From the smallest islands to the highest peaks – oceans, ice and climate change

26 September 2019

Dr Adelle Thomas, Dr Michiel Schaeffer
Key Findings from IPCC Special Report on Oceans and Cryosphere
Focus on SIDS and LDCs

Dr. Adelle Thomas
Senior Caribbean Research Associate
Climate Analytics
Last of Special Reports in AR6 Cycle

Global Warming of 1.5°C

Climate Change and Land

The Ocean and Cryosphere in a Changing Climate

6th assessment reports
Scope of SROCC

- Physical Science and Impacts
- Vulnerabilities and Adaptation Capacities
- Climate-resilient Development Pathways
Particularly relevant for LDCs...

Nepal: July 2019
64 deaths
~80,000 ppl displaced
And SIDS...

Bahamas: September 2019
>50 deaths
~80,000 ppl displaced
5 KEY MESSAGES FROM SUMMARY FOR POLICYMAKERS
1. Widespread shrinking of cryosphere

- Glaciers, snow, ice and permafrost are declining
- Stability of high-mountain slopes is decreasing
- September Arctic sea ice reductions are unprecedented for last >1000 years
Changes to the cryosphere are affecting ecosystems and communities

- Changes in the amount and seasonality of runoff and water resources
- Declines in agricultural yields
- Linked to disasters in High Mountains
- High Mountain aesthetic and cultural aspects have been negatively impacted
- Shifts in ranges of plants and animals
Major projected changes to the cryosphere still to come

- By 2100, glacier mass reductions of 18% - 36%; 10% reduction in basin runoff
- Smaller glaciers may lose more than 80% of their mass by 2100, many projected to disappear
- Floods, landslides and snow avalanches to occur in new locations or different seasons
- Reduced livelihood options
2. Oceans are warming rapidly

- Rate of ocean warming has more than doubled since 1993
- Ocean has absorbed > 90% of the heat added to the climate system
- Marine heatwaves have doubled in frequency, become longer-lasting, more intense and more extensive
- Oceans have become more acidic, absorbing 20-30% of total CO$_2$ emissions
Changes to oceans have extensive impacts now

- Marine species shifting towards the poles, challenging fisheries governance
- ~50% of vegetated coastal ecosystems lost over past 100 years
- Large-scale coral bleaching events occurring with increased frequency since 1997, with slow recovery
- Increased range and frequency of harmful algal blooms
Changes to oceans projected to increase

- Unprecedented changes to temperature, acidification, oxygen
- Decline in fisheries catch potential
- More frequent and intense marine heatwaves and El Nino and La Nina events
- Near complete loss of warm-water coral reefs, even at 1.5C
- Seafood safety compromised
3. Sea level rise is accelerating

- Rate of sea level rise is unprecedented over last century and is accelerating
- Already seeing changes in Antarctica which may lead to irreversible ice sheet instability
- Extreme sea level events, coastal erosion and flooding have increased
Sea levels will continue to rise at an increasing rate:

- Extreme sea level events will occur more frequently.
- SIDS are projected to experience historical centennial events at least annually by 2050.
- Increased risk of erosion, land loss, flooding, salinization, cascading impacts.
- Sea levels will continue to rise for centuries even after emissions have stopped.
- Some island nations may become uninhabitable.
4. Tropical cyclones are becoming more intense

Increased rainfall, winds and extreme waves
Projected increase in intensity of tropical cyclones

- Intensity, proportion of Category 4 and 5 cyclones and average precipitation rates are projected to increase at 2°C
- Rising sea levels will contribute to higher storm surges
5. Adaptation can only temporarily address climate change risks

- Adaptation is essential to reduce risks, but is a governance challenge
- Ecosystem based adaptation has limits, even at 1.5ºC
- Barriers to adaptation can reduce effectiveness or lead to limits
- Even with major adaptation efforts, residual risks and associated losses are projected to occur
Choices made now are critical for the future of our ocean and cryosphere

• SROCC underscores the message of great urgency needed to address climate change

• Changes to the ocean and cryosphere are already happening, with significant impacts for LDCs and SIDS

• While LDCs and SIDS may be on the frontline of climate change, the impacts of climate change will be significant for everyone if we stay on the current emissions trajectory
Oceans, ice & NDCs
What does the special report on oceans and ice mean for mitigation?

Dr Michiel Schaeffer
• SROCC does not speak much directly to 1.5°C, but substantial part of underlying literature does

• Content of presentation:
  – Adding to previous presentation by drawing from the literature to make the connection between SROCC messages and Paris Agreement
  – Step through key mitigation efforts and enhancing NDCs
SROCC SPM.1: Observed & modelled historical changes in the ocean and cryosphere since 1950 and projections under low and high emissions scenarios.

Past and future changes in the ocean and cryosphere

- Historical changes (observed and modelled) and projections under RCP2.6 and RCP8.5 for key indicators:
  - Historical (observed)
  - Historical (modelled)
  - Projected (RCP2.6)
  - Projected (RCP8.5)

(a) Global mean surface air temperature change relative to 1986–2005
(b) Global mean sea surface temperature change relative to 1986–2005
(c) Marine heatwave days factor of change relative to 1986–2005
(h) Surface ocean pH
  - Low acidity
  - High acidity
(i) Ocean oxygen (100–600m depth) change relative to 1986–2005
(j) Arctic sea ice extent (September)
(k) Arctic snow cover extent (June)
(l) Near-surface permafrost area change relative to 1986–2005
SROCC SPM.1: Observed & modelled historical changes in the ocean and cryosphere since 1950 and projections under low and high emissions scenarios

Past and future changes in the ocean and cryosphere

Historical changes (observed and modelled) and projections under RCP2.6 and RCP8.5 for key indicators

- Historical (observed)
- Historical (modelled)
- Projected (RCP2.6)
- Projected (RCP8.5)

(d) Ocean heat content (0–2000m depth) and sea level equivalent (right axis) change relative to 1986–2005

(e) Greenland ice sheet mass loss as sea level equivalent, change relative to 1986–2005

(f) Antarctic ice sheet mass loss as sea level equivalent, change relative to 1986–2005

(g) Glacier mass loss as sea level equivalent, change relative to 1986–2005

(m) Global mean sea level change relative to 1986–2005

- 0.84 m
- 0.43 m

Primary drivers
B1.4 Widespread permafrost thaw is projected for this century (very high confidence) and beyond. By 2100, projected near-surface (within 3–4 m) permafrost area shows a decrease of 24 +/-16% (likely range) for RCP2.6 and 69 +/-20% (likely range) for RCP8.5. The RCP8.5 scenario leads to the cumulative release of tens to hundreds of billions of tons (GtC) of permafrost carbon as CO$_2$ and methane to the atmosphere by 2100 with the potential to exacerbate climate change (medium confidence). Lower emissions scenarios dampen the response of carbon emissions from the permafrost region (high confidence). Methane contributes a small fraction of the total additional carbon release but is significant because of its higher warming potential. Increased plant growth is projected to replenish soil carbon in part, but will not match carbon releases over the long term (medium confidence)...

FOOTNOTE 26: For context, total annual anthropogenic CO$_2$ emissions were 10.8 +/- 0.8 GtC yr$^{-1}$ (39.6 +/- 2.9 GtCO$_2$ yr$^{-1}$) on average over the period 2008–2017. Total annual anthropogenic methane emissions were 0.35 +/- 0.01 GtCH$_4$ yr$^{-1}$, on average over the period 2003–2012...
Why does 1.5°C matter? “Reasons for concern” diagrams

SR1.5
• Focused on 1.5 vs 2°C
SROCC SPM
• Does not speak much on 1.5°C specifically
• Extends RFCs range upward to 3-4°C (current policies & NDCs)
• Risk diagram covers ecosystems, does not include fisheries, Arctic region and coastal flooding for which SR1.5 shows medium-high risk at 1.5°C
Why does 1.5°C matter?
Marine heatwaves (frequency, extent, duration)

Frölicher et al. 2018
Why does 1.5°C matter? Survival chances for tropical coral reefs

Virtually all coral reefs at risk of annual bleaching at 2°C of warming

- Negative impacts reef fish and other resources
- Negative impacts on tourism industry

Source: Schleussner et al., 2016b, King et al., 2017
Why does 1.5°C matter?
Arctic Sea Ice: probability of ice-free Arctic summer (September)

Sigmond et al. 2018

→ Once every 1.5 years
→ Once every 5 years
→ Once every 40 years

Sigmond et al. 2018
Why does 1.5°C matter?

Sea level rise

- Sea level rise (SLR) will continue well beyond 2100 for centuries to millennia
- <1.5°C warming implies about 1.5m SLR by 3000
- 3-4°C warming (Current policies and NDCs) implies about 6.5m SLR by 3000

Clark et al. 2018
Why does 1.5°C matter? The legacy of inaction

The timing of peaking CO₂ emissions under the Paris Agreement will be decisive for sea level rise over the next 300 years.

The long-term goals of the Paris Agreement require emissions to reach net-zero GHG in the second half of this century.

SOURCE: Committed sea-level rise under the Paris Agreement and the legacy of delayed mitigation action - Mengel et. al. 2018 - Nature Communications
Why does 1.5°C matter? Sea level commitment of the NDCs

- Addition sea level rise commitment of about 20 cm by 2300 every 15 years under 2030 NDC pathway

- 2030 NDC levels commit us to sea level rise in 2300 of >1m

- Top-5 emitters commit more than 10 cm of sea level rise by 2300 due to GHG emitted between Paris Agreement adoption in 2015 and the end of the first NDC cycle in 2030

Nauels et al. (accepted)
Where do we stand?
Significant acceleration in ambition and action needed
Getting to Zero: Key Global Benchmarks
Paris Compatible 1.5°C Emission Pathways

TOTAL NET GREENHOUSE GAS EMISSIONS

Graph showing emissions reducing from 2000 to 2100.
Getting to Zero: Key Global Benchmarks
Paris Compatible 1.5°C Emission Pathways

GHG EMISSIONS PEAK AROUND 2020
Getting to Zero: Key Global Benchmarks
Paris Compatible 1.5°C Emission Pathways

GHG EMISSIONS DECLINE RAPIDLY TO 45% BELOW 2010 LEVELS BY 2030
Getting to Zero: Key Global Benchmarks
Paris Compatible 1.5°C Emission Pathways

GHG emissions reach net-zero around 2070.
Getting to Zero: Key Global Benchmarks
Paris Compatible 1.5°C Emission Pathways

GHG EMISSIONS REMAIN NEGATIVE FROM 2070 ONWARDS
Getting to Zero: Key Global Benchmarks
Paris Compatible 1.5°C Emission Pathways

PEAK AND RAPID DECLINE TO BELOW NET-ZERO

Key global benchmarks for Paris Agreement compatible 1.5°C emissions pathways

- GHG Emissions peak around 2020
- GHG emissions decline rapidly to 45% below 2010 levels by 2030
- CO₂ emissions decline rapidly to 45% below 2010 levels by 2030
- CO₂ emissions reach net-zero around 2050
- GHG emissions reach net-zero around 2070
- Residual CO₂ and non-CO₂ emissions remain in some sectors
- Carbon dioxide removal needed to compensate for insufficient action to date and residual emissions

Global benchmarks stipulated from Paris Agreement Article 4
Other key global benchmarks and pathway characteristics

- CO₂ Emissions from fossil fuels and industry
- Non-CO₂ greenhouse gas emissions
- Emissions from agriculture, forestry & land use (AFOLU)
- Carbon Dioxide Removal from BECCS (Bio Energy with Carbon Capture and Storage)

Insights from the IPCC Special Report on 1.5°C for preparation of long-term strategies

April 2019
1.5°C transformation requires action in all sectors

- With full transformation of energy-related sectors still strong push needed in land sectors
- **Investment** in low-carbon energy technologies and energy efficiency needs to be increased by factor 6 by 2050
  - Global annual investments in low-carbon energy technologies **overtake fossil investments already by around 2025**

Source: Climate Analytics (2019); IPCC (2018)
Rapid Phaseout of Coal needed to get to 1.5°C … and even to 2°C

Coal power generation must:
• Peak by 2020, and
• Rapidly decrease to 80% below 2010 levels by 2030, and
• Be phased out by 2040 at the latest

Single most important step to keep the door open for achieving the Paris Agreement
Energy system transformations for 1.5°C (SR1.5)

- Fully decarbonised primary energy supply by 2050 (including with CCS)
- Large reductions of fossil fuel use, in particular coal:
  - minus 64% by 2030
  - minus 75% by 2050
  and oil:
  - minus 11% by 2030
  - minus 60% by 2050
- Enhanced energy efficiency, faster electrification in all sectors with large energy demand reductions across all end-use sectors
- Bioenergy is used in 1.5°C pathways (and in 2°C pathways), both with CCS (BECCS) and without, with uncertainties regarding limits to sustainable use
- Far-reaching transitions in energy, land, urban and infrastructure (including transport and buildings), and industrial systems (high confidence)
### Vast majority of NDCs not in line with Paris Agreement

<table>
<thead>
<tr>
<th>Category</th>
<th>Countries</th>
<th>Number of Countries</th>
</tr>
</thead>
<tbody>
<tr>
<td>4°C+ World</td>
<td>RUSSIA, SAUDI ARABIA, TURKEY, UKRAINE, USA</td>
<td>5</td>
</tr>
<tr>
<td>&lt; 4°C World</td>
<td>ARGENTINA, CHILE, INDONESIA, JAPAN, SINGAPORE, SOUTH AFRICA, SOUTH KOREA, UAE</td>
<td>9</td>
</tr>
<tr>
<td>&lt; 3°C World</td>
<td>AUSTRALIA, BRAZIL, CANADA, EU, KAZAKHSTAN</td>
<td>5</td>
</tr>
<tr>
<td>&lt; 2°C World</td>
<td>BHUTAN, COSTA RICA, ETHIOPIA, INDIA, MEXICO, NEW ZEALAND, NORWAY, PERU, SWITZERLAND</td>
<td>10</td>
</tr>
<tr>
<td>1.5°C PARIS AGREEMENT COMPATIBLE</td>
<td>MOROCCO, THE GAMBIA</td>
<td>2</td>
</tr>
<tr>
<td>&lt;&lt; 1.5°C World</td>
<td>ROLE MODEL</td>
<td>0</td>
</tr>
</tbody>
</table>

**June 2019 update**

The vast majority of countries have insufficient targets that must be improved.
What level of ambition do we need to close the gap to 1.5°C?

**Incrementalism** risks the Paris Agreement goal slipping out of reach

• A **long-term** and **whole-economy** view is essential
• Full transformation is needed across **all sectors**
• Need for increased ambition in **all countries**

Geiges et al (2019)
Reducing warming will reduce climate impacts

<table>
<thead>
<tr>
<th>Climate Impact</th>
<th>Year</th>
<th>NDC reference scenario</th>
<th>%33% ambition increase for big emitters</th>
<th>1.5°C scenario</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median increase in annual maximum temperature (TXx) relative to 1986-2005</td>
<td>2100</td>
<td>+2.7°C</td>
<td>+1.8°C</td>
<td>+1.1°C</td>
</tr>
<tr>
<td>Sea level rise relative to average between 1986-2005</td>
<td>2100</td>
<td>64 (50-81) cm</td>
<td>54 (43 -68) cm</td>
<td>45 (36-57) cm</td>
</tr>
<tr>
<td></td>
<td>2300</td>
<td>190 (140-250) cm</td>
<td>140 (110-180) cm</td>
<td>100 (80-130) cm</td>
</tr>
<tr>
<td>GDP reductions relative to a no-climate %change scenario for LDC countries</td>
<td>2050</td>
<td>-20%</td>
<td>-17%</td>
<td>-14%</td>
</tr>
<tr>
<td></td>
<td>2100</td>
<td>-63%</td>
<td>-48%</td>
<td>-34%</td>
</tr>
</tbody>
</table>

Substantial reduction in climate impact resulting from high ambition in short term

Incremental improvements of 2030 targets insufficient to achieve the Paris Agreement goals

Geiges et al (2019)
Conclusions

- SROCC and SR1.5 together point to climate risks at 1.5°C that increase rapidly above that level – complementary reports
- NDCs and current policies are not sufficient to reach 1.5°C. Strongly enhanced NDCs and LTSs are needed by 2020
- SR1.5 is clear that 1.5°C is still feasible
- However, we are at a critical window of opportunity for increased climate action and ambition.
- Incrementalism risks the Paris Agreement goal slipping out of reach
  - A long-term and whole-economy view is essential
  - Full transformation is needed across all sectors
- There is room for substantial NDC updates (and not incremental)
Thank you!

www.climateanalytics.org

@CA_Latest
ClimateAnalytics
company/climateanalytics-ggmbh