Box: Information relevant to Article 2 of the UNFCCC

Article 2 states the objective of the Convention: « stabilisation of *greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system (...) within a time frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner»*. At their 16th Conference, in Cancun (2010), the Parties to the UNFCCC agreed that "*deep cuts in global greenhouse gas emissions are required… with a view to reducing global greenhouse gas emissions, so as to hold the increase in global average temperature below 2°C above pre- industrial levels*" (decision 1/CP.16). They also agreed to review this long-term global target on the basis of the best available scientific knowledge with a view to possibly strengthening the target to 1.5°C. Nonetheless, global GHG emissions continue to grow at an increasing rate (Topic 1).

While human influence on the climate system is clear, defining a level of risk as "dangerous" involves both risk assessment and value judgments. This report documents the magnitude of current and future projected climate change and provides a basis for judgment about the level of climate change at which risks become dangerous. This is done by assessing them across contexts and through time, including considerations of extreme vulnerability, potential for severe impacts in specific locations, and for low-probability events with high and irreversible consequences, and also by assessing approaches to valuing these risks. The determination of which level of anthropogenic interference is considered dangerous is not done here, as it would require value judgments (Topic 3.1). However, the assessment provide below may assist in the exercise of such value judgements on an informed basis.

Key vulnerabilities and risks related to ecosystems, food and water, development and other socioeconomic factors are integrated into five complementary and overarching Reasons for Concern (see Figure 3.4; all references to "RFC" below relate to this figure). Risks differ due to the nature of the climate change, vulnerability, and exposure op people, society, and ecosystems, which vary by location, setting, and degree of inequality and marginalization, particularly for the least developed countries and vulnerable communities, given their limited ability to cope. Risks from extreme weather and climate events (RFC 2) and low probability/high-impact events or from exceeding critical global thresholds (RFC 5) may affect the potential for "development to proceed in a sustainable manner" because they are associated with a wide range of impacts, including on infrastructures, services, food systems, and livelihoods.*{1.5, WGII SPM}*

Impacts from current changes in the climate system

- Some unique and threatened ecosystems are already affected, e.g., tropical coral reefs and Arctic systems, which are showing early warning signs of approaching critical thresholds due to climate change (RFC1,3).
- Climate change has already negatively affected wheat and maize yields for many regions and in the global aggregate. In many regions, water resources are already being altered in terms of quantity and quality by changing precipitation or melting snow and ice (Topic 1.4.2; RFC 3).

Risks for warming between about 1°C and 2°C above pre-industrial[19]

Risks increase as temperature and CO_2 concentrations increase, and become high for unique and threatened systems between about 1 and 2°C of warming as do risks associated with extreme events (Figure 3.4).

- Food insecurity linked to warming, drought, and precipitation variability is a key risk particularly in poorer regions (RFC 1, 2, 3, 4).Without adaptation, local temperature increases of 2°C or more above late-20th-century levels are projected to negatively impact yields for the major crops in tropical and temperate regions. Adaptation is potentially effective up to about 2°C, with greater benefits for crops in temperate than in tropical regions (RFC 3*).{WGII 7.5 WGII SPM B.2}*

[19]In this box, except specified otherwise, all global temperature increases are expressed relative to pre-industrial level (the average temperature over the period 1850-1900 can be used as approximations for this level). "Additional warming" refers to a temperature increase above late-20th-century levels.

- Many impacts are difficult to value and monetize; estimates of global annual economic losses for additional temperature increases of ~2°C are between 0.2 and 2.0% of income. Aggregate economic damages accelerate with increasing temperature, with large differences between and within countries(RFC 4*).{WGII 10.9, 13.2.2.1, 19.6}*
- Risks associated with large-scale singular events (e.g. possibility of a near-complete loss of the Greenland ice sheet over a millennium or more for sustained global mean warming above a threshold which is greater than about 1°C but less than about 4°C, causing global mean sea level rise of up to 7 m.*{WGI SPM}*) become moderate for a warming above ~1°C (RFC 5).

Scenarios reaching atmospheric concentration levels of about 450 ppm CO_2eq by 2100 require substantial cuts in anthropogenic GHG emissions by mid-century. Such scenarios are consistent with a *likely* chance to keep temperature increase below 2°C relative to pre-industrial levels (Topic 3.2).
Global surface temperature change for the end of the 21st century is *likely* to exceed 1.5°C relative to 1850 to 1900 for all RCP scenarios except RCP2.6, for which it is *likely* to remain below 2°C (Topic 2.4).Limiting the warming to less than 2°C above pre-industrial with a probability of 50% or >66% require cumulative CO_2 emissions since 1870 to stay below about 3000 and about 2900 $GtCO_2$, respectively, when accounting for non-CO_2forcings. An amount of 1890 $GtCO_2$ (1630-2150) was emitted by 2011. Meeting the 2°C goal with a >66% probability will require GHG emissions reductions of roughly 40% to 70% in 2050 relative to 2010 through fundamental changes in energy systems and potentially land use and agriculture, and emission levels near zero $GtCO_2$eq or below in 2100. *{WG I SPM, WGIII SPM}*

Reducing emissions so that it is *likely* that temperature change will remain below 2°C compared to preindustrial levels will entail its own set of risks. These include the potential for reductions in aggregate economic growth (between 0.04 to 0.14% per year over the century, not including benefits from reduced climate change) and larger economic impacts on specific countries and industries (Topic 3.4).Some mitigation efforts could undermine action to promote sustainable development and equity. Achieving a *likely* chance of remaining below 2°C will bring on these risks more rapidly than higher temperature goals. Delaying mitigation narrows the range of options consistent with maintaining temperature change below 2°C relative to pre-industrial levels, and therefore further increases mitigation costs in the medium to long term (Topic 3.2). All energy technologies – including bioenergy, nuclear power, carbon capture with storage, hydropower, and even wind power – are associated with both risks and possible co-benefits when deployed at large-scale (Topic 3.4).

Risks for warming between about 2°C and 4°C above pre-industrial

Risks increase with temperature and become high for all Reasons for Concern by 4°C warming above preindustrial levels (Figure 3.4).

- Many species and systems with limited adaptive capacity are subject to very high risks with additional warming of 2°C, particularly Arctic sea-ice and coral-reef systems (RFC 1).
- Many species will be unable to track suitable climates under mid- and high-range rates of change (RCP 4.5 and higher) and those that cannot adapt sufficiently fast will decrease in abundance or go extinct in part or all of their ranges. For medium- to high-emission scenarios (RCP 4.5 and higher), ocean acidification, together with decreasing oxygen levels and other drivers, poses substantial risks to marine ecosystems. A large fraction of terrestrial, freshwater, and marine species face increasing extinctions risk under projected climate change during and beyond the 21st century (RFC 1, 4*). {WGII SPM.B1}* Extensive biodiversity loss with associated loss of ecosystem goods and services results in aggregate risks becoming high by 4°C warming (RFC 1, 4)
- Climate change is projected to reduce renewable surface water and groundwater resources significantly in most dry subtropical regions (Topic 2.5.2).
- Aggregate economic damages accelerate with increasing temperature but few quantitative estimates have been completed for additional warming around 3°C or above (RFC 4).
- Risks from large-scale singular events increase disproportionately around ~2°C and become high above 3°C, due to the potential for a large and irreversible sea-level rise from ice sheet loss. *{RFC 5, WGII SPM B-1}*

Global surface temperature change for the end of the 21st century is *more likely than not* to exceed 2°C for RCP4.5, and *likely* to exceed 2°C for RCP6.0 and RCP8.5. It is *about as likely as not* to exceed 4°C for

RCP8.5. Such scenarios require slower emission cuts than the scenarios *likely* to avoid a warming above 2°C, but all scenarios that limit climate change require substantial and sustained reductions in greenhouse gas emissions (Topic 3.2). *{WGI SPM}*

Risks from warming above 4°C compared to pre-industrial

Above 4°C warming compared to preindustrial levels, as projected by RCP8.5, risks from climate change are high to very high in all reasons for concerns and include substantial species extinction, large risks to global and regional food security, and the combination of high temperature and humidity compromising normal human activities in some areas for parts of the year (Figure 3.4) All aspects of food security are potentially affected by climate change including food access, utilization, and price stability (RFC 3). *{WGII SPM B2}*

Interaction with sustainable development

Limiting the effects of climate change is necessary to achieve sustainable development and equity, including poverty eradication.
Throughout the 21st century, climate-change impacts, especially without additional mitigation, are projected to slow economic growth, make poverty reduction more difficult, and prolong existing and create new poverty traps, the latter particularly in urban areas and emerging hotspots of hunger. Climate-related hazards exacerbate other stressors, often with negative outcomes for livelihoods, especially for people living in poverty. *{WGII SPM B-2}* Climate change is projected to increase displacement of people, and can indirectly increase risks of violent conflicts by amplifying drivers of conflict such as poverty and economic shocks (Topic 2.5).

Societal responses, particularly adaptation, will influence outcomes over the next few decades.
Greater rates and magnitude of climate change increase the likelihood of exceeding adaptation limits and delaying mitigation actions may reduce options for climate-resilient pathways in the future (Topic 4.2).

International cooperation is required to effectively mitigate GHG emissions and address other climate change issues. *{WGIII SPM}* Because emissions by any agent (e.g., individual, community, company, country) affect other agents, the risk of climate change in the second half of the 21st century and beyond will be determined by the cumulative amount of near-term and longer-term mitigation, as well as development pathways and resulting adaptation (Topic 4.5).