Framing of vulnerability and risk for assessing progress in vulnerability reduction
Basic Risk Formula

Risk = Probability x Consequence
For exposed and vulnerable communities, even non-extreme weather and climate events can have extreme impacts.

- Africa’s largest recorded cholera outbreak
- over 90,000 affected
- over 4,000 killed
- began following onset of seasonal rains
- vulnerability and exposure increased risk

Case Study: Zimbabwe 2008

IPCC 2012
Who and what are most vulnerable?

• **Who is vulnerable?**
  – Older adults
  – Women
  – Children
  – …..

• **What is vulnerable?**
  – Cultural monuments
  – Supply chains
  – ….

• **Emerging vulnerabilities**
Measuring vulnerability reduction

- Depends on baseline
- Absolute numbers
- Proportion of population at risk (e.g. aging)
- Areal extent of vulnerability (e.g. water security)
- Risk reduction

What drives adaptive capacity?
Flexible risk management approach

- At any point in time, risks associated with hazards depend markedly on interactions between components of risk
- Can start with hazards or vulnerability
- Be mindful of feedbacks:
  - Exposure over time (or lack thereof) can feed back into vulnerability
  - Implications for adaptive capacity, development, & resilience
"Climate Models, Scenarios, Impacts-First"

- Begin with the question: "What if climate extremes change according to scenarios, x, y, z?"
- Structure impacts problem
  - Assess relevant climatic changes from climate change models, downscaling
  - Assess relevant impacts based on projected climate changes
  - Design and assess adaptation options for relevant impacts
  - Evaluate outcomes

"Vulnerability, Thresholds-First"

- Begin with the questions: "Where are the sensitivities, thresholds, and priorities considering climate variabilities?" "What can communities cope with?"
- Identify development context, hazards, and vulnerability problems
  - Identify vulnerabilities, sensitivities, thresholds; propose adaptation measures
    - Input climate change projections and other relevant information about underlying drivers
    - Assess adaptation measures and timing for action against climate change scenarios
    - Assess tradeoffs between adaptation options
    - Evaluate outcomes
SRES vs new scenario process

- Demographic
- Economic
- Technological
- Global vs. local focus
## Scenario matrix architecture

<table>
<thead>
<tr>
<th>SPAs</th>
<th>RCP Replication</th>
<th>SSP 1</th>
<th>SSP 2</th>
<th>SSP 3</th>
<th>SSP 4</th>
<th>SSP 5</th>
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<td>8.5 Wm⁻²</td>
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<td>2.6 Wm⁻²</td>
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</table>

Van Vuuren et al. 2013
Shared socioeconomic pathways

O’Neill et al. 2015
SSP components

Quantitative elements
- Population
- Urbanization
- Rates of technological change
- Income
- Human Development Index
- Income distribution
- Etc.

Does not include:
- typical model output such as emissions, land use, climate change
- climate policy (mitigation or adaptation)
- not influenced by climate change
### SSP elements

#### Key determinants of adaptation challenges:

<table>
<thead>
<tr>
<th>Determinant:</th>
<th>SSP variable:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average wealth</td>
<td>GDP projection</td>
</tr>
<tr>
<td>Poverty</td>
<td>Income distribution</td>
</tr>
<tr>
<td>Quality of governance</td>
<td>Governance</td>
</tr>
<tr>
<td>People in coastal zones</td>
<td>Spatial population projection</td>
</tr>
<tr>
<td>Urbanization</td>
<td>Urbanization</td>
</tr>
<tr>
<td>Education</td>
<td>Education</td>
</tr>
<tr>
<td>Innovation</td>
<td>Innovation</td>
</tr>
<tr>
<td>Quality of healthcare</td>
<td>Health projections</td>
</tr>
</tbody>
</table>
SSP1: World is shifting gradually but dramatically toward a more sustainable path, emphasizing more inclusive development that respects perceived environmental boundaries.
SSP2: World experiences moderate progress towards a multitude of goals and interests. Global and national institutions make slow progress towards achieving sustainable development goals.
SSP3: Growing interest in regional identity & concerns about competitiveness & security push countries to increasingly focus on domestic and regional issues. Global institutions are relatively weak, with uneven coordination and cooperation for addressing environmental concerns.
A) Population

B) Urbanization

C) GDP

D) GDP per capita & Gini

SSP projections

Other major studies

Riahi et al. in review
Table 3. Different drivers of heat-related mortality and how they could change under three socio-economic pathways (SSPs). Cells marked with green indicate a lowering of the health impacts and red an increase.

<table>
<thead>
<tr>
<th>Drivers</th>
<th>SSP2</th>
<th>SSP1</th>
<th>SSP3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population</td>
<td>Medium</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>Age-structure</td>
<td></td>
<td>Larger proportion of elderly</td>
<td>Smaller proportion of elderly</td>
</tr>
<tr>
<td>Chronic disease prevalence</td>
<td>Medium</td>
<td>High</td>
<td>High, better care</td>
</tr>
<tr>
<td>Urbanization</td>
<td>Medium</td>
<td>High</td>
<td>Higher, poor care</td>
</tr>
<tr>
<td>Access to indoor cooling</td>
<td>Medium</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Urban planning</td>
<td>Continuation of historical patterns</td>
<td>Well managed</td>
<td>Poorly managed</td>
</tr>
<tr>
<td>Heatwave Early</td>
<td>Medium</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Warning System</td>
<td>Medium</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Societal participation</td>
<td>Medium</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Equity</td>
<td>Medium</td>
<td>High</td>
<td>Medium</td>
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