Outline

- Risk perception and communication
- Risk vs. social benefit
- Managing real and perceived risks
## Risk-risk comparisons (avg. annual risk of death)

<table>
<thead>
<tr>
<th>Action, event, or occupation</th>
<th>Average Annual Risk of Death (per 100,000)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cancer from arsenic at 50 ppb in water</td>
<td>14</td>
</tr>
<tr>
<td>Air pollution in U.S.</td>
<td>25</td>
</tr>
<tr>
<td>Cigarette smoking</td>
<td>300</td>
</tr>
<tr>
<td>Being President of the United States</td>
<td>1,900</td>
</tr>
<tr>
<td>Annual coast-to-coast flight</td>
<td>1</td>
</tr>
<tr>
<td>Motor vehicle accident</td>
<td>15</td>
</tr>
<tr>
<td>Tornadoes</td>
<td>0.015</td>
</tr>
<tr>
<td>Snowboarding</td>
<td>0.25</td>
</tr>
<tr>
<td>Snow skiing</td>
<td>12</td>
</tr>
<tr>
<td>Sky diving</td>
<td>58</td>
</tr>
</tbody>
</table>

Psychological factors influencing risk perception

- Amos Tversky’s three contributors to cognitive biases
  - Representativeness
    - One small event is representative of a large class of events
  - Anchoring
    - Initial estimates of risks define a psychological range that subsequent risks are compared against
  - Availability
    - Ease of recollection of events leads to perception of higher probability of risk

- Other important factors to discuss
  - Voluntariness; necessity; trust
Involuntary risks are generally unacceptable

Decreasing Probability of Effect

Voluntary (e.g., smoking)  ←  Involuntary (e.g., drinking water)

Acceptable Risk

Unacceptable Risk
Information about benefit (A) or information about risk (B) could create a more positive affective evaluation and lead to inferences about risk and benefit that are affectively congruent with the information input.

Similarly, information could decrease the affective evaluation as in C and D, resulting in inferences that are opposite those in A and B.

Source: Slovic (1993)
Influence of trust on risk perception

Trust is easier to destroy than create because:
1) Trust-destroying events are more visible and carry greater weight than trust-building events.
2) Sources of trust-destroying news tend to be perceived as more credible than sources of trust-building news.
3) Once initiated, distrust tends to reinforce and perpetuate more distrust.

Source: Slovic (1993)
Social amplification of risk

Phenomenon by which information processes, institutional structures, social-group behavior, and individual responses shape the social experience of risk, thereby contributing to risk perception, consequences, and management.

Source: Kasanor et al. (1988)
Perceived risks change as events unfold

2010 BP Oil Spill in the Gulf of Mexico

Daily oil spill estimates (barrels per day)

- April 20th
- April 25th
- April 28th
- May 28th
- June 10th
- June 16th
- July 15th

1K  5K  12-19K  25-30K  35-60K

Deepwater Horizon explosion

Containment cap closed

BP Stock (NYSE: BP)
Sept. 2009 to Aug. 2011

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Modern risk communication networks

Risk communication is communication that provides people with the information they need to make informed, independent judgments about risks to health, safety, and the environment. Risk communication requires effective delivery of the right information to the right audience.

Source: Paustenbach (2009)
Effective communication depends on trust and credibility

Critical determinants of trust and credibility:
1) Perceptions of knowledge and expertise
2) Perceptions of openness and honesty
3) Perceptions of concern and care

Using risk communication to intensify or attenuate risk

Three types of risk communication:

**Precaution advocacy**
Alerting insufficiently upset people to serious risks. “Watch out!”

**Outrage management**
Reassuring excessively upset people about small risks. “Calm down.”

**Crisis communication**
Helping appropriately upset people cope with serious risks. “We’ll get through this together.”

Source: Peter M. Sandman (http://www.psandman.com/)
Three keys for communicating risk

1) Motivation
   - Reduce outrage, share power, and find out what people want to know

2) Simplification
   - Simplify language, graphics, and content

3) Orientation
   - Tell people where you are and where you are going
   - Use risk comparisons — carefully
   - Don’t tell more than you know and explain (be honest about) uncertainty

Source: Peter M. Sandman (http://www.psandman.com/)
Do real or perceived risks outweigh societal benefits?

<table>
<thead>
<tr>
<th>Risk</th>
<th>Benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>Low</td>
</tr>
</tbody>
</table>

**Decision:**
Reduce or eliminate risk

<table>
<thead>
<tr>
<th>Risk</th>
<th>Benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>Low</td>
</tr>
</tbody>
</table>

Non-controversial
Clear, rapid decisions

<table>
<thead>
<tr>
<th>Risk</th>
<th>Benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moderate</td>
<td>Moderate</td>
</tr>
</tbody>
</table>

Often controversial due to uncertainties; formal risk-cost-benefit analysis usually needed

<table>
<thead>
<tr>
<th>Risk</th>
<th>Benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>High</td>
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</table>

**Decision:**
Approve action

<table>
<thead>
<tr>
<th>Risk</th>
<th>Benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moderate</td>
<td>Moderate</td>
</tr>
</tbody>
</table>

Decision:
Depends on societal values, economy, etc.
Risks and benefits to society do not accrue in unison

Immediate **benefits**, delayed **risks**
(e.g., urban expansion)

Immediate **risks**, delayed **benefits**
(e.g., ethanol production)
Risk-cost-benefit analysis (RCBA)

Net worth ($) = $W(t) = \alpha (B,t)B(t) - \beta (C,t)C(t) - \gamma (R,t)R(t)$

$\alpha, \beta, $ and $\gamma$ are used to reduce benefits, costs, and risks to a common scale ($$)

Benefit of action
Cost of action/risk mitigation
Risk of action

Cash Inflow
Cash Outflow

$^{t=T}$

Net present value (NPV) ($) = $\int_{t=0}^{T} D(t)W(t)dt$

Where...

$t = 0$ to $T =$ time horizon for analysis (e.g., years to decades)

Discounting function $[D(t) = 1 / (1 + r)^t$ where $r =$ interest rate and $t =$ year 1, 2, 3, etc.

<table>
<thead>
<tr>
<th>If...</th>
<th>It means...</th>
<th>Then...</th>
</tr>
</thead>
<tbody>
<tr>
<td>NPV &gt; 0</td>
<td>Benefits outweigh costs and/or risks</td>
<td>Action should proceed</td>
</tr>
<tr>
<td>NPV &lt; 0</td>
<td>Costs and/or risks outweigh benefits</td>
<td>Action should not proceed</td>
</tr>
<tr>
<td>NPV = 0</td>
<td>Benefits = costs and/or risks</td>
<td>Other factors need to be considered</td>
</tr>
</tbody>
</table>
Using RCBA for resource allocation decisions

Majority of resources reallocated from Program A to Program C
What is risk management?
What is risk management?

- Defined
  - “The process which evaluates how to protect public health.” (EPA)
  - “the action taken based on consideration of that [risk assessment information] and other information” (EPA)
- Should be separated from risk assessment (science)
- Mitigation strategies will be case- and issue-specific
Factors influencing risk management

- Economic factors (cost of risks and/or risk mitigation)
- Laws and legal decisions
- Socioeconomic factors
- Technological factors (feasibility of risk management)
- Political factors (local, state, and Federal)
- Public values and attitudes about perceived risk
External forces influencing EPA’s risk decisions

- Supreme Court
- White House
- Congress
- Industry
- Academia and Public
- Lobby (industry)
- Lobby (activist)
- Lobby (end user)

Branches of gov’t

Lobbyists

Third parties
General risk management options

1) Zero risk
   - Ban or voluntary phase-out
   - Replace with safer alternative (without a ban)

2) As low as reasonably achievable
   - Reduce application or incorporation rates
   - Restrict when, where, and how a chemical is used

3) Best-available control technology
   - Targeted delivery of chemical (e.g., precision agriculture)
   - Install scrubbers to reduce/remove chemicals from air or water
   - Remediate soil or water using bioremediation

4) Risk-cost-benefit analysis
   - If NPV < 0, use one or more options above until NPV > 0