COMMUNICATION TO THE COMMITTEE ON THE RIGHTS OF THE CHILD

In the case of

CHIARA SACCHI (Argentina); CATARINA LORENZO (Brazil); IRIS DUQUESNE (France); RAINA IVANOVA (Germany); RIDHIMA PANDEY (India); DAVID ACKLEY, III, RANTON ANJAIN, AND LITOKNE KABUA (Marshall Islands); DEBORAH ADEGBILE (Nigeria); CARLOS MANUEL (Palau); AYAKHA MELITHAFA (South Africa); GRETA THUNBERG AND ELLEN-ANNE (Sweden); RASLEN JBEILI (Tunisia); & CARL SMITH AND ALEXANDRIA VILLASEÑOR (USA);

Petitioners,

v.

ARGENTINA, BRAZIL, FRANCE, GERMANY & TURKEY,

Respondents.

Submitted under Article 5 of the Third Optional Protocol to the United Nations Convention on the Rights of the Child

23 September 2019

Petitioners' Legal Representatives

Michael D. Hausfeld
Richard Lewis
Scott Gilmore
Jeanette Bayoumi
Kimberly Fetsick
Hausfeld LLP (US)
1700 K Street NW, Suite 650
Washington, DC 20006
+1 202-540-7147 main
+1 202-540-7201 fax

Anthony Maton
Ingrid Gubbay
Wessen Jazrawi
Claus Wenzler
Hausfeld UK
12 Gough Square
London
EC4A 3DW
+44 (0)20 7665 5000 main
+44 (0)20 7665 5001 fax

Ramin Pejan
Martin Wagner
Earthjustice
50 California Street, Suite 500
San Francisco, CA 94111
+1 415-217-2000 main
+1 415-217-2040 fax

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I. Introduction

"There may be no greater, growing threat facing the world's children– and their children – than climate change."– UNICEF[1]

1. The science is incontrovertible: global warming is caused by human activities that emit carbon dioxide ("CO_2") and other greenhouse gases ("GHG")[2] into the atmosphere of the planet.[3] Each day, the burning of fossil fuels, deforestation, industrial processes, and agriculture add hundreds of millions of tons of CO_2 to the atmosphere, where it will remain for centuries. There is now more CO_2 in the atmosphere than at any time in the past 800,000 years.

2. The Earth is 1.1°C hotter than before the industrial revolution, and it is approaching a tipping point of foreseeable and irreversible catastrophic effects. If the Earth reaches 2°C of heating, the exacerbated air pollution alone is forecast to cause 150 million deaths. If the Earth reaches 3-4°C of heating by 2100—which is the current trajectory if states do not make drastic emissions reductions—the impacts of climate change will threaten the lives and welfare of over 2 billion children.

3. The climate crisis is not an abstract future threat. The 1.1°C rise in global average temperature is presently causing devastating heat waves, forest fires, extreme weather patterns, floods, and sea level rise, infringing on the human rights of millions of people globally. Because children are among the most vulnerable to these life-threatening impacts, physiologically and mentally, they will bear the burden of these harms far more and far longer than adults.

4. Petitioners, children from around the world, already carry that burden. Climate change is exposing them to life-threatening dangers and harming their health and development. For the indigenous petitioners, their thousand-years-old cultures are threatened by climate change.

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[1] Unless we act now: The impact of climate change on children, UNICEF (Nov. 2015).

[2] Throughout this Communication, the petitioners refer to these emissions as "carbon emissions" or simply "carbon pollution."

[3] IPCC (2013) *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* (Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA) p. 1535 (hereinafter "IPCC 2013: Physical Science"). The main GHGs are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_{20}), ozone (O_3), and fluorinated gases. U.S. Environmental Protection Agency, https://www.epa.gov/ghgemissions/overview-greenhouse-gases.

5. Hotter temperatures foster the spread of infectious diseases and exacerbate health hazards. In Lagos, Nigeria, Petitioner Debby Adegbile has been repeatedly hospitalized for asthma as hotter temperatures worsen the air quality. Mosquito-borne diseases have spread to new regions. In the Marshall Islands Petitioner Ranton Anjain contracted dengue fever in 2019, now prevalent in the islands, and Petitioner David Ackley III contracted chikungunya, a new disease there.

6. Wildfires are growing more frequent and intense because of hotter and drier conditions. In Tabarka, Tunisia, Petitioner Raslen Jbeili heard screams one night and saw a wildfire approaching his home: he was spared, his neighbors were not. In California, Petitioner Alexandria Villaseñor suffered smoke inhalation from the Paradise wildfire and was bedridden for three weeks.

7. Heat waves and drought are threatening children's lives and creating water scarcity. In Cape Town, South Africa, drought has made Petitioner Ayakha Melithafa's family and 3.7 million other residents prepare for the day municipal water supplies run dry. In Bordeaux, France, the first summer of Petitioner Iris Duquesne's life was Europe's hottest summer since 1540: tens of thousands died in the heat wave of 2003. Unfortunately, heat waves have become a regular part of her life.

8. Extreme storms that were once rare are now regular events. On Ebeye in the Marshall Islands, a violent storm forced Petitioner Litokne Kabua and his family to evacuate to a U.S. army base. In Haedo, Argentina, an unprecedented windstorm devastated Petitioner Chiara Sacchi's neighborhood. In Hamburg, Germany, Petitioner Raina Ivanova waded through knee-deep water on her school's grounds during the "Hervert" storm of 2017. South Atlantic storms come more often in Bahia, Brazil; one damaged the home of Petitioner Catarina Lorenzo.

9. Floods and rising sea levels are transforming children's relationships with the land. The Marshall Islands could become uninhabitable within decades. In Palau, Petitioner Carlos Manuel sees waves increasingly breach the sea walls and crash into homes as the Pacific sea level rises. In Haridwar, India, Petitioner Ridhima Pandey has seen downpours flood infrastructure and cause sewage to overflow into the sacred Ganges river, increasing the risk of infectious diseases.

10. The subsistence way of life of many indigenous communities is at stake. In northern Sweden, Petitioner Ellen-Anna is learning the reindeer herding traditions of the Sami people, passed down from millennia, but climate change is destroying the reindeers' food sources. In Akiak, Alaska, Petitioner Carl Smith learned to hunt and fish from the elders of the Yupiaq tribe, but the

salmon population on which they rely has been dying from heat stress in record numbers, and the warming temperatures have prevented his tribe from accessing traditional hunting grounds.

11. Climate change has affected children's mental health around the world. As the American Psychological Association observed, psychologists now grapple with new, 21st Century disorders, including climate anxiety and *solastalgia*—mourning the destruction of a cherished place. In Sweden, Greta Thunberg states she was so disturbed by the climate crisis that she fell into depression and stopped eating.

12. These harmful impacts are the result of just 1°C of global warming. As heating accelerates, unabated climate change will expose the petitioners to further deadly and foreseeable consequences for the rest of their lives. The extent of the harm depends on the extent of the warming. Every day of delay depletes the remaining "carbon budget"—the amount of carbon that can still be emitted before the climate reaches unstoppable and irreversible ecological and human health tipping points. The respondents are creating an imminent risk; it will be impossible to "make up" for lost mitigation opportunities and impossible to ensure the sustainable and safe livelihood of future generations.

13. The climate crisis is a children's rights crisis.[4] Children have an inalienable right to life under the Convention on the Rights of the Child (the "Convention"). The Convention—the most widely ratified human rights instrument in the world—obligates nations to respect, protect, and fulfill children's inalienable right to life, from which all other rights flow. Mitigating climate change is a human-rights imperative.

14. In the context of the climate crisis, obligations under international human rights law are informed by the rules and principles of international environmental law. The CRC must be interpreted taking into account the respondents' obligations under international environmental law. Each respondent has failed to uphold its obligations under the Convention to (i) prevent foreseeable domestic and extraterritorial human rights violations resulting from climate change; (ii) cooperate internationally in the face of the global climate emergency; (iii) apply the precautionary principle to protect life in the face of uncertainty, and (iv) ensure intergenerational justice for children and posterity.

[4] Petitioners respectfully note that children and adults generally share the same human rights; however, children's rights focus on the special needs specific to children and young people. *See Child rights and why they matter*, UNICEF, https://www.unicef.org/child-rights-convention/child-rights-why-they-matter.

Each respondent has knowingly caused and perpetuated the climate crisis

15. Each respondent—Argentina, Brazil, France, Germany, and Turkey—has known about the harmful effects of its internal and cross-border contributions to climate change for decades. In 1992, each signed the United Nations Framework Convention on Climate Change ("Climate Change Convention") and undertook to protect children from the foreseeable threats of climate change. It was clear then that every metric ton of CO_2 that they emitted or permitted was adding to a crisis that transcends all national boundaries and threatens the rights of all children everywhere. It was even clearer that their emissions were endangering children's lives in 2016, when each signed the Paris Agreement. In Paris, each pledged to make efforts to limit global warming to 1.5°C above pre-industrial levels. None of the respondents has kept nor met that pledge, which in itself is inadequate to prevent human rights violations on a massive scale.

16. The Climate Change Convention, 1997 Kyoto Protocol, and 2016 Paris Agreement were important steps in securing recognition from all states that the climate crisis is a "common concern of humankind." But none of these efforts have reduced carbon emissions enough to avert further disaster and widespread human rights violations. In the twenty years after the Kyoto Protocol was signed, the world produced more emissions than in the twenty years before.

17. Every nation has contributed to climate change. For decades, the excuse that no harm can be traced to any particular emission or country, and thus that no state bears responsibility, has led to inaction. But under human rights law, states are individually responsible for, and should be held accountable for, their sovereign actions and inactions that cause and contribute to climate change, and thereby breach their fundamental human rights obligations.

18. As major historical emitters and influential members of the Group of Twenty ("G20"), a forum of the world's 20 leading economies, the respondents must lead by example, reducing emissions at the greatest possible rate and consistent with a scale that is scientifically established to protect life. Moreover, emissions from other G20 members and in particular the "major emitters"—China, the United States ("U.S."), the European Union ("E.U."), and India—must also be curbed to ensure children's rights. Therefore, the respondents must also use all available legal, diplomatic, and economic tools to ensure that the major emitters are also decarbonizing at a rate and scale necessary to achieve the collective goals.

19. To date, however, each respondent is failing on both of these fronts.

20. *First*, each respondent has failed to prevent foreseeable human rights harms caused by climate change by reducing its emissions at the "highest possible ambition." Each respondent is delaying the steep cuts in carbon emissions needed to protect the lives and welfare of children at home and abroad.

21. Not one of the respondents is on an emissions pathway that is consistent with keeping heating under 3.0°C much less under 1.5°C. Each respondent has set inadequate emission reduction targets in its Paris Agreement pledges—and then failed to even meet these inadequate goals. For example, if all the world's governments implemented comparable reductions to Argentina's Paris commitments, it would lead to 3-4°C of global warming by 2100. Comparable reductions to Brazil's emissions would lead to 2-3°C, *before* President Bolsonaro's rollback of environmental protections that will likely make Brazil's contribution even greater. Comparable emissions to France and Germany—in many ways leaders on international climate action—would lead to 3-4°C. Meanwhile, comparable emissions to Turkey's rate of emissions would lead to more than 4°C of warming, as it continues to invest in new coal-fired power plants.

22. *Second*, as members of the G20, which makes up 84% of all global emissions, each respondent has failed to use all available legal, diplomatic, and economic means to protect children from the life-threatening carbon pollution of the major emitters (China, the U.S., the E.U., and India) and other G20 members. As G20 members, the respondents have diplomatic, legal, and economic tools at their disposal. Yet, none of the respondents have used, much less exhausted, all reasonable measures to protect children's rights from the major emitters.

Each respondent's actions that caused and are perpetuating the climate crisis are violating the petitioners' human rights.

23. The Convention enshrines children's rights as universal. All governments have a responsibility to take all available measures to ensure these rights are respected, protected, and fulfilled.

24. By recklessly causing and perpetuating life-threatening climate change, the respondents have failed to take necessary preventive and precautionary measures to respect, protect, and fulfill the petitioners' rights to life (Article 6), health (Article 24), and culture (Article 30) and are thus violating the Convention. Under the Convention, states must "limit ongoing and future damage" to these rights, including those caused by environmental threats.

25. *Right to life.* The respondents' acts and omissions perpetuating the climate crisis have already exposed the petitioners throughout their childhood to the foreseeable, life-threatening risks of human-caused climate change, be it heat,

floods, storms, droughts, disease, or polluted air. A scientific consensus shows that the life-threatening risks confronting the petitioners will increase throughout their lives as the world heats up to 1.5°C and beyond. If the respondents continue their current emissions pathways, the world would warm enough to threaten the lives of billions of children worldwide. The respondents have thus violated the petitioners' right to life under Article 6(1).

26. *Right to health.* The respondent's acts and omissions perpetuating the climate crisis have already caused injuries to the petitioners' mental and physical health—from asthma to emotional trauma. These injuries violate the petitioners' right to health under Article 24. And the injuries will worsen as the world continues to warm.

27. *Right to Culture*. The respondents' contributions to the climate crisis have already jeopardized millennia-old subsistence practices of the indigenous Petitioners from Alaska the Marshall Islands, and the Sapmi (the cultural region inhabited by the Sami people in the Arctic region of Europe), which are not just the main source of their livelihoods, but directly relate to a specific way of being, seeing, and acting in the world, that are essential to their cultural identity. If rising sea levels force the Marshallese to relocate to other nations, they would lose thousand years old cultural practices tied to their islands. If the respondents continue their current emissions pathways, the world would warm enough to decimate indigenous cultures, including those of the indigenous petitioners here. The respondents are thus violating Article 30 of the Convention.

28. *Best interests of the child.* By supporting climate policies that delay decarbonization, the respondents are shifting the enormous burden and costs of climate change onto children and future generations. In doing so, they have breached their duty to ensure the enjoyment of children's rights for posterity, and failed to act in accordance with the principle of intergenerational equity. No state acting rationally in the best interests of the child would ever choose to delay and impose this burden upon them. As such, the respondents have each violated the petitioners' right under Article 3 to have children's bests interests be made a primary consideration in their climate actions and omissions.

29. This petition documents the violation of the petitioners' rights under the Convention, but the scope of the climate crisis should not be reduced to the harms of a small number of children. Ultimately, at stake are the rights of every child, everywhere. If the respondents, acting alone and in concert with other states, do not immediately take available measures to stop the climate crisis, the devastating effects of climate change will nullify the ability of the Convention to protect the rights of any child, anywhere.

30. Each of the respondents has contributed to causing the climate crisis through their past emissions. The cumulative sum of the respondents' historical emissions show that they are major emitters, responsible for a significant share of today's concentration of GHG in the atmosphere. Each of the respondents ranks in the top 50 historical emitters since 1850, based on fossil fuel emissions: Germany ranks 5th, France 8th, Brazil 22nd, Argentina 29th, and Turkey 31st. When land-use, such as deforestation, is factored in, Brazil surpasses France in its historical share.

31. These emissions continue to grow. The respondents are currently emitting at levels they know with scientific certainty are damaging the climate, harming children's health, and jeopardizing their lives. Yet they continue to delay and undermine the domestic and international actions needed to mitigate climate change.

32. In short, each respondent has contributed to the degradation of the climate that is directly harming the petitioners and threatening their lives. Through their acts and omissions, they have caused and are perpetuating climate change, and they have caused and are causing the violations of the petitioners' rights.

Request for Relief

33. The petitioners do not seek compensation; no amount of money could compensate for the harm children are and will be suffering from climate change, both now and in the future. Instead, the petitioners respectfully request that the Committee on the Rights of the Child (the "Committee" or "CRC") adopt the following recommendations for precautionary, declaratory, and remedial relief:

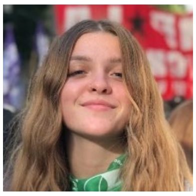
- Finds that climate change is a children's rights crisis.
- Finds that each respondent, along with other states, has caused and is perpetuating the climate crisis by knowingly acting in disregard of the available scientific evidence regarding the measures needed to prevent and mitigate climate change.
- Finds that by recklessly perpetuating life-threatening climate change, each respondent is violating the petitioners' rights to life, health, and the prioritization of the child's best interests, as well as the cultural rights of the Petitioners from indigenous communities.
- Recommends that the respondents review, and where necessary, amend their laws and policies to ensure that mitigation and adaptation efforts are being accelerated to the maximum extent of available resources and on the basis of the best available scientific evidence to (i) protect the petitioners' rights and (ii) make the best interests of the child a primary

consideration, particularly in allocating the costs and burdens of climate change mitigation and adaption.

- Recommends that each respondent initiate cooperative international action—and increase its efforts with respect to existing cooperative initiatives—to establish binding and enforceable measures to mitigate the climate crisis, prevent further harm to the petitioners and other children, and secure their inalienable rights.
- Recommends that pursuant to Article 12, the respondents shall ensure the child's right to be heard and to express their views freely, in all international, national, and subnational efforts to mitigate or adapt to the climate crisis and in all efforts taken in response to this Communication.[5]

II. The Petitioners

34. **Chiara Sacchi (Argentina).** Chiara is a seventeen-year-old from Haedo, Argentina, which lies along the outskirts of Buenos Aires. She recently took part in a global project called "Terra Madre," which seeks to protect and support small-scale food producers.



35. **Catarina Lorenzo (Brazil).** Catarina is a twelve-year-old from Salvador, Brazil, located in Brazil's northeastern state of Bahia. Catarina is an aspiring professional surfer and spends a lot of time on Brazil's beaches. She is very passionate about protecting Brazil's trees and forests.

36. **Iris Duquesne (France).** Iris is a sixteen-year-old from Bordeaux, France, which lies along France's southeastern coast. Since moving to California earlier this year, Iris has become an avid surfer and is dedicated to raising awareness about climate change.

37. **Raina Ivanova (Germany).** Raina is a fifteen-year-old who lives in Germany's northern city of Hamburg. Raina's favorite subjects in school are geography and philosophy. She participates in

[5] The Petitioners reserve the right to request interim measures.

"Fridays for the Future," foregoing school on Fridays in an effort to bring awareness and spark action to combat climate change.

38. **Ridhima Pandey (India).** Ridhima is an eleven-year-old from Haridwar, India. Ridhima is passionate about protecting India's forests. In 2017, at just nine-years-old, Ridhima sued the Indian government for failing to take adequate action to tackle climate change.

39. **David Ackley III "David" (Marshall Islands).** David is a sixteen-year-old from Majuro, the capitol of the Marshall Islands. David loves everything to do with basketball and has traveled to Micronesia with his club team. David participated in Heirs to Our Oceans,[6] where he spoke with government officials about passing legislation to protect the environment.

40. **Ranton Anjain (Marshall Islands).** Ranton is a seventeen-year-old from Ebeye Island, Marshall Islands. Ranton now attends high school on Chuuk in the Federated States of Micronesia but used to go fishing on Ebeye every day. Ranton began participating in the Heirs to Our Oceans programs in 2018 and is now an advocate on climate issues with local leaders.

41. **Litokne Kabua (Marshall Islands).** Litokne is a sixteen-year-old from Ebeye Island, Marshall Islands who understands the importance of the ocean to the Marshallese, and has studied coral health on his island as part of a summer camp through Heirs to Our Oceans. When Litokne grows up, he wants to work for his government to encourage the government to become more active in fighting climate change.

[6] Heirs to our Oceans is a non-profit organization dedicated to providing environmental education, leadership development, and ensuring that all youth, regardless of socio-economic status, race, ethnicity, or religion are empowered to participate in environmental conservation. https://h2oo.org/vision-mission-and-pillars/.

42. **Deborah ("Debby") Morayo Adegbile (Nigeria).** Debby is a twelve-year-old from Lagos, along Nigeria's southwestern coast. Debby wants to be a lawyer when she grows up and has joined Heirs to Our Oceans to learn more about the changing climate and advocate against plastic pollution.

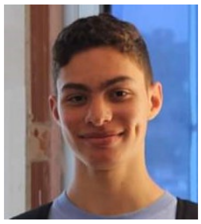
43. **Carlos Manuel (Palau).** Carlos is a seventeen-year-old originally from the Philippines, now living on Koror, Palau. Three years ago, after attending a meeting as a school requirement, Carlos started an Heirs to Our Ocean chapter at his school, educating his peers about ocean health and the impacts of climate change.

44. **Ayakha Melithafa (South Africa).** Ayakha is a seventeen-year-old living in Eerste River on the outskirts of Cape Town in the Western Cape province of South Africa. She is a dedicated climate activist, taking part in Project 90 by 2030 YouLead initiative and acts as a recruitment official for the African Climate Alliance.

45. **Greta Thunberg (Sweden).** Greta is sixteen-year-old climate activist who began the global 'Skolstrejk for Klimatet' (School Strike for Climate) when she began protesting outside of the Swedish Parliament in August 2018. Greta has inspired hundreds of thousands of other children and adults around the world to speak up and urge world leaders to take action to combat the climate crisis.

46. **Ellen-Anne (Sweden).** Ellen-Anne is an eight-year-old Sami from Kareusando, Sweden. When Ellen-Anne grows up, she wants to be a reindeer herder, just like her father. She loves working with reindeer and describes them as "such beautiful creatures."

47. **Raslen Jbeli (Tunisia).** Raslen is a seventeen-year-old from Tabarka, Tunisia, located along Tunisia's northern coast. Raslen loves playing basketball with friends. He participates in the Access Program, a school program that allows him to research climate change and other environmental issues affecting Tabarka.



48. **Alexandria Villaseñor (USA).** Alexandria is a fourteen-year-old climate activist who grew up in Davis, California and moved to New York City in the fall of 2018. Alexandria began school striking for the climate outside the United Nations on December 14, 2018, inspiring thousands of others, and also started and runs her own youth-led nonprofit, Earthuprising.org.

49. **Carl Smith (USA).** Carl is a seventeen-year-old from Akiak, Alaska. As a member of the Indigenous Yupiaq tribe, Carl grew up learning the traditional hunting, fishing, and cultural practices that have shaped his community for thousands of years. Carl is speaking out about climate change because as the temperatures rise Akiak is changing and Carl fears that the Yupiaq way of life will disappear.

50. Pursuant to Rule 17(2) of the Rules of procedure under the Optional Protocol to the Convention on the Right of the Child on a communications procedure (the "OPIC"), the petitioners respectfully request that the Committee consider this Communication jointly, since they arise from a common core of facts: the respondents' contributions to the life-threatening impacts of climate change.

51. Additional personal information of the petitioners is on file with the petitioners' legal representatives and is available upon request.

52. This Communication is submitted by Hausfeld LLP (USA & UK) and Earthjustice (USA), who are retained as *pro bono* legal representatives of the petitioners, through their parents and legal guardians.[7] Letters of Authority are included in a confidential Annex filed simultaneously with this Communication.

53. Address for exchange of confidential correspondence:

Michael D. Hausfeld

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[7] Petitioners also recognize the support of expert consultant Professor John Cerone of The Fletcher School of Law & Diplomacy (Tufts University).

Hausfeld LLP
1700 K Street, NW, Suite 650
Washington, District of Columbia, USA, 20006
mhausfeld@hausfeld.com

III. The Respondents

54. The five respondents have all accepted the jurisdiction of the Committee under the OPIC.

55. ARGENTINA—The Argentine Republic ratified the Convention on 4 December 1990. The Convention entered into force for Argentina 30 days later. Argentina ratified the OPIC on 14 April 2015 without reservation or declaration. Argentina ratified the Paris Agreement on 21 September 2016, the Kyoto Protocol on 28 September 2001, and the Climate Change Convention on 11 March 1994 (Non-Annex I Party).

56. BRAZIL—The Federative Republic of Brazil (Brazil) ratified the Convention on 24 September 1990. The Convention entered into force for Brazil 30 days later. Brazil ratified the OPIC on 29 September 2017 without reservation or declaration. Brazil ratified the Paris Agreement on 21 September 2016, the Kyoto Protocol on 23 August 2002, and the Climate Change Convention on 28 February 1994 (Non-Annex I Party).

57. FRANCE—The French Republic (France) ratified the Convention on 7 August 1990. The Convention entered into force for France 30 days later. France ratified the OPIC on 7 January 2016 without reservations or declarations. France ratified the Paris Agreement on 05 October 2016, the Kyoto Protocol on 31 May 2002, and the Climate Change Convention on 25 March 1994 (Annex I Party).

58. GERMANY—The Federal Republic of Germany (Germany) ratified the Convention on 6 March 1992. The Convention entered into force for Germany 30 days later. Germany ratified the OPIC on February 28, 2013 without reservation. Germany also entered a declaration accepting the competence of the Committee to receive inter-state communications under Article 12 of the OPIC. Germany ratified the Paris Agreement on 05 October 2016, the Kyoto Protocol on 31 May 2002, and the Climate Change Convention on 9 December 1993 (Annex I Party).

59. TURKEY—The Republic of Turkey (Turkey) ratified the Convention on 4 April 1995, reserving the right to interpret and apply Articles 17, 29, and 30 “according to the letter and spirit of the Constitution of the

Republic of Turkey and those of the Treaty of Lausanne of 24 July 1923." The Convention entered into force for Turkey 30 days later. Turkey ratified the OPIC on 26 December 2017 with a declaration affirming its reservations to the Convention. Turkey signed the Paris Agreement on 22 April 2016, ratified the Kyoto Protocol on 28 May 2009, and acceded to the Climate Change Convention on 24 February 2004 (Annex I Party).

IV. Competence of the Committee on the Rights of the Child

60. The Committee is competent to receive and act on this Communication in accordance with Articles 1 and 5 of the OPIC. The respondents are parties to the Convention and the OPIC; the Communication concerns multiple violations of the Convention; and the victims of the violations are within the jurisdiction of the respondents, as discussed below in Section VIII.

V. The climate crisis is already here and harming children

A. The climate crisis is approaching a tipping point of irreversible catastrophic effects, threatening the lives and welfare of millions of children.

61. Climate change is human made. A scientific consensus holds that global warming is caused by human activities that emit CO_2 and other GHGs[8] into Earth's atmosphere.[9] The burning of fossil fuels, industrial manufacturing, and agriculture add tons of CO_2 to the atmosphere each day, to remain there for centuries and cause more dangerous global warming.[10]

62. Nearly 70% of this CO_2 comes from the burning of fossil fuels.[11] Another driver of global warming is the destruction of natural carbon

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[8] GHG are defined in the Kyoto Protocol to the UN Framework Convention on Climate Change as Carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF6).

[9] *See generally* IPCC, 2018: Summary for Policymakers. In: Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty [Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T.

sinks, such as forests and sea grass meadows, which absorb more carbon than they emit. Human activities like deforestation, agriculture, and urbanization can turn carbon sinks into carbon sources, producing a quarter of all emissions. [12]

63. As a result, the average temperature on Earth is 1.1°C hotter now than at any time before the industrial revolution, and it is approaching a tipping point of foreseeable and irreversible catastrophic effects.[13] 2014 to 2018 were each, in succession, the hottest years on record; 20 of the warmest years on record have occurred over the past 22 years.[14] Some regions like the Arctic and Alaska have experienced two to three times more warming than elsewhere on Earth.[15] Already, with this amount of warming, the world is seeing widespread harm to the environment and human health and well-being from more frequent and intense storms, droughts, heatwaves, and other climactic events.

64. Every fraction of a degree of warming brings greater risks. In 2018, the Intergovernmental Panel on Climate Change ("IPCC")—the world's foremost authority on climate science—reported that at the current rate of emissions, the global average temperature will likely reach 1.5°C between 2030 and 2050, with much higher averages in various regions,

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Waterfield (eds.)] (hereinafter "IPCC 1.5 SPM 2018 Report"); Climate change 2014: Impacts, Adaptation, and Vulnerability 2. 5th Assessment Report (ARS) (hereinafter "IPCC 2014"). Throughout this Communication, the Petitioners refer to these emissions as "carbon emissions" or simply "carbon pollution."

[10] Appendix B, Joeri Rogelj, *Climate physics consequences of further delay in achieving CO_2 emission reductions and intergenerational fairness*, Grantham Institute Science Brief, (Sept. 2019) (hereinafter "Rogelj Report 2019") at 4.

[11] IPCC 2014, "Drivers, Trends and Mitigation" in Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, at 354, https://www.ipcc.ch/site/assets/uploads/2018/02/ipcc_wg3_ar5_chapter5.pdf.

[12] IPCC 2014: "Agriculture, Forestry and Other Land Use (AFOLU)" in Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, p. 816, https://www.ipcc.ch/site/assets/uploads/2018/02/ipcc_wg3_ar5_chapter11.pdf.

[13] IPCC 1.5 SPM 2018 Report.

[14] Climate Central, The Ten Hottest Global Years on Record (February 6, 2019), https://www.climatecentral.org/gallery/graphics/the-10-hottest-global-years-on-record.

[15] Appendix C, Climate Analytics, *Scientific Report on Impacts and Drivers on Climate Change* (Sept. 10, 2019) (hereinafter "Climate Analytics Report 2019") at 121-132, 144-158.

like the Arctic and sub-Saharan Africa.[16] At 1.5°C of heating, an estimated 4.5 billion people will be exposed to deadly heat weaves.[17] If the Earth reaches 2°C of heating by the end of the century, some models estimate that 150 million people will die from air pollution alone.[18]

65. 1.5°C and 2°C are not random numbers: they are the limits to global warming proposed by the Paris Agreement under the Climate Change Convention, which aims to keep heating by 2100 well below 2°C and to pursue efforts "limit[ing] the temperature increase to 1.5°C above pre-industrial levels".[19] The IPCC's 2018 special report now demonstrates a greater scientific understanding of these limits. It makes clear that even attaining these limits would still not be sufficient to avoid widespread violations of human rights. Nonetheless, every fraction of a degree makes a difference. Preventing any additional rise in global warming matters to the ultimate health and survival of the planet and the children of today and tomorrow.[20]

66. The Paris Agreement benchmarks, unfortunately, are already considered unduly optimistic compared to the current emissions trajectories of the Agreement's parties. A year after the Paris Agreement opened for

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[16] IPCC 1.5 SPM 2018 Report at 6.

[17] IPCC, 2018: Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty [Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (eds.)] (hereinafter "IPCC 1.5 SR 2018 Report"), at 453.

[18] Drew Shindell et al., "Quantified, Localized Health Benefits of Accelerated Carbon Dioxide Emissions Reductions," Nature Climate Change 8 (Mar. 2018) at 291-95. By comparison, "150 million people is the equivalent of twenty-five Holocausts." David Wallce-Wells, The Uninhabitable Earth: Life After Warming, Penguin Random House (2019) at 28 (hereinafter "Uninhabitable Earth").

[19] U.N. Framework Convention on Climate Change Conference of the Parties, 21st Session, Adoption of the Paris Agreement, pmbl., U.N. Doc. FCCC/CP/2015/10/Add.1 (Jan. 29, 2016) (hereinafter "Paris Agreement"), art. 2.

[20] Based on statistical models, limiting warming to 1.5°C would: reduce the number of people frequently exposed to extreme heatwaves by about 420 million; reduce the number of people susceptible to climate-related poverty risks by as much as several hundred million by 2050; and reduce the number of people in urban areas exposed to severe drought by 61 million. Alan Buis, *A Degree of Concern: Why Global Temperatures Matter*, NASA (Jun. 19, 2019), https://climate.nasa.gov/news/2865/a-degree-of-concern-why-global-temperatures-matter.

signature, global annual emissions increased, reaching a record high of 53.3 billion metric tons in 2017.[21] At current rates, global emissions are projected to cause 3.3-4°C of heating over the next 80 years.[22]

67. With each fraction of a degree of heat, the Earth comes closer to more tipping points, critical thresholds beyond which rapid climate change becomes unavoidable and irreversible.[23] The disintegration of the Greenland ice sheet is one tipping point; melting permafrost is another.[24] There is scientific certainty that these tipping points exist; when exactly they will occur is less certain.[25]

68. There is no doubt that more heat brings us closer to going over the edge. Continuing on this path will endanger the lives of over 2 billion children by 2100.[26]

69. There is no more time to delay mitigating CO_2 emissions. The world's nations have a finite amount of carbon—called a "carbon budget"—that can still be emitted before catastrophic climate change becomes unavoidable and irreversible. To stay within the remaining carbon budget, global emissions must be cut in half by 2030 with total decarbonization by 2050 to have at minimum a 50% chance of limiting warming to 1.5°C or less.[27]

70. Global warming requires an immediate increase of mitigation commitments. Even with that, adaptation must also play a critical role in protecting children from the adverse impacts of climate change, particularly those acute impacts that have and continue to occur, and

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[21] UN Environmental Programme, Emissions Gap Report 2018 (herinafter "UNEP Gap Report 2018") at XV.

[22] Climate Action Tracker, https://climateactiontracker.org/global/cat-thermometer/.

[23] IPCC 1.5 SR 2018 Report at 177, 252, 257.

[24] Lenton TM, et al. (2008) Tipping elements in the Earth's climate system. Proc. Natl. Acad. Sci. U. S. A. 105(6):1786-1793.

[25] Rogelj Report 2019 at 4-5.

[26] When will the world reach "peak child," Our World in Data (Feb. 8, 2018) https://ourworldindata.org/peak-child.

[27] IPCC 1.5 SMP 2018 Report at 15; UNEP Gap Report 2018 at .XV. The IPCC's report is critically important because it represents a scientific consensus that is conservative in its approach, drawing on 6,000 scientific papers and more than 42,000 comments.

which will certainly occur more severely in the future. These impacts include, for example, extreme weather events, floods, drought, food insecurity, and water shortages. The IPCC has identified adaptation measures that can assist in lessening the damage to children caused by these occurrences. Such measures include flood levees and culverts, water storage and pump storage, improved drainage, flood and cyclone shelters, storm and wastewater management, food banks and distribution of food surplus, improved water and sanitations services, and essential public health services.[28]

71. In sum, the climate crisis is caused by human economic, industrial, and consumption activities. It is perpetuated by political decisions to delay decarbonizing. The laws of physics dictate the remaining amount of carbon that we can still emit into the atmosphere before the tipping points are reached. We have already reached the limit.

1. Climate change is substantially altering our global environment.

72. The rise of 1.1°C in global average temperature that we experience today has already transformed the environment and damaged the planet.

73. The multiple heat waves that swept through the Northern Hemisphere in the summer of 2019 illustrate the far-reaching and inter-connected threat of the climate crisis. Between June and September, record high temperatures hit Europe (namely, the Netherlands, France, the United Kingdom, and Germany), North America (namely, Alaska),[29] and the Arctic, melting glaciers, exacerbating wildfires, and imperiling public health, among other impacts.[30] June and July were the hottest months on

[28] IPCC 2014, Impacts, Adaptation, and Vulnerability at Table 14-1. While adaptation measures are not the subject of this Communication, they are important human rights obligations for states to uphold.

[29] Temperatures in Alaska reached record highs of up to 32°C (90°F) on July 4, 2019. World Meteorological Organization, *Unprecedented wildfires in the Arctic* (Jul. 12, 2019), https://public.wmo.int/en/media/news/unprecedented-wildfires-arctic.

[30] World Meteorological Organization, *July matched, and maybe broke, the record for the hottest month since analysis began* (Aug. 1, 2019), https://public.wmo.int/en/media/news/july-matched-and-maybe-broke-record-hottest-month-analysis-began; BBC News, *Europe heatwave: French city of Bordeaux hits record temperature* (Jul. 24, 2019), https://www.bbc.com/news/world-europe-49083283.

record globally, with temperatures more than 2°C above average in Europe.[31]

74. The climatic events associated with the 2019 heat waves are not an anomaly; they have become the new normal. Climate change has significantly increased the chances of more intense and regular heatwaves, including those that took place in 2019. For example, a recent multi-institutional study found that climate change made the 2019 record-breaking heatwave in France and Netherlands, which would typically be 1,000 year events, ten times more likely.[32] The record-high temperatures, the study concluded, "would have had extremely little chance to occur without human influence on climate."[33] The 2003 Central European hot summer, which would have been a one in one-hundred year event without climate change, is projected to be a one in four year event at current global temperatures.[34]

75. Indeed, record-high heatwaves intensified the melting of Greenland's ice sheet, the second largest in the world, after Antarctica. In just five days between July 30 and August 3, 2019, it lost approximately 55 billion tons of ice through melt runoff. Before 2003, it used to lose approximately 74 billion tons *in an entire year*.[35] A recent study based on NASA data predicts that at current rates of global warming, the melting Greenland ice sheet will contribute 1.6 meters (5.25 ft) to global sea-level rise over the next 200 years.[36]

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[31] Climate Change Service, *Record-breaking temperatures for June* (Jul. 2, 2019), https://climate.copernicus.eu/record-breaking-temperatures-june. Climate Change Service, *Another exceptional month for global average temperatures* (Aug. 5, 2019), https://climate.copernicus.eu/another-exceptional-month-global-average-temperatures.

[32] Robert Vautard et al, *Human contribution to the record-breaking July 2019 heat wave in Western Europe* (Aug. 2019), https://www.worldweatherattribution.org/human-contribution-to-the-record-breaking-july-2019-heat-wave-in-western-europe/.

[33] *Id*.

[34] Climate Analytics Report 2019 at 6-8.

[35] National Snow and Ice Data Center, *Greenland Ice Sheet Today*, https://nsidc.org/greenland-today.

[36] NASA, *Study Predicts More Long-Term Sea Level Rise from Greenland Ice* (Jun. 19, 2019), https://www.nasa.gov/feature/goddard/2019/study-predicts-more-long-term-sea-level-rise-from-greenland-ice.

76. In 2019, people in Iceland gathered in midsummer on a small patch of ice atop a volcano to mourn the country's first glacier to succumb to warming.[37] The crowd honored the former glacier with a plaque that read:

> *[Okjökull] is the first Icelandic glacier to lose its status as glacier. In the next 200 years all our main glaciers are expected to follow the same path. This monument is to acknowledge that we know what is happening and what needs to be done. Only you know if we did it.*[38]

77. In the Arctic Circle, June 2019 wildfires emitted 50 million tons of carbon dioxide, roughly equivalent to Sweden's total annual emissions, and more than the combined total of all June Arctic fires between 2010 and 2018.[39] By mid-July, Alaska had over 400 fires,[40] while an estimated 745 wildfires had burned 33,200 square kilometers in Siberia by the end of July.[41]

78. These are just a handful of examples of how climate change is already taking place. The world is seeing more extreme storms and weather events, sea level rise, severe droughts, flooding, and many other adverse impacts, which are already harming billions of people globally, in particular children.[42]

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[37] BBC News, *Iceland's Okjokull glacier commemorated with plaque* (Aug. 18, 2019), https://www.bbc.com/news/world-europe-49345912.

[38] *Id*.

[39] World Meteorological Organization, *Unprecedented wildfires in the Arctic* (Jul. 12, 2019), https://public.wmo.int/en/media/news/unprecedented-wildfires-arctic.

[40] *Id*.

[41] World Meteorological Organization, *July matched, and maybe broke, the record for the hottest month since analysis began* (Aug. 1, 2019), https://public.wmo.int/en/media/news/july-matched-and-maybe-broke-record-hottest-month-analysis-began

[42] Climate Analytics Report 2019 at 6-8; Report of the Special Rapporteur on Human Rights and the Environment on Climate Change, U.N. Doc. A/74/161, (Jul. 15, 2019) at ¶¶ 6-11.

2. Climate change is triggering life-threatening, adverse impacts.

79. The changes described above are harming human health, threatening food and water security, causing mass migrations, and destroying species and the environment.[43]

80. For instance, extreme heat waves like those that hit Europe seriously endanger human health. High temperatures increase hazardous levels of ozone air pollution, which cause shortness of breath, coughing, intense asthma attacks, child mortality and premature death.[44] Hot temperatures also cause a wide range of physiological stress such as heat cramps, heatstroke, hyperthermia, and exhaustion, and quickly worsen existing health conditions.[45] Extreme heat causes death and hospitalization.[46] For example, a European heat wave in 2003 killed an estimated 70,000 people.[47] Certain populations are more vulnerable to these harms, including infants and children, pregnant women, and the elderly.[48]

81. Melting glaciers are one of the main causes of sea level rise, along with thermal expansion of warming ocean water. Currently, global sea level has risen about 20 cm from pre-industrial times;[49] however, the rate at which sea level is rising has increased significantly in the past two decades.[50] Sea-level rise is exposing coastal freshwater supplies to saltwater intrusion, creating bigger storm surges, and threatening and

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[43] *See, e.g.*, U.N. Doc. A/74/161 at ¶¶ 6-11; Climate Analytics Report 2019 at 21-27.

[44] Euronews, *Why was there a spike in pollution during the European heatwave?* (Apr. 7, 2019), https://www.euronews.com/2019/07/04/why-was-there-a-spike-in-pollution-during-the-european-heatwave; American Lung Association, State of the Air 2019, https://www.lung.org/assets/documents/healthy-air/state-of-the-air/sota-2019-full.pdf.

[45] World Health Organization, Information and public health advice: heat and health, https://www.who.int/globalchange/publications/heat-and-health/en/.

[46] *Id*.

[47] *Id*.

[48] *Id*.

[49] Climate Analytics Report 2019 at 8.

[50] U.S. Global Change Research Program, Climate Science Special Report: Fourth National Climate Assessment (2017), Chapter 12, https://science2017.globalchange.gov/chapter/12/.

destroying coastal infrastructure.[51] It has already forced entire communities in some countries to relocate, including the communities of Vunidogoloa, Fiji; Nusa Hope and Taro, Solomon Islands; and Shishmaref, Kivalina.[52]

82. The oceans, seas, and other large bodies of water are also absorbing large amounts of the heat and carbon dioxide in the atmosphere, causing them to warm, acidify, and expand. The ocean has warmed at all depths since the 1960s and surface waters have warmed by about 0.7°C (1.3° ± 0.1°F) globally from 1900 to 2016.[53] 2018 set a record for ocean heating.[54] In addition to causing sea level rise, warming oceans already contribute to more intense storms and heavier rains, declining ocean oxygen, melting sea ice and ice shelves through bottom heating, and increasing frequency and duration of marine heat waves.[55] For example, as of 2016, the number of floods and other hydrological events globally had quadrupled since 1980 and had doubled since 2004, and meteorological events, such as storms, have doubled since 1980.[56]

83. Warming oceans have increased the occurrence of major storms, particularly in the North Atlantic and Pacific basins, and sea-level rise

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[51] Lijing Cheng et al., 2018 Continues Record Global Ocean Warming (2019), Adv. Atmos. Sci., 36(3), 249–252, https://link.springer.com/content/pdf/10.1007%2Fs00376-019-8276-x.pdf; U.N. Doc. A/74/161 at ¶ 10.

[52] U.N. Doc. A/74/161 at ¶ 10; The Conversation, "Climate change forced these Fijian communities to move – and with 80 more at risk, here's what they learned" (Apr. 30, 2019), http://theconversation.com/climate-change-forced-these-fijian-communities-to-move-and-with-80-more-at-risk-heres-what-they-learned-116178.

[53] U.S. Global Change Research Program, Climate Science Special Report: Fourth National Climate Assessment (2017), Chapter 13: Ocean Acidification and Other Ocean Changes, https://science2017.globalchange.gov/chapter/13/.

[54] Cheng, *supra* note 51, at 249-52.

[55] *Id*. (For example, "Hurricanes and other storms are natural phenomena and they are affected by many other factors besides ocean changes, but conditions allowing for the formation of severe hurricanes are occurring more often because of the record high OHC, with increases in intensity, lifetime, size, and especially increases in heavy rainfall."); Ove Hoegh-Guldberg, Jacob, D., Taylor, M., & et al. (2018); IPCC 1.5 SR 2018 Report at 177.

[56] European Academies' Science Advisory Council (EASAC) (2018), *Extreme weather events in Europe Preparing for climate change adaptation: an update on EASAC's 2013 study*, Figure 1, https://easac.eu/fileadmin/PDF_s/reports_statements/Extreme_Weather/EASAC_Statement_Extreme_Weather_Events_March_2018_FINAL.pdf

is amplifying the damage from such storms.[57] For example, in 2016, Cyclone Winston, which was one of the largest and strongest tropical cyclones recorded in the Southern Hemisphere, displaced over 130,000 people in Fiji and destroyed about 500 schools.[58] In 2015, Cyclone Pam displaced 65,000 people in Vanuatu.[59]

84. More intense rainfall events due to climate change are causing increased flooding, particularly in urban environments that have poor or defunct infrastructure. This increases vector-borne diseases, causes deaths, and destroys homes, farms, infrastructure, and businesses, creating billions of dollars of damages.[60] For example, climate change is causing increasingly intense rainstorms in Nigeria that have triggered unprecedented flooding and damage.[61] In 2012, massive flooding occurred in 30 of Nigeria's 36 states, causing an estimated $16.9 billion in damage, killing 431 people, and displacing over 1.3 million people.[62] Three years later, floods in the south displaced more than 1,200 families and destroyed 4,500 farms, while floods in the north killed 53 people and displaced more than 100,000.[63] In 2016, floods displaced 92,000 people and killed 38.[64] In 2018, floods again wreaked havoc, affecting

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[57] Union of Concerned Scientist, *Hurricanes and Climate Change: Increasingly destructive hurricanes are putting a growing number of people and structures at risk*, https://www.ucsusa.org/global-warming/science-and-impacts/impacts/hurricanes-and-climate-change.html.

[58] Adelle Thomas et al., Briefing Note on Tropical Cyclones: Impacts, the link to Climate Change and Adaptation (2017), Impact, https://bit.ly/2kuSCkA

[59] *Id*. at 2.

[60] Climate Analytics Report 2019 at 24-27.

[61] Quartz Africa, *(Don't) Send Down the Rain: It's only just started, flooding is going to get a lot worse in Nigeria* (Aug. 17, 2017), https://qz.com/africa/1054825/climate-change-in-nigeria-floods-in-lagos-abuja-niger-delta-are-going-to-get-a-lot-worse/; Council of Foreign Relations, Nigerian and U.S. Flooding Similar, Linked to Climate Change (October 2, 2018), https://www.cfr.org/blog/nigerian-and-us-flooding-similar-linked-climate-change.

[62] *Id*.

[63] *Id*.

[64] BBC News, *Why does Nigeria keep flooding?* (Sept. 27, 2018), https://www.bbc.com/news/world-africa-45599262.

1.9 million people, destroying 82,000 houses, displacing 210,000 people, and again devastating crops and livestock.[65]

85. The frequency and intensity of droughts has also already increased in some regions, including the Mediterranean, west Asia, some South Pacific islands, many parts of South America, much of Africa, and northeastern Asia.[66] Severe droughts threaten food and water supplies. For example, after three of its lowest rainfall years on record, in January 2018 Cape Town became the first major world city on the verge of shutting off its water supply.[67] That day, known as “day zero”, did not occur, but imminently threatened to cut off water to 3.7 million people. Climate change has already made the 1 in 100-year drought that contributed to the Cape Town water crisis three times more likely.[68] Another drought in southern Africa in late 2018 hit just after the maize planting season, causing a severe food crisis for 10.8 million people.[69]

86. Between 2008 and 2015, increased big storms, intense rainfall, drought, and other climatic disasters have displaced an estimated 22.5 million people per year on average - equivalent to 62,000 people every day.[70]

3. Children are among the most vulnerable to climate change.

87. In addition to the fact that today’s children and their children will bear the brunt of climate change impacts as they get older, children are among the most vulnerable to the current consequences of climate change, along with women, persons with disabilities, indigenous peoples, and persons living in poverty.[71]

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[65] Relief Web, *Nigeria Floods 2018: Work Report 1* (Oct. 24, 2018), https://reliefweb.int/report/nigeria/nigeria-floods-2018-work-report-1.

[66] Climate Analytics Report 2019 at 11-16.

[67] World Weather Attribution, Likelihood of Cape Town water crisis tripled by climate change (July 13, 2018), https://www.worldweatherattribution.org/the-role-of-climate-change-in-the-2015-2017-drought-in-the-western-cape-of-south-africa/.

[68] *Id*.

[69] Relief Web, Southern Africa: Drought - Nov 2018, https://reliefweb.int/disaster/dr-2018-000429-zwe.

[70] UNICEF, Unless we act now, at 30.

[71] U.N. Doc. A/74/161.

88. For example, nearly 160 million children are currently living in areas of high or extremely high drought severity, predominately in Africa and Asia.[72] Food and water insecurity from increased drought will disproportionately affect children because they need to consume more food and water per unit of body weight to meet their developmental needs.[73] The World Health Organization ("WHO") estimates that climate-induced malnutrition will increase moderate or severe stunting in an additional 7.5 million children.[74]

89. More than half a billion children live in extremely high flood occurrence zones, and about 115 million live in areas of high or extremely high risk of tropical cyclones.[75] These events harm children in many ways, including increasing the risk of death, injury, or illness from drowning, ingesting contaminated drinking water, and lack of water and food.[76] These events also cause long-term displacement, which exposes children to multiple risks, such as increasing their vulnerability to child labor and trafficking.[77]

90. Extreme heat also poses unique dangers to children's health. Wildfires and air pollution, aggravated by extreme heat, also disproportionately harm children.[78]

91. Climate change will also increase the risks of many lethal diseases, such as malaria, dengue fever, cholera, and meningitis, all of which pose greater harm to children than adults.[79] The WHO has estimated that 88 percent of the existing burden of disease from climate change occurs in

[72] UNICEF, Unless we act now, at 22.

[73] *Id*.

[74] WHO, Quantitative risk assessment of the effects of climate change on selected causes of death, 2030s and 2050s (2014) at 80.

[75] *Id*. at 30, 34.

[76] *Id*. at 10.

[77] *Id*. at 30, 34, 54.

[78] *Id*. at 44.

[79] *Id*. at 48.

children under five years of age.[80] The United Nations Children's Fund ("UNICEF") stated, "[w]hen it comes to the spread of disease influenced by climate change, the risk falls squarely on children."[81]

92. Further, climate change has a unique impact on indigenous children, whose close connection to nature and dependence on wildlife and plants are integral to their livelihoods and their spiritual and cultural practices.[82] As UNICEF has noted, "[d]ue to their close, dependent relationship with the environment and its resources, climate change is posing an existential threat to today's indigenous children and future generations."[83]

93. Climate change also places girls (and women) at a particularly heightened risk of harm due to existing gender-based inequities in access to health care and resources, as well as impacts on maternal health.[84]

94. In addition to physical harm, climate change causes significant acute and chronic mental health impacts on children.[85] For example, mental health professionals have identified a range of conditions and symptoms related to experiencing extreme weather events including depression, anxiety, Post-Traumatic Stress Disorder, increased drug and alcohol

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[80] *Id*.

[81] UNICEF, Unless we act now, at 48.

[82] U.N. Doc. A/74/161 at ¶ 48.

[83] UNICEF, Unless we act now, at 62

[84] *See* World Health Organization, *Gender, Climate Change, and Health* at 8-18.

[85] Susie E. L. Burke et al., "The Psychological Effects of Climate Change on Children," Current Psychiatry Reports 20: 35 (Apr. 11, 2019), 2 ("[C]hildren exposed to EWE disasters and the ensuing family stress [19], disruptions to social support networks, and displacement are at risk of developing PTSD and other mental health problems like depression, anxiety, phobias and panic, sleep disorders, attachment disorders, and substance abuse. . . In addition to diagnosable mental health problems, other psychological effects of traumatic experiences in climate-related disasters and their ensuing disruptions can include negative impacts on children's capacity to regulate emotions, increased cognitive deficits, learning problems, behavioral problems, adjustment problems, impaired language development, and an undermining of academic performance. Sustained and repeated stressful early-life events, likely in the context of climate change, can also create a predisposition to adverse mental health outcomes later in life."); see also American Psychological Association, *Mental Health and our Changing Climate: Impacts, Implications, and Guidance*, (Mar. 2017) at 22-23, 25-27 (discussing acute impacts) (hereinafter "*Mental Health and Our Changing Climate*").

abuse, domestic violence, and child abuse.[86] In addition, as climate change transforms communities, "large numbers are likely to experience a feeling that they are losing a place that is important to them—a phenomenon called *solastalgia*."[87]

95. Children are especially vulnerable to the mental health impacts of climate-related disasters.[88] The psychological toll can become chronic – triggered by acute events, slow-moving disasters, and the persistent awareness of current and predicted impacts of climate change.[89] Psychological literature identifies a distinct phenomenon of climate anxiety, where "habitual ecological worrying" about impending climate-related disasters can "elicit dramatic reactions, such as loss of appetite, sleeplessness, and panic attacks."[90] This can impact childhood development, with lifelong consequences: "Chronic stress from the acute and ongoing impacts of climate change may alter biological stress response systems and make growing children more at risk for developing mental health conditions later in life, such as anxiety, depression, and other clinically diagnosable disorders."[91]

B. Climate change is already exposing the petitioners to life-threatening dangers, harming their health, and disrupting their cultural traditions.

96. Climate change is already harming the petitioners, threatening and altering the regions where they live, in many ways:[92] rising temperatures both on land and in the ocean; droughts; severe storms; sea level rise; wildfires; unhealthy air quality; increased diseases; and their mental health. These changes have threatened their homes, their livelihood, and their sense of safety. The excerpts below highlight some examples of how the petitioners are experiencing, and are threatened by, climate

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[86] *Id.*

[87] *Id.* at 25.

[88] Philipsborn et al, Climate Change and Global Child Health, Pediatrics v.141, n. 6 (Jun. 2018).

[89] *Mental Health and our Changing Climate* at 22.

[90] Eva Gifford and Robert Gifford, *The largely unacknowledged impact of climate change on mental health*, Bulletin of the Atomic Scientists, v. 72, no. 5 (2016), http://dx.doi.org/10.1080/00963402.2016.1216505.

[91] USDHHS Impacts Study at 224.

[92] *See* Appendix A.

change. A full description of climate impacts faced by each petitioner is set forth in Appendix A; a description of climate impacts on their countries and regions is set forth in Appendix C.

1. Extreme heat

97. **France.** The first summer of Petitioner Iris Duquesne's life was the hottest summer in Europe since 1540.[93] Born in Bordeaux, Iris was three months old when the deadly heat wave of 2003 swept France. In Bordeaux, temperatures reached a record-breaking 40.7° C. It was one of the worst weather events in the Continent's history, killing some 15,000 people in France alone.[94] Along with the elderly, young children like Iris were most at risk; her parents were scared they would lose their baby to the heat. In July 2019, two months after Iris's 16th birthday, Bordeaux broke a new record at a scorching 41.2°C.[95]

98. **Argentina.** Haedo, Argentina is also warming. Petitioner Chiara Sacchi explains the extreme heat has also significantly increased the use of air-conditioning units, placing pressure on the electricity grid. Frequent power outages are common and interrupt Chiara's daily life. For example, Chiara cannot complete her homework during power outages because the school system uses web-based platforms. In the extreme heat of summer, power outages quickly ruin food.

99. **Tunisia.** In Tabarka, a coastal town in north-western Tunisia, Petitioner Raslen Jbeili is also experiencing changing temperatures, noting that "Tabarka used to have four distinct seasons. Now we have two main seasons—summer and winter." Summers have been extremely hot, with temperatures exceeding 40°C. Raslen says, "we can't go outside. We will melt if we go outside."

100. **Alaska, USA and Kareusando, Sweden.** In the world's North, Petitioners Carl Smith and Ellen-Anne have experienced significant global warming, beyond that in most other parts of the world. Unprecedented heat in the Arctic last summer led to temperatures in Alaska above 32°C (90°F), and widespread forest fires in the Scandinavian Arctic. As explained below, this extreme heat is

[93] Rene Orth, et al 2016 Environ. Res. Lett. 11 114021, https://bit.ly/2kFXa7M.

[94] World Bank, *Turn Down the Heat: Why a 4C World Must be Avoided* (2012), p. 13, http://documents.worldbank.org/curated/en/865571468149107611/pdf/NonAsciiFileName0.pdf.

[95] NASA, *Climate Change: how do we know*, https://climate.nasa.gov/evidence/.

threatening Carl and Ellen Anne's thousand years old subsistence practices, including reindeer herding, hunting, and fishing, which are closely connected to their heritage, culture, and livelihoods.

101. Deadly heatwaves will increase as the world warms. The rising temperatures affecting the petitioners are just the beginning. In the coming years, the petitioners and other children will experience hotter, more frequent, and more deadly heatwaves. The IPCC calculates that if warming reaches 1.5°C, 350 million additional people could be exposed to deadly heat wave conditions in 2050 than present.[96] Without climate change, the 2003 European heat wave that killed 70,000 would be a one in one-hundred years event. With 1.5°C of warming, the probability of such a heat wave would increase to four out of ten summers—at 2°C, six out of every ten.[97]

2. Wildfires

102. **Tunisia**. Wildfires are also increasing in and around Tabarka. Through a school program, Raslen documented 146 fires in 2017, a dramatic increase from the 37 in 2016. One fire in 2018 came within reach of his home. "We heard screams and yelling in the night," he recalls. "I looked up and saw a huge fire approaching our home and we could do nothing. We just prayed for the fire not to reach our home. Although we were spared, it burned down many of our neighbors' homes."

103. **United States.** In November 2018, one of the deadliest wildfires blazed across Paradise, California, destroying nearly 14,000 residences and killing about 85 people.[98] Over the last 100 years, California has warmed by about 1.7°C (3°F),[99] drying the plants and soil and leaving shrubs, grassland, and trees in California prone to burning.[100]

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[96] IPCC 1.5 SR 2018 Report, Chapter 5, table 5.1.

[97] Climate Analytics Report 2019 at 11-13.

[98] Kristin Lam, *Death Toll drops to 85 at Camp Fire; 11 people remain missing,* USA Today, (Dec. 3, 2018) https://www.usatoday.com/story/news/2018/12/03/camp-fire-death-toll-california-deadliest-wildfire/2199035002/.

[99] Alexandra Borunda, *See how a warmer world primed California for large fires*, National Geographic, Nov. 15, 2018, https://www.nationalgeographic.com/environment/2018/11/climate-change-california-wildfire/.

[100] *Id.*

104. The toxic clouds from the Paradise Wildfire reached Petitioner Alexandria Villaseñor's home in Davis, California. Alexandria remembers feeling as if needles were pricking her chest. As the fire spread, Alexandria recalls,

> *I would wake up nauseous from all the smoke because the smoke was seeping into our house. We had rolled up wet towels and put them under doors and windows to keep the smoke from coming in. Because I have asthma, it was a really scary situation.*

105. Because of the deadly air quality and her quickly deteriorating asthma, Alexandria's family evacuated her for health reasons to New York City, where she had been living with her mother since the fall of 2018. In New York, Alexandria continued feeling the effects from the smoke inhalation. She was bedridden for three weeks and had to go to the emergency room for her asthma.

106. Extreme wildfires will burn more regularly, consume more land, and spew more smoke into the atmosphere. Globally, the wildfire season has grown by roughly 20% since 1979 as warming reached 1°C.[101] The risk of more frequent, devastating wildfires increases with global warming, especially at 2°C or more.[102] Already, 260,000 to 600,000 people die each year from smoke from wildfires, with impacts felt across continents: in 2018, smoke from Arctic fires in Siberia reached mainland U.S.[103]

3. Drought

107. **South Africa.** In early 2018, Petitioner Ayakha Melithafa, along with the other residents of Cape Town, prepared for "Day Zero" – the day when municipal water supplies would largely be switched off and up to 3.7 million residents would have to queue for their daily ration of water. Ayakha explains,

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[101] W. Matt Jolly et al., *Climate-Induced Variations Global Wildfire Danger from 1979 to 2013*, Nature Communications 6, no. 7537 (July 2015).

[102] Climate Analytics Report 2019 at 11-15.

[103] Fay H. Johnston et al., *Estimated Global Mortality Attributable to Smoke from Landscape Fires*, Environmental Health Perspectives 120, no. 5, at 695 (May 2012), https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3346787/pdf/ehp.1104422.pdf; NASA, *Fires in Russia's Siberian Area Send Smoke to U.S.* (Jul. 11, 2018), https://www.nasa.gov/image-feature/goddard/2018/fires-in-russias-siberian-area-send-smoke-to-us.

> *The water crisis was really bad because we always had to buy water. At home we had to take shorter showers. We had to water our garden less or not at all. We had to be really cautious so we don't reach Day Zero. There were a lot of water restrictions. There are other people who grow their own food where I live, and it was really hard on them. It was hard to see them unable to feed their families because of the water restrictions.*

108. **Tunisia.** Tunisia, which is a water-scarce country, is particularly vulnerable to its new, drier climate. Over the past few years, drought has threatened the country's water supply. Tabarka, which typically has more precipitation than most of the country, has also experienced frequent supply disruptions. Raslen and his family have had to buy water in these situations, making it "too hard to cook, shower, and clean." Raslen explains,

> *The water is shut-off without any notice, sometimes for hours, sometimes for days. Last year we had three days without water. Once it is shut-off, we don't know when it will return.*

109. **Brazil**. In Salvador, Petitioner Catarina Lorenzo notes, "It's raining less now. It should rain between April through August, but now it's just raining between July and August." This brings numerous problems, says Catarina. "We are having water shortages. There are times when the city lacks water for a day or two and cuts off our water supply for that time." Because of these water shortages—which come without warning from the local government—Catarina and her family save water in a tank in preparation for the next water shortage. Some of her neighbors, however, who do not have access to a large water tank, try to store water in buckets to use for showering or washing dishes, or otherwise go without water.

110. **India**. Drought is worsening in India's northern eastern city of Haridwar, and greater region of Uttarakhand. Petitioner Ridhima Pandey explains, "the rainy season is getting shorter. The rain used to last for weeks during the rainy season" – June through September – "but now the rain that does fall only lasts for a day every once in a while. It is not consistent like before." The lack of rain is lowering the water level in the holy Ganges River in the summer and endangering the religious rituals and festivals centered on it, such as Kanwar Yatra—a festival in

which people come from all over India to collect water from the Ganges and give back to the Lord Shiva with the Ganges' holy water.

111. Extreme drought events will increase, threatening food and water security. Up to 1.15 billion people will experience water stress at 1.5°C warming, and up to 1.34 billion with 2°C warming.[104] Similarly, 1.5°C will expose up to 36 million people to lower crop yields, increasing up to 396 million with 2°C warming.[105] The petitioners, like all children alive today, will grow up in a world where fresh water can no longer be taken for granted.

4. Dangerous air quality

112. **Nigeria.** In Lagos, where twelve-year old Petitioner Debby Adegbile has lived her entire life, rising temperatures are exacerbating smog. Debby is now hospitalized several times a year because of asthma attacks triggered by the hot and polluted air in Lagos. "Whenever I have an attack it takes about 5 days to get over it, and I'm usually hospitalized." Her family must pay for the costly medications and injections provided by the hospital. Her frequent illnesses and hospitalization force her to miss school.

113. **United States.** New York City consistently has unhealthy levels of ozone pollution.[106] The hotter temperatures increase ozone pollution to hazardous levels.[107] Although New York City provided a respite for Alexandria from the smoky air in California during the Paradise wildfire, the air pollution in New York City has also affected her health. Alexandria's inhaler has become her "best friend," accompanying her everywhere around the city to make sure her asthma does not land her back in the emergency room.

114. Global warming will worsen ozone and particle pollution and increase mortality from respiratory illnesses. With additional warming, mortality

[104] IPCC 1.5 SR 2018 Report, Chapter 5, table 5.1 at 453.

[105] *Id.*

[106] Adam Nichols, NYC Is Among Smoggiest Cities In Nation, Report Says, Patch Media (Apr. 24, 2019), https://patch.com/new-york/new-york-city/nyc-among-smoggiest-cities-nation-report-says.

[107] American Lung Association, *supra* note 44, at 5.

related to ozone concentrations, allergens, and particles will increase.[108] Children are at particular risk. Because of their smaller lungs and more rapid breathing rate, children disproportionately inhale more polluted air.[109] By mid-century the U.S. will see a 70% increase in days with health-threatening ozone smog, according to one study.[110] Another study estimates that globally 150 million more people will die prematurely from air pollution at 2°C of warming by 2100.[111]

5. Storms and flooding

115. **Marshall Islands.** The South Pacific is experiencing more severe storms and flooding. In 2015, a violent storm struck Ebeye in the Marshall Islands, tearing open the roof of Petitioner Ranton Anjain's home.

> *In 2015, we were inside my house, my dad was off island for meetings, and a really strong wind came and opened the roof of my house. It flooded my house. I was with family, but then we evacuated to our neighbor's house.*

116. During another storm, Petitioner Litokne Kabua's family had to evacuate their home on Ebeye and seek shelter on the Kwajalein U.S. Army Base.

117. **Nigeria.** When it floods in Lagos, Nigeria, Debby's parents carry her and her siblings to school because the children cannot walk in the high waters. Because it is so difficult to get to school, children in Lagos miss class when the flood waters are high. Lagos, with its tropical climate, historically had a rainy season that spanned between April and September. But recently with climate change, "the rainy season extends to December," says Debby. The excess rain poses serious logistical and health problems: "every time it rains in Lagos, there is flooding." Debby's mother, Ronky, remembers,

[108] Climate Analytics Report 2019 at 25-26.

[109] *Id.*

[110] G.G. Pfister et al., "Projections of Future Summertime Ozone over the U.S.," Journal of Geophysical Research Atmospheres 119, no. 9 at 5579-79 (May 2014), https://agupubs.onlinelibrary.wiley.com/doi/epdf/10.1002/2013JD020932.

[111] Shindell, *supra* note 18, at 291-95.

It used to take five hours of rainfall to flood the streets, and now it just takes one hour.

118. The frequent flooding is extreme, making it difficult to walk or commute by car while also increasing the spread of diseases and other illnesses.

119. **Tunisia.** Over the past two years, Tabarka has also experienced heavier rainstorms that flood roads and buildings. When it rains intensely, Raslen's school floods because it is located in a low-lying area surrounded by wetlands. Sometimes the floods submerge the school up to four feet. Raslen explains, "[w]hen we have consecutive or heavy rains our school floods and closes. I don't want to miss school, and last year we had no school for a week." In one terrible incident, Raslen recounts how overflowing rivers fatally swept away some schoolchildren on their way home from school.

120. A hotter world will increase the occurrence of the most devastating storms, causing widespread damage and displacement. The storms that have terrified the petitioners and damaged some of their homes will only get worse. Researchers have found a 15-30% increase in Category 4 and 5 hurricanes with just 1°C of global warming. Warming of 1.5° C and 2° C will substantially increase the occurrence of the most devastating tropical cyclones.[112] Warming of 2.5° C would double the occurrence of Category 4 or 5 cyclones across all ocean basins and quadruple their occurrence in the South Pacific.[113] Because warmer air holds more moisture, a hotter climate will mean heavier rainfall during storms, increasing the risk of flooding and damage.[114]

6. Sea-level rise

121. **Marshall Islands.** The Pacific islands of Oceania are facing an existential threat from sea-level rise. One of the countries most threatened by sea-level rise is the Marshall Islands. Ebeye Island is getting "smaller, and the waves are still eating up the islands" Litokne says. The rising sea levels threaten to submerge Litokne's home in Ebeye during his lifetime and have already caused stronger storm surges

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[112] Adelle Thomas et al., *Briefing Note on Tropical Cyclones: Impacts, the link to Climate Change and Adaptation, Impact*, at 4 (2017), https://bit.ly/2kuSCkA.

[113] *Id.*

[114] *Id.*

and other flooding events. Litokne's stepfather, Carl, remarks, "[t]he level of sea level rise you see, it is so crazy, it's scary." Additionally, exceptionally high "king tides" now consistently breach the sea walls on Majuro and damage homes and property, says Petitioner David Ackley III. Wave driven flooding contaminates freshwater resources and destroys infrastructure. A recent study shows that most tropical atolls will be uninhabitable by 2050 due to wave over-wash.[115]

122. **Palau.** The coastal lowlands of Koror, Palau are also under threat from sea-level rise. Increasingly high tides and storm surges have forced Petitioner Carlos Manuel's friends and neighbors to abandon their homes near the beach. The government will have to relocate Koror's only hospital due to the rising sea level.

123. **Tunisia.** Non-island coastal areas are also threatened by the rising seas. Higher and more damaging storm surges have struck Tabarka, Tunisia. For the first time that Raslen and his family can recall, a storm pushed the tide and waves above the rocky barrier protecting the town, flooding and damaging restaurants and other buildings situated near the sea.

124. Sea level will continue to rise as the climate warms, threatening cities and countries around the world. Globally about 145 million people live within a meter above the current sea level. At 1.5°C warming, global sea level will rise up to 0.77 meters by 2100 and would be much greater for higher warming scenarios.[116] At the world's current trajectory of 3-4°C warming by 2100, it is increasingly likely that large parts of the Antarctic and Greenland ice sheets will collapse, causing a rapid rise in sea-level.[117]

125. Additional sea level rise will have devastating impacts on coastal communities. For example, a 1.5°C temperature rise would expose up to 69 million people living in cities to coastal flooding, increasing up to 79 million with a 2°C rise.[118] Another study found that a one-meter rise

[115] Climate Analytics Report 2019 at 8-11, 96-103.

[116] Climate Analytics Report 2019 at 8-10; IPCC 1.5 SR 2018 Report, Chapter 3 at 178.

[117] *See id*.

[118] IPCC 1.5 SR 2018 Report, Chapter 5, table 5.1 at 453.

in sea level would destroy over 15,000 square kilometers of land in the Niger Delta, displacing 80 percent of the population.[119]

7. Warming oceans and threatened marine life

126. **Marshall Islands.** Ocean warming is profoundly affecting the Marshall Islands. Fishing is a way of life there. But as the ocean gets warmer, it becomes harder for David, Litokne, and Ranton to fish on the islands. Litokne says,

> *My grandpa used to get more fish, like a lot more fish than the number of our family. But nowadays when we go fishing, you could come home with a bucket of nothing.*

127. Some of the fish traditionally eaten have become poisonous, likely from ingesting toxic ciguatera algae, which tends to proliferate on dead coral reefs.[120] People have recently died from eating these fish. Ranton and his father now avoid catching and eating bottom fish, explaining that "red snapper from the northern part of the atoll is a 'no-no,' but if the snapper is from the southern part it is ok."

128. **Brazil**. According to Catarina, the ocean and beaches in Bahia are much hotter than before. In summer 2019, Catarina observed, "the water was really, really hot and the coral was white – it was dead. I had to swim away from the coral reef because it was all white and there were pieces of the coral reef floating around the water." Brazil has six major coral reef areas, and the Abrolhos Bank reef, which is the southernmost reef located in the state of Bahia, is the largest reef in Brazil.[121] Marine heat waves between 2014 and 2017 caused coral bleaching across Brazil's reefs, including among the Abrolhos reefs.[122]

129. Ocean warming and acidification will eradicate vast amounts of marine life. The risk of irreversible loss of many marine and coastal ecosystems

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[119] Etiosa Uyigue and Matthew Agho, Community Research and Development Centre (CREDC) Nigeria, Coping with Climate Change and Environmental Degradation in the Niger Delta of Southern Nigeria (2007), http://www.credcentre.org/Publications/adaptation_nigerdelta.pdf.

[120] ScienceDirect, Cigautera, https://www.sciencedirect.com/topics/pharmacology-toxicology-and-pharmaceutical-science/ciguatera.

[121] Carol Luther, *Coral Reefs of Brazil*, USA Today (Mar. 21, 2018), https://traveltips.usatoday.com/coral-reefs-brazil-1153.html.

[122] Climate Analytics Report 2019 at 30-31.

increases with global warming, especially at 2°C or more.[123] Coral bleaching is expected to affect 70-90% of coral reefs with a 1.5°C temperature rise, and reefs will be irreversibly lost at 2°C.[124] Coral reefs support as much as a quarter of all marine life and supply food and half a billion people depend on reefs for their food and livelihoods.[125] At the same time, it is estimated that annual global fisheries catches will decrease by more than three million metric tons per 1°C of warming, and species turnover is more than halved when warming is lowered from 3.5° to 1.5°C.[126]

8. Increased incidents of malaria, dengue fever, and other diseases

130. **Marshall Islands.** This past summer, Ebeye in the Marshall Islands experienced its second dengue fever outbreak in two years, forcing the government to declare an emergency. Ranton caught dengue during the 2019 emergency, and his father Jelton caught dengue in 2018. Mosquitos spread dengue, known as "bone-break fever" because of the pain it causes. Dengue used to be rare on Ebeye, Ranton's father recalls, and there was never an emergency declaration before last year.

131. Mosquito-borne illnesses have also become much more common on Majuro Island. According to David's father, a doctor on Majuro, chikungunya and zika are new to the islands since 2015 and growing more common. In October 2018, David contracted chikungunya. For an entire week, he felt weak and dizzy, he kept throwing up, and his arm went numb.

132. **Nigeria.** Debby gets malaria two or three times every year. The fever often lasts for three days, forcing Debby to go to the hospital to get medication, which can come at a high cost. Her mother Ronky believes that increased flooding is behind the malaria outbreaks. Every member in Debby's family has had malaria—and gets it at least once a year.

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[123] *Id*. at 96-103.

[124] IPCC 1.5 SR 2018 Report, Chapter 5, table 5.1 at 453.

[125] United States National Oceanic and Atmospheric Administration, "Coral Reefs: Essential and Threatened," https://www.noaa.gov/explainers/coral-reefs-essential-and-threatened.

[126] William W. L. Cheung et al., Large benefits to marine fisheries of meeting the 1.5°C global warming target, Science 23Vol. 354, Issue 6319, at 1591-1594 (Dec. 2016).

133. Global warming will expand the geographic reach of tropical pandemic diseases and increase the risk of water-borne diseases. As tropical climates expand northwards and southwards, mosquito-borne diseases—malaria, dengue, yellow fever, zika, chikungunya—will reach new parts of the globe and affect new populations.[127] At the same time, flooding, severe storms, and strained infrastructure will increase incidents of water-borne diseases such as cholera.[128] Currently, 88% of the burden of climate-related vector-borne disease occurs in children under five years of age: over the coming decades, the youngest children will face the greatest risk of exposure.[129]

9. Threats to the cultural and subsistence practices of indigenous communities

134. Although all the petitioners are experiencing harm from climate change, for Ellen-Anne of the Sami community in Karesuando, Sweden; Carl Smith of the Yupiaq Tribe in Akiak, Alaska; and David, Litokne, and Ranton of the Marshall Islands, the effects of the climate crisis could destroy their way of life, culture and livelihoods.

135. **The Sami people** have lived in the Arctic regions for thousands of years in what is now Norway, Sweden, Finland, and Russia. The Arctic region where the Sami people live is called the Sapmi. Many Sami people, including eight-year-old Ellen-Anne and her family, depend on the thousands-of-years-old tradition of reindeer husbandry or herding for their livelihoods. The Sami rely on reindeer for their own subsistence and as a source of income. Every part of the reindeer is used, nothing is wasted.

136. Ellen-Anne's mother Susanna explains the importance of reindeer herding to their way of life:

> *The reindeer are our life. It's everything. We live with, and we live off the reindeers, and I can't even imagine a life without them. . . Reindeer herding is our livelihood, our economy, our culture, our way of living for many, many generations. We and the reindeer depend on each other.*

[127] Climate Analytics Report 2019 at 25.

[128] *Id.*

[129] *Id.*

137. Generation after generation have passed on the reindeer herding tradition that is essential to Sami culture and spiritual practices. Both of Ellen-Anne's parents are reindeer herders, and Susanna explains how reindeer herding was passed down to her from her father, and how she is passing it on to her daughter:

> *I was very little when I was with him the first time, but I don't know if I was too much help then. I first went in the summer when I was five years old. We brought our own child when she was only two months old up to the mountain when we were working with the reindeer. . . The children are intimately connected to the life of living with the reindeers, and they learn this culture by doing and helping out. . . I plan to be a reindeer herder my whole life and will do everything I can to assure my children can continue with it.*

138. The changing climate in the Sapmi is threatening the traditional methods of reindeer herding. Reindeer are wild animals, and the Sami migrate with the animals into the lowlands in the winter and to the mountains in the summer. In recent decades, increased warming and rains have caused the soil and snow to get very wet, which then freezes to ice. The ice prevents the reindeer from accessing the lichens and plants essential to their survival in the winter. The result is increased costs of reindeer herding, geographic displacement of the reindeer herds, and the need to supplement the reindeers' entirely natural sources of food.

139. Herding reindeer now requires harder work, longer hours, and more expenses, impacting families. Susanna explains:

> *The reindeer herders have to work longer days, have to drive around much more with their snowmobiles, and the expenses for fuel has increased a lot. The climate crisis for us who live with reindeer is like when you throw a rock in the water, the problem just spreads as ripples and cause many new types of problems.*

140. Ellen-Anne already knows, "when I grow up I want to work with reindeers." However, her mother Susanna is seeing in her own lifetime the severe changes in the Arctic environment, and she worries what life she can pass on to her children and future generations.

> *It is not only about the economic value of a reindeer, it's the whole culture. The value is in the culture of living with*

> *reindeer and in nature—all of which is being threatened for the first time in thousands of years.*

141. ***The Yupiaq Tribe in Akiak*** are an indigenous tribe that have lived for millennia in southwestern Alaska next to the Kuskokwim River. Carl moved to Akiak, Alaska with his family, who come from the Yupiaq Tribe, after spending the first ten years of his life in Anchorage.

142. The Yupiaq are a self-sustaining people, who have practiced traditions of subsistence hunting and gathering for as long as they can remember. Hunting, fishing, and gathering are integral to maintaining their livelihoods and the traditional cultural and spiritual practices passed down from their ancestors for generations. Carl cannot imagine living anywhere else. He says,

> *Everyone is our family here. Our parents taught us to respect our teachers, adults, the elders especially whenever they need it. Everyone helps each other out.*

143. The elders in the tribe educate the younger generations about cultural practices and the importance of fishing and hunting. Carl's uncles, grandfather, and father have taught him hunting and fishing, and the traditions surrounding these generations old practices. Carl explains, "They teach us discipline and to respect everyone. It's really important because when we get older, we will have to teach our kids how to do it so they can survive in the winter."

144. The sharing of harvests with elders and others from within the community is also a key component of maintaining and strengthening tribal and communal cultural and social connections. For example, Carl explained that there is a "first catch" celebration when a young hunter catches their first animal and gives it away to the elders who can no longer hunt for themselves; this is called *payugteq*.

145. The warming temperatures are making hunting and fishing more difficult. For example, last year, Carl's family did not catch any caribou, which only pass by the Yupiaq hunting region from November to December each year. Carl explained that the river must freeze solid in order for the hunters to access their hunting grounds, and last year it did not get cold enough to freeze the river in time.

146. The rising temperature has also affected the men's ability to fish, a large part of which is done on the ice during the winter. Traditionally, "we used to go on the river and set fish nets and fish traps," Carl says. Now, with the river no longer freezing solid, fishing has become dangerous,

and sometimes Tribe members fall through thin ice and die. "One of my buddies fell through the ice," Carl says. Carl's mother Kimberly explains,

> *Usually we are good to travel on the river through end of April, beginning of May. But this last winter we had five people fall through the ice and two didn't survive. You can't go up and fish during the fall time and wintertime because the ice is thin.*

147. Fish in the winter has become important because summer fish, especially salmon, are also becoming harder to catch due to their dwindling population. Increasingly warming river temperatures are making things worse by killing salmon and increasing parasites in them. This past summer, record-high water temperatures killed large numbers of salmon along the Kuskokwim River between Bethel and Akiak.[130] This never happened when Kimberly was younger.

148. Now, because of her family is catching less food, Kimberly has to buy more food for her family than she used to, which is an added cost and less nutritious. Kimberly explains,

> *Because I have a huge family, we usually relied on one to two moose per year, one to two caribous, and a whole lot of fish. Last year we were only able to catch one moose, so I catch myself having to buy processed meat when I don't want to. Because what we eat is what we catch, and I've noticed that we've had to buy a lot of store bought.*

149. Climate change is also directly threatening Akiak. Excess rain, the breaking up ice on the river, and unusual high winds are eroding the Kuskokwim River. According to Carl, because of unprecedented "south winds in front of the villages – they get three to five-foot waves and it crashes against the riverbank and it takes away sand and the bank starts

[130] *See e.g.*, Anna Rose MacAruthur, *Record Warm Water Likely Gave Kuskokwim Salmon Heart Attacks*, Alaska Public Media (July 12, 2019) *available at* https://www.alaskapublic.org/2019/07/12/record-warm-water-likely-gave-kuskokwim-salmon-heart-attacks/.

falling over, and there is starting to be little cliffs. This year in May sixty feet eroded and our fish camp got lost in the erosion."[131]

150. All of these changes signify to Carl the loss of his way of life. He says,

> *Climate change might change everything—how we feel, how we hunt. It is scary because if I have kids, I want them to live like I did—to hunt, fish, gather. I want to teach them but I'm scared because there might not be any more subsistence. There will be less fish and there won't be any more ice in the winter, and it will be warm, and it might not be the same. I feel scared, like we'll have to adapt to climate change, and teach them a different way.*

151. **The Marshallese culture**, which has existed in the southern Pacific for millennia, is closely connected to the ocean. The Marshallese live on 29 low-lying coral atolls, 1,156 islets, and five single islands, as part of the larger island group of Micronesia.[132]

152. According to Litokne, his family has lived on Ebeye Island "since the beginning of time." The relationship between Ebeye and the ocean that surrounds the island is paramount. Litokne explains that, "culturally, the ocean is the center-way of life." The ocean connects Litokne to his family on the outer islands and is the main way by which people distribute supplies between islands. The ocean is also an important means of subsistence to the Marshallese.[133] For example, Litokne often eats red snapper and tuna at lunch or dinner, and Ranton used to fish every day when he was younger.

153. The family is also a centerpiece of Marshallese culture and society.[134] As Ranton explains, the Marshallese community is built on respect, "it is what makes us Marshallese." According to David's mother, Neilani, to be Marshallese in the Marshall Islands "means safety"—not having

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[131] *See, e.g.*, Greg Kim, *Erosion in Akiak Swallows up to 100 Feet of Riverbank Along the Village*, Anchorage Daily News (May 23, 2019), https://www.adn.com/alaska-news/rural-alaska/2019/05/23/erosion-in-akiak-swallows-up-to-100-feet-of-riverbank-along-the-village/.

[132] The Republic of the Marshall Islands, 2050 Climate Strategy, "Lighting the Way," at 6 (Sept. 2018).

[133] *See, e.g.*, Embassy of the Republic of the Marshall Islands to the United States of America, Culture, http://www.rmiembassyus.org/index.php/about/marshall-islands/culture.

[134] *Id.*

to worry where her son is because she knows her neighbors and everyone in their community.

154. There are also many ancient Marshallese traditions that are vital to maintaining the Marshallese culture. For example, Neilani describes *kemem*, which arose long ago and is a baby's first birthday celebration when the baby is given a name. Many Marshallese, including Litokne, also grow traditional foods for subsistence, medicinal purposes, and to make baskets and other handicrafts. For example, Litokne explains that bananas are the most common traditional medicine for reduction of body pain and easing toothache, while ground cherries (physalis peruviana) and scented fern are mixed together for patients to drink to treat diabetes. The leaves of the pandanus tree are used to make mats, baskets, thatch walls and roofing, and other handicrafts.[135]

155. As described above, risings seas, warming and acidifying ocean, drought, and more severe storms threaten the Marshall Islands' continued existence, and with it these ancient cultural practices and traditions. For the petitioners living in small-island nations, the threat of climate change instils particularly strong fears about relocating from their home and country—and losing their culture and traditions.

156. David and his family talk about climate change often. It is hard to avoid the topic when you can see the impacts of climate change creeping up onto your island with the rising sea. David's family wonders if they will have to move away from their home, something that worries David, who wants to live in the Marshall Islands when he grows up. He does not want to be separated from his community, his homeland, and his culture.

> *I feel lost. I like to keep my mind off it because it scares me, but it still pops up a couple of times a day.*

157. Litokne now "knows" his home and his island "are not here forever… they will disappear, unexpectedly." Despite the fact that Ebeye is noticeably shrinking, when Litokne grows up he says, "I want to live here. It is my home, there is no place other like Ebeye."

158. Ranton worries about losing his home and culture. He thinks about climate change all the time, and "sometimes in my mind I just see Ebeye sinking and a lot of people drowning."

10. Emotional distress Linked to Present and Future Impacts

[135] *Id.*

159. **Greta Thunberg (Sweden).** Petitioner Greta Thunberg, a sixteen-year-old from Stockholm, Sweden, began researching the climate crisis after she first learned about it in school, reading everything she could. To her, the crisis was akin to a world war: once she understood the climate crisis, she could not "un-understand it." Greta thought about the climate emergency all the time: "I was a lot more worried about it and I thought about this very often – I had climate anxiety."

> *How could we just continue like before? Why were there no restrictions? Why wasn't it made illegal? To me, that did not add up. It was too unreal. So when I was eleven, I became ill. I fell into depression, I stopped talking, and I stopped eating. In two months, I lost about 10 kilos of weight.*

160. **Alexandria Villaseñor (United States).** For Alexandria, the wildfires she experienced last year were highly traumatizing. Her experience was so distressing that she "compartmentalized" those memories, and only recalled them after recently locating a journal she had kept during the frightening wildfires. She remembered,

> *It was really scary. At nighttime, I'd sleep next to the air filter. I'd get a wet washcloth and I'd have to keep it over my face because the smoke was preventing me from actually sleeping . . . I'd have sleep deprivation because I'd be so worried to fall asleep and I would have panic attacks.*

161. **Chiara Sacchi (Argentina).** Chiara is scared of the future world with climate change. She says,

> *It's hard to imagine a future with all these events. I think we are all quite desperate. . . It feels like we are alone, like no one knows what to do, and when you know what to do, nobody takes action.*

162. **Iris Duquesne (France).** Iris thinks about climate change every day and often feels powerless.

> *The world is going to be sad. There will be climate refugees everywhere in Europe and the US. There will be tension and pollution and the geography will be completely changed. There are islands that are going to disappear and countries like the Netherlands that will disappear. I don't want to have kids if they're going to live in a world like that.*

163. **Catarina Lorenzo (Brazil).** The extreme temperatures and changing weather patterns in Salvador, Brazil also worry Catarina.

> *I feel that I don't know exactly what will happen in the future. If we don't act to stop the climate crisis, it will be the kids who pay the consequences.*

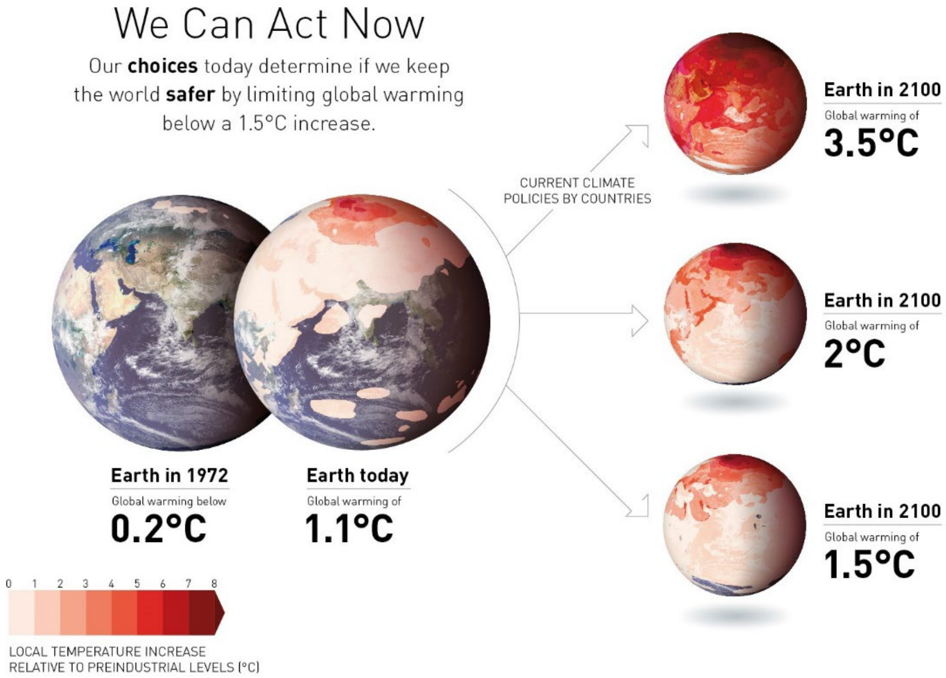
164. **Raslen Jbeli (Tunisia).** The changing climate is also deeply affecting Raslen. He says,

> *Sometimes I have nightmares that climate change is destroying our world. I am very worried about the future. If we don't do something, maybe we will face extinction. That is scary. It is not fair that my generation has to experience this.*

165. **Ayakha Melithafa (South Africa).** The climate changes Ayakha is experiencing in Cape Town makes her feels sad and angry, and she thinks of a "miserable future" with climate change.

166. **Raina Ivanova (Germany).** The consequences of climate change disrupt Raina's daily life, thoughts, and dreams. Her younger sisters have begun to ask her about the rising temperatures. Raina tries to soothe their worries, although she is also concerned. As she says, "[climate change] makes me really sad" and "is something that really scares me when I talk about it with my little sister" because "global warming will have a bigger impact on our lives."

167. In summary, temperature increases, sea-level rise, extreme weather events and other impacts associated with climate change are already harming the petitioners' health and well-being, and for some, their cultural and traditional ways of life. If the world does not reduce its carbon emissions urgently and drastically, the impacts of the climate crisis will significantly worsen.



VI. The climate crisis triggers human rights obligations informed by environmental law.

168. This Communication concerns the violation of the petitioners' rights under the Convention, as set forth above. But the scope of the climate crisis cannot be reduced to the particular harms of any small group of children. The climate crisis threatens to undermine every right under the Convention. At stake are the human rights of every child, everywhere.

169. The Convention enshrines children's rights as universal. All governments have a responsibility to take all available measures to ensure these rights are respected, protected, and fulfilled.[136]

[136] Only 45 states, however, have ratified the OPIC, which is an essential safeguard of children's rights.

170. As a foundational rule of international law, all signatories to a treaty are bound, before they even ratify it, not to take any action or inaction that would "defeat the object and purpose of the treaty."[137] If emission reductions are further delayed and irreversible tipping points reached, climate change will defeat the purpose of the Convention and nullify its ability to protect children anywhere.

171. Each respondent has ratified not only the Convention, but also the Climate Change Convention. All have signed the Paris Agreement, which all but Turkey have ratified.

172. These treaties, as well as the development of international human rights and environmental law, demonstrate the emerging consensus that mitigating climate change is a human rights imperative. From the creation of the IPCC in 1988, through the adoption of the Climate Change Convention in 1992, to the negotiation of the Paris Agreement in 2015, the international climate action framework has moved towards a rights-based approach.

173. The Climate Change Convention—now universally ratified—called for efforts to mitigate the adverse effects of climate change on human health and welfare.[138] The Paris Agreement went a step further, calling on states to "respect, promote and consider their respective obligations on human rights" including the rights of the child and intergenerational equity, when "taking action to address climate change."[139]

174. In the Paris Agreement, State Parties pledged to keep global warming well below 2°C above pre-industrial levels and pursue efforts to limit it to 1.5°C.[140] To achieve this, they set voluntary emission reduction targets called Nationally Determined Contributions ("NDCs")[141] and pledged to reduce emissions at the "highest possible ambition."[142]

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[137] Vienna Convention on the Law of Treaties, art. 18, May 23, 1969, 1155 U.N.T.S. 331.

[138] UN Framework on Climate Change, 1771 UNTS 107; UN Doc. A/AC237/18 (Part II)/ Add 1 (1992), art. 1(1), art. 3(3) (hereinafter "UNFCCC") (May 9, 1992).

[139] Paris Agreement, *supra* note 19.

[140] *Id.* art. 2(1).

[141] *Id.* art. 3.

[142] *Id.* art. 4.

175. To date, the emission reduction targets pledged under the Paris Agreement are nowhere in line with keeping heating under 2°C, much less 1.5°C. The UN Environmental Program has determined that the world's combined NDCs would lead to 3°C of warming by 2100, with warming continuing afterwards.[143] A rise of 3°C is associated with catastrophic climate change impacts and would result in widespread violations of rights under the Convention. Unlike the voluntary commitments under the Paris Agreement, obligations under the Convention are binding and enforceable.

176. In light of the above, the Convention must be interpreted as taking into account the respondents' obligations under international environmental law.[144] Thus, all states, including the respondents, have four related obligations under the Convention: (i) to prevent foreseeable domestic and extraterritorial human rights violations resulting from climate change; (ii) to cooperate internationally in the face of the global climate emergency; (iii) to apply the precautionary principle to prevent deadly consequences even in the face of uncertainty, and (iv) to ensure intergenerational justice for children and posterity.

A. The duty to prevent foreseeable human rights harms caused by climate change.

177. This Committee and four other Human Rights Treaty Bodies unanimously recognized that "State parties have obligations, including extra-territorial obligations to respect, protect and fulfill all human rights of all peoples."[145] These obligations include a duty "to prevent foreseeable

[143] UNEP Gap Report 2018 at 18.

[144] This interpretive principle is anchored in the Vienna Convention on the Law of Treaties, art. 31(3)(c) U.N.T.S. Doc. A/CONF. 39/27, 1155 U.N.T.S. 331, 340 (1980) ("[T]here shall be taken into account, together with the context: any relevant rules of international law applicable to the relation between the parties.") and incorporated throughout the CRC Convention, which repeatedly references having regard to relevant instruments of international law. *See, e.g.*, The Convention, Article 41 (providing the Convention does not supersede any norms that offer greater child-rights protection under "International law in force for that State"). Similarly, the Human Rights Committee has noted that international environmental law should "inform the contents of Article 6 [right to life] of the Covenant [on Civil and Political Rights], and the obligation of States parties to respect and ensure the right to life should also inform their relevant obligations under international environmental law." UNHRC, General Comment No. 36, on Article 6 of the International Covenant on Civil and Political Rights on the Right to Life, 124th Sess. ¶ 62 CCPR/C/GC/36 (2018).

[145] Joint Statement on "Human Rights and Climate Change," CEDAW, CESC, CMW, CRC, CRPD (Sept. 16, 2019).

human rights harm caused by climate change, [and] to regulate activities contributing to such harm."[146]

178. To meet this obligation, all states must reduce emissions "at the highest possible ambition"[147] and, as the Committee on Economic, Social, and Cultural Rights ("CESCR") observed, use the "maximum available resources."[148] The Committees' joint statement further clarifies:

> In order for States to comply with their human rights obligations, and to realize the objectives of the Paris Agreement, they must adopt and implement policies aimed at reducing emissions, which reflect the highest possible ambition, foster climate resilience and ensure that public and private investments are consistent with a pathway towards low carbon emissions and climate resilient development.[149]

179. The duty to prevent foreseeable human rights harms caused by climate change dovetails with the prevention principle under international environmental law. As the Inter-American Court on Human Rights has noted, because "it is often impossible to restore the status quo that existed before the environmental damage has occurred, prevention must be the main policy regarding the protection of the environment."[150]

180. Once environmental damage occurs, states have a duty to repair the damage and prevent further harm. The Committee recognized these principles in its General Comment 16, observing:

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[146] *Id.*

[147] Paris Agreement, art. 4(3).

[148] Statement, Committee on Economic, Social, and Cultural Rights, "Climate change and the International Covenant on Economic, Social, and Cultural Rights" (Oct. 8, 2018), www.ohchr.org/en/NewsEvents/Pages/DisplayNews.aspx?NewsID=23691&LangID=E .

[149] *Id.* (citing art. 2.1 of the Paris Agreement).

[150] State Obligations in Relation to the Environment in the Framework of the Protection and Guarantee of Rights to Life and Personal Integrity—Interpretation and Scope of arts. 4.1 and 5.1, in Relation to arts. 1.1 and 2 of the American Convention of Human Rights, Advisory Opinion OC-23/17 Inter-Am. Ct. H.R., Human Rights and the Environment, ¶ 130 (Nov. 15, 2017) (Bearing in mind that, frequently, it is not possible to restore the situation that existed before environmental damage occurred, prevention should be the main policy as regards environmental protection.").

> if children are identified as victims of environmental pollution, immediate steps should be taken by all relevant parties to prevent further damage to the health and development of children and repair any damage done.[151]

181. The prevention principle extends beyond a state's borders. As the OHCHR emphasized: "The negative impacts of climate change on children trigger obligations among *all* duty bearers to take action to protect *all* children from its actual and foreseeable adverse effects."[152] Indeed, the Climate Change Convention, which all respondents have ratified, incorporates the transboundary principle in its preamble—reinforcing that states have extraterritorial responsibility for the adverse effects of their emissions:

> . . . States have, in accordance with the Charter of the United Nations and the principles of international law . . . the responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other States or of areas beyond the limits of national jurisdiction.[153]

182. Reducing emissions at the highest possible ambition is the only way the respondents and other states can pursue efforts to prevent the domestic and transboundary human rights harms caused by climate change. The Committee's joint statement further explained that in reducing emissions, states:

- should effectively contribute to phasing out fossil fuels,
- should promot[e] renewable energy and address[] emissions from the land sector, including by combating deforestation,
- must regulate private actors, including by holding them accountable for harm they generate both domestically and extraterritorially, and

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[151] CRC, General Comment 16, on State obligations regarding the impact of business on children's rights ¶31 (Feb. 2013).

[152] Rep. of the Office of the U.N. High Commissioner for Human Rights, Analytical Study on the relationship between climate change and the full and effective enjoyment of the rights of the child – Report of the Office of the United Nations High Commissioner for Human Rights, ¶ 30 A/HRC/35/13 (2017) (emphasis added).

[153] UNFCCC, preamble (1992).

- should as a mitigation measure to prevent further damage and risk, discontinue financial incentives or investments in activities and infrastructure which are not consistent with low GHG emissions pathways.[154]

183. As demonstrated below, in Section IX, each respondent has violated their duty to prevent the foreseeable human rights harms caused by climate change by adopting carbon emission pathways that would lead to catastrophic global warming. Moreover, rather than prevent further harm, each respondent is actively promoting fossil fuel production and consumption, and/or encouraging or tolerating destructive land use such as deforestation.

B. The duty to cooperate internationally in the face of a global climate emergency.

184. The universal ratification of the Climate Change Convention confirms that climate change is a "common concern of humankind" and that "the global nature of climate change calls for the widest possible cooperation by all countries and their participation in an effective and appropriate international response."[155]

185. International cooperation is also required under the Convention. As this Committee has recognized, "implementation of the Convention is a cooperative exercise for the states of the world."[156] International cooperation is made explicit in Article 4, which provides that states shall implement economic, social, and cultural rights "to the maximum extent of their available resources and, where needed, within the framework of international co-operation."

186. Confronting the climate crisis requires states to not only reduce their own domestic emissions, including those of non-state actors,[157] but also to

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[154] Joint Statement on "Human Rights and Climate Change" (Sept. 16, 2019).

[155] UNFCCC, preamble (1992).

[156] CRC, General Comment no. 5, General measures of implementation ¶60 (Nov. 27, 2003).

[157] The Mavromattis Palestine Concessions, (Greece v. Britain), 1924 P.C.I.J., Ser. B, No. 2, 3, at 21 (Aug. 30, 1924) ("It is an elementary principle of international law that a State is entitled to protect its subjects, when injured by acts contrary to international law committed by another State, from whom they have been unable to obtain satisfaction through the ordinary channels. By taking up the case of one of its subjects and by resorting to diplomatic action or international judicial proceedings on his behalf, a State is in reality asserting its own rights - its right to ensure, in the person of its subjects, respect for the rules of international law.").

cooperate internationally to reduce global emissions. States are thus obligated to "refrain from nullifying or impairing human rights in other countries"[158] and must cooperate internationally to ensure that *other* states are not impairing its ability to mitigate climate change. As Special Rapporteur John Knox pointed out, the "failure of States to effectively address climate change through international cooperation would prevent individual States from meeting their duties under human rights law to protect and fulfill the human rights of those within their own jurisdiction."[159]

187. The Human Rights Committee has recognized the duty to protect against the life-threatening actions of other states: "States parties must take appropriate measures to protect individuals against deprivation of life by other States, international organizations and foreign corporations operating within their territory or in other areas subject to their jurisdiction."[160] Similarly, the European Court of Human Rights recognized this duty in the landmark case *Ilascu v. Moldova and Russia*, where the Court found that Moldova had breached its positive obligations by failing to take all available measures in its negotiations with Russia to bring about the end the abuse of detainees by forces under Russian control.[161]

188. As demonstrated below in VII, the respondents' actions and omissions violate the duty to cooperate internationally by undermining climate action and failing to use all available legal, diplomatic, and economic means to influence other G20 member states to adopt emission reduction pathways that are in line with limiting warming to well below 1.5°C.

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[158] Commentary on the Maastricht Principles, 14; Case concerning the Gabčíkovo-Nagymaros project (Hungary/Slovakia), I.C.J. 1997, ¶ 142.

[159] Human Rights Council, Report of the Special Rapporteur on the issue of human rights obligations relating to the enjoyment of a safe, clean, healthy and sustainable environment, A/HRC/37/58 ¶57 (Feb. 1 2016).

[160] HRC, General Comment 36, on Article 6 of the International Covenant on Civil and Political Rights and on the Right to Life, ¶22 (2008).

[161] Ilaşcu and Others v. Moldova and Russia, Judgment ([GC], App. no. 48787/99 2004 Eur. Ct. H.R. 2004§§ 348-352 (July 8, 2004). See also Manoilescu v. Romania, 2005-VI Eur. Ct. H.R. 357, 390, ¶ 101 ("even in the absence of effective control of a territory outside its borders, the State still has a positive obligation under Article 1 of the [European] Convention to take the diplomatic, economic, judicial or other measures that it is in its power to take . . . to secure . . . the rights guaranteed by the Convention.").

C. The duty to apply the precautionary principle and prevent life-threatening consequences even in the face of uncertainty.

189. The obligation to respect and ensure the right to life in this context is informed by the precautionary principle, which is the legal expression of the common-sense approach that is it "better to be safe than sorry." The Climate Change Convention enshrines this principle, holding that all states

> should take precautionary measures to anticipate, prevent or minimize the causes of climate change and mitigate its adverse effects. Where there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing such measures . . .[162]

190. The precautionary principle has particular significance for the rights of the child: "The cumulative effects of long-term environmental harm, such as climate change and the loss of biodiversity, increase over time, so that decisions taken today will affect children much more than adults." [163]

191. Because of the delayed onset of the climate crisis's worst potential consequences, it is critically important that states cannot invoke scientific uncertainty as an excuse for inaction. And yet states can still invoke uncertainty in pernicious ways, despite the fact that there is no longer any scientific doubt as to the causes and effects of climate change. For example, a state may claim that it is impossible to determine with certainty whether its particular emissions have caused or will cause any given injury—since all states' emissions have merged in the atmosphere. Or, states may argue it is uncertain if any given reduction in its emissions will make a meaningful difference in global levels of CO_2.

192. But it is precisely these sorts of excuses, premised on uncertainty, that are disallowed under the Climate Change Convention and must not be permitted under the Convention if the child's inalienable rights are to be protected.

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[162] UNFCCC, art. 3(3) (1992); *see also* UN Conference on Environment and Development, Rio Declaration on Environment and Development, Principle 15 U.N. Doc. A/CONF 151/ 26 Rev. 1 (Vol. 1) annex 1 (Aug. 12, 1992).

[163] Human Rights Council, Report of the Special Rapporteur on the issue of human rights obligations relating to the enjoyment of a safe, clean, healthy and sustainable environment, A/HRC/37/58 ¶57 (Feb. 1 2016).

D. The duty to ensure intergenerational equity for children and for posterity.

193. Two foundational principles of the Convention are at stake in the climate crisis: non-discrimination and the prioritization of the best interests of the child. Both principles are undermined by delaying climate-change mitigation, because delay shifts the burden onto children and future generations, with irreversible human rights consequences. Costs that could have been minimized through prevention become astronomical once environmental damage is inflicted and must be repaired or adapted to, if adaptation is even possible.

194. The Climate Change Convention enshrines the principle of intergenerational equity, which "places a duty on current generations to act as responsible stewards of the planet and ensure the rights of future generations to meet their developmental and environmental needs."[164] The notion that states are stewards of public commons held in trust for the good of future generations has been recognized by human rights treaty bodies.[165] And it is deeply rooted in the "public trust" doctrine, which has its origins in Justinian's *Corpus Juris Civilis*, the 6th century codification of Roman law.[166]

195. The notion that states must act now to safeguard posterity is incorporated into domestic law around the world. For example, the German Constitution recognizes "responsibility toward future generations."[167]

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[164] OHCHR, Analytical Study on Climate, ¶35; see UNFCCC, art. 3(1) ("The Parties should protect the climate system for the benefit of present and future generations of humankind . . ."); Paris Agreement, preamble.

[165] *See, e.g.*, CESCR, General Comment 15, The Right to Water (arts. 11, 12), UN ESCOR, CESCR, 29th Sess. Agenda Item 3 U.N Doc. E/C.12/2002/11 at ¶ 11 (directing states to take comprehensive measures to ensure there is safe drinking water for present and future generations).

[166] *See* Helen Althaus, Public Trust Rights 23 (1978).

[167] *See, e.g.*, Basic Law of the German Federal Republic, art. 20a (added 1994), English trans available at: https://www.gesetze-im-internet.de/englisch_gg/englisch_gg.html ("Mindful also of its responsibility toward future generations, the state shall protect the natural foundations of life and animals by legislation and, in accordance with law and justice, by executive and judicial action, all within the framework of the constitutional order."). Similarly, the New York Appellate Division cited Roman law for the proposition that "conservation of resources is intrinsically good and necessary for the continuation of society" and that environmental regulation of private property meets the government's obligation to protect natural resources for future generations. W.J.F. Realty Corp. v. State, 672 N.Y.S.2d 1007, 1012 (N.Y. App. Div. 1998).

The U.S. Constitution expressly aims to "secure the Blessings of Liberty to ourselves and our Posterity."[168] Indeed, intergenerational equity is the bedrock of sustainable development, as expressed in the Rio Declaration: "The right to development must be fulfilled so as to equitably meet developmental and environmental needs of present and future generations."[169]

VII. Each of the respondents is knowingly causing and perpetuating the climate crisis.

196. Each respondent helped cause the climate crisis, and is still perpetuating it, knowing that it endangers children's inalienable rights. Despite that knowledge, each is undermining the global collective effort to solve the crisis. Each continues to promote fossil fuels and continues to emit hazardous levels of GHG, damaging the environment at home and abroad in defiance of the precautionary principle. And each continues to acquiesce when other major-emitting states and private industries pollute the Earth's atmosphere.

A. The respondents have all known about the deadly and foreseeable consequences of climate change for decades.

> *Every bit of evidence I've seen persuades me we are on a course leading to tragedy. I don't agree with those who say the status quo is the answer.*
>
> —UN Conference on Environment and Development Secretary General Maurice F. Strong, 1992.

197. Each respondent has known about the threat of anthropogenic climate change—and the need to curb emissions—for decades. 1988 was the watershed year when climate change was recognized as a global threat. The IPCC was established that year. 1988 was also the year the UN General Assembly called for "timely action," noting "with concern that the emerging evidence indicates that continued growth in atmospheric concentrations of 'greenhouse' gases could produce global warming

[168] Constitution of the United States, 1789, preamble.

[169] Rio Declaration on Environment and Development (1992), Principle 3.

with an eventual rise in sea levels, the effects of which could be disastrous for mankind if timely steps are not taken at all levels."[170]

198. Since then, public awareness of the risks climate change poses has only deepened. In 1990, the IPCC's First Assessment Report concluded "with confidence" that "the steady anthropogenic emissions into the atmosphere represent a significant disturbance of the natural carbon cycle."[171]

199. Even at this early date, the warnings were clear. In 1990, the IPCC projected global warming of 1°C by 2025—a line already passed. It warned that, among other impacts, climate change could cause increased water shortages, increased vector-borne diseases in higher latitudes, and "in coastal lowlands such as in Bangladesh, China and Egypt, as well as in small island nations, inundation due to sea-level rise and storm surges" leading to "significant movements of people."[172]

200. Two years later, Brazil hosted the 1992 Rio Earth Summit, where the Climate Change Convention was opened for signature. In over two decades of global accords, protocols, and platforms—Berlin, Kyoto, Copenhagen, and now Paris—the respondents have recognized that climate change threatens children and future generations.[173] In 2016, each respondent signed the Paris Agreement and committed to hold global warming well below 2°C by 2100 and to pursue efforts to limit it to 1.5°C. Then on October 8, 2018, when the IPCC issued its Special Report on Global Warming of 1.5°C, the respondents learned that hundreds of millions of lives could be saved by limiting warming to no more than 1.5°C—and that even more could be saved by limiting warming further.

201. These treaties were important steps in securing recognition from the respondents and other states that the climate crisis is a "common

[170] Protection of global climate for present and future generations of mankind: resolution / adopted by the General Assembly, UN Doc. A/RES/43/53, 6 December 1988.

[171] IPCC, Climate Change: The IPCC 1990 and 1992 Assessments, First Assessment Report, Overview (1990) at 52.

[172] IPCC, First Assessment Report, Policymaker Summary of Working Group II (Potential Impacts of Climate Change) (1990) at 89.

[173] See *supra* at notes 137-139.

concern of humankind."[174] But none of these efforts has secured the drastic reduction in carbon emissions needed to avert further disaster. In the twenty years after the Kyoto Protocol was signed, the world produced more emissions than in the twenty years before.[175]

202. The respondents have thus known for decades that every metric ton of CO_2 that they emitted or permitted was adding to a crisis that transcends all national boundaries and threatens the rights of children everywhere.

B. Despite their decades-long knowledge, each respondent has breached its human rights duties by causing and perpetuating the climate crisis and undermining international cooperation.

> *We expect more than words on paper and promises. We expect action. Action on a big scale. And we expect action today, not tomorrow.*
>
> — Getrude Clement, 16-year-old Tanzanian youth representative at Paris Agreement Signature Ceremony, 2016

1. The tragedy of the commons: The pursuit of short-term self-interest is undermining the international cooperation needed to mitigate climate change.

203. The respondents, as parties to the universally ratified Climate Convention, have recognized for decades that "the global nature of climate change calls for the widest possible cooperation of all countries."[176]

204. Every country's emissions matter in the race to reverse global warming. To fulfill their human rights duties, states must reduce their domestic emissions *and* cooperate internationally to decarbonize the global economy. For decades, the excuse that no site-specific harm can be traced to any particular emission or country, and thus that no state bears responsibility, has been used to justify inadequate climate action. This excuse has turned the climate crisis into what economists call a "tragedy of the commons." This is where a common resource, like Earth's life-sustaining atmosphere, is spoiled by individual actors, such as

[174] UNFCCC, preamble.

[175] Uninhabitable Earth, *supra* note 18, at 13.

[176] UNFCCC, preamble.

individual states, acting in their individual, short-term economic interests, ruining everyone's long-term collective interest.[177]

205. Climate change is the ultimate tragedy of the commons. The classic example is where farmers overgraze a common pasture until it can no longer sustain anyone's herd. With climate change the dynamic is the same. The Earth has a finite carbon budget—the amount of GHG that can accumulate in the atmosphere without destabilizing the current climate.[178] If enough states exceed their carbon budget, they spoil the common atmosphere—and undermine the effort to decarbonize it.

206. Acting in their self-interest, each state has an incentive to delay decarbonizing and reap the short-term economic and political benefits of preserving the *status quo*.[179] This is particularly true for many developed countries, since the most damaging near-term effects of warming are felt most acutely in developing countries and small island states. Germany, for example, is less incentivized to decarbonize its auto industry when people in the Marshall Islands bear the worst impacts first.

207. Germany also has less incentive to decarbonize *without delay* when it can point to France—who as demonstrated below is decarbonizing *with delay*. The only way for the world to decarbonize the global economy and limit or reduce atmospheric concentrations of GHG is for each state to stay within its carbon budget and for each to ensure that other states are complying as well. For this collective effort to succeed, the most influential states must not shirk these duties.

208. Regional leaders and major economies—like the respondents—have a unique responsibility to mitigate climate change, because they exercise an outsized influence. The G20, to which each respondent is a member, make up 84% of all global emissions.[180] If the G20 does not decarbonize at a rate and scale established as necessary by available science, collective climate action will unravel.

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[177] Garrett Hardin, "The Tragedy of the Commons", 162 Science3859 at 1243–1248 (Dec. 13 1968).

[178] Rogelj Report 2019 at 4.

[179] Jouni Paavola, *"Climate Change: The Ultimate Tragedy of the Commons?" in Property in Land and other Resources* at 419-20 (2012).

[180] Rogelj Report 2019 at 7, Table 1.

209. The respondents' cooperation—or defection—shapes the success or failure of climate action. If they meet or exceed climate action targets, they signal to other states that long-term interests in the global commons will be protected. If they fail, they encourage other states to deplete the remaining carbon budget.

210. This ability to influence international cooperation makes the respondents' impact on climate change greater than their actual share of emissions. Germany represents only 2% of current global emissions; France 1%.[181] Yet each can influence other states through trade, aid, and diplomacy, amplifying their ability to shape global emissions. This is equally true for Brazil (2.2%), Turkey (1.1%), and Argentina (0.7%).

211. Because the respondents play an essential role in building the international cooperation on climate change, they have a duty to use their influence to protect children from environmental threats caused by the world's other major emitters, especially the top four, which account for 58% of all emissions: China (26.3%), the U.S. (13.5%), the E.U. (9.4%), and India (7.3%).[182]

Table 1: Overview of current and projected emissions per country or country group, as well as corresponding emission levels in 2030 consistent with limiting global warming to below 1.5°Cor 2°C

	% share of globe in 2016	**Implied warming by 2100 if whole world implements comparable emissions reductions[†]**	
[Unit]	**%**	**Following current policy**	**Following NDCs[‡]**
Argentina	0.8%	exceeding 4°C	below 4°C
Brazil	2.3%	below 3°C	below 3°C
China	26.3%	below 4°C	below 4°C
France[#]	1.0%	below 4°C	below 4°C
Germany[#]	1.9%	below 4°C	below 3°C
India	7.3%	below 2°C	below 2°C
Turkey	1.1%	exceeding 4°C	exceeding 4°C
United States*	13.5%	exceeding 4°C	exceeding 4°C
European Union	9.4%	below 3°C	below 3°C
G20 (incl. EU)	84.0%	NR	NR
Marshall Islands	0.0%	NR	NR
Global	100.0%	See Table 2	See Table 2

Table 1: Excerpt from Rogelj Report Table 1

[181] *Id.*

[182] *Id.*

212. To reverse global warming, and prevent a global tragedy of the commons, the respondents, and all other states, must reduce their domestic emissions and contribute to international cooperation. Failing to do either has grave consequences.[183]

213. In order to respect, protect, and fulfill children's rights all states—especially leading economies, major carbon emitters, and regional leaders like respondents—must take action on two fronts: reduce emissions and cooperate internationally. To date, however, each of the respondents is failing on both fronts.

2. Each respondent has failed to reduce its emissions at the "highest possible ambition."

214. Each respondent is delaying the steep cuts in carbon emissions needed to protect the lives and welfare of children at home and abroad. NDCs under the Paris Agreement set targets that are expressed in the estimated total annual emission of carbon dioxide equivalents ("CO_2e") (*i.e.*, all GHG), measured in megatons ("Mt") meaning a million tons. Climate scientists use statistical models to calculate how certain amounts of GHG emissions will impact the global average temperature. A "fair share" model is used to determine how much global warming is consistent with a single state's emission reduction pathway. This "implied warming" is expressed as the amount of warming that would result if all other governments were to implement comparable reductions given their different circumstances.[184]

[183] In the context of preventing genocide, the International Court of Justice stressed the importance of each state's cooperation in collective prevention: "It is irrelevant whether the State whose responsibility is in issue claims, or even proves, that even if it had employed all means reasonably at its disposal, they would not have sufficed to prevent the [foreseeable harm]. . . [T]his is irrelevant . . . since the possibility remains that the combined efforts of several States, each complying with its obligation to prevent, might have achieved the result . . . which the efforts of only one State were insufficient to produce." *Case Concerning App. of the Convention on the Prevention and Punishment of the Crime of Genocide Bosnia, Judgement International Court of Justice, Application of the Genocide Convention* (*Bosnia and Herzegovina v. Serbia and Montenegro*), Judgment, 2007 I.C.J. Rep. 43,¶ 430 (Feb. 26), https://www.icj-cij.org/files/case-related/91/091-20070226-JUD-01-00-EN.pdf.

[184] The estimate of global warming implied by a single country's emissions is based on an assessment of a broad literature of international fairness approaches carried out by the Climate Action Tracker research consortium (https://climateactiontracker.org/methodology/comparability-of-effort/). By comparing a country's projected emissions with the equity-based range consistent with limiting warming to below 1.5°C, 2°, 3°C or higher levels, an indicative level of global warming can be inferred assuming all other countries implement emissions reductions that are considered to be similarly ambitious given their different circumstances.; Rogelj Report 2019 at 7, Table 1.

215. Based on these models, scientists estimate that annual global GHG emissions under current policies will reach 58,983 $MtCO_2e$ (58,983 million tons) in 2030 and this amount corresponds to 3.1-3.5°C of warming by 2100.[185]

216. As demonstrated below, not one of the respondents is on an emissions pathway that is consistent with keeping heating under 3°C much less under 1.5°C, a limit that would still subject millions to poor health and increased mortality. Each respondent has set inadequate emission reduction targets in its Paris Agreement pledges—and then failed to even meet these inadequate goals.

217. **ARGENTINA**. Under the Paris Agreement, Argentina submitted an NDC pledging to reduce emissions to 422 million tons by 2030. If all the world's governments implemented comparable reductions, it would lead to 3-4°C of global warming by 2100. Even worse, Argentina's current policies are on a much higher emission pathway than its NDCs, reaching 490 million tons in 2030, with implied warming exceeding 4°C.[186]

Current Policy 2030	Unconditional NDC 2030	<2.0°C	<1.5°C	Implied warming by 2100	
$MtCO_2e$ per year	$MtCO_2e$ per year	$MtCO_2e$ per year	$MtCO_2e$ per year	Following current policy	Following NDCs
490	422	256	205	exceeding 4°C	below 4°C

Table 2. Argentina: Projected emissions, emissions required for Paris Agreement targets, and implied warming.

218. Argentina's emissions are the result of deliberate policy choices. The largest share of Argentina's emissions come from the energy sector. Yet Argentina continues to subsidize fossil fuels. In 2018, an estimated 93% of total public energy investments went to coal, oil and gas projects while virtually no financing went to renewable energy projects (such as wind and solar). Argentina has no sectoral plan to decarbonize its economy by 2050; instead, the government intends to further develop the natural gas industry and make this fuel the main energy source in the country. At the same time, cattle farming is a sizable driver of emissions, producing methane emissions and stressing forests through the

[185] Rogelj Report 2019 at 7, Table 1.

[186] Rogelj Report 2019 at 7, Table 1.

encroachment of grazing lands. Yet Argentina has no policy instruments in place to plan for mitigating livestock emissions.

219. **BRAZIL.** In its NDC, Brazil pledged to reduce annual emissions to 890 million tons by 2030, a pathway consistent with 2-3°C of global warming, if all countries were to make comparable reductions. But Brazil's current policies are projected to produce 1119 million tons of emissions in 2030—an excess of 229 million tons. And those projections were made before President Jair Bolsonaro took office in January 2019 and launched the roll-back of Brazil's once-strict environmental protections, which will likely lead to even higher emissions.

Current Policy 2030	Unconditional NDC 2030	<2.0°C	<1.5°C	Implied warming by 2100	
$MtCO_2e$ per year	$MtCO_2e$ per year	$MtCO_2e$ per year	$MtCO_2e$ per year	Following current policy	Following NDCs
1119	890	744	432	below 3°C	below 3°C

Table 3. Brazil: Projected emissions, emissions required for Paris Agreement targets, and implied warming.

220. Brazil has been contributing to global warming through an active campaign of dismantling environmental regulations and enforcement. Brazil's current policies under President Bolsonaro, as well as policies undertaken at the end of the previous administration's term, have increased deforestation and emissions. Those new policies include: cutting 95% of the Ministry of Environment's budget for climate change related activities; transferring the body responsible for certifying indigenous territory from the National Indian Foundation to the Ministry of Agriculture; easing the rules for converting environmental fines into alternative compensations; changing the Forest code to extend deadlines for enforcement measures; and abolishing most committees and commissions for civil participation and social control in the government.[187] At the same time, Brazil's fossil fuel subsidies as of 2016 were $16.2 billion USD, doubling since 2007. 66% of Brazil's energy investments went to fossil fuels, and only 21% to renewable energy.

[187] Climate Action Tracker, https://climateactiontracker.org/countries/brazil/.

221. Brazil's rollbacks are already starting to have a damaging effect. In 2018, Brazil recorded the loss of 1.3 million hectares of tropical primary rainforests—the highest recorded loss in the world—mostly due to deforestation of the Amazon.[188] And just this year, the Amazon has seen a record number of forest fires, with a detected 83% increase this summer in forest fires from the same time period in 2018.[189] The Amazon acts as a large carbon sink for the entire world, absorbing a quarter of carbon taken up forests around the world annually. Burning the Amazon has a direct transboundary effect on all countries and all children, who depend on its ability to remove carbon from the atmosphere.

222. **FRANCE**. Although France has been a vital leader in negotiating international climate action, its domestic emissions tell another story. France's emissions, under current policies, are consistent with 3-4°C of global warming, if all governments made comparable reductions.[190] If these policies continue, France's projected annual emissions in 2030 (395 million tons) will be **more than 10 times** what its fair share would need to be in a scenario of keeping global warming under 1.5°C (37 million tons).[191]

Current Policy 2030	Unconditional NDC 2030	<2.0°C	<1.5°C	Implied warming by 2100	
$MtCO_2e$ per year	$MtCO_2e$ per year	$MtCO_2e$ per year	$MtCO_2e$ per year	Following current policy	Following NDCs
395	403	154	37	below 4°C	below 4°C

Table 4. France: Projected emissions, emissions required for Paris Agreement targets, and implied warming.

223. France set a long-term, domestic decarbonization strategy, aiming to reach carbon neutrality by 2050, but has so far failed to meet its targets. In June 2019, France's independent High Council for the Climate reported that France is not on track to meet its 40% emissions reductions

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[188] Climate Analytics Report 2019 at 50-52.

[189] Mahita Gajana, A Record Number of Fires Are Currently Burning Across the Amazon Rainforest, Time (Aug. 21, 2019) https://time.com/5657387/brazil-amazon-forest-fires-surge/.

[190] *Id.*

[191] Rogelj Report 2019 at 7, Table 1.

target for 2030, and, without a change in policy, will not meet its carbon neutrality target for 2050.[192] France adopted an annual carbon budget of 442 million tons of CO_2e for 2015-2018, but then exceeded that budget by some 72 million tons.[193] Like carried-over interest, that excess amount had to be factored into the carbon budget for 2019-2023.[194] If, as anticipated, France again goes over-budget, it will keep carrying the balance forward, compounding it, and requiring ever more drastic cuts in emissions in the future. In short, France is delaying decarbonization.

224. In order to make up for exceeding its carbon budget, France will need to make more drastic emission reductions in the transport sector, France's biggest single source of carbon pollution, representing 38% of energy emissions.[195] France will also need to shift greater investments into renewable energy, energy-efficient construction, and electric transport, among others. Yet on this front, a study commissioned by the French Environment and Energy Management Agency concluded in 2018 that France had massively delayed making the public investments in climate mitigation necessary to achieve its emission reduction targets: "the delay taken between 2016 and 2018 represents 40 to 90 billion euros in missing investments. To make up for this delay in the period 2019 to 2023 and cover initial needs, it will be necessary to invest between 55 and 85 billion euros each year."[196] In short, France's delay in decarbonizing is inconsistent with the 1.5°C goal announced in Paris, and inconsistent with France's international climate leadership.

225. **GERMANY**. Like France, Germany has played a leading diplomatic role in international climate action but has failed to lead by example. Even on paper, Germany's emission-reduction targets are inadequate. Germany's domestic 2030 mitigation target is consistent with warming of 2-3°C, if all countries made comparable commitments, while its

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[192] Climate Analytics Report 2019 at 195; Haut conseil pour le climat, Agir en cohérence avec les ambitions, Rapport annuel Juin 2019, https://www.hautconseilclimat.fr/wp-content/uploads/2019/06/hcc_rapport_annuel_2019.pdf.

[193] Projet de SNBC de décembre 2018, at 35., https://www.ecologique-solidaire.gouv.fr/sites/default/files/Projet%20strategie%20nationale%20bas%20carbone.pdf.

[194] *Id.*

[195] Climate Analytics Report 2019 at 194.

[196] "Panorama des financements climat, Edition 2018", Institute for Climate Economics (I4CE) at 2, https://www.i4ce.org/wp-core/wp-content/uploads/2018/11/I4CE-Panorama-des-financements-climat-résumé-2018-FR.pdf.

current policies exceed that target, and would be in line with 3-4°C. If these policies continue, Germany's projected annual emissions in 2030 (735 million tons) will be nearly 13 times what its fair share would need to be in a scenario of keeping global warming under 1.5°C (57 million tons).

Current Policy 2030	Unconditional NDC 2030	<2.0°C	<1.5°C	Implied warming by 2100	
$MtCO_2e$ per year	$MtCO_2e$ per year	$MtCO_2e$ per year	$MtCO_2e$ per year	Following current policy	Following NDCs
735	553	265	57	below 4°C	below 3°C

Table 5. Germany: Projected emissions, emissions required for Paris Agreement targets, and implied warming.

226. Under its domestic targets, Germany aims to cut emissions by 40% by 2020, 55% for 2030, and at least 70% for 2040, compared to 1990 levels.[197] In May 2019, however, the German government announced that it had overshot its 2020 target by 8%, mainly due to the remaining large share of coal in power generation and rising transport emissions.[198] Missing the target results in a massive surplus in emissions, adding an additional 100 million tons of CO_2e to an already growing surplus.[199] The balance is carried forward and grows: It is estimated that by 2030, Germany will have emitted an excess 1.1 billion tons beyond its carbon budget.[200] Thus, in order to meet the 2030 and 2050 targets, Germany must not only reduce ongoing emissions, but also compensate for the surplus that keeps accruing. Making up for this surplus will require even steeper reductions.

[197] Aktionsprogramm Klimaschutz 2020 Kabinettsbeschluss vom 3. Dezember 2014; Klimaschutz- plan 2050 [English Version] Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety, Climate Action Plan 2050, Principle and goals of the German government's climate policy, at 28, https://bit.ly/2C8wGAz.

[198] Report, Federal Ministry for the Environment, Nature Conservation and Nuclear Safety of 1 May 2019, https://bit.ly/2kNpaGK at 28; Brown to Green Report, Germany at 9, https://bit.ly/2ksxc7y.

[199] Niklas Höhne, et al., 1,5°C: Was Deutschland tun muss, März 2019, https://newclimate.org/wp-content/uploads/2019/03/Deutschland_1.5_Web.pdf.

[200] *Id.*

227. These reductions must come from the two sectors generating the most emissions: the energy sector, especially power generation, and transport.[201] Yet the German federal government has not adopted any concrete measures to make up for the surplus. While the government is acting on the German Coal Commission's recommendation to phase out coal power generation by 2038, climate models indicate that delaying the phase-out until then could breach a Paris Agreement-compatible pathway by more than a billion tons of CO_2.[202] At the same time, Germany continues to heavily subsidize fossil fuel consumption through, for example, tax relief on diesel (8 billion euros) and exemptions for company cars (3 billions).[203] These actions are inconsistent with holding warming to below 1.5°C.

228. **TURKEY**. Between 2005 and 2016, Turkey's GHG emissions increased by 49%.[204] Turkey signed, but has not ratified, the Paris Agreement and submitted an "Intended" NDC pledging a 21% economy-wide reduction in emissions. That pledge was not kept. Emissions are instead projected to increase continuously by 2030. Under these policies, Turkey's emissions are in line with exceeding 4°C of global warming by 2100, if all countries made comparable reductions.

Current Policy 2030	Unconditional NDC 2030	<2.0°C	<1.5°C	Implied warming by 2100	
$MtCO_2e$ per year	$MtCO_2e$ per year	$MtCO_2e$ per year	$MtCO_2e$ per year	Following current policy	Following NDCs
853	999	434	357	exceeding 4°C	exceeding 4°C

Table 6. Turkey: Projected emissions, emissions required for Paris Agreement targets, and implied warming.

[201] Brown to Green Report, Germany, 2018 at 3, https://www.climate-transparency.org/wp-content/uploads/2019/01/BROWN-TO-GREEN_2018_Germany_FINAL.pdf.

[202] Carbon Brief, Analysis: How far would Germany's 2038 coal phaseout breach Paris climate goals?, Jan 29, 2019, https://www.carbonbrief.org/analysis-how-far-would-germanys-2038-coal-phaseout-breach-paris-climate-goals.

[203] Ipek Gençsü and Florian Zerzawy, Phase-out 2020: monitoring Europe's fossil fuel subsidies: Germany, Climate Action Network at 2-3 (Sept. 2017), https://www.odi.org/sites/odi.org.uk/files/resource-documents/11778.pdf.

[204] OECD, Environmental Performance Reviews: Turkey (2019), 38, https://www.oecd.org/turkey/oecd-environmental-performance-reviews-turkey-2019-9789264309753-en.htm..

229. Coal is a significant driver of these emissions. Far from keeping fossil fuels in the ground, Turkey has implemented a series of subsidies for coal mines and coal-fired power plants. As of 2017, 88% of Turkey's energy supply comes from fossil fuels, and coal accounts for a third of that. Investments in coal mining and coal-fired power plants receive subsidies including VAT exemption, customs duty exemption, low-interest loans, and social security breaks.[205] Coal subsidies also take the form of environmental exemptions: not a single environmental impact assessment of a coal-fired power plant was disapproved between 1999 and 2015. Indeed, there is often a symbiotic relationship between the Turkish government and the coal industry: coal is largely extracted by three state-owned companies and a growing number of private companies, some of which operate through a public-private partnership scheme, in which management is privatized in exchange for royalties to the Turkish government and agreements to provide coal to the state-owned energy company.[206]

3. Each respondent has failed to protect children from the acts of the major carbon emitters.

230. Avoiding a tragedy of the commons also requires the respondents to ensure that other states are not racing to deplete the carbon budget. This is more than a diplomatic goal; it is a human rights imperative. The respondents cannot fully protect children from the climate crisis without addressing the main carbon polluters: the major emitting states and business entities, all of whom fall within the G20, who are collectively responsible for 84% of global emissions.[207] Roughly 58% of global emissions come from four G20 members: China, the U.S., the E.U., and India.[208]

231. The influence G20 members exert over the climate crisis can also be measured by the carbon footprint of the private industries over which they exercise jurisdiction. Just 90 fossil-fuel and cement producers are

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[205] Sevil Acar, Lucy Kitson, & Richard Bridle, Subsidies to Coal and Renewable Energy in Turkey, Inst. Int'l for Sustainable Redevelopment at 8 (March 2015), https://www.iisd.org/gsi/sites/default/files/ffsandrens_turkey_coal_eng.pdf.

[206] *See*, Eurocoal, the Voice of Coal in Europe, https://euracoal.eu/info/country-profiles/turkey/.

[207] Rogelj Report 2019 at 7, Table 1.

[208] UNEP Gap Report 2018 at 6-7.

responsible for 63% of all GHG emitted from 1751 to 2010: 914 billion tons.[209] Of these, the top 50 investor-owned entities are all nationals of G20 member states.[210]

232. The G20 states and the industries they control have the power to decarbonize the global economy by shifting to sustainable energy and keeping fossil-fuels in the ground. As G20 members, the respondents have diplomatic, legal, and economic tools at their disposal. Yet none of the respondents have used, much less exhausted, all reasonable measures to protect children's rights from the major emitters.

233. The G20 is a starting point. The 2019 G20 Summit in Osaka offered a political forum where the world's major economies could exercise international cooperation to confront climate change. The petitioners acknowledge that among the respondents, France pushed for more ambitious climate action at the summit,[211] but the U.S. and other countries quashed France's effort. In the end, the summit failed to secure a commitment from all members to reduce emissions to net-zero by 2050. Indeed, the G20 is ramping up coal finance, spending some $63.9 billion annually on coal, despite committing a decade ago to phase out fossil fuel subsidies.[212]

234. Failure at the G20 summit only highlights the need for each of the respondents to take enforceable measures under international and domestic law to confront the major emitters. For example, international arbitration is a classic inter-state complaint mechanism for transboundary environmental damage. Yet none of the respondents have

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[209] Richard Heede, *Tracing anthropogenic carbon dioxide and methane emissions to fossil fuel and cement producers, 1854–2010*, 122 Climatic Change at 122:229–241 (2014); Richard Heede, Carbon Majors: Accounting for carbon and methane emissions 1854-2010, Methods & Results Report (2014), https://bit.ly/2kgH4RJ.

[210] Heede, *Tracing anthropogenic carbon dioxide*, at Supplemetary Materials, Table 4, https://bit.ly/2lW71q7.

[211] Adam Nossiter, *Macron Calls Climate Change a 'Red Line' Issue at G20, Rebuking Trump*, N.Y. Times (Jun. 26, 2019), https://nyti.ms/2mgJoZM.

[212] Han Chen, *Japan G20 Lacked Ambition on Climate Change & Coal Phaseout*, National Resources Defense Council Blog (Jul. 15, 2019), https://on.nrdc.org/2miwDhl.

sought to arbitrate claims against any major emitter, or exercise other forms of diplomatic protection.[213]

235. The U.S.' reversal on climate mitigation is a stark example of the global threat to children's rights and lives. The U.S. is the world's second largest emitter of GHG, contributing 13.5% of global emissions in 2016.[214] Those emissions will only get worse. The Trump Administration has disregarded scientific consensus and instead has taken actions which raise the amount of deadly carbon pollution emitted by the U.S. across international borders. Since 2017, the U.S. government has announced its withdrawal from the Paris Agreement and the rollback of six federal environmental rules essential for mitigating climate change.[215] At the same time, the U.S. government is ramping up fossil-fuel subsidies, opening Alaska's Arctic National Wildlife Refuge to oil and gas development, and giving $25 billion in direct one-time benefits to oil and gas companies through tax reforms.[216] The regulation rollbacks alone would lead to an estimated annual increase of more than 400 million metric tons of CO_2e emissions[217] and represent a significant threat to children's rights inside and outside the United States, triggering an obligation among the respondents, and other states, to protect children's lives from these third-party harms.

236. In sum, each of the respondents are undermining international cooperation on climate change through emissions gaps and accountability gaps. They are failing to lead by example in their emissions reductions. And they are failing to use all reasonable means

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[213] In contrast, state and local governments in the United States have brought legal challenges against the federal government's climate rollbacks. Lisa Friedman, "States Sue Trump Administration Over Rollback of Obama-era Climate Rule," NY Times (Aug. 13, 2019), https://www.nytimes.com/2019/08/13/climate/states-lawsuit-clean-power-ace.html.

[214] Climate Analytics Report 2019 at 163.

[215] Climate & Health Showdown in the Courts: State Attorneys General Prepare to Fight, NYU School of Law, State Energy & Environmental Impact Center, Special Report, (March 2019), https://www.law.nyu.edu/sites/default/files/climate-and-health-showdown-in-the-courts.pdf.

[216] Coady et al., "Global Fossil Fuel Subsidies Remain Large: An Update Based on Country-Level Estimates, IMF Working Paper, WP/19/89, at 23 (May 2019), https://www.imf.org/~/media/Files/Publications/WP/2019/WPIEA2019089.ashx; Antonia Juhasz, "Inside the Tax Bill's $25 billion oil company bonanza," Mar. 27, 2018, https://psmag.com/economics/tax-bill-oil-company-bonanza.

[217] Climate Analytics Report 2019 at 163-65.

to engage the major emitters in international efforts to mitigate climate change. Meanwhile, the carbon budget is being depleted, like a pasture overgrazed. This tragedy of the commons has real victims: children like the petitioners, who suffer the life-long consequences of the respondents' decisions to value short-term gain over long-term sustainability.

4. Each respondent's contributions to climate change has caused and continues to cause the petitioners' injuries.

237. Each of the respondents has contributed to causing the climate crisis through their past and present emissions. The cumulative sum of the respondents' historical emissions show that they are major emitters, responsible for a significant share of today's concentration of GHG in the atmosphere. Each of the respondents ranks in the top 50 historical emitters since 1850, based on fossil fuel emissions: Germany ranks 5th, France 8th, Brazil 22nd, Argentina 29th, and Turkey 31st.[218] When land-use, such as deforestation, is factored in, Brazil surpasses France in its historical share.[219]

238. These emissions continue to grow. A global scientific consensus—reflected in years of IPCC reports—establishes that the respondents are currently emitting at levels that are damaging the climate, harming children's health, and jeopardizing their lives.

239. The injuries the petitioners have incurred, and the life-long threats they face, are foreseeable harms that each respondent has known about for decades. In 1990, the IPCC's first-assessment report warned that global warming "may produce adverse impacts on air quality such as increases in ground-level ozone in some polluted urban areas."[220] It stated the same with "very high confidence" in 2014.[221] Twenty nine years after the first IPCC report, Petitioner Debby Adegbile is repeatedly hospitalized in

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[218] Baumert, et al., Navigating the Numbers Greenhouse Gas Data and International Climate Policy, World Resources Institute at 32 (2005), http://pdf.wri.org/navigating_numbers.pdf.

[219] Id. at 33.

[220] IPCC, Policymaker Summary of Working Group II (Potential Impacts of Climate Change) (1990) at 88.

[221] IPCC, 2014: Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, p. 16.

Lagos with asthma attacks from air pollution aggravated by heat. While it is true that no molecule of CO_2 can be traced from Lagos to a coal-fired plant in Germany, the fact remains that Debby suffers from the precise injuries, and under the precise environmental conditions that were identified in the IPCC's climate impact assessments. The same is true for Ranton Anjain, who contracted dengue fever during the 2019 dengue emergency in the Marshall Islands—29 years after the IPCC forecast that climate change had the "potential for increase and reintroduction of vector-borne diseases," singling out dengue.[222]

240. The same is true for each petitioner—the injuries they suffer today were predicted years ago as likely outcomes of the global warming created by the respondents and other states. The respondents were aware of these risks then, and they are aware now that the foreseeable risks to the petitioners' human rights will worsen as the world gets warmer. The petitioners' injuries are documented in Appendix A. The impacts on the petitioners' countries and regions are documented in Appendices C and D. And the conduct of the respondents that caused these impacts and injuries is documented in Appendices B and C.

241. Human rights law holds states responsible for jointly causing a violation of rights—joint responsibility is, for example, inherent in the concept of complicity and the duty to protect individuals against third-party harms.[223] The respondents have individually and jointly caused and perpetuated climate change. And they have individually and jointly caused, and are perpetuating, the petitioners' injuries.

VIII. The petitioners are within each respondent's jurisdiction as victims of the foreseeable consequences of respondents' domestic and cross-border contributions to climate change.

242. Article 2 of the Convention provides that "States parties shall respect and ensure the rights" of "each child within their jurisdiction."[224] Certain

[222] IPCC, Policymaker Summary of Working Group II (Potential Impacts of Climate Change) (1990) at 102, 105.

[223] *See* HRC, General Comment 36, ¶ 22.

[224] The Convention, art. 2. It should be noted that there are two significant differences between the scope of application provisions of the ICCPR and the Convention that lend support to giving the Convention's obligations a broader scope. First, Article 2 of the Convention does not mention the word "territory". Second, rather than referring to each individual state party's jurisdiction, as with Article 2 of the ICCPR's reference to "its jurisdiction", the Convention

of the petitioners are within the jurisdiction of certain respondents by virtue of their nationality or residence: Chiara Sacchi is a citizen of Argentina; Catarina Lorenzo is a citizen of Brazil; Iris Duquesne is a citizen of France; and Raina Ivanova is a resident of Germany. All petitioners, however, are within the jurisdiction of each respondent because the petitioners are all victims of the foreseeable consequences of the carbon pollution knowingly emitted, permitted, or promoted by each respondent from within their respective territory.

243. It is well established under international human rights law that a state's jurisdiction extends beyond its territorial boundaries to territories and persons within its power or over which it has control.[225] A state's jurisdiction also follows when its acts or omissions within its territory cause foreseeable cross-border effects.[226] This flows from the foundational rule that a state has sovereign, territorial jurisdiction over acts occurring in its territory.[227] Indeed, under the subjective territoriality

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refers to "their jurisdiction", a collective possessive that suggests Convention obligations are applicable vis-a-vis all children within any state party's jurisdiction. This notion of collective jurisdiction accords with the purposes of the Convention, its guiding principle of the best interests of the child, and with the near universal participation in the treaty. J. Cerone, "Jurisdiction and Power: The Intersection of Human Rights Law & the Law of Non-International Armed Conflict in a Extraterritorial Context," Israel Law Review, vol. 40, no. 2 (2007), at 449.

[225] *See* HRC, General Comment No. 31, Nature of the General Legal Obligation on States Parties to the Covenant, ¶1010 (2004), https://www.unhcr.org/4963237716.pdf ("a State party must respect and ensure the rights laid down in the Covenant to anyone within the power or effective control of that State Party, even if not situated within the territory of the State Party"); *Case Concerning Armed Activities on the Territory of the Congo (DRC v. Uganda)*, Judgment, 2005 I.C.J. 116, Rep. 168, ¶216 (Dec. 19) (recalling that in its Wall opinion the Court had "concluded that international human rights instruments are applicable 'in respect of acts done by a State in the exercise of its jurisdiction outside its own territory,' particularly in occupied territories"); *Legal Consequences of the Construction of a Wall in the Occupied Palestinian Territory*, Advisory Opinion, 2004, I.C.J. 136, at ¶ 109 (9 July), https://www.icj-cij.org/files/case-related/131/131-20040709-ADV-01-00-EN.pdf; *Case of Al-Skeini v. United Kingdom*, App. No. 55721/07, 2011, Eur.Ct. H.R. (2011), ¶ 133137, http://hudoc.echr.coe.int/eng?i=001-105606 ("whenever the State through its agents exercises control and authority over an individual, and thus jurisdiction, the State is under an obligation under Article 1 to secure to that individual");") ; *Victor Saldaño v. Argentina*, Petition, Inter-Am. C.H.R., Report No. 38/99, OEA/Ser.L/V/II.95 doc. 7 rev. 289, ¶ 19 (1998) (jurisdiction with respect to human rights obligations "is linked to authority and effective control, and not merely to territorial boundaries.").

[226] *See* Maastricht Principle 9, ¶ b.

[227] *See* Int'l Law Comm'n, Survey of International Law, Extract from the Yearbook of the Int'l L. Comm'n (1949), U.N. Doc. A/CN.4/1/Rev.1 (1949), at ¶ 58 (addressing State responsibility for transboundary harm as an "obligation of territorial jurisdiction").

principle, a state has prescriptive jurisdiction over an act "commenced within the state even if consummated or completed abroad."[228]

244. Thus, while some early human rights jurisprudence focused on cases of territorial control, it is now established that control over the individual is sufficient to establish the requisite jurisdictional link, and that a sufficient degree of control may be found in the conduct constituting the violation itself, be it environmental damage, cross-border shootings, or pushbacks of asylum-seekers on land or at sea. This approach does not render the jurisdictional requirement superfluous, as causation must still be established *(i.e.*, that the state's wrongful conduct caused or contributed to the violation).[229]

245. The Committee made clear in its General Comment 16 that the Convention "does not limit a State's jurisdiction to territory."[230] Rather, "State obligations under the Convention and the Optional Protocols thereto apply to each child within a State's territory and to all children subject to a State's jurisdiction."[231] The Committee has recognized that:

> State parties have obligations, including extra-territorial obligations, to respect, protect and fulfil all human rights of all peoples. Failure to take measures to prevent foreseeable human rights harm caused by climate change, or to regulate activities contributing to such harm, could constitute a violation of States' human rights obligations.[232]

246. The Committee also noted that "Home States also have obligations . . . to respect, protect and fulfil children's rights in the context of

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[228] Brownlie's Principles of Public International Law, 9th ed., (James Crawford, ed., 2019) at 442. Regional human rights mechanisms have recognized that jurisdiction under the Inter-American and European conventions encompasses the textbook example of subjective territoriality: cross-border shootings. See, e.g., Bastidas Meneses v. Ecuador, Petition 189-03, Inter-Am. Comm'n H.R., Report No. 153/11, ¶ 18 (2011); Andreou v. Turkey, App. No. 45653/99 (Eur. Ct. H.R. June 3, 2008), (admissibility decision).

[229] *See* Communication No. 1539/2006 (Munaf v. Rom.), adopted 30 July 2009, U.N. GAOR, Hum. Rts. Comm., 96th Sess., Annex ¶ 14.2, U.N. Doc. CCPR/C/96/D/1539/2006 (2009).

[230] CRC, General comment No. 16 (2013) on State obligations regarding the impact of the business sector on children's rights, , CRC/C/GC/16, ¶ 39. (Apr. 17, 2013).

[231] *Id.*

[232] Joint Statement on "Human Rights and Climate Change" (Sept. 16, 2019).

businesses' extraterritorial activities and operations, provided that there is a reasonable link between the State and the conduct concerned."[233]

247. The Committee's understanding of jurisdiction is buttressed by recent jurisprudence of regional courts and other human rights bodies that monitor compliance with treaties that have similar jurisdictional language as the Convention.

248. The leading opinion on state responsibility for transboundary environmental threats to human rights is the Inter-American Court of Human Rights' Advisory Opinion on Environment and Human Rights, which dovetails with the Committee's interpretation of the jurisdictional scope of the Convention.[234] At issue was whether a state party to the American Convention on Human Rights had jurisdiction over a person situated outside that state's territory whose rights were violated, or at risk of violation, as a result of cross-border environmental pollution caused or permitted by that state party.[235] The American Convention on Human Rights, like the Convention, contains language that limits a state's human rights obligations to people subject to its "jurisdiction." Reaffirming that the enjoyment of virtually all human rights depends on a healthy environment, the Court concluded that states have jurisdiction over individuals outside their territory who are harmed or at risk of harm from foreseeable transboundary environmental damage:

> As regards transboundary harms, a person is under the jurisdiction of the State of origin if there is a causal relationship between the event that occurred in its territory and the violation of the human rights of persons outside its territory. The exercise of jurisdiction arises when the State of origin exercises effective control over the activities that

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[233] CRC, General comment No. 16 (2013), at ¶¶ 39, 41; The CEDAW Committee has adopted a similar approach. See General recommendation No. 30 (2013) on women in conflict prevention, conflict and post-conflict situations, CEDAW/C/GC/30, ¶¶ 8-10. (Oct. 18, 2013).

[234] Advisory Opinion on the Environment and Human Rights (State Obligations in Relation to the Environment in the Context of the Protection and Guarantee of the Rights to Life and to Personal Integrity – Interpretation and Scope of Articles 4(1) and 5(1) of the American Convention on Human Rights), OC- 23/17, Inter-Am. Ct. H.R. (ser. A) No. 23 (Nov. 15, 2017) [hereinafter Advisory Opinion on the Environment and Human Rights], http://www.corteidh.or.cr/docs/opiniones/seriea_23_ing.pdf.

[235] Advisory Opinion on the Environment and Human Rights, ¶ 37.

> caused the harm and consequent violation of human rights.[236]
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> . . .
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> The exercise of jurisdiction by a State of origin in relation to transboundary damage is based on the understanding that it is the State in whose territory or in whose jurisdiction these activities are undertaken, who has effective control over them and is in a position to prevent the causation of transboundary damage that may affect the enjoyment of human rights of individuals outside its territory. The potential victims of the negative consequences of these activities should be deemed to be within the jurisdiction of state of origin for the purposes of any potential state responsibilities for failure to prevent transboundary damage.[237]

249. Similarly, the United Nations Human Rights Committee (HRC) applied an interpretation of the term "jurisdiction" in Article 2(1) of the ICCPR that recognized transboundary damage gives rise to cross-border human rights obligations. In its General Comment 36 on the right to life under the International Covenant on Civil and Political Rights, the HRC observed that states are under a duty:

> to ensure that all activities taking place in whole or in part within their territory and in other places subject to their jurisdiction, but having a direct and reasonably foreseeable impact on the right to life of individuals outside their territory, including activities taken by corporate entities based in their territory or subject to their jurisdiction, are consistent with [the right to life].[238]

[236] *Id.* ¶ 104(h).

[237] *Id.* ¶ 102.

[238] U.N. Human Rights Comm., General comment No. 36 (2018) on article 6 of the International Covenant on Civil and Political Rights, on the right to life, ¶ 22, U.N. Doc CCPR/C/GC/36 (October 30, 2018);; see also CESCR, General Comment 15, E/C.12/2002/11, ¶ 31 (recognizing that "[i]nternational cooperation requires States parties to refrain from" interfering directly or indirectly with access to water in other countries).

250. Likewise, the European Court of Human Rights held in *Andreou v. Turkey*, where Turkish forces shot a Cypriot national on territory beyond Turkey's control,[239] that the victim was within Turkey's jurisdiction because the shooting was "the direct and immediate cause" of his injuries: "acts . . . which produce effects outside [a State's] territory . . . may amount to the exercise by them of jurisdiction."[240] The Court applied this same principle in *Ilascu v. Moldova and Russia*, stating: "[a] State's responsibility may [. . .] be engaged on account of acts which have sufficiently proximate repercussions on rights guaranteed by the Convention, even if those repercussions occur outside its [territorial] jurisdiction."[241]

251. Critically for this case, responsibility for extraterritorial harm is also a pillar of international environmental law. All states have a duty under customary international law to ensure that "activities within their jurisdiction and control" do not cause significant transboundary damage to "the environment of other States or areas beyond national control".[242] As discussed above, this tenet of international environmental law informs the scope of human rights obligations in the context of rights violations caused by environmental harm.[243]

252. Based on this body of authority, the Committee should recognize that, in the context of human rights violations caused by climate change, a

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[239] Andreou v. Turkey, App. No. 45653/99 (Eur. Ct. H.R. June 3, 2008), (admissibility decision); Bastidas Meneses v. Ecuador, Petition 189-03, Inter-Am. Comm'n H.R., Report No. 153/11, ¶ 18 (2011).

[240] Andreou v. Turkey, App. No. 45653/99, 10–11.

[241] Ilascu and Others v. Moldova and Russia, Appl. No. 48787/99 (Eur. Ct. H.R. July 8, 2004), at ¶ 317.

[242] Legality of the Threat or Use of Nuclear Weapons, Advisory Opinion, 1996 I.C.J. Reports 226, ¶ 29 (underscoring that states have a general obligation "to ensure that activities within their jurisdiction and control respect the environment of other States or of areas beyond national control."); *see also* Trail Smelter Case (United States v. Canada), 3 R.I.A.A. 1905 (1941); Gabcikovo-Nagymaros Project (Hungary v. Slovakia), 1997) I.C.J. Reports 7 (1997), https://www.icj-cij.org/files/case-related/92/092-19970925-JUD-01-00-EN.pdf; Ilascu and Others v. Moldova and Russia, Appl. No. 48787/99 (Eur. Ct. H.R. July 8, 2004), http://legal.un.org/ilc/texts/instruments/english/commentaries/9_7_2001.pdf ¶ 317.

[243] *See* U.N. Human Rights Comm., General comment No. 36 (2018) on article 6 of the International Covenant on Civil and Political Rights, on the right to life, ¶ 62, U.N. Doc CCPR/C/GC/36 (October 30, 2018) ("Obligations of States parties under international environmental law should thus inform the contents of article 6 of the Covenant, and the obligation of States parties to respect and ensure the right to life should also inform their relevant obligations under international environmental law.").

child is within the jurisdiction of a state party when (1) that state's acts or omissions contribute to a polluting activity originating in its territory and (2) that polluting activity directly and foreseeably impacts the rights of children within or outside that state's territory.

253. As demonstrated above, these are exactly the facts in this petition. The respondents are causing and perpetuating climate change through their historic and current carbon pollution. They do so despite their decades-old knowledge that by contributing to climate change, they risk the lives and welfare of children within and outside their territory. The petitioners are the foreseeable victims of that pollution; their present injuries and exposure to risks are precisely the life-threatening harms that the respondents knew would happen if they failed to use all available means to reduce emissions and cooperate internationally to prevent global warming. As a result, each and every petitioner is within the jurisdiction of each respondent.

IX. Each respondent's actions are causing and perpetuating the climate crisis and violate the petitioners' rights.

254. There is no need for guesswork about the threat of climate change. A scientific consensus holds that climate change is already here. The world is already on average 1.1°C warmer than pre-industrial levels, which already results in more extreme and frequent heat waves, droughts, storms, and flooding, sea-level rise, ocean warming, and many other impacts. The changes are causing life-threatening and adverse impacts to millions of children around the world, including the petitioners by harming human health, threatening water and food security, damaging infrastructure, buildings and homes, and destroying the environment.

255. Each of the respondents has known that global heating has threatened lives for decades. Since 1992, when they signed the Climate Change Convention, Argentina, Brazil, France, Germany, and Turkey have undertaken to protect children such as the petitioners from the foreseeable threats of climate change. It was clear then that every metric ton of CO_2 that they emitted, or permitted, was adding to a life-threatening situation. In signing the 2016 Paris Agreement, each respondent further acknowledged the "urgent threat" of climate change in its Preamble.[244] Two years later, in 2018, the respondents learned that keeping heating

[244] Paris Agreement, Preamble, U.N. Doc. FCCC/CP/2015/10/Add.1 (Jan. 29, 2016).

under 1.5°C would save hundreds of millions of people this century from premature deaths associated with extreme heat, air pollution, devastating storms, sea-level rise, severe drought, water stress, and increased disease, among other things.[245] Every day of delay depletes the remaining carbon budget.

256. Knowing these consequences, each of the respondents has endangered and continues to endanger the lives of the petitioners by perpetuating and exacerbating climate change. Not one of the respondents is on an emissions pathway that is consistent with safe levels established by the best available scientific evidence and none have used all available means to prevent excess emissions from the four major emitters, other G20 member states, or the main carbon-producing business entities.

257. These actions are the product of deliberate policy choices, and they directly harm children all around the world. Each excess emission adds more dangerous carbon to the atmosphere, helps lock in irreversible climate change, and exacerbates the foreseeable risks to the petitioners' human rights and future generations.[246]

258. As global heating accelerates, due in part to the respondents' acts and omissions, children and future generations will continue to be exposed to foreseeable catastrophic consequences, threatening children's lives, health, and development. In a joint statement on climate change with other treaty bodies, the Committee has stated:

> The adverse impacts [of climate change], threaten, among others, the right to life, the right to adequate food, the right to adequate housing, the right to health, the right to water and cultural rights. These negative impacts are also illustrated in the damage suffered by the ecosystems which in turn affect the enjoyment of human rights. The risk of harm is particularly high for those segments of the population already marginalised or in vulnerable situations or that, due to discrimination and pre-existing inequalities, have limited access to

[245] *See supra* section V; "The 1.5 Health Report: Synthesis on Health & Climate Science in the IPCC SR 1.5," World Health Organization, at 12, https://www.who.int/globalchange/181008_the_1_5_healthreport.pdf; IPCC, "Special Report: Global Warming of 1.5 ºC," 2018, https://www.ipcc.ch/sr15/ pp. 447, 452, 464.

[246] Rogelj Report 2019 at 5-7, Table 1.

> decision-making or resources, such as women, children, persons with disabilities, indigenous peoples and persons living in rural areas. Children are particularly at heightened risk of harm to their health, due to the immaturity of their body systems.[247]

259. Any delay in meaningful and adequate emissions reductions will cause irreversible and high-risk consequences that future generations must contend with. The Committee and other treaty bodies have recognized "that to avoid the risk of irreversible and large-scale systemic impacts, urgent and decisive climate action is required."[248] By recklessly causing and perpetuating excessive levels of carbon emissions, the respondents are failing to prevent the deadly and harmful impacts of climate change, and are violating the petitioners' rights to life, health, and culture, and failing to have the best interest of the child be a primary consideration in their climate actions.

A. Each respondent is exacerbating the deadly and foreseeable consequences of climate change, violating the petitioners' right to life (Art. 6).

260. Article 6(1) of the Convention provides: "States Parties recognize that every child has the inherent right to life." The right to life is the "supreme right" from which other rights flow.[249] States have a negative duty to refrain from conduct that results in the arbitrary deprivation of life.[250] They also have a positive duty to protect against deprivation of life by "private persons or entities" or by "other States."[251]

261. The right to life is meant to protect against potentially lethal risk-taking. As the UN Human Rights Committee explained, these obligations extend to "reasonably foreseeable threats and life-threatening situations that can

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[247] Committee on the Elimination of Discrimination Against Women, Committee on Economic, Social and Cultural Rights, Committee on the Protection of the Rights of All Migrant Workers and Members of their Families, Committee on the Rights of the Child, Committee on the Rights of Persons, with Disabilities, Joint Statement on "Human Rights and Climate Change" (September 16, 2019), https://www.ohchr.org/EN/NewsEvents/Pages/DisplayNews.aspx?NewsID=24998&LangID=E.

[248] *Id*.

[249] UNHRC, General Comment No. 36, CCPR/C/GC/36, ¶ 2.

[250] *Id*. at ¶ 7.

[251] *Id.* at ¶¶7, 21, 22.

result in loss of life."[252] States violate the right to life by exposing victims to a real risk of the deprivation of life, even if "such threats and situations do not result in loss of life."[253] A deprivation of this right "goes beyond injury to bodily or mental integrity or threat thereto."[254]

262. The duty to protect life also implies that "States parties should take appropriate measures to address the general conditions in society that may give rise to direct threats to life or prevent individuals from enjoying their right to life with dignity."[255] These general conditions may include "degradation of the environment," and "deprivation of land, territories and resources of indigenous peoples."[256]

263. In *Portillo Cáceres v. Paraguay*, the Human Rights Committee held that the government violated the right to life of the victims by failing to protect them from the toxic environmental effects of large-scale agro-chemical spraying in the region.[257] The Committee found that Paraguay did not exercise adequate controls over illegal polluting activities, which it found constituted foreseeable threats to the life of the victims.

264. The Human Rights Committee has also noted that climate change is one "of the most pressing and serious threats to the ability of present and

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[252] *Id*. at ¶¶7.

[253] *Id*.; *see also* UNHCR, Communication No. 821/1998, Chongwe v. Zambia, Views adopted on 25 Nov. 2000, ¶ 5.2; Cf. Ilhan v. Turkey, Judgment, App. No. 22277/93ECHR (ECHR June 27, 2000), ¶ 75-76; Rochela Massacre v. Colombia, Judgment (InterInt-Am. Ct. H.R. May 11, 2007), ¶ 127.

[254] UNHRC, General Comment No. 36, CCPR/C/GC/36, ¶ 7.

[255] UNHRC, General Comment No. 36, CCPR/C/GC/36, ¶ 26.

[256] *Id*. The Inter-American Commission on Human Rights has also recognized that indigenous peoples' "special relationship [to their territories] is fundamental … for the[ir] material subsistence," and that such subsistence is related to the right to life. Inter-Am. C.H.R, *Indigenous and Tribal Peoples' Rights over their Ancestral Lands and Natural Resources: Norms and Jurisprudence of the Inter-American Human Rights System* (Inter-Am. C.H.R, *Indigenous and Tribal Peoples' Rights*) (Dec. 30, 2009), ¶ 56. In *Yakye Axa*, the Court found that Paraguay's failure to legally recognize and protect traditional lands of indigenous peoples "has had a negative effect on the right of the … [Yakye Axa] Community to a decent life, because it has deprived them of the possibility of access to their traditional means of subsistence." *Case of the Yakye Axa Indigenous Community v. Paraguay*, 2005 Inter-Am. Ct. H.R. (ser. C) No. 125 (June 17, 2005), ¶ 168.

[257] *Portillo Cáceres v. Paraguay*, Human Rights Committee, CCPR/C/126/D/2751/2016 (August 8, 2019), ¶ 7.5.

future generations to enjoy the right to life."[258] It implicates both negative and positive duties, both of which have been breached by each of the respondents. The Human Rights Committee has further found that,

> Implementation of the obligation to respect and ensure the right to life, and in particular life with dignity, depends, *inter alia*, on measures taken by States parties to preserve the environment and protect it against harm, pollution and climate change caused by public and private actors. States parties should therefore … pay due regard to the precautionary approach.[259]

265. As discussed, the precautionary principle prevents a state from invoking scientific uncertainty to justify its failure to take all available measures to prevent the life-threatening effects of climate change on its own children and on others. A state cannot gamble with children's lives. When a state takes dangerous actions with uncertain but foreseeable fatal consequences and accepts the risks of those foreseeable consequences, that constitutes in many jurisdictions "depraved indifference," "reckless endangerment", or *dolus eventualis*.[260] And it is a violation of the right to life under Article 6.

266. The respondents' acts and omissions causing and perpetuating the climate crisis have already exposed the petitioners throughout their childhood to the life-threatening risks of human-caused climate change, be it heat, floods, storms, droughts, disease, or polluted air.

267. The more frequent, extreme heat caused by climate change have already harmed many of the petitioners.[261] For example, Petitioners Iris Duquesne and Raina Ivanova have been exposed to frequent heatwaves in France and Germany that have killed tens and thousands of people across Europe. For indigenous Petitioners Carl Smith of Akiak, Alaska and Ellen-Anne of the Sapmi region of Sweden, increasingly hot temperatures are threatening their thousand year-old subsistence

[258] UNHRC, General Comment No. 36, CCPR/C/GC/36, ¶ 62.

[259] *Id*.

[260] *See, e.g.*, Model Penal Code, §§ 2.02, 211.2 (U.S.); Code Pénal, art. 223-1 (France); *Prosecutor v. Stakic*, ICTY, Appeals, 22 March 2006. *See generally* Greg Taylor, *Concepts of Intention in German Criminal Law*, 24 Oxford J. Legal Stud. 99-127 (2004).

[261] *See*, Appendix A.

traditions, which are intimately connected to their livelihoods and well-being.

268. Drier and hotter weather contribute to more intense wildfires, which have threatened Petitioners Alexandria Villaseñor and Raslen Jbeili. The deadly smoke from the Paradise Wildfire in California quickly aggravated Alexandria's asthma, forced her to flee her hometown, stay bedridden for weeks, and go to the emergency room. In Tabarka, Raslen's family narrowly escaped a wildfire in 2018, but many of his neighbors did not.

269. Dirty air exacerbated by the increased heat is worsening Petitioners Debby Adegbile's and Alexandria's asthma. For example, worsening deadly air in Lagos sends Debby to the hospital several times a year to treat her asthma attacks, forcing her to miss school and putting a financial strain on her family.

270. Increasingly intense storms are putting many of the petitioners in life-threatening situations, including in Palau, the Marshall Islands, Nigeria, Tunisia, Brazil, and Argentina. In Tabarka, for example, extreme rains regularly submerge Raslen's school, sometimes up to four feet. One flooding event swept away and killed some of Raslen's schoolmates as they were fleeing a storm. Recent storms have battered Petitioners Chiara Sacchi and Iris Duquesne with golf-ball sized hail, something they never had experienced before. One recent tropical storm ripped the roof off Ranton's home in Ebeye, the Marshall Islands, forcing him and his family to evacuate.

271. Drought is threatening the water security of many of the petitioners, including in South Africa, Brazil, Tunisia, Palau, and the Marshall Islands. For example, in Cape Town, Petitioner Ayakha Melithafa, along with the other residents of Cape Town, faced the imminent shutdown of their water supply, threatening the water security of over 3.7 million residents. Petitioners Catarina Lorenzo and Raslan are experiencing frequent water shortages in Salvador and Tabarka, respectively.

272. Some of the petitioners are exposed to increased disease due to more flooding and warmer temperatures. For example, Petitioners David Ackley III and Ranton Anjain are seeing an increase in Dengue Fever, a deadly disease that use to be rare on Ebeye and Majuro. Ranton caught dengue in 2019, and his father Jelton caught dengue in 2018.

273. Sea level rise and warmer oceans are already harming the petitioners from the Marshall Islands by reducing their ability to fish and grow gardens,

and damaging their homes and businesses. Rising oceans will decimate the entire Marshall Islands and much of Palau in the not so distant future if the world continues to warm.

274. The petitioners have also experienced mental stress from their fears of future catastrophic climate change; some have questioned whether to have children in a world riven by extreme climate change.

275. In summary, by recklessly causing and perpetuating life-threatening climate change, respondents have failed to take necessary preventive and precautionary measures to guarantee the petitioners' right to life and are thus violating Article 6(1) of the Convention.

B. Each respondent is exacerbating the deadly and foreseeable consequences of climate change, violating the petitioners' right to health (Art. 24).

276. Article 24 requires states to "pursue full implementation" of the "right of the child to the enjoyment of the highest attainable standard of health."[262] In particular, states are obligated to "take appropriate measures" to "diminish infant and child morality" and "combat disease and malnutrition" by, inter alia, protecting against the "dangers and risks of environmental pollution."[263] The Committee views health "as a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity."[264]

277. The Committee has recognized that climate change is "one of the biggest threats to children's health."[265] As a key determinant of children's health, climate change must be addressed through "evidence-based interventions."[266] Accordingly, states must "put children's health concerns at the centre of their climate change adaptation and mitigation strategies."[267]

[262] The Convention, art. 24(1).

[263] *Id.* art. 24(2)(a), 24(2)(c).

[264] CRC, General Comment 15, ¶ 4.

[265] *Id.* at ¶ 50.

[266] *Id.* at ¶ 16.

[267] *Id.* at ¶ 50.

278. For many of the petitioners—and other children around the world—the climate crisis has already physically harmed them and poses an imminent and foreseeable physical threat.

279. For example, the smoke from the Paradise wildfires caused Petitioner Alexandria Villaseñor's asthma to dangerously flare up, sending her to the hospital. Heat-related pollution in Lagos has led to Petitioner Debby Adegbile being hospitalized regularly due to asthma attacks.

280. The spread and intensification of vector-borne diseases has already impacted the petitioners. In Lagos, Debby now catches malaria multiple times a year. On the Marshall Islands, Ranton Anjain contracted dengue fever in 2019; David Ackley III contracted chikungunya, a new disease in the islands as of 2015.

281. Extreme heat waves that have increased in frequency because of climate change have been a serious threat to health of many of the petitioners. High temperatures are not only deadly, they can cause a wide range of health impacts, including heat cramps, heatstroke, hyperthermia, and exhaustion, and quickly worsen existing health conditions.[268] Extreme heat causes death and hospitalization.[269]

282. Drought is also threatening water security for many petitioners, like Catarina Lorenzo, Raslan Jbeili, and Ayakha Melithafa.

283. Hotter temperatures, sea-level rise and warming oceans are also threatening the indigenous petitioners' subsistence way of life, forcing some of them to shift their diet to more expensive, less nutritious store-bought food. For example, Petitioner Carl Smith's family have been catching substantially less fish, moose and caribou, requiring his family to rely on store-bought processed meats as a substitute.

284. The climate crisis is also triggering fear, anger, feelings of powerlessness and betrayal.[270] The petitioners have suffered and will continue to suffer from climate-related emotional trauma. For example, Petitioner Iris Duquesne thinks about climate change every day. She often feels powerless and fears what the future will bring. The wildfires in California caused Alexandria anxiety, mental trauma, and sleep deprivation. The

[268] World Health Organization, Information and public health advice: heat and health, https://www.who.int/globalchange/publications/heat-and-health/en/.

[269] *Id.*

[270] *See* Appendix A.

climate changes Ayakha is experiencing in Cape Town make her sad and angry, and she envisions a "miserable future." In Argentina, Chiara Sacchi cannot imagine a future with climate change and feels desperate. These are just a few examples of the mental trauma that the petitioners are already experiencing.

285. In summary, by recklessly causing and perpetuating life-threatening climate change, the respondents have failed to take necessary preventive and precautionary measures to guarantee the petitioners' right to health and are thus violating Article 24 of the Convention.

C. Each respondent's actions perpetuating the climate crisis are violating the indigenous petitioners' right to their culture (Art. 30).

286. Article 30 of the Convention guarantees indigenous children the right to enjoy their culture. It states:

> In those States in which ethnic, religious or linguistic minorities or persons of indigenous origin exist, a child belonging to such a minority or who is indigenous shall not be denied the right, in community with other members of his or her group, to enjoy his or her own culture . . . .

287. This right applies to any individual or community that self-identifies as indigenous peoples, and there is no requirement of state recognition for indigenous peoples to exercise their rights.[271]

288. The Committee has recognized that this right "may be closely associated with the use of traditional territory and the use of its resources."[272] It has noted that:

> In the case of indigenous children whose communities retain a traditional lifestyle, *the use of traditional land is of significant importance to their development and enjoyment of culture*. States parties should closely consider the cultural significance of traditional land and the quality of the natural environment while ensuring the children's right

[271] CRC, General Comment No. 11 (2009) Indigenous children and their rights under the Convention, U.N.Doc. CRC/C/GC/11, February 12, 2019, ¶ 19.

[272] *Id*. at ¶ 16.

to life, survival and development to the maximum extent possible.[273]

289. Other International human rights bodies have recognized the special relationship that indigenous peoples have with their land and resources, and its connection to their right to culture.[274] For instance, the UN Human Rights Committee acknowledged the importance of natural resources to the right to the benefits of culture in *Bernard Ominayak and the Lubicon Lake Band v. Canada*. In that case, the petitioners alleged that the government of the province of Alberta had deprived the Band of their means of subsistence and their right to self-determination by selling oil and gas concessions on their lands.[275] The Human Rights Committee characterized the claim as being based on the right to enjoy culture under Article 27 of the ICCPR.[276] It found that oil and gas exploitation, in conjunction with historic inequities, threatened the way of life and culture of the Band and that Canada had thus violated Article 27.[277]

290. The UN Human Rights Committee has explained that degradation of natural resources may violate the ICCPR's right to enjoy culture:

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[273] *Id*. at ¶ 35 (emphasis added).

[274] *See, e.g.*, *Centre for Minority Rights Development v. Kenya*, Case 276/2003, Afr. Comm'n on Human and Peoples' Rights, ¶ 156 (2009) (citing extensively the Inter-American Court's jurisprudence in *Awas Tingni*, *Moiwana*, and *Saramaka* in observing that indigenous peoples' "culture, religion, and traditional way of life are intimately intertwined with their ancestral lands [ ] and the surrounding area" and that "without access to their ancestral land, [they] are unable to fully exercise their cultural and religious rights, and feel disconnected from their land and ancestors.").

[275] UN Human Rights Committee, *Bernard Ominayak and the Lubicon Lake Band v. Canada*, Communication No. 167/1984, U.N. Doc. CCPR/C/38/D/167/1984 (Mar. 26, 1990) (*Lubicon Lake Band*).

[276] *Id.*; *see* International Covenant on Civil and Political Rights, art. 27, Dec. 16, 1966, 6 I.L.M. 368, 999 U.N.T.S. 171 (Members of minority groups "shall not be denied the right, in community with other members of their group, to enjoy their own culture, to profess and practice their own religion, or to use their own language."). S*ee also* UN Human Rights Committee, *Apirana Mahuika et al. v. New Zealand*, Communication No. 547/1993, ¶ 9.5, U.N. Doc. CCPR/C/70/D/547/1993 (Nov. 16, 2000) (noting that, according to general comment to Article 27, "especially in the case of indigenous peoples, the enjoyment of the right to one's own culture may require positive legal measures of protection by a State party and measures to ensure the effective participation of members of minority communities in decisions which affect them.").

[277] *Lubicon Lake Band*, *supra* note 275, ¶ 33.

> [C]ulture manifests itself in many forms, including a particular way of life associated with the use of land resources, especially in the case of indigenous peoples. That right may include such traditional activities as fishing or hunting and the right to live in reserves protected by law. … The protection of these rights is directed towards ensuring the survival and continued development of the cultural, religious and social identity of the minorities concerned, thus enriching the fabric of society as a whole.[278]

291. In addition, the UN Committee on Economic and Social Rights in 2009 recognized that "[i]ndigenous peoples' cultural values and rights associated with their ancestral lands and their relationship with nature should be regarded with respect and protected, in order to prevent the degradation of their particular way of life, including their means of subsistence, the loss of their natural resources and, ultimately, their cultural identity."[279]

292. The Inter-American system also recognizes that the right to culture has particular importance for indigenous peoples, including in particular, the vital connection of their lands and natural resources to this right. For example, in *Case of the Mayagna (Sumo) Awas Tingni Community*, the Inter-American Court has emphasized the importance of this connection:

> [T]he close ties of indigenous people with the land must be recognized and understood as the fundamental basis of their cultures, their spiritual life, their integrity, and their economic survival. For indigenous communities, relations to the land are not merely a matter of possession and production but a material and spiritual element which they

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[278] OHCHR, Gen. Comment No. 23, ¶¶ 7, 9.

[279] CESCR, General Comment No. 21, *Right of everyone to take part in cultural life,* (art. 15*,* para. 1 (a), of the International Covenant on Economic, Social and Cultural Rights, ¶ 36, E/C.12/GC/21 (Dec. 21, 2009) (CESCR, Gen. Comment No. 21) (citing International Labour Organization, Convention concerning Indigenous and Tribal Peoples in Independent Countries, June 27, 1989, arts. 13-16); International Covenant on Economic, Social and Cultural Rights (ICESCR), art. 15(1), Dec. 16, 1966, 6 I.L.M. 360, 365, 993 U.N.T.S. 3 ("The States Parties to the present Covenant recognize the right of everyone[] [t]o take part in cultural life.").

> must fully enjoy, even to preserve their cultural legacy and transmit it to future generations.[280]

293. The respondents' acts and omissions perpetuating the climate crisis has already jeopardized thousands years old subsistence practices of the indigenous petitioners from Alaska and the Sapmi, which are not just the main source of their livelihoods, but directly relate to a specific way of being, seeing, and acting in the world, and form part of their cultural identity. If the respondents continue their current emissions pathways, the world would warm enough to decimate indigenous cultures throughout the world, including those of the indigenous petitioners here.

294. As described above, subsistence hunting, fishing, and gathering have been primary sources of food and livelihood among the Yupiaq of Akiak, Alaska, for millennia, including for Petitioner Carl Smith. These subsistence practices are inextricably linked to the Yupiaq's culture and traditions, allowing Carl and others in his community to engage in communal gift-giving, sharing of stories, bonding with their own tribes, and ceremonies, practices they have passed on for generations.

295. Extreme heat in Akiak has reduced the amount of time that the Kuskokwim River is frozen, preventing Carl and others in his community from accessing traditional hunting grounds for caribou, moose, and other animals and making it more difficult and dangerous to set fish traps in the winter. The Kuskokwim has also warmed to unprecedented temperatures in the summer, killing salmon, a staple food for the Yupiaq. Akiak also faces increasing threats from erosion and flooding due to flash floods in the Kuskokwim.

296. In the Sapmi, generations of Sami have passed on the reindeer herding tradition that is essential to Sami culture and spiritual practices. Reindeer herding has been integral to the livelihood, economy, and way of life for the Sami for generations. Sami children, like Elle-Anne, are closely connected to the life of living with the reindeers, and they learn this culture from their parents and elders from a very young age.

297. The increasing heat in the Sapmi is making it impossible for reindeer, who are wild animals, to forage for the food that has sustained them for centuries. The reindeer are forced to alter their migration patterns to find food, a change that threatens and increases the cost of the traditional

[280] *Mayagna (Sumo) Awas Tingni Community v. Nicaragua*, Merits, Reparations and Costs, Judgment, Inter-Am. Ct. H.R. (ser. C) No. 79, ¶ 149 (Aug. 31, 2001) (Awas Tingni).

practice of reindeer herding, requiring the herders to work harder and longer. imperiling its future existence.

298. The Marshallese culture has evolved over millennia and is intimately connected with the ocean and the islands. The ocean provides food and connects Petitioners David, Litokne, and Ranton with their families on outer islands. The Marshallese grow traditional foods, make traditional medicines and practice ancient cultural ceremonies, like *Kemen*, the baby naming ceremony, that have been passed down over centuries. Risings seas, a warming and acidifying ocean, drought, and more severe storms have already harmed the Marshallese petitioners' fishing and other traditions.

299. Increasingly worsening climate change perpetuated by the respondents and other countries threatens to decimate these ancient subsistence and cultural traditions practiced by Petitioners Carl, Ellen-Anne, Litokne, David, and Ranton. The heating path that the respondents are exacerbating will make it impossible for the Sami and Yupiaq to practice their long-standing subsistence traditions that are so closely connected to their way of life and being. Rising oceans would wipe out the islands that the Marshallese have called home for millennia.

300. In summary, unabated climate change carried out by each of the respondents' acts and omissions would permanently undermine the ability of the indigenous petitioners to engage in their subsistence way of life and culture practices. By recklessly perpetuating life-threatening climate change, the respondents have failed to take necessary preventive and precautionary measures to guarantee the indigenous petitioners' right to their culture, and thus violating Article 30 of the Convention.

D. Each respondent has failed to make the best interests of children a primary consideration in their climate actions (Art. 3).

301. Article 3, paragraph 1 of the Convention gives children the right to have their best interests be given priority in any action or decision that affects them:

> In all actions concerning children, whether undertaken by public or private social welfare institutions, courts of law, administrative authorities or legislative bodies, the best interests of the child shall be a primary consideration.

302. The child's best interest is a substantive right. In any governmental decision that involves weighing competing interests, and assessing costs and benefits, the interests of "a child, a group of children, or children in

general", must be made a priority over other competing interests.[281] As the Committee observed, a "child's best interests may not be considered on the same level as other considerations."[282]

303. The child's best interest parallels the principle of intergenerational equity under the Climate Change Convention, which "places a duty on current generations to act as responsible stewards of the planet and ensure the rights of future generations to meet their developmental and environmental needs."[283]

304. By delaying decarbonization, despite all scientific evidence, the respondents' climate policies have under-valued children's lives and treated their present and future interests as lesser considerations.

305. Every day of delay depletes the remaining carbon budget, and if states fail to sufficiently reduce emissions in the next decade, children will bear the brunt of the consequences.

306. Delaying meaningful and adequate emissions reductions means exposing children to more likely and more severe threats to their lives, health, culture, and livelihoods. Delay also means denying children lost mitigation opportunities.[284] Every time the respondents and other states fail to meet their reduction targets, their excess emissions commit children and "future generations to steeper and more challenging emissions reductions in the decades thereafter to stay within the same carbon budget."[285] Ultimately delay "creates an imminent risk that it will be impossible to 'make up' for lost mitigation opportunities and will undermine the sustainable and safe livelihood of future generations."[286]

307. No state acting rationally in the best interests of the child would ever impose this burden by choosing such delay. The only cost-benefit analysis that would justify any of the respondents' policies is one that

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[281] CRC General Comment 14 at ¶ 6, 37.

[282] *Id*. at ¶ 6.

[283] OHCHR, Analytical Study on Climate at ¶ 35. *See* UNFCCC, art. 3(1) ("The Parties should protect the climate system for the benefit of present and future generations of humankind . . .").

[284] Rogelj Report 2019 at 4.

[285] *Id.* at 1.

[286] *Id.*

discounts children's lives and prioritizes short-term economic interests over the rights of the child.

308. Placing a lesser value on the best interests of the petitioners and other children in the respondents' climate actions is in direct violation of Article 3(1). By doing so, the respondents have breached their duties to ensure intergenerational equity and to respect, protect, and fulfill the enjoyment of children's rights for posterity.

X. Admissibility

A. Exception to exhaustion of domestic remedies

309. Article 7(e) of the OPIC makes communications inadmissible when:

> All available domestic remedies have not been exhausted. This shall not be the rule where the application of the remedies is unreasonably prolonged or unlikely to bring effective relief.

310. This Committee has noted that "Children's special and dependent status creates real difficulties for them in pursuing remedies for breaches of their rights."[287] UNICEF and the High Commissioner for Human Rights have documented major obstacles to children accessing justice to enforce their rights.[288] For example, the justice system is complex and difficult for children to understand.[289] UNICEF has noted, "Children have less knowledge, fewer financial resources and are generally less well equipped to deal with the complexity of the justice system, in all its forms."[290] In addition, children's ability to access justice usually requires support from adults, who themselves may not be aware of children's rights or know how to best support their children.[291] UNICEF documented

[287] CRC, General Comment No. 5, U.N. Doc. CRC/GC/2003/5 (27 Nov. 2003), ¶ 24.

[288] *See, e.g.*, UNICEF, Children's Equitable Access to Justice: Central and Eastern Europe and Central Asia at 9-11 (May 2015); United Nations High Commissioner for Human Rights, Access to justice for children, U.N. Doc. A/HRC/25/35 (Dec. 16, 2013), ¶¶ 13-16; UNICEF Bulgaria, Access to justice for children, https://www.unicef.org/bulgaria/en/access-justice-children-0.

[289] *Id.*

[290] UNICEF, Children's Equitable Access to Justice at 9.

[291] *Id.*; UNHCHR, Access to justice for children at ¶ 13-16.

situations in several countries of a "poor understanding among children and their families, both of children's rights and how to seek help in specific situations."[292]

311. In addition to these challenges facing children when trying to vindicate their rights, the petitioners face unique obstacles in exhausting domestic remedies in all five of the respondents' jurisdictions would be (1) unduly burdensome for the petitioners, (2) unlikely to bring effective relief, and (3) unreasonably prolonged.

312. *First*, pursuing remedies at the respondents' domestic level would be unduly burdensome. This case turns on the global scope and nature of injuries to sixteen children worldwide and the breaches of the five respondents through their individual and collective actions, raising claims that implicate foreign sovereign immunity. Each respondent recognizes in its domestic law that foreign states enjoy jurisdictional immunity for sovereign acts, but not for private or commercial acts.[293] Setting emission reduction targets and engaging in international cooperation are sovereign, not commercial activities. This means, for example, that a French court could not hear claims by French petitioner Iris Duquesne against Brazil concerning Brazil's climate policies. In essence, no single court could provide the same remedy sought in this petition against these five sovereigns. To compel even this small number of major emitters to abide by international climate change targets, lawsuits would have to be issued in five jurisdictions. Attempting to exhaust remedies in Argentina, Brazil, France, Germany, and Turkey would be so costly and unduly burdensome for the petitioners as to make any potentially available legal remedies an impossibility.

[292] UNICEF, Children's Equitable Access to Justice at 9.

[293] Under customary international law, immunized sovereign acts are deemed "acta de jure imperii", while private or commercial acts, which are not immunized, are deemed "acta de jure gestionis." All five Respondents apply this principle. *E.g.*, CSJN, "Manauta, Juan J. y otros c/ Embajada de la Federación Rusa," Fallos 93485 of Dec. 22, 1994, La Ley (LL), Sept. 1, 1995 (**ARGENTINA**); Arraci Barreto v. Germany, 9.7.2008 (**BRAZIL**) (recognizing immunity of Germany from claims arising from World War II because, despite their unlawful nature, they were nevertheless sovereign acts); Cour de la cassation, Rapport annuel 36, *L'évolution de l'immunité de juridiction des Etats étrangers (par M. Régis de Gouttes, premier avocat général)* (2003) (**FRANCE**), https://bit.ly/2N9MZnU (noting State immunity for acts having "*le caractère d'un acte 'jure imperii' accompli dans un but d'intérêt public et participant à l'exercice de la souveraineté de l'Etat étranger*."); *Empire of Iran*, German Federal Constitutional Court, 45 ILR 57 (1963) (**GERMANY**) (recognizing exception to immunity for commercial or private acts); Act on Private International and Procedural Law (Act No. 5718), art. 49 ("A foreign state may not claim immunity from jurisdiction in legal disputes arising out of private law relations." (**TURKEY**).

313. Take for example the petitioners from the Marshall Islands. In order to protect their human rights on the same scale as submitted in this petition, they would need to initiate lawsuits in all five respondent states with legal teams in each of these jurisdictions. The cost of retaining five legal teams and litigating five simultaneous cases through trial and appeal would be prohibitively expensive. And while certain petitioners might have access to more private or state funding than others, dividing petitioners would prevent them from acting as a group of rights-bearers with common interests and would substantially narrow the scope of their claims: it simply could not be the same case.

314. The high cost of accessing courts has been recognized by human rights bodies as an exception to exhaustion of remedies. For example, in *Hul'Qumi'Num Treaty Group v. Canada*, the Inter-American Commission on Human Rights recognized that "access to Canadian courts is very costly for [the indigenous petitioners] and makes it impossible to lodge the legal remedies mentioned by the State."[294] For similar reasons, the multinational character of the petitioners' claims render the cost of pursuing domestic remedies through five or more lawsuits unduly burdensome.

315. *Second*, the respondents' courts are unable to effectively remedy the violations in this case because they involve legal questions that raise, with respect to diplomatic relations, non-justiciable issues in their domestic tribunals. The petitioners' claims against their own states (here the petitioners from Brazil, France, Germany, and Argentina) cannot be fully reviewed by their domestic tribunals, because they address diplomatic decision-making. The petitioners allege that the respondent states have failed to use legal, economic, and diplomatic means to confront emissions from other G20 member-states and fossil-fuel industries. This claim implicates a state's obligations of international cooperation and its duty to protect under the Convention. But the petitioners are not aware of any domestic legal avenue in the respondent states permitting judicial review of a state's diplomatic relations, nor are the petitioners aware of any domestic mechanism to compel a state to initiate an inter-state complaint before the International Court of Justice or other available forum. While Petitioner Chiara Sacchi could potentially challenge Argentina's climate policies in an Argentine court, she could not challenge Argentina's failure

[294] IACHR, Report No 105/09, P592-07, Admissibility, *Hul'Qumi'Num Treaty Group v. Canada*, October 30, 2009 at ¶ 33.

to use diplomatic means to protect her from U.S. emissions, or challenge the climate actions of the other respondents.

316. While the petitioners recognize that important climate cases are proceeding in the Netherlands, France, Germany, Belgium, India and other countries, these cases are focused on climate policies in each respective country.[295] For the reasons of immunity and justiciability stated above, they do not and could not address the climate policies of foreign states or states' failure to cooperate internationally.

317. *Finally*, not only would exhausting remedies in multiple jurisdictions at the same time would be unduly burdensome and not provide the multi-jurisdictional relief petitioners are seeking here, it would cause unreasonable delay. Defenses are consistently raised by states to delay or prevent youth from accessing justice in domestic tribunals and the judicial process itself has inherent delays in reaching trial, judgment, and enforcement of remedies.[296]

318. For the above reasons, the petitioners respectfully submit that no effective remedies could be exhausted domestically.

B. Timeliness

319. The Communication is timely because to this date the respondents continue to perpetuate climate change through their acts or omissions—even if their excess emissions commenced long before the OPIC entered into force on April 14, 2014.

320. Under Article 20 of the OPIC, the Committee is only competent to hear violations by a state party that occurred after the OPIC entered into force for that state.[297] This requirement is waived, however, under Article

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[295] Urgenda Foundation v. The State of the Netherlands (2015), HAZA C/09/00456689; *Greenpeace and Others v. France* (2019), Tribunal administratif de Paris; *Greenpeace v. Federal Republic of Germany*, https://www.greenpeace.de/sites/www.greenpeace.de/files/20181101-greenpeace-legal-summary-climate-case-english.pdf (2018); *Armando Ferrão Carvalho and Others v. The European Parliament and the Council* (2018) Case T-330/18 (Germany); *Juliana v. United States*, 339 F. Supp. 3d 1062, 1071 (D. Or. 2018); *VZW Klimaatzaak v. The Kingdom of Belgium, et al.* (2015) (Court of First Instance, Brussels).

[296] For example, two of the cases noted above have been pending for four and seven years. *VZW Klimaatzaak v. The Kingdom of Belgium, et al.* (2015) (Court of First Instance, Brussels); Urgenda letter to the State of the Netherlands, 12 November 2012, available at https://www.urgenda.nl/wp-content/uploads/Letter_to_the_government.pdf

[297] Argentina ratified the Protocol on April 14, 2015; France ratified the Protocol on January 7, 2016; Brazil ratified the Protocol on September 29, 2017; and Turkey ratified the Protocol on

7(7), which permits the Committee hear violations that commenced prior to the OPIC's entry into force, so long as the "facts continued after that date" (the "continuing violations exception").

321. Human rights treaty bodies routinely apply this exception to the non-retroactivity of treaties when either the conduct or its effects are continuing.[298] Where the effects of a state party's acts are permanent and irreversible, such acts are considered to be "continuous in nature" and "admissibility *ratione temporis* is thereby justified."[299] Environmental damage has been recognized as one such permanent effect, continuous in nature. [300]

322. Here, both the respondents' actions and the petitioners' injuries are ongoing. As shown above, the respondents are continuing to perpetuate the climate crisis by promoting the fossil-fuel energy system and by permitting the emission of GHG at rates that far exceed scientifically established safe limits.

323. Further, the effects of respondents' pre-2014 GHG emissions will continue to affect the petitioners for decades. The respondents' emissions have contributed to permanent and irreversible adverse

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December 26, 2017. Germany ratified the Protocol on February 28, 2013, but because this was before the Protocol itself entered into force, the effective date for Germany is April 14, 2014.

[298] Compare Millan Sequeira v. Uruguay, HRC Comm. No. 6/1977, U.N. Doc. A/35/40, at 127 (HRC 1980) (finding that Uruguay's violations were continuing when a victim was arrested prior to entry-in-force but was still arbitrarily detained after that date) with Lovelace v. Canada, HRC Comm. No. 24/1977, U.N. Doc. A/36/40 (HRC 1981) (finding that a woman stripped of First Nations status by marrying a non-native man, in accordance with Canada's Indian Act and before entry-into-force, was a continuing violation because she continued to be barred from residing on a reserve).

[299] Szijiarto v. Hungary, Comm. No. 4/2004, U.N. Doc. A/61/38 (CEDAW 2006); see also Kayhan v. Turkey, Comm. No. 8/2005, U.N. Doc. A/61/38 (CEDAW 2006) (petitioner was dismissed from her post as a teacher prior to Turkey's entry into force of the Convention in 2002; the "effects" of petitioner's "loss of her status", such as loss of pension, salary and income, education grant, and health insurance, continued after entry into force).

[300] In Marangopoulos Foundation for Human Rights v. Greece, Complaint No. 20/2005, the European Committee of Social Rights found that Greece violated the "right to a healthy environment" afforded to all Europeans under the European Social Charter because Greece failed to counteract air pollution. Id. Notably, on the issue of ratione temporis, the Committee acknowledged the principle of nonretroactivity of treaties, but instead relied on the notion of a "continuing violation", underscoring that if an event occurring before entry into force of a treaty continues to produce effects after that date, then the state's obligations under the treaty are triggered. *See id*. (citing Papamichalopoulos and others v. Greece, 260B Eur. Ct. H.R. (ser. A), ¶ 40)).

impacts on the climate that impair and threaten to impair the petitioners' rights to life and health. Since the effects of climate change will continue to harm the petitioners for the foreseeable future, the continuing violations exception applies to Article 20.

C. Absence of parallel international proceedings

324. The subject of this Communication—Argentina, Brazil, France, Germany, and Turkey's violations of the petitioners' rights through their contributions to climate change—is not pending in any other international proceeding or settlement, nor does it duplicate, to the petitioners' knowledge, any Communication pending before or already examined by the Committee.

XI. Request for Relief

325. The petitioners respectfully request that the Committee adopt the following as proposed recommendations for relief: [301]

326. Finds that climate change is a children's rights crisis.

327. Finds that each respondent, along with other states, has caused and is perpetuating the climate crisis by knowingly acting in disregard of the available scientific evidence regarding the measures needed to prevent and mitigate climate change.

328. Finds that by recklessly perpetuating life-threatening climate change, each respondent is violating petitioners' rights to life, health, and the prioritization of the child's best interests, as well as the cultural rights of the petitioners from indigenous communities.

329. Recommends that the respondents review, and where necessary, amend their national and subnational laws and policies to ensure that mitigation and adaptation efforts are being accelerated to the maximum extent of available resources and on the basis of the best available scientific evidence to (i) protect the petitioners' rights and (ii) make the best interests of the child a primary consideration, particularly in allocating the costs and burdens of climate change mitigation and adaption.

330. Recommends that each respondent initiate cooperative international action—and increase its efforts with respect to existing cooperative initiatives—to establish binding and enforceable measures to mitigate

[301] The Petitioners reserve the right to request interim measures.

the climate crisis, prevent further harm to the petitioners and other children, and secure their inalienable rights.

331. Recommends that pursuant to Article 12, the respondents shall ensure the child's right to be heard and to express their views freely, in all international, national, and subnational efforts to mitigate or adapt to the climate crisis and in all efforts taken in response to this Communication.

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APPENDIX A

APPENDIX A.1
Chiara Sacchi
(Argentina)

A.1

Chiara Sacchi (Haedo, Argentina)

Chiara Sacchi has lived in Haedo, Argentina all seventeen years of her life. Part of Greater Buenos Aires, Haedo is in the Pampa Húmeda ecoregion, which typically has hot summers, cold winters, and moderate precipitation. The climate is changing though. As Chiara explains, lately the climate has become extreme, with weeks of intense heat in the summer. Sometimes, a week of this unusual heat will uncharacteristically arrive in the middle of winter.

Haedo is a densely built urban environment, with plenty of concrete and limited green space. Chiara, who likes to spend her free time with her friends in the plaza drinking mate and talking, is finding it difficult to adjust to the new climate. When it gets blistering hot, it is difficult to be outside. "In the summer, it is very hard to be out and about. It is unusually hot and it is hard for us to get used to that," Chiara explains. "The streets are all asphalt so that makes it even hotter."

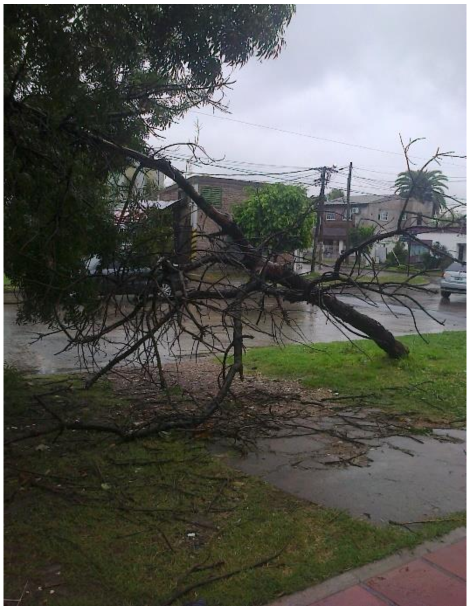
The extreme heat has also significantly increased the use of air-conditioning units, placing pressure on the electricity grid. Frequent power outages are common. Chiara explains that in the past, air-conditioning units were not necessary, "but now every home is equipped with a unit and the demand for electricity has increased. The infrastructure is not prepared for this, so that brings very frequent power losses."

Flooding in General Rodriguez, 40 km from Chiara's hometown, Haedo.

The electricity outages interrupt Chiara's daily life. For example, Chiara cannot complete her homework during power outages because the school system uses web-based platforms. In the extreme heat of summer, power outages quickly ruins food in the refrigerator. The outages also affect Chiara's mother, Perla, who is a farm-to-table chef.

More powerful and frequent storms are also hitting Haedo, like much of Argentina. Chiara recounts, "There are now storms with heavy winds and rain that is very unfamiliar to our area. About a year or two ago, a windstorm blew the roofs of our neighbors' houses and that is unthinkable for our climate. These last few years there have been too many storms and there's been severe flooding. One particularly bad storm dropped hail the size of tennis balls."

The storms damage buildings and flood the urban landscape. "We are not prepared to deal with rains and floods," Chiara explains. "The entire province of Buenos Aires is mainly now like a cement block rather than in the past we used to have green spaces. Now all the cities and towns are connected and there is no place for precipitation- everything is cemented and everything is built."



The impact of a heavy storm in Chiara's neighborhood: flooding and damage.

Despite facing these challenges, Chiara feels more fortunate than many others living in Argentina. "The truth is we are lucky enough to be in a home. We don't have an air conditioner, but we have fans. There are people in the streets that don't have a home and it's horrible. It is either too hot or too cold. We are lucky enough to not be as affected as other people."

All of the climate harms Chiara is experiencing, will only worsen, but to what extent depends on how much greenhouse gas the world continues to emit.

Chiara was aware of climate change growing up through her mother and social media. For example, climate change and other environmental issues are threatening her mother's ability to source materials for her cooking. Recently, Chiara's awareness of climate change has heightened because of her own experience in Haedo and from her participation in Terra Madre, a global project that seeks to protect and support small-scale food producers. Through Terra Madre, she has learned how climate change threatens the livelihoods of many small-scale food producers.

Chiara is scared of the future. The changes she is experiencing in Haedo makes her "think a lot with uncertainty about the future and that perhaps the country and the people are not ready to deal with what's to come."

> "It's hard to imagine a future with all these events. I think we are all quite desperate. I feel kind of—I don't want to say lonely—but I can't get the right word. It feels like we are alone, like no one knows what to do, and when you know what to do, nobody takes action."

Her friends and she question whether to have children in this changing world. "Yes, I'm scared to death. Why would I bring another human being here when we don't

Chiara striking for a better future and a better environment.

know what we will do with the ones that are already here. It’s very hard to control that, and I have spoken to a lot of young people that feel this way.”

Chiara feels angry about the global community’s response to climate change. “I’m truly mad. It’s not like ‘oh, I’m sad.’ I’m angry! We are alone here and there aren’t a lot of people that will take action. I’m mad.”

Chiara believes that young people must lead in the fight against climate change. “I mainly believe that the youth are the protagonists because we are the generation that are coming and who have to deal with that.”

“I wish I could beg for attention,” she says. “I think we need to be responsible. We need to make a change. We need to move and we need to do things right – the future is here. We don’t have any time. We cannot consider the world as we do now – there are no walls with climate change. We are here, we are all together.”

APPENDIX A.2
Catarina Lorenzo
(Brazil)

A.2

Catarina Lorenzo (Salvador, Brazil)

Catarina Lorenzo was born and raised in Salvador, located in Brazil's northeastern state of Bahia. An aspiring professional surfer, Catarina has spent a lot of time on Brazil's beaches and in the ocean. But, according to Catarina, who is twelve, the ocean and the beaches are much hotter than before. In the summer now, Catarina explains that "the water is so hot" and the sand is too hot to touch. Recalling a swim in the ocean this past summer, Catarina describes:

> "The water was really, really hot and the coral was white – it was dead. I had to swim away from the coral reef because it was all white and there were pieces of the coral reef floating around the water. The water surrounding the reef was too hot and unbearable – I had to get out of the water. I couldn't stay in the water."

Catarina on Salvador's coast.

Brazil has six major coral reef areas, and the Abrolhos Bank reef, which is the southernmost reef located in the state of Bahia – close to Salvador – is the largest reef in Brazil. The Abrolhos Bank reef is important because it contains mushroom-shaped coral species that no longer exists in other Atlantic reef beds. Heat waves between 2014 and 2017 resulted in coral bleaching across Brazil's reefs, including among the Abrolhos reefs.

Coral bleaching off Salvador's coast.

Catarina has seen coral bleaching affect the sea life surrounding the reefs as well: "There are many animals that are dying from the dead reef."

And while the summers are getting hotter than Catarina ever remembers them to be, Catarina explains that the winters are getting colder. "Each year the summer is too hot and the winter is too cold. Now it's winter – it's colder for me."

There are other changes too, notes Catarina. "It's raining less now. It should rain between April through August, but now it's just raining between July and August." This brings numerous problems, says Catarina. "We are having water shortages. There are times when the city lacks water for a day or two and cuts off our water supply for that time." Because of these water shortages – which come without warning from the local government – Catarina and her family save water in a tank in preparation for the next water shortage. Some of her neighbors, however, who do not have access to a large water tank, try to store water in buckets to use for showering or washing dishes, or otherwise go without water, having to use a neighbor or friend's water supply to wash up.

The lack of rain, Catarina explains, is also causing drier conditions: "The rain should make the soil muddy. Instead, the soil is staying dry. The soil is not like before." Indeed, the lack of rain is a prime concern for Brazil and for Brazil's forests, including the Amazon. This summer Amazon rainforest fires destroyed thousands of acres of forests, in part, the result of the drier climate and in other part, the result of Brazil's new policy of increased agricultural development. Catarina remarks that there is a "lack of supervision" and often times "invaders take advantage of forest fires to invade the land."

Brazil's forest fires are exacerbated by the drier climate, which spreads the fires to unmanageable sizes at a much faster rate. In August 2019 alone, there were more than 27,400 fires detected in the Amazon. Although the Amazon is located in the western part of Brazil, the effect of the damage goes far beyond Brazil and its borders. The Amazon rainforest contains enormous amounts of carbon as wood and other organic matter that, when burned, contribute to the climate crisis. In its pristine state however, the Amazon rainforest is a major contributor in reducing carbon dioxide from the earth's atmosphere, acting to cool the planet. "It makes me feel really sad that people would try to destroy the trees – something that helps them and the planet" remarks Catarina.

Catarina also describes that Salvador is experiencing more severe storms. "Here in Bahia for the first time ever we had a tropical cyclone." In March 2019, a rare South Atlantic tropical storm, named "Iba", surged along Bahia's coast. "There was a lot of flooding where people lost their houses, their boats, and the waves were gigantic because of the high winds." Another high impact storm with heavy rain and strong winds hit Bahia this year in July, damaging Catarina's home: "In my house some roof tiles flew off the exterior and the wooden lining of our house got wet and is now warped."

Catarina emphasizes that the government is ill-equipped to handle the intense rainfall from these strong storms. The heavy rains from the July storm caused the overflow of a local dam due to water pressure, resulting in flooding and the evacuation of hundreds of families from their homes. Additionally, Catarina explains, "in Salvador when it rains a lot the government opens the sewage system, which is jammed with water, and dumps the sewage into the river and ocean because the water pumps don't work." But

Catarina in front of the ocean in Salvador.

such a move pushes toxic waste into water streams and beaches, and “we risk getting diseases,” says Catarina.

All of the climate harms Catarina is experiencing, will only worsen, but to what extent depends on how much greenhouse gas the world continues to emit.

The extreme temperatures and changing weather patterns worry Catarina. “I feel that I don’t know exactly what will happen in the future. If we don’t act to stop the climate crisis, it will be the kids who pay the consequences.” Although she is only twelve-years-old, Catarina fears what will happen to her future, and the future of her children, if she decides to have any. “The future will not be the same as today.”

To the world leaders, Catarina says that they “need to respect the limits of planet earth. They need to understand they cannot detract all the natural resources and pollute the atmosphere because other people and living things need to continue living in the future.” She explains that it is the children of the world who stand to suffer the most from the climate crisis: “It is our future and world leaders should hear us. If they don’t act to stop the climate crisis it is our future that will be affected.”

APPENDIX A.3
Iris Duquesne
(France)

A.3

Iris Duquesne (Bordeaux, France)

The first summer of sixteen-year-old Iris Duquesne's life was the hottest summer in Europe since 1540. Born in Bordeaux, France on April 22, 2003, Iris was three months old when the deadly heat wave of 2003 swept France. It was one of the worst weather events in the Continent's history, killing as many as 70,000 Europeans, some 15,000 in France alone. The most vulnerable to heat stress are the very old, the very young, and the infirm. Iris's parents, Christine and Gregory, were scared they would lose their baby girl to the heat.

The family had moved to Bordeaux before Iris was born. As Iris grew up, Bordeaux experienced climate change induced temperature extremes they had never anticipated.

The 2003 heat wave was followed by another in 2006, which claimed around 2000 lives, a lower toll thanks to a National Heat Wave Plan and adaptation measures. But the heat has stayed. The five hottest summers in Europe since 1500 have all occurred after 2002. In 2003, Bordeaux reached an all-time high of 40.7°C; in July 2019, two months after Iris's 16th birthday, Bordeaux broke that record at a scorching 41.2°C.

Indeed, the increased heat has affected Bordeaux's local economy. Iris notes that Bordeaux is known as one of the world's top wine regions, and grape harvests, which used to take place in September, now because of the heat occur in mid-August – which impacts the assembly process and delivery.

Storms have also hit Bordeaux with more frequency and intensity. In February 2010, Cyclone Xynthia struck southwestern France, causing deadly floods. The river Gironde almost broke its banks in the city. Iris was eight when the cyclone struck: she and her mother were caught outside and raced home on foot in the lashing winds and rain. Iris was terrified of the storm: "I was really scared, I went into my room and hid under my pillows and blankets." After that, Iris developed a fear of rain. She had recurring nightmares of tsunamis and storms.

Flooding from the 2018 rainstorm in Bordeaux.

Yet major storms came more frequently; on May 28, 2018, a violent hailstorm ravaged Bordeaux. At the Duquesne's home, the hail was the size of golf balls. The street flooded like a stream. Water poured into their house through a leaky roof. When Iris's mother, Christine, was growing up, these kinds of storms were rare: “I only remember 3 storms—big, big storms like that—in 16 years.” For Iris they are regular events.

Bordeaux’s Atlantic coast.

The sea level along Bordeaux’s coast has also risen. Tides are getting higher, pushing the coastline closer inland. Iris recalls in 2014, one of Bordeaux’s largest buildings, known as “le signal”, was evacuated as the coastline almost reached the base of the building. Christine, remembers “le signal was too close from the ocean” and people feared “it might fall in.”

Moreover, the changing weather patterns has brought with it an influx of tiger mosquitoes, which Iris says, were not present before. “Five years ago, there were only a few in Bordeaux, but now it became an indigenous population, spreading diseases like chikunguya and zika.” Christine explains that because of this new increase in tiger mosquitoes “in summer being outside is more difficult” as there is a greater risk of contracting one of the mosquito-borne diseases.

All of the climate harms Iris is experiencing, will only worsen, but to what extent depends on how much greenhouse gas the world continues to emit. Indeed, experts predict that climate change will only increase the frequency and intensity of such heat waves and storms in Europe.

Iris first heard about climate change from her teachers in primary school. In seventh grade, Iris bean to understand the global nature of climate change. “We read an article in class and the teacher asked what was global warming, and I said that it was something happening in France… And the teacher told me that I was right except that it was happening everywhere in the world. And that is when I realized, ‘oh ok, that is bad, that is important.’”

View of Bordeaux’s Atlantic coast from above.

Iris eventually conquered her fear of water. But she cannot shake her fears rooted in living through extreme weather events.

Now, at 16, Iris thinks about climate change every day: “I’m wondering, ok, what is going to happen today. Sometimes I try to figure out solutions in my mind.” She often feels powerless. She fears what the future will bring: “The world is going to be sad. There will be climate refugees everywhere in

Europe and the US. There will be tension and pollution and the geography will be completely changed. There are islands that are going to disappear and countries like the Netherlands that will disappear."

Iris with family and friends on Bordeaux's beaches.

In thinking about her future, Iris says, "I don't want to have kids if they're going to live in a world like that."

Iris feels betrayed by authorities: "It just makes me angry. They're supposed to be our government and they're supposed to protect us . . . they're supposed to protect us now and in the future, and they're not doing anything . . . they don't realize it will cost less money if we act now than if we act later."

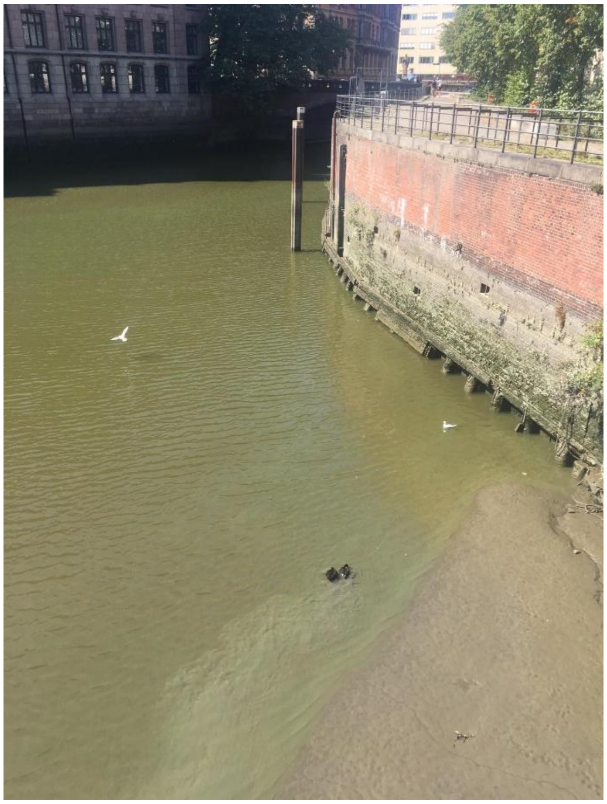
In 2019, Iris moved with her family to California, where she is finishing high school. She wants to attend university in North America before returning to France. She is not sure if she would want to return to her home city: "It would be hotter and harder to live."

APPENDIX A.4
Raina Ivanova
(Germany)

A.4

Raina Ivanova (Hamburg, Germany)

As countries all over Europe reached peak and record-breaking temperatures this summer, so too did Germany, which recorded its highest-ever temperature of 40.5 Celsius (105 Fahrenheit). Unsurprisingly, the unprecedented sweltering heat has severely affected people and the environment.



Dried out canal bed in Hamburg.

For Raina Ivanova, a 15-year-old Hamburg native, going to school is not like it once was. Hamburg's recent blazing spring and summer temperatures force Raina and her classmates to switch classrooms and take breaks in an attempt to disrupt the lingering warm, clammy air, making it harder to concentrate on school subjects. Heat waves are not the only consequence of the climate crisis that Raina is experiencing. Hamburg's famous canals – which fill with water from the Elbe and Alster Rivers – have taken a severe hit in recent years. Boats that once beautifully lined the city's smaller canals have suspended services as high summer temperatures have led to dangerously low river levels, and by default, shockingly low canal water levels where locals, like Raina, for the first time "see the sand that's on the bottom" of the canal bed.

At other times, intense rainfall and storms has caused the canals to overflow, flooding nearby land, and pushing canoes over canal beds in Raina's neighborhood. Raina has seen this firsthand. In October 2017, Hamburg experienced a severe storm, dubbed "Herwert", which had winds blowing up to 176 km/h (109 mph) in parts of Germany, and flooding the streets of Hamburg. Neighbors and friends saw their garages fill with water and ruin their belongings, while Raina and her friends walked in knee-high water in her school's football field.

These weather patterns are "very shocking" for Raina and her friends, and are changing the landscape of her beloved city. The increasingly powerful storms have specifically posed a danger to Hamburg's trees; Raina remembers:

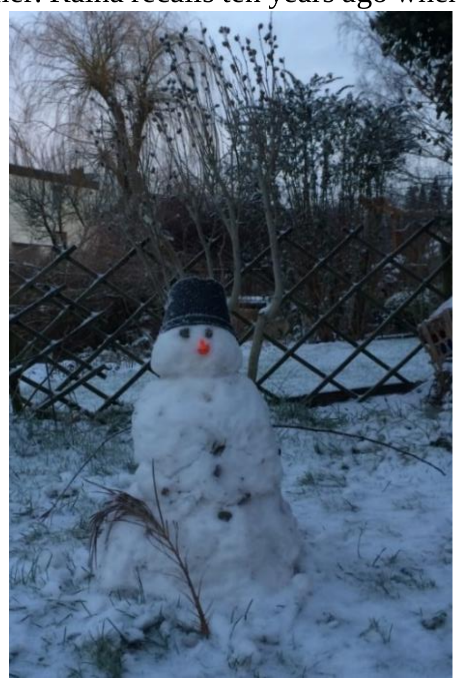
A.4

Hamburg after Herwert hits the city in 2017.

> Near our house by the channel there is a little island and there used to be a very big [willow] tree and it was very pretty. When we were little we took the canoe and paddled to the island under the willow tree. After the storm they cut [the willow tree] down and now it’s not there anymore.

In fact, Raina acknowledges that “there were a lot of trees in our neighborhood and so they decided to cut some big ones that could possibly fall on houses if there is again such a bad storm.”

The ramifications of these changing weather patterns include unfamiliar winters as compared to historically picturesque white winters in Hamburg. This is because as the summers in Germany have been heating up, the winters have also gotten much warmer. Raina recalls ten years ago when Hamburg used to get moderate amounts of snow, and now “there is barely any snow and it doesn’t stay for long”, unable to stick to the warm ground below. Even Hamburg’s canals, which were known for freezing up in the winter – something that the locals used to take full advantage of by ice skating on the frozen surface – nowadays, and in particular the channels in Raina’s neighborhood, forms an ice layer “so thin the ice can barely even hold one person.”



“The Last Snowman”

All of the climate harms Raina is experiencing, will only worsen, but to what extent depends on how much greenhouse gas the world continues to emit.

Raina’s focus is no longer solely on her studies; rather, in the back of her mind there is a looming fear that she cannot ignore – the fear that one day her world, “*our* world,” as she expressed it will be different, scary, and sad. This sadness and fear and a belief to overcome it has driven her to participate in “Fridays for the Future” – a movement initiated by global activist Greta Thunberg, in which youths, like Raina, forego school on Fridays in an effort to bring awareness and spark action to combat climate change. On these Fridays, Raina and her friends go to Hamburg: “we

"Fridays for the Future" in Hamburg.

draw signs and we go around the Alster" – a lake within the city limits of Hamburg – "and we sing songs about the climate … and we have flyers that we give to people that are around there to help them see the need to do more ." She participates in these events hoping to spark an interest among "the adults" to act, to make a change for children like herself.

The consequences of climate change disrupt Raina's daily life, thoughts, and dreams. Her sisters, all younger than her, have begun to ask her about the rising temperatures. Raina tries to soothe her little sisters' worries, although she herself shares those same concerns. As she says, "[climate change] makes me really sad" and "is something that really scares me when I talk about it with my little sister" because "global warming will have a bigger impact on our lives." Raina encourages her family to actively do their part, however small it may be, to prevent contributing to global warming. "I try to turn down the heat in my room also in the winter" and "we have solar panels on our roof and we try to use more renewable energy and less energy in general."

Indeed, Raina's experiences and the more she learns about the changing climate has made her question whether she herself wants to fulfill her "dream" of having children one day:

> When I was younger I was very sure that I wanted to have children and to live in Hamburg but because of all these consequences [as a result of climate change] I'm not sure I would want my children to face this or to live in such an environment that they have to worry about their lives because of the weather.

Raina (right) and her friends.

Having experienced in her short lifetime these dramatic weather patterns, climate change "is something very emotional" for Raina. She hopes that world leaders "know that the little children in [her] generation sometimes cry because of the decisions [world leaders] make." Raina knows she is likely to live in a world where climate change is very present: "it will affect my life and the life of my children, if I decide to have some." But she remains hopeful that her politicians and "the adults" in a position to make a change – who "didn't really have to face all these problems and issues that we have to face now because in their childhood they didn't have to think about these consequences" – "know what will happen if we don't act the right way now."

APPENDIX A.5
Ridhima Pandey
(India)

A.5

Ridhima Pandey (Haridwar, India)

Eleven years old Ridhima Pandey moved to the northeastern town of Haridwar, India, six years ago, from Nainital. Haridwar is known as the “holy area” of India, Ridhima explains, where many Hindu temples are located, including Lord Shiva’s temple. Central to the holy area, is the nearby Ganges River: “Every year in July, there is a festival, known as Kanwar Yatra. People come to Haridwar from all over India to collect water from the Ganges, and give back to the Lord Shiva with the Ganges’ holy water.” This tradition, notes Ridhima, is specific to Haridwar and the greater state of Uttarakhand since the Ganges only runs through the northeastern part of the country.

People come to Haridwar from all over India during Kanwar Yatra to collect water from the Ganges River.

The holy Ganges River, however, faces lowering water levels from recent droughts – threatening the religious rituals that are centered around it. Ridhima says: “the temperature is increasing. The environment here used to be very cool and now it is very hot. And in the winter the temperature is much hotter.” Ridhima’s father Dinesh explained that this is causing more droughts in the summer months which “seems to be drying out the Ganges more in the summer.”

Lower water levels in the Ganges.

The Ganges River, spanning 2,520 kilometers from the Gangotri glacier in Uttarakhand on the border of Tibet to the Bay of Bengal, is among the world’s most endangered rivers. The Gangotri glacier rests almost 5,000 meters above sea level and provides 70 percent of the river’s water, but is shrinking by 22 meters per year, almost twice as fast as it was 20 years ago. Groundwater discharge and rainfall contribute the remainder of the river’s flow, but increased summer temperatures have dried out nearby land, reducing the groundwater flow to the river by 50 percent.

And, as Ridhima explains, “the rainy season is getting shorter. The rain used to last for weeks during the rainy season” – June through September – “but now the rain that does fall only lasts for a day every once in a while. It is not consistent like before.”

The lack of rain is intensifying water shortages in some areas. Ridhima and her family experienced water shortages when they lived in Nainital. Although water shortages are a concern in Nainital the entire year, with water outages lasting two to three days at a time, “the lack of rain increases the water problem.” Ridhima explains, “the ground water level is very low there. We had to store water in underground tanks.”

Now though, the few times it does rain, “the raining is heavy,” says Ridhima. Ridhima explains, there are times when it rains so hard that “the [Ganges] river gets to the danger mark. If the water level crosses the danger mark, the water will come out and overflow onto the land.” Ridhima notes, however, that in the past the rain did not cause as much damage as it does now: “Now if a heavy rain occurs the river overflows and those living near the river get stuck there.”


Pollution combined with increased extreme weather patterns has caused an influx of mosquitoes.

The increased intensity of rainstorms has challenged the local infrastructure, causing water to pool and sewage to overflow into the Ganges. “The drainage is not proper, and the water will collect and come out in some places closing the streets and schools.”

The polluted environment, stagnant water, and increased flooding in the area is also creating an influx of mosquitoes, says Ridhima. As a result of a mosquito bite, Ridhima’s mother “suffered typhoid one month ago and had to go to the hospital.” Ridhima explains, “my mother had high fever, body pains, and was very cold. The doctor put her on glucose and medicine, and after a month she took the vaccine.”

All of these developments, which Ridhima attributes to the changing weather patterns, has made Ridhima very vocal about her government’s contribution to the climate crisis.

Aftermath of the 2013 rainstorm that devastated Uttarakhand.

In 2013, Ridhima and her family in Uttarakhand experienced a devastating rainstorm that resulted in flooding and many casualties. “Everything in the area got damaged. People were dying – they were stuck under the stones, the sand. The holy places got flooded.” This destructive 2013 rainstorm sparked Ridhima’s interest in advocating against the climate crisis. “At that time I realized all these things were happening due to global warming, and I got interested. I feel really bad that we, the humans, are spoiling our nature and future. We are destroying the future of other generations and our future.” From that point on Ridhima began reading and learning about the climate crisis to understand how should could become a better advocate.

In 2017, at just nine years old, Ridhima decided to sue the Indian government for failing to take adequate action to tackle climate change: “I sued my government because I want a better future. I want to save my future. I want to save our future. I want to save the future of all the children and all people of future generations. In India, the government is not acting as they should to prevent climate change.” Although the court of first instance – the National Green Tribunal, a specialized court established in 2010 to hear environmental cases – dismissed Ridhima’s petition, she has appealed to the Supreme Court of India and her case is currently pending there.

Ridhima gives a speech at her school on protecting the environment.

“People in India are not making the environment a priority,” says Ridhima. “We are destroying all our resources – wasting water and polluting our air so badly.” And while Ridhima faults the

Indian government for their contribution to the climate crisis, she acknowledges that “it is not a problem which any country can solve on its own. All the countries must join their hands together to solve this crisis as it is a global issue.”

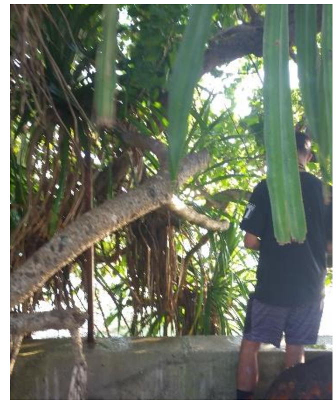
Indeed, all of the climate harms Ridhima is experiencing, will only worsen, but to what extent depends on how much greenhouse gas the world continues to emit.

“When I think about the future with global warming, I feel very disappointed because I can’t imagine a healthy and long life. Every person deserves to live in a healthy environment. We, children, want a better future. I personally don’t want to suffer – I want a healthy future, I want to live a healthy life. And future generations also have the right to live a healthy future.”

APPENDIX A.6
David Ackley III
(Marshall Islands)

A.6

David Ackley III (Majuro, Marshall Islands)



David Ackley III in Majuro

David Ackley III ("David") is a sixteen-year old living on Majuro, the capitol of the Republic of the Marshall Islands, in a town called Uliga. Although Majuro always served as his "home base" and most of his extended family lives there, David was born in Illinois while his father, David Jr. completed his residency. Their family moved from Illinois to the Hopi Reservation in Arizona for eight years, and then spent three years in Honolulu, Hawaii while his father worked for the US Public Health Service. When David was eleven years old, his family moved back to Majuro permanently.

David feels lucky to live in a place where he is surrounded by his culture, family, and friends. "I goof around a lot on this island, but it's easier to do that when you know everyone and everyone knows you." According to David's mother, Neilani, to be Marshallese in the Marshall Islands "means safety" – not having to worry where her son is because she knows her neighbors and everyone in their community. "Everyone is close," David agreed. Majuro is a place where David can "actually be a Marshallese person," which he appreciates even more after facing prejudice in other places. In particular, David and his mother experienced racism in Hawaii, recalling that people looked down on them for being Marshallese.

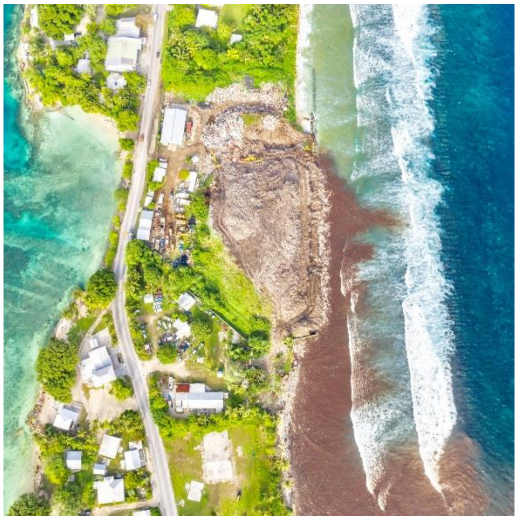
On Majuro, David and his family can keep alive traditions, and "be Marshallese". For example, Neilani describes one tradition in particular, *kemem*, which is a baby's first birthday celebration where friends and family gather outside the hosts' home, singing, dancing, and celebrating all night long. According to Neilani, the tradition arose long ago because there used to be a risk that a newborn baby would die before reaching its first birthday, and *kemem* is when the baby is named to celebrate the baby's survival. David does not think *kemem* would be the same outside of the Marshall Islands – it would be harder to celebrate when you are not surrounded by community members who understand *kemem*: the "neighbors might call the police in the middle of the night," rather than coming out and joining the singing and dancing.

Majuro dump, two days after fire in March 2019.

Now, David's home, traditions, and way of life are all at risk. David first heard about the climate crisis in fifth grade: "I thought this was immediate, and I was scared. Now that I know it takes longer, it is more subtle, and I am less scared, but I still think about it a lot. I feel lost. I like to keep my mind off it because it scares me, but it still pops up a couple of times a day."

The Marshall Islands have already suffered severe climate crisis impacts and are facing complete destruction as sea levels continue to rise. Greenhouse gas emissions of major emitting countries thousands of miles away are threatening the approximately 59,677 citizens living on 29 low-lying coral atolls, 1,156 islets, and five single islands that make up the Marshall Islands. Rising temperatures and sea levels, combined with droughts and dying coral reefs have already begun to change this island nation, and unless other countries urgently make significant changes, its islands will be unrecognizable in 40 years, if they exist at all.

In just five years, David has seen these impacts on Majuro firsthand. King tides, which are exceptionally high tides, now consistently breach the sea wall and damage homes. King tides also cause the landfill, which is located on a thin strip of reef between two islands to overflow, and push trash onto Majuro. According to David Jr., "when it rains, colored water runs into the ocean from the landfill." Although David's family home is located approximately fifty meters inland from both the lagoon- and ocean-sides of Majuro, his neighbors' oceanfront houses flood at least once a year – every time there is a king tide – and some have had to abandon their homes to seek higher ground during floods, which often overtake the main road on the island, making travel difficult and unsafe.



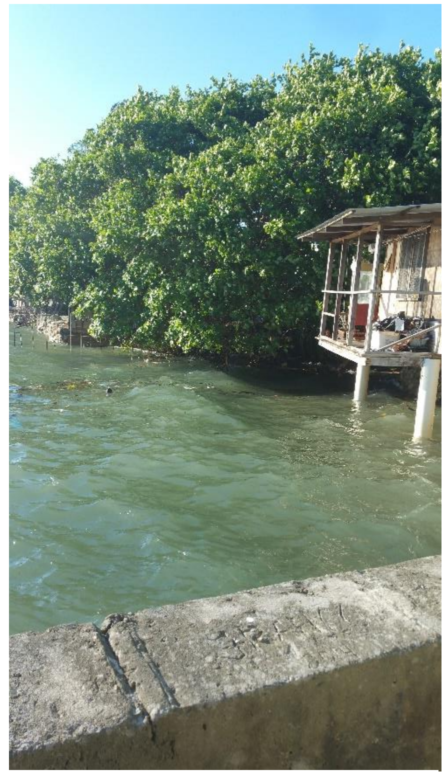
Aerial view of the Majuro Dump

David works part time at his family's docking business and at a restaurant and night club his grandmother runs. King tides have damaged both of these businesses. Last year the dock collapsed during a high tide that also damaged the restaurant. The family restaurant is built right on the water, "so you sometimes get splashed." This used to be just part of the experience, because, according to David, "everything tastes better with a little saltwater on it." Now, however, their family has contemplated moving the restaurant because of how often it floods. These predictable floods that accompany king tides are a new phenomenon - Neilani does not remember her mother's restaurant flooding when she was younger.

The coral surrounding Majuro is also mostly dead, although David recalls that when he was younger, the coral on the lagoon side, was, at least, "not as dead as it is now, even though the oceanside coral was always dead." Now, the reef is bleached "almost everywhere." This, too, is a change that took place in the span of one generation; when Neilani was David's age, the coral on both sides of the island was vibrant and alive. David has also noticed that it is becoming a lot harder to find fish. David goes spearfishing as often as he can, but now he has to take a boat to one of the smaller islands to catch anything. Additionally, some of the fish David and his family used to eat have become poisonous, likely from ciguatera, and Neilani knows that people have recently died from eating these fish.

Storms on Majuro have also increased in frequency and violence. Recently the winds from the lagoon side were unusually strong and a fishing boat crashed onto the shore from the water. El Niño events, which Neilani says "seem to happen every year now" rather than once every five to ten years, bring drought and excessive heat, causing the grass, banana, and breadfruit trees in David's yard to turn brown.

Mosquito-borne illnesses have also become much more common on Majuro. According to David Jr., Majuro previously had instances of dengue, but chikungunya and zika are new to the islands since 2015, and all three have become more common. As of August 20, 2019, Majuro was in the middle of a dengue outbreak. Last October, David contracted chikungunya, one of the newly arrived mosquito-borne illnesses. For an entire week, David felt weak and dizzy, he kept throwing up, and his arm went numb. Luckily, David did not have to go to the hospital because his father brought home an IV to treat David there.



View from Majuro, Marshall Islands

David and his family talk about climate change fairly often: it is hard to avoid the topic when you can see the impacts of climate change creeping up onto your island with the rising sea. David's family wonders if they will have to move away from their home, something that worries David, who wants to live in the Marshall Islands when he grows up. He does not want to be separated from his community, his homeland and his culture, and does not want to move to a place where he might face racism and prejudice again. But, all the climate harms David is experiencing will worsen, only the extent to which depends on how much Greenhouse Gas the world continues to emit.

When David thinks about his future, he is not sure what he wants to do, but he is sure he wants to live on Majuro, that when he eventually has a family, he wants his children to grow up where he did. "The experiences I've had here are different than what there is in other places. This is a place where you can actually be a Marshallese person."

APPENDIX A.7
Ranton Anjain
(Marshall Islands)

A.7

Ranton Anjain (Ebeye, Marshall Islands)

Ranton on a fishing trip when younger.

Ranton Anjain is a sixteen-year old Marshallese living on Ebeye Island, the most populous of the Marshall Islands. Although he was born on Majuro, Ranton has lived on Ebeye for most of his life, and his father, Jelton, was "born and raised" on Ebeye. Ranton appreciates that growing up on Ebeye allowed him to go swimming and fishing every day, something he realizes you cannot do in most places. Ranton also enjoys learning about his culture and his community. For Ranton, the Marshallese community is built on respect, "it is what makes us Marshallese."

Ranton's way of life on Ebeye is threatened, however. The Marshall Islands have already suffered severe climate crisis impacts and are facing complete destruction as sea levels continue to rise. Greenhouse gas emissions of major emitting countries thousands of miles away are threatening the approximately 59,677 citizens living on 29 low-lying coral atolls, 1,156 islets, and five single islands that make up the Marshall Islands. Rising temperatures and sea levels, combined with droughts and dying coral reefs have already begun to change this island nation, and unless other countries urgently make significant changes, its islands will be unrecognizable in 40 years, if they exist at all.

Ranton has felt a lot of these changes firsthand. Ranton and Jelton used to go fishing on the weekends with a fishing trawler. But now, it is too hot to be outside for long, and the water has gotten noticeably warmer. Poisonous fish have become more common: Ranton and his dad now avoid bottom fish and explained that "red snapper from the northern part of the atoll is a 'no-no', but if the snapper is from the southern part it is ok." Ranton has also seen increased coral bleaching. In 2018, Ranton participated in a program where he measured coral vitality, and found that the bleached, dead coral outnumbered living coral.

Ranton places a quadrant while studying coral.

A.7

The increasing heat has brought more frequent outbreaks of dengue, which is spread by mosquitos and known as "bone-break fever" because of the pain it can cause. The dengue outbreaks during the summers of 2018 and 2019 were both grave enough for the government to declare a state of emergency. Ranton caught dengue during the 2019 emergency and his father Jelton caught dengue in 2018. According to Jelton, a six-year old child died from dengue during late summer 2019. Jelton does not remember dengue outbreaks on Ebeye when he was younger, nor does he remember the government issuing an emergency declaration warning residents of dengue outbreaks prior to last year's.

Ebeye Island in 1971 and 2016.

Ranton has also experienced worsening storms on Ebeye. "In 2015, we were inside my house, my dad was off island for meetings, and a really strong wind came and opened the roof of my house. It flooded my house. I was with family, but then we evacuated to our neighbor's house." This storm had a profound effect on Ranton. "After experiencing the open-roof house storm, I wanted to learn how to speak in public so I could ask for help from other places."

Ebeye has also seen significant flooding on the causeway, which connects the islands of Ebeye and Gugeegue for pedestrians and vehicles. According to Ranton, "when I was young the causeway didn't flood like how it's flooding today. The first time I saw the causeway flood really badly was when the same typhoon in 2015 came that tore open the roof of my house. But, even with no typhoon, the causeway still floods when the tide is really high. Pebbles and trash wash up from the side of the causeway and also from the ocean." Recently Jelton was caught on the causeway when the flooding water breached it and felt "inundated when all the debris came in and blocked the road." According to Jelton, "one of our high schools is located on an island connected by the causeway and students usually are forced to collect rocks and other debris from the road so they could get to and from school."

The Marshall Islands, including Ebeye, rely predominately on rainwater for clean water: according to Ranton, "if there is no rain, there is no clean water. And this happens usually during the summer, that is when the drought comes in." When there is not enough rain, people have to rely on the stored groundwater, which the rising sea-level is already infiltrating. "You have to boil it, and it is a bit salty."

Ranton noticed a lot of these changes on his island before he attributed them to the climate crisis. He heard about "climate change" when he was younger, but "I thought it was a hoax. I didn't believe in sea level rise, all those things. I just said it's from us, Marshallese people who are the ones ruining all this, causing all this."

Ranton attended a summer camp in 2018 where he learned about the gravity of the climate crisis, and finally understood its implications, connecting it to the impacts he had already seen on his island. "After learning about climate change and what it meant, it was pretty scary." All of these climate harms Ranton is experiencing will only worsen, but to what extent depends on how much Greenhouse Gas the world continues to emit.

"Now I think about it every day. Every day. Sometimes in my mind I just see Ebeye sinking and a lot of people drowning."

Ranton talks to his friends about these concerns "every day – we have a group chat. We ask each other how our islands are doing, what has happened. We talk about how hot it is and how it is getting warmer, discussing sea level rise as well." When Ranton returns to school this fall, he wants to speak more about the impacts of the climate crisis even though there are no classes on the subject.

What worries Ranton the most is sea level rise. "It's not the whole island that I believe is going to go underwater. It's the parts where I see sea level rise that I worry about – mostly the lagoon side, where I'm from."

"I don't want to be underwater. I want future generations to experience what I experience, I want them to experience living on Ebeye. It still saddens me – I want them to experience the same things I did."

Typhoon Nangka, 2015.

APPENDIX A.8
Litokne Kabua
(Marshall Islands)

Litokne Kabua (Ebeye, Marshall Islands)

Litokne weaves a basket out of pandanus leaves.

According to Litokne Kabua, a sixteen-year old Marshallese, his family has lived on Ebeye Island "since the beginning of time." His home is a two minute walk to the ocean, where he often goes swimming. The relationship between Ebeye and the ocean that surrounds the island is paramount: according to Litokne, "culturally, the ocean is the center-way of life." It has allowed generations of Marshallese to travel to the other islands to connect with each other and is a major source of food.

"We use the ocean for navigation, transporting our people and supplies." The ocean connects Litokne to his family on the outer islands where there are limited resources, and the residents need to have food and supplies brought in by boat. The ocean also provides food, and fishing is a big part of Litokne's life and subsistence – red snapper and tuna often comprise parts of his lunch or dinner.

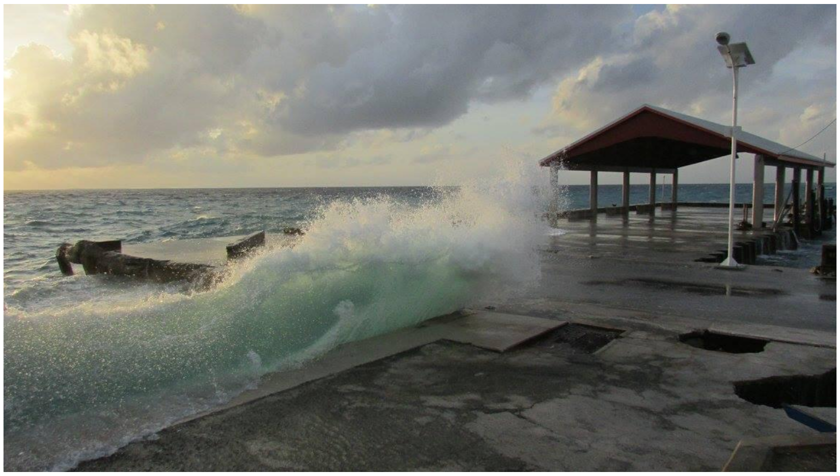
Now, Litokne's way of life is threatened. The Marshall Islands have already suffered severe climate crisis impacts and are facing complete destruction as sea levels continue to rise. Greenhouse gas emissions of major emitting countries thousands of miles away are threatening the approximately 59,677 citizens living on 29 low-lying coral atolls, 1,156 islets, and five single islands that make up the Marshall Islands. Rising temperatures and sea levels, combined with droughts and dying coral reefs have already begun to change this island nation, and unless other countries urgently make significant changes, its islands will be unrecognizable in 40 years, if they exist at all. Through climate change induced sea-level rise and warming, the ocean is becoming the biggest potential threat to the existence of the Marshall Islands.

The Marshall Islands consist of 29 low-lying coral atolls, 1,156 islets, and 5 islands.

Fish are becoming harder to find. "My grandpa used to get more fish, like a lot more fish than the number of our family. But nowadays when we go fishing, you could come home with a bucket of nothing."

High tides creep onto a dock in Ebeye Island.

The most pressing concern Litokne has about the climate emergency, however, is the rising sea level, which threatens to submerge his home during his lifetime, and is already causing stronger storm surges and other flooding events. His stepfather, Carl, explained, “nowadays it is harder to live – it is hotter – the climate is so hot. The level of sea level rise you see, it is so crazy, it’s scary.” Litokne’s mother, Anta, worries about her family and their livelihoods. “How do we make our way of life? It has all been damaged by the sea level rising. It destroys everything.” Anta’s uncles have a garden where they grow coconut trees, pandanus, taro, papaya, and breadfruit. According to Anta, beginning about five years ago, the garden floods with sea water two to three times a year, forcing her uncles to pull all of the crops out every time and start fresh Because of the rising sea level he has seen, when Litokne thinks about his future, he thinks climate change will be hard to overcome. “The ocean might start eating up my islands, the ocean might be a lot stronger than it was before.” Anta adds “the island is getting smaller, in twenty years, a lot of it will be under water.”



A wave crashes over a dock on Ebeye Island.

Litokne has also noticed increasingly violent storms on Ebeye, which have caused Litokne and his family to seek shelter on the US Kwajalein Atoll Army base. Litokne explains that all the communications systems on Ebeye announce the coming of big storms with alerts, sirens, and radio announcements. Litokne recalls a particularly bad storm: “it was scary – the ocean was really, really crazy and it was very dangerous to go through, so we had to stay on the base, overnight, just for that storm.” The ocean gets really rough during these more violent storms, and “waves smash into people’s houses,” sometimes breaching the sea walls.

High waves overtake a home on Ebeye Island.

According to Carl, there are also more droughts, requiring the government to take action and bring water and food supplies to the outer islands. Litokne explained, "with severe droughts and climate change impacts we are unlikely to be able to make traditional medicines, including banana leaves that are pounded to make liquid medicine. Bananas are the most common traditional medicine we make for reduction of body pain and easing toothache." Litokne also discussed how "ground cherries (physalis peruviana) and scented fern are mixed for patients to drink to treat diabetes, which are the common uses of our traditional medicine, but with the droughts and surging rising seas, these medicines will be rarely used" as the plants used struggle to survive.

These impacts, Litokne understands, are the consequences of the climate crisis. Litokne first learned about "climate change" in school, and that it would impact his surroundings. Litokne now "knows" his home and his island "are not here forever… they will disappear, unexpectedly." Litokne worries too that his family and community will lose a source of income from making handicrafts as palm trees and pandanus trees disappear. Despite the fact that "Ebeye might get smaller, and the waves are still eating up the islands," when Litokne grows up, he says, "I want to live here. It is my home, there is no place other like Ebeye." Ebeye is special to Litokne because he is part of such a close cultural community. Litokne is able to spend time with his friends, learn traditional arts, and listen to stories from his elders. Litokne feels "disappointed, and kind of sad" at the thought of losing all of that.

Litokne has worked to convince everyone he knows about the impacts the climate crisis will have on their home and way of life: "it is the first thing you see when you go outside. It is happening a lot more, a lot more . . . you cannot ignore it." All of the climate harms Litokne is experiencing will only worsen, but to what extent depends on how much Greenhouse Gas the world continues to emit.

High waves surge over a home on Ebeye.

When he grows up, Litokne wants to work for the government so it will become more active the fight against the climate crisis, reaching out to bigger countries like the United States to encourage them to help his country. If he was working for the government now, Litokne would emphasize that everyone has to take responsibility – his generation and those already in power, and they must do so immediately: "If the government does not act now, then who will? If the time to act is not now, then when will it be? So, it is now or never if we are going to combat climate change."

APPENDIX A.9
Deborah Adegbile
(Nigeria)

A.9

Debby Adegbile (Lagos, Nigeria)

Twelve-year old Deborah ("Debby") Adegbile has lived her entire life Lagos, Nigeria. Debby believes the city itself is heating up and undergoing significant changes to its climate. Looking back at when she was a child, Debby's mother Ronky recalls that Lagos used to be "surrounded by water where everyone would go to the beach all day and enjoy the natural resources, but now the industrialization and expansion has changed Lagos, making the air and water dirtier."

Lagos is the largest city in Nigeria, covering 1,171 kilometers with over 17 million residents. It is one of the most populated cities in the world and operates as Nigeria's economic nerve center. Geographically, Lagos is located on the West African coast where high rainfall is common and sits slightly above sea level. Its density, size of the population, and poor infrastructure makes it one of the most vulnerable cities to the deleterious impacts of the climate crisis.

Historically, with its tropical climate, Lagos had a rainy season that generally spanned from April through September, but recently with climate change, "the rainy season extends to December," says Debby, which, apart from the obvious effects of increased rainfall, poses serious logistical and health problems. For example, Debby explains that "every time it rains in Lagos, there is flooding and the rainfall has intensified." Debby's mother remembers, "it used to take five hours of rainfall to flood the streets, and now it just takes one hour." For Debby, however, the intense rainfall and frequent flooding is something to which she has always been accustomed. Unfortunately, Debby explains that the frequent flooding is extreme, making it difficult to walk and commute by car while also increasing the spread of diseases and other illnesses.

Flooding in Maryland, Lagos, May 2018.

Ronky says that although the schools do not close when it floods, the flooding makes it much more difficult for parents to get their children to the classroom, with many of them missing classes because it is near impossible for the children to walk in the high waters. Debby recalls:

Flooding makes commuting and walking difficult and dangerous.

"If it floods too much – it can flood up to three feet off the ground – my parents have to carry me and my two siblings, lifting us off the ground because we can't walk. They pick me up and carry me to school, and they have to carry all of us, me and my siblings, one by one to school."

The flooding has also caused Debby, along with her family, to more frequently contract malaria. The increased floodwater lingers in the streets, creating an influx of mosquitoes, which carry diseases such as malaria. Ronky reports that every member in Debby's family has had malaria – and gets it at least once a year. Debby, on the other hand, gets malaria two or three times every year. The fever often lasts for three days, forcing Debby to go to the hospital to get medication, which can come at a high cost.

In addition to malaria, Debby also reports that she has asthma, which intensifies with hotter temperatures. "Whenever I have an attack it takes about 5 days to get over it, and I'm usually hospitalized." And again, as the hospital provides Debby with "medications and injections" to feel better, the cost can be quite expensive. Indeed, Debby's frequent illnesses and hospitalization forces her to miss school, where she has to try and catch up with her classmates. Debby exclaims, "I really feel odd about getting sick!" She is growing up expecting that every year she'll become ill, and knows she will need to be hospitalized at least a few times as well.

But Debby's illnesses have not stopped her advocating against the climate crisis and the effects that she is seeing in Lagos:

> There is not enough awareness and efforts to address climate change. There is lots of flooding and many areas have little to no drainage and bad roads make the impacts of climate change worse. Poor electricity and power results in too many generators owned by individuals releasing too much carbon and affecting children's health. Poor waste management increases diseases. And there is no disaster management such that many people die in floods or accidents during heavy rains.

Debby explains that the climate crisis has resulted in sea level rise and ocean surges, which threaten ecosystems and freshwater sources while also eroding the coast line in Lagos. "The houses are sinking into the sand. There are lots of places that used to be land but now they are part of the sea," explains Ronky.

Debby explains, "I sincerely don't think Lagos will get any better with the way we are using the environment presently. It depends on the way we start caring about our environment." And this lack of environmental concern, makes Debby worried about the future: "I feel scared about the future considering the terrible experiences I have been through in the places I have lived where I have to wait for the rains to subside before leaving for school or stay at home at times when the rain is unbearable due to the weather condition."

Debby advocating against plastic pollution.

All of the climate harms Debby is experiencing, will only worsen, but to what extent depends on how much greenhouse gas the world continues to emit.

As a result of these changes, Debby has become an advocate for ocean protection. Last June Debby participated in the Summit for Empowerment Action and Leadership. Through the program, she spoke to legislators in Sacramento, California, advocating for plastic reduction – which she has seen affect the ocean and marine species off the coast of Lagos. When she grows up, she "wants to become a lawyer and advocate for endangered species in the ocean that are put at risk from pollution, such as plastic waste, and the heating climate."

To our world leaders, Debby says:

> I will tell our world leaders to pay attention to the cries of their citizens about the effect of this climate change such as flooding, housing problems, food scarcity, traffic congestion due to flooding and blocked drains due to plastic pollution and the outbreak of diseases such as malaria due to mosquito bites, asthma, colds, and other diseases.

For Debby, "children can speak out to global leaders" because the climate crisis "is an issue that children are more affected by because they are helpless and forced to change things like school, home, and lifestyle due to flooding and other impacts which affects their health, family, and well-being."

APPENDIX A.10
Carlos Manuel
(Palau)

A.10

Carlos Manuel (Koror, Palau)

Carlos Manuel and his family moved from the Philippines to Koror, Palau, nine years ago. At the time, Carlos was eight years old. The first thing Carlos did when he arrived was jump in the ocean and swim. His fondest early memories in Palau are spending full days at the beach with his family and friends and swimming in the refreshing ocean. Now, although the beach is just a short walk away, Carlos says "it's is too hot to go to the beach and the water feels like it is boiling. It's just not as refreshing anymore." Carlos now spends more time inside.

Carlos swimming in the ocean with friends.

Palau is a small island nation of 18,000 people that consists of 586 islands, only 12 of which are inhabited. Unlike the majority of small-island states, much of Palau's landmass is more than ten meters above sea level. However, most Palauans live and work in the country's coastal lowlands, as the higher ground is hilly and thickly forested. Tourism, subsistence agriculture and fishing are the main drivers of the Palauan economy.

Carlos, who is now 17, learned about the climate crisis in 9th grade from a friend. He began to understand that the climate crisis is a global issue that "is not just affecting one country but our whole planet, and it doesn't just affect us humans."

The increasingly hot ocean and air temperatures are not the only climate change impacts confronting Palau. Since 1993, the sea level rise around Palau has been measured at about 0.3 inches per year. Sea level is expected to continue rising, perhaps by more than 3 feet (1 meter) by the year 2100. Palau is also expected to experience more regular and intense droughts, while typhoons and other severe storms are predicted to increase in frequency and strength. Palau's reliance on the ocean as an island nation make it particularly vulnerable to these impacts.

Super Typhoon Haiyan passes through Palau in 2013.

Carlos has observed many of these harms already. In November 2013, super typhoon Haiyan devastated the island of Kayangel in Palau's north. Carlos remembers that the typhoon's incredibly strong winds "completely wiped out the whole island so the people from Kayangel had to move to another island."

Carlos has also noticed that increasingly high tides and storm surges have forced many people living near the beach, including one of his good friends, to abandon their homes. Sea level rise is also requiring the government to relocate Koror's only hospital.

Record high tide caused flooding on Koror in late August 2019.

Intense drought is also wreaking havoc in Palau. In 2016, the government issued a state of emergency in response to one of the worst droughts in Palau's history. The extreme drought particularly harmed traditional Palauan families who grow Taro and Tapioca for their subsistence. As part of a community education program, Carlos and his friend interviewed one elder woman who was struggling to grow crops for food and subsistence because the increasing temperature and drought have dried up the soil and depleted rivers.

Carlos has also seen coral bleaching due to increasingly warm ocean water temperatures. Although some reefs around Palau are thriving, many are unhealthy.

Carlos is unsure whether he will be able to live in Palau as he gets older. "If no one tries to listen and make a change and take action, this island will just get worse every day. If no one takes action we won't have a place to live in." All of the climate harms Carlos is experiencing will only worsen, but to what extent depends on how much Greenhouse Gas the world continues to emit.

Although he is worried about the future, he is also hopeful. "I hope everything could change so that it doesn't get worse than it is now. That's why I'm trying to do this work to make the world a better place". Carlos has become a leading advocate in his community for protecting the ocean and taking action against the climate crisis. He is motivated to spread awareness of the global heating to other children and adults so that "we can do more work to stop climate change and make this planet a better place to live in." Carlos believes:

"We all have the right to enjoy our planet and we should all protect that right. Our generation is trying to prevent climate change for our future generation."

Carlos attending a Climate Youth Summit in 2018.

Carlos recognizes that world leaders need to do much more. “I would be disappointed with myself and our leaders for not taking action. I would feel I failed myself for not having those leaders take action because we are kids and we have a voice to make the change, but we don’t have the power to make it. We could say everything we want to say, but it’s still in their hand to make those changes.”

APPENDIX A.11
Ayakha Melithafa
(South Africa)

A.11

Ayakha Melithafa (Cape Town, South Africa)

Ayakha Melithafa, who is 17 years old, lives in Eerste River on the outskirts of Cape Town in the Western Cape province of South Africa. Her mother Nokulunga lives in the Eastern Cape Province of South Africa, some 1000km from Cape Town. Nokulunga is financially supporting Ayakha, her siblings and her cousin through various work, including farming.

The Eastern Cape, like many parts of South Africa, has been badly affected by drought, explains Ayakha. “Climate change has affected my mom and me because of the terrible drought it is causing. If they can’t plant in the Eastern Cape and the livestock can’t eat and drink, my mom and other farmers can’t earn any money”.

In Cape Town, Ayakha describes her own experience with the climate crisis. Between 2017 and 2018, Cape Town saw a period of unprecedented severe water shortage, compounded by dam levels that had been declining since 2015 and very limited rainfall. In early 2018, Ayakha, along with the other residents of Cape Town, prepared for “Day Zero” - the day when municipal water supplies would largely be switched off and residents would have to queue for their daily ration of water. This would make the City of Cape Town the first major city in the world to potentially run out of water.

According to Ayakha, “the water crisis was really bad because we always had to buy water. At home we had to take shorter showers. We had to water our garden less or not at all. We had to be really cautious so we don’t reach Day Zero. There were a lot of water restrictions. There are other people who grow their own food where I live, and it was really hard on them. It was hard to see them unable to feed their families because of the water restrictions.”

During the water crisis Ayakha noticed that the quality of the fresh produce she was used to purchasing from local vendors had deteriorated or was no longer available. Accordingly, she has had to travel by bus much more frequently to get to a supermarket to buy food for her and the family, at higher prices. She also is incurring additional expenses for the bus fare and has concerns for her personal safety when taking the bus in the evenings, especially after dark.

The climate crisis has also brought intense changes in weather patterns to Ayakha’s home. A few months ago, her area suffered severe rain and flooding. Ayakha explains that this flooding caused delays of 30 minutes to an hour in getting to and from school on the bus. The floods also affected the water quality, and Ayakha knows many people who became sick from the drinking water. Many of her friends, who live in informal settlements, experienced water damage to their homes and personal items. The houses in informal settlements are generally made with poor quality materials, with little or no access to adequate services and sanitation.

Ayakha has noticed that a lot of people, especially farmers, are migrating from rural areas to live in Cape Town because of “climate change”. Ayakha notes, they are hoping to avoid flood disasters and drought – “they are looking for something more stable”. Ayakha says that in some ways, the influx of people migrating to Cape Town is affecting her negatively, although she enjoys the diverse mix of people. “It is also hard on infrastructure. The sewage system cannot handle the influx.”

South Africa is extremely vulnerable to the impacts of climate change - its existing water scarcity is predicted to intensify in many regions and a global average temperature increase of 2°C translates to up to 4°C for South Africa by the end of the century. In the last five years, South Africa has experienced record temperature highs, droughts, devastating floods, and fires. This has cost the country billions; and has impacted food prices and exacerbated the already high poverty levels in South Africa. These consequences are only expected to worsen. Climate change has already made events like the 2015-2018 Western Cape drought three times more likely. With an additional 1 degree warming, the chances of the drought recurring are again tripled.

Ayakha participating in the Project 90 by 2030 YouLead Initiative.

“The changes in the weather make me feel sad and angry. There are things you can do about this, but no one is doing anything. It is hard for young people to tell adults what to do, and to get them to listen. Climate change affects us as youth more because we still have a life to live. People who are older aren’t paying as much attention because they will not be as affected. They don’t take us children seriously, but we want to show them we are serious. We want to show them we are dedicated and we know what we are talking about. I want to make sure that I will be part of the solution to climate change, and not just part of the people who are causing the problem.”

The changes around her have led Ayakha to become a dedicated climate activist in her community. She is part of the Project 90 by 2030 YouLead initiative, and acts as a recruitment official for the African Climate Alliance. Ayakha believes “we, as society, have a chance now to change things”.

Ayakha shares her knowledge and experiences in climate activism with the people in her community, and tries to show people how to live with a low-carbon footprint, through calling and participating in regular meetings to discuss relevant climate and environmental issues; and through initiatives supporting practical solutions in her community such as planting vegetable gardens, building solar-powered phone chargers, and waste use and recycling initiatives.

For Ayakha, a future impacted by climate change is a “miserable future”. “I don’t want to be stranded at home not able to go out because it is too hot. Or deal with flooding or drought. It is worse for the people living in poverty. They have to live with and are most vulnerable to the effects of climate change.”

A.11

All of the climate harms Ayakha is experiencing, will only worsen, but to what extent depends on how much greenhouse gas the world continues to emit.

Ayakha advocating against climate change with her classmates.

Ayakha would be sad to see the natural world, including the animals and the Fynbos, a small belt of natural shrubland or heathland vegetation, in the Eastern and Western Cape provinces, around her impacted by climate change. It is anticipated that as the Western Cape, where Ayakha lives, becomes hotter and drier, with less winter rainfall and more irregular rainfall events, this will have severe detrimental effects on biodiversity, and result in significant species losses in the Cape Floristic Region.

Ayakha doubts that she would want to have children in the future because of the environment they would grow up in, and the higher costs of living and food. “I wouldn’t be able to live the life I want”, she says. “I wouldn’t enjoy my future very much knowing that there is this climate change future”.

“If I could speak to the President of South Africa I would ask to have mandatory teachings for climate change in schools, and make everyone learn about climate change and the solutions. I’m tired of people saying ‘I don’t know if that is true’”. Ayakha would also ask the President to implement ways to reach 100% renewable energy in South Africa, and she would ask the President and other global leaders to stop using fossil fuels, especially coal, and instead to use technology to fight climate change.

APPENDIX A.12
Ellen-Anne
(Sweden)

A.12

Ellen-Anne (Karesuando, Sweden)

Ellen-Anne is an eight-year-old living in Karesuando, Sweden, 200 kilometers north of the Arctic Circle. She is Swedish and a member of the Sami community. The Sami people have lived in the Arctic regions for thousands of years in what is now Norway, Sweden, Finland and Russia. The Arctic region where the Sami people live and carry out reindeer herding, and other livelihoods and cultural practices connected to nature is called Sapmi. The Sami people, particularly those involved in reindeer husbandry who today depend on reindeer for their livelihood, live close to nature and must be aware of changes in nature. They must adjust their lifestyle to assure the welfare of the reindeer. They value the land and the natural order in cultural and spiritual terms, as well as economic terms. Reindeer are a central part of the Sami heritage. Sami people have been taking care of reindeer in the Sapmi for thousands of years.

Ellen-Anne leading her reindeer. Kebnekaise Mountains in the background after a glacier has melted. September 2019.

The Sapmi and the Sami livelihoods and culture are severely threatened by the climate crisis. The global heating in this part of the world has reached a 2°C increase since the onset of the industrial era. The disruption of the seasons and the changing climate in the Sapmi are threatening the Sami's traditional methods of reindeer herding. Reindeer are wild animals and the Sami migrate with the animals into the lowlands in the winter and to the mountains in the summer. However, in recent decades the increased warming and increased rains have severely threatened the winter food supply. Winter rains, previously uncommon, now freeze to form an impenetrable ice cover beneath the snow, on top of the lichens and moss essential to the reindeer's survival in the winter. The result is increased costs of reindeer herding, geographic displacement of the reindeer herds as they search for food, and the need to supplement the reindeer's entirely natural sources of food. All of this taken together poses a fundamental threat to the Sami people's livelihood that has existed for thousands of years.

Ellen-Anne belongs to a reindeer-herding family. Her parents belong to different Sami villages on the grounds of birthright. Her mother Susanna explains how the work with reindeers was passed down to her from her father.

> I was very little when I was with him the first time, but I don't know if I was too much help then. I first went in the summer when I was maybe-five years old. The children are usually with the parents except when the children are in school. We brought our own child when she was only two months old up to the mountain when we were working with the reindeer. The reindeer are an intrinsic part of our whole lives and how we live.

Ellen-Anne, now in the second grade, also loves to go with her parents when they are reindeer herding. Ellen-Anne says, "I like to go up into the mountains with the reindeer because they are such beautiful creatures, and I have learned to throw a lasso around their horns." Susanna further explains the importance of reindeer herding to their way of life:

> The reindeer is our life. It's everything. We live with, and we live off the reindeers, and I can't even imagine a life without them. Reindeer herding is our livelihood, our economy, our culture, our way of living for many, many generations. We and the reindeer depend on each other. I plan to be a part of reindeer herding my whole life and will do everything I can to assure my children can continue with it.

Susanna and Per-Jonas (Ellen-Anne's father) have already introduced their daughter Ellen-Anne to reindeer herding, just as they were introduced to it:

> It's part of bringing the children up, they are usually part of most of the work we have around the reindeer. It's maybe in the winter when they are small that we protect the children from the extreme cold weather, but that's their life too. The children are intimately connected to the life of living with the reindeers, and they learn

Ellen-Anne feeding calves placed in a corral due to poor pastures and deep snow.

> this culture by doing and helping out. They have to be there to see how it's happening, how do you move the reindeer, how do you help them.

Susanna explains that in Sampi and in the Sami culture, there are eight seasons, not four. In each season there are different tasks to be carried out to take care of the reindeer, and each season offers different plants and lichens for the reindeer to eat for their survival, and the reindeer graze in different areas in different seasons.

> A normal good climate used to mean that we get a good fall that prepares the ground for good winter grazing. A normal good fall is dry and cold before the first snowfall that covers the plants and lichen on the ground. These frozen plants are accessible as food to the reindeer who can dig down through the snow.
>
> But nowadays, we get warmer temperatures, and more rain that cause the soil and snow to get really wet, and then the snow freezes to ice, and the food reindeers need is now covered by ice. Even if reindeer can dig down in the snow, they can't get to the food because of the ice layer. This is a serious problem and then we have to drive out into the lowlands on snowmobiles with food supplements for the reindeer to survive in the winter.

Ellen-Anne and Susanna driving food out to reindeer due to ice-locked pastures. Winter/ Spring.

> Because of this new climate phenomena, the reindeers now need to start walking to other areas to find food. In the old days, there can be more reindeer in an area for a longer time before they would start migrating to another area. So now they have move around more when they also would need the time for more winter rest. We want them to be in the same place, but the reindeer start to move because they don't get any food.
>
> This winter food situation is aggravated by the disappearance of the old forests because of new deforestation type logging. Old pine forests have a special kind of lichen hanging form the trees that reindeer eat in the winter, but that lichen does not grow in the newly planted trees.
>
> This all creates so much more work and costs for the reindeer herders – the reindeer herders have to work longer days, have to drive around much more with their snowmobiles, and the expenses for fuel has increased a lot. The climate crisis for

> us who live with reindeer is like when you throw a rock in the water, the problem just spreads as ripples and cause many new types of problems.

Susanna explains that the elders in the community have intimate knowledge of the 8 seasons that relate both to when is the right time to, for example, start moving reindeer, and how to safeguard the health of the reindeer herds. Ellen-Anne says, "my grandfather knows so much about the reindeer." The value and use of this knowledge is threatened by the climate crisis. According to Susanna:

> Another problem with the disruption in the climate and the seasons in the Sami culture is that we are losing our special need and use of the knowledge of the elders. They knew all these special calendar dates over the whole year, if it's cold this day, or if it's very wet this day, that will forecast the weather or what to do with regards to herding reindeer. they call it marking days. They knew these days and recognized them but all that kind of deep knowledge of nature that they knew so much about, does not hold up anymore. It doesn't make the same sense now with the disruptions. The wisdom they had, we needed it, but now we have lost our ability to know and predict the seasonal changes.

Susanna earmarking the calves to identify the family it belongs to.

Ellen-Anne already knows what she wants to be when she grows up. "When I grow up, I want to work with reindeers." However, Susanna is seeing in her own lifetime the severe changes in the Arctic environment, and she worries what life she can pass on to her children and future generations.

> It has become more difficult, and I worry about the future. I wish that my children will continue to be able to herd reindeers, but reindeers are not like cows or cattle, they must wander freely in nature, and to be feeding them supplements is not going to work very well. I can't see how that situation can work. The winter is the most valuable time for the reindeers, that's when they need to have peace and rest and be more stationed in one place and eat; but now they are kind of forced to be moving. It's not only an economic problem, it is not only about the economic value of a reindeer, it's the whole culture. The value is in the culture of living with reindeer and in nature- all of which is being threatened for the first time in thousands of years.

Susanna explains that climate change science is warning us, and she and the Sami people see the warnings in their environment. All of the climate harms Susanna and Ellen-Anne are experiencing will only worsen, but to what extent depends on how much Greenhouse Gas the world continues to emit. According to Susanna,

> Climate change is real. It is so hurtful to listen to others in authority say it is not real because we are affected by it. It's not a coincidence. The normal winters feels like they are gone now. We see it and our elders see it every season, every year.

APPENDIX A.13
Greta Thunberg
(Sweden)

A.13

Greta Thunberg (Stockholm, Sweden)

Greta Thunberg is a sixteen-year-old resident of Stockholm, a densely populated city in Northern Europe that as a result of the climate crisis has shifted from a cold-temperature climate to a warm-temperature climate with fewer snowy winters. Stockholm's freshwater reserve, provided by its third largest lake, Mälaren, is threatened by predicted sea water rise to be contaminated with salt water from the Baltic Sea.

When Greta was eight years old, she watched a documentary in school on something called "climate change." She and her classmates were terrified. But, when the documentary was over, her fellow students seemed to move on, and their worries shifted back to less existential concerns. For Greta, it was not so simple. This knowledge changed her entire life. Once Greta understood the climate crisis, she could not "un-understand it."

"I remember thinking that it was very strange. That humans who are an animal species among others could really be changing the earth's climate. Because if we were, and if it was really happening, we wouldn't be talking about anything else. As soon as you'd turn on the TV, everything would be about that."

Greta began researching the climate crisis, reading everything she could over the next few years. To her, the crisis was akin to a world war. Greta, however, could not understand why none of the adults were acting to prevent it. "How could we just continue like before? Why were there no restrictions? Why wasn't it made illegal. To me, that did not add up. It was too unreal. So when I was eleven, I became ill. I fell into depression, I stopped talking, and I stopped eating. In two months, I lost about 10 kilos of weight." Moved to tears, Greta later explained that already, the impacts of the climate emergency are deeply felt: "over 200 species becoming extinct every single day, erosion of fertile topsoil, deforestation of our great forests, toxic air pollution, loss of insects and wildlife, the acidification of our oceans – these are all disastrous trends being accelerated by a way of life that we in our financially fortunate part of the world see as our right to simply carry on."

On August 20, 2018, Greta Thunberg began striking for the climate outside the Swedish Parliament.

Educating herself and others about the climate crises became Greta's coping mechanism. The climate crisis remains an ever-present fear, but taking action has helped her manage: "I thought about this very often – I had climate anxiety. But now I don't really have that anymore the same way, because it has just become such a normal part of my life that I don't even think about it. This is just sort of a full time job. . . But of course, I sometimes get worried and scared about how the future will be … I don't know how it will become… I do know that change needs to happen now if we are to avoid the worst consequences." Greta began to focus on what she, as an individual, could do – and in taking action began to combat the feelings of despair and anxiety that at first overcame her.

Recognizing how much of a carbon footprint each person has, Greta minimized her own. Greta chooses to travel in the most-carbon neutral method available, such as trains and subways whenever possible.

"School Strike week 52." Greta Thunberg on the Malizia II, a solar-powered racing yacht, crossing the Atlantic Ocean.

Greta recognizes that while the climate emergency has affected her in a personal manner, it is a "very global problem," affecting some people more than others. Speaking with children from countries in the global south, Greta was able to confirm what she feared: these children are facing more extreme weather, food shortages, and are experiencing water shortages. Greta sees this as profoundly unfair. Countries in the global south have generally contributed the least to the climate emergency, and yet they will be affected the most. According to Greta, climate justice means that everyone should be protected from the impacts of the climate crisis, no matter where they live or what their economic status is.

Greta worries what the future will look like – "it is not just the weather. [The climate emergency] means also, lack of food and lack of water . . . places that are unlivable and refugees because of it. It is scary."

And yet, despite these weighty concerns, Greta persists. Over the course of barely a year, Greta has become a global ambassador for climate change, speaking out despite backlash and the dramatic change wrought on her life. In August 2018, Greta began protesting outside of the Swedish Parliament during school hours with a sign painted with the words, "Skolstrejk for Klimatet" ("School Strike for Climate"). She has continued striking every Friday, inspiring hundreds of thousands of children worldwide to follow her example. Like so many children facing this crisis, Greta feels that she has had to educate the world on this issue that adults should have tackled decades ago. "The climate crisis has already been solved. We already have all the facts and solutions. All we have to do is wake up and change."

Although Greta has expressed that she just "wants to be a kid," she is determined to continue protesting: "I am going to do everything I possibly can as long as there is still time to do that, and I guess I am waiting for something to happen – a change. And I am trying to – because I know that change is going to come – I mean – it *has* to come – so I am just trying to help push it to happen sooner because I know there is no second option." For Greta, activism is the only way to gain a sense of agency. She hopes that others who are also scared of what the future holds will join a movement and try to do something. "That is the best medication and the best cure against anxiety about this and feeling helpless."

The climate harms that Greta feels so personally, and that are impacting so many children around the world, will only worsen, but to what extent depends on how much greenhouse gas the world continues to emit.

"What we do or don't do right now will affect my entire life and the lives of my children or grandchildren. What we do or don't do right now my generation can't undo in the future."

APPENDIX A.14
Raslen Jbeli
(Tunisia)

A.14

Raslen Jbeili (Tabarka, Tunisia)

Raslen Jbeili grew up in Ouechtata, a town in north-western Tunisia nestled between the mountains and the Mediterranean Sea. Seven years ago, his family moved to Tabarka, a coastal town in north-western Tunisia, close to the border with Algeria. Tabarka is a small town with natural beauty, well known for its beaches, vibrant coral reefs, and easy access to the extensive cork-oak forests of the Kroumirie Mountains.

Tabarka usually has mild and dry summers, and rainy and cold winters. Raslen, who is now seventeen, is worried though. The climate in Tabarka has changed considerably the past few years.

“Tabarka used to have four distinct seasons,” Raslen and his mother, Chadhlia recall. “Now we have two main seasons—summer and winter—which is completely different from before. Or we can have four seasons in one day! In February we can have very hot days, which is very abnormal. We also have been getting a lot more rain. But mainly, the weather is getting hotter and hotter, and winter is starting later than usual.”

Summers have been extremely hot, with temperatures exceeding 40°C. “We can’t go outside,” says Raslen. “We will melt if we go outside.”

Wildfires are also increasing. Raslen participates in the Access Program, a school program that allows him to research climate change and other environmental issues affecting Tabarka. Through his research, Raslen documented 146 fires in 2017, a dramatic increase from the 37 he documented in 2016. One fire last year came a little too close for comfort. “We heard screams and yelling in the night,” he recalls. “I looked up and saw a huge fire approaching our home and we could do nothing. We just prayed for the fire not to reach our home. Although we were spared, it burned down many of our neighbor’s homes.”

Over the past two years, Tabarka has also experienced heavier rainstorms that flood roads and buildings. When it rains intensely, Raslen’s school floods because it is located in a low-lying area surrounded by wetlands. Sometimes the floods submerge the school up to four feet. Raslen explains, “When we have consecutive or

Raslen’s school flooding from heavy rains.

heavy rains our school floods and closes. I don't want to miss school, and last year we had no school for a week." In one terrible incident, Raslen recounts how overflowing rivers fatally swept away some school-children on their way home from school.

Although more intense rains are occuring, the climate has gotten drier. Tunisia, which is a water-scarce country, is particularly vulnerable. Over the past few years, drought has threatened the country's water supply. Tabarka, which typically has more precipitation than most of the country, has also experienced frequent supply disruptions. "The water is shut-off without any notice, sometimes for hours, sometimes for days," laments Raslen. "Last year we had three days without water. Once it is shut-off, we don't know when it will return." Raslen and his family have had to buy water in these situations, making it "too hard to cook, shower, and clean."

Raslen participating in the Access Program cleaning litter in Tabarka.

Raslen has also noticed changes to the sea. "The water is much hotter than before," says Raslen. "It is too hot and not refreshing." The storm surge is also much higher. For the first time that Raslen and his family remember, a storm pushed the tide and waves above the rocky barrier protecting the town, flooding and damaging restaurants and other buildings situated near the sea. "This never happened before. The tide came up four to five meters, submerging the restaurants and cafes in the harbor."

All of the climate harms Raslen is experiencing, will only worsen, but to what extent depends on how much greenhouse gas the world continues to emit.

The changing climate is deeply affecting Raslen. "I sometimes have nightmares that climate change is destroying our world. I am very worried about the future. If we don't do something, maybe we will face extinction. That is scary." He adds, "It is not fair that my generation has to experience this."

Raslen is also uncertain he can stay in Tabarka. "In the future, I think we will be suffering more and more. We would have to move away from here if we don't solve the problems we are facing." He questions whether he can have children. "I am worried about having children without stopping the threat of climate change. I don't know what will happen to my children. I want them to live as comfortably as possible."

"Unfortunately, governments are ignoring us," says Raslen. With regard to his government in particular, Raslen says, "they are more concerned with politics than with environmental or social issues as they try to build a country based on democracy after the revolution." But Raslen notes that although the Tunisian government is trying to rebuild itself to become a strong nation, it cannot ignore the imminence of the threat of the climate crises: "the problem is we don't have the years to wait."

As to world leaders, Raslen states, "they are careless about climate change in general. I would tell the leaders that if they are humans, they will do anything to stop climate change because if they don't their children will be suffering."

Yet, Raslen is "hopeful we can make a change. It is our duty as children to do anything no matter the cost to save our planet and to live in a safer world."

APPENDIX A.15
Carl Smith
(USA)

A.15

Carl Smith (Akiak, Alaska, USA)

Smith family, 2019: (clockwise) Dylan, Carl, Kimberly, Clifton, Eva, Keilani, Harper, Brody.

Seven years ago, Carl Smith, a seventeen-year old Yupiaq, moved to Akiak, Alaska with his family after spending the first ten years of his life in Anchorage. The Yupiaq of Akiak, are an indigenous Tribe that live in southwestern Alaska next to the Kuskokwim River. The river and its surrounds are teeming with biodiversity, including dozens of species of fish and animals.

The Akiak are a self-sustaining people, who have practiced traditions of subsistence hunting and gathering for as long as they can remember. The Yupiaq hunt moose, caribou, rabbit, deer, beaver, muskrat, and occasionally, porcupine. They fish lush fish, black fish, and especially salmon. Hunting, fishing, and gathering are integral to maintaining their livelihoods and the traditional cultural and spiritual practices passed down from their ancestors for generations. Carl cannot imagine living anywhere else. "Everyone is our family here. Our parents taught us to respect our teachers, adults, the elders especially whenever they need it. It's like a big family here. Everyone is friends and cousins. Everyone helps each other out."

Carl appreciates how much he has learned about Yupiaq traditions since moving to Akiak. The elders in the Tribe educate the younger generations about cultural practices and the importance of fishing and hunting. Carl's uncles, grandfather, and father have taught him hunting and fishing, and the traditions surrounding these generations-old practices. "They teach us discipline and to respect everyone. It's really important because when we get older, we will have to teach our kids how to do it so they can survive in the winter." Carl is also hoping to renew old traditions, including starting a Yupiaq dance group in Akiak, a tradition that has been lost, along with the Yupiaq language, to the younger generations, although Carl's grandmother is teaching the Yupiaq dance to the children. Carl's mother Kimberly explained that the dance tells stories of hunting and fishing.

The sharing of harvests with elders and others from within the community is also a key component of maintaining and strengthening tribal and communal cultural and social connections. Carl explained that there is a "first catch" celebration when a young hunter catches their first animal. The animal is butchered, and the young man will give all of it away to the elders who can no longer hunt for themselves – this is called *" payugteq*". After the food is given away, there is a village feast. Carl's first catch was moose– "I was thirteen or fourteen." Moose, Carl's mother, Kimberly, explains, are special: “when a moose presents itself that means the creator is giving it to you – that the moose is giving itself to you. You have to be respectful to the catch because it gave its life to you.”

“The main thing is to respect your catch,” Kimberly continued. “Whether it is fish or meat, the entire animal is consumed; even the fish guts are used to make fermented fish heads.” There is no waste in the preparation of the game animals that Carl and his family bring home. Kimberly explains that, “they eat everything, so nothing goes to waste, except the guts in the mammals. They eat the stomach, the liver, the heart. “My mom cooks the moose nose and she cooks the brain and the hooves, but the men don’t usually eat the hooves,” Carl explained, “because it is bad luck.”

Kimberly Smith, holding king salmon, 2019.

According to Kimberly, while the men go out and hunt, the women take care of the home. “I learned a lot from my grandma and my mom. I learned how to cut fish, how to make fur booties - *kameksak* – and fur hats – *malakais* – they also taught me how to prepare food, how to butcher a moose, how to process meats and anything that the men bring back for us.”

Wild berries are also critical to the Akiak diet. Salmon berries are used to make *akutaq*, eskimo ice cream, and *mak-aq*, yogurt with berries. The berries are also used in dishes with liver, fish, and eggs. When Carl’s family lived in Anchorage, his grandparents worried where they would get their berries. Kimberly explained “when we lived in Anchorage, we didn’t know where to go to pick berries. And my parents would ask me where I would pick berries, and I would tell them that I had to pick them from COSTCO.” It is important to Kimberly to be able to pass along not only the traditional dishes, but also gathering – “It is not only me – it is my mom teaching my kids and I’m constantly getting direction from my parents on how to cook certain foods or how to make something. It’s really important for me, even if they don’t have these things, that they learn about them at least.”

Carl cutting red salmon, 2019.

The changing climate as imperiled all of these traditions. Carl said “there hasn’t been a lot of snow in the winters, and the berries need the water from the snowmelt. It is starting to rain during the winter, though, and it never used to. It used to get to -30 or -40 and now it stays in the teens.” The summers are hotter too. While the summer temperature used to stay at about 70 or

80 degrees Fahrenheit, now it is getting as hot as 105 degrees Fahrenheit, something Carl and Kimberly do not remember happening in the past.

Carl and his father Clifton returning home with a moose, 2019.

Hunting and fishing are becoming more difficult. Caribou, a staple in Yupiaq diets, has become more elusive. Last year, Carl's family did not catch any caribou, which only pass by the Yupiaq hunting region from November to December each year. Carl explained that the river must freeze solid to allow the hunters to access the land on the other side of the river with their snowmobiles where the caribou pass through, and last year it did not get cold enough. According to Kimberly, by mid-November, the Kuskokwim river would be frozen solid, and that is when the men would cross the river on snowmobiles to hunt the caribou, but now, in November, "they are still using boats."

The rising temperature has also affected the men's ability to fish, a large part of which is done on the ice during the winter. Traditionally, "we used to go on the river and set fish nets and fish traps," Carl said. But now, with the river no longer freezing solid, fishing has become dangerous. "One of my buddies fell through the ice," Carl said.

Kimberly expanded, "usually we are good to travel on the river through end of April, beginning of May – but this last winter we had five people fall through the ice and two didn't survive. You can't go up and fish during the fall time and winter time because the ice is thin." Carl's family used to set their traps in the winter when the river freezes over, but that is becoming harder, and more dangerous, to do.

Carl explains that "we mainly collect our food during spring and fall and we need it during the winter. In the village, most families aren't doing good financially and we need it during the winter so that we don't have to buy it from the store." However, fishing in the winter have become even more important because summer fish, especially salmon, are also becoming harder to find. Fishing regulations in the summer restrict how much chinook, a type of salmon with a higher fat content than any other fish, they can catch. According to Kimberly, these "fishing regulations make it harder for us to fish in the summer and the salmon count is a lot lower than it used to be. This summer, we noticed fish that had died and were just floating in the river."

Carl's grandfather Sammy Jackson, working on a fishing net, 2019.

In preparing the catch of fish the men brought in this year, Kimberly said: "We've noticed this year the fish were smaller and there were some fish that when we cut them, there was a *stink*. When women cut fish, we know how they smell and look. Because we clean fish every day; when I noticed a really bad odor coming from the fish, I moved them away from the good fish to dry them and feed to the dogs. Some of the fish also have parasitic looking things in the meat. I've been cutting fish since I was seven or eight years old, and that's about 30 years, and the last few years the fish were like that –with the parasites. This is the first year we noticed stink fish. We never had that smell before. And there is one family that will not eat their salmon because they are scared to eat it."

Even though Kimberly and her children have been able to pick their own berries since moving back to Akiak, that tradition is also under threat. This past July, when she and her children went berry picking, they noticed a new kind of caterpillar on the plants. Carl said, "they were yellow and black with spiky hairs, and they were on every salmon berry, every stem, eating the salmon berries." According to Kimberly, "everyone came home with lots of bumps on their bodies and they turned into this puffy – I don't know it was so gross. We had to treat the kids and it took 3 weeks." Carl said he still has scars from the scabs he got from touching the caterpillar's hair, and "my younger sister went to the hospital. The bumps were like the size of her chest and stomach." Kimberly explained that while her two year old daughter had to be admitted to the hospital, all of her children had to make multiple visits to the clinic, and four out of six of her children had to be put on antibiotics. "It was really bad." Kimberly looked up the caterpillars afterwards, because she had never seen them before. She read a newspaper article describing the caterpillars as invasive to the area, and not usually seen so far north. "I'm not going back to that place again, I'll have to find a completely different place to get my berries," Kimberly worried. "I'll probably have to go further away, there is no way I'm going to go back there." Carl added she will need to find "a colder place."

Invasive caterpillars, 2019.

Now, because her family is catching and gathering less food, Kimberly has to buy more food for her family than she used to, which is an added cost and less-nutritious. The Yupiaq usually do not buy or sell goods; instead they trade with others for items they need and cannot get, and so shopping for food is atypical. "Because I have a huge family, we usually relied on one to two moose per year, one to two caribous, and a whole lot of fish. Last year we were only able to catch one moose, so I catch myself having to buy processed meat when I don't want to. Because what we eat is what we catch, and I've noticed that we've had to buy a lot of store bought food – even when I was little I grew up eating the Yupiaq food off the land, but now…" Kimberly added,

A fish camp balances precariously on the edge of the Kuskokwim River following massive overnight erosion, May 2019.

"people are starting to garden more to get their vegetables, but I would rather feed my kids moose and caribou and fish than other things."

The Akiak are also confronting other climate-related threats. The Kuskokwim River is eroding because of excess rain, the breaking up ice on the river, and unusual high winds. According to Carl, because of "south winds in front of the villages – they get three to five foot waves and it crashes against the river bank and it takes away sand and the bank starts falling over, and there is starting to be little cliffs. This year in May sixty feet eroded and our fish camp got lost in the erosion." Kimberly explained, "we lost a lot of riverbank. There was a spring storm where the water was really high and overnight, there are several houses now in danger of falling into the river, so they are working on getting those houses moved. They placed sand bags as a temporary measure to stop the erosion from happening, but when we have strong storms that pass through, it will erode more. All that I knew growing up is gone."

Carl also felt the impacts of a forest fire in July on a nearby mountain. "There was a big forest fire and the smoke went through to the river and we could barely get the boat around. I breathed in the smoke, it was hazy outside and the air smelled. It lasted for about a week until the wind changed, and the smoke blew away. Last year when this happened it pushed more animals towards the village; this year there were wolves at the airport." All of the climate impacts Carlos is experiencing will only worsen, but to what extent depends on how much Greenhouse Gas the world continues to emit.

All of these changes signify to Carl the loss of his way of life. "Climate change might change everything – how we feel, how we hunt. It is scary because if I have kids, I want them to live like I did – to hunt, fish, gather. I want to teach them but I'm scared because there might not be any more subsistence. There will be less fish and there won't be any more ice in the winter, and it will be warm, and it might not be the same. I feel scared, like we'll have to adapt to climate change, and teach them a different way." After living in the city for part of his life, Carl is not hopeful that the Yupiaq would be able to maintain their culture and traditions if they did not live off the land in Akiak, like they have done for generations. "They might learn a little bit of the lifestyle, but they won't understand. I'm worried because I feel like I might have to live in the city to find a job."

For Kimberly, "It's scary for me to think that I'll have grandkids that I won't be able to teach how I grew up – how to cut fish, how to put away moose and caribou and to know that the home I've always known is slowly eroding and fading away and it is going to be gone. I wish more people cared about climate change – I'm hoping that people who otherwise wouldn't know what climate change was; I want them to know that the way of life that we've lived for thousands of years is coming to an end. If we ruin it, there is no going back. We're destroying our world and it seems like not enough people care about that."

Over 60 feed of the Kuskokwim River eroded in one night in May 2019.

Carl added, "I hope this will change it. Our culture is dying slowly, and our hometown is eroding and there might be no more villages, no more Yupiaq. There won't be any more natives. If I could, I would tell the United Nations that it is hard to live here because everything is changing that we need to teach our kids how we lived, and to teach them our way of life. If the world leaders listen to us, children can make a difference in this world, because we're the ones that are going to be affected."

APPENDIX A.16

Alexandria Villaseñor (USA)

Alexandria Villasenor (California and New York, USA)

It was less than a year ago that Alexandria Villasenor, a fourteen-year old living in California first understood what it meant to be impacted by the climate crisis. Alexandria's hometown, Davis, California, is located about an hour away (about 100 miles) from Paradise, California – where in November 2018, one of the deadliest wildfires blazed across 153,336 acres, destroying nearly 14,000 residences and killing about 85 people. It took firefighters close to twenty days to put out the fire. Global heating is contributing to the increase in wildfires. Significantly, over the last 100 years, California has warmed by about 3°F (1.7°C). As a result, the hotter climate dries the plants and soil, leaving shrubs, grassland, and trees in California prone to burning.

The black smoke clouds and ashes from the Paradise wildfire effected areas hundreds of miles away. Before any news of the wildfire had been released, Alexandria remembers feeling as if needles were pricking her chest. Indeed, the toxic clouds easily reached Alexandria's home in Davis, California As the fire spread, Alexandria recalls:

> I would wake up nauseous from all the smoke because the smoke was seeping into our house. We had rolled up wet towels and put them under doors and windows to keep the smoke from coming in. Because I have asthma, it was a really scary situation.

Smoke from the 2018 Paradise wildfire spreading across California.

This experience was so distressing for Alexandria that she "compartmentalized" those traumatizing memories, and only recalled them after recently locating a journal she had kept during the frightening wildfires. She remembered:

> It was really scary. At nighttime I'd sleep next to the air filter. I'd get a wet washcloth and I'd have to keep it over my face because the smoke was preventing me from actually sleeping . . . I'd have sleep deprivation because I'd be so worried to fall asleep and I would have panic attacks.

Because of the deadly air quality and her quickly deteriorating asthma, Alexandria fled to New York City, where her mother was living. An excerpt from her journal just before she left for New York City reads:

A.16

12:35 AM | 11/29/18

Its technically the next day but I'm still counting it as monday. So, it's a good thing I'm leaving because I smell smoke inside the house. I have a cold washcloth over my face but I still feel sick. Smelling in the smoke gets me anxious. Earlier I had a panick attack, it wasn't as bad as others but still not the most fun. With me getting like this I'm so scared to go on a plane by myself. I feel like crying rn honestly. I'm holding it in though.

"*It's technically the next day but I'm still counting it as Monday. So, it's a good thing I'm leaving [Davis] because I smell smoke inside the house. I have a cold washcloth over my face but I still feel sick. Smelling in the smoke gets me anxious. Earlier I had a panic attack, it wasn't as bad as others but still not the most fun. With me getting like this I'm so scared to go on a plane by myself. I feel like crying [right now] honestly. I'm holding it in though.*"

In New York, Alexandria continued feeling the effects from the smoke inhalation. She was bedridden for three weeks and had to go to the emergency room for her asthma. Although, New York City has been an "escape" for Alexandria from the Paradise wildfire, she fears that more fires like the Paradise Fire will break out next year. And while Alexandria is currently living in New York City with her mother, she will return to Davis at the end of the year; however, her mother has decided to keep a home in New York City in the likely event another wildfire breaks in California and Alexandria needs to escape.

Meanwhile, New York City has also affected Alexandria's health. Alexandria's inhaler has become her "best friend", accompanying her everywhere around the city to make sure her asthma does not land her back in the emergency room.

New York City ranks as one of the worst cities for air quality in the country. While the city itself is almost free from particle pollution – pollution that results from wildfires, wood-burning devices, coal plants, and diesel engines –New York City consistently has a thick layer of smog from ozone pollution. An American Lung Association study revealed that hotter temperatures increase ozone pollution, and as the climate crisis increases temperatures, with 2015-2017 being the three warmest years on record, ozone pollution has worsened. Ozone pollution has serious damaging effects, essentially leaving a sunburn on the lungs. Breathing in ozone can cause shortness of breath,

Alexandria in the emergency room following the Paradise wildfire.

coughing, intense asthma attacks, and premature death. The American Lung Association underscored that children and teens are some of the most vulnerable to the risks from breathing ozone.

Alexandria, just like children around the world, is experiencing what she coins, “the new normal” – that is, a world very different from the one that her parents and grandparents grew up in. The annual wildfires in her hometown and the worsening air quality in New York City has relegated Alexandria to a life indoors – preventing her from playing outdoors with friends and going to the beach.

This “new normal” includes a world where many animal species and insects are near extinction or already extinct. The thought of koalas, monarch butterflies, fireflies, and other creatures becoming extinct often makes Alexandria cry and fearful of the future. The extinction of these species coupled with the impacts of the climate crisis has made Alexandria not want to have children because she believes subjecting a new generation to the climate emergency would be unjust.

Alexandria protesting outside the United Nations building in New York City. She has been protesting every Friday for the last eight months.

These fears are deeply rooted in Alexandria’s thoughts, in particular, her thoughts about the future. While the climate continues to heat up, Alexandria dreams of living on a beach when she grows up, asserting that “if I have to die” because of the climate emergency “at least I’ll be on a beach.”

Many children, who like Alexandria are anxious about the future, are mobilizing and striking on Fridays, foregoing school classes, to bring awareness and incite action by world leaders to combat global heating. Alexandria, inspired by Greta Thunberg, has been a leader of these strikes in the United States:

"I've been forced to organize a revolution instead of doing normal kid things."

All of the climate harms Alexandria is experiencing, will only worsen, but to what extent depends on how much greenhouse gas the world continues to emit.

Alexandria leading March 15th protests for climate action in Columbus Circle, New York City.

Understanding the immediacy of the climate crisis, Alexandria – in the mere span of eight months – has started and organized her own youth-led non-governmental organization, Earth Uprising, which has already expanded to over 150 cities in 50 countries. Earth Uprising mobilizes youths, giving them the necessary tools to raise awareness and spark action within their own countries to respond to the climate emergency. Alexandria hopes that our world leaders will listen and will quickly take action to save their future.

APPENDIX A.17
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APPENDIX B

Imperial College London

Grantham Institute Science Brief

September 2019

Climate physics consequences of further delay in achieving CO_2 emission reductions and intergenerational fairness

JOERI ROGELJ

Grantham Institute, Imperial College London, Exhibition Road, South Kensington, London SW7 2AZ, UK

Highlights

- Global warming is broadly proportional to the total cumulative amount of carbon dioxide (CO_2) emitted into the atmosphere
- This geophysical fact results in key consequences for intergenerational fairness and equity:
  - To halt global warming at any level global man-made CO_2 emissions have to decline to net zero;
  - The total cumulative amount of CO_2 emitted until the time of reaching net zero, also referred to as carbon budget, determines to a large degree the maximum amount of warming.
- The remaining carbon budget for limiting warming to 1.5°C or lower relative to preindustrial levels is small and will be exhausted unless net global CO_2 emissions have been strongly reduced over the next decade.
- Failure to reduce CO_2 emissions in the next years and decade:
  - Commits future generations to steeper and more challenging emissions reductions in the decades thereafter to stay within the same carbon budget;
  - Commits future generations to higher levels of risk that limiting warming to acceptable levels will become impossible;
  - Commits future generations to rely on the wide-spread deployment of at present unproven and controversial technologies to actively remove CO_2 from the atmosphere;
  - Creates an imminent risk that it will be impossible to "make up" for lost mitigation opportunities and will undermine the sustainable and safe livelihood of future generations.
- Risks of crossing critical temperature thresholds can be robustly lowered through stringent and effective emissions reductions in the next year and decade.
- Mitigation options are available to achieve the required emissions reductions and decarbonisation of energy, industry and society as a whole, and require targeted policy decisions to materialize.

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Introduction and context

Climate change is a global challenge that is caused by, affects and has to be addressed by human society over time horizons from the immediate present to future years, decades, and centuries. The main activities that are causing climate change started over a century ago when Western industries started burning fossil fuels for energy at the beginning of the industrial revolution (1, 2). As a result, past and present climate changes can be attributed to these century-long activities (3, 4). At the same time, if humanity indeed intends to limit climate change to a level that is currently considered acceptable (5, 6), solutions and strategies to limit and ultimately halt climate change should be implemented now and continue over the next several decades (7-9). The impacts of climate change are persistent and at times further materializing, even if global carbon-dioxide emissions would be brought to zero (8, 10-12). These impacts will thus be experienced and suffered by the future generations that live during the next decades and centuries to come. Climate change therefore poses both a global and an intergenerational problem. This characteristic is a direct consequence of the physical principles that underlie our robust scientific understanding of climate change (13).

Global warming (that is, the global average temperature increase of our planet relative to pre-industrial times) is not something that is typically experienced by individuals directly. However, global average temperature increase is shown to be a good proxy for the severity of some of the more direct, local impacts, like extreme heat during specific seasons, extreme rainfall, or disruptive storms, or crop failures (12, 14, 15). Other impacts, like sea-level rise, are more closely related to the trajectory of global warming over time instead of the instantaneous amount of global warming. **In all cases, global average temperature increase is either a direct or an indirect proxy for the risk of local climate change impacts that are harming people and putting a life sustaining environment at risk** (12, 14, 16).

The link between global warming and CO_2 emissions

On-going global warming, also referred to as climate change, is caused by human activities that generate waste gases or other emissions that are released into the common global atmosphere of our planet. This disturbs the equilibrium of the natural uptake and release of greenhouse gases like carbon dioxide (CO_2) or methane (CH_4) and results in increasingly higher levels of these greenhouse gases in the atmosphere. This increase is the main culprit for raising the overall average temperature of our planet (1). CO_2 is the most important of these greenhouse gases from human activities (1). In the last decade, climate science has established that there is a robust, broadly linear relationship between the total amount of CO_2 emissions that humanity emits into the atmosphere and the total amount of long-term global warming that the planet will experience (1, 17-26). A direct consequence of this relationship between the total cumulative amount of CO_2 that humanity has added to the planet's atmosphere and global average temperature increase is that to halt global warming to any level – be it 1.0 degrees C, 1.5°C, 2°C or higher – the total of CO_2 emissions emitted by humanity has to be kept to within a given maximum amount, or a carbon budget (27). This linear relationship and the idea that a global carbon budget ultimately determines the amount of global warming also comes with further important implications for the challenges, fairness, and responsibility for climate change and its solutions across generations.

Consequences for intergenerational fairness and equity

Every ton of CO_2 emitted by human activities causes roughly the same amount of global warming, whether it is emitted in the past, present, or future (13). **At present, however, activities of past generations have already increased the global mean temperature of our planet by about 1°C relative to pre-industrial levels (3, 8). If warming is to be kept under or at 1.5°C or well-below 2°C as referenced in the UN Paris Agreement (5), this leaves a much smaller remaining carbon budget for future generations compared to what was emitted by current and past generations** (9). Halting global warming to below a limit of 1.5°C or less requires staying within a carbon budget which can only be achieved if global annual CO_2 emissions are reduced to net zero (8, 13). Any climate policies that aim at providing a long-term solution to climate change should hence include a clear milestone target of when net-zero CO_2 emissions are going to be achieved (19, 28, 29).

A further consequence of carbon budgets is that unwillingness or failure by governments to reduce either national or global CO_2 emissions over the next decade results in a higher burden on future generations to reduce global emissions faster later on. This is a straightforward consequence of a higher share of the remaining carbon budget being used up if emissions stay at higher levels over the next years (13). Steeper emissions reductions are generally considered more risky and potentially more disruptive or costly compared to emissions reductions that start early and follow a more gradual path (7). Currently, global CO_2 emissions are still on the rise and every year an increasing amount of the remaining carbon budget is being used up, currently at a rate of more than 40 billion tons of CO_2 (Gt CO_2) a year (2). This continued rise in global CO_2 emissions resulting from our economic activities implies a stronger burden on future generations, with higher risks of exceeding temperature thresholds that are considered dangerous (5, 6). These risks are linked to both the risk of higher near-term warming and risks that the required emissions reductions that are presumed by the current delay in meaningful global CO_2 emissions reductions are not achievable.

The precise amount of global warming as a result of staying within a specific carbon budget is uncertain. Remaining carbon budgets that are consistent with limiting warming to a specific level are therefore typically reported for various levels of likelihood of success. For example, to limit warming to no more than 1.5°C relative to preindustrial level, the latest assessment of the Intergovernmental Panel on Climate Change (IPCC) reported a remaining carbon budget of 580 Gt CO_2 to have a one-in-two chance that warming is effectively limited to that level, and of 420 Gt CO_2 for a two-in-three chance of success (8, 9). Several other factors, some of which can be influenced by targeted policy decisions, are known to further affect the remaining carbon budget consistent with a given temperature limit or, vice versa, to change the temperature outcome for a given carbon budget (30).

However, an important insight for intergenerational fairness is that the uncertainty in remaining carbon budgets and global warming outcomes can be hedged against by reducing emissions more strongly in the near-term. Emission reductions in the next decade reduce the risk that stronger-than-assumed warming would render impossible the ability to keep global warming to safe levels at or below 1.5°C or well-below 2°C. Decision makers often design climate policies based on today's central estimate of the remaining carbon budget or climate uncertainties, or a pathway consistent with, for example, a two-in-three chance of limiting warming to 1.5°C or 2°C (31, 32). This approach neglects potentially disastrous climate outcomes that are currently still well in the realm of the possible and where the planet warms much more than the central estimate (33, 34). A strategy that pursues a pathway in line with a one-in-two or two-in-three chance of success does not effectively limit the risks of climate change, but rather intentionally leaves open the possibility that future generations will have to shoulder much stronger emissions reductions compared to those considered today, or will have to suffer the consequences of a planet that was heated beyond what today is considered a safe level, or both.

Finally, the warming that is expected as a result of a certain total amount of CO_2 will remain virtually constant for centuries even if humanity stops adding CO_2 to the atmosphere (13, 27, 35, 36). The warming caused by CO_2 is therefore at times referred to as irreversible (35). In other words, even if global man-made CO_2 emissions are reduced to net zero, the warming caused by the CO_2 emitted into the atmosphere will continue to linger for centuries. Our current understanding of climate physics indicates that the only hypothetical way to undo this warming at some point in the future is by trying to remove the cause of it through actively removing CO_2 from the atmosphere at a rate faster than would be the case naturally (3, 9, 13, 37).

Available mitigation opportunities and options for reducing greenhouse gas emissions

Reducing national and global CO_2 emissions to net zero requires rapid, far-reaching changes on an unprecedented scale (8, 9, 38). Importantly, quantitative pathways that describe how these stringent emissions reductions can be achieved have been identified (8, 9, 38-42). These include changing the way energy is produced, away from fossil fuel burning, the ways in which we design sustainable infrastructure and cities, or the ways in which we consume and produce food, to only name a few (8, 9, 38). As a common feature, all identified pathways necessarily bring about the stringent emissions reductions that are required to halt warming at the temperature levels included in the Paris Agreement (8, 9). However, the rich literature also shows that there are still important societal choices and value judgments that have to be made regarding the strategies that we pursue to achieve these emissions reductions (9, 43). Although not all measures that reduce emissions are compatible with the broader societal goals of sustainable development and poverty eradication, mutually beneficial strategies have been identified and are helped by early mitigation action and emissions reductions (8, 9, 41, 43).

Imminent risk of lost mitigation opportunities and the undermining of a sustainable and safe livelihood of future generations

The current delay in meaningful and adequate emissions reductions implies irreversible and high-risk consequences that will have to be shouldered by future generations. Several independent analyses consistently show how current pledged actions by countries are insufficient, either at a national or global level, to limit warming to the safe levels defined in the Paris Agreement (31, 34, 38, 44-46). This shortfall in climate action and resulting high-risk warming outcomes are illustrated in Tables 1 and 2.

A consequence for intergenerational fairness of heating the planet beyond a level that is considered safe, is thus that future generations are committed to suffer higher climate change impacts than are currently deemed unacceptable, or to actively drawdown CO_2 from the atmosphere (also known as carbon-dioxide removal or CDR) to slowly recover from these higher temperatures. At the same time, both these consequences expose future generations to significantly higher levels of risk.

Risks of triggering an irreversible collapse of unique and threatened ecosystems, like tropical coral reefs, is markedly increased with global warming exceeding 1.5°C, and so are the risks for extreme weather events, and impacts that particularly affect vulnerable people (8). The risk of crossing of tipping points (47) is also increased (8). For many of these tipping points, like the disintegration of the Greenland Ice Sheet or the unstoppable release of CO_2 from thawing permafrost, there is certainty that they exist, but the ability to determine at what level of warming they would precisely occur, is limited (8). Risks are often projected to increase markedly when the planet is heated beyond 1.5°C relative to preindustrial levels (8, 16). This combination of deep uncertainty about when these tipping points would take place and the large-scale impact they would have on future societies makes them particularly important to consider in the context of future risks and intergenerational equity.

Further risks future societies would be exposed to if the planet is heated beyond a level that is considered safe is that there are no readily available solutions to reverse warming. Technologies or measures to achieve the required active drawdown of CO_2 are currently still speculative and important trade-offs have been identified for their implementation at a globally significant scale (48-51). For example, bio-energy is assumed to be used in combination with technologies that could capture and sequester CO_2 underground (abbreviated to CCS) to drawdown CO_2 from the atmosphere. However, this bio-energy production can compete with agricultural production over land and water resources, and other sustainable development goals (38, 43, 48), and so can other methods like large-scale afforestation on land that would be needed to feed a growing global population. Insufficient emissions reductions over the next decade(s) will increase the need for large-scale carbon-dioxide removal with an important burden on a sustainable development, and the food and water security of future generations that will be increasingly hard to avoid. **If mitigation opportunities are squandered today, it very well may be too late to "make up" for them later.** This is hence a second important dimension where insufficient emission reductions in the next decade undermine the sustainable and safe livelihood of future generations.

Conclusion

In conclusion, the fundamental scientific understanding of the physics governing climate change thus results in a series of key consequences for intergenerational fairness. Past and current emissions of CO_2 either have used up or are continuing to deplete the carbon budget consistent with keeping warming to safe levels, to the detriment of future generations. The lack of globally significant CO_2 emissions reductions that would bring global CO_2 emissions to net zero as soon as possible puts an increasing burden of steeper and more disruptive emissions reductions on future generations. Options are available to reduce emissions in line with limiting warming at or below 1.5°C or well below 2°C relative to preindustrial levels but require policy decisions and action to materialize. Finally, the high risk of failure and the currently limited global emissions reductions are committing future generations to levels of climate change that at present are already deemed unacceptable, and also commit future generations to depend on the unproven and in many cases contentious global deployment of carbon-dioxide removal measures, some of which can have important negative side effects on water and food security, biodiversity, and sustainable development as a whole.

About the author

Dr Joeri Rogelj is a Lecturer in Climate Change at the Grantham Institute for Climate Change and the Environment at Imperial College London (UK). He researches the implications of our understanding of the Earth system for climate policy. He has published more than 70 peer-reviewed contributions to the scientific literature on carbon budgets, climate change mitigation, societal transitions consistent with limiting warming to 1.5°C, and climate change mitigation equity. He served as a Coordinating Lead Author on the Special Report on Global Warming of 1.5°C of the Intergovernmental Panel on Climate Change (IPCC). He has been a Lead Author on the annual UN Environment Emissions Gap Reports since their inception in 2010. Currently, he serves a Lead Author on the Physical Science Assessment for the Sixth Assessment Report (AR6) of the IPCC and is a member of the UN Secretary-General Climate Science Advisory Group.

Accompanying data tables

The following pages contain two accompanying data tables that illustrate the current inadequacy of proposed, pledged, or implemented policies in limiting global warming to well below 2°C or 1.5°C relative to preindustrial levels.

Table 1 shows the estimated historical greenhouse gas emission for the years 2010 and 2016 for a set of countries and regional or political groups as well as for the entire globe. These estimates are taken from the peer-reviewed scientific literature and use data provided by third-party sources to increase the independence of the estimates (52). These historical estimates provide context for the estimates of future emissions that either reflect projections of current policies and pledged actions under the Paris Agreement (referred to as Nationally Determined Contributions, NDCs) or emissions levels in 2030 at the national or regional level that are deemed consistent with limiting warming well below 2°C or to 1.5°C relative to preindustrial levels. The latter estimates are taken from two sources: the 2018 Emissions Gap Report (31) published by the United Nations Environment Program (UNEP, currently called UN Environment) and the analyses of a research consortium that tracks climate action called Climate Action Tracker (climateactiontracker.org).

Table 1 illustrates that despite uncertainties and variations in current and pledged climate actions, all but one country listed here are currently implementing emissions reductions measures that can be considered adequate to limit warming well below 2°C, and no country is implementing measures in line with limiting warming to about 1.5°C relative to preindustrial levels. In most cases, the warming implied by the lack of mitigation action would lead to global temperature rise in the range of 3 to 4°C.

Table 2 provides an overview of estimates of global mean temperature increase, based on the globally aggregated emissions that are estimated to be emitted under currently adopted and planned policies or under the full implementation of pledged action as reflected in the Paris Agreement NDCs.

Table 1: Overview of current and projected emissions per country or country group, as well as corresponding emission levels in 2030 consistent with limiting global warming to below 1.5°C or 2°C

	PRIMAPHIST[a] Third-party data based			UNEP Emissions Gap[b] Based on multiple independent studies				Climate Action Tracker[c] Independent research consortium						
	2010	2016	% share of globe in 2016	2010	Current Policy 2030	Unconditional NDC 2030	Conditional NDC 2030	Current Policy 2030	Unconditional NDC 2030	Conditional NDC 2030	<2.0°C	<1.5°C	Implied warming by 2100 if whole world implements comparable emissions reductions[†]	
[Unit]	MtCO$_2$e per year	MtCO$_2$e per year	%	MtCO$_2$e per year	MtCO$_2$e per year	MtCO$_2$e per year	MtCO$_2$e per year	MtCO$_2$e per year	MtCO$_2$e per year	MtCO$_2$e per year	MtCO$_2$e per year	MtCO$_2$e per year	Following current policy	Following NDCs[‡]
Argentina	335	358	0.8%	448	530	483	369	490	422	322	256	205	exceeding 4°C	below 4°C
Brazil	1030	1080	2.3%	1301	1328	1200	same	1119	890	same	744	432	below 3°C	below 3°C
China	10800	12400	26.3%	10180	14438	14388	same	15125	15192	same	10686	8399	below 4°C	below 4°C
France[#]	515	473	1.0%	NR	NR	NR	NR	395	403	same	165	42	below 4°C	below 4°C
Germany[#]	926	887	1.9%	NR	NR	NR	NR	735	553	same	285	65	below 4°C	below 3°C
India	2720	3450	7.3%	1848	4861	5241	4633	4558	5068	same	6194	4520	below 2°C	below 2°C
Turkey	413	505	1.1%	357	745	928	same	853	999	same	434	357	exceeding 4°C	exceeding 4°C
United States*	6710	6350	13.5%	6206	5566	4805	same	6254	5522	same	3488	1761	exceeding 4°C	exceeding 4°C
European Union	4860	4430	9.4%	4449	3428	3131	same	3427	3404	same	1918	758	below 3°C	below 3°C
G20 (incl. EU)	37702	39549	84.0%	32900	40714	39694	38274	41881	41348	40968	29283	19807	NR	NR
Marshall Islands	0.127	0.172	0.0%	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Global	43900	47100	100.0%	50000**	59000**	56000**	53000**	58983	55582	54164	40000**	24000**	See Table 2	See Table 2

Notes and sources:

MtCO$_2$e per year stands for million metric tons of CO_2 equivalent emissions per year. CO_2 equivalent emissions are reported using conversion factors knows as GWP-100 which stands for "Global Warming Potentials over a 100-year time horizon" as reported by the UN Intergovernmental Panel on Climate Change in its Second Assessment Report (SAR). "NR" means "not reported" by this specific source, in most cases because this country's climate policy and nationally determined contribution (NDC) under the UNFCCC is part of the broader EU28 NDC and can thus not be assessed in isolation.

a) Latest values of national and global greenhouse gas emissions excluding land-use change emissions. Note that the NDC emissions levels can also include land-use change emissions, which are very uncertain and for which limited independent sources are available. From: Gütschow, Johannes; Jeffery, Louise; Gieseke, Robert (2019): The PRIMAP-hist national historical emissions time series (1850-2016). V. 2.0. GFZ Data Services. http://doi.org/10.5880/PIK.2019.001

"Third party data based" values are labelled HISTTP in the original data source, and prioritize third party data over country reported data to estimate historical emissions.

b) Source: Central values from UNEP (2018). The Emissions Gap Report 2018. Nairobi, Kenya, UNEP: 1-113. ISBN: 978-92-807-3726-4. "Chapter 2. Trends and progress towards the Cancun pledges, NDC targets and peaking of emissions" and "Chapter 3. The emissions gap"

c) Estimates by the Climate Action Tracker research consortium. www.climateactiontracker.org - 17 June 2019 update. Where ranges are reported in the original source, the center-point of the most ambitious NDC target is taken. The conditional end of the global pathway is the lower end of the range of pledges assessed globally.

[#] Values for current policies and NDCs for Germany and France are based on an assessment of national policies and targets, respectively. These estimates are not publicly available on the Climate Action Tracker website but assessed with similar methods. Values consistent with limiting warming below 2°C or 1.5°C for France and Germany are based on the European Union's (EU28) values and adjusted based on EU internal effort sharing decisions. Unadjusted for EU internal effort sharing the emission values in 2030 for limiting warming to below 2°C and 1.5°C would be 203 and 80, and 364 and 144 MtCO$_2$e per year for France and Germany, respectively. Also the implied warming by 2100 is estimated with this adjustment method. France's unconditional NDC assessment assumes the use of gross-net land-use, land-use change and forestry (LULUCF) accounting. Tightening the LULUCF accounting to net-net would lower France's NDC projection to 312 MtCO$_2$e per year in 2030, implying a global warming of below 3°C if the whole world implements comparable emissions reductions.

* the United States' NDC is defined for 2025 and in absence of an updated NDC for 2030 emissions here listed as constant after 2025.

** Rounded global values from the 2018 UN Environment Emissions Gap Report. "<2.0°C" scenarios are consistent with holding global warming to below 2°C with 66% probability. "<1.5°C" hold warming to below 1.5°C in 2100 with 66% probability but have a lower probability over the course of the century. Increasing the probability that warming would be held to below these limits would imply these benchmarks to be lowered.

[†] Estimated by comparing the emissions projected for the year 2030 that result from either the implementation of current climate change mitigation policies (labelled as 'Following current policy') or the current NDCs (labelled as 'Following NDCs') with the science-based effort sharing ranges estimated by the Climate Action Tracker research consortium.

[‡] In case a country has both a conditional and an unconditional NDC, the average is taken for estimating the illustrative implied warming.

Table 2: Estimates of global warming resulting from current levels of climate policies and climate pledges

	Current policies	Unconditional NDCs	Conditional NDCs
UNEP Emissions Gap[a]		around 3.2°C (with a range of 2.9–3.4°C) relative to pre-industrial levels by 2100	about 0.2°C lower in 2100 than projections for unconditional NDCs
Climate Action Tracker[b]	3.1–3.5°C relative to pre-industrial levels by 2100. Optimistic interpretations of current policies bring it down to 3.0°C	2.7–3.0°C relative to pre-industrial levels by 2100	

Notes:

a) Source: Central values from UNEP (2018). The Emissions Gap Report 2018. Nairobi, Kenya, UNEP: 1-113. ISBN: 978-92-807-3726-4. "Chapter 3. The emissions gap"
b) Estimates by the Climate Action Tracker research consortium. www.climateactiontracker.org - accessed 26 July 2019

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APPENDIX C

CLIMATE ANALYTICS

Scientific Report on Impacts and Drivers of Climate Change

Authors/Contributors

Marina Andrijevic
Marie-Camille Attard
Claire Fyson
Inga Menke
Paola Yanguas Parra
Emily Theokritoff
Nicole van Maanen
Ryan Wilson
Carl-Friedrich Schleussner

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About Climate Analytics

Climate Analytics is a non-profit climate science and policy institute based in Berlin, Germany with offices in New York, USA, Lomé, Togo and Perth, Australia, which brings together interdisciplinary expertise in the scientific and policy aspects of climate change. Our mission is to synthesise and advance scientific knowledge in the area of climate change and on this basis provide support and capacity building to stakeholders. By linking scientific and policy analysis, we provide state-of-the-art solutions to global and national climate change policy challenges.

Climate Analytics was founded in 2008 in Potsdam, Germany by Dr (h.c) Bill Hare, Dr. Malte Meinshausen and Dr. Michiel Schaeffer to bring vanguard climate science and policy analysis to bear on one of the most pressing global problems of our time: human induced climate change. We are motivated by the desire to empower those most vulnerable – small island states and least developed countries – to use the best science and analysis available in their efforts to secure a global agreement to limit global warming to levels that don't threaten their very survival.

Contact

contact@climateanalytics.org

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1. Global Impacts

Global Impacts

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1. Summary

There are currently 2.3 billion children under the age of 18 living on earth who are among the group of people most vulnerable to climate change. Already today the global average temperature is 1°C above pre industrial times. The likelihood of children to live in a 1.5°, 2° and 3° world is significantly higher than for adults. Almost all children will experience 1.5° warming. Mitigation efforts of countries to date are insufficient to achieve the 1.5°C limit (or lower) of the Paris Agreement, but rather set the world on track towards a 3°C warming by the end of the century. Under such a pathway, 92% of all 16-year-old children alive today are expected to live in a 2°C warmer world and 4% will experience a 3° warmer world.

Global sea levels have risen by about 20cm since pre-industrial times. Current projections show a risk for **global sea level rise** of up to 1m by 2100. Sea level rise will continue for centuries to millennia after emissions have been reduced to zero and could amount to many meters. Only limiting warming to 1.5°C in line with the Paris Agreement may hold long-term sea level rise in 2300 below 1m. Every delay of 5 years in peaking of emissions will lead to a 20cm increase in sea level rise over that time frame.

Extreme events will increase in frequency and intensity. Heat waves and extreme hot summers such as the 2003 Central European hot summer, which would have been a 1 in a 100-year event without climate change, is currently projected to be a 1 in a 4-year event and is projected to happen almost every other year under 1.5° warming. Six out of 10 central European summers would be like that or warmer if there is a 2°C warming. Even at 1.5°C warming in comparison to present day warming levels, globally twice as many megacities will be exposed to heat stress exposing up to 250 million additional people to deadly heat wave conditions by 2050.

Tropical cyclones as severe as Irma, Harvey or Maria which hit the Caribbean in 2017, are likely to reoccur or worsen in strength, with global warming.

The IPCC has identified five key "**reasons for concern**" summarizing the **impacts of climate change**. Risks and impacts related to all five reasons will worsen to high or even very high if warming of 1.5°C is exceeded. Without additional substantial emissions reduction, children of today will live half their lives in a world characterized by high climate risks across a broad range of impacts.

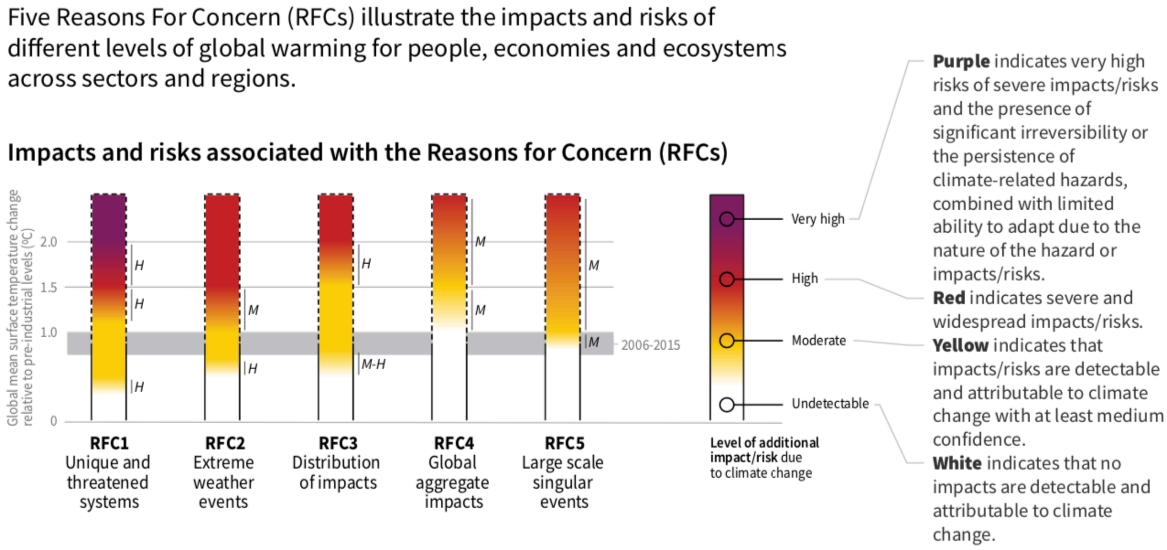

Figure 1: How the level of global warming affects impacts and/or risks associated with the Reasons for Concern (RFCs) and selected natural, managed and human systems. Source: IPCC, 2018

The **tropical rainforest biomass** is expected to reduce due to deforestation, fire and change in biomes. The biomass expected to be lost between 1.5°C and 3°C warming levels - doubles from 20 to 40%.

Crop yield is expected to decrease in most regions increasing the risk for food shortage. The West Sahel zone is projected to face serious food security issues above 2°C.

The number of people exposed to **water stress** will increase with rising temperatures. At 1.5°C warming an increase of 4% more people of the world population are expected to be exposed to water stress, while 8% more people will be exposed at 2°C warming.

Increasing temperatures have an impact on **biodiversity** as the biomes shift and habitats are destroyed. The expected losses for insects, plans and vertebrates are twice to three times as large at 2°C warming levels than at 1.5° warming.

Health impacts will disproportionally affect children and will worsen with increasing temperatures. Child mortality especially for children below five years of age will increase due to the higher vulnerability of children which includes lower tolerance for heatwaves, air pollution, and food deprivation/undernutrition. 88% of the existing burden of diseases as a result of climate change is put on children under the age of five.

Occupational health will become an increasing challenge particularly in sectors that require manual labor outside such as agriculture and construction, which will lead to economic loss particularly in tropical and sub-tropical countries. In 2017 an estimated 153 billion **hours of labor** were lost which equals an increase of 62 billion hours in comparison to the year 2000. 80% of the losses are linked to the agricultural sector.

The costs of preventing workplace heat-related illnesses through worker breaks suggest that the difference in economic loss between 1.5°C and 2°C could be approximately 0.3% of global gross domestic product (GDP) in 2100.

Since 2008, climate-related **displacement** has affected an estimated 22.5 million people per year on average - equivalent to 62,000 people every day. Populations of Small Island Developing States in particular are being threatened by sea level rise and are threatened for their very survival. In response to that existential threat, Kiribati was the first island state to actually purchase land in Fiji to consider the migration of a whole nation due to future sea level rise which will make the island uninhabitable.

Already today at about 1°C global warming, **poverty** and disadvantage have increased and are likely to increase even further with rising temperatures. At approximately 1.5°C of global warming, climate change is expected to be a poverty multiplier. Climate change alone could force 3 million to 16 million people into extreme poverty, mostly through impacts on agriculture and food prices.

Sea level rise and other extreme events will impact **Cultural heritage**. A global analysis of sea level rise risk to 720 UNESCO Cultural World Heritage sites projected that about 47 sites might be affected under 1°C of warming, with this number increasing to 110 and 136 sites under 2°C and 3°C, respectively.

Soft and hard limits of adaptation will cause irreversible **loss and damage** already for warming levels at around 1.5°C and even more so if 1.5°C is exceeded. Exceeding the limits of adaptation can trigger escalating losses or result in undesirable transformational changes such as loss of livelihoods in Small Island Developing States.

2. Demographic developments (global)

Based on the 019 revision of the United Nation’s population prospects, the world is currently populated by about 2.5 billion children, up to the age of 19, comprising more than a third of the world’s total population (United Nations, 2019). The youngest populations tend to reside in the least developed countries which are still undergoing early phases of demographic transitions and are still experiencing high fertility rates.

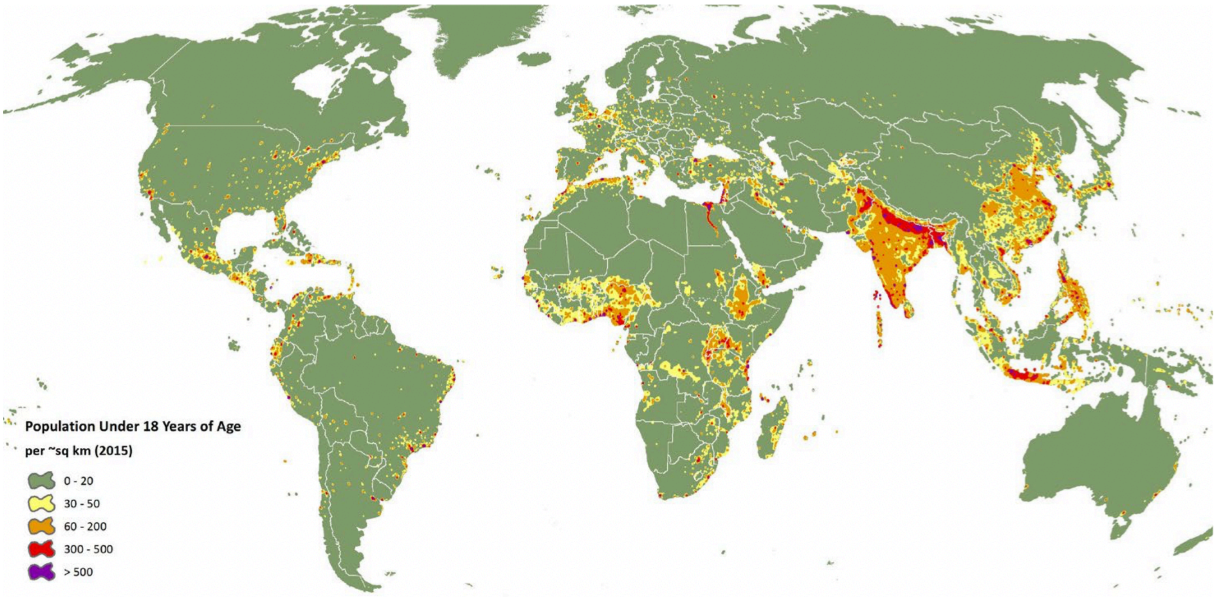

Figure 2: *Global map of where the 2.3 billion children currently live (population below the age of 18). Source:* UNICEF, 2015

2.1. Likelihood of children to experience 1,5, 2 and 3°C

Today's children are expected to live longer, and be healthier and better educated than any of their ancestors, though with large disparities between countries. An average 16-year-old citizen of the world is expected to live until the age of 82 (World Data Lab, 2019), with a 98% probability to experience the 1.5°C world (~2035), 92% for a 2°C world (~2055). About 4% of today's teenagers are expected to live until the end of the century when the current emissions pathways could bring about a 3°C warmer climate (Climate Action Tracker, 2018).

3. Observed and projected impacts

Today the impacts of climate change are noticeable around the world. With increasing global warming, the impacts on humans and natural systems will increase. Demographic developments increase the likelihood of children to experience a 1.5°, 2° and even 3° warmer world. Impacts from these global temperature increases are considered in the analysis of projected impacts.

3.1. Representative Concentration Pathways – temperature warming

Representative Concentration Pathways (RCPs) are a suite of scenarios considering future emissions and concentrations of greenhouse gases, aerosols, and land use (Moss et al., 2008). The International Panel on Climate Change (IPCC) and the climate modelling community use four different scenarios named after their radiative forcing potential (RCP 2.6, 4.5, 6.0, 8.5)(Moss et al., 2010). Each RCP is associated with an approximation for the range of the temperature increase by 2100 in comparison to pre-industrial times. The table below shows the median temperature estimate of this range. RCP2.6 is the pathway compatible with the Paris Agreement and would lead to about 1.5°C by the end of the century. RCP4.5 translates to about 2.5°C warming by 2100, RCP6.0 to about 3° warming and is corresponding to a business-as-usual approach to emissions reduction, in line with current policies (Climate Action Tracker, 2018). RCP8.5 is a high emissions scenario reaching more than 4°C by 2100. Many studies in climate research use a subset of the RCPs and hence do not provide estimates of impacts under all warming levels. In the analysis on global and national impacts, we will refer to the expected temperature increase by 2100 rather than the RCP. For high emission scenarios either RCP8.5 and 6.0 are used, while 2.6 is consistently used for a low emission scenario.

Name	**Expected temperature increase in 2100 (median)**
RCP2.6	1.6°C
RCP4.5	2.4°C
RCP6.0	2.8°C
RCP8.5	4.3°C

***Table 1**: Representative Concentration Pathways scenarios and their approximate temperature increase by 2100 in comparison to pre-industrial times). Source:* Field et al., 2014)

3.2. Temperature increase globally

Reflecting the long-term warming trend since pre-industrial times, observed global mean surface temperature (GMST) for the decade 2006–2015 was 0.87°C (likely between 0.75°C and 0.99°C) higher than the average over the 1850–1900 period (very high confidence). Estimated anthropogenic global warming matches the level of observed warming to within ±20% (likely range). Estimated anthropogenic global warming is currently increasing at 0.2°C (likely between 0.1°C and 0.3°C) per decade due to past and ongoing emissions (high confidence).(IPCC, 2018)

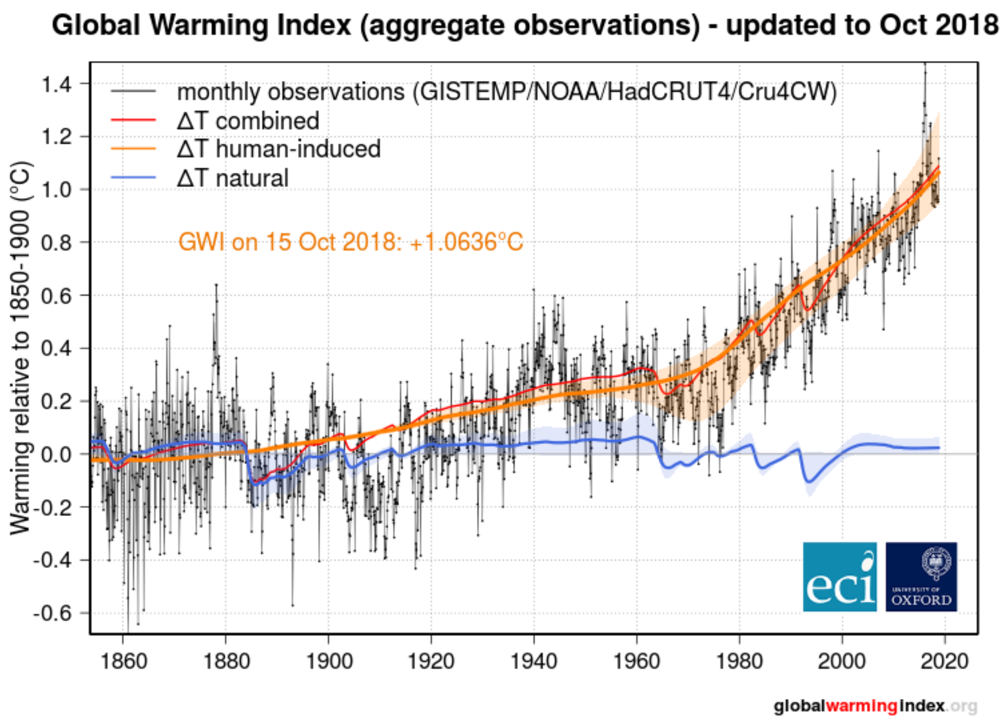

***Figure 3**: Global warming index – warming levels Oct 2018 1.06°C Source:* globalwarmingindex.org

Human-induced warming reached approximately 1°C (*likely* between 0.8°C and 1.2°C) above pre-industrial levels in 2017 (high confidence) (Allen et al., 2018). The global temperature increase is an average across the world. Research has shown that the warming above land is generally higher than above the ocean. Additionally, specific regions and seasons experience a higher warming with the Arctic reaching two to three times higher temperatures than the average (high confidence) (IPCC, 2018).

Today, 20-40% (depending on data source) of the world population has already experienced more than 1.5° warming in at least one season in the decade 2006-2015.

Past emissions are unlikely to raise temperatures above 1.5°C above pre-industrial levels (medium confidence). Based on current emissions, 1.5°C warming will likely be reached between 2030 and 2052 (IPCC, 2018). Based on the Climate Action Tracker information 2°C warmer world would be reached in about 2055 (median) and a 3°C towards 2100 (median) (Climate Action Tracker, 2018).

3.3. Sea Level Rise globally

> Sea level rise will continue beyond 2100 even if global warming is limited to 1.5°C in the 21st century (high confidence). Marine ice sheet instability in Antarctica and/or irreversible loss of the Greenland ice sheet could result in multi-meter rise in sea level over hundreds to thousands of years. These instabilities could be triggered at around 1.5°C to 2°C of global warming (medium confidence).

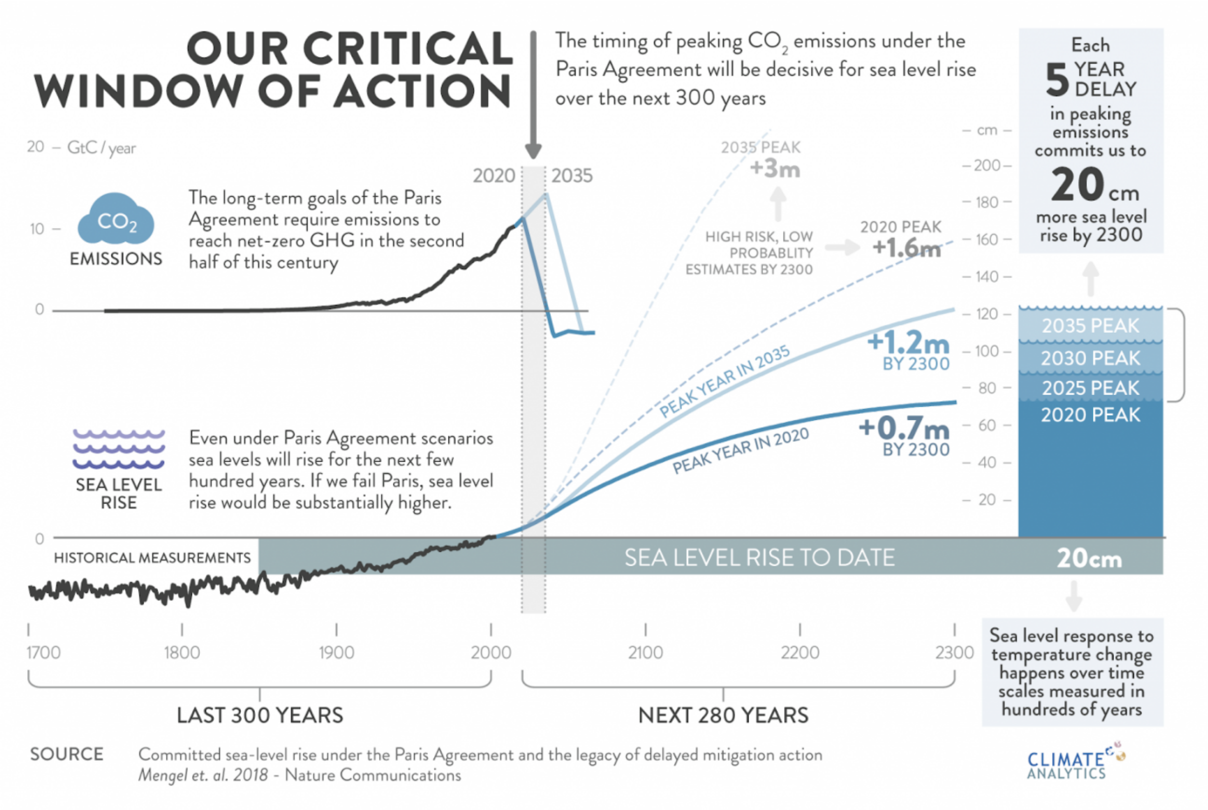

***Figure 4**: Our critical window of action. Source:* (Mengel et al., 2018b)

Currently the world has experienced about 20 cm of global sea level rise since pre-industrial times.

The IPCC states with high confidence that the sea level will continue to rise well beyond 2100, and the magnitude and rate of this rise will depend on future emission pathways. For 1.5°C the IPCC report projects a sea level rise of up to 0.77m by 2100 (Ove Hoegh-Guldberg, Jacob, Taylor, & et al, 2018) for scenarios not exceeding 2°C. Sea levels could be much higher, for higher warming scenarios (Nauels et al., 2017).

The paper from Mengel et al. 2018 analyses the relationship between future emission pathways and sea level rise. As Figure 4 shows the timing of mitigation actions matters for long-term sea level rise. Every 5-year delay in limiting CO_2 emissions will increase the sea level rise in 2300 by 20 cm. This analysis was only done for 1.5°C emission pathway (RCP2.6). For higher emission scenarios, reaching 2°, 3° or even 4°C higher levels of sea level rise can be expected. Future generations will therefore be affected by actions taken within the next decades (Mengel et al., 2018a). A reduction of 10 cm in global sea level rise would translate into 10 million fewer people exposed based on the population of 2010 (high confidence). Particularly Small Island Developing States (SIDS), low-lying coastal areas and deltas are at risk of increased flooding and loss of land due to sea level rise. A slower rate of sea level rise will enable these regions with a greater opportunity for adaptation (medium confidence). These regions have an increasing risk of experiencing saltwater intrusion, flooding and damage to infrastructure (high confidence) (Ove Hoegh-Guldberg et al., 2018).

Furthermore, the oceans have been absorbing about 30% of the past CO_2 emissions which has led to ocean acidification and changes to the carbonate chemistry (high confidence) impacting marine organisms and ecosystems. There is also *high confidence* that global warming has resulted in an increase in the frequency and duration of marine heatwaves (IPCC, 2018).

Considering that cold regions are warming more rapidly , by a factor of 2-3 times , the Arctic is likely to experience a warming of up to 4.5°, associated with a global increase of 1.5°C (high confidence). For a 2° warmer world Arctic temperatures would be expected to go up to 8°C (high confidence). Landscapes such as the tundra would shift northwards. Permafrost would likely deteriorate (IPCC, 2018).

Instabilities for both the Greenland and the Antarctic ice sheets exist, which could result in a multi- measure sea level rise. These instabilities are less likely to be triggered at a lower warming level (1.5°C) than higher ones (medium confidence). The Arctic sea ice is likely to be maintained under the 1.5°C scenario. For 1.5 to 2° warming, scientists expect every second summer to be ice-free. For 2 to 3°C, the Arctic is very likely ice free in summer. Polar bears, whales, seals and sea birds would lose their natural habitat (IPCC, 2018).

The impacts that climate change has on the ocean system go beyond the impacts felt in the Arctic region and include erosion of land, loss of land, loss of mangroves and loss of coral reefs. The following figure (5) shows the expected impact of different warming levels on different natural and human systems and the respective confidence level.

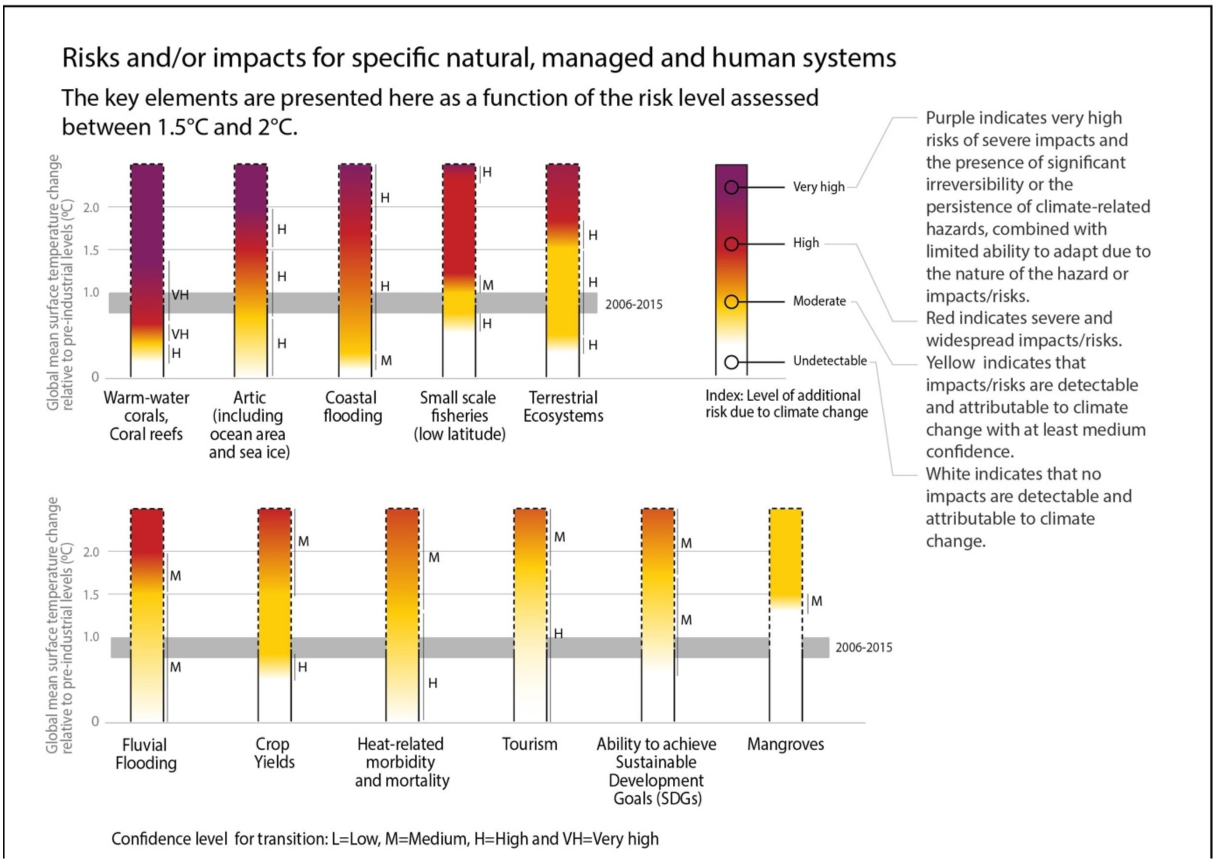

***Figure 5**: Risks and/or impacts for specific natural, managed and human systems. Source:* Ove Hoegh-Guldberg et al., 2018

3.4. Intensity of weather events

> Evidence from attributed changes in some climate and weather extremes for a global warming of about 0.5°C supports the assessment that an additional 0.5°C of warming compared to present is associated with further detectable changes in these extremes (medium confidence). Several regional changes in climate are assessed to occur with global warming up to 1.5°C compared to pre-industrial levels, including warming of extreme temperatures in many regions (high confidence), increases in frequency, intensity, and/or amount of heavy precipitation in several regions (high confidence), and an increase in intensity or frequency of droughts in some regions (medium confidence) (IPCC, 2018).

Extreme weather events are among the most prominent impacts of climate change. Many extreme weather events including heat waves, extreme precipitation, tropical cyclones, drought and associated wildfires, and flooding have already increased in frequency and intensity due to observed climate change and will continue to do so with increasing warming. An increasing number of extreme events can be attributed in part to climate change (see figure 6).

Heat waves

> Regarding hot extremes, the strongest warming is expected to occur at mid-latitudes in the warm season (with increases of up to 3°C for 1.5°C of global

warming, i.e., a factor of two) and at high latitudes in the cold season (with increases of up to 4.5°C at 1.5°C of global warming, i.e., a factor of three) (high confidence). The strongest warming of hot extremes is projected to occur in central and eastern North America, central and southern Europe, the Mediterranean region (including southern Europe, northern Africa and the Near East), western and central Asia, and southern Africa (medium confidence). The number of exceptionally hot days are expected to increase the most in the tropics, where interannual temperature variability is lowest; extreme heatwaves are thus projected to emerge earliest in these regions, and they are expected to already become widespread there at 1.5°C global warming (high confidence). (Ove Hoegh-Guldberg et al., 2018)

Attribution studies show that extreme heat experienced today can already be associated with anthropogenic climate change. Particularly for heat related studies, scientists were able to show that due to human-induced climate change heat related events are more severe or more likely to occur.

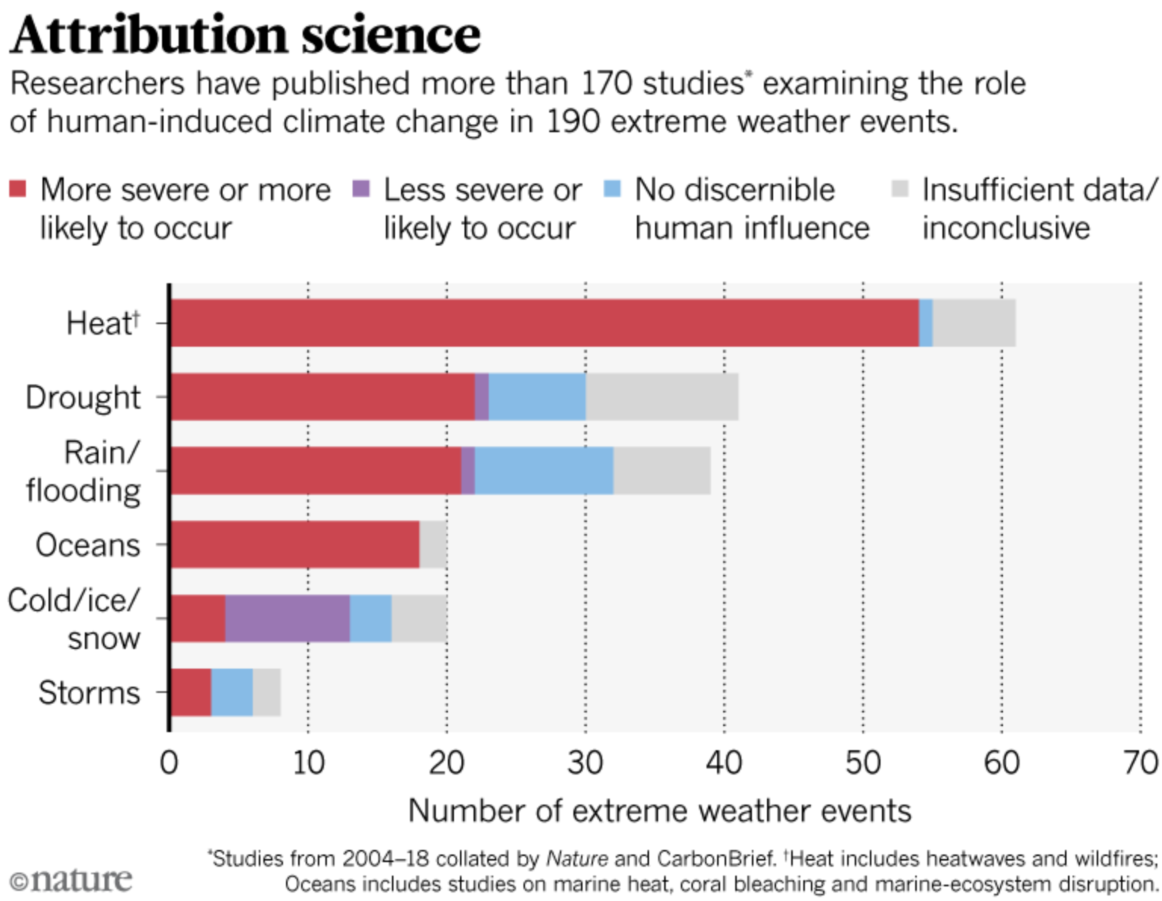

***Figure 6**: Studies in attribution of human-induced climate change and extreme weather events. Source: Schiermeier, 2018*

Studies by King & Karoly (2017) show the increasing likelihood of similar heatwave events occurring with current temperature increase of about 1°C, for 1.5 and 2° warming in comparison to a world without climate change. When looking at the 2003 heat wave in central Europe this would be a once in 100 years event without climate change. At current warming levels a similar event can be expected once every four years. For 1.5°C warming the likelihood increases to 4 out of 10 summers and for 2°C warming reaches 6 out of 10.

For the 2018 north hemispheric concurrent heat events, attribution to climate change even goes further. Vogel et al. (2019) found that these events would not have occurred without human- induced climate change and that these events would be exceeded in severity or frequency annually under 2°C warming.

EVENT	CONTEXT, IMPACT	VARIABLE	Likelihood of similar event per year: NATURAL	CURRENT	1.5°C	2°C
Europe 2016	Hottest year on record	T	0% (0%)	27% (17-37%)	52% (42-63%)	88% (83-92%)
Central England 2014	Hottest year on record	T	0% (0-1%)	19% (13-25%)	29% (21-37%)	48% (38-59%)
Central Europe JJA 2003	Hottest summer on record, thousands of heat-related deaths	T	1% (1-2%)	25% (17-33%)	42% (32-51%)	59% (50-70%)
		TXx	2% (0-6%)	21% (7-37%)	21% (9-34%)	31% (14-50%)

***Figure 7**: Likelihood of similar heat waves occurring without climate change, at current warming levels, for 1.5° and 2° warming. Source:* King & Karoly, 2017

According Chapter 3 of the IPCC 1.5 Special Report limiting global warming to 1.5°C means that 420 million fewer people will be exposed to extreme heatwaves and 65 million less are exposed to exceptional heatwaves (medium confidence). The report also points out that twice as many megacities will be exposed to heat stress at 1.5°C warming in comparison to present day warming levels exposing up to 250 million additional people to deadly heat wave conditions by 2050 (Roy et al., 2018).

Drought

The frequency and intensity of droughts has already increased in some regions, including the Mediterranean, west Asia, many parts of South America, much of Africa, and north-eastern Asia (IPCC, 2019b). The risk of extreme drought is substantially higher for 2°C warming levels and above than for 1.5°C global warming (medium confidence). The Mediterranean region and southern Africa particularly will be affected by extreme drought including increasing water stress (Ove Hoegh-Guldberg et al., 2018).

The IPCC report offers a detailed analysis for the Eastern Mediterranean region showing that the drought episode between 2007-2010 was the longest and most intense one in 900 years. A comparison between the 2008 drought and the drought in 1960 for Syria which was similar in precipitation, but with lower temperatures than 2008, shows that the increased evapotranspiration due to higher temperatures and the increase in population (from 5 to 22 million) amplified the drought in 2008 (Ove Hoegh-Guldberg et al., 2018).

Extreme precipitation

There is medium confidence that extreme precipitation events have increased in frequency, intensity and/or amount of heavy precipitation due to anthropogenic climate change on a global level which affect all sectors including agriculture, transport, health, freshwater availability, biodiversity, forests, etc. Heavy precipitation (aggregated at a global scale) is projected to increase with higher temperatures (IPCC, 2018). The largest increase in heavy precipitation is expected in high-latitude regions (e.g. Alaska /western Canada, eastern Canada/ Greenland/Iceland, northern Europe and northern Asia); mountainous regions (e.g., Tibetan Plateau); eastern Asia (including China and Japan); and eastern North America (medium confidence).Heavy precipitation associated with tropical cyclones will increase with higher temperatures (e.g. 2°C instead of 1.5°C of global warming).

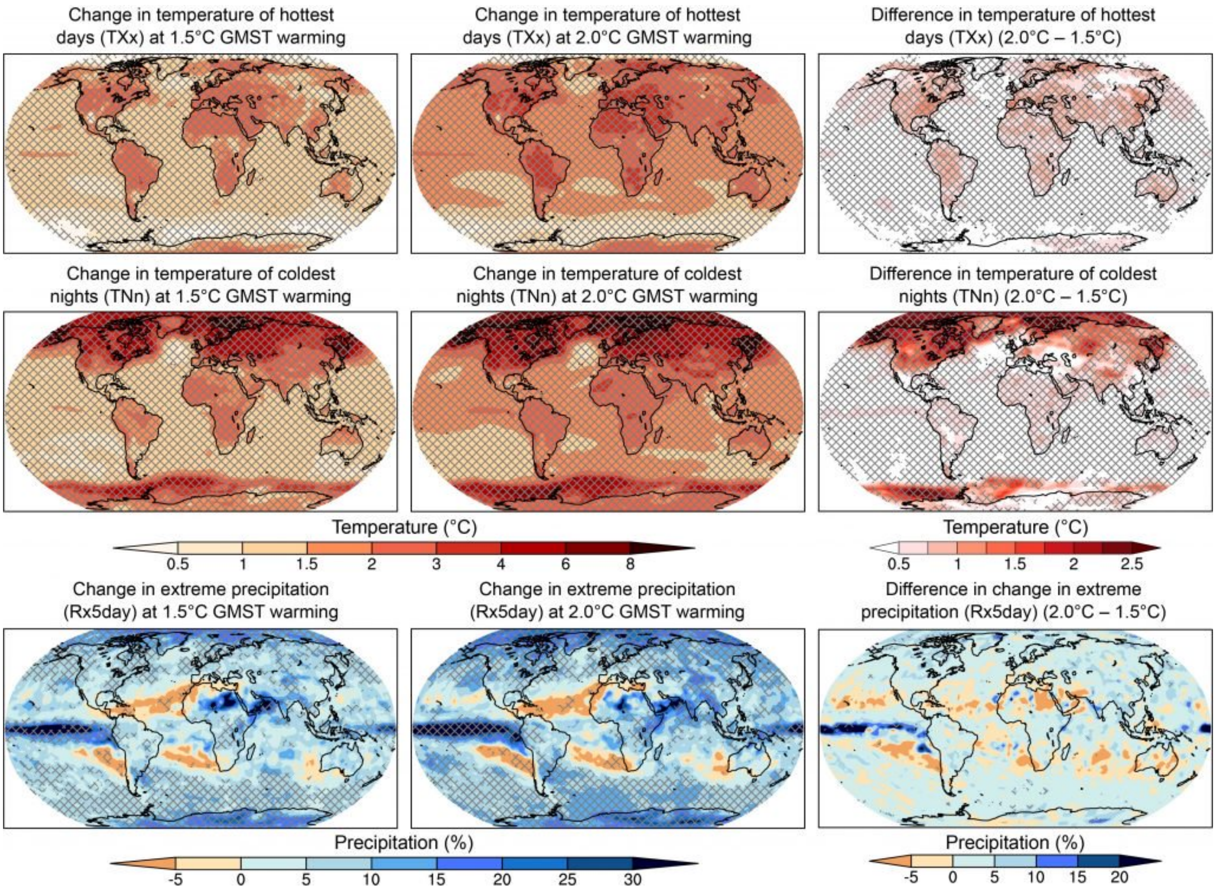

Figure 8*: Projected changes in extremes at 1.5°C (left) and 2°C (middle) of global warming compared to the pre-industrial period (1861–1880), and the difference between 1.5°C and 2°C of global warming (right). Source:* Ove Hoegh-Guldberg et al., 2018

Figure 8 from the IPCC 1.5 special report shows the global increase in extreme precipitation for the world (bottom left and middle for 1.5°C and 2°C warming respectively). The bottom right graph shows the difference in change between 2°C and 1.5°C warming. The top six maps show the change in temperature extreme for hottest days and coldest nights.

Floods

According to the IPCC 1.5 special report, the expected frequency and magnitude of floods are likely higher for temperatures exceeding 1.5°C warming (medium confidence). At 1.5°C global warming the IPCC 1.5 special report gives medium confidence for an expansion of the areas with significant increases in runoff and areas affected by flood hazards. For 2°C further increase in runoff and flood hazards is expected (medium confidence) (Ove Hoegh-Guldberg et al., 2018).

Tropical cyclones

While tropical cyclones are projected to decrease in frequency they will increase in the number of very intense cyclone (limited evidence, low confidence). Major tropical cyclones develop at sea surface temperatures of 27°C and above. With increasing global temperatures, sea surface temperatures also increase making Cat. 3-5 tropical cyclones more probable (Ove Hoegh-Guldberg et al., 2018). The following graphic supports the shift towards an increase of Cat. 3-5 cyclones both in the Caribbean and the Pacific region.

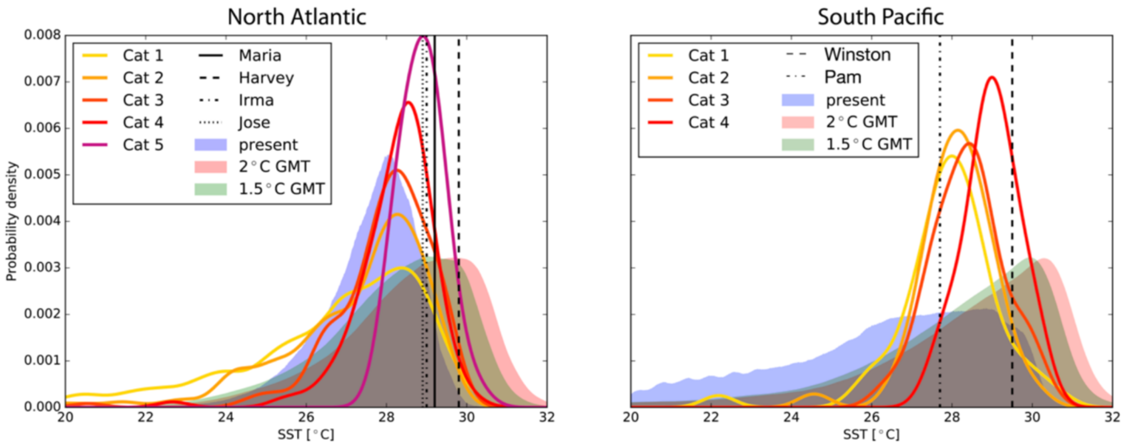

Figure 9*: Probability density of tropical cyclone formation against sea surface temperatures (SST) in the formation region by cyclone category for the North Atlantic (left) and the South Pacific basin (right). Black lines show recent tropical cyclones. The shaded areas show monthly sea-surface temperature (SST) distributions for the months of the main cyclone season including all grid cells of the main development region. Present (blue) for the period 1986-2005. Projections for 2°C global warming (red) and 1.5°C global warming (green) are presented for a multi-model mean of CMIP5 models. Source: Thomas, Pringle, Pfleiderer, & Schleussner, 2017*

Tropical cyclones are often linked to extreme precipitation and extreme sea level rise which creates a compound climate hazard (Ove Hoegh-Guldberg et al., 2018).

A recent study on wave-driven flooding shows that most atolls located in the tropics will be uninhabitable by 2050 due to expected annual wave overwash which will contaminate available freshwater resources without allowing them to recover and will damage the infrastructure of these islands (Storlazzi et al., 2018).

Wildfires

Due to increasing droughts and heat waves, wildfires are increasing in intensity. The Mediterranean in particular will experience an increase under 1.5°C warming. Under 2°C warming, the USA and Canada are projected to experience increasing wildfires. According to the IPCC 1.5 special report, there is still little information available for many world regions including Central and South America, Australia, Russia, China, and Africa (Ove Hoegh-Guldberg et al., 2018). The IPCC 5th Assessment Report rates with medium confidence that the frequency of wildfires in subarctic conifer forests and tundra will increase (Field et al., 2014).

3.5. Impacts on different sectors

The global climate has changed relative to the pre-industrial period, and there are multiple lines of evidence that these changes have had impacts on organisms and ecosystems, as well as on human systems and well-being (high confidence) (Ove Hoegh-Guldberg et al., 2018).

The IPCC 5th Assessment Report gives an overview of key sectors that are already impacted by climate change in different regions.

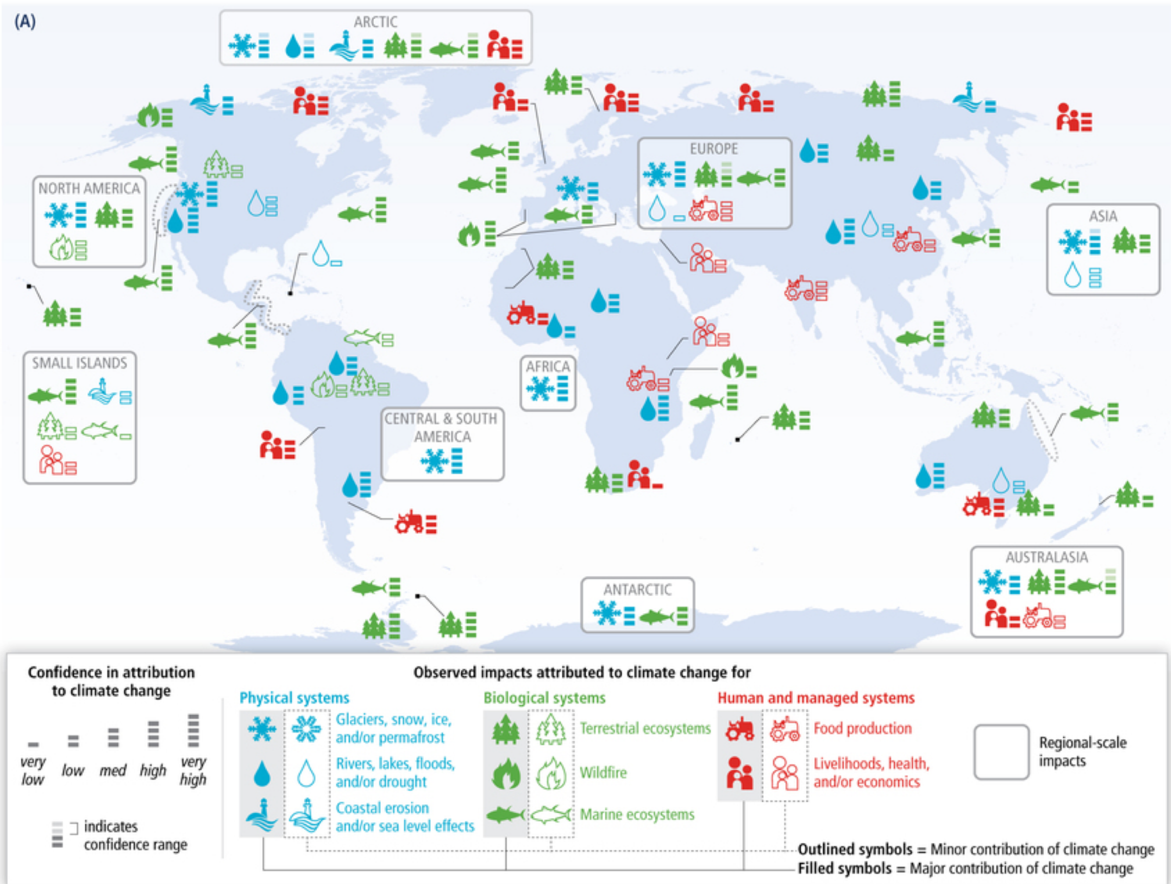

***Figure 10**: Widespread impacts in a changing world. Global patterns of impacts in recent decades attributed to climate change, based on studies since the AR4. Impacts are shown at a range of geographic scales. Symbols indicate categories of attributed impacts, the relative contribution of climate change (major or minor) to the observed impact, and confidence in attribution. Source: C B Field et al., 2014*

The newly published special report on climate change and land assesses the risk to humans and ecosystems from changes in land-based processes as a result of climate change and is able to show that today at 1°C warming impacts are noticeable and will increase significantly for 1.5°C, 2°C and further degrees of warming. Food supply insecurity in particular could affect whole regions periodically (medium confidence) (IPCC, 2019b).

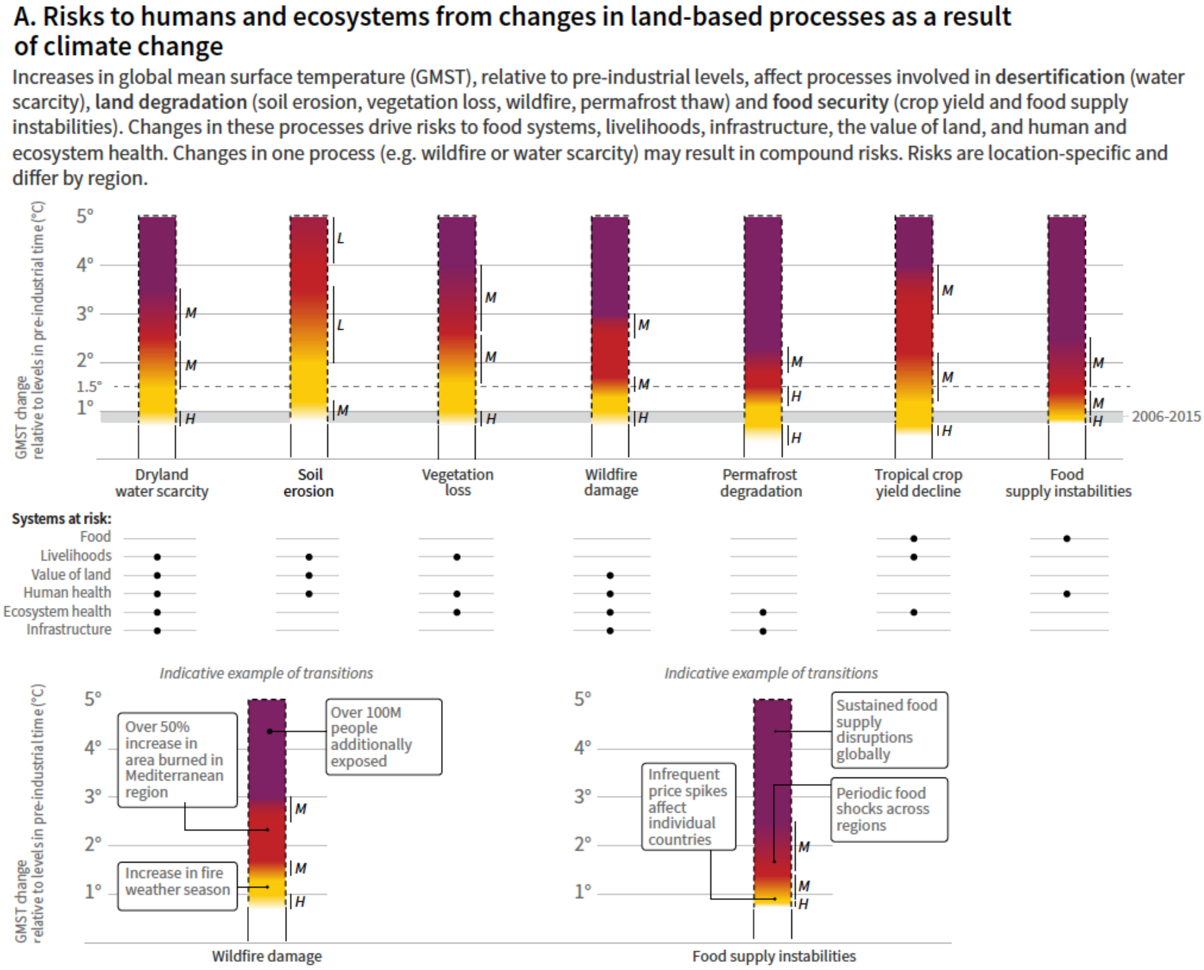

Figure 11: Risks to land-related human systems and ecosystems from global climate change, socio-economic development and mitigation choices in terrestrial ecosystems. Source: IPCC, 2019

3.5.1. Crops

Climate change impacts on crop yields have been detected and attributed to climate change with *high confidence.* Today crop production has been affected by climate change impacting particularly local crops that grow under specific climate conditions, such as for example olives or grapevines in Mediterranean. Among the main agricultural crops worldwide, particularly wheat and maize have experienced the highest negative impact. While some high-altitude areas experience an increase in crop yield; tropical crop yield in West Africa, Southeast Asia and Central and South America in particular are at a significant risk of declining for a global temperature increase of 2° and more (high confidence). West Africa has been identified as a hotspot for negative impacts from climate change on crop yields and production for 2° warming endangering food security in the future (Ove Hoegh-Guldberg et al., 2018).

For each degree of global mean temperature increase, a significant reduction in global production of all main agricultural crops is projected. Reductions in global production are projected to be as follows: wheat (by 6.0 ± 2.9%), rice (by 3.2 ± 3.7%), maize (by 7.4± 4.5%), and soybean (by 3.1%). Adaptation measures such as adjusted planting times, fertilizers and irrigation may increase wheat and maize yields by 7-12% (de Coninck et al., 2018).

Heat stress impacts livestock causing increased animal mortality, increased water need and reduced production of e.g. milk. At approximately 2°C of warming a global loss of 7–10% of rangeland livestock is projected, with considerable economic consequences for many communities and regions (medium confidence) (Ove Hoegh-Guldberg et al., 2018).

3.5.2. Freshwater availability

Water scarcity has been an increasing problem which has worsened due to changes in climate, water consumption behavior, population growth and distribution, ranging from .24 billion (14% of the global population) in the 1900s, to 3.8 billion (58%) in the 2000s. 1.1 billion people (17% of the global population) mostly in South and East Asia, North Africa and the Middle East faced serious water shortage and high water stress in the 2000s (Ove Hoegh-Guldberg et al., 2018).

Even though regions particularly affected by drought will face an increasing impact on the level of water stress, the IPCC 1.5 special report concludes that the changes in population will generally have a greater effect on water resource availability. At 1.5°C warming the percentage of the world population expected to be exposed to water stress will increase by 4%, while 8% more - will be exposed at 2°C warming (Roy et al., 2018).

Small islands in particular will face water stress linked to coastal flooding and sea level rise which is expected to be worse at 2°C in comparison to 1.5° warming (medium confidence) (Ove Hoegh-Guldberg et al., 2018).

3.5.3. Biodiversity/ecosystems

The IPCC 1.5 special report confirms the findings of IPCC 5th Assessment Report which concluded that the geographical ranges of many terrestrial and freshwater plant and animal species have moved over the last several decades in response to warming: approximately 17 km poleward and 11 m up in altitude per decade (Ove Hoegh-Guldberg et al., 2018).

Of 105,000 species studied, 6% of insects, 8% of plants and 4% of vertebrates are projected to lose over half of their climatically determined geographic range for global warming of 1.5°C, compared with 18% of insects, 16% of plants and 8% of vertebrates for global warming of 2°C (medium confidence). Impacts associated with other biodiversity-related risks such as forest fires and the spread of invasive species are lower at 1.5°C compared to 2°C of global warming (high confidence) (IPCC, 2018).

Alpine regions are generally regarded as climate change hotspots given that rich biodiversity has evolved in their cold and harsh climate, but with many species consequently being vulnerable to increases in temperature. Under regional warming, alpine species have been found to migrate upwards on mountain slopes (Reasoner and Tinner, 2009), an adaptation response that is obviously limited by mountain height and habitability (Ove Hoegh-Guldberg et al., 2018).

3.5.4. Forests

Forests, particularly tropical forests are considered the biggest carbon sink and afforestation and reforestation are part of mitigation strategies to store carbon.

Projected impacts on forests as climate change occurs include increases in the intensity of storms, wildfires and pest outbreaks (Settele et al., 2014), potentially leading to forest dieback (medium confidence). Warmer and drier conditions in particular facilitate fire, drought and insect disturbances, while warmer and wetter conditions increase disturbances from wind and pathogens (Seidl et al., 2017). Particularly vulnerable regions are Central and South America, Mediterranean Basin, South Africa, South Australia where the drought risk will increase (Ove Hoegh-Guldberg et al., 2018).

The increase in frequency of forest fires in North America between 1984-2015 has been attributed to climate change. Compared to what would have been expected without climate change, forest fires via the mechanism of increasing fuel aridity almost doubled in the western USA (Ove Hoegh-Guldberg et al., 2018).

High-latitude tundra and boreal forest are particularly at risk, and woody shrubs are already encroaching into tundra (*high confidence*) and will proceed with further warming. Increased disturbance from fire, pests and heat-related mortality may affect the southern boundary of boreal forests in particular (*medium confidence*) (Ove Hoegh-Guldberg et al., 2018).

At 1.5°C warming levels, deforestation and fire increases pose an uncertain risk to forest dieback. At 2- 3°C warming levels, a reduced extent of tropical rainforest is expected for Central America, where the tropical rainforest biomass would be reduced by about 40% under global warming of 3°C, with considerable replacement by savanna and grassland. With a global warming of close to 1.5°C in 2050, a biomass decrease of 20% is projected for tropical rainforests of Central America. If a linear response is assumed, this decrease may reach 30% (medium confidence) (Ove Hoegh-Guldberg et al., 2018).

3.5.5 Land degradation, permafrost and biomes

> Climate change exacerbates land degradation, particularly in low-lying coastal areas, river deltas, drylands and in permafrost areas (high confidence). People living in already degraded or desertified areas are increasingly negatively affected by climate change (high confidence) (IPCC, 2019b).

Land degradation resulting from the combination of sea level rise and more intense cyclones is projected to jeopardize lives and livelihoods in cyclone prone areas (very high confidence). Within populations, women, the very young, elderly and poor are most at risk (high confidence) (IPCC, 2019b).

Climate change can lead to land degradation, even with the implementation of measures intended to avoid, reduce or reverse land degradation (high confidence). Examples of climate change induced land degradation that may exceed limits to adaptation include coastal erosion exacerbated by sea level rise where land disappears (high confidence), thawing of permafrost affecting infrastructure and livelihoods (medium confidence), and extreme soil erosion causing loss of productive capacity (medium confidence) (IPCC, 2019b).

The Arctic tundra biome is experiencing increasing fire disturbance and permafrost degradation (Ove Hoegh-Guldberg et al., 2018).

At a 1.5°C warming scenario, a biome shift in the tundra and permafrost deterioration are likely. A 17-44% reduction in permafrost is projected for under 1.5°C warming, compared to 28-53% for under 2°C warming. For more than 2°C warming there is potential for permafrost to collapse (low confidence). In any case, the reduction of permafrost will cause an irreversible loss of stored carbon (Ove Hoegh-Guldberg et al., 2018).

The map shows the results of an ecosystem model illustrating that biome shifts in the Arctic, Tibet, Himalayas, southern Africa and Australia would be avoided by constraining warming to 1.5°C compared with 2°C (Ove Hoegh-Guldberg et al., 2018).

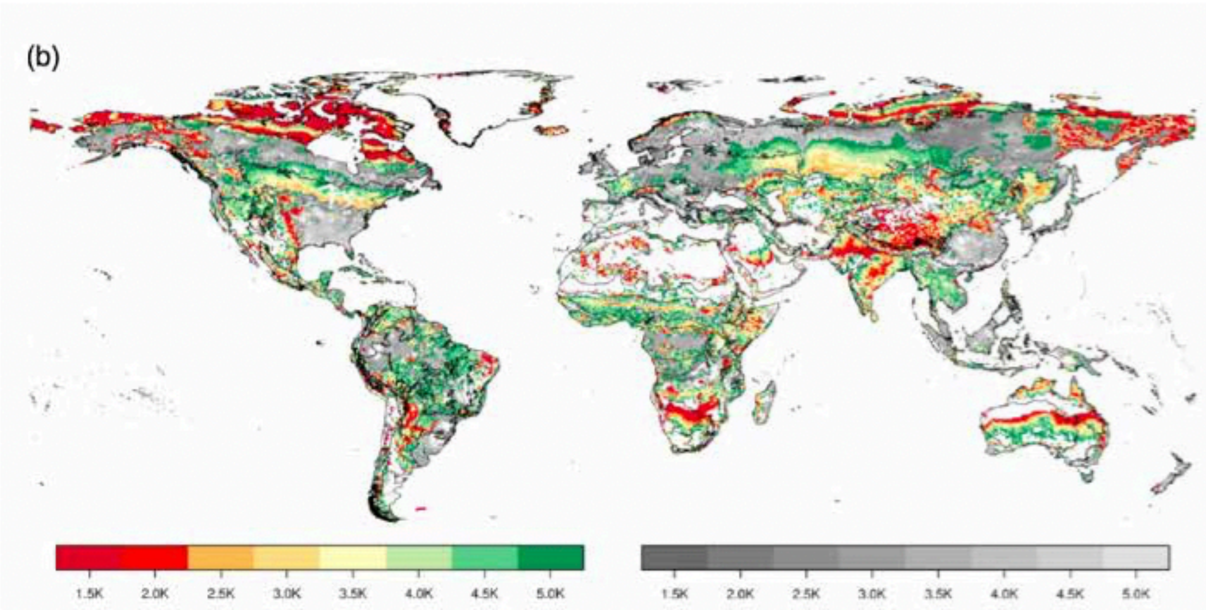

***Figure 12**: Level of global temperature anomaly above pre-industrial levels that leads to significant local changes in terrestrial ecosystems. Regions with severe (coloured) or moderate (greyish) ecosystem transformation; delineation refers to the 90 biogeographic regions. All values denote changes found in >50% of the simulations. Source: (Gerten et al., 2013). Regions coloured in dark red are projected to undergo severe transformation under a global warming of 1.5°C while those coloured in light red do so at 2°C; other colours are used when there is no severe transformation unless global warming exceeds 2°C. Source:* Ove Hoegh-Guldberg et al., 2018

3.5.6. Economic impacts

Global economic damages of climate change are projected to be smaller under warming of 1.5°C than 2°C in 2100. The mean net present value of the costs of damages from warming in 2100 for 1.5°C and. 2°C (including costs associated with climate change-induced market and non-market impacts, impacts due to sea level rise, and impacts associated with large-scale discontinuities) are $54 and $69 trillion, respectively, relative to 1961–1990 (Ove Hoegh-Guldberg et al., 2018).

As almost all impacts will worsen with increasing temperatures, the costs associated with these impacts will increase as well. At the same time, extreme events and slow-onset events as well as related health impacts such as heat stress will decrease the GDP. The IPCC 1.5 special report states that at 2°C global warming, lower economic growth is projected for many countries than at 1.5°C of global warming, with low-income countries projected to experience the greatest losses (low to medium confidence) (Ove Hoegh-Guldberg et al., 2018). A recent paper from Burke et al. (2018) shows decreases of global GDP for different warming levels between 10 and more than 30% for 1.6 and 4.3° warming levels by 2100 respectively (RCP2.6 and RCP8.5).

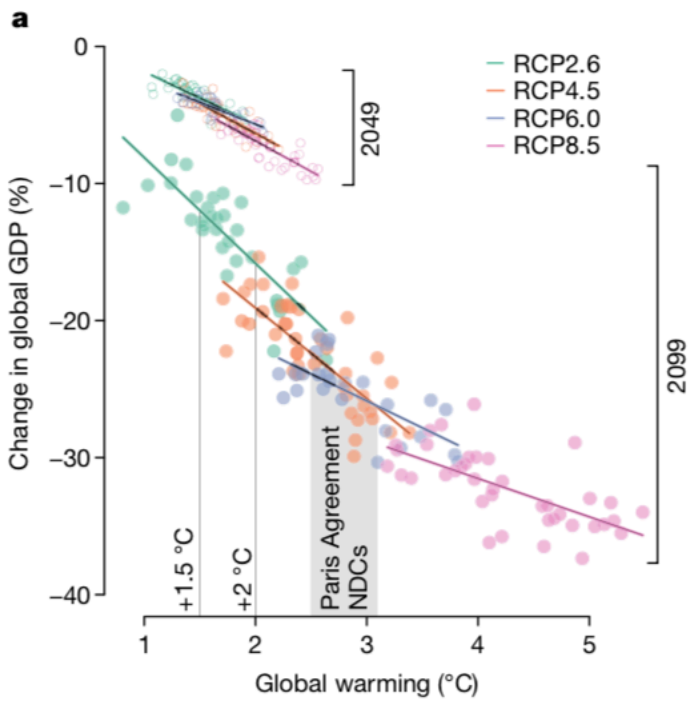

Figure 13: The impact of global warming on global GDP per capita, relative to a world without warming, for different forcing levels. Projected percentage change in global GDP for different climate models under different warming levels (RCPs), relative to a no-warming baseline. Colours denote different warming levels. Green about 1.6°C warming by 2100, orange about 2.3°C warming by 2100, purple 2.8°C warming by 2100 and pink 4.3°C warming by 2100. Warming is relative to pre-industrial levels. Unfilled points show mid-century projections, filled points show end-of-century projections. Vertical lines show the UN temperature targets as well as the range of estimates of end-of-century warming under current Paris commitments.

3.6. Health

The IPCC 5th Assessment Report concluded there is high to very high confidence that climate change will lead to greater risks of injuries, disease and death, owing to more intense heatwaves and fires, increased risks of undernutrition, and consequences of reduced labour productivity in vulnerable populations (Ove Hoegh-Guldberg et al., 2018).

In every crisis, children are amongst the most vulnerable. The same is true for climate change. Considering that areas at risk for flood and drought often overlap with areas of higher poverty, the most disadvantaged will be unproportionally affected by climate change (UNICEF, 2015). This definition is in line with the one of the IPCC 1.5 special report which defines the population at highest risk to include older adults, children, women, those with chronic diseases, and people taking certain medications (*very high confidence*) (Ove Hoegh-Guldberg et al., 2018).

These effects will impact children more significantly than adults, as they do not only face direct risks of climate change, but are also affected indirectly for example if their parents lose their livelihood or are affected by crop failure (UNICEF, 2015). Additionally and compared to adults, children are physically more vulnerable to the direct effects of extreme heat, drought, and natural disasters (Currie & Deschênes, 2016). The following overview shows the health impacts children face due to the diverse environmental impacts of climate change.

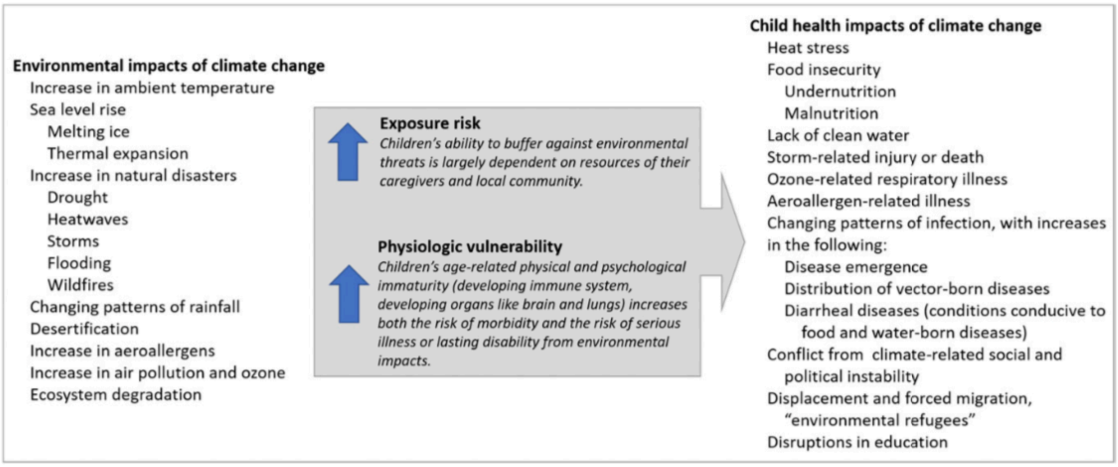

Figure 14*: Climate-related environmental health threats to children. Source:* Pass Philipsborn & Chan, 2018

3.6.1. Health impacts linked to temperature rise

> *Any increase in global temperature (e.g., +0.5°C) is projected to affect human health, with primarily negative consequences (high confidence) (Ove Hoegh-Guldberg et al., 2018).*

Higher temperature increase will have a negative effect on heat-related morbidity and mortality (*very high confidence*), and for ozone related mortality (*high confidence*). Urban populations in particular will be affected by amplified impacts due to urban heat islands (*high confidence*) (Ove Hoegh-Guldberg et al., 2018). The extent that urban populations are at risk of being impacted negatively by climate change depends on human vulnerability and the effectiveness of adaptation for regions (coastal and non- coastal), informal settlements and infrastructure sectors (such as energy, water and transport) (*high confidence*) (Ove Hoegh-Guldberg et al., 2018).

Additionally, poverty and disadvantage have increased with recent warming (about 1°C) and are expected to increase for many populations as average global temperatures increase from 1°C to 1.5°C and higher (medium confidence) (Ove Hoegh-Guldberg et al., 2018).

3.6.2. Health impacts linked to extreme weather events

> Due to several major global trends, including demographic and migration trends, more and more people are living in disaster- prone areas and exposed to weather extremes (UNICEF, 2015).

According to the report from UNICEF (2015) 500 million children live in extremely high flood occurrence zones and 160 million live in high or extremely high drought severity zones. With an expected increase in the frequency and intensity of these events driven by climate change, children will face even greater risk of exposure in the future. Infrastructure such as schools, hospitals and transport, as well as natural goods such as water systems and crops are crucial for the well-being of children and can get destroyed or damaged during floods and droughts.

Mortality

Studies have shown that children under 12 months old are particularly vulnerable to heatwaves. The mortality rate of infants and small children who are more likely to die or suffer from heatstroke because they are unable or lack agency to regulate their body temperature and control their surrounding environment. Dehydration can be caused by extreme heat stress which slows the sweating rate leading to hyperthermia and infant mortality. Diarrhea is another factor that can increase the risk of heat injury and death (UNICEF, 2015).

Physical impacts

The long-term effects of experiencing flooding can be substantial for children and has not only psychological impacts but results in physical impacts as well. A long-term study on children exposed to El Niño flooding in 1997/98 showed that five years later they were found to be smaller (1-1.8cm shorter than their peers), had higher incidence of stunting and lower body weight for age (0.38kg) compared to the control group (UNICEF, 2015).

Heatwaves can cause heat rash, heat-related cramps, exhaustion and stroke particularly in young children. Children with chronic health conditions, those living in poverty, those who lack adequate nutrition, water and sanitation face a higher risk (UNICEF, 2015).

Psychological impacts

Extreme events can cause emotional distress for children including fear of separation from their families, mounting tensions and pressures within households, a lack of emotional support at family level, and increased workloads (UNICEF, 2015).

A study conducted in southeast USA following Hurricane Andrew and another study in Poland conducted after the 1997 floods showed that children are 2-3 times more likely to suffer from posttraumatic stress disorder (UNICEF, 2015).

Other health impacts

Potential wildfires resulting from extreme heat and drought can cause death and displacement or destruction or damage of essential services, shelter and food (UNICEF, 2015).

3.6.3. Food security

> An estimated 821 million people are currently undernourished, 151 million children under 5 are stunted, 613 million women and girls aged 15 to 49 suffer from iron deficiency, and 2 billion adults are overweight or obese. The food system is under pressure from non-climate stressors (e.g., population and income growth, demand for animal-sourced products), and from climate change. These climate and non-climate stresses are impacting the four pillars of food security (availability, access, utilization, and stability) (IPCC, 2019a).

Climate change has already affected food security due to warming, changing precipitation patterns, and greater frequency of some extreme events (high confidence) (IPCC, 2019b). The people most affected live in low and middle-income countries some of which already at present day face a decline in food security partly due to migration and poverty (Allen et al., 2018).

Although hunger has been declining for the past 3 decades, undernutrition has worsened, particularly in parts of sub-Saharan Africa, South-Eastern Asia and Western Asia, and recently Latin America. Deteriorations have been observed most notably in situations of conflict and conflict combined with droughts or floods (IPCC, 2019a). The stability of food supply is projected to decrease as the magnitude and frequency of extreme weather events that disrupt food chains increases (high confidence). Increased atmospheric CO_2 levels can also lower the nutritional quality of crops (high confidence) (IPCC, 2019a).

Overall, food security is expected to be reduced at 2°C global warming compared to 1.5°C, owing to projected impacts of climate change and extreme weather on yields, crop nutrient content, livestock, fisheries and aquaculture and land use (cover type and management) (high confidence) (Ove Hoegh-Guldberg et al., 2018). The West Sahel zone is projected to face serious food security issues above 2°C (Ove Hoegh-Guldberg et al., 2018).

Considering that children need to consume more food and water per unit of body weight than adults, they are more vulnerable to deprivation of food and water. Therefore, undernutrition affects children over-proportionally and is responsible for nearly half of all under-five deaths. Extreme events such as droughts increase the direct risk of undernutrition, but also impacts children indirectly. The weight of children born to women exposed to drought in the year before giving birth can be negatively impacted. Furthermore, exposure to undernutrition in their first two years of life can cause stunting in children which affects physical and cognitive development, impacting the rest of a child’s life – including his or her schooling, health and livelihood (UNICEF, 2015).

3.6.4. Spreading of diseases

Changing weather patterns are associated with shifts in the geographic range, seasonality and transmission intensity of selected climate-sensitive infectious diseases (Ove Hoegh-Guldberg et al., 2018).

Vector-borne diseases

Children face a higher vulnerability to vector-borne diseases such as dengue and malaria (UNICEF, 2015). The World Health Organization (WHO) has estimated that 88 % of the existing burden of disease as a result of climate change occurs in children under five years of age (Ahdoot & Pacheco, 2015). Malaria is estimated to be responsible for 438,000 deaths in 2015 of which two-thirds were children below the age of five (UNICEF, 2015).

Risks for some vector-borne diseases, such as malaria and dengue fever are projected to increase with warming from 1.5°C to 2°C, including potential shifts in their geographic range (*high confidence*). Overall for vector-borne diseases, whether projections are positive or negative depends on the disease, region and extent of change (*high confidence*) (Ove Hoegh-Guldberg et al., 2018).

Water-borne diseases

Diarrheal diseases are estimated to have caused 480,000 deaths of children in 2016 alone (United Nations Children's Fund, 2018). They rank among the top five causes of death for children under five. Extreme events such as floods, droughts and severe storms which are increasing in frequency and intensity due to climate change, disrupt the access to safe water and sanitation which can lead to contamination of water resources resulting in water-borne diseases (UNICEF, 2015).

3.6.5. Air quality

Because ozone formation is temperature dependent, projections focusing only on temperature increase generally conclude that ozone-related mortality will increase with additional warming, with the risks higher at 2°C than at 1.5°C (high confidence) (Ove Hoegh-Guldberg et al., 2018).

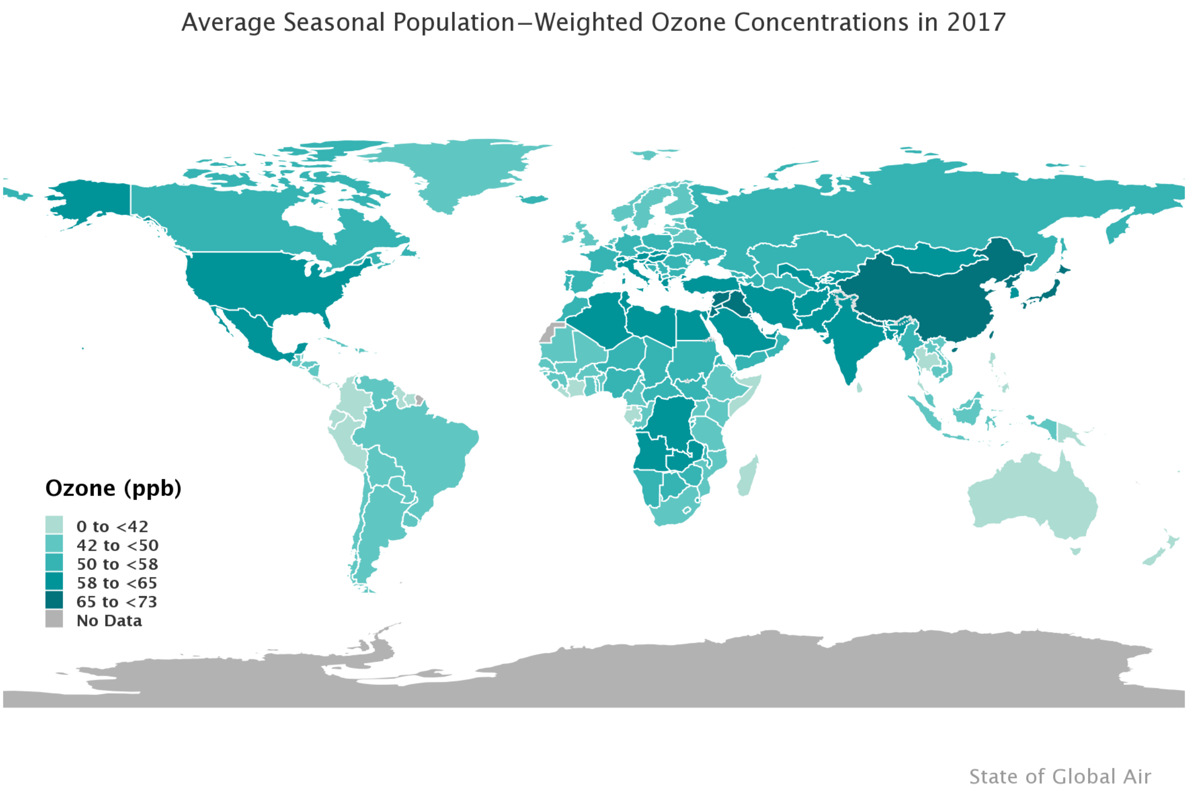

***Figure 15**: Global ozone concentrations in 2017 (shown as population-weighted seasonal averages) Source:* Health Effects Institute, 2019

Due to smaller lungs and a twice as rapid breathing rate up until the age of 12, children inhale proportionally more polluted air. Ozone as one of the increasing pollutants is a trigger of childhood asthma. It can exacerbate asthma symptoms in children. Children may be exposed to higher levels of ozone as they are likely to be outside during peak ozone times (UNICEF, 2015).

Increasing global temperatures increase pollen production and result in higher levels of natural allergens increasing the severity of asthma and other respiratory conditions (UNICEF, 2015).

Smoke from wild fires resulting from extreme heat and drought periods cause 260,000 to 600,000 deaths annually. Due to the higher breathing rate of children under 12, the impact on their health is particularly severe (UNICEF, 2015).

3.6.6. Occupational health

Increasing temperature and higher humidity levels pose additional stress on individuals engaging in physical activity. Safe work activity and worker productivity during the hottest months of the year would be increasingly compromised with additional climate change (medium confidence) (Ove Hoegh-Guldberg et al., 2018).

The Lancet report estimates 153 billion hours of labor were lost in 2017 which equals an increase of 62 billion in comparison to the year 2000. 80% of the losses are linked to the agricultural sector. The areas most affected are India, southeast Asia, and sub-Saharan Africa, and South America (Watts et al., 2018) which is visible in Figure 16.

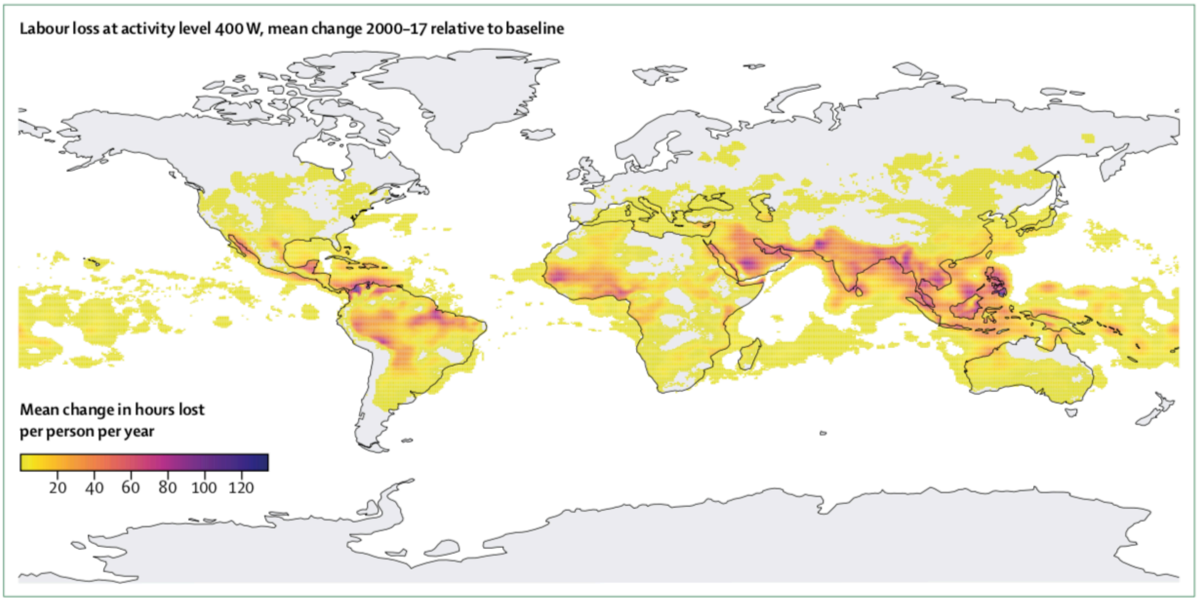

Figure 16: Mean change in total hours of labor lost at the agricultural activity level (metabolic rate of 400 W) over the 2000-2017 period relative to the 1986-2005 baseline. Source: Watts et al., 2018

The impacts of occupational health will become even more pressing with increasing temperatures. According to the IPCC 1.5 special report, the costs of preventing workplace heat-related illnesses through worker breaks suggest that the difference in economic loss between 1.5°C and 2°C could be approximately 0.3% of global gross domestic product (GDP) in 2100 (Ove Hoegh-Guldberg et al., 2018).

3.7. Societal impacts

> Drought significantly increases the likelihood of sustained conflict for particularly vulnerable nations or groups, owing to the dependence of their livelihood on agriculture. This is particularly relevant for groups in the least developed countries, in sub-Saharan Africa and in the Middle East (Ove Hoegh-Guldberg et al., 2018).

Conflict

According to the IPCC 5th Assessment Report, climate change can indirectly increase risks of violent conflicts in the form of civil war and inter-group violence by amplifying well-documented drivers of these conflicts such as poverty and economic shocks (*medium confidence*). Multiple lines of evidence relate climate variability to these forms of conflict (IPCC, 2014).

According to the IPCC 1.5 special report a 1°C increase in temperature or more extreme rainfall increases the frequency of intergroup conflicts by 14%. If the world warms by 2°C–4°C by 2050, rates of human conflict could increase. Some causal associations between violent conflict and socio-political instability were reported from local to global scales and from hour to millennium time frames. A temperature increase of one standard deviation increased the risk of interpersonal conflict by 2.4% and intergroup conflict by 11.3% (Ove Hoegh-Guldberg et al., 2018).

Migration

> Changes in climate can amplify environmentally induced migration both within countries and across borders (medium confidence), reflecting multiple drivers of mobility and available adaptation measures (high confidence). Extreme weather and climate or slow-onset events may lead to increased displacement, disrupted food chains, threatened livelihoods (high confidence), and contribute to exacerbated stresses for conflict (medium confidence) (IPCC, 2019b).

Conflict as well as natural disasters can lead to migration. The social, economic and environmental factors underlying migration are complex and varied; therefore, detecting the effect of observed climate change or assessing its possible magnitude with any degree of confidence is challenging (Ove Hoegh-Guldberg et al., 2018). Since 2008, climate-related displacement has affected an estimated 22.5 million people per year on average - equivalent to 62,000 people every day (UNICEF, 2015).

Even though migration cannot be easily attributed to climate change, the IPCC report does conclude that temperature has had a positive and statistically significant effect on outmigration over recent decades in 163 countries, but only for agriculture-dependent countries (*medium confidence*) (Ove Hoegh-Guldberg et al., 2018). The conflict in Syria follows a multi-year drought period which is one of the stressors that contributed to the outbreak of conflict as recent research shows (Gleick, 2014). The following figure (17) shows asylum seeker flows around the world clearly shows the migration waves particularly leaving Syria (Western Asia).

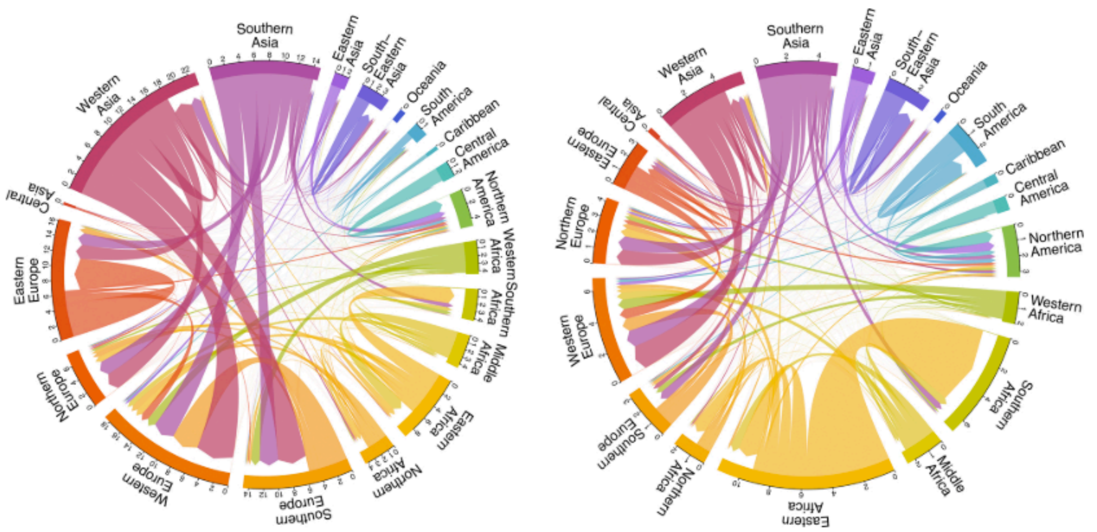

Fig. 2. Asylum seeking flows by world region, 2006–2010 and 2011–2015.

***Figure 17**: Asylum seeker flow by world region, 2006-2010 and 2011-2015. Source:* Abel, Brottrager, Crespo Cuaresma, & Muttarak, 2019

Migration in small islands (internally and internationally) occurs for multiple reasons and purposes, mostly for better livelihood opportunities (high confidence) and increasingly owing to sea level rise (medium confidence) (Ove Hoegh-Guldberg et al., 2018). Kiribati was the first island state to actually purchase land in Fiji to consider the migration of a whole nation as a back-up option for future generations (Caramel, 2014).

Warming levels of 2°C have potential for significant population displacement concentrated in the tropics with possible moving distances greater than 1000 km. A disproportionately rapid evacuation from the tropics could lead to a concentration of population in tropical margins and the subtropics, where population densities could increase by 300% or more (Ove Hoegh-Guldberg et al., 2018).

Educational attainment

Extreme weather events, conflict and migration have an impact on the educational attainment of children, as the economic resources of parents are reduced by e.g. destroyed crops, or the loss of livelihoods. One result may be that parents spend less on their children's schooling or children need to seek work to contribute to the income of the family. Both leads to a decrease in the children's overall educational attainment (Fuller et al., 2018).

Additionally, schools may be damaged or used as shelter during extreme events and are therefore not available for their original purpose (UNICEF, 2015).

Loss of livelihoods and cultural heritage

Sea level rise, loss of sea ice and glaciers, as well as extreme events can have implications of the livelihoods of people around the world.

Tourism as one of the largest industries is already affected by climate change, with increased risks projected under 1.5°C of warming in specific geographic regions and for seasonal tourism including sun, beach and snow sports destinations (very high confidence). Risks for coastal tourism, particularly in subtropical and tropical regions, will increase with temperature-related degradation (e.g., heat extremes, storms) or loss of beach and coral reef assets (high confidence) (Ove Hoegh-Guldberg et al., 2018).

Beyond 1.5°C warming, both ocean warming and acidification increase, with substantial losses likely for coastal livelihoods and industries (e.g., fisheries and aquaculture) (medium to high confidence). Marine systems and associated livelihoods in Small Island Developing States face higher risks at 2°C compared to 1.5°C (medium to high confidence) (Ove Hoegh-Guldberg et al., 2018).

Today at about 1°C global warming, poverty and disadvantage have increased and are likely to increase even further with rising temperatures. At approximately 1.5°C of global warming (2030), climate change is expected to be a poverty multiplier that makes poor people poorer and increases the poverty head count. Climate change alone could force more than 3 million to 16 million people into extreme poverty, mostly through impacts on agriculture and food prices (Ove Hoegh-Guldberg et al., 2018).

Cultural heritage will be impacted by sea level rise and extreme events. A global analysis of sea level rise risk to 720 UNESCO Cultural World Heritage sites projected that about 47 sites might be affected under 1°C of warming, with this number increasing to 110 and 136 sites under 2°C and 3°C, respectively (Ove Hoegh-Guldberg et al., 2018).

4. Loss and Damage

> Long-term risks of coastal flooding and impacts on 2. populations, infrastructures and assets (high confidence), freshwater stress (medium confidence), and risks across marine ecosystems (high confidence) and critical sectors (medium confidence) are projected to increase at 1.5°C compared to present-day levels and increase further at 2°C, limiting adaptation opportunities and increasing loss and damage (medium confidence).

Within the IPCC 1.5 special report Loss and Damage is associated with adverse impacts of climate change on human and natural systems and includes impacts from extreme events (e.g. cyclones) and slow-onset processes (e.g. sea level rise). Loss and damage refer both to economic (loss of assets and crops) and non-economic impacts (biodiversity, culture, health) and irreversible and permanent loss and damage (e.g. loss of coral reefs). The IPCC report addresses both soft and hard limits to adaptation. Soft limits are described as adaptive actions currently not available, while hard limits are adaptive actions which appear infeasible leading to unavoidable impacts (Roy et al., 2018).

For a global warming levels of 1.5°C and 2°C, soft and hard limits will be reached and will be experienced by children living today. Particularly Small Island Developing States populations are threated to lose their livelihoods forcing people to migrate. In some situations, exceeding the limits of adaptation can trigger escalating losses or result in undesirable transformational changes (medium confidence), such as forced migration (low confidence), conflicts (low confidence) or poverty (medium confidence) (IPCC, 2019b).

System/Region	Example	Soft Limit	Hard Limit
Coral reefs	Loss of 70–90% of tropical coral reefs by mid-century under 1.5°C scenario (total loss under 2°C scenario) (see Chapter 3, Sections 3.4.4 and 3.5.2.1, Box 3.4)		✓
Biodiversity	6% of insects, 8% of plants and 4% of vertebrates lose over 50% of the climatically determined geographic range at 1.5°C (18% of insects, 16% of plants and 8% of vertebrates at 2°C) (see Chapter 3, Section 3.4.3.3)		✓
Poverty	24–357 million people exposed to multi-sector climate risks and vulnerable to poverty at 1.5°C (86–1220 million at 2°C) (see Section 5.2.2)	✓	
Human health	Twice as many megacities exposed to heat stress at 1.5°C compared to present, potentially exposing 350 million additional people to deadly heat wave conditions by 2050 (see Chapter 3, Section 3.4.8)	✓	✓
Coastal livelihoods	Large-scale changes in oceanic systems (temperature and acidification) inflict damage and losses to livelihoods, income, cultural identity and health for coastal-dependent communities at 1.5°C (potential higher losses at 2°C) (see Chapter 3, Sections 3.4.4, 3.4.5, 3.4.6.3, Box 3.4, Box 3.5, Cross-Chapter Box 6, Chapter 4, Section 4.3.5; Section 5.2.3)	✓	✓
Small Island Developing States	Sea level rise and increased wave run up combined with increased aridity and decreased freshwater availability at 1.5°C warming potentially leaving several atoll islands uninhabitable (see Chapter 3, Sections 3.4.3, 3.4.5, Box 3.5, Chapter 4, Cross-Chapter Box 9)		✓

Table 2*: Soft and hard adaptation limits in the context of 1.5°X and 2°C of global warming. Source:* Roy et al., 2018

Limits to adaptation are also discussed in the IPCC 5th Assessment Report. Chapter 23 on Europe gives a detailed overview of the limits to adaptation for different sectors summed up in the following table:

Area/location	System	Adaptation measures	Limits to adaptation measure(s)	References
Low-altitude/small-size ski resorts	Ski tourism	Artificial snowmaking	Climatic, technological, and environmental constraints; economic viability; social acceptability of charging for previously free skiing; social acceptability of alternatives for winter sport/leisure	Steiger and Mayer (2008); Unbehaun et al. (2008); Steiger (2010, 2011); Landauer et al. (2012)
Thermal power plants/cooling through river intake and discharge	Once-through cooling systems	Closed-circuit cooling	High investment cost for retrofitting existing plants	Koch and Vögele (2009); van Vliet et al. (2012); Hoffman et al. (2013)
Rivers used for freight transport	Inland transport	Reduced load factor of inland ships	Increased transport prices (Rhine and Moselle market)	Jonkeren et al. (2007); Jonkeren (2009)
		Use of smaller ships	Existing barges below optimal size (Rhine)	Demirel (2011)
Agriculture, northern and continental Europe	Arable crops	Changing sowing date as agricultural adaptation	Other constraints (e.g., frost) limit farmer behavior.	Oort (2012)
		Irrigation	Groundwater availability; competition with other users	Olesen et al. (2011)
Agriculture, viticulture	High-value crops	Change distribution	Legislation on cultivar and geographical region	Box 23-1
Conservation; cultural landscapes	Alpine meadow	Extend habitat	No technological adaptation option	Engler et al. (2011); Dullinger et al. (2012)
Conservation of species richness	Movement of species	Extend habitat	Landscape barriers and absence of climate projections in selection of conservation areas	Butchart et al. (2010); Araújo et al. (2011); Filz et al. (2012); Virkkala et al. (2013)
Forests	Movement of species and productivity reduction	Introduce new species	Not socially acceptable; legal barriers to non-native species	Casalegno et al. (2007); Giuggiola et al. (2010); Hemery et al. (2010); García-López and Alluéa (2011)

Table 3*: Limits to adaptation to climate change in Europe. Source:* (Sari Kovats et al., 2014)

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2.1. Argentina

Country Profile: Buenos Aires, Argentina

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Summary

Argentina has already experienced changes in temperatures, rainfall and extreme events because of climate change. These impacts are set to worsen with increasing warming, leading to negative impacts on agricultural production, health and urban infrastructure.

Increasing warming will result in more frequent droughts, floods and extreme heat events, with impacts worsening substantially at warming levels above 1.5°C. At 1.5°C, strong El Niño events, which typically lead to increasing rainfall and floods, are set to occur at twice the frequency of pre-industrial times. Extreme rainfall events are projected to become 19% more frequent under 1.5°C of warming, but 40% more frequent under 2°C. The frequency of heat events in south-eastern South America would double at 1.5°C, but almost triple at 2°C. Such heat events can increase morbidity and mortality, especially among the elderly and young. Risks in cities such as Buenos Aires, where high numbers of children live, are particularly high because warming is worsened by the urban heat island effect.

Buenos Aires is projected to be substantially affected by sea level rise, particularly at higher levels of warming. In 2100, limiting warming to 1.5°C would keep sea level rise in Buenos Aires to about 45 cm, about 10 cm less than under warming of 2.5°C. Storm surges will become increasingly frequent and severe and are set to affect growing numbers of people in Buenos

Aires. Under current emission trajectories, Argentina's children of today will spend more than half their lives in a world warmer than 1.5°C above pre-industrial levels.

Agriculture – a major sector in Argentina's economy – is highly vulnerable to future warming and associated climate variability, with floods, droughts and heat extremes posing increasing risks to agricultural production. Water deficits are projected to worsen in dry regions (Northern Argentina), and glacial retreat and changing snowpack are expected to shift peak river flows to earlier in the Spring, leading to reduced flows during times of peak summertime demand. Water supply reductions also present risks for urban areas and hydropower production.

In addition to the negative impacts of extreme events on health, climate change is expected to play a role in the spread of malaria and the incidence of dengue in Argentina. Children are particularly vulnerable to these diseases.

1. The IPCC Reports' summary on Climate Impacts in Argentina

The IPCC 5th Assessment Report (G. O. Magrin et al., 2014) found "increasing trends in annual rainfall in south-eastern South America (SESA; 0.6mm/day/50yr during 1950-2008)", while decreases were experienced in southwest Argentina. "Increases in temperature extremes have been identified in …most of …subtropical SA [South America] (medium confidence), while more frequent extreme rainfall in south-eastern South America has favored the occurrence of landslides and flash floods (medium confidence)". "By 2100 projections show an increase in …warm days and nights in most of South America (medium confidence)." Projections in rainfall are uncertain, but suggest an increase in south-eastern South America.

The report also found that "Changes in streamflow and water availability have been observed and [are] projected to continue in the future in … South America, affecting already vulnerable regions (high confidence). The Andean cryosphere is retreating, affecting the seasonal distribution of stream flows (high confidence)." Changes in snowpack exacerbate this effect, reducing flows in the dry seasons and increasing them in the wet seasons. "Increasing runoffs in the La Plata River basin and decreasing ones in the Central Andes (Chile, Argentina) …in the second half of the 20th century were associated with changes in precipitation (high confidence)." "Risk of water supply shortages will increase owing to precipitation reductions and evapotranspiration increases in semi-arid regions (high confidence) … thus affecting water supply for cities (high confidence) …, hydropower generation (high confidence) …, and agriculture."

On agricultural impacts, the recent Special Report on Climate Change and Land (SRCCL) found that Argentina has already seen an increase in yield variability of maize and soybeans, which has impacted the agriculture, human health and biodiversity of the country (IPCC, 2019). "In…western Argentina, yields could be reduced by water limitation", and fruit and vegetable growing in northern Patagonia could be negatively affected by reduced rainfall and river flows.

The IPCC 1.5 special report also found that the nutritional quality of rice and wheat will reduce as CO_2 levels rise, and that limiting warming to 1.5°C would limit this effect.

Regarding health impacts, the IPCC 5th Assessment Report found that changes in weather and climatic patterns are already negatively affecting human health in South America "by increasing morbidity, mortality and disabilities (high confidence), and through the emergence of diseases in previously non-endemic areas (high confidence)". Climate-related drivers are associated with, among others, respiratory and cardiovascular diseases, vector- and water-borne diseases (such as malaria, dengue and visceral leishmaniasis), and psychological trauma. Vulnerabilities vary with geography, age, gender, race, ethnicity, and socioeconomic status, and are rising in large cities (very high confidence)." The worsening of air quality and higher temperatures in urban settings [in South America] are increasing chronic respiratory and cardiovascular diseases, and morbidity from asthma and rhinitis…, but also atherosclerosis, pregnancy-related outcomes, cancer, cognitive deficit, otitis, and diabetes." "Climate change will exacerbate current and future risks to health, given the region's population growth rates and vulnerabilities in existing health, water, sanitation and waste collection systems, nutrition, pollution, and food production in poor regions (medium confidence)".

The IPCC 1.5 special report assessed recent projections of the potential impacts of climate change on malaria and found that the geographic range, seasonality and intensity of transmission of malaria in South America are driven in part by weather and climate. Additional warming will affect malaria risk, but in a complex way (IPCC, 2018b).

2. Demographics and intergenerational aspects

Argentina have a population of about 44 million, out of which 33% are children under the age of 19 (Wittgenstein Centre for Demography and Global Human Capital, 2018). An average 17-year-old Argentinian citizen, the petitioner's peer, is expected to live until the age of 86 (World Data Lab, 2019). The demographic estimates can be coupled with the projections of global mean temperature increases. Following the best estimate of the future temperature trajectory based on the Climate Action Tracker (Climate Analytics; Ecofys; New Climate Institute, 2019), increase in the global mean temperature is expected to exceed 1.5°C around the year 2035 (model median), 2°C around 2055, and more than 3°C in 2100. Today's Argentinian 17-year-old has a 99% probability of being alive in 2035, 94% in 2055 and 4% in 2100. Nearly all children in Argentina therefore have a high probability of experiencing a 2°C world and the ensuing impacts, with a portion of them living to possibly experience an even higher warming.

3. Temperature increases

Over the period 1901 – 2012 the average temperature across most of Argentina increased by about 0.5°C – a little lower than the global average (Vicente Ricardo Barros et al., 2015). While the annual peak temperature declined over 1953-2003, a trend that is consistent with the observed increase in summer precipitation, there has been a strong warming in night time temperatures, resulting in fewer cold nights and more warm nights (Vicente Ricardo Barros et al., 2015). The number and intensity of heat waves has increased (Vicente Ricardo Barros et al., 2015).

In a 2°C warmer world, the Atlantic coast of Argentina would see about 0.5-1.5°C warming by 2100 (compared with a 1951-1980 baseline), while northern Argentina would see up to 2.5°C of warming. However, in a 4°C warmer world the Atlantic coast could warm by 2-4°C, and northern Argentina could warm up to 6°C (Schellnhuber et al., 2014). Figure 1 shows warming levels relative to the period 1986-2005, hence the levels of warming depicted are slightly lower than when compared to the period 1951-1980.

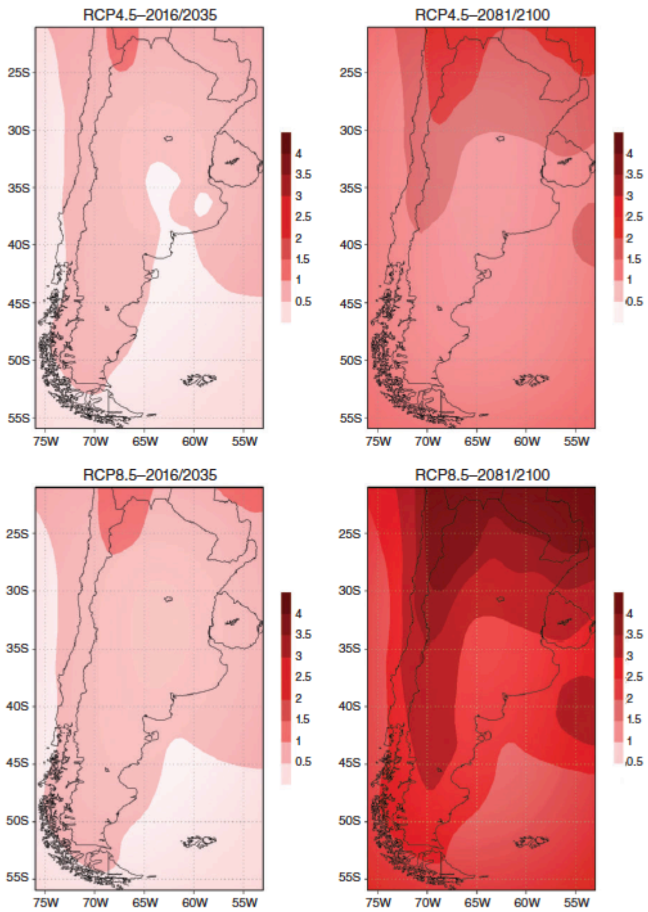

Figure 1: CMIP5 multi-model ensemble mean of projected changes (°C) in annual temperature for the near-term (2016-2035), left, and long-term (2081-2100), right, relative to 1986-2005, for a 2.4°C warmer world by 2100 (RCP4.5) (top) and a 4.4°C warmer world by 2100 (RCP8.5) (bottom). Source: Barros et al., (2015)

Extreme heat events will become more common with further warming. Under 1.5°C of warming, the frequency of heat events in south-eastern South America would double, while under 2°C it would almost triple (an increase in frequency of 288%) (Carbon Brief, n.d.; V. et al., 2018). In a 4°C world, events that are extremely rare today will become the new norm. In other words, temperature levels that are currently extremely unlikely (i.e. events that are less frequent than 100-year events) would be exceeded over at least half of the summer months

(Schellnhuber et al., 2014). Warm spells will also become longer: warm spells could be 30-90 days longer in a 4°C world (RCP 8.5) (Schellnhuber et al., 2014), and 15 – 18 days longer in a 2°C world (Aerenson et al., 2018; Carbon Brief, 2019). Limiting warming to 1.5°C would limit the lengthening of warm spells to 7 – 13 days (Aerenson et al., 2018; Carbon Brief, 2019).

4. Precipitation

Annual precipitation has increased over the past four decades in subtropical (north-eastern) Argentina, but this increase has been concentrated in the heaviest rainfalls, while precipitation during dry months has decreased (Vicente Ricardo Barros et al., 2015). Figure 2 shows that the frequency of heavy rainfall days (>100 mm) in Buenos Aires has increased in recent decades (Vicente Ricardo Barros et al., 2015). Further south in northern Argentine Patagonia, average precipitation has decreased since the middle of last century (Vicente Ricardo Barros et al., 2015).

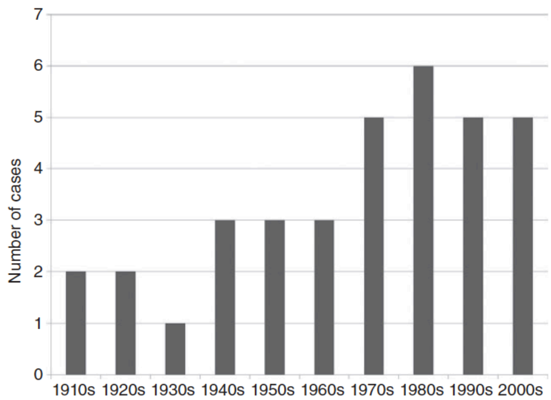

Figure 2: Number of days per decade with precipitation over 100 mm in the city of Buenos Aires. Source: Barros et al., (2015)

With increasing global warming, precipitation in northern and central regions is projected to increase, particularly during the summer months, while the dry central-western region and Patagonia will experience less precipitation (see figure 3) (Vicente Ricardo Barros et al., 2015; Schellnhuber et al., 2014). In other words, most dry regions may get drier, while wet regions may get wetter. In a 4°C world, Patagonia (which is already dry) is projected to become 60% more arid (Schellnhuber et al., 2014).

Increases in extreme precipitation are projected to continue in eastern Argentina (the Pampas region), hence it can be expected that flooding events will also become more frequent (Vicente Ricardo Barros et al., 2015; Schellnhuber et al., 2014). Limiting warming to 1.5°C, rather than 2°C or even 4°C, would significantly reduce these changes in heavy rainfall events (Schellnhuber et al., 2014) (Carbon Brief). For example, for south-eastern South America, rainfall extreme events are projected to become 19% more frequent under 1.5°C of warming, but 40% more frequent under 2°C (Carbon Brief, 2019; Kharin. et al., 2018).

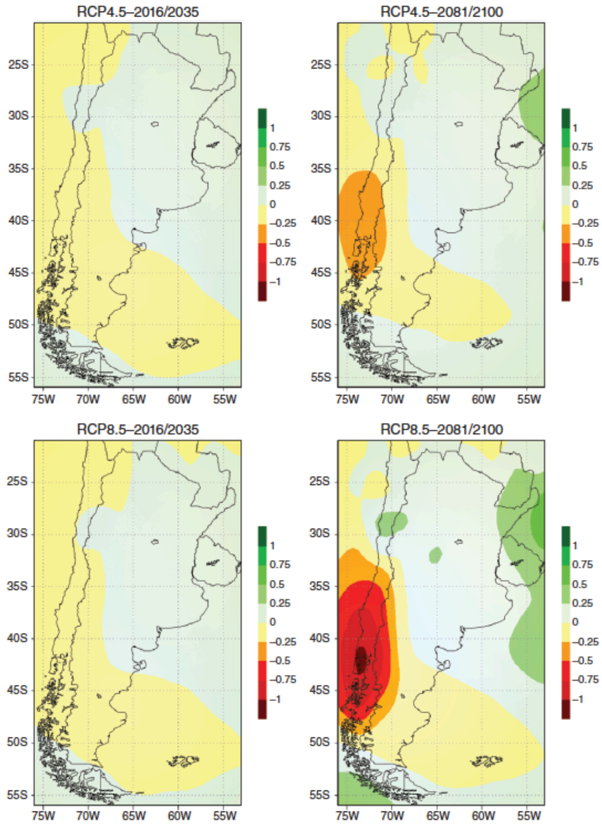

Figure 3: CMIP5 multi-model ensemble mean of annual precipitation (mm/day) for the near-term (2016-2035), left, and long-term (2081-2100), right, relative to 1986-2005, for a 2.4° warmer world by 2100 (RCP4.5) (top) and a 4.4° warmer world by 2100 (RCP8.5) (bottom). Source: Barros et al., (2015)

5. Glaciers and Andean rivers

Rising temperatures and declining precipitation over the southern Andes mountains have caused glaciers to retreat, with a loss in volume of about 20% over the 20th Century (Schellnhuber et al., 2014). Glaciers in Patagonia are also retreating: at the southern end of Argentina, at least 48 out of 50 glaciers are receding (Vicente Ricardo Barros et al., 2015). For example, San Quintín in Northern Patagonia lost 14.6 % of its area between 1870 and 2011 (NASA, 2016). According to scientists at NASA, “Patagonia glaciers experience some of the world’s most dramatic thinning per unit area, more than Alaska or Iceland or Svalbard or Greenland.” (NASA, 2016).

Glacier retreat has caused peak river flows to shift earlier, increasing the flow rate during the spring, and decreasing it during the summer, when agricultural demand for water is high (Vicente Ricardo Barros et al., 2015).

Ice fields and glaciers in the extratropical Andes in Argentina face substantial reductions under climate change. Under 2°C of warming, the glaciers of the southern Andes could lose about 20% of their mass (compared with 2015), compared with about 50% in a 4°C world (RCP8.5) (see figure 4) (Hock et al., 2019).

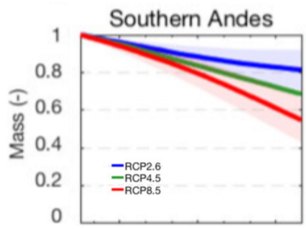

Figure 4: Projected time series of glacier evolution 2015–2100 the Southern Andes, based on three warming levels (RCPs). Glacier mass is normalized to mass in 2015. Thick lines show the means of all model projections (all available glacier models and GCMs) based on the same RCP, and the shading marks ±1 Std dev. (not shown for RCP4.5 for better readability). Source: (Hock et al.,

The retreat of glaciers and ice fields is expected to affect water availability in Argentina. Accelerated glacier melting leads to increased runoff early in the melt season, but decreased runoff during the dry season (G. O. Magrin et al., 2014), which could substantially increase water deficits in downstream areas. This is likely to be particularly problematic later in the summer when agricultural demand for water is highest (Vicente Ricardo Barros et al., 2015; G. O. Magrin et al., 2014). The vulnerability of highly populated basins with high water demand for irrigation and hydropower production is expected to rise (see water availability) (G. O. Magrin et al., 2014).

6. Sea level rise

Buenos Aires is projected to be substantially affected by sea level rise, particularly at higher levels of warming. In 2100, limiting warming to 1.5°C would keep sea level rise in Buenos Aires to about 45 cm, about 10 cm less than under warming of 2.5°C (Climate Analytics, n.d.; Kopp et al., 2014). 4°C of warming is projected to cause sea level rise in 2100 of about 76 cm, reaching 193 cm by 2200 (Climate Analytics, n.d.; Kopp et al., 2014) (see figure 5).

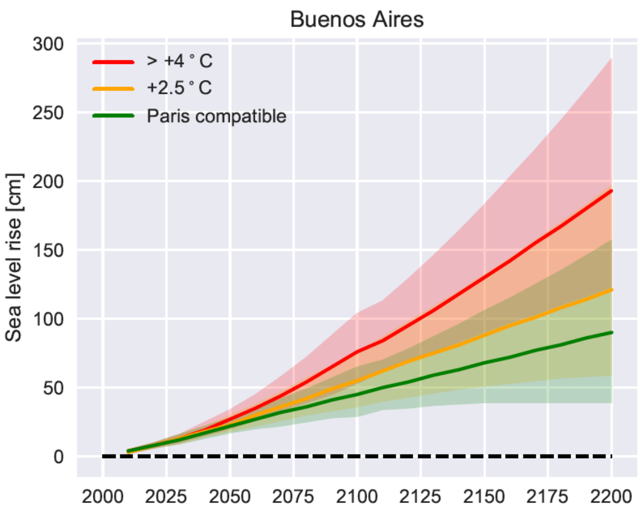

Figure 5: Local sea level projections for Buenos Aires for a scenario compatible with the Paris agreement (green), a scenario leading to +2.5°C global mean temperature (orange) and a

scenario exceeding +4°C (red). The solid lines represent multi-model medians, the shaded areas include 66% of the models. Source: (Climate Analytics, n.d.; Kopp et al., 2014)

With rising sea levels, storm surges are projected to become more frequent and more severe in the Plata River coastal areas, including around Buenos Aires (Vicente Ricardo Barros et al., 2015). At present, about 200,000 people in Buenos Aires are estimated to be affected by extreme storm surge events with a 20-year return period; this number is projected to almost triple under a scenario of 50cm sea level rise (Vicente Ricardo Barros et al., 2015).

7. Extreme events and El Niño

Flooding:

Changing rainfall patterns have had implications for flooding events. In the extended flat plains in the north of Argentina, the frequency of prolonged flooding events increased in the 1980s and 1990s: four of the five largest floods in the 20th century have occurred during the last two decades (Gosling et al., 2011). These flooding anomalies, the result of more frequent extreme river discharges in the Paraná and Uruguay rivers, connected to El Niño events and related precipitation trends (Vicente Ricardo Barros et al., 2015).

There are high uncertainties in projections of future flood risk under climate change in Argentina, but the literature suggests that the risk of extreme floods will increase in the future (Gosling et al., 2011). For example, one study using 21 climate models found that under a scenario in which warming reaches 2.8 °C in 2100 (scenario A1B, comparable to RCP6.0), the majority of models project an increase in flood risk during the 21st century, with the most pronounced changes occurring later in the century (Gosling et al., 2011). Flooding events are also influenced by El Niño (see below).

ENSO events: El Niño and La Niña

Latin America is particularly exposed to the effects of the El Niño Southern Oscillation (ENSO). Strong El Niño events typically lead to increasing rainfall and floods in Argentina, which has impacts for agricultural productivity, water supply, energy production, infrastructure and public health, as well as economic losses. (Schellnhuber et al., 2014). Recent research suggests that global warming will lead to more frequent extreme El Niño events: under 1.5°C of warming, the number of events could double from the frequency in pre-industrial times, to one every ten years (IPCC, 2018a; Wang et al., 2017).

La Niña events tend to cause dryness over southern Argentina (Gosling et al., 2011). In recent decades this has led to significant negative impacts on the yields of maize and soybean in Argentina (see figure 6) (Iizumi et al., 2014).

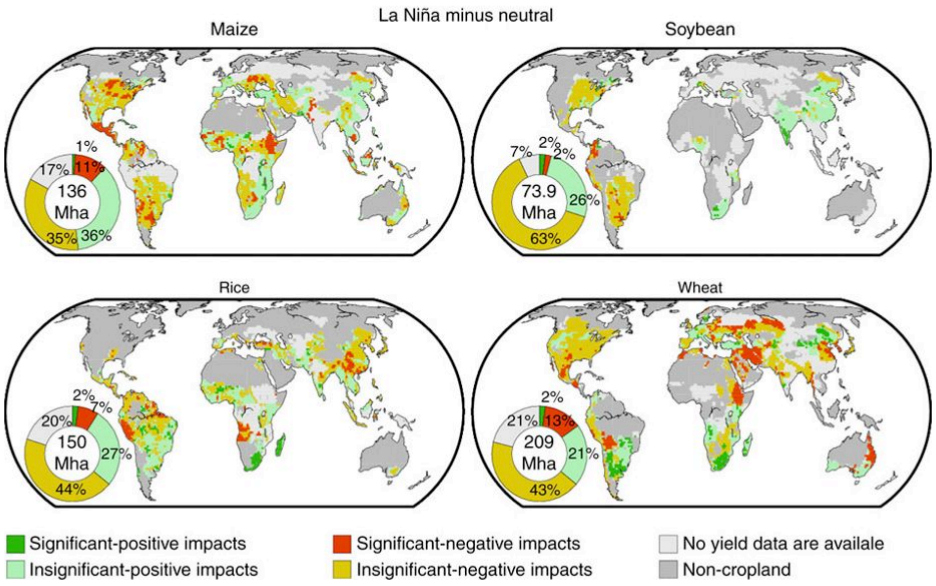

Figure 6: Impacts of La Niña on crop yield anomalies of four crops, compared with normal years, for the period 1982-2006. Pie diagrams show the percentages of harvested area. Source: (Iizumi et al., 2014)

8. Sectoral Impacts

8.1. Health

Malaria incidence has increased in Latin America in recent decades, partly because of land use change. Periodic epidemics have been associated with warm phases of ENSO (Schellnhuber et al., 2014). There is evidence to suggest that higher temperatures could cause malaria to spread to high altitude cities, but it is likely that the influence of climate change on malaria transmission will not be uniform (Schellnhuber et al., 2014). At high levels of warming reaching 4.3°C by 2100 (about 4°C in 2080; RCP8.5) an increase in the length of transmission period for malaria is projected for some highland areas of Argentina (Caminade et al., 2014; Schellnhuber et al., 2014).

Argentina is at the southern limit of dengue transmission in South America. Outbreaks of dengue in Argentina are associated with outbreaks in neighbouring countries as well as mild temperature conditions during autumn (Carbajo et al., 2018). While it is often difficult to separate social influences on dengue incidence from the impacts of climate change, it is expected that climate change will play a role in future dengue outbreaks (Schellnhuber et al., 2014).

Children are particularly vulnerable to vector-borne diseases such as malaria and dengue (UNICEF, 2015). Hence increases in the length of transmission period of malaria and expansion in the range of Dengue will pose greater risks for children.

Extreme heat events can increase morbidity and mortality, especially amongst the elderly and young and in cities where the urban heat island effect raises temperatures further. In Buenos Aires, 10% of summer deaths are already associated with heat strain (Wong et al., 2013). High density areas in the city have more than 950 inhabitants per hectare and a substantial heat island effect has been observed (one study found a 3.5°C difference between dense urban areas and areas close to the river (Leveratto et al., 2000). Heat extremes are projected to become more frequent in a warming climate (see above).

Extreme flooding events have caused evacuation and even deaths in Argentina. For example, in 2018, heavy rain and flash flooding caused 3000 people to be evacuated, mostly from Buenos Aires, and four people were killed (Floodlist, 2018).

8.2. Agriculture

Agriculture is an important sector for Argentina's economy, currently contributing about 6% of Argentina's GDP (World Bank, n.d.). In 2016, Argentina ranked sixth in the world for agricultural product exports, and second in Latin America (FAO, 2018). However, most agricultural activities in the region are rain-fed, and are highly vulnerable to climate variability and future climate change.

Observed impacts: In the Pampa region, simulations suggest that yields of some major crops (wheat, maize, soy) have increased, largely as a result of increased rainfall (Vicente Ricardo Barros et al., 2015). However, in some areas, increases in minimum temperatures during winter and spring have led to smaller yield increases or even yield decreases for wheat (Leary et al., 2009; Graciela O. Magrin et al., 2009). There has been an observed increase in yield variability in Argentinean maize and soybean as a result of climate change, meaning that yields have become more unstable (Iizumi & Ramankutty, 2016). Extreme flooding and droughts events related to ENSO have caused losses in agricultural production (Iizumi et al., 2014; Schellnhuber et al., 2014) (see figure 7).

Projected risks: Extreme weather events such as floods and droughts also pose increasing risks to agricultural production (Vicente Ricardo Barros et al., 2015). Changing rainfall patterns and rising heat extremes are expected to impact the yields of maize and soy, although there will be regional variation in the extent of these impacts (Schellnhuber et al., 2014).

The greatest body of evidence is for impacts on crops in South America as a whole, or for regions within South America, rather than at the country level. The IPCC 1.5 special report found that limiting warming to 1.5°C, compared with 2°C, would result in smaller net reductions in maize, rice and wheat in South America, as well as reductions in the nutritional quality of rice and wheat (which decreases at elevated CO_2 levels) (IPCC, 2018). In the Southern Cone of South America, maize yields are projected to decline by 30 – 45 % under 3°C of warming compared with 1971 – 2000 levels, or 15 – 30 % if warming is limited to 2°C (Schellnhuber et al., 2014), although these estimates do not include the highly uncertain effects of CO_2 fertilization, which may lead to a net increase in yields (Schellnhuber et al., 2014).

Within Argentina, evidence suggest that losses are likely in the main producing regions, although there may be gains in the southern and western Pampa region (Vicente Ricardo Barros et al., 2015). Higher temperatures are expected to exacerbate existing water deficits in northern parts of Argentina (Schellnhuber et al., 2014) and the Mendoza region, where grapes for wine are grown (McMartin et al., 2018). Strong or extreme ENSO events elevate the risks of flooding or drought during the cropping season (Schellnhuber et al., 2014), posing risks to agricultural production (see extreme events and water availability).

The livestock sector plays a key role in the Argentinian economy, but studies of the potential impacts of climate change are scarce (Reyer et al., 2017). Heat stress is known to reduce productivity, for example, by reducing cattle food intake and milk production and by affecting reproduction, growth and mortality rates (Reyer et al., 2017). Under 1 – 2 °C of warming, farmers in the Andes are less likely to choose beef cattle and dairy cattle for their livestock, and more likely to increase sheep ownership (Seo et al., 2010). This is because sheep are better adapted to warmer and drier conditions.

8.3. Water availability

In central Western Argentina, where rainfall levels are low, river discharge is directly affected by the amount of snow accumulation during the winter. Freshwater availability is therefore highly dependent on meltwater from the mountain snowpack, which varies substantially from year-to-year (Schellnhuber et al., 2014). Warming temperatures have caused a greater number of high flow discharges during autumn, due to precipitation falling more as rain rather than snow. Conversely, during spring and summer there has been an observed drop in annual low-flow levels in some river basins. A continued trend of lower discharges during the dry season could present risks for water supply in urban areas, including for hydropower production (Schellnhuber et al., 2014).

8.4. Infrastructure

During the extreme December heat wave of 2013, the power system in Buenos Aires and other big cities collapsed due to extreme demand for air conditioning (Vicente Ricardo Barros et al., 2015). Increasingly frequent floods in Buenos Aires have damaged property, impaired living and working conditions, and negatively affected public health (C40, n.d.).

Extreme flooding and heat events are projected to increase in frequency and intensity with warming (see temperature increase and extreme events sections above).

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2.2. Brazil

Brazil – Salvador

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Summary

Brazil is experiencing increasing climate change today that manifests itself in a range of impacts for humans and ecosystems. Under scenarios of ongoing temperature increase exceeding 4°C in 2100, the annual average temperature in Brazil is expected to be above 30°C in 2100. Over central Brazil, annual mean precipitation is projected to drop by 20% in a 4°C world. Due to its proximity to the sea, Salvador is exposed to the threat of sea level rise, with a warming of 2.5°C by 2100, about 60 cm rise are expected. Brazil is also suffering from more frequent and intense weather events such as floods, heat waves, drought and wildfires.

The agricultural sector, including the economically important livestock sector, is expected to be severely impacted by climate change, with a potential reduction of approximately 11 million hectares of high-quality agricultural land. The health of people, in particular children, will be adversely affected by rising temperatures, heat waves and the spread of vector and water-borne diseases. Research in São Paulo (Brazil) found that for every degree increase above 20°C, there was a 2.6% increase in overall mortality in children under 15, meaning that a 26% increase in overall child mortality is to be expected under scenarios of 4.3°C expected temperature increase by 2100. The livelihoods of mangrove fishermen along the coast are also

threatened through rising sea levels and rising water temperature. Under current emission trajectories, Brazilian children will spend more than half of their lives in a world warmer than 1.5°C above pre-industrial levels.

The threats by climate change to the Amazon are exacerbated by deforestation. In addition to the severe damage to biodiversity on the global scale, the loss of parts of the Amazonian rainforest would have far reaching effects for precipitation across South America. Without stringent climate mitigation, even the crossing of a tipping point for the Amazon rainforest cannot be ruled out.

1. The IPCC report's summary on climate impacts in Brazil

"Warming has been detected throughout South America" and "changes in climate variability and in extreme events have severely affected the region (medium confidence)". "Increases in temperature extremes have been identified in most of tropical and subtropical South America (medium confidence)". "Climate projections suggest increases in temperature (…) (medium confidence)" and "a reduction of –22% in northeast Brazil" for rainfall. Indeed, "Changes in streamflow and water availability have been observed and projected to continue in the future in South America, affecting already vulnerable regions (high confidence)". "Sea level rise (SLR) and human activities on coastal and marine ecosystems pose threats to fish stocks, corals, mangroves, recreation and tourism, and control of diseases (high confidence)" (Magrin *et al* 2014).

In South America as a whole, the IPCC's Special Report on 1.5 found that risks to tropical crop yields are projected to increase with warming levels: at more than 2°C of warming, substantial reductions in crop yields are very likely, while risks would be significantly lower, if warming is limited to 1.5°C (Ove Hoegh-Guldberg *et al* 2018). "In northeast of Brazil (…), increases in temperature and decreases in rainfall could decrease the productivity in the short term (by 2030), threatening the food security of the poorest population (medium confidence)". "Changes in weather and climatic patterns are negatively affecting human health in South America (…), by increasing morbidity, mortality, and disabilities (high confidence), and through the emergence of diseases in previously non-endemic areas (high confidence). With very high confidence, climate-related drivers are associated with respiratory and cardiovascular diseases, vector- and water-borne diseases" (Magrin *et al* 2014).

2. Demographics and intergenerational aspects

Brazil has a population of about 210 million people, 31% of which are under the age of 19 (Wittgenstein Centre for Demography and Global Human Capital 2018). An average 12-year-old Brazilian citizen, the petitioner's peer, is expected to live until the age of 86 (World Data Lab 2019). These demographic estimates can be coupled with the projections of global mean temperature increase. Following the best estimate of the future temperature trajectory based on the Climate Action Tracker (2019), an increase in the global mean temperature of 1.5°C will be exceeded around the year 2035, 2°C around 2055, and more than 3°C in 2100. Today's Brazilian 12-year-old has a probability of 99% to be alive in 2035, 95% in 2055 and 12% in 2100. Nearly all of Brazil's children therefore have a very high probability of experiencing a

2°C warmer world and the ensuing impacts, with more than 10% of them living to possibly experience an even higher warming.

3. Temperature increase

Over the period 1960-2010, there has been warming in the Northern, Eastern and Southern regions of Brazil for both summer (December to February) and winter (June to August) (Met Office 2011). The average temperature for the period 1861–1890 (pre-industrial period) for Brazil is 24.41 °C. Since pre-industrial times, the average temperature in Brazil has increased by around 1°C (*Figure 1*).

Temperature projections show that under scenarios of 2.4°C expected temperature increase by 2100 (RCP 4.5, purple line in *Figure 1*), the annual average temperature will be 25.8 °C in 2020, will reach 28°C in 2100, and a maximum of 28.8 °C at the end of 2300. Under scenarios of 4.3°C expected temperature increase by 2100 (RCP 8.5, red line in *Figure 1*) the annual average temperature is expected to be above 30°C in 2100. The duration of warm spells are also predicted to increase, with 28 days at a 1.5°C warming and 71 days at a 2°C warming in the Amazonia region (Carbon Brief 2019).

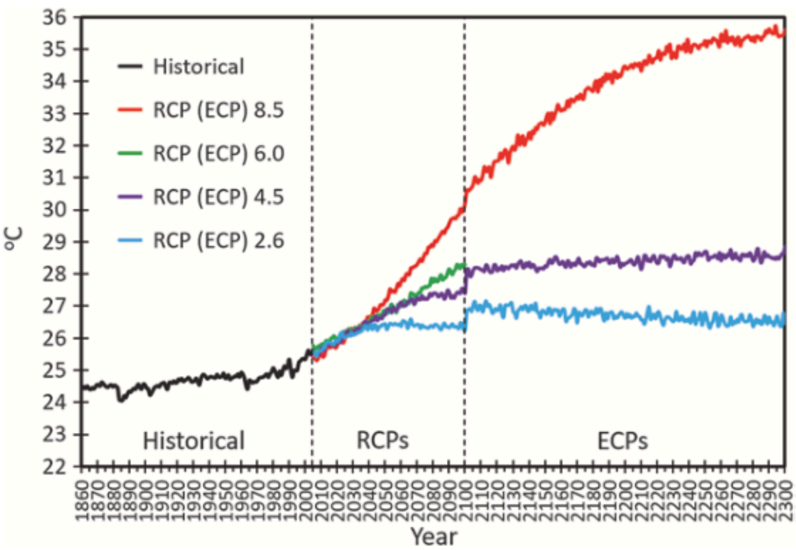

Figure 1: Temporal series of annual average temperatures climate close to the surface of Brazil for the period 1860-2300 (Nobre *et al* 2018)

4. Precipitation

Between 1960 and 2003, a small increase in annual total precipitation was observed over Brazil, variations that are linked to natural inter-annual and decadal variability (Met Office 2011). Based on the data from the National Institute of Meteorology of Brazil, the largest precipitation anomalies in 2018 in Brazil occurred in the Amazon region, with a reduction in precipitation compared to the 1981-2010 reference period (*Figure 2*). Along Brazil’s coastline, including Salvador, slight increases in precipitation were observed.

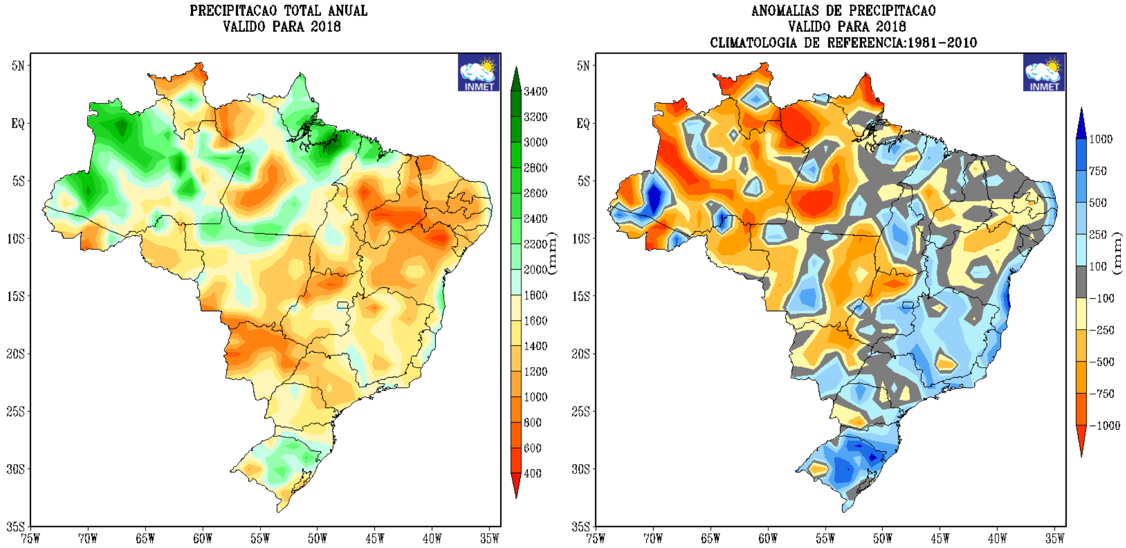

Figure 2: Total annual precipitation in Brazil in 2018 (left) and anomalies in precipitation in 2018 based on the reference period 1980-2010 (Retrieved from: http://www.inmet.gov.br/portal/index.php?r=clima/page&page=desvioChuvaAnual)

Projected changes in precipitation remain uncertain over most land regions in South America. However, in a 4°C world, annual mean precipitation is projected to drop by 20% in central Brazil by the end of the century due to a strong and robust decrease in dry season (JJA) precipitation (-50%) (*Figure 3*).

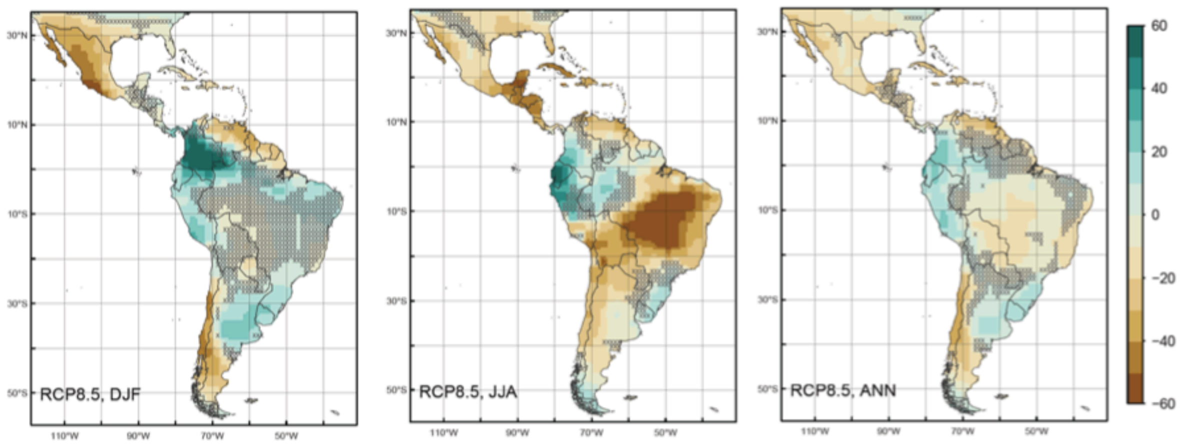

Figure 3: Multi-model mean of the percentage change in austral summer (DJF, left), winter (JJA, middle) and annual (right) precipitation for RCP8.5 (4.3 °C world by 2100) for Latin America and the Caribbean by 2071–2099 relative to 1951–1980. Hatched areas indicate uncertain results, with two or more out of five models disagreeing on the direction of change. Note that projections are given as percentage changes compared to the 1951–1980 climatology, and thus, especially over dry regions, large relative changes do not necessarily reflect large absolute changes (Reyer *et al* 2017)

5. Sea level rise

Brazil is projected to experience above-average sea level rise, with a median estimate of 0.63 m in a 4°C world (Reyer *et al* 2017). *Figure 4* shows the projections of sea level rise for the tide gauge station in Salvador. In 2100, limiting warming to 1.5°C would keep sea level rise in Salvador to about 50 cm, about 10 cm less than under warming of 2.5°C. 4°C of warming is projected to cause sea level rise of 80 cm in 2100, reaching 197 cm by 2200.

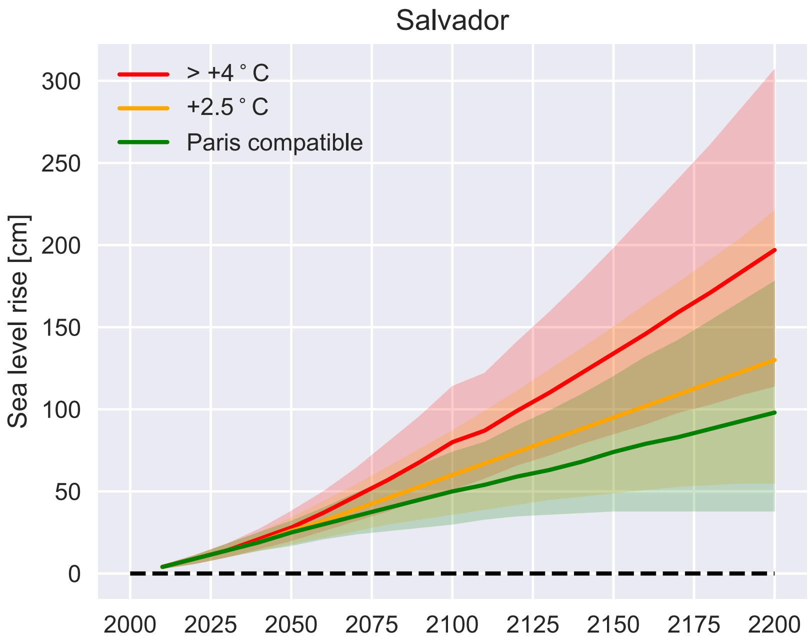

Figure 4: Local sea level projections for Salvador for a scenario compatible with the Paris agreement (green), a scenario leading to +2.5°C global mean temperature (orange) and a scenario exceeding +4°C (red). The solid lines represent multi-model medians, the shaded areas include 66% of the models (retrieved from http://localslr.climateanalytics.org/location/Salvador)

6. Extreme weather events

6.1 Floods

Catastrophic flooding has affected Brazil in recent years, triggering landslides and mudslides which can be a consequence of flooding exacerbated by deforestation and poor urban planning (World Bank 2014). In April 2015, Salvador was hit by the heaviest rains in two decades, with more than half of the monthly average falling within 10 hours, triggering two landslides killing 14 people and sweeping away numerous homes (BBC News 2015). In April 2009, floods and mudslides also affected over 186,000 people in North-East Brazil as this region experienced its worst deluge in over 20 years (Met Office 2011). Regarding flood projections in North-East Brazil, the direction of discharge and groundwater recharge trends vary due to diverging rainfall projections (Reyer *et al* 2017).

6.2 Heat waves

Over South America and in particular Brazil, there is a lack of analysis regarding the characterization of heat waves and evaluating their impacts (Son *et al* 2016, Geirinhas *et al* 2018). However, Salvador, in the Northeast Brazilian which is characterized by semi-arid climate (with dry and extreme hot periods) has recorded gradual increase of extreme heat waves, especially since 1990 (Geirinhas *et al* 2018).

6.3 Droughts

The drought in the South-East of the Brazil in 2014–2015 was considered the fifth costliest natural disaster in the world in 2014 by MunichRE (the oldest reinsurance company in

Germany), with estimated losses around 5 billion USD (Nobre *et al* 2018). Currently, drought magnitude is one of the largest in the world in North-Eastern Brazil (Naumann *et al* 2018). With a 1.5°C warming, drought magnitudes are projected to rise rapidly, with a doubling of drought magnitude in parts of Brazil (Naumann *et al* 2018). In addition, strong rises in the recurrence frequency of droughts with warming are also projected for the eastern regions of Brazil (ibid). When accounting for the effects of runoff and evaporation and local soil and vegetation, it was found that Brazil (except the Southern coast) will be facing severe to extreme drought conditions relative to the present climate under a scenario of 2.4°C global warming expected by 2100 (Reyer *et al* 2017). In Northeastern Brazil, at 1.5°C warming, 6 million people will be exposed to water scarcity, with 2°C, it will be a total of 7m people (Carbon Brief 2019).

6.4 Wildfires and forest impacts

Brazil's National Institute for Space Research (INPE) reported a record 72,843 fires in 2019 (until end of August), representing an 80% increase from last year. While drought has played a large role in exacerbating fires in the past (World Meteorological Organization 2019), the current 2019 fires seem to be deforestation driven and started by humans (Gibbens 2019). These fires are a great threat to many indigenous communities (World Meteorological Organization 2019), trigger great loss of biodiversity and harm those dependent on this biodiversity (Gibbens 2019). In addition, these wildfires also release harmful pollutants including particulate matter and toxic gases that can travel far with strong winds, as far as the Atlantic coast of Brazil (World Meteorological Organization 2019). Studies projecting future fires in the Amazon are scarce. However, fires are projected to increase along major roads in the Southern and Southwestern part of Amazonia for scenarios of 4.3°C expected temperature increase by 2100 (RCP 8.5). High rates of deforestation would contribute to an increasing fire occurrence of 19 % by 2050, whereas climate change alone would account for a 12 % increase (Reyer *et al* 2017).

7. Sectoral impacts

7.1 Agriculture

Most of the global and regional-scale studies project yield losses for soybean, maize and rice, three of Brazil's major crops, as a consequence of climate change (Met Office 2011). In Brazil, at 2°C warming, crop yields could decrease by up to 70 % for soybean and up to 50 % for wheat relative to a 1989–2009 baseline (World Bank 2014). The livestock sector of high economic importance in Brazil will also be severely impacted by climate change regarding the quantity and quality of feed and heat stress (Assad *et al* 2013). Brazil could face a reduction of approximately 11 million hectares of high-quality agricultural land as a result of climate change with the South Region (current grain belt) being the worst impacted losing ~5 million hectare of 'low climate risk' crop land (ibid).

7.2 The Amazon forest

Brazil holds the biggest share of the Amazon rain forest, the largest tropical rain forest system on the planet. The Amazon is under severe threat by human stressors such as climate change and deforestation. The Amazon is not only a unique biodiversity hotspot, it also serves as a key climate regulator for all of South America with about 25% or more of all precipitation falling in southern Brazil originating from the Amazon (Zemp *et al* 2014).

With ongoing warming and a regional drying trend, the threats to the Amazonian rainforest are also on the rise. For global warming scenarios reaching temperatures above 4°C in 2100 (RCP8.5), even a potential of crossing a tipping point to large scale Amazon dieback cannot be excluded (Zemp *et al* 2017, Malhi *et al* 2009). Severe damage to the Amazon forest would thereby have profound consequences for all of Brazil and beyond, affecting regional climate as well as one of the most important carbon sinks of the planet(Bastin *et al* 2019).

1.1 Health impacts from heat waves

Climate change is expected to increase mean annual temperature and the intensity and frequency of heat waves resulting in a greater number of people at risk of heat-related medical conditions. The elderly, children, the chronically ill, the socially isolated and at-risk occupational groups are particularly vulnerable to heat-related conditions (World Health Organization and United Nations 2015). For warming levels of 1.5°C, 2°C and 4°C, Brazil is projected to experience respectively 0.9%, 1.6% and 5.2% excess deaths due to heat. Research in São Paulo (Brazil) found that for every degree increase above 20°C, there was a 2.6% increase in overall mortality in children under 15 (same as for those over 65), with an almost certainly high increase for younger children (Bartlett 2008). Considering that under scenarios of 4.3°C expected temperature increase by 2100 (RCP 8.5) the annual average temperature is expected to be above 30°C in 2100 in Brazil, a 26% increase in overall child mortality is to be expected.

1.2 Health impacts from vector and water-borne diseases

Climate conditions are projected to become significantly more favorable for transmission of some of the world's most virulent infections, slowing progress in reducing burdens, and increasing the populations at risk. In Brazil during the period 2001–2009, a 1°C increase in monthly minimum temperature was associated with a 45 % increase in dengue fever cases the following month and a 10 mm increase in precipitation with a 6 % increase (Reyer *et al* 2017). With a warming of 1.5°C, 2°C and 3.7°C by 2100, the annual cases of dengue fever in Latin America is projected to reach respectively 4.5 million, 5 million and 7.8 million people (Carbon Brief 2019). Warmer average temperatures are expanding the areas where many tropical diseases can occur, with children most often being the victims (Bartlett 2008). Children's mental growth can also be affected by intestinal parasites, diarrheal disease and malaria (ibid).

1.3 Livelihood

In Cairu, 150 km South from Salvador, fishermen have been hunting crabs along coastal mangrove forests for their living for decades. However, they have testified about rapid alterations of the environment: the average daily catch is half of what was 10 years ago, the water line has advanced 3 m inland from where it used to be and rising water temperature are killing off marine life (Doce 2019). With increasing sea-surface temperatures, most coral reef locations in the Western Atlantic are projected to have a 60–80 % probability of annual bleaching events with a 2 °C warming by 2050 (Reyer *et al* 2017). By the year 2100, almost all coral reef locations are expected to be subject to severe bleaching events occurring on an annual basis in a 4 °C world (ibid).

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2.3. France

FRANCE – Bordeaux

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Summary

France is experiencing an increase in temperature well above global average that manifests itself in a range of impacts for humans and ecosystems.

If global warming exceeds the Paris Agreement limit of 1.5°C, France, including Bordeaux, will experience an increase in average temperatures and a decrease in annual precipitation in the south. Extreme weather events will become more frequent and more intense in particular heat waves, heavy precipitation, droughts and floods.

France has already suffered from high numbers of heat-related deaths (about 15,000 during the 2003 heat wave) and the number of people at risk of heat-related medical conditions is projected to increase. The climate conditions will also become more favorable for the spread of diseases such as dengue, yellow fever and chikungunya. Bordeaux is also potentially endangered by floods linked to sea level rise. For the region of Bordeaux, its cultural heritage is seriously threatened as the wine industry is impacted by higher temperatures and increasing extreme weather events affecting the yield of the vineyards and the quality of the wine. Under current emission trajectories, French children will spend more than half of their lives in a world warmer than 1.5°C above pre-industrial levels.

1The IPCC report's summary on climate impacts in France

The IPCC (2014) states that "observed climate trends and future climate projections show (…) projected increases in temperature throughout Europe" and "decreasing precipitation in Southern Europe". In addition, "climate projections show a marked increase in high temperature extremes (high confidence), meteorological droughts (medium confidence), and heavy precipitation events (high confidence)". "Climate change is very likely to increase the frequency and intensity of heat waves, particularly in Southern Europe (high confidence)". It is "expected to impede economic activity in Southern Europe more than in other sub-regions (medium confidence)" and is "*likely* to affect human health in Europe", for example, "heat-related deaths and injuries are likely to increase, particularly in Southern Europe (medium confidence)" (IPCC, 2014).

1. Demographics and intergenerational aspects

France has a population of about 65 million people, one quarter of which are under the age of 19 (Wittgenstein Centre for Demography and Global Human Capital, 2018). An average 16-year-old French citizen, the petitioner's peer, is expected to live until the age of 91 (World Data Lab, 2019). These demographic estimates can be coupled with the projections of global mean temperature increase. Following the best estimate of the future temperature trajectory based on the Climate Action Tracker (2019), increase in the global mean temperature of 1.5°C will be exceeded around the year 2035, 2°C around 2055, and more than 3°C in 2100. Today's French 16-year-old has a probability of 99% to be alive in 2035, 96% in 2055 and 10% in 2100 (Climate Action Tracker, 2019). Nearly all of France's children therefore have a very high probability of experiencing a 2°C warmer world and the ensuing impacts, with a portion of them living to possibly experience an even higher warming.

2. Temperature increase

Since pre-industrial times, increasing temperatures have been observed: the increase global mean surface temperature reached 0.87°C in 2006-2015 (Hoegh-Guldberg et al., 2018). *Figure 1* shows that under a scenario where global mean temperature peaks at 2.4°C in 2100, mean temperature will increase by 1-2.5°C by mid-century in the region, compared to the baseline 1976-2005. The highest increases will be experienced in summer.

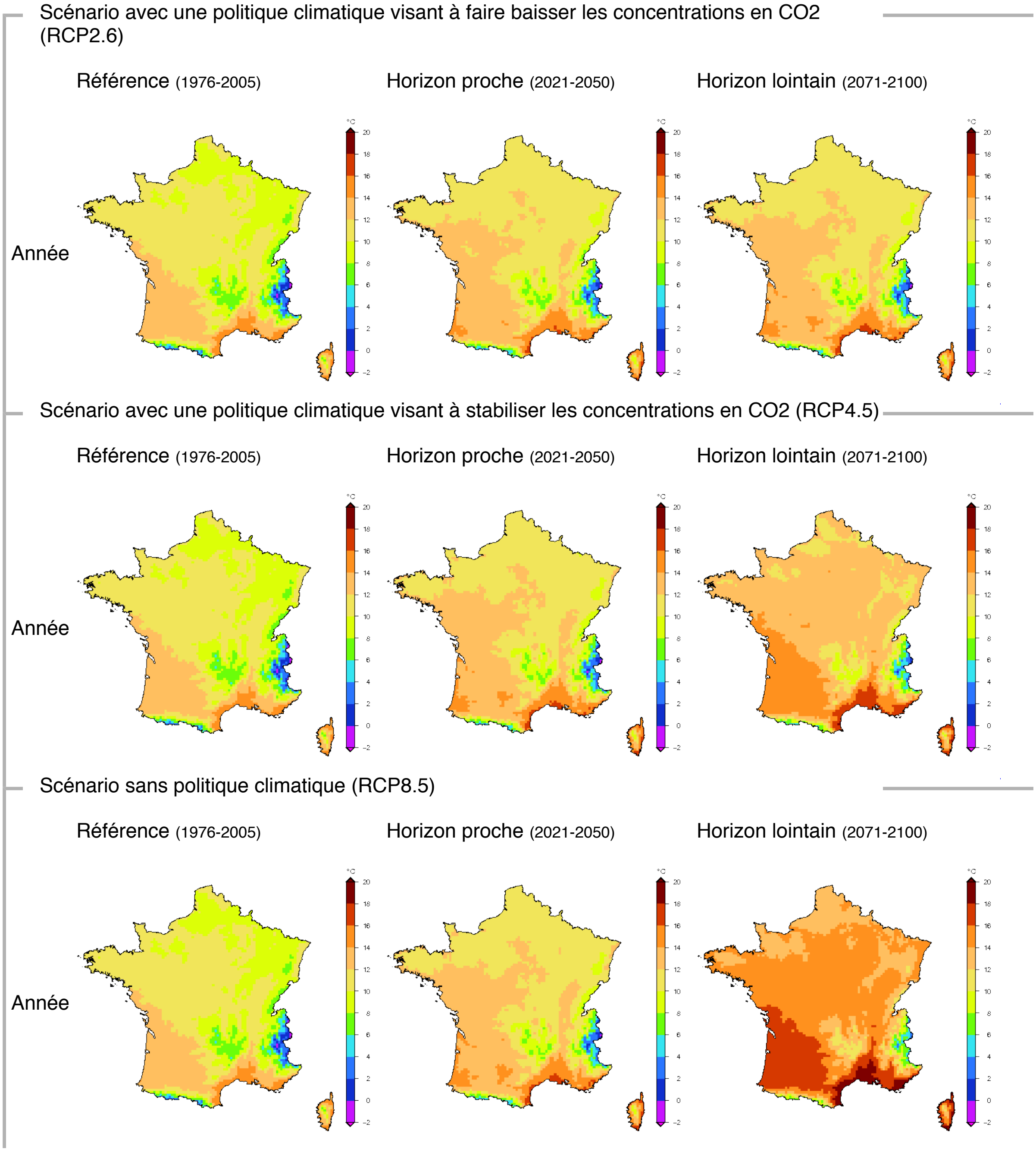

Figure 1: Average daily temperature with scenarios of 1.6°C, 2.4°C and 4.3°C expected temperature increase by 2100 (respectively RCP 2.6, RCP4.5 and RCP 8.5) from the model Aladin of Météo France/CNRM2014 (Drias, 2019)

3. Precipitation

Figure 2 shows that decreases in precipitation have been observed in Southern France over the 1959-2009 period. Combined with a temperature-driven increase in evapotranspiration, this decrease in rainfall has resulted in significant augmentations of drought frequency, severity and duration over the 1950-2012 period in Southern France (Spinoni et al., 2015).

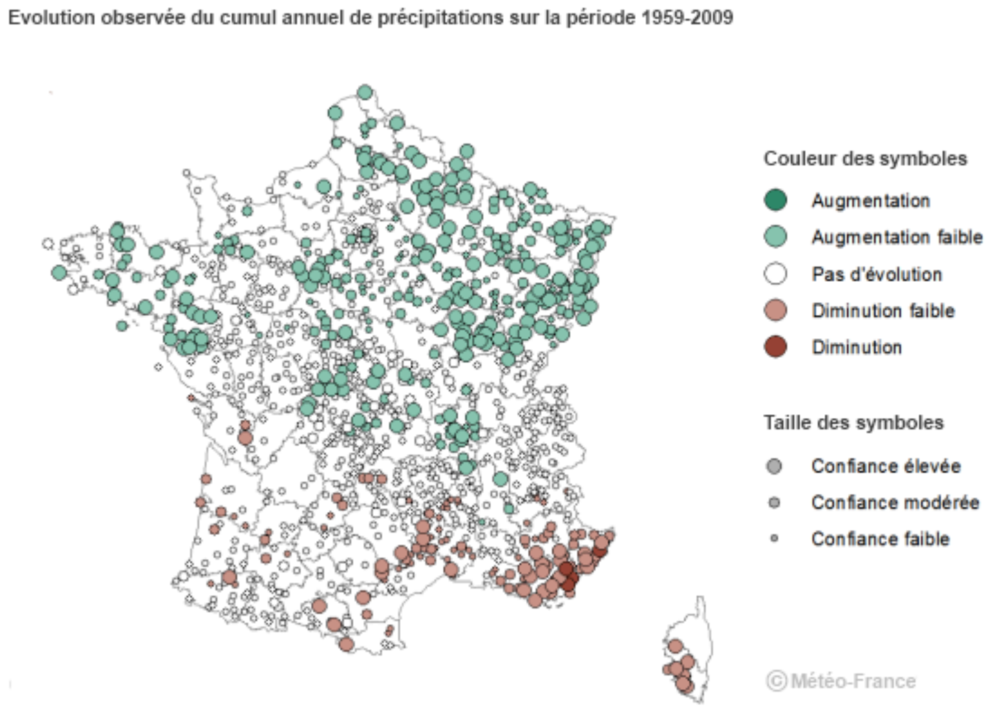

Figure 2: Observed change in total annual precipitation over the period 1959-2009 (Météo France, 2019a)

Figure 3 shows that cumulated annual precipitation is projected to experience a significant decrease by 5-15% by the end of the century compared to 1971-2000, under warming scenario of 2.8°C by 2100 (scenario A1B corresponding to RCP 6.0 (O'Donnell, 2019)), which is approximately in line with the projections for current policies estimates (Climate Action Tracker, 2019). Changes are highest for summertime and would be amplified for a higher-emission scenario (Füssel et al., 2017a; Jacob et al., 2014). This is consistent with other studies indicating moderate model agreement for significant changes towards more droughts over this region in the future (Stagge et al., 2015).

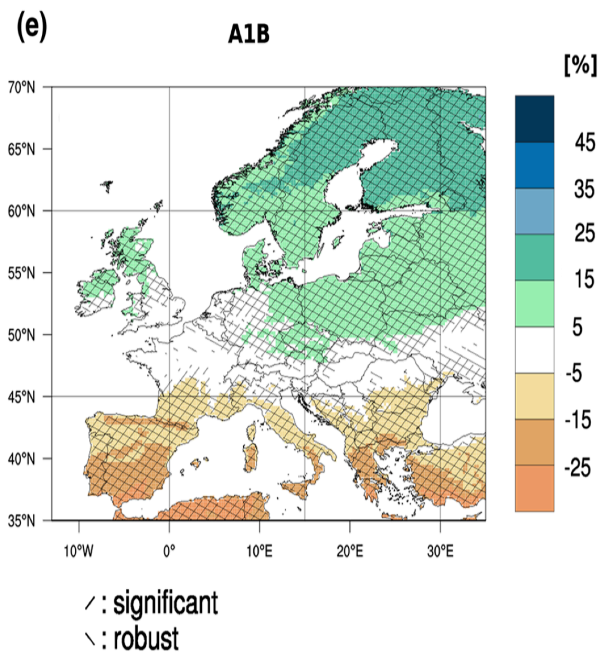

Figure 3: Projected changes of total annual precipitation (%) for 2071–2100 compared to 1971–2000, for A1B scenario. Hatched areas indicate regions with robust and/or statistical significant change (Jacob et al., 2013)

4. Sea level rise

Mean and extreme sea levels have increased globally and along most coasts in Europe (Füssel et al., 2017b). Currently, global mean sea level is about 20 cm higher than at the beginning of the 20th century (EEA, 2017). *Figure 4* shows the projections for the tide gauge station of Port Bloc about 100 kms North-West from Bordeaux.

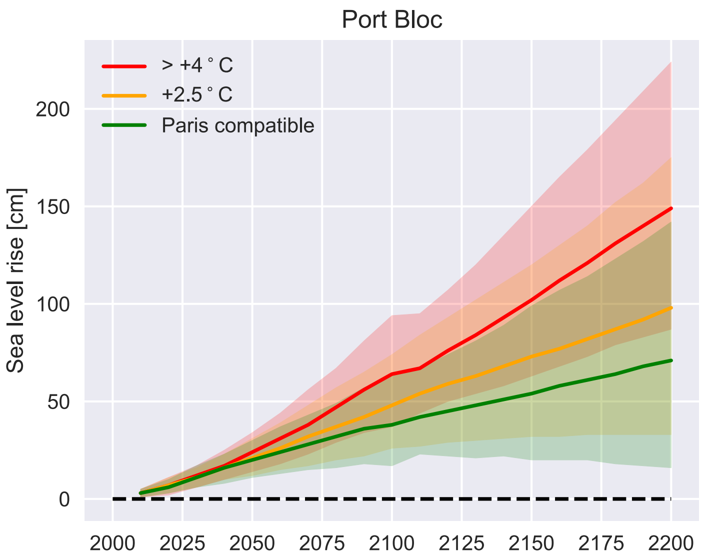

Figure 4: Local sea level projections for Port Bloc for a scenario compatible with the Paris agreement (green), a scenario leading to +2.5°C global mean temperature (orange) and a scenario exceeding +4°C (red). The solid lines represent multi-model medians, the shaded areas include 66% of the models.

The French Coastal Protection Agency estimates, based on the assumption that sea levels will have risen 22 cm by 2050 and 44 cm by 2100, that the effects of erosion and those of submersion are likely to have a limited impact in France, to the order of around 2,000 hectares for erosion and 36,000 hectares for submersion (French Institute for Public Health Surveillance, 2010). *Figure 5* highlights that Bordeaux, located close to the European Atlantic coast, is likely to be affected by floods linked to sea level rise.

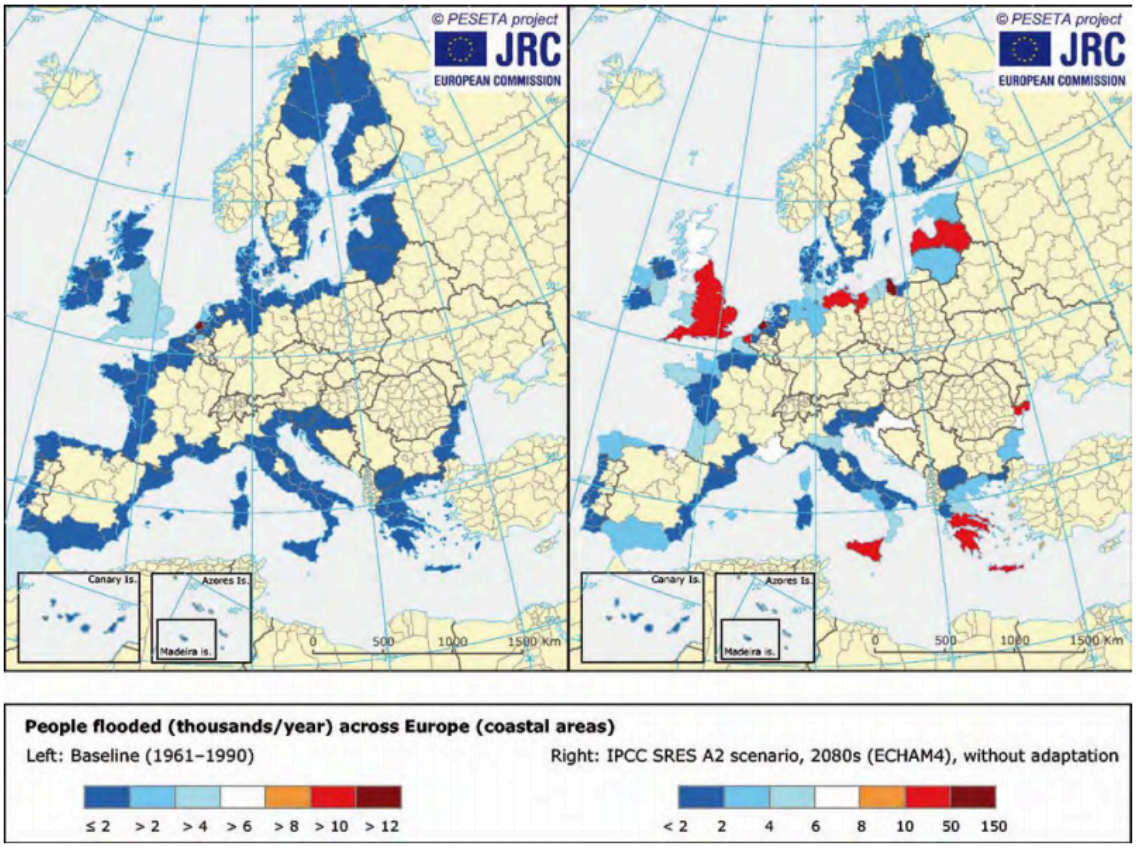

Figure 5: Populations impacted by floods linked to rising sea levels during the period from 1961-1990 (left) and 2080 (right) (French Institute for Public Health Surveillance, 2010)

5. Extreme weather events

5.1 Heavy precipitation events

There is low agreement on the past evolution of heavy precipitation events in Southwestern Europe (Füssel et al., 2017a). *Figure 6* shows an increased intensity of heavy precipitation events in all seasons except summer in the future over Southern France.

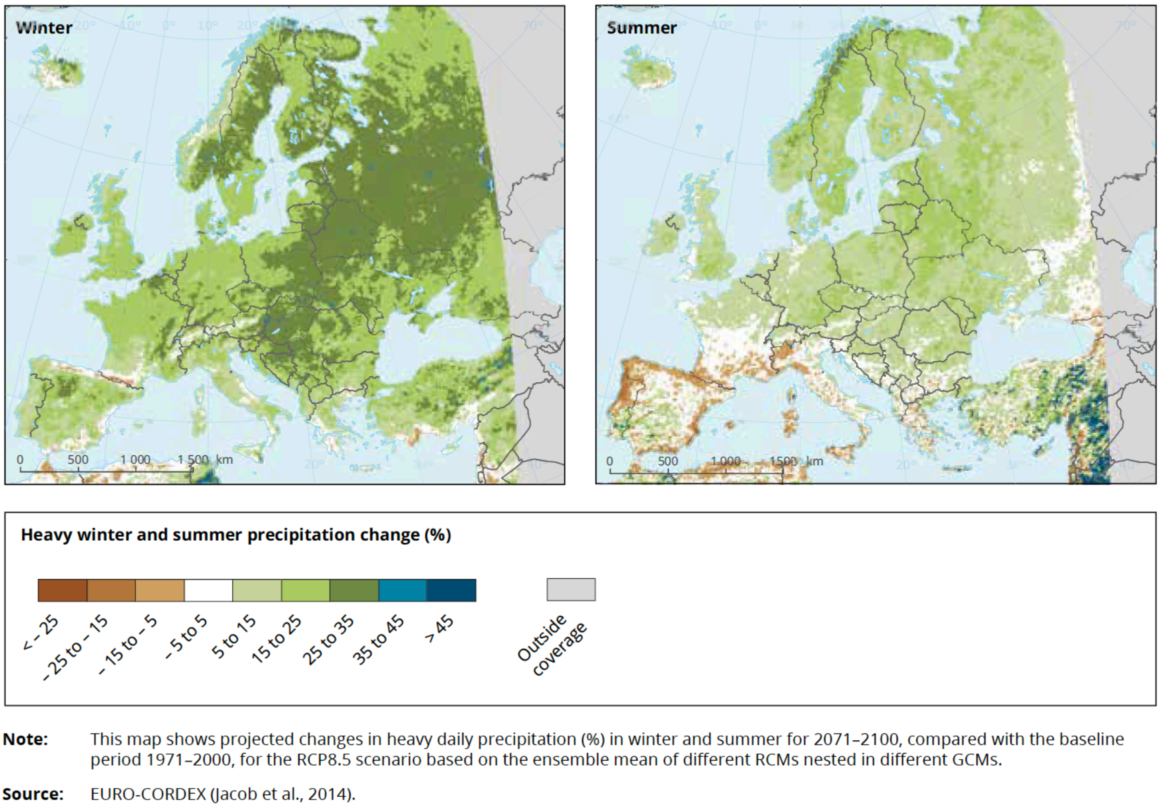

Figure 6: Projected changes in heavy precipitation in winter and summer. From (Füssel et al., 2017a)*, based on* (Jacob et al., 2013)

5.2 Heat waves

On a national level, there have been 3 times more heat waves during the past 30 years, compared to the period 1947-1989 (Météo France, 2019b). Since 2010, 16 heat waves have occurred, 2014 is the only year without a heat wave (ibid). Heat waves are also becoming longer and more severe, the worst heat wave observed was in August 2003 (ibid). In June 2019, France broke its previous temperature records, including Bordeaux which hit 41.2°C (Lenley, 2019). *Figure 7* shows the deviation of monthly temperature averages for June 2019.

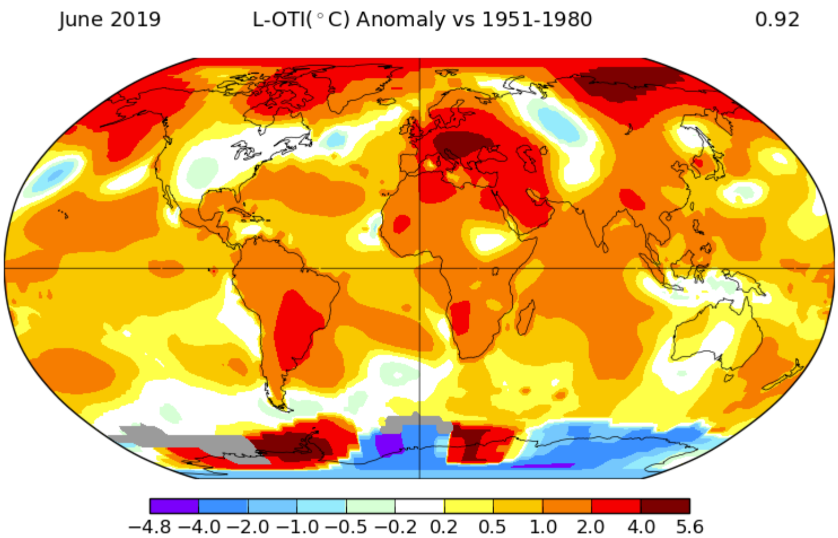

Figure 7: Deviation of monthly temperature averages in June 2019 in comparison of those between 1951-1980. (source: NASA: GISS Surface Temperature Analysis: https://data.giss.nasa.gov/gistemp/maps/)

Every heat wave in Europe is made more likely and more intense by human-induced climate change (Jan van Oldenborgh et al., 2019). An attribution study combining climate models and observations concludes that the June 2019 heat wave was made *at least* 5 times more likely by climate change (ibid). In addition, studies by King & Karoly (2017) show the increasing likelihood of similar heatwave events occurring with current temperature increase of about 1°C, for 1.5°C and 2°C warming in comparison to a world without climate change. When looking at the 2003 heat wave in central Europe, during which 15,000 deaths were recorded in France alone (French Institute for Public Health Surveillance, 2010), this would be a once in 100 years event without climate change. At current warming levels a similar event can be expected once every four years. For 1.5°C warming the likelihood increases to 4 out of 10 summers and for 2°C warming reaches 6 out of 10 (*Figure 8*).

			Likelihood of similar event per year			
EVENT	CONTEXT, IMPACT	VARIABLE	NATURAL	CURRENT	1.5°C	2°C
Central Europe JJA 2003	Hottest summer on record, thousands of heat-related deaths	T	1% (1-2%)	25% (17-33%)	42% (32-51%)	59% (50-70%)
		TXx	2% (0-6%)	21% (7-37%)	21% (9-34%)	31% (14-50%)

Figure 8: Likelihood of similar heat waves occurring without climate change, at current warming levels, for 1.5° and 2° warming (King & Karoly, 2017)

5.3 Droughts

Generally, there has been a constant increase in droughts in France during the 20th Century. By the end of the 21st Century, the average humidity level of the soil is projected to correspond to the extremely dry level of the reference period 1961-1990 (Drias, 2019) (*Figure 9*).

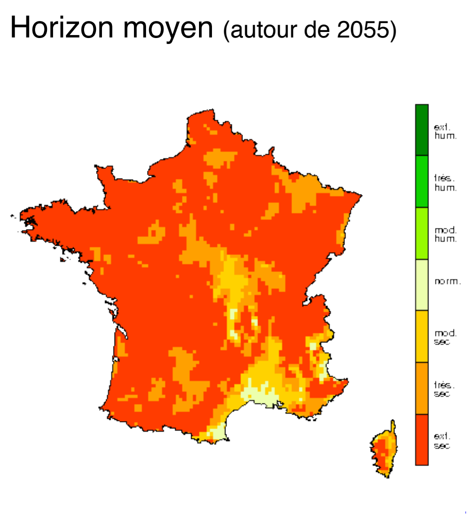

Figure 9: Indicator of soil drought for the ISBA model (Météo France/CLIMSEC – CERFACS/SCRATCH08) based on the A1B scenario (corresponding to RCP 6.0, a scenario of 2.8°C expected temperature increase in 2100 (O'Donnell, 2019)). The reference period used is around 1970 for a mid-term horizon around 2055. (Drias, 2019)

6. Sectoral impacts

6.1 Health impacts from heat waves

The impacts of heat waves on mortality and morbidity rates are well-documented in France today. Nearly 15,000 deaths were recorded during the heat wave in 2003, and nearly 2,000 during the heat wave in 2006 (French Institute for Public Health Surveillance, 2010). During the heat wave in 2018, 1,500 deaths were recorded, 10 times less than in 2003, mainly thanks to improved prevention measures that have been implemented (Le Figaro, 2018). Climate change is expected to increase mean annual temperature and the intensity and frequency of heat waves resulting in a greater number of people at risk of heat-related medical conditions (WHO, 2015). The elderly, children, the chronically ill, the socially isolated and at-risk occupational groups are particularly vulnerable to heat-related conditions (ibid). *Figure 10* shows that under a scenario of 4.3°C expected temperature increase by 2100 (RCP8.5), heat-related deaths in the elderly are projected to increase to about 61 deaths per 100,000 by 2080 compared to the estimated baseline of about 4 deaths per 100,000 annually for the period 1961-1990. In 2080, the nowadays 16-year-old child will be 77, part of the vulnerable group exposed to heat-related conditions.

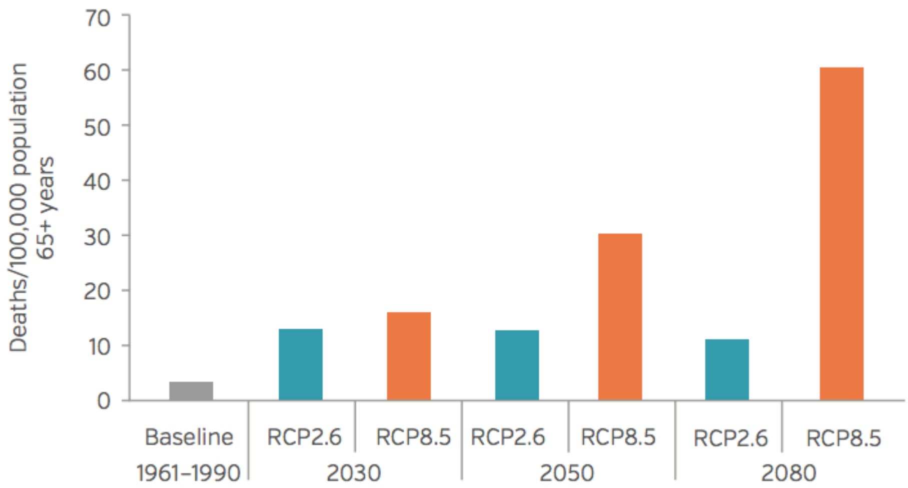

Figure 10: Heat-related mortality in population 65 years or over, France [deaths/100,000 population 65+ years] (WHO, 2015)

6.2 Health impacts from infectious and vector-borne diseases

Vector-borne diseases that may be affected by climate change in France include chikungunya, dengue, yellow fever and leishmaniases. Climate conditions are projected to become significantly more favorable for transmission, slowing progress in reducing burdens, and increasing the populations at risk if control measures are not maintained or strengthened. *Figure 11* shows that under a scenario of 4.3°C expected temperature increase by 2100 (RCP8.5), around 26% of the geographic area of France is projected to exceed the threshold suitable for dengue transmission for at least 3 months a year (compared to the baseline of less than 5% of the country annually for the period 1961-1990) (WHO, 2015).

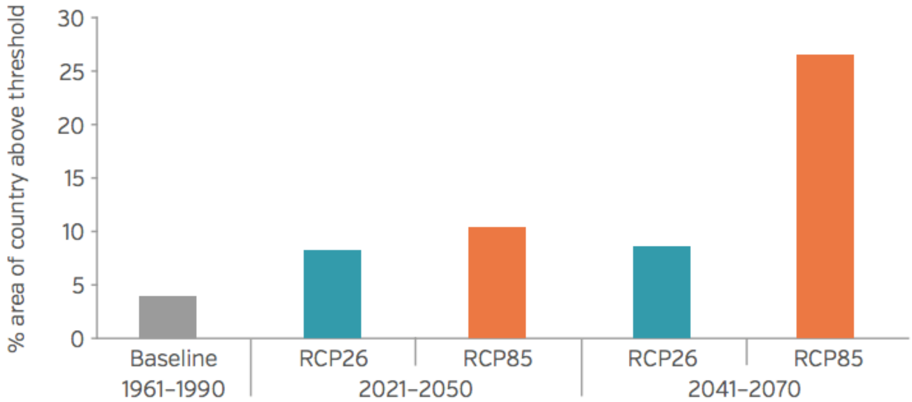

Figure 11: Dengue fever transmission in France (% area of the country with 3 months or greater above threshold for dengue transmission) (WHO, 2015)

6.3 Cultural heritage of the wine industry

The IPCC has stated that "climate change will change the geographic distribution of wine grape varieties (high confidence) and this will reduce the value of wine products and the livelihoods of local wine communities in Southern and Continental Europe (medium confidence)" (IPCC, 2014). Bordeaux is one of the world's oldest wine growing regions and rising global temperatures are threatening this cultural heritage, the livelihood of 14,000 wine growers around Bordeaux and its $4.2 billion wine industry (Ruitenberg, 2015).

Higher temperatures have impacts on grapevine yield and affect the quality of the wine (IPCC, 2014). Extreme weather such as storms, heavy rains and hail storms during summer destroy the grapes (Fichtner, 2014). Mild temperatures in winters and at night time do not allow the plants to rest. Therefore, for the grape varieties that do not tolerate the heat, maturation processes are impaired (ripening processes are getting shorter, harvest season is earlier) (ibid).

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2.4. Germany

Country Profile Germany – Hamburg

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Summary

The city of Hamburg is already experiencing climate change impacts today: heatwaves, sea level rise and storm intensities that are increasing leading to a salinization of groundwater. Moreover, extreme precipitation is increasing leading to an increased risk of both local flooding events as well as increased river or coastal flooding. Due to the urban heat island effect, extreme temperatures in Hamburg are increasing faster than the average of Germany.

If global warming exceeds 1.5°C, Hamburg has a 59% chance to experience an extreme heat wave such as in the summer of 2003. Moreover, the probability of a 7-day period of consecutive rain days is projected to increase by about 18% under 2°C global warming. Under current emission trajectories, Germany's children will spend more than half their lives in a world warmer than 1.5°C above pre-industrial levels.

Future impacts of climate change will strongly affect the population of Hamburg. Children are particularly vulnerable to increasing floods as it takes more time to evacuate in cases of emergency. There are also a number of increasing health related risks for children related to climate change and fossil fuel combustion, such as increasing air pollution and the spread of pathogens or carriers of infectious diseases.

1. The IPCC Report's summary on Climate Impacts in Germany

Coastal regions such as Hamburg are among the most affected by climate change (IPCC, 2018). Climate change impacts affect "a range of natural and human systems, such as terrestrial, coastal and marine ecosystems and their services; agricultural production; infrastructure; the built environment; human health; and other socio-economic systems" (IPCC, 2018). These trends are largely of anthropogenic nature, as for example for precipitation extremes and flooding in Germany, which are "explained in terms of increasing frequency and persistence of circulation patterns favorable to flooding" (IPCC, 2014). Impacts such as flooding lead to direct losses and fatalities and will increase in the absence of adequate adaptation (IPCC, 2014). More extreme water levels due to rising sea levels are also expected to increase in coastal urban areas such as Hamburg (IPCC, 2018). This can increase flooding and lead to salinization of groundwater and damage to infrastructure from extreme events (IPCC, 2018). "At least 136 megacities (port cities with a population greater than 1 million in 2005) are at risk from flooding due to SLR (with magnitudes of rise possible under 1.5°C or 2°C in the 21st century), unless further adaptation is undertaken" (IPCC, 2018). All these long-term risks (e.g. of coastal flooding) and possible impacts on populations and thus children are projected to increase with higher levels of warming (high confidence) (IPCC, 2018).

2. Demographics

Germany has a population of about 83 million people, 18% of which are under the age of 19. An average 15-year-old German citizen, the petitioner’s peer, is expected to live until the age of 90. These demographic estimates can be coupled with the projections of global mean temperature increase. Following the best estimate of the future temperature trajectory based on the Climate Action Tracker increase in the global mean temperature of 1.5°C will be exceeded around the year 2035, 2°C around 2055, and more than 3°C in 2100 (Climate Action Tracker, 2018). Today’s German 16-year-old has a probability of 99% to be alive in 2035, 97% in 2055 and 10% in 2100 (World Data Lab, 2019). Nearly all of Germany’s children therefore have a very high probability of experiencing a 2°C warmer world and the ensuing impacts, with a portion of them living to possibly experience an even higher warming.

3. Temperature

Each of the past three decades has been successively warmer than all the previous decades in Germany (Weyrich, 2016). The first decade of the 21st century was recorded as being the warmest (Weyrich, 2016). The average near surface temperature has increased by 1.2°C between 1881-2013 (Weyrich, 2016). Moreover, the temperature extremes (number of hot days, tropical nights and heatwaves) are increasing (Weyrich, 2016). At the same time, the number of ice days per year has decreased (Weyrich, 2016).

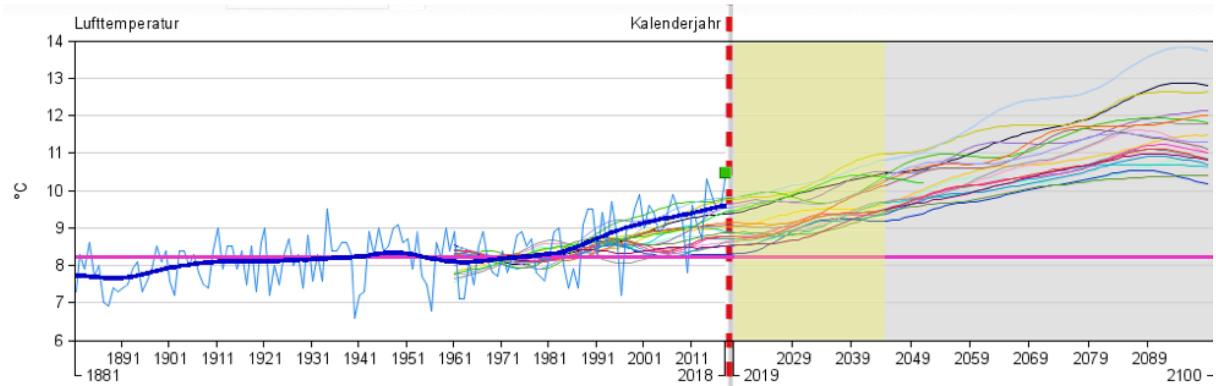

Figure 1: Mean annual temperature for Germany – thick blue line indicates the 30-year mean temperatures from 1881-2018. The future scenario assumes global temperature increases by 2100 at ~2.8°C (RCP6.0) and displays an ensemble of 21 climate models from 2019-2100 (https://www.dwd.de/DE/klimaumwelt/klimaatlas/klimaatlas_node.html)

For the period 2071-2100 the mean annual temperature for Germany is projected to rise by 2.5°C to 4°C (RCP4.5 and RCP8.5) compared to the baseline period (1971-2000) which is within the global average warming levels expected for the respective emissions scenarios (Weyrich, 2016). These effects may be even stronger in urban areas such as Hamburg. The Urban Heat Island (UHI) describes the temperature difference between urban and rural areas (Quante & Colijn, 2016), caused by human activities as well as soil sealing by building and lack of latent heat cooling. In addition, waste heat emissions will add to the rise in temperatures caused by the urban fabric (Quante & Colijn, 2016). Thus, for the urban population heat risks will increase more than for their rural counterparts, which affects energy use, comfort and health (Quante & Colijn, 2016).

4. Precipitation

Average summer precipitation in Germany remained mainly unchanged, whereas winter precipitation has increased by 28%, leading to overall precipitation increases by 10.6% since 1881 (Weyrich, 2016). This precipitation increase is also displayed in figure 2 below. Precipitation intensity and frequency has and will increase during the 20th century (Weyrich, 2016).

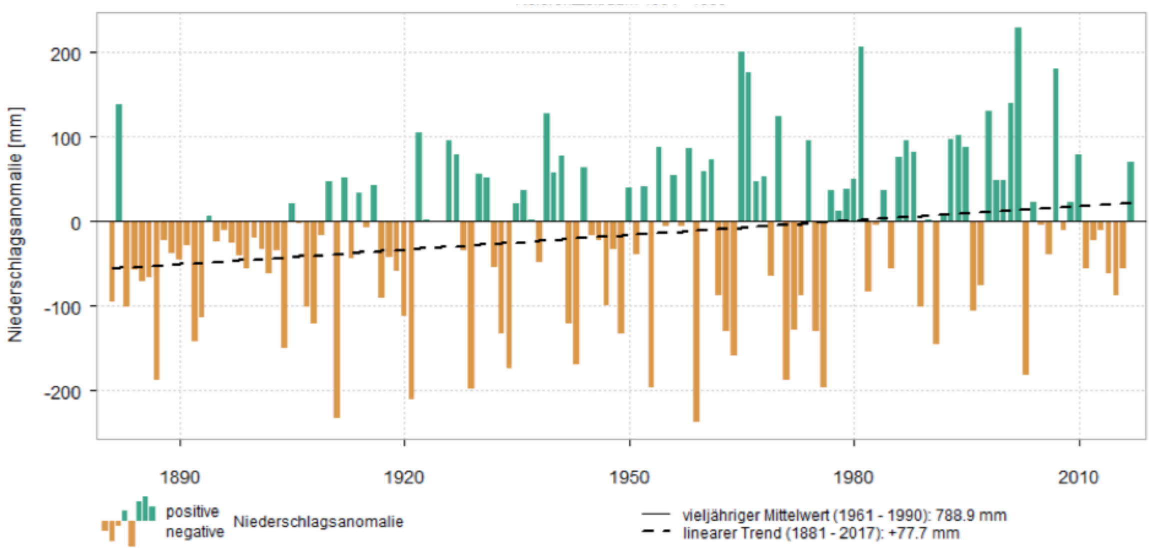

Figure 2: Positive and negative precipitation deviation (mm) of the area average for Germany from 1881-2017 (reference period 1961-1990) (Deutscher Wetterdienst, 2017)

Specifically in the North of Germany, heavy precipitation events have become more frequent and the annual maximum 5-day precipitation has increased from 38 mm to 45 mm (Weyrich, 2016). Precipitation patterns are projected to increase in large parts of Central Europe (and Germany) by 25% (for a projected temperature increase by 4.3°C by 2100 (RCP8.5)) (Weyrich, 2016). Increases in extreme precipitation were found to be largely anthropogenic and will impact direct losses and fatalities in various locations in the absence of adequate adaptation (IPCC, 2014). Extreme precipitation events are projected to increase not only in intensity, but also in length. For central Europe, the probability of a 7 (14) day period of consecutive rain days is projected to increase by about 18% (44%) under 2°C global warming (Pfleiderer et al., 2019). These precipitation increases will challenge urban infrastructure, as it causes streets and houses to flood or even the total breakdown of some urban infrastructure (Quante & Colijn, 2016).

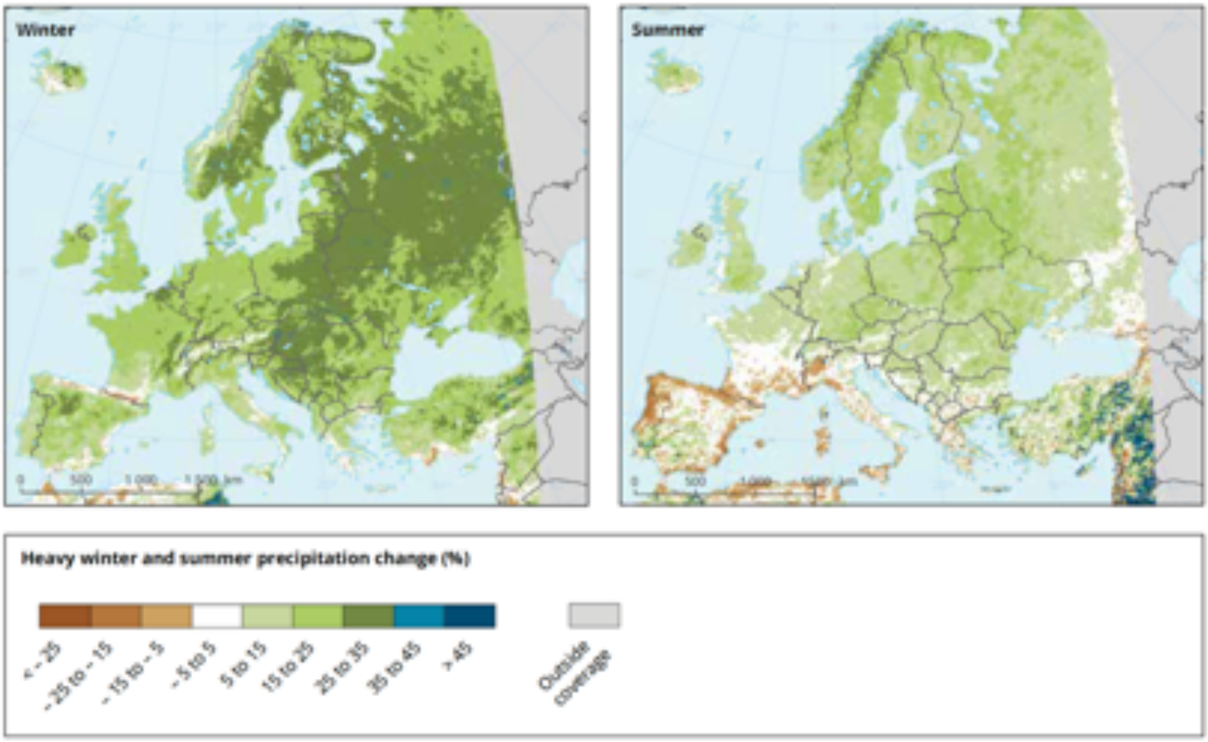

Figure 3: Projected changes in heavy daily precipitation (%) in winter and summer for 2071-2100 with the baseline period 1971-2000 for global temperature increases of 4.3°C by 2100 (RCP8.5) (Jacob et al., 2014)

5. Sea level rise

"Sea level rise is accelerating in response to climate change and will produce significant impacts (high confidence)" (IPCC, 2018). Especially in coastal urban areas or large river deltas, such as Hamburg, more extreme water levels are projected to occur due to rising sea levels, which can lead to flooding and damage of infrastructure (IPCC, 2018). Port cities with a population larger than 1 million in 2005 are "at risk from flooding due to sea level rise (with magnitudes of rise possible under 1.5°C or 2°C in the 21st century), unless further adaptation is undertaken" (IPCC, 2018).

Sea level rise, which is projected to increase with higher levels of warming, will pose long-term risks and impacts on populations, infrastructure and assets (IPCC, 2018). The changes in sea level rise and the resulting coastal flooding have been attributed to anthropogenic climate change since 1970 (IPCC, 2018). Figure 3 shows the local sea level projections for Cuxhaven, the closest tide gauged station to Hamburg (100 km from Hamburg).

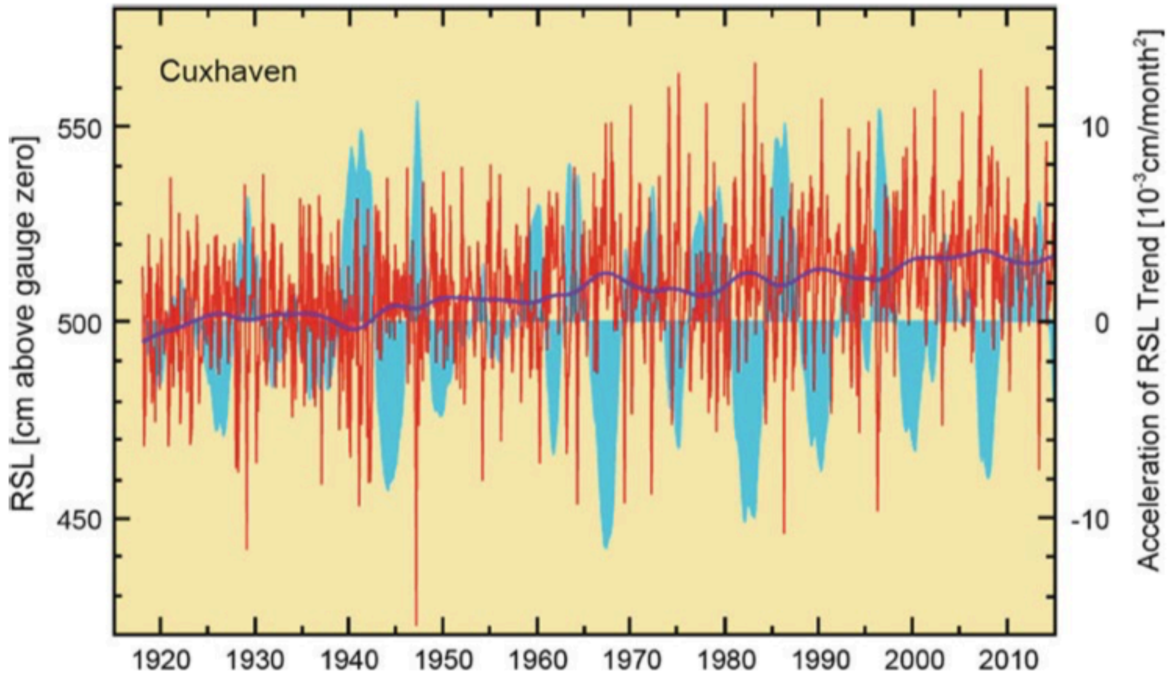

Figure 4: Observed monthly averages (red) of the relative sea level at the gauge station Cuxhaven from 1981-2015 with smoothed curve (dark blue) and acceleration of the rise (right blue) (Meinke and von Storch, 2018)

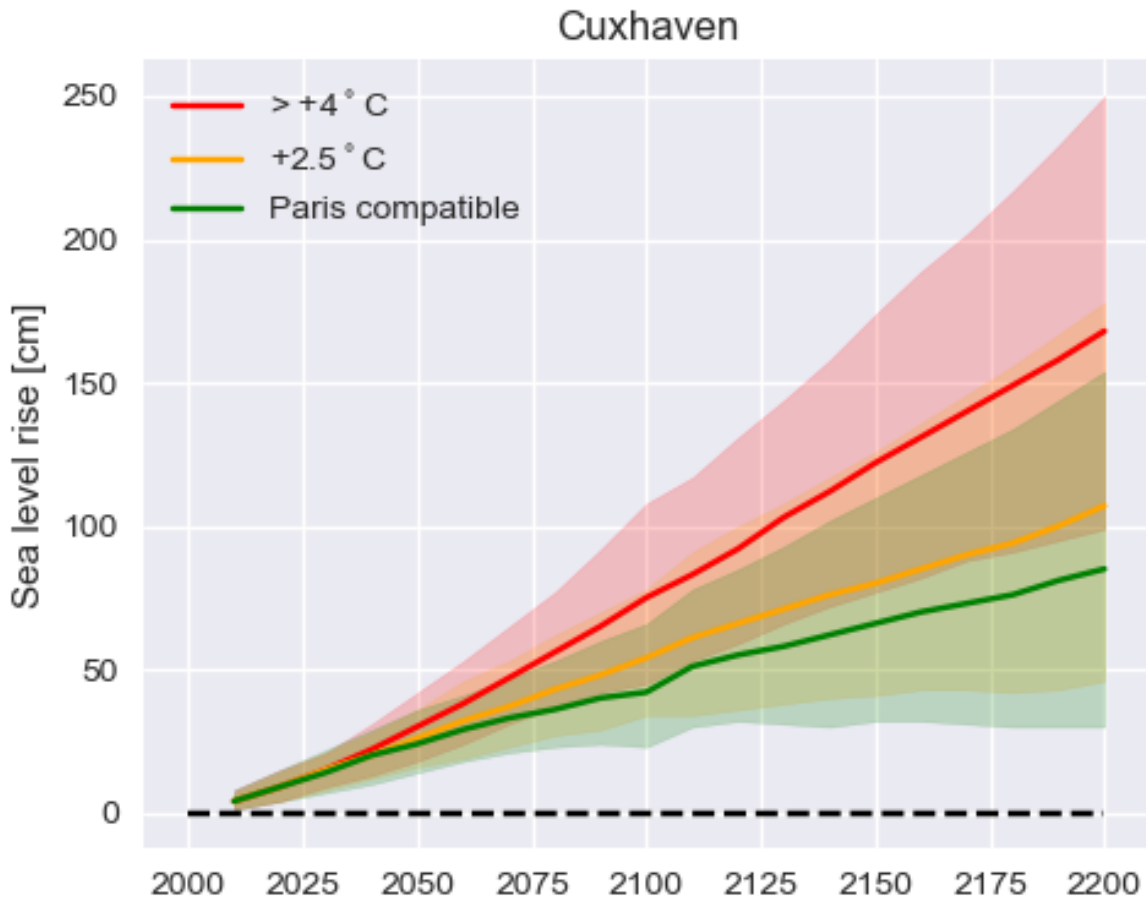

Figure 5: Local sea level projections for Cuxhaven for a scenario compatible with the Paris Agreement (~RCP2.6) (green), a scenario leading to +2.5°C global mean temperature (~RCP4.5) (orange) and a

scenario exceeding +4°C (~RCP8.5) (red) The solid lines represent multi-model medians, the shaded areas include 66% of the models (http://localslr.climateanalytics.org/location/Cuxhaven)

Sea level rise also has implications for groundwater salinization in Germany (Martens, S.; Wichmann, 2011). Sea level rise in coastal areas causes groundwater salinization, which has implications for groundwater resources and public water supply (71% of public water supply depends on groundwater resources) (Martens, S.; Wichmann, 2011). Higher salt contents can only be removed by complex and cost-intensive treatment processes and can thus pose a problem for sustainable water management (Martens, S.; Wichmann, 2011). Figure 5 show how Hamburg and surroundings are currently affected by groundwater salinization. The groundwater salinization levels are expected to increase with increasing sea levels.

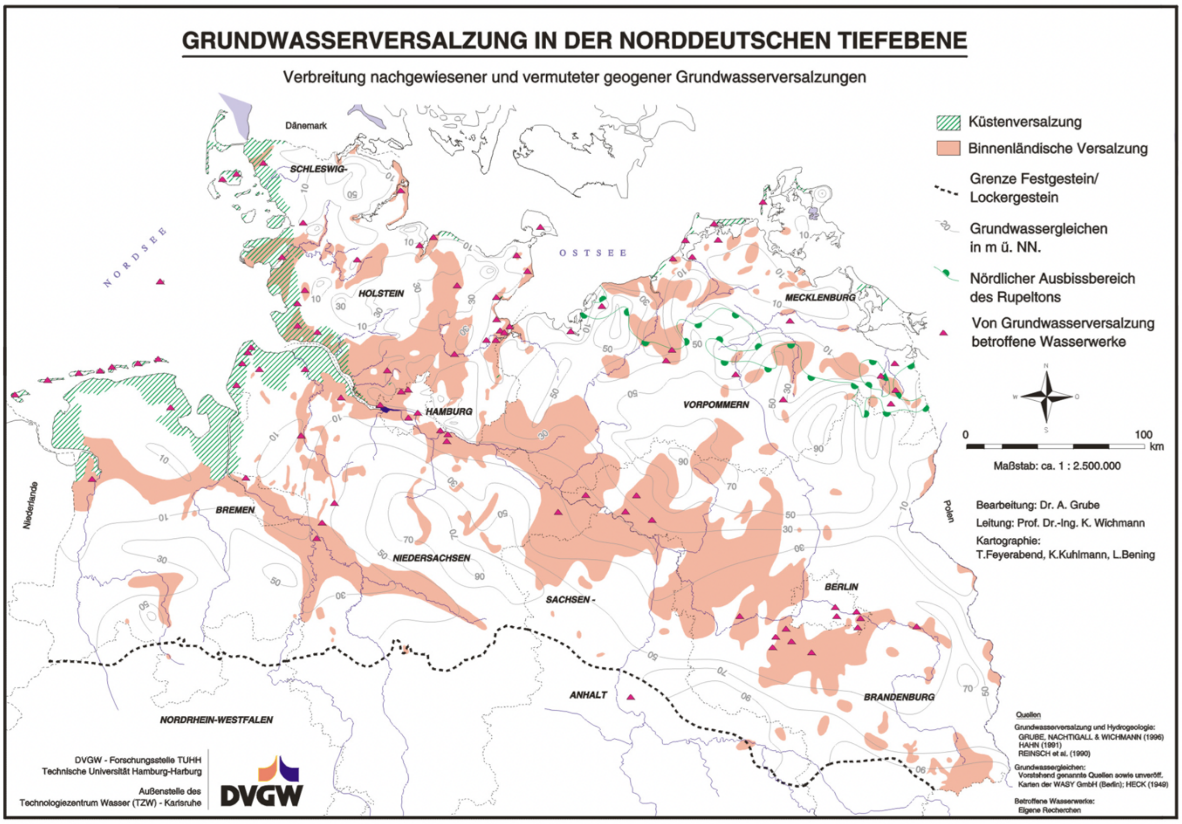

Figure 6: Groundwater salinization in the North German Plain (green areas showing coastal salinization and red areas inland salinization) (Martens, S.; Wichmann, 2011)

6. Extreme weather events

Hamburg has and will be subject to increasing extreme weather events such as heat waves and storms. For example in 1962, the city of Hamburg experienced a catastrophic storm surge, causing 347 deaths, 61 dyke failures and 370 km^2 area flooded. Increasing global temperatures affect the upper layers of the ocean, which drives more intense storms and greater rates of inundation, which together with sea level rise, causes significant impacts (IPCC, 2018).

The IPCC projects that due to increased storm frequency and sea level rise, Europe will be subject to risk of tidal and storm floods with greater erosion in the future (Huang-Lachmann & Lovett, 2016). For example, projected increases in hail (due to more severe thunderstorms) could cause mean annual loss ratios from homeowners' insurance to increase by 15% (2011-2040) and 47% (2041-2070) (IPCC, 2014). The protection level in Hamburg is comparably high, however, there is risk for certain areas (e.g. located close to the Elbe) of being flooded during storm surge.

Heatwaves in Europe are becoming more frequent. June 2019 was the warmest June in Germany since the beginning of observations (Imbery et al., 2019). Figure 7 shows the change in frequency of European climate extremes among different levels of global warming. The probabilities in a given year to reach similar events to the last European extreme values (heatwaves Europe 2003) are displayed for a natural world, the present world, a 1.5°C world and a 2°C world in Figure 8. This indicates, that under global temperature increases of 2°C (~RCP4.5), Europe will experience heat waves as in 2003 in summer as often as six out of ten summers. German children of today will spend more than half of their lives in a 1.5°C or warmer world.

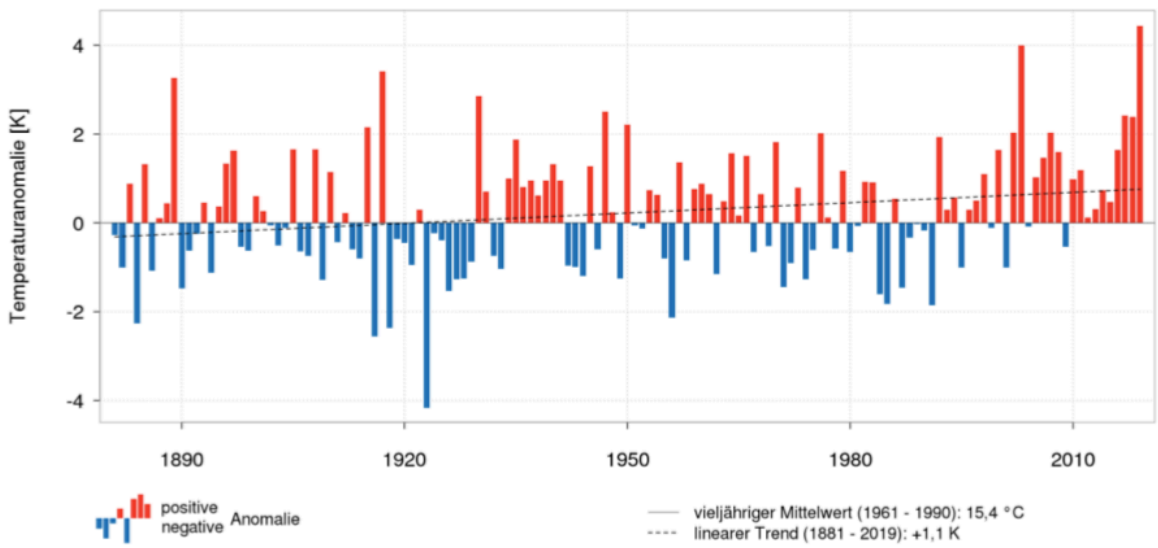

Figure 7: Deviations of June temperatures for Germany (1881-2019) from the long-term average 1961-1990 (Imbery et al., 2019)

			Likelihood of similar event per year			
EVENT	CONTEXT, IMPACT	VARIABLE	NATURAL	CURRENT	1.5°C	2°C
Central Europe JJA 2003	Hottest summer on record, thousands of heat-related deaths	T	1% (1-2%)	25% (17-33%)	42% (32-51%)	59% (50-70%)
		TXx	2% (0-6%)	21% (7-37%)	21% (9-34%)	31% (14-50%)

Figure 8: The change in the frequency of European climate extremes among different levels of warming (King and Karoly, 2017)

7. Floods

Nearly half of the area of Hamburg is declared flood prone (Rose and Wilke, 2015). Moreover, Hamburg is the second largest city in Germany with a population that is exposed to natural flooding threats from the North Sea and the Elbe river, which is also why the city has identified flood as their main climate change challenge (Huang-Lachmann et al., 2016).

Mean annual insured flood loss is projected by the IPCC 5th Assessment Report to increase by 84% in 2011-2040, by 91% in 2041-2070 and by 114% in 2071-2100 (IPCC, 2014). The city of Hamburg faces a total of three different flood risks: storm surges, inland flooding and heavy rainfall (Rose and Wilke, 2015). As there are so many water bodies in Hamburg, there is a specific risk of inland flooding events (Rose and Wilke, 2015). The sensitivity of people varies within the region, however, children (and families with children) are among the most vulnerable, as it takes more time to evacuate in case of emergency (Rose and Wilke, 2015).

8. Sectoral impacts

8.1 Health

Hamburg is one of the cities that has experienced urban climate problems, especially regarding heavy air pollution (Quante & Colijn, 2016). There are higher levels of primary pollutants due to higher emissions from a range of anthropogenic sources, especially in harbor cities like Hamburg and Rotterdam, where emissions from ships add to the air pollution load (Quante & Colijn, 2016). In Hamburg, "poor air quality has serious implications for human health and the related societal costs are considerable" (Quante & Colijn, 2016).

Climate change also has an impact of air pollution levels, for example through changes in temperature, solar radiation or humidity. Heat waves can increase the impacts on air quality, and as they are expected to increase in the coming decades this could have a impact on life expectancy (Quante & Colijn, 2016). At the same time, a sizeable part of air pollution is linked to combustion of fossil fuels, e.g. by vehicle engines or ships, thereby contributing both to global warming as well as local air pollution in particular in the urban context.

In the EU, pollution resulting from human activity is estimated to have reduced life expectancy in 2000 by 8.6 months (Quante & Colijn, 2016). Figure 4 indicates the number of premature deaths due to air pollution in 2000. For example in 2015, 81 people in Germany died prematurely because of pollution (EEA, 2018). It has been argued, that "the effects on air quality of emission changes since preindustrial times are stronger than the effects of climate change" (Quante & Colijn, 2016).

Increasing thermal loads can lead to heat waves (see chapter 6), which particularly affects older people and children (Meinke and von Storch, 2018). There are also changes to the vegetation that can cause a prolongation of the pollen season and thus make the period of symptoms of allergy sufferers longer (Meinke and von Storch, 2018). Moreover, climate change may also favour the spread of pathogens or carriers of infectious diseases (Meinke and von Storch, 2018). Finally, climate warming significantly influences tick populations due to shorter generation times and migration of tick species from warmer regions of Europe to Germany (Meinke and von Storch, 2018). This could be dangerous as ticks (as well as mosquitos) play an increasing role as carriers of pathogens and could thus affect children in Germany and Hamburg.

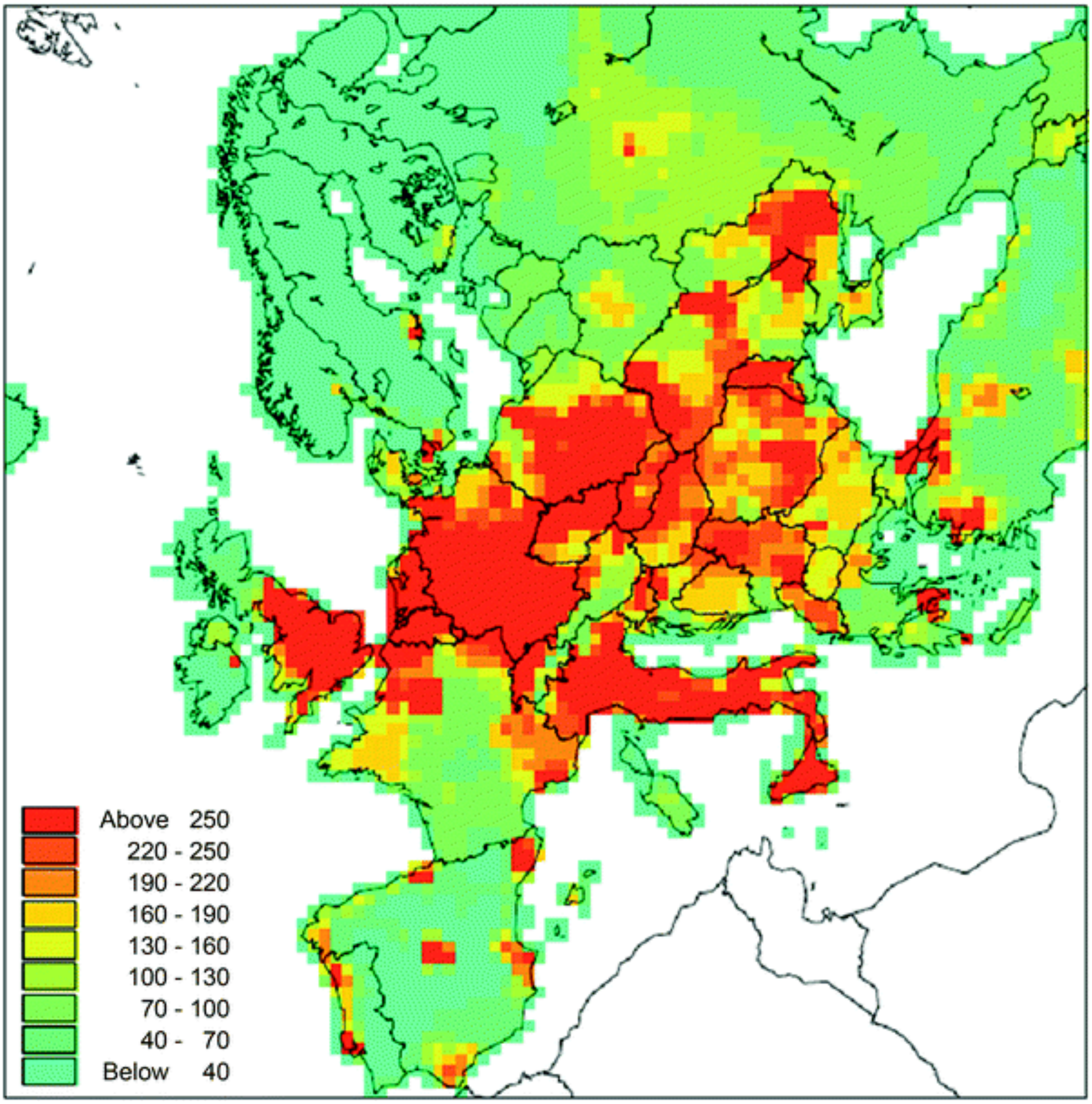

Figure 9: Estimated number of premature deaths due to air pollution per 2500 km2 grid cell in 2000 (Quante & Colijn, 2016)

8.2 Agriculture

Agriculture is an important economic factor for Hamburg as 60% of the metropolitan area of Hamburg are agriculturally used (Herrmann et al., 2016). Climate change may lead to declines in frost occurrence which could lead to longer growing seasons, whereas increasing temperatures can lead to soil moisture stress, impacting crop suitability (IPCC, 2014). The IPCC 5th Assessment Report projected a decrease in wheat, maize and soybean between -8 (4.3°C by 2100 (RCP8.5)) to +4% (2.8°C by 2100 (RCP6.0)) in 2080 (IPCC, 2014). Moreover, an increase in irrigation demand leads to decreasing low flows in rivers (e.g. -25% over the last 25 years in the Ilmenau River) and groundwater abstractions (Herrmann et al., 2016). This could reduce the sustainably recoverable groundwater quantities needed for irrigation and public water supply in the future (Herrmann et al., 2016). As mentioned in chapter 5, sea level rise can lead to salinization of groundwater, which could also substantially affect irrigation water in the future.

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2.5. India

Country profile: India - Uttarakhand

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Summary

Together with other South Asian countries, India is among the world's most vulnerable regions, faced with a combination of climate-related hazards and acute vulnerability. The IPCC Fifth Assessment Report (AR5) lists a multitude of challenges that South Asia is currently facing and will continue to experience in the future: temperature increase and more temperature extremes *(high confidence)*, increased rate of sea level rise *(high confidence)*, changing patterns of rainfall and melting snow and ice. At the same time, population will increase, and so will the demand for water and food *(high confidence)*. The region is particularly vulnerable to extreme precipitation, which has often been compounded by deadly floods and landslides. In 2013, Uttarakhand was hit by one of the deadliest recorded floods that left almost 6000 people dead and affected 4500 villages (BBC, 2013). In 2017, major monsoon flooding in the Ganges river basin left more than 1200 people dead and many missing and displaced (Uhe et al., 2019). Additionally, impacts of extreme heat, food and water shortages, can have cascading effects on the livelihoods of the population, particularly its youth that is going to experience further increases in global mean temperature increase and the resulting impacts.

Particularly pertinent to the state of Uttarakhand is climate change-induced retreat and loss of glacial ice, which will threaten the water supply of the local population. Under current emission trajectories, Indian children of today will spend more than half of their lives in a world warmer than 1.5°C above pre-industrial levels and be exposed to health risks from impacts of climate change that will increase in both frequency and intensity in the future. Impacts of floods, heat waves and melting ice can be avoided significantly with mitigation efforts to limit the temperature increase to 1.5°C above the pre-industrial period (Dosio et al., 2018; Lutz et al., 2019; Schleussner et al., 2016; Uhe et al., 2019) .

1. Demographic profile

India's population is currently over 1.3 billion people, making the words second-most populous country (United Nations, 2019). Almost 40% of India's population is under the age of 19 (Wittgenstein Centre for Demography and Global Human Capital, 2018). An average 11-year-old Indian citizen, the petitioner's peer, is expected to live until the age of 81 (World Data Lab, 2019). These demographic estimates can be coupled with the projections of global mean temperature increase for comparisons of climate change timelines and the children's lifespans. Following the best estimate of the future temperature trajectory based on the Climate Action Tracker, increase in the global mean temperature of 1.5°C will be exceeded around the year 2035 (model median), 2°C around 2055, and more than 3°C in 2100 (Climate Action Tracker, 2018). Today's Indian 11-year-old has a probability of 99% to be alive in 2035, 95% in 2055 and 8% in 2100 (World Data Lab, 2019). India's children therefore have a high probability of experiencing a 2°C warmer world and the ensuing impacts, with a portion of them living to possibly experience even higher degrees of warming.

2. The Hindu Kush Himalaya Assessment

The climatic conditions of India and local impacts of climate change are very heterogeneous, and for a more accurate analysis of impacts requires downscaling. The recent assessment of the Hindu Kush Himalaya (HKH) provides comprehensive information on current and future climate-related risks in the region where the Indian petitioner's home – the state of Uttarakhand – is located. The report was produced by the Hindu Kush Himalayan Monitoring and Assessment Programme (HIMAP), as a joint effort of scientists and experts from the region and around the world.

3. Temperature increase

Figure 1 (a) displays temperature and extreme temperature trends for the Hindu Kush Himalaya region from 1901 to 2014. In this period, annual mean surface air temperature increased at a rate of about 0.10 °C per decade. In the past 60 years, the rate of increase has been about 0.20°C per decade. Both temperature trends are congruent with the global mean temperature increases. Figure 1 (b) shows that the occurrences of extreme cold days and nights have decreased, while extreme warm days and nights have increased. For the period 1951-2014, the trend of the average annual minimum temperature was lower than that of the global average, and the trend of the average annual maximum temperature higher than the global average.

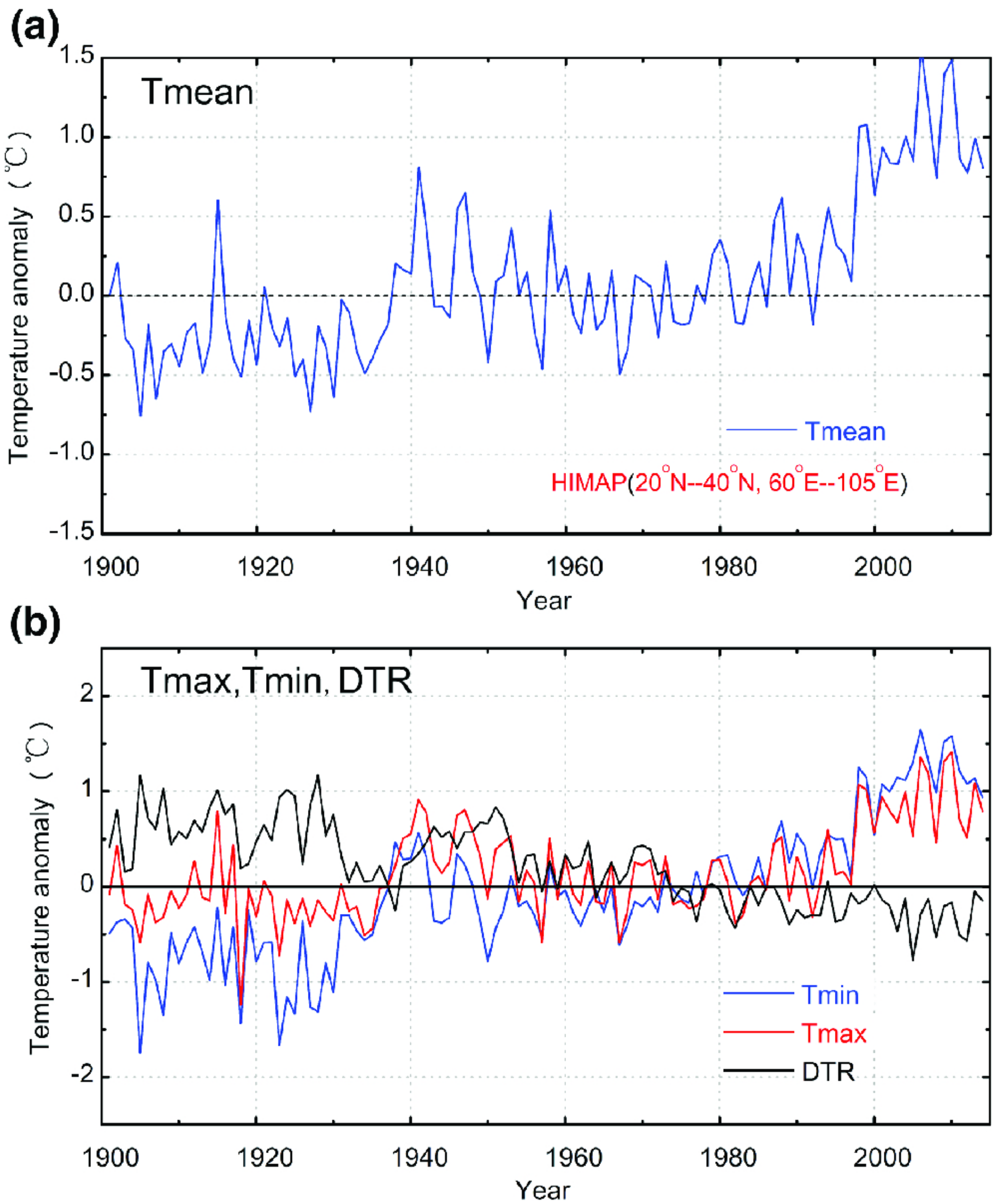


Figure 18: Annual mean temperature anomaly series (C) relative to 1961-1990 mean values for mean temperature (a) and maximum and minimum temperature (b). Source: Krishnan et al. (2019).

Future temperature increase is projected to be higher for the Hindu Kush Himalaya, than the likely ranges reported for global and South Asian regions by the recent IPCC assessment. Figure 2 displays outputs from the Coordinated Regional Downscaling Experiment (CORDEX) models project which show a significant increasing trend in temperature. In the near term (2036–2065), the region is projected to warm by 1.7–2.4 °C for global warming scenarios RCP4.5 (global warming of 1.9°C in the same period) and 2.3–3.2°C for the RCP8.5 (global warming of 2.4°C in the same period). At the end of the century, regional warming is projected to be 2.2–3.3°C for RCP4.5 (global warming of 2.4°C in the same period) and 4.2–6.5 °C for RCP8.5 (global warming of 4.3°C in the same period) (Krishnan et al., 2019). The global warming scenario reaching about 1.6°C by 2100 (RCP 2.6) would for this region imply temperature increases of around 2.0°C for both mid- and end-of-century (Figure 3).

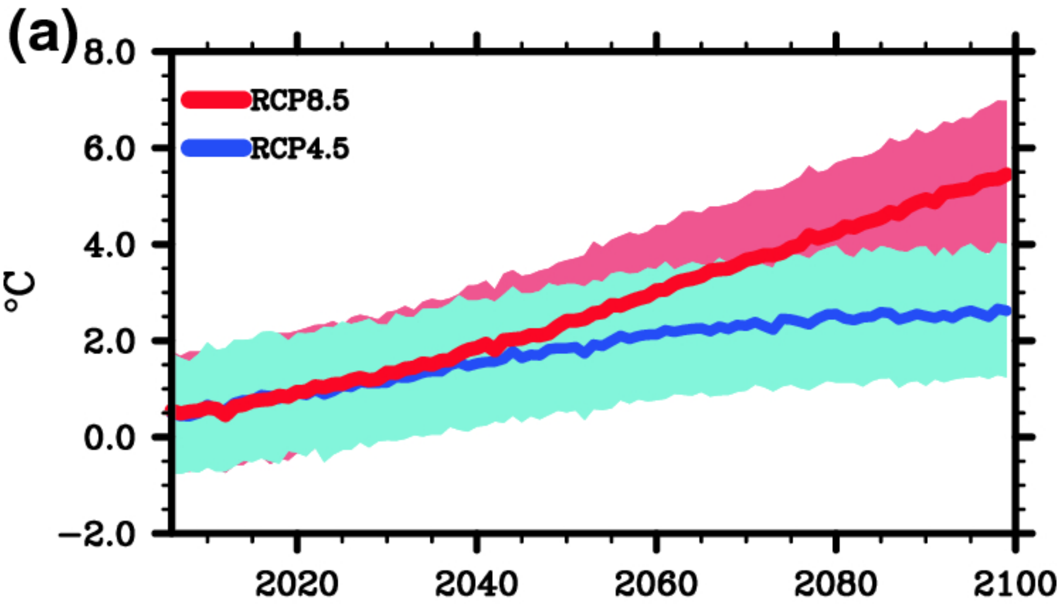


Figure 19: Annual mean surface temperature change from 2006 to 2100 relative to 1976-2005 for the Hindu Kush Himalaya region. Source: Krishnan et al. (2019).

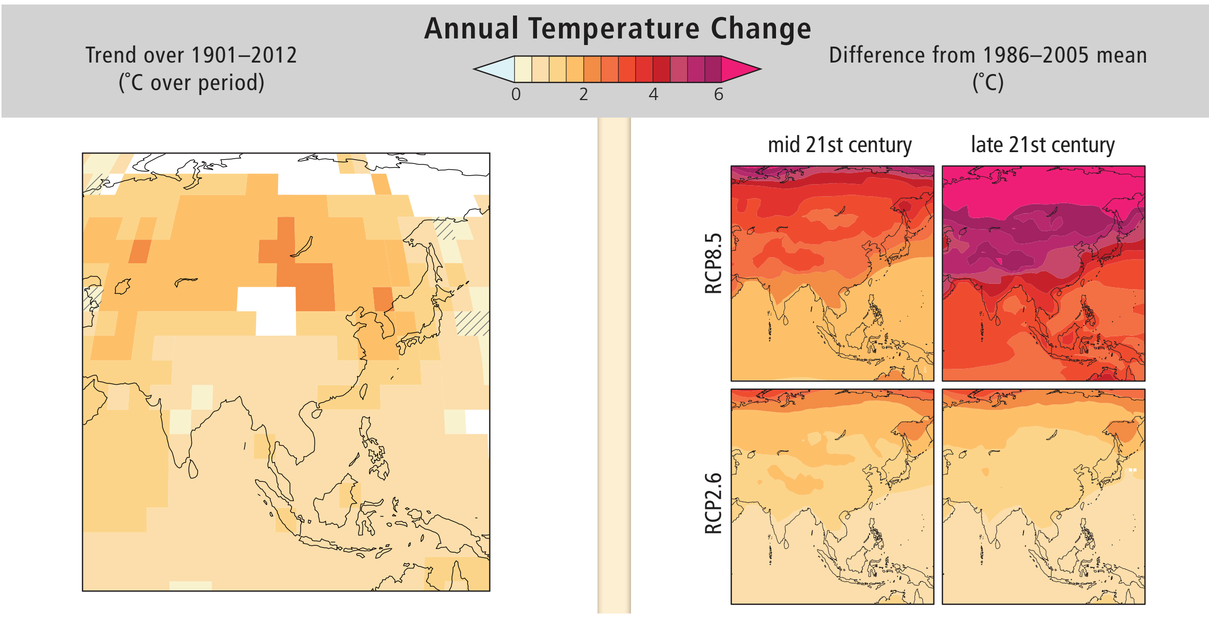


Figure 20: Observed and CMIP5 projected changes in annual temperature in Asia. Source: IPCC (2014).

4. Heat waves

Severe heat waves and warm spells are already occurring and in the future are *likely* to become more frequent and/or longer (IPCC, 2014). For end-of century, maximum population exposed to heatwave days would increase by 18 times the current level under the 1.5°C temperature target, compared to 92 times in a 2°C world (Mishra, Mukherjee, Kumar, & Stone, 2017). Figure 4 shows changes in frequency and duration of heat waves, under the warming scenarios of 1.5°C, 2.0°C and RCP8.5 (4.2°C by 2100). The frequency of severe heat waves in India substantially reduces when limiting the warming to lower degrees, compared to the RCP8.5 scenario during the mid and end of 21st century. The extent to which the impacts are avoided is the highest if the temperature increase is limited to 1.5°C.

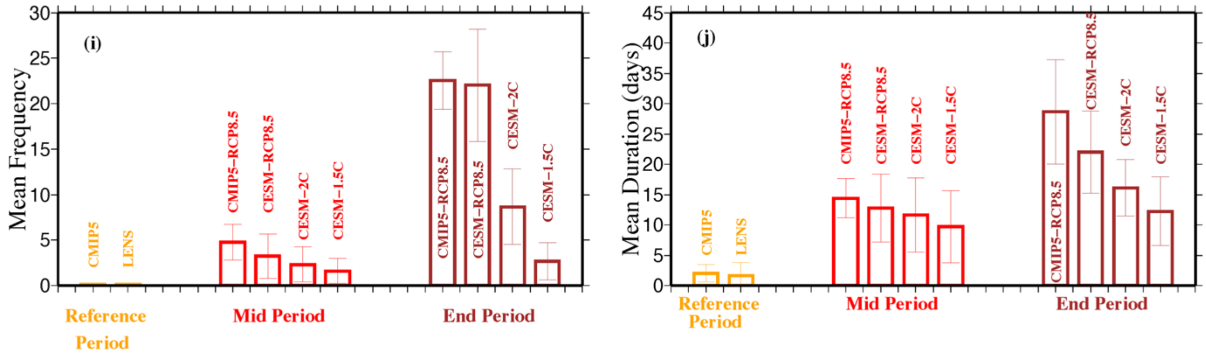


Figure 21: The frequency of heatwaves in India for the reference period (1971-2000), mid-century, end-of-century, for RCP8.5, 1.5°C and 2°C. Source: Mishra et al. (2017).

An additional indicator of heat-related impacts is the wet bulb temperature which combines the air temperature and humidity to indicate the potential for evaporation. Research has shown that a wet-bulb temperature of 35°C can be considered an upper limit on human survivability. Recent estimates project large parts of India to become practically uninhabitable by the end of the century under RCP8.5 scenario (4.2°C in 2100), and with some reduction but nevertheless high wet bulb temperatures under the RCP4.5 scenario (2.4°C in 2100), with Ganges and Indus river basins projected to be affected the most (Im, Pal, & Eltahir, 2017).

5. Precipitation

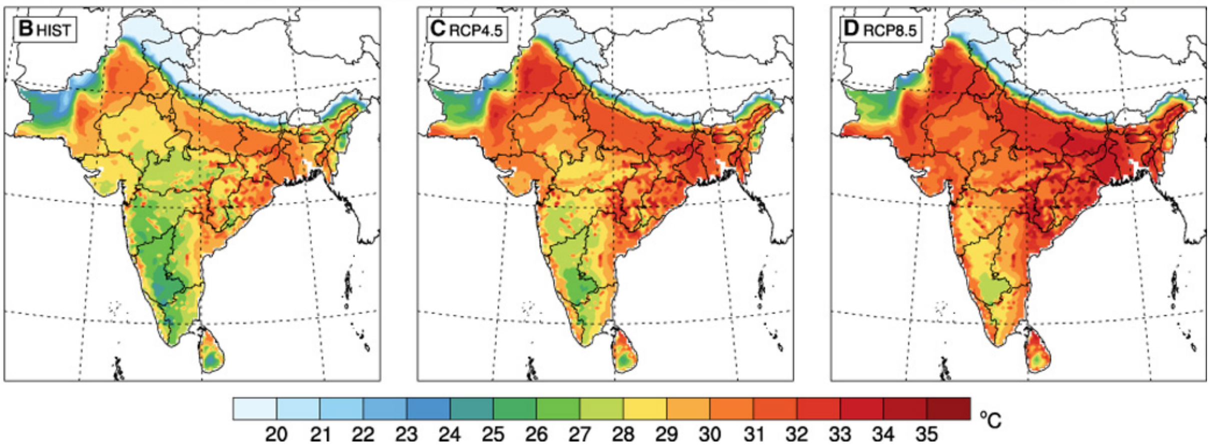


Figure 22: Historical (1975) and projected (2100) wet bulb temperatures in India for RCP4.5 and RCP8.5. Source: Im, Pal & Eltahir (2017).

In the Hindu Kush Himalaya region, the annual precipitation and the annual mean daily precipitation intensity of roughly the last 60 years have increased. Figure 4 shows the regional average annual precipitation percentage anomaly and wet-day anomalies from 1951 to 2013, with a clear upward shift for both indicators since the year 1990.

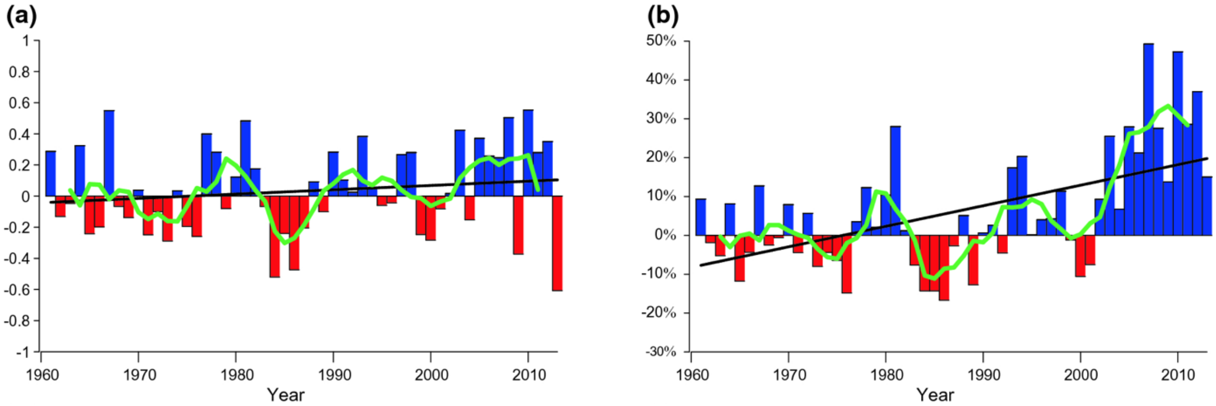


Figure 23: The regional average annual precipitation standardized anomaly (a) and wet day anomaly (b). Green lines are 5-year moving averages, and black lines are linear trends. Source: Krishnan et al. (2019).

Figure 5 shows CMIP5 future projections of annual mean precipitation change in the Hindu Kush Himalayan region. In mid-century, the increase in precipitation is similar for the two scenarios, but at the end-of-century, the increase is higher for the RCP 8.5 scenario (global mean temperature increase of 4.3°C by 2100).

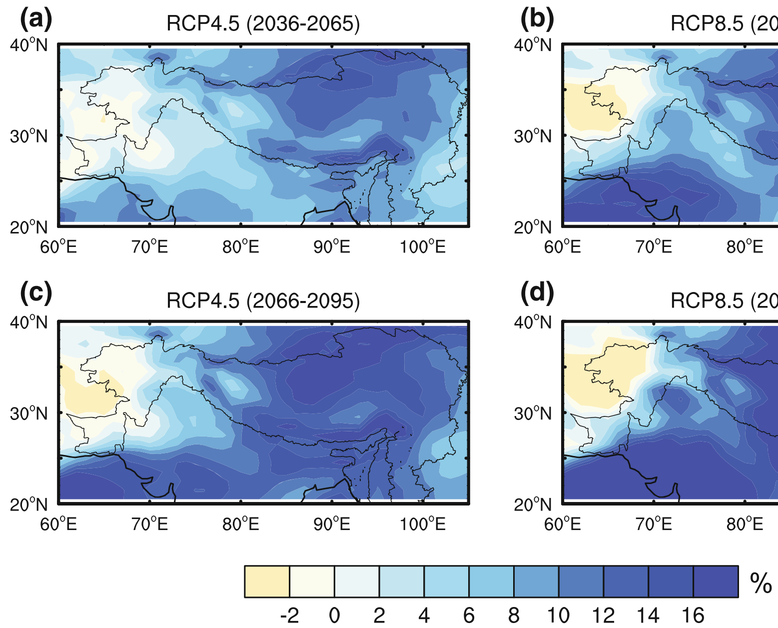


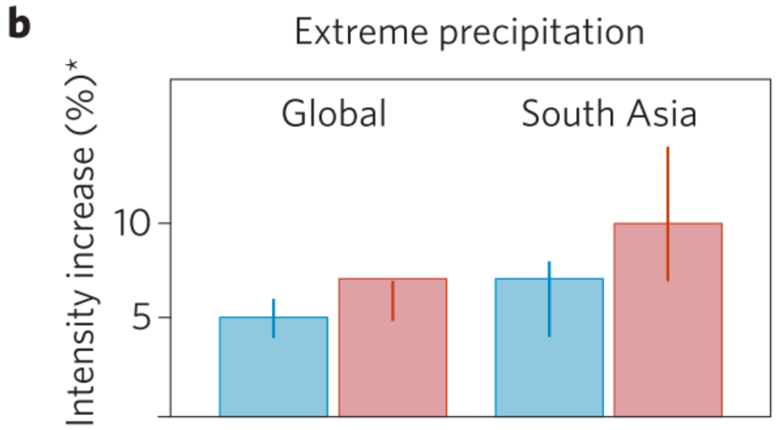
Figure 24: Annual mean precipitation change over the Hindu Kush Himalayan region for mid- and end-of-century for RCP 4.5 and RCP 8.5. Source: Krishnan et al. (2019).

6. Extreme precipitation and floods

India, and in particular its northern states at the slopes of the Himalaya, is very vulnerable to heavy precipitation, flooding and landslides. Floods have caused fatalities almost every year in 2016 more than 70 people died and thousands were displaced in Uttarakhand alone (Davies, 2016). Heavy flooding in 2019 caused dozens of people to be declared dead or missing in the northern states of India (FloodList, 2019). The footprint of climate change in the increase of extreme precipitation is already evident, but will further increase in intensity, particularly in South Asia. Figure 8 shows the higher intensity of extreme precipitation in South Asia compared to a global average, and a substantial difference between a 1.5°C and 2°C warming (Schleussner, Rogelj, et al., 2016). Extreme precipitation is often followed by floods, which are among the costliest natural disasters, both in terms of human casualties and economic losses (Dottori et al., 2018). Climate models project further increase in extreme precipitation and subsequent flooding. Strongest increases are projected for the Ganges basin (Figure 9), even for the 1.5 °C scenario, but with each additional degree, the risk increases further (Lutz et al., 2019; Uhe et al., 2019).

7. Glaciers

Water availability in the Hindu Kush Himalayan region is affected by glacial retreating and melting. The trend has been observed since the 1970s, but has accelerated in the past decades and is expected to continue with climate change. River flows are expected to increase in the short term, but in the long run the trend will reverse because of the eventual shrinkage and disappearance of glaciers and snow cover (Krishnan et al., 2019). Even with limiting the temperature increase to 1.5°C above the pre-industrial period, glaciers will be lost by approximately a third. For higher levels of warming, the loss of glacier ice increases starkly until the end of the century, ranging between 49 ± 7 percent loss for RCP 4.5 (global warming levels of about 2.4°C by 2100), 51 ± 6 percent for RCP 6.0 (global warming levels of about 2.8°C by 2100) and 64 ± 5 per cent loss for RCP 8.5 (global warming levels of about 4.3°C by 2100) until the end of the century. Materialization of either of these scenarios would have serious consequences for the livelihood of the population that relies on this water. Water scarcity will be exacerbated by population growth and higher consumption per capita with higher standards of living (IPCC, 2014).



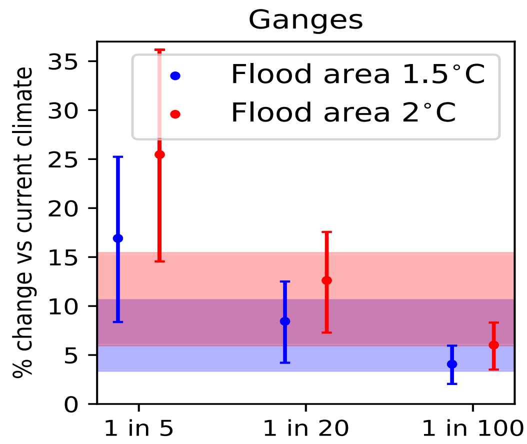


Figure 26: Aggregate changes in flooded area for the Ganges river basin for flood hazards expected once in 5 years, once in 20, and once in 100 years. The medium estimate is shown by the dot (blue for 1.5C of global warming, and red for 2C), and the error bars show the range between high and low estimates. The shaded area shows the range in percentage change in precipitation for the two temperature limits. Source: Uhe et al. (2019)

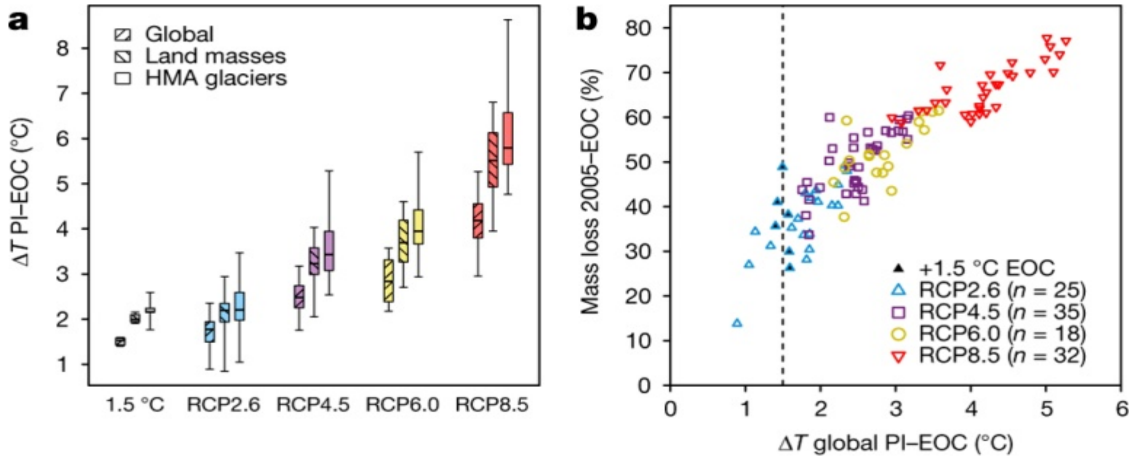


Figure 27: Temperature changes between the pre-industrial period and end-of-century for 1.5C models and four RCP scenarios (a) and the projected loss of ice versus global temperature increase (b). Source: Kraaijenbrink et al.

8. Sectoral impacts

8.1. Agriculture

Over 70% of the population in the Hindu Kush Himalaya relies on agriculture as the main source of income. The region relies on mostly rainfed sources of irrigation, and is therefore vulnerable to the changing patterns of precipitation. Climate change is changing precipitation and heat patterns, which will directly influence agricultural production and subsequently the livelihoods of the populations that depend on it, with children being particularly vulnerable to this risk because of their need to consume more food and water per unit of body than adults (UNICEF, 2015). Additionally, there are indications of climate-induced changes in phenology which pose risks for the production of some of the most important crops in the region (Krishnan et al., 2019). IPCC's 5th Assessment Report points out the effect of heat stress on the expected reduction of the production of wheat in the Indo-Gangetic plains by 50%. This would pose a substantial threat to the people in the region whose food security depends on these crops (IPCC, 2014).

8.2. Health, food and water security

The population's health in India is impacted through different channels: deaths and health hazards from extreme events such as heat and floods; nutritional deficiencies and diseases from food and water contamination and scarcity; mental-health related conditions such as the post-traumatic stress syndrome in disaster-prone areas (IPCC, 2014). 1.1 billion people (17% of the global population) mostly in South and East Asia, North Africa and the Middle East faced serious water shortage and high water stress in the 2000s (Ove Hoegh-Guldberg, Jacob, Taylor, & et al, 2018). Today millions of children mostly in South and East Asia, North Africa and the Middle East are affected by serious water shortage and high water stress, which will increase for a temperature rise of 1.5°C, but will be even higher when temperatures exceed 1.5°C of global warming (Roy et al., 2018).

Due to multiple climate-related stressors, food security is and will remain a major concern in this region. Food production is negatively affected by the changing dynamics of melting and loss of ice. Similarly, increased variability in precipitation and temperature, and the related floods and droughts also directly affect agriculture and thus food security (Rasul et al., 2019).

Research also shows the correlation between rainfall and vector-borne diseases such as malaria and dengue, and parasitic diseases such as diarrhea. In the Himalayan region, there have been outbreaks of vaccine-preventable Japanese encephalitis linked to rainfall. High temperatures are correlated with higher mortality, and heat waves in particular have been shown to have an effect on outdoor workers (IPCC, 2014). Effects of air pollution are pronounced in India, particularly in combination with high temperatures (IPCC, 2014). Air pollution in the Hindu Kush Himalaya region is on the rise and regional air quality has worsened in the past two decades, with the adjacent Indo-Gangetic Plains (IGP) having become one of the most polluted regions in the world.

In the future, climate change will contribute to increased mortality from heat-related stressors an the transmission of the climate-sensitive diseases, with the impacts more evident in regions of lower socio-economic development. More frequent extreme events such as droughts, intense rainfall, and floods will all further exacerbate food insecurity of this region (Rasul et al., 2019). In addition, increasing temperature and higher humidity levels pose additional stress on individuals engaging in physical activity. Safe work activity and worker productivity during the hottest months of the year would be increasingly compromised with additional climate change *(medium confidence)* (Ove Hoegh-Guldberg et al., 2018). Figure 8 shows India as one of the countries most affected by labor loss (hours of labor lost per person, per year), with 80% of the losses linked to the agricultural sector (Watts et al., 2018).

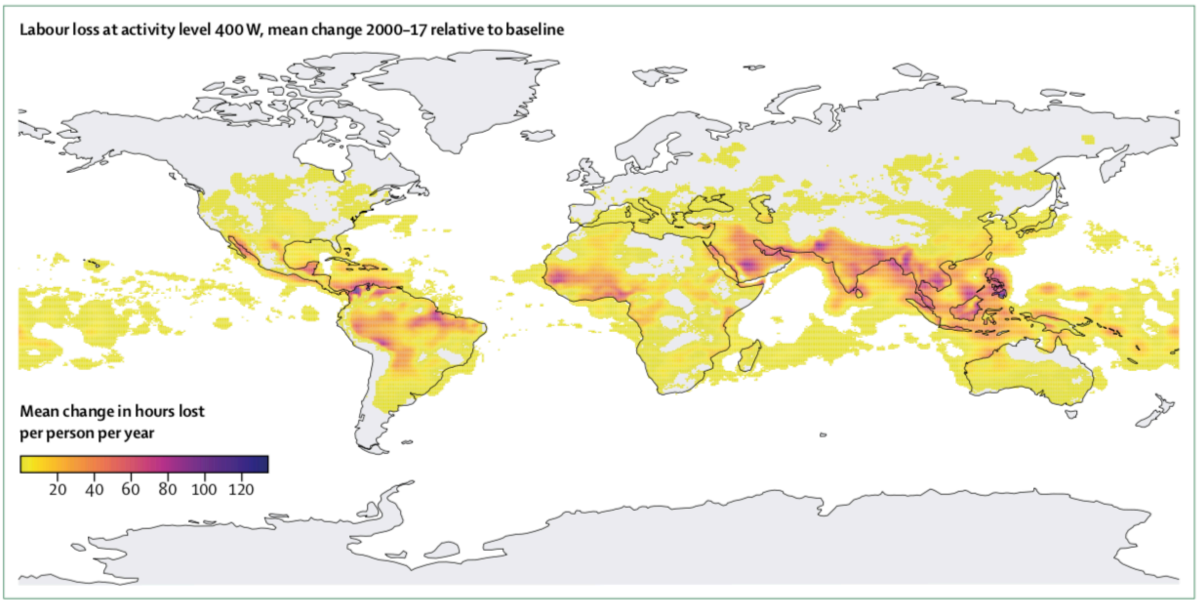


Figure 28: Labor loss at activity level 400W, mean change 2000-2017 relative to 2000. Source: Watts et al. (2018).

8.3. Migration

The annual rate of increase in migration in the countries of the Hindu Kush Himalaya has been high, and the number of internally displaced people also is expected to rise significantly (Krishnan et al., 2019). With further impacts of climate change on livelihoods, internal and international migration will become a necessary coping strategy, leading to profound demographic changes.

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2.6. Marshall Islands

Country profile: Republic of the Marshall Islands

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Summary

The Marshall Islands are located in the Micronesian region of the Pacific Ocean, formed by more than 1200 islands and atolls, 24 of which are inhabited. They are one of the lowest-lying island nation-states in the world, and as such are among the world's most vulnerable to the impacts of climate change. With an average elevation of the islands of about 2 meters above sea level, the Marshall Islands are most acutely vulnerable to the consequences of sea level rise: coastal erosion, flooding, saltwater intrusion into freshwater lenses and loss of marine ecosystems such as coral reefs all of which indirectly endanger livelihoods by threatening food and water security. Warming above 1.5°C would almost certainly lead to the complete loss of coral reef systems around the Marshall Islands also leading to substantial decline in fishing potential. Sea level rise associated with warming scenarios above 1.5°C may lead to the loss of whole islands as early as mid-century.

With the population of about 60,000 people, out which almost half are below the age of 19, the Marshall Islands is a country younger than the world average. For more than half of their lives, children of the Marshall Islands will live in the world with temperatures at least 1.5°C warmer than pre-industrial times. Impacts of climate change will increase in frequency and intensity in the future, and in the case of Marshall Islands well within the lifespans of its children. Without substantial reductions in global emissions, the country could become uninhabitable probably within this century. Limiting warming to 1.5°C will be decisive to ensure a future for the people of the Marshall Islands .

1. The IPCC Report's summary of climate impacts on the Marshall Islands

As most Small Island Developing States (SIDS), the contribution of the Marshall Islands to the global CO_2 emissions is insignificant, yet they are and will remain among the areas most vulnerable to the impacts of climate change and the related health risks. Based on the Fifth Assessment Report (AR5), the key risks for the small islands during the course of the 21st century include "sea level rise (SLR), topical and extratropical cyclones, increasing air and sea surface temperatures, and changing rainfall patterns *(high confidence, robust evidence, high agreement)*", with sea level rise being "the most widely recognized threat *(high confidence; robust evidence, high agreement)"* (Nurse et al., 2014).

2. Demographic profile

The Marshall Islands population is estimated to about 60 000 people, 45% of which are under the age of 19 (UNFPA PSRO, 2014; United Nations Department of Economic and Social Affairs Population Division, 2019). An average 16-year-old Marshallese citizen is expected to live until the age of 80 (World Data Lab, 2019). These demographic estimates can be coupled with the projections of global mean temperature increase for the comparisons of climate change timelines and the children's lifespans. Following the best estimate of the future temperature trajectory, increase in the global mean temperature of 1.5°C will be exceeded around the year 2035 (model median), 2°C around 2055, and more than 3°C in 2100 (Climate Action Tracker, 2018). Today's Marshallese 16-year-old has a probability of 98% to be alive in 2035, 91% in 2055 and 2% in 2100 (World Data Lab, 2019). Nearly all of Marshall Islands' children therefore have a very high probability of experiencing a 2°C warmer world and the ensuing impacts, with a small portion of them living to possibly experience an even higher warming, if no further emission reductions are achieved.

3. Temperature increase

Temperature increases in the Marshall Islands are consistent with the global pattern of global warming. Since 1960s, temperatures on the island of Majuro have increased at the rate of 0.12°C (0.21°F) per decade, and on the island of Kwajalein 0.30°C (0.53°F) per decade (Australian Bureau of Meteorology & CSIRO, 2015). Compared to the period between 1986 and 2005, temperature estimates suggest an increase in mid-century from about 1.0°C in the lowest emissions scenario, to 1.5°C in the RCP 8.5. At the end of the 21st century, the RCP2.6 emissions scenario (which resembles a <2°C scenario) would result in 0.9°C increase, while the highest emissions scenario reaches more than 3°C of warming, compared to the 1985-2005 levels.

	2030		2050		2090	
	°C	°F	°C	°F	°C	°F
RCP 2.6	0.7	1.3	1.0	1.7	0.9	1.6
RCP 4.5	0.7	1.3	1.2	1.9	1.6	2.8
RCP 6.0	0.7	1.2	1.1	1.9	2.0	3.6
RCP 8.5	0.8	1.5	1.5	2.6	3.1	5.7

Table 1: Projected changes in the annual surface temperature for the Marshall Islands relative to the period 1986-2005 (Australian Bureau of Meteorology & CSIRO, 2015).

4. Sea level rise

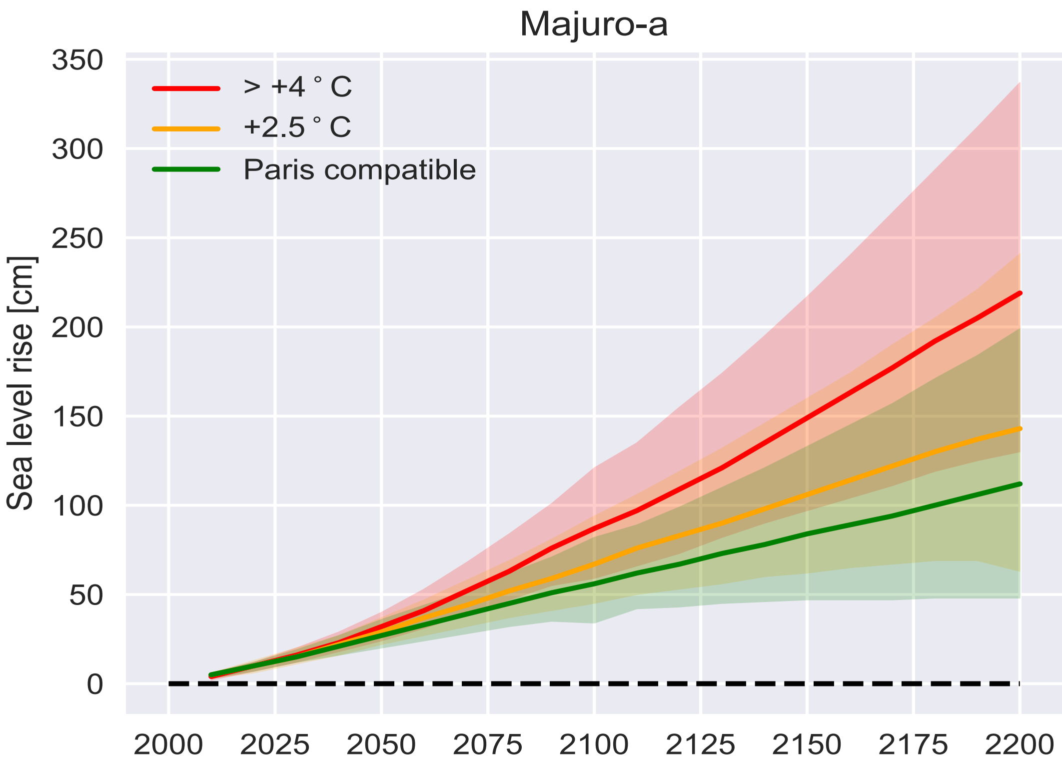

Figure 29: Local sea level projections for the Majuro island, for a scenario compatible with the Paris agreement goal of keeping the temperature increase below 2°C (green), a scenario leading to +2.5°C global mean temperature (orange) and a scenario exceeding +4°C (red). The solid lines represent multi-model medians, the shaded areas include 66% of the models (based on Kopp et al. (2014)).

Sea level increased by about 7 mm per year since 1993, with a higher pace than the global average of 3.2 mm per year. Tropics are expected to experience sea level rise higher than the global average (Slangen et al., 2014), with the projected ranges in different emissions scenarios shown on Figure 1. For mid-century, median estimate is 27 cm increase for the RCP 2.6 scenario, 29 cm for RCP 4.5 and 32 cm for RCP 8.5. In the year 2100, the estimates increase to the median of 56 cm sea level rise for RCP 2.6, 67 cm for RCP 4.5 and 87 cm for RCP 8.5 (Kopp et al., 2014).

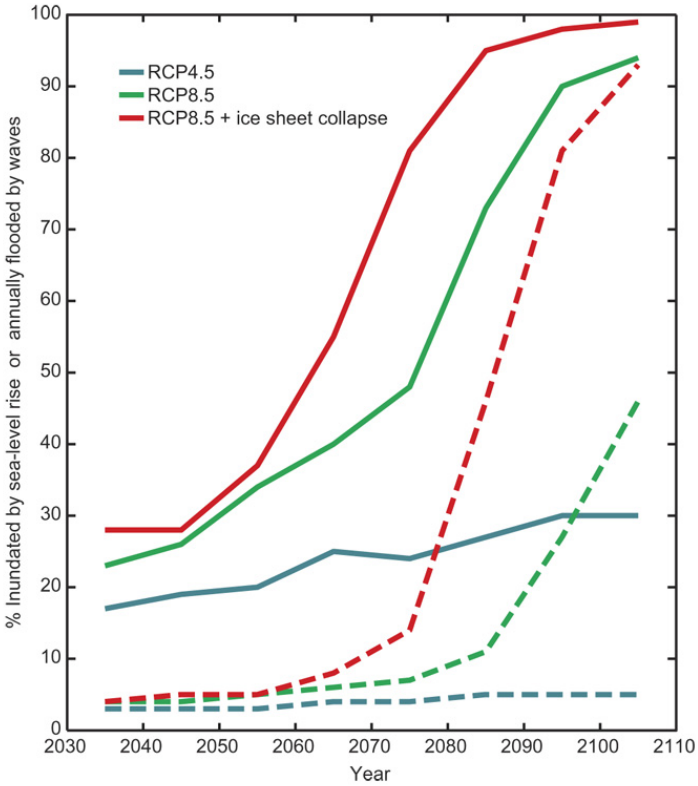

Figure 2: The projected percentage of the Marshall Islands' Roi-Namur Island on Kwajalein Atoll inundated because of sea level rise and annually flooded because of the combined effects of waves and sea level rise. Dashed lines show the percentage of inundated land, and solid lines show the portions of the island annually flooded by waves (Storlazzi et al., 2018).

Local consequences of sea level rise will manifest through the loss of habitable land, and salinization of water resources, both of which have direct impacts on livelihoods. Figure 2 shows how annual flooding could affect up to 30% of the land in mid-century, and up to 100% at the end of the 21st century. However, flooding of 25% of the land is already enough to make water non-potable, and hence threaten water and food security. The contamination of seawater limits freshwater availability for two years after the flooding event, with a 0.4 m of sea level rise (Storlazzi et al., 2018).

As displayed in Figure 1, at the current rates of global warming, the risks of sea level rise continue well beyond the 21st century (see more in Global Impacts, section 3.3). For the generation after today's children, this could mean complete disappearance of the islands. The consequences of present day actions therefore have implications not only for today's children, but also future generations. However, limiting the warming to 1.5°C relative to the pre-industrial times may halt the long term sea level rise below 1 m.

5. Extreme weather events

The climate of the Marshall Islands if affected by the El Niño-Southern Oscillation (ENSO), which manifests in two extreme phases: El Niño, which contributes to warmer wet season and warmer and drier dry seasons; and La Niña, which tends to bring wetter weather conditions than usual. These weather patterns will continue to occur in the future *(very high confidence),* and will cause significant negative socio-economic consequences. The occurrence of El Niño is estimated to double as a consequence of increased global warming, and is expected to cause more devastating weather events (Cai et al., 2014). The occurrences of La Niña are consistent with El Niño, and climate models project a tripling of extreme La Niña events under greenhouse warming (Cai et al., 2015).

Australian Bureau of Meteorology and CSIRO (2015) report the annual mean temperatures and extremely high daily temperatures will continue to rise *(very high confidence)*. Droughts are projected to decline in frequency *(medium confidence).* Average rainfall is projected to increase *(high confidence)*, along with more extreme rain events *(high confidence)*. A substantial increase in the frequency of the most devastating tropical cyclones at 1.5°C of global warming and even more so at 2°C of global warming (Thomas, Pringle, Pfleiderer, & Schleussner, 2017). Compared to the period 1986-2005, the total number of storms in the Central Pacific is projected to increase by 2.7% in the period 2016-2035, and by 33.1% in 2081-2100. The number of category 4 hurricanes is projected to increase by 66.7% in 2016-2035, and 111% in 2081-2100 (Bhatia, Vecchi, Murakami, Underwood, & Kossin, 2018). The intensity of storms also increases with the rise in sea surface temperatures (Bhatia et al., 2019).

6. Coastal ecosystems and livelihoods

Livelihoods of island populations critically depend on coral reefs and their ecosystems, as they are important nutritional sources, as well as generators of employment as fisheries. With increasing ocean acidification and rising ocean temperatures, the survival corals and species that keep the coral ecosystems in balance are under threat. The IPCC AR5 Chapter on small islands states with *"high confidence"* that "sea surface temperature will result in coral bleaching and reef degradation. Given the dependence of island communities on coral reef ecosystems for a range of services including coastal protection, subsistence fisheries, and tourism, there is *high confidence* that coral reef ecosystem degradation will negatively impact island communities and livelihoods" (Nurse et al., 2014). Coral reefs are projected to decline by a further 70–90% at 1.5°C *(high confidence),* and be irreversibly lost at 2°C *(very high confidence)* (IPCC, 2018)*.* The risk of irreversible loss of many marine and coastal ecosystems increases with global warming, especially at 2°C or more (high confidence). Similarly, the negative impact on the catchment potential for fisheries is projected to be three times as large from the warming of 3.5°C as compared to limiting the temperature increase to 1.5°C (Cheung, Reygondeau, & Frölicher, 2016).

7. Health, water and food security

"Until mid-century, projected climate change will impact human health mainly by exacerbating health problems that already exist *(very high confidence).* Throughout the 21st century, climate change is expected to lead to increases in ill-health in many regions and especially in developing countries with low income, as compared to a baseline without climate change *(high confidence)*." (IPCC, 2014)

Climate related health risks with the highest priority in the Marshall Islands (World Health Organization, 2015):

- diarrhoeal disease
- malnutrition
- vector-borne diseases
- ciguatera (fish poisoning)
- mental health

- respiratory disease
- non-communicable diseases
- injuries and deaths from extreme weather events
- other diseases (eye disease, skin disease, radiation-induced illnesses)

The health risks are projected to increase with climate change (Nurse et al., 2014). Direct effects on health stem from extreme weather events which are expected to increase in frequency and intensity. Particularly dengue fever is associated with rainfall, temperature, and unplanned rapid urbanization (UNICEF, 2015). Indirect effects that manifest as a consequence of poor access to water and food insecurity are also expected to further amplify with sea level rise and saltwater intrusion. Scientific models estimate increase in annual flooding that could damage infrastructure and cause unavailability of freshwater, rendering the Marshall Islands uninhabitable by the mid-21st century (Storlazzi et al., 2018), well within the lifespan of its today's children.

Climate change impacts are of particular concern for the agriculture of the Marshall Islands as they have limited space to expand areas of cultivated land. Food security in Micronesia "has worsened in the past half century and climate change is *likely* to further hamper local food production, especially in low-lying atolls". Additionally, deterioration of agricultural land and food production can imply higher dependency on food aid, which can in turn have negative impacts on health outcomes because of poor nutritional quality (Ahlgren, Yamada, & Wong, 2014). Aquatic pathogens that can cause ciguatera fish poisoning (the most common food-borne illness in tropical regions) "are known to be highly-temperature sensitive and may flourish when certain temperature thresholds are reached" (Llewellyn, 2010). Lovell (2011) notes that in the Pacific many of the anticipated health effects of climate change are expected to be indirect, connected to the increased stress and declining well-being that comes with property damage, loss of economic livelihood, and threatened communities.

8. Limits to adaptation

The IPCC Special Report on 1.5°C describes "hard limits" to adaptation in the Small Island Developing States, resulting from the "sea level rise and increased wave run up combined with increased aridity and decreased freshwater availability at 1.5°C warming potentially leaving several atoll islands uninhabitable" (IPCC, 2018). The threat to livelihoods on the Marshall Islands will be exacerbated by the effects of climate change. Migrating, internally or externally, is an adaptation measure, which also results in disruption to society–land relationships and loss of community identity. Relocation can also fail as an adaptation strategy and cause homelessness, unemployment, social marginalization, food insecurity, and increased levels of disease (Keener et al., 2018). Additionally, with the loss of habitable land from the sea level rise, internal migration will not be a viable adaptation strategy, making international migration possibly the only option. Consequently, the entire culture will be at stake as the islanders will find it "increasingly difficult to sustain the region's many unique customs, beliefs and languages" (National Climate Assesssment and Development Advisory Committee (NCADAC), 2013).

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2.7. Nigeria

NIGERIA –Lagos

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Summary

Nigeria is the most populous African country and is heavily dependent on rainfed agriculture. 70% of the Nigerian population is classified as poor of which 35% live in absolute poverty. Poverty and disadvantage have increased with observed warming (about 1°C above pre-industrial levels) and are expected to increase for many populations as average global temperatures increase from 1°C to 1.5°C and higher. Climate change has caused and will cause adverse impacts on livelihoods, life, property and health in Nigeria in particular for children. For example, changing rainfall regimes and patterns with increasing floods devastate farmlands, and increasing temperature and humidity accelerate pests, diseases, and extreme events like storm surges. These climate impacts will cause harm to life and property. Under current emission trajectories, Nigeria's children of today will spend more than half their lives in a world warmer than 1.5°C above pre-industrial levels.

In addition to profound country-wide risks under climate change, Lagos, the capital city of Nigeria, is specifically vulnerable to climate impacts. Lagos' high vulnerability to climate change has been demonstrated by extensive damages to floods and storms, which together with the city's geographic location and inadequate and poorly maintained infrastructure exacerbates the sensitivity. Lagos is expected to rank as the fifth most exposed city to climate change by 2070. For example, projections suggest that by 2070, approximately 550 000 people could be affected by flooding each year due to sea level rise.

If global warming exceeds 1.5°C, the risk of climate related impacts increases, particularly for people exposed to poverty. For example, under a global warming scenario of 4.3°C by 2100 (RCP8.5), the number of days with extreme temperature events increases in the south of Nigeria by about 40 days per year in 2046-2065 and by about 106 per year in 2081-2100.This has severe implications for the health of children in Nigeria. Moreover, with sea level rise being a major threat, limiting global warming to 1.5°C would lower global mean sea level rise and thus enable greater opportunities for adaptation in the human and ecological systems in Nigeria's coastal areas.

Tropical West Africa is found to be at significant risk of declining crop yield for a global temperature increase of 2°C and more, which is seriously endangering food security in the future particularly affecting children under the age of 5. While global hunger has been declining over the past few decades, undernutrition has increased particularly in Sub-Saharan Africa.

1. The IPCC Report's Summery on Climate Impacts in Nigeria

Climate change and its extreme weather events including droughts and floods have significant impacts on economic sectors, natural resources, ecosystems, livelihoods and human health in Africa (IPCC, 2014). The risk of multiple and compound climate-related impacts increase between 1.5°C and 2°C of global warming, with greater proportions of people both so exposed and susceptible to poverty in Africa *(high confidence)* (Hoegh-Guldberg et al., 2018). Particularly in sub-Saharan Africa, reductions in yields of maize, rice, wheat, and potentially other cereal crops will be smaller when limiting warming to 1.5°C compared with 2°C (Hoegh-Guldberg et al., 2018).

Densely populated coastal cities with high poverty and vulnerability to erosion such as Lagos are already impacted, and will be impacted by sea level rise in the future (IPCC, 2014). People living in Lagos, as being disadvantaged, vulnerable and highly dependent on agricultural and coastal livelihoods will be disproportionately higher at risk of adverse consequences with global warming at 1.5°C and beyond (Hoegh-Guldberg et al., 2018).

Coastal flooding, sea level rise and storm surges will affect this lowland area and coastal city and challenge its industries, infrastructure and tourism (IPCC, 2014). Lagos is already affected by floods and is at risk of submersion (IPCC, 2014). Limiting global warming to 1.5°C would lower global mean sea level rise and thus enable greater opportunities for adaptation in the human and ecological systems *(medium confidence)* (Hoegh-Guldberg et al., 2018).

As Figure 1 shows flooding coupled with further effects driven by climate change impact the livelihoods of the poor population in Lagos in particular and increase the vulnerability to climate change driven extreme events such as flooding.

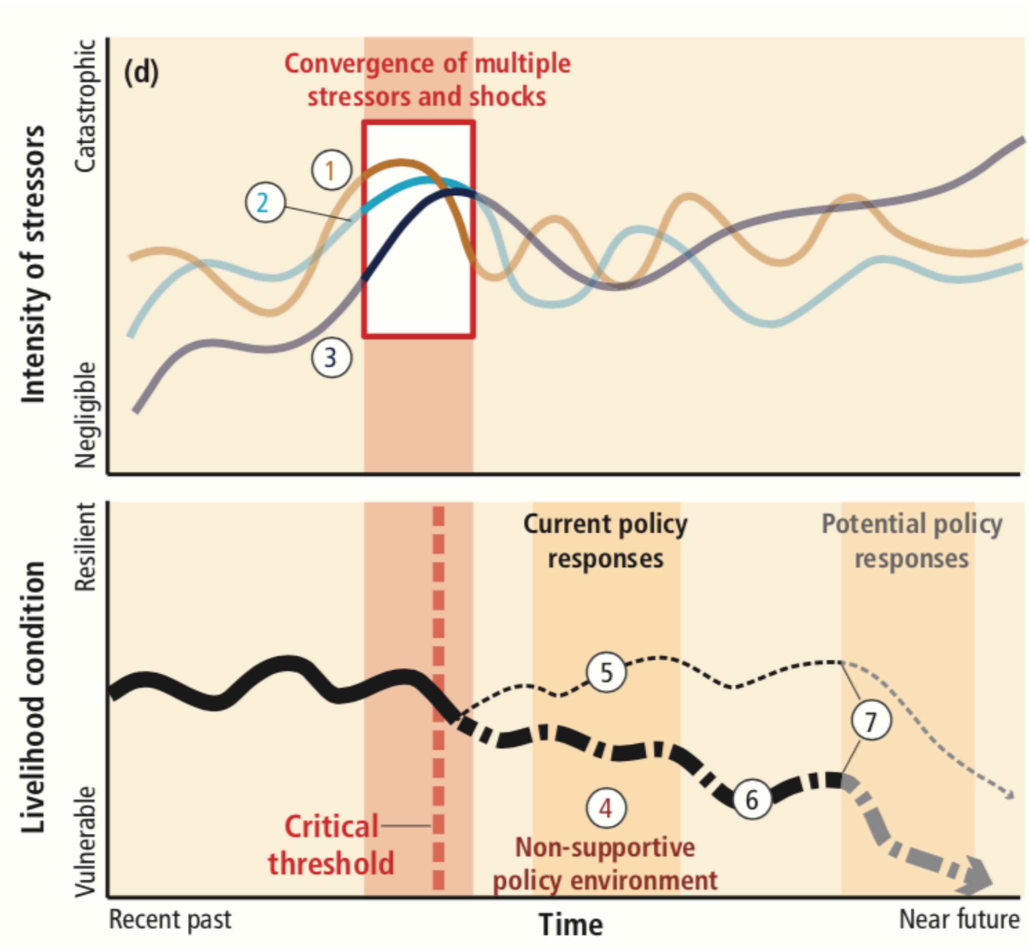

Figure 1: Flooding threatens the livelihoods of people in Lagos, Nigeria, where >70 % live in slums. Increased severity in rainstorms, sea level rise, and storm surges (1) coupled with the destruction of mangroves and wetlands (2), disturb people's jobs as traders, wharf workers, and artisans, while destroying physical and human assets. Urban management, infrastructure for water supply, and storm water drainage have not kept up with urban growth (3). Inadequate policy responses, including uncontrolled land reclamation, make these communities highly vulnerable to flooding (4). Only some residents can afford sand and broken sandcrete blocks (5). Livelihood conditions in these slums are expected to further erode for most households (6). Given policy priorities for the construction of high-income residential areas, current residents fear eviction (7). Source: Olsson et al., 2014

2. Demographics

Nigeria has a population of about 201 million, of which 54% are children under the age of 19 (Wittgenstein Centre for Demography and Global Human Capital, 2018). An average 12-year-old Nigerian citizen, the petitioner's peer, is expected to live until the age of 67 (World Data Lab, 2019). The demographic estimates can be coupled with the projections of global mean temperature increases. Following the best estimate of the future temperature trajectory based on the Climate Action Tracker (Climate Analytics; Ecofys; New Climate Institute, 2019), increase in the global mean temperature is expected to exceed 1.5°C around the year 2035 (model median), 2°C around 2055, and more than 3°C in 2100. Today's Nigerian 12-year-old has a 92% probability of being alive in 2035, 81% in 2055 and 1% in 2100. Nearly all children in Nigeria therefore have a high probability of experiencing a 2°C world and the ensuing impacts, with a portion of them living to possibly experience an even higher warming.

Nigeria counts as one of the most densely populated countries with a population over 200 million people, half of which are considered to be in abject poverty (Idowu, Ayoola, Opele, & Ikenweiwe, 2011). As Table 1 shows, Lagos as a state has seen an extreme population growth, with 763 000 people in 1960 and over 16 million in 2010 (Elias & Omojola, 2015). Lagos is the most populous city in sub-Saharan Africa due to its concentration of economic activities and urban agglomeration (Elias & Omojola, 2015). The population density in Lagos also far exceeds the global average population density of 112 persons per km^2 by inhabiting 20 000 persons per km^2 (Adelekan, 2016). Figure 2 highlights the rapid and extreme growth of Lagos State from 1900 until 2010.

Table 1

Population of Lagos State, 1960–2015 (in millions).

Year	Population
1960	0.07
1970	2.05
1980	4.38
1990	7.74
2000	13.4
2006	17.6
2010	19.8
2015	23.04

Source: Adapted from Lagos State Government [1••].

Table 1: Population of Lagos State from 1960-2015 in millions (Elias and Omojola, 2015)

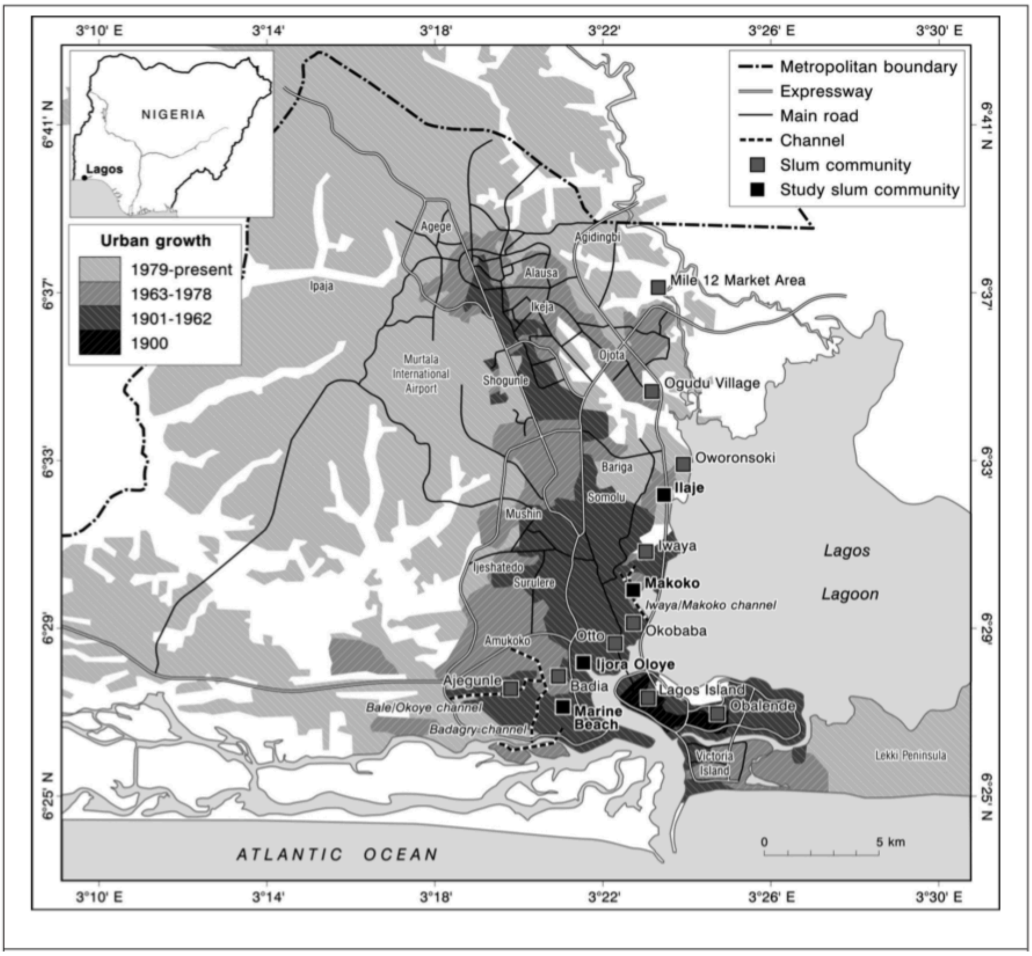

Figure 2: Growth of metropolitan Lagos (1900-present) and location of coastal slum communities (Adelekan, 2010)

3. Temperature Increase

As seen in Figure 3, temperature trends have been increasing in Nigeria since 1901, with a gradual increase until the 1960s and a sharp increase in temperatures from the 1970s onwards until today (Akpodiogaga-a & Odjugo, 2010). Mean air temperature between 1901-2005 was 16.6°C, which shows a temperature increase of 1.1°C over those 105 years. This is higher than the global mean temperature increase in the same time period of 0.74°C recorded since 1860 (Akpodiogaga-a & Odjugo, 2010).

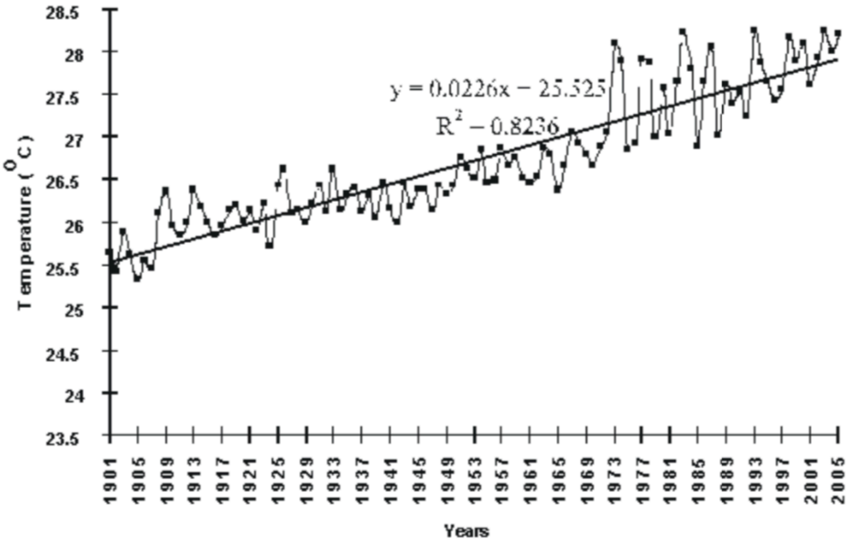

Figure 3: Air temperature distribution in Nigeria between 1901 and 2005 (Akpodiogaga-a & Odjugo, 2010)

Temperatures are further expected to increase for all climate scenarios. Figure 4a indicates the changes in warming over the entire country, with lowest warming over the coastal regions as they receive a cooling effect from the Atlantic Ocean (Abiodun, Lawal, Salami, & Abatan, 2013). Figure 4b also shows the temperature increase from 1960-2100 for a global warming scenario of 2.4°C by 2100 (RCP4.5). Also extreme temperature events are further expected to increase under all emission scenarios.

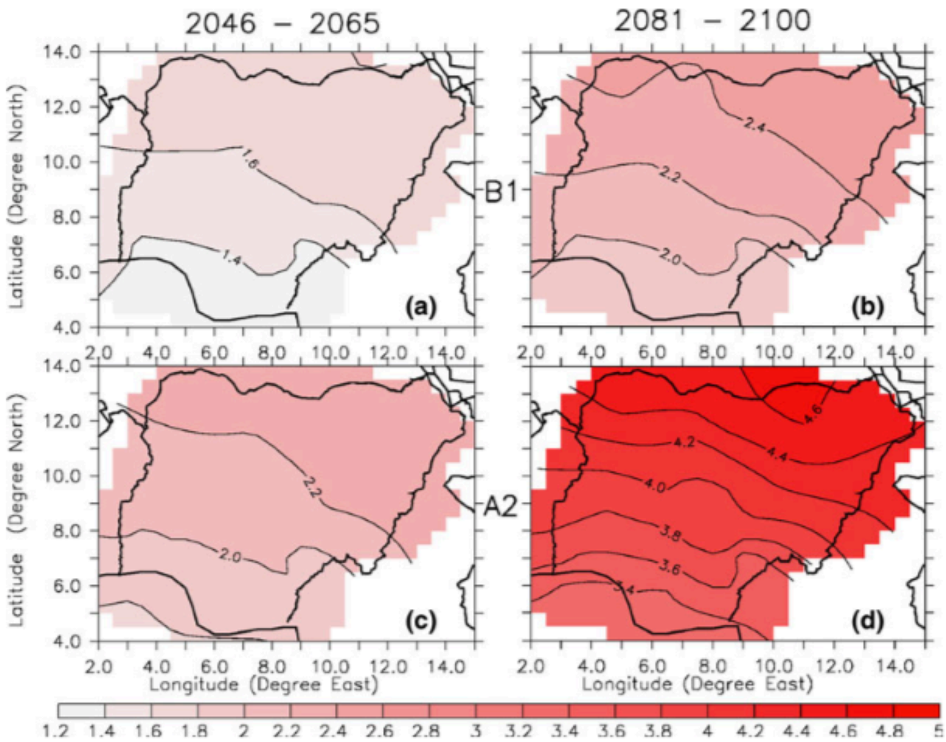

Figure 4a: Spatial distribution of the projected changes in maximum temperature (°C) over Nigeria in the future (2046-2065 and 2081-2100) under B1 (2.4°C global warming by 2100) and A2 (4.5°C global warming by 2100) (Abiodun et al., 2013)

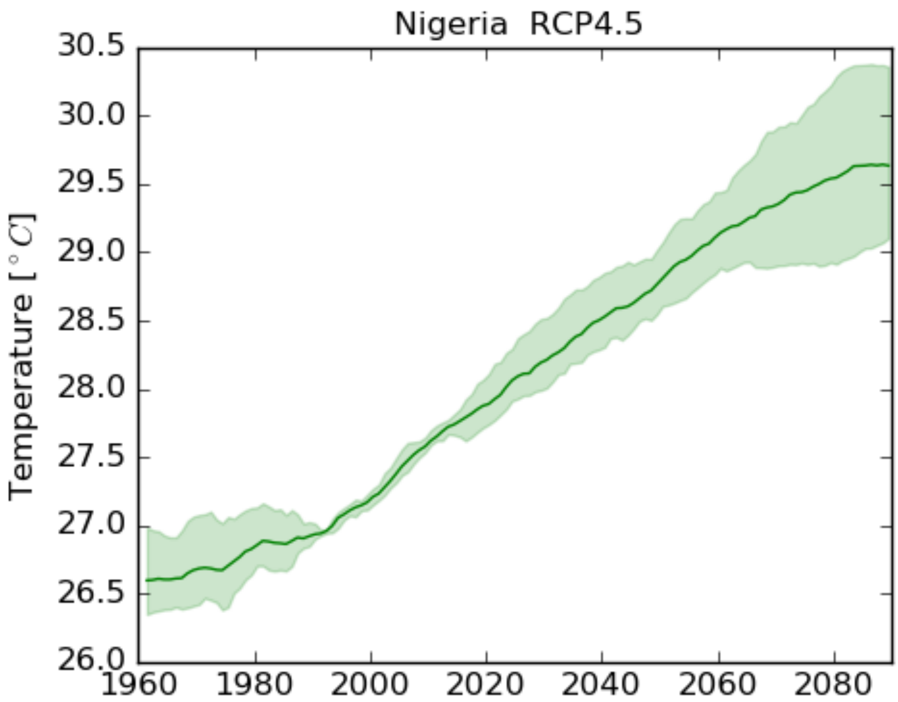

Figure 4b: Regional climate model projections for temperature displayed as a 20 year running mean - the line represents the ensemble mean while the shaded area represent the model spread. The projections are based on a global warming scenario of 2.5°C by 2100 (RCP4.5) (http://regioclim.climateanalytics.org/choices)

For a global warming scenario of 2.4°C by 2100 (RCP4.5), the number of days with extreme temperature event increases in the South of Nigeria by about 24 per year in 2046-2065 and by about 42 per year in 2081-2100 (Abiodun et al., 2013). For a global warming scenario of 4.3°C by 2100 (RCP8.5), the number of days with extreme temperature event increases in the South of Nigeria by about 40 per year in 2046-2065 and by about 106 per year in 2081-2100 (Abiodun et al., 2013).

For a global warming scenario of 2.4°C by 2100 (RCP4.5), the number of days with heat wave events increases in the south of Nigeria by about 3 per year in 2031-2060 and by about 8 per year in 2081-2100 (Abiodun et al., 2013). For a global warming scenario of 4.3°C by 2100 (RCP8.5), the number of days with heat wave events increases in the South of Nigeria by about 7 per year in 2031-2060 and by about 45 per year in 2081-2100 (Abiodun et al., 2013).

Increasing temperatures lead, for example, to river drying up or becoming only seasonally navigable (Akpodiogaga-a & Odjugo, 2010). For example, Lake Chad shrunk by 5.7% from 1963 until the year 2000 (Akpodiogaga-a & Odjugo, 2010). This creates water scarcity and will increase the concentration of users around the remaining limited water resources (Akpodiogaga-a & Odjugo, 2010). Such circumstances also increase the possibility of additional contamination and the transmission of water borne diseases like cholera (Akpodiogaga-a & Odjugo, 2010).

4. Precipitation

In general, Nigeria shows a declining rainfall trend by 81 mm between 1901 and 2005 (Akpodiogaga-a & Odjugo, 2010). The coastal areas however are observed to be experiencing increasing rainfall in recent times (Akpodiogaga-a & Odjugo, 2010). Figure 5 indicates the observed rainfall characteristics between 1971-1995 and 1996-2005.

Rainfall characteristics for Lagos Island

Rainfall characteristics	1971–1995	1996–2005
Mean number of rain days	112	82
Maximum number of rain days	163	105
Minimum number of rain days	76	69
Mean rainfall (mm)	1,697.8	1,647.3

Figure 5: Rainfall characteristics for Lagos Island (Adelekan, 2010)

Rainfall patterns are projected to be wetter over Nigeria (especially over the southern half) in the future (see Figure 6). For global warming of 2.4°C by 2100 (RCP4.5/B1), precipitation is expected to increase by 0.8 mm per day (Abiodun et al., 2013). For global warming of 4.3°C by 2100 (RCP8.5/A2) rainfall is expected to be even stronger (Abiodun et al., 2013). This increase in rainfall is caused by the stronger temperature gradient, as more moisture is transported to produce rainfall over the country, especially over the coastal region (Abiodun et al., 2013).

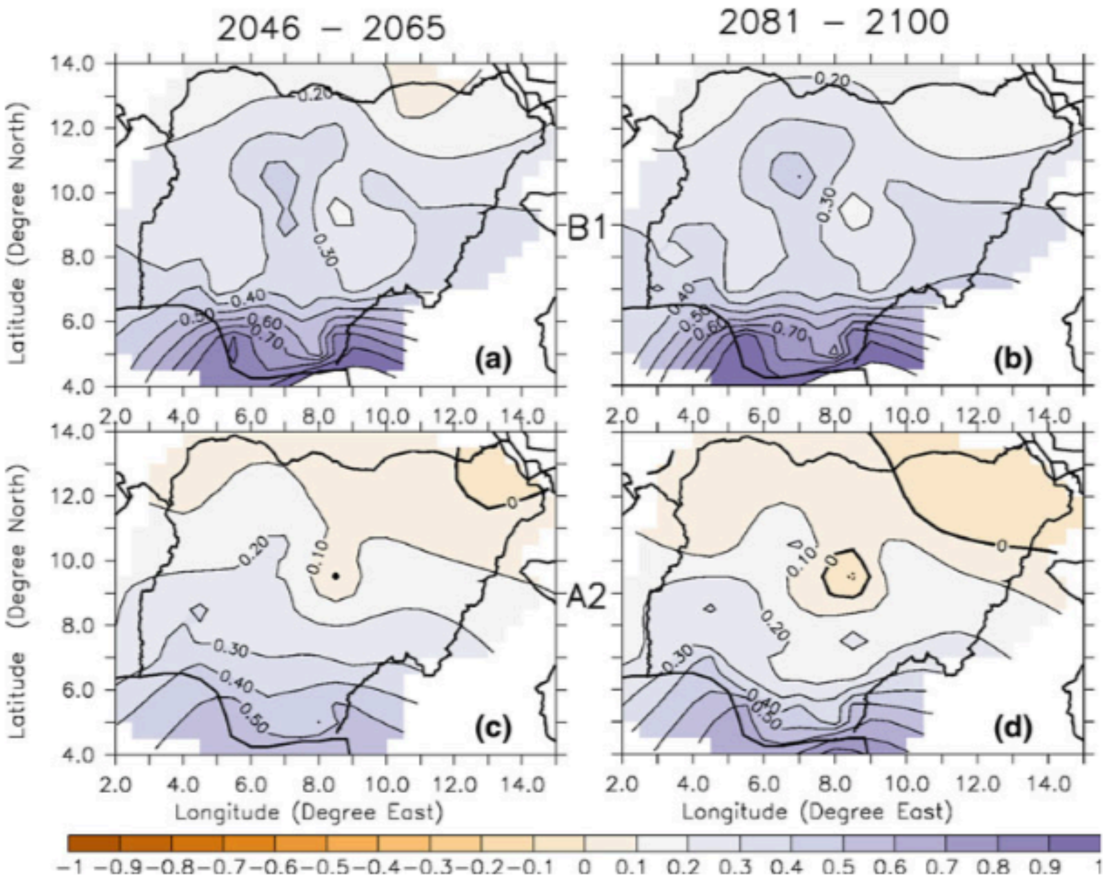

Figure 6a: Spatial distribution of the projected changes in rainfall (mm day-1) over Nigeria in the future (2046-2065 and 2081-2100) under B1 (2.4°C global warming by 2100) and A2 (4.5°C global warming by 2100) (Abiodun et al., 2013)

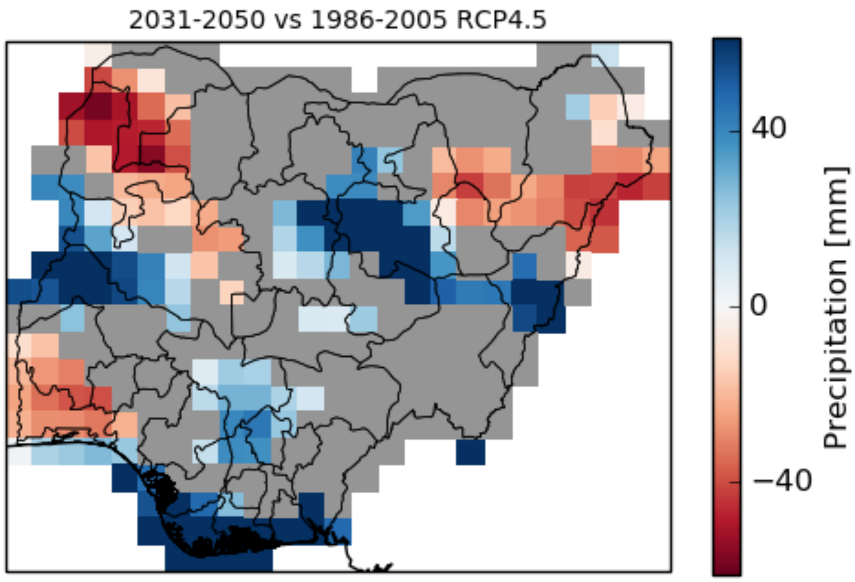

Figure 6b: Projected change in precipitation for 2031-2050 compared to reference period 1986-2005. Here the ensemble mean of regional climate model projections is displayed. Grid cells for which model disagreement is found are colored in gray. The projections are based on a global warming scenario of 2.4°C by 2100 (RCP4.5) (http://regioclim.climateanalytics.org/choices)

5. Sea Level Rise

Sea level rise for Nigeria indicates salt-water intrusion into freshwater, invasion and destruction of mangrove ecosystems, coastal wetlands and coastal beaches (Akpodiogaga-a & Odjugo, 2010). Moreover, sea level rise can indicate population displacement due to coastal inundation, which is already currently a problem in coastal areas of Lagos State (Akpodiogaga-a & Odjugo, 2010). Many of Africa's large coastal cities have a high concentration of poor populations in potentially hazardous regions that are vulnerable to sea level rise. One meter in sea level rise (which is projected to happen under global warming of 4.3°C by 2100 (RCP8.5)) will displace about 14 million people from the coastal areas of Nigeria, which makes it one of the 11 countries with global port cities "with high exposure and vulnerability to sea level rise and storm surges" (Akpodiogaga-a & Odjugo, 2010; Adelekan, 2010).

Lagos as a coastal city has been categorized as one of the 50 cities most exposed to extreme sea level - which is especially concerning regarding the 800% increase in population exposed to sea level rise by the 2070s (Adelekan, 2010). It is projected that sea level rise will affect large parts of the populations towards the end of this century, and the possible cost of adaptation is expected to be between 5-10% of GDP (Fashae & Onafeso, 2011).

Figure 7 shows how a total loss of beach land of 0.75 km^2 occurred in one decade between 1999 and 2009 (Fashae & Onafeso, 2011). As stated by the IPCC, limiting global warming to 1.5°C would lower global mean sea level rise and thus enable greater opportunities for adaptation in the human and ecological systems *(medium confidence)* (Hoegh-Guldberg et al., 2018).

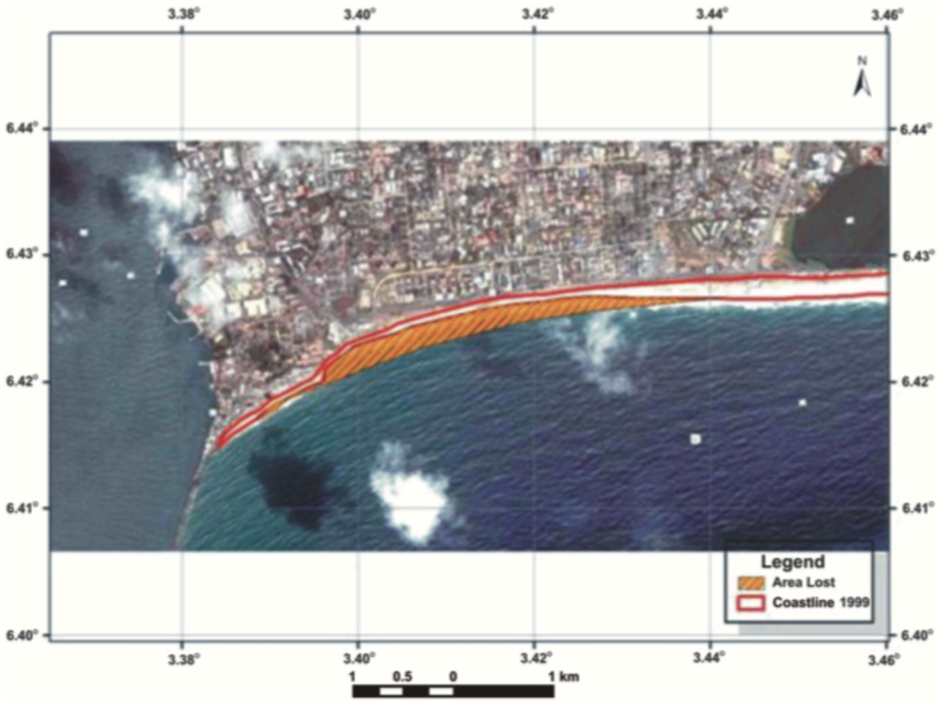

Figure 7: Satellite imagery of Lagos coastline showing the area lost between 1999 and 2009 (Fashae and Onafeso, 2011)

Figure 8 indicates that under global warming of 4°C, sea level rise is expected to increase by 85-125 cm by 2080-2100 (Schellnhuber et al., 2013). For a 2°C warmer world, the rise will be significantly lower yet considerable at between 60-80 cm (Schellnhuber et al., 2013).

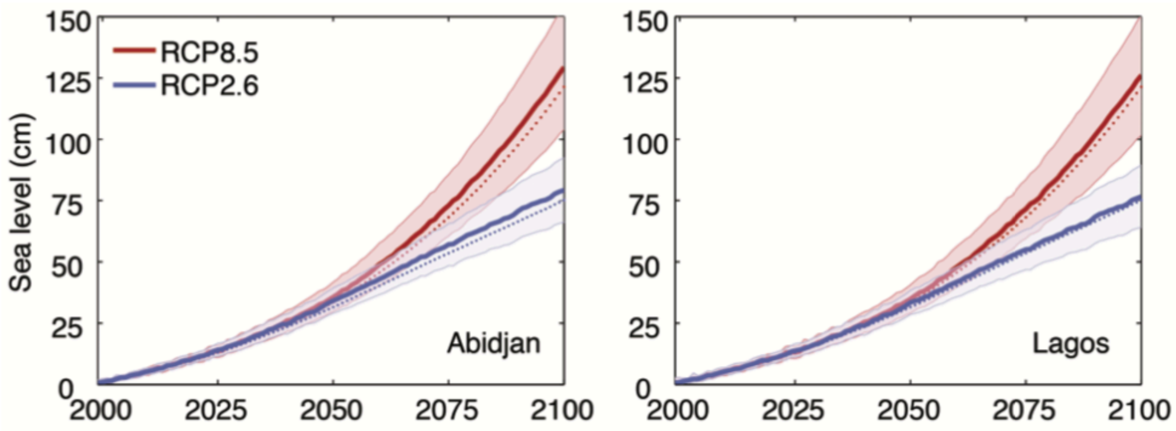

Figure 8: Local sea level rise above 1986-2005 for Abidjan and Lagos until 2100 (in cm) for global temperature increase of 4°C and 2°C (Schellnhuber et al., 2013)

6. Food Security and Droughts

The frequency and intensity of droughts has increased in some regions of the globe, including in West Africa (IPCC, 2019). The IPCC found that in Sub-Saharan Africa, increased land surface air temperature and evapotranspiration and decreasing precipitation leads to desertification and droughts *(medium confidence)* (IPCC, 2019). The frequency and intensity of such droughts is projected to increase particularly in African countries *(medium confidence)* (IPCC, 2019).

"West Africa has a high number of people vulnerable to increased desertification and yield decline" (IPCC, 2019), which is strongly linked with food security in Nigeria. Climate change is already affecting food security in Africa through warming, changing precipitation patterns an increase in some extreme events (IPCC, 2019). While there are some areas in the higher altitudes that might experience an increase in crop yield, tropical West Africa is found to be at significant risk of declining crop yield for a global temperature increase of 2°C and more, which is seriously endangering food security in the future (Hoegh-Guldberg et al., 2018). While global hunger has been declining over the past few decades, undernutrition has increased particularly in Sub-Saharan Africa, which is extremely dangerous for children (IPCC, 2019).

7. Extreme Weather Events

7.1 Extreme Precipitation

Rainstorm intensity has strongly increased over the past years. Mean annual rainfall was similar but the recorded rain days have declined, indicating that rainstorms have been much heavier than those of the earlier periods (Akpodiogaga-a & Odjugo, 2010). Especially in the coastal areas and Lagos, between 1996 and 2005, rainstorms have been heavier despite decreasing numbers of total rain days per annum (Akpodiogaga-a & Odjugo, 2010). Between 1992 and 2007 these extreme rainstorm events destroyed properties in Nigeria and killed 199 people (Akpodiogaga-a & Odjugo, 2010).

In July 2011, for example, there was a heavy rainfall event that lasted 17 hours in which a total of 233.3 mm of rainfall occurred - this amount of rain is equivalent to the precipitation of one whole month (Adelekan, 2016). During this rainfall event, 25 people were killed and over 5000 people had to be displaced from their homes (Adelekan, 2016). One year later 216.3 mm of rainfall was recorded in a single rainfall event, which severely damaged infrastructure, roads, bridges, rail tracks, houses and other properties and claimed seven lives (Adelekan, 2016).

Increases in extreme rainfall over the south of Nigeria are expected. With warming temperatures the atmosphere contains more water at saturation, increasing the possible amount of water during rainfall events (Abiodun et al., 2013). The changes in number of days with extreme rainfall in overall Nigeria are small (less than 1 day per decade) whereas the highest increase (1.2 days per decade) is expected to occur over Lagos under a global warming scenario of 2.4°C in 2100 (RCP4.5) (Abiodun et al., 2013).

7.2 Floods

Due to the combination of sea level rise, extreme precipitation and the low elevation and topography of Lagos, the entire Nigerian coastline is highly susceptible to flooding, especially at high tides and during rainy season (Adelekan, 2010). Flooding can lead to "road tracks inundation, house losses, public health hazards and losses of potable water owing to saltwater intrusion into wells and seaside beels, farmland losses and population displacements and ultimate livestock mortalities" (Idowu et al., 2011). Flooding and associated pollution will also greatly reduce the potable water quantity and water quality in Lagos (Elias & Omojola, 2015). Numerous studies found that highly populated communities within 10 km of the coastline can be inundated or submerged as a result of sea level rise and flooding (Elias & Omojola, 2015). For example, the above described rainfall events of 2011 and 2012 lead to flooding that heavily impacted 1500 households and 10 communities in Lagos (Elias & Omojola, 2015).

In 2005, 136 port cities were assessed for exposed population to flooding with Lagos ranking 30th. Under the current climate scenario Lagos will rank 15th in the future (Adelekan, 2010). A study showed that flooding in different urban communities had worsened between 2002 and 2006, with 71% of the respondents reporting flooding of their streets in 2006, compared with 54% in 2002 (Adelekan, 2010). Figure 9 shows that flooding is a major problem in most parts of metropolitan Lagos (Adelekan, 2010).

Figure 9: Lagos showing communities that were affected by flooding in 2011 (Adelekan, 2016)

8. Sectoral Impacts

8.1 Agriculture

For more than 70% of the population of Nigeria, agriculture is their primary occupation and means of livelihood (Idowu et al., 2011). Agriculture in Nigeria is mainly rainfed and strongly depends on precipitation patterns. Climate change has multiple effects on agriculture, for example, "uncertainties and variations in the pattern of rainfall, floods and devastated farmlands cause pest and diseases migrate in response to climate change while high temperatures smother crops" (Idowu et al., 2011). The future changes in precipitation and temperature will decline harvest of rice, maize, cassava, melon, sorghum and yam by 2.5% per annum (Idowu et al., 2011). Also cacao, oil palm, cotton and others suffer severe setbacks under reduced photoperiods that reduced annual yields by 5.5 metric tons per hectare (Idowu et al., 2011).

Pests and diseases also become uncontrollable under extreme weather events and further decline crop harvest (Idowu et al., 2011). Furthermore, climate change reduces arable land of coastal plains, as can be seen in Figure 7, which reduces agricultural farmland and grazing rangelands for many farmers (Akpodiogaga-a & Odjugo, 2010). Also fish production is affected by climate change as a study of Adeoti et al. (2010) revealed, where the impact of flooding, temperature increase and wind on fish production affected 81% of the fish farmers (Elias &

Omojola, 2015). The livestock sector will also be affected by increases in temperature and humidity. For example, livestock mortalities (stock losses) have increased in poultry, pork and rodent production systems by at least 15% per annum (Idowu et al., 2011). These trends and impacts will further increase with increasing global and local temperatures. In general, reductions in yields of maize, rice, wheat, and potentially other cereal crops will be smaller when limiting warming to 1.5°C compared with 2°C (Hoegh-Guldberg et al., 2018). Figure 10, for example, displays the decrease in maize yields under a global warming scenario of 2.5°C by 2100.

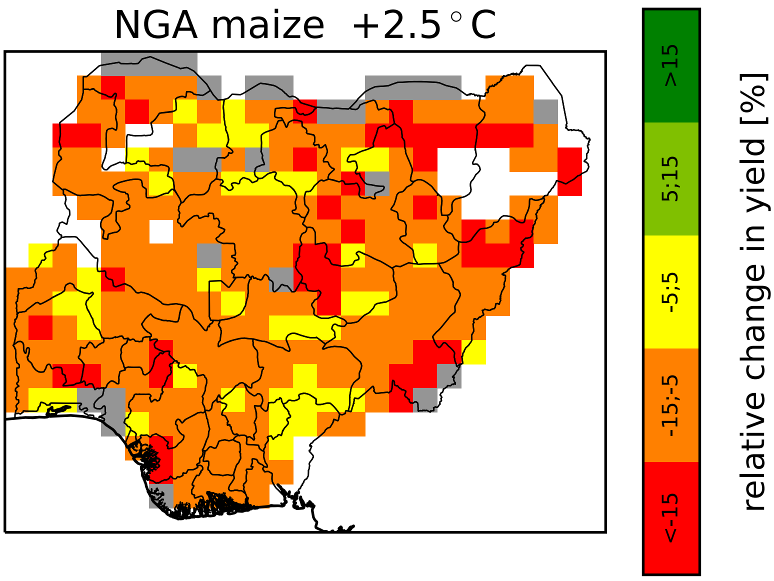

Figure 10: Projected change in maize yield (%) relative to 2000 under global warming scenario of 2.5°C - yellow areas shows small level of impacts, whereas orange areas show a decline between 5-15%, and red areas a decline by more than 15% (http://regiocrop.climateanalytics.org/choices)

8.2 Health

Air pollution, increasing water stress, excessive heat, and suppressed immune system suppression caused by climate change "will result in increasing incidence of excessive death due to heat exhaustion, famine, water related diseases (diarrhea, cholera and skin diseases), inflammatory and respiratory diseases (cough and asthma), depression, skin cancer and cataract" (Akpodiogaga-a & Odjugo, 2010). In 2011 the impact of climate change on the public health of Nigeria's farming communities was reported as 70% of the population being affected by Malaria annually, 45% suffering from skin ailments, 40% noticing a loss of productivity, 4% experiencing heat strokes and 60% witnessing portable water shortages due to floods and/or saltwater intrusion (Idowu et al., 2011).

For example, increasing temperatures will trigger a northward migration of mosquitos, which will extend Malaria fever from the tropical region to the warm temperate regions, increasing the number of people affected (Akpodiogaga-a & Odjugo, 2010). Moreover, the frequency and duration of cholera outbreaks for children in West Africa has been associated with climate change and its changes in precipitation patterns (heavy rainfall) (UNICEF, 2015). The increase in precipitation is also expected to affect the water and sanitation infrastructure and may thus increase the proportion of diarrheal deaths attributable to climate change by 14% by 2050 (U.S. Agency for International Development, 2018).

The Lancet Report estimates that 153 billion labour hours were lost due to climate change and increasing temperatures (Watts et al., 2018). That is an increase of 62 billion compared with the year 2000. 80% of these lost labour hours are linked to the agricultural sector, which explains the strong increase in Nigeria, where 70% depend on agriculture as a source of living (Watts et al., 2018). The IPCC also found that "higher temperature increase will have a negative effect on heat related morbidity and mortality *(very high confidence)*" and that "especially urban populations will be affected by amplified impacts due to urban heat island *(high confidence)*" (Hoegh-Guldberg et al., 2018).

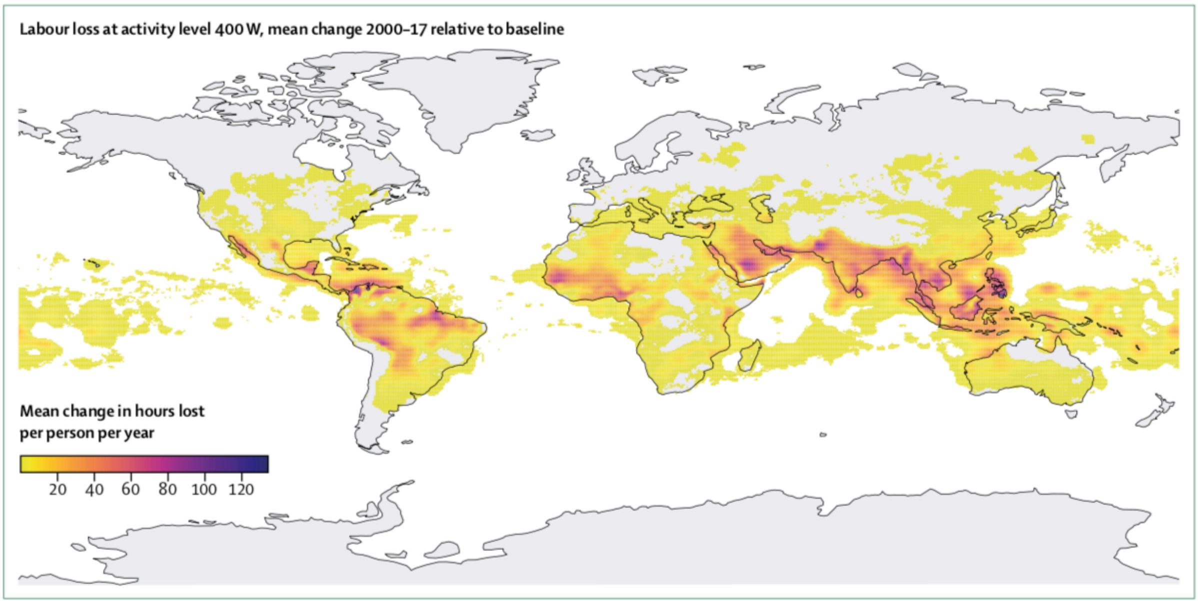

Figure 11: Labour loss at activity level 400 W, mean change in hours lost per person per year 2000-17 relative to baseline (Watts et al., 2018).

8.3 Infrastructure and Displacement

As described above, many climate stressors lead to the loss of roads and road tracks and other parts of infrastructure. This is especially true for farming communities in Nigeria (Idowu et al., 2011). Turbulent floods and inundated road tracks up to 5 months per year also prevents children from attending school; moreover, losses of lives of pupils have been reported (Idowu et al., 2011).

Climate change also leads to population displacement and relocations with immediate abandonment and hence farm occupation decline (Idowu et al., 2011). At least 32 000 farmers are effected annually by displacement in Nigeria's farming communities (Idowu et al., 2011).

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2.8. Sweden - North

Sweden – Karesuando

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Summary

Sweden is experiencing an increase in temperature well above global average that manifests itself in a range of impacts for human and ecosystems. The greatest temperature increases have occurred over central and Northern Sweden during winter, with a positive trend in the frequency and intensity of winter warming events. Projections show that warming will continue, at greater rates than the global average in Sweden. Annual precipitation has also increased (between 10 and 40% over Northern Europe) and precipitation changes of additional 20% increases have been projected for a 2°C scenario, with a stronger increase in Northern Sweden during winter. The snow cover is also undergoing large amount of changes: increased precipitation leading to greater accumulation of snow, increased number of freeze-thaw days causing frost damage and increased frequency and areal extent of rain-on-snow events.

These changes hinder foraging conditions for reindeer putting the traditional livelihood of reindeer herding Sami under existential threat. Permafrost thawing accelerates climate change and affects infrastructures and livelihoods. Extreme weather events such as heat waves and wildfires will also intensify and become more frequent. The Sami people, who

closely depend on direct and indirect contributions of ecosystems to their well-being, will be strongly affected by shifts in vegetation zones, damaged grasslands, plant pests and diseases. The reindeer are impacted by decreasing body condition, increasing stress due to the shrinking of grazing lands and variation in fecundity and thus population growth, which has impacts on the Sami people as reindeer are part of their livelihood. The mental and physical health of the Sami is threatened by climate change through increased frequency and distribution of diseases, anxiety linked to environmental changes, and safety issues due to less stable ice and snow routes. The overall livelihood and the rich cultural heritage of the Sami people is therefore at the brink of a socio-ecological tipping point, a critical threshold where it could be irreversibly lost. Under current emission trajectories, the Sami children of today will spend more than half of their lives in a world warmer than 1.5°C above pre-industrial levels.

1. The IPCC report's summary on climate impacts in Northern Sweden

"Increases in temperature throughout Europe and increasing precipitation in Northern Europe" are projected. "Climate projections show a marked increase in high temperature extremes (high confidence), meteorological droughts (medium confidence), and heavy precipitation events (high confidence), with variations across Europe" and "increases in winter wind speed extremes over Central and Northern Europe (medium confidence)". "Observed climate change in Europe has had wide ranging effects throughout the European region including the distribution, phenology, and abundance of animal, fish, and plant species (high confidence)". "Climate change has affected both human health (from increased heat waves) (medium confidence) and animal health (changes in infectious diseases) (high confidence)" (IPCC, 2014, p. 1270).

2. Demographics and intergenerational aspects

Sweden has a population of about 10 million, out of which 22% are children under the age of 19 (Wittgenstein Centre for Demography and Global Human Capital, 2018). An average 8-year-old Swedish citizen is expected to live until the age of 91 (World Data Lab, 2019). The demographic estimates can be coupled with the projections of global mean temperature increases. Following the best estimate of the future temperature trajectory based on the Climate Action Tracker (2019), increase in the global mean temperature is expected to exceed 1.5°C around the year 2035 (model median), 2°C around 2055, and more than 3°C in 2100. Today's Swedish 8-year-old has a 99% probability of being alive in 2035, 99% in 2055 and 38% in 2100. Therefore, these children still have a high probability of experiencing a 2°C world and its respective climate change impacts.

3. Temperature increase

The mean temperature in Sweden over the period 1991-2007 was about 1°C higher than over the period 1961-1990, which is more than twice the global average over this period. The greatest increase (just over 2°C) occurred during winter in central and Northern Sweden (Climate Change Post, 2019). Observational data shows that winters in particular have been warmer in recent decades. Over the past 50 years there has also been a positive trend in both the frequency and intensity of winter warming events (e.g. increased rates for number of melt days) in Northern Scandinavia (Vikhamar-Schuler et al., 2016). This supports findings that climate change warming is amplified in polar regions (Stocker et al. 2013). Projections show that this warming will continue, often at greater rates than the global average.

For Northern Europe, the Fifth Assessment Report (AR5) (IPCC, 2014) states that there will be an increase in high temperature extremes (high confidence). On a European level, North-Eastern Europe and Scandinavia are the regions for which the strongest warming is projected in winter affecting particularly the northern parts of Sweden (*Figure 1*) (Füssel et al., 2017).

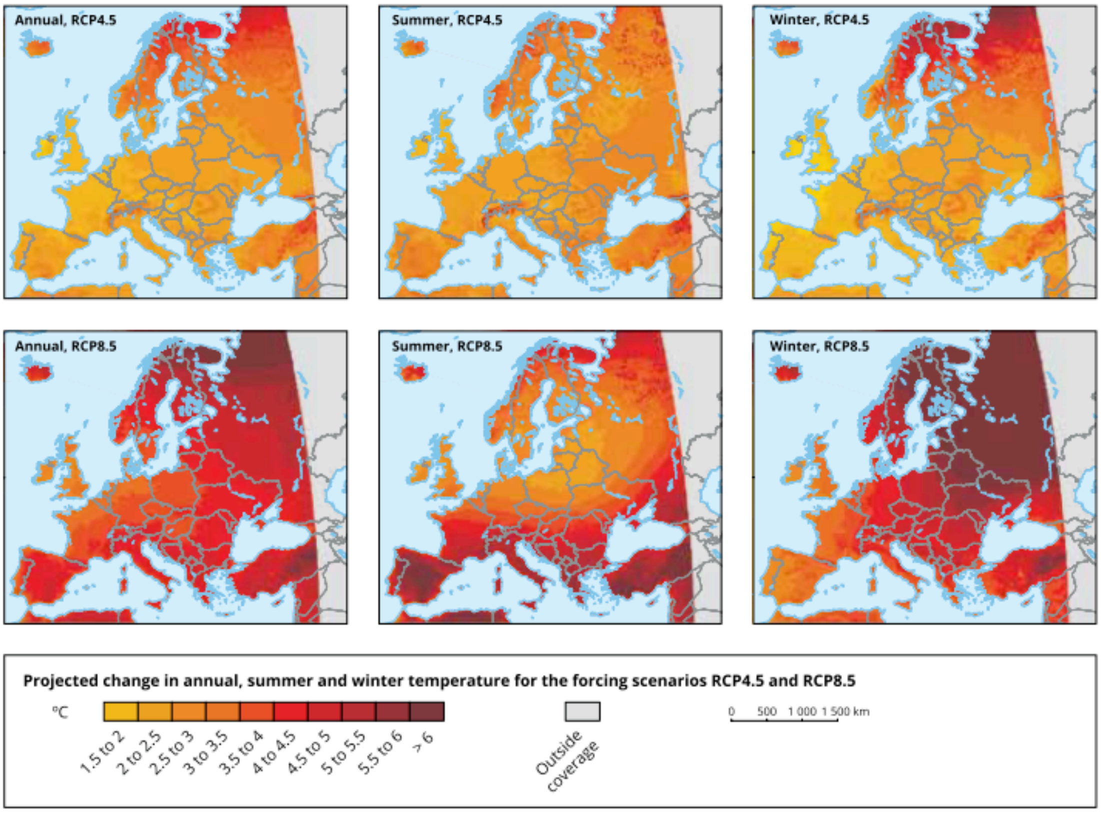
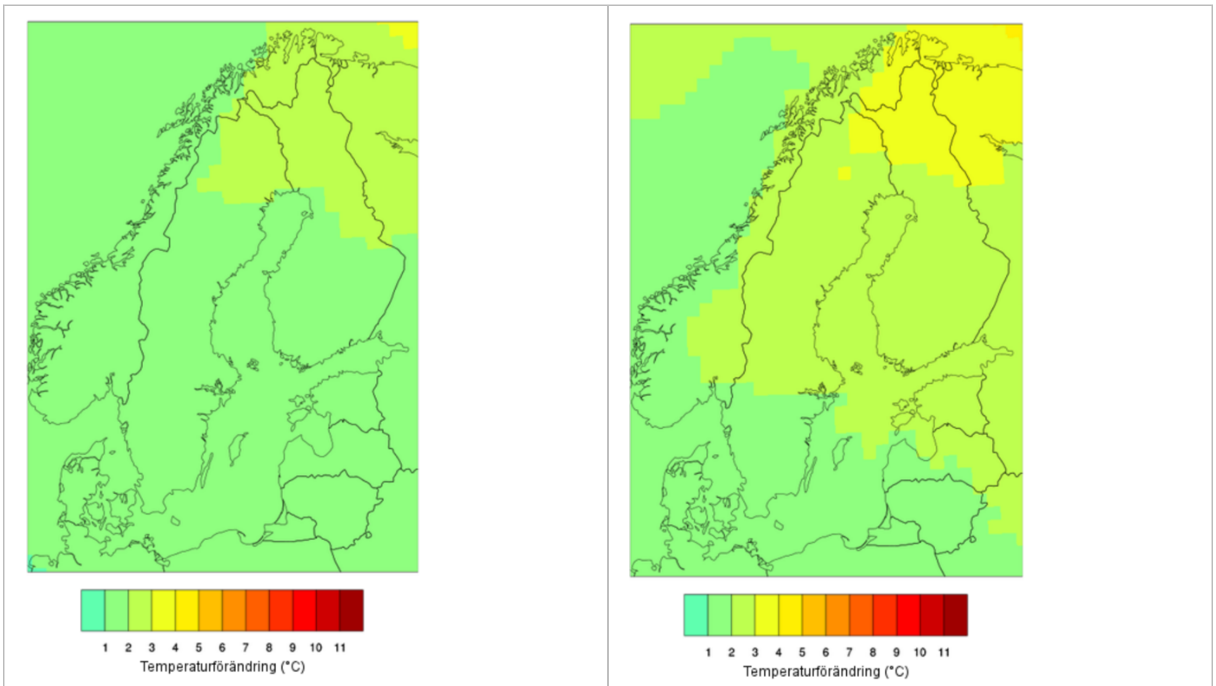


Figure 1: Projected changes in mean annual, summer and winter temperature in the period 2071-2100 for scenarios of 2.4°C expected temperature increase by 2100 (RCP4.5) and 4.3°C expected temperature increase by 2100 (RCP8.5) against the baseline period 1971-2000 (source: Füssel et al., 2017)

Figure 2 shows that with 1.5°C and 2°C of global warming, Northern Sweden will be most affected by an increase in annual mean temperatures (Swedish Meteorological and Hydrological Institute, 2019a). Even greater levels of warming are projected during winter months.



1.5°C global warming	2°C global warming

Figure 2: Calculated change in annual mean temperature (°C) compared to 1971-2000 at the period for 1.5°C and 2°C global warming according to a scenario of 4.4°C expected temperature increase by 2100 (RCP8.5) (Swedish Meteorological and Hydrological Institute, 2019a)

4. Precipitation

Annual precipitation over Northern Europe has increased by between 10 and 40% in the last century, in particular in winter (EEA, 2007; Füssel et al., 2017).

Recent studies summarised in the IPCC Special Report on the Impacts of Global Warming of 1.5°C (SR1.5) have shown that 2°C of global warming was associated with a robust increase in mean precipitation over Northern Europe in winter and in summer (Hoegh-Guldberg et al., 2018). Precipitation changes reaching 20% have been projected for the 2°C scenario (ibid). The latest report from the European Environment Agency (EEA) also states that there will be an increase in river flows, less snow and greater damage by winter storms in this region (Füssel et al., 2017). Precipitation is mostly expected to increase in Northern Sweden and during the winter (Swedish Meteorological and Hydrological Institute, 2019b) (*Figure 2*).

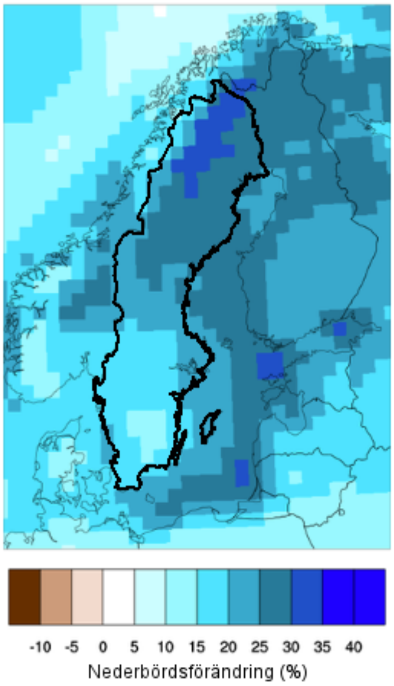


Figure 3: Calculated change in annual precipitation (%) for the period 2071-2100 compared with 1971-2000. The map is based scenarios of 4.3°C expected temperature increase by 2100 (RCP8.5) (Swedish Meteorological and Hydrological Institute, 2019b)

5. Snow cover

Increased precipitation during winter may lead to greater accumulation of snow on pastures, restricting forage access (Tyler et al., 2007). In addition, while most of Europe is expected to experience a decrease in the number of freeze-thaw days under 2°C of warming, Northern Scandinavia will experience a small increase (IMPACT2C, 2019). Melting snow and loss of snow cover, followed by low temperatures of -20°C to -30°C, cause ice encasement and frost damage. Ground-ice formation due to such melting events or winter rain events prevents ungulates (e.g. reindeers) from grazing, leads to vegetation browning, and impacts soil temperatures (Vikhamar-Schuler et al., 2016). Rain-on-Snow events have been implicated in catastrophic die-offs of ungulates in the polar region (Rennert et al., 2009). In addition, the frequency and areal extent of rain-on-snow events is expected to increase in the Arctic (the underlying study focused more on Canada and Alaska) (Rennert et al., 2009). Such an increase would also make it increasingly difficult for reindeer to find suitable foraging conditions, potentially leading to mass starvation or displacement (Mallory and Boyce, 2017). Changes in snow pack structure and quality could also cause problems for reindeer herders when moving their herds (ibid).

6. Permafrost thawing

Permafrost is found in lowland areas at high Northern latitudes in Sweden and is sensitive to climate change (Sannel et al., 2018). Increasing temperatures lead to the thawing of permafrost, threatening to release carbon to the atmosphere (Gisnås et al., 2017). It has a large impact on periglacial environments and results in a substantial positive feedback loops accelerating climate change (Hällberg, 2018). The IPCC has stated that "limiting global warming to 1.5°C rather than 2°C is projected to prevent the thawing over centuries of a permafrost area in the range of 1.5 to 2.5 million km^2 (medium confidence)" (Hoegh-Guldberg et al., 2018). In addition, "climate change exacerbates land degradation, particularly in low-lying coastal areas, river deltas, drylands and in permafrost areas (high confidence)" (IPCC, 2019, p. 3). The thawing of permafrost therefore affects infrastructure and livelihoods (Füssel et al., 2017).

7. Extreme weather events

7.1. Heat waves

The frequency, intensity, duration and spatial extent of heat waves will increase with climate change (Oudin Åström et al., 2013). The heatwaves in 2003, 2007 and 2010 in Europe illustrate the increase in the number of extreme temperature events. The temperatures in 2010 broke 20^{th} and 21^{st} century records, with an 80% probability the record heat would not have occurred without climate change (Oudin Åström et al., 2013). Europe is projected to experience years like 2016 every other year for 1.5° warming and 9 out of 10 years for 2° warming (King and Karoly, 2017). Warm spell durations are projected to increase from 14 days to 24 days for warmings of 1.5°C and 2°C in Northern Europe (Carbon Brief, 2019). The frequency of warm extremes over land will also increase 73% at 1.5°C warming and 179% at 2°C warming in Northern Europe (ibid). *Figure 3* shows the deviation of temperature averages in July 2018, supporting the estimations of increasing heat waves.

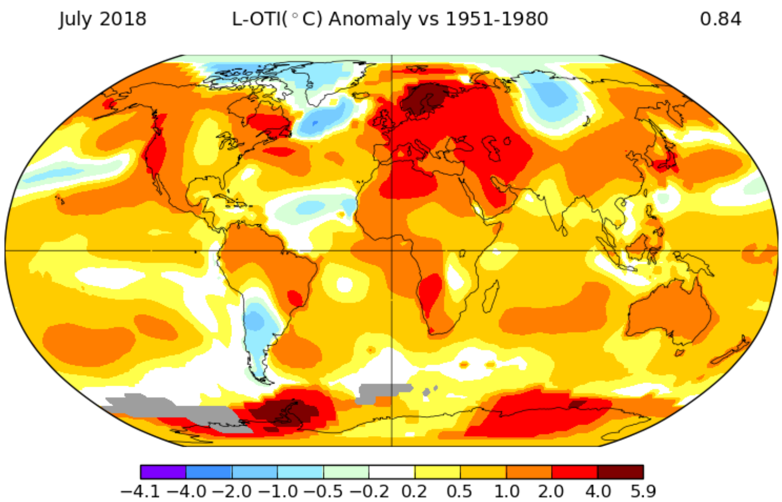


Figure 4: Deviation of temperature averages in July 2018 in comparison of those between 1951-1980. (source: NASA: GISS Surface Temperature Analysis: https://data.giss.nasa.gov/gistemp/maps/)

7.2. Wildfires

Sweden is also exposed to wildfires (3000-4000 fires per year), the large forest areas that are sparsely populated result in large fires with considerable financial impacts (Ministry of the Environment and Energy, 2017), estimated at almost 70 million USD by the Swedish Forestry Agency (The Local, 2018). The fire risk is expected to increase together with the increase in temperature (Ou, 2017), expanding fire-prone areas and fire seasons (Füssel et al., 2017).

During the heatwave of 2018 in Sweden, hot and dry conditions spurred more than 40 fires, resulting in over 10 000 hectares of burned land, 24 times higher than the amount of burned land averaged over 2008-2017 (NASA, 2018). *Figure 5* shows land surface temperature anomalies during that period.

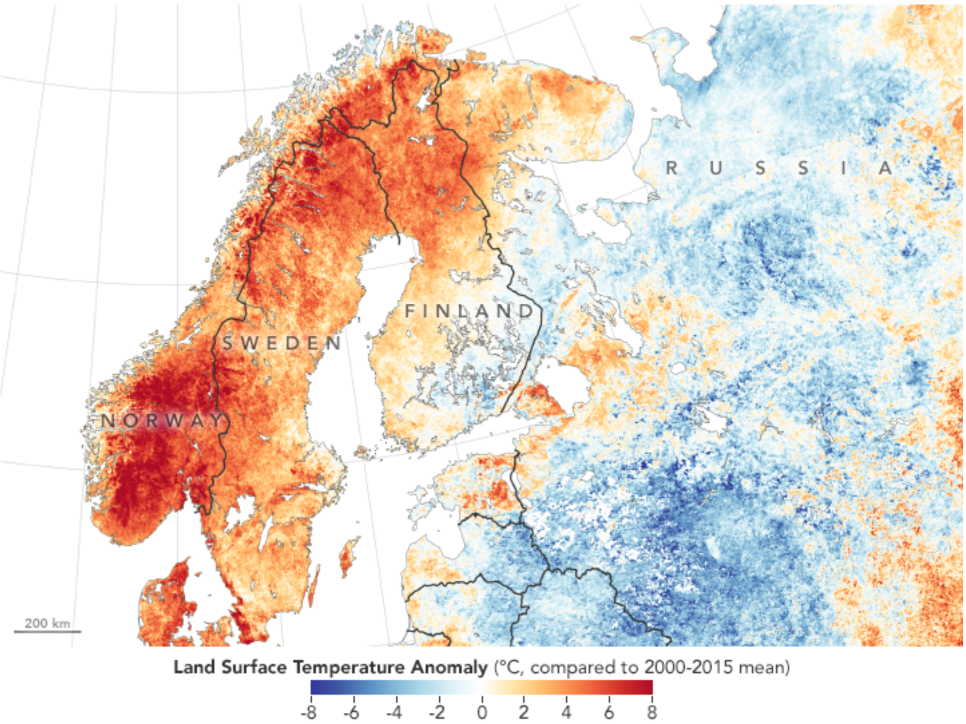


Figure 5: Land surface temperatures from July 1-15, 2018, compared to the 2000–2015 average for the same two-week period (NASA, 2018)

7.3. Floods

Increasing precipitation and thawing permafrost will be reflected in water courses together with the dynamics of freshwater systems, altering lake and wetland patterns and the ecosystems they support (Füssel et al., 2017).

8. Sectoral impacts

8.1. Health

Climate change could particularly impact Sami youth as they become the next generation of reindeer herders which, due to geography, is more likely to be strongly impacted by climate change (Kowalczewski and Klein, 2018). The warming climate is already influencing Sami reindeer culture and mental health and suicide risk partly linked to the changing physical and social environments are major concerns (Jaakkola et al., 2018). Loss of language, culture and urban life can have negative implications for the mental and physical health of the Sami people (Jaakkola et al., 2018; Kowalczewski and Klein, 2018). Increased safety issues also threaten the Sami people due to less stable ice and snow routes (Kowalczewski and Klein, 2018). Rising temperatures and changing precipitation regimes have also been linked to increased frequency and distribution of foodborne, waterborne and vector borne diseases; increased mortality and morbidity from hazardous travel conditions and extreme weather events; and disruptions to nutritional intake from wild foods and an increased reliance on processed foods (Cunsolo Willox et al., 2014). The small population size, their dispersed settlement and urbanization limits the opportunities for cultural adaptation in the changing climate (Jaakkola et al., 2018).

8.2. Ecosystems and agriculture

Ecosystems and human activities in the Arctic will be strongly affected due to the particularly fast increase in air and sea temperatures and the associated melting of land and sea ice (Füssel et al., 2017). “Arctic vegetation zones are likely to shift, causing wide-ranging secondary impacts” (ibid, p. 295). Warm winter temperatures are damaging grasslands, and plant pests and diseases are becoming more abundant.

8.3. Reindeer husbandry

There has been an observed decline in reindeer body condition during warm summers, which has been connected to a lengthening of the period of high insect activity under warmer temperatures (Mallory and Boyce, 2017). Harassment by parasitic insects affects reindeer behavior, movement and body condition during the summer. Reindeer respond to harassment by running, sometimes for long periods, causing increased energy expenditure and decreased time spent foraging (ibid).

The flexibility in herding practices that has allowed reindeer herders to adapt to changing conditions is being eroded by a number of non-climatic factors (e.g. shrinking grazing lands, predation, poor financial conditions), which is enhancing their vulnerability to future climate change. Sami reindeer herders in Sweden already find themselves to be “facing the limit of resilience” as a result of rapidly shifting and unstable weather, changing vegetation, and alterations in the freeze-thaw cycle, and climate change forecasts themselves contribute to stress and anxiety (Furberg et al., 2011).

It is already well documented that large-scale climate variability associated with the North Atlantic and Arctic Oscillations causes variation in growth, body size, survival, fecundity and population growth. This is generally thought to be due to changing grazing conditions (e.g. access to forage beneath snow in winter, or changes in nutritional quality of forage plants in summer) (Tyler et al., 2007).

8.4. Cultural heritage

The Arctic, in comparison to other European regions, has a relatively large proportion of indigenous people (Füssel et al., 2017), in Northern Sweden, the Sami people. The livelihood and culture of the Sami people is threatened by the impacts described above, since they closely depend on ecosystem services for their way of life dominated by hunting, fishing and reindeer herding. Due to these alterations, traditional skills and knowledge are getting lost (Furberg et al., 2011). Reindeer play a major role in the Sami spiritual life, old religions and language also maintain the Sami community and identity, providing structure to the year. However, reindeer-herding Sami are facing the limit of resilience and there is fear among the Sami people that they will be the last generation practicing traditional reindeer herding (Furberg et al., 2011). In addition, as climate change also shifts the distribution and seasonal occurrence of snow, the Sami are also in competition for space, caused by the exploitation of natural resources (Füssel et al., 2017).

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2.9. Sweden South

SWEDEN – Stockholm

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Summary

Sweden is experiencing an increase in temperature well above global average that manifests itself in a range of impacts for human and ecosystems already today.

If global warming exceeds the Paris Agreement limit of 1.5°C, Sweden, including Stockholm, will experience further increase in annual mean temperatures and high extreme temperatures together with an increase in annual precipitation. Ongoing sea level rise also increases flooding risks and coastal erosion. The thawing of permafrost in Northern Sweden threatens to accelerate climate change and leads to land degradation. Extreme weather events such as heat waves and heavy precipitations are expected to increase in frequency and intensity.

These changes lead to agricultural impacts, health impacts due to extreme heat and heat waves, wild-fires and the expansion of insect outbreak zones and high-risk seasons. Under current emission trajectories, Swedish children of today will spend more than half of their lives in a world warmer than 1.5°C above pre-industrial levels.

1. The IPCC Report's summary on Climate Impacts in Sweden

"Projected increases in temperature throughout Europe and increasing precipitation in Northern Europe" are expected, also in Sweden (IPCC, 2014a, p. 1270). This will lead to a wide range of impacts on society and its supporting sectors: "climate change is *likely* to affect human health in Europe" (IPCC, 2014a, p. 1272) and "will increase the likelihood of systemic failures across European countries caused by extreme climate events (medium confidence)"

(IPCC, 2014a, p. 1270). In addition, "sea level rise may damage European cultural heritage, including buildings, local industries, landscapes archaeological sites and iconic places (medium confidence)" (IPCC, 2014a, p. 1272).

2. Demographics and intergenerational aspects

Sweden has a population of about 10 million, out of which 22% are children under the age of 19 (Wittgenstein Centre for Demography and Global Human Capital, 2018). An average 16-year-old Swedish citizen is expected to live until the age of 90 (World Data Lab, 2019). The demographic estimates can be coupled with the projections of global mean temperature increases. Following the best estimate of the future temperature trajectory based on the Climate Action Tracker (2019), increase in the global mean temperature is expected to exceed 1.5°C around the year 2035 (model median), 2°C around 2055, and more than 3°C in 2100. Today's Swedish 16-year-old has a 99% probability of being alive in 2035, 98% in 2055 and 8% in 2100. These children therefore have a high probability of experiencing a 2°C world and its respective climate change impacts.

3. Temperature increase

Between 1991 and 2018, Sweden's annual average temperature rose by 1.7°C compared to average temperatures in pre-industrial times (1861-1890) (Swedish Meteorological and Hydrological Institute, 2019c). Densely populated areas such as Stockholm, have shifted from a cold-temperate climate to a warm-temperate climate, reducing the frequency of winters with heavy snow (Climate Change Post, 2019).

For Northern Europe, the Fifth Assessment Report (AR5) (IPCC, 2014) states that there will be an increase in high temperature extremes (high confidence). On a European level, North-Eastern Europe and Scandinavia are the regions for which the strongest warming is projected in winter (*Figure 1*) (Füssel *et al.*, 2017).

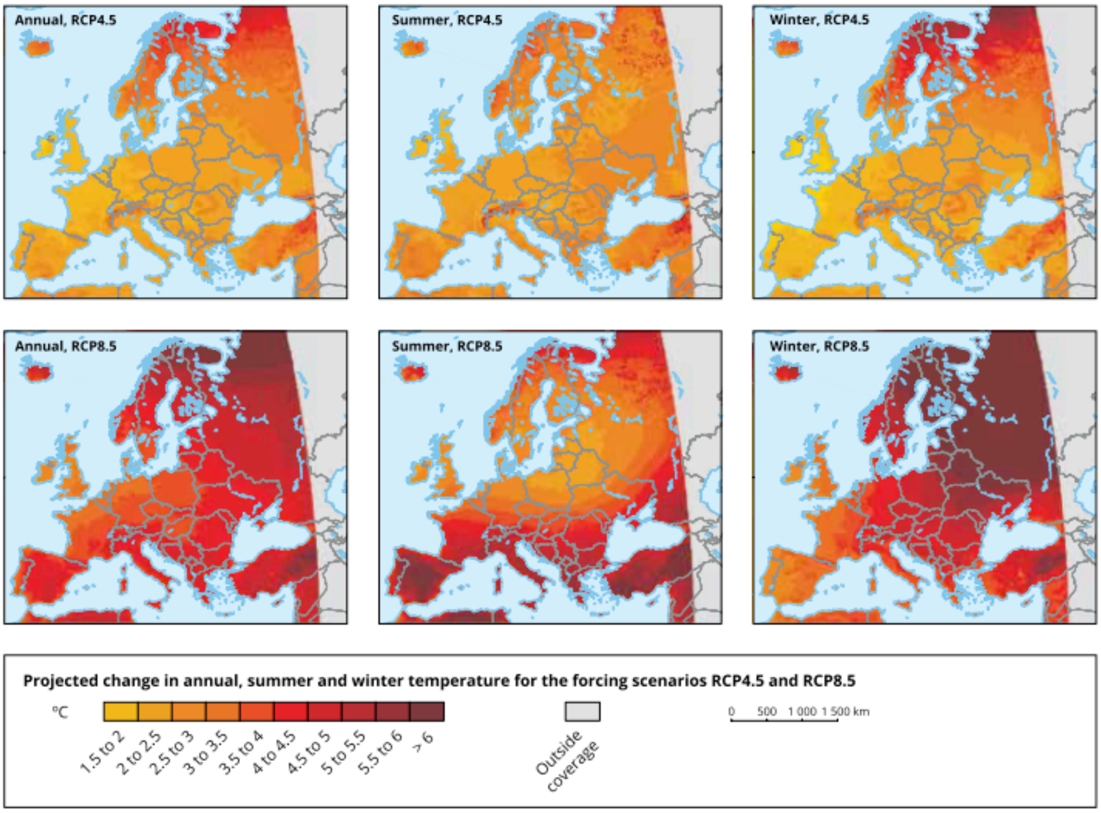
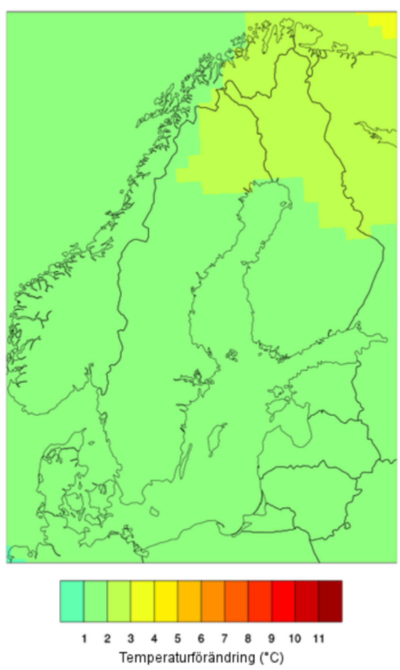
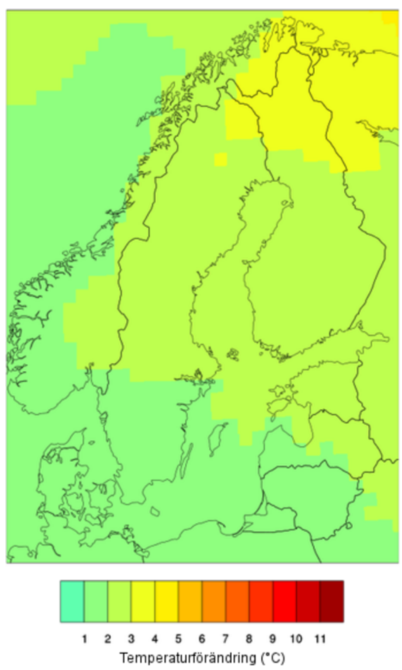


Figure 1: Projected changes in mean annual, summer and winter temperature in the period 2071-2100 for scenarios of 2.4°C expected temperature increase by 2100 (RCP4.5) and 4.3°C expected temperature increase by 2100 (RCP8.5) against the baseline period 1971-2000 (source: Füssel et al., 2017)

Figure 2 shows that with 1.5°C and 2°C of global warming, central and Northern Sweden will be most affected by an increase in annual mean temperatures.



1.5°C global warming



2°C global warming

Figure 2: Change in annual mean temperature (°C) compared to 1971-2000 at the period for 1.5°C and 2°C global warming (Swedish Meteorological and Hydrological Institute, 2019b).

4. Precipitation

Annual precipitation over Northern Europe has increased by between 10 and 40% in the last century, in particular in winter (EEA, 2007; Füssel *et al.*, 2017). The calculated change in annual precipitation for Stockholm from 1960 to 2100 represented in *Figure 3*.

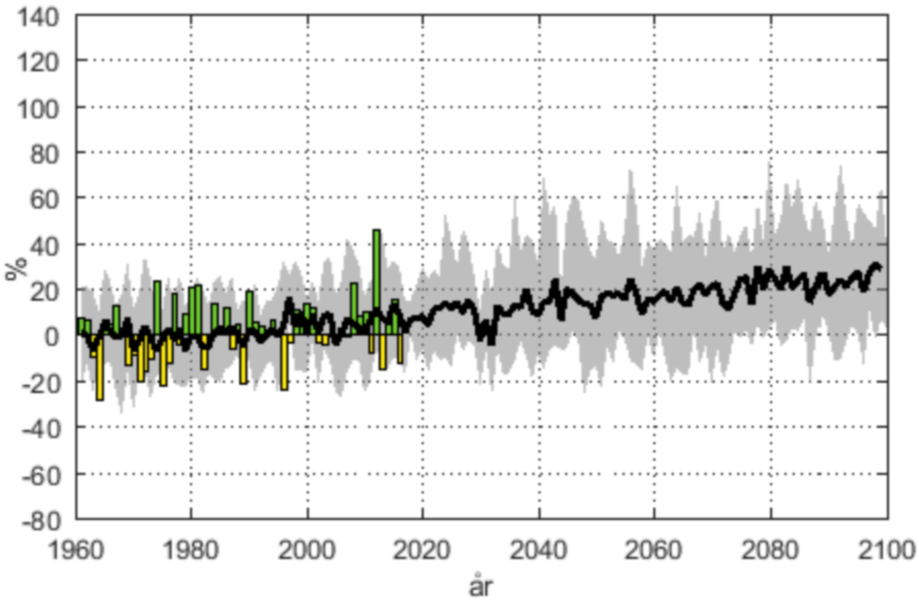


Figure 3: Calculated change in annual precipitation (%) in Stockholm County during the years 1961-2100 compared with normal (mean for 1961-1990). The bars show historic data from observations. The green bars show precipitation above normal and the yellow bars show precipitation below normal. The black line shows the ensemble mean of nine climate scenarios for a scenario of 4.3°C expected temperature increase by 2100 (RCP8.5). The grey field shows the range in variation between the highest and lowest value for the members of the ensemble (source: Swedish Meteorological and Hydrological Institute, 2019a)

Recent studies summarised in the IPCC Special Report on the Impacts of Global Warming of 1.5°C (SR1.5) have shown that 2°C of global warming was associated with a robust increase in mean precipitation over Northern Europe in winter and in summer (*Figure 4*) (Hoegh-Guldberg *et al.*, 2018). Precipitation changes reaching 20% have been projected for the 2°C scenario and are overall more pronounced than with 1.5°C of global warming. Limiting global warming to 1.5°C would limit risks of increases in heavy precipitation events that are projected to occur in Northern Europe (ibid). The latest report from the European Environment Agency (EEA) also states that there will be an increase in river flows, less snow and greater damage by winter storms in this region (Füssel *et al.*, 2017).

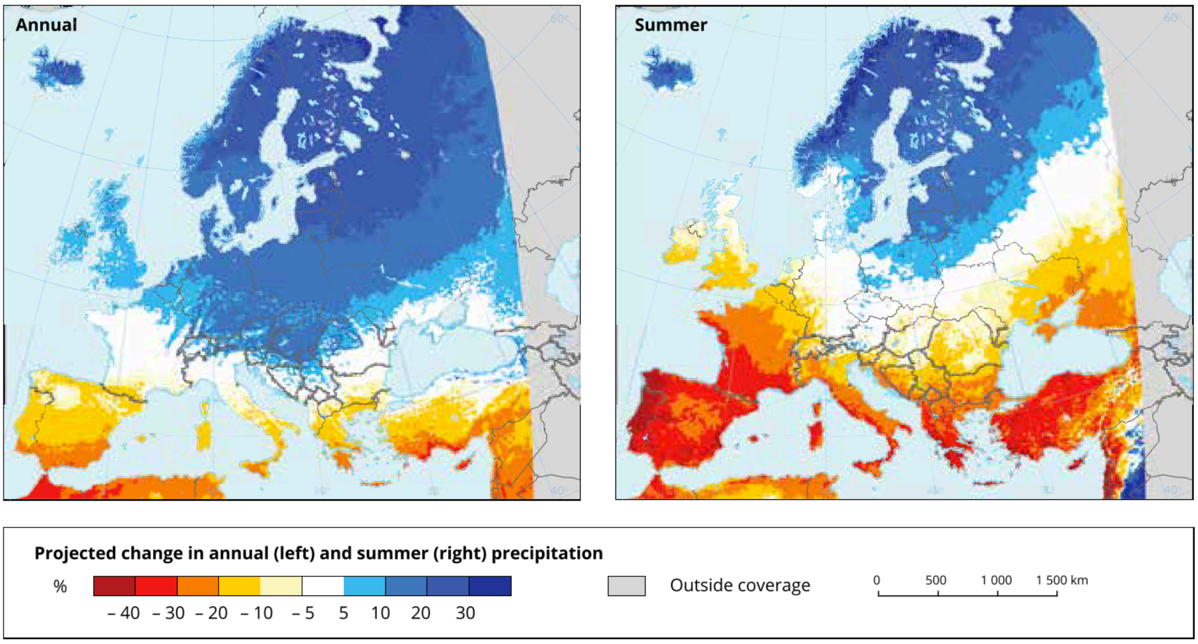


Figure 4: Projected change in annual and summer precipitation during 2071-2100, compared with the baseline period 1971-2000, for a scenario of 4.3°C expected temperature increase in 2100 (RCP8.5), based on many different regional climate model simulations (source: Füssel et al., 2017)

5. Sea level rise

Since 1886, the sea level has risen by just under 20 cm along the Swedish coasts, at an average rate of 1.5 mm per year (Hammarklint, 2009). There has been an increased rate in sea level rise during the last 30 years with an approximate 3mm sea level rise per year between 1980 and 2009. The sea level rise in Stockholm corresponds to the average Baltic sea level rise, due to Stockholm's unique oceanographic position close to the nodal line in the central Baltic Sea (ibid).

In general, coastal zones across Europe are facing an increasing risk of flooding from sea level rise and a possible increase in storm surges (Füssel *et al.*, 2017). According to the AR5 (IPCC, 2014b), global sea levels will continue to rise during the 21st century, very likely exceeding the current global observed rate of 2mm/year during 1971-2010 with the rate of rise of 8 to 16 mm/year from 2081 to 2100 with a scenario of expected 4.3°C global warming by 2100 (RCP8.5) (medium confidence). Sea level rise in the northern Baltic sea including Stockholm is below the global average mainly due to local geostatic processes, but the ongoing rise in sea level is leading to substantial coastal erosion where the land consists of easily eroded soils.

In addition, if the sea level rises, Sweden's third largest lake Mälaren and large freshwater reserve, providing fresh water for 2.5 million Swedes (including the population of Stockholm) is threatened to be contaminated with saltwater from the Baltic Sea. The fresh water in Mälaren and the salt water in the Baltic Sea are on different levels: Mälaren's surface currently averages 0.67 meters above the Baltic sea level (Ekopolitan, 2011). Already today, there is an immediate risk that Lake Mälaren will flood; future scenarios will increase the risk of flooding (The Local, 2004).

6. Permafrost thawing

Permafrost is found in lowland areas at high Northern latitudes in Sweden and is sensitive to climate change (Sannel *et al.*, 2018). Increasing temperatures lead to the thawing of permafrost, threatening to release carbon to the atmosphere (Gisnås *et al.*, 2017). It has a large impact on periglacial environments and results in a substantial positive feedback loops accelerating climate change (Hällberg, 2018). The IPCC has stated that "limiting global warming to 1.5°C rather than 2°C is projected to prevent the thawing over centuries of a permafrost area in the range of 1.5 to 2.5 million km^2 (medium confidence)" (Hoegh-Guldberg *et al.*, 2018). In addition, "climate change exacerbates land degradation, particularly in low-lying coastal areas, river deltas, drylands and in permafrost areas (high confidence)" (IPCC, 2019, p. 3). The thawing of permafrost therefore affects infrastructure and livelihoods.

7. Extreme weather events

Heavy precipitation events are projected to increase, leading to an increased risk of urban floods and associated impacts (Füssel *et al.*, 2017). For the Mälaren lake, for example, the inflow to the lake may be higher than the outflow capacity through the sluices that manage the water levels (WSP, 2015).

The frequency, intensity, duration and spatial extent of heat waves will increase with climate change (Oudin Åström *et al.*, 2013). The heatwaves in 2003, 2007 and 2010 in Europe illustrate the increase in the number of extreme temperature events (*Figure 6*). The temperatures in 2010 broke 20th and 21st century records, with an 80% probability the record heat would not have occurred without climate change (Oudin Åström *et al.*, 2013). Europe is projected to experience summers like 2016 every other year for 1.5°C warming and 9 out of 10 years for 2°C warming (King and Karoly, 2017). The 2018 monthly average temperature graph (*Figure 7*) shows the deviation of the expected average supporting the estimations of increasing heat waves.

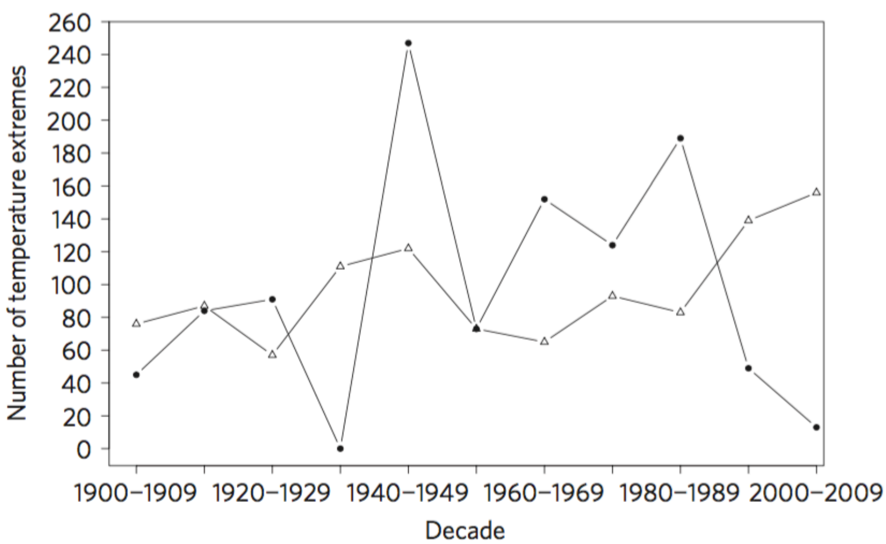


Figure 6: Number of cold/heat extremes per decade 1900-2009 in Stockholm, Sweden (filled circles, number of cold extremes; open triangles, number of heat extremes) (source: Oudin Åström et al., 2013)

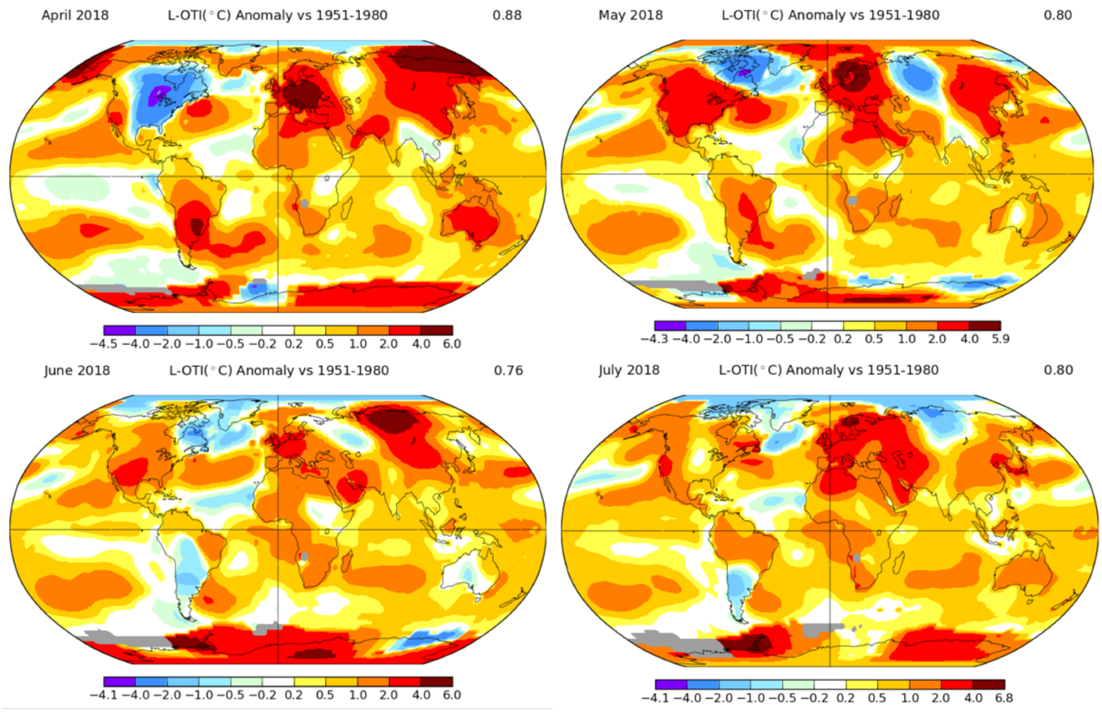


Figure 7: Deviation of monthly temperature averages between April and Juliy2018 in comparison of those between 1951-1980. (source: NASA: GISS Surface Temperature Analysis: https://data.giss.nasa.gov/gistemp/maps/)

Sweden is also exposed to wildfires (3000-4000 fires per year), the large forest areas that are sparsely populated result in large fires with considerable financial impacts (Ministry of the Environment and Energy, 2017). The fire risk is expected to increase together with the increase in temperature (Ou, 2017), expanding fire-prone areas and fire seasons (Füssel *et al.*, 2017).

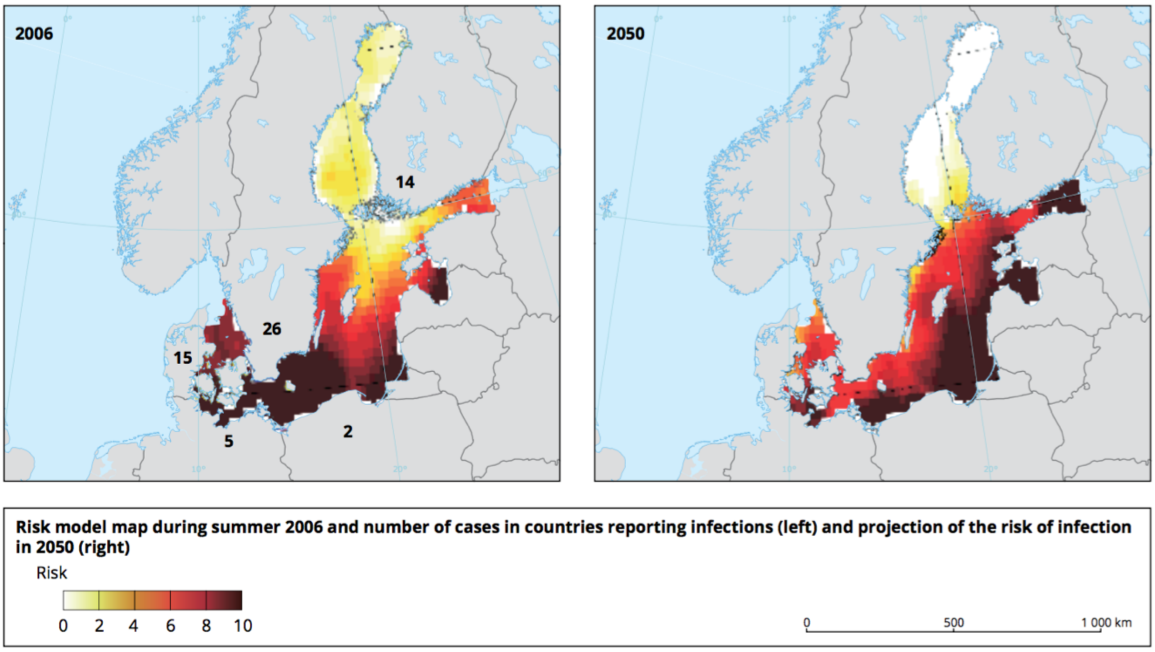
8. Sectoral impacts

8.1 Health

The AR5 (IPCC, 2014a) concluded that there is high to very high confidence that climate change will lead to greater risks of injuries, disease and death, owing to more intense heatwaves and fires, increased risks of undernutrition and consequences of reduced labour productivity in vulnerable populations in Europe.

The negative effects of heat and heat waves on human health cover the spectra from relatively mild symptoms such as heat syncope and fainting to more serious effects such as cramps, heat exhaustion and heat stroke. In Stockholm, mortality from heat extremes between 1980–2009 was double what would have occurred without climate change, due to more frequent events compared to the beginning of the 20th century and an increase in size of the vulnerable population (ageing population and other potentially vulnerable groups). Although temperature shifted towards warmer temperatures in the winter season, cold extremes occurred more frequently, contributing to a small increase of mortality during the winter months (Oudin Åström *et al.*, 2013).

A spread of insect outbreak zones has been observed in boreal forests with the greatest warming (Füssel *et al.*, 2017). Results of the Lancet study (Lindgren and Gustafson, 2001) suggest that milder climate in Sweden has contributed not only to increases in tick-borne encephalitis incidence, but also to increases in the incidence of other diseases transmitted by *Iricinus*, such as Lyme borreliosis and human erlichiosis. Both the SR1.5 (Hoegh-Guldberg *et al.*, 2018) and the EEA report (Füssel *et al.*, 2017) state that climate change negatively affects the emergence of water-borne diseases such as the Vibrio disease in Northern Europe. In fact, the percentage of coastal area suitable for Vibrio infections in the 2010s has increased by 24% compared with the 1980s baseline in the Baltic sea (Watts *et al.*, 2018). Similarly, the number of days suitable per year has almost doubled in the Baltic region, extending the highest risk season by around 5 weeks (ibid). *Figure 7* shows the projection of the risk of infection for 2050.



Note: Left: A risk model map during summer 2006 showing the number of cases in countries reporting infections. Right: A projection of the risk of infection in 2050.

Source: Adapted from Baker-Austin et al., 2012. © 2012 Macmillan Publishers Ltd. Reproduced with permission.

Figure 7: Current and projected risk of Vibrio infections in the Baltic Sea region (source: Füssel et al., 2017)

8.2 Agriculture

Increased frequency of extreme weather events is expected to increase the risk of crop losses and impose risks on livestock production (Füssel *et al.*, 2017). During dry years, water shortages pose serious challenges on a local and national level (including Stockholm). They result in competition between water supply, irrigation or sewage. Therefore, the agricultural sector will be affected by both the increased risk of flooding and drought (Ministry of the Environment and Energy, 2017).

8.3 Cultural heritage

Climate change and its impacts threatens both the livelihood and culture of the Sami, indigenous people of Northern Europe, who have a traditional lifestyle dominated by hunting, fishing and reindeer herding. Therefore, they closely depend on ecosystems for their way of life. However, lately, grazing lands have been shrinking, migration is becoming more difficult and traditional skills and knowledge are disappearing (Furberg, Evengå Rd and Nilsson, 2011).

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2.10. USA - Alaska

Country Profile: Akiak, Alaska (USA)

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Summary

Alaska is at the forefront of climate impacts already today: extreme temperatures and more wildfires, melting sea ice and glaciers, rising sea levels, increasing storm surges, increased precipitation and flooding, thawing permafrost, less predictable river conditions and shifting vegetation patterns. Alaska is warming much faster than the global average and these impacts will only intensify with increasing warming.

If global warming exceeds 1.5°C, key risks such as heat waves, glacier loss, sea ice melt, sea level rise, extreme precipitation and permafrost thawing will escalate rapidly. Under current emission trajectories, Alaska's children of today will spend more than half their lives in a world warmer than 1.5°C above pre-industrial levels.

Future impacts of climate change will strongly affect Alaska's Native societies, for which risks are assessed to become very high and exceeding their ability to adapt if warming exceeds 1.5°C. A number of native villages including Akiak are facing imminent flooding and erosion threats. Children in Alaska are vulnerable to psychological and social effects of climate change impacts such as loss of land and relocation including loss of cultural identity. At the same time, health impacts of climate change such as those associated with increases in wildfires in Alaska particularly affect children.

1. The IPCC Report's summary on Climate Impacts in Alaska

The increasing impacts of climate change have and will force indigenous communities in Alaska to relocate (IPCC, 2014). Climate change, for example, leads to increasing permafrost temperatures, which have increased in Alaska up to 3°C since the early 1980s (high confidence) (IPCC, 2014). Permafrost thawing leads to substantial decreases in soil strength, which impacts existing infrastructures such as transport and energy structures and their operation in Alaska (Hoegh-Guldberg et al., 2018). Moreover, Alaska is one of the regions with the largest increases in heavy precipitation events for 1.5°C to 2°C (Hoegh-Guldberg et al., 2018).

A combination of these impacts have already caused an increase in coastal and hillslope erosion, expansion of channel networks and landslides in Alaska since the 1980s (medium confidence), which have been directly attributed to climate change (IPCC, 2014 and IPCC et al., 2018). The seasonal changes and alterations in extreme events that result from climate change could reduce the reliance on indigenous knowledge, such as of the Yup'ik people in Akiak. This would strongly reduce the adaptive capacity of these indigenous communities in Alaska (medium evidence, medium agreement) (Hoegh-Guldberg et al., 2018).

2. Demographics and intergenerational aspects

The United States population is about 330 million, out of which 26% are children under the age of 19 (Wittgenstein Centre for Demography and Global Human Capital, 2018). An average 16-year-old US citizen, the petitioner's peer, is expected to live until the age of 87 (World Data Lab, 2019). The demographic estimates can be coupled with the projections of global mean temperature increases. Following the best estimate of the future temperature trajectory based on the Climate Action Tracker (Climate Analytics; Ecofys; New Climate Institute, 2019), increase in the global mean temperature is expected to exceed 1.5°C around the year 2035 (model median), 2°C around 2055, and more than 3°C in 2100. Today's US 16-year-old has a 99% probability of being alive in 2035, 95% in 2055 and 6% in 2100. Nearly all children in the United States therefore have a high probability of experiencing a 2°C world and the ensuing impacts, with a portion of them living to possibly experience an even higher warming.

Instead of the populations declining through out-migration in Alaska, many of the threatened places in Alaska are growing – raising both the potential costs of relocation and the number of people exposed to risks (Hamilton et al., 2016).

3. Temperature increases

Annual average air temperatures across Alaska have increased over the last 50 years at a rate more than twice the global average (very high confidence) (USGCRP, 2017). Alaska has already warmed by 1.8°C in the last 67 years, which is far above the mean global value of about 0.6°C per century (Wendler et al., 2017).

The average annual temperatures in Alaska are projected to increase by an additional 1.1°C to 2.2°C (2°F to 4°F) by 2050 (Chapin et al., 2014) - which will be experienced by 95% of todays 16-year old children from the US. If global warming is kept below 2°C, Alaska is still projected to warm by 3.3°C to 4.4°C (6°F to 8°F) in the north and 2.2°C to 3.3°C (4°F to 6°F) in the rest of the state by the end of the century. If global warming accelerates beyond 3°C, a temperature rise of 5.5°C to 6.6°C (10°F to 12°F) in the interior and 3.3°C to 4.4°C (6°F to 8°F) in the other parts of the state is expected (Chapin et al, 2014). The Fifth Assessment Report (AR5) also states that there will very likely be a large increase in hot days and a decrease in cool days in Alaska in the future (IPCC, 2014).

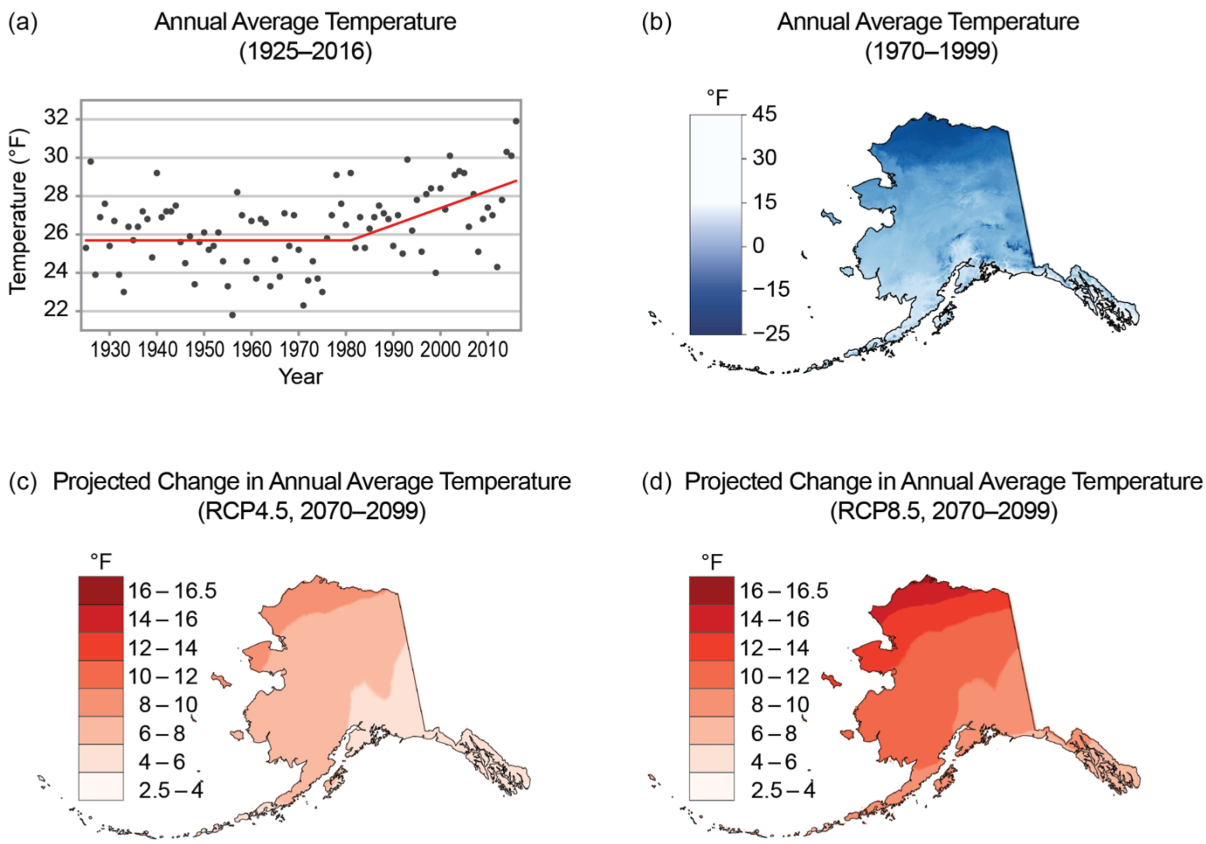

Figure 1: Observed and projected changes in annual average temperature (Fleming et al., 2018)

4. Precipitation

Precipitation increases were observed in all regions of Alaska (Wendler et al., 2017). The average total precipitation in the West, where Akiak is situated, has increased by 16% from 1946 to 2016 (Wendler et al., 2017). Extreme precipitation in summer, following a period of warm weather, has already caused increased glacial melting, which leads to flooding events and often results in additional driftwood movement (Mariana, 2008).

Alaska is one of the regions with the largest increases in heavy precipitation events for 1.5°C to 2°C (Hoegh-Guldberg et al., 2018). Under current emission trajectories, United States and thus

Alaskan children of today will spend more than half their lives in a world warmer than 1.5°C above pre-industrial levels.

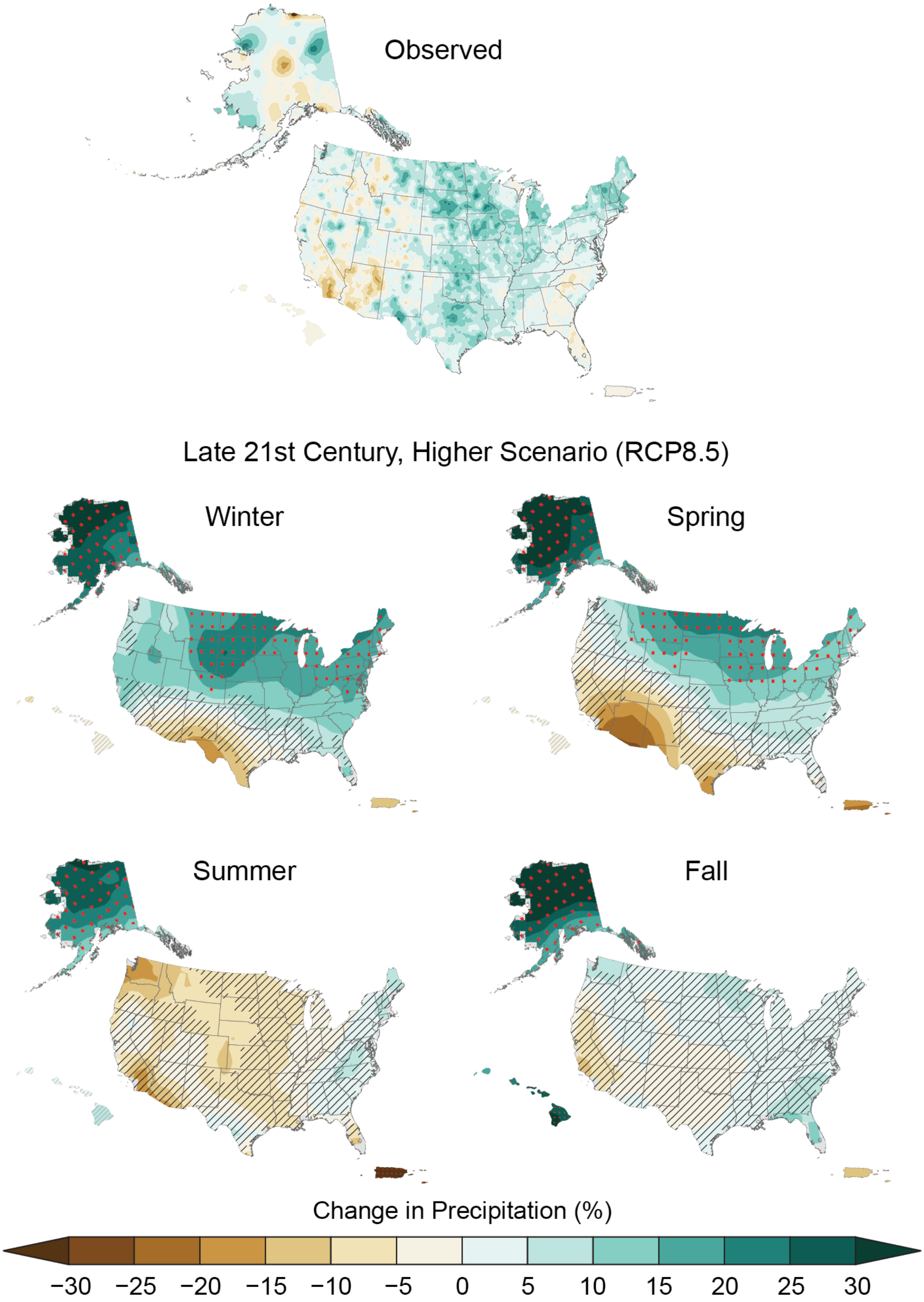

Figure 2: Observed and projected (RCP8.5 – 4.3°C by 2100) change in precipitation for the US (%) (Fleming et al., 2018)

5. Sea ice and glaciers

Annual arctic sea ice extent has decreased between 3.5% and 4.1% per decade since the early 1980s (Fleming et al., 2018). If warming exceeds 1.5°C, an ice-free Arctic in September is to be expected to occur frequently with drastic consequences for the ecosystems and livelihoods depending on sea ice (IPCC, 2018). The winter of 2017/2018 was the lowest winter-maximum areal sea-ice coverage on record (1980-2019) (Stabeno & Bell, 2019). The changes that were observed during the last few years "fall within changes predicted to occur before 2030 – ice retreating earlier and arriving later, resulting in an annual decrease in ice duration of 20-30 days" (Stabeno & Bell, 2019). Moreover, near-bottom ocean temperatures in 2018 were the warmest on record (the data is not yet available for 2019) (Stabeno & Bell, 2019).Sea ice is a relevant surface for numerous marine ecosystems that serve as an important source of carbon for grazers and provide food for people and ecosystems (Fleming et al., 2018). Moreover, organisms such as Arctic cod, polar bears and walruses depend on the sea ice and are directly affected by sea ice loss or thinning (Fleming et al., 2018).

The variability in ice extent has and is predicted to increase in the future, which directly impacts ecosystems "beyond the physics" and the coastal communities of Alaska that depend on sea ice for travels, hunting and to protect coastal infrastructure from winter storm surges (Stabeno & Bell, 2019).

Glaciers also "continue to melt in Alaska, with an estimated loss of 75 ± 11 gigatons (Gt) of ice volume per year from 1994 to 2013, 70% of which is coming from land-terminating glaciers; this rate is nearly double the 1962-2006 rate" (Fleming et al., 2018). With a temperature increase of 4.°C (RCP8.5) by 2100, mean annual runoff is expected to increase by 13% compared to historical conditions (Crumley et al., 2019). This could still be experienced by 6% of todays 16-year olds.

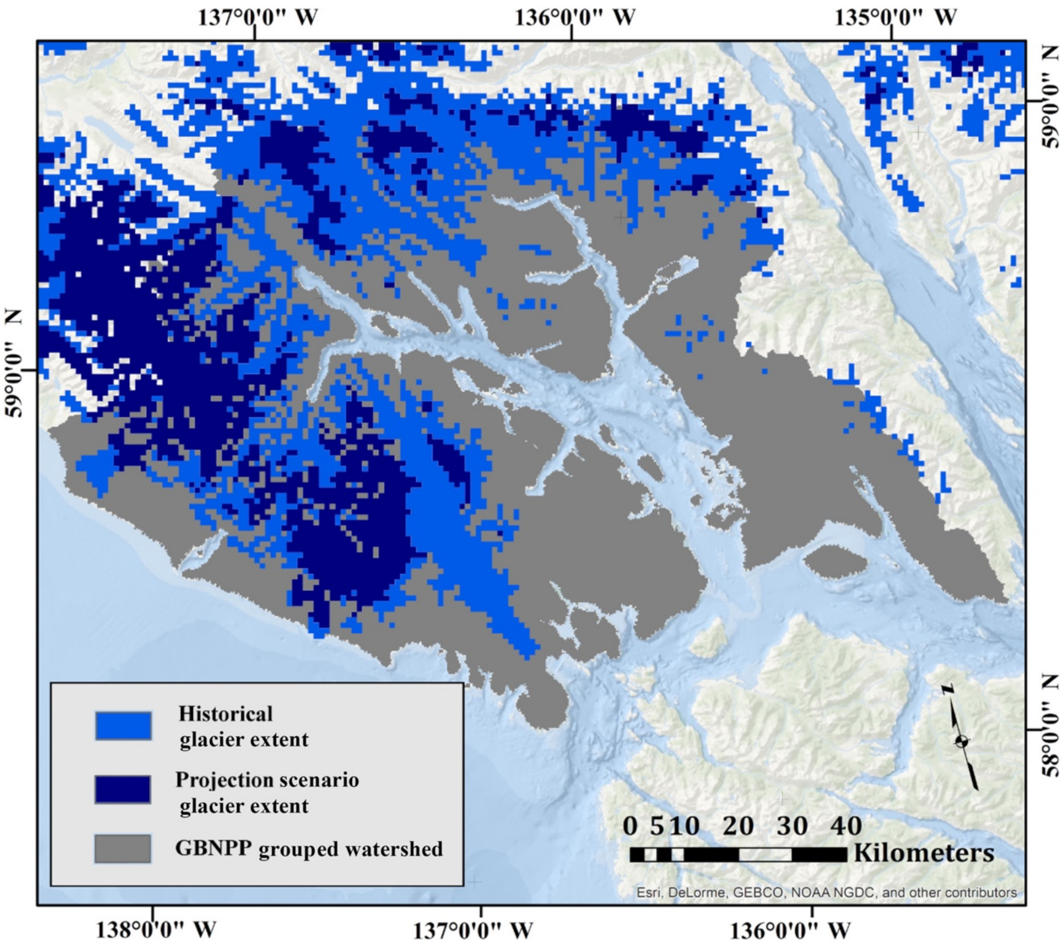

Figure 3: Changes in glacier extent for the historical period (1979-2015) and the projected scenario (2070-2099) using RCP8.5 (4.3°C increase by 2100) (Crumley et al., 2019)

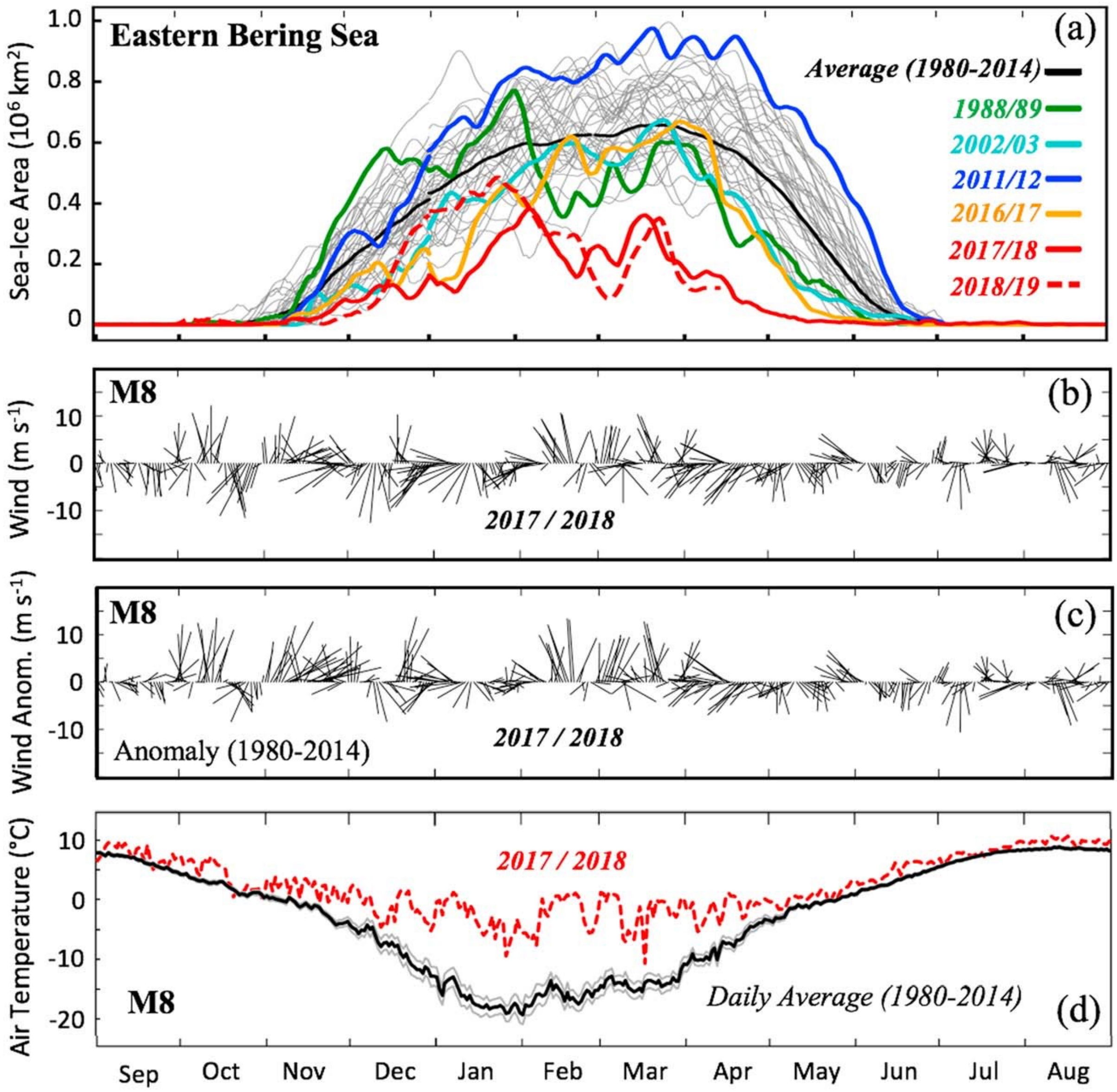

Figure 4: (a) Areal ice cover in the eastern Bering Sa for 1980-2019. (b) Wind and (c) wind anomalies for September 2017 to August 2018. (d) Atmospheric temperature (red) for 2017-2018 and daily mean for 1980-2014 (black) (Stabeno & Bell, 2019)

6. Sea level rise

For intermediate scenarios of climate change (2.4°C by 2100) mean maximum monthly sea levels are projected to increase from 1.8 m to 2.3 m by 2100 and would cause overbank flooding on a monthly basis in the Yukon-Kuskokwim Delta (Terrenzi et al., 2014). This is expected to cause salinization of ponds and meadows, damage vegetation, cause thermokarst and affect village infrastructure (Terenzi et al., 2014).

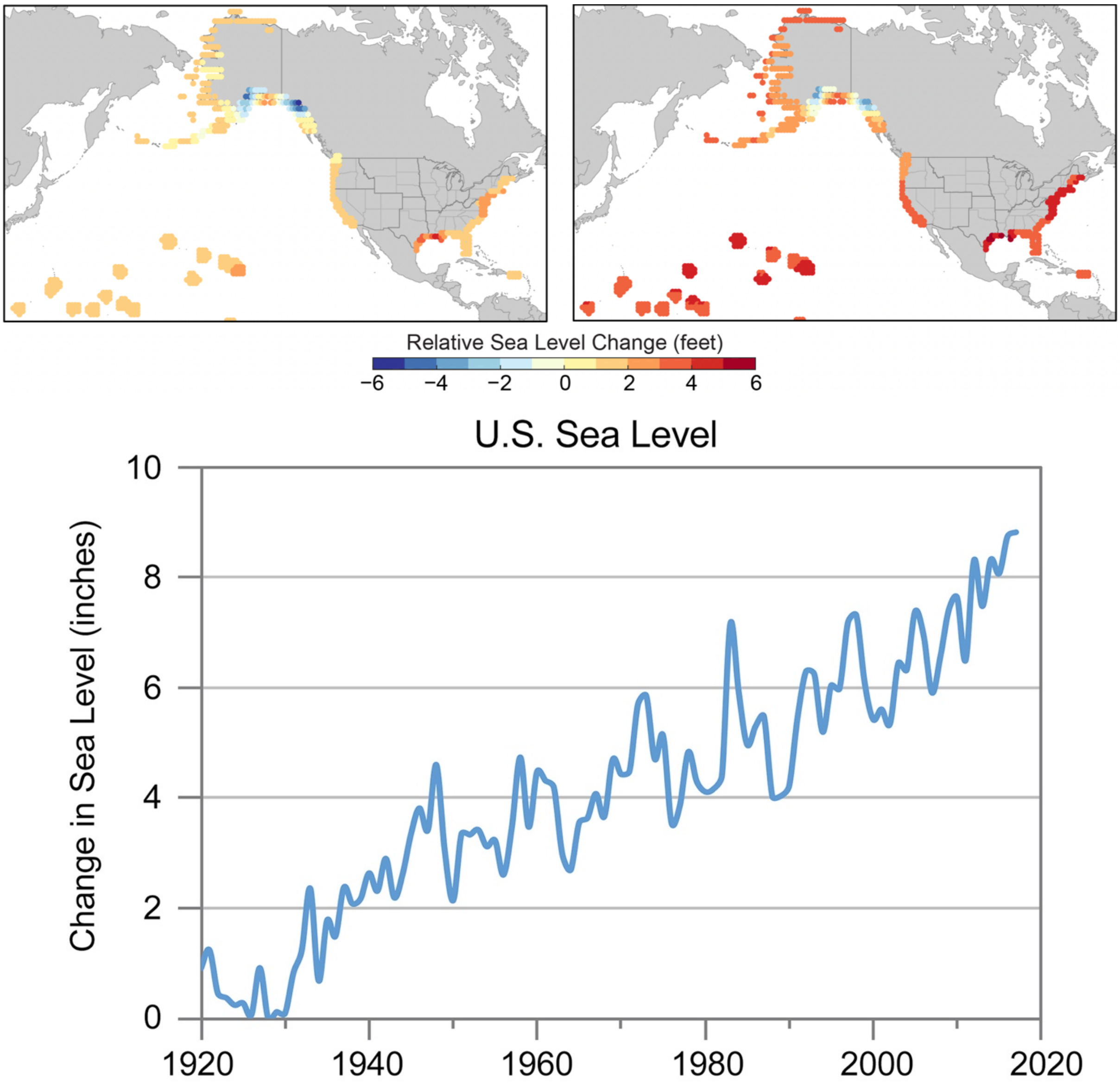

Figure 5: Observed and projected (left RCP4.5 – 2.4°C by 2100; right RCP8.5 – 4.3°C by 2100) changes in US sea level

7. Coastal erosion and coastal flooding

Coastal erosion can be facilitated by sea level rise, thawing permafrost, increasing river flows and reduced sea ice protection of shorelines (Hamilton et al., 2016). There has been an increase in coastal and hillslope erosion, expansion of channel networks and landslides in Alaska since the 1980s (medium confidence), which can be attributed to climate change (IPCC, 2014 and IPCC et al., 2018). These erosions threaten numerous riverine communities such as Akiak and affect their infrastructures (Melvin et al., 2017).

A number of coastal villages were and will be forced to resettle, which can lead to strong resistance in Alaskan native communities and can cost up to 1 million USD per person (Hoegh-

Guldberg et al., 2018). Akiak has been identified as one of the thirty-one Alaskan native villages facing immanent flooding and erosion threats (GAO, 2009).

More than 200 native villages have already been affected by some degree of coastal flooding and erosion, which have caused millions of dollars of property damage and have posed imminent threats to lives, homes and infrastructure (GAO, 2009). A local newspaper reported that in May 2019, there was massive erosion along the riverbank in Akiak (Kim, 2019). Around 30 meter of the river bank was lost within one day, leaving some houses only 3 meter away from the river. There is a growing concern that Akiak might turn into an island as it is surrounded by sloughs that might also be impacted by future erosion (Kim, 2019).

8. Permafrost thawing

Rising temperatures have increased permafrost thawing in most regions of Alaska since the 1980s (GAO, 2009). Permafrost thawing leads to substantial decreases in soil strength, which has impacted existing infrastructures such as transport and energy structures and their operation in Alaska (Hoegh-Guldberg et al., 2018). Other impacts, including an increase of flow speed rock glaciers and debris lobs, have also been related to permafrost changes (IPCC, 2018). Globally, the IPCC has found that "Limiting global warming to 1.5°C rather than 2°C is projected to prevent the thawing over centuries of a permafrost area in the range of 1.5 to 2.5 million km^2 *(medium confidence)*" (IPCC, 2018).

Finally, as large amounts of carbon dioxide and methane are stored in permafrost grounds *(high confidence)*, permafrost thawing has the potential to compromise the ability to limit global temperature increase (USGCRP, 2017). Permafrost thawing will increase with rising temperatures and can be directly attributed to climate change.

9. Wildfires

The thawing of permafrost may cause an increase in wildfires due to drying of land. Large forest fires in Alaska have increased since the early 1980s (high confidence) (USGCRP, 2017). Three out of the four big fire years, which indicates wildfires larger than around 8000 km^2, have occurred after the year 2000 (Fleming et al., 2018). Big forest fires are projected to further increase as the climate warms (medium confidence) (USGCRP, 2017). The area that will be affected by wildfires in 2100 is around 40.000 km^2 (98 million acres) under a scenario that leads to global warming by 2.4°C in 2100 and around 500.000 km^2 (120 million acres) under a scenario that leads to a global warming of 4.3°C by 2100 (Fleming et al., 2018).

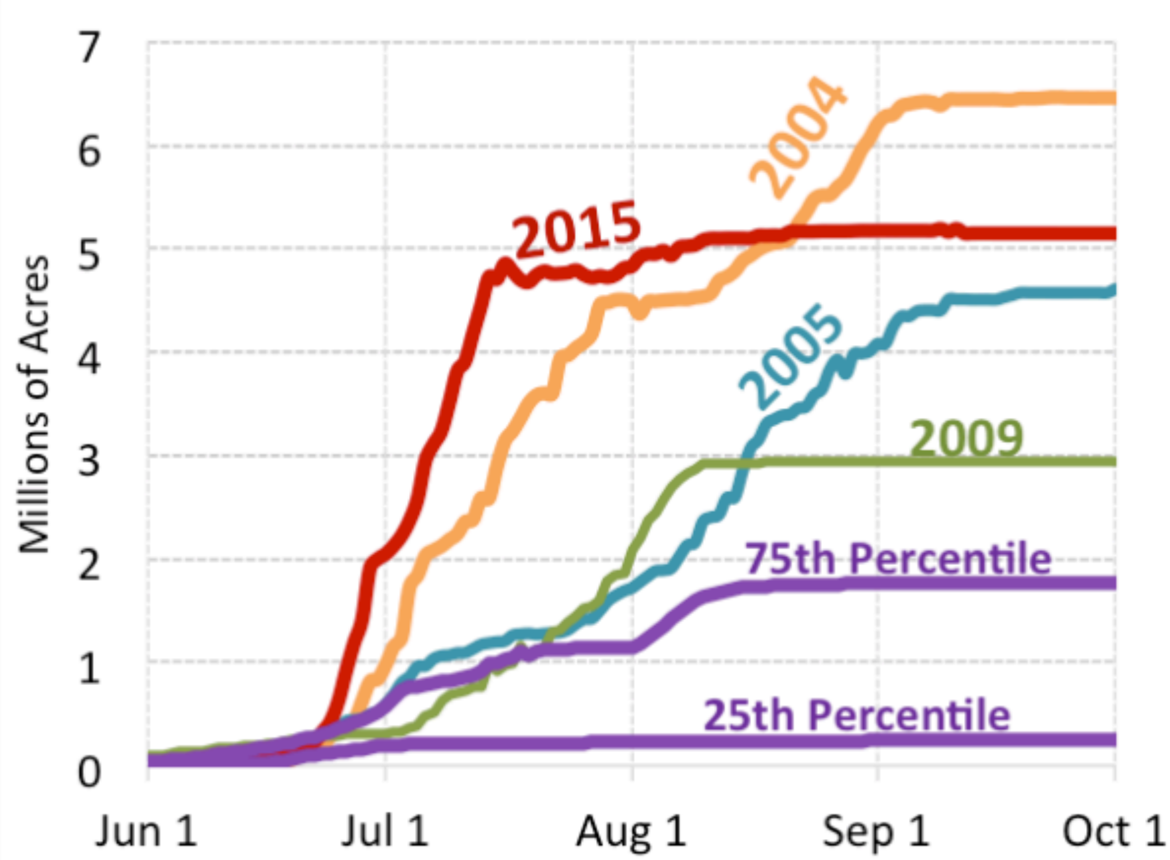

Figure 6: Averaged daily cumulative acres burned for specific recent above-normal fire years in Alaska compared to the climatological 25th and 75th percentile (1994-2015) levels (Partain et al., 2016)

10. Sectoral Impacts

10.1 Health

Climate change impacts such as floods and droughts can hinder water access, which leads to an increased risk of hospitalization from infectious diseases in Alaskan native communities (Cozzetto et al., 2013). Floods and storm damages also increased the "loss of vital food sources, disrupted traditional practices or relocation" (Fleming et al., 2018). Changing climate conditions have also increased hazards associated with subsistence activities among indigenous individuals (Hueffer et al., 2019). There is moreover an increasing risk and emergence of infectious diseases and insect vectors due to climate change, that have not been documented at high latitudes before (Hueffer et al., 2019). Moreover, the contamination of the Arctic and thus Alaskan food web by the industrialized world has endangered the health and wellbeing of indigenous people who depend on marine species (Hueffer et al., 2019).

Children are particularly vulnerable to climate driven increases in air pollution caused by wildfires (Fleming et al., 2018), which are predicted to increase with climate change.

There is also a growing concern of psychological and social effects on children caused by climate change, as community relocation can lead to a loss of cultural connections and adverse childhood experiences (Fleming et al., 2018). The uncertainty associated with these changes has mental health and may lead to substance abuse and self-harm (Fleming et al., 2018). Children are one of the most vulnerable groups to these climate-related changes (Fleming et al., 2018).

10.2 Agriculture and ocean acidification

As many of Alaskan natives, Akiak's Yup'ik children, rely on sea or river waters for hunting, fishing and gathering wild plants for food (GAO, 2009). Increasing temperatures, thinning artic summer sea ice and ocean acidification have strong impacts on ecological systems, such as an alteration in terrestrial and marine ecosystems, which lead to changing animal migration and distribution patterns (Hueffer et al., 2019). These patterns will negatively impact the subsistence practices by indigenous people with increasing climate change (Hueffer et al., 2019).

Ocean acidification, which is accelerated by warming temperatures, negatively affects organisms such as corals and affects the growth, behaviour and survival of relevant species in Alaska (e.g. pink salmon). For increasing global temperatures by 4.3°C in 2100, the Chukchi Sea is expected to cross the ocean acidification threshold (aragonite saturation state) around 2030, whereas the Bering Sea will likely cross the threshold around 2065 (Fleming et al., 2018). This would strongly limit "the ability of many marine species to form shells or skeletons" (Fleming et al., 2018).

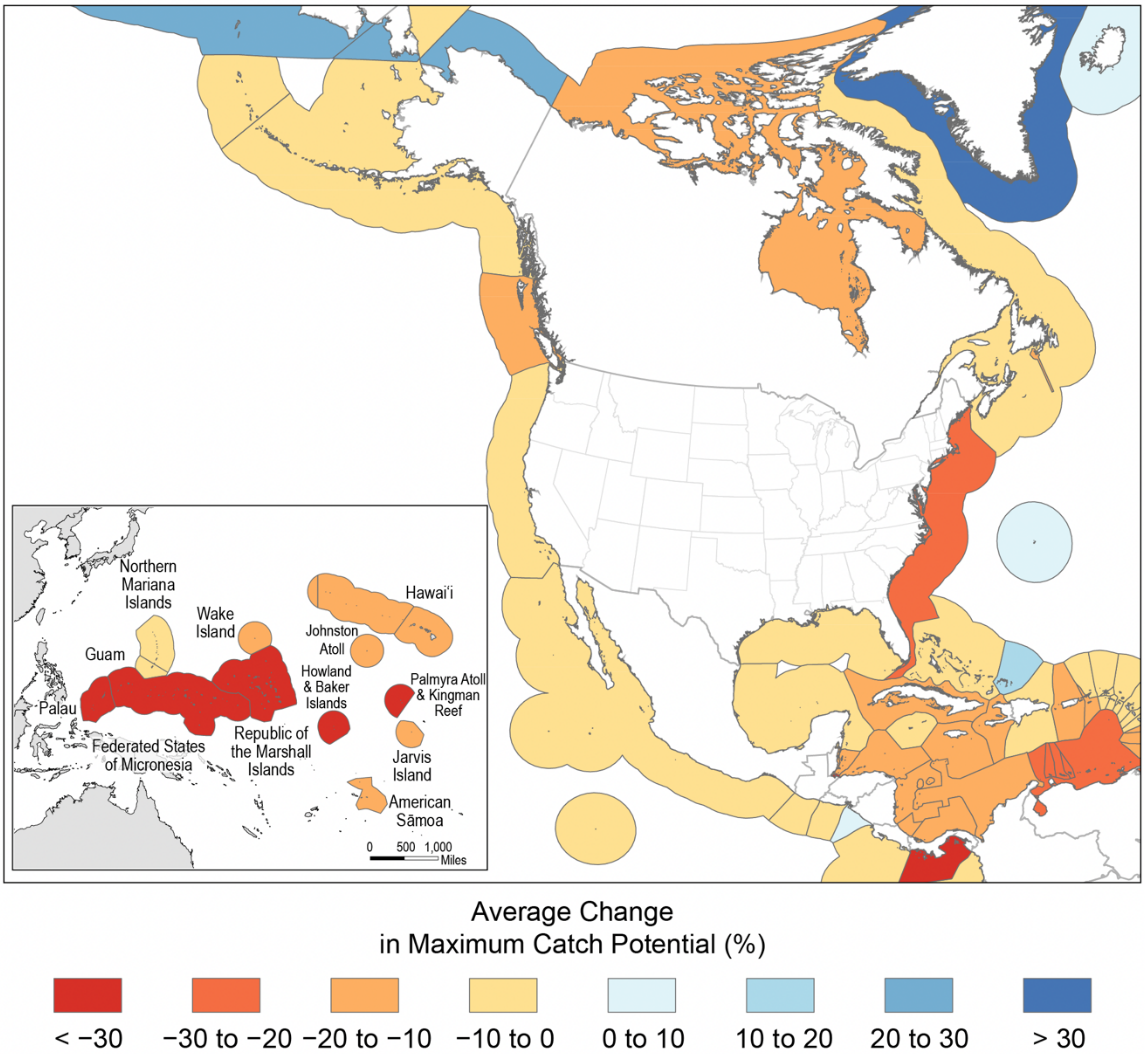

Figure 7: Average change in maximum catch potential in the US (Wendler et al., 2017)

10.3 Infrastructure

Climate change impacts, such as permafrost thawing, threatens homes and infrastructural prerequisites in villages such as Akiak (GAO, 2009). The economic impacts of climate change on infrastructure are projected at 4.2 billion USD to 5.5 billion USD from 2015 to 2099 (Hoegh-Guldberg et al., 2018). Adaptation measures would halve these estimates (Hoegh-Guldberg et al., 2018).

10.4 Cultural heritage and loss of livelihoods

Climate change and its subsequent seasonal changes and changes in extreme events could reduce the reliance on indigenous knowledge, such as of the Yup'ik people in Akiak. This would strongly reduce the adaptive capacity of these indigenous communities in Alaska (medium evidence, medium agreement) (Hoegh-Guldberg et al., 2018). Up until now, the Alaskan Inuit knowledge has ensured the source of food for hunters and reduced various risks (Hoegh-

Guldberg et al., 2018). Climate change will, however, alter subsistence activities and physical settings of Alaskan Native villages such as hunting, fishing and gathering on e.g. shore-fast ice.

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3. Key drivers of global climate change (including discussion of China, US, EU, and India)

Key Drivers of Global Climate Change

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Summary

--- Global greenhouse gases (GHG) emitted in 2016, led to the largest annual increase in global concentration of atmospheric CO_2 on record.

---- Nearly three fifths of these total GHG in 2016 were emitted by the top four emitting entities, China, the US, the EU and India.

---- Many countries continue to fall short in their policy ambition and emission reduction targets and this must be addressed in order to keep warming below the imperative 1.5°C

----China: China is the world's largest emitter, and its targets and policies have been rated as highly insufficient, as they are found to be consistent with warming between 3°C and 4°C if all other countries followed a similar approach.

---- United States: The US is one of the top CO_2 emitters in the world on a per capita basis at two and a half times the average of G20 countries in 2015 (Climate Transparency Initiative, 2018), and is currently planning on withdrawing from the Paris Agreement at the end of 2020, the only country with an intention to do so. If this intention is followed through with, it will go completely against significant global progress towards climate change mitigation.

----European Union: The EU's emissions are not consistent with what is required to keep warming to 1.5°C, but rather is consistent with warming between 2°C to 3°C.

----India: Given its growing population and development needs, with almost a fifth of the population still lacking access to electricity, how India chooses to address the growing energy demand has important implications for the global efforts to achieve the Paris Agreement goal.

Global greenhouse gases (GHG) emitted in 2016 totaled 47 $GtCO_2e$, leading to the largest annual increase in global concentration of atmospheric CO_2 on record (Gütschow et al., 2016; World Meteorological Organization, 2017). Nearly three fifths of these total GHG in 2016 (56.5%) were emitted by the top four emitting entities, China, the US, the EU and India (Gütschow et al., 2016). Since then, emissions have continued to rise, with global emissions in 2018 growing at their fastest pace since 2011, and energy emissions reaching a historic high, with China, India and the US accounting for 85% of the net 2018 GHG emissions increase from energy (Climate Action Tracker, 2019a). This increasing emissions trajectory stands in stark contrast to what is needed to keep warming at or below 1.5°C, which is for global emissions to halve by 2030 (Climate Action Tracker, 2019a).

While many countries are on track to meet their Nationally Determined Contributions (NDCs) that outline their current emission reduction commitments to 2030 under the Paris Agreement, overall these commitments amount to a critical deficit in ambition required to limit warming to 1.5°C, with unconditional pledges and targets leading to warming of 3.0°C at the end of the century (Climate Action Tracker, 2018a). Many countries continue to fall short in their policy ambition and emission reduction targets, leading to an even higher deficit as current policies would lead to an expected warming of 3.3°C. The level of ambition and action needs to be stepped up considerably in order to keep warming below the 1.5°C limit as required by the Paris Agreement (Climate Action Tracker, 2019a).

While climate action and ambition needs to increase in virtually all countries in order to close the global emissions gap between current emissions trends and emissions pathway compatible with the Paris Agreement, this briefing will focus on the four biggest emitters: China, the US, the EU and India, who have a critical role to play.

1. China

With its large population, China is the world's largest GHG emitter, contributing 26.3% of global emissions in 2016, almost double the next largest emitter in that year, the US (Gütschow et al., 2016). However, per capita emissions levels are below the global average. While China's annual GHG emissions levelled out between 2013 and 2016, total CO_2 emissions have increased in both subsequent years, rising 2.3% year-on-year (y-o-y) in 2018 (Climate Action Tracker, 2019c; Korsbakken, Andrew, & Peters, 2019). Total emissions (excl. LULUCF) are expected to continue rising to 2020 and beyond to 2030, reaching between 14.4 and 15.8 $GtCO_2e$/yr in 2030. This is an increase in total GHG emissions of 11%-21% above 2017 levels by 2030 (Climate Action Tracker, 2019).

China is currenty on track to meet its NDC requiring a peaking of emissions by 2030 and a reduction in carbon intensity of GDP by 60-65% below 2005 levels by 2030 (Climate Action Tracker, 2019). These targets and policies have been rated as highly insufficient by the Climate Action Tracker (2019), as they are found to be consistent with warming between 3°C and 4°C if all other countries followed a similar approach. These targets are not ambitious enough to limit warming to below 2°C, let alone to 1.5°C as required under the Paris Agreement, unless other countries make much deeper reductions at comparably greater effort. China must therefore substantially increase the ambition of its NDC and climate related policies.

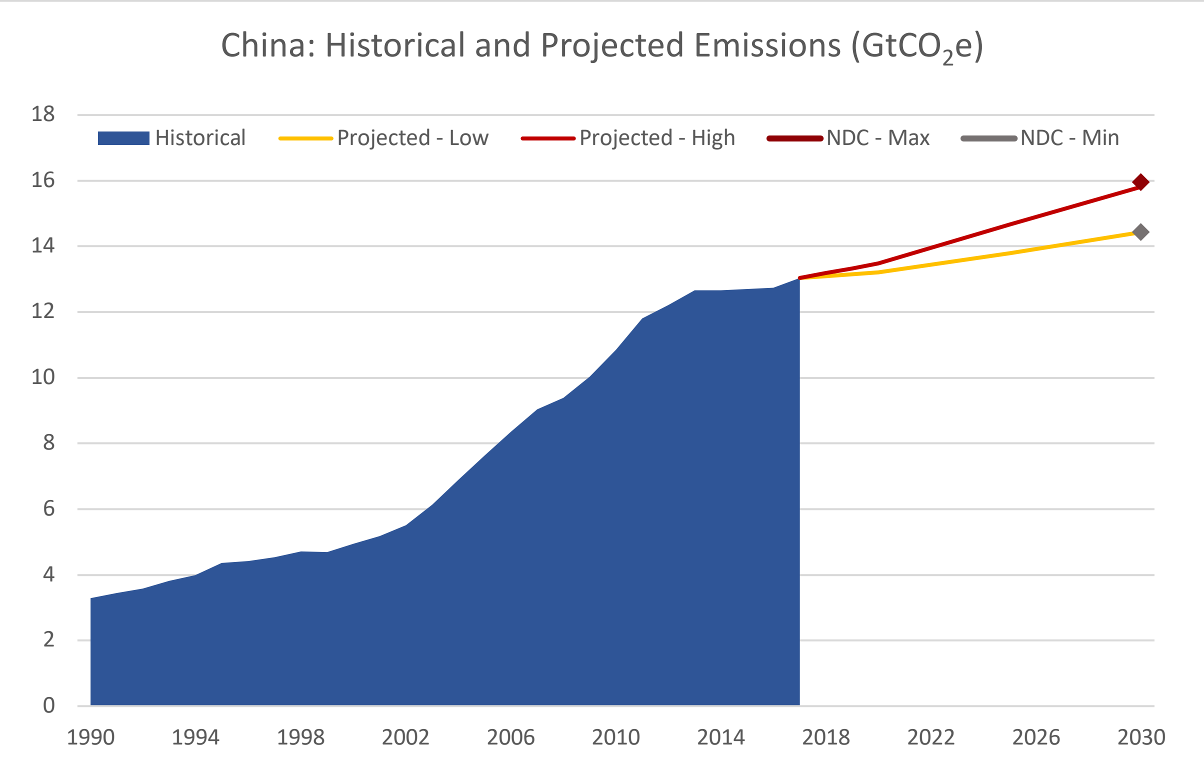

Table 1. Chinese Emissions and Emission Targets
Source: (Climate Action Tracker, 2019a)

Sectoral Emissions and Policy Gaps

Energy:

China's energy sector is heavily dependent on coal power, with the latest data from 2016 showing it constituted 65% of the primary energy supply, down from 2011's peak of 69% (IEA, 2018). This is projected to decrease to 55% by 2030 based on current policies (IEA, 2017). In 2016, China also accounted for 51% of the world's primary coal energy supply (IEA, 2018). Although coal consumption in China peaked in 2013, it has risen in the last two years due to increased electricity demand and heightened heavy industrial output (Feng, 2018).

China's energy related CO_2 emissions are projected to be roughly 70% of China's total GHG in 2020 (IEA, 2017), meaning increasing the ambition of energy policy is imperative. However, the abrupt reduction of subsidies for solar projects and the lifting of a ban on new coal-fired power plants in 2018 are sending Chinese energy policy in the wrong direction. In 2018, China began construction on 28 GW of new coal-fired capacity, bringing total coal capacity under construction to 235 GW. The IPCC Special Report on 1.5°C found that coal needs to exit the power sector by 2050 globally if warming is to be limited to this level (IPCC, 2018), and efforts by China to reduce coal in the next few years will be critical to this. In global cost-optimal, Paris Agreement-consistent pathways, China phases out coal by 2040 (Climate Analytics, 2016).

Industry:

Industry accounted for an estimated 30% of energy-related CO_2 emissions in China in 2017, and increased industrial output was primarily responsible for the overall CO_2 emission increase in 2018 (International Energy Agency, 2018). China has committed to modernising and improving the quality of its industrial sector, implementing an industrial energy saving standard in 2017 which aims to align 80% of China's energy efficiency standards with international standards by 2020. Between 2012 and 2017, 177 compulsory energy consumption and efficiency standards were published, which exist alongside China's Industrial Green Development Plan that promotes green manufacturing and supply chains (Gallagher, Zhang, Orvis, Rissman, & Liu, 2019).

Efforts to monitor and reduce non-CO_2 gases such as hydrofluorocarbons (HFCs) began in 2014, which in 2012 accounted for 1.6% of total Chinese GHG emissions (UNFCCC, 2018), however widespread use of CFC-11, a globally banned ozone depleting substance that is a GHG 4,000 times more potent than CO_2 was reported recently (Environmental Investigation Agency, 2018). Such non-CO_2 GHG emissions are much more potent than CO_2 emissions and are expected to constitute 23-25% of China's total GHG emissions by 2030. While the importance of addressing these emissions is acknowledged in their NDC, greater effort is needed to control projected emission increases.

Transport:

China has seen rapid progress in the uptake of electric vehicles (EVs), with over 1.1 million sold in 2018 (Irle, 2019), constituting a 4.2% market share and meeting the goal of one million vehicles by 2020 two years early. This is largely due to the implementation of subsidies and tax breaks. As part of China's broader industrial policy, a fuel economy standard of 5L/100km is in place for new vehicles from 2020 (Gallagher et al., 2019).

2. US

The US is the world's second largest emitter of GHG, contributing 13.5% of global emissions in 2016 (Gütschow et al., 2016), while also one of the world's top GHG emitters in the world on a per capita basis, at two and a half times the average of all G20 countries in 2015 (Climate Transparency Initiative, 2018). While US GHG emissions peaked in 2007, they subsequently rose in 2010, 2013, and 2014 and preliminary evidence shows them rising in 2018 after three consecutive years of declines (Houser, Pitt, & Hess, 2019). Given the current administration's campaign to rollback US federal climate policy, emissions could potentially increase by up to 400 $MtCO_2e$ over what they were projected to be before President Trump took office (Climate Action Tracker, 2019a). Projected emissions are not expected to fall back below 2017 levels before either 2022 or 2023 under current policies with only minor emission reductions expected to 2030. Emissions are expected to reach between 6.3 and 6.4 $GtCO_2e$ by 2025 and between 6.2 and 6.3 $GtCO_2e$ by 2030 under current policies (Climate Action Tracker, 2019b). This level of emissions is equivalent or slightly below (0-2%) 1990 levels and only 13 to 15% below 2005 levels.

The US is currently planning on withdrawing from the Paris Agreement at the end of 2020, the only country with an intention to do so. If this intention is followed through with, it will go completely against significant progress towards climate change mitigation, as it will not have any official emission reduction targets. The US is in any case not on track to meet its existing NDC of a 26-28% reduction below 2005 levels by 2025. This commitment already falls short of putting the US on an emissions pathway compatible with limiting warming to 1.5°C, being compatible instead with warming between 2°C to 3°C, implying that policies would need to be more robust than even those that are currently being rolled back or planned to be rolled back (Climate Action Tracker, 2019b).

While at the subnational level, some cities, states, businesses, and other organisations are adopting mitigation targets, recent analysis suggests that even if these targets were fully implemented, they would not be enough to meet the NDC targets, resulting in emissions that are 17–24% below 2005 levels in 2025 (incl. LULUCF) (Climate Action Tracker, 2019b).

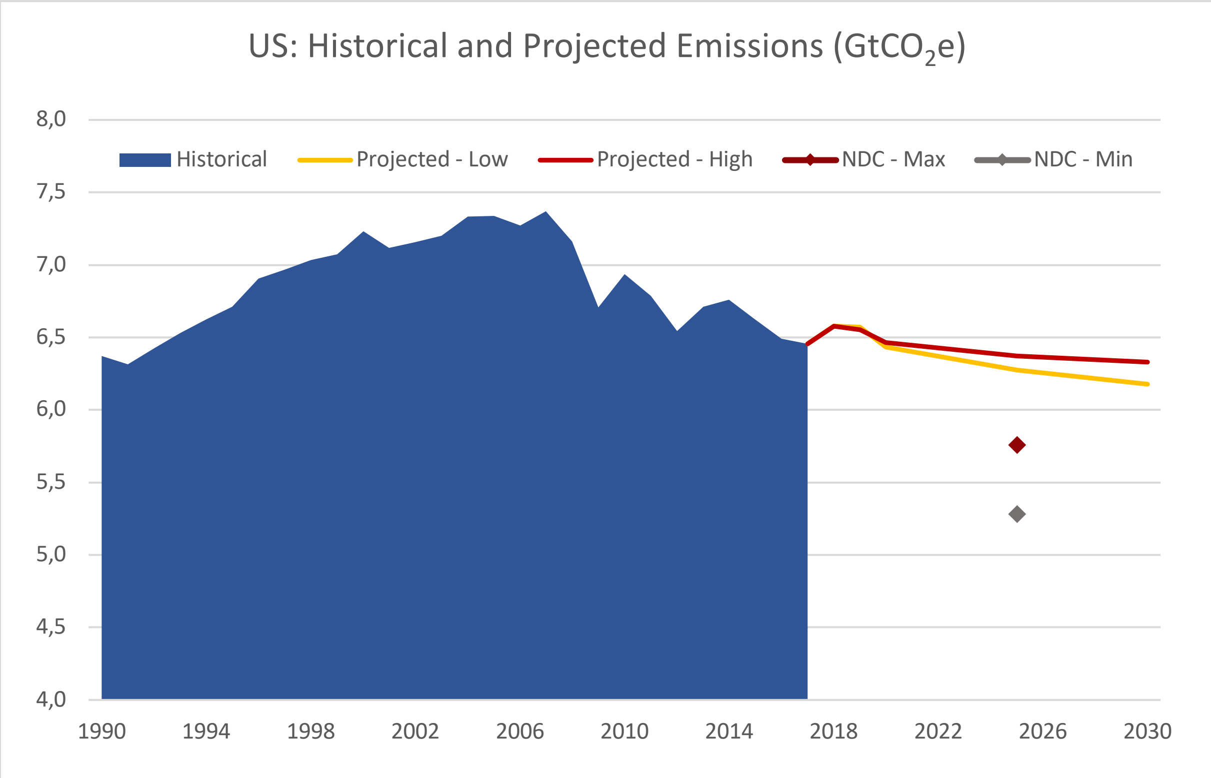

Table 2. US Emissions and Emission Targets
Source: (Climate Action Tracker, 2019a)

Sectoral Emissions and Policy Gaps

Energy:

The emissions intensity of US electricity generation has decreased from its 1997 peak of 639gCO_2/kWh to 427gCO_2/kWh in 2018, thanks in part to an almost doubling of the percentage of renewables from 1990 levels to 21.56% in 2018 (US Department of Energy, 2019a). In 2018 the US became the world's largest producer of crude oil (US.Energy Information Administration, 2018), while LNG exports grew by 53% in 2018 (US Department of Energy, 2019b). Rapidly increasing levels of fracking activity brings with it the threat of higher levels of fugitive methane emissions, with methane gas a much more potent GHG than CO_2 (UNFCCC, 2014). To meet its current NDC, the US would have had to implement the Clean Power Plan (CPP) and the Obama administration`s Climate Action Plan or equivalent measures (Climate Action Tracker, 2019b).

The Trump administration's proposed replacement for the CPP, the Affordable Clean Energy (ACE) rule is a significant departure from the CPP and is likely to result in emissions that are up to 81 $MtCO_2e$ higher in 2025 and 212 $MtCO_2e$ higher in 2030 than if the CPP had been fully implemented (U.S. Energy Information Administration, 2018a). The Trump Administration has also proposed weakening emissions standards for new coal-fired power plants from the 2015 standard of 635 gCO-2/kWh to between 860 and 1000 gCO2/kWh depending on the type of plant (U.S. Energy Information Administration, 2018b).

Industry

The intended prohibition of the use of certain HFCs in industry under the Obama administration's Significant New Alternatives Policy (SNAP) was subsequently blocked by a court ruling (U.S. Environmental Protection Agency, 2018). This means the estimated 78-101 $MtCO_2e$/yr reduction by 2030 that was expected under this policy is unlikely to be achieved (U.S. Environmental Protection Agency, 2015). Meeting the Kigali Amendment of the Montreal Protocol which seeks to eliminate the use of such gases would have required more stringent reductions than those expected under the SNAP programme.

Transport:

While the US has made progress on mandating higher fuel efficiency standards in recent years, these are set to be weakened under a current EPA proposal to freeze them at 2020 levels (U.S. Environmental Protection Agency, Administration, & U.S. National Highway Safety Administration, 2018). This is expected to increase emissions by 22 MtCO2e/yr in 2025 and 76 MtCO2e/yr in 2030 (Climate Action Tracker, 2017). Subsidies to encourage the purchase of EVs have been rolled back over time which will put pressure on the current strong upward trajectory of US EV sales.

3. EU

The EU is the world`s third largest GHG emitter contributing 9.4% of global GHG emissions in 2016 (Gütschow et al., 2016). While EU GHG emissions have been generally trending down since 1990, they were more or less stable between 2014 and 2017, suggesting that the EU needs to increase its efforts to continue its downward emissions trajectory. There have been positive recent policy developments which suggest this is happening. The reform of the EU ETS finalised in 2018 has already led to an increase in the price of allowances. In 2018 the EU adopted new renewable energy and energy efficiency directives with the goals of increasing the share of renewables to 32% and lowering energy demand by 32.5%, both by 2030 (European Parliament and the Council of the European Union, 2018b, 2018c). Currently the EU is also discussing the adoption of the long-term strategy for climate action with the goal of emissions neutrality by 2030 (European Commission, 2018). EU emissions are expected to reach between 2.94 and 3.92 $GtCO_2e$ by 2030 with its NDC falling in the middle of this projection range at 3.39 $GtCO_2e$ by 2030 (Climate Action Tracker, 2019b).

The EU's NDC of at least a 40% GHG emission reduction below 1990 levels by 2030 is not consistent with what is required to keep warming to 1.5°C without requiring other countries to compensate with greater levels of ambition and is instead consistent with warming between 2°C to 3°C. Policies already adopted will result in an emission reduction of around 48% (Climate Action Tracker, 2019a). Thus it is imperative for the EU to go beyond the NDC. Furthermore, to increase planning security and facilitate development of new low carbon solutions, the EU needs to adopt the goal of emissions neutrality by the middle of the century.

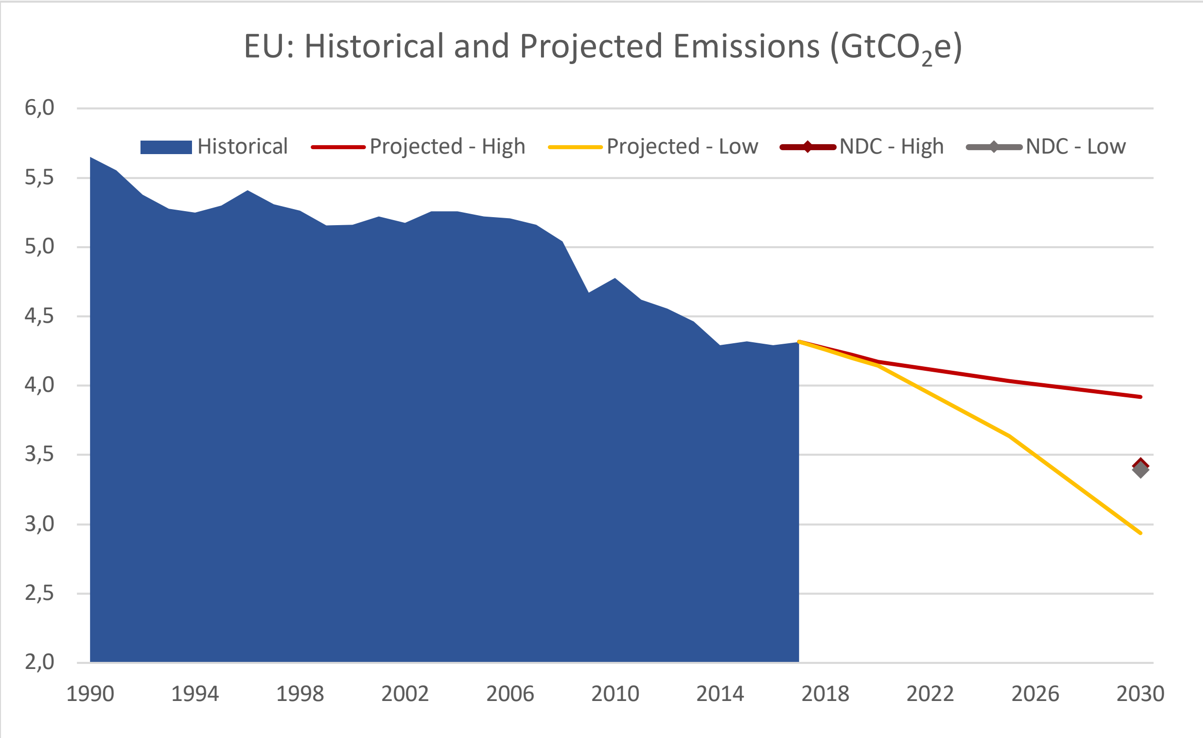

Table 3. EU Emissions and Emission Targets Source: (Climate Action Tracker, 2019a)

Sectoral Emissions and Policy Gaps

Energy:

The EU has made significant strides recently to increase the ambition of its targets relating to the energy sector. The 2018 adoption of the Renewable Energy Directive sets a binding goal of generating 32% of the EU's gross final energy consumption from renewable sources by 2030, while the Energy Efficiency Directive, adopted at the same time, aims to increase energy efficiency by 32.5% by 2030. Coal phase-out policies are currently being discussed in a number of countries with some already producing target dates. While the renewable energy and energy efficiency goals would result in emissions reduction by 48%, in combination with the coal phase-out plans emissions would fall by at least 50% (Sandbag, 2019).

The National Energy and Climate Plans (NECPs) of EU member states show that more action and ambition is needed in this sector for the EU as a whole, with some member States lagging significantly behind (Flisowska & Moore, 2019). An EU level coal phase-out strategy, however, could facilitate a timely transition away from coal across the continent, and make a large contribution to GHG emission reductions. Furthermore, EU member states are increasing their support for the development of gas infrastructure that will increase EU dependency on energy imports and lock-in the energy sector in a carbon intensive pathway. Abolishing these plans and accelerating the development of renewables and smart solutions to adapt the grid to a 100% share of renewables is essential to meet the emissions neutrality goal.

Industry:

The strengthening of the EU ETS in 2018 will have a significant impact on emission reductions from industry, with many emission intensive sectors covered by the scheme. The 2010 Industrial Emissions Directive works to reduce emissions from those large industrial installations not covered by the ETS, by requiring them to prove they are operating according to the Best Available Techniques (European Parliament and the Council of the European Union, 2010).

Transport:

The transport sector – as well as the building and agriculture sectors – is covered by the Effort Sharing Regulation, which stipulates emissions reduction by 30% by 2030 in comparison to 2005. This goal is divided between EU member states depending on the GDP per capita (European Parliament and the Council of the European Union, 2018d). The transport sector in the EU has seen a large increase in emissions above 1990 levels up until 2017 (28% higher), with the aviation sector in particular doubling in emissions over this time (European Environment Agency, 2018). While aviation is included in the EU ETS, extra-EU flights have been exempted from the obligation to submit emissions allowances and intra-EU flights continue to benefit from Value Added Tax exemptions. Further measures must be taken accordingly to address the rising contribution aviation makes to total emissions. The EU Sustainable Transport Strategy has not been updated since 2009, while the European Investment Bank's transport policy dates from 2011; both need to be updated to catalyse deepening emission cuts. With multiple policy tools in place to address the transport sector, including emission standards for vehicles and mandates for low carbon vehicles, there is great scope for ratcheting up emission reduction potential from this sector.

Buildings:

The adoption of the Energy Performance Buildings Directive (EPBD) in 2010 committed member countries states to ensuring all new buildings from 2021 are "nearly zero energy buildings". With many EU member states having low rates of renovation of their existing building stock, the EU also amended the EPBD in 2018 to oblige member states to submit a long-term renovation strategy in order to fully decarbonise their building stock by 2050 (European Parliament and the Council of the European Union, 2018a). Under the Energy Efficiency Directive of 2012, member states are required to ensure that 3% of the total floor area of publicly owned buildings are renovated annually to meet minimum energy requirements (European Parliament and the Council of the European Union, 2012). However, only seven member states complied with this directive, with overall renovation rates sitting between 1-2% annually overall (Climate Action Tracker, 2018b).

4. India

With its large population, India is the world's fourth largest GHG emitter, contributing 7.3% of global GHG emissions in 2016 (Gütschow et al., 2016). However, per capita emissions levels are well below the global average. Given its growing population and development needs, with almost a fifth of the population still lacking access to electricity, how India chooses to address the growing energy demand has important implications for the global efforts to achieve the Paris Agreement goal (Climate Analytics, 2019).

Emissions have been rising steadily since 1990 and are expected to continue rising to 2030, but based on strong recent policy developments, India's projected future GHG emission trajectory is far lower than it would have been otherwise. Emissions are expected to reach between 4.5 and 4.6 $GtCO_2e$ by 2030 (Climate Action Tracker, 2019b).

India is well on track to meet and even overachieve its NDC commitments of reducing the emissions intensity of GDP by 33-35% below 2005 levels by 2030 and the more ambitious conditional target to increase the share of non-fossil-based energy resources to 40% of installed electric power capacity by 2030 (Climate Action Tracker, 2019b). While these targets are not consistent with placing India on a pathway to limit warming to 1.5°C, they are compatible with the ambition level required to limit warming to 2°C if other countries of similar levels of development made similar commitments. Given India is likely to surpass these targets, there is a strong case for India to ratchet up the ambition level of its NDC and reach 1.5°C compatible status.

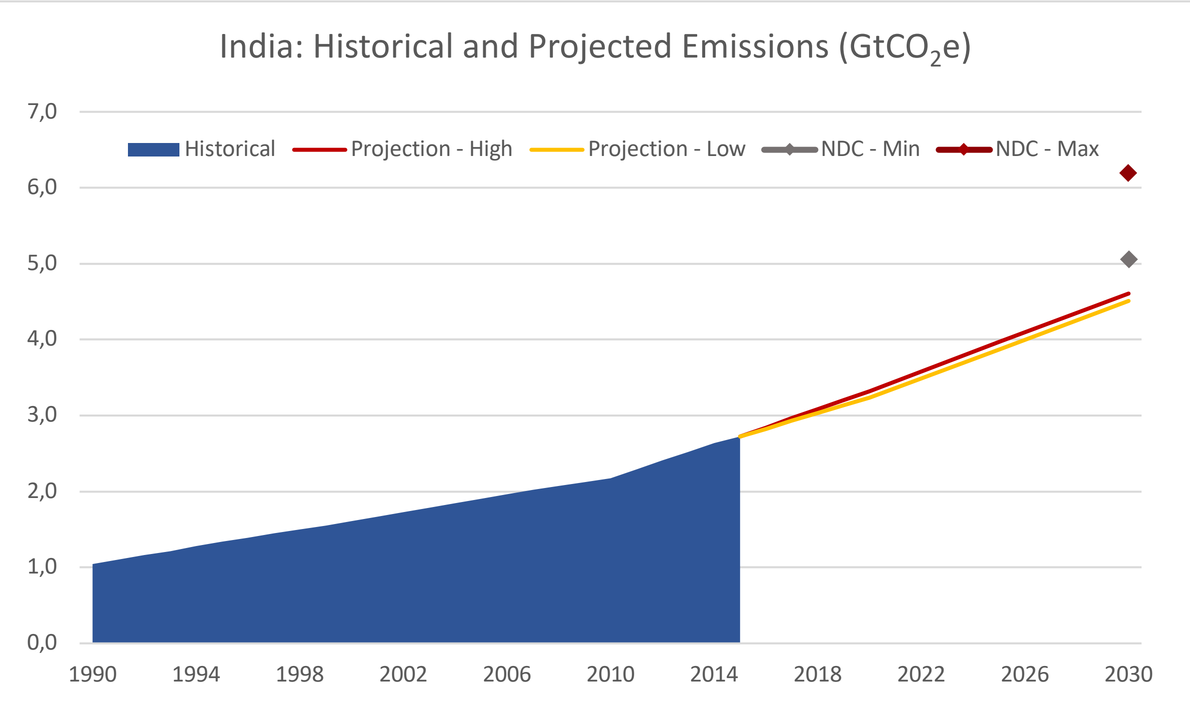

Table 4. Indian Emissions and Emission Targets. **Source:** (Climate Action Tracker, 2019a)

Sectoral Emissions and Policy Gaps

Energy:

The power sector accounted for 32% of India's total emissions (excluding LULUCF) in 2015. India's CO2 emissions from energy rose by 4.8% in 2018, largely driven by emissions from coal power plants (IEA, 2019). Coal fired power generation accounted for 75% of India's total power generation in 2015 (IEA, 2017), which results in an emissions intensity of power supply (767 gCO2/kWh) far higher than the global average (475 gCO2/kWh). While coal capacity is expected to continue growing substantially, with 46GW of additions between 2022 and 2027 (CEA, 2018), the rate of growth in renewable energy capacity is encouraging with current policies expected to lead to non-fossil electricity generation of 40-44% by 2030 which is still not high enough to be consistent with the Paris Agreement (Climate Analytics, 2019).

Significant uncertainty still remains though regarding the trajectory of India's coal power capacity, with subsidies still in place contributing to the expected future capacity (IISD, 2018). However, with strong government support for renewables and falling prices likely to continue the strong uptake in renewables, there is potential that not all future projected coal capacity will eventuate or that future coal plant projects will end up as stranded assets (Dubash, Kale, & Bharvirkar, 2018). The government's Draft National Energy Policy and Three-Year Action Agenda (2017–18 to 2019–20) include recommendations to increase domestic production and distribution of coal, oil and gas, which, if adopted by the government, will prove to be a significant threat to India's climate goals (NITI Aayog, 2017b, 2017a). Addressing concerns over the grid integration of renewables and cancelling the planned coal expansion plans are pivotal steps in the short term for India to meet the goals of the Paris Agreement.

Industry:

India's main tool for increasing industrial energy efficiency is the Perform, Act, Achieve Mechanism, which resembles an emissions trading scheme, although it sets intensity-based energy targets. In addition to this there is an intention to launch a pilot carbon market mechanism for micro, small, and medium enterprises (MSMEs) and the waste sector, which are not covered by existing climate policies and currently rely on outdated technologies, meaning they have a large emissions reduction potential.

Transport:

Recent policy efforts have been put in place to encourage faster uptake of EVs including subsidies and provisions for constructing charging infrastructure (Business Today, 2019), but an announced ambitious sales target of 100% EV sales by 2030 has since not been followed through on. This target would have been consistent with global benchmarks to reach full decarbonisation. India's first light vehicle fuel efficiency standards came into force in 2017, starting at the equivalent of 130 gCO2/km in 2017 and falling to 113 gCO2/km in 2022 (Transportpolicy.net, 2017), however there are currently no emission standards for light commercial vehicles.

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4.1. Argentina

Drivers of Climate Change: the case of Argentina

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Summary

The largest share of Argentina's emissions are from the energy sector, followed by agriculture and Land Use and Land Use Change sector. The electricity sector is the main contributor of Argentina's energy emissions (34%), with fossil fuel-based generation (mostly gas) accounting for 64% of the total generation. In the agriculture sector, livestock farming is the main contributor to emissions (78%), which have been steadily growing historically and are set to continue increasing.

Argentina's climate commitment and projected emissions levels under current policies for 2030 are consistent with global warming between 3°C and 4°C by the end of the century, if all countries were to follow Argentina's approach.

Argentina will need to implement additional policies to meet its 2030 NDC target. While under current policy projections, the energy mix target for biofuels for 2030 will likely be achieved, other targets, in particular the renewable energy share in the electricity sector by 2025 and 2030 and its NDC target by 2030 will be missed by a large margin.

Although Argentina has shown significant positive developments in the transport and electricity sectors by adopting policies increasing the share of biofuels in combustible and pushing the uptake of renewable energies, more climate ambition and action are needed. In the transport sector, mitigation efforts are centered in biofuels use, which prologues dependency on combustion engine vehicles in the medium and long term as demonstrated by

the very low projected penetration rate of electric vehicles in Argentina. Moreover, full decarbonization of the Argentinian power sector is at odds with high government support on natural gas production. Argentina is also lagging behind in agriculture sector emissions mitigation with no particular policies in place to halt emissions growth in this sector.

Paris Agreement compatible emissions pathways require emissions to peak and decline fast afterwards, reaching carbon neutrality by mid-century. In contrast, under current policies, emissions of Argentina are expected to grow by 2030.

Argentina's Emissions Profile

Historical and Projected Emissions

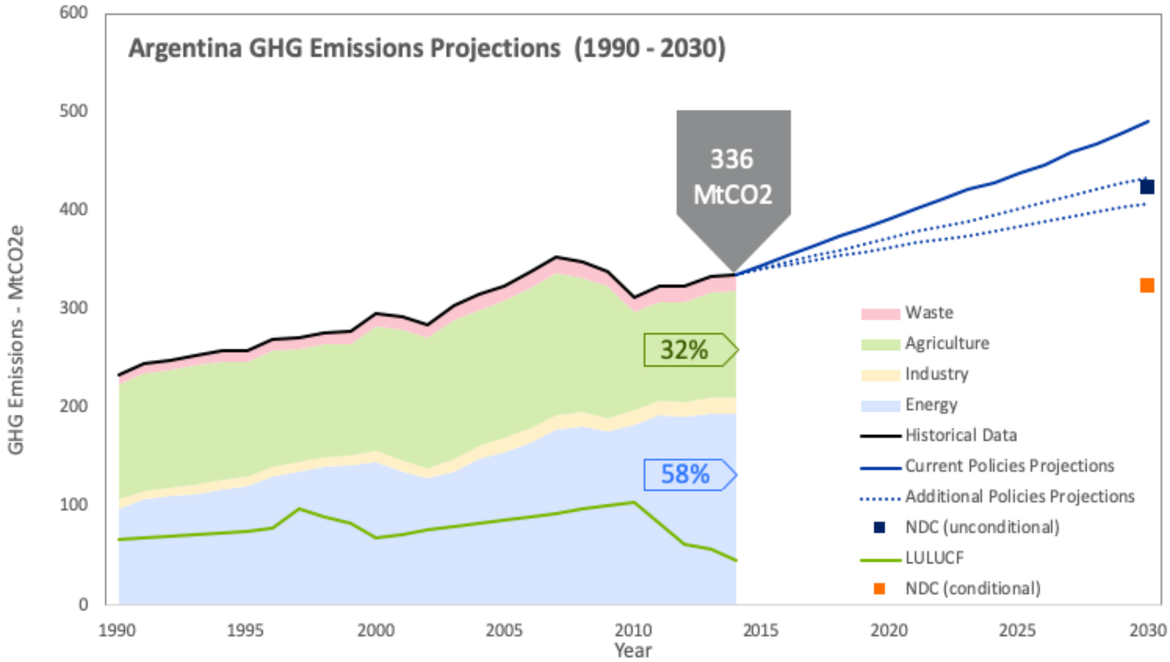

Figure 30: *Historical and projected emissions of Argentina from 1990 to 2030 based on the most recent update from Climate Action Tracker* (Climate Action Tracker, 2019). *Sector breakdown is made available from the National Inventory Report from 2017 submitted by the Government of Argentina* (Ministerio de Ambiente y Desarrollo Sustentable, 2017). *Shares of Agriculture and Energy sectors (respectively 32% and 58%) are here indicated excluding LULUCF emissions.*

As shown in figure 1, historical emissions in Argentina decreased significantly between 2007 and 2010 reaching 313 $MtCO_2$ in 2010 excluding Land Use and Land Use Change (LULUCF). Since then, Argentina's emissions have been steadily growing to reach 336 $MtCO_2$ in 2014 (excl. LULUCF), upon most recent historical data provided by official sources (Secretaria de Ambiente y Desarrollo Sustentable, 2017). Third party sources estimated the country emissions for 2015 and 2016, reaching a share of 0,8% of emissions worldwide in 2016 (Gütschow, Jeffery, & Gieseke, 2019).

According to Climate Action Tracker most recent assessment (Climate Action Tracker, 2019), under current policies, annual emissions from all sectors (excluding LULUCF) are still projected to grow significantly, by about 56% above 2010 levels by 2030, reaching approximately 490 $MtCO_2$ in 2030. This is equal to doubling 1990 emissions levels.

The current policies emissions projections shown in figure 1 is based on the mitigation scenarios underlying the third National Communication of Argentina to the UNFCCC (Secretariat of Environment and Sustainable Development, 2015). Additional policy scenarios, assuming a full implementation of the renewable targets and additional energy efficiency measures, shown in figure 1 are based on the Energy Scenarios from the Ministry of Energy (Ministry of Energy and Mining Argentina, 2018).

Key sectors drivers of Emissions

The largest share of Argentina's emissions is from the energy sector, accounting for 58% of the total (excl. LULUCF) in 2017 (Figure 30), followed by agriculture emissions accounting for 32% of the total (excl. LULUCF). Instead of being an emissions sink, the LULUCFs sector is the third largest single contributor to Argentinian total emissions, accounting for 46 Mt in 2014, which is equivalent to 12% of total emissions (including LULUCF).

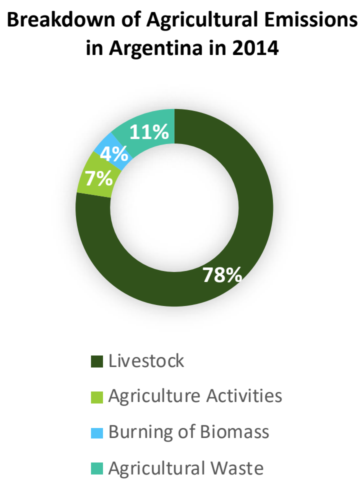

Figure 31: *Shares of agricultural activities in agricultural emissions in 2017.*
Source: National Inventory Report from 2014, Argentina (Ministry of Environment Argentina, 2017)

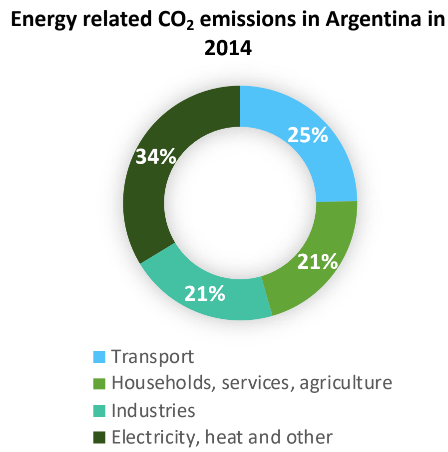

Figure 32: *Shares in energy related co_2 emissions.*
Source: G20 Brown to Green report 2018 (Climate Transparency, 2018).

- **Drivers of Energy emissions:**

The electricity sector is the main contributor of Argentina's energy emissions, accounting for 34% of energy related emissions in 2014, representing approximately 34% of the energy related emissions in 2014 (Climate Transparency, 2018). Fossil fuel-based generation dominates electricity supply in Argentina accounting for 64% of the total generation in 2017, of which 90% is generated by natural gas, 8% by liquid fuels (diesel and fuel oil), and a marginal 2% by coal (CAMMESA, 2019). Electricity generation from hydro resources represented 29% of the generation mix in the same year, followed by 5% from nuclear and less than 2% from non-conventional renewable sources (i.e., biomass, wind and solar).

The transport sector is the second largest contributor to Argentina's energy emissions and accounted for about 25% of Argentina's energy related emissions in 2014 (Climate Transparency, 2018). Road transport, with 90% of all transport related emissions in 2014, constitutes by far the most important source of transport-related emissions (Ministry of Environment and Sustainable Development, 2017), with the emissions being distributed equally between passenger vehicles and trucks.

- **Drivers of Agriculture emissions:**

Agriculture emissions from Argentina are driven by livestock farming representing approximately 78% of the agriculture emissions in 2014, of which 71% is due to Enteric Fermentation and which has been steadily growing (Ministry of Environment and Sustainable Development, 2017). The agriculture sector, with a strong exports-oriented nature, has a huge importance for the Argentinian economy. Although its value added to GDP has been decreasing over the last decade, it accounts currently for 5% (Agriculture and Forestry sectors included), above world average which is of 3.5% (World Bank, 2018). The land area used for agriculture on the other hand has increased to above 54% in Argentina (World Bank, 2018) which has an impact on forestry. LULUCF emissions have been reported so far by the Argentinian government together with agriculture emissions, representing together 40 % of total emissions (see figure 1).

Country specific targets and compliance

Country specific targets

Sector	Target 2020	NDC Target 2030	Other national targets
Economy wide, incl. LULUCF	List of Nationally Appropriate Mitigation Actions (NAMAs)	1) Unconditional target: 483 MtCO2 by 2030 incl. LULUCF 422 MtCO2 by 2030 excl. LULUCF 2) Conditional target: 369 MtCO2 by 2030 excl. LULUCF 322 MtCO2 by 2030 excl. LULUCF	
Energy			1) To achieve 20% and 25% of renewables shares (excl. hydro) by 2025 and 2030 respectively. 2) 20% blending of biodiesel in liquid fuels for trucks and the incorporation of flex-fuel technologies for gasoline-gasoline based cars by 2030

Agriculture	No mitigation targets.
LULUCF	Restoration of 20,000 ha annually until 2030

Table 1. *Sector specific emission targets.*

Sources: Most recent Argentina Climate Action Tracker update (Climate Action Tracker, 2019)*, National Plan for the restauration of the Native Forest* (Ministry of Environment and Sustainable Development, 2018)*, National Energy Action Plan (Ministry of Energy of Argentina, 2017).*

How well is the country complying with its targets?

- **Compliance with Targets:**

According to the Climate Action Tracker most recent assessment, Argentina will need to implement additional policies to meet its NDC 2030 target, see **Figure 30**, with a gap of 68 $MtCO_2$ in 2030 (Climate Action Tracker, 2019). Additional policy scenarios, assuming a full implementation of the renewable targets and additional energy efficiency measures, based on the Energy Scenarios from the Ministry of Energy could close this gap, and even lead to an overachievement of the unconditional NDC target.

With regards to sector specific targets, by the implementation of some short-term measures such as Biofuels Law 26.093 amended in 2016 through the Resolution 37/2016 aiming at the uptake of biofuels in the transport sector, the target to reach 20% blending of biodiesel seems to be reasonable (Climate Action Tracker, forthcoming). This stands in strong contrast with current policy projections in the electric sector, which would only lead to a 7% renewable share by 2025 (excl. hydro) missing by far the electricity share target for non-conventional renewables in 2025 (Climate Action Tracker, forthcoming). Although emissions from forestry sector have been significantly reduced since the implementation of the Native Forests Law in 2010, the law has only been partially implemented, where for example between 2010 and 2015, only 8.5% of the total targeted budget for the conservation of native forests was spent (Climate Action Tracker, 2019).

- **Global Warming Pathway regarding NDC and current policies projections:**

  Based on the Climate Action Tracker methodology, Argentina's climate commitment and projected emissions levels under current policies for 2030 are not consistent with holding warming to below 2°C, let alone limiting it to 1.5°C as required under the Paris Agreement, and are instead consistent with warming between 3°C and 4°C, if all countries were to follow Argentina's approach (Climate Action Tracker, 2019).

  Paris Agreement compatible emissions pathways require emissions to peak and decline fast afterwards, reaching carbon neutrality by mid-century. In contrast, under current policies, emissions of Argentina are expected to grow by 2030 (Climate Action Tracker, 2019).

Country's climate policies and practices:

How are the key and most emitting sectors under current policies contributing to limit global warming to 1.5°?

The following table shows an overview of positive and negative policy developments in four key emitting sectors in Argentina compared with sector-specific short-term benchmarks for limiting global warming to 1.5°C as identified by (Kuramochi et al., 2017).

Sector	1.5 °C-consistent benchmark	Assessment and opportunities for improvement
Electricity and heat sector	Sustain the global average growth of renewables and other zero and low carbon power until 2025 to reach 100% by 2050	+ Increasing political will to support an accelerated increase of renewables + Policy instrument in place to initiate uptake of renewables in line with renewable targets (envisioned growth of non-conventional renewables from 2.5% of total electricity consumption in 2018 to 12% in 2019). + Uptake of renewable generation encouraged at different scales: from large-scale renewable projects to decentralized electricity generation at residential level + Grid expansion initiatives planned from 2019 onwards are expected to remove barriers that support a further deployment of renewables - Renewable projects are facing major delays due to financial difficulties and grid-related limitations. Large-scale renewable auctions suspended until grid limitations are resolved. - Government shows strong support for natural gas in electricity generation through subsidies and tax benefits, which put higher shares of renewables and the full decarbonization of the power sector by mid-century or shortly thereafter at doubt. - Additional actions are needed to achieve the share of renewables (excl. hydro) electricity supply set in the targets.
	No new coal plants commissioned, reduce emissions from coal power by at least 30% by 2025	+ Government's support of renewables and natural gas might lead to completely phase out of coal from the electricity mix + Share of coal in total power generation is currently low (<2%), making a coal phase-out relatively easy to manage - No policy exists to formally phase out coal fired plants and one plant currently under construction - The only operating coal-fired plant has gone through several refurbishments that has postponed its decommissioning
Transport sector	Last fossil fuel car sold before 2035	+ Several minor demand-side efficiency policies are in place that aim to reduce emissions in transport sector +/- Substantial growth of biofuels driven by higher blending mandates in fuels. However, there are sustainability concerns regarding the impact of biofuel production on LULUCF. +/- Moderate overall impact is expected from proposed mitigation actions in National Mitigation Plan: aiming to reach an annual emission reduction of up to 7,6% in 2030 if all measures would be implemented. - No overarching 1.5°C compatible vision for transport sector - Incipient uptake of EV with low coverage in transport sector policies to incentivize their uptake

		-	Tax exemptions for CNG and LPG encourage the continuation and use of these fossil-powered vehicles
Agriculture	Keep emissions in 2020 at or below current levels, establish and disseminate regional best practice, ramp up research	+	There are activities around climate smart agriculture and crop rotation, however no comprehensive policy framework
		+/-	Emissions intensity of agricultural production has decreased over the last two decades, due to improved farming methods but also economies of scale. This is driven by the need to most efficient production practices to remain competitive on the global market.
		-	No overarching 1.5°C compatible vision for agriculture sector
LULUCF	Reduce emissions from forestry and other land use to 95% below 2010 by 2030, stop net deforestation by 2025	-	Deforestation remains an issue, also due to pressure from agriculture and livestock farming expansion
		+	Commercial forest plantations growing and certain policy developments to promote reforestation such as Law 27.487 to support investments in forests (previously law 25.080)

***Table 2:** Positive and negative policy developments in key sectors.*

Source: Scaling Up Climate Action in Argentina (Climate Action Tracker, forthcoming).

Lacking policies and practices or negatively contributing to global warming in key and most emitting sectors

- **No full decarbonization of power sector envisioned:** Despite a substantial growth of renewables in the short and medium-term, Argentina has no specific sectoral plan or target to reach the required 100% share of low-carbon electricity generation by 2050 to be in line with the Paris Agreement temperature target. In fact, latest energy sector plans from the Secretariat of Energy (Secretaría de Energía Argentina, 2018) and the support to natural gas indicate that the government aims to further develop the natural gas industry and make this fuel the main energy source in the country. Under these conditions, it seems unlikely to reach full decarbonization of the power system by mid-century if Argentina will not decrease its gas consumption soon and avoids building up significant additional infrastructure (Climate Action Tracker, forthcoming).

- **No action on cattle-related (livestock) agricultural activities and impact on forestry:** the livestock farming sector is the main contributor of the agriculture sector (78% in 2014 from Agricultural emissions from Argentina), and so far, no policy instruments in place or planned to mitigate emissions have been announced. In addition to the large methane emissions produced by this activity, the area needed for grazing and production of animal feed puts stress on forests and is reason for other environmental and social concerns. Exports of agricultural products play an important role in this context, with the growth of beef-demand expected worldwide (Climate Action Tracker, forthcoming).

- **Limited decarbonization of the transport sector:** Implemented policies such as blending cuts for biofuels are expected to have a limited impact on moving Argentina towards a 1.5° compatible vision for the sector, even though Argentina is considerably above global average in terms of share of biofuels in transport, fossil fuels consumption in the sector is still growing and further increases are projected with Incipient uptake of EVs insufficient policies to incentivize their uptake. Additionally, these biofuels policies must be assessed from a sustainability point of view considering trade-offs and impacts of large-scale biofuels production on food security, forestry protection and emissions from land use (Climate Action Tracker, forthcoming).

- **Public finance in power sector subsiding coal, oil and gas sectors**: In 2018, it is estimated that 93% of total public finance to power went to coal, oil and gas projects in contrast with close to no financing towards renewables projects and no financing streams were identified for "grey sector" (such as nuclear, biomass, large-scale hydropower etc.) (Climate Transparency, 2018).

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CLIMATE ANALYTICS

4.2. Brazil

Drivers of Climate Change: the case of Brazil

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Summary

Emissions excluding land use, land use change and forestry, (LULUCF) in Brazil rose steadily from 1990 to 2014, declined from 2014 to 2016, but resumed growth after 2016. Brazil's remarkable progress in forestry emissions mitigation observed since 2005 has stopped, and deforestation and resulting emissions increases have picked up speed again in recent years after the reversal of key environmental policies in Brazil, driving LULUCF emissions up.

Brazil's climate commitments and projected emissions through 2030 under current policies are consistent with global warming between 2°C and 3°C by the end of the century, if all countries were to follow Brazil's approach.

Brazil will need to strengthen its current policies or implement additional policies to meet its NDC targets (2025 and 2030). Under current policy projections, the indicative NDC energy mix targets for renewable energy and biofuels for 2030 will likely be achieved, other targets, in particular in the LULUCFs sector, will be missed by a large margin.

In the transport sector, mitigation efforts are centered in biofuels use, which prolongs dependency on combustion engine vehicles in the medium and long term as demonstrated by the low current and projected penetration rate of electric vehicles in Brazil.

Moreover, despite its large share of renewable power generation, full decarbonization of the Brazilian power sector is at odds with high government support fossil fuels. Brazil is also lagging behind in agriculture sector emissions mitigation with no particular policies in place to halt emissions growth in this sector, particularly from cattle.

Paris Agreement compatible emissions pathways require emissions to peak and decline fast afterwards, reaching carbon neutrality by mid-century. In contrast, under current policies, emissions of Brazil—both including and excluding LULUCF — are expected to increase steadily through 2030.

Brazil's Emissions Profile

Historical and Projected Emissions

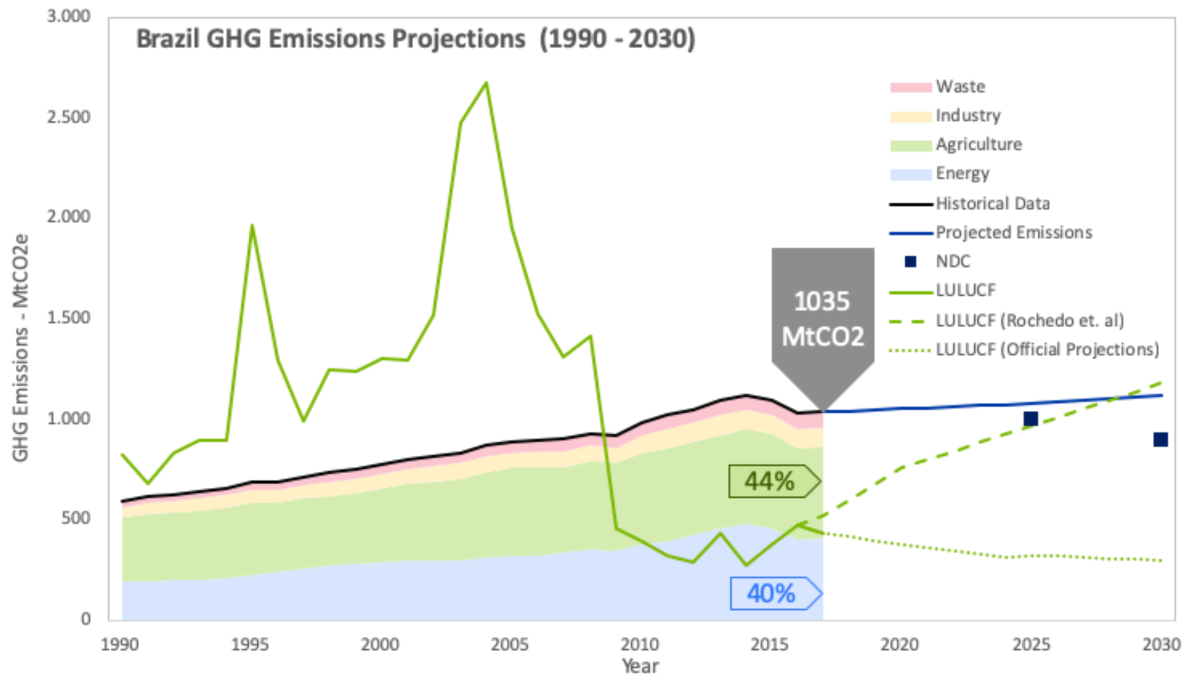

Figure 33: *Historical and projected emissions of Brazil from 1990 to 2030 based on the most recent update from Climate Action Tracker* (Climate Action Tracker, 2019). *Historical emissions are taken from official communication until 2015* (Ministry of Science Technology and Innovations and Communications, 2019) *and complemented with third party sources until 2017* (Observatório do Clima, 2019).

As shown in Figure 1, emissions excluding land use, land use change and forestry, (LULUCF) in Brazil rose steading from 1990 to 2014, declined from 2014 to 2016, and has risen to 1035 $MtCO_2$ in 2017, Third party sources estimated the country account for roughly 2.3% of global emission excluding LULUCF (Gütschow, Jeffery, & Gieseke, 2019). It is of especial concern that Brazil's remarkable progress in reducing LULUCF emissions from 2005 to 2014 has stopped, with LULUCF emissions increasing since 2014 due to the reversal of key environmental policies (Observatório do Clima, 2019) (Climate Action Tracker, 2019).

With current policies, Brazil will reach emissions levels (excluding LULUCF) of 1079 MtCO2e in 2025 and 1121 MtCO2e by 2030 (respectively, 27% and 32% above 2005 levels and 92% and 99% above 1990 levels) (Climate Action Tracker, 2019). Official projections for the LULUCF sector show decreasing emissions until 2030 (Ministério da Ciência Tecnologia Inovações e Comunicações Brasil, 2017) but alternative projections by Brazilian modeling groups show emissions from this sector going in the opposite direction (Rochedo et al., 2018).

Key sector drivers of Emissions

The largest share of Brazil's emissions excluding LULUCF correspond to non-energy related emissions, with Agriculture emissions accounting for 44% of the total in 2017 (Figure 30) Energy related emissions accounted for 40% of the emissions in 2017.

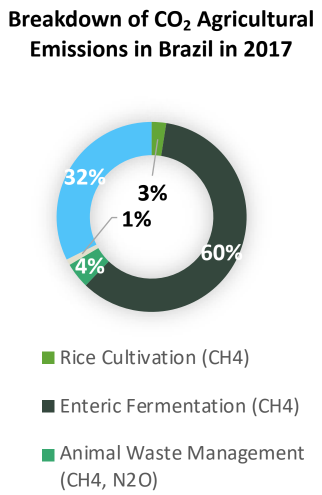

***Figure 2**: Shares of agricultural activities in agricultural emissions in 2017.*
Source: Observatóro do Clima, 2019.

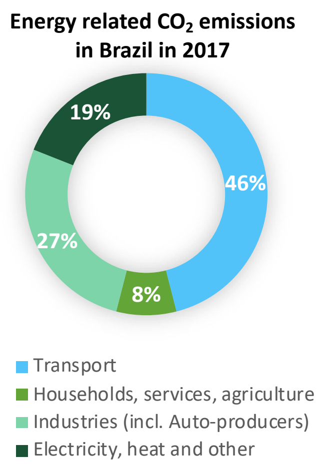

***Figure 3**: Shares in energy-related CO_2 emissions.*
Source: G20 Brown to Green report 2018 (Climate Transparency, 2018).

- **Drivers of LULUCF emissions:**

Since the early 1990's, the land use and forestry sector was usually the largest source of GHG emissions in Brazil. This picture changed significantly between 2005 and 2014, when effective anti-deforestation policies, including the National Forest Code, the Action Plan for Deforestation Prevention and Control in the Legal Amazon (PPCDAm) and the Cerrado (PPCerrado), were implemented and resulted in a reduction on LULUCF emissions of about 86% between 2005 and 2012. Brazil's remarkable progress in forestry emissions mitigation observed since 2005 has stopped, with deforestation and resulting emissions increases picking up speed again in recent years after the reversal of key environmental policies in Brazil (Observatório do Clima, 2019). In 2018, Brazil recorded the highest loss of tropical primary rainforest in the world of 1.3 million hectares, mostly due to deforestation in the Amazon, with major impacts in indigenous territories (Climate Action Tracker, 2019).

- **Drivers of Agriculture emissions:**

Agriculture is an important industry in Brazil, due to the immense land resource available. The most significant products are coffee, soybeans, wheat, rice, corn, sugarcane, cocoa, citrus and beef. Main drivers of agriculture emissions are the activities related to Agricultural Soils and Enteric Fermentation contributing respectively to 32% and 60% to the sector emissions (Observatório do Clima, 2019). If the indirect emissions of the agriculture sector (mostly related to deforestation resulting from the expansion of the agricultural frontier) were accounted for, the agricultural sector would be by far the single largest emissions source in Brazil (Climate Action Tracker, 2019). Together, the Agriculture and Land Use and Land Use Changes sector accounted for almost 70% of the country's emissions in 2017 (FABLE Consortium, 2019).

- **Drivers of Energy emissions:**

With around 80% of the electricity production coming from renewable energy sources (mainly hydro), emissions from fuel-combustion are mainly driven by transport. As shown in Figure 3, the transport sector emits 46% of Brazil's CO_2 from fossil fuel combustion, followed by industry (27%) and electricity (19%) in 2017 (Climate Transparency, 2018). Transport emissions have more than doubled since 1990 (Climate Transparency, 2018) mainly due to increased vehicle ownership. Road transport accounted for 92% of transport emissions in 2017 (Observatório do Clima, 2019).

Country specific targets and compliance

Country specific targets

Sector	Target 2020	NDC Target 2025	NDC Target 2030	Other national targets
Economy wide, incl. LULUCF	36.1% - 38.9% under BAU	1.3GtCO_2 (37% below 2005 emissions levels incl LULUCF)	1.2 GtCO_2 (43% below 2005 emissions levels incl LULUCF)	
LULUCFs			1) Zero illegal deforestation in the Brazilian Amazonia 2) Restore and reforest12 million ha of forests 3) Enhance sustainable native forest management	
Agriculture			1) Restore 15 million hectares of degraded pasturelands 2) Enhance 5 million hectares of integrated cropland-livestock-forestry systems	

Energy		1) Achieve 45% of renewables in the energy mix 2) Increase the share of sustainable biofuels in the energy mix to approximately 18% 3) Achieve 23% of renewables (other than hydro) in the power supply	1) 47% share of renewable energy in the energy mix by 2027 2) 21% share of biofuels in the energy mix by 2027 3) 22% of renewables (other than hydro) in power supply by 2027 4) Reduce carbon intensity of transportation fuels by 10.1% by 2028 from base year 2017

Table 1. *Sector specific emission targets*

Sources: Most recent Brazil (Climate Action Tracker, 2019), Brazil's NDC (Government of Brazil, 2015), National Biofuel Policy, Renovabio (Conselho nacional de política energética, 2018b), Brazil's Ten-Year Plan for Energy Expansion (Ministerio de Minas e Energia, 2018).

How well is the country complying with its targets?

- **Compliance with Targets:**

According to the Climate Action Tracker most recent assessment, Brazil will need to implement additional policies to meet its NDC targets (2025 and 2030), see Figure 30, with a gap of 86-88 MtCO2 in 2025 and of 228-231 MtCO2 in 2030 (Climate Action Tracker, 2019).

With regards to sector specific targets, under current policy projections, the indicative NDC target of a 45% share of renewables in the total energy mix by 2030 will be achieved, with renewable energy expected to represent 47% of the energy mix in 2027 (Ministerio de Minas e Energia, 2018). The biofuels indicative target (18% by 2030) will also be achieved with the most recent energy plan targeting 21% share of biofuels by 2027. Policies in place to achieve this target include the Renovarbio program and a new resolution on increasing the share of biodiesel (Conselho nacional de política energética, 2018a). In contrast, Brazil is going in the opposite direction with regards to its targets in LULUCFs sector, as recent legislative proposals are going against successful environmental policies and a relaxation of the forest code in 2012 (Rochedo et al., 2018). Impacts were observed in 2016, when deforestation in the Amazon increased 30% compared to 2015 (IPAM, 2017). Brazil is also lagging being in agriculture sector emissions mitigation, with no particular policies in place to halt emissions growth in this sector, which accounts for 44% of its non-LULUCF emissions in 2017.

- **Global Warming Pathway regarding NDC and current policies projections:**

Brazil's climate commitment and projected emissions levels under current policies for 2030 are not consistent with holding warming to below 2°C, let alone limiting it to 1.5°C as required under the Paris Agreement. They are instead consistent with warming between 2°C and 3°C, if all countries were to follow Brazil's approach (Climate Action Tracker, 2019).

Paris Agreement-compatible emissions pathways require emissions to peak and decline fast afterwards, reaching carbon neutrality by mid-century. In contrast, under current policies, emissions of Brazil are expected to grow by 2030 (Climate Action Tracker, 2019).

Country's climate policies and practices

How are the key and most emitting sectors under current policies contributing to limit global warming to 1.5°?

The following table shows an overview of positive and negative policy developments in four key emitting sectors in Brazil compared with sector-specific short-term benchmarks for limiting global warming to 1.5°C as identified by (Kuramochi et al., 2017).

Sector	Necessary step	Assessment and opportunities for improvement
Power	Sustain the growth of renewables and other zero and low carbon power until 2025 to reach 100% by 2050	+ Historically high share of renewable generation. + NDC target to increase the share of renewables (other than hydropower) in power generation to at least 23% by 2030. + 6 large-scale renewable energy auctions planned up to the end of 2021 - Huge untapped potential for renewable power. - **Plan to increase share of investments in fossil energy sources to 76.1% of total energy investments in the period 2018-2027** **- Long-term energy scenarios released by the Energy Ministry show a 2050 energy mix projection that has very similar shares of fossil fuels compared to current levels.**
	No new coal plants, reduce emissions from coal power by at least 30% by 2025	+ Low historical importance of coal in the electricity mix. - New coal capacity still planned to come online threatens achievement of NDC goal. Four power plants are currently in pre-construction phase (CoalSwarm, 2019). - Coal generation allowed to participate in national energy auctions
Transport	Last fossil fuel car sold before 2035	+ Brazil has one of the highest shares of biofuels in road transport of the world. + National Target to reduce the carbon intensity of transportation fuels by 10,1% by 2028 from base year 2017 + August 2019 Resolution that sets increasing percentage of biodiesel blending from 11% in 2019 to 15% in 2023. -Focus on biofuels prologues dependency on combustion engine vehicles in the medium and long term. - Insignificant share of Electric Vehicles sales and no policies in place to promote the use of EVs, which would be needed to achieve decarbonization without putting additional pressure on forests.
LULUCF	Reduce emissions from forestry and other land use to 95% below 2010 by 2030, stop net deforestation by the 2020s	+ Anti-deforestation policies reduced LULUCF emissions by 85% between 2005 and 2012. + NDC pledge to maintain and strengthen current policies in the sector. - Increased biofuel production could lead to increased land use emissions. - Deforestation in the Amazon region increasing again since 2016. - Legislative acts and decrees in 2017 have lowered environmental licensing requirements, suspended the ratification of indigenous lands, reduced the size of protected areas in the Amazon, and facilitated land grabbers to obtain the deeds of illegally deforested areas as large as 2,500ha per farm in the Amazon rainforest (Rochedo et al., 2018).

Agriculture	Keep emissions at or below current levels, establish and disseminate regional best practice, ramp up research	+ NDC pledge to restore degraded pasturelands and enhance integrated cropland-livestock-forestry systems by 2030. + Policy instrument to promote low-carbon agriculture (ABC Program) already in place. - Implementation lag in policy instruments. - No policy instruments in place or planned to mitigate emissions from cattle-raising sector, which is expected to grow fast and is the main contributor of the Agriculture sector.

Table 2: *Positive and negative policy developments in key sectors.*

Source: Evaluations of Climate Analytics.

Lacking policies and practices or negatively contributing to global warming in key and most emitting sectors

- **Reversal of action on deforestation:** while Brazil's NDC target aims at zero illegal deforestation, recent legislative proposals (see section 3.1) have had a direct impact on increasing deforestation observed already since 2016 (see section 2.2), and thus increasing GHG emissions from the LULUCFs sector, which together with the agriculture sector are the top contributors to the country's emissions. The previous administration had already begun reverting key environmental policies in Brazil (budget cuts to the environmental authorities, and reversal of LULUCF policies already in place). Bolsonaro's administration, supported by "ruralist" legislators who have traditionally opposed land preservation efforts and other anti-deforestation policies, has continued with the reversal of key environmental policies and weakening of environmental institutions (Climate Action Tracker, 2019). The changes include eliminating 95% of the Ministry of Environment's budget for climate change-related activities; transferring the body responsible for certifying Indigenous territory from National Indian Foundation to the Ministry of Agriculture; easing the rules for converting environmental fines into alternative compensations; changes in the Forest Code to extend deadlines for enforcement measures; and the abolition of most committees and commissions for civil participation and social control in the Federal Government (Climate Action Tracker, 2019).

- **No action on cattle-related activities:** the cattle sector has historically been the main contributor of the agriculture sector (64% in 2107, (Observatório do Clima, 2019)), and so far no policy instruments are in place or planned to mitigate emissions.

- **Limited decarbonization of transport:** even if Brazil is on track to reduce emissions from its transport sector through the increase of the use of biofuels, the full decarbonization will be only possible by a shift within the transport sector to zero emissions technologies such as electric vehicles (EVs), which currently have an insignificant penetration rate and no clear strategy for substantial increase. The Ministry of Energy projects an insignificant share of EVs in the market until at least 2035, reaching 11% penetration rate in 2050 (Climate Action Tracker, 2019). Moreover, the increase in the production of biofuels will require an increase of land-use for this purpose, putting additional pressure on the land-use sector, which is experiencing growing deforestation.

- **Increasing the share of fossil fuels:** full decarbonization of the Brazilian power sector is at odds with recent policy developments which show the government is planning to increase investments in fossil fuels to meet Brazil's increasing energy demand. In fact, the share of fossil fuels in the Brazilian energy matrix is increasing while the share of renewable energy sources in the energy supply has been declining— from around 50% in the 1990s to only 39% in 2014 and has only started to rise again in the last three years, reaching 47% in 2017 (Climate Action Tracker, 2019)

- **High subsidies in fossil-fuels and in power sector**: In 2016, Brazil's fossil fuel subsidies were US$16.2bn, doubling since 2007. Between 2007 and 2016, subsidies were greater than the G20 average per unit of GDP. The largest subsidy is the PIS/CONFINS[1] measure to maintain fixed prices for the import and retail sale of gasoline, diesel, aviation kerosene and natural gas. With regards to the power sector, in 2016, 66% of total public finance to power went to coal, oil and gas projects in contrast with 21% to renewables projects and 14% others (such as nuclear, biomass, large-scale hydropower etc.) (Climate Transparency, 2018).

[1] The PIS (Program of Social Integration) and COFINS (Contribution for the Financing of Social Security) are federal taxes based on the turnover of companies.

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4.3. France

Drivers of Climate Change: France

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Summary

France's total greenhouse gas emissions have been increasing since 2014. The main drivers of emissions in France is the transport sector followed by agriculture and building sectors, which account for 71% of total emissions in 2016 excluding LULUCF.

France has failed to meet its 2015-2018 domestic emissions target and under current policy the renewable energy share in the electricity sector by 2030 and its EU NDC target by 2030 will be missed by a large margin.

Although France has historically low CO_2 emissions from its energy sector due to its high nuclear share, transport and buildings sectors emissions have been stagnant for the past decade. In transport sector mitigation efforts are centered in the introduction of low-carbon technology vehicles but no policy is targeted to limit road transport demand and low investment levels are directed to modal shift from road transport. Reductions in support schemes for renovation (such as tax credit) have been put in place to reduce emissions from the building sector, but related administrative procedures remain too complex, resulting in a limited improvement in buildings' energy efficiency. France is also lagging behind in its 2030 renewable energy share and has postponed its nuclear share target of 50% from 2025 to 2035.

France's domestic 2030 mitigation target and current policy projections are consistent with warming of between 3°C and 4°C, if all countries made comparable efforts. Similarly, the EU's NDC target of a 40% reduction below 1990 levels by 2030 is compatible with warming of

between 2°C and 3°C if all countries made comparable commitments. It is therefore imperative that France adopts more ambitious targets and policies.

1. France's Emission Profile

1.1. Historical and Projected Emissions

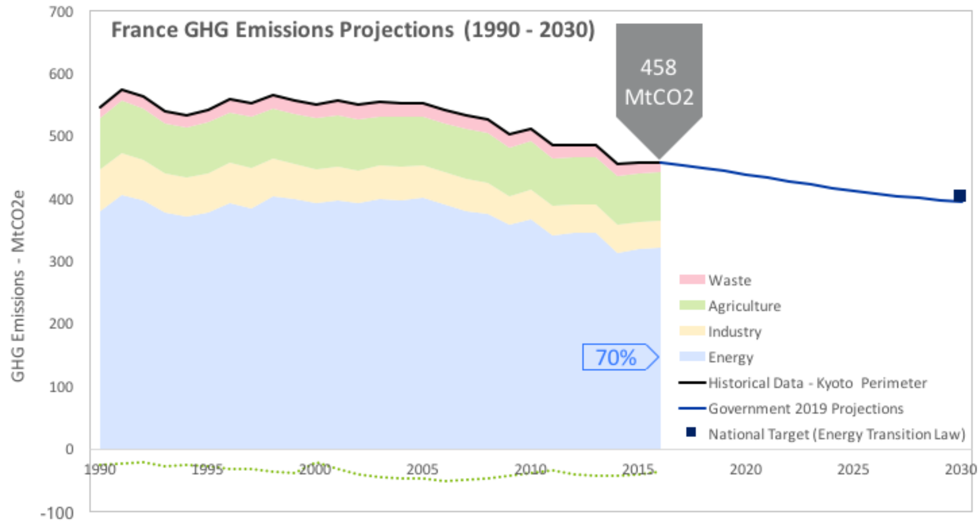

Figure 34 : Historical and projected emissions of France from 1990 to 2030 based the National Inventory Report 2018 (European Environmental Agency, 2018)*, and the National Integrated Climate and Energy Plan published in January 2019, scenario based on "existing measures"* (Ministère de la Transition écologique et solidaire, 2019)*. Emissions provided here cover the Kyoto Perimeter, which includes metropolitan France and overseas territories included in the EU.*

Following a "pick and decline" trajectory between 1990 and 1994, France's total greenhouse gas (GHG) emissions have grown until 1998 to decline until its lowest recorded emissions level in 2014 reaching 454,2 $MtCO_2e$ (excluding LULUCF). France's emissions have however been growing since 2014 to reach 458 $MtCO_2e$ (excluding LULUCF) in 2016, roughly 16% lower than 1990 levels. France's 2016 constituted approximately 1.0% of global emissions for that year.

Based on current policies, France's emissions are expected to be 394 $MtCO_2$ by 2030, roughly 28% below 1990 excluding LULUCF (Ministère de la Transition écologique et solidaire, 2019).

France's LULUCF accounting approach within its target remains unclear: no precision has been given whether LULUCF emissions are planned to be accounted in the 40% emissions reduction domestic target. If LULUCF emissions are excluded in the base year and included in the target year, as France's communications seem to indicate, this approach is called "gross-net" and the use of this approach raises many questions in terms of the environmental integrity of the target (Rocha et al., 2015).

1.2. Key emission contributions

The largest share of France's emissions corresponds to the energy sector, accounting for 70% of the total (excl. LULUCF) in 2016 (Figure 1), followed by Agriculture emissions accounting for 17% of the total (excl. LULUCF).

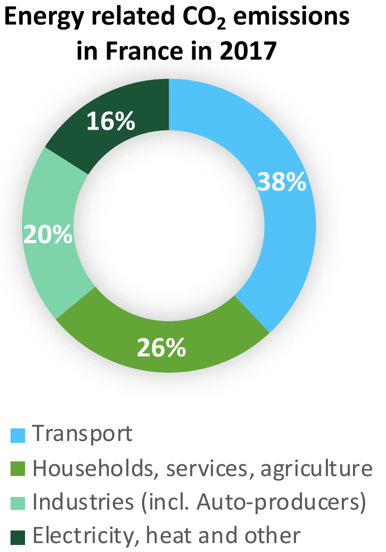

Figure 35: Emissions Breakdown from Energy Sector in France in 2016. Source: Brown to Green Report 2018 (Climate Transparency., 2018)

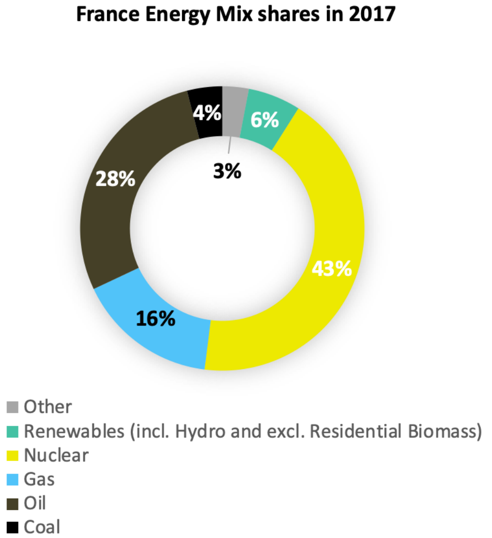

Figure 3: Shares of energy sources in France's energy mix of 2017. Source : Brown to Green Report 2018, France (Climate Transparency., 2018)

- **Drivers of Energy Emissions:**

The transport sector is the main contributor of France‘s energy emissions, accounting for 38% of energy related emissions in 2016, of which 96,1% was generated by road transport in 2016 (Agora Verkehrswende, 2018) which is steadily growing since 2014 (Observatoire Climat Energie, 2018). Road transport emissions are dominated by private passenger transport, representing 53,7% of emissions in France in 2015 (Ministère de la Transition écologique et Solidaire, 2017). This increase is partly due to the decrease of diesel-based cars sales to the profit of gasoline-based cars and intensive fuel-consuming cars such as SUVs together with an increase of road transport-demand three times higher than expected in the period 2015-2018 (Haut Conseil pour le Climat, 2019).

Emissions from buildings sector (private as well as tertiary) is the second largest contributor to energy emissions, reaching 19% of total GHG emissions in 2018, mostly due to domestic fuel for thermal usage as well as the use of fluorinated gazes (such as for air conditioning). Building sector emissions have been very insignificantly decreasing since 1990 (4% per year). Although CO_2 emissions have been decreasing due to a better energy efficiency of buildings and the use of non-fossil fuel energy, this has been balanced by an increase of surfaces to be heated as well as in the use of fluorinated gazes (HFC and PFC) such as for air conditioning (Haut Conseil pour le Climat, 2019).

- **Drivers of Agriculture Emissions:**

Following the energy sector, the agriculture sector is the second largest emitting sector in France accounting for 17% of total GHG emissions in 2016. In 2018, 45% of these emissions are provided by methane (CH_4) emissions due to enteric fermentation followed by N_2O emissions coming from cultivated soils (Haut Conseil pour le Climat, 2019).

2. Country specific targets and compliance

2.1. Sector specific emission targets

Table 2: Sector specific emission reduction targets. Low-Carbon National Strategy, Draft December 2018 (Ministère de la Transition écologique et Solidaire, 2018).

Sector	Target 2020	Target 2030	Other national targets
Economy wide	20% below 1990 level	40% below 1990 level	Carbon-Neutrality by 2050
Energy Production		60% below 1990 level	Renewable energy (share of gross final energy consumption): • 23% by 2020 • 32% by 2030 Share of Nuclear Energy in power production reduced to 50% by 2035 Virtually decarbonize energy sector: 97% below 1990 levels by 2050
Transport		28% below 1990 level	Final energy consumption: 16% below 2016 level by 2028 Virtually decarbonize transport sector: 97% below 1990 levels by 2050 Last fossil-fuel based vehicle sold in 2040
Buildings		53% below 1990 level	Final energy consumption: 14% below 2012 level by 2028 Virtually decarbonize building sector: 94% below 1990 level by 2050
Industry		63% below 1990 level	89% below 1990 levels by 2050
Agriculture		22% below 1990 level	50% below 1990 levels by 2050

2.2. How well is the country complying with its targets?

Target Compliance

France's newly appointed independent climate advisory council, the Haut Conseil pour le Climat (HCC) indicated in its recent report published in June 2019 that France is not on track to meet its carbon neutrality target for 2050 and thus its 40% emissions reductions target for 2030, having emitted 4% more than what was needed to meet these targets for the period

2015-2018 (Haut Conseil pour le Climat, 2019). Upon French government projections, under existing measures, emissions are projected to be reduced up to 28% below 1990 level excluding LULUCF emissions. It is unclear yet if France plans to include its LULUCFs sinks in the target, if included, this would mean a reduction of 39% below 1990, which would virtually meet the targets. However, the sectoral emission targets require a strong deviation in current emission reduction trajectories for most sectors. Government projections for emission reductions under current policies for other sectors are shown in Table 2.

Table 3 : Government emission projections with existing measures for 2030. Source: Targets are based from the Low-Carbon Draft Strategy published in December 2018 (Ministère de la Transition écologique et Solidaire, 2018) *and the projections are based on the National integrated Climate-Energy Plan published in January 2019* (Ministère de la Transition écologique et solidaire, 2019).

Sector	Target 2030	Projection to 2030 with existing measures
Economy wide	40% below 1990 level	28% below 1990 level excl. LULUCF 39% below 1990 incl. LULUCF
Energy production	60% below 1990 level	30% below 1990 level
Agriculture	22% below 1990 level	14% below 1990 level
Industry	63% below 1990 level	50% below 1990 level
Transport	28% below 1990 level	1% above 1990 level

The EU's nationally determined contribution (NDC) under the Paris Agreement is for a 40% reduction in emissions below the 1990 level by 2030. Under the EU's Effort Sharing Regulation, EU Member States have binding targets to reduce their GHG emissions from those sectors not covered by the EU Emissions Trading Scheme (ETS) that were agreed on largely according to their relative economic strength. The overall EU 2030 target for these sectors, which includes transport, buildings, agriculture and waste, is a 30% reduction below the 2005 level, which translate for France to a reduction of 37% below 2005 levels.

Upon Governmental projections, France is not on track to meet its 2030 EU Target of 37% emissions reduction below 2005 for non-ETS sectors. In fact, non-ETS emissions projections under existing measures are expected to be 18% higher than the target in 2030. France will need to make higher efforts to reach its EU NDC target as well as to reach its domestic target of 40% reduction below 1990 levels by 2030.

Global Warming Pathway Related to EU and National Targets

Based on the methodology of the Climate Action Tracker, the EU's NDC and projected emissions under current policies for 2030 are not consistent with holding warming to below 2°C, let alone limiting it to 1.5°C as required under the Paris Agreement. EU projected 2030 emission levels are instead consistent with warming of between 2°C and 3°C, if all countries made comparable commitments (Climate Action Tracker, 2019). Downscaling the Climate

Action Tracker fair share range for the European Union to France[2], it can be concluded that France's domestic mitigation target and current policy projections are consistent with warming of between 3°C and 4°C, if all countries made comparable efforts.

3. Country's climate policies and practices

3.1. How are the key and most emitting sectors under current policies contributing to limit global warming to 1.5°?

The following table shows an overview of positive and negative policy developments in four key emitting sectors in France compared with sector-specific short-term benchmarks for limiting global warming to 1.5°C as identified by (Kuramochi et al., 2017).

Sector	Necessary step	Assessment and opportunities for improvement
Transport	Last fossil fuel car sold before 2035	+National programmes to sup-port shift to public transport: Development of High Speed Railway Lines (HSL) and dedicated-lane public transport (757 km of additional new high-speed lines put into service between 2015 and 2020) +Financial support scheme for „combined transport" where the main link of the transport chain is rail, waterway or maritime +/- National target on end date for sales of fossil fuel cars in 2040 existing but still not compliant with PA benchmark of 2035. -Missing the emissions trajectory cap for 2015-2018 by 9% above the target -Fuel-tax abandoned in December 2018 -No specific policies to moderate the increase of private road transport demand -Slow electrification of the transport sector -Support scheme to the purchase of Electric Bicycles restricted in January 2018
Buildings		+ construction of low-consumption buildings to become standard by 2012 + construction of energy-plus houses to become standard by 2020. -missing the emissions trajectory cap for 2015-2018 by 16% above the target -slow renovation rate due to complex administrative procedures and non-stable regulations -lack of monitoring framework does not allow precise assessment of the sector
Agriculture	Keep emissions in 2020 at or below current levels, establish and disseminate regional best practice, ramp up research	+/- Slow reduction of emissions observed (8% between 1990 and 2018) -No comprehensive policy to close the gap and accelerate the decarbonization of the sector

[2] France fair share range is calculated by applying a proportional percent reduction below 2005 emissions levels from the EU fair share range, adjusted considering the higher proportional reduction obligation of France according to the EU's Effort Sharing Regulation.

Industry	All new installations in emissions-intensive sectors are low-carbon after 2020, maximise material efficiency	-no target for new installations in emission-intensive sectors to be low-carbon
Energy	Sustain the growth of renewables and other zero and low carbon power until 2025 to reach 100% by 2050	- Share of Nuclear Energy in power production target of 50% postponed from 2025 to 2035. - France will not meet its 2020 and 2030 renewable energy targets of 23% and 32% respectively in final energy consumption. Renewable Energy Shares in is expected to reach between 16,6% - 20,4% under current policies in 2020 (Navigant, 2019). - 2050 decarbonization strategy relies on sinks and the development of CCS technology yet unclear
	No new coal plants, reduce emissions from coal power globally by at least 30% by 2025, coal phase out by 2030 in EU and OECD countries.	+ coal phase-out planned for 2021

3.2. Policy deficiencies and policies or practices negatively contributing to global warming in key sectors

- **Transportation Policies needs to be reinforced:** the transport sector and more specifically the private passenger road transport is the main contributor to France National GHG emissions. While France targets to close to 30% by 2030 compared to 1990, transport emissions have remained stagnant for the past decade. A slow electrification combined with a slow modal shift and an increase in demand may explain this increase in emissions. (Haut Conseil pour le Climat, 2019). While the French Mobility law was adopted in June 2019, the concrete financing plan of its implementation is so far unclear and thus threaten the feasibility of its implementation (Autorité Environnementale Conseil général de l'environnement et du développement durable, 2019; I4CE - Institute For Climate Economics, 2019) and an attempt of the government to introduce a fuel-tax bill on private transport generated massive social protest in 2018 which led to the government's abandonment of the bill. While limiting the road transport demand and supporting the transition from road to other transport modals will need stronger measures, the support to the purchase of electric bicycles which had proven its benefit in 2017 was restricted in 2018 (Autorité Environnementale Conseil général de l'environnement et du développement durable, 2019; Rüdinger et al., 2018).

- **Lagging behind in renewable energy and energy efficiency targets:** France will not meet its 2020 and 2030 renewable energy targets having postponed from 2025 to 2035 the target of a 50% share of nuclear in energy production. 2020 renewable share in final energy consumption is expected to reach between 16,6% - 20,4% under current policies (Navigant, 2019). A lack of investment in the renewable energy sector together with a lack of clarity and planification on the phase-down from the nuclear sector contribute to this trend (Climate Action Network Europe (CAN), 2018; Rüdinger et al., 2018). In the buildings sector, France to meets its emissions reduction 2017 target (+22% compared to the 2017 target in building sector) and is unlikely to meet its 2030 target (see previous section). An unclear support scheme for renovations with heavy administrative implementation and constantly changing scope are slowing the rate of renovations (Haut Conseil pour le Climat, 2019; Rüdinger et al., 2018). It is estimated that to reverse this trend France should spend between 15 to 30 billion euro per year over 30 years which is much higher than what is currently planned (13,5 billion euros) (Autorité Environnementale Conseil général de l’environnement et du développement durable, 2019).

- **High level of “Brown” climate investments:** in 2017, investments in non-climate friendly investments reached 27 billion euros which support the use of fossil fuels energy. 98% of them were dedicated to fossil-fuel vehicles sector. “Green” investments were 1,5 times lower than expected to meet emissions cap settled for the period 2015-2018 (Haut Conseil pour le Climat, 2019).

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4.4. Germany

Drivers of Climate Change: Germany

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Summary

Germany's total greenhouse gas emissions steadily declined between 1990 and 2010, but have largely been stagnant since. The main drivers of emissions in Germany are the energy, transport and industry sectors, which account for 75% of total emissions.

Germany has made significant strides in its approach to climate change policy, with its Energiewende project leading to strong renewable energy uptake over many years and with its advocacy for robust EU action on the issue and on ambitious climate policy in the past. However, in recent years Germany's progress in decarbonizing its economy has stalled and so has its former leadership role within the EU. Germany will now definitely miss its own 2020 emission reduction target and also the binding EU 2020 target for sectors outside the European Emissions Trading Scheme (ETS). This raises questions as to whether Germany will step up its climate policy to embrace transformational change towards becoming largely greenhouse gas neutral by 2050, as agreed by the Government in its long-term strategy adopted in 2016.

Emissions in the key sectors of transportation and industry have been rising over recent years until 2017, with current policies in these sectors found to be lacking in transformational ambition. Germany will need to implement additional policies if it is to meet its 2030 target of a 55% emission reduction below 1990 levels, while meeting even its 38% target under the EU ESR is likely to be challenging without increasing its policy ambition.

Germany's domestic 2030 mitigation target consistent with warming of between 2°C and 3°C, if all countries made comparable commitments, while current policy projections would be in line with between 3°C and 4°C global warming. Similarly, the EU's NDC target of a 40% reduction below 1990 levels by 2030 is compatible with warming of between 2°C and 3°C if all countries made comparable commitments. It is therefore imperative that Germany adopts more ambitious targets and policies.

4. Germany's Emission Profile

4.1. Historical and Projected Emissions

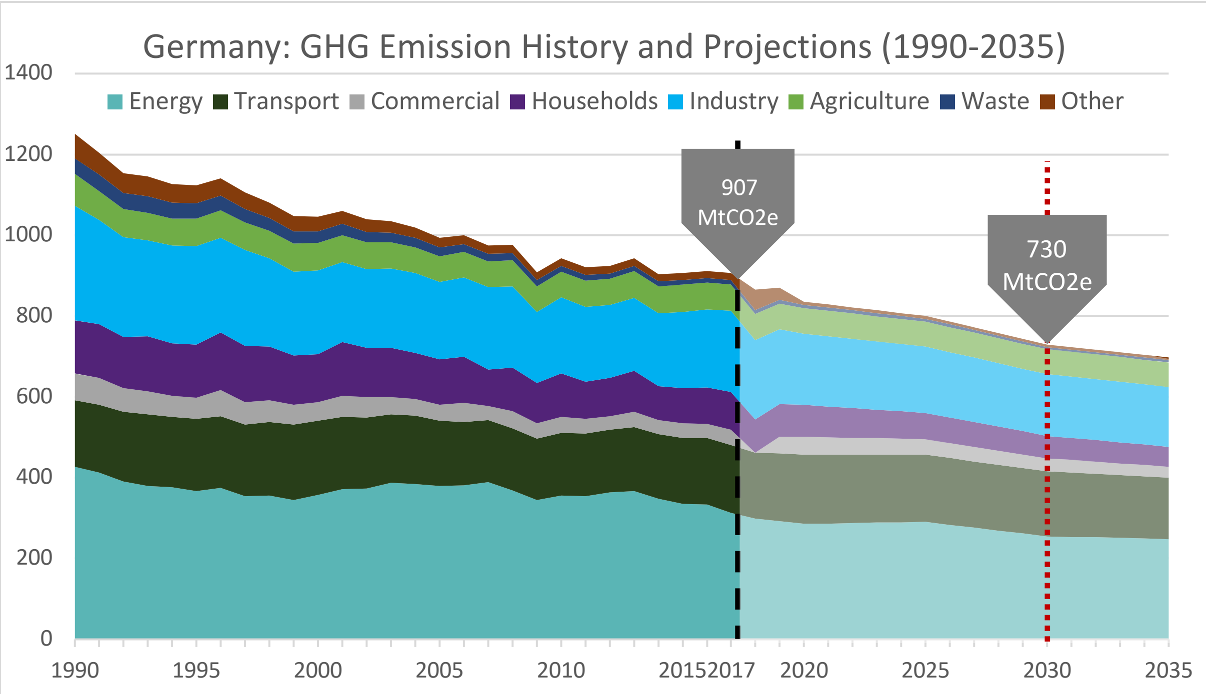

Figure 1: *Historical and projected emissions of Germany from 1990 to 2035.*

Source: German Ministry of Environment, 2017a, 2019c

Germany's total greenhouse gas (GHG) emissions steadily declined between 1990 and 2010, but have been largely stagnant since. Emissions data from 2017 puts Germany's overall emissions at 907 $MtCO_2e$ (excluding LULUCF), roughly 28% lower than 1990 levels. Germany's 2016 level of GHG emissions (911 $MtCO_2e$) constituted approximately 1.9% of global emissions for that year (Gütschow, Jeffery, & Gieseke, 2019).

Based on current policies[3], Germany's emissions are expected to be 730 $MtCO_2$ by 2030 (German Ministry of Environment, 2019d).

[3] Emissions projections include policies implemented as of 2017, as reported in the latest projection report provided to the European Commission in 2019. These projections do not yet include the effect of new policies and market trends in the last two years, nor policies currently under discussion such as the coal phase-out regulation, which is expected to become a national law by the end of 2019.

4.2. Key emission contributions

Germany's energy, transport and industry sectors contributed a combined 75% of emissions in 2017, up from 70% in 1990. This is primarily due to a lack of emission reductions from the transport sector, with transport increasing its emission share from 13.1% in 1990 to 18.5% in 2017 (German Ministry of Environment, 2019b).

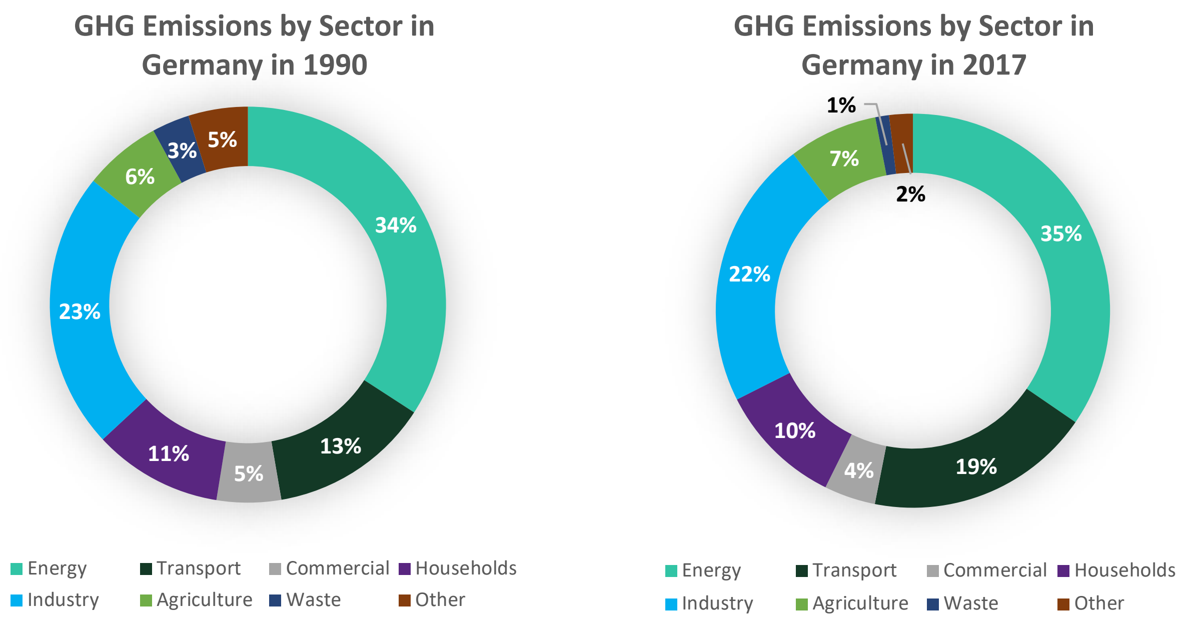

Figure 2: *GHG emissions contributions by sector in 1990 (left) and 2017 (right).*
Source: German Ministry of Environment, 2019c

- **Drivers of Energy Emissions:**

Due to a fall in the price of coal and of CO_2 emission allowances from 2010 and increasing natural gas prices, coal fired power began replacing that from gas plants, pushing them out of the market. This led to a paradoxical situation whereby GHG emissions were rising despite an increasing share of renewable energy in Germany's energy supply (Graichen, Redl, & Kleiner, 2014).

Strong investment in renewable energy, led higher by the introduction of feed-in tariff legislation in 2000 has led to a more than doubling of output from renewable sources between 2010 and 2018. Continued strong growth in renewable energy capacity will be required to offset the looming reductions in coal power capacity related to the likely 2038 coal phase-out, while also replacing nuclear energy capacity that is scheduled to be phased out by 2022 (German Ministry of Environment, 2019e). Energy sector emissions resumed their downward trajectory from 2014, although the latest government projections show energy sector emission reductions stagnating between 2020 and 2025 (German Ministry of Environment, 2019d).

- **Drivers of Transport Emissions:**

Despite Germany´s transport sector achieving a steady reduction in emissions from their peak in 1999 to the recession year of 2009, emissions have been rising since, peaking in 2017 above 1990 levels (German Ministry of Environment, 2019c). While Germany´s automotive manufacturers have invested substantially in researching lower emission vehicles (VDA, 2017), the average weight of German cars has increased substantially since 2000, with the average mass of the German new car fleet 170kg heavier than the European average in 2016 (Campestrini & Mock, 2011; International Council on Clean Transportation, 2017). In addition, German car manufacturers have considerable political clout and were behind the successful push by Germany to water down EU level emissions standards for vehicles in 2013. Meanwhile demand for electric vehicles has failed to materialise, with battery and plug-in hybrid sales accounting for less than 2% of total passenger vehicle sales in 2018 (German Federal Motor Transport Authority, 2019).

5. Country specific targets and compliance

5.1. Sector specific emission targets

Sector	Target 2020	Target 2030	Other national targets
Economy wide excl. LULUCF	40% below 1990 level	55% below 1990 level	Extensive greenhouse gas neutrality by 2050
Energy		61-62% below 1990 level	Renewable energy (share of gross final energy consumption): • 18% by 2020 • 30% by 2030 Primary energy consumption: 50% below 2008 level by 2050 Almost complete decarbonisation of the energy supply by 2050
Transport		40-42% below 1990 level	Final energy consumption: 40% below 2005 level by 2050 Virtually decarbonised transport system by 2050
Industry		49-51% below 1990 level	Greenhouse gas neutrality by 2050
Buildings		66-67% below 1990 level	Primary energy demand for buildings: 80% below 2008 level by 2050 Virtually carbon neutral building stock by 2050
Agriculture		31-34% below 1990 level	Further reductions beyond the 2030 target by 2050

Table 1. *Sector specific emission targets.*

Source: German Ministry of Environment, 2016, 2019b

5.2. How well is the country complying with its targets?

- **Compliance with Targets:**

According to the German federal government, Germany will miss its own goal of a 40% reduction in GHG emissions below 1990 levels by 2020 by a large margin, with the current projection showing a reduction of 33% by 2020 (German Ministry of Environment, 2019d). This makes the achievement of its 2030 target of a 55% reduction below 1990 levels much more difficult, and will require substantial additional policies to be put in place. Germany edging closer, however to meeting its 2020 goal of 18% of gross final energy consumption sourced from renewable energy, reaching 16,6% in 2018 (German Ministry of Environment, 2019a).

The sectoral emission targets require a strong deviation in current emission reduction trajectories for most sectors. Government projections for emission reductions under current policies for other sectors are shown in Table 2.

Sector	Target 2030	Projection to 2030 with Current Policies
Economy wide excl. LULUCF	55% below 1990 level	42% below 1990 level
Energy	61-62% below 1990 level	40% below 1990 level
Agriculture	31-34% below 1990 level	23% below 1990 level
Industry	49-51% below 1990 level	46% below 1990 level
Transport	40-42% below 1990 level	3% below 1990 level

Table 2. *Targeted vs. Projected Sectoral Emission Reductions*

Source: German Ministry of Environment, 2019d, 2019b

Under the EU's Effort Sharing Regulation, EU Member States have binding targets to reduce their GHG emissions from those sectors not covered by the EU Emissions Trading Scheme (ETS) that were agreed on largely according to their relative economic strength. The overall EU 2030 target for these sectors, which includes transport, buildings, agriculture and waste, is a 30% reduction below the 2005 level, with Germany's target set at 38% below the 2005 level (German Ministry of Environment, 2019b). Under current projections, Germany's emissions from these sectors is set to be 26.5% below the 2005 level in 2030 (German Ministry of Environment, 2019d).

- **Global Warming Pathway Related to EU and National Targets:**

The EU's nationally determined contribution (NDC) under the Paris Agreement is for a 40% reduction in emissions below the 1990 level by 2030. While Germany is on track, with current policies, for a 41% reduction in emissions below 1990 levels by 2030, this in effect requires other EU countries, many of which are less wealthy than Germany, to make comparatively higher emissions reduction efforts in order to meet the EU NDC. Germany is not on track to achieve its domestic target of 55% reduction below 1990 levels by 2030.

Based on the methodology of the Climate Action Tracker, the EU's NDC and projected emissions under current policies for 2030 are not consistent with holding warming to below 2°C, let alone limiting it to 1.5°C as required under the Paris Agreement. EU projected 2030 emission levels are instead consistent with warming of between 2°C and 3°C, if all countries made comparable commitments (Climate Action Tracker, 2019). Downscaling the Climate Action Tracker fair share range for the European Union to Germany[4], it can be concluded that Germany's domestic mitigation target is also consistent with warming of between 2°C and 3°C, if all countries made comparable commitments, while current policy projections would be in line with between 3°C and 4°C global warming.

6. Country's climate policies and practices

6.1. How are the key and most emitting sectors under current policies contributing to limit global warming to 1.5°?

Table 3 shows an overview of positive and negative policy developments in four key emitting sectors in Germany compared with sector-specific short-term benchmarks for limiting global warming to 1.5°C as identified by (Kuramochi et al., 2017).

Sector	Necessary step	Assessment and opportunities for improvement
Power	Sustain the growth of renewables and other zero and low carbon power until 2025 to reach 100% by 2050	+ More than doubling in renewable energy share of electricity production since 2010, to 35.2% in 2018 + Recently improved renewable energy target of 65% of electricity production by 2030 - Significant slowdown in investment in onshore wind power - Subsidies for solar, wind and biomass facilities will begin expiring in 2020
	No new coal plants, reduce emissions from coal power globally by at least 30% by 2025, coal phase out by 2030 in EU and OECD countries.	+ Legislation passed in 2016 to transition 2.7GW of lignite coal plants to "security standby" before being shut down after four years + No new coal plants are planned, and phase-out has been agreed to by 2038, with a review scheduled in 2032 for a potential phase out date of 2035 + Emissions from coal to be reduced by 30% by 2022 - Multiple coal plants have been commissioned in recent years, making it costlier and more difficult to abide by the 2038 phase-out date - 2038 date is not consistent with the Paris Agreement benchmark for coal phase-out in OECD countries, which would require a full phase-out by 2030
Transport	Last fossil fuel car sold before 2035	+ Up to €4,000 grants for electric vehicle purchases + €300 committed for construction of charging infrastructure + €5 billion invested to encourage electric mobility since 2009 - Germany pushed for weaker EU vehicle emission standards both in 2013 and 2018, leading to less ambitious legislation

[4] See table X. The Germany fair share range is calculated by applying a proportional percent reduction below 2005 emissions levels from the EU fair share range, adjusted considering the higher proportional reduction obligation of Germany according to the EU's Effort Sharing Regulation (8% more than EU average).

		- Subsidies still exist for diesel fuel and for car travel under the commuters' tax allowance - Low EV uptake compared to European neighbours and target of 1 million EVs on German roads by 2020 has been pushed back to 2022
Industry	All new installations in emissions-intensive sectors are low-carbon after 2020, maximise material efficiency	+ Commitment to double Germany's resource efficiency from 1994 levels by 2020 + A range of Energy efficiency policies have been implemented including incentives for energy management systems + Only sector projected to come close to meeting its 2030 target under current policies - A large proportion of industrial emission reductions since 1990 were due to East German factory closures, not process improvements, emissions have stagnated instead of decreasing between 2009 and 2017.

Table 3. *Positive and Negative Policy Developments in Key Sectors*

Source: Climate Analytics own evaluation, Climate Analytics, 2016, 2018

6.2. Policy deficiencies and policies or practices negatively contributing to global warming in key sectors

- **Climate Action Law has not been legislated:** While many German states have implemented their own climate action legislation, of yet there is, no federal German climate law, even though there is a political commitment to do so (CDU, CSU, & SPD, 2018). Such climate action legislation ensures a country's national climate targets are legally binding, creating enforceable consequences if they are not met. Such enforceable consequences already exist at the EU level, however, Germany's EU emission reduction responsibilities are less stringent than its national targets (German Ministry of Environment, 2019b). A first draft of the climate action legislation was sent to the chancellery in early 2019 by the Environment ministry (Appunn & Wettengel, 2019), but was met with fierce criticism by many in Chancellor Angela Merkel's conservative party. Under the proposed law, the current 2030 sector targets would not only become legally binding, but they would be broken down into annual emission budgets (Appunn & Wettengel, 2019). This is similar to the already existing EU Effort Sharing Regulation (ESR), which stipulates countries not meeting their annual targets must purchase emission reductions from other EU countries that have overachieved their targets (European Commission, 2016). Under the proposed legislation, shortfalls under the ESR would be allocated at a sector level and paid by the corresponding ministry budget.

- **Energy policies must be strengthened:** Though Germany has seen a strong uptake in renewable energy in the last decade, coal still constituted 35% of German electricity production in 2018 (AG-Energiebilanzen, 2019). The recommendation in 2019 to a coal phase out date is a promising development, but the date of 2038 is not consistent with the Paris Agreement. An analysis on least cost pathways for a global coal phase out found that OECD countries should phase out coal by no later than 2030 (Climate Analytics, 2018). With renewable energy feed-in tariffs being replaced by auctioning from 2020 onwards and investment in wind energy flagging (Eckert, 2019; German Ministry of Environment, 2017b), there is a risk that Germany's strong recent progress on renewable energy uptake will falter without further government support.

- **Industry emissions have been rising:** Germany made strong progress on industrial decarbonization throughout the 1990s as inefficient East German plants were shut down and efficiency policies were implemented. However, emissions from industry stabilised around the turn of the century and actually rose between 2013 and 2017 to reach above 2001 levels in 2017 (German Ministry of Environment, 2019c). While Germany has targets and policies for energy efficiency (German Ministry of Environment, 2019b), no significant policy to focus Germany's emission reduction efforts from industry towards decarbonisation has yet been implemented, however, with the Climate Action Plan, the Government has decided to develop a strategy toward decarbonisation together with Industry (German Ministry of Environment, 2016).

- **Transportation policies are proving insufficient:** Transport emissions in Germany peaked in 1999, but have not yet fallen below 1990 levels after sitting flat between 2007 and 2012 and rising thereafter until 2017 (German Ministry of Environment, 2019c). Electrification of the German vehicle stock is an important strategy, particularly as the proportion of renewable energy stock rises, but so far German policy on this front is not strong enough. Subsidies are in place to encourage the purchase of electric vehicles (EVs) (German Ministry of Economy and Energy, 2019), but there is no target set for phasing out fossil fuel LDV sales, and the target of 1 million EVs on German roads by 2020 has been pushed back to 2022 (Heller, 2018). With Germany lagging in its EV uptake, it makes the existence of the commuter's tax allowance for vehicle costs particularly damaging with regards to emissions, while subsidies available for diesel fuel work against EV uptake.

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4.5. Turkey

Drivers of Climate Change: the case of Turkey

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Summary

Emissions in Turkey have been steadily growing since 1990, with most of the growth coming from energy related emissions. Energy emissions (excluding LULUCF) are (72%), followed by Industry (13%) and Agriculture (12%).

Turkey's climate commitment and projected emissions levels under current policies for 2030 are consistent with global warming above 4°C by the end of the century, if all countries were to follow Turkey's approach. In addition, Turkey remains one of the few countries in the world that have not ratified the Paris Agreement.

In the energy sector, besides the planned increase of renewable shares in the power sector and some energy efficiency measures, Turkey continues with its plan to meet increasing energy demand by building new coal-fired power plants and promote the use of domestic coal, which is against a decarbonization of the power sector. Due to its strategic location and the increasing demand on Liquified Natural Gas (LNG) worldwide, Turkey is also promoting the use of natural gas abroad and developing its storage and regasification capacities

Although Turkey has settled a partly successfully renewable auctions program (YEKA), if the delays and cancellation for renewables experienced so far were to continue, it is unlikely that the targeted timeline of renewable shares increase will be met. Tukey is also lagging behind

on transport sector, dependent on fossil-fuel and with insufficient incentives for low-carbon alternatives.

Turkey will need to review the ambition of its INDC and sectorial targets to meet the 1.5°C compatible benchmarks and scale up climate action substantially to halt emissions growth. Paris Agreement compatible emissions pathways require emissions to peak and decline fast afterwards, reaching carbon neutrality by mid-century. In contrast, under current policies, emissions of Turkey are expected to grow by 2030.

Turkey’s Emissions Profile

Historical and Projected Emissions

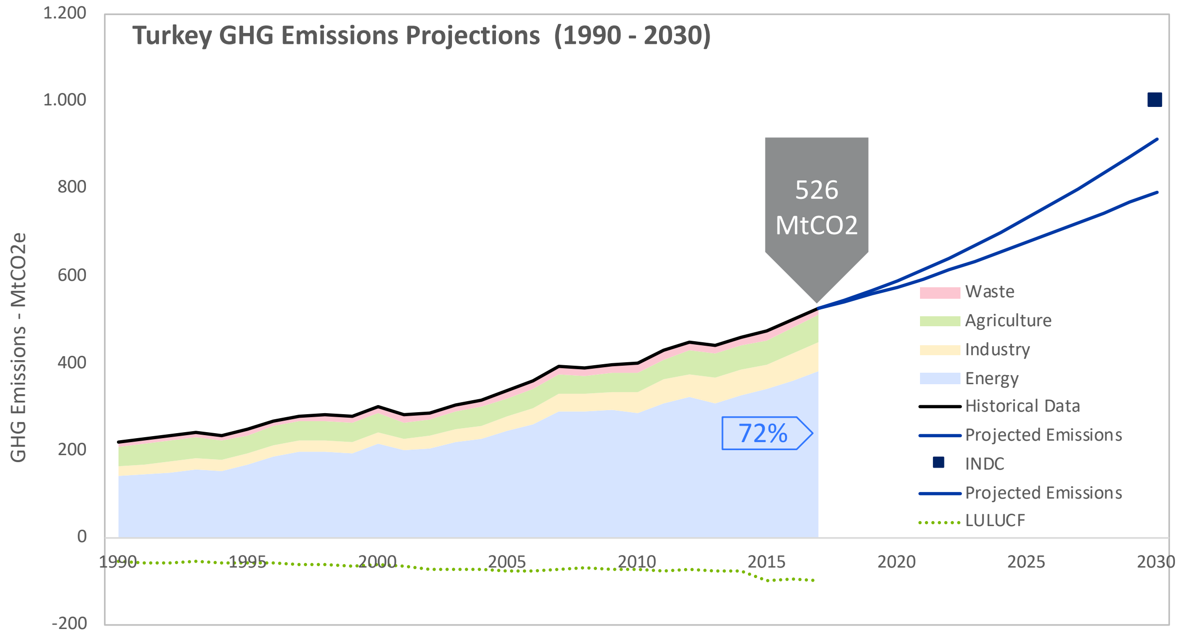

Figure 36: *Historical and projected emissions of Turkey from 1990 to 2030 based on the most recent update from Climate Action Tracker* (Climate Action Tracker, 2019)*. Share of the Energy sector (72%) is here indicated excluding LULUCF emissions.*

As shown in figure 1, historical emissions in Turkey have been steadily growing since 1990 to reach 526 $MtCO_2$ emissions in 2017 (excluding LULUCF), which is more than doubling 1990 levels of emissions, with most of the growth coming from energy related emissions. Third party sources estimated the country emissions for 2015 and 2016, reaching a share of 1,1% of emissions worldwide in 2016 (Gütschow, Jeffery, & Gieseke, 2019).

According to Climate Action Tracker most recent assessment (Climate Action Tracker, 2019), under current policies, annual emissions from all sectors (excluding LULUCF) are still projected to grow significantly, namely by between 199% to 229% above 2010 levels by 2030, reaching about 792-914 $MtCO_2$ in 2030, which is equal to doubling emissions from 2010 levels.

The projection of current policies shown in figure 1 (Climate Action Tracker, 2019) is based on the mitigation scenarios underlying the seven National Communication of Turkey to the UNFCCC (Republic of Turkey Ministry of Environment and Urbanization, 2018), including Turkey's nuclear power plant planned to be launched in 2023 (Republic of Turkey Ministry of Environment and Urbanization, 2018) and expected to be fully operational by 2025. The upper-bound projections for the current policies scenario are based on the "with measures" scenario from the National Communication, including a nuclear target for 2025 The lower-bound of the current policy projection is based on historical trends of GDP elasticity of energy and industry GHG emissions between 1990 and 2017 with adjusted GDP on more recent growth estimates (IMF, 2018; PWC, 2017), due to unrealistic high assumptions made within official projections.

Key sectors drivers of Emissions

The largest share of Turkey current emissions (excluding LULUCF) correspond to energy emissions, accounting for 72% of the total in 2017 (Figure 30), followed by Industry (13%) and Agriculture (12%).

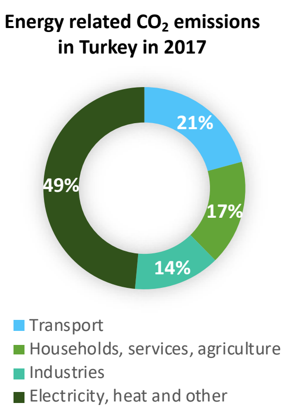

***Figure 37:** Shares in energy related co₂ emissions. Source: G20 Brown to Green report 2018* (Climate Transparency, 2018)

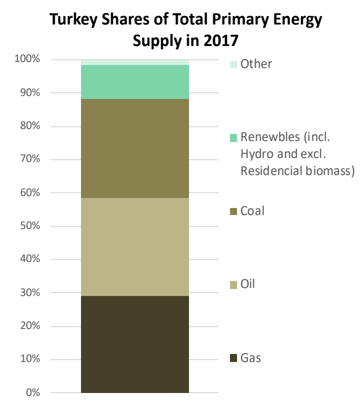

***Figure 38:** Share of total primary Energy Supply in Turkey in 2017. Source: G20 Brown to Green report 2018* (Climate Transparency, 2018)

- **Drivers of Energy emissions:**

Electricity and heat sector is the main contributor of Turkey's energy emissions, accounting for 49% of energy related emissions in 2017, representing approximately 28% of the total national GHG emissions in 2017 (excl. LULUCF) (Turkish Statistical Institute, 2019). Fossil fuel-based generation dominates primary energy supply in Turkey accounting for over 70% of the electricity mix in 2017, with 37% of electricity generation coming from natural gas, followed by coal (32%). Renewable generation is dominated by hydro (20%). Liquid fuel, waste, wind and geothermal contribute the remaining 11% (IEA, 2019). Turkey's electricity sector heavily relies on natural gas, mostly imported from Russia. To reduce dependency and meet the increasing power demand (expected to be 4% to 6% annually (Erdin & Ozkaya, 2019)), the

Turkish Government aims to increase the share of electricity generation based on coal and renewables (Republic of Turkey Ministry of Environment and Urbanization, 2016) (Climate Action Tracker, forthcoming 2019). 2018 saw Turkey breaking its record in domestic coal production, which reached 101.5 million tonnes (Anadolu Agency, 2019) and the government is continuing to press for a large expansion in coal power with close to 37 GW of planned power plants (announced, pre-permitted and permitted) (Coalswarm, 2019). This stands in strong contrast to the global need to reduce the use of coal in electricity by two-thirds over 2020-2030 and to zero by 2050 (IPCC, 2018). Turkey is also embarking on nuclear power plant production. Having no nuclear power at the moment, the Energy and Natural Resources Minister announced that between 2023 and 2030 Turkey will put three nuclear power plants into operation, expected to meet 10% of the country-wide electricity consumption (Republic of Turkey Ministry of Environment and Urbanization, 2018).

- **Drivers of Transport Emissions:**

Transport emissions account for around 18% of Turkey's GHG emissions (excl. LULUCF) (Republic of Turkey Ministry of Environment and Urbanization, 2018). Transport sector emissions are dominated by the road transport accounting for 93% of transport sector GHG emissions in 2017. Turkish inventory data shows that between 1990 and 2017, road transport-related emissions more than tripled (Turkish Statistical Institute, 2019). The majority of transport is road-based, with diesel playing a major role and LPG having an notably high share in sector fuel use (71,5% for Gas and Diesel in 2016 and 13,6% for LPG in 2016) (Agora Verkehrswende, 2018).

Country specific targets and compliance

Country specific targets

Sector	Target 2020	INDC[5] Target 2030	Other national targets
Economy wide, incl. LULUCF	None	Unconditional target: 21% below BAU by 2030 [356% above 1990 by 2030 excl. LULUCF] [150% above 2010 by 2030 excl. LULUCF]	
Energy		Increasing capacity of production of electricity from solar power to 10 GW and from wind power to 16 GW until 2030	1) Increase the share of renewables in the electricity generation mix to 38,8% by 2023 2) 20% reduction in energy intensity by 2023 compared to 2008
Transport			Increase the share of railway transport above 15% (which was 5% in 2009), thereby reducing the road transport share to below 60% in 2023 (which was 81% in 2009).

[5] As of August 15th 2019, Turkey has not ratified the Paris Agreement, making its 2030 emissions target only an "Intended Nationally Determined Contribution" (INDC). Source for ratification status: https://treaties.un.org/Pages/ViewDetails.aspx?src=TREATY&mtdsg_no=XXVII-7-d&chapter=27&lang=_en&clang=_en

Table 1: *Sector specific emission targets.*

Sources: Most recent Turkey Climate Action Tracker update (Climate Action Tracker, 2019), National Renewable Energy Action Plan (Ministry of Energy and Natural Resources, 2014), National Energy Efficiency Strategy Paper (Republic of Turkey Ministry of Energy and Natural Resources, 2012), National Climate Change Action Plan (Republic of Turkey Ministry of Environment and Urbanisation, 2011), 11th Development Plan (Presidency of the Republic of Tukey, 2019)

How well is the country complying with its targets?

- **Compliance with Targets:**

According to the Climate Action Tracker most recent assessment, Tukey is on track to overachieve its INDC 2030 target although rated as "critically insufficient" by Climate Action Tracker (Climate Action Tracker, 2019). Turkey remains one of the only two G20 countries that have not ratified the Paris Agreement. Its Intended National Determined Contribution (INDC) target submitted in 2015 is equivalent to a 90% increase from 2017 levels, excluding LULUCF.

With regards to sector specific targets, based on the high share of hydropower in electricity generation (25% in 2016), Tukey has already achieved its National Renewable Energy Action Plan target of 30% power generation from renewable sources for 2023 (IEA, 2018) and unveiled a new target in its 11th Development Plan published in July 2019 of 38,8% share of renewable energy in electricity generation in 2023 (Presidency of the Republic of Tukey, 2019). However, it is still lagging behind from its INDC targets of solar and wind energy installed capacity, where even though the Ministry of Energy and Natural Resources has new plans for an additional 10 GW of solar PV and 10 GW of wind capacity to be installed in the coming decade, ongoing delays for renewables auctioning and installation are threatening the achievement of the target (Climate Action Tracker, 2019).To meet its renewable energy share target, the government has introduced in 2016 the Renewable Energy Resource Areas (YEKA) strategy, a tender process to procure the production of renewable energy on 'Renewable Energy Designated Areas' (REDAs) which are deemed most suitable for energy generation and the first auctions were awarded for a Solar PV plant in March 2017 and for a Wind onshore plant in August 2017 (Sarı, Saygın, & Lucas, 2019). A third wind onshore auction (1 GW) has recently (May 2019) been awarded to the German-Turkish consortia (Enercon-Enerjisa) (Daily Sabah, 2019). However, while the 2017 auctioning process was successful, the 1.2 GW off-shore wind auction initially announced for June 2018 has been postponed to 2019 at the earliest. This was followed by the cancellation of the second solar PV YEKA auction, originally planned for January 2019.

- **Global Warming Pathway regarding INDC and current policies projections:**

Based on the Climate Action Tracker methodology, Turkey's climate commitment and projected emissions levels under current policies for 2030 are not consistent with holding warming to below 2°C, let alone limiting it to 1.5°C as required under the Paris Agreement, and are instead consistent with warming above 4°C, if all countries were to follow Turkey's approach (Climate Action Tracker, 2019).

Paris Agreement compatible emissions pathways require emissions to peak and decline fast afterwards, reaching carbon neutrality by mid-century. In contrast, under current policies, emissions of Turkey are expected to grow by 2030 (Climate Action Tracker, 2019).

Country's climate policies and practices:

How are the key and most emitting sectors under current policies contributing to limit global warming to 1.5°?

The following table shows an overview of positive and negative policy developments in two key emitting sectors in Turkey compared with sector-specific short-term benchmarks for limiting global warming to 1.5°C as identified by (Kuramochi et al., 2017).

Sector	1.5 °C-consistent benchmark	Assessment and opportunities for improvement
Electricity and heat sector	Sustain the global average growth of renewables and other zero and low carbon power until 2025 to reach 100% by 2050	+ The renewable energy share grew significantly in recent years (from 27% in 2012 to 33% in 2016) with big additions of wind and solar capacity and clear national targets and policies to increase share further in the future. + National Energy Efficiency Action Plan can attenuate energy demand growth facilitate integration of higher shares of renewable energy - Current target (38,8% by 2023) will not be sufficient to meet the 1.5°C compatible benchmark of 59%-81% by 2030 (world average) - Delays in both RE projects construction and auctions, put at risk the achievement of the RE installation targets - Significant untapped potential for renewable power, especially solar power
	No new coal plants commissioned, reduce emissions from coal power by at least 30% by 2025	- The use of "clean coal technologies" and measures to increase energy efficiency is mentioned in the National Climate Change Action Plan - 1.2 GW of additional capacity is under construction, with completion expected by the end of 2019 and significant new coal capacity in the pipeline (37 GW of planned power plants (announced, pre-permitted and permitted) (Coalswarm, 2019) - Increasing domestic coal production and domestic push for further increase with announced tenders for coal mines acquisition (Ahval, 2019).
Transport	Last fossil fuel car sold before 2035	+ Policies in place focused on the development of legal arrangements, capacity building and promotion of alternative fuels and clean vehicles - No overarching 1.5°C/2°C compatible vision for transport sector in Turkey - Insignificant share of EVs (less than 1% since 2011) and no policy to ramp up EVs uptake

Table 2: *Positive and negative policy developments in key sectors of Turkey.*

Source: Scaling Up Climate Action in Turkey (Climate Action Tracker, forthcoming 2019).

Lacking policies and practices or negatively contributing to global warming in key and most emitting sectors

- **Increasing coal share in power sector:** besides renewable energy sources, coal is considered the most important source of substitution to reduce the dependency on imported natural gas. To meet its increased energy demand, Turkey plans to build new coal-fired power plants (Istanbul Policy Center, 2016) and, as the Ministry of Energy and Natural Resources announced in May 2019, is holding tenders for coal mines promoting domestic coal. 1.2 GW of additional capacity is under construction, with completion expected by the end of 2019 and significant new coal capacity in the pipeline (37 GW of planned power plants (announced, pre-permitted and permitted) (Coalswarm, 2019). Apart from the impact on emissions, this would add severe stress to already drought-prone regions, increasing the threat to water demand, by adding competition with other water users (Climate Action Tracker, 2019).

- **Incentivation to increase natural gas share in energy mix:** Due to its strategic location and the increasing demand on Liquified Natural Gas (LNG) worldwide, Turkey is aiming to become a gas trading hub by developing its storage and regasification capacities : two new floating storage and regasification units (FSRU) planned by 2023 when the second FSRU was commissioned in January 2018 (DAILY SABAH, 2019).

- **No incentives to shift to low-carbon vehicles:** current National action plans (namely NCCAP[6] and NEEAP)[7] stay qualitative (i.e. development of legal arrangements, capacity building and promotion of alternative fuels and clean vehicles) and it is unclear whether the intended development and promotion of alternative fuels and clean vehicle technologies can be realized in the near to medium-term. Tax incentives for smaller and low-carbon fueled cars are insufficient to cause a clear shift of the market to low-carbon vehicles (Climate Action Tracker, forthcoming 2019).

- **Public finance in power sector subsiding coal, oil and gas sectors**: In 2017, it is estimated that 83% of total public finance to power went to coal, oil and gas projects in contrast with close to no financing towards renewables projects while 17% financing streams were identified for “grey sector” (such as nuclear, biomass, large-scale hydropower etc.) (Climate Transparency, 2018).

- **No ratification of the Paris Agreement:** Turkey remains one of the only two G20 countries that have not ratified the Paris Agreement and submitted its INDC in 2015.

[6] National Climate Change Action Plan (Republic of Turkey Ministry of Environment and Urbanisation, 2011)
[7] National Renewable Energy Action Plan (Ministry of Energy and Natural Resources, 2014)

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APPENDIX D

APPENDIX D.1

Climate Impacts in Palau

Additional Country Reports Climate Impacts in Palau

Report by: Earthjustice

September 2019

D.1

Climate Impacts in Palau

Palau is a cluster of 586 volcanic, limestone and coral islands in the western Pacific Ocean, just north of the Equator, twelve of which are permanently inhabited.[1] Twenty five percent of the land area is below 10 meters above sea level.[2] Palau's higher ground is not well suited for habitation and economic activity due to steep slopes and thick vegetation, so most Palauans live and work in the country's coastal lowlands.[3] The economy relies on tourism, fishing, and subsistence agriculture.[4] The main island of Babeldaob, comprising 75 percent of Palau's land area, is unsuited for large-scale agriculture due to severely leached and acidic soils.[5] With a population of 21,000, Palau's per capita GDP was just $14,700 in 2017.[6] Palau has the most diverse coral of Micronesia, with a high density of tropical marine habitats including mangroves, seagrass beds, deep algal beds, mud basins, lagoons, and tidal channels.[7]

Palau is already experiencing disruptive changes due to climate change, including extensive coastal erosion, coral bleaching, ocean acidification, persistent alteration of regional weather patterns, decreased productivity in fisheries and agriculture, saltwater intrusion into taro and yam cultivation areas during extreme high tides, severe water shortages, and more widespread and frequent occurrence of mosquito-borne diseases.[8] According to the Government of Palau:

> Palau is particularly vulnerable to the impacts of climate change, principally from sea level rise and the increase in extreme events (drought, flooding, Category 4 and 5 typhoons). Sea-level rise threatens vital infrastructure, settlements, and facilities that support the livelihood of island communities. Moreover, under most climate change scenarios, water resources in small islands are likely to be seriously compromised. Subsistence and commercial agriculture will be adversely affected by climate change, and ocean warming and acidification will heavily impact coral reefs, fisheries, and other marine-based resources crucial to our livelihoods, economy and culture.[9]

In its Fifth Assessment Report of 2014, the Intergovernmental Panel on Climate Change (IPCC) projects that anthropogenic climate change will have significant adverse effects not only on the natural environment, but also on the human populations that inhabit that environment and rely on its processes and services.[10] Climate change impacts in the tropical Pacific are projected to increase significantly by the end of the century.[11] In Palau's region, the IPCC Fifth Assessment projects median **surface air temperature increase** in the range 0.5°C to 0.9°C by 2100 compared to 1986–2005.[12] **Precipitation events** are also projected to become more extreme by the end of the century.[13] **Sea level rise**, along with extreme sea level events including swell waves, storm surges, and ENSO events, poses risks of sea flood and erosion for low-lying coastal areas and atolls. [14] **Overwash** of sea water will degrade fresh groundwater resources.[15] **Sea temperature rise** will result in increased coral bleaching and reef degradation. [16]

Subsistence agriculture in Palau consists primarily of taro, cassava, coconuts, and sweet potatoes.[17] Taro is culturally and religiously important crop traditionally cultivated in coastal lowlands by women.[18] It is particularly threatened by saltwater intrusion and wave overtopping.[19] During El Niño-Southern Oscillation (ENSO) events, major damage to taro crops has occurred, with poor recovery.[20] Fires are also a major hazard during ENSO events.[21] Steep grasslands are severely impacted by these fires, and the subsequent erosion harms downstream mangrove forests, lagoons, and coral reefs.[22]

Fisheries in the Pacific are predicted to be harmed by climate change impacts, including sea temperature rise, increasing acidity and salinity, changing currents, and typhoon damage.[23] Palauans rely on fresh fish a food source.[24] Nearly every household participates in coastal fishing,[25] and annual per capita fish consumption is over 67 kilograms per year.[26] Fish protein comprises 52 percent of animal protein in the average diet.[27] As fish become harder to catch, Palauans will have to reduce the amount of fish (and thus protein essential for good nutrition) in their diets, or turn to substitutes that are more expensive.[28] Decline of coral communities will reduce the richness of fish species and will result in local extinctions and loss of species within key functional groups of fish.[29] Rising ocean temperatures also increase the risk of ciguatera fish poisoning.[30]

Coral bleaching threatens coastal marine ecosystems and the tourism industry. Rising sea surface temperatures trigger to corals eject their symbiotic algae in response to stress, resulting in coral bleaching, mass mortality of reefs, and loss of storm protection to coastlines and mangroves.[31] Palau's corals were in excellent condition prior to the 1997-8 ENSO, but one-third died at that time, with nearly 100% mortality of some coral species in some locations.[32] Tourism is a major foreign exchange earner and employment provider, responsible for 47% of the GDP.[33] Business and tourist arrivals in 2015 reached nearly 168,000 visitors, roughly eight times the national population.[34] As snorkeling and scuba diving are the major tourist attractions, the loss of coral reefs is a major threat to Palau's tourism sector.[35] The 1997-8 ENSO caused more than USD100 million in damage to Palau's corals, equivalent to 88 percent of that year's GDP.[36] According to a UNESCO 2017 report, Palau's World Heritage-listed coral reef, Rock Islands Southern Lagoon, will face ecosystem collapse caused by bleaching occurring more than twice per decade as early as 2028 under a business as usual CO_2 emissions scenario. [37] Only if CO2 emissions reductions are implemented to keep temperature rise to within 1.5°C above preindustrial levels will the twice per decade bleaching risk be eliminated during this century, giving Palau's coral reefs a much greater chance of survival.[38]

Palau suffers from **severe water shortages** during ENSO events.[39] In 2016, extreme drought prompted the President to declare a state of emergency. The capital city received its lowest recorded rainfall in 65 years and a major reservoir dried up.[40] By the end of this century, the IPCC (2014) projects that intensity and/or duration of drought in the western Pacific is likely to increase.[41]

Trends in **extreme temperature** across the South Pacific from 1961 to 2003 show increases in the annual number of hot days and warm nights, particularly following ENSO events.[42] Increased heat events around the world are linked to increased cardiovascular mortality, respiratory illnesses, malnutrition from crop failures, and altered transmission of infectious diseases.[43] Palauans are already suffering from increases in dengue fever and other diseases.[44]

High surface water temperatures intensify the destructive force of **tropical storms**.[45] These storms threaten the lives of Palauans during the rainy season from June to December each year.[46] Rising sea levels raise the baseline for storm surges, increasing the risk of catastrophic loss of life and infrastructure onshore.

Rising sea levels also pose a serious threat to the majority of Palauans.[47] The IPCC predicts that sea levels will rise an additional 0.23 to 0.47 meters before the end of the century if global fossil fuel use is not significantly reduced.[48] This will exacerbate inundation, storm surges, erosion and other coastal hazards, threatening vital infrastructure and facilities that support island communities.[49] Entire atolls, including the state of Kayangel, will disappear if sea levels rise to one meter.[50] Loss of lands due to sea level rise could force thousands of Palauan citizens to become climate migrants and to move to other countries.[51] According to Palau's Permanent Representative to the United Nations, displacement to another country "might be the only option if climate change continues at the current or increased rate without significant and urgent mitigation by the international community."[52] Such involuntary relocation would result in the loss of Palau's traditional cultural practices developed over thousands of years, including the indigenous language of Palau and matrilineal land inheritance.[53]

Human health in Palau may suffer from lack of access to adequate safe water, adequate nutrition, as well as increased stress and declining well-being that comes from property damage, loss of economic livelihood, threatened communities.[54] Freshwater scarcity, more intense droughts and storms could lead to a deterioration in standards of hygiene, increasing exposure to communicable diseases and other health risks. [55]

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APPENDIX D.2
Climate Impacts in South Africa

Additional Country Reports Climate Impacts in South Africa

Report by: Earthjustice

September 2019

D.2

Climate Impacts in South Africa

Sub-Saharan Africa will experience some of the greatest negative effects of climate change of any region globally.[1] The South African government recognises that the country is extremely vulnerable to the impacts of climate change,[2] and that a global average temperature increase of 2°C translates to up to 4°C for South Africa by the end of the century.[3]

Already, temperature extremes have increased significantly in frequency annually across the country, and rainfall has shown high inter-annual variability.[4] In the last five years, South Africa has experienced record temperature highs, droughts and fires.[5] This has been impacting on food prices and exacerbating the already high poverty levels in South Africa.[6] These costs are predicted to escalate, as climate-related disasters, such as droughts and fires, get larger in extent and magnitude. In 2017/2018, the fires in the Garden Route (Knysna/George area of South Africa), resulted in up to R6 billion (300 million US Dollars) in losses, and the losses resulting from the Western Cape drought on the Agriculture sector alone, were R14 billion (916 million US Dollars) (more than double the damage costs from extreme climate events in the preceding decade),[7] with 30 000 jobs lost.[8] The likelihood of an event like the 2015-2017 Western Cape drought recurring has increased threefold as a result of existing global warming, and will increase an additional three times with 2°C global warming.[9]

Significant socio-implications from climate change are expected, particularly for vulnerable groups and communities, in South Africa under the South African government's own predicted climate futures. These implications will largely be felt through: significant warming (as high as 5–8°C, over the South African interior by the end of this century);[10] impacts on water resources, such as changes in water availability; and a higher frequency of natural disasters (flooding and drought), with cross-sectoral effects on human settlements, health, disaster risk management and food security.[11] Climate change poses a high risk for the water quality and flow of the Olifants,[12] Limpopo and Crocodile Rivers.[13]

If temperature increases are not limited to 1.5 degrees, Southern Africa will be exposed to increased food shortages and poverty.[14] The cooler coastal regions of the country are likely to see significant in-migration from the interior of the country (as well as from further north on the continent).[15]

In addition, South Africa's unique biodiversity is at great risk – as climate change poses a threat to indigenous flora such as the Cape Floristic Kingdom, fauna and ecosystems, which are deeply ingrained in the cultural identity of the people of South Africa. This will have knock-on effects for livelihoods dependent on these ecosystems.[16]

D.2

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APPENDIX D.3
Climate Impacts in Tunisia

Additional Country Reports
Climate Impacts in Tunisia

Report by: Earthjustice

September 2019

D.3

Climate Impacts in Tunisia

Tunisia is one of the most climate vulnerable countries of the Mediterranean.[1]

1. Temperature

Based on historical climate conditions and recent trends over the past few decades, Tunisia's temperatures range from an average monthly high of 30.5°C in mid-summer to an average monthly low of 10°C in mid-winter.[2] Tunisia's mean annual temperatures rose by about 1.4°C in the 20th century, with the fastest warming taking place in the summer (1.8°C) and the least in the spring (1.4°C).[3] Most of the warming has occurred since the 1970s, though summer mean maximums have risen since the 1960s.[4] The number of warm days per year has also increased.[5] A global analysis shows a statistically significant increase in heat waves and warm nights in North Africa.[6]

According to the World Bank Group (2019):

- Annual maximum temperature is likely to increase by 1.5°C to 2.5°C by 2030 and 1.9°C to 3.8°C by 2050.[7]
- Annual minimum temperature is likely to rise from 0.9°C to 1.5°C by 2030 and from 1.2°C to 2.3°C by 2050.[8]
- The number of hot days is projected to increase by about 1.3 days per year between 2020 and 2039.[9]
- The duration of heatwaves is likely to increase by 4 to 9 days by 2030 and by 6 to 18 days by 2050.[10]
- The duration of cold spells is likely to decrease by 1 to 3 days by 2030 and by 2 to 4 days by 2050. [11]

2. Precipitation and Flooding

In Tunisia, there are notable differences between mean annual rainfall from the south (less than 100 mm on the margins of the Sahara) to north (more than 700 mm on the Mediterranean coast) [12] Over the last few decades, Northern Africa, including Tunisia, has experienced a significant decrease in the amount of precipitation received in winter and early spring. [13] The record indicates over 330 dry days with less than 1 mm day rainfall per year over a 1997–2008-time period. Annual rainfall has decreased 5% per decade in northern Tunisia since 1950, while heavy rainfall events have become more frequent.[14] Western Tunisia has experienced stable or declining rainfall, while eastern Tunisia has experienced increasing winter totals since the 1950s.[15] Spring rainfall has decreased in most areas, but particularly in the eastern half of the country. [16] Autumn rainfall has declined mostly in the southern region.[17] There is an association between El Niño and reductions in rainfall for parts of Tunisia.[18]

A reduction in rainfall over northern Africa is very likely by the end of this century.[19] The annual and seasonal drying and warming signal over the northern African region (including Tunisia) is a consistent feature in the global and regional climate change projections.[20] The greatest uncertainty is in summer rainfall over southern Tunisia.[21]

All models project a likely decrease in overall precipitation in Tunisia by 2050, with most projecting a minimum decrease of around 4% and maximum decrease varying from 7% to as much as 22%.[22]

The duration of dry spells is likely to increase by 1 to 21 days by 2030 and by 1 to 30 days by 2050.[23]

3. Drought

The decrease in precipitation is accompanied by an anticipated increase in the frequency and intensity and droughts and flooding.[24]

Nearly two-thirds of Tunisia is semiarid to arid, with frequent drought.[25] Droughts have been traced back to the sixth century; between 1907 and 1997, Tunisia experienced 23 dry years.[26] Most recently, Tunisia experienced drought in 1982, 1987 to 1989, 1993 to 1995, with its worst drought in over 50 years from 1999 to 2002.[27]

The combination of higher temperatures and declining rainfall is projected to reduce water resources in Tunisia.[28] Projections also suggest a drying trend in the region, particularly along the Mediterranean coast, driven by large decreases expected in summertime precipitation.[29] North Africa would be particularly affected by droughts that would be more frequent, more intense and longer-lasting.[30] Drought would be more frequent in summer than in winter.[31]

4. Sea Level Rise and Storm Surge

Sea levels have risen across the Mediterranean by an average of more than 3.1 mm each year since 1992, although records from further back indicate considerable local variability.[32] Since 1990, Mediterranean Sea levels have risen 5–10% faster than the 20th century mean rate.[33]

By 2030, the total, Mediterranean basin averaged sea level rise will be between 6.86 and 17.92 cm.[34] By 2040–2050, the total Mediterranean basin averaged sea level rise will be 9.8 and 25.6 cm.[35] Sea levels are projected to rise between 3 and 61 cm this century, depending upon local heat and salinity levels of the Mediterranean.[36] Between 1% and 3% of land in Tunisia will be affected by a 1-meter sea level rise.[37]

5. Winds and Storms

Recent cyclone trends in Tunisia are not readily available, so estimates are highly uncertain.[38] Uncertainties in projections of cyclone frequency and tracks make it difficult to project how these changes will impact particular regions.[39] There is only low confidence in region-specific projections,[40] but global and regional climate scenarios show fewer cyclones over the Mediterranean.[41]

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