15.023J / 12.848J / ESD.128J Global Climate Change: Economics, Science, and Policy
Spring 2008

Analysis of Benefits of GHG Mitigation

- Why they are needed
- Uses and limits
- Issues in estimation
- Market-based methods
- The Stern Review approach
- Can we do better?

Need for Benefit Measures

- Inform mitigation policy deliberations
  - Short-term effort (% reduction or price)
  - Long-term goals (atmospheric target)
- Guide adaptation at a regional level
- Stir public interest and concern

➔ Desire that measures be
  - Widely understood
  - Accepted by diverse parties
  - Robust, for long-term use

Use: Inform Current Effort

- Current mitigation is *the* most important issue
  - Think about path of effort
  - What is the initial period level?
- Alternative approaches
  - B/C analysis: max PV of net benefits
  - Set long-run target and work back
  - [Precautionary principle?]
- For formal analysis, need a benefit measure
- NOTE: Benefits are implicit in any solution!

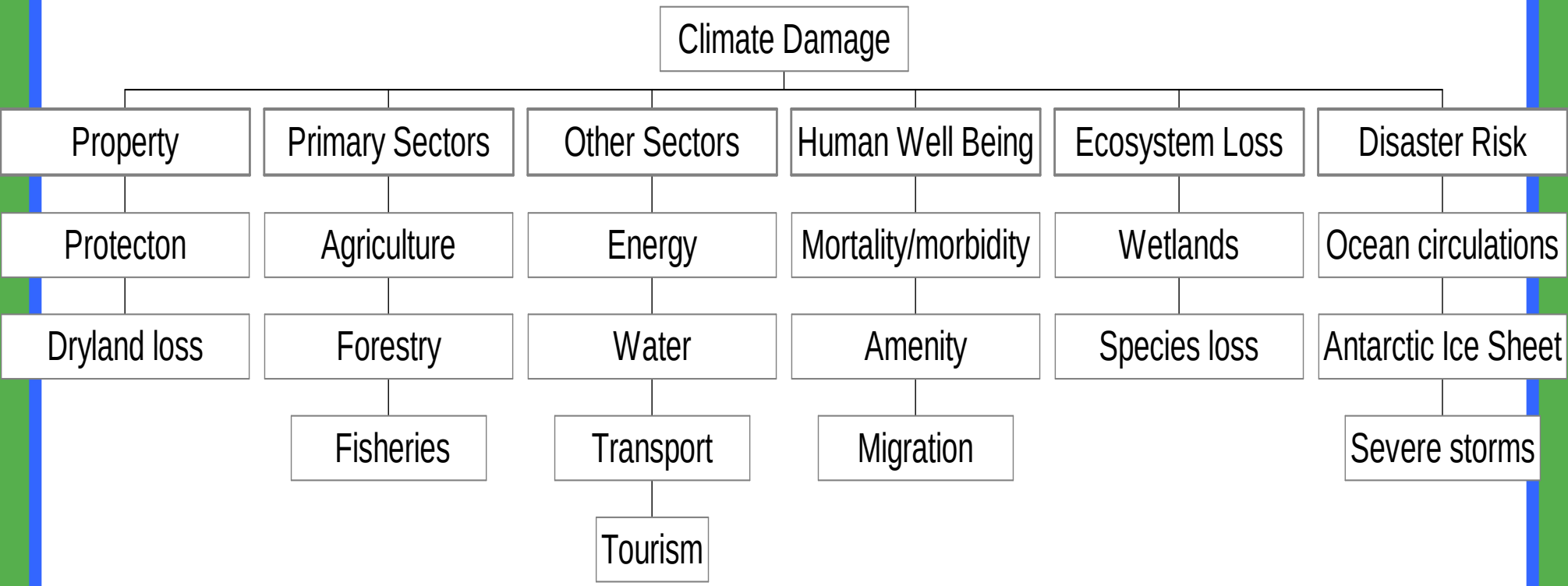
Use: Guide Atmos. Target

- FCCC's facilitating myth: a "danger" level
  - Atmospheric GHG concentrations
  - W/m^2
  - ΔT
- Then fold back to current effort by
  - Cost effectiveness analysis
    - Lowest cost way to attain assumed goal
  - Tolerable windows
    - Minimum effort required now to preserve future option
- Implicit assumption about benefit function?

Issues In Benefit Estimation

- Weakness in the underlying science
- Conversion to a common unit (like $)
  - Limits of expressing all in natural units
  - Keep track of multiple attributes?
- Valuation: willingness to . . .
  - Pay *(what pay to get benefit)*
  - Accept *(payment demanded to give up)*
- What to assume about adaptation?

Potential Effects of Climate Change (±)



Stern Review Summary

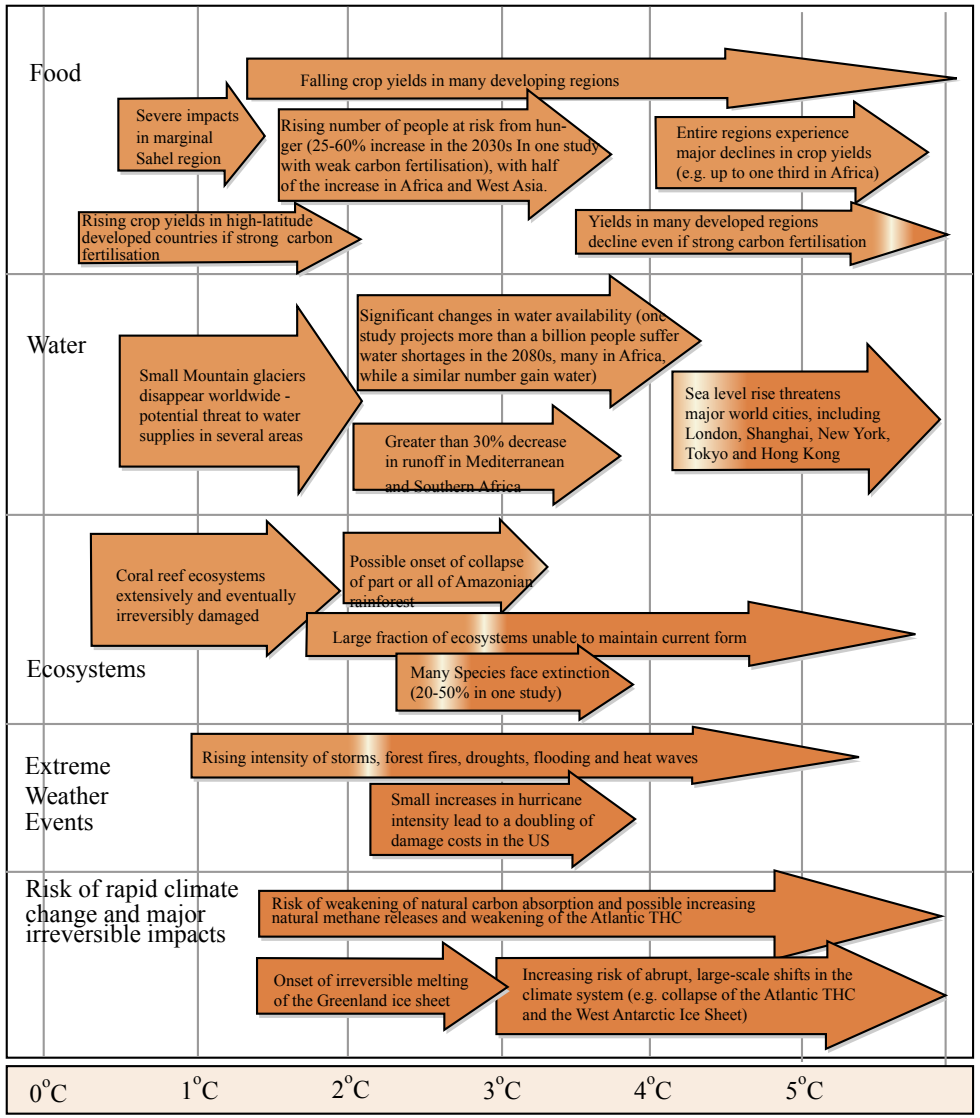


Figure by MIT OpenCourseWare, adapted from Stern Review.

Getting to Common Units
(Problems of Incommensurability)

~ Uncertainty
- Differences in risk preference

$ Non-market effects
- "Constructed market" methods controversial
- Scale, time overwhelm empirical methods

+ Aggregation
- WTP = f(income)
- People not at the table (discounting)

Market Analysis & Extensions - I

- Traded goods at market prices
  - Agriculture (farm budget studies)
  - Energy
  - Sea level rise (capital loses, with adaptation)
  - Health effects (medical costs, lost wages)
- Indirect information from related markets
  - *E.g.*, real estate values
- Surrogate markets
  - *E.g.*, recreation benefits from travel cost

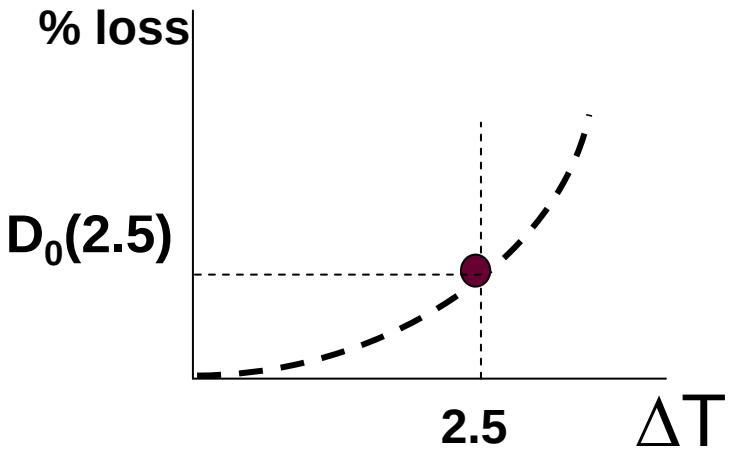
Market Analysis & Extensions - II

- Hypothetical mkts (contingent valuation)
  - Survey methods
  - Experimental methods
- Categories of value
  - Use
  - Option
  - Existence
- Special problems in application to climate change

Future Impact Index

$$D_i(\Delta T_t) = A_1(\Delta T_t) + A_2\left[\Delta T_t\right]^X$$

- Common unit of account: WTP as % of GDP
  - Basis: global mean temperature change (ΔT)
  - Using literature survey, guess $D_i(\Delta T_0 = 2.5\ ^\circ C)$, X
  - Aggregate to get $D = g(T)$
- Solve for different ΔT
  - & assumed shape

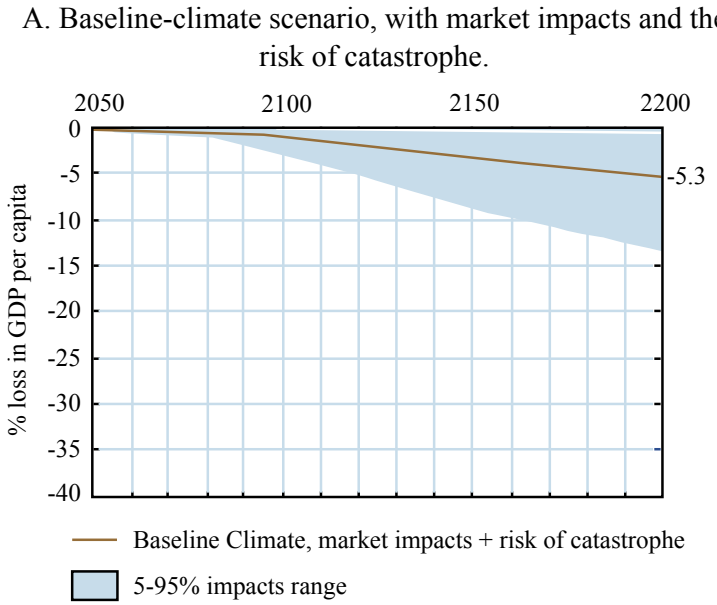


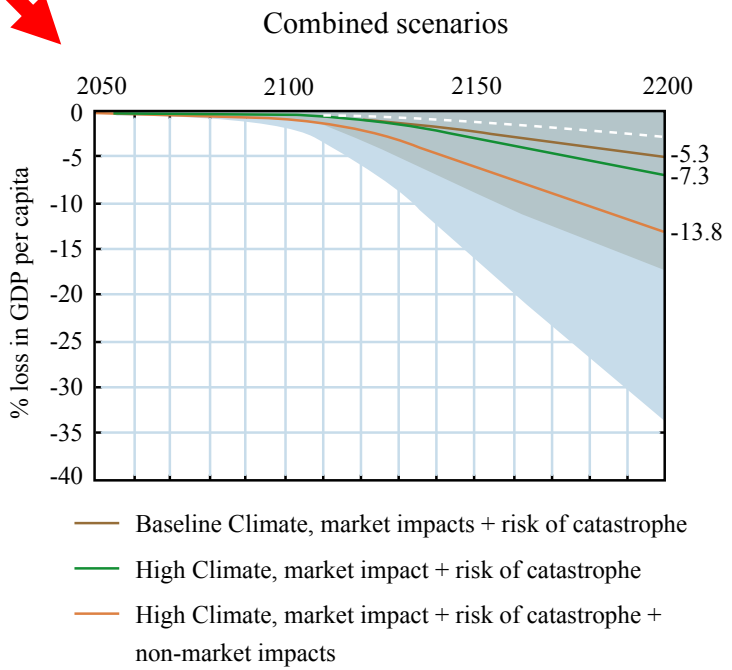
Assumptions Needed

(Nordhaus example)

- Sea-level rise
  - For US, assume $Q(2.5\ ^{\circ}C) = 0.1\ \%$ of GDP
  - Others: $Q_r = Q_{US}\ (A_{Coastal,\ r} / A_{Total,\ r}) / (A_{Coastal,\ US} / A_{Total,\ US})$
- Health
  - Estimates of years of life lost (YLL) to disease
  - Assume 1 YLL = 2 years of per capita income
- Human settlements and ecosystems
  - Assign regions within the range 5-25% of GDP
- Catastrophes
  - Probabilities based on Delphi method (survey technique)
  - Guess expected loss, regional vulnerability ~ 30% of GDP

The Stern damage calculation

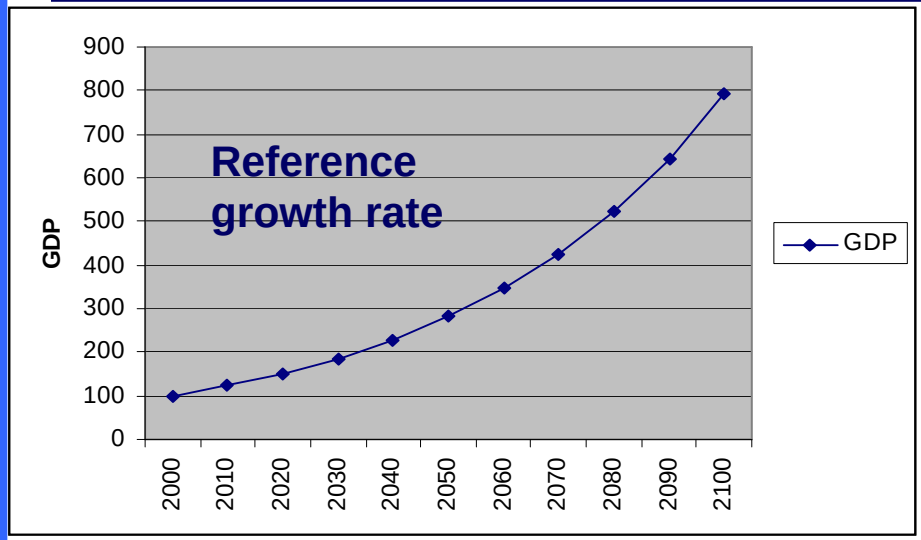


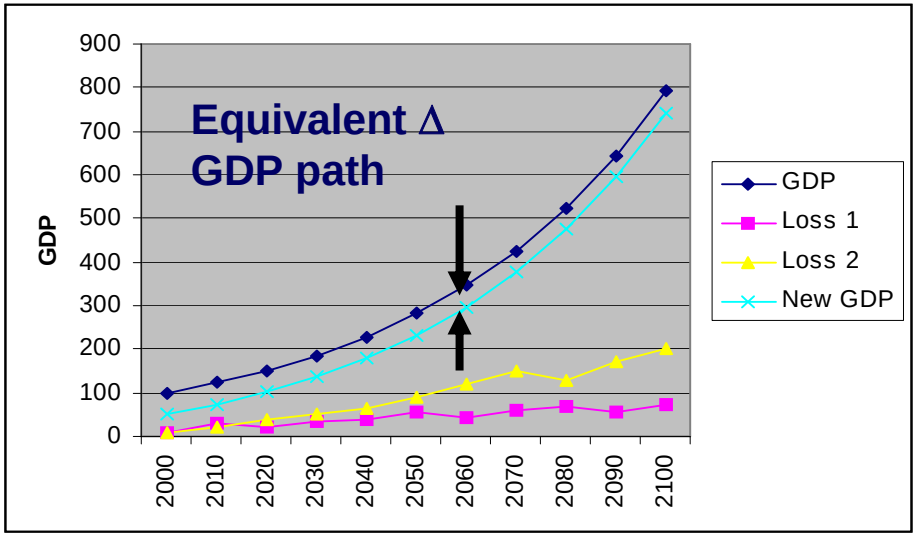


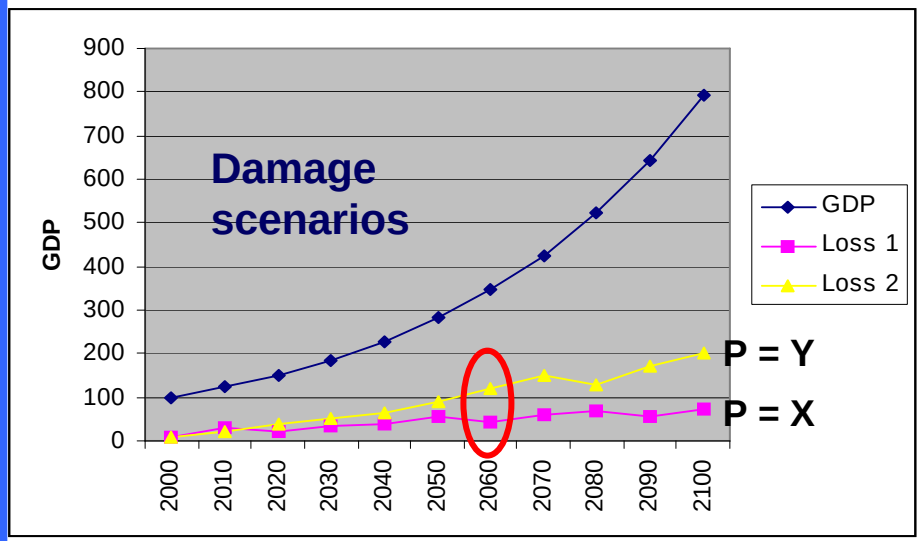
20% loss now and forever

Figure by MIT OpenCourseWare, adapted from Stern Review.

“Now and Forever” Costs







An annuity, indexed to GDP, with the same welfare implications as the projected (uncertain) damage.

Aggregate Benefit Functions: Value and Limits

- Guard against unreasonable estimates
- Seek insights, not accurate numbers
  - Efficient paths of effort over time
  - Explore the role of waiting, learning
- Know when just any number is worse than just no number at all!

Can We Do Better?

- Data gathering, research and analysis
- A portfolio at different levels of detail (OECD recommendation)
  1. Global physical variables, with analysis of uncertainty
  2. Effects at regional scale, mainly in natural units
  3. Market and non-market valuation, aggregation and estimation of monetary benefit functions