What to do when you’re not sure
The role of uncertainty in policy evolution

Paul Baer
Center for Environmental Science and Policy
Stanford University

Presented at the HFI Symposium
August 15, 2006
What I’m going to talk about

- Uncertainty, probability and risk management
- The likelihood that global and regional temperatures will increase and fire risk will increase
Themes of my research

• Where science has policy implications, the treatment of uncertainty requires special attention
• Where policy depends on scientific input, the treatment of uncertainty requires special attention
• Controversy about policy-relevant science is typically about the distribution of risk (or the distribution of risks and costs)
Sample policy-relevant question:

• What is the likelihood that average summer temperature in Fairbanks will increase by more than 3°C in forty years?
Contributing uncertainties:

- Emissions drivers
  - How much will the global economy and population grow?
  - What global restrictions on GHG emissions will be put in place?
- Climate response
  - How will the global climate respond to increasing GHGs?
  - How will regional temperatures vary from global temperatures?
The key point:

- There is no “true” probability!
- There are only more or less reasonable estimates - and reasonable people can disagree
- Such estimates can be represented quantitatively as ranges (e.g., 10-30%) or as qualitatively (e.g., very likely, moderately likely)
- But there is no “correct” range either!
Policy, uncertainty and the distribution of risk

• Typically, the scientifically determined “official” probability estimate for some harmful event or consequence determines how much effort will be expended to prevent it
  – The use of more “optimistic” estimates increases the likelihood of negative consequences
  – The use of more “pessimistic” estimates increases the costs on those who must pay to reduce the risk

• Thus even the “scientific” components of risk management involve ethics and politics
Probability, valuation and risk management

• Classical risk management strategies are based on maximizing expected value
  – Each possible outcome must have a precise probability and a precise valuation

• But for most important consequences, neither precise probabilities nor uncontroversial valuations are available

• Thus there can be no objectively “optimal” strategy
Alternative risk management strategies

• No simple rules (e.g., the precautionary principle, safe minimum standards) can be made operational on purely “objective” basis

• All practical risk management requires judgment

• Key criteria for good risk management include openness to multiple perspectives, transparency, and accountability
Reasonable estimates of temperature increase and fire risk

- Global emissions scenarios
- GCM scenario results
- Regional temperature response
- Fire correlation with temperature
Sample IPCC “SRES” Scenarios

515 – 686 ppm CO₂ equivalent in 2050
Sample GCM results - B1 Scenario

~490 ppm CO₂, 515 ppm CO₂ equivalent
0.8 – 1.6°C above 1990 in 2050
Sample GCM results - A1B Scenario

~530 ppm CO\(_2\), 605 ppm CO\(_2\) equivalent
1.2–1.9°C above 1990 in 2050
Ratio of temperature increase at 65º N to global mean

1.5 to 1.7 (for 2080-2099) - average of ~15 GCMs
Estimated temperature change at 65ºN in 2050 - Some back-of-the-envelope calculations

• Modeled global temp increase is 0.8 (B1 low) to 1.9ºC (A1B high)
• Unmodeled uncertainty range is 0.5 to 2.2ºC
• Ensemble mean ratio of 65ºC is 1.4 to 1.6 in 2080
• Plausible estimated ratio range in 2050 is 1.2 to 1.8
• Overall uncertainty range is 0.6 to 4.0ºC
• Likelihood of exceeding 3ºC is small but significant
Climate change and fire risk

- Average area burned and number of fires increase with average growing season temperature
- Precipitation also matters
- Non-linear relationships are possible and other factors may be relevant (e.g., pests)
- Overall likelihood of increased fire risk is... significant?
Conclusions: uncertainty and risk

• The likelihood that some event will happen is not a fact that we discover, but a judgment made on evidence.

• Policies to manage risks necessarily combine scientific, ethical and political judgment.

• There can be no objectively “optimal” strategy for hedging against uncertainty.
Conclusions: uncertainty, climate change and forest fire

• It is likely that both global and regional temperature increases over the 20th century are caused by human activities

• Even with significant emission reductions, temperatures will likely continue to increase
  – Neither the global nor regional increases can be predicted with high confidence, but regional increase will likely exceed the global mean increase

• Fire risk will likely increase with increasing regional temperature
  – Correlations with change in precipitation are also uncertain and make prediction more difficult
Conclusions: policy implications

• Policy frameworks must be designed to manage risk controversies, not suppress them
• Five to forty year planning should expect increased fire risk, but that risk cannot be precisely quantified
• Reduction of long-term catastrophic risk requires national and global policy change