

Annex I: Glossary

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Notes:

Note that subterms are in italics beneath main terms.

This glossary defines some specific terms as the Lead Authors intend them to be interpreted in the context of this report. Blue, italicised words indicate that the term is defined in the Glossary.

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1.5°C pathway See *Pathways*.

2030 Agenda for Sustainable Development A UN resolution in September 2015 adopting a plan of action for people, planet and prosperity in a new global development framework anchored in 17 *Sustainable Development Goals* (UN, 2015).

Acceptability of policy or system change The extent to which a policy or system change is evaluated unfavourably or favourably, or rejected or supported, by members of the general public (public acceptability) or politicians or governments (political acceptability). Acceptability may vary from totally unacceptable/fully rejected to totally acceptable/fully supported; individuals may differ in how acceptable policies or system changes are believed to be.

Acclimatisation A change in functional or morphological traits occurring once or repeatedly (e.g., seasonally) during the lifetime of an individual organism in its natural environment. Through acclimatisation the individual maintains performance across a range of environmental conditions. For a clear differentiation between findings in laboratory and field studies, the term acclimation is used in ecophysiology for the respective phenomena when observed in well-defined experimental settings. The term (adaptive) plasticity characterises the generally limited scope of changes in phenotype that an individual can reach through the process of acclimatisation.

Activity A practice or ensemble of practices that take place on a delineated area over a given period of time.

Activity data Data on the magnitude of a human *activity* resulting in emissions or removals taking place during a given period of time. In the *Agriculture, Forestry and Other Land Use (AFOLU)* sector, data on area of different *land uses*, management systems, animal numbers, lime and fertiliser use are examples of activity data.

Adaptability See *Adaptive capacity*.

Adaptation In *human systems*, the process of adjustment to actual or expected *climate* and its effects, in order to moderate harm or exploit beneficial opportunities. In natural systems, the process of adjustment to actual climate and its effects; human intervention may facilitate adjustment to expected climate and its effects.

Incremental adaptation

Adaptation that maintains the essence and integrity of a system or process at a given scale (Park et al., 2012).

Transformational adaptation

Adaptation that changes the fundamental attributes of a *social-ecological system* in anticipation of climate change and its impacts.

Adaptation limits

The point at which an actor's objectives (or system needs) cannot be secured from intolerable risks through adaptive actions.

- Hard adaptation limit: No adaptive actions are possible to avoid intolerable risks.
- Soft adaptation limit: Options are currently not available to avoid intolerable risks through adaptive action.

See also *Adaptation options*, *Adaptive capacity* and *Maladaptive actions (Maladaptation)*.

Adaptation behaviour See *Human behaviour*.

Adaptation limits See *Adaptation*.

Adaptation options The array of strategies and measures that are available and appropriate for addressing *adaptation*. They include a wide range of actions that can be categorised as structural, institutional, ecological or behavioural. See also *Adaptive capacity*, and *Maladaptive actions (Maladaptation)*.

Adaptation pathways See *Pathways*

Adaptive capacity The ability of systems, *institutions*, humans and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences (IPCC, 2014; MA, 2005). See also *Adaptation*, *Adaptation options*, and *Maladaptive actions (Maladaptation)*.

Adaptive governance See *Governance*.

Adverse side-effect The negative effects that a policy or measure aimed at one objective might have on other objectives, without yet evaluating the net effect on overall social welfare. Adverse side-effects are often subject to uncertainty and depend on, among others, local circumstances and implementation practices. See also *Co-benefits* and *Risk*.

Aerosol A suspension of airborne solid or liquid particles, with a typical size between a few nanometres and 10 µm that reside in the *atmosphere* for at least several hours. The term aerosol, which includes both the particles and the suspending gas, is often used in this report in its plural form to mean aerosol particles. Aerosols may be of either natural or *anthropogenic* origin. Aerosols may influence *climate* in several ways: through both interactions that scatter and/or absorb radiation and through interactions with cloud microphysics and other cloud properties, or upon deposition on snow or ice covered surfaces thereby altering their *albedo* and contributing to *climate feedback*. Atmospheric aerosols, whether natural or anthropogenic, originate from two different pathways: emissions of primary particulate matter (PM), and formation of secondary PM from gaseous *precursors*. The bulk of aerosols are of natural origin. Some scientists use group labels that refer to the chemical composition, namely: sea salt, organic carbon, *black carbon* (BC), mineral species (mainly desert dust), sulphate, nitrate, and ammonium. These labels are, however, imperfect as aerosols combine particles to create complex mixtures. See also *Short-lived climate forcers (SLCF)*.

Afforestation Conversion to *forest* of land that historically has not contained forests. [Note: For a discussion of the term forest and related terms such as afforestation, *reforestation* and *deforestation*, in the context of reporting and accounting Article 3.3 and 3.4 activities under the *Kyoto Protocol*, see 2013 Revised Supplementary Methods and Good Practice Guidance Arising from the Kyoto Protocol.] See also *Reforestation*, *Deforestation*, *Forest* and *Reducing Emissions from Deforestation and Forest Degradation (REDD+)*.

Agreement In this report, the degree of agreement within the scientific body of knowledge on a particular finding is assessed based on multiple lines of *evidence* (e.g., mechanistic understanding, theory, data, models, expert judgement) and expressed qualitatively (Mastrandrea et al., 2010). See also *Confidence*, *Likelihood*, and *Uncertainty*.

Agriculture, Forestry and Other Land Use (AFOLU) In the context of national *greenhouse gas (GHG)* inventories under the *United Nations Convention on Climate Change (UNFCCC)*, AFOLU is the sum of the GHG inventory sectors Agriculture and *Land Use, Land-Use Change and Forestry (LULUCF)*; see the 2006 IPCC Guidelines for National GHG Inventories for details. Given the difference in estimating the ‘anthropogenic’ *carbon dioxide (CO₂)* removals between countries and the global modelling community, the land-related net GHG emissions from global models included in this report are not necessarily directly comparable with LULUCF estimates in national GHG Inventories.

FOLU (Forestry and Other Land Use) – also referred to as LULUCF

The subset of AFOLU emissions and removals of greenhouse gases (GHGs) resulting from direct human-induced *land use, land-use change*, and forestry activities excluding agricultural emissions.

See also *Land-Use Change (LUC)* and *Land Use, Land-Use Change and Forestry (LULUCF)*.

Agrobiodiversity ‘The variety and variability of animals, plants and micro-organisms that are used directly or indirectly for food and agriculture, including crops, livestock, forestry and fisheries. It comprises the diversity of genetic resources (varieties, breeds) and species used for food, fodder, fibre, fuel and pharmaceuticals. It also includes the diversity of non-harvested species that support production (soil micro-organisms, predators, pollinators), and those in the wider environment that support agro-ecosystems (agricultural, pastoral, forest and aquatic) as well as the diversity of the agro-ecosystems’ (FAO, 2005).

Agroecology ‘The science and practice of applying ecological concepts, principles and knowledge (i.e., the interactions of, and explanations for, the diversity, abundance and activities of organisms) to the study, design and management of sustainable agroecosystems. It includes the roles of human beings as a central organism in agroecology by way of social and economic processes in farming systems. Agroecology examines the roles and interactions among all relevant biophysical, technical and socioeconomic components of farming systems and their surrounding landscapes’ (IPBES, 2019).

Agroforestry Collective name for land-use systems and technologies where woody perennials (trees, shrubs, palms, bamboos, etc.) are deliberately used on the same land-management units as agricultural crops and/or animals, in some form of spatial arrangement or temporal sequence. In agroforestry systems there are both ecological and economical interactions between the different components. Agroforestry can also be defined as a dynamic, ecologically based, natural resource management system that, through the integration of trees on farms and in the agricultural landscape, diversifies and sustains production for increased social, economic and environmental benefits for land users at all levels (FAO, 2015a).

Air pollution Degradation of air quality with negative effects on human health, the natural or built environment, due to the introduction by natural processes or human activity in the *atmosphere* of substances (gases, *aerosols*) which have a direct (primary pollutants) or indirect (secondary pollutants) harmful effect. See also *Short-lived climate forcers (SLCF)*.

Albedo The proportion of sunlight (solar radiation) reflected by a surface or object, often expressed as a percentage. Clouds, snow and ice usually have high albedo; soil surfaces cover the albedo range from high to low; vegetation in the dry season and/or in arid zones can have high albedo, whereas photosynthetically active vegetation and the ocean have low albedo. The Earth’s planetary albedo changes mainly through varying cloudiness, snow, ice, leaf area and land cover changes.

Ambient persuasive technology Technological systems and environments that are designed to change human cognitive processing, attitudes and behaviours without the need for the user’s conscious attention.

Anomaly The deviation of a variable from its value averaged over a *reference period*. See also *Reference period*.

Anthromes ‘*Human systems*, with natural *ecosystems* embedded within them’ (Ellis and Ramankutty 2008). The anthrome classification system is based on human population density and *land use*, and comprises the following classes: dense settlements, villages, croplands, rangeland, forested (then broadened to seminatural) and wildlands (Ellis et al. 2010).

Anthropocene A proposed new geological epoch resulting from significant human-driven changes to the structure and functioning of the Earth System, including the *climate system*. Originally proposed in the Earth System science community in 2000, the proposed new epoch is undergoing a formalisation process within the geological community based on the stratigraphic *evidence* that human activities have changed the Earth System to the extent of forming geological deposits with a signature that is distinct from those of the *Holocene*, and which will remain in the geological record. Both the stratigraphic and Earth System approaches to defining the Anthropocene consider the mid-20th century to be the most appropriate starting date, although others have been proposed and continue to be discussed. The Anthropocene concept has been taken up by a diversity of disciplines and the public to denote the substantive influence humans have had on the state, dynamics and future of the Earth System. See also *Holocene*.

Anthropogenic Resulting from or produced by human activities. See also *Anthropogenic emissions*, and *Anthropogenic removals*.

Anthropogenic emissions Emissions of *greenhouse gases (GHGs)*, *precursors* of GHGs and *aerosols* caused by human activities. These activities include the burning of *fossil fuels*, *deforestation*, *land use and land-use changes (LUC)*, livestock production, fertilisation, waste management, and industrial processes. See also *Anthropogenic*, and *Anthropogenic removals*.

Anthropogenic removals The withdrawal of *greenhouse gases (GHGs)* from the atmosphere as a result of deliberate human activities. These include enhancing biological sinks of CO₂ and using chemical engineering to achieve long term removal and storage. *Carbon capture and storage (CCS)* from industrial and energy-related sources, which alone does not remove CO₂ from the atmosphere, can help reduce atmospheric CO₂ if it is combined with *bioenergy production (BECCS)*. [Note: In the 2006 IPCC Guidelines for National GHG Inventories, which are used in reporting of emissions to the UNFCCC, ‘anthropogenic’ land-related GHG *fluxes* are defined as all

those occurring on '*managed land*', i.e. 'where human interventions and practices have been applied to perform production, ecological or social functions'. However, some removals (e.g. removals associated with CO₂ fertilisation and N deposition) are not considered as 'anthropogenic', or are referred to as 'indirect' anthropogenic effects, in some of the scientific literature assessed in this report. As a consequence, the land-related net GHG emission estimates from global models included in this report are not necessarily directly comparable with LULUCF estimates in national GHG Inventories. See also *Anthropogenic emissions*, *Bioenergy with carbon dioxide capture and storage (BECCS)*, *Carbon dioxide capture and storage (CCS)* and *Land use, Land-use change, and Forestry (LULUCF)*.

Aridity The state of a long-term climatic feature characterised by low average precipitation or available water in a region. Aridity generally arises from widespread persistent *atmospheric* subsidence or anticyclonic conditions, and from more localised subsidence in the lee side of mountains (adapted from Gbeckor-Kove, 1989; Türkeş, 1999).

Atmosphere The gaseous envelope surrounding the Earth, divided into five layers — the *troposphere* which contains half of the Earth's atmosphere, the *stratosphere*, the mesosphere, the thermosphere, and the exosphere, which is the outer limit of the atmosphere. The dry atmosphere consists almost entirely of nitrogen (78.1% volume mixing ratio) and oxygen (20.9% volume mixing ratio), together with a number of trace gases, such as argon (0.93 % volume mixing ratio), helium and radiatively active *greenhouse gases (GHGs)* such as *carbon dioxide (CO₂)* (0.04% volume mixing ratio) and *ozone (O₃)*. In addition, the atmosphere contains the GHG water vapour (H₂O), whose amounts are highly variable but typically around 1% volume mixing ratio. The atmosphere also contains clouds and aerosols. See also *Carbon dioxide (CO₂)*, *Ozone (O₃)*, *Troposphere*, *Stratosphere*, *Greenhouse gas (GHG)*, and *Hydrological cycle*.

Atmosphere-ocean general circulation model (AOGCM) See *Climate model*.

Atmospheric boundary layer The atmospheric layer adjacent to the Earth's surface that is affected by friction against that boundary surface, and possibly by transport of heat and other variables across that surface (AMS, 2000). The lowest 100 m of the boundary layer (about 10% of the boundary layer thickness), where mechanical generation of turbulence is dominant, is called the surface boundary layer or surface layer.

Attribution See *Detection and attribution*.

Baseline scenario In much of the literature the term is also synonymous with the term business-as-usual (BAU) *scenario*, although the term BAU has fallen out of favour because the idea of business as usual in century-long socio-economic *projections* is hard to fathom. In the context of *transformation pathways*, the term baseline scenarios refers to scenarios that are based on the assumption that no mitigation policies or measures will be implemented beyond those that are already in force and/or are legislated or planned to be adopted. Baseline scenarios are not intended to be predictions of the future, but rather counterfactual constructions that can serve to highlight the level of emissions that would occur without further policy effort. Typically, baseline scenarios are then compared to

mitigation scenarios that are constructed to meet different goals for *greenhouse gas (GHG)* emissions, atmospheric concentrations or temperature change. The term baseline scenario is often used interchangeably with reference scenario and no policy scenario. See also *Emission scenario*, and *Mitigation scenario*.

Biochar Relatively stable, carbon-rich material produced by heating *biomass* in an oxygen-limited environment. Biochar is distinguished from charcoal by its application: biochar is used as a soil amendment with the intention to improve soil functions and to reduce *greenhouse gas (GHG)* emissions from biomass that would otherwise decompose rapidly (IBI, 2018).

Biodiversity Biodiversity or biological diversity means the variability among living organisms from all sources including, among other things, terrestrial, marine and other aquatic *ecosystems* and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems (UN, 1992). See also *Ecosystem*, and *Ecosystem service*.

Bioenergy Energy derived from any form of biomass or its metabolic by-products. See also *Biomass* and *Biofuel*.

Bioenergy with carbon dioxide capture and storage (BECCS) *Carbon dioxide capture and storage (CCS)* technology applied to a *bioenergy* facility. Note that depending on the total emissions of the BECCS supply chain, *carbon dioxide (CO₂)* can be removed from the *atmosphere*. See also *Bioenergy*, and *Carbon dioxide capture and storage (CCS)*.

Biofuel A fuel, generally in liquid form, produced from *biomass*. Biofuels include bioethanol from sugarcane, sugar beet or maize, and biodiesel from canola or soybeans. See also *Biomass*, and *Bioenergy*.

Biogeochemical effects Processes through which land affects *climate*, excluding *biophysical effects*. These processes include changes in net emissions of *carbon dioxide (CO₂)* towards the *atmosphere*, net emissions of *aerosols* (mineral and organic), ozone deposition on *ecosystems*, and net emissions of biogenic volatile organic compounds (BVOCs) and their subsequent changes in atmospheric chemistry. See also *Biophysical effects*.

Biomass Organic material excluding the material that is fossilised or embedded in geological formations. Biomass may refer to the mass of organic matter in a specific area (ISO, 2014). See also *Bioenergy*, and *Biofuel*.

Traditional biomass

The combustion of wood, charcoal, agricultural residues and/or animal dung for cooking or heating in open fires or in inefficient stoves as is common in low-income countries.

Biome 'Global-scale zones, generally defined by the type of plant life that they support in response to average rainfall and temperature patterns. For example, tundra, coral reefs or savannas' (IPBES, 2019).

Biophysical effects The range of physical processes through which *land* affects *climate*. These processes include changes in hydrology (e.g. water vapor fluxes at the land/atmosphere interface), heat exchanges via convective *fluxes* (latent and sensible), radiation (solar and infra-red, absorbed and emitted), and momentum (e.g. affecting wind speed).

Black carbon (BC) A relatively pure form of carbon, also known as soot, arising from the incomplete combustion of *fossil fuels*, *biofuel*, and *biomass*. It stays in the *atmosphere* only for days or weeks. Black carbon is a climate forcing agent with strong warming effect, both in the atmosphere and when deposited on snow or ice. See also *Atmosphere*, and *Aerosol*.

Blue carbon All biologically-driven carbon *fluxes* and storage in marine systems that are amenable to management can be considered as blue carbon. Coastal blue carbon focuses on rooted vegetation in the coastal zone, such as tidal marshes, mangroves and seagrasses. These *ecosystems* have high carbon burial rates on a per unit area basis and accumulate carbon in their soils and sediments. They provide many non-climatic benefits and can contribute to ecosystem-based adaptation. If degraded or lost, coastal blue carbon ecosystems are likely to release most of their carbon back to the *atmosphere*. There is current debate regarding the application of the blue carbon concept to other coastal and non-coastal processes and ecosystems, including the open ocean. See also *Ecosystem services*, and *Carbon sequestration*.

Business as usual (BAU) See *Baseline scenario*.

Carbon budget Refers to three concepts in the literature: (1) an assessment of *carbon cycle sources* and *sinks* on a global level, through the synthesis of *evidence* for *fossil-fuel* and cement emissions, *land-use change* emissions, ocean and land CO₂ sinks, and the resulting atmospheric *carbon dioxide (CO₂)* growth rate. This is referred to as the global carbon budget; (2) the estimated cumulative amount of global carbon dioxide emissions that that is estimated to limit global surface temperature to a given level above a *reference period*, taking into account global surface temperature contributions of other *greenhouse gases* (GHGs) and climate forcers; (3) the distribution of the carbon budget defined under (2) to the regional, national, or sub-national level based on considerations of *equity*, costs or efficiency. See also *Remaining carbon budget*.

Carbon cycle The flow of carbon (in various forms, e.g., as *carbon dioxide (CO₂)*, carbon in *biomass*, and carbon dissolved in the ocean as carbonate and bicarbonate) through the *atmosphere*, hydrosphere, terrestrial and marine biosphere and lithosphere. In this report, the reference unit for the global carbon cycle is GtCO₂ or GtC (one Gigatonne = 1 Gt = 10¹⁵ grams; 1GtC corresponds to 3.667 GtCO₂).

Carbon dioxide (CO₂) A naturally occurring gas, CO₂ is also a by-product of burning *fossil fuels* (such as oil, gas and coal), of burning *biomass*, of *land-use changes (LUC)* and of industrial processes (e.g., cement production). It is the principal *anthropogenic* greenhouse gas (GHG) that affects the Earth's radiative balance. It is the reference gas against which other GHGs are measured and therefore has a Global Warming Potential (GWP) of 1. See also *Greenhouse gas (GHG)*, *Land use*, and *Land-use change*.

Carbon dioxide capture and storage (CCS) A process in which a relatively pure stream of *carbon dioxide (CO₂)* from industrial and energy-related sources is separated (captured), conditioned, compressed and transported to a storage location for long-term isolation from the atmosphere. Sometimes referred to as Carbon Capture and Storage. See also *Carbon dioxide capture and utilisation*

(*CCU*), *Bioenergy with carbon dioxide capture and storage (BECCS)*, and *Sequestration*.

Carbon dioxide capture and utilisation (CCU) A process in which *carbon dioxide (CO₂)* is captured and then used to produce a new product. If the CO₂ is stored in a product for a *climate*-relevant time horizon, this is referred to as carbon dioxide capture, utilisation and storage (CCUS). Only then, and only combined with CO₂ recently removed from the *atmosphere*, can CCUS lead to carbon dioxide removal. CCU is sometimes referred to as Carbon dioxide capture and use. See also *Carbon dioxide capture and storage (CCS)*.

Carbon dioxide capture, utilisation and storage (CCUS) See *Carbon dioxide capture and utilisation (CCU)*.

Carbon dioxide removal (CDR) *Anthropogenic* activities removing *carbon dioxide (CO₂)* from the *atmosphere* and durably storing it in geological, terrestrial, or ocean reservoirs, or in products. It includes existing and potential anthropogenic enhancement of biological or geochemical sinks and direct air capture and storage, but excludes natural CO₂ *uptake* not directly caused by human activities. See also *Mitigation (of climate change)*, *Greenhouse gas removal (GGR)*, *Negative emission technologies*, and *Sink*.

Carbon intensity The amount of emissions of *carbon dioxide (CO₂)* released per unit of another variable such as *gross domestic product (GDP)*, output energy use or transport.

Carbon price The price for avoided or released *carbon dioxide (CO₂)* or *CO₂-equivalent emissions*. This may refer to the rate of a carbon tax, or the price of emission permits. In many models that are used to assess the economic costs of *mitigation*, carbon prices are used as a proxy to represent the level of effort in mitigation policies. See also *Mitigation*.

Carbon sequestration The process of storing carbon in a carbon *pool*. See also *Blue carbon*, *Carbon dioxide capture and storage (CCS)*, *Uptake*, and *Sink*.

Carbon sink See *Sink*.

Carbon stock The quantity of carbon in a carbon *pool*. See also *Pool*, *carbon and nitrogen*.

Citizen science A voluntary participation of the public in the collection and/or processing of data as part of a scientific study (Silvertown, 2009).

Clean Development Mechanism (CDM) A mechanism defined under Article 12 of the *Kyoto Protocol* through which investors (governments or companies) from developed (Annex B) countries may finance *greenhouse gas (GHG)* emission reduction or removal projects in developing countries (Non-Annex B), and receive Certified Emission Reduction Units (CERs) for doing so. The CERs can be credited towards the commitments of the respective developed countries. The CDM is intended to facilitate the two objectives of promoting *sustainable development (SD)* in developing countries and of helping *industrialised countries* to reach their emissions commitments in a cost-effective way.

Climate Climate in a narrow sense is usually defined as the average weather, or more rigorously, as the statistical description in terms of the mean and variability of relevant quantities over a period

of time ranging from months to thousands or millions of years. The classical period for averaging these variables is 30 years, as defined by the World Meteorological Organization. The relevant quantities are most often surface variables such as temperature, precipitation and wind. Climate in a wider sense is the state, including a statistical description, of the *climate system*.

Climate change A change in the state of the *climate* that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external *forcings* such as modulations of the solar cycles, volcanic eruptions and persistent *anthropogenic* changes in the composition of the *atmosphere* or in *land use*. Note that the *United Nations Framework Convention on Climate Change (UNFCCC)*, in its Article 1, defines climate change as: ‘a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods’. The UNFCCC thus makes a distinction between climate change attributable to human activities altering the atmospheric composition and climate variability attributable to natural causes. See also *Climate variability*, *Global warming*, *Ocean acidification*, and *Detection and attribution*.

Climate extreme (extreme weather or climate event) The occurrence of a value of a weather or *climate* variable above (or below) a threshold value near the upper (or lower) ends of the range of observed values of the variable. For simplicity, both extreme weather events and extreme climate events are referred to collectively as ‘climate extremes.’ See also *Extreme weather event*.

Climate feedback An interaction in which a perturbation in one *climate* quantity causes a change in a second and the change in the second quantity ultimately leads to an additional change in the first. A negative feedback is one in which the initial perturbation is weakened by the changes it causes; a positive feedback is one in which the initial perturbation is enhanced. The initial perturbation can either be externally forced or arise as part of internal variability.

Climate governance See *Governance*.

Climate model A numerical representation of the *climate system* based on the physical, chemical and biological properties of its components, their interactions and *feedback* processes and accounting for some of its known properties. The climate system can be represented by models of varying complexity; that is, for any one component or combination of components a spectrum or hierarchy of models can be identified, differing in such aspects as the number of spatial dimensions, the extent to which physical, chemical or biological processes are explicitly represented, or the level at which empirical parametrizations are involved. There is an evolution towards more complex models with interactive chemistry and biology. *Climate models* are applied as a research tool to study and simulate the *climate* and for operational purposes, including monthly, seasonal and interannual climate predictions. See also *Earth system model (ESM)*.

Climate projection Simulated response of the *climate system* to a *scenario* of future emissions or concentrations of *greenhouse*

gases (GHGs) and *aerosols*, and changes in land use, generally derived using *climate models*. Climate projections are distinguished from climate predictions by their dependence on the emission/concentration/*radiative forcing* scenario used, which is in turn based on assumptions concerning, for example, future socioeconomic and technological developments that may or may not be realised.

Climate-resilient development pathways (CRDPs) Trajectories that strengthen *sustainable development* and efforts to eradicate *poverty* and reduce inequalities while promoting *fair* and cross-scalar *adaptation* to and *resilience* in a changing *climate*. They raise the *ethics*, *equity*, and *feasibility* aspects of the deep *societal transformation* needed to drastically reduce emissions to limit *global warming* (e.g., to 2°C) and achieve desirable and liveable futures and *well-being* for all.

Climate-resilient pathways Iterative processes for managing change within complex systems in order to reduce disruptions and enhance opportunities associated with *climate change*. See also *Climate-resilient development pathways (CRDPs)*, *Development pathways*, *Pathways*, and *Transformation pathways*.

Climate sensitivity The change in the annual *global mean surface temperature* in response to a change in the atmospheric *carbon dioxide (CO₂)* concentration or other radiative forcing.

Equilibrium climate sensitivity

An estimate of the *global mean surface temperature* response to a doubling of the atmospheric *carbon dioxide (CO₂)* concentration that is evaluated from model output or observations for evolving non-equilibrium conditions. It is a measure of the strengths of the *climate feedbacks* at a particular time and may vary with *forcing* history and *climate* state, and therefore may differ from *equilibrium climate sensitivity*.

Transient climate response

The change in the *global mean surface temperature*, averaged over a 20-year period, centred at the time of atmospheric *carbon dioxide (CO₂)* doubling, in a *climate model* simulation in which CO₂ increases at 1% yr⁻¹ from *pre-industrial*. It is a measure of the strength of *climate feedbacks* and the timescale of ocean heat uptake.

See also *Climate model*, and *Global mean surface temperature (GMST)*.

Climate services Information and products that enhance users’ knowledge and understanding about the *impacts* of *climate change* and/or *climate variability* so as to aid decision-making of individuals and organisations and enable preparedness and early climate change action. Such services involve high-quality data from national and international databases on temperature, rainfall, wind, soil moisture and ocean conditions, as well as maps, *risk* and *vulnerability* analyses, assessments, and long-term *projections* and *scenarios*. Depending on the user’s needs, these data and information products may be combined with non-meteorological data, such as agricultural production, health trends, population distributions in high-risk areas, road and infrastructure maps for the delivery of goods, and other socio-economic variables (WMO, 2019).

Climate-smart agriculture (CSA) An approach to agriculture that aims to transform and reorient agricultural systems to effectively support development and ensure *food security* in a changing climate

by: sustainably increasing agricultural productivity and incomes; adapting and building resilience to climate change; and reducing and/or removing *greenhouse gas* emissions, where possible (FAO, 2018).

Climate system The system consisting of five major components: the *atmosphere*, the hydrosphere, the cryosphere, the lithosphere and the biosphere and the interactions between them. The climate system evolves in time under the influence of its own internal dynamics and because of external *forcings* such as volcanic eruptions, solar variations, orbital forcing, and *anthropogenic* forcings such as the changing composition of the atmosphere and *land-use change*.

Climate target A temperature limit, concentration level, or emissions reduction goal used towards the aim of avoiding dangerous *anthropogenic* interference with the *climate system*. For example, national climate targets may aim to reduce *greenhouse gas* emissions by a certain amount over a given time horizon, for example those under the *Kyoto Protocol*.

Climate variability Variations in the mean state and other statistics (such as standard deviations, the occurrence of extremes, etc.) of the *climate* on all spatial and temporal scales beyond that of individual weather events. Variability may be due to natural internal processes within the *climate system* (internal variability), or to variations in natural or *anthropogenic* external *forcing* (external variability). See also *Climate change*.

CO₂ equivalent (CO₂-eq) emission The amount of *carbon dioxide (CO₂)* emission that would cause the same integrated *radiative forcing* or temperature change, over a given time horizon, as an emitted amount of a *greenhouse gas (GHG)* or a mixture of GHGs. There are a number of ways to compute such equivalent emissions and choose appropriate time horizons. Most typically, the CO₂-equivalent emission is obtained by multiplying the emission of a GHG by its Global Warming Potential (GWP) for a 100 year time horizon. For a mix of GHGs it is obtained by summing the CO₂-equivalent emissions of each gas. CO₂-equivalent emission is a common scale for comparing emissions of different GHGs but does not imply equivalence of the corresponding climate change responses. There is generally no connection between CO₂-equivalent emissions and resulting CO₂-equivalent concentrations.

CO₂ fertilisation The enhancement of plant growth as a result of increased atmospheric *carbon dioxide (CO₂)* concentration. The magnitude of CO₂ fertilisation depends on nutrients and water availability.

Co-benefits The positive effects that a policy or measure aimed at one objective might have on other objectives, thereby increasing the total benefits for society or the environment. Co-benefits are often subject to uncertainty and depend on local circumstances and implementation practices, among other factors. Co-benefits are also referred to as ancillary benefits. See also *Adverse side-effects*, and *Risk*.

Collective action A number of people working together voluntarily to achieve some common objective (Meinzen-Dick and Di Gregorio, 2004).

Conference of the Parties (COP) The supreme body of UN conventions, such as the *United Nations Framework Convention on*

Climate Change (UNFCCC), comprising parties with a right to vote that have ratified or acceded to the convention. See also *United Nations Convention to Combat Desertification (UNCCD)*.

Confidence The robustness of a finding based on the type, amount, quality and consistency of *evidence* (e.g., mechanistic understanding, theory, data, models, expert judgment) and on the degree of *agreement* across multiple lines of evidence. In this report, confidence is expressed qualitatively (Mastrandrea et al., 2010). See also *Likelihood*, and *Uncertainty*.

Convection Vertical motion driven by buoyancy forces arising from static instability, usually caused by near-surface cooling or increases in salinity in the case of the ocean and near-surface warming or cloud-top radiative cooling in the case of the *atmosphere*. In the atmosphere, convection gives rise to cumulus clouds and precipitation and is effective at both scavenging and vertically transporting chemical species. In the ocean, convection can carry surface waters to deep within the ocean.

Coping capacity The ability of people, *institutions*, organisations, and systems, using available skills, values, beliefs, resources, and opportunities, to address, manage, and overcome adverse conditions in the short to medium term. (UNISDR, 2009; IPCC, 2012a). See also *Resilience*.

Cost-benefit analysis Monetary assessment of all negative and positive impacts associated with a given action. Cost-benefit analysis enables comparison of different interventions, investments or strategies and reveal how a given investment or policy effort pays off for a particular person, company or country. Cost-benefit analyses representing society's point of view are important for *climate change* decision making, but there are difficulties in aggregating costs and benefits across different actors and across timescales. See also *Discounting*.

Cost-effectiveness A measure of the cost at which a policy goal or outcome is achieved. The lower the cost the greater the cost effectiveness.

Coupled Model Intercomparison Project (CMIP) A climate modelling activity from the World Climate Research Programme (WCRP) which coordinates and archives *climate model* simulations based on shared model inputs by modelling groups from around the world. The CMIP3 multi-model data set includes *projections* using SRES scenarios. The CMIP5 data set includes projections using the *Representative Concentration Pathways (RCPs)*. The CMIP6 phase involves a suite of common model experiments as well as an ensemble of CMIP-endorsed model intercomparison projects (MIPs).

Cumulative emissions The total amount of emissions released over a specified period of time. See also *Carbon budget*.

Decarbonisation Process by which countries, individuals or other entities aim to achieve zero fossil carbon existence. Typically refers to a reduction of the carbon emissions associated with electricity, industry and transport.

Decoupling Decoupling (in relation to *climate change*) is where economic growth is no longer strongly associated with consumption of *fossil fuels*. Relative decoupling is where both grow but at different

rates. Absolute decoupling is where economic growth happens but fossil fuels decline.

Deforestation Conversion of *forest* to non-forest. [Note: For a discussion of the term forest and related terms such as *afforestation*, *reforestation* and *deforestation* in the context of reporting and accounting Article 3.3 and 3.4 activities under the Kyoto Protocol, see 2013 Revised Supplementary Methods and Good Practice Guidance Arising from the Kyoto Protocol.] See also *Reducing Emissions from Deforestation and Forest Degradation (REDD+)*.

Deliberative governance See *Governance*.

Demand and supply-side measures

Demand-side measures

Policies and programmes for influencing the demand for goods and/or services. In the energy sector, demand-side management aims at reducing the demand for electricity and other forms of energy required to deliver energy services.

Supply-side measures

Policies and programmes for influencing how a certain demand for goods and/or services is met. In the energy sector, for example, supply-side mitigation measures aim at reducing the amount of greenhouse gas (GHG) emissions emitted per unit of energy produced.

See also *Mitigation measures*.

Demand-side measures See *Demand and supply-side measures*.

Desertification *Land degradation* in arid, semi-arid, and dry sub-humid areas resulting from many factors, including climatic variations and human activities (UNCCD, 1994).

Detection See *Detection and attribution*.

Detection and attribution Detection of change is defined as the process of demonstrating that climate or a system affected by climate has changed in some defined statistical sense, without providing a reason for that change. An identified change is detected in observations if its *likelihood* of occurrence by chance due to internal variability alone is determined to be small, for example, <10%. Attribution is defined as the process of evaluating the relative contributions of multiple causal factors to a change or event with a formal assessment of *confidence*.

Development pathways See *Pathways*.

Diet 'The kinds of food that follow a particular pattern that a person or community eats' (FAO, 2014). See also *Dietary patterns*.

Dietary patterns The quantities, proportions, variety or combinations of different foods and beverages in diets, and the frequency with which they are habitually consumed (Dietary Guidelines Advisory Committee, 2015). See also *Diet*.

Dietary and nutrition transitions Modernisation, urbanisation, economic development, and increased wealth lead to predictable shifts in diet, referred to as 'nutrition transitions' (Misra and Khurana, 2008; Popkin, 2006). Over historical time there have been a number of dietary *transitions* but in recent decades the prime transition has been associated with changes from subsistence towards eating diets rich in calories and relatively poor in nutrition (the 'westernised diet') that are obesogenic. From a public health

perspective, a new dietary transition is in focus, from the obesogenic diet to one promoting health.

Disaster A 'serious disruption of the functioning of a community or a society at any scale due to hazardous events interacting with conditions of exposure, vulnerability and capacity, leading to one or more of the following: human, material, economic and environmental losses and impacts' (UNISDR, 2017). See also *Exposure*, *Risk*, *Vulnerability* and *Hazard*.

Disaster risk management (DRM) Processes for designing, implementing, and evaluating strategies, policies, and measures to improve the understanding of current and future *disaster* risk, foster disaster risk reduction and transfer, and promote continuous improvement in disaster preparedness, prevention and protection, response, and recovery practices, with the explicit purpose of increasing human security, *well-being*, quality of life, and *sustainable development* (UNISDR, 2017).

Discounting A mathematical operation that aims to make monetary (or other) amounts received or expended at different times (years) comparable across time. The discounter uses a fixed or possibly time-varying discount rate from year to year that makes future value worth less today (if the discount rate is positive). The choice of discount rate(s) is debated as it is a judgement based on hidden and/or explicit values.

Discount rate See *Discounting*.

(Internal) Displacement The forced movement of people within the country they live in. Internally displaced persons (IDPs) are 'Persons or groups of persons who have been forced or obliged to flee or to leave their homes or places of habitual residence, in particular as a result of or in order to avoid the effects of armed conflict, situations of generalized violence, violations of human rights or natural or human-made *disasters*, and who have not crossed an internationally recognized State border' (UN, 1998). See also *Migration*.

Displacement In land system science, displacement denotes the increasing spatial separation between the location of agricultural and forestry production and the place of consumption of these products, as it occurs with trade. Displacement disconnects spatially environmental impacts from their socioeconomic drivers.

Downscaling Method that derives local- to regional-scale (up to 100 km) information from larger-scale models or data analyses. Two main methods exist: dynamical downscaling and empirical/statistical downscaling. The dynamical method uses the output of regional *climate models*, global models with variable spatial resolution, or high-resolution global models. The empirical/statistical methods [are based on observations and] develop statistical relationships that link the large-scale atmospheric variables with local/ regional climate variables. In all cases, the quality of the driving model remains an important limitation on quality of the downscaled information. The two methods can be combined, e.g., applying empirical/statistical downscaling to the output of a regional climate model, consisting of a dynamical downscaling of a global climate model.

Drainage 'Artificial lowering of the soil water table' (IPCC, 2013). See also *Rewetting*.

Drought A period of abnormally dry weather long enough to cause a serious hydrological imbalance. Drought is a relative term, therefore any discussion in terms of precipitation deficit must refer to the particular precipitation-related activity that is under discussion. For example, shortage of precipitation during the growing season impinges on crop production or *ecosystem* function in general (due to *soil moisture* drought, also termed agricultural drought), and during the *runoff* and percolation season primarily affects water supplies (hydrological drought). Storage changes in soil moisture and groundwater are also affected by increases in actual *evapotranspiration* in addition to reductions in precipitation. A period with an abnormal precipitation deficit is defined as a meteorological drought.

Megadrought

A very lengthy and pervasive drought, lasting much longer than normal, usually a decade or more.

Early warning systems (EWS) The set of technical, financial and *institutional capacities* needed to generate and disseminate timely and meaningful warning information to enable individuals, communities and organisations threatened by a *hazard* to prepare to act promptly and appropriately to reduce the possibility of harm or loss. Dependent upon context, EWS may draw upon scientific and/or *Indigenous knowledge*. EWS are also considered for ecological applications e.g., conservation, where the organisation itself is not threatened by hazard but the *ecosystem* under conservation is (an example is coral bleaching alerts), in agriculture (for example, warnings of ground frost, hailstorms) and in fisheries (storm and tsunami warnings) (UNISDR, 2009; IPCC, 2012a).

Earth system feedbacks See *Climate feedback*.

Earth system model (ESM) A coupled atmosphere–ocean general circulation model in which a representation of the *carbon cycle* is included, allowing for interactive calculation of atmospheric *carbon dioxide (CO₂)* or compatible emissions. Additional components (e.g., atmospheric chemistry, *ice sheets*, dynamic vegetation, nitrogen cycle, but also urban or crop models) may be included. See also *Climate model*.

Ecological cascade A series of secondary extinctions as a result of the extinction of a key species within an *ecosystem* (Soulé, 2010).

Ecosystem A functional unit consisting of living organisms, their non-living environment and the interactions within and between them. The components included in a given ecosystem and its spatial boundaries depend on the purpose for which the ecosystem is defined: in some cases they are relatively sharp, while in others they are diffuse. Ecosystem boundaries can change over time. Ecosystems are nested within other ecosystems and their scale can range from very small to the entire biosphere. In the current era, most ecosystems either contain people as key organisms, or are influenced by the effects of human activities in their environment. See also *Ecosystem services*.

Ecosystem services Ecological processes or functions having monetary or non-monetary value to individuals or society at large. These are frequently classified as (1) supporting services such as productivity or *biodiversity* maintenance, (2) provisioning services such as food or fibre, (3) regulating services such as climate regulation

or *carbon sequestration*, and (4) cultural services such as tourism or spiritual and aesthetic appreciation. See also *Ecosystem*.

Effective climate sensitivity See *Climate sensitivity*.

Effective radiative forcing See *Radiative forcing*.

El Niño-Southern Oscillation (ENSO) The term El Niño was initially used to describe a warm-water current that periodically flows along the coast of Ecuador and Peru, disrupting the local fishery. It has since become identified with warming of the tropical Pacific Ocean east of the dateline. This oceanic event is associated with a fluctuation of a global-scale tropical and subtropical surface pressure pattern called the Southern Oscillation. This coupled atmosphere–ocean phenomenon, with preferred time scales of two to about seven years, is known as the El Niño-Southern Oscillation (ENSO). It is often measured by the surface pressure anomaly difference between Tahiti and Darwin and/or the *sea surface temperatures* in the central and eastern equatorial Pacific. During an ENSO event, the prevailing trade winds weaken, reducing upwelling and altering ocean currents such that the sea surface temperatures warm, further weakening the trade winds. This phenomenon has a great impact on the wind, sea surface temperature and precipitation patterns in the tropical Pacific. It has climatic effects throughout the Pacific region and in many other parts of the world, through global *teleconnections*. The cold phase of ENSO is called La Niña.

Embodied (embedded) [emissions, water, land] The total emissions [water use, *land use*] generated [used] in the production of goods and services regardless of the location and timing of those emissions [water use, *land use*] in the production process. This includes emissions [water use, *land use*] within the country used to produce goods or services for the country's own use, but also includes the emissions [water use, *land use*] related to the production of such goods or services in other countries that are then consumed in another country through imports. Such emissions [water, *land*] are termed 'embodied' or 'embedded' emissions, or in some cases (particularly with water) as 'virtual water use' (David and Caldeira, 2010; Allan, 2005; MacDonald et al., 2015).

Emission scenario A plausible representation of the future development of emissions of substances that are radiatively active (e.g., *greenhouse gases (GHGs)*, *aerosols*) based on a coherent and internally consistent set of assumptions about driving forces (such as demographic and socio-economic development, technological change, energy and *land use*) and their key relationships. Concentration *scenarios*, derived from emission scenarios, are often used as input to a *climate model* to compute *climate projections*. See also *Baseline scenario*, *Mitigation scenario*, *Representative Concentration Pathways (RCPs)* (under *Pathways*), *Shared socio-economic pathways (SSPs)* (under *Pathways*), *Scenario*, *Socio-economic scenario*, and *Transformation pathway*.

Emission trajectories A *projected* development in time of the emission of a *greenhouse gas (GHG)* or group of GHGs, *aerosols*, and GHG *precursors*. See also *Pathways*.

Energy access Access to clean, reliable and affordable energy services for cooking and heating, lighting, communications, and productive uses (with special reference to *Sustainable Development Goal 7*) (AGECC, 2010). See also *Traditional biomass*.

Enabling conditions (for adaptation and mitigation options) Conditions that affect the *feasibility* of *adaptation* and *mitigation* options, and can accelerate and scale-up systemic transitions that would limit temperature increase and enhance capacities of systems and societies to adapt to the associated *climate change*, while achieving *sustainable development*, eradicating *poverty* and reducing *inequalities*. Enabling conditions include finance, technological innovation, strengthening policy instruments, *institutional capacity*, *multi-level governance*, and changes in *human behaviour* and lifestyles. They also include inclusive processes, attention to power asymmetries and unequal opportunities for development and reconsideration of values.

Energy efficiency The ratio of output or useful energy or energy services or other useful physical outputs obtained from a system, conversion process, transmission or storage activity to the input of energy (measured as kWh kWh⁻¹, tonnes kWh⁻¹ or any other physical measure of useful output like tonne-km transported). Energy efficiency is often described by energy intensity. In economics, energy intensity describes the ratio of economic output to energy input. Most commonly energy efficiency is measured as input energy over a physical or economic unit, i.e. kWh USD⁻¹ (energy intensity), kWh tonne⁻¹. For buildings, it is often measured as kWh m⁻², and for vehicles as km liter⁻¹ or liter km⁻¹. Very often in policy 'energy efficiency' is intended as the measures to reduce energy demand through technological options such as insulating buildings, more efficient appliances, efficient lighting, efficient vehicles, etc.

Energy security The goal of a given country, or the global community as a whole, to maintain an adequate, stable and predictable energy supply. Measures encompass safeguarding the sufficiency of energy resources to meet national energy demand at competitive and stable prices and the resilience of the energy supply; enabling development and deployment of technologies; building sufficient infrastructure to generate, store and transmit energy supplies and ensuring enforceable contracts of delivery.

Enhanced weathering Enhancing the removal of *carbon dioxide (CO₂)* from the *atmosphere* through dissolution of silicate and carbonate rocks by grinding these minerals to small particles and actively applying them to soils, coasts or oceans.

(Model) Ensemble A group of parallel model simulations characterising historical climate conditions, *climate* predictions, or *climate projections*. Variation of the results across the ensemble members may give an estimate of modelling-based *uncertainty*. Ensembles made with the same model but different initial conditions only characterise the uncertainty associated with internal *climate variability*, whereas multi-model ensembles including simulations by several models also include the impact of model differences. Perturbed parameter ensembles, in which model parameters are varied in a systematic manner, aim to assess the uncertainty resulting from internal model specifications within a single model. Remaining sources of uncertainty unaddressed with model ensembles are related to systematic model errors or biases, which may be assessed from systematic comparisons of model simulations with observations wherever available. See also *Climate projection*.

Equality A principle that ascribes equal worth to all human beings, including equal opportunities, rights, and obligations, irrespective of origins.

Inequality

Uneven opportunities and social positions, and processes of discrimination within a group or society, based on gender, class, ethnicity, age, and (dis)ability, often produced by uneven development. Income inequality refers to gaps between highest and lowest income earners within a country and between countries. See also *Equity and Fairness*.

Equilibrium climate sensitivity See *Climate sensitivity*.

Equity The principle of being fair and impartial, and a basis for understanding how the *impacts* and responses to *climate change*, including costs and benefits, are distributed in and by society in more or less equal ways. It is often aligned with ideas of *equality*, fairness and justice and applied with respect to *equity* in the responsibility for, and distribution of, climate impacts and policies across society, generations, and gender, and in the sense of who participates and controls the processes of decision making.

Distributive equity

Equity in the consequences, outcomes, costs and benefits of actions or policies. In the case of *climate change* or climate policies for different people, places and countries, including equity aspects of sharing burdens and benefits for *mitigation* and *adaptation*.

Gender equity

Equity between women and men with regard to their rights, resources and opportunities. In the case of *climate change*, gender equity recognises that women are often more vulnerable to the *impacts* of climate change and may be disadvantaged in the process and outcomes of climate policy.

Inter-generational equity

Equity between generations. In the context of *climate change*, inter-generational equity acknowledges that the effects of past and present emissions, *vulnerabilities* and policies impose costs and benefits for people in the future and of different age groups.

Procedural equity

Equity in the process of decision making including recognition and inclusiveness in participation, equal representation, bargaining power, voice and equitable access to knowledge and resources to participate.

See also *Equality and Fairness*.

Evaporation The physical process by which a liquid (e.g., water) becomes a gas (e.g., water vapour).

Evapotranspiration The combined processes through which water is transferred to the atmosphere from open water and ice surfaces, bare soil, and vegetation that make up the Earth's surface.

Potential Evapotranspiration

The potential rate of water loss without any limits imposed by the water supply. See also *Evaporation*.

Evidence Data and information used in the scientific process to establish findings. In this report, the degree of evidence reflects the amount, quality, and consistency of scientific/technical information

on which the Lead Authors base their findings. See also *Agreement*, *Confidence*, *Likelihood*, and *Uncertainty*.

Exposure The presence of people; *livelihoods*; species or *ecosystems*; environmental functions, services, and resources; infrastructure; or economic, social, or cultural assets in places and settings that could be adversely affected. See also *Hazard*, *Risk*, and *Vulnerability*.

Extratropical Cyclone Any cyclonic-scale storm that is not a *tropical cyclone*. Usually refers to a middle- or high-latitude migratory storm system formed in regions of large horizontal temperature variations. Sometimes called extratropical storm or extratropical low. See also *Tropical cyclone*.

Extreme weather or climate event See *Climate extreme (extreme weather or climate event)*.

Extreme weather event An event that is rare at a particular place and time of year. Definitions of 'rare' vary, but an extreme weather event would normally be as rare as or rarer than the 10th or 90th percentile of a probability density function estimated from observations. By definition, the characteristics of what is called extreme weather may vary from place to place in an absolute sense. When a pattern of extreme weather persists for some time, such as a season, it may be classed as an extreme climate event, especially if it yields an average or total that is itself extreme (e.g., *drought* or heavy rainfall over a season). See also *Heat wave*, and *Climate extreme (extreme weather or climate event)*.

Fairness Impartial and just treatment without favouritism or discrimination in which each person is considered of equal worth with equal opportunity. See also *Equity*, and *Equality*.

Feasibility The degree to which climate goals and response options are considered possible and/or desirable. Feasibility depends on geophysical, ecological, technological, economic, social and *institutional* conditions for change. Conditions underpinning feasibility are dynamic, spatially variable, and may vary between different groups. See also *Enabling conditions*.

Feedback See *Climate feedback*.

Flexible governance See *Governance*.

Flood The overflowing of the normal confines of a stream or other body of water, or the accumulation of water over areas that are not normally submerged. Floods include river (fluvial) floods, flash floods, urban floods, rain (pluvial) floods, sewer floods, coastal floods, and glacial lake outburst floods.

Flux A movement (a flow) of matter (e.g., water vapor, particles), heat or energy from one place to another, or from one medium (e.g., land surface) to another (e.g., atmosphere).

Food loss and waste 'The decrease in quantity or quality of food'. Food waste is part of food loss and refers to discarding or alternative (non-food) use of food that is safe and nutritious for human consumption along the entire food supply chain, from primary production to end household consumer level. Food waste is recognised as a distinct part of food loss because the drivers that generate it and the solutions to it are different from those of food losses (FAO, 2015b).

Food security A situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life (FAO, 2001). [Note: Whilst the term 'food security' explicitly includes nutrition within its 'dietary needs ... for an active and healthy life', in the past the term has sometimes privileged the supply of calories (energy), especially to the hungry. Thus, the term 'food and nutrition security' is often used (with the same definition as food security) to emphasise that the term food covers both energy and nutrition (FAO, 2009).]

Food system All the elements (environment, people, inputs, processes, infrastructures, institutions, etc.) and activities that relate to the production, processing, distribution, preparation and consumption of food, and the output of these activities, including socio-economic and environmental outcomes (HLPE, 2017). [Note: Whilst there is a global food system (encompassing the totality of global production and consumption), each location's food system is unique, being defined by that place's mix of food produced locally, nationally, regionally or globally.]

Forcing See *Radiative forcing*.

Forest A vegetation type dominated by trees. Many definitions of the term forest are in use throughout the world, reflecting wide differences in biogeophysical conditions, social structure and economics. [Note: For a discussion of the term forest in the context of National GHG inventories, see the 2006 IPCC Guidelines for National GHG Inventories and information provided by the United Nations Framework Convention on Climate Change (UNFCCC, 2019).] See also *Afforestation*, *Deforestation*, and *Reforestation*.

Fossil fuels Carbon-based fuels from fossil hydrocarbon deposits, including coal, oil, and natural gas.

Framework Convention on Climate Change See *United Nations Framework Convention on Climate Change (UNFCCC)*.

Gender equity See *Equity*.

Glacier A perennial mass of ice, and possibly firn and snow, originating on the *land* surface by the recrystallisation of snow and showing evidence of past or present flow. A glacier typically gains mass by accumulation of snow, and loses mass by melting and ice discharge into the sea or a lake if the glacier terminates in a body of water. Land ice masses of continental size (>50 000 km²) are referred to as *ice sheets*.

Global climate model (also referred to as general circulation model, both abbreviated as GCM) See *Climate model*.

Global mean surface temperature (GMST) Estimated global average of near-surface air temperatures over land and sea-ice, and *sea surface temperatures* over ice-free ocean regions, with changes normally expressed as departures from a value over a specified *reference period*. When estimating changes in GMST, near-surface air temperature over both land and oceans are also used. See also *Global mean surface air temperature (GSAT)*, *Land surface air temperature*, and *Sea surface temperature (SST)*.

Global mean surface air temperature (GSAT) Global average of near-surface air temperatures over land and oceans. Changes in GSAT are often used as a measure of global temperature change in *climate models* but are not observed directly. See also *Global mean surface temperature (GMST)*, and *Land surface air temperature*.

Global warming An increase in *global mean surface temperature (GMST) averaged* over a 30-year period, or the 30-year period centred on a particular year or decade, expressed relative to *pre-industrial* levels unless otherwise specified. For 30-year periods that span past and future years, the current multi-decadal warming trend is assumed to continue. See also *Climate change*, and *Climate variability*.

Governance A comprehensive and inclusive concept of the full range of means for deciding, managing, implementing and monitoring policies and measures. Whereas government is defined strictly in terms of the nation-state, the more inclusive concept of governance recognises the contributions of various levels of government (global, international, regional, sub-national and local) and the contributing roles of the private sector, of nongovernmental actors, and of civil society to addressing the many types of issues facing the global community, and the local context where the effectiveness of policies and measures are determined.

Adaptive governance

An emerging term in the literature for the evolution of formal and informal institutions of governance that prioritise planning, implementation and evaluation of policy through iterative *social learning*; in the context of *climate change*, governance facilitating social learning to steer the use and protection of natural resources, and *ecosystem services*, particularly in situations of complexity and uncertainty.

Climate governance

Purposeful mechanisms and measures aimed at steering social systems towards preventing, mitigating, or adapting to the risks posed by climate change (Jagers and Striiple, 2003).

Deliberative governance

Involves decision making through inclusive public conversation which allows opportunity for developing policy options through public discussion rather than collating individual preferences through voting or referenda (although the latter governance mechanisms can also be proceeded and legitimated by public deliberation processes).

Flexible governance

Strategies of governance at various levels, which prioritise the use of *social learning* and rapid feedback mechanisms in planning and policy making, often through incremental, experimental and iterative management processes.

Governance capacity

The ability of governance *institutions*, leaders, and non-state and civil society to plan, co-ordinate, fund, implement, evaluate and adjust policies and measures over the short, medium and long term, adjusting for *uncertainty*, rapid change and wide ranging impacts and multiple actors and demands.

Multi-level governance

Negotiated, non-hierarchical exchanges between institutions at the transnational, national, regional and local levels.

Participatory governance

A governance system that enables direct public engagement in decision-making using a variety of techniques for example, referenda, community deliberation, citizen juries or participatory budgeting. The approach can be applied in formal and informal institutional contexts from national to local, but is usually associated with devolved decision making (Fung and Wright, 2003; Sarmiento and Tilly, 2018).

Governance capacity See *Governance*.

Grazing land The sum of rangelands and *pastures* not considered as cropland, and subject to livestock grazing or hay production. It includes a wide range of *ecosystems*, e.g. systems with vegetation that fall below the threshold used in the *forest* land category, silvo-pastoral systems, as well as natural, managed grasslands and semideserts.

Green infrastructure The interconnected set of natural and constructed ecological systems, green spaces and other landscape features. It includes planted and indigenous trees, wetlands, parks, green open spaces and original grassland and woodlands, as well as possible building and street level design interventions that incorporate vegetation. Green infrastructure provides services and functions in the same way as conventional infrastructure (Culwick and Bobbins, 2016).

Greenhouse gas (GHG) Gaseous constituents of the *atmosphere*, both natural and *anthropogenic*, that absorb and emit radiation at specific wavelengths within the spectrum of terrestrial radiation emitted by the Earth's surface, the atmosphere itself, and by clouds. This property causes the greenhouse effect. Water vapour (H₂O), *carbon dioxide* (CO₂), *nitrous oxide* (N₂O), *methane* (CH₄) and *ozone* (O₃) are the primary GHGs in the Earth's atmosphere. Moreover, there are a number of entirely human-made GHGs in the atmosphere, such as the *halocarbons* and other chlorine- and bromine-containing substances, dealt with under the Montreal Protocol. Beside CO₂, N₂O and CH₄, the *Kyoto Protocol* deals with the GHGs sulphur hexafluoride (SF₆), hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs).

Greenhouse gas removal (GGR) Withdrawal of a *greenhouse gas (GHG)* and/or a *precursor* from the *atmosphere* by a sink. See also *Carbon dioxide removal (CDR)*, and *Negative emissions*.

Gross domestic product (GDP) The sum of gross value added, at purchasers' prices, by all resident and non-resident producers in the economy, plus any taxes and minus any subsidies not included in the value of the products in a country or a geographic region for a given period, normally one year. GDP is calculated without deducting for depreciation of fabricated assets or depletion and degradation of natural resources.

Halocarbons A collective term for the group of partially halogenated organic species, which includes the chlorofluorocarbons (CFCs), hydrochlorofluorocarbons (HCFCs), hydrofluorocarbons (HFCs), halons, methyl chloride and methyl bromide. Many of the halocarbons have large Global Warming Potentials. The chlorine and bromine-containing halocarbons are also involved in the depletion of the ozone layer.

Hazard The potential occurrence of a natural or human-induced physical event or trend that may cause loss of life, injury, or other

health impacts, as well as damage and loss to property, infrastructure, *livelihoods*, service provision, *ecosystems* and environmental resources. See also *Disaster*, *Exposure*, *Risk*, and *Vulnerability*.

Heatwave A period of abnormally hot weather. Heatwaves and warm spells have various and in some cases overlapping definitions. See also *Extreme weather event*.

Holocene The current interglacial geological epoch, the second of two epochs within the Quaternary period, the preceding being the Pleistocene. The International Commission on Stratigraphy defines the start of the Holocene at 11,700 years before 2000 (ICS, 2019). See also *Anthropocene*.

Human behaviour The way in which a person acts in response to a particular situation or stimulus. Human actions are relevant at different levels, from international, national, and *sub-national actors*, to NGO, firm-level actors, and communities, households, and individual actions.

Adaptation behaviour

Human actions that directly or indirectly affect the risks of climate change *impacts*.

Mitigation behaviour

Human actions that directly or indirectly influence *mitigation*.

Human behavioural change A transformation or modification of human actions. Behaviour change efforts can be planned in ways that mitigate *climate change* and/or reduce negative consequences of climate change *impacts*.

Human rights Rights that are inherent to all human beings, universal, inalienable, and indivisible, typically expressed and guaranteed by law. They include the right to life, economic, social, and cultural rights, and the right to development and self-determination (based upon the definition by the UN Office of the High Commissioner for Human Rights).

Procedural rights

Rights to a legal procedure to enforce substantive rights.

Substantive rights

Basic human rights, including the right to the substance of being human such as life itself, liberty and happiness.

Human security A condition that is met when the vital core of human lives is protected, and when people have the freedom and capacity to live with dignity. In the context of *climate change*, the vital core of human lives includes the universal and culturally specific, material and non-material elements necessary for people to act on behalf of their interests and to live with dignity.

Human system Any system in which human organisations and *institutions* play a major role. Often, but not always, the term is synonymous with society or social system. Systems such as agricultural systems, urban systems, political systems, technological systems, and economic systems are all human systems in the sense applied in this report.

Hydrological cycle The cycle in which water evaporates from the oceans and the land surface, is carried over the Earth in atmospheric circulation as water vapour, condenses to form clouds, precipitates as rain or snow, which on land can be intercepted by trees and

vegetation, potentially accumulating as snow or ice, provides *runoff* on the land surface, infiltrates into soils, recharges groundwater, discharges into streams, and ultimately, flows out into the oceans as rivers, polar *glaciers* and *ice sheets*, from which it will eventually evaporate again. The various systems involved in the hydrological cycle are usually referred to as hydrological systems.

Ice sheet An ice body originating on land that covers an area of continental size, generally defined as covering >50,000 km². An ice sheet flows outward from a high central ice plateau with a small average surface slope. The margins usually slope more steeply, and most ice is discharged through fast flowing ice streams or outlet *glaciers*, often into the sea or into ice shelves floating on the sea. There are only two ice sheets in the modern world, one on Greenland and one on Antarctica. The latter is divided into the East Antarctic Ice Sheet (EAIS), the West Antarctic Ice Sheet (WAIS) and the Antarctic Peninsula ice sheet. During glacial periods there were other ice sheets. See also *Glacier*.

Impacts (consequences, outcomes) The consequences of realised risks on natural and *human systems*, where risks result from the interactions of climate-related *hazards* (including *extreme weather and climate events*), *exposure*, and *vulnerability*. Impacts generally refer to effects on lives, *livelihoods*, health and *well-being*, *ecosystems* and species, economic, social and cultural assets, services (including *ecosystem services*), and infrastructure. Impacts may be referred to as consequences or outcomes, and can be adverse or beneficial. See also *Adaptation*, *Exposure*, *Hazard*, *Loss and Damage*, and *losses and damages*, and *Vulnerability*.

(climate change) Impact assessment The practice of identifying and evaluating, in monetary and/or non-monetary terms, the effects of climate change on natural and human systems.

Incremental adaptation See *Adaptation*.

Indigenous knowledge The understandings, skills and philosophies developed by societies with long histories of interaction with their natural surroundings. For many Indigenous peoples, Indigenous knowledge informs decision-making about fundamental aspects of life, from day-to-day activities to longer term actions. This knowledge is integral to cultural complexes, which also encompass language, systems of classification, resource use practices, social interactions, values, ritual and spirituality. These distinctive ways of knowing are important facets of the world's cultural diversity. (UNESCO, 2018). See also *Local knowledge*.

Indirect land-use change See *Land-use change*.

Industrial revolution A period of rapid industrial growth with far-reaching social and economic consequences, beginning in Britain during the second half of the 18th century and spreading to Europe and later to other countries including the United States. The invention of the steam engine was an important trigger of this development. The industrial revolution marks the beginning of a strong increase in the use of *fossil fuels*, initially coal, and hence emission of *carbon dioxide (CO₂)*. See also *Pre-industrial*.

Industrialised/developed/developing countries There are a diversity of approaches for categorising countries on the basis of their level of economic development, and for defining terms such

as industrialised, developed, or developing. Several categorisations are used in this report. (1) In the United Nations system, there is no established convention for designating of developed and developing countries or areas. (2) The United Nations Statistics Division specifies developed and developing regions based on common practice. In addition, specific countries are designated as Least Developed Countries (LDC), landlocked developing countries, *small island developing states (SIDS)*, and transition economies. Many countries appear in more than one of these categories. (3) The World Bank uses income as the main criterion for classifying countries as low, lower middle, upper middle, and high income. (4) The United Nations Development Programme (UNDP) aggregates indicators for life expectancy, educational attainment, and income into a single composite Human Development Index (HDI) to classify countries as low, medium, high, or very high human development.

Inequality See *Equity*.

Institution Rules, norms and conventions held in common by social actors that guide, constrain and shape human interaction. Institutions can be formal, such as laws and policies, or informal, such as norms and conventions. Organisations - such as parliaments, regulatory agencies, private firms, and community bodies - develop and act in response to institutional frameworks and the incentives they frame. Institutions can guide, constrain and shape human interaction through direct control, through incentives, and through processes of socialisation. See also *Institutional capacity*.

Institutional capacity Building and strengthening individual organisations and providing technical and management training to support integrated planning and decision-making processes between organisations and people, as well as empowerment, social capital, and an enabling environment, including the culture, values and power relations (Willems and Baumert, 2003).

Integrated assessment A method of analysis that combines results and models from the physical, biological, economic and social sciences and the interactions among these components in a consistent framework to evaluate the status and the consequences of environmental change and the policy responses to it. See also *Integrated assessment model (IAM)*.

Integrated assessment model (IAM) Models that integrate knowledge from two or more domains into a single framework. They are one of the main tools for undertaking *integrated assessments*. One class of IAM used in respect of climate change *mitigation* may include representations of: multiple sectors of the economy, such as energy, *land use* and *land use change*; interactions between sectors; the economy as a whole; associated *greenhouse gas (GHG)* emissions and *sinks*; and reduced representations of the *climate system*. This class of model is used to assess linkages between economic, social and technological development and the evolution of the climate system. Another class of IAM additionally includes representations of the costs associated with climate change *impacts*, but includes less detailed representations of economic systems. These can be used to assess impacts and mitigation in a *cost-benefit* framework and have been used to estimate the *social cost of carbon*.

Integrated response options In this report, integrated response options are those options that simultaneously address

more than one *land challenge*. These can be categorised into options that rely on a) *land management*, b) value chain management, and c) *risk management*. Integrated response options are not mutually exclusive. See also *Land challenge*.

Integrated water resources management (IWRM) A process which promotes the coordinated development and management of water, land and related resources in order to maximise economic and social welfare in an equitable manner without compromising the sustainability of vital *ecosystems*.

Inter-generational equity See *Equity*.

Internal variability See *Climate variability*.

Irreversibility A perturbed state of a dynamical system is defined as irreversible on a given timescale if the recovery timescale from this state due to natural processes is substantially longer than the time it takes for the system to reach this perturbed state. See also *Tipping point*.

Kyoto Protocol The Kyoto Protocol to the *United Nations Framework Convention on Climate Change (UNFCCC)* is an international treaty adopted in December 1997 in Kyoto, Japan, at the Third Session of the *Conference of the Parties (COP3)* to the UNFCCC. It contains legally binding commitments, in addition to those included in the UNFCCC. Countries included in Annex B of the Protocol (mostly OECD countries and countries with economies in transition) agreed to reduce their anthropogenic *greenhouse gas (GHG) emissions (carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulphur hexafluoride (SF₆))* by at least 5% below 1990 levels in the first commitment period (2008–2012). The Kyoto Protocol entered into force on 16 February 2005 and as of May 2018 had 192 Parties (191 States and the European Union). A second commitment period was agreed in December 2012 at COP18, known as the Doha Amendment to the Kyoto Protocol, in which a new set of Parties committed to reduce GHG emissions by at least 18% below 1990 levels in the period from 2013 to 2020. However, as of May 2018, the Doha Amendment had not received sufficient ratifications to enter into force. See also *Paris Agreement*.

Land The terrestrial portion of the biosphere that comprises the natural resources (soil, near surface air, vegetation and other biota, and water), the ecological processes, topography, and human settlements and infrastructure that operate within that system (FAO, 2007; UNCCD, 1994).

Land challenges In this report, land challenges refers to land-based *mitigation* and *adaptation, desertification, land degradation* and *food security*.

Land cover The biophysical coverage of *land* (e.g., bare soil, rocks, forests, buildings and roads or lakes). Land cover is often categorised in broad land-cover classes (e.g., deciduous forest, coniferous forest, mixed forest, grassland, bare ground). [Note: In some literature assessed in this report, land cover and *land use* are used interchangeably, but the two represent distinct classification systems. For example, the land cover class woodland can be under various land uses such as livestock grazing, recreation, conservation, or wood harvest.] See also *Land cover change*, and *Land-use change*.

Land cover change Change from one *land cover* class to another, due to change in land use or change in natural conditions (Pongratz et al., 2018). See also *Land-use change*, and *Land management change*.

Land degradation A negative trend in land condition, caused by direct or indirect human-induced processes including *anthropogenic* climate change, expressed as long-term reduction or loss of at least one of the following: biological productivity, ecological integrity or value to humans. [Note: This definition applies to *forest* and non-forest land. Changes in land condition resulting solely from natural processes (such as volcanic eruptions) are not considered to be land degradation. Reduction of biological productivity or ecological integrity or value to humans *can* constitute degradation, but any one of these changes need not necessarily be considered degradation.]

Land degradation neutrality A state whereby the amount and quality of land resources necessary to support *ecosystem* functions and services and enhance *food security* remain stable or increase within specified temporal and spatial scales and ecosystems (UNCCD, 2019).

Land management Sum of *land-use* practices (e.g., sowing, fertilizing, weeding, harvesting, thinning, clear-cutting) that take place within broader land-use categories. (Pongratz et al., 2018)

Land management change

A change in land management that occurs within a *land-use* category. See also *Land-use change*.

Land potential The inherent, long-term potential of the *land* to sustainably generate *ecosystem services*, which reflects the capacity and resilience of the land-based natural capital, in the face of ongoing environmental change (UNEP, 2016).

Land rehabilitation Direct or indirect actions undertaken with the aim of reinstating a level of *ecosystem* functionality, where the goal is provision of goods and services rather than ecological restoration (McDonald, et al., 2016).

Land restoration The process of assisting the recovery of *land* from a degraded state (McDonald et al., 2016; IPBES, 2018).

Land surface air temperature (LSAT) The near-surface air temperature over land, typically measured at 1.25–2 m above the ground using standard meteorological equipment.

Land use The total of arrangements, activities and inputs applied to a parcel of land. The term land use is also used in the sense of the social and economic purposes for which land is managed (e.g., grazing, timber extraction, conservation and city dwelling). In national GHG inventories, land use is classified according to the IPCC land use categories of *forest* land, cropland, grassland, *wetlands*, settlements, other lands (see the 2006 IPCC Guidelines for National GHG Inventories for details). See also *Land-use change* and *Land management*.

Land-use change (LUC) The change from one *land use* category to another. [Note: In some of the scientific literature assessed in this report, land-use change encompasses changes in land-use categories as well as changes in *land management*.]

Indirect land-use change (iLUC)

Land use change outside the area of focus, that occurs as a consequence of change in use or management of land within the area of focus, such as through market or policy drivers. For example, if agricultural land is diverted to *biofuel* production, *forest* clearance may occur elsewhere to replace the former agricultural production. See also *Afforestation, Agriculture, Forestry and Other Land Use (AFOLU), Deforestation, Land use, land-use change and forestry (LULUCF), Reforestation, the IPCC Special Report on Land Use, Land-Use Change, and Forestry (IPCC, 2000)*, and the *2006 IPCC Guidelines for National GHG Inventories (IPCC, 2006)*.

Land use, land-use change and forestry (LULUCF) In the context of national *greenhouse gas (GHG)* inventories under the *United Nations Framework Convention on Climate Change (UNFCCC, 2019)*, LULUCF is a GHG inventory sector that covers anthropogenic emissions and removals of GHG in managed lands, excluding non-CO₂ agricultural emissions. Following the 2006 IPCC Guidelines for National GHG Inventories, ‘anthropogenic’ land-related GHG fluxes are defined as all those occurring on ‘managed land’, i.e., ‘where human interventions and practices have been applied to perform production, ecological or social functions’. Since managed land may include *carbon dioxide (CO₂)* removals not considered as ‘anthropogenic’ in some of the scientific literature assessed in this report (e.g., removals associated with CO₂ fertilisation and N deposition), the land-related net GHG emission estimates from global models included in this report are not necessarily directly comparable with LULUCF estimates in National GHG Inventories. See also *Land-use change (LUC)*.

Latent heat flux The turbulent flux of heat from the Earth’s surface to the atmosphere that is associated with *evaporation* or condensation of water vapour at the surface; a component of the surface energy budget. See also *Atmosphere*, and *Flux*.

Leakage The effects of policies that result in a displacement of the environmental impact, thereby counteracting the intended effects of the initial policies.

Lifecycle assessment (LCA) Compilation and evaluation of the inputs, outputs and the potential environmental impacts of a product or service throughout its life cycle (ISO, 2018).

Likelihood The chance of a specific outcome occurring, where this might be estimated probabilistically. Likelihood is expressed in this report using a standard terminology (Mastrandrea et al., 2010). See also *Agreement, Evidence, Confidence, and Uncertainty*.

Livelihood The resources used and the activities undertaken in order to live. Livelihoods are usually determined by the entitlements and assets to which people have access. Such assets can be categorised as human, social, natural, physical, or financial.

Local knowledge The understandings and skills developed by individuals and populations, specific to the places where they live. Local knowledge informs decision-making about fundamental aspects of life, from day-to-day activities to longer term actions. This knowledge is a key element of the social and cultural systems which influence observations of, and responses to *climate change*; it also informs *governance* decisions (UNESCO, 2018). See also *Indigenous knowledge*.

Lock-in A situation in which the future development of a system, including infrastructure, technologies, investments, *institutions*, and behavioural norms, is determined or constrained ('locked in') by historic developments.

Long-lived climate forcers (LLCF) A set of well-mixed greenhouse gases with long atmospheric lifetimes. This set of compounds includes *carbon dioxide (CO₂)* and *nitrous oxide (N₂O)*, together with some fluorinated gases. They have a warming effect on climate. These compounds accumulate in the atmosphere at decadal to centennial timescales, and their effect on *climate* hence persists for decades to centuries after their emission. On timescales of decades to a century already emitted emissions of long-lived climate forcers can only be abated by *greenhouse gas removal (GGR)*. See also *Short-lived climate forcers (SLCF)*.

Loss and Damage, and losses and damages Research has taken Loss and Damage (capitalised letters) to refer to political debate under the *United Nations Framework Convention on Climate Change (UNFCCC)* following the establishment of the Warsaw Mechanism on Loss and Damage in 2013, which is to 'address loss and damage associated with impacts of climate change, including extreme events and slow onset events, in developing countries that are particularly vulnerable to the adverse effects of climate change.' Lowercase letters (losses and damages) have been taken to refer broadly to harm from (observed) *impacts* and (projected) *risks* (Mechler et al., 2018).

Maladaptive actions (Maladaptation) Actions that may lead to increased *risk* of adverse climate-related outcomes, including via increased *greenhouse gas (GHG)* emissions, increased *vulnerability* to *climate change*, or diminished welfare, now or in the future. Maladaptation is usually an unintended consequence.

Malnutrition Deficiencies, excesses, or imbalances in a person's intake of energy and/or nutrients. The term malnutrition addresses three broad groups of conditions: undernutrition, which includes wasting (low weight-for-height), stunting (low height-for-age) and underweight (low weight-for-age); micronutrient-related malnutrition, which includes micronutrient deficiencies (a lack of important vitamins and minerals) or micronutrient excess; and overweight, obesity and diet-related noncommunicable diseases (such as heart disease, stroke, diabetes and some cancers) (WHO, 2018). Micronutrient deficiencies are sometimes termed 'hidden hunger' to emphasise that people can be malnourished in the sense of deficient without being deficient in calories. Hidden hunger can apply even where people are obese.

Managed forest *Forests* subject to human interventions (notably silvicultural management such as planting, pruning, thinning), timber and fuelwood harvest, protection (fire suppression, insect suppression) and management for amenity values or conservation, with defined geographical boundaries (Ogle et al., 2018). [Note: For a discussion of the term 'forest' in the context of National GHG inventories, see the 2006 IPCC Guidelines for National GHG Inventories.] See also *Managed land*.

Managed grassland Grasslands on which human interventions are carried out, such as grazing domestic livestock or hay removal.

Managed land In the context of national *greenhouse gas (GHG)* inventories under the *United Nations Framework Convention on Climate Change (UNFCCC)*, the 2006 IPCC Guidelines for National GHG Inventories (IPCC, 2006) defines managed land 'where human interventions and practices have been applied to perform production, ecological or social functions'. The IPCC (2006) defines *anthropogenic* GHG emissions and removals in the LULUCF sector as all those occurring on 'managed land'. The key rationale for this approach is that the preponderance of anthropogenic effects occurs on managed lands. [Note: More details can be found in 2006 IPCC Guidelines for National GHG Inventories, Volume 4, Chapter 1.]

Market failure When private decisions are based on market prices that do not reflect the real scarcity of goods and services but rather reflect market distortions, they do not generate an efficient allocation of resources but cause welfare losses. A market distortion is any event in which a market reaches a market clearing price that is substantially different from the price that a market would achieve while operating under conditions of perfect competition and state enforcement of legal contracts and the ownership of private property. Examples of factors causing market prices to deviate from real economic scarcity are environmental externalities, public goods, monopoly power, information asymmetry, transaction costs, and non-rational behaviour.

Measurement, reporting and verification (MRV)

Measurement

'The process of data collection over time, providing basic datasets, including associated accuracy and precision, for the range of relevant variables. Possible data sources are field measurements, field observations, detection through remote sensing and interviews' (UN REDD, 2009).

Reporting

'The process of formal reporting of assessment results to the UNFCCC, according to predetermined formats and according to established standards, especially the Intergovernmental Panel on Climate Change (IPCC) Guidelines and GPG (Good Practice Guidance)' (UN REDD, 2009).

Verification

'The process of formal verification of reports, for example, the established approach to verify national communications and national inventory reports to the UNFCCC' (UN REDD, 2009).

Megadrought See *Drought*.

Methane (CH₄) One of the six *greenhouse gases (GHGs)* to be mitigated under the *Kyoto Protocol*. Methane is the major component of natural gas and associated with all hydrocarbon fuels. Significant *anthropogenic* emissions also occur as a result of animal husbandry and paddy rice production. Methane is also produced naturally where organic matter decays under anaerobic conditions, such as in *wetlands*.

Migrant See *Migration*.

Migration 'The movement of a person or a group of persons, either across an international border, or within a State. It is a population movement, encompassing any kind of movement of people, whatever its length, composition and causes; it includes migration of refugees,

displaced persons, economic migrants, and persons moving for other purposes, including family reunification' (IOM, 2018).

Migrant

'Any person who is moving or has moved across an international border or within a State away from his/her habitual place of residence, regardless of (1) the person's legal status; (2) whether the movement is voluntary or involuntary; (3) what the causes for the movement are; or (4) what the length of the stay is' (IOM, 2018).

See also *(Internal) Displacement*.

Millennium Development Goals (MDGs) A set of eight time-bound and measurable goals for combating *poverty*, hunger, disease, illiteracy, discrimination against women and environmental degradation. These goals were agreed at the UN Millennium Summit in 2000 together with an action plan to reach the goals by 2015.

Mitigation (of climate change) A human intervention to reduce emissions or enhance the *sinks* of *greenhouse gases*.

Mitigation behaviour See *Human behaviour*.

Mitigation measures In climate policy, *mitigation* measures are technologies, processes or practices that contribute to mitigation, for example renewable energy technologies, waste minimisation processes, public transport commuting practices.

Mitigation option A technology or practice that reduces *greenhouse gas (GHG)* emissions or enhances sinks.

Mitigation pathways See *Pathways*.

Mitigation scenario A plausible description of the future that describes how the (studied) system responds to the implementation of *mitigation* policies and measures. See also *Emission scenario*, *Pathways*, *Socio-economic scenarios*, and *Stabilisation (of GHG or CO₂-equivalent concentration)*.

Monitoring and evaluation (M&E) Mechanisms put in place at national to local scales to respectively monitor and evaluate efforts to reduce *greenhouse gas* emissions and/or adapt to the impacts of *climate change* with the aim of systematically identifying, characterising and assessing progress over time.

Motivation (of an individual) An individual's reason or reasons for acting in a particular way; individuals may consider various consequences of actions, including financial, social, affective, and environmental consequences. Motivation can arise from factors external or internal to the individual.

Multi-level governance See *Governance*.

Narratives (in the context of scenarios) Qualitative descriptions of plausible future world evolutions, describing the characteristics, general logic and developments underlying a particular quantitative set of *scenarios*. Narratives are also referred to in the literature as 'storylines'. See also *Scenario*, *Scenario storyline*, and *Pathways*.

Nationally Determined Contributions (NDCs) A term used under the *United Nations Framework Convention on Climate Change (UNFCCC)* whereby a country that has joined the *Paris Agreement* outlines its plans for reducing its emissions. Some countries NDCs

also address how they will adapt to climate change impacts, and what support they need from, or will provide to, other countries to adopt low-carbon pathways and to build climate resilience. According to Article 4 paragraph 2 of the *Paris Agreement*, each Party shall prepare, communicate and maintain successive NDCs that it intends to achieve. In the lead up to the 21st *Conference of the Parties* in Paris in 2015, countries submitted Intended Nationally Determined Contributions (INDCs). As countries join the Paris Agreement, unless they decide otherwise, this INDC becomes their first Nationally Determined Contribution (NDC).

Negative emissions Removal of *greenhouse gases (GHGs)* from the *atmosphere* by deliberate human activities, i.e., in addition to the removal that would occur via natural *carbon cycle* processes. See also *Net negative emissions*, *Net-zero emissions*, *Carbon dioxide removal (CDR)*, and *Greenhouse gas removal (GGR)*.

Negative emissions technologies An activity or mechanism that results in *negative emissions*.

Net negative emissions A situation of net negative emissions is achieved when, as result of human activities, more *greenhouse gases (GHG)* are removed from the *atmosphere* than are emitted into it. Where multiple greenhouse gases are involved, the quantification of *negative emissions* depends on the climate metric chosen to compare emissions of different gases (such as global warming potential, global temperature change potential, and others, as well as the chosen time horizon). See also *Negative emissions*, *Net-zero emissions* and *Net-zero CO₂ emissions*.

Net-zero CO₂ emissions Conditions in which any remaining *anthropogenic* carbon dioxide (CO₂) emissions are balanced by anthropogenic CO₂ removals over a specified period. See also *Net-zero emissions*, and *Net negative emissions*.

Net-zero emissions Net-zero emissions are achieved when emissions of *greenhouse gases (GHGs)* to the *atmosphere* are balanced by *anthropogenic removals*. Where multiple greenhouse gases are involved, the quantification of net-zero emissions depends on the climate metric chosen to compare emissions of different gases (such as global warming potential, global temperature change potential, and others, as well as the chosen time horizon). See also *Net-zero CO₂ emissions*, *Negative emissions*, and *Net negative emissions*.

Nitrous oxide (N₂O) One of the six *greenhouse gases (GHGs)* to be mitigated under the *Kyoto Protocol*. The main anthropogenic source of N₂O is agriculture (soil and animal manure management), but important contributions also come from sewage treatment, *fossil fuel* combustion, and chemical industrial processes. N₂O is also produced naturally from a wide variety of biological sources in soil and water, particularly microbial action in wet tropical *forests*.

Non-overshoot pathways See *Pathways*.

Nutrition transition A predictable change in *dietary patterns* associated with a country's economic development whereby 'problems of under- and overnutrition often coexist, reflecting the trends in which an increasing proportion of people consume the types of diets associated with a number of chronic diseases' (Popkin, 1994).

Ocean acidification (OA) A reduction in the *pH* of the ocean, accompanied by other chemical changes, over an extended period, typically decades or longer, which is caused primarily by *uptake* of *carbon dioxide* (CO_2) from the *atmosphere*, but can also be caused by other chemical additions or subtractions from the ocean. *Anthropogenic* ocean acidification refers to the component of *pH* reduction that is caused by human activity (IPCC, 2011, p. 37). See also *Climate change*.

Ocean fertilisation Deliberate increase of nutrient supply to the near-surface ocean in order to enhance biological production through which additional *carbon dioxide* (CO_2) from the *atmosphere* is sequestered. This can be achieved by the addition of micro-nutrients or macro-nutrients. Ocean fertilisation is regulated by the London Protocol

Overshoot See *Temperature overshoot*.

Overshoot pathways See *Pathways*.

Ozone (O_3) The triatomic form of oxygen (O_3). In the *troposphere*, it is created both naturally and by photochemical reactions involving gases resulting from human activities (smog). Tropospheric ozone acts as a *greenhouse gas* (GHG). In the *stratosphere*, it is created by the interaction between solar ultraviolet radiation and molecular oxygen (O_2). Stratospheric ozone plays a dominant role in the stratospheric radiative balance. Its concentration is highest in the ozone layer.

Paris Agreement The Paris Agreement under the *United Nations Framework Convention on Climate Change* (UNFCCC) was adopted on December 2015 in Paris, France, at the 21st session of the *Conference of the Parties* (COP) to the UNFCCC. The agreement, adopted by 196 Parties to the UNFCCC, entered into force on 4 November 2016 and as of May 2018 had 195 Signatories and was ratified by 177 Parties. One of the goals of the Paris Agreement is 'Holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels', recognising that this would significantly reduce the risks and impacts of climate change. Additionally, the Agreement aims to strengthen the ability of countries to deal with the impacts of climate change. The Paris Agreement is intended to become fully effective in 2020. See also *Kyoto Protocol*, and *Nationally Determined Contributions* (NDCs).

Participatory governance See *Governance*.

Pasture Area covered with grass or other plants used or suitable for grazing of livestock; grassland.

Pathways The temporal evolution of natural and/or *human systems* towards a future state. Pathway concepts range from sets of quantitative and qualitative *scenarios* or *narratives* of potential futures to solution-oriented decision-making processes to achieve desirable societal goals. Pathway approaches typically focus on biophysical, techno-economic, and/or socio-behavioural trajectories and involve various dynamics, goals, and actors across different scales.

1.5°C pathway

A pathway of emissions of *greenhouse gases* and other climate forcers that provides an approximately one-in-two to two-in-three chance, given current knowledge of the climate response, of *global*

warming either remaining below 1.5°C or returning to 1.5°C by around 2100 following an overshoot.

See also *Temperature overshoot*.

Adaptation pathways

A series of *adaptation* choices involving trade-offs between short-term and long-term goals and values. These are processes of deliberation to identify solutions that are meaningful to people in the context of their daily lives and to avoid potential maladaptation.

Development pathways

Development pathways are trajectories based on an array of social, economic, cultural, technological, institutional, and biophysical features that characterise the interactions between human and natural systems and outline visions for the future, at a particular scale.

Mitigation pathways

A mitigation pathway is a temporal evolution of a set of *mitigation scenario* features, such as *greenhouse gas* (GHG) emissions and socio-economic development.

Overshoot pathways

Pathways that exceed the stabilisation level (concentration, *forcing*, or temperature) before the end of a time horizon of interest (e.g., before 2100) and then decline towards that level by that time. Once the target level is exceeded, removal by *sinks* of *greenhouse gases* (GHGs) is required. See also *Temperature overshoot*.

Non-overshoot pathways

Pathways that stay below the stabilisation level (concentration, forcing, or temperature) during the time horizon of interest (e.g., until 2100).

Representative Concentration Pathways (RCPs)

Scenarios that include time series of emissions and concentrations of the full suite of *greenhouse gases* (GHGs) and *aerosols* and chemically active gases, as well as *land use/land cover* (Moss et al., 2008). The word representative signifies that each RCP provides only one of many possible scenarios that would lead to the specific *radiative forcing* characteristics. The term pathway emphasises the fact that not only the long-term concentration levels, but also the trajectory taken over time to reach that outcome are of interest (Moss et al., 2010). RCPs were used to develop *climate projections* in CMIP5. See also *Coupled Model Intercomparison Project* (CMIP), and *Shared Socio-economic Pathways* (SSPs).

- RCP2.6: One pathway where radiative forcing peaks at approximately 3 W m^{-2} and then declines to be limited at 2.6 W m^{-2} in 2100 (the corresponding Extended Concentration Pathway, or ECP, has constant emissions after 2100).
- RCP4.5 and RCP6.0: Two intermediate stabilisation pathways in which radiative forcing is limited at approximately 4.5 W m^{-2} and 6.0 W m^{-2} in 2100 (the corresponding ECPs have constant concentrations after 2150).
- RCP8.5: One high pathway which leads to $>8.5 \text{ W m}^{-2}$ in 2100 (the corresponding ECP has constant emissions after 2100 until 2150 and constant concentrations after 2250).

Shared Socio-economic Pathways (SSPs)

Shared Socio-economic Pathways (SSPs) were developed to complement the Representative Concentration Pathways (RCPs) with varying socio-economic challenges to *adaptation* and *mitigation*

(O'Neill et al., 2014). Based on five *narratives*, the SSPs describe alternative socio-economic futures in the absence of climate policy intervention, comprising sustainable development (SSP1), regional rivalry (SSP3), inequality (SSP4), fossil-fueled development (SSP5), and a middle-of-the-road development (SSP2) (O'Neill et al., 2017; Riahi et al., 2017). The combination of SSP-based socio-economic scenarios and RCP-based *climate projections* provides an integrative frame for climate *impact* and policy analysis.

Transformation pathways

Trajectories describing consistent sets of possible futures of *greenhouse gas (GHG)* emissions, atmospheric concentrations, or *global mean surface temperatures* implied from *mitigation* and *adaptation* actions associated with a set of broad and irreversible economic, technological, societal, and behavioural changes. This can encompass changes in the way energy and infrastructure are used and produced, natural resources are managed and *institutions* are set up and in the pace and direction of technological change (TC).

See also *Scenario*, *Scenario storyline*, *Emission scenario*, *Mitigation scenario*, *Baseline scenario*, *Stabilisation (of GHG or CO₂-equivalent concentration)*, and *Narratives*.

Peat Soft, porous or compressed, sedentary deposit of which a substantial portion is partly decomposed plant material with high water content in the natural state (up to about 90 percent) (IPCC, 2013). See also *Peatlands*.

Peatlands Peatland is a land where soils are dominated by *peat*. See also *Reservoir*, and *Sink*.

Peri-urban areas Parts of a city that appear to be quite rural but are in reality strongly linked functionally to the city in its daily activities.

Permafrost Ground (soil or rock and included ice and organic material) that remains at or below 0°C for at least two consecutive years.

pH A dimensionless measure of the acidity of a solution given by its concentration of hydrogen ions ([H⁺]). pH is measured on a logarithmic scale where $\text{pH} = -\log_{10}[\text{H}^+]$. Thus, a pH decrease of 1 unit corresponds to a 10-fold increase in the concentration of H⁺, or acidity. See also *Ocean acidification*.

Phenology The relationship between biological phenomena that recur periodically (e.g., development stages, migration) and *climate* and seasonal changes.

Planetary health The Rockefeller-Lancet Commission defines planetary health as 'the achievement of the highest attainable standard of health, well-being, and equity worldwide through judicious attention to the human systems — political, economic, and social — that shape the future of humanity *and* the Earth's natural systems that define the safe environmental limits within which humanity can flourish. Put simply, planetary health is the health of human civilisation and the state of the natural systems on which it depends' (Whitmee et al., 2015).

Political economy The set of interlinked relationships between people, the state, society and markets as defined by law, politics, economics, customs and power that determine the outcome of

trade and transactions and the distribution of wealth in a country or economy.

Pool, carbon and nitrogen A *reservoir* in the earth system where elements, such as carbon and nitrogen, reside in various chemical forms for a period of time.

Poverty A complex concept with several definitions stemming from different schools of thought. It can refer to material circumstances (such as need, pattern of deprivation or limited resources), economic conditions (such as standard of living, *inequality* or economic position) and/or social relationships (such as social class, dependency, exclusion, lack of basic security or lack of entitlement). See also *Poverty eradication*.

Poverty eradication A set of measures to end *poverty* in all its forms everywhere. See also *Sustainable Development Goals (SDGs)*.

Precursors Atmospheric compounds that are not *greenhouse gases (GHGs)* or *aerosols*, but that have an effect on GHG or aerosol concentrations by taking part in physical or chemical processes regulating their production or destruction rates. See also *Aerosol*, and *Greenhouse gas (GHG)*.

Pre-industrial The multi-century period prior to the onset of large-scale industrial activity around 1750. The *reference period* 1850–1900 is used to approximate pre-industrial *global mean surface temperature (GMST)*. See also *Industrial revolution*.

Primary production The synthesis of organic compounds by plants and microbes, on land or in the ocean, primarily by photosynthesis using light and *carbon dioxide (CO₂)* as sources of energy and carbon respectively. It can also occur through chemosynthesis, using chemical energy, e.g., in deep sea vents.

Gross Primary Production (GPP)

The total amount of carbon fixed by photosynthesis over a specific time period.

Net primary production (NPP)

The amount of carbon accumulated through photosynthesis minus the amount lost by plant respiration over a specified time period that would prevail in the absence of land use.

Procedural equity See *Equity*

Procedural rights See *Human rights*.

Projection A potential future evolution of a quantity or set of quantities, often computed with the aid of a model. Unlike predictions, projections are conditional on assumptions concerning, for example, future socio-economic and technological developments that may or may not be realised. See also *Climate projection*, *Scenario*, and *Pathways*.

Radiative forcing The change in the net, downward minus upward, radiative flux (expressed in W m⁻²) at the tropopause or top of *atmosphere* due to a change in a driver of *climate change*, such as a change in the concentration of *carbon dioxide (CO₂)*, the concentration of volcanic aerosols or the output of the Sun. The traditional radiative forcing is computed with all tropospheric properties held fixed at their unperturbed values, and after allowing for stratospheric temperatures, if perturbed, to readjust to radiative-dynamical equilibrium. Radiative forcing is called instantaneous if no

change in stratospheric temperature is accounted for. The radiative forcing once rapid adjustments are accounted for is termed the effective radiative forcing. Radiative forcing is not to be confused with cloud radiative forcing, which describes an unrelated measure of the impact of clouds on the radiative flux at the top of the atmosphere.

Reasons for concern (RFCs) Elements of a classification framework, first developed in the IPCC Third Assessment Report, which aims to facilitate judgments about what level of *climate change* may be dangerous (in the language of Article 2 of the *UNFCCC*) by aggregating risks from various sectors, considering hazards, exposures, vulnerabilities, capacities to adapt, and the resulting impacts.

Reducing Emissions from Deforestation and Forest Degradation (REDD+) REDD+ refers to reducing emissions from *deforestation*; reducing emissions from forest degradation; conservation of forest carbon stocks; sustainable management of forests; and enhancement of forest carbon stocks (see UNFCCC decision 1/CP.16, para. 70).

Reference period The period relative to which *anomalies* are computed. See also *Anomalies*.

Reference scenario See *Baseline scenario*.

Reforestation Conversion to *forest* of *land* that has previously contained forests but that has been converted to some other use. [Note: For a discussion of the term forest and related terms such as *afforestation*, *reforestation* and *deforestation* in the context of reporting and accounting Article 3.3 and 3.4 activities under the *Kyoto Protocol*, see 2013 Revised Supplementary Methods and Good Practice Guidance Arising from the Kyoto Protocol.] See also *Afforestation, Deforestation, and Reducing Emissions from Deforestation and Forest Degradation (REDD+)*.

Region A relatively large-scale land or ocean area characterised by specific geographical and climatological features. The *climate* of a land-based region is affected by regional and local scale features like topography, *land use* characteristics and large water bodies, as well as remote influences from other regions, in addition to global climate conditions. The IPCC defines a set of standard regions for analyses of observed climate trends and climate model projections (see IPCC 2018, Fig. 3.2; AR5, SREX).

Remaining carbon budget Cumulative global *carbon dioxide (CO₂)* emissions from the start of 2018 to the time that CO₂ emissions reach net-zero that would result, at some probability, in limiting *global warming* to a given level, accounting for the impact of other *anthropogenic emissions*. See also *Carbon budget*.

Representative concentration pathways (RCPs) See *Pathways*.

Reservoir A component or components of the climate system where a *greenhouse gas (GHG)* or a *precursor* of a greenhouse gas is stored (UNFCCC Article 1.7).

Resilience The capacity of interconnected social, economic and ecological systems to cope with a hazardous event, trend or disturbance, responding or reorganising in ways that maintain their essential function, identity and structure. Resilience is a positive

attribute when it maintains capacity for *adaptation*, learning and/or *transformation* (adapted from the Arctic Council, 2013). See also *Hazard, Risk*, and *Vulnerability*.

Respiration The process whereby living organisms convert organic matter to *carbon dioxide (CO₂)*, releasing energy and consuming molecular oxygen.

Rewetting 'The deliberate action of changing a drained soil into a wet soil, e.g. by blocking *drainage* ditches, disabling pumping facilities or breaching obstructions' (IPCC, 2013). See also *Drainage*.

Risk The potential for adverse consequences for human or ecological systems, recognising the diversity of values and objectives associated with such systems. In the context of *climate change*, risks can arise from potential *impacts* of climate change as well as human responses to climate change. Relevant adverse consequences include those on lives, *livelihoods*, health and *well-being*, economic, social and cultural assets and investments, infrastructure, services (including *ecosystem services*), *ecosystems* and species.

In the context of climate change impacts, risks result from dynamic interactions between climate-related *hazards* with the *exposure* and *vulnerability* of the affected human or ecological system to the hazards. Hazards, exposure and vulnerability may each be subject to *uncertainty* in terms of magnitude and likelihood of occurrence, and each may change over time and space due to socio-economic changes and human decision-making (see also *risk management, adaptation, and mitigation*).

In the context of climate change responses, risks result from the potential for such responses not achieving the intended objective(s), or from potential trade-offs with, or negative side-effects on, other societal objectives, such as the *Sustainable Development Goals* (see also *risk trade-off*). Risks can arise for example from uncertainty in implementation, effectiveness or outcomes of climate policy, climate-related investments, technology development or adoption, and system *transitions*.

Risk assessment The qualitative and/or quantitative scientific estimation of *risks*. See also *Risk management*, and *Risk perception*.

Risk management Plans, actions, strategies or policies to reduce the *likelihood* and/or magnitude of adverse potential consequences, based on assessed or perceived *risks*. See also *Risk assessment*, and *Risk perception*.

Risk perception The subjective judgment that people make about the characteristics and severity of a *risk*. See also *Risk assessment*, and *Risk management*.

Risk trade-off The change in portfolio of *risks* that occurs when a countervailing risk is generated (knowingly or inadvertently) by an intervention to reduce the target risk (Wiener and Graham, 2009). See also *Adverse side-effect*, and *Co-benefits*.

Runoff The flow of water over the surface or through the subsurface, which typically originates from the part of liquid precipitation and/or snow/ice melt that does not evaporate or refreeze, and is not transpired. See also *Hydrological cycle*.

Saline soils Soils with levels of soluble salts (commonly sulphates and chlorides of calcium and magnesium) in the saturation extract

high enough to negatively affect plant growth. Saline soils are usually flocculated and have good water permeability (Well and Brady, 2016). See also *Soil salinity* and *Sodic soils*.

Scenario A plausible description of how the future may develop based on a coherent and internally consistent set of assumptions about key driving forces (e.g., rate of technological change (TC), prices) and relationships. Note that scenarios are neither predictions nor forecasts, but are used to provide a view of the implications of developments and actions. See also *Baseline scenario*, *Emission scenario*, *Mitigation scenario* and *Pathways*.

Scenario storyline A *narrative* description of a *scenario* (or family of scenarios), highlighting the main scenario characteristics, relationships between key driving forces and the dynamics of their evolution. Also referred to as ‘narratives’ in the scenario literature.

Sea ice Ice found at the sea surface that has originated from the freezing of seawater. Sea ice may be discontinuous pieces (ice floes) moved on the ocean surface by wind and currents (pack ice), or a motionless sheet attached to the coast (land-fast ice). Sea ice concentration is the fraction of the ocean covered by ice. Sea ice less than one year old is called first-year ice. Perennial ice is sea ice that survives at least one summer. It may be subdivided into second-year ice and multi-year ice, where multi-year ice has survived at least two summers.

Sea level change (sea level rise/sea level fall) Change to the height of sea level, both globally and locally (relative sea level change) due to (1) a change in ocean volume as a result of a change in the mass of water in the ocean, (2) changes in ocean volume as a result of changes in ocean water density, (3) changes in the shape of the ocean basins and changes in the Earth’s gravitational and rotational fields, and (4) local subsidence or uplift of the land. Global mean sea level change resulting from change in the mass of the ocean is called barystatic. The amount of barystatic sea level change due to the addition or removal of a mass of water is called its sea level equivalent (SLE). Sea level changes, both globally and locally, resulting from changes in water density are called steric. Density changes induced by temperature changes only are called thermosteric, while density changes induced by salinity changes are called halosteric. Barystatic and steric sea level changes do not include the effect of changes in the shape of ocean basins induced by the change in the ocean mass and its distribution.

Sea surface temperature (SST) The subsurface bulk temperature in the top few meters of the ocean, measured by ships, buoys, and drifters. From ships, measurements of water samples in buckets were mostly switched in the 1940s to samples from engine intake water. Satellite measurements of skin temperature (uppermost layer; a fraction of a millimetre thick) in the infrared or the top centimetre or so in the microwave are also used, but must be adjusted to be compatible with the bulk temperature.

Sendai Framework for Disaster Risk Reduction The Sendai Framework for Disaster Risk Reduction 2015–2030 outlines seven clear targets and four priorities for action to prevent new, and to reduce existing disaster risks. The voluntary, non-binding agreement recognises that the State has the primary role to reduce disaster risk but that responsibility should be shared with other stakeholders

including local government, the private sector and other stakeholders, with the aim for the substantial reduction of disaster risk and losses in lives, livelihoods and health and in the economic, physical, social, cultural and environmental assets of persons, businesses, communities and countries.

Sequestration See *Uptake* and *Carbon sequestration*.

Shared socio-economic pathways (SSPs) See *Pathways*.

Short-lived climate forcers (SLCF) A set of compounds that are primarily composed of those with short lifetimes in the atmosphere compared to well-mixed *greenhouse gases (GHGs)*, and are also referred to as near-term climate forcers. This set of compounds includes *methane (CH₄)*, which is also a well-mixed greenhouse gas, as well as *ozone (O₃)* and *aerosols*, or their *precursors*, and some halogenated species that are not well-mixed greenhouse gases. These compounds do not accumulate in the atmosphere at decadal to centennial timescales, and so their effect on *climate* is predominantly in the first decade after their emission, although their changes can still induce long-term climate effects such as sea level change. Their effect can be cooling or warming. A subset of exclusively warming short-lived climate forcers is referred to as short-lived climate pollutants. See also *Long-lived climate forcers (LLCF)*.

Short-lived climate pollutants (SLCP) See *Short-lived climate forcers (SLCF)*.

Sink Any process, activity or mechanism which removes a *greenhouse gas*, an *aerosol* or a *precursor* of a greenhouse gas from the *atmosphere* (UNFCCC Article 1.8). See also *Sequestration*, *Source*, and *Uptake*.

Small Island Developing States (SIDS) Small Island Developing States (SIDS), as recognised by the United Nations OHRLLS (Office of the High Representative for the Least Developed Countries, Landlocked Developing Countries and Small Island Developing States), are a distinct group of developing countries facing specific social, economic and environmental vulnerabilities (UN-OHRLLS, 2011). They were recognised as a special case both for their environment and development at the Rio Earth Summit in Brazil in 1992. Fifty eight countries and territories are presently classified as SIDS by the UN OHRLLS, with 38 being UN member states and 20 being Non-UN Members or Associate Members of the Regional Commissions (UN-OHRLLS, 2018).

Social costs The full costs of an action in terms of social welfare losses, including external costs associated with the impacts of this action on the environment, the economy (GDP, employment) and on the society as a whole.

Social cost of carbon (SCC) The net present value of aggregate climate damages (with overall harmful damages expressed as a number with positive sign) from one more tonne of carbon in the form of *carbon dioxide (CO₂)*, conditional on a global emissions trajectory over time.

Social-ecological system An integrated system that includes human societies and *ecosystems*, in which humans are part of nature. The functions of such a system arise from the interactions and interdependence of the social and ecological subsystems. The system’s structure is characterised by reciprocal feedbacks, emphasising that

humans must be seen as a part of, not apart from, nature (Arctic Council, 2016; Berkes and Folke, 1998).

Social inclusion A process of improving the terms of participation in society, particularly for people who are disadvantaged, through enhancing opportunities, access to resources, and respect for rights (UN DESA 2016).

Social learning A process of social interaction through which people learn new behaviours, capacities, values, and attitudes.

Societal (social) transformation See *Transformation*.

Socio-economic scenario A *scenario* that describes a possible future in terms of population, *gross domestic product (GDP)*, and other socio-economic factors relevant to understanding the implications of *climate change*. See also *Baseline scenario*, *Emission scenario*, *Mitigation scenario*, and *Pathways*.

Socio-technical transitions Where technological change is associated with social systems and the two are inextricably linked.

Sodic soils Soils with disproportionately high concentration of sodium (Na⁺) in relation to calcium (Ca²⁺) and magnesium (Mg²⁺) adsorbed at the cation exchange site on the surface of soil particles. Sodic soils are characterised by a poor soil structure and poor aeration (NDSU, 2014). See also *Soil salinity*.

Soil carbon sequestration (SCS) Land management changes which increase the *soil organic carbon* content, resulting in a net removal of *carbon dioxide (CO₂)* from the *atmosphere*.

Soil conservation The maintenance of soil fertility through controlling erosion, preserving soil organic matter, ensuring favourable soil physical properties, and retaining nutrients (Young, 1989).

Soil erosion The displacement of the soil by the action of water or wind. Soil erosion is a major process of *land degradation*.

Soil organic carbon Carbon contained in *soil organic matter*.

Soil organic matter The organic component of soil, comprising plant and animal residue at various stages of decomposition, and soil organisms.

Soil moisture Water stored in the soil in liquid or frozen form. Root-zone soil moisture is of most relevance for plant activity.

Soil salinity The concentration of soluble salts in the water extracted from a saturated soil (saturation extract), comprising chlorides and sulphates of Sodium (Na⁺), calcium (Ca²⁺) and magnesium (Mg²⁺) as well as carbonate salts (adapted from FAO, 1985). See also *Saline soils*, and *Sodic soils*.

Source Any process or activity which releases a *greenhouse gas*, an *aerosol* or a *precursor* of a greenhouse gas into the atmosphere (UNFCCC Article 1.9). See also *Sink*.

Stabilisation (of GHG or CO₂-equivalent concentration) A state in which the *atmospheric* concentrations of one *greenhouse gas (GHG)* (e.g., carbon dioxide) or of a *CO₂-equivalent* basket of GHGs (or a combination of GHGs and *aerosols*) remains constant over time.

Stranded assets Assets exposed to devaluations or conversion to 'liabilities' because of unanticipated changes in their initially expected revenues due to innovations and/or evolutions of the business context, including changes in public regulations at the domestic and international levels.

Stratosphere The highly stratified region of the *atmosphere* above the *troposphere* extending from about 10 km (ranging from 9 km at high latitudes to 16 km in the tropics on average) to about 50 km altitude. See also *Atmosphere*, and *Troposphere*.

Subnational actors State/provincial, regional, metropolitan and local/municipal governments as well as non-party stakeholders, such as civil society, the private sector, cities and other subnational authorities, local communities and indigenous peoples.

Substantive rights See *Human rights*.

Supply-side measures See *Demand and supply-side measures*.

Surface temperature See *Global mean surface temperature (GMST)*, *Land surface air temperature*, and *Sea surface temperature (SST)*.

Sustainability A dynamic process that guarantees the persistence of natural and human systems in an equitable manner.

Sustainable development (SD) Development that meets the needs of the present without compromising the ability of future generations to meet their own needs (WCED, 1987) and balances social, economic and environmental concerns. See also *Sustainable Development Goals (SDGs)*, and *Development pathways* (under *Pathways*).

Sustainable Development Goals (SDGs) The 17 global goals for development for all countries established by the United Nations through a participatory process and elaborated in the *2030 Agenda for Sustainable Development*, including ending *poverty* and hunger; ensuring health and *well-being*, education, gender *equality*, clean water and energy, and decent work; building and ensuring resilient and sustainable infrastructure, cities and consumption; reducing *inequalities*; protecting land and water ecosystems; promoting peace, justice and partnerships; and taking urgent action on *climate change*. See also *Sustainable development (SD)*.

Sustainable forest management The stewardship and use of *forests* and forest lands in a way, and at a rate, that maintains their *biodiversity*, productivity, regeneration capacity, vitality and their potential to fulfil, now and in the future, relevant ecological, economic and social functions, at local, national, and global levels, and that does not cause damage to other *ecosystems* (Forest Europe, 1993).

Sustainable intensification (of agriculture) Increasing yields from the same area of land while decreasing negative environmental impacts of agricultural production and increasing the provision of environmental services (CGIAR, 2019). [Note: this definition is based on the concept of meeting demand from a finite land area, but it is scale-dependent. Sustainable intensification at a given scale (e.g., global or national) may require a decrease in production intensity at smaller scales and in particular places (often associated with previous, unsustainable, intensification) to achieve *sustainability* (Garnett et al., 2013).]

Sustainable land management The stewardship and use of *land* resources, including soils, water, animals and plants, to meet changing human needs, while simultaneously ensuring the long-term productive potential of these resources and the maintenance of their environmental functions (Adapted from WOCAT, undated).

Technology transfer The exchange of knowledge, hardware and associated software, money and goods among stakeholders, which leads to the spread of technology for *adaptation* or *mitigation*. The term encompasses both diffusion of technologies and technological cooperation across and within countries.

Teleconnections A statistical association between climate variables at widely separated, geographically-fixed spatial locations. Teleconnections are caused by large spatial structures such as basin-wide coupled modes of ocean-atmosphere variability, Rossby wave-trains, mid-latitude jets and storm tracks, etc.

Temperature overshoot The temporary exceedance of a specified level of *global warming*, such as 1.5°C. Overshoot implies a peak followed by a decline in global warming, achieved through *anthropogenic removal of carbon dioxide (CO₂)* exceeding remaining CO₂ emissions globally. See also *Pathways (Subterms: Overshoot pathways, Non-overshoot Pathways)*.

Tier In the context of the IPCC Guidelines for National Greenhouse Gas Inventories, a tier represents a level of methodological complexity. Usually three tiers are provided. Tier 1 is the basic method, Tier 2 intermediate and Tier 3 most demanding in terms of complexity and data requirements. Tiers 2 and 3 are sometimes referred to as higher tier methods and are generally considered to be more accurate (IPCC, 2019).

Tipping point A level of change in system properties beyond which a system reorganises, often abruptly, and does not return to the initial state even if the drivers of the change are abated. For the *climate system*, it refers to a critical threshold beyond which global or regional climate changes from one stable state to another stable state. Tipping points are also used when referring to *impact*: the term can imply that an impact tipping point is (about to be) reached in a natural or *human system*. See also *Irreversibility*.

Transformation A change in the fundamental attributes of natural and human systems.

Societal (social) transformation

A profound and often deliberate shift initiated by communities toward sustainability, facilitated by changes in individual and collective values and behaviours, and a fairer balance of political, cultural, and *institutional* power in society.

Transformation pathways See *Pathways*.

Transformational adaptation See *Adaptation*.

Transformative change A system wide change that alters the fundamental attributes of the system.

Transient climate response to cumulative CO₂ emissions (TCRE) The transient global average surface temperature change per unit cumulative *carbon dioxide (CO₂)* emissions, usually 1000 GtC. TCRE combines both information on the airborne fraction of cumulative CO₂ emissions (the fraction of the total CO₂ emitted that

remains in the atmosphere, which is determined by *carbon cycle* processes) and on the transient climate response (TCR). See also *Transient climate response (TCR) (under Climate sensitivity)*.

Transit-oriented development (TOD) An approach to urban development that maximises the amount of residential, business and leisure space within walking distance of efficient public transport, so as to enhance mobility of citizens, the viability of public transport and the value of urban land in mutually supporting ways.

Transition The process of changing from one state or condition to another in a given period of time. Transition can occur in individuals, firms, cities, regions and nations, and can be based on incremental or transformative change.

Tropical cyclone The general term for a strong, cyclonic-scale disturbance that originates over tropical oceans. Distinguished from weaker systems (often named tropical disturbances or depressions) by exceeding a threshold wind speed. A tropical storm is a tropical cyclone with one-minute average surface winds between 18 and 32 m s⁻¹. Beyond 32 m s⁻¹, a tropical cyclone is called a hurricane, typhoon, or cyclone, depending on geographic location. See also *Extratropical cyclone*.

Troposphere The lowest part of the *atmosphere*, from the surface to about 10 km in altitude at mid-latitudes (ranging from 9 km at high latitudes to 16 km in the tropics on average), where clouds and weather phenomena occur. In the troposphere, temperatures generally decrease with height. See also *Atmosphere*, and *Stratosphere*.

Uncertainty A state of incomplete knowledge that can result from a lack of information or from disagreement about what is known or even knowable. It may have many types of sources, from imprecision in the data to ambiguously defined concepts or terminology, incomplete understanding of critical processes, or uncertain *projections of human behaviour*. Uncertainty can therefore be represented by quantitative measures (e.g., a probability density function) or by qualitative statements (e.g., reflecting the judgment of a team of experts) (see IPCC, 2004; Mastrandrea et al., 2010; Moss and Schneider, 2000). See also *Confidence*, and *Likelihood*.

United Nations Convention to Combat Desertification (UNCCD) A legally binding international agreement linking environment and development to sustainable land management, established in 1994. The Convention's objective is 'to combat desertification and mitigate the effects of drought in countries experiencing drought and/or desertification'. The Convention specifically addresses the arid, semi-arid and dry sub-humid areas, known as the drylands, and has a particular focus on Africa. As of October 2018, the UNCCD had 197 Parties.

United Nations Framework Convention on Climate Change (UNFCCC) The UNFCCC was adopted in May 1992 and opened for signature at the 1992 Earth Summit in Rio de Janeiro. It entered into force in March 1994 and as of May 2018 had 197 Parties (196 States and the European Union). The Convention's ultimate objective is the 'stabilisation of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system'. The provisions of the Convention are pursued and implemented by two treaties: the *Kyoto Protocol* and the *Paris Agreement*.

Urban green infrastructure Public and private green spaces, including remnant native vegetation, parks, private gardens, golf courses, street trees, urban farming and engineered options such as green roofs, green walls, biofilters and raingardens (Norton et al., 2015).

Urban and Peri-urban agriculture 'The cultivation of crops and rearing of animals for food and other uses within and surrounding the boundaries of cities, including fisheries and forestry' (EPRS, 2014).

Uptake The addition of a substance of concern to a *reservoir*. See also *Carbon sequestration*, and *Sink*.

Vegetation browning A decrease in photosynthetically active plant *biomass* which is inferred from satellite observations.

Vegetation greening An increase in photosynthetically active plant *biomass* which is inferred from satellite observations.

Vulnerability The propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts and elements including sensitivity or susceptibility to harm and lack of capacity to cope and adapt. See also *Exposure*, *Hazard*, and *Risk*.

Water cycle See *Hydrological cycle*.

Well-being A state of existence that fulfils various human needs, including material living conditions and quality of life, as well as the ability to pursue one's goals, to thrive, and feel satisfied with one's life. Ecosystem well-being refers to the ability of *ecosystems* to maintain their diversity and quality.

Wetland Land that is covered or saturated by water for all or part of the year (e.g., *peatland*).

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