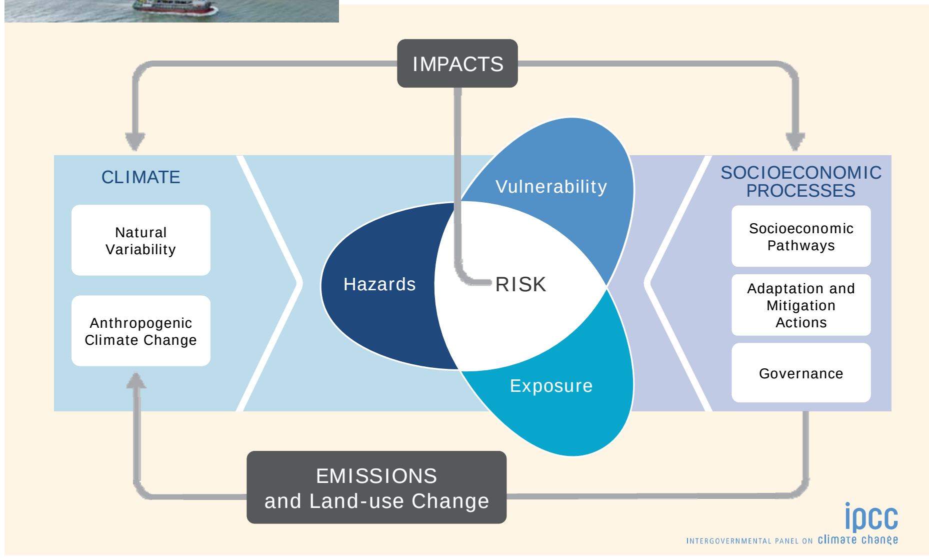
# IPCC AR5 is based on risk.


# IPCC AR4 (2010)

- >2°C increase in global temperature has a heavy impacts on global environment.
  - Scientific advise by climate change group
- Action plan to prevent the 2°C increase.
  - Numerical goal of Kyoto Protocol
  - CDM, REDD+ --- Scientific advises
- *There are large quantitative uncertainties in the relationship between GHG emission and global warming.*



# 3 Working Groups of IPCC AR4

- WG1: Physical Science Basis
  - Global warming actually occurred, perhaps by GHG.
- WG2: Impacts, Adaptation and Vulnerability
  - Warn what kind of hazards may happen by CC.
- WG3: Mitigation of Climate Change
  - Compile data and ecnomic/technical advise to reduce GHG emission
- These "results" in SPM that recommends 2°C threshold, <480ppm $CO_2$ target, 80% reduction of GHG.

IPBES?



**GHG emissions accelerate despite reduction efforts. Most emission growth is $CO_2$ from fossil fuel combustion and industrial processes.**

Total Annual Anthropogenic GHG Emissions by Groups of Gases 1970-2010

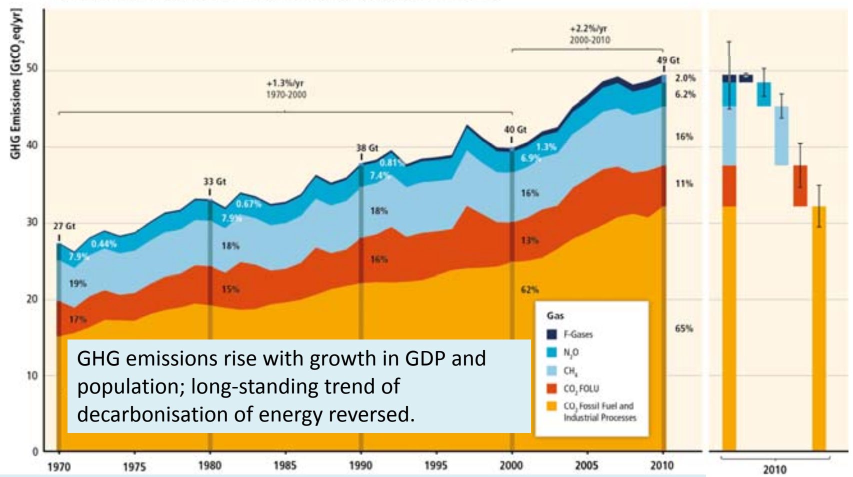
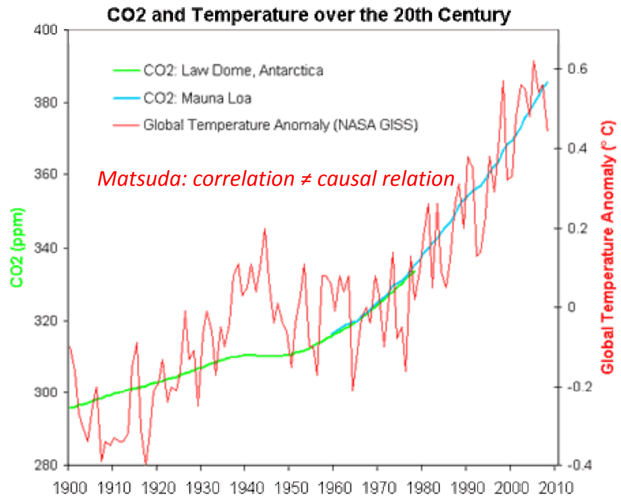


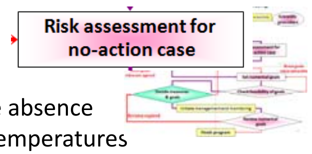

Figure SPM.1 | **Total annual anthropogenic GHG emissions (GtCO2eq / yr) by groups of gases 1970 – 2010: CO2 from fossil fuel combustion and industrial processes; CO2 from** Forestry and Other Land Use (FOLU); methane (CH4); nitrous oxide (N2O); fluorinated gases covered under the Kyoto Protocol (F-gases). At the right side of the figure GHG emissions in 2010 are shown again broken down into these components with the associated uncertainties (90 % confidence interval) indicated by the error bars. Total anthropogenic GHG emissions uncertainties are derived from the individual gas estimates as described in Chapter 5 [5.2.3.6].

# Past trends in $CO_2$ and temperature

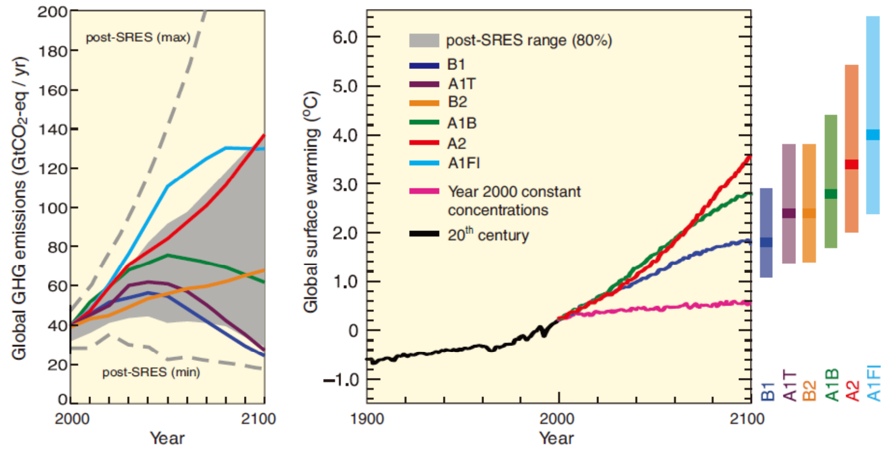



http://www.skepticalscience.com/co2-temperature-correlation.htm



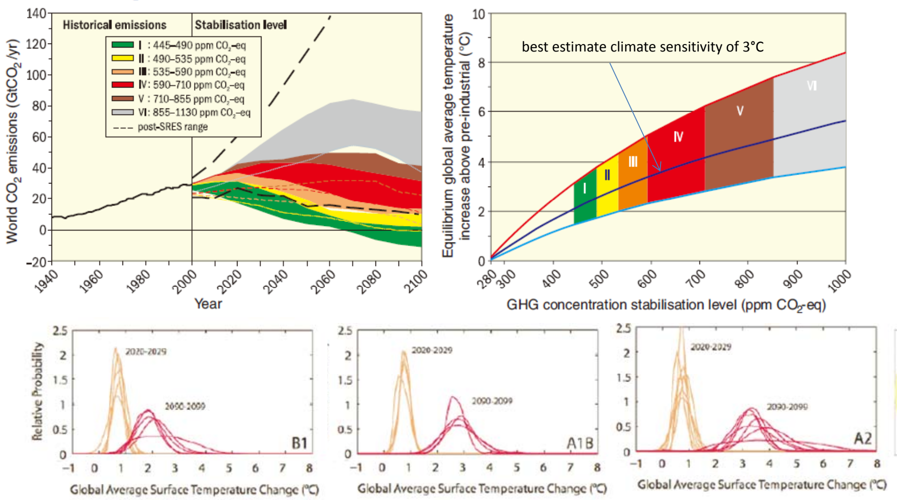



Scenarios for GHG emissions from 2000 to 2100 (in the absence of additional climate policies) and projections of surface temperatures





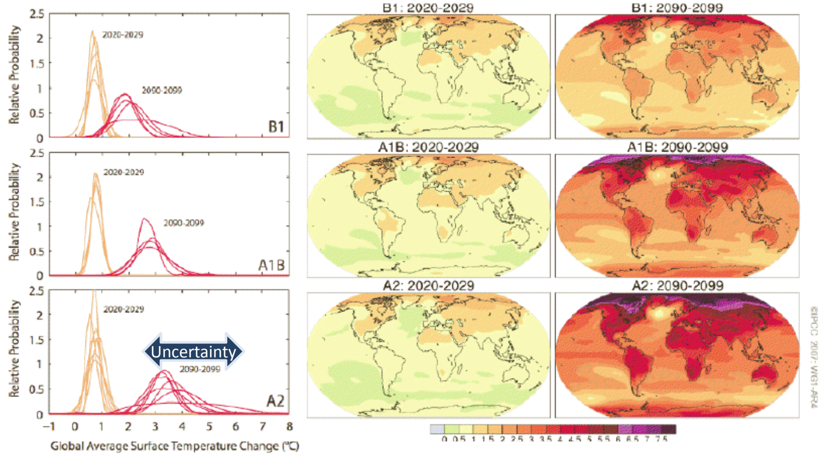

# CO2 emissions & equilibrium temperature increase for a range of stabilization levels






# Projections of surface temperatures

depend on scenario, large uncertainty




Quelle: IPCC-AR4-wg1_SPM: Scientific Basis, Bild SPM-5, (2007-02)

## Projected Patterns of Precipitation Changes

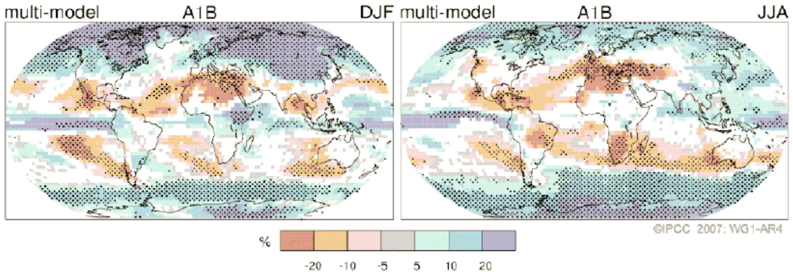



**Figure TS.5 | Observed and projected changes in annual average surface precipitation. This figure informs understanding of climate-related risks in the WGII** AR5. It illustrates changes observed to date and projected changes under continued high emissions and under ambitious mitigation.



## WG2 : Extreme Weather Events

**Risk assessment for no-action case**

which there is an observed late 20th century trend. {Tables 3.7, 3.8, 9.4, Sections 3.8, 5.5, 9.7, 11.2-11.9}

| Phenomenon[a] and direction of trend | Likelihood that trend occurred in late 20th century (typically post 1960) | Likelihood of a human contribution to observed trend [b] | Likelihood of future trends based on projections for 21st century using SRES scenarios |
|---|---|---|---|
| Warmer and fewer cold days and nights over most land areas | *Very likely* [c] | *Likely* [e] | *Virtually certain* [e] |
| Warmer and more frequent hot days and nights over most land areas | *Very likely* [d] | *Likely (nights)* [e] | *Virtually certain* [e] |
| Warm spells / heat waves. Frequency increases over most land areas | *Likely* | *More likely than not* [f] | *Very likely* |
| Heavy precipitation events. Frequency (or proportion of total rainfall from heavy falls) increases over most areas | *Likely* | *More likely than not* [f] | *Very likely* |
| Area affected by droughts increases | *Likely* in many regions since 1970s | *More likely than not* | *Likely* |
| Intense tropical cyclone activity increases | *Likely* in some regions since 1970 | *More likely than not* [f] | *Likely* |
| Increased incidence of extreme high sea level (excludes tsunamis) [g] | *Likely* | *More likely than not* [f, h] | *Likely* [i] |

Quelle: IPCC-AR4-wg1_SPM: Scientific Basis, Tabelle SPM-1, (2007-02)



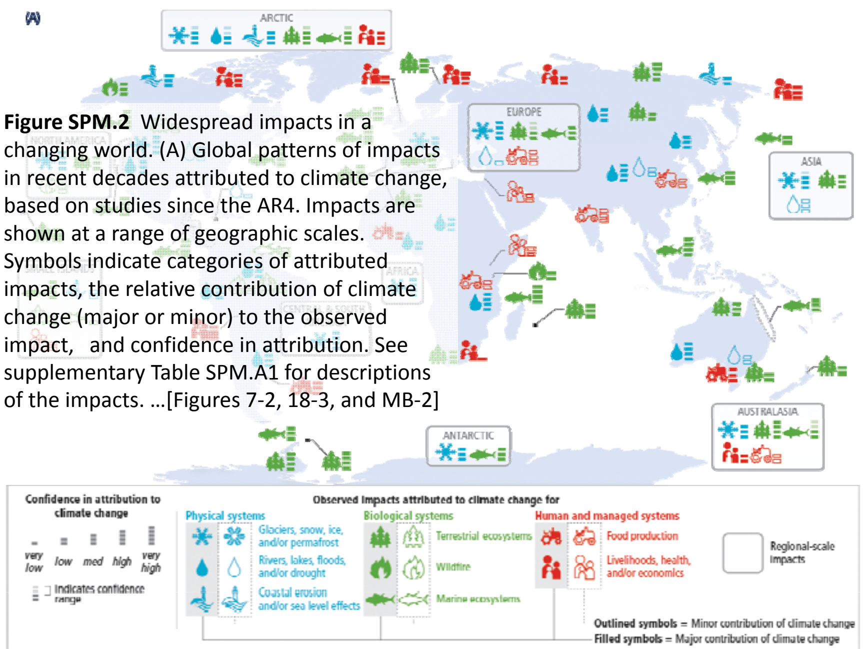
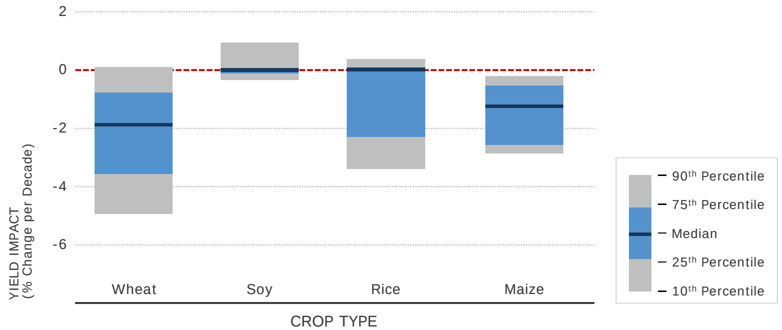



**Figure SPM.2** Widespread impacts in a changing world. (A) Global patterns of impacts in recent decades attributed to climate change, based on studies since the AR4. Impacts are shown at a range of geographic scales. Symbols indicate categories of attributed impacts, the relative contribution of climate change (major or minor) to the observed impact, and confidence in attribution. See supplementary Table SPM.A1 for descriptions of the impacts. ...[Figures 7-2, 18-3, and MB-2]

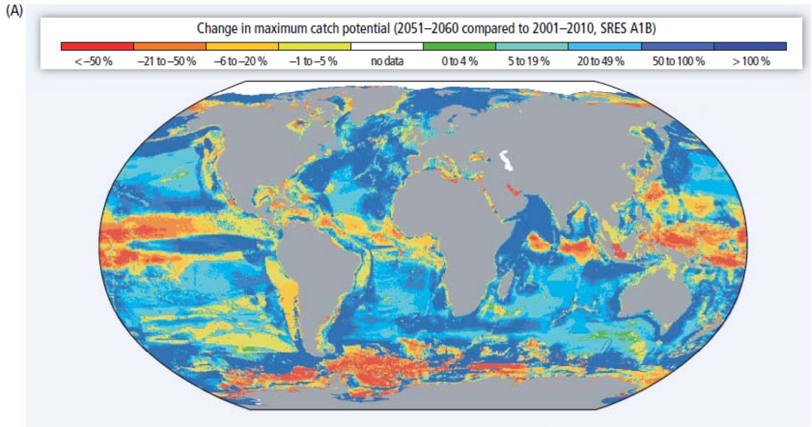
## Projection of crop yield **without adaptation**




- **For the major crops (wheat, rice, and maize) in tropical and temperate regions, climate change without adaptation is projected tonegatively impact production for local temperature increases of 2˚C or more above late-20th-century levels, although individual locations may benefit (medium confidence)**

ipcc INTERGOVERNMENTAL PANEL ON climate change

# Climate change risks for fisheries



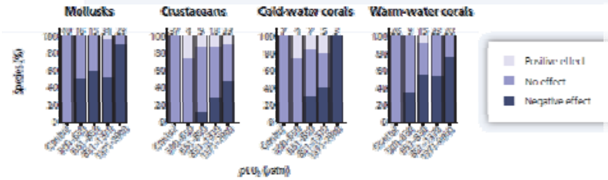




**Figure SPM.6** Climate change risks for fisheries. (A) Projected global redistribution of maximum catch potential of ~1000 exploited fish and invertebrate species. Projections compare the 10-year averages 2001–2010 and 2051–2060 using SRES A1B, without analysis of potential impacts of overfishing or ocean acidification. [6.1, 6.3, 30.5, Figures 6-10 and 6-14; WGI AR5 Box SPM.1]

# Marine systems

- **Due to projected climate change by the mid 21st century and beyond, global marine-species redistribution and marine-biodiversity reduction in sensitive regions will challenge the sustained provision of fisheries productivity and other ecosystem services (*high confidence*).** Spatial shifts of marine species due to projected warming will cause high-latitude invasions and high local-extinction rates in the tropics and semi-enclosed seas (*medium confidence*). Species richness and fisheries catch potential are projected to increase, on average, at mid and high latitudes (*high confidence*) and decrease at tropical latitudes (*medium confidence*). …
- **For medium- to high-emission scenarios (RCP4.5, 6.0, and 8.5), ocean acidification poses substantial risks to marine ecosystems, especially polar ecosystems and coral reefs, associated with impacts on the physiology, behavior, and population dynamics of individual species from phytoplankton to animals (*medium* to *high confidence*).** Highly calcified mollusks, echinoderms, and reef-building corals are more sensitive than crustaceans (*high confidence*) and fishes (*low confidence*), with potentially detrimental consequences for fisheries and livelihoods.

[52] 6.3-5, 7.4, 25.6, 28.3, 30.6-7, Boxes CC-MB and CC-PP
[53] 5.4, 6.3-5, 22.3, 25.6, 28.3, 30.5, Boxes CC-CR, CC-OA, and TS.7

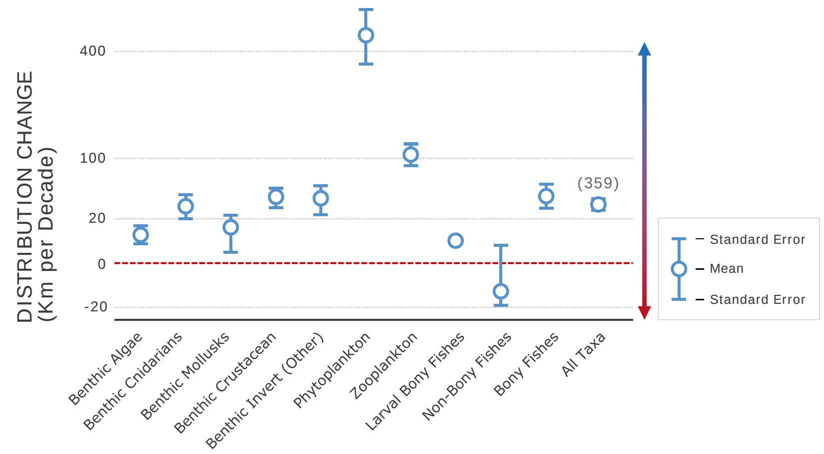
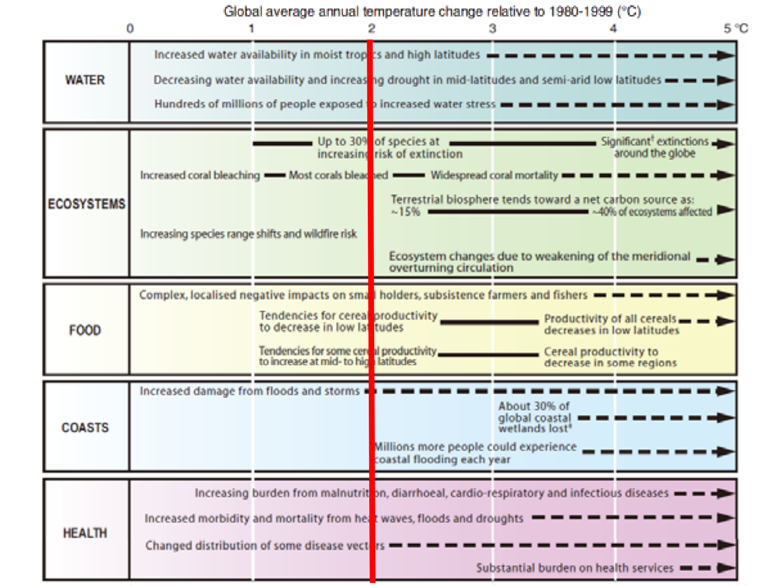



**Figure SPM.2** Widespread impacts in a changing world. (B) Average rates of change in distribution (km per decade) for marine taxonomic groups based on observations over 1900–2010. Positive distribution changes are consistent with warming (moving into previously cooler waters, generally poleward). The number of responses analyzed is given within parentheses for each category. [Figures 7-2, 18-3, and MB-2]

Examples of impacts associated with global average temperature change

(Impacts will vary by extent of adaptation, rate of temperature change and socio-economic pathway)




† Significant is defined here as more than 40%. ‡ Based on average rate of sea level rise of 4.2mm/year from 2000 to 2080.

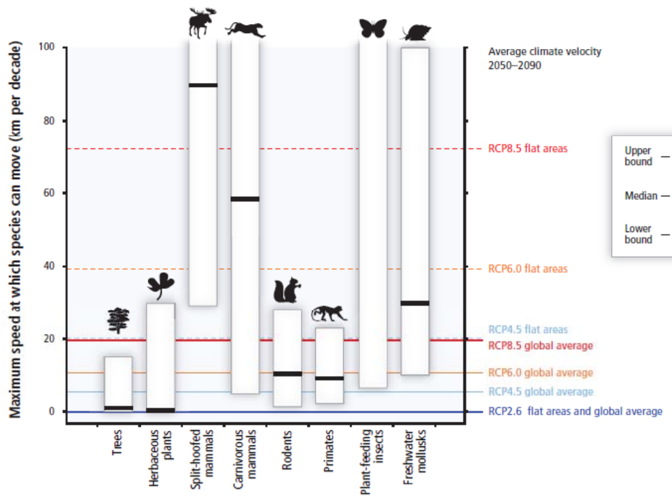



**Figure SPM.5 | Maximum speeds at which species can move across landscapes (based on observations and models; vertical axis on left), compared with speeds at which** temperatures are projected to move across landscapes (climate velocities for temperature; vertical axis on right). Human interventions, 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]

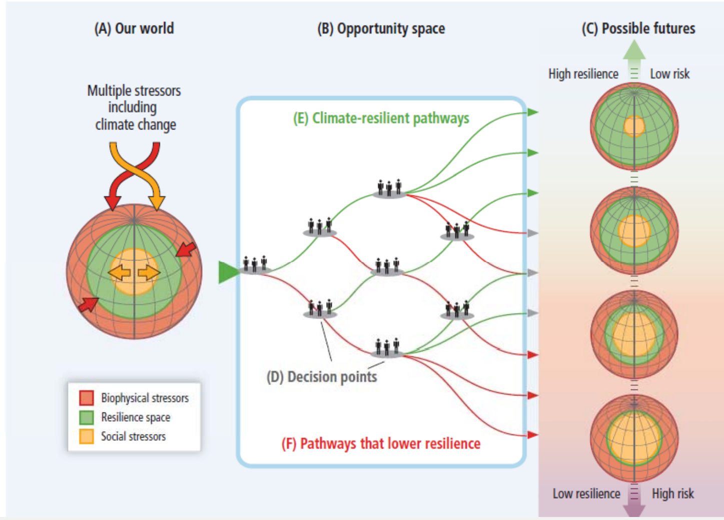



**Figure SPM.9 | Opportunity space and climate-resilient pathways. (A) Our world [Sections A-1 and B-1] is threatened by multiple stressors that impinge on resilience from many directions,** represented here simply as biophysical and social stressors. Stressors include climate change, climate variability, land-use change, degradation of ecosystems, poverty and inequality, and cultural factors. (B) Opportunity space [Sections A-2, A-3, B-2, C-1, and C-2] refers to decision points and pathways that lead to a range of (C) possible futures [Sections C and B-3] with differing levels of resilience and risk. (D) Decision points result in actions or failures-to-act throughout the opportunity space, and together they constitute the process of managing or failing to manage risks related to climate change. (E) Climate-resilient pathways (in green) within the opportunity space lead to a more resilient world through adaptive learning, increasing scientific knowledge, effective adaptation and mitigation measures, and other choices that reduce risks. (F) Pathways that lower resilience (in red) can involve insufficient mitigation, maladaptation, failure to learn and use knowledge, and other actions that lower resilience; and they can be irreversible in terms of possible futures.

# **Climate-change adaptation** as an iterative risk management process

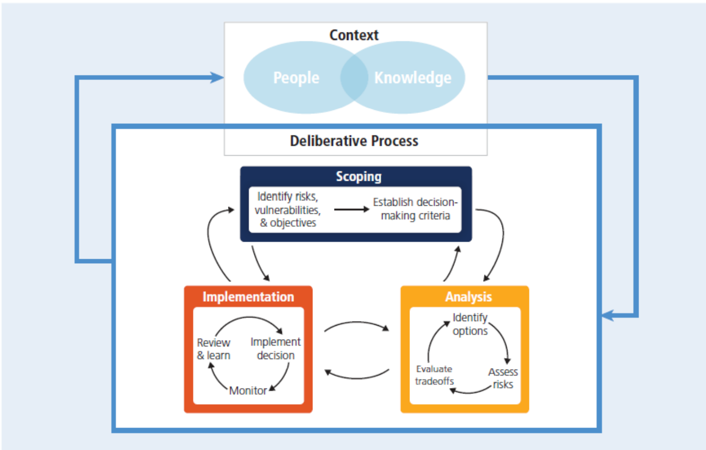



**Figure SPM.3 | Climate-change adaptation** as an iterative risk management process with multiple feedbacks. People and knowledge shape the process and its outcomes

# Change of mean streamflow

(B)

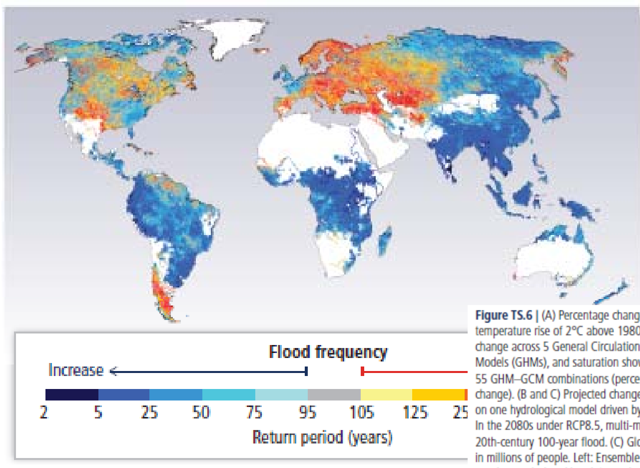
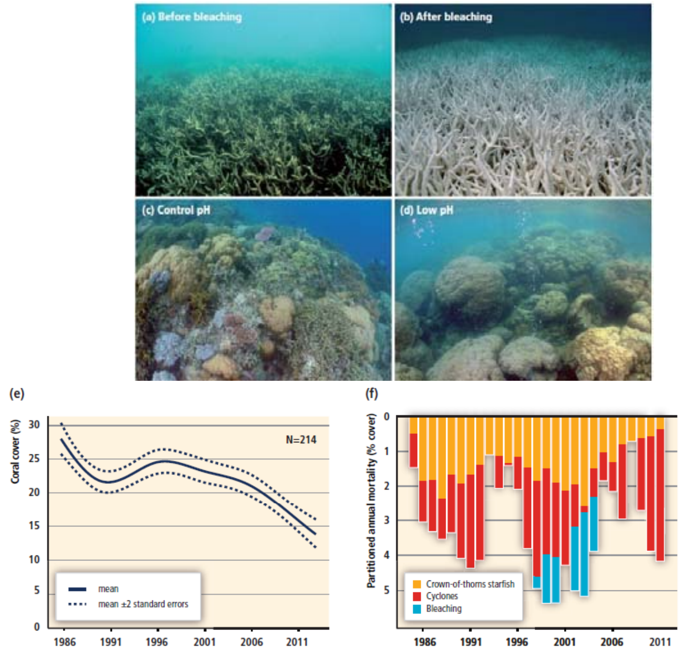



**Figure TS.6 |** (A) Percentage change of mean annual streamflow for a global mean temperature rise of 2°C above 1980–2010. Color hues show the multi-model mean change across 5 General Circulation Models (GCMs) and 11 Global Hydrological Models (GHMs), and saturation shows the agreement on the sign of change across all 55 GHM–GCM combinations (percentage of model runs agreeing on the sign of change). (B and C) Projected change in river flood return period and exposure, based on one hydrological model driven by 11 GCMs and on global population in 2005. (B) In the 2080s under RCP8.5, multi-model median return period (years) for the 20th-century 100-year flood. (C) Global exposure to the 20th-century 100-year flood in millions of people. Left: Ensemble means of historical (black line) and future simulations (colored lines) for each scenario. Shading denotes ±1 standard deviation. Right: Maximum and minimum (extent of white), mean (thick colored lines), ±1 standard deviation (extent of shading), and projections of each GCM (thin colored lines) averaged over the 21st century. [Figures 3-4 and 3-6]




# Ecosystem-based adaptation

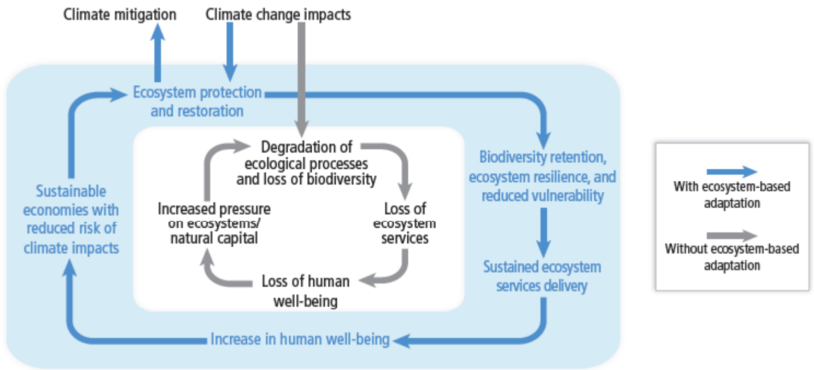
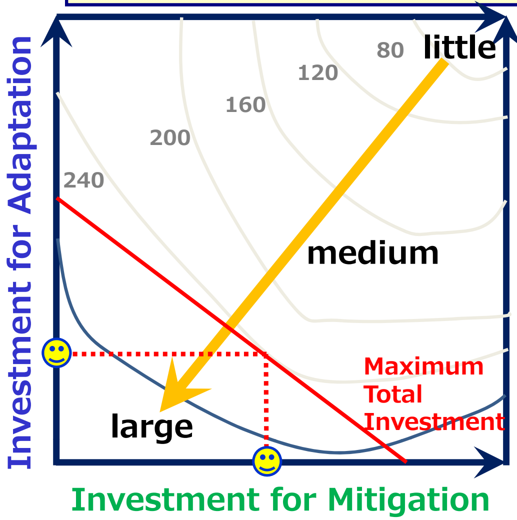



**Figure EA-1 | Adapted from Munangi et al. (2013). Ecosystem-based adaptation (EBA) uses the capacity of nature to buffer human systems from the adverse impacts of climate** change. Without EBA, climate change may cause degradation of ecological processes (central white panel) leading to losses in human well-being. Implementing EBA (outer blue panel) may reduce or offset these adverse impacts resulting in a virtuous cycle that reduces climate-related risks to human communities, and may provide mitigation benefits.

# Best mix of mitigation and adaptation in CC




**Total economic Loss = Mitigation Cost + Adaptation Cost + Residual Damage**

How optimal point would be different if evaluated by..
Ddisability-adjusted life year
Subjective Well-being
Bio-diversity Loss ?????

- Global
- Japan, local municipalities

# Tragedy of the mitigation policy

- *Every nation (i) has 2 options, mitigation ($M_i$) and adaptation ($A_i$).*
- *Climate change depends on global effort for mitigation ($\Sigma M_j$), not local.*
- *Benefit from adaptation usually depends on local effort ($A_i$), not global ($\Sigma A_j$);*
- *If the net benefit is given by $F_i(M_i, N_i-M_i)=(N_i-M_i)f_i(\Sigma M_j)+g_i(\Sigma M_j)$*
- Nash solution is $N_i-M_i=(f_i-g_i')/f_i'$
- *Functional forms $f_i$* and $g_i$ may vary with nation, but adaptation effort ($N_i-M_i$) of a nation does not change with its GDP.
- Mitigation cost must be paid by developed countries at non-cooperative solution.
- Anyway, we should NOT use Nash solution. We need to seek a cooperative solution.
- If so, how do we get it?