

Guide to the Science of Climate Change in the 21st Century

Chapter 19 Adaptation – AR5

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Chapter 19.0 Adaptation – AR5

19.1 Introduction

The ‘science of climate change’ sets the stage for consideration of the impact climate change will have on all life on Earth, nature and human. Nature in this context is equated to natural ecosystems, which include the physical, and to all biological systems which include all life, all animals, plants, insects, to life forms as small as bacteria and viruses or smaller, except humans (or life managed by human activity such as agriculture). Nature can and does coexist with humans.

The impacts on the physical system are impacts on the environment where there is life – and there is life everywhere. Any change to the physical system will result in changes to some form of life and in general, any change is destabilizing to a broader ecosystem. All changes are negative. That said, life might continue by adapting to the change.

Nature is considered separately from humans or human managed systems. Nature is the precious legacy of the billions of years since Earth was formed and life evolved. Humans are only recently discovering how precious it is, both intrinsically and to the well-being of humanity.

Science has enabled the identification and causes of climate change and its effects. How the effects will impact life requires a thorough knowledge of each form of life and its relationship to the environment.

19.2 Nature

The Intergovernmental Panel on Climate Change reviews the impacts of climate change on nature, in their reports; IPCC AR5 Climate Change 2014 WG2, Impacts, Adaptation and Vulnerability. Two other very important organizations specifically concerned with nature are the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, IPBES and the Convention on Biological Diversity, CBD, discussed in Chapter 16. There are several other organizations (international, national and local) concerned with biodiversity from a variety of perspectives including but not limited to the International Union for Conservation of Nature (IUCN), Nature Conservancy, World Wildlife Fund (WWF), The International Indigenous Forum on Biodiversity (IIFB) and the Food and Agriculture Organization of the United Nations as expressed in their recent report, State of Knowledge of Soil Biodiversity.

Extinction of life is occurring. IPBES produced a graph identifying life that is already extinct or soon will be, Figure 19.1. They report that around one million animal and plant species are now threatened with extinction. The causes are all the result of human activity: loss of habitat, pollution, invasive species, over harvesting, and global climate change.

It is not possible to describe in detail how all life on Earth will be impacted by climate change. There is just too much to consider and there is insufficient knowledge. It is estimated that 15 million different species live on Earth, but only 2 million of them have been identified. All life

forms evolved together and if one element is affected it is likely that the total is affected – at least locally, depending on the change. Even life on the most remote part of the Earth will be affected by changes in Earth’s physical system that might occur very far away. Soil is believed to hold one-quarter of all life forms of which only one per cent have been identified.

As climate change impacts all of Earth’s physical systems it will also impact every aspect of life on Earth. It is possible to predict what the impacts will be, at least the trend, with knowledge of how climate change will affect the atmosphere, land and sea environments as described in Chapter 18 and a thorough knowledge of the life and/or life supporting activity of interest.

Humanity has developed several excuses to justify inaction:

1. There is a view that nature will somehow adapt to the changes imposed by climate change. This is not true. Adaptation requires several hundred to thousands of years. The life form will become extinct before adaptation can occur.
2. Life forms that can move will move to more favourable environments. This is highly questionable as indicated by Figure 19.2, an IPCC graph from AR5 WG1. It may not be possible for life to move because of lack of a corridor that can be used to move or the existence of a place to move to, or, simply the inability to move. If a suitable habitat ceases to exist or is no longer accessible the life form will become extinct. If the life form is at the lower end of a food chain those life forms which depend on it will also be affected.
3. It is acceptable for a life form to go extinct. This is a ridiculous position made to defend a destructive activity.
4. They just didn’t know or realize the extent of the problem.

Two very good summaries discussing the impact of climate change on nature is the IPCC Summary Report for Policy Makers in IPCC 2014 AR5 WG2 and the IPBES 2019 Summary for Policy Makers, Global Assessment Report on Biodiversity and Ecosystem Services at <https://ipbes.net/global-assessment>.

There are several other discussions produced by most of the major conservation organizations.

Two books worth reading are ‘The Ferocious Summer’ which describes the plight of penguins in the Antarctic in coping with a mismatch of food availability and feeding their young as a result of climate change, and ‘The Sixth Extinction’ whose title is self-explanatory. The references for these books may be found in Section 19.4.

Nature cannot adapt to climate change in the conventional concept of ‘adaptation’.

Humans will need to continue to find ways to coexist with nature and preserve it.

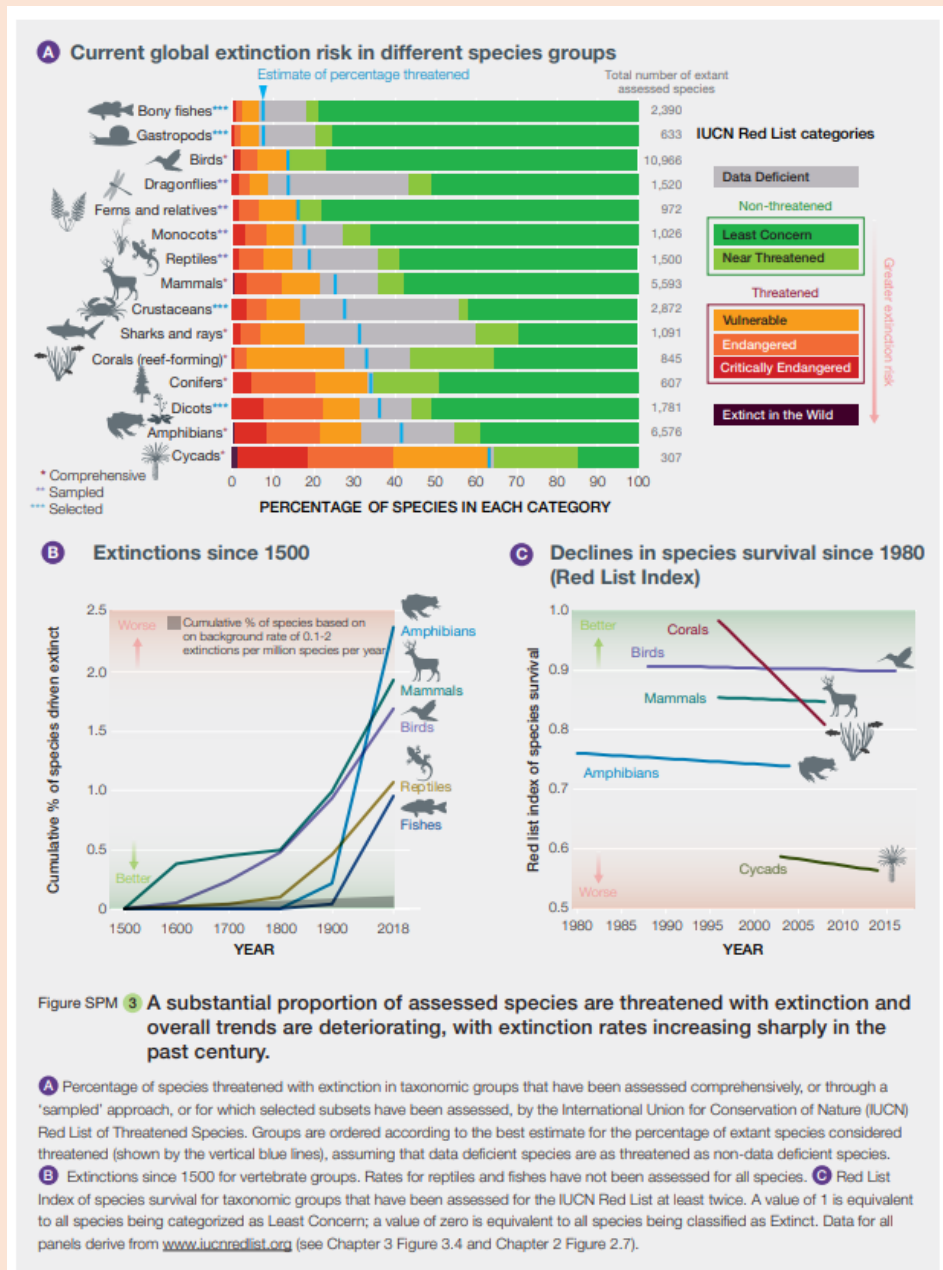


Figure 19.1 Current global extinction risk in different species groups. https://www.ipbes.net/sites/default/files/2020-02/ipbes_global_assessment_report_summary_for_policymakers_en.pdf

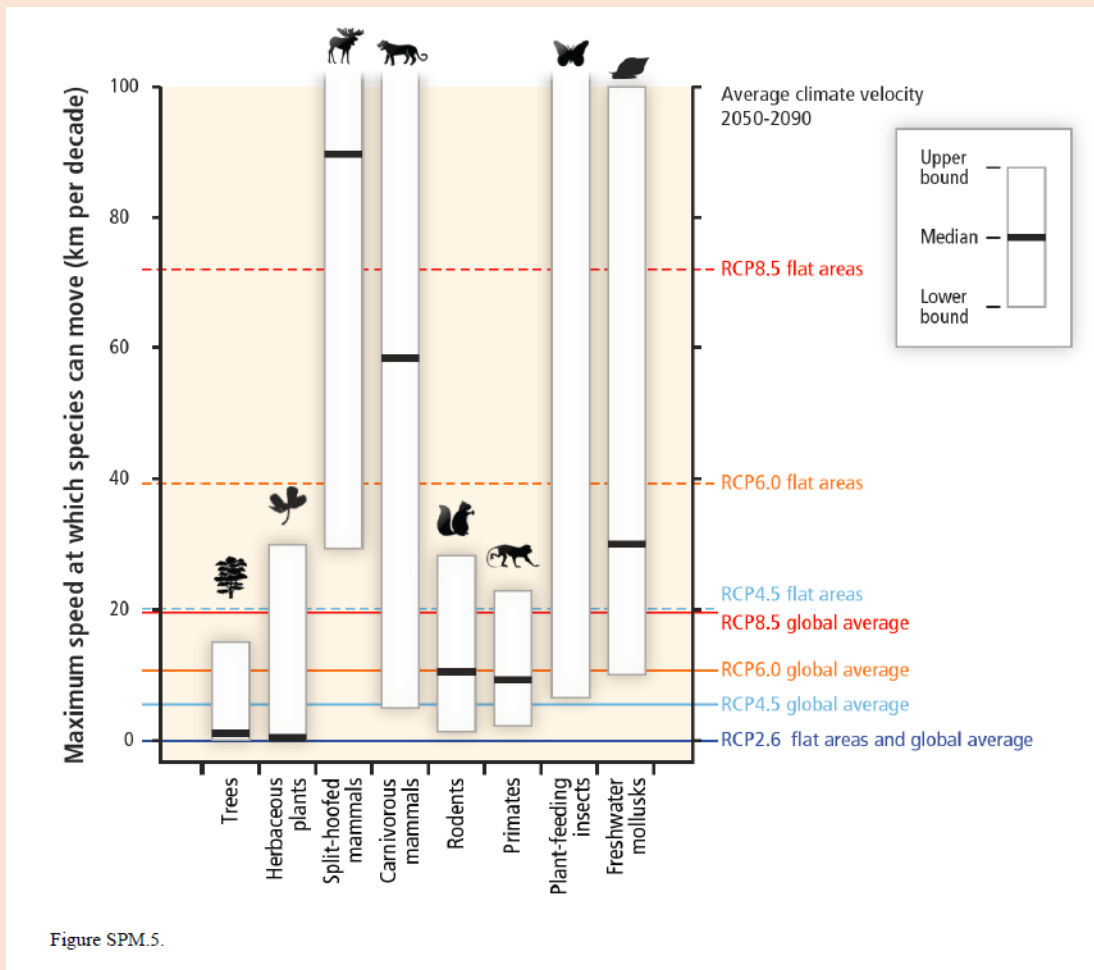


Figure SPM.5 | Maximum speeds at which species can move across landscapes (based on observations and models; vertical axis on left), compared with speeds at which temperatures are projected to move across landscapes (climate velocities for temperature; vertical axis on right). Human interventions, such as transport or habitat fragmentation, can greatly increase or decrease speeds of movement. White boxes with black bars indicate ranges and medians of maximum movement speeds for trees, plants, mammals, plant-feeding insects (median not estimated), and freshwater mollusks. For RCP2.6, 4.5, 6.0, and 8.5 for 2050–2090, horizontal lines show climate velocity for the global-land-area average and for large flat regions. Species with maximum speeds below each line are expected to be unable to track warming in the absence of human intervention. [Figure 4-5]

Figure 19.2 Maximum speed at which species can move.

https://www.ipcc.ch/site/assets/uploads/2018/02/ar5_wgII_spm_en.pdf

19.3 Humans and human managed systems

Climate change will impact every aspect of human life. Climate and weather are very important to people. Everyday predictable weather (helps guide our day-to-day activities) and extreme weather, (like cyclones, drought, flooding), that might not be anticipated, and may possibly overwhelm best efforts to securely accommodate them. Global climate change is expected to result in significant deviations from normal climate conditions and a greater frequency of extreme events. All impacts resulting from climate change, from a human perspective, are negative.

Similar to nature, there are limits with which human adaptation to expected climate change is possible. Ultimately, human willpower and available resources will determine human action.

Virtually every aspect of human endeavour is the subject of intense study by numerous individuals, societies, agencies, educational institutions, research organizations, not to mention almost every element of commercial and government sectors. The information society has facilitated communication on a scale that is making almost all knowledge, on any subject, available to anyone interested. Physical impacts are understood and can be accommodated.

Society has the ability to understand and possibly resolve most of the physical impacts of climate change but will be challenged by the socioeconomic consequences of problems that can only be resolved by human displacement. Cross-over issues such like the spread of diseases such as malaria will also be problematic.

The serious questions relate to what will be human reactions to impacts of climate change at the level of the individual, family, community and nation.

Human concerns relate to:

1. Health/ Disease. (Web sites no. 10 to 20.)
2. Agriculture. (Including temperature effects and changes in all elements of the hydrological cycle, Figure 6.1)
3. Aquaculture.
4. Harvesting nature (like fishery and forestry).
5. Living with nature. (Changes in all elements of the hydrological cycle, Figure 6.1)
6. Urban environment.
7. Rural environment.
8. Competition for resources such as water (internally and internationally).
9. Business/ financial environment.
10. Politics (local, provincial, national and international).
11. Conflict (internal and internationally) including insurgencies and war.
12. Quality of life.

Each concern will be impacted by one or more physical aspects of climate change and they will interact with each other.

In their report IPCC AR5 WG2 makes an attempt to comment on most of these aspects, but it is a challenge to provide little more than a 'heads up' on some of the more serious issues that will arise. (Sea level increase and small island issues come to mind.) It is difficult to impossible to comprehend the implications of drought affecting large areas of the Sahel, the reactions of the population to simply survive by migrating to other overstressed rural areas, urban areas and to other countries.

If the impacts can be minimized some form of adaptation may be feasible and useful. Large scale impacts can be expected to be catastrophic.

(Health impacts: The World Health Organization states that climate change is expected to cause approximately 250,000 additional deaths per year, from malnutrition, malaria, diarrhoea and heat stress. <https://www.who.int/news-room/fact-sheets/detail/climate-change-and-health#:~:text=Between%202030%20and%202050%2C%20climate,malaria%2C%20diarrhoea%20and%20heat%20stress>. This view was recently discussed by Mark Carney, United Nations Special Envoy on Climate Action and Finance in an interview with the BBC, February, 2021, <https://www.bbc.com/news/business-55944570> and <https://ca.finance.yahoo.com/news/mark-carney-climate-crisis-deaths-221400673.html> . Note that Mark Carney recently was the Bank of England governor and before that the head of the Bank of Canada.)

Clearly, the most practical response to the impending dangers of climate change is mitigation. However, even if greenhouse gas emissions are managed such that global temperature increases will be limited to between 1-2°C above pre-industrial, adaptation measures will need to be undertaken.

Determining which adaptations are necessary may be the simpler question to answer. It is very difficult to predict socio-economic-political strategies that will be required to implement them. Significant climate change adaptation problems and initiatives:

1. Paris Agreement, December 12, 2015. <https://www.unep.org/resources/adaptation-gap-report-2020> , is a legally binding international treaty on climate change adopted at COP 21 in Paris on 12 December 2015 and entered into force on 4 November 2016. Its goal is to limit global warming to well below 2 and preferably 1.5 degrees Celsius compared to pre-industrial levels. Countries submit their plans for climate action known as nationally determined contributions (NDCs) which includes long-term low greenhouse gas emission development strategies. Additionally, the agreement aims to increase the ability of countries to deal with the impacts of climate change, and at making finance flows consistent with a low GHG emissions

- and climate-resilient pathway <https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement/key-aspects-of-the-paris-agreement>.
2. Adaptation Gap Report 2020 is the fifth edition of the UNEP Adaptation Gap Report, Nairobi, 14 January 2021, <https://unfccc.int/news/step-up-climate-change-adaptation-or-face-serious-human-and-economic-damage-un-report>, <https://www.unep.org/resources/adaptation-gap-report-2020>, ‘... finds that while nations have advanced in planning, huge gaps remain in finance for developing countries and bringing adaptation projects to the stage where they bring real protection against climate impacts such as droughts, floods and sea-level rise. Public and private finance for adaptation must be stepped up urgently, along with faster implementation. Nature-based solutions – locally appropriate actions that address societal challenges, such as climate change, and provide human well-being and biodiversity benefits by protecting, sustainably managing and restoring natural or modified ecosystems – must also become a priority.’
 3. Northern migration of commercial fish species and impact on national fisheries regulation and international fishery agreements. This is discussed in Section 16.9. This is especially important with the implementation of Brexit and relations elsewhere such as between Canada and the United States.
 4. Stop and reverse the desertification of the Sahel region of Africa. <https://britishheritage.com/royals/prince-charles-launches-terra-carta>,
 5. <https://www.oneplanetsummit.fr/en> and <https://www.worldwatercouncil.org/en/one-planet-summit-2021>.

19.4 Financial implications of global warming and climate change

The financial implications to civilization if global warming and associated climate change were reviewed by Nicholas Stern as requested by the Government of the United Kingdom. The reports were produced in 2007 <https://www.cambridge.org/ca/academic/subjects/earth-and-environmental-science/climatology-and-climate-change/economics-climate-change-stern-review?format=PB&isbn=9780521700801> . It is a lengthy thorough analysis which had significant impact on discussions on climate change at the time. It still does. Reviews of the report as published in 2007 may be found in <https://journals.openedition.org/sapiens/240>, https://en.wikipedia.org/wiki/Stern_Review and also in an article titled, ‘A Critique of the Stern Report’ by Robert O. Mendelsohn of Yale University, <https://environment.yale.edu/files/biblio/YaleFES-00000260.pdf>

The most important take away is that ignoring global warming and climate change will come at a tremendous cost – unacceptable cost; and, it is expedient to take all steps necessary to avoid the costs. Essentially, mitigation is the only intelligent path to pursue.

19.5 Information support

Key web sites:

1. IPCC 2014, AR5 Working Group One, Science <https://www.ipcc.ch/report/ar5/wg1/>
2. IPCC 2014, AR5 Working Group Two, Impacts, Adaptation and Vulnerability. <https://www.ipcc.ch/report/ar5/wg2/>
3. Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, IPBES. <https://ipbes.net/global-assessment>
4. International Union for Conservation of Nature, IUCN. <https://www.iucn.org/>
5. World Wildlife Fund, WWF. <https://www.worldwildlife.org/>
6. Nature Conservancy. <https://www.nature.org/en-us/>
7. European Association of Environmental and Resource Economists, EAERE. <https://www.eaere.org/>
8. International Indigenous Forum on Biodiversity, IIFB. <https://iifb-fiib.org/>
9. UNFAO Report, State of knowledge of soil biodiversity – status, challenges and potentialities, 2020. <http://www.fao.org/documents/card/en/c/CB192>
10. UNFAO Report, FAO Strategy on Climate Change. <http://www.fao.org/policy-support/tools-and-publications/resources-details/en/c/1026871/>
11. World Health Organization, Climate change and health – risks and responses 2003. <https://www.who.int/globalchange/publications/cchhbook/en/>
12. American Medical Association, Medical Education, Climate Change and Human Health 101. <https://journalofethics.ama-assn.org/article/climate-change-and-human-health-101/2009-06>
13. IPCC Human Health: Impacts, Adaptation and Co-Benefits. https://www.ipcc.ch/site/assets/uploads/2018/02/WGIIAR5-Chap11_FINAL.pdf
14. National Academy of Medicine, Climate Change and Human Health. <https://nam.edu/programs/climate-change-and-human-health/>

15. Pan American Health Organization, Climate Change and Health.
<https://www.paho.org/salud-en-las-americas-2017/?p=53>
16. Effects of climate change on human health, Wikipedia.
https://en.wikipedia.org/wiki/Effects_of_climate_change_on_human_health
17. Climate Change and Health, WHO. <https://www.who.int/news-room/fact-sheets/detail/climate-change-and-health#:~:text=Between%202030%20and%202050%2C%20climate,malaria%2C%20diarrhoea%20and%20heat%20stress.>
18. GlobalChange.gov, U.S. Global Change Research Program.
<https://health2016.globalchange.gov/>
19. Environmental Health Perspectives and the National Institute of Environmental Health Sciences.
https://www.niehs.nih.gov/health/materials/a_human_health_perspective_on_climate_change_full_report_508.pdf
20. Safeguarding human health in the Anthropocene epoch: report of The Rockefeller Foundation-Lancet Commission on planetary health.
[https://www.thelancet.com/pdfs/journals/lancet/PIIS0140-6736\(15\)60901-1.pdf](https://www.thelancet.com/pdfs/journals/lancet/PIIS0140-6736(15)60901-1.pdf)
21. World Health Organization. Guidance to protect health from climate change through health adaptation planning.
<https://www.who.int/globalchange/publications/guidance-health-adaptation-planning/en/>
22. The Lancet Commissions Volume 386, Issue 10006, p1862-1914, Health and climate change: policy responses to protect public health.
[https://www.thelancet.com/journals/lancet/article/PIIS0140-6736\(15\)60854-6/fulltext?referrer=justicewire](https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(15)60854-6/fulltext?referrer=justicewire)
23. Mark Carney, United Nations Special Envoy on Climate Action and Finance, BBC Interview February, 2021. <https://www.bbc.com/news/business-55944570> and <https://ca.finance.yahoo.com/news/mark-carney-climate-crisis-deaths-221400673.html>

24. Terra Carta – Prince Charles. <https://britishheritage.com/royals/prince-charles-launches-terra-carta>
25. Terra Carta – green recovery charter for business – Prince Charles. <https://www.businessgreen.com/news/4025586/terra-carta-prince-wales-launches-green-recovery-charter-business>
26. Sahel. One Planet Summit 2021. <https://www.worldwatercouncil.org/en/one-planet-summit-2021>, and <https://www.oneplanetsummit.fr/en>.
27. Paris Agreement, December 12, 2015. <https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement/key-aspects-of-the-paris-agreement>.
28. UNEP Adaptation Gap Report 2020 released 14. January 2021. <https://unfccc.int/news/step-up-climate-change-adaptation-or-face-serious-human-and-economic-damage-un-report> and <https://www.unep.org/resources/adaptation-gap-report-2020>.
29. The economics of climate change, Nicholas Stern, Cambridge University Press, 2007 revised 2014, <https://www.cambridge.org/core/books/economics-of-climate-change/A1E0BBF2F0ED8E2E4142A9C878052204#>.
30. Stern Review – description, Wikipedia. https://en.wikipedia.org/wiki/Stern_Review.
31. The Stern Review on the economics of climate change: contents, insights and assessment of the critical debate, Godard, O., and Mainguy, G., 2008 available from OpenEdition Journals. <https://journals.openedition.org/sapiens/240>.
32. A Critique of the Stern Report' by Robert O. Mendelsohn of Yale University, <https://environment.yale.edu/files/biblio/YaleFES-00000260.pdf>.