Emerging Technologies: What Have We Learned About scoverning: the Risks?s:

Paul C. Stern, National Research Council, USA Norwegian University of Science and Technology

Presentation to Science and Technologyy Innovation Program Woodrow Wilson Center for Scholars Washington, DC December 15, 2011

# The Emerging Technologies Project

- Started with NRC committee; completed at ORNL
- Objective: identify ways to address risks of emerging technologies, drawing on
  - Experience with technologies now in place (nuclear power, radioactive waste management, DNA manipulation, etc.)
  - Early experience with currently emerging technologies (nano-, bio-, and info-)
  - Deduction from fundamental knowledge of social processes (risk perception and assessment; commons management, international institutions and networks; science communication and utilization)

# Some Insights from the Nuclear Power Case

- Scientists tend to focus on distinguishing large vs. small risks; the public, on zero vs. non-zero risks
- Scientists tend to focus on the probability of a hazard; the public on the consequences
- Public concerns are strongly influenced by trust in risk management institutions
- Public concerns are related to whether or not the consequences are known from experience

### Some Insights from Radioactive Waste Management

- Public perceptions matter in technology acceptance, regardless of whether technical experts think the judgments are wrong
- Public judgments are related to whether a possible consequence is dreaded, especially if the effects are potentially unbounded
- Population segments differ in risk judgments (white, male, affluent people see radioactive waste as less risky than other people do)
- Public participation can promote confidence in institutions and technologies

### Some Insights from DNA Manipulation

- Risks should be analyzed and assessed not only as scientists view them but also as society is likely to view them
- It is easier to discuss risk issues before positions become hardened

In many cases, risk assessment needs to be case-specific because consequences can depend on subtle differences in substance composition or use Some Insights from Research on Risk Perception, Assessment, and Management

- Qualitative aspects of hazards are important (e.g., dread, controllability); there are multiple metrics of risk
- Different parties have different value priorities and even different understandings of a risk situation
- Usefulness of analytic-deliberative processes

Understanding Risk,



#### Some additional, generic lessons

Technology acceptance is fundamentally a social process Social impediments are more likely to arise if risk communication comes late Building trust through public participation can increase the likelihood of acceptance Boundary organizations that link producers and users of u information about risk are important Information about benefits often developed more aggressively than about risks, leading to governance challenges later Non-governmental "policy networks" can perform important risk governance functions Reference: P.C. Stern, T.J. Wilbanks, S. Cozzens, and E.A. Rosa, Generic lessons learned about societal responses to emerging technologies perceived as involving risks. ORNL/TM-2009/114. Oak Ridge National Laboratory, 2009.

#### Some Implications for Emerging Technologies

Deliberation is especially important for problem formulation and if risks are not yet identified and

 In that situation, it may be hard to get meaningful input from the spectrum of interested and affected parties

Established regulatory bodies may not be appropriately tasked because hazards are

Research on commons management may be relevant

#### Commons Governance/Management

Elinor Ostrom, Nobel laureate in economics

The problem: limiting damage to resource bases by private appropriation of depletable resources accessible to all

What she studied:

 local resource bases (e.g., forests, fisheries, water sources)

institutions created by resource users

managing commons

Identifying Governance Principles for Risks of Emerging Technologies
Can the Ostrom governance principles be applied outside the domain of the kinds of commons she studied?
Can they be extended to:
Global natural resources

Risks of technology

New paper addresses these questions

Reference: P.C. Stern, Design principles for global commons: natural resources and emerging technologies. *International Journal of the Commons*, 2011, 5:213-232. Characteristics of Local Resource Commons: Why the Theory Might not Generalize

Geographic extent: tens to thousands of km2
Number of appropriators: tens to thousands
Commons are degraded intentionally
Appropriators share an interest in preserving the commons

Appropriators share common institutional and cultural context

Resources regenerate on a human time scale, so learning is a feasible management strategy

### How Global Resources are Different

Geog scale	Local Resouces	Global Resources
# of users	Thousands	Billions
Salience	Resouce use is conscious purpose	Resource use is a byproduct of intent
Dirstribution of interests, power	Benefits and costs internal among users	Significant externalities; interest and power differentials
Cultures, institutions	Homogeneous	Heterogeneous
Feasibility of learning	Good	Limited
Regeneration time	Less than a generation	More than a generation
Ease of understanding resource	Feasible without scientific training	Scientifically complex, limited predictive ability
Resource dynamics	Stable rules	Changing rules
Learning transfer across places	Possible	Difficult

#### Applicability of Ostrom's 8 Design Principles

- Define boundaries for appropriators and resource: Not applicable
- Define rules congruent with ecological conditions: Difficult to identify the conditions, enforce global rules
- Allow most users to participate: Size of group, need to understand science make this difficult
- Hold monitors accountable: Challenges include need for global monitoring, uncertainty about what to monitor, and diversity of those monitors should account to
- Apply graduated sanctions: Sanctioning authority is limited
- Low-cost conflict resolution: Disconnects between parties and generations makes difficult
- External authorities permit local control: Need to facilitate local control and learning; also limit externalization
- Nested layers of organization: same as above

#### How Emerging Technologies are Different from Resource Commons

- Some are integrated global systems, but some are global only in distribution
- Irreversible processes are endemic
- Scientific complexity, uncertainty, and ignorance are rife
- Strongconflictsoffvalues:betweendeveloperss and affected parties

Strong conflicts of interest, too

Nature of the risks incompletely known (including an expectation of surprises)

# **Implications of the Differences**

Need for science is critical Need for anticipating risks (not only managing them) is also critical Strong interests imply need to insulate science from policy (Red Book model) Interests and value differences make that ainfeasible, calling for analytic deliberation

## A Revised Set of Design Principles

- 1. Invest in science to understand resource/technology and its interactions with users and those affected
- 2. Establish independent monitoring, accountable to the interested and affected parties
- 3. Ensure meaningful participation of parties in framing questions, interpreting science, and developing rules
- 4. Integrate scientific analysis and broadly based deliberation
- *5. Higher-level actors should facilitate participation of lower-level actors*
- 6. Engage and connect a variety of institutional forms, global to local, in making rules, monitoring, and sanctioning
- 7. Plan for instituional adaptation and change (iterative risk management)

Additional Principles Suggested by Global Commons Problems and Emerging Technologies

Invest in science

- Integrate scientific analysis with broadly based deliberation
- Plan for institutionalized adaptation and change (iterative risk management)
- Engage a variety of institutional forms (not only levels of organization)

*Source:* Dietz, Ostrom, and Stern, The struggle to govern the commons, *Science*, 302:1907-1912.

## Risk Governance Challenges and Synthetic Biology

- Identifying the risks before hazards are experienced
- Integrating the spectrum of interested and affected parties with cutting-edge science and unclear risks
- Coping with surprises (e.g., unexpected hazards)
- Developing rules and governance mechanisms that can adapt as risks become clearer
- Developing institutional forms that can meet the above challenges