Regional impacts and the 1.5 degree climate target - Africa

South Africa - GSCC desk

South Africa's NDC is rated by Climate Action Tracker as "highly insufficient" - well below what is needed to reach the 1.5 degrees celsius temperature target contained in the Paris Agreement. Current South African climate pledges are consistent with the world warming by 3-4 degrees celsius.

- South Africa has ratified the Paris Agreement, and pledged to keep domestic emissions to 20-82% by 2030, on 1990 levels.
- South Africa has a long-term goal to stabilise emissions over 2025-2035 followed by a decline in emissions to 28% above 1990 levels.

Projected impacts across the African continent

With 1.5 degrees celsius of global warming:

- In today's climate, the average African region experiences one to three heatwaves per year. Under 1.5 degrees celsius of warming, this number could more than double by 2050.
- Compared to now, megacities like Lagos in Nigeria will be more vulnerable to heat stress, with perhaps twice as many becoming affected by the middle of the century, meaning more than 350 million people exposed to potentially deadly heat.
- Rising temperatures, drought, and unstable weather patterns have serious implications for global food production. Every degree of global temperature rise reduces global yields of wheat by 6.0%, rice by 3.2%, maize by 7.4%, and soybean by 3.1%. Some regions are more affected than others - for example in West Africa, wheat yields could fall by up to 25% if temperatures rise 1.5°C.[1]

With more than 1.5 degrees celsius of global warming:

- Globally, agricultural yields fall rapidly between one and three degrees celsius of warming. Once local temperatures reach three degrees celsius above pre-industrial levels, all crops are negatively affected, wherever they are in the world - including in temperate regions.[2] Fish species go locally extinct, with serious impacts on fisheries.[3]
- By the end of the century, 29% of the global population face 'beyond tolerable' risk in at least two out of the three main sectors - water, energy and food, and environment. More than nine out of ten people exposed and vulnerable people are in Africa and Asia.
- Without immediate global cuts in carbon dioxide emissions, average temperatures in Africa will rise more than two degrees celsius above pre-industrial levels by 2050. By this time, heat extremes never experienced before by humans in this part of the world could affect 15%[4] of sub-Saharan Africa's land area in the hot season, causing deaths and threatening farmers' ability to grow crops.
- This part of the world is likely to warm faster than the global average. If global temperatures rise by two degrees celsius, summer temperatures in the Middle East and North Africa region could increase by more than double that. The region is currently home to more than 500 million people. By 2050, daytime temperatures could rise to 46°C on the hottest days. Temperatures of 30-40°C can be deadly and this could make parts of the region uninhabitable because of extreme heat.

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[1] Differential climate impacts for policy-relevant limits to global warming: the case of 1.5C and 2C (Earth System Dynamics, 2016), p.337.

[2] IPCC, AR5, WGII, Chapter 7, p.497.

[3] IPCC, AR5, WGII, Chapter 7, p.508.

[4] Turn down the heat: Climate extremes, regional impacts, and the case for resilience (2013), The World Bank, p.xxvi.

Rising temperatures are also likely to lead to water shortages. In North Africa, a three degree celsius temperature increase could cause rain fed maize yields to drop by 15-25% by 2080.[5]

- Under 3.5 degrees celsius of warming, people in sub-Saharan Africa would be at higher risk of Malaria.[6]
- Under four degrees celsius of warming, the subtropical region of North Africa is likely to experience a rise in monthly summer temperatures of more than six degrees celsius.[7]
- 35% of cropland is expected to become unsuitable for cultivation with four degrees celsius or more of warming.[8]
- Under a high emissions scenario (RCP8.5) where temperatures rise four to six degrees celsius by the end of the century, sub-Saharan Africa could see about 53.5 million climate migrants by 2050. This is about 3% of the current population.[9]

Benefits of limiting temperature rise to 1.5 degrees celsius:

- 55 million fewer people in African countries would be at risk of hunger, compared to a two degrees celsius future.[10]
- By 2100, 90% of the world's population,[11] particularly poor countries in Africa, Asia, and Latin America, would be likely to experience reduced economic damages compared to those at warming at two degrees celsius.

[5] UNDP-GEF report: Climate Change Adaptation in the Arab States, p.26.

[6] Turn down the heat: why a 4°C warmer world must Be avoided (2012), The World Bank, p.56.

[7] Turn down the heat: why a 4°C warmer world must Be avoided (2012), The World Bank, p.38.

[8] Turn down the heat: why a 4°C warmer world must Be avoided (2012), The World Bank, p.62.

[9] Groundswell: Preparing for Internal Climate Migration, (2018), World Bank Group, p.111.

[10] Clements, R. (2009). The Economic Cost of Climate Change in Africa.

[11] Large potential reduction in economic damages under UN mitigation targets (208), Nature, p.552.

Regional impacts and the 1.5 degree climate target - Asia

India - GSCC Desk

India's NDC is rated by Climate Action Tracker as "2 degrees celsius compatible" - If all government targets were within this range, warming could be held below 2 degrees celsius, but temperatures will still be too high for the 1.5 degrees celsius limit set in Paris.

- India has ratified the Paris Agreement, and pledged to reduce domestic emissions by 33%–35% below 2005 levels by 2030, increase the share of non-fossil based energy resources to 40% of installed electric power capacity by 2030, and to create an additional carbon sink of 2.5–3 GtCO2e through additional forest and tree cover by 2030.
- India has a long-term goal of keeping per capita emissions below those of the developed world.

Projected impacts across India

With more than 1.5 degrees celsius of global warming:

- Under a two degree celsius temperature rise, Kolkata in India could experience temperature conditions equivalent to its deadly 2015 heatwaves every year.
- Under two degrees celsius of temperature rise, annual runoff in the Ganges river basin is expected to decrease by about 20%.[12]
- Up to 30% of humid tropical forests in central Sumatra, Sulawesi, India, and the Philippines could be threatened by climate induced loss under four degrees celsius of warming.[13]

Projected impacts across South Asia

With more than 1.5 degrees celsius of global warming:

- Rising temperatures, drought, and unstable weather patterns have serious implications for global food production. Every degree of global temperature rise reduces global yields of wheat by 6.0%, rice by 3.2%, maize by 7.4%, and soybean by 3.1%.
- Globally, agricultural yields fall rapidly between one and three degrees celsius of warming. Once local temperatures reach three degrees celsius above pre-industrial levels, all crops are negatively affected, wherever they are in the world - including in temperate regions.[14] Fish species go locally extinct, with serious impacts on fisheries.[15]
- Glaciers in the high mountains of Asia play an important role in supplying water to millions of people living downstream. 800 million people are at least partly dependent on meltwater from glaciers. Around a third of the ice stored in these glaciers will be lost by the end of the century under two degrees celsius temperature rise.
- Under a high emissions scenario (RCP8.5) where temperatures rise four to six degrees celsius by the end of the century, Bangladesh could see about 6.7 million climate migrants by 2050. This is about 3.4% of the current population.[16]
- Under a high emissions scenario (RCP8.5) where temperatures rise four to six degrees celsius by the end of the century, and unequal development practices[17], South Asia could see about 35.7

[12] Turn down the heat: why a 4°C warmer world must Be avoided (2012), The World Bank, p.xvi.

[13] Turn down the heat: why a 4°C warmer world must Be avoided (2012), The World Bank, p.51.

[14] IPCC, AR5, WGII, Chapter 7, p.497.

[15] IPCC, AR5, WGII, Chapter 7, p.508.

[16] Groundswell: Preparing for Internal Climate Migration (2018), World Bank Group, p.148.

million climate migrants by 2050. By the middle of the century, climate migrants are predicted to make up about 23% of all internal migrants in South Asia.[18]

- A four degrees celsius temperature rise is estimated to lead to sea level rise of nearly nine metres over several hundred years as it triggers melting of the Antarctic and Greenland ice sheets. This level of sea level rise would inundate all the world's coastal cities. 470 to 760 million people currently live in at-risk areas, including 145 million people in China. India, Bangladesh, Vietnam, Indonesia, Japan, the Philippines, Thailand, and Myanmar all have more than 10 million people living in areas at risk.

Benefits of limiting temperatures to 1.5 degrees celsius:

- 4.5% of the population in Asian river basins will have better water availability and greater food security, compared to higher levels of temperature rise.
- By 2100, 90% of the world's population,[19] particularly poor countries in Africa, Asia, and Latin America, would be likely to experience reduced economic damages compared to those at warming at two degrees celsius.

China - GSCC desk

China's NDC is rated by Climate Action Tracker as "highly insufficient" and "not at all consistent" with holding temperatures to 2 degrees celsius by the end of the century as promised by the Paris Agreement, let alone the 1.5 degrees celsius limit. China's current pledges are consistent with the world warming by up to 4 degrees celsius by 2100.

- China has ratified the Paris Agreement, and has an unconditional target to peak its carbon emissions by 2030, as well as reduce the carbon intensity of GDP to 60-65% below 2005 levels by 2030.
- With current policies, China is on track to meet its 2020 pledge and its NDC targets, but this will still be slightly higher current emissions levels.

Projected impacts across China

With 1.5 degrees celsius of global warming:

- Coastal areas in China - home to 12 million people - are at risk of permanent inundation as a result of sea level rise.
- The average annual runoff from the Yiluo River catchment in northern China will decrease by about a fifth, impacting the 7.7 million people that rely on the water source.

With more than 1.5 degrees celsius of global warming:

- Under four degrees celsius of warming, maize and wheat production in China is expected to decrease by 8% and 3% respectively for every degree rise in global temperature.
- More than 20 million people in Shanghai currently live in areas that are likely to be flooded as a result of sea level rise under a four degrees celsius temperature rise.

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[17] Unequal development: "inequality remains high, leaving developing regions highly vulnerable to climate change and with limited adaptive capacity. Urbanisation rates are also high across low and middle income countries." - Groundswell: Preparing for Internal Climate Migration (2018), World Bank Group, p.9.

[18] Under the pessimistic reference scenario - Groundswell: Preparing for Internal Climate Migration (2018), World Bank Group, p.89.

[19] Large potential reduction in economic damages under UN mitigation targets (208), Nature, p.552.

South Korea - GSCC desk

South Korea's NDC is rated by Climate Action Tracker as "highly insufficient" - well below what is needed to reach the 1.5 degree celsius temperature target contained in the Paris Agreement. Current South Korean climate pledges are consistent with the world warming by 3-4 degrees celsius.

- South Korea has ratified the Paris Agreement, and pledged to reduce domestic emissions by 37% below BAU by 2030.

Japan - GSCC desk

Japan's NDC is rated by Climate Action Tracker as "highly insufficient" - well below what is needed to reach the 1.5 degree celsius temperature target contained in the Paris Agreement. Current Japanese climate pledges are consistent with the world warming by 3-4 degrees celsius.

- Japan has ratified the Paris Agreement, and pledged to reduce domestic emissions by 26% below 2013 levels by 2030, which translates to a 18% reduction from 1990 levels.
- Japan has a long-term goal to reduce emissions, 80% by 2050 (base year not specified).

Projected impacts across Asia

With 1.5 degrees celsius of global warming:

- 46 million people[20] currently live in areas that are at risk of permanent inundation from sea level rise if temperatures rise by 1.5°C, equivalent to about 70% of the number[21] of people currently displaced from their homes globally by war, instability or human rights violations. About half of this at-risk population is in China, Vietnam or Japan.
- Glaciers in the high mountains of Asia play an important role in supplying water to millions of people living downstream. 800 million people are at least partly dependent on meltwater from glaciers. Around a third of the ice stored in these glaciers will be lost by the end of the century under two degrees celsius temperature rise.
- Rising temperatures, drought, and unstable weather patterns have serious implications for global food production. Every degree of global temperature rise reduces global yields of wheat by 6.0%, rice by 3.2%, maize by 7.4%, and soybean by 3.1%.

With more than 1.5 degrees celsius of global warming:

- Globally, agricultural yields fall rapidly between one and three degrees celsius of warming. Once local temperatures reach three degrees celsius above pre-industrial levels, all crops are negatively affected, wherever they are in the world - including in temperate regions.[22] Fish species go locally extinct, with serious impacts on fisheries.[23]
- By the end of the century, 29% of the global population face 'beyond tolerable' risk in at least two out of the three main sectors - water, energy and food, and environment. More than nine out of ten people that are exposed and vulnerable are in Africa and Asia, with about half in south Asia alone.
- A four degrees celsius temperature rise is estimated to lead to sea level rise of nearly nine metres over several hundred years as it triggers melting of the Antarctic and Greenland ice sheets. This level of sea level rise would inundate all the world's coastal cities. 470 to 760 million people currently live in at-risk areas, including 145 million people in China. India, Bangladesh, Vietnam,

[20] These are median estimates. The ranges are 31.87–68.83 for 1.5°C and 31.99–78.38 for 2C. The estimates are based on the 2010 population.

[21] By the end of 2016, 65.6 million people had been displaced from their homes as a result of persecution, conflict, violence, or human rights violations. http://www.unhcr.org/5943e8a34.pdf

[22] IPCC, AR5, WGII, Chapter 7, p.497.

[23] IPCC, AR5, WGII, Chapter 7, p.508.

Indonesia, Japan, the Philippines, Thailand, and Myanmar all have more than 10 million people living in areas at risk.

Indonesia - GSCC desk

Indonesia's NDC is rated by Climate Action Tracker as "highly insufficient" - well below what is needed to reach the 1.5 degree celsius temperature target contained in the Paris Agreement. Current Indonesian climate pledges are consistent with the world warming by 3-4 degrees celsius.

- Indonesia has ratified the Paris Agreement, and it includes a unilateral reduction target of 29% below BAU emissions by 2030, plus a conditional target of up to 41% reductions below BAU with sufficient international support.

Projected impacts across South-East Asia

With 1.5 degrees celsius of global warming:

- Even with 1.5 degrees of warming, the intensity of heavy rainfall in urban areas in South-East Asia could increase 7% by 2100.
- Rising temperatures, drought, and unstable weather patterns have serious implications for global food production. Every degree of global temperature rise reduces global yields of wheat by 6.0%, rice by 3.2%, maize by 7.4%, and soybean by 3.1%.
- By the end of the century, nine out of ten of coral reefs are at risk from severe degradation from 2050 onwards. If warming is limited to 1.5 degrees, this declines to 70% by 2100 - meaning that some coral reefs have a chance of survival. At the moment, coral reefs provide about US$30 billion annually to the world economy, in coastal protection, building materials, fisheries and tourism.

With more than 1.5 degrees celsius of global warming:

- Globally, agricultural yields fall rapidly between one and three degrees celsius of warming. Once local temperatures reach three degrees celsius above pre-industrial levels, all crops are negatively affected, wherever they are in the world - including in temperate regions.[24] Fish species go locally extinct, with serious impacts on fisheries.[25]
- By 2040, per capita crop production in South-East Asia could fall by one third under two degrees celsius of warming.
- Under two degrees celsius of warming, the intensity of heavy rainfall in urban areas of South-East Asia could reach 10% over the 21st century.
- If temperatures rise to two degrees celsius, virtually all the world's tropical coral reefs are at risk of severe degradation and collapse. Coral reefs account for 10 to 12% of the fish caught in tropical countries, and 20 to 25% of the fish caught by developing nations.[26] They provide food, income and protection from storms for millions of people along coastal areas.
- Up to 30% of humid tropical forests in central Sumatra, Sulawesi, India, and the Philippines could be threatened by climate induced loss under four degrees celsius of warming.[27]

[24] IPCC, AR5, WGII, Chapter 7, p.497.

[25] IPCC, AR5, WGII, Chapter 7, p.508.

[26] IPCC, AR5, WGII, CC Boxes, p.99.

[27] Turn down the heat: why a 4°C warmer world must Be avoided (2012), The World Bank, p.51.

Regional impacts and the 1.5 degree climate target - Australia/Pacific

Australia

Australia's NDC is rated by Climate Action Tracker as "insufficient" to reach the 1.5 degrees celsius temperature target contained in the Paris Agreement. Current Australian climate pledges are consistent with the world warming by up to 3 degrees celsius.

- Australia has ratified the Paris Agreement, and pledged to reduce emissions 26–28% below 2005 levels by 2030, including emissions from land use (LULUCF). Australia's current policies would mean it misses this target, with emissions increasing by 0.4% a year.

- Australia's NDC target emissions by 2030: 413 MtCO2e
  Australian emissions in 2030 under current policies: 548 MtCO2e
  Australian emissions in 2018 under current policies: 529 MtCO2e

Projected impacts across Australia and the Pacific

With 1.5 degrees celsius of warming:

- The amount of freshwater available in rivers and lakes could decrease by 10% in Australia.[28]
- The number of El Niño events in the Pacific is expected to double, potentially boosting temperatures during the years when the event occurs.
- Rising temperatures, drought, and unstable weather patterns have serious implications for global food production. Every degree of global temperature rise reduces global yields of wheat by 6.0%, rice by 3.2%, maize by 7.4%, and soybean by 3.1%.
- By the end of the century, nine out of ten of coral reefs are at risk from severe degradation from 2050 onwards. This declines to 70% by 2100 - meaning that some coral reefs have a chance of survival. At the moment, coral reefs provide about US$30 billion annually to the world economy, in coastal protection, building materials, fisheries and tourism.

With more than 1.5 degrees celsius of warming:

- Globally, agricultural yields fall rapidly between one and three degrees celsius of warming. Once local temperatures reach three degrees celsius above pre-industrial levels, all crops are negatively affected, wherever they are in the world - including in temperate regions.[29] Fish species go locally extinct, with serious impacts on fisheries.[30]
- Under two degrees celsius of temperature rise, annual runoff is expected to decrease by about 30% in the Murray Darling river basin.[31]
- If temperatures rise to two degrees celsius, virtually all the world's tropical coral reefs are at risk of severe degradation and collapse. Coral reefs account for 10 to 12% of the fish caught in tropical countries, and 20 to 25% of the fish caught by developing nations.[32] They provide food, income and protection from storms for millions of people along coastal areas.

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[28] Differential climate impacts for policy-relevant limits to global warming: the case of 1.5C and 2C, (2015), Earth System Dynamics, Table S4.

[29] IPCC, AR5, WGII, Chapter 7, p.497.

[30] IPCC, AR5, WGII, Chapter 7, p.508.

[31] World Bank report: Turn down the heat: why a 4°C warmer world must Be avoided, p.xvi.

[32] IPCC, AR5, WGII, CC Boxes, p.99.

- With three degrees celsius of warming, groundwater levels will fall, with the rate at which groundwater is replenished predicted to fall to perhaps half of 1990 levels by 2050 in some parts of Australia.[33]

[33] IPCC, AR5, WGII, Chapter 3, Table 3-2.

Regional impacts and the 1.5 degree climate target - Europe

European Union (Any country)

The European Union submitted a joint Nationally Determined Contribution, which Climate Action Tracker rates as "insufficient" to reach the 1.5 degree celsius temperature target contained in the Paris Agreement. Current EU climate pledges are consistent with the world warming by up to 3 degrees celsius.

- The EU has ratified the Paris Agreement, and pledged to reduce domestic emissions at least 40% by 2030 on 1990 levels, with no use of carbon trading credits.
- The EU has a long-term goal to reduce emissions 80-95% by 2050, on 1990 levels.

France - GSCC Desk

France comes under the EU's NDC, which Climate Action Tracker rates as "insufficient" to reach the 1.5 degree celsius temperature target contained in the Paris Agreement. Current EU climate pledges are consistent with the world warming by up to 3 degrees celsius.

- The EU has ratified the Paris Agreement, and pledged to reduce domestic emissions at least 40% by 2030 on 1990 levels, with no use of carbon trading credits.
- The EU has a long-term goal to reduce emissions 80-95% by 2050, on 1990 levels.

Germany - GSCC Desk

Germany comes under the EU's NDC, which Climate Action Tracker rates as "insufficient" to reach the 1.5 degrees celsius temperature target contained in the Paris Agreement. Current EU climate pledges are consistent with the world warming by up to 3 degrees celsius.

- The EU has ratified the Paris Agreement, and pledged to reduce domestic emissions at least 40% by 2030 on 1990 levels, with no use of carbon trading credits.
- The EU has a long-term goal to reduce emissions 80-95% by 2050, on 1990 levels.

Poland - GSCC Desk

Poland comes under the European Union's Nationally Determined Contribution (NDC), which Climate Action Tracker rates as "insufficient" to reach the 1.5 degrees celsius temperature target contained in the Paris Agreement. Current EU climate pledges are consistent with the world warming by up to 3 degrees celsius.

- The EU has ratified the Paris Agreement, and pledged to reduce domestic emissions at least 40% by 2030 on 1990 levels, with no use of carbon trading credits.
- The EU has a long-term goal to reduce emissions 80-95% by 2050, on 1990 levels.

Projected impacts across Europe

With 1.5 degrees celsius of global warming:

- The amount of freshwater available in rivers and lakes could decrease by 9% across the Mediterranean region.[34]

[34] Differential climate impacts for policy-relevant limits to global warming: the case of 1.5C and 2C (2015), Earth System Dynamics, Table S4.

- 86% of Europe's population could be affected by flood, compared to 93% under two degrees celsius of temperature rise.
- Rising temperatures, drought, and unstable weather patterns have serious implications for global food production. Every degree of global temperature rise reduces global yields of wheat by 6.0%, rice by 3.2%, maize by 7.4%, and soybean by 3.1%.

With more than 1.5 degrees celsius of global warming:

- Globally, agricultural yields fall rapidly between one and three degrees celsius of warming. Once local temperatures reach three degrees celsius above pre-industrial levels, all crops are negatively affected, wherever they are in the world - including in temperate regions.[35] Fish species go locally extinct, with serious impacts on fisheries.[36]
- Under two degrees celsius of temperature rise, the number of temperature-related deaths could increase by 15-22% every summer in European cities compared to conditions under 1.5 degrees celsius of warming.
- Southern Europe is particularly vulnerable to climate change, and likely to be more affected than other parts of Europe. A two degrees celsius temperature rise could lead to summer rain decreasing by 20%. Water availability in the region could decrease by 9% if temperatures rise by 1.5 degrees celsius, and 17% if they rise by two degrees celsius. As temperatures rise, droughts are likely to become increasingly frequent and severe. Multiple sectors[37] - tourism, agriculture, infrastructure, energy and health - could be affected. If temperatures rise by more than four degrees celsius, much of southern Spain[38] could become a desert by the end of the century.
- Almost half of the plants and animals and more than half of the habitats protected by the EU Habitats Directive occur in the Mediterranean region. If temperatures rise by 1.5 degrees celsius, Mediterranean ecosystems may survive, but if temperatures rise by two degrees celsius or more, they will change more dramatically than at any point in human history.
- Under a scenario where temperatures rise three degrees celsius by the end of the century, heatwaves could increase by a factor of five by the middle of the century. Droughts are likely to become increasingly frequent and severe in the Mediterranean area, western Europe, and Northern Scandinavia.
- Changes in snowfall are expected to reduce ski tourism overnight stay numbers by 10 million people in Austria, France, Italy, and Switzerland under two degrees celsius of warming.
- Under 3.5 degrees celsius temperature rise, agricultural yields are projected to drop by 10% by the 2080s, with southern Europe experiencing a 20% decline.[39]
- Under four degrees celsius of warming, monthly summer temperatures in the Mediterranean are expected to rise by more than six degrees celsius.[40]
- Under four degrees celsius of warming, the whole European continent, with the exception of Iceland, will be affected by more frequent and severe droughts.

[35] IPCC, AR5, WGII, Chapter 7, p.497.

[36] IPCC, AR5, WGII, Chapter 7, p.508.

[37] IPCC, AR5, WGII, Chapter 23, p.1270.

[38] RCP8.5 emissions scenario.

[39] UK Climate Change Risk Assessment 2017: Evidence Report (Northern Ireland), p.75.

[40] World Bank report: Turn down the heat: why a 4°C warmer world must Be avoided, p.38.

Regional impacts and the 1.5 degree climate target - UK

United Kingdom - GSCC Desk

The United Kingdom comes under the European Union's Nationally Determined Contribution (NDC), which Climate Action Tracker rates as "insufficient" to reach the 1.5 degrees celsius temperature target contained in the Paris Agreement. Current EU climate pledges are consistent with the world warming by up to 3 degrees celsius.

- The EU has ratified the Paris Agreement, and pledged to reduce domestic emissions at least 40% by 2030, on 1990 levels, with no use of carbon trading credits.
- The EU has a long-term goal to reduce emissions 80-95% by 2050, on 1990 levels.

Projected impacts across the UK

With more than 1.5 degrees celsius of global warming:

- Globally, agricultural yields fall rapidly between one and three degrees celsius of warming. Once local temperatures reach three degrees celsius above pre-industrial levels, all crops are negatively affected, wherever they are in the world - including in temperate regions.[41] Fish species go locally extinct, with serious impacts on fisheries.[42]
- Rising temperatures, drought, and unstable weather patterns have serious implications for global food production. Every degree of global temperature rise reduces global yields of wheat by 6.0%, rice by 3.2%, maize by 7.4%, and soybean by 3.1%.
- Under two degrees celsius of warming, the number of people in England at risk of flooding could hit 1.7 million by the middle of next century. Under four degrees celsius of warming, this could rise to 2.2 million, assuming no population growth.[43]
- Under two degrees celsius of warming, agricultural land in Scotland at risk of flooding annually is expected to increase by 21% by the 2080s.[44]
- 27% of native species in England would be at medium or high risk of decline by the 2080s under two degrees celsius of temperature rise.[45]
- Under three degrees celsius of warming, the amount of groundwater recharge (where water moves down from the surface to groundwater) in England could fall to 22% below current levels[46] by 2050.
- Under a two to four degrees celsius temperature rise, the number of non-residential properties in the UK at risk of significant flooding is expected to increase by 2050. Countries will experience an average increase of:
    - 48% in Northern Ireland[47] with expected damages costing an average £10 million annually,
    - 35% in Wales[48] with damages costing an average £37 million annually,
    - 15% in Scotland[49] with damages costing an average £48 million annually,
    - 30% in England[50] with damages costing an average £275 million annually.
- In Scotland, damages from coastal flooding are expected to increase by about 450% by the 2080s under four degrees celsius of temperature rise.[51]

[41] IPCC, AR5, WGII, Chapter 7, p.497.

[42] IPCC, AR5, WGII, Chapter 7, p.508.

[43] UK Climate Change Risk Assessment 2017: Evidence Report (England), p.67.

[44] UK Climate Change Risk Assessment 2017: Evidence Report (Scotland), p.22.

[45] UK Climate Change Risk Assessment 2017: Evidence Report (England), p.11.

[46] IPCC, AR5, WGII, Chapter 3, p.249.

[47] UK Climate Change Risk Assessment 2017: Evidence Report (Northern Ireland), p.64.

[48] UK Climate Change Risk Assessment 2017: Evidence Report (Wales), p.67.

[49] UK Climate Change Risk Assessment 2017: Evidence Report (Scotland), p.78.

[50] UK Climate Change Risk Assessment 2017: Evidence Report (England), p.86.

[51] UK Climate Change Risk Assessment 2017: Evidence Report (Scotland) p.80.

- Under two degrees celsius of temperature rise, 142,000 people in Wales would be living in areas at a 1-in-75 or greater chance of flooding in any given year. This could increase to 209,000 people under four degrees celsius of warming.[52]

[52] UK Climate Change Risk Assessment 2017: Evidence Report (Wales) p.52.

Regional impacts and the 1.5 degree climate target - US/region

US - GSCC Desk

Based on the Trump Administration's intent to withdraw from the Paris Agreement, Climate Action Tracker rates the US's policy response to climate change as "critically insufficient", and consistent with more than 4 degrees celsius of global warming.

- The US has ratified the Paris Agreement, and pledged to reduce domestic emissions by 26%-28% below 2005 levels by 2025. However, the Trump Administration has indicated that it intends to withdraw from the Paris Agreement and stop implementation of the NDC. It legally remains in place until 4 November 2019.
- Under the Obama Administration's mid-century strategy, the US has a long term goal to reduce emissions 68-76% below 2005 levels by 2050.

Projected impacts across the US

With more than 1.5 degrees celsius of global warming:

- Subtropical parts of the US are likely to experience a temperature rise of more than six degrees celsius during the summer months, with four degrees celsius global temperature rise.[53]
- Economic damages resulting from climate change could cost about 1.2% of the country's GDP for every additional degree on average under a high emissions scenario (RCP8.5) where temperatures rise 4.0-6.1 degrees celsius by the end of the century.

Projected impacts across the US and South America

With 1.5 degrees celsius of global warming:

- Rising temperatures, drought, and unstable weather patterns have serious implications for global food production. Every degree of global temperature rise reduces global yields of wheat by 6.0%, rice by 3.2%, maize by 7.4%, and soybean by 3.1%.

With more than 1.5 degrees celsius of global warming:

- Globally, agricultural yields fall rapidly between one and three degrees celsius of warming. Once local temperatures reach three degrees celsius above pre-industrial levels, all crops are negatively affected, wherever they are in the world - including in temperate regions.[54] Fish species go locally extinct, with serious impacts on fisheries.[55]
- Under a two degrees celsius temperature rise, mean annual precipitation is projected to decrease by about 30% in the Mississippi and Amazon river basins.[56]
- Under a high emissions scenario (RCP8.5) where temperatures rise four to six degrees celsius by the end of the century, the Southwest and Central Plains have a high likelihood (80%) of experiencing decade-long megadroughts between the middle and end of the century.

[53] Turn down the heat: why a 4°C warmer world must Be avoided (2012), The World Bank, p.38.

[54] IPCC, AR5, WGII, Chapter 7, p.497.

[55] IPCC, AR5, WGII, Chapter 7, p.508.

[56] Turn down the heat: why a 4°C warmer world must Be avoided (2012), The World Bank, p.xvi.

Argentina - GSCC Desk

Argentina's NDC is rated by Climate Action Tracker as "highly insufficient" - well below what is needed to reach the 1.5 degree celsius temperature target contained in the Paris Agreement. Current Argentinian climate pledges are consistent with the world warming by 3-4 degrees celsius.

- Argentina has ratified the Paris Agreement, and pledged to reduce domestic emissions by 22% above 2010 levels (unconditional target), and by 7% below 2010 levels (conditional target).

Brazil - GSCC Desk

Brazil's NDC is rated by Climate Action Tracker as "insufficient" to reach the 1.5 degrees celsius temperature target contained in the Paris Agreement. Current Brazilian climate pledges are consistent with the world warming by up to 3 degrees celsius.

- Brazil has ratified the Paris Agreement, and pledged to reduce domestic emissions by 37% by 2025 and 43% by 2030 below 2005 levels.
- Brazil has a long term goal to shift towards energy systems based on renewable sources and decarbonisation of the global economy by the end of the century.

Projected impacts across South America

With 1.5 degrees celsius of global warming:

- The amount of freshwater available in rivers and lakes in North-east Brazil could drop by 7%.
- Rising temperatures, drought, and unstable weather patterns have serious implications for global food production. Every degree of global temperature rise reduces global yields of wheat by 6.0%, rice by 3.2%, maize by 7.4%, and soybean by 3.1%.

With more than 1.5 degrees celsius of global warming:

- Globally, agricultural yields fall rapidly between one and three degrees celsius of warming. Once local temperatures reach three degrees celsius above pre-industrial levels, all crops are negatively affected, wherever they are in the world - including in temperate regions.[57] Fish species go locally extinct, with serious impacts on fisheries.[58]
- As temperatures rise protected areas start to disappear. In wo degrees celsius temperature rise, 25% of the 80,000 plant and animal species in the world's most naturally rich areas, such as the Amazon and the Galapagos, could face local extinction by the end of the century. Warming temperatures may affect the behaviour of insects and animals, causing a cascade effect that affects entire ecosystems.
- There are a number of potential 'tipping points' at which abrupt change may occur. The Arctic could become ice-free even in winter, the Amazon rainforest could die off, or the Tibetan Plateau could see the total disappearance of snow and ice cover. It is extremely difficult to know if and when such sudden events will occur - so scientists can only assess changing levels of risk. But in a recent study, half of the potential tipping points identified could be triggered by a global temperature rise of two degrees celsius or less.
- Under a high emissions scenario (RCP8.5) where temperatures rise 4.0-6.1 degrees celsius by the end of the century, and moderate development, South America could see about 9.1 million climate migrants by the middle of the century. This is about 1.9% of the population.[59]

[57] IPCC, AR5, WGII, Chapter 7, p.497.

[58] IPCC, AR5, WGII, Chapter 7, p.508.

[59] Groundswell: Preparing for Internal Climate Migration, (2018), World Bank Group, p.109.

- A three degrees celsius temperature rise increases the possibility that fragile natural systems like the Arctic or Amazon experience “abrupt and irreversible changes” by melting entirely, or drying out, for example. The risks of these ‘tipping points’ are moderate from 0 to one degree celsius temperature rise, but “increase disproportionately” as temperature increases from one to two degrees celsius, becoming “high” above three degrees celsius[60], according to the IPCC. The inclusion of these risks in to an economic model raises the social cost of carbon from $15/tCO2 to $116/tCO2.
- With 3.5 degrees celsius of temperature rise, the rate of malaria in the region is expected to increase by 50%, compared to pre-industrial levels.[61]

Projected impacts across Central America

With 1.5 degrees celsius of global warming:

- Under a low emissions scenario (RCP2.6) where temperatures rise 1.3-1.9C degrees celsius by the end of the century, Mexico and Central America could see 1.4 million climate migrants by the middle of the century.[62]
- Rising temperatures, drought, and unstable weather patterns have serious implications for global food production. Every degree of global temperature rise reduces global yields of wheat by 6.0%, rice by 3.2%, maize by 7.4%, and soybean by 3.1%.
- By the end of the century, nine out of ten of coral reefs are at risk from severe degradation from 2050 onwards. This declines to 70% by 2100 - meaning that some coral reefs have a chance of survival. At the moment, coral reefs provide about US$30 billion annually to the world economy, in coastal protection, building materials, fisheries and tourism.

With more than 1.5 degrees celsius of global warming:

- Globally, agricultural yields fall rapidly between one and three degrees celsius of warming. Once local temperatures reach three degrees celsius above pre-industrial levels, all crops are negatively affected, wherever they are in the world - including in temperate regions.[63] Fish species go locally extinct, with serious impacts on fisheries.[64]
- Agriculture in tropical parts of Central America is likely to be particularly hard hit. Wheat yields could fall by 25% in some places if temperatures rise by 1.5 degrees celsius. However, limiting temperature rise to 1.5 degrees celsius instead of two degrees celsius will mean less serious implications for food security in many poorer countries.
- If temperatures rise to two degrees celsius, virtually all the world’s tropical coral reefs are at risk of severe degradation and collapse. Coral reefs account for 10 to 12% of the fish caught in tropical countries, and 20 to 25% of the fish caught by developing nations.[65] They provide food, income and protection from storms for millions of people along coastal areas.
- In Nicaragua, the percentage of days with high heat stress could increase 5% by the middle of the century under three degrees celsius of warming.
- Under three degrees celsius of warming, tropical rainforests could decline by more than 50%. A large proportion of these would be replaced by savanna and grassland.

[60] IPCC, AR5, WGII, SPM, p.12.

[61] Turn down the heat: why a 4°C warmer world must Be avoided (2012), The World Bank, p.56.

[62] Groundswell: Preparing for Internal Climate Migration, (2018), World Bank Group, p.163.

[63] IPCC, AR5, WGII, Chapter 7, p.497.

[64] IPCC, AR5, WGII, Chapter 7, p.508.

[65] IPCC, AR5, WGII, CC Boxes, p.99.

- Under a high emissions scenario (RCP8.5) where temperatures rise 4.0-6.1 degrees celsius by the end of the century, Mexico could see about 1.2 million internal climate migrants by the middle of the century.[66]

Projected impacts across Latin America

With 1.5 degrees celsius of global warming:

- Under a low emissions scenario (RCP2.6) where temperatures rise 1.3-1.9C degrees celsius by the end of the century, Latin America could see about 5.8 million internal climate migrants by 2050.[67]
- Rising temperatures, drought, and unstable weather patterns have serious implications for global food production. Every degree of global temperature rise reduces global yields of wheat by 6.0%, rice by 3.2%, maize by 7.4%, and soybean by 3.1%.

With more than 1.5 degrees celsius of global warming:

- Globally, agricultural yields fall rapidly between one and three degrees celsius of warming. Once local temperatures reach three degrees celsius above pre-industrial levels, all crops are negatively affected, wherever they are in the world - including in temperate regions.[68] Fish species go locally extinct, with serious impacts on fisheries.[69]
- Under a high emissions scenario (RCP8.5) where temperatures rise 4.0-6.1 degrees celsius by the end of the century, and moderate development, Latin America could see about 10.5 million climate migrants by 2050.[70]

Benefits of limiting temperatures to 1.5 degrees celsius of global warming:

- About 3.3 million cases of dengue fever annually in Latin America and the Caribbean could be avoided compared with a no-policy scenario with warming of 3.7°C. (An additional 0.5 million per year, compared with two degrees celsius.)

[66] Groundswell: Preparing for Internal Climate Migration, (2018), World Bank Group, p.163.
[67] Groundswell: Preparing for Internal Climate Migration, (2018), World Bank Group, p.111.
[68] IPCC, AR5, WGII, Chapter 7, p.497.
[69] IPCC, AR5, WGII, Chapter 7, p.508.
[70] Groundswell: Preparing for Internal Climate Migration, (2018), World Bank Group, p.111.

Regional impacts and the 1.5 degree climate target - Canada & North America

Canada

Canada's NDC is rated by Climate Action Tracker as "highly insufficient" - well below what is needed to reach the 1.5 degrees celsius temperature target contained in the Paris Agreement. Current Canadian climate pledges are consistent with the world warming by 3-4 degrees celsius.

- Canada has ratified the Paris Agreement, and pledged to reduce emissions 30% below 2005 levels by 2030. With current policies, Canada will miss this target.

- Canada' NDC target emissions by 2030: 504-646 MtCO2e (depending on whether land use is included)
  Canadian emissions in 2030 under current policies: 636-775 MtCO2e.

Projected impacts across Canada

With more than 1.5 degrees celsius of global warming:

- Under a high emissions scenario (RCP8.5) where temperatures rise 4.0-6.1 degrees celsius by the end of the century, losses in the average ski season in Ontario could increase to about 34% by 2050, and to 75% by late-century.[71]

Projected impacts across North America

With 1.5 degrees celsius of global warming:

- Rising temperatures, drought, and unstable weather patterns have serious implications for global food production. Every degree of global temperature rise reduces global yields of wheat by 6.0%, rice by 3.2%, maize by 7.4%, and soybean by 3.1%.

With more than 1.5 degrees celsius of global warming:

- Globally, agricultural yields fall rapidly between one and three degrees celsius of warming. Once local temperatures reach three degrees celsius above pre-industrial levels, all crops are negatively affected, wherever they are in the world - including in temperate regions.[72] Fish species go locally extinct, with serious impacts on fisheries.[73]
- Under a high emissions scenario (RCP8.5) where temperatures rise 4.0-6.1 degrees celsius by the end of the century, summer cyclones could drop by over 40% by 2100. This would reduce cloudiness and accentuate maximum temperatures.

[71] 18-50% by mid-century and 60-90% by late-century - The differential futures of ski tourism in Ontario (Canada) under climate change: the limits of snowmaking adaptation (2017), Scott et al., Current Issues in Tourism 0, 1–16.

[72] IPCC, AR5, WGII, Chapter 7, p.497.

[73] IPCC, AR5, WGII, Chapter 7, p.508.

Regional impacts and the 1.5 degree climate target - Small Island Developing States (SIDS)

Projected impacts across SIDS

- Small islands are extremely vulnerable to the impacts of climate change. People living on small islands are very exposed to the weather, often live on the coast, are dependent on fisheries based on corals, and only have limited resources and options for employment available. One extreme weather event can have a significant effect. More than 4,600 people died on the island of Puerto Rico for example as a result of a hurricane in November 2017, which has also triggered a healthcare and humanitarian crisis.
- As sea levels rise, large waves are also likely to inundate the low lying islands more and more often, contaminating groundwater supplies of drinking water with salt. In a high emissions scenario where temperatures rise by more than four degrees celsius by the end of the century, this could make these islands uninhabitable by around 2030-40, according to one study. In a scenario where temperature rise is limited to three degrees celsius, they could be uninhabitable by 2055-65. Previous studies are more optimistic, suggesting they could be uninhabitable by the end of the century.
- The difference between a 1.5 to two degrees celsius temperature rise are important for small island states. For several SIDS, particularly across the Caribbean, about a quarter of the overall freshwater stress projected under a two degrees celsius temperature rise can be avoided if temperatures only rise by 1.5 degrees celsius.

Projected impacts across SIDS/Caribbean

With 1.5 degrees celsius of global warming:

- By the end of the century, nine out of ten of coral reefs are at risk from severe degradation from 2050 onwards. This declines to 70% by 2100 - meaning that some coral reefs have a chance of survival. At the moment, coral reefs provide about US$30 billion annually to the world economy, in coastal protection, building materials, fisheries and tourism.
- Coral reefs in Small Island Developing States (SIDS) could decline by about 80%.
- Half the annual year is projected to be very warm in the Caribbean.
- Rising temperatures, drought, and unstable weather patterns have serious implications for global food production. Every degree of global temperature rise reduces global yields of wheat by 6.0%, rice by 3.2%, maize by 7.4%, and soybean by 3.1%.

With more than 1.5 degrees celsius of global warming:

- Globally, agricultural yields fall rapidly between one and three degrees celsius of warming. Once local temperatures reach three degrees celsius above pre-industrial levels, all crops are negatively affected, wherever they are in the world - including in temperate regions.[74] Fish species go locally extinct, with serious impacts on fisheries.[75]
- By 2150, about 40,000 more people could experience flooding from sea level rise under two degrees celsius of warming compared to warming at 1.5 degrees celsius.
- If temperatures rise to two degrees celsius, virtually all the world's tropical coral reefs are at risk of severe degradation and collapse. Coral reefs account for 10 to 12% of the fish caught in tropical

[74] IPCC, AR5, WGII, Chapter 7, p.497.

[75] IPCC, AR5, WGII, Chapter 7, p.508.

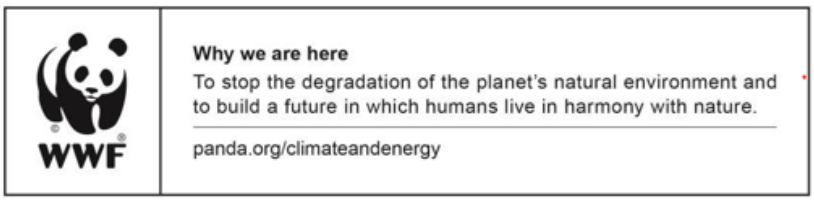
countries, and 20 to 25% of the fish caught by developing nations.[76] They provide food, income and protection from storms for millions of people along coastal areas.

- Under four degrees celsius of warming, one metre sea level rise could cost the Caribbean over US$68 billion from its cumulative GDP.[77]

Benefits of limiting temperatures to 1.5 degrees celsius:

- Two degrees of warming will create substantially more water stress in SIDS in the Caribbean region. About 25% of the freshwater stress projected under two degrees celsius at 2030 in several Caribbean SIDS can be avoided by limiting global warming to 1.5°C.

This paper was prepared by GSCC to support understanding of issues arising from the IPCC's Special Report on 1.5°C warming.



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[76] IPCC, AR5, WGII, CC Boxes, p.99.

[77] Turn down the heat: why a 4°C warmer world must Be avoided (2012), The World Bank, p.34.