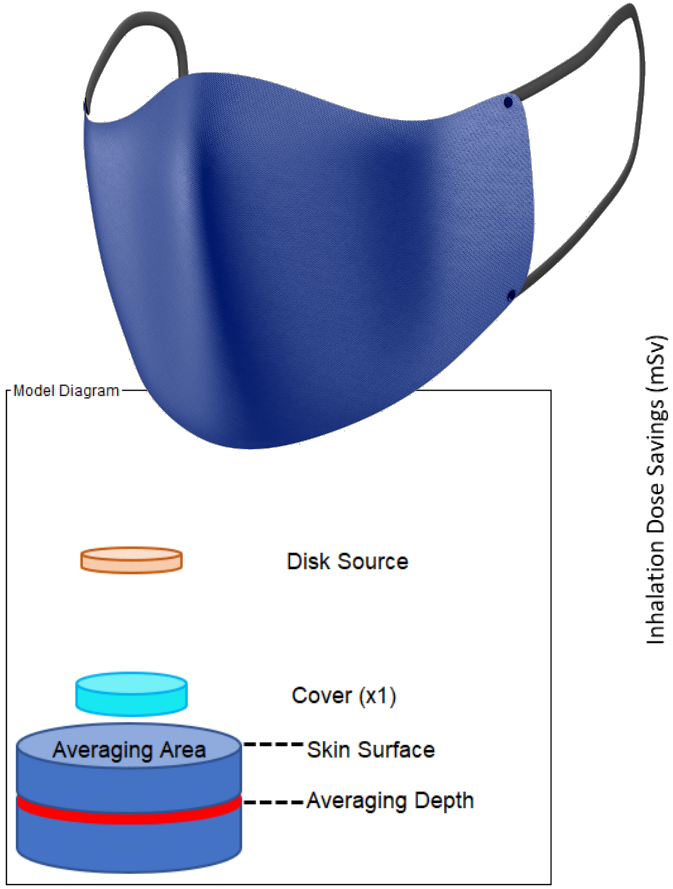
Quantifying the benefits of masks

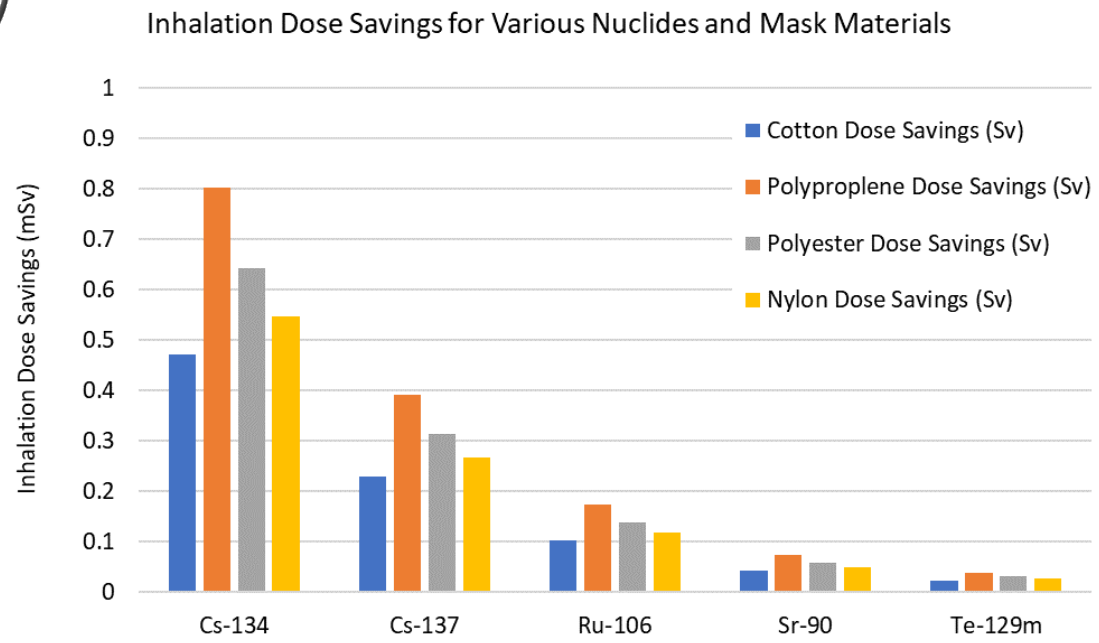
RASCAL

Radiological Assessment System for Consequence Analysis for radiological emergencies

VARSKIN

Dose calculation for skin contamination





Because the public wants to know how to be safe

Health Effects Message Testing (U.S. CDC, 2012)

Feedback on Public Messages:

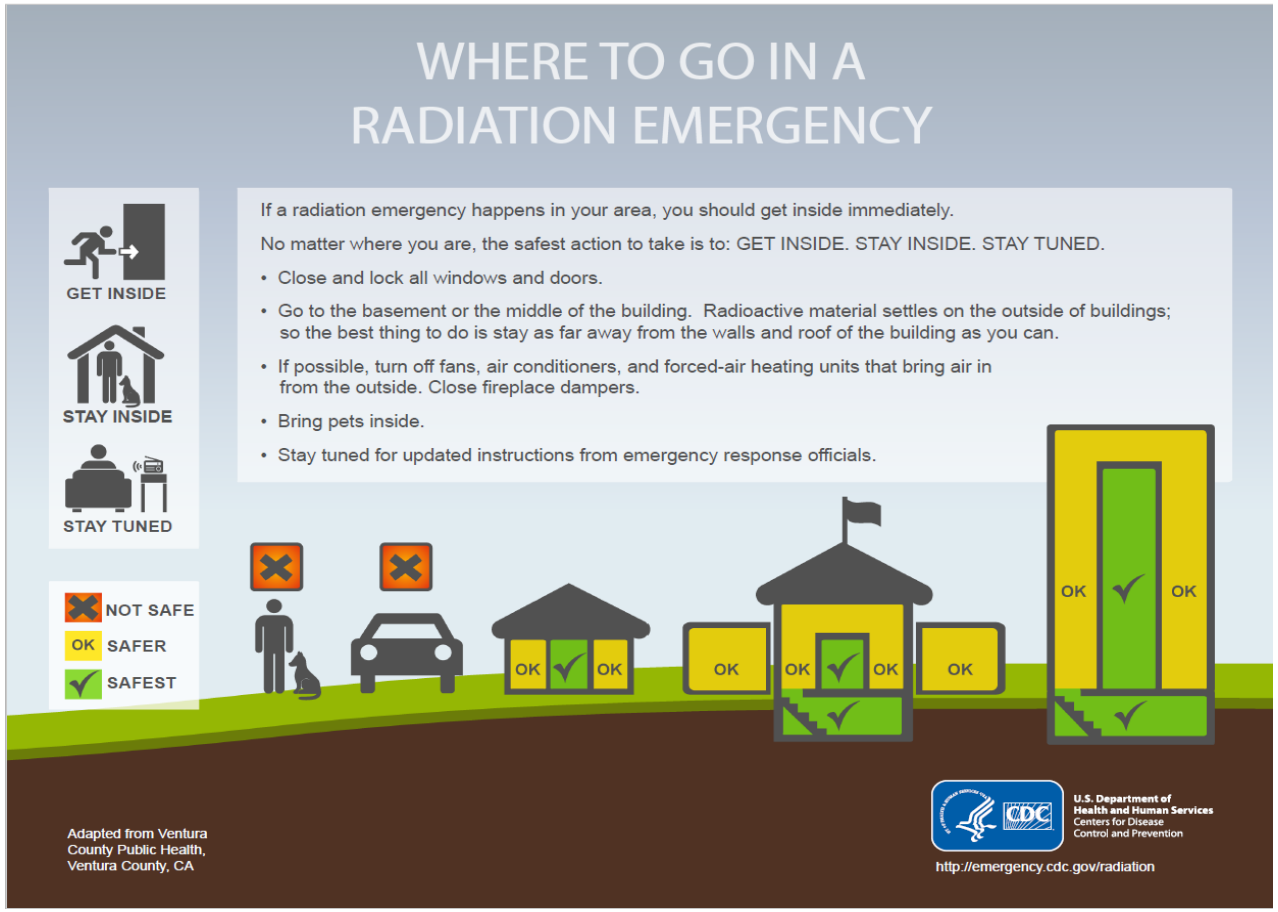
Although participants understood the main messages, they expressed that the information they would want to hear during an emergency came too late in the message. If there was any good message, it was one that you're best off being inside and I really don't remember exactly, but let's say go in a cellar or someplace that's secure.

- *The first part of it reminds me of just going back to very informational, and the second part reminds me more of what you would do for an emergency.*
- *I marked out the first two sections. Just give me the rest down at the bottom.*
- *Just give them the information to keep themselves safe, what to do until further notice.*

U.S. CDC. "Health Effects Message Testing: Detonation of Improvised Nuclear Device," Oak Ridge Institute for Science and Education (ORISE) and National Center for Environmental Health, Radiation Studies Branch, January 2012.

Develop protection habits supported by science

Clear, concise instruction on how to be safe, supported by evidence



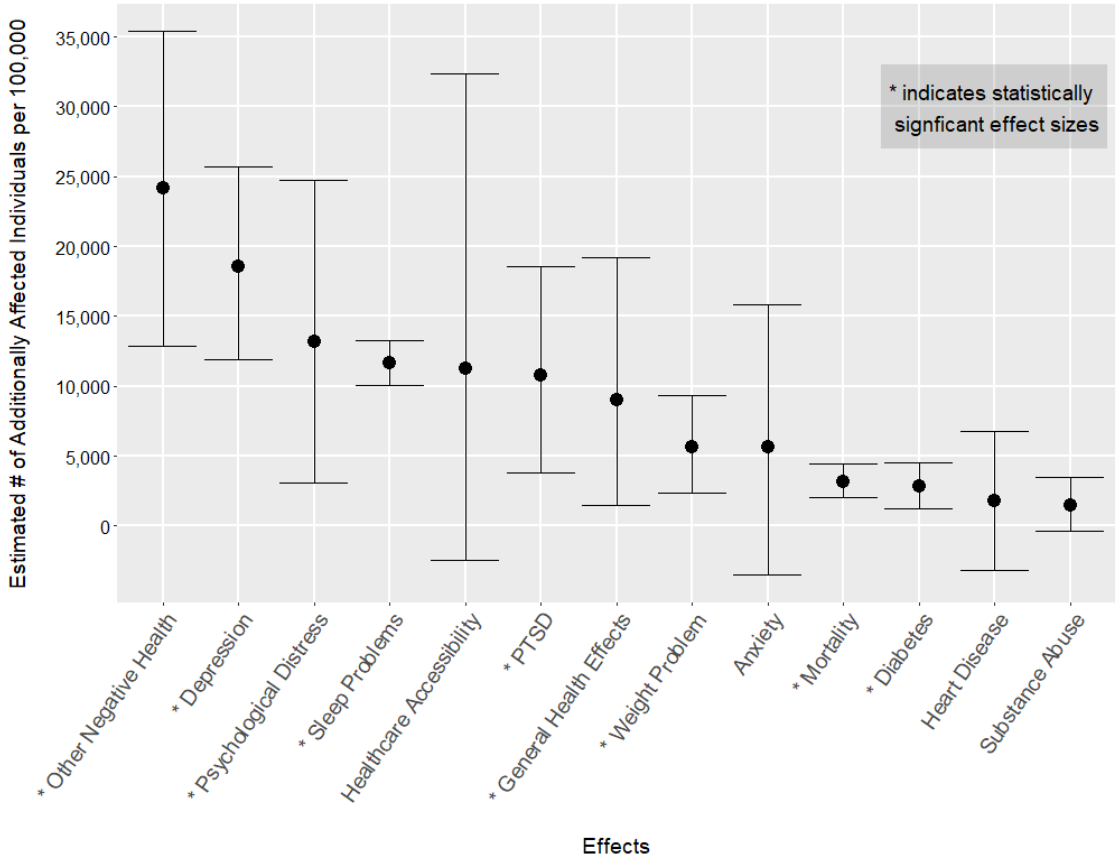
Stressor 3: Stigmatization

Which habit is useful?

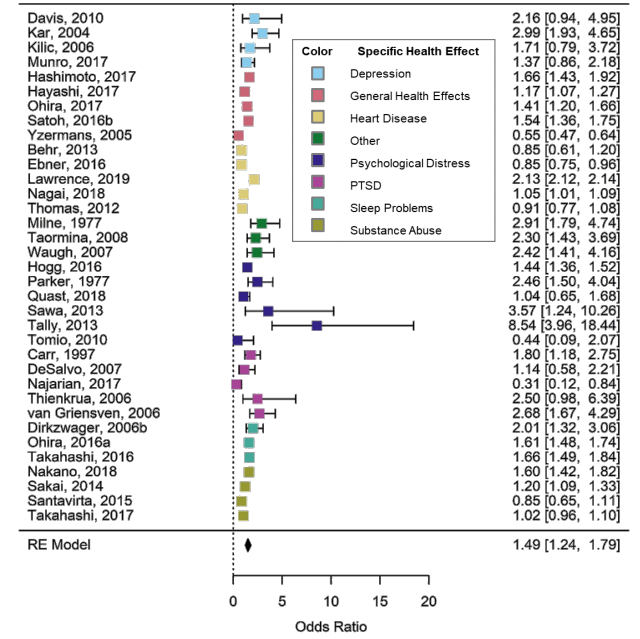
Habit 1: Unique response to radiological emergencies and prolonged displacement from home.

Habit 2: Develop resilient communities able to face all hazards.

Prolonged displacement has quantifiable effects



Meta-analysis of Odds Ratio for All Health Effects



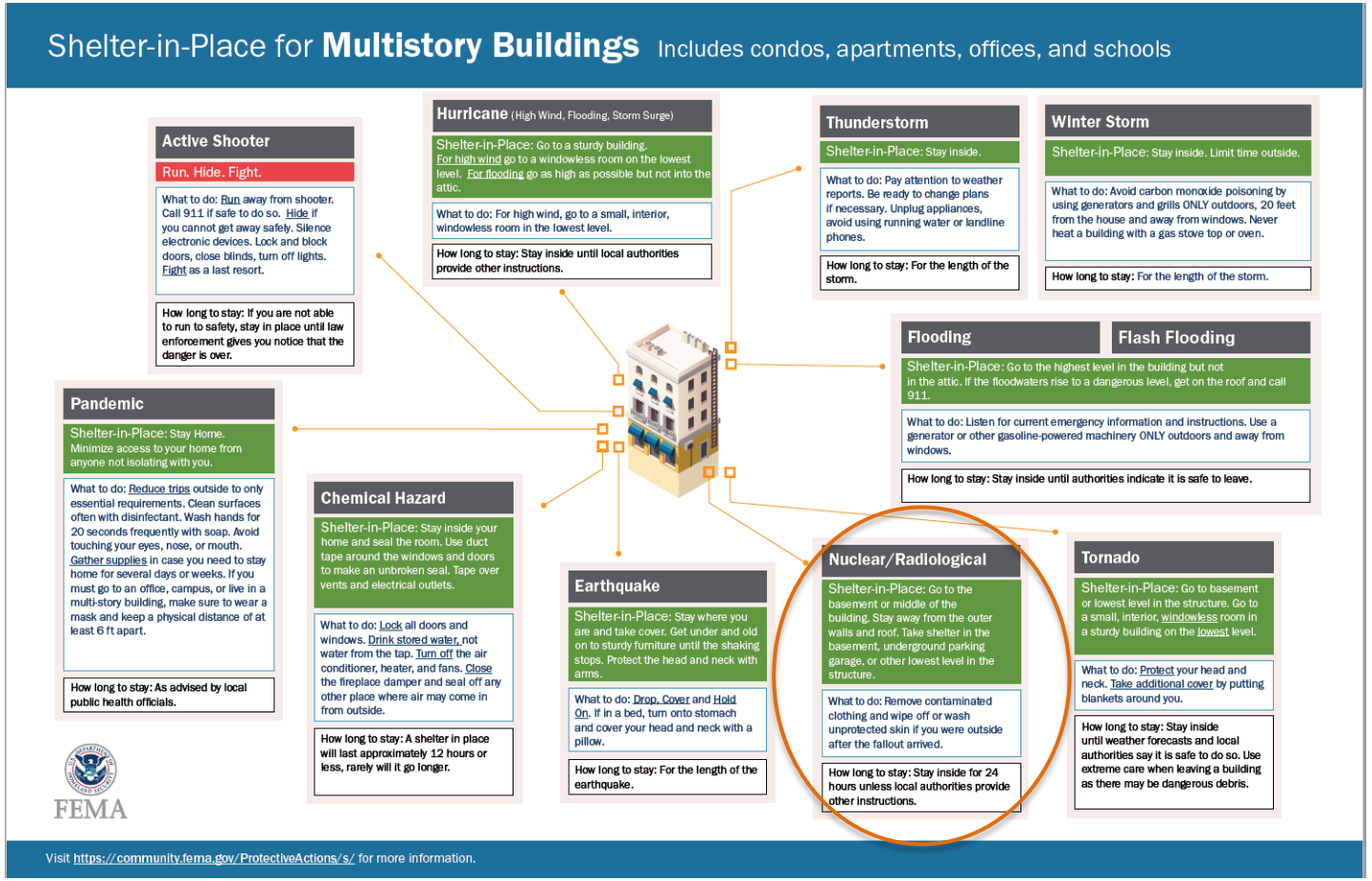
Health Outcome	Special Populations Included
Anxiety	
Depression	Children
Diabetes	Elderly
General Health Effects	Elderly, Males
Healthcare Accessibility	Elderly
Heart Disease	Elderly
Mortality	Hospital Patients, Nursing Home Residents
Other	Low-educated Mothers
Psychological Distress	Children, Hospitalized Patients
PTSD	University Students, Children
Respiratory Problem	Elderly
Sleep Problems	
Substance Abuse	Children
Weight Problem	

Displaced populations are more at risk across all hazards and all health effects

U.S. NRC. NUREG/CR-7285, "Nonradiological Health Consequences of Evacuation and Relocation" August 2021.
https://www.nrc.gov/reading-rm/doc-collections/nuregs/contract/cr7285/index.html

Use the same habits for all hazards

A unique hazard does not require a unique response



U.S. Federal Emergency Management Agency. https://community.fema.gov/ProtectiveActions/s/

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Communicate balanced views of the risk

Protective Action Questions & Answers for Radiological and Nuclear Emergencies (U.S. EPA, 2017)

How much radiation is safe? How much is considered low risk?

It takes a large dose of radiation—more than 75 rem (75,000 mrem or 750 mSv)—in a short amount of time (usually minutes to hours) to cause immediate health effects, such as acute radiation sickness. Infants, the elderly and pregnant women are more sensitive to radiation exposure than healthy adults. Factors like age, gender and even previous exposure also might influence a body's reaction to radiation exposure.

Follow these three steps to limit your exposure to radiation and lower your risk:

*1. **Get inside** a building or to a basement to protect yourself.*

*2. **Carefully remove the outer layer of your clothing**, seal it in a plastic bag and get clean (shower or wipe off).*

*3. **Listen** to officials and emergency responders for further safety instructions.*

U.S. EPA. EPA-402/K-17/002, "Protective Action Question & Answers for Radiological and Nuclear Emergencies: A companion document to the U.S. Environmental Protection Agency Protective Action Guide (PAG)," September 2017.

Change is possible

Through deliberation, good governance, and good habit, we can keep the public safe.

What will not change

The U.S. NRC's commitment to protect public health and safety will not change.