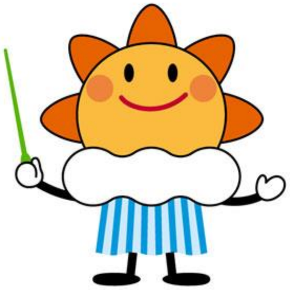
TCC Training Seminar on Global Warming Projection Information
16:15 – 17:15 (UTC+9) on 9 November 2022 (Day 1)

気象庁
Japan Meteorological Agency

Outline of IPCC AR6

Introduction to IPCC AR6

WAKAMATSU Shunya



Schedule of this seminar

気象庁
Japan Meteorological Agency

1st Day (9 November 2022)

- Lecture on climate change
- Lecture on IPCC AR6 <- We are here

2nd Day (10 November 2022)

- Lecture on Climate Change Monitoring and Future Projections
- Lecture on assessment of future climate change and introduction to your exercise

3rd Day – 4th Day (11 and 14 November)

- (self-study format) Exercise on Observed Trends and Global Warming Projection for your country

5th Day (15 November)

- Your presentation (6 minutes per person)

PART 1: INTRODUCTION TO IPCC AR6

PART 2: DISCUSSION ABOUT STATEMENTS ABOUT YOUR COUNTRY/REGION

The Intergovernmental Panel on Climate Change (IPCC)

気象庁 Japan Meteorological Agency

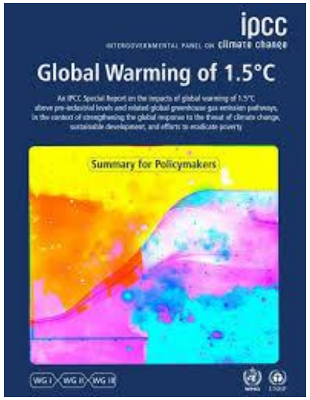
- IPCC was established by the United Nations Environment Programme (UNEP) and the World Meteorological Organization (WMO) in 1988.
- The IPCC currently has 195 members.

- The objective of the IPCC is to provide governments at all levels with scientific information that they can use to develop climate policies.
  - The IPCC does not conduct its own research. Experts volunteer their time as IPCC authors to assess the thousands of scientific papers published to provide a comprehensive summary on assessment reports.
  - The assessment reports are a key input into the international negotiations (e.g., UNFCCC) to tackle climate change. The reports also provide fundamental information to the member governments.
- IPCC reports are neutral, policy-relevant but not policy-prescriptive.

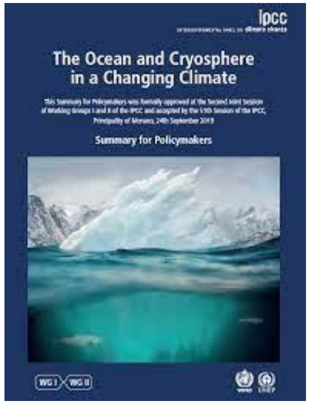
https://www.ipcc.ch/
https://archive.ipcc.ch/organization/bureaumembers.shtml

Sixth Assessment Cycle

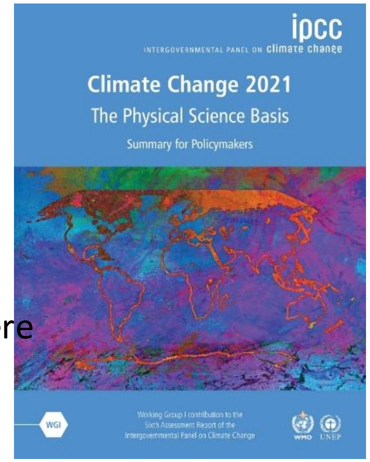
気象庁
Japan Meteorological Agency

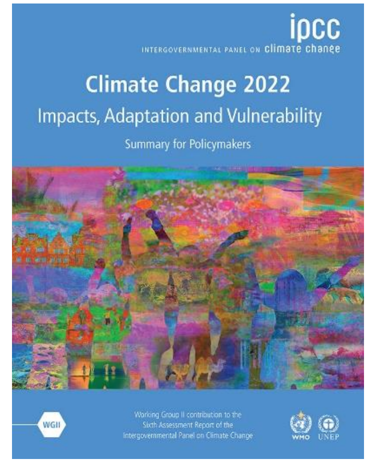


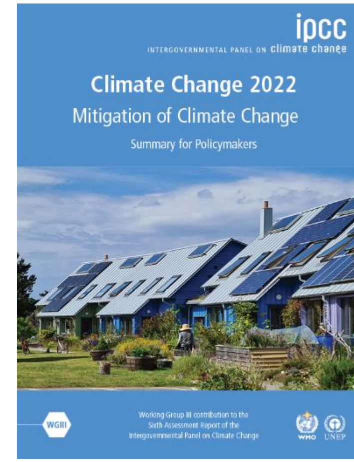
Global Warming of 1.5° C
(October 2018)

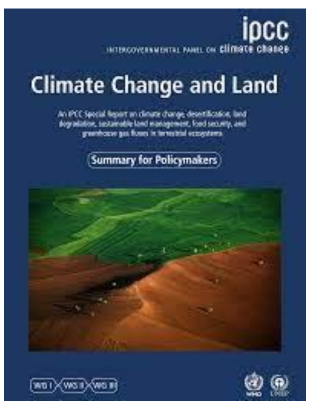


The Ocean and Cryosphere in a Changing Climate
(September 2019)

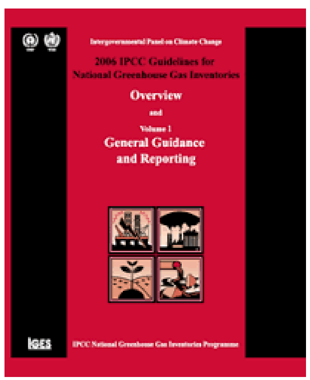








Climate Change and Land
(August 2019)



2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories
(May 2019)

Sixth Assessment Reports

AR6 WG1: The Physical Science Basis (August 2021)

AR6 WG2: Impacts, Adaptation and Vulnerability (February 2022)

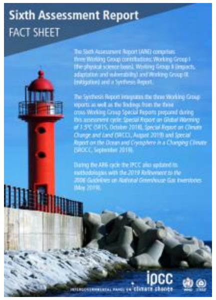
AR6 WG3: Mitigation of Climate Change (April 2022)

AR6 Synthesis Report: Climate Change 2022
(not yet published)

Innovations and changes in AR6 WG1

WG1

- The new structure of the Working Group I report shows there will be more **integrated knowledge** and understanding compared to the previous report.
  - In the Fifth Assessment Report (AR5) there were separate chapters on the assessment of models, observational evidence, paleo-climate records etc, but now these topics are integrated together across multiple chapters.
- There is a far greater emphasis on **regional climate change** in the Working Group I report; the final third of the chapters all have a regional focus.
  - These chapters will cover the large advances in scientific knowledge on changes in extreme events and attributing these events to man-made climate change, notably in Chapter 11 (Weather and climate extreme events in a changing climate), a new dedicated chapter on this topic.
- Interactive online regional atlas featuring data underpinning the Working Group I assessment, including observed and projected climate change information.
  - Users can perform spatial and temporal analyses using many datasets used in the assessment, access synthesized regional information for climatic impact drivers and download data.
- There's a greater focus on how the **Earth responds to climate change** in the Working Group I report, looking for example at how the oceans and atmosphere respond when greenhouse gas emissions are reduced or if carbon removal techniques are used, and the timelines associated with these actions.
  - There will also be an updated assessment of our understanding of how sensitive the Earth's temperature is to carbon dioxide emissions.
- In the Fifth Assessment Report, four Representative Concentration Pathways (RCPs) were used to simulate future climate change. This time the IPCC uses **Shared Socio-Economic Pathways** (SSPs) that look at a far great range of options / scenarios. There's a greater focus on lower degrees of warming because of these scenarios.
  - Levels of warming like 1.5° C and 2° C can be assessed more rigorously than in AR5. The assessment can also look at the timing of when we could see a global mean temperature of these global warming levels.
- Others are shown in AR6 Fact Sheet (https://www.ipcc.ch/site/assets/uploads/2021/06/Fact_sheet_AR6.pdf).



Improved understanding of human influence

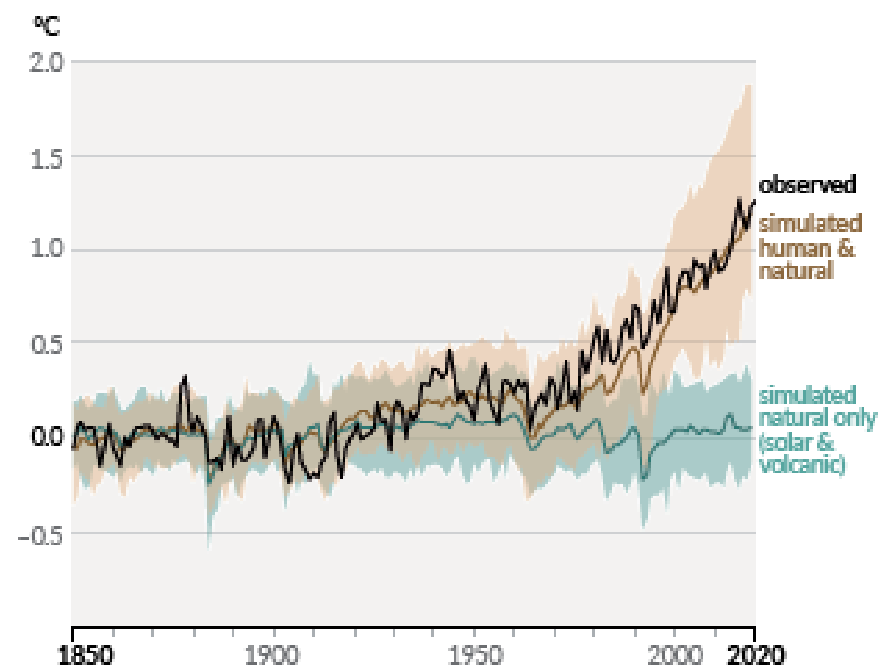
WG1

It is unequivocal that human influence has warmed the atmosphere, ocean and land.

- AR5 Climate Change 2013:
  - Warming of the climate system is unequivocal, and since the 1950s, many of the observed changes are unprecedented over decades to millennia.
  - It is extremely likely that human influence has been the dominant cause of the observed warming since the mid-20th century.
- AR4 Climate Change 2007:
  - Warming of the climate system is unequivocal
  - Most of the observed increase in global average temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic greenhouse gas concentrations.
- TAR Climate Change 2001:
  - most of the observed warming over the last 50 years is likely to have been due to the increase in greenhouse gas concentrations
- SAR Climate Change 1995:
  - a discernible human influence on global climate
- FAR Climate Change (1990):
  - There is concern that human activities may be inadvertently changing the climate of the globe through the enhanced greenhouse effect

Changes in global surface temperature relative to 1850–1900

Change in global surface temperature (annual average) as **observed** and simulated using **human & natural** and **only natural** factors (both 1850–2020)

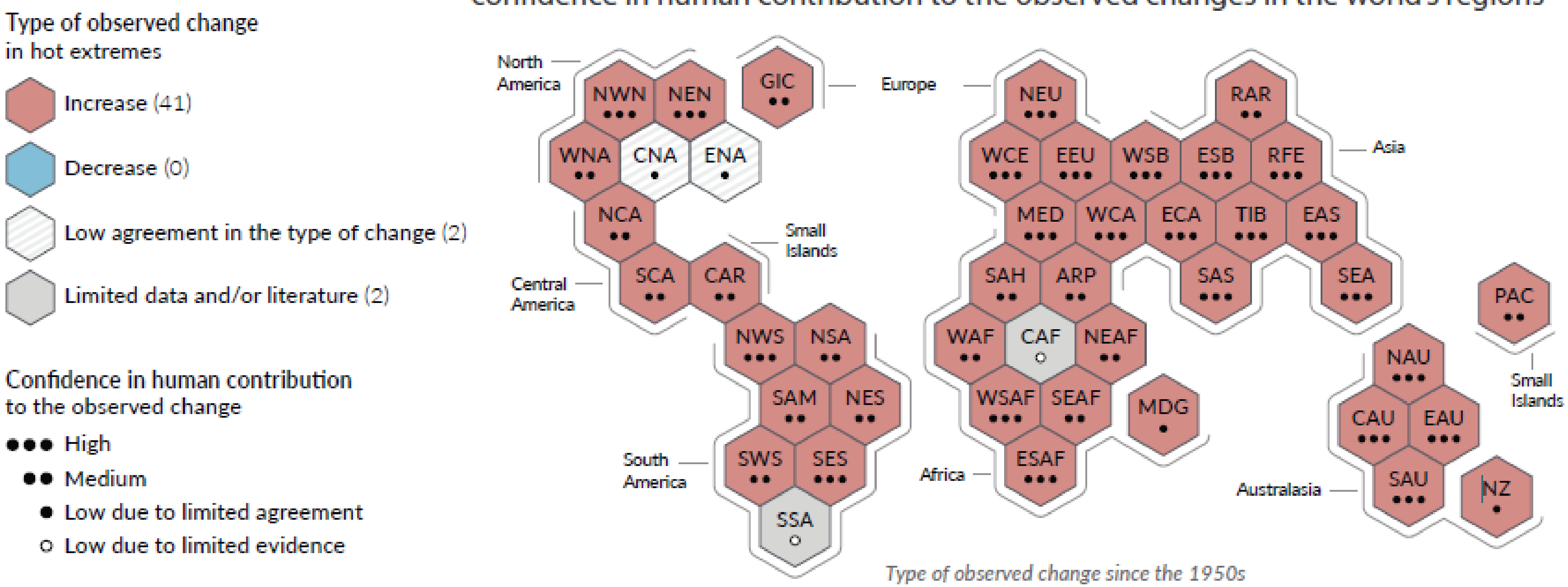


IPCC AR6 WG1 SPM Figure SPM.1

Evidence of observed changes in extremes has strengthened

Climate change is already affecting every inhabited region across the globe, with human influence contributing to many observed changes in weather and climate extremes

(a) Synthesis of assessment of observed change in **hot extremes** and confidence in human contribution to the observed changes in the world's regions



IPCC AR6 WG1 SPM Figure SPM.3

Evidence of observed changes in extremes such as heatwaves, heavy precipitation, droughts, and tropical cyclones, and, in particular, their attribution to human influence, has strengthened since AR5.

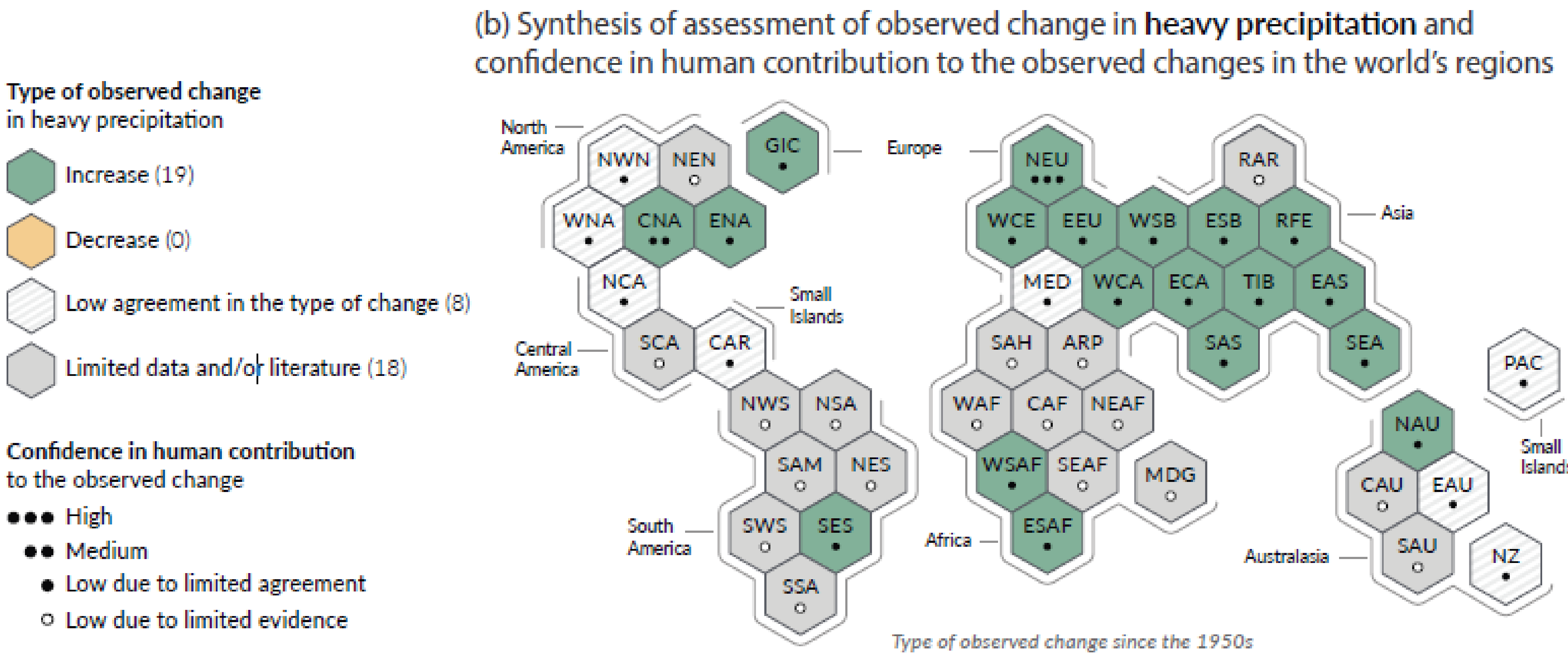
The **confidence level** for the human influence on these observed changes is based on assessing trend detection and attribution and event attribution* literature

** the relatively new science of event attribution is able to quantify the role of climate change in altering the probability and magnitude of some types of weather and climate extremes. (FAQ 11.3)*

Updated Assessments of observed changes in extremes

WG1

Climate change is already affecting every inhabited region across the globe, with human influence contributing to many observed changes in weather and climate extremes



IPCC AR6 WG1 SPM Figure SPM.3

Evidence of observed changes in extremes such as heatwaves, heavy precipitation, droughts, and tropical cyclones, and, in particular, their attribution to human influence, has strengthened since AR5.

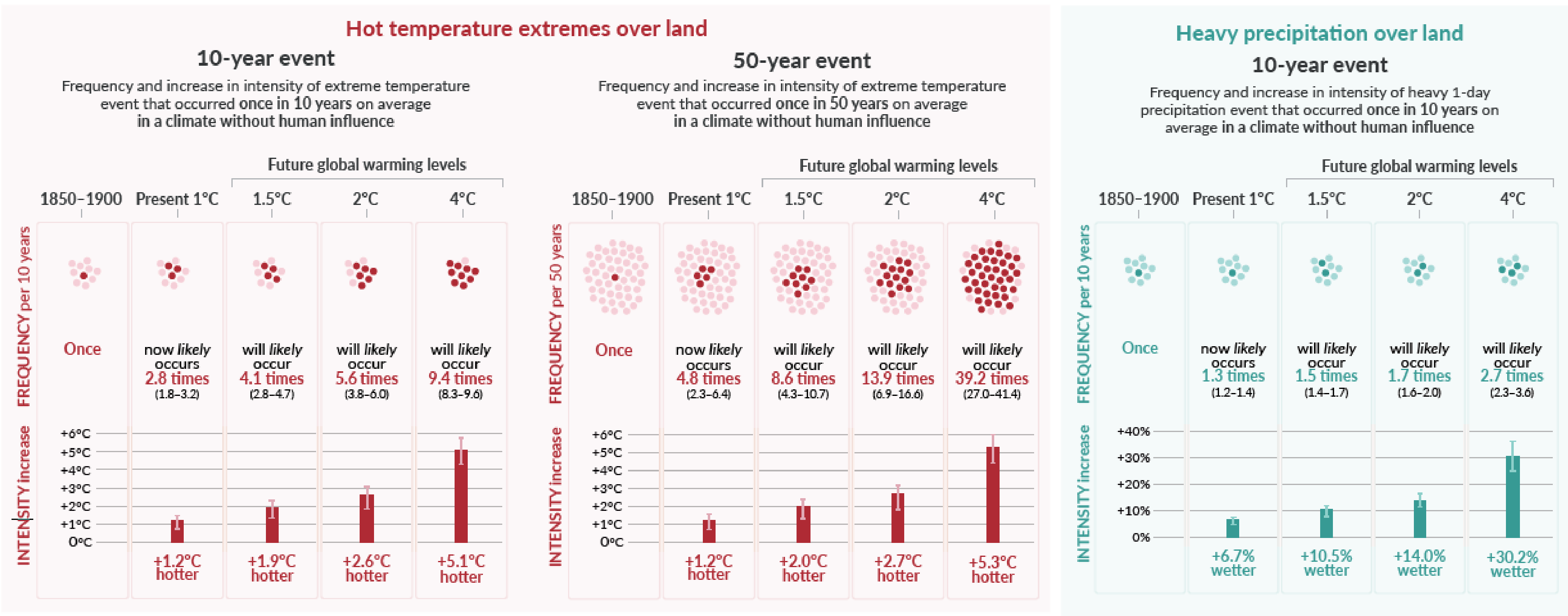
The **confidence level** for the human influence on these observed changes is based on assessing trend detection and attribution and <u>event attribution*</u> literature

** the relatively new science of event attribution is able to quantify the role of climate change in altering the probability and magnitude of some types of weather and climate extremes. (FAQ 11.3)*

Updated Assessments of projected changes in extremes

WG1

Projected changes in extremes are larger in frequency and intensity with every additional increment of global warming

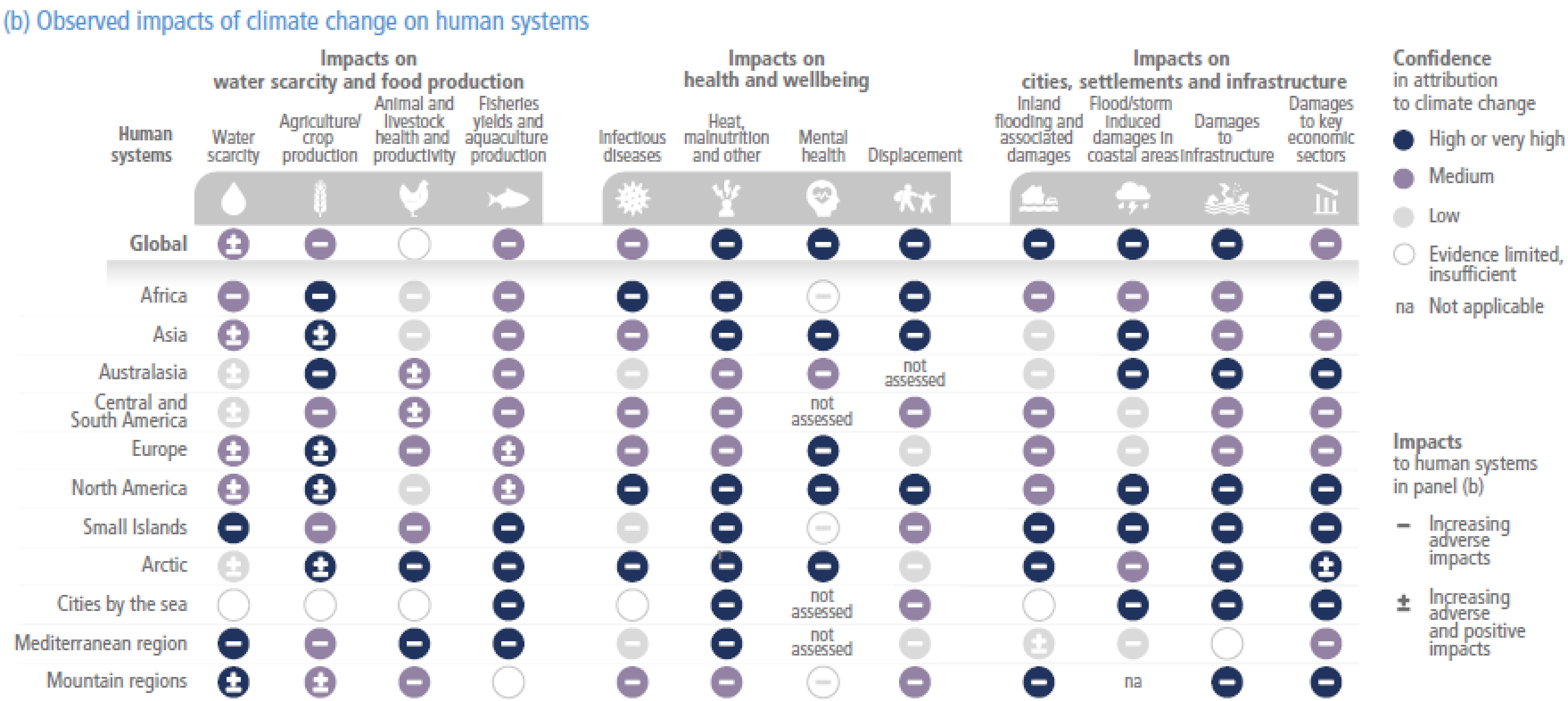


IPCC AR6 WG1 SPM Figure SPM.6

Impacts of extreme events

WG2

- Human-induced climate change, including more frequent and intense extreme events, has caused widespread adverse impacts and related losses and damages to nature and people, beyond natural climate variability.
- The rise in weather and climate extremes has led to some irreversible impacts as natural and human systems are pushed beyond their ability to adapt.



IPCC AR6 WG2 SPM Figure SPM.2

Early warning systems as adaptation

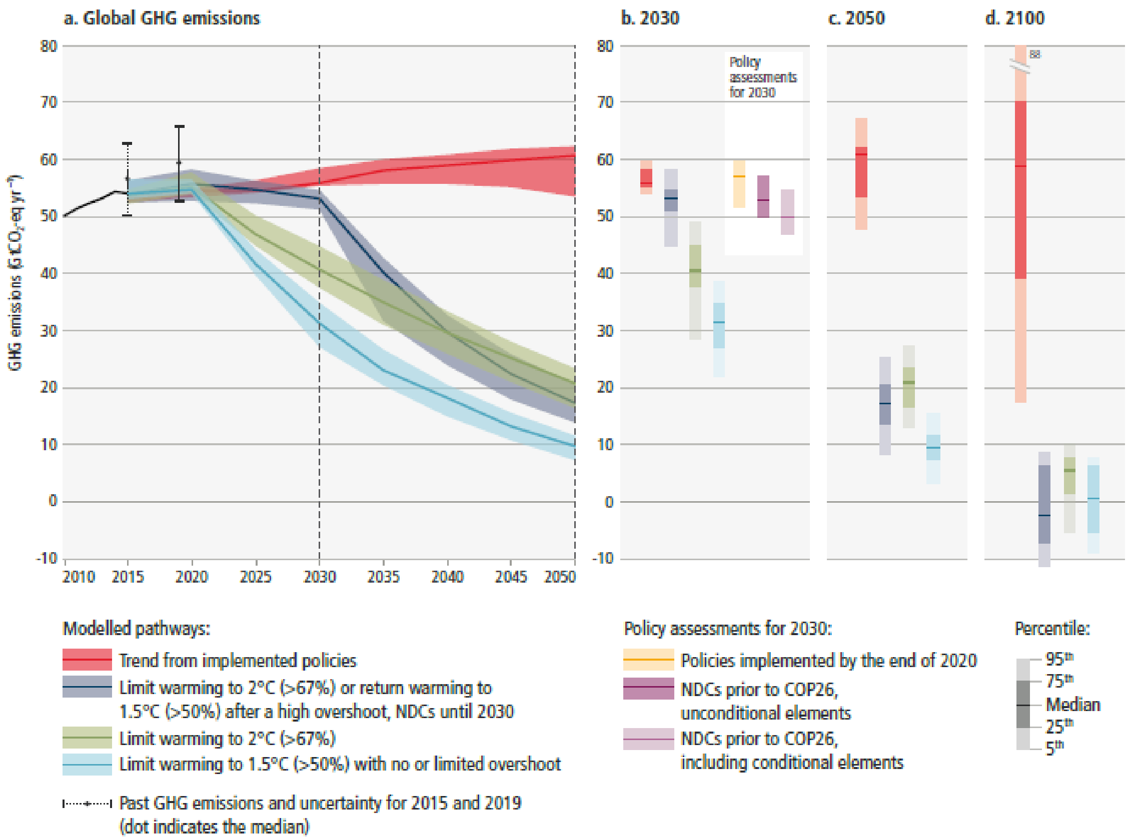
WG2

- Adaptation to water-related risks and impacts make up the majority of all documented adaptation (high confidence).
- For inland flooding, combinations of non-structural measures like early warning systems and structural measures like levees have reduced loss of lives *(medium confidence)*
- There are a range of adaptation options, such as disaster risk management, early warning systems, climate services and risk spreading and sharing that have broad applicability across sectors and provide greater benefits to other adaptation options when combined *(high confidence)*.

Without a strengthening of policies, it leads to a warming of 3.2

WG3

- Without a strengthening of policies beyond those that are implemented by the end of 2020, GHG emissions are projected to rise beyond 2025, leading to a median global warming of 3.2 [2.2 to 3.5] °C by 2100
- Global GHG emissions in 2030 associated with the implementation of Nationally Determined Contributions (NDCs) announced prior to COP26 would make it likely that warming will exceed 1.5°C during the 21st century.24 Likely limiting warming to below 2°C would then rely on a rapid acceleration of mitigation efforts after 2030.



Projected changes in extremes are larger in frequency and intensity with every additional increment of global warming (WG1)

The magnitude and rate of climate change and associated risks depend strongly on near-term mitigation and adaptation actions, and projected adverse impacts and related losses and damages escalate with every increment of global warming (WG2)

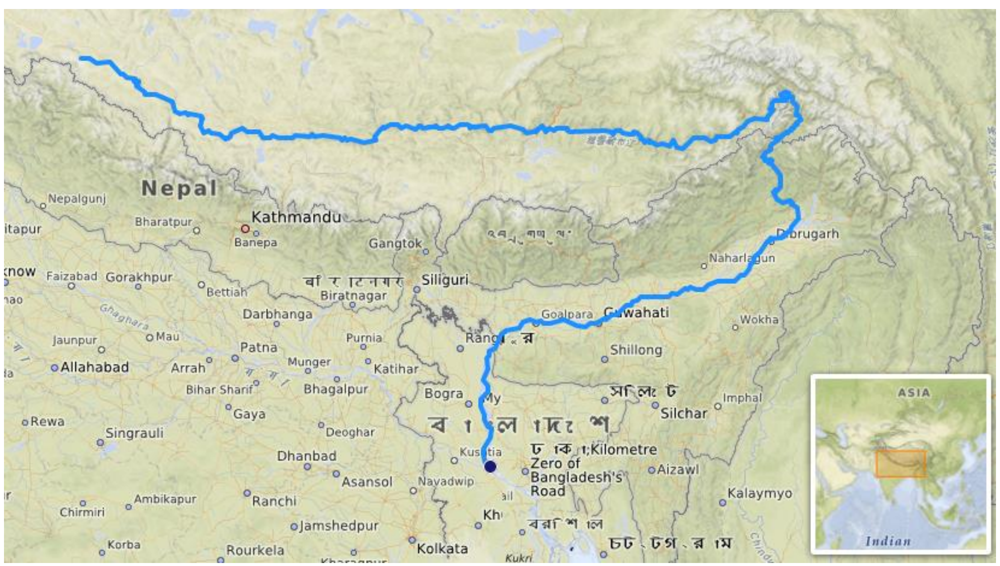
PART 1: INTRODUCTION TO IPCC AR6

<u>PART 2: DISCUSSION ON IPCC SENTENCES ABOUT YOUR COUNTRY/REGION</u>

Sentences in Chapter 11

気象庁
Japan Meteorological Agency

- Bangladesh
  - …… event attribution focused on runoff using hydrological models, and examples include …… the Brahmaputra River in Bangladesh (Philip et al., 2019).
  - In Bangladesh, the annual number of propagating mesoscale convective systems (MCSs) decreased significantly during 1998–2015 based on TRMM precipitation data (Habib et al., 2019).
- Indonesia
  - In 2015 (when Extreme El Niño happened), Indonesia experienced a severe drought and forest fire, causing pronounced impact on economy, ecology and human health due to haze crisis (Field et al., 2016; Huijnen et al., 2016; Patra et al., 2017; Hartmann et al., 2018).



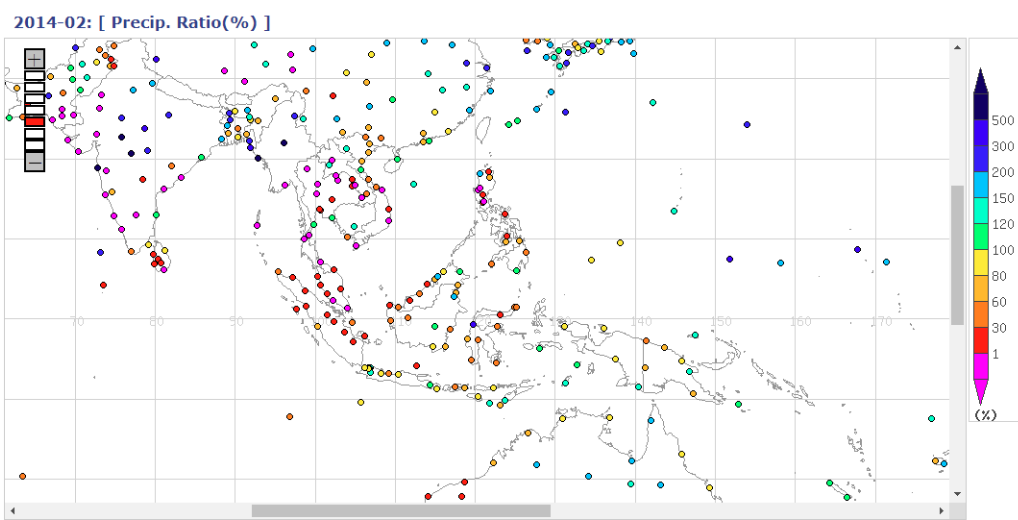
Path of the Brahmaputra River (Wikipedia)

2015 Southeast Asian haze (Wikipedia)

Sentences in Chapter 11

気象庁 Japan Meteorological Agency

- Malaysia
  - there are studies in regions of almost all continents that generally indicate intensification of sub-daily extreme precipitation, although there remains low confidence in an overall increase at the global scale. …… Studies include an increase in extreme sub-daily rainfall …… in Peninsular Malaysia (Syafrina et al., 2015),
  - In Asia, no climate change signal was found in the record dry spell over Singapore and Malaysia in 2014 (Mcbride et al., 2015) …… Nevertheless, the South East Asia drought of 2015 has been attributed to anthropogenic warming effects (Shiogama et al., 2020).
- Mongolia
  - Increases in the frequency and duration of heatwaves are also observed in Mongolia (Erdenebat and Sato, 2016) and India (Ratnam et al., 2016; Rohini et al., 2016).



(ClimatView)

dry spell over Singapore and Malaysia in 2014

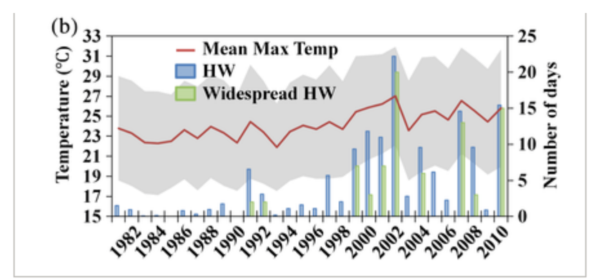


Figure 1 Open in figure viewer PowerPoint

(a) Climatology of HW frequency determined from reanalysis data. White and black circles indicate the 70 surface meteorological stations. Black circles indicate 21 stations used for soil moisture. Red line shows the area used for Figure 4. (b) Interannual variation of JJA-mean maximum air temperature and its standard deviation (gray shading) averaged over the 70 stations in Mongolia. Bars represent the annual number of HW and widespread HW (when more than half of the 70 stations simultaneously observed HW) days, respectively.

(Erdenebat and Sato, 2016)

Sentences in Chapter 11

- Pakistan
  - More intense heatwaves of longer durations and occurring at a higher frequency are projected over India (Murari et al., 2015; Mishra et al., 2017) and Pakistan (Nasim et al., 2018).
- Philippines
  - In Super Typhoon Haiyan, which struck the Philippines on 8 November 2013, Takayabu et al. (2015) took an event attribution approach with cloud system-resolving (around 1 km) downscaling ensemble experiments to evaluate the anthropogenic effect on typhoons, and showed that the intensity of the simulated worst-case storm in the actual conditions was stronger than that in a hypothetical condition without historical anthropogenic forcing in the model. However, in a similar approach with two coarser parametrized convection models, Wehner et al. (2019) found conflicting human influences on Haiyan's intensity.

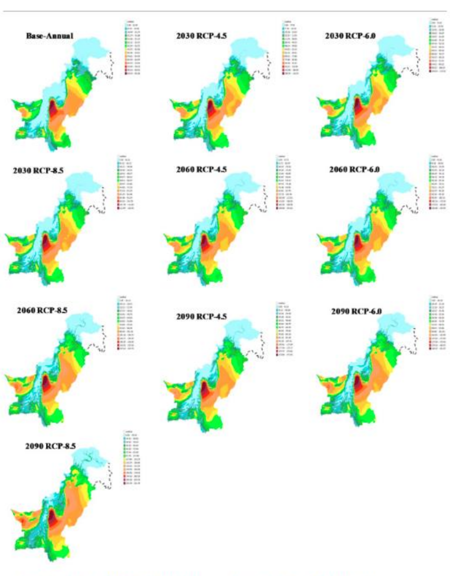


Fig. 8. Projections of Annual heat accumulation by spatial degree day model for 2030, 2060, and 2090 with Representative concentration pathways.

(Nasim et al., 2018)

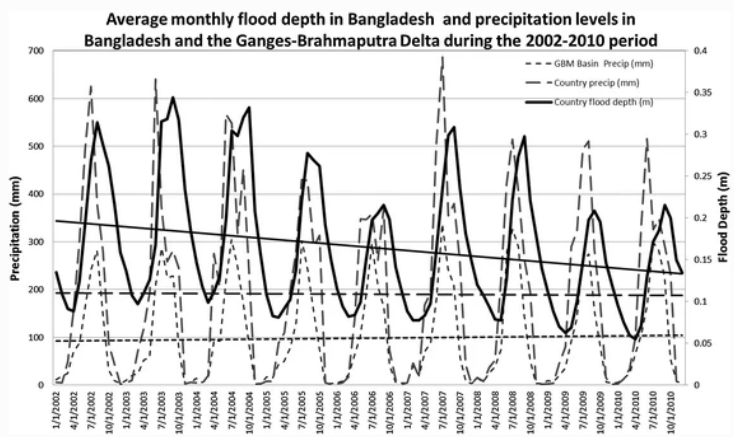
(Wikipedia)

Map plotting the storm Haiyan's track and intensity, according to the Saffir–Simpson scale

Sentences in Chapter 12

- Bangladesh
  - In South Asia (SAS), the numbers of flood events and human fatalities have increased in India during 1978–2006 (Singh and Kumar, 2013), whereas the average country-wide inundation depth has been decreasing during 2002–2010 in Bangladesh, attributed to improved flood management (low confidence) (Sciance and Nooner, 2018).
- Indonesia
  - High confidence of decrease (Mean precipitation projected change) in Indonesia (Atlas.5.4.5).

Fig. 6



Average country flood depth (m) plotted against the average country and basin wide precipitation (mm) between January 1, 2002 and December 27, 2010). Each datasets trend line is also displayed with matching line styles. Flood depth slope was −0.00601 m/year, country level precipitation slope was 0.12 mm/year, and GBM basin level precipitation slope was 0.15 mm/year

(Sciance and Nooner, 2018)

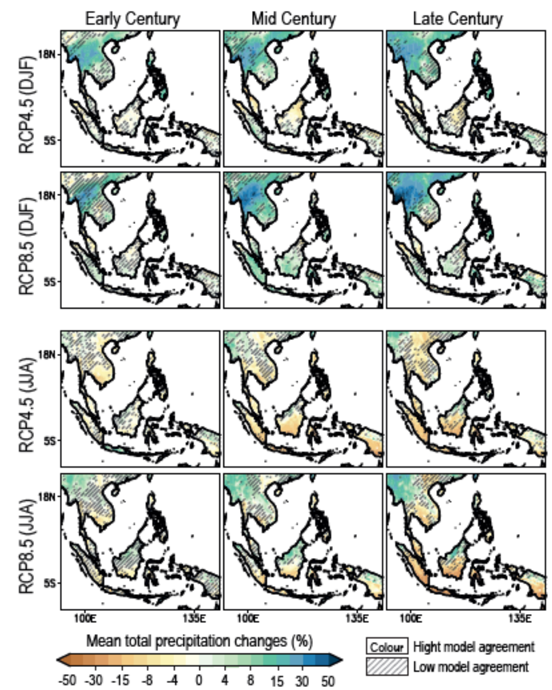


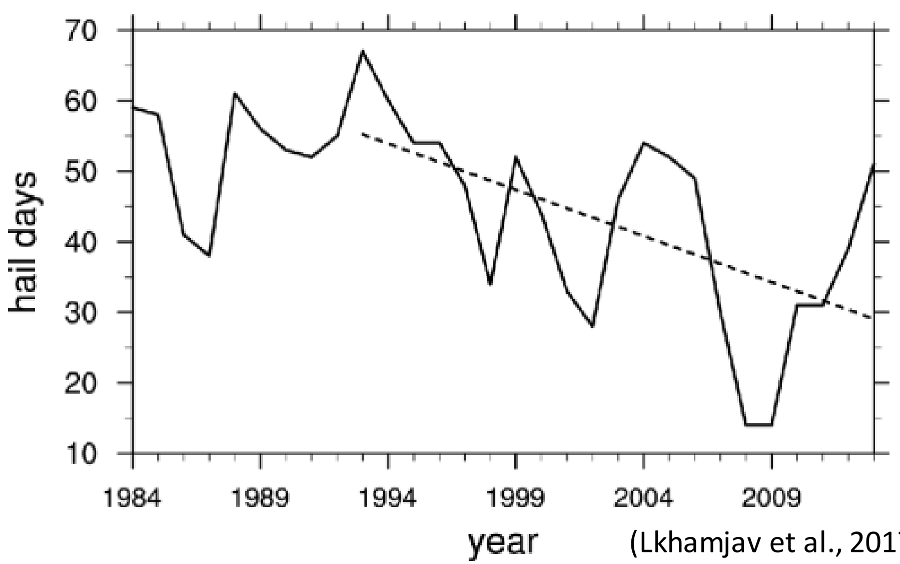
Figure Atlas.19 | The RCM-projected changes in mean precipitation between the early (2011–2040), mid- (2041–2070) and late (2071–2099) 21st century and the historical period 1976–2005. Data are obtained from the CORDEX-SEA downscaling simulations. Diagonal lines indicate areas with low model agreement (less than 80%). Figure adapted from Tangang et al. (2020).

(IPCC AR6 WG1 Atlas)

Sentences in Chapter 12

気象庁
Japan Meteorological Agency

- Mongolia
  - A rate of decrease of 0.214 hail days per decade has also been reported for Mongolia between 1984–2013, where the annual number of hail days averaged is 0.74 (Lkhamjav et al., 2017).
- Nepal
  - Intense monsoon rainfall in northern India and western Nepal in 2013, which led to landslides and one of the worst floods in history, has been linked to increased loading of GHG and aerosols (Cho et al., 2016).



(Lkhamjav et al., 2017)

Fig. 2. Annual variation of the number of hail days. The dashed line indicates the linear trend since 1993.

(Wikipedia)

Effect of flood in Darchula district of Nepal.

Sentences in Chapter 12

気象庁 Japan Meteorological Agency

- Pakistan
  - Aridity in West Central Asia and parts of South Asia increased in recent decades (medium confidence), as documented in Afghanistan (Qutbudin et al., 2019), Iran (Zarei et al., 2016; Zolfaghari et al., 2016; Pour et al., 2020), most parts of Pakistan (K. Ahmed et al., 2018, 2019), and many parts of India (Roxy et al., 2015; Mallya et al., 2016; Matin and Behera, 2017; Ramarao et al., 2019).
- Papua New Guinea
  - a swell event due to distant extratropical cyclones in December 2008 raised extreme water levels leading to flooding affecting five Pacific island nations: Marshall Islands, Micronesia, Papua New Guinea, Kiribati and Solomon Islands (Hoeke et al., 2013; Merrifield et al., 2014).

Up to 1,408 houses were damaged or destroyed as a direct result of the sea swells and subsequent floods in New Ireland province. PNGRCS.

(The International Federation's Disaster Relief Emergency Fund (DREF) operation final report)

Sentences in Chapter 12

- Philippines and Vietnam
  - There was a drying tendency in the dry season and significant wetting in the wet season in the Philippines during 1951–2010 (Villafuerte et al., 2014), and slight wetting in Vietnam during 1980–2017 (Stojanovic et al., 2020) (low confidence).
  - the frequency of TCs affecting the Philippine region and Vietnam is projected to decrease (Kieu-Thi et al., 2016; C. Wang et al., 2017; Gallo et al., 2019) (medium confidence).
- Philippines
  - decreasing exposure in the region of South Asia (SAS) and southern China (Cinco et al., 2016; Kossin et al., 2016; see Chapter 11). However, while the analysis shows fewer typhoons, more extreme TCs have affected the Philippines (low confidence) (Takagi and Esteban, 2016).

    e.g., 2013 Typhoon Haiyan
- Vietnam
  - Relative sea level (RSL) change in many coastal areas in Asia, especially in EAS, is affected by land subsidence due to sediment compaction under building mass and groundwater extraction (high confidence) (Erban et al., 2014; Nicholls, 2015; Minderhoud et al., 2019; Qu et al., 2019). During 1991–2016, the Mekong Delta in Vietnam sank on average about 18 cm as a consequence of groundwater withdrawal, and the subsidence related to groundwater extraction has gradually increased with highest sinking rates estimated to be 11 mm yr^{-1} in 2015 (Minderhoud et al., 2017).
  - Compound impacts of precipitation change, land subsidence, sea level rise, upstream hydropower development, and local water infrastructure development may lead to larger flood extent and prolonged inundation in the Vietnamese Mekong Delta (Triet et al., 2020).

Mekong Delta (Wikipedia)

Thank you for your attention!