Better Decision Making Under Climate Uncertainty: Lessons from Psychology

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"Behavioral science matters"

- Economics and institutional constraints are important design elements for (climate) risk management, but
  - economics, political science, geography not the only useful social sciences
  - risk communication needs to reach human decision makers
  - risk management needs to be embraced and implemented by human decision makers
    - What is special about *human* risk perception and decision making under (climate) risk and uncertainty?
  - *psychology*, *behavioral economics*, and *behavioral game theory* add important insights and risk management process design tools

Outline

- Uncertainty as barrier to predictability of an action
- Models of how people (actually) deal with uncertainty
  - A. Predicting uncertain events
  - B. Choosing among actions with uncertain outcomes
  - C. Choosing among actions with delayed outcomes
- Multiple processing systems
  - Analytic vs. experiential
- Multiple goals and incentives
- Policy Implication

Predictability

- Powerful human need and human skill
  - result of evolutionary selection (or intelligent design?)
- Provides control
  - avoid threats to physical and material well-being
- Allows to plan and budget for the future
  - Homo sapiens arguably the most successful species on earth

Need for Control

- So strong, it can lead to wishful thinking
  - "illusion of control" in situations that are obviously determined by chance
    - superstitious behaviors
    - control, even when illusory, has important health benefits
- Perceived lack of control raises anxiety, individually and socially
  - Inverse u-shaped function for beneficial effect of anxiety
  - Moderate levels motivate behaviors to regain control
    - protective or evasive action
    - mitigation of risk
      - information search, theory building
      - science and technology development
        - » Forecast developments for weather, climate, earthquakes, economy, etc.

Multiple Processing Systems

- Analytic system
  - New evolutionary accomplishment; only available to homo sapiens in full form
  - Effortful, slow, requires conscious awareness, and knowledge of rules
    - e.g., probability calculus, Bayesian updating, formal logic
  - Conscious calculation-based decisions
    - May become habits/rules by virtue of repeated execution

- Experiential system
  - Evolutionarily older, hard-wired, fast, automatic
    - Trial and error learning: Association between behavior and consequences
    - Emphasis on outcomes of decisions (probabilities not explicitly represented)
    - Emotions as a powerful class of associations
      - risk represented as a "feeling" that serves as an "early warning system"
  - Affect-based decisions (fear or worry as motivator for action)
  - Rule-based decisions that get triggered (automatically) by cues in the environment
    - Emergency room procedures, trading floor decisions

Analytic and Experiential System

- Interact to some extent
  - Emotional reactions as input into analytic processing
- Operate in parallel
  - "Is a whale a fish?"
  - Affective/experiential system is fast, delivers output earlier
  - When output of two systems in conflict, behavior typically determined by experiential processing system
- Discrepancy in output of two systems often accounts for controversies and debates about magnitude and acceptability of risks
  - e.g., nuclear power, genetic engineering
    - Technical experts and academics rely more heavily on analytic processing
    - Politicians, policy makers, end-user stakeholders, and general public rely more heavily on experiential/affective processing

How do we know about the possible outcomes of different actions?

- In Decisions from Description
  - Outcome distribution fully described
    - possible outcomes and their probabilities provided numerically or graphically
      - seasonal climate forecast for next growing season
      - hurricane warning issued by local TV station
  - Extensive use of analytic processing system
    - rare events are overweighted (Prospect Theory) or ignored

- In Decisions from Experience
  - Outcome distribution initially unknown
    - knowledge of possible outcomes and their likelihood acquired by personal exposure in repeated choices
      - intuitive forecast of climate in next growing season based on years of experience
      - intuitive assessment of likelihood of being affected by hurricane based on past experience with warnings and events
  - Extensive use of experiential processing system
    - recent events get disproportionate weight
    - rare events are underweighted, unless they recently occurred

A. Predicting uncertain events

- Normative models
  - Probability calculus
  - Bayesian updating and belief revision
- Descriptive reality
  - Phenomena
    - Deterministic/causal/experiential thinking more prevalent than statistical/probabilistic thinking
    - Overconfidence in accuracy of prediction

Experiential processing to predict uncertain events

- Use of heuristics that utilize stored past experience
  - ***Representativeness heuristic***: Similarity to category prototype as indicator of likelihood
    - "What is the probability of having a hot and dry summer?"
    - Answer is based on similarity of current conditions to prototype; base rates get ignored

  - ***Availability heuristic:*** Ease of recall as indicator of likelihood
    - "How likely will New York City experience a terrorist attack before the 2008 election?"
    - More likely events generally easier to recall, but not all easily-recalled events are very likely
      - emotional impact (psychological risk dimensions of Slovic et al.)
      - recency effects
      - media distortions, overreporting of catastrophic rather than chronic risks

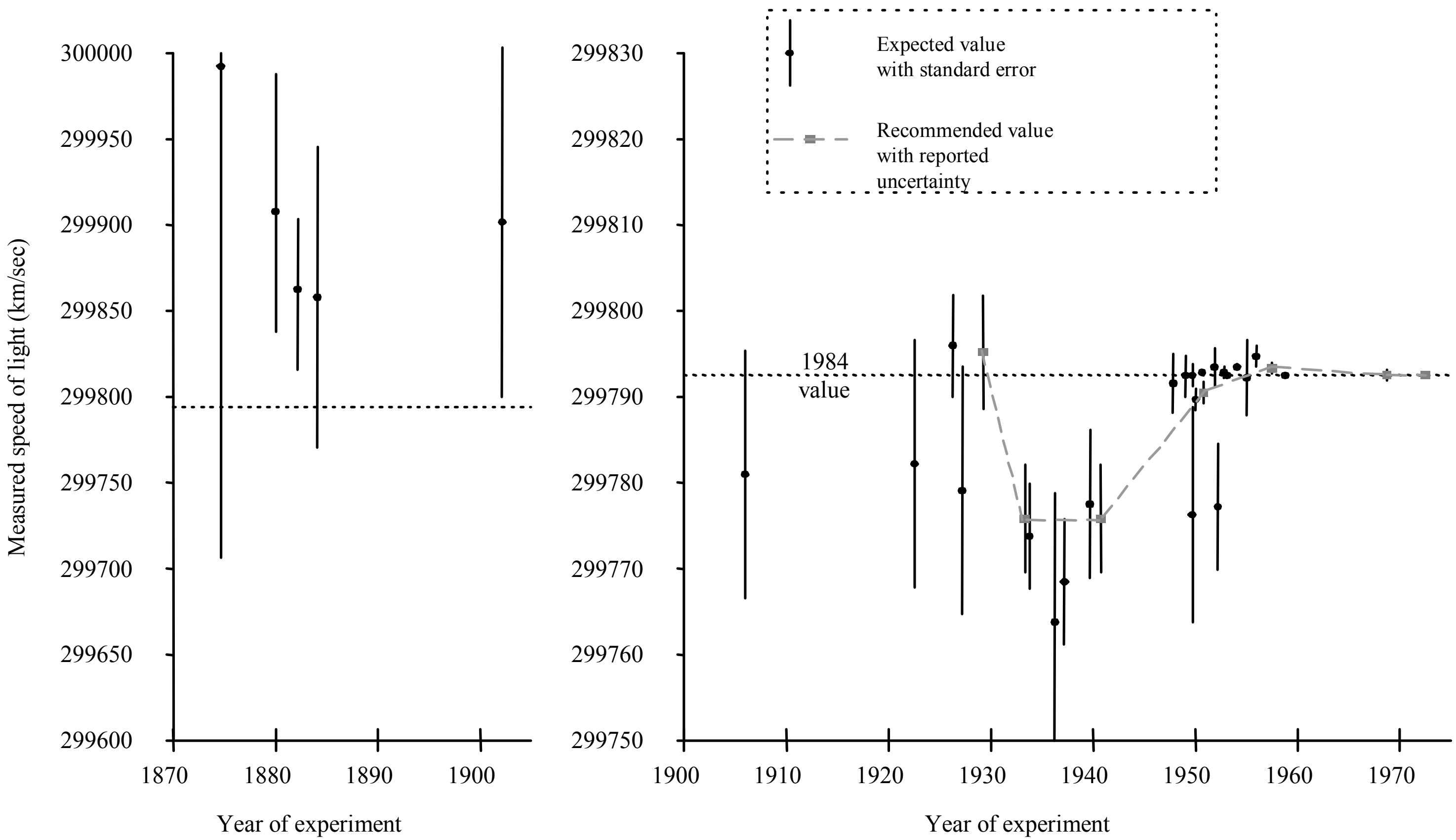
Overconfidence in judgments or decisions

"There is no likelihood man can ever tap the power of the atom."
Robert Milikan, Nobel Prize in Physics, 1923

"Heavier than air flying machines are impossible."
Lord Kelvin, President of Royal Science Society, 1895

- Confidence ratings
  - Poor calibration found in most cases
    - Proportion of time a prediction of answer is correct ought to equal the confidence assigned to that estimate
    - Only weather forecasters, bookies, and expert bridge players are well calibrated
      - Due to availability of quick and frequent corrective feedback
- Confidence intervals (CIs) tend to be too narrow
  - 95% CIs are closer to 50% CIs
    - E.g., for general knowledge questions
      - Length of Nile river?
  - engineering discount/safety factors are social acknowledgment of systemic overconfidence

Overconfidence in Science



Henrion & Fischhoff (1986)

Reasons for Overconfidence

- **Attentional**
  - Selective information and memory search
    - Difficult to know what we don't know
    - Confirmation bias
    - Implications for veridicality of personal recollections of climate information
- **Motivational**
  - Need to appear competent and confident to others and oneself
  - Confidence and optimism help to get the job done

B. Choosing among actions with uncertain outcomes

- Normative models
  - Expected utility theory
    - Outcomes of actions as random variables
    - Outcomes transformed into subjective value/utility
    - Shape of utility function as measure of risk aversion/seeking
  - Risk-return models
    - Using moments of outcome distributions
      - EV and Variance
    - Decision as tradeoff between greed and fear
      - <u>C</u>apital <u>A</u>sset <u>P</u>ricing <u>M</u>odel
        - » WTP(X) = EV(X)-bVar(X)
        - » Willingness to Pay for Option X involves a tradeoff between Return (EV) and Risk (Var)

- Descriptive Modifications
  - Expected utility theory → Prospect theory
    - Psychological extension of expected utility theory
      - by Kahneman and Tversky (1979)
    - Value Function:
      - Defined over gains and losses on deviations from reference point
      - Concave for gains (risk-averse), convex for losses (risk-seeking)
      - Steeper for losses than for gains ("losses loom larger")
  - Variance-EV models→ Psychological Risk-Return Models
    - WTP(X) = a Perceived Benefits(X) – b Perceived Risk(X)
    - Variance of outcomes does not describe how people perceive the risk of risky options
      - Upside and downside variability do not enter symmetrically; downside gets greater weight
    - Variability and risk often perceived in a relative fashion
      - in very basic psychophysical judgments like perceived loudness or brightness (Weber's law, 1834)
      - *coefficient of variation* (CV) a measure of relative risk: risk per unit of return
        - » defined as standard deviation / expected value

C. Choosing among actions with delayed outcomes

- Same framework as for decisions under risk
  - Integrate/aggregate over all possible outcomes of a choice option, but also discount outcomes based on their time delay

- Normative models
  - Discounted utility theory
    - Utility of outcome x (u(x)) is discounted as a function of its time delay
    - Constant discount rate for all time periods (exponential discounting)
    - Interest rate on financial deposits a reasonable standard

Intertemporal Choice Stylized Facts

- People are impatient
  - Discount “too much”
  - Implicit discount rate far greater than interest rate
- Discount rates are inconsistent over time
  - People especially dislike delays that prevent immediate consumption
  - Delays on existing delays less consequential
    - Captured by hyperbolic discounting, where initially very high discount rate levels off with time delay

Multiple Goals and Incentives

- Multiattribute utility theory is normative model
  - allows decision makers to make tradeoffs between multiple outcome dimensions in ways that can satisfy multiple goals

- Deviations from normative model
  - People dislike tradeoffs (we "want it all")
  - Use noncompensatory choice processes
    - Decision rules used that avoid the realization of goal conflict
    - Editing out of elements that remind us of goal conflicts
  - Goal space broader than assumed by traditional economic view of human nature
    - Includes social goals not just selfish goals of homo economicus
    - Includes process goals as well as material goals

Economic and Other Incentives

- Common-pool resource dilemmas ("tragedy of the commons") are serious, but situation not as hopeless as envisioned by Hardin
  - Communication and trust play a major role
    - Most interactions seen as repeated games
    - Communication is seen as binding and not just "cheap talk"
  - Cooperation can be facilitated by appealing to social identity of people
    - Social affiliation and social approval are powerful human needs
    - Priming of social goals by the way situations are described or "framed" often more effective, "cheaper," and more feasible than the modification of economic incentives

Policy Implications

- How to get stakeholders (public officials, members of the general public) to pay attention to climate change and variability?
  - Analytic appeals not very effective
    - Contrary to personal experience of climate change in many regions of the worlds
    - Mitigative and adaptive actions often require immediate costs/sacrifices/losses to achieve time-delayed benefits/gains
      - Both hyperbolic discounting and loss aversion argue against taking such actions
  - Is there wisdom in designing more emotional appeals, i.e., in inducing people to worry more about climate change and variability?
    - Could be done by
      - visualization or graphic description of catastrophic climate change
      - concretizing future changes in simulations of conditions in local environments

Caveats

- Finite Pool of Worry
  - Increases in worry about one hazard may result in decrease in worry about other hazards
    - Found in Argentine farmers with climate risks and political risks (Hansen, Marx, Weber, 2004)

- Single Action Bias
  - Tendency to engage in only a single corrective action to remove perceived threat of a hazard (single action removes "hazard flag"), even when portfolio of responses is clearly advantageous
    - Radiologist: detect single abnormality, miss others
    - US Midwestern farmers: engaged in single adaptation to climate change (*either* production practice, pricing practice, or endorsement of government intervention) (Weber, 1997)
    - Argentina Pampas farmers: less likely to use irrigation or use crop insurance if they had capacity to store grain on their farms (Hansen, Marx, Weber, 2004)
  - Reactions on multiple fronts may require more analytic response to situation

Risk Communication and Management Challenges and Implications

- How to use people's experiential and affective processing and their aversion to uncertainty constructively?
  - Help people plan for uncertainties
    - Scenario analysis provides good match to nonprobabilistic information processing of experiential system
      - Worst case, best case, most likely case scenarios
    - Contingency plans, especially for worrisome worst and bad case scenarios
      - Real benefits
        - » Increased response speed; better responses
      - Psychological benefits
        - » Perceived preparedness reduces anxiety

Conclusions

- Probabilistic nature of climate (change) forecasts
  - Liability
    - In the absence of clear action implications (that allow a feeling of control), awareness of climate risk may arouse too much anxiety
      - Gets edited out, i.e., treated as being effectively zero, resulting in procrastination and decision avoidance
    - Strategic use of uncertainty to justify decisions that are desired for other reasons (hidden agendas)
  - Opportunity
    - "Uncertainty is not the enemy"
    - Range of outcomes as natural impetus for contingency planning
    - Development of forecast formats that take into consideration human information processing modes and constraints can minimize liabilities and maximize opportunities

Conclusions – cont'd

- Consider the combination of analytic and experiential/emotional processes
  - to facilitate correct interpretation of climate forecasts
  - to motivate forecast usage and adaptive risk management actions
- Tailor forecast formats and risk management process to different segments of users
  - Amount and sophistication of analytic processing a key variable, but time horizon and incentives/goals also differ
  - For most users, it will pay to
    - Elicit optimal level of worry/concern
      - Development of envisioning tools to concretize the (temporally and spatially distant) impacts of climate change
    - Concretize statistical uncertainty measures
      - Localize forecasts
      - Provide analogies to previously experienced situations
      - Discretize the distribution of different futures
        - » Best case, most likely case, worst case, likelihood of extreme events
    - Provide accurate degree of confidence in forecasts

Conclusions – cont'd

- Actions and choices can be influenced by strategic use of "framing"
  - Description of situation in ways that prime cross-group commonalities, social goals, and cooperation vs. differences, selfish goals, and competition
  - Choice of reference points that depict alternatives as involving gains or losses, depending on desired response
    - Risk seeking in the domain of losses, risk aversion for gains
    - Protective or mitigative actions can be seen as either involving costs and losses or benefits and opportunities
      - Both perceptions are true, but attentional focus induced by problem description often determines responses

“Social science matters”

- In addition to economic and institutional constraints, constraints on human cognition and motivation need to be considered to design of effective risk communication and risk management processes
- Knowledge about human capabilities and constraints can provide useful tools
- Ignoring such knowledge leaves many problems seemingly more intractable than they have to be