Impacts of climate change as a (social) risk assessment

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- Anthony Nyong, University of Jos
- Richard Tol, University of Hamburg
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Key messages

• We have varying confidence in climate change
• And a corresponding range of confidence in the valuation of climate impacts
• Resulting in a (simple) matrix of risks
• Coverage of existing estimates of the SCC are not a representative sample from the matrix, probably introducing a bias
• Challenging gaps in our knowledge relate to multiple stresses, response processes and decision perspectives
• One way forward is social risk assessment using techniques of knowledge elicitation to bound estimates from across potential risks
A risk approach to uncertainty in the valuation of climate change impacts

<table>
<thead>
<tr>
<th>Confidence in climate change</th>
<th>Market</th>
<th>Non-market</th>
<th>Robust valuation</th>
<th>Multiple stresses &amp; socially contingent</th>
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<tbody>
<tr>
<td>Projection (trend)</td>
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<td>Displacement from coastal zones</td>
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<td>Coastal protection</td>
<td>Heat stress</td>
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<td>Regional economies</td>
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<td>Dryland loss</td>
<td>Wetlands loss</td>
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<td>Energy (heating &amp; cooling)</td>
<td>Ocean acidification</td>
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<td>Investment</td>
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<td>Bounded probabilities</td>
<td>Agriculture</td>
<td>Loss of life</td>
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<td>Comparative advantage</td>
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<td>Water</td>
<td>Biodiversity</td>
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<td>Secondary social effects</td>
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<td>Environmental services</td>
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<td></td>
<td>Storms</td>
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<td>Environmental migration</td>
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<td>System change &amp; surprise</td>
<td>Non-marginal effects on land, resources</td>
<td>Higher order social effects</td>
<td>Irreversible losses</td>
<td>Regional collapse</td>
</tr>
</tbody>
</table>
Perceptions of risk and uncertainty: Knowledge elicitation of key experts

- 14 Interviews completed
  - William Cline
  - Tom Downing
  - Sam Fankhauser
  - Michael Grubb
  - Cameron Hepburn
  - Chris Hope
  - Alistair Hunt
  - Alan Ingham
  - David Maddison
  - Anil Markandya
  - David Pearce
  - Joel Smith
  - Richard Tol
  - Paul Watkiss

- Unable to respond to the protocol
  - Robert Mendelsohn: uses a different metric
  - Paul Ekins: is not willing to assign numeric values to the social cost of carbon

- Unavailable
  - Dieter Helm
  - Clive Spash

Protocol based on S Bharwani and M Fisher, knowledge elicitation tools
An example of a scenario

• What would you estimate to be the SCC (in $/tC) for a scenario where:
  – Climate change is over 5 deg C by 2100 and over 70 cm SLR?
    • With additional information that large scale declines in precipitation occur in some regions
  – What if both market and non-market sectors are included?
    • And what if the socially contingent effects are included?
  – What if the discount rate is 3% declining after 2030 (the Green Book)
    • With per capita income weighting of the impacts and a local decision perspective?

• What is your confidence in these estimates?
Results by respondent, £/tC

**SCC, Quartiles**

- All respondents:
  - Q1 = 8 £/tC
  - Q2 = 22 £/tC
  - Q3 = 72 £/tC
  - Q4 = 501 £/tC
Scenario results: Min-Avg-Max, £/tC

Min=11  Median=22  Average=49  Max = 501;  StdDev = 66

KEY:
Climate
L/M/H = low, medium, high temperature
D/S = regional changes in drought or storms
S = systemic climate changes included

Sectors:
M/N/S = market, non-market & socially contingent sectors

Decision variables:
1/3/5 = discount rate
P/L = per capita equity weighting,
weighting losers more than winners
A = adaptation included
L/W/E = local, world average or EU values
Respondents had no difficulty in imagining relatively high values, but some heavily discounted the more uncertain nature of impacts (e.g., the multiple stresses and contingent effects).

- If temperature projection is high, SCC is $>35\text{£/tC}$
- Some indeterminacy for medium climate scenario depending on precipitation and coverage of sectors, but this is relatively minor
- No other factors are necessary to discriminate between low and high values of the SCC
Challenging gaps

• **Multiple stresses**
  – Synergistic impacts of climate change in specific vulnerable regions or actors

• **Coupled systems**
  – Responses to climate impacts might increase vulnerability, or adaptation might not significantly reduce vulnerability

• **Decision frameworks**
  – Perceptions of uncertainty
  – Risk and finance
Regional hot spots: Sahel drought-migration

- Other stresses
- Climate stress e.g. drought
- Agricultural yields decline
  - Prices increase
  - Increase in demand for crops
  - Extensification
  - Intensification

- Food availability
  - Household labour
  - Household wellbeing
  - Labour migration
  - Household income
  - Sell assets
  - Change in livelihood system

- Marginal land
  - Rural flood plain
  - Land degradation
  - Destruction of resources (e.g. farmland)
  - Conflict with pastoralists

Conceptual model developed with Tony Nyong
ABSS model developed by Centre for Policy Modelling
Hot spots

- Are there tipping points that lead to non-marginal and irreversible impacts?
- How many regions might suffer disproportionate impacts?
- Are there sectors that would trigger multiple failures?
Vulnerability-Impacts-Adaptation as a coupled process

• Adaptation is ...
  – not a currency, stock or capacity that exists in a readily transferable form that can be applied in all locations and circumstances
  – Is a process of interaction between vulnerability (perception of risks) and impacts (events)

• Attributes/types:
  – Context-specific or systemic
  – Delayed or no net benefits
  – Climate crisis vs climate change
  – Urgent and effective or increases vulnerability
Knowledge elicitation respondents

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Decision tree for pool of all respondents

- If temperature projection is low or medium:
  - SCC is < £35/tC
- If temperature projection is high:
  - SCC is > £35/tC
- Some indeterminacy for medium climate scenario depending on precipitation and coverage of sectors, but this is relatively minor
- No other factors are necessary to discriminate between low and high values of the SCC
Some adaptation is contextual and local

The use of seasonal forecasts differs:
Lesotho: farmers would take advantage of forecasts of wet seasons to orient surplus (dryland) production toward markets

Limpopo: farmers would take advantage of forecasts of dry seasons to orient (irrigated) production toward markets

A multi-agent model evaluates the benefits of season climate forecasts, as climate changes, to well-off and poor farmers Limpopo basin, South Africa
Delayed benefits

Some adaptation has immediate costs and delayed benefits

Building a reservoir with added capacity to cope with increased flood volumes that are not expected for 30-50 years in the future

(an analogue of mitigation)
Costs exceed benefits

Some adaptation has no benefits, or costs exceed benefits

Increasing the design standard of a road surface to cope with increased rainfall intensity only has benefits if that road experiences a storm of such magnitude

( meantime the costs are incurred at present )
Increases vulnerability

Some adaptation increases vulnerability, in other populations or other enterprises

Draw down reservoir levels in anticipation of floods increases the flood volume downstream, one factor in the Mozambique floods

Water restrictions in Cape Town led to increased boreholes by the wealthy, further depleting groundwater

Withdrawal of credit to vulnerable farmers after a drought forecast in southern Africa
Sampling across the matrix: Metrics match with decision uses

- Geophysical impacts & area affected
- Population affected (including equity)
- Public perception (e.g., cultural values)
- Loss of life, livelihood
- Iconic disasters
- Risk of systemic effects
- Threat of catastrophe
- Economic impacts (e.g., SCC)

- Global policy negotiations
- National negotiator or policy maker
- Climate driven project analysis
- Non-climate project evaluation
- Corporate environmental responsibility
- Individual behaviour

See also typology for IPCC WGII Chapter 18 on adaptation-mitigation linkages
Policy-Project Appraisal

High Costs

Market impacts
Marginal changes to economies
Substitutability of benefits and damages
Low valuation of life & ecosystems

Non-market impacts
Equity weighting of benefits/impacts
High value of life
Valuation of non-marginal changes (regional collapses)
Approaching a liability regime

Low Costs
Profiles of decision choices

**Project profile:**
Constrained bounds, high discount rate but moderate risks only

- Score = 40
- SCC = £88/tC

**Global negotiator:**
Serious concern for equity and risk aversion

- Score = 80
- SCC = £296/tC
Are experiences in finance relevant?

- Ideas for a new financial framework, Robert Schiller
  - Insurance for livelihoods and home values
  - Macro markets: trading off the biggest risks
  - Income-linked loans: reducing the risks of hardship and bankruptcy
  - Inequality insurance: protecting the distribution of income
  - Intergenerational social security: sharing risks between young and old
  - International agreements for risk control

After a discussion with Prof. Gordon Clark, Oxford University
Further research and next steps

- Substantive improvement in estimates of the social cost of carbon require well validated assessments at the regional scale that value the dynamic processes of vulnerability and adaptation.

- The relative effort in calculating the benefit of mitigation (i.e., SCC) is probably 1/100 of the effort in calculating the cost of mitigation.

- Revisiting the SCC in global negotiations to set policy targets will require substantial research in partnership with scientists and policy makers in developing countries.

- A multi-attribute metric of impacts and their uncertainties might be possible as a decision tool, drawing upon multiple models and expert judgement.