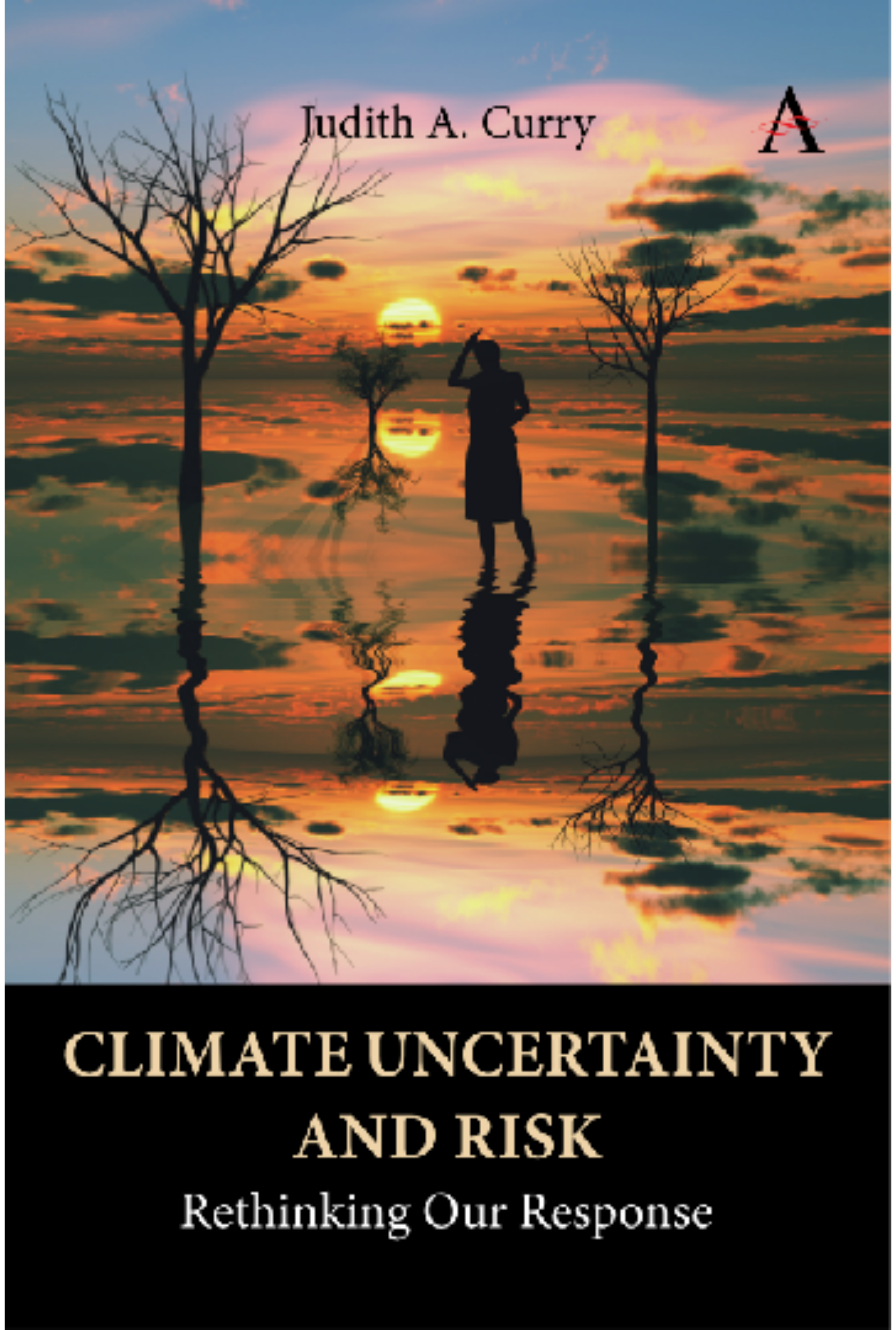


# Climate Uncertainty And Risk

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# What we know with certainty

- Surface **temperatures have increased** since 1880
- Humans are **adding carbon dioxide** to the atmosphere
- Carbon dioxide and other greenhouse gases have a **warming effect** on the planet

## Disagreement among scientists:

- How much of the warming has been **caused by humans**
- How much the planet will warm in the **21st century**
- Whether warming is'**dangerous**'
- How we should **respond** to the warming, to improve human well being

# Why do scientists disagree?

- Insufficient & inadequate observational evidence
- Disagreement about the value of different classes of evidence (e.g. paleoclimate reconstructions, GCMs)
- Disagreement about the appropriate logical framework for linking and assessing the evidence
- Assessments of areas of ambiguity & ignorance
- Belief polarization as a result of politicization of the science

Uncertainty • Doubt • Ignorance

# Scientific perils of an explicit consensus building process

- Explicit consensus building processes can enforce overconfidence and belief polarization.
- Beliefs tend to serve as agents in their own confirmation
- Dismissal of skepticism is detrimental to scientific progress
- Overreliance on expert judgment motivates shortcuts in reasoning and hidden biases
- Narrow framing provides a basis for neglecting research in certain areas

speaking consensus to power

# Climate Change – 2 different perspectives

Tame problem


Goal: controlling the climate
Solution: global

# Climate Change – 2 different perspectives

Tame problem

$CO_2$


Goal: controlling the climate
Solution: global

Complex, wicked problem

Unknowns – known and unknown

**Climate change:**

- ocean/atm circulations
- solar effects
- volcanoes
- **emissions**
- land use
- tidal effects

We can't control the climate

Reduce vulnerability

**Solutions:**

- abundant clean **energy**
- manage **water** resources
- **food** productivity

Economic development

Goal: understanding the climate
Solutions: regional

# The climate 'crisis' isn't what it used to be


Signals from the UNFCCC and IPCC:

- Emissions scenario RCP8.5 is **implausible**
- As 2$^{o}$C warming target is in reach, **target is reduced** to 1.5$^{o}$C
- IPCC AR6 **lowered** the upper *likely* bound of ECS to 4$^{o}$C
- IPCC AR6: many climate models are running **too hot**

COP27: expected warming of 2.5$^{o}$C by 2100.  This is still too high:

- Neglect lower and more realistic values of **climate sensitivity** (Nic Lewis)
- Natural factors are skewed **cooler** during the remainder of the 21st century:
  - ➢ Baseline **volcanic activity** since 1850 has been unusually low
  - ➢ Possible **solar minimum** in the 21$^{st}$ century; solar indirect effects **neglected**
  - ➢ Shift to cold phase of **Atlantic Multidecadal Oscillation** expected in next decade

Temperature change by 2100 could easily be **below** 2$^{o}$C and even 1.5$^{o}$C – note that 1.1$^{o}$C warming has **already** occurred.

# “Warming is less than we expected, but the impacts are worse”

“climate risk” is conflation of

**incremental risk**

sea level rise
water shortages
potential for tipping points

**Management:** minimize emissions??; global

Logical fallacy: **conflation**
Treating two different concepts as one

**emergency risk**

severe weather events
interannual climate variability

**Management:** vulnerability reduction, economic development; regional

Urgency of addressing **emergency risk** is used to motivate the urgency of reducing emissions

Energy poverty from reducing emissions **increases** emergency risk

# Perceptions of Risk

In each pair, 1st risk type is preferred to 2nd:

- natural versus **manmade** risks
- risks that are detectable versus **undetectable**
- controllable versus **uncontrollable** risks
- voluntary versus **imposed** risks
- risks with benefits versus **uncompensated** risks
- known risks versus **vague** risks
- everyday risks versus **uncommon** risks
- future versus **immediate** risks
- equitable versus **asymmetric distribution** of risks.

Climate communications emphasize:

- **manmade** aspects
- unfair burden on the **poor**
- **extreme weather** events
- uncontrollable **tipping points**

# Problems with mixing politics and science

"What you get when you mix politics with science is . . . just politics, unfortunately."

Policy makers misuse science by:

- Using science as a vehicle to avoid 'hot potato' policy issues
- expecting black-and-white answers to complex problems
- demanding scientific arguments for desired policies
- funding a narrow range of projects that supports preferred policies.

Scientists misuse policy-relevant science by:

- playing power politics with their expertise
- conflating evidence with expert judgment
- ignoring data and research paths that undermine their political preference
- entangling disputed facts with values
- intimidating scientists whose research interferes with their political agendas

# We have mischaracterized climate risk

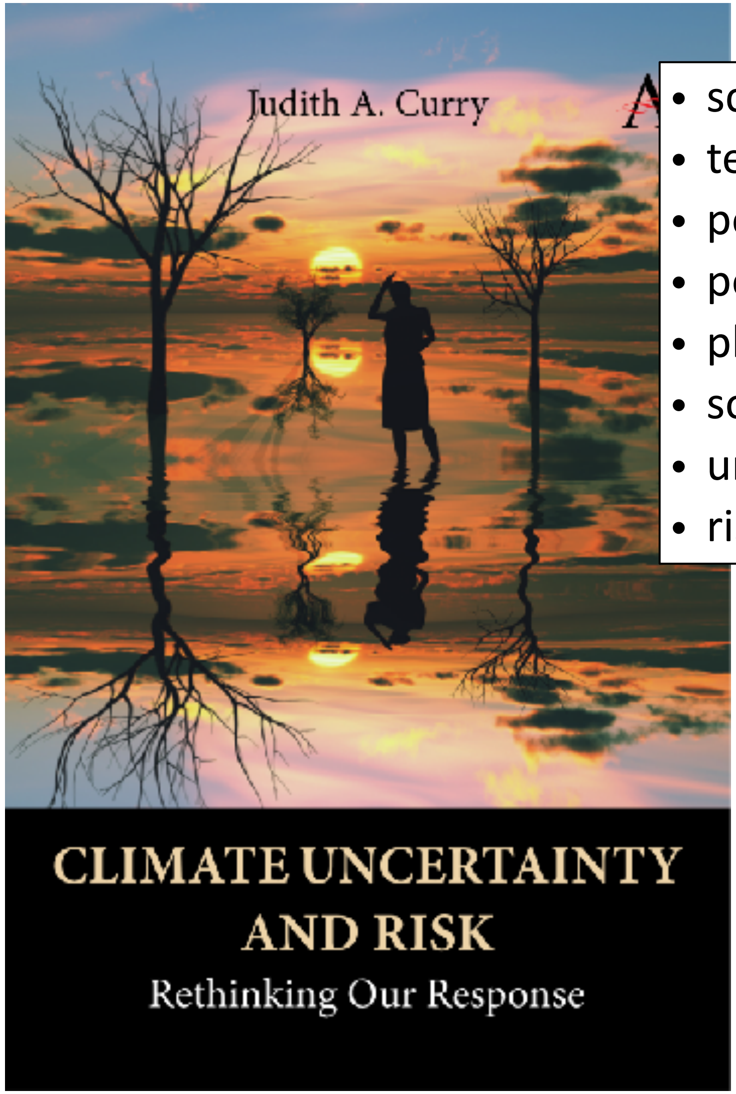
"The current thinking and approaches have been shown to lack scientific rigour, the consequence being that climate change risk and uncertainties are poorly presented. The climate change field needs to strengthen its risk science basis, to improve the current situation."

- risk scientist Terje Aven

"The global climate change debate has gone badly wrong. Many mainstream environmentalists are arguing for the wrong actions and for the wrong reasons, and so long as they continue to do so they put all our futures in jeopardy."

– philosopher Thomas Wells

# Navigating the wickedness of climate change




- science
- technology
- politics
- policy
- philosophy
- social psych
- uncertainty
- risk

Rethinking the climate change problem,
the risks we are facing, and
how we can respond.

Judith Curry, **Climate Uncertainty and Risk**,
Anthem Press, 256 pp (in press)

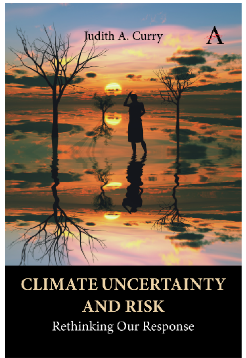
# Climate Uncertainty and Risk

- provides a comprehensive framework for understanding the climate change debate.
- shows how both the climate change problem and its solution have been oversimplified.
- explains how understanding uncertainty helps us to better assess the risks.
- describes how uncertainty and disagreement can be part of the decision-making process.
- provides a road map for formulating pragmatic solutions that can improve our well-being in the 21st century.

**I. THE CLIMATE CHANGE CHALLENGE**

**II. UNCERTAINTY OF 21st CENTURY CLIMATE CHANGE**

**III. CLIMATE RISK AND RESPONSE**



# Part I. THE CLIMATE CHANGE CHALLENGE

## 1. INTRODUCTION

- 1.1 What Is “Climate Change”?
- 1.2 What We Know with Confidence
- 1.3 Is Global Warming Dangerous?
  - *1.3.1 The Goldilocks dilemma*
  - *1.3.2 Defining “dangerous”*
  - *1.3.3 The catastrophe narrative*
  - *1.3.4 Vulnerability to climate change*

## 2. CONSENSUS, OR NOT?

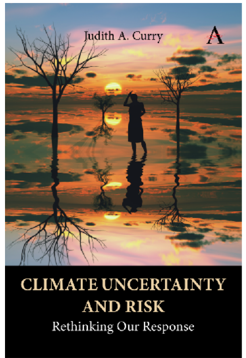
- 2.1 The Problem of Overconfidence
- 2.2 Why Scientists Disagree
- 2.3 Biases Caused by a Consensus Building Process
- 2.4 Heresy, Doubt and Denial
  - *2.4.1 Scientific skepticism*
  - *2.4.2 Climate heretics*
  - *2.4.3 The consensus on COVID-19 origins*
- 2.5 Rethinking Consensus Messaging

## 3. THE CLIMATE CHANGE RESPONSE CHALLENGE

- 3.1 Inconvenient Truths
- 3.2 The Sustainability Trap
  - *3.2.1 Resilience and the tension with sustainability*
  - *3.2.2 Thrivability and anti-fragility*
- 3.3 Warming Is Not the Only Problem
- 3.4 Tame Problem or Wicked Mess?

## 4. MIXING SCIENCE AND POLITICS

- 4.1 Models of the Science-Policy Interface
- 4.2 Politicizing Climate Science
- 4.3 Scientizing Climate Policy
- 4.4 Scientists and Power Politics
- 4.5 Institutional Politics of Climate Science



# Part II. UNCERTAINTY OF 21st CENTURY CLIMATE CHANGE

## 5. THE CLIMATE CHANGE "UNCERTAINTY MONSTER"

5.1 The Uncertainty Monster

5.2 Uncertainty Typologies

5.3 Uncertainty and the IPCC

5.4 Taming the Uncertainty Monster

## 6. CLIMATE MODELS

6.1 Global Climate Models

*6.1.1 Complexity and chaos*

*6.1.2 Model calibration and tuning*

*6.1.3 Ensemble modelling techniques*

6.2 Climate Model Inadequacies and Uncertainties

6.3 Sociology and Epistemology of Climate Modeling

*6.3.1 Assessing confidence in climate models*

*6.3.2 Fitness for purpose*

6.4 Are Global Climate Models the Best Tools?

## 7. IPCC SCENARIOS OF 21ST CENTURY CIMATE CHANGE

7.1 Emissions Scenarios

7.2 Climate Sensitivity to $CO_2$ Emissions

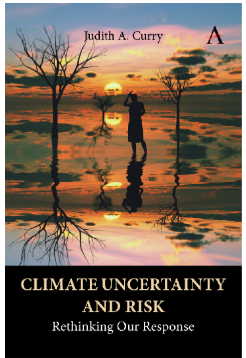
7.3 IPCC Projections of Climate Change for 21st Century

7.4 Climate Impact-drivers

*7.4.1 Detection of changes in extreme weather and climate events*

*7.4.2 Sea level rise*

7.5 Climate Predictions or Possible Futures?



# Part II. UNCERTAINTY OF 21st CENTURY CLIMATE CHANGE (cont'd)

**8. ALTERNATIVE METHODS FOR GENERATING CLIMATE CHANGE SCENARIOS**

8.1 Escape from Model-land

8.2 Emissions and Temperature Targets

*8.2.1 Natural internal variability*
*8.2.2 Volcanoes*
*8.2.3 Solar variations*
*8.2.4 Global surface temperature projections to 2050*

8.3 Regional Scenarios of Extreme Events

*8.3.1 Extreme weather and climate events*
*8.3.2 Scenarios for stress test applications*

**9. WHAT'S THE WORST CASE?**

9.1 Scenario Probabilities and Plausibility

*9.1.1 Possibility theory*
*9.1.2 Plausibility*

9.2 Fat Tails and Tall Tales

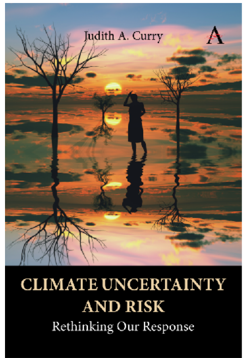
9.3 Scenario Justification and Falsification

9.4 Worst-Case Weather and Climate Events

*9.4.1 Florida landfalling hurricanes*
*9.4.2 ARkStorm*
*9.4.3 South Asian monsoon failure*

9.5 Sea Level Rise

*9.5.1 Storylines of West Antarctic Ice Sheet collapse*
*9.5.2 Candidate worst-case scenarios*
*9.5.3 Scenario falsification and the plausible worst case*



# Part III. CLIMATE RISK AND RESPONSE

## 10. RISK AND ITS ASSESSMENT

10.1 Risk and Perception
- *10.1.1 Risk perceptions*
- *10.1.2 Risk characterization*
- *10.1.3 Direct versus systemic risk*

10.2 Risk Assessment
- *10.2.1 Acceptable versus intolerable risk*
- *10.2.2 Assessment of systemic risks*

10.3 Climate Change Risk
- *10.3.1 How we have mischaracterized climate risk*
- *10.3.2 Reframing the assessment of climate risk*
- *10.3.3 Climate change versus COVID-19 risk*

## 11. RISK MANAGEMENT

11.1 Risk Management Principles
- *11.1.1 Risk responses*
- *11.1.2 Risk management strategies*

11.2 Principles of Precaution
- *11.2.1 Precautionary principle*
- *11.2.2 Proportionary and proactionary principles*

11.3 Applications of the Precautionary Principle
- *11.3.1 COVID-19*
- *11.3.2 Climate change*

11.4 Resilience and Robustness
- *11.4.1 Resilience*
- *11.4.2 Robustness*

11.5 Managing Systemic Risk

## 12. DECISION MAKING UNDER DEEP UNCERTAINTY

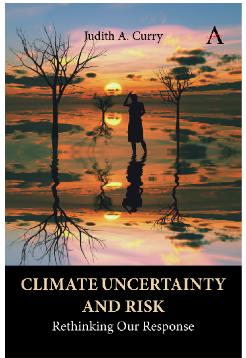
12.1 Classical Decision Analysis

12.2 DMDU Framework

12.3 Robust Decision Making

12.4 Robustness Metrics

12.5 Dynamic Adaptive Decision Making



# Part III. CLIMATE RISK AND RESPONSE (cont'd)

## 13. ADAPTATION, RESILIENCE, & DEVELOPMENT

13.1 Context
- *13.1.1 Adaptation success stories*
- *13.1.2 Political context*
- *13.1.3 Misplaced blame*

13.2 Adaptation Frameworks
- *13.2.1 Resist or retreat*
- *13.2.2 Microeconomics of adaptation*
- *13.2.3 Planning to fail safely*

13.3 Adaptation Lessons and Challenges
- *13.3.1 Lessons*
- *13.3.2 Maladaptation*
- *13.3.3 Resilience traps*

13.4 Development and Resilience
- *13.4.1 Adaptive capacity*
- *13.4.2 Disaster reduction*
- *13.4.3 Conflicts with mitigation*
- *13.4.4 Bangladesh*

## 14. MITIGATION

14.1 Carbon Mitigation and Management
- *14.1.1 Global carbon cycle, feedbacks and budget*
- *14.1.2 Carbon sequestration*

14.2 Short-lived Carbon Pollutants

14.3 Energy Transitions
- *14.3.1 History of previous energy transitions*
- *14.3.2 State of the energy transition – circa 2020*
- *14.3.3 Vision – 2100*

14.4 Managing Transition Risk: Electric Power Systems
- *14.4.1 Relevant risk management principles*
- *14.4.2 Nuclear power*

14.5 Mid Transition

## 15. CLIMATE RISK AND THE POLICY DISCOURSE

15.1 Moral Dilemmas and the Fallacy of Control

15.2 Towards Post-apocalyptic Climate Politics

15.3 Climate Pragmatism

15.4 Wicked Science for Wicked Problems