climate change

Scotland's centre of expertise connecting climate change research and policy

A shortened summary of IPCC AR5 WGII "Impacts, Adaptation and Vulnerability"

Caroline Holmes, University of Edinburgh
December 2015

Adaptation seeks to avoid or reduce harm from a changing climate by reducing exposure and/or vulnerability to climate hazards, and to exploit beneficial opportunities. This report summarises the findings of the IPCC AR5 adaptation report, including risks to human and natural systems under current climate change and differing levels of future climate change, as well as the potential for adaptation.

Headlines

- For past impacts, climate influences on natural systems are clearer than for human systems due to other (socioeconomic) drivers on human systems.
- Risk is considered as the interaction between a climate hazard, exposure to the hazard, and vulnerability to the hazard. Exposure and vulnerability are affected by socioeconomic factors.
- Human and natural systems are exposed to current climate variability; reducing this exposure is an important first step in managing future risk.
- Climate change will introduce new risks as well as amplifying existing ones. In human systems, these risks are unevenly distributed across society.
- Warming of 4°C introduces risks of "substantial species extinction, global and regional food insecurity", restrictions on human activity, and limited potential for adaptation. Warming of 1–2°C introduces moderate to high risks to unique and threatened systems and risks associated with extreme weather events.
- Adaptation can reduce, but not eliminate, risk due to a climate hazard. The potential for adaptation reduces with increased climate change.
- Key principles for successful adaptation are emerging as experience of adaptation grows.

Attributed impacts

Changes in climate over the last few decades have caused impacts on natural and human systems across the globe. (In this section, changes in climate are generally not separated by their cause, for example, greenhouse gas emissions. The causes of recent climate change are discussed in the WG1 summary.)

Impacts of observed climate change include:-

- Changes to **water resources**, due to rainfall changes or melting snow and ice
- **Species movement and changes** in seasonal or migration behaviour
- Predominately negative changes to **crop yields**, particularly wheat and maize.
  - Possible positive impacts in some high latitude areas
  - Food markets have displayed sensitivity to climatic extremes (*medium confidence*[1])

[1] Text in italics indicates use of IPCC uncertainty language for confidence; details are given under 'Further Information'

- Changes in the geographical distribution and incidence of some water-borne illnesses and vector-borne **diseases,** and increases in **mortality** related to temperature *(medium confidence)*

- **Impacts of ocean acidification**[2] on marine organisms

Influences of climate are clearer on natural than on human systems, where other socioeconomic drivers affect vulnerability and exposure, and particularly its distribution across society.

Climate hazards exacerbate pre-existing social, economic, agricultural and environmental stresses, especially for those living in poverty. Violent conflict increases vulnerability to climate change by damaging social and physical structures that are key for adaptation.

Some ecosystems and many human systems are vulnerable and exposed to current variability in climate, for example heat waves and floods. This is evident in impacts from such events on ecosystems, food and water supply, human health and mortality, and infrastructure. These impacts occur across the development scale.

Future risks

Key risks are identified where they represent a 'Reason for Concern' (RFC). The RFCs have been used in previous IPCC reports and are (examples or clarification in *italics*):-

1) Unique and threatened systems *e.g. coral reefs*
2) Extreme weather events *e.g. risks from extreme precipitation*
3) Distribution of impacts *i.e., greater risks for disadvantaged communities*
4) Global aggregate impacts; *biodiversity and the global economy*
5) Large scale singular events*; abrupt and irreversible change e.g. loss of Greenland ice sheet*

These correspond to Article 2 of the United Nations Framework Convention on Climate Change (UNFCCC) which refers to "dangerous anthropogenic interference with the climate system."

Climate change exacerbates these risks to different extents. For RFCs 1 to 3, there are already high additional risks due to climate change when global warming is 1—2°C above pre-industrial levels. For RFCs 4 and 5, additional risks are high when warming reaches 3—4°C; in particular, risks of "substantial species extinction, global and regional food insecurity, consequential constraints on common human activities and limited potential for adaptation in some cases". Some unique and threatened systems are already at risk (from the current level of climate change).

Sectoral risks (and limited opportunities)

The following risks have been identified for the 21st century. Changes phrased as something which 'will' happen are projected with at least *high confidence.*

Biodiversity: There will be a substantial reduction in marine biodiversity and redistribution of marine species, challenging the productivity of fisheries. Marine ecosystems, especially coral reefs and polar ecosystems, will be at risk from ocean acidification for all but the weakest forcing scenarios. There is an extinction risk for land and freshwater species from climate change and other stressors (such as pollution, habitat removal), and for all but the weakest forcing scenarios, there is risk of irreversible change in ecosystems this century *(medium confidence*).

Water availability, flooding, and urban areas: An increasing fraction of the world's population will be affected by water scarcity or river flooding as warming increases. There is *limited evidence* that there may also be increasing competition for water in dry subtropical areas. Sea level rise will cause impacts on coastal and low-lying areas, a

[2] Ocean acidification is a consequence of increased carbon dioxide in the ocean

key risk for small islands. Globally, many risks from climate change are concentrated in urban areas**,** but sustainable development to increase resilience[3] has potential for successful adaptation.

Food and agriculture: A reduction in major crop yields (wheat, rice, and maize) is projected for local warming of over 2°C in tropical and temperate regions. For example, for 2090, nearly 80% of projections show a decrease in yield relative to the late 20th century. However, individual locations may benefit (*medium confidence*). Global and regional food security will be affected, including effects on access to food and on price stability. Impacts on rural areas and agricultural practice are expected in the near-term and beyond due to many of the aspects above (water scarcity, species suitability etc.).

Economic sectors: For most economic sectors, the impacts from demographic, economic, social, regulatory, and governance changes are projected to be large relative to those from climate change, but some aspects such as heating demand are predominately affected by climate change. Estimating global economic impacts is challenging; this is reflected in varied estimates at warming of 2°C and few quantitative estimates for greater warming.

Human health: Climate change is expected to exacerbate many existing health problems, and increase ill-health in many regions especially low-income developing countries. Contributing factors include heat waves, malnutrition, reduced labour productivity, food- and water-borne disease, and possibly vector-borne diseases (*medium confidence*).

Other impacts: Other projected negative impacts are increased displacement of people, increased risk of violent conflict (*medium confidence*), and impacts on state security (*medium confidence*). Finally, climate change impacts are projected to reduce economic growth, and introduce new challenges to poverty reduction and sustainable development.

Managing risk: adaptation experience and opportunity

In recent years, adaptation planning has become more widespread.

Over the next few decades the interactions of socioeconomic factors with climate, rather than the level of emissions and emissions-driven climate change, primarily determine the level of risk to human systems. Reducing vulnerability and exposure to present weather and climate variability is a key first step to adapting to climate change.

The potential to reduce risks through adaptation is dependent on sector, region and level of warming. Due to this dependence on the level of warming, adaptation and mitigation[4] are complementary strategies for managing the risks of climate change, as without mitigation there is limited potential for reducing risks through adaptation.

Decisions about adaptation move societies towards more or less resilient futures, but must be made in the face of uncertainty. The approach to adaptation should vary according to setting, taking account of societal values, for example different perceptions of risk. Resource restrictions, conflicting values, ineffective governance, uncertainties, and limited tools for monitoring are all barriers to adaptation, while factors such as poor planning, undue focus on short-term outcomes, and failure to anticipate consequences may result in adaptation attempts actually leading to increased climate-related risk. On the other hand, adaptation can be enhanced by working across multiple levels, from national to individual.

Transformations, such as behavioural shifts, technological innovations, or political actions can be particularly effective in enabling climate-resilient pathways.

---

[3] Resilience is "[the] capacity of [a system] to cope with a hazardous event, trend or disturbance" (IPCC AR5 WGII, Glossary)

[4] Mitigation is "a human intervention to reduce the sources or enhance the sinks of greenhouse gases" (IPCC AR5 WGIII Glossary). The IPCC WGIII report on mitigation of climate change is covered in a separate document.

Further Information

The information is drawn from the Fifth Assessment Report (AR5) of the IPCC, in particular the WGII Summary for Policy Makers and Technical Summary and the Synthesis Report Summary for Policy Makers. Quotations are taken from one of these documents, but short technical phrases and lists may be quotes without quotation marks.

Full citation:

> IPCC, 2014: **Summary for Policymakers** and **Technical Summary**, In: *Climate Change 2014, Impacts, Adaptation and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Field, C.B., V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L.White (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

In general there is insufficient information in the IPCC documents to draw conclusions for Scotland so the information presented is general.

Evidence for risk contributing to the AR5 includes observations, experiments, process based understanding, statistical models, and simulations and descriptions of different scenarios.

The forcing scenarios are as in WGI (see CXC summary here).

Advances since AR4

Since the Fourth Assessment Report (AR4, 2007), the literature available to WGII has vastly increased. In particular there have been more studies on human and ocean systems, and an increased focus on adaptation, on the interaction of climatic and other stresses, and on the ethical and social aspects of adaptation.

Confidence

The IPCC qualifies its statements, where appropriate, with a level of confidence ('*very low', 'low', 'medium', 'high'* and *'very high*') based on the level of agreement in the scientific community and the amount of evidence. This confidence is specified here only where it is *medium* or lower.