Nature-based solutions and resilience to climatic change - contribution of nature conservation to human well-being

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Direct and indirect effects of climate change on health and wellbeing

• Risks to health from climate change may be
  – **direct** (e.g. extreme weather) or
  – **indirect** (e.g. affecting food, water, energy, disease risks)

• We present results from investigating the direct effects from increased *exposure* of *vulnerable* people to direct effects from storms, drought, floods and heatwaves.
The impacts of climate change on people

There are complex interactions between both causes and effects. Ecological processes, such as impacts on biodiversity and changes in disease vectors, and social dynamics, can amplify these risks. Social responses also ameliorate some risks through adaptive actions.

Resilience to extreme weather

Science-Policy project

Evidence gathering, analysis and reporting from May 2013 to November 2014

Communication and outreach from December 2014 to December 2015
Members of the Working Group.

*Expertise included ecology, hydrology, social & development science, climate science, insurance and financing, urban engineering & design, policy*

- Professor Georgina Mace (Chair)
- Professor Andrew Balmford
- Professor Paul Bates
- Professor Katrina Brown
- Professor Peter Cox
- Rowan Douglas
- Professor Charles Godfray
- Professor Nancy Grimm
- Professor Peter Head
- Professor Robert Nicholls
- Dr Youba Sokona
- Dr Camilla Toulmin
- Professor Kerry Turner
- Dr Bhaskar Vira
- Professor Virgilio Viana
- Professor Sir Bob Watson
Why extreme weather?

- Extreme weather has a huge impact on society – globally, we have a resilience deficit now.

And why now?

- 2015 offers a unique opportunity to build global resilience.

This report looks at:

- the impact of extreme weather; coastal flooding, river flooding, droughts and heatwaves
- how impact might change in future
- how best to build resilience.
The problem

• People are **not resilient** to extreme weather now.

• **Impact is not uniform** - it is felt in both developed and developing countries.

• **The problem is going to get worse** - demographic and climate changes will increase the number of people exposed to extreme weather.

• The report contains maps which **combine future climate and demographic change** with vulnerability indicators.
Climate Projections based on RCP8.5 from more than 30 climate models
## Indicators for Climatic Extremes

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature change</td>
<td>Summer mean temperature anomaly (from 1986-2005)</td>
</tr>
<tr>
<td>Labour capacity</td>
<td>Maximum labour capacity determined from the WBGT</td>
</tr>
<tr>
<td>Heatwave</td>
<td>5 consecutive days 5°C above the summer mean $T_{min}$</td>
</tr>
<tr>
<td>Drought</td>
<td>Maximum number of consecutive dry days ($\text{pr} &lt; 1 \text{mm}$)</td>
</tr>
<tr>
<td>Flood</td>
<td>Maximum 5 day precipitation total</td>
</tr>
</tbody>
</table>
Projections of Climate Extremes

(a) ‘Drought’

(b) ‘Flood’

2080–2099 mean relative to 1986–2005 mean

0.3 0.7 0.9 1.1 1.3 1.5 2

(c) ‘Heatwave’

(d) Wet bulb globe temperature

2080–2099 mean relative to 1986–2005 mean

0.1 0.5 0.9 1.3 1.7 2.1 2.5 2.9

THE ROYAL SOCIETY
Risk measurement includes climate and the affected population.

**Number of Exposure Events (per year)**

\[ \text{Number of Exposure Events (per year)} = \text{Frequency of Climatic Extreme (per year)} \times \text{Number of Vulnerable People that experience that Climatic Extreme} \]
Estimated change in exposure to floods resulting from projections of 21st century climate to 2090 (RCP 8.5 emission scenario) and population change (SSP2 population scenario).
a) Change in Heat-wave Frequency (2090-1995)

b) Change in Exposure (2010 population)

c) Change in Exposure (2090 population)

d) Time-series of Exposure Events
### Amplification of Exposure
(2090s relative to 1990s)

<table>
<thead>
<tr>
<th>Climate</th>
<th>Population</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heatwave</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>
The problem - summary

- Climate change will increase the frequency of heatwaves, and rainfall extremes associated with floods and droughts.

- Projected changes in population, such as population size and aging, will increase the number of people exposed to these extremes.

- The impacts will be geographically uneven, and include areas with little resilience currently.

- The case for building resilience to climate extremes, both now and in the future, is strong.
Solutions
defensive measures

• Physical defences against extreme weather can be:
  a. Engineered
  b. Ecosystem based
  c. A hybrid of the two
Solutions
defensive
measures

Coastal flooding

1. Maintenance of natural reefs (coral/oyster)
2. Maintenance of mangroves
3. Mangrove planting and re-establishment
4. Maintenance of saltmarsh, wetlands, inter-tidal ecosystems
5. Creation of saltmarsh, wetlands, inter-tidal ecosystems
6. Maintenance of other coastal vegetation, forest and ecosystems
7. Coastal re-vegetation/afforestation (above inter-tidal zone)
8. Beach and dune nourishment
9. Artificial reefs (and/or substrates for reef replenishment)
10. Dykes, levees
11. Coastal barrages

<table>
<thead>
<tr>
<th>Category of option</th>
<th>Strength of evidence</th>
<th>Additional consequences</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ecosystem-based</td>
<td>Weaker</td>
<td>Overall positive</td>
</tr>
<tr>
<td>Hybrid</td>
<td></td>
<td>Overall negative</td>
</tr>
<tr>
<td>Engineering</td>
<td>Stronger</td>
<td>Approximately neutral</td>
</tr>
</tbody>
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Solutions

defensive measures

1. Re-establishment of floodplains, ‘green rivers’
2. Catchment afforestation, increased vegetation cover
3. Maintenance of existing catchment vegetation
4. Planting of riparian ‘buffers’
5. Changes to catchment agricultural land management
6. ‘Natural’ flood management
7. Stream habitat restoration
8. Dams
9. Drains, dykes, levees, sluices, pumps
10. Dredging
11. Sustainable urban drainage systems (SUDS)
12. Canalisation of urban streams

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Additional consequences

Access to food

Access to livelihoods

Climate change mitigation

Access to water

Biodiversity

Protection against multiple hazards

KEY
- Ecosystem-based
- Engineering
- Hybrid
Solutions
defensive
measures
Analysis suggests defensive strategies should:

a. Be based on portfolio of measures

b. Look beyond traditional engineering approaches

c. Be monitored and evaluated.
Develop and resource resilience strategies; which will be most effective when

- They minimise consequences of infrastructure failure rather than avoiding failure completely
- Incorporate resilience-building into all policies
- Consider the whole system likely to be impacted
- Use a range of expertise
- Support and enable local action
Solutions

Financial system and research

- Risks need to be better accounted for in the wider financial system
- Organisations to report financial exposure to extreme weather at a minimum of 1 in 100 (1%) per year risk levels
- Research to improve the analysis of extreme weather and its impacts
Solutions
knowledge sharing and education

- Information about extreme weather should be suitable for users needs

The research community should:
- Improve the analysis of extreme weather and its impacts
- Expand interdisciplinary research
- Improve international collaborations
Thank you for listening.

The report, maps and more detailed analysis can be found at:

https://royalsociety.org/policy/projects/resilience-extreme-weather/
Resilience to extreme weather

27 November 2014

Downloads

- Summary report
  - PDF, 1.3mb

- Full report
  - PDF, 4.1mb