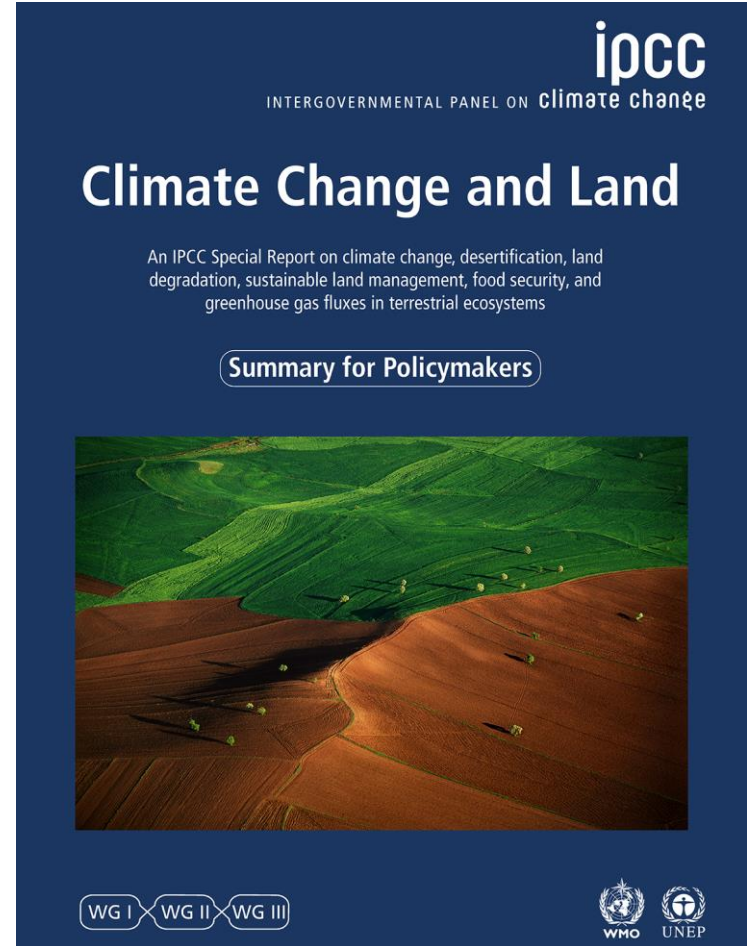


CLIMATE CHANGE AND LAND

An IPCC Special Report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems.

REPORT COVER IMAGE:

Agricultural landscape between Ankara and Hattusha, Anatolia, Turkey (40°00' N – 33°35' E)
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“ Land is a critical resource – we rely on it for food, water, health and wellbeing – but it is already under growing human pressure. Climate change is adding to these pressures

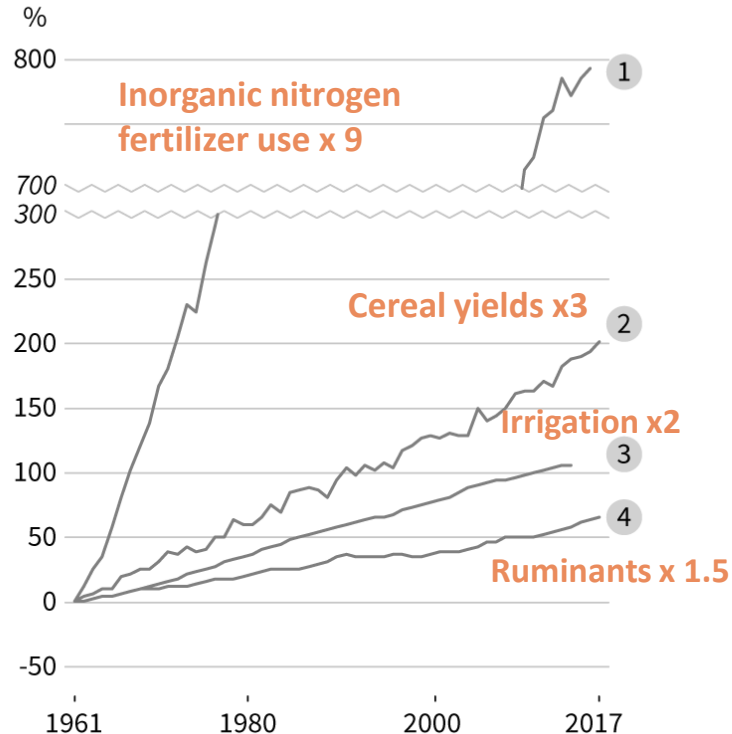


Land is under growing human pressure with unprecedented rates of land and freshwater use

- Human activities directly affect more than 70% of the global, ice-free and surface
- People currently use $\frac{1}{4}$ to $\frac{1}{3}$ of land's potential net primary production for food, feed, timber and energy
- About $\frac{1}{4}$ of the global ice-free land area is subject to human-induced degradation
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- Since 1961, population growth and changes in per capita consumption of food, feed, fiber, timber and energy have caused unprecedented rates of land and freshwater use

CHANGE in % rel. to 1961

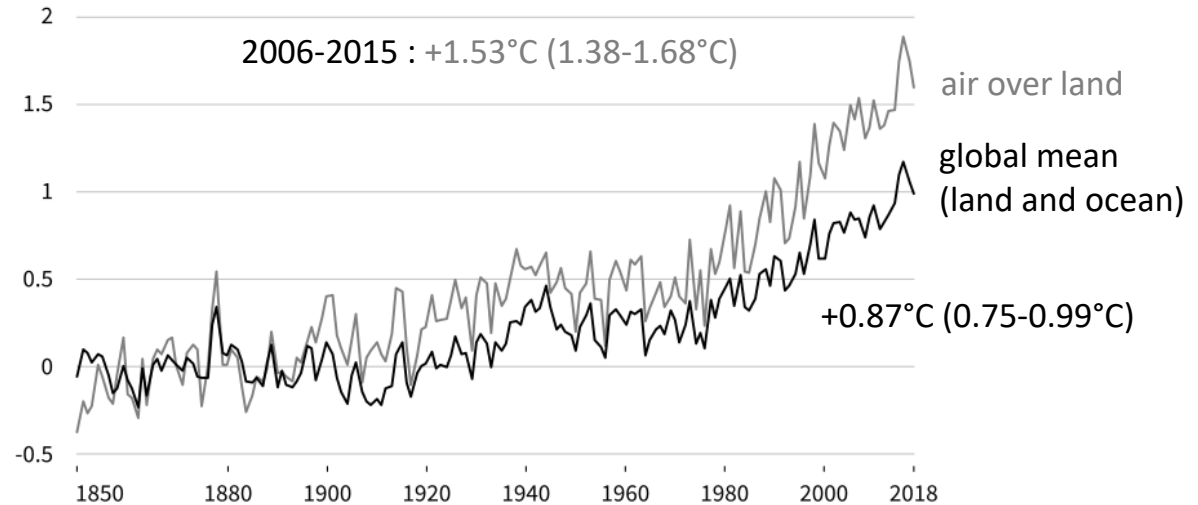
- 1 Inorganic N fertiliser use
- 2 Cereal yields
- 3 Irrigation water volume
- 4 Total number of ruminant livestock



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Climate Change is adding to these pressures

Temperature change at the Earth's surface since 1850-1900



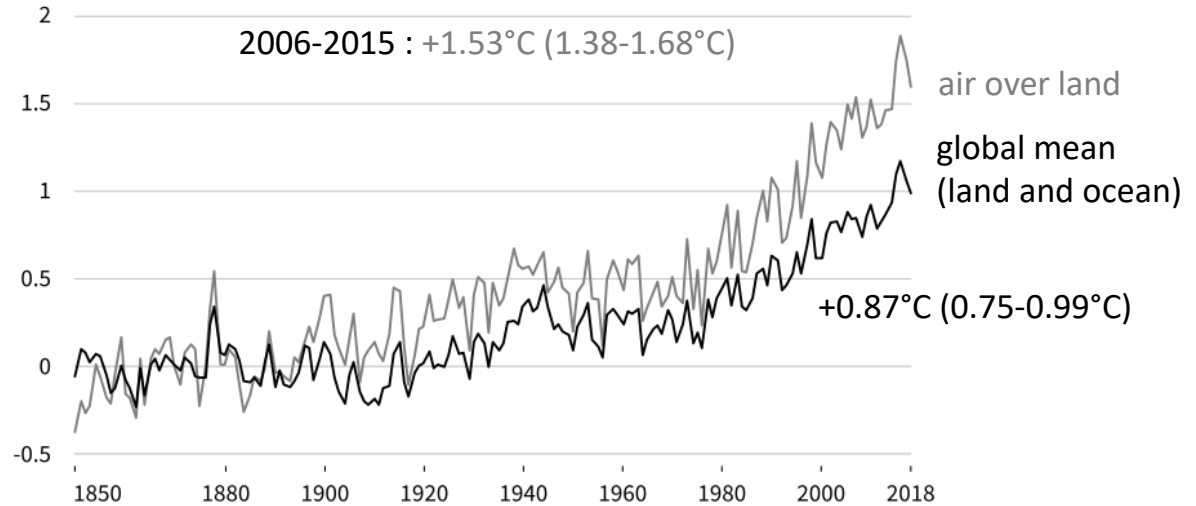
Climate Change is adding to these pressures

- Frequency, intensity and duration of heat waves
- Intensity of heavy rainfall events
- Frequency and intensity of drought (Mediterranean, West and NorthEast Asia, regions in South America and Africa)

Shifts of climate zones affecting many plant and animal species

Vegetation greening area > browning area

Temperature change at the Earth's surface since 1850-1900

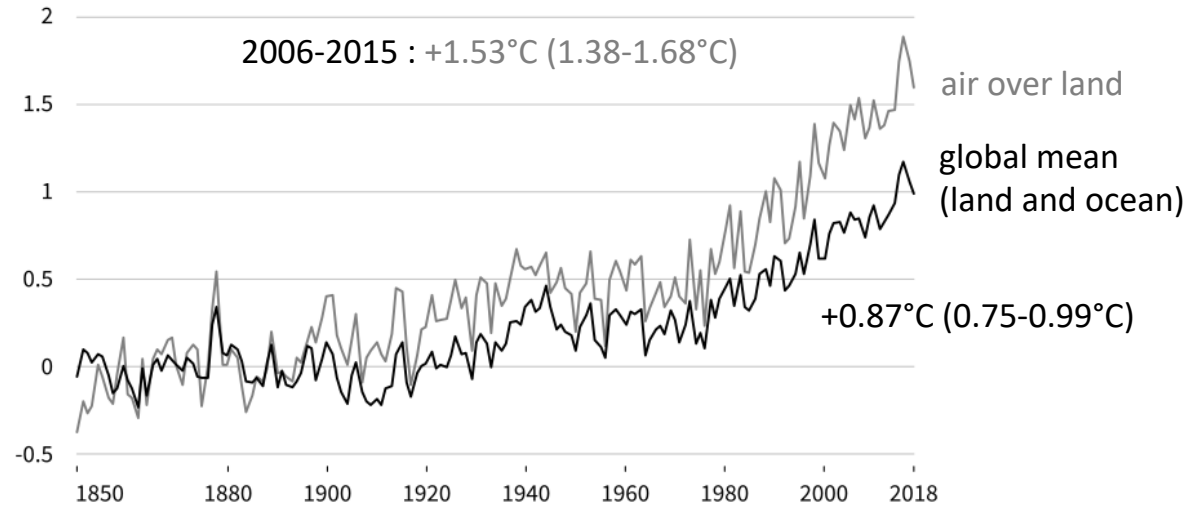


➤ Annual area of drylands in drought by 1% per year since 1961

➤ Frequency and intensity of dust storms

Climate Change is adding to these pressures

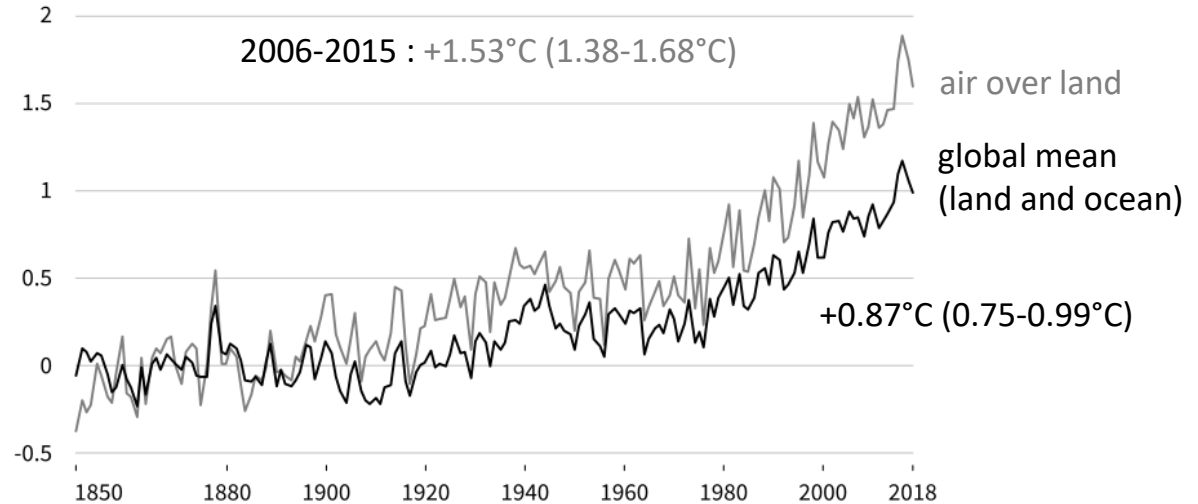
Temperature change at the Earth's surface since 1850-1900



Climate change exacerbates land degradation, particularly in low-lying coastal areas, river deltas, drylands and in permafrost areas due to changes in rainfall intensity, heat and water stress, permafrost thaw, coastal erosion and sea level rise.

Climate Change is adding to these pressures

Temperature change at the Earth's surface since 1850-1900





The food system is under pressure and is vulnerable to climate change

- Per capita supply of food calories +1/3 since 1961
- Per capita consumption of vegetable oils and meat x2

- 821 million people still undernourished
2 billion people now being overweight or obese

- 25 to 30 % of total food produced is lost or wasted

- Climate change is already affecting food security
 - Yields of some crops in lower-latitude regions (ex. maize, wheat, barley)
 - Animal growth rates and productivity in pastoral systems in Africa
 - Yields of some crops (e.g. maize, wheat, sugar beet) in higher latitude regions
- Agricultural pests and diseases and infestations*

2007-2016:

13 % of CO₂ emissions
→ *deforestation*

44 % of CH₄ emissions
↗ *ruminants, rice*

82% of nitrous oxide
(N₂O) emissions
↗ *nitrogen application,
manure deposition*

Agriculture, Forestry and Other Land Use account for around 23% of total net anthropogenic greenhouse gas emissions

Food system (including pre and post-production activities) : 21-37% of total net anthropogenic greenhouse gas emissions

- *Large regional differences*
- *Projected to increase driven by population and income growth, changes in consumption patterns*

Food loss and waste :

8 - 10 % of global greenhouse gas emission



The natural response of land to human-induced environmental changes results in net removal of ~29 % of global anthropogenic CO₂ annual emissions

- Future net increases in CO₂ emissions from vegetation and soils due to climate change are projected to counteract increased removals due to CO₂ fertilization and longer growing seasons. The balance between these processes is a key source of uncertainty for determining the future of the land carbon sink.
- Projected thawing of permafrost is expected to increase the loss of soil carbon. During the 21st century, vegetation growth in those areas may compensate in part for this loss.



Changes in land conditions, either from land-use or climate change, affect global and regional climate

- At the regional scale, changing land conditions can reduce or accentuate warming and affect the intensity, frequency and direction of extreme events
- Drier (wetter) soil conditions can increase (reduce) the severity of heat waves
- When forest cover increases in tropical regions, cooling results from enhanced evapotranspiration.



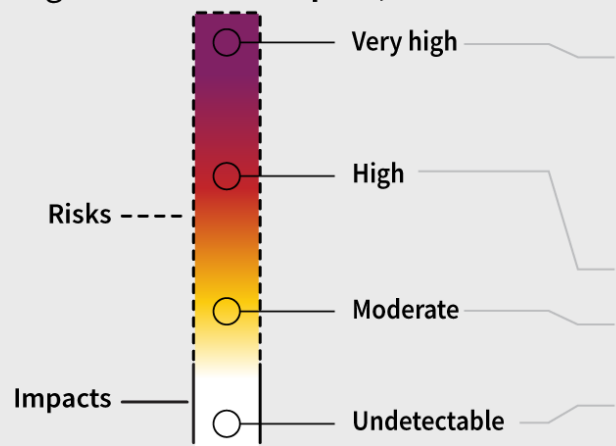
Climate change exacerbates existing risks to:

- Livelihoods
- Biodiversity
- human and ecosystem health
- Infrastructure
- food systems

Increasing impacts on land are projected under all future GHG emission scenarios.

- Some regions will face higher risks, while some regions will face risks previously not anticipated.
- With increasing warming, the frequency, intensity and duration of heat waves, droughts and rainfall are expected to increase in many regions.
- **Climate zones** are projected to further shift poleward in the middle and high latitudes.
- In **high-latitude regions**, warming is projected to increase disturbance in boreal forests, including drought, wildfire, and pest outbreaks.
- In **tropical regions**, under medium and high GHG emissions scenarios, warming is projected to result in the emergence of unprecedented climatic conditions by the mid to late 21st century.

Legend: Level of impact/risk



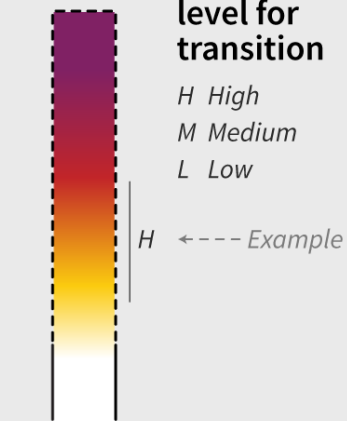
Purple: Very high probability of severe impacts/ risks and the presence of significant irreversibility or the persistence of climate-related hazards, combined with limited ability to adapt due to the nature of the hazard or impacts/risks.

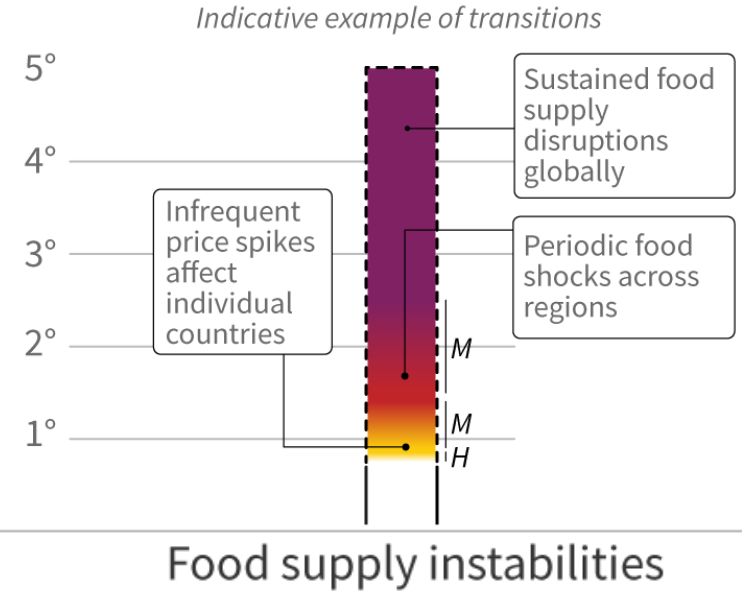
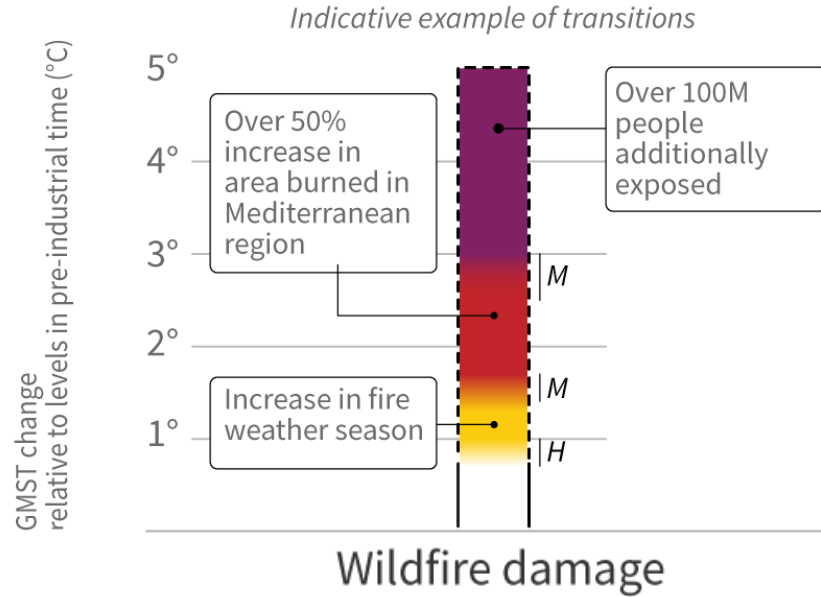
Red: Significant and widespread impacts/risks.

Yellow: Impacts/risks are detectable and attributable to climate change with at least medium confidence.

White: Impacts/risks are undetectable.

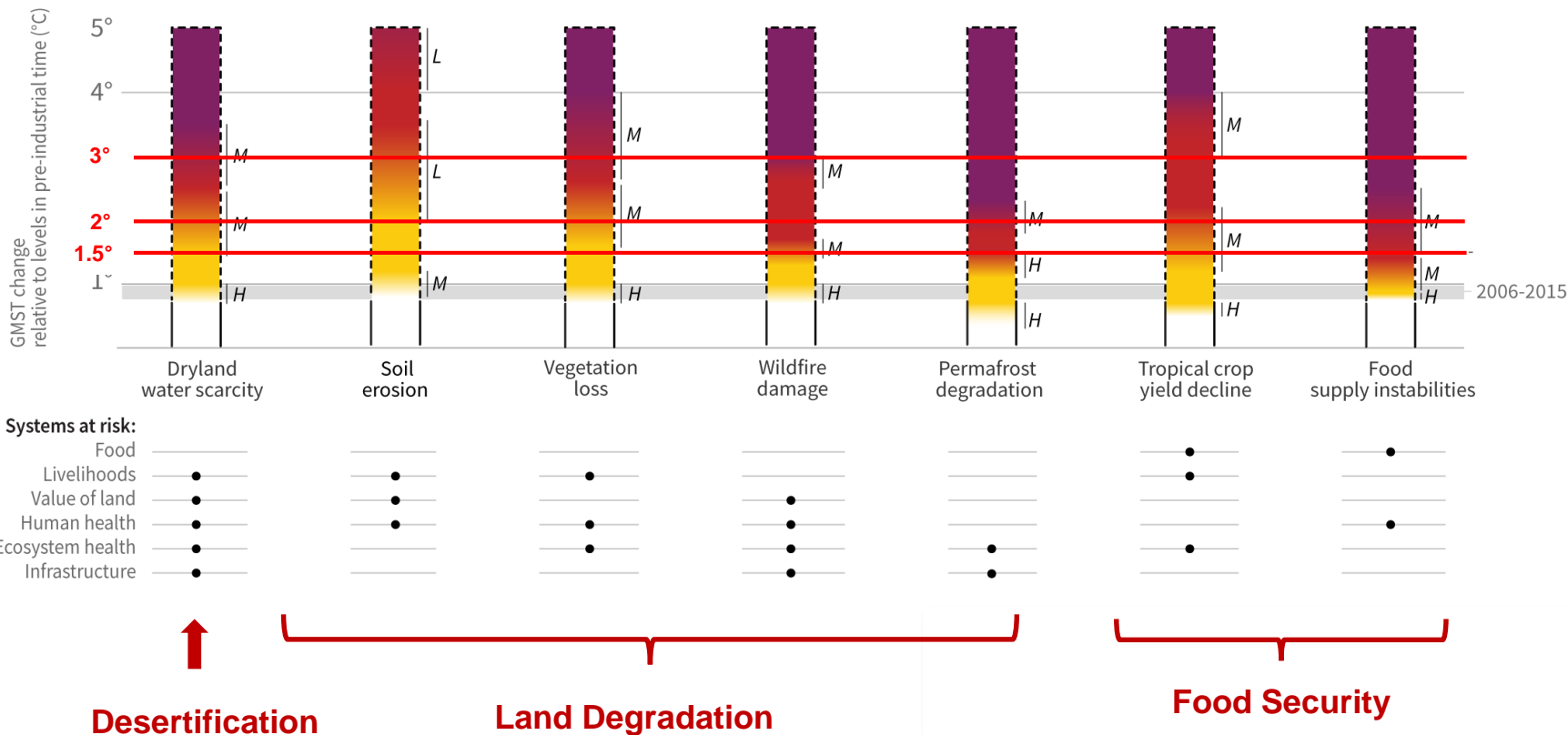
Legend: Confidence level for transition



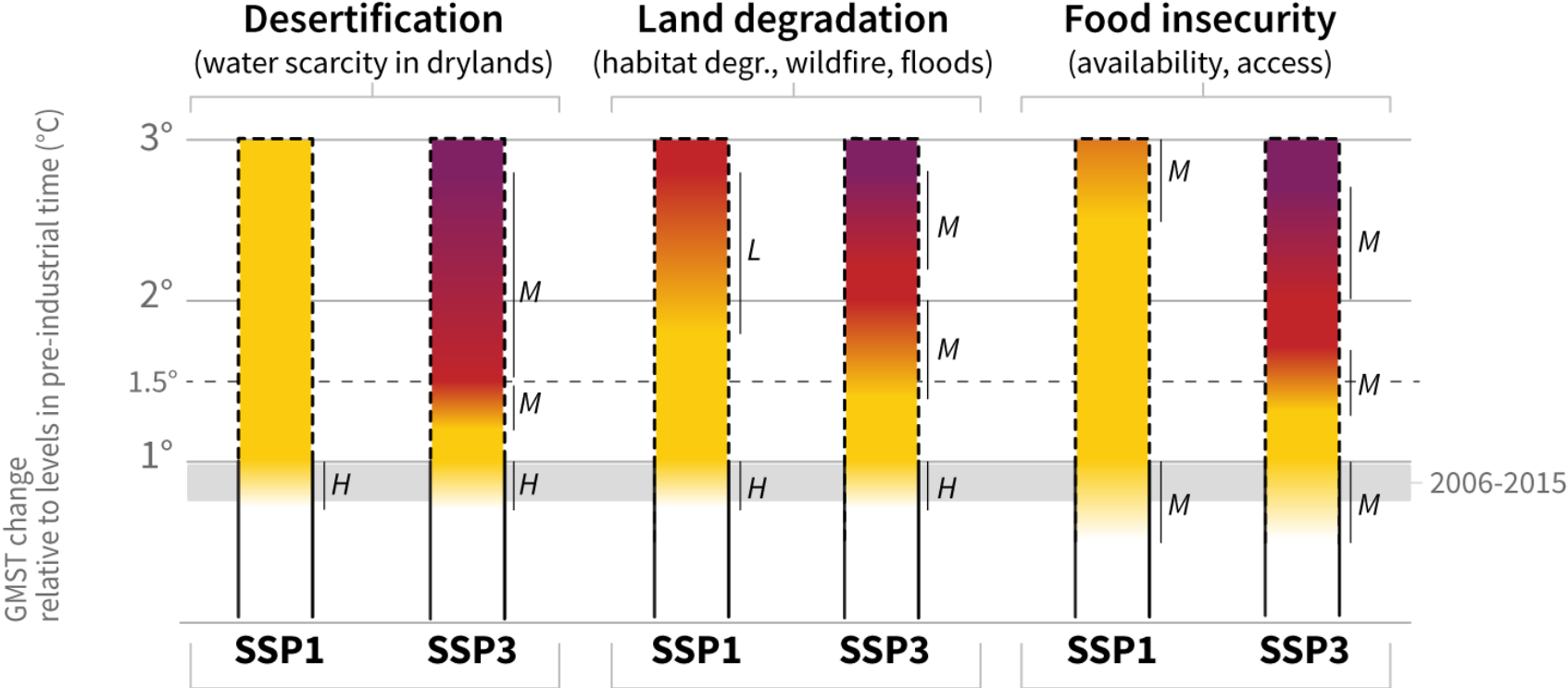


SPM Figure 2 – A -1

The warming climate affects processes connected to desertification, land degradation, and food security, and increase their risks.



For the same level of warming, the level of risk depends on the choice of development



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In SSP 1 there is low population growth, reduced inequalities, low emission production systems, efficient use of land, increased capacity for adaptation.

In SSP3 there is increased population and demand, increasing inequality, multiple pressures on land, low capacity for adaptation.

Vulnerabilities

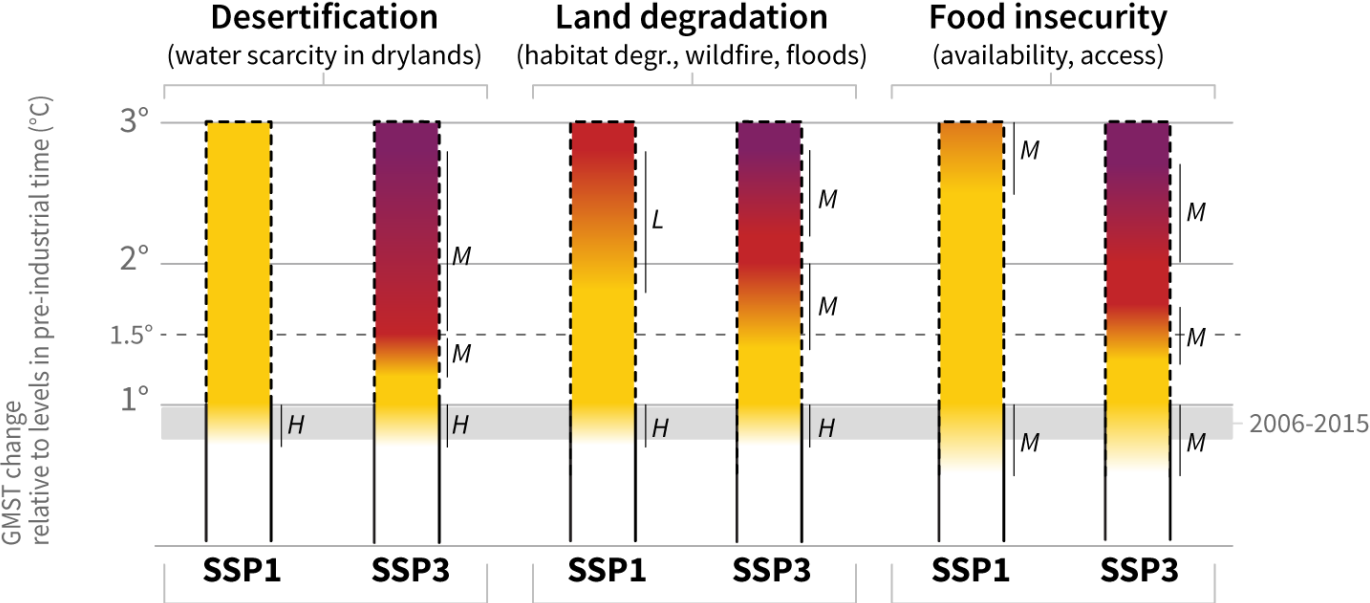


North America, South America, Mediterranean, southern Africa and central Asia may be increasingly affected by wildfire.

Asia and Africa are projected to have the highest number of people vulnerable to increased desertification.

The tropics and subtropics are projected to be most vulnerable to crop yield decline.

The level of risk posed by climate change depends both on the level of warming and on how population, consumption, production, technological development, and land management patterns evolve.



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- Pathways with increases in population and income result in increased demand for food, feed, and water in 2050 in all SSPs.
- Together with resource-intensive consumption and production, and limited technological improvements in agriculture yields this results in higher risks from water scarcity and food insecurity.
- These changes have implications for terrestrial GHG emissions, carbon sequestration potential, and biodiversity.

The level of risk posed by climate change depends both on the level of warming and on how population, consumption, production, technological development, and land management patterns evolve.

- Risks are higher in pathways with low adaptive capacity and other barriers to adaptation.
- Risks related to food security are greater in pathways with lower income, increased food demand, increased food prices resulting from e.g. competition for land, more limited trade.
- Urban expansion is projected to lead to conversion of cropland leading to losses in food production. This can result in additional risks to the food system.