



Annexes

Annex I: Glossary

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Note:

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

Subterms appear in *italics* beneath main terms.

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1.5°C pathway See *Pathways*.

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.

Access to modern energy services Access to clean, reliable and affordable energy services for cooking, heating, lighting, communications, and productive uses.

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

Adaptation limits

The change in climate where adaptation is unable to prevent damaging impacts and further risk. Soft limits occur when additional adaptation may be possible if constraints are able to be overcome. Hard limits occur when no additional adaptation is possible.

Incremental adaptation

Adaptation that maintains the essence and integrity of a system or process at a given scale (Park et al. 2012). In some cases, incremental adaptation can accrue to result in transformational adaptation (Tàbara et al. 2019; Termeer et al. 2017). Incremental adaptations to change in climate are understood as extensions of actions and behaviours that already reduce the losses or enhance the benefits of natural variations in extreme weather/climate events.

Transformational adaptation

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

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.

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 (MA 2005).

Adaptive governance See *Governance*.

Additionality The property of being additional. Mitigation is additional if the *greenhouse gas* emission reductions or removals would not have occurred in the absence of the associated policy intervention or activity.

[Note: Additionality is one of several key criteria used to ensure the environmental integrity of *Offsets (in climate change mitigation)*].

See also *Greenhouse gas emission metric*.

Adverse side-effect A negative effect that a policy or measure aimed at one objective has on another objective, thereby potentially reducing the net benefit to society or the environment. See also *Co-benefits*, *Risk*, and *Trade-off*.

Aerosol A suspension of airborne solid or liquid particles, with typical particle size in the range of a few nanometres to several tens of micrometres and atmospheric lifetimes of up to several days in the troposphere and up to years in the stratosphere. 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 in the troposphere; stratospheric aerosols mostly stem from volcanic eruptions. Aerosols can cause an effective radiative forcing directly through scattering and absorbing radiation (aerosol–radiation interaction), and indirectly by acting as cloud condensation nuclei or ice nucleating particles that affect the properties of clouds (aerosol–cloud interaction), and upon deposition on snow- or ice-covered surfaces. Atmospheric aerosols may be either emitted as primary particulate matter or formed within the atmosphere from gaseous precursors (secondary production). Aerosols may be composed of sea salt, organic carbon, black carbon (BC), mineral species (mainly desert dust), sulphate, nitrate and ammonium or their mixtures. See also *Short-lived climate forcers (SLCFs)*.

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*, see the 2006 IPCC Guidelines for National Greenhouse Gas Inventories and their 2019 Refinement, and information provided by the *United Nations Framework Convention on Climate Change* (IPCC 2006, 2019; UNFCCC 2021a,b).]

See also *Deforestation*, *Reducing Emissions from Deforestation and Forest Degradation (REDD+)*, *Reforestation*, *Anthropogenic Removals*, and *Carbon dioxide removal (CDR)*.

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 Framework 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. See also *Land use*, *Land-use change and forestry (LULUCF)* and *Land-use change (LUC)*.

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 socio-economic components of farming systems and their surrounding landscapes (IPBES 2019).

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

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 changes in cloudiness and of snow, ice, leaf area and *land cover*.

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

Anthropogenic Resulting from or produced by human activities.

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 (LULUC)*, 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)*, which alone does not remove CO₂ from the atmosphere, can help reduce atmospheric CO₂ from industrial and energy-related sources if it is combined with bioenergy production (*BECCS*), or if CO₂ is captured from the air directly and stored (*DACCS*).

[Note: In the 2006 IPCC Guidelines for National GHG Inventories (IPCC 2006), 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 *Carbon dioxide removal (CDR)*, *Afforestation*, *Biochar*, *Enhanced weathering*, *Ocean alkalisation/Ocean alkalinity enhancement*, *Reforestation*, and *Soil carbon sequestration (SCS)*.

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), *methane (CH₄)*, *nitrous oxide (N₂O)* and *ozone (O₃)*. In addition, the atmosphere contains the GHG water vapour (H₂O), whose concentrations are highly variable (0–5% volume mixing ratio) as the sources (*evapotranspiration*) and sinks (precipitation) of water vapour show large spatio-temporal variations, and atmospheric temperature exerts a strong constraint on the amount of water vapour an air parcel can hold. The atmosphere also contains clouds and *aerosols*.

Avoid, Shift, Improve (ASI) Reducing *greenhouse gas* emissions by avoiding the use of an emissions-producing service entirely, shifting to the lowest-emission mode of providing the service, and/or improving the technologies and systems for providing the service in ways that reduce emissions.

Baseline/reference See *Reference period* and *Reference scenario*.

Baseline period See *Reference period*.

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* emissions from *biomass* that would otherwise decompose rapidly (IBI 2018). See also *Anthropogenic removals* and *Carbon dioxide removal (CDR)*.

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 *Bioenergy* and *Biomass*.

Bioenergy Energy derived from any form of *biomass* or its metabolic by-products. See also *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 *Anthropogenic removals* and *Carbon dioxide removal*.

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 *Bioenergy*.

Biogenic carbon emissions Carbon released as *carbon dioxide* or *methane* from combustion or decomposition of *biomass* or biobased products.

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.

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 only stays in the *atmosphere* for days or weeks. BC is a climate forcing agent with strong warming effect, both in the atmosphere and when deposited on snow or ice. See also *Aerosol*.

Blue carbon Biologically-driven carbon fluxes and storage in marine systems that are amenable to management. 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 *Sequestration*.

Blue infrastructure See *Infrastructure*.

Business as usual (BAU) The term *business as usual* scenario has been used to describe a scenario that assumes no additional policies beyond those currently in place and that patterns of socio-economic development are consistent with recent trends. The term is now used less frequently than in the past. See also *Reference scenario* (under *Scenario*).

Carbon budget Refers to two concepts in the literature: (i) an assessment of carbon cycle *sources* and *sinks* on a global level, through the synthesis of evidence for *fossil fuel* and cement emissions, emissions and removals associated with *land use* and *land-use change*, ocean and natural land sources and sinks of *carbon dioxide (CO₂)*, and the resulting change in atmospheric CO₂ concentration. This is referred to as the global carbon budget; (ii) the maximum amount of cumulative net global *anthropogenic* CO₂ emissions that would result in limiting *global warming* to a given level with a given probability, taking into account the effect of other anthropogenic climate *forcers*. This is referred to as the Total Carbon Budget when expressed starting from the *pre-industrial* period, and as the Remaining Carbon Budget when expressed from a recent specified date.

[Note 1: Net anthropogenic CO₂ emissions are anthropogenic CO₂ emissions minus anthropogenic CO₂ removals. See also *Carbon Dioxide Removal (CDR)*.

Note 2: The maximum amount of cumulative net global anthropogenic CO₂ emissions is reached at the time that annual net anthropogenic CO₂ emissions reach zero.

Note 3: The degree to which anthropogenic climate forcings other than CO₂ affect the Total Carbon Budget and Remaining Carbon Budget depends on human choices about the extent to which these forcings are mitigated and their resulting *climate* effects.

Note 4: The notions of a Total Carbon Budget and Remaining Carbon Budget are also being applied in parts of the scientific literature and by some entities at regional, national, or sub-national level. The distribution of global budgets across individual different entities and emitters depends strongly on considerations of equity and other value judgements.]

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 3.664 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* (LUCs) 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.

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 *Anthropogenic removals*, *Bioenergy with carbon dioxide capture and storage (BECCS)*, *Carbon dioxide capture and utilisation (CCU)*, *Carbon dioxide removal (CDR)*, and *Sequestration*.

Carbon dioxide capture and utilisation (CCU) A process in which *carbon dioxide (CO₂)* is captured and the carbon then used in a product. The *climate* effect of CCU depends on the product lifetime, the product it displaces, and the CO₂ source (fossil, *biomass* or *atmosphere*). CCU is sometimes referred to as Carbon Dioxide Capture and Use, or Carbon Capture and Utilisation. See also *Anthropogenic removals*, *Carbon dioxide capture and storage (CCS)*, and *Carbon dioxide removal (CDR)*.

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 CO₂ *sinks* and *direct air carbon dioxide capture and storage (DACCS)*, but excludes natural CO₂ *uptake* not directly caused by human activities. See also *Anthropogenic removals*, *Afforestation*, *Biochar*, *Bioenergy with carbon dioxide capture and storage (BECCS)*, *Carbon dioxide capture and storage (CCS)*, *Enhanced weathering*, *Ocean alkalinisation/Ocean alkalinity enhancement*, *Reforestation*, and *Soil carbon sequestration (SCS)*.

Carbon footprint Measure of the exclusive total amount of emissions of *carbon dioxide (CO₂)* that is directly and indirectly caused by an activity or is accumulated over the lifecycle stages of a product (Wiedmann and Minx 2008).

Household carbon footprint

The carbon footprint of an individual household, inclusive of the direct and indirect *carbon dioxide (CO₂)* emissions associated with home energy use, transportation, food provision, and consumption of other goods and services associated with household expenditures.

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 leakage See *Leakage*.

Carbon neutrality Condition in which *anthropogenic carbon dioxide (CO₂)* emissions associated with a subject are balanced by anthropogenic CO₂ removals. The subject can be an entity such as a country, an organisation, a district or a commodity, or an activity such as a service and an event. Carbon neutrality is often assessed over the lifecycle including indirect ('scope 3') emissions, but can also be limited to the emissions and removals, over a specified period, for which the subject has direct control, as determined by the relevant scheme.

[Note 1: Carbon neutrality and *net-zero CO₂ emissions* are overlapping concepts. The concepts can be applied at global or sub-global scales (e.g., regional, national and sub-national). At a global scale, the terms carbon neutrality and *net-zero CO₂ emissions* are equivalent. At sub-global scales, *net-zero CO₂ emissions* is generally applied to emissions and removals under direct control or territorial responsibility of the reporting entity, while carbon neutrality generally includes emissions and removals within and beyond the direct control or territorial responsibility of the reporting entity. Accounting rules specified by *greenhouse gas (GHG)* programmes or schemes can have a significant influence on the quantification of relevant CO₂ emissions and removals.

Note 2: In some cases, achieving carbon neutrality may rely on the supplementary use of *offsets* to balance emissions that remain after actions by the reporting entity are taken into account.]

See also *Greenhouse gas neutrality*, *Land use*, *land-use change and forestry (LULUCF)* and *Net-zero CO₂ emissions*.

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.

Carbon sink See *Sink*.

Carbon stock The quantity of carbon in a carbon *pool*.

Choice architecture The presentation of choices to consumers, and the impact that presentation has on consumer decision-making.

Circular economy A system with minimal input and operational losses of materials and energy through extensive reduce, reuse, recycling, and recovery activities. Ten strategies for circularity include: Refuse, Rethink, Reduce, Reuse, Repair, Refurbish, Remanufacture, Repurpose, Recycle, Recover.

Cities Cities are open systems, continually exchanging resources, products and services, waste, people, ideas, and finances with the hinterlands and broader world. Cities are complex, self-organising, adaptive, and constantly evolving. Cities also encompass multiple actors with varying responsibilities, capabilities and priorities, as well as processes that transcend the institutional sector-based approach to city administration. Cities are embedded in broader ecological, economic, technical, institutional, legal, and governance structures that enable or often constrain their systemic function, which cannot be separated from wider power relations. Urban processes of physical,

social, and economic nature are causally interlinked, with interactions and feedbacks that result in both intended and unintended impacts on emissions. See also *City region*, *Peri-urban areas* and *Urban*.

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

City region The areal extent of an individual city's material associations and economic or political influence. The city region concept accepts that rural livelihoods and land uses can be incorporated within the functional activities of a city. This will include dormitory settlements, sources for critical inputs of water, some food, and waste disposal. See also *Cities*, *Region* and *Urban systems*.

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 (WMO). 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.

Climate change commitment The unavoidable future *climate change* resulting from inertia in the geophysical and socio-economic systems. Different types of climate change commitment are discussed in the literature. Climate change commitment is usually quantified in terms of the further change in temperature, but it includes other future changes, for example in the hydrological cycle, in *extreme weather events*, in extreme climate events, and in sea level.

Zero emissions commitment

The zero emissions commitment is an estimate of the subsequent *global warming* that would result after *anthropogenic emissions* are set to zero. It is determined by both inertia in physical *climate system* components (ocean, cryosphere, land surface) and *carbon cycle* inertia. In its widest sense it refers to emissions of each climate *forcer* including *greenhouses gases*, *aerosols* and their precursors. The climate response to this can be complex due to the different climate response time scale of each climate forcer. A specific sub-category of zero emissions commitment is the Zero CO₂ Emissions Commitment which refers to the climate system response to CO₂ emissions after setting these to net zero. The CO₂-only definition is of specific use in estimating *remaining carbon budgets*.

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. 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 classified as an extreme climate event, especially if it yields an average or total that is itself extreme (e.g., high temperature, *drought*, or heavy rainfall over a season). For simplicity, both extreme weather events and extreme climate events are referred to collectively as 'climate extremes'.

Climate finance There is no agreed definition of climate finance. The term 'climate finance' is applied to the financial resources devoted to addressing climate change by all public and private actors from global to local scales, including international financial flows to developing countries to assist them in addressing climate change. Climate finance aims to reduce net *greenhouse gas* emissions and/or to enhance adaptation and increase resilience to the impacts of current and projected climate change. Finance can come from private and public sources, channelled by various intermediaries, and is delivered by a range of instruments, including grants, concessional and non-concessional debt, and internal budget reallocations.

Climate governance See *Governance*.

Climate justice See *Justice*.

Climate model A qualitative or quantitative 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 parametrisations 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 *Simple climate model (SCM)* and *Emulators*.

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 socio-economic and technological developments that may or may not be realised.

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

Transient climate response (TCR)

The surface temperature response for the hypothetical scenario in which atmospheric *carbon dioxide (CO₂)* increases at 1% yr⁻¹

from *pre-industrial* to the time of a doubling of atmospheric CO₂ concentration (year 70).

Transient climate response to cumulative CO₂ emissions (TCRE)

The transient 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)*.

Climate services Climate services involve the provision of climate information in such a way as to assist decision-making. The service includes appropriate engagement from users and providers, is based on scientifically credible information and expertise, has an effective access mechanism, and responds to user needs (Hewitt et al. 2012).

Climate system The global 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 changes 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 variability Deviations of climate variables from a given mean state (including the occurrence of extremes, etc.) at all spatial and temporal scales beyond that of individual weather events. Variability may be intrinsic, due to fluctuations of processes internal to the *climate system (internal variability)*, or extrinsic, due to variations in natural or anthropogenic external forcing (forced variability). See also *Climate change*.

Co-benefits A positive effect that a policy or measure aimed at one objective has on another objective, thereby increasing the total benefit to society or the environment. Co-benefits are also referred to as ancillary benefits. See also *Adverse side-effect* and *Trade-off*.

CO₂ equivalent (CO₂-eq) emission The amount of *carbon dioxide (CO₂)* emission that would have an equivalent effect on a specified key measure of *climate change*, over a specified time horizon, as an emitted amount of another *greenhouse gas (GHG)* or a mixture of other GHGs. For a mix of GHGs, it is obtained by summing the CO₂-equivalent emissions of each gas. There are various ways and time horizons to compute such equivalent emissions (see *greenhouse gas emission metric*). CO₂-equivalent emissions are commonly used to compare emissions of different GHGs, but should not be taken to imply that these emissions have an equivalent effect across all key measures of climate change.

[Note: Under the Paris Rulebook [Decision 18/CMA.1, annex, paragraph 37], parties have agreed to use GWP100 values from the IPCC AR5 or GWP100 values from a subsequent IPCC Assessment Report to report aggregate emissions and removals of GHGs. In addition, parties may use other metrics to report supplemental information on aggregate emissions and removals of GHGs.]

Concentrations scenario See *Scenario*.

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.

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

Conservation agriculture A farming system that promotes minimum soil disturbance (e.g., by using no till practices), maintenance of a permanent soil cover, and diversification of plant species. It aims to prevent *land degradation* and regenerate degraded lands by enhancing *biodiversity* and natural biological processes above and below the ground surface, that contribute to increased water and nutrient use efficiency and improved and sustained crop production (FAO 2016).

Consumption-based emissions Emissions released to the atmosphere in order to generate the goods and services consumed by a certain entity (e.g., a person, firm, country, or region). See also *Production-based emissions*.

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 2012). See also *Resilience*.

Cost-benefit analysis A type of economic evaluation that compares all monetised negative and positive impacts associated with a given action. Cost-benefit analysis enables comparison of different interventions, investments or strategies, and reveals how a given investment or policy effort pays off for a particular person, company or country, or at a global scale. 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 time scales. See also *Discounting*.

Cost-effectiveness analysis (CEA) A type of economic evaluation that compares the costs of different courses of action reaching the same outcome. In this report, CEA focuses on comparing the costs of *mitigation* strategies designed to meet a prespecified *climate change* mitigation goal (e.g., an emission-reduction target or a temperature stabilisation target).

Cumulative emissions The total amount of emissions released over a specified period of time. See also *Carbon budget* and *Transient climate response to cumulative CO₂ emissions (TCRE)*.

Decarbonisation Human actions to reduce *carbon dioxide* emissions from human activities.

Decent Living Standard A set of minimal material requirements essential for achieving basic human *well-being* including nutrition, shelter, basic living conditions, clothing, healthcare, education, and mobility (Rao and Baer 2012; Rao and Min 2018; O'Neill et al. 2018).

Decoupling Decoupling (in relation to climate change) is where economic growth is no longer strongly associated with another relevant indicator such as *greenhouse gas* emissions. Relative decoupling is where both these indicators grow but the other indicators grow

more slowly than the economy. Absolute decoupling is where there is economic growth but there is a decline in the other indicator.

Deforestation Conversion of *forest* to non-forest.

[Note: For a discussion of the term *forest* and related terms such as *afforestation*, *reforestation* and *deforestation*, see the 2006 IPCC Guidelines for National Greenhouse Gas Inventories and their 2019 Refinement, and information provided by the United Nations Framework Convention on Climate Change (IPCC 2006, 2019; UNFCCC 2021a,b).]

See also *Reducing Emissions from Deforestation and Forest Degradation (REDD+)*.

Deliberative governance See *Governance*.

Demand Disciplinary approaches use the term in different ways. In economics, demand by a consumer is willingness and ability to purchase in a marketplace. However, the motivation for purchase may vary and can include economic utility, welfare, *Decent standard of living (DSL)*, or for the good/services.

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 mitigation measures aim at reducing the amount of *greenhouse gas* emissions emitted per unit of energy service used.

Supply-side measures

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

Demand-side management See *Demand-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).

Developed/developing countries (Industrialised/developed/developing countries) There is a diversity of approaches for categorising countries on the basis of their level of development, and for defining terms such as 'industrialised', 'developed', or 'developing'. Several categorisations are used in this report: (i) In the United Nations (UN) system, there is no established convention for the designation of developed and developing countries or areas. (ii) The UN Statistics Division specifies developed and developing regions based on common practice. In addition, specific countries are designated as least developed countries, landlocked developing countries, *Small Island Developing States (SIDS)*, and transition economies. Many countries appear in more than one of these categories. (iii) The World Bank uses income as the main criterion for classifying countries as low, lower middle, upper middle, and high income. (iv) The UN 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.

Development pathway See *Pathways*.

Diet The kinds of food that follow a particular pattern that a person or community eats (FAO and Alliance of Bioversity International and CIAT, 2021).

Direct air capture (DAC) Chemical process by which a pure *carbon dioxide (CO₂)* stream is produced by capturing CO₂ from the ambient air. See also *Anthropogenic removals*, *Carbon dioxide removal (CDR)* and *Direct air carbon dioxide capture and storage (DACCS)*.

Direct air carbon dioxide capture and storage (DACCS) Chemical process by which *carbon dioxide (CO₂)* is captured directly from the ambient air, with subsequent storage. Also known as direct air capture and storage (DAC). See also *Anthropogenic removals*, *Carbon dioxide removal (CDR)* and *Direct air capture (DAC)*.

Direct and indirect services Direct Services: Services (e.g., passenger mobility) required by end-users (consumers). Indirect services: Services required (e.g., goods transport, manufacturing) for provisioning systems of direct services.

Direct emissions Emissions that physically arise from activities within well-defined boundaries of, for instance, a *region*, an economic sector, a company, or a process. See also *Indirect emissions*.

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' (UNGA 2016). See also *Exposure*, *Hazard*, *Risk* and *Vulnerability*.

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 (SD)*.

Discount rate See *Discounting*.

Discounting A mathematical operation that aims to make monetary (or other) amounts received or expended at different times (years) comparable across time. If the discount rate is positive, future values are given less weight than those today. The choice of discount rate(s) is debated as it is a judgement based on hidden and/or explicit values.

Disruptive innovation Demand-led technological change that leads to significant system change and is characterised by strong exponential growth.

Distributive equity See *Equity*.

Drought An exceptional period of water shortage for existing *ecosystems* and the human population (due to low rainfall, high temperature, and/or wind).

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: (i) supporting services such as productivity or biodiversity maintenance; (ii) provisioning services such as food or fibre; (iii) regulating services such as climate regulation or carbon *sequestration*; and (iv) cultural services such as tourism or spiritual and aesthetic appreciation. See also *Ecosystem* and *Nature's Contribution to People*.

Ecosystem-based adaptation (EBA) The use of *ecosystem* management activities to increase the *resilience* and reduce the *vulnerability* of people and *ecosystems* to *climate change* (Campbell et al. 2009).

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' (Davis and Caldeira 2010; Allan 2005; MacDonald et al. 2015).

Emission and Socio-economic Scenario Ensemble A set of modelled emission and socio-economic *scenarios* collected in a database. The scenarios can come from a single multi-model study with systematic variation of harmonised scenario designs (structured ensemble) or from multiple studies in the literature (unstructured ensemble). Depending on the scope of the ensemble, variation of the results across the scenarios in the ensemble give an indication of the spread of results in the literature (unstructured ensemble), or an estimate of uncertainties due to different modelling structures and methodologies (structured ensemble).

Emission factor/Emissions intensity A coefficient that quantifies the emissions or removals of a gas per unit activity. Emission factors are often based on a sample of measurement data, averaged to develop a representative rate of emission for a given activity level under a given set of operating conditions.

Emission pathways See *Pathways*.

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*.

Emissions See *Anthropogenic emissions*, *Direct emissions*, *Cumulative emissions*, *Indirect emissions*, *Consumption-based emissions*, *Production-based emissions* and *Embodied (embedded) [emissions, water, land]*.

Emissions scenario See *Scenario*.

Emulation Reproducing the behaviour of complex, process-based models – namely, Earth System Models (ESMs) – via simpler approaches, using either *emulators* or *simple climate models (SCMs)*. The computational efficiency of emulating approaches opens new analytical possibilities, given that ESMs take a lot of computational resources for each simulation.

Emulators A broad class of heavily parametrised models ('simple climate models'), statistical methods like neural networks, genetic algorithms or other artificial intelligence approaches, designed to reproduce the responses of more complex, process-based Earth System Models (ESMs). The main application of emulators is to extrapolate insights from ESMs and observational constraints to a larger set of emission scenarios. See also *Emulation* and *Simple climate models (SCMs)*.

Enabling conditions (for adaptation and mitigation options)

Conditions that enhance the *feasibility* of *adaptation* and *mitigation* options. Enabling conditions include finance, technological innovation, strengthening policy instruments, *institutional capacity*, *multi-level governance*, and changes in *human behaviour* and lifestyles.

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*.

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.

Energy poverty The absence of sufficient choice in accessing adequate, affordable, reliable, high quality, safe and environmentally benign energy services to support economic and human development (Reddy 2000). See also *Fuel poverty*.

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.

Energy services A benefit or amenity (e.g., mobility, communication, thermal comfort) received as a result of energy or other resources use.

Enhanced weathering A proposed method to increase the natural rate of removal of *carbon dioxide (CO₂)* from the *atmosphere* using silicate and carbonate rocks. The active surface area of these minerals is increased by grinding, before they are actively added to soil, beaches or the open ocean. See also *Anthropogenic removals* and *Carbon dioxide removal (CDR)*.

Ensemble A collection of comparable datasets that reflect variations within the bounds of one or more sources of *uncertainty*, and that when averaged can provide a more robust estimate of underlying behaviour. Ensemble techniques are used by the

observational, reanalysis and modelling communities. See also *Emission and Socio-economic Scenario Ensemble* and *Integrated Assessment Scenario Ensemble*.

Enteric fermentation A natural part of the digestion process in ruminant animal species (domesticated and wild), such as cattle, buffalo, sheep, goats, antelope, etc. Microorganisms (bacteria, archaea, fungi, protozoa and viruses) present in the fore-stomach (reticulorumen or rumen) breakdown plant *biomass* to produce substrates that can be used by the animal for energy and growth with methane produced as a by-product. Fermentation end-products such as hydrogen, *carbon dioxide*, formate and methyl-containing compounds are important substrates for the production of methane by the rumen's methane-forming archaea (known as methanogens).

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*.

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. 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.

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 are basing their findings. See also *Agreement*, *Confidence*, *Likelihood*, and *Uncertainty*.

Exergy Capacity of energy flows to perform useful work. Exergy is a quality (versatility) indicator of energy flows which ranges from low (e.g., low-temperature heat, biomass) to high (e.g., electricity). Exergy efficiency describes how much useful work can be performed by a particular energy flow in relation to the thermodynamic maximum possible. It can be determined for all energy flows and energy conversion steps, also including alternative service delivery systems (Grubler et al. 2012).

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.

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. See also *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 *Equality* and *Equity*.

Feasibility In this report, feasibility refers to the potential for a mitigation or adaptation option to be implemented. Factors influencing feasibility are context-dependent, temporally dynamic, and may vary between different groups and actors. Feasibility depends on geophysical, environmental-ecological, technological, economic, socio-cultural and institutional factors that enable or constrain the implementation of an option. The feasibility of options may change when different options are combined, and increase when enabling conditions are strengthened. See also *Enabling conditions (for adaptation and mitigation options)*.

Final energy The energy delivered to final users (firms, individuals, *institutions*), where it becomes usable energy in supplying energy services (e.g., light, heat, mobility). See also *Primary energy*.

Flexibility (demand and supply) Adjustment of energy load characteristics by technical and/or non-technical change to balance energy demand and supply.

Flexible governance See *Governance*.

Flood The overflowing of the normal confines of a stream or other water body, or the accumulation of water over areas that are not normally submerged. Floods can be caused by unusually heavy rain, for example, during storms and cyclones. Floods include river (fluvial) floods, flash floods, *urban* floods, rain (pluvial) floods, sewer floods, coastal floods, and glacial lake outburst floods (GLOFs).

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 2015).

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. The four pillars of food security are: availability; access; utilisation; and stability. The nutritional dimension is integral to the concept of food security (FAO 2009, 2018).

Access

Economic and/or physical access to food. Economic access is determined by disposable income, food prices and the provision of and access to social support. Physical access is determined by the availability and quality of land and other infrastructure, property rights or the functioning of markets.

Availability

Physical availability of food. Food availability addresses the supply side of food security and is determined by the levels of food production, stocks and net trade.

Stability

The stability of the other three dimensions over time. Even if individuals' food intake is adequate today, they are still considered food-insecure if periodically they have inadequate access to food, risking deterioration of their nutrition status. Adverse weather conditions, political instability or economic factors (unemployment, rising food prices) may have an impact on individuals' food security status.

Utilisation

The way in which the body uses the various nutrients in food. Individuals achieve sufficient energy and nutrient intake through good care and feeding practices, food preparation, diet diversity and intra-household distribution of food. Combined with biological utilisation of the food consumed, energy and nutrient intake determine the nutrition status of individuals.

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.]

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 their 2019 Refinement, and information provided by the United Nations Framework Convention on Climate Change (IPCC 2006, 2019; UNFCCC 2021a,b).]

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

Fuel poverty A condition in which a household is unable to guarantee a certain level of consumption of domestic energy services

(especially heating) or suffers disproportionate expenditure burdens to meet these needs. See also [Energy poverty](#).

Fugitive emissions (oil and natural gas systems) The release of [greenhouse gases](#) that occur during the exploration, processing and delivery of [fossil fuels](#) to the point of final use. This excludes [greenhouse gas emissions](#) from fuel combustion for the production of useful heat or power. It encompasses venting, flaring, and leaks.

Gender equity See [Equity](#).

Geothermal energy Accessible thermal energy stored in the Earth's interior, in both rock and trapped steam or liquid water (hydrothermal resources), which may be used to generate electric energy in a thermal power plant, or to supply heat to any process requiring it. The main sources of geothermal energy are the residual energy available from planet formation and the energy continuously generated from radionuclide decay. See also [Renewable energy](#).

Gini coefficient A statistical measure of dispersion in a distribution and degree of mathematical measure of [inequality](#). For example, it can be used for measuring inequality in income, wealth, carbon emissions, and access to well-being defining services. The dimensionless GINI coefficient ranges between 0 (absolute [equality](#)) and 1 (absolute inequality).

Global carbon budget See [Carbon budget](#).

Global mean surface air temperature (GSAT) Global average of near-surface air temperatures over land, oceans and sea ice. Changes in GSAT are often used as a measure of global temperature change in [climate models](#). See also [Global mean surface temperature \(GMST\)](#).

Global mean surface temperature (GMST) Estimated global average of near-surface air temperatures over land and sea ice, and [sea surface temperature \(SST\)](#) over ice-free ocean regions, with changes normally expressed as departures from a value over a specified [reference period](#). See also [Global mean surface air temperature \(GSAT\)](#).

Global warming Global warming refers to the increase in [global surface temperature](#) relative to a baseline [reference period](#), averaging over a period sufficient to remove interannual variations (e.g., 20 or 30 years). A common choice for the baseline is 1850–1900 (the earliest period of reliable observations with sufficient geographic coverage), with more modern baselines used depending upon the application. See also [Climate change](#) and [Climate variability](#).

Global warming potential (GWP) An index measuring the [radiative forcing](#) following an emission of a unit mass of a given substance, accumulated over a chosen time horizon, relative to that of the reference substance, [carbon dioxide \(CO₂\)](#). The GWP thus represents the combined effect of the differing times these substances remain in the atmosphere, and their effectiveness in causing radiative forcing. See also [Greenhouse gas emission metric](#).

Governance The structures, processes, and actions through which private and public actors interact to address societal goals. This includes formal and informal [institutions](#) and the associated norms, rules, laws and procedures for deciding, managing, implementing and monitoring policies and measures at any geographic or political scale, from global to local.

Adaptive governance

Adjusting to changing conditions, such as climate change, through governance interactions that seek to maintain a desired state in a social-ecological system.

Climate governance

The structures, processes, and actions through which private and public actors seek to mitigate and adapt to climate change.

Deliberative governance

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 preceded 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 policymaking, often through incremental, experimental and iterative management processes.

Multi-level governance

The dispersion of governance across multiple levels of jurisdiction and decision-making, including, global, regional, national and local, as well as trans-regional and trans-national 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 The ability of governance [institutions](#), leaders, and non-state and civil society to plan, coordinate, 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. See also [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](#), for example, systems with vegetation that fall below the threshold used in the [forest](#) land category, silvo-pastoral systems, as well as natural, managed grasslands and semi-deserts.

Green Climate Fund (GCF) The GCF was established by the 16th Session of the [Conference of the Parties \(COP\)](#) in 2010 as an operating entity of the financial mechanism of the [United Nations Framework Convention on Climate Change \(UNFCCC\)](#), in accordance with Article 11 of the Convention, to support projects, programmes and policies and other activities in developing country Parties. The Fund is governed by a Board and will receive guidance of the COP. See also [Climate finance](#).

Green infrastructure See *Infrastructure*.

Greenhouse gas emission metric A simplified relationship used to quantify the effect of emitting a unit mass of a given *greenhouse gas (GHG)* on a specified key measure of *climate change*. A relative GHG emission metric expresses the effect from one gas relative to the effect of emitting a unit mass of a reference GHG on the same measure of climate change. There are multiple emission metrics, and the most appropriate metric depends on the application. GHG emission metrics may differ with respect to: (i) the key measure of climate change they consider; (ii) whether they consider climate outcomes for a specified point in time or integrated over a specified time horizon; (iii) the time horizon over which the metric is applied; (iv) whether they apply to a single emission pulse, emissions sustained over a period of time, or a combination of both; and (v) whether they consider the climate effect from an emission compared to the absence of that emission or compared to a reference emissions level or climate state.

[Note: Most relative GHG emission metrics (such as the *global warming potential (GWP)*, global temperature change potential (GTP), global damage potential, and GWP*), use carbon dioxide (*CO₂*) as the reference gas. Emissions of non-*CO₂* gases, when expressed using such metrics, are often referred to as ‘carbon dioxide equivalent’ emissions. A metric that establishes equivalence regarding one key measure of the *climate system* response to emissions does not imply equivalence regarding other key measures. The choice of a metric, including its time horizon, should reflect the policy objectives for which the metric is applied.]

Greenhouse gas neutrality Condition in which metric-weighted anthropogenic *greenhouse gas (GHG)* emissions associated with a subject are balanced by metric-weighted *anthropogenic* GHG removals. The subject can be an entity such as a country, an organisation, a district or a commodity, or an activity such as a service and an event. GHG neutrality is often assessed over the lifecycle, including indirect (‘scope 3’) emissions, but can also be limited to the emissions and removals, over a specified period, for which the subject has direct control, as determined by the relevant scheme. The quantification of GHG emissions and removals depends on the GHG emission metric chosen to compare emissions and removals of different gases, as well as the time horizon chosen for that metric.

[Note 1: Greenhouse gas neutrality and net-zero greenhouse gas emissions are overlapping concepts. The concepts can be applied at global or sub-global scales (e.g., regional, national and sub-national). At a global scale, the terms greenhouse gas neutrality and net-zero greenhouse gas emissions are equivalent. At sub-global scales, net-zero GHG emissions is generally applied to emissions and removals under direct control or territorial responsibility of the reporting entity, while GHG neutrality generally includes emissions and removals within and beyond the direct control or territorial responsibility of the reporting entity. Accounting rules specified by GHG programmes or schemes can have a significant influence on the quantification of relevant emissions and removals.]

Note 2: Under the Paris Rulebook (Decision 18/CMA.1, annex, paragraph 37), parties have agreed to use GWP100 values from the IPCC AR5 or GWP100 values from a subsequent IPCC Assessment Report to report aggregate emissions and removals of GHGs. In addition, parties may use other metrics to report supplemental information on aggregate emissions and removals of GHGs.

Note 3: In some cases, achieving greenhouse gas neutrality may rely on the supplementary use of *offsets* to balance emissions that remain after actions by the reporting entity are taken into account.]

See also *Carbon neutrality*, *Greenhouse gas emission metric*, *Land use*, *Land-use change and forestry (LULUCF)* and *Net-zero greenhouse gas emissions*.

Greenhouse gases (GHGs) Gaseous constituents of the *atmosphere*, both natural and *anthropogenic*, that absorb and emit radiation at specific wavelengths within the spectrum of radiation emitted by the Earth’s surface, by 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. Human-made GHGs include sulphur hexafluoride (*SF₆*), hydrofluorocarbons (HFCs), chlorofluorocarbons (CFCs) and perfluorocarbons (PFCs); several of these are also *O₃-depleting* (and are regulated under the Montreal Protocol).

Grey infrastructure See *Infrastructure*.

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.

Human behaviour The responses of persons or groups to a particular situation, here likely to relate to *climate change*. Human behaviour covers the range of actions by individuals, communities, *organisations*, governments and at the international level.

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 (OHCHR 2018).

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.

Hydropower Power harnessed from the flow of water. See also [Renewable energy](#).

Impacts The consequences of realised [risks](#) on natural and [human systems](#), where risks result from the interactions of climate-related [hazards](#) (including [extreme weather/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](#), [Loss and Damage](#), and [losses and damages](#).

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 emissions Emissions that are a consequence of the activities within well-defined boundaries of, for instance, a [region](#), an economic sector, a company or process, but which occur outside the specified boundaries. For example, emissions are described as indirect if they relate to the use of heat but physically arise outside the boundaries of the heat user, or to electricity production but physically arise outside of the boundaries of the power supply sector. See also [Direct emissions](#).

Indirect land-use change (iLUC) See [Land-use change \(LUC\)](#).

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 \(CO₂\)](#).

Inequality See [Equality](#).

Infrastructure The designed and built set of physical systems and corresponding [institutional](#) arrangements that mediate between people, their communities, and the broader environment to provide services that support economic growth, health, quality of life, and safety (Chester 2019; Dawson et al. 2018).

Blue infrastructure

Blue infrastructure includes bodies of water, watercourses, ponds, lakes and storm drainage, that provide ecological and hydrological functions including evaporation, transpiration, drainage, infiltration, and temporary storage of runoff and discharge.

Green infrastructure

The strategically planned interconnected set of natural and constructed ecological systems, green spaces and other landscape features that can provide functions and services including air

and water purification, temperature management, floodwater management and coastal defence often with co-benefits for people and biodiversity. Green infrastructure includes planted and remnant native vegetation, soils, wetlands, parks and green open spaces, as well as building and street-level design interventions that incorporate vegetation (Bobbins and Culwick 2016).

Grey infrastructure

Engineered physical components and networks of pipes, wires, roads, tracks that underpin energy, transport, communications (including digital), built form, water and sanitation and solid waste management systems.

Social infrastructure

The social, cultural, and financial activities and institutions as well as associated property, buildings and artefacts and policy domains such as social protection, health and education that support well-being and public life (Latham and Layton 2019; Frolova et al. 2016).

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). See also [Governance](#) and [Institutions](#).

Institutions Rules, norms and conventions that guide, constrain or enable human behaviours and practices. Institutions can be formally established, for instance through laws and regulations, or informally established, for instance by traditions or customs. Institutions may spur, hinder, strengthen, weaken or distort the emergence, adoption and implementation of climate action and climate governance.

[Note: Institutions can also refer to a large organisation.]

See also [Institutional capacity](#).

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 with respect to 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](#). See also [Integrated Assessment Scenario Ensemble](#).

Integrated Assessment Scenario Ensemble A set of modelled scenarios from an intercomparison of *integrated assessment models (IAMs)* based on a systematic variation of harmonised scenario designs.

Inter-generational equity See *Equity*.

Internet of Things (IoT) The network of computing devices embedded in everyday objects such as cars, phones and computers, connected via the internet, enabling them to send and receive data.

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

Just transitions A set of principles, processes and practices that aim to ensure that no people, workers, places, sectors, countries or regions are left behind in the transition from a high-carbon to a low-carbon economy. It stresses the need for targeted and proactive measures from governments, agencies, and authorities to ensure that any negative social, environmental or economic impacts of economy-wide transitions are minimised, whilst benefits are maximised for those disproportionately affected. Key principles of just transitions include: respect and dignity for vulnerable groups; fairness in energy access and use, social dialogue and democratic consultation with relevant stakeholders; the creation of decent jobs; social protection; and rights at work. Just transitions could include fairness in energy, land use and climate planning and decision-making processes; economic diversification based on low-carbon investments; realistic training/retraining programmes that lead to decent work; gender-specific policies that promote equitable outcomes; the fostering of international cooperation and coordinated multilateral actions; and the eradication of poverty. Lastly, just transitions may embody the redressing of past harms and perceived injustices (ILO 2015; UNFCCC 2016).

Justice Justice is concerned with ensuring that people get what is due to them, setting out the moral or legal principles of *fairness* and *equity* in the way people are treated, often based on the ethics and values of society.

Climate justice

Justice that links development and human rights to achieve a human-centred approach to addressing *climate change*, safeguarding the rights of the most vulnerable people and sharing the burdens and benefits of climate change and its impacts equitably and fairly (MRFCJ 2018).

Kaya identity In this identity, global emissions are equal to the population size, multiplied by per capita output (gross world product), multiplied by the energy intensity of production, multiplied by the carbon intensity of energy.

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 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, 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.]

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).

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.]

See also *Desertification*.

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 2020).

Land management Sum of land-use practices (e.g., sowing, fertilising, 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.

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 (IPBES 2018; McDonald et al. 2016).

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 *greenhouse gas (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 and their 2019 Refinement for details (IPCC 2006, 2019)).

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 and their 2019 Refinement, ‘anthropogenic’ land-related GHG fluxes are defined as all those occurring on ‘managed land’, that is, ‘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 (IPCC 2006, 2019).

Land-use change (LUC) The change from one *land use* category to another. Note that, in some scientific literature, land-use change encompasses changes in land-use categories as well as changes in land management. See also *Afforestation, Agriculture, Forestry and Other Land Use (AFOLU), Deforestation, Land use, land-use change and forestry (LULUCF), and Reforestation*.

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.

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.

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

Leapfrogging The ability of developing countries to bypass intermediate technologies and jump straight to advanced clean technologies.

Lifecycle assessment (LCA) Compilation and evaluation of the inputs, outputs and the potential environmental impacts of a product or service throughout its lifecycle (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, Confidence, Evidence, and Uncertainty*.

Livelihood The resources used and the activities undertaken in order for people 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 (LK) 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. See also *Path dependence*.

Long-lived greenhouse gases (LLGHGs) 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 time scales, and their effect on *climate* hence persists for decades to centuries after their emission. On time scales of decades to a century already emitted emissions of long-lived climate forcers can only be abated by greenhouse gas removal (GGR).

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 International Mechanism for 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, and can be economic or non-economic (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). See also *Managed land*.

[Note: For a discussion of the term ‘forest’ in the context of National GHG inventories, see the 2006 IPCC Guidelines for National GHG Inventories (IPCC 2006).]

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'. 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 IPCC 2006 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.

Material substitution Replacement of one material (including an energy carrier used as a feedstock) by another, due to scarcity, price, technological change, or because of lower environmental impacts or *greenhouse gas emissions*.

Measurement, Reporting and Verification (MRV)

Measurement

'Processes 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 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).

Megacity Urban agglomerations with 10 million inhabitants or more. See also *City*.

Methane (CH₄) The *greenhouse gas (GHG)* 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. Under future *global warming*, there is potential for increased methane emissions from thawing permafrost, wetlands and sub-sea gas hydrates. See also *Short-lived climate forcers (SLCFs)*.

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).

Migration (of humans) 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).

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

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

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

Mitigation pathways See *Pathways*.

Mitigation potential The quantity of net *greenhouse gas* emission reductions that can be achieved by a given *mitigation option* relative to specified emission baselines.

[Note: Net greenhouse gas emissions reduction is the sum of reduced emissions and/or enhanced *sinks*.]

See also *Sequestration potential*.

Biogeophysical potential

The mitigation potential constrained by biological, geophysical and geochemical limits and thermodynamics, without taking into account technical, social, economic and/or environmental considerations.

Economic potential

The portion of the technical potential for which the social benefits exceed the social costs, taking into account a social discount rate and the value of externalities.

Technical potential

The mitigation potential constrained by biogeophysical limits as well as availability of technologies and practices. Quantification of technical potentials takes into account primarily technical considerations, but social, economic and/or environmental considerations are occasionally also included, if these represent strong barriers for the deployment of an option.

Mitigation scenario See *Scenario*.

Multi-level governance See *Governance*.

Narrative See *Storyline*.

Nature's contributions to people (NCP) All the contributions, both positive and negative, of living nature (i.e., diversity of organisms, *ecosystems*, and their associated ecological and evolutionary processes) to the quality of life for people. Beneficial contributions from nature include such things as food provision,

water purification, flood control, and artistic inspiration, whereas detrimental contributions include disease transmission and predation that damages people or their assets. Many NCP may be perceived as benefits or detriments depending on the cultural, temporal or spatial context (Díaz et al. 2018). See also *Ecosystem services*.

Nature-based solutions Actions to protect, sustainably manage and restore natural or modified ecosystems that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits (IUCN 2016). See also *Biodiversity* and *Ecosystem*.

Net negative greenhouse gas emissions A situation of net negative greenhouse gas emissions is achieved when metric-weighted *anthropogenic greenhouse gas (GHG)* removals exceed metric-weighted anthropogenic GHG emissions. Where multiple GHG are involved, the quantification of net emissions depends on the 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 *Carbon dioxide removal (CDR)*, *Greenhouse gas emission metric*, *Net-zero CO₂ emissions*; *Net-zero greenhouse gas emissions*, and *Negative greenhouse gas emissions*.

Net-zero CO₂ emissions Condition in which *anthropogenic carbon dioxide (CO₂)* emissions are balanced by anthropogenic CO₂ removals over a specified period.

[Note: *Carbon neutrality* and net-zero CO₂ emissions are overlapping concepts. The concepts can be applied at global or sub-global scales (e.g., regional, national and sub-national). At a global scale, the terms *carbon neutrality* and net-zero CO₂ emissions are equivalent. At sub-global scales, net-zero CO₂ emissions is generally applied to emissions and removals under direct control or territorial responsibility of the reporting entity, while *carbon neutrality* generally includes emissions and removals within and beyond the direct control or territorial responsibility of the reporting entity. Accounting rules specified by GHG programmes or schemes can have a significant influence on the quantification of relevant CO₂ emissions and removals.]

See also *Carbon neutrality*, *Land use, land-use change and forestry (LULUCF)* and *Net-zero greenhouse gas emissions*.

Net-zero greenhouse gas emissions Condition in which metric-weighted *anthropogenic greenhouse gas (GHG)* emissions are balanced by metric-weighted anthropogenic GHG removals over a specified period. The quantification of net-zero GHG emissions depends on the *GHG emission metric* chosen to compare emissions and removals of different gases, as well as the time horizon chosen for that metric.

[Note 1: Greenhouse gas neutrality and net-zero GHG emissions are overlapping concepts. The concept of net-zero GHG emissions can be applied at global or sub-global scales (e.g., regional, national and sub-national). At a global scale, the terms GHG neutrality and net-zero GHG emissions are equivalent. At sub-global scales, net-zero GHG emissions is generally applied to emissions and removals under direct control or territorial responsibility of the reporting entity, while GHG neutrality generally includes anthropogenic emissions and anthropogenic removals within and beyond the direct control or territorial responsibility of the reporting entity. Accounting rules specified by GHG programmes or schemes can have a significant influence on the quantification of relevant emissions and removals.]

Note 2: Under the Paris Rulebook (Decision 18/CMA.1, annex, paragraph 37), parties have agreed to use GWP100 values from the IPCC AR5 or GWP100 values from a subsequent IPCC Assessment Report to report aggregate emissions and removals of GHGs. In addition, parties may use other metrics to report supplemental information on aggregate emissions and removals of GHGs.]

See also *Greenhouse gas neutrality*, *Net-zero CO₂ emissions*, and *Land use, land-use change and forestry (LULUCF)*.

Nitrous oxide (N₂O) The main *anthropogenic* source of N₂O, a *greenhouse gas (GHG)*, 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*.

Ocean alkalisation/Ocean alkalinity enhancement A proposed *carbon dioxide removal (CDR)* method that involves deposition of alkaline minerals or their dissociation products at the ocean surface. This increases surface total alkalinity, and may thus increase ocean *carbon dioxide (CO₂)* uptake and ameliorate surface ocean acidification. See also *Anthropogenic removals*.

Ocean fertilisation A proposed *carbon dioxide removal (CDR)* method that relies on the deliberate increase of nutrient supply to the near-surface *ocean* with the aim of *sequestering* additional CO₂ from the *atmosphere* through biological production. Methods include direct addition of micro-nutrients or macro-nutrients. To be successful, the additional carbon needs to reach the deep ocean where it has the potential to be sequestered on climatically relevant time scales. See also *Anthropogenic removals*.

Offset (in climate policy) The reduction, avoidance or removal of a unit of *greenhouse gas (GHG)* emissions by one entity, purchased by another entity to counterbalance a unit of GHG emissions by that other entity. Offsets are commonly subject to rules and environmental integrity criteria intended to ensure that offsets achieve their stated mitigation outcome. Relevant criteria include, but are not limited to, the avoidance of double counting and *leakage*, use of appropriate baselines, *additionality*, and permanence or measures to address impermanence. See also *Greenhouse gas emission metric* and *Carbon neutrality*.

Organic farming An agricultural production system that aims to utilise natural processes and cycles to limit off-farm and notably synthetic inputs, while also aiming to enhance agroecosystems and society. Organic farming is often legally defined and governed by standards, typically guided by principles outlined by the International Federation of Organic Agriculture Movements (IFOAM – Organics International) (IFOAM – Organics International 2014).

Overshoot pathways See *Pathways*.

Ozone (O₃) The triatomic form of oxygen, and a gaseous *atmospheric* constituent. In the troposphere, O₃ is created both naturally and by photochemical reactions involving gases resulting from human activities (e.g., smog). Tropospheric O₃ acts as a *greenhouse gas (GHG)*. In the stratosphere, O₃ is created by the interaction between solar ultraviolet radiation and molecular oxygen

(O₂). Stratospheric O₃ plays a dominant role in the stratospheric radiative balance. Its concentration is highest in the ozone layer.

Pareto optimum A state in which no one's welfare can be increased without reducing someone else's welfare.

Participatory governance See *Governance*.

Particulate matter (PM) Atmospheric aerosols involved in air pollution issues. Of greatest concern for health are particles of aerodynamic diameter less than or equal to 10 micrometers, usually designated as PM₁₀ and particles of diameter less than or equal to 2.5 micrometers, usually designated as PM_{2.5}.

Path dependence The generic situation where decisions, events, or outcomes at one point in time constrain *adaptation*, *mitigation*, or other actions or options at a later point in time. See also *Lock-in*.

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. See also *Scenario* and *Storyline*.

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.

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*.

Climate-resilient pathways

Iterative processes for managing change within complex systems in order to reduce disruptions and enhance opportunities associated with climate change.

Development pathways

Development pathways evolve as the result of the countless decisions being made and actions being taken at all levels of societal structure, as well due to the emergent dynamics within and between institutions, cultural norms, technological systems and other drivers of behavioural change.

See also *Shifting development pathways (SDPs)* and *Shifting development pathways to sustainability (SDPS)*.

Emission pathways

Modelled trajectories of global *anthropogenic emissions* over the 21st century.

Mitigation pathways

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

Non-overshoot pathways

Pathways that stay below a specified concentration, *forcing*, or global warming level during a specified period of time (e.g., until 2100).

Overshoot pathways

Pathways that first exceed a specified concentration, *forcing*, or global warming level, and then return to or below that level again before the end of a specified period of time (e.g., before 2100). Sometimes the magnitude and likelihood of the overshoot is also characterised. The overshoot duration can vary from one pathway to the next, but in most overshoot pathways in the literature and referred to as overshoot pathways in the AR6, the overshoot occurs over a period of at least one decade and up to several decades.

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. 2010). 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 that not only the long-term concentration levels are of interest, but also the trajectory taken over time to reach that outcome (Moss et al. 2010).

RCPs usually refer to the portion of the concentration pathway extending up to 2100, for which *integrated assessment models* produced corresponding emission scenarios. Extended concentration pathways describe extensions of the RCPs from 2100 to 2300 that were calculated using simple rules generated by stakeholder consultations, and do not represent fully consistent scenarios. Four RCPs produced from integrated assessment models were selected from the published literature and used in the Fifth IPCC Assessment, and are also used in this Assessment for comparison, spanning the range from approximately below 2°C warming to high (>4°C) warming best-estimates by the end of the 21st century: RCP2.6, RCP4.5 and RCP6.0 and RCP8.5.

- 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 W m⁻² in 2100 (the corresponding ECP has constant emissions after 2100 until 2150 and constant concentrations after 2250).

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

Shared Socio-economic Pathways (SSPs)

SSPs have been developed to complement the *Representative Concentration Pathways (RCPs)*. By design, the RCP emission and concentration pathways were stripped of their association with a certain socio-economic development. Different levels of *emissions* and *climate change* along the dimension of the RCPs can hence be explored against the backdrop of different socio-economic development pathways (SSPs) on the other dimension in a matrix. This integrative SSP-RCP framework is now widely used in the climate *impact* and policy analysis literature, where *climate projections*

obtained under the RCP scenarios are analysed against the backdrop of various SSPs. As several emission updates were due, a new set of emission scenarios was developed in conjunction with the SSPs. Hence, the abbreviation SSP is now used for two things: On the one hand SSP1, SSP2, ..., SSP5 are used to denote the five socio-economic scenario families. On the other hand, the abbreviations SSP1-1.9, SSP1-2.6, ..., SSP5-8.5 are used to denote the newly developed emission scenarios that are the result of an SSP implementation within an integrated assessment model. Those SSP scenarios are bare of climate policy assumption, but in combination with so-called shared policy assumptions (SPAs), various approximate *radiative forcing* levels of 1.9, 2.6, ..., or 8.5 W m⁻² are reached by the end of the century, respectively.

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.

Peri-urban areas Dynamic transition zones that have intense interaction between rural and *urban* economies, activities, households, and lifestyles. Neither fully rural or urban (Seto et al. 2010).

Policies (for climate change mitigation and adaptation)

Strategies that enable actions to be undertaken to accelerate *adaptation* and *mitigation*. Policies include those developed by national and subnational public agencies, and with the private sector. Policies for adaptation and mitigation often take the form of economic incentives, regulatory instruments, and decision-making and engagement processes.

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. See also *Sequestration*, *Sink*, *Source* and *Uptake*.

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).

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.

Pre-industrial (period) 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 energy The energy that is embodied in resources as they exist in nature (e.g., coal, biomass uranium, solar radiation, wind, ocean currents) (Grubler et al. 2012).

[Note: Primary energy is defined in several alternative ways. The method used in this report is the direct equivalent method, which counts one unit of secondary energy provided from non-combustible sources as one unit of primary energy. For more details on the methodology, see Section 7 in Working Group III Annex II.]

See also *Final energy*.

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, for example, in deep sea vents.

Private costs Costs carried by individuals, companies or other private entities that undertake an action, whereas *social costs* include additionally the external costs on the environment and on society as a whole. Quantitative estimates of both private and social costs may be incomplete, because of difficulties in measuring all relevant effects.

Production-based emissions Emissions released to the *atmosphere* for the production of goods and services by a certain entity (e.g., a person, firm, country, or region). See also *Consumption-based emissions*.

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*, *Pathways* and *Scenario*.

Prosumers A consumer that also produces energy and inputs energy to the system, for which it is an active agent in the energy system and market.

Radiative forcing The change in the net, downward minus upward, radiative flux (expressed in W m⁻²) due to a change in an external driver of *climate change*, such as a change in the concentration of *carbon dioxide (CO₂)*, the concentration of volcanic *aerosols* or in the output of the Sun. The stratospherically adjusted 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 both stratospheric and tropospheric adjustments are accounted for is termed the 'effective radiative forcing'.

Rebound effect Phenomena whereby the reduction in energy consumption or emissions (relative to a baseline) associated with the implementation of *mitigation measures* in a jurisdiction is offset to some degree through induced changes in consumption, production, and prices within the same jurisdiction. The rebound effect is most typically ascribed to technological energy efficiency improvements.

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 A time period of interest, or a period over which some relevant statistics are calculated. A reference period can be used as a *baseline period* or as a comparison to a baseline period.

Baseline period

A time period against which differences are calculated (e.g., expressed as anomalies relative to a baseline).

Reference scenario See *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*, see the 2006 IPCC Guidelines for National Greenhouse Gas Inventories and their 2019 Refinement, and information provided by the United Nations Framework Convention on Climate Change (IPCC 2006, 2019; UNFCCC 2021a,b).]

See also *Anthropogenic removals*, *Carbon dioxide removal (CDR)* and *Reducing Emissions from Deforestation and Forest Degradation (REDD+)*.

Regenerative agriculture A universally agreed definition of this relatively new farming approach has yet to be established, but regenerative agriculture broadly refers to the implementation of varying combinations of agricultural management practices, to ensure the continued restoration and enhancement of soil health, *biodiversity* and *ecosystem* functioning, in conjunction with profitable agricultural production.

Region *Land* and/or *ocean* area characterised by specific geographical and/or climatological features. The *climate* of a region emerges from a multi-scale combination of its own features, remote influences from other regions, and global climate conditions.

Remaining carbon budget See *Carbon budget*.

Renewable energy (RE) Any form of energy that is replenished by natural processes at a rate that equals or exceeds its rate of use.

Variable renewable energy (VRE)

Renewable energy sources such as *wind* and *solar energy* whose output is determined by weather, in contrast to 'dispatchable' generators that adjust their output as a reaction to economic incentives. Variable renewables have also been termed intermittent, fluctuating, or non-dispatchable (Hirth 2013).

Representative Concentration Pathways (RCPs) See *Pathways*.

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 (Arctic Council 2016). See also *Hazard*, *Risk* and *Vulnerability*.

Resource cascade Tracking resource use (materials, energy, water, etc.), efficiency and losses through all conversion steps from primary resource extraction to various conversion steps, all the way to final service delivery.

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 (SDGs)* (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.

See also *Hazard* and *Impacts*.

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 judgement that people make about the characteristics and severity of a *risk*. See also *Risk assessment*, and *Risk management*.

Risk trade-off The change in the 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).

Sea surface temperature (SST) The subsurface bulk temperature in the top few metres 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.

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, 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.

Baseline scenario

See *Reference Scenario* (under *Scenario*).

Concentrations scenario

A plausible representation of the future development of atmospheric concentrations of substances that are radiatively active (e.g., *greenhouse gases*, *aerosols*, tropospheric *ozone*), plus human-induced *land cover changes* that can be radiatively active via *albedo* changes, and often used as input to a *climate model* to compute *climate projections*.

Emissions scenario

A plausible representation of the future development of emissions of substances that are radiatively active (e.g., *greenhouse gases* or *aerosols*), plus human-induced land-cover changes that can be radiatively active via *albedo* changes, 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*.

Mitigation scenario

A plausible description of the future that describes how the (studied) system responds to the implementation of *mitigation* policies and measures.

Reference scenario

Scenario used as starting or reference point for a comparison between two or more scenarios.

[Note 1: In many types of *climate change* research, reference scenarios reflect specific assumptions about patterns of socio-economic development and may represent futures that assume no climate policies or specified climate policies, for example, those in place or planned at the time a study is carried out. Reference scenarios may also represent futures with limited or no climate impacts or adaptation, to serve as a point of comparison for futures with impacts and adaptation. These are also referred to as ‘baseline scenarios’ in the literature.

Note 2: Reference scenarios can also be climate policy or impact scenarios, which in that case are taken as a point of comparison to explore the implications of other features, for example, of delay, technological options, policy design and strategy or to explore the effects of additional impacts and adaptation beyond those represented in the reference scenario.

Note 3: The term *business as usual* scenario has been used to describe a scenario that assumes no additional policies beyond those currently in place, and where patterns of socio-economic development are consistent with recent trends. The term is now used less frequently than in the past.

Note 4: In climate change attribution or impact attribution research reference scenarios may refer to counterfactual historical scenarios assuming no anthropogenic *greenhouse gas (GHG)* emissions (climate change attribution) or no climate change (impact attribution).]

Socio-economic scenario

A scenario that describes a plausible future in terms of population, *gross domestic product (GDP)*, and other socio-economic factors relevant to understanding the implications of *climate change*.

Scenario storyline See *Storyline*.

Sequestration The process of storing carbon in a carbon pool. See also *Pool, carbon and nitrogen, Sequestration potential, Sink, Soil carbon sequestration (SCS), Source, and Uptake*.

Sequestration potential The quantity of *greenhouse gases* that can be removed from the *atmosphere* by anthropogenic enhancement of *sinks* and stored in a pool. See *Mitigation potential* for different subcategories of sequestration potential. See also *Pool, carbon and nitrogen, Sequestration, Sink, Source, and Uptake*.

Service provisioning Various services (such as illumination and mobility) can be provided by ‘systems’ through the use of energy, materials, and other resources comprising: (i) Resource flows (e.g., energy); (ii) Technologies for resource use and energy conversion (e.g., vehicles and their engines); and (iii) Social/organisational forms of service delivery (e.g., publicly owned companies, or privately owned companies, e-commerce).

Services Activities that help satisfy human wants or needs. While they usually involve relationships between producers and consumers, services are less tangible and less storable than goods since they represent flows not stocks, and when their regeneration conditions are protected they may be reused over time.

Settlements Places of concentrated human habitation. Settlements can range from isolated rural villages to *urban regions* with significant global influence. They can include formally planned and informal or illegal habitation and related infrastructure. See also *Cities* and *Urban*.

Shared policy assumptions (SPAs) See *Shared Socio-economic Pathways (SSPs)*.

Shared Socio-economic Pathways (SSPs) See *Pathways*.

Sharing economy A system which allows people to share goods and services by enabling collaborative use, access or ownership.

Shifting development pathways (SDPs) In this report, shifting development pathways describes transitions aimed at re-directing existing developmental trends. Societies may put in place *enabling conditions* to influence their future development pathways, when they endeavour to achieve certain outcomes. Some outcomes may be common, while others may be context-specific, given different starting points. See also *Development pathways* (under *Pathways*), and *Shifting development pathways to sustainability*.

Shifting development pathways to sustainability Shifting development pathways to sustainability involves transitions aligned with a shared aspiration in the *Sustainable Development Goals (SDGs)* agreed globally, though sustainability may be interpreted differently in various contexts as societies pursue a variety of sustainable development objectives. See also *Development pathways* (under *Pathways*), and *Shifting development pathways (SDPs)*.

Short-lived climate forcers (SLCFs) A set of chemically reactive compounds with short (relative to *carbon dioxide*) atmospheric

lifetimes (from hours to about two decades) but characterised by different physiochemical properties and environmental effects. Their emission or formation has a significant effect on radiative forcing over a period determined by their respective atmospheric lifetimes. Changes in their *emissions* can also induce long-term *climate* effects via, in particular, their interactions with some biogeochemical cycles. SLCFs are classified as direct or indirect, with direct SLCFs exerting climate effects through their *radiative forcing* and indirect SLCFs being the *precursors* of other direct climate forcers. Direct SLCFs include *methane (CH₄)*, *ozone (O₃)*, primary *aerosols* and some halogenated species. Indirect SLCFs are *precursors* of ozone or secondary aerosols. SLCFs can be cooling or warming through interactions with radiation and clouds. They are also referred to as near-term climate forcers. Many SLCFs are also air pollutants. A subset of exclusively warming SLCFs is also referred to as short-lived climate pollutants (SLCPs), including methane, ozone, and *black carbon (BC)*.

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

Simple climate model (SCM) A broad class of lower-dimensional models of the energy balance, radiative transfer, *carbon cycle*, or a combination of such physical components. SCMs are also suitable for performing emulations of climate-mean variables of Earth System Models (ESMs), given that their structural flexibility can capture both the parametric and structural uncertainties across process-oriented ESM responses. They can also be used to test consistency across multiple lines of evidence with regard to *climate sensitivity* ranges, *transient climate responses (TCRs)*, *transient climate response to cumulative CO₂ emissions (TCREs)* and *carbon cycle* feedbacks. See also *Emulators*.

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 (UNFCCC 1992)). See also *Pool, carbon and nitrogen, Sequestration, Source* and *Uptake*.

Small Island Developing States (SIDS) SIDS, as recognised by the United Nations OHRLLS (UN 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).

Smart grids A smart grid uses information and communications technology to gather data on the behaviours of suppliers and consumers in the production, distribution, and use of electricity. Through automated responses or the provision of price signals, this information can then be used to improve the efficiency, reliability, economics, and sustainability of the electricity network.

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 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 group A collective of people who share similar characteristics and collectively may have a sense of unity (Forsyth 2010).

Social identity The portion of an individual's self-concept derived from perceived membership in a relevant *social group* (Tajfel and Turner 1986).

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 (UNDESA 2018).

Social infrastructure See *Infrastructure*.

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

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 (Berkes and Folke 1998; Arctic Council 2016).

Socio-economic scenario See *Scenario*.

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

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*. See also *Anthropogenic removals* and *Carbon dioxide removal (CDR)*.

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.

Solar energy Energy from the Sun. Often the phrase is used to mean energy that is captured from solar radiation either as heat, as light that is converted into chemical energy by natural or artificial photosynthesis, or by photovoltaic panels and converted directly into electricity. See also *Renewable energy*.

Solar radiation modification (SRM) Refers to a range of radiation modification measures not related to *greenhouse gas (GHG)* mitigation that seek to limit *global warming*. Most methods involve reducing the amount of incoming solar radiation reaching the surface, but others also act on the longwave radiation budget by reducing optical thickness and cloud lifetime.

Source Any process or activity which releases a *greenhouse gas (GHG)*, an *aerosol* or a *precursor* of a GHG into the *atmosphere*

(UNFCCC Article 1.9 (UNFCCC 1992)). See also *Sink*, *Pool*, *carbon and nitrogen*, *Sequestration*, *Sequestration Potential* and *Uptake*.

Spill-over effect The effects of domestic or sector mitigation measures on other countries or sectors. Spill-over effects can be positive or negative and include effects on trade, (carbon) *leakage*, transfer of innovations, and diffusion of environmentally sound technology and other issues.

Storyline A way of making sense of a situation or a series of events through the construction of a set of explanatory elements. Usually, it is built on logical or causal reasoning. In *climate* research, the term storyline is used both in connection to *scenarios* as related to a future trajectory of the climate and human systems or to a weather or climate event. In this context, storylines can be used to describe plural, conditional possible futures or explanations of a current situation, in contrast to single, definitive futures or explanations.

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.

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.

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.

Sufficiency A set of measures and daily practices that avoid demand for energy, materials, land and water while delivering human well-being for all within planetary boundaries.

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 *Development pathways* and *Sustainable Development Goals (SDGs)*.

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*.

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 (WOCAT, no date).

Systems of Innovation (SI) The set of public and private sector organisations (i.e., formally organised entities such as firms and universities; 'actors') and *institutions*, whose activities and interactions generate, modify and deploy new technologies. The SI approach has been used to understand and analyse innovation at the national, regional, and technological levels, and in transnational contexts (Lundvall 1992, 1988).

Technology deployment The act of bringing technology into effective application, involving a set of actors and activities to initiate, facilitate and/or support its implementation. See also *Technology diffusion*.

Technology diffusion The spread of a technology across different groups users/markets over time. See also *Technology deployment* and *Technology transfer*.

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. See also *Technology diffusion*.

Teleconnection Association between *climate* variables at widely separated, geographically fixed locations related to each other through physical processes and oceanic and/or atmospheric dynamical pathways. Teleconnections can be caused by several climate phenomena, such as Rossby wave-trains, mid-latitude jet and storm track displacements, fluctuations of the Atlantic Meridional Overturning Circulation (AMOC), fluctuations of the Walker circulation, etc. They can be initiated by modes of climate variability, thus providing the development of remote climate anomalies at various temporal lags.

Temperature overshoot Exceedance of a specified global warming level, followed by a decline to or below that level during a specified period of time (e.g., before 2100). Sometimes the magnitude and likelihood of the overshoot is also characterised. The overshoot duration can vary from one *pathway* to the next, but in most *overshoot pathways* in the literature and as referred to as overshoot pathways in the AR6, the overshoot occurs over a period of at least one decade and up to several decades.

Tipping point A critical threshold beyond which a system reorganises, often abruptly and/or irreversibly. See also *Irreversibility*.

Total carbon budget See *Carbon budget*.

Trade-off A competition between different objectives within a decision situation, where pursuing one objective will diminish achievement of other objective(s). A trade-off exists when a policy or measure aimed at one objective (e.g., reducing *greenhouse gas* emissions) reduces outcomes for other objective(s) (e.g., *biodiversity* conservation, *energy security*) due to *adverse side effects*, thereby potentially reducing the net benefit to society or the environment. See also *Co-benefit*.

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

Transformation pathways See *Pathways*.

Transient climate response (TCR) See *Climate sensitivity*.

Transient climate response to cumulative CO₂ emissions (TCRE) See *Climate sensitivity*.

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.

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 judgement of a team of experts) (Moss and Schneider 2000; Mastrandrea et al. 2010). 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 September 2020, the UNCCD had 197 Parties. See also *Desertification*, *Drought* and *Land degradation*.

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 September 2020, 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' (UNFCCC 1992). The provisions of the Convention are pursued and implemented by two further treaties: the Kyoto Protocol and the Paris Agreement.

Uptake The transfer of substances (such as carbon) or energy (e.g., heat) from one compartment of a system to another; for

example, in the Earth System from the atmosphere to the ocean or to the land. See also *Pool*, *carbon and nitrogen*, *Sequestration*, *Sequestration potential*, *Sink* and *Source*.

Urban The categorisation of areas as 'urban' by government statistical departments is generally based either on population size, population density, economic base, provision of services, or some combination of the above. *Urban systems* are networks and nodes of intensive interaction and exchange including capital, culture, and material objects. Urban areas exist on a continuum with rural areas and tend to exhibit higher levels of complexity, higher populations and population density, intensity of capital investment, and a preponderance of secondary (processing) and tertiary (service) sector industries. The extent and intensity of these features varies significantly within and between urban areas. Urban places and systems are open with much movement and exchange between more rural areas as well as other urban regions. Urban areas can be globally interconnected facilitating rapid flows between them – of capital investment, of ideas and culture, human migration, and disease. See also *Cities*, *Peri-urban areas*, and *Urbanisation*.

Urban heat island The relative warmth of a *city* compared with surrounding rural areas, associated with heat trapping due to land use, the configuration and design of the built environment, including street layout and building size, the heat-absorbing properties of urban building materials, reduced ventilation, reduced greenery and water features, and domestic and industrial heat emissions generated directly from human activities. See also *City region*, *Urban*, and *Urban System*.

Urban Systems Urban systems refer to two interconnected systems: first, the comprehensive collections of city elements with multiple dimensions and characteristics: a) encompass physical, built, socio-economic-technical, political, and ecological subsystems; b) integrate social agent/constituency/processes with physical structure and processes; and c) exist within broader spatial and temporal scales and governance and institutional contexts; and second, the global system of cities and towns. See also *City region*, and *Urban*.

Urbanisation Urbanisation is a multi-dimensional process that involves at least three simultaneous changes: (i) land-use change: transformation of formerly rural settlements or natural land into urban settlements; (ii) demographic change: a shift in the spatial distribution of a population from rural to urban areas; and (iii) infrastructure change: an increase in provision of infrastructure services including electricity, sanitation, etc. Urbanisation often includes changes in lifestyle, culture, and behaviour, and thus alters the demographic, economic, and social structure of both urban and rural areas (Stokes and Seto 2019; Seto et al. 2014; UNDESA 2018). See also *Urban*, and *Urban Systems*.

Variable renewable energy (VRE) See *Renewable energy*.

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*.

Well-being A state of existence that fulfils various human needs, including material living conditions, meaningful social and community relationships 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.

Eudaimonic

Relational well-being concept based on the premise that experiencing life purpose, challenges and growth leads to flourishing, self-realisation, personal expression, and full functioning (Niemi 2014; Lamb and Steinberger 2017).

Hedonic

Subjective well-being concept based on the idea that attaining pleasure and avoiding pain leads to happiness (Ryan and Deci 2001).

Wind energy Kinetic energy from airflow arising from the uneven heating of the Earth's surface. The wind's kinetic energy is converted to mechanical shaft energy and electricity by a wind turbine, a rotating machine. A wind farm, wind project, wind park, or wind power plant is a group of wind turbines interconnected to a common utility system through a system of transformers, distribution lines, and (usually) one substation. See also [Renewable energy](#).

Zero emissions commitment See [Climate change commitment](#).

References

- AGECC, 2010: *Energy for a Sustainable Future. The secretary-general's Advisory group on Energy and climate Change*, New York, NY, USA.
- Allan, J.A., 2005: Virtual water: A strategic resource global solutions to regional deficits. *Groundwater*, **36**(4), 545–546, doi:10.1111/j.1745-6584.1998.tb02825.x.
- Arctic Council, 2016: *Arctic Resilience Report 2016*. [Carson, M. and G. Peterson (eds.)]. Stockholm Environment Institute and Stockholm Resilience Centre, Stockholm, Sweden, 218 pp. <https://oaarchive.arctic-council.org/handle/11374/1838> (Accessed October 2021).
- Berkes, F. and C. Folke, 1998: *Linking Social and Ecological Systems: Management Practices and Social Mechanisms for Building Resilience*. [Berkes, F. and C. Folke (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA, 459 pp.
- Bobbins, K. and C. Culwick, 2016: *A Framework for a Green Infrastructure Planning Approach in the Gauteng City-Region*. Gauteng City-Region Observatory (GRCO), Johannesburg, South Africa, 127 pp. <http://hdl.handle.net/10539/23595>.
- Campbell, A. et al., 2009: *Review of the Literature on the Links between Biodiversity and Climate Change: Impacts, Adaptation and Mitigation*. Secretariat of the Convention on Biological Diversity, Montreal, QC, Canada, 124 pp. <https://www.cbd.int/doc/publications/cbd-ts-42-en.pdf> (Accessed October 11, 2021).
- CGIAR, 2019: Sustainable intensification of agriculture: oxymoron or real deal? <https://wle.cgiar.org/thrive/big-questions/sustainable-intensification-agriculture-oxymoron-or-real-deal/sustainable-1> (Accessed October 11, 2021).
- Chester, M.V., 2019: Sustainability and infrastructure challenges. *Nat. Sustain.*, **2**(4), 265–266, doi:10.1038/s41893-019-0272-8.
- Davis, S.J. and K. Caldeira, 2010: Consumption-based accounting of CO₂ emissions. *Proc. Natl. Acad. Sci.*, **107**(12), 5687–5692, doi:10.1073/pnas.0906974107.
- Dawson, R.J. et al., 2018: A systems framework for national assessment of climate risks to infrastructure. *Philos. Trans. R. Soc. A Math. Phys. Eng. Sci.*, **376**(2121), 20170298, doi:10.1098/rsta.2017.0298.
- Díaz, S. et al., 2018: Assessing nature's contributions to people. *Science*, **359**(6373), 270–272, doi:10.1126/science.aap8826.
- FAO, 2007: *Land evaluation: Towards a revised framework. Land and water discussion paper*. Food and Agriculture Organization of the United Nations (FAO), Rome, Italy.
- FAO, 2009: *Declaration of the World Summit on Food Security. WSFS 2009/2*. Food and Agriculture Organization of the United Nations (FAO), Rome, Italy.
- FAO, 2015: Food waste. Food and Agriculture Organization of the United Nations (FAO). <http://www.fao.org/platform-food-loss-waste/food-waste/definition>.
- FAO, 2016: Conservation agriculture. <https://www.fao.org/conservation-agriculture/overview/what-is-conservation-agriculture/en/> (Accessed October 11, 2021).
- FAO, 2018: *The State of Food Security and Nutrition in the World: Building Climate Resilience for Food Security and Nutrition*. Food and Agriculture Organization of the United Nations (FAO), Rome, Italy, 181 pp.
- FAO and Alliance of Bioversity International and CIAT, 2021: *Indigenous Peoples' food systems: Insights on sustainability and resilience from the front line of climate change*, Rome, doi: 10.4060/cb5131en.
- Forest Europe, 1993: *Resolution H1 General Guidelines for the Sustainable Management of Forests in Europe*. Second Ministerial Conference on the Protection of Forests in Europe, 16–17 June 1993, Helsinki, https://www.foresteurope.org/docs/MC/MC_helsinki_resolutionH1.pdf.
- Forsyth, D.R., 2010: *Group Dynamics*. Fifth Edition. Wadsworth Cengage Learning, Inc., Belmont, CA, USA.
- Frolova, E.V., M.K. Vinichenko, A.V Kirillov, O.V Rogach, and E.E. Kabanova, 2016: Development of social infrastructure in the management practices of local authorities: trends and factors. *Int. J. Environ. Sci. Educ.*, **11**(15), 7421–7430.
- Fung, A. and E.O. Wright, 2003: *Deepening Democracy: Institutional Innovations in Empowered Participatory Governance*. [Fung, A. and E.O. Wright (eds.)]. Verso, London, UK, 312 pp.
- Garnett, T. et al., 2013: Sustainable intensification in agriculture: Premises and policies. *Science*, **341**(6161), 33, doi:10.1126/science.1234485.
- Grubler, A. et al., 2012: Energy Primer. In: *Global Energy Assessment*, pp. 99–150. Cambridge University Press, Cambridge, UK, doi:10.1017/CBO9780511793677.007.
- Hewitt, C., S. Mason, and D. Walland, 2012: The Global Framework for Climate Services. *Nat. Clim. Change*, **2**(12), 831–832, doi:10.1038/nclimate1745.
- Hirth, L., 2013: The market value of variable renewables: The effect of solar wind power variability on their relative price. *Energy Econ.*, **38**, 218–236, doi:10.1016/j.eneco.2013.02.004.
- HLPE, 2017: *Nutrition and food systems*. High Level Panel of Experts on Food Security and Nutrition (HLPE), Rome, Italy, 152 pp.
- IBI, 2018: Frequently Asked Questions About Biochar: What is biochar? International Biochar Initiative (IBI). <https://biochar-international.org/faqs/> (Accessed October 11, 2021).
- IFOAM-Organics International, 2014: *The IFOAM Norms for Organic Production and Processing*. IFOAM-Organics International, Germany. [https://www.ifoam.bio/sites/default/files/2020-09/IFOAM Norms July 2014 Edits 2019.pdf](https://www.ifoam.bio/sites/default/files/2020-09/IFOAM%20Norms%20July%202014%20Edits%202019.pdf) (Accessed October 11, 2021).
- ILO, 2015: *Guidelines for a just transition towards environmentally sustainable economies and societies for all*. International Labour Organization (ILO), Switzerland.
- IOM, 2018: Key Migration Terms. Retrieved from: <https://www.iom.int/key-migration-terms> (Accessed May 15, 2018).
- IPBES, 2018: *The IPBES assessment report on land degradation and restoration*. [Montanarella, L., R. Scholes, and A. Brainich (eds.)]. Secretariat of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), Bonn, Germany, 744 pp.
- IPBES, 2019: Glossary. *Global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services*. Secretariat of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), Bonn, Germany.
- IPCC, 2006: *2006 IPCC Guidelines for National Greenhouse Gas Inventories, Prepared by the National Greenhouse Gas Inventories Programme*. [Eggleston, H.S., L. Buendia, K. Miwa, T. Ngara, and K. Tanabe (eds.)]. Institute for Global Environmental Strategies (IGES), Hayama, Japan, <https://www.ipcc-nggip.iges.or.jp/public/2006gl/index.html>.
- IPCC, 2012: *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change*. [Field, C.B., V. Barros, T.F. Stocker, D. Qin, D.J. Dokken, K.L. Ebi, M.D. Mastrandrea, K.J. Mach, G.-K. Plattner, S.K. Allen, M. Tignor, and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA, 582 pp.
- IPCC, 2019: *Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories*. [Buendia, E.C., S. Guendehou, B. Limmechokchai, R. Pipatti, Y. Rojas, R. Sturgiss, K. Tanabe, T. Wirth, D. Romano, J. Witi, A. Garg, M.M. Weitz, B. Cai, D.A. Ottinger, H. Dong, J.D. MacDonald, S.M. Ogle, M.T. Rocha, M. José Sanz Sanchez, D.M. Bartram, S. Towprayon (eds.)]. Intergovernmental Panel on Climate Change (IPCC), Geneva, Switzerland. <https://www.ipcc-nggip.iges.or.jp/public/2019rf/index.html> (Accessed October 11, 2021).
- ISO, 2014: ISO 16559:2014(en). Solid biofuels – Terminology, definitions and descriptions. <http://www.iso.org/obp/ui/#iso:std:iso:16559:ed-1:v1:en> (Accessed October 11, 2021).

- ISO, 2018: ISO 14044:2006. Environmental management – Life cycle assessment – Requirements and guidelines. <https://www.iso.org/standard/38498.html> (Accessed May 31, 2018).
- IUCN, 2016: Defining Nature-based Solutions. WCC-2016-Res-069-EN, World Conservation Congress.
- Lamb, W.F. and J.K. Steinberger, 2017: Human well-being and climate change mitigation. *Wiley Interdiscip. Rev. Clim. Change.*, **8(6)**, doi:10.1002/wcc.485.
- Latham, A. and J. Layton, 2019: Social infrastructure and the public life of cities: Studying urban sociality and public spaces. *Geogr. Compass*, **13(7)**, 12444.
- Lundvall, B.-Å., 1988: Innovation as an interactive process: from user-producer interaction to the national system of innovation. In: *Technical Change and Economic Theory* [Dosi, G., C. Freeman, R. Nelson, G. Silverberg, and L. Soete (eds.)]. Pinter Publishers, London, UK and New York, NY, USA.
- Lundvall, B.-Å., 1992: *National Systems of Innovation: Toward a Theory of Innovation and Interactive Learning*. [Lundvall, B.-Å., (ed.)]. Pinter Publishers, London, UK, 342 pp.
- MA, 2005: Appendix D: Glossary. In: *Ecosystems and Human Well-being: Current States and Trends. Findings of the Condition and Trends Working Group* [Hassan, R., R. Scholes, and N. Ash (eds.)], Millennium Ecosystem Assessment (MA). Island Press, Washington, DC, USA, pp. 893–900.
- MacDonald, G.K. et al., 2015: Rethinking agricultural trade relationships in an era of globalization. *Bioscience*, **65(3)**, 275–289, doi:10.1093/biosci/biu225.
- Mastrandrea, M.D. et al., 2010: *Guidance Note for Lead Authors of the IPCC Fifth Assessment Report on Consistent Treatment of Uncertainties*. Intergovernmental Panel on Climate Change (IPCC), Geneva, Switzerland, 6 pp.
- McDonald, T., J. Jonson, and K.W. Dixon, 2016: National standards for the practice of ecological restoration in Australia. *Restor. Ecol.*, **24(S1)**, S4–S32, doi:10.1111/rec.12359.
- Mechler, R., L. Bouwer, T. Schinko, S. Surminski, and J. Linnerooth-Bayer, 2018: *Loss and Damage from Climate Change: Concepts, Methods and Policy Options*. [Mechler, R., L.M. Bouwer, T. Schinko, S. Surminski, and J. Linnerooth-Bayer (eds.)]. Springer International Publishing, Cham, Switzerland, 561 pp.
- Moss, R.H. and S.H. Schneider, 2000: Uncertainties in the IPCC TAR: Recommendations to Lead Authors for More Consistent Assessment and Reporting. In: *Guidance Papers on the Cross Cutting Issues of the Third Assessment Report of the IPCC* [Pachauri, R., T. Taniguchi, and K. Tanaka (eds.)], Intergovernmental Panel on Climate Change (IPCC), Geneva, Switzerland, pp. 33–51.
- Moss, R.H. et al., 2010: The next generation of scenarios for climate change research and assessment. *Nature*, **463(7282)**, 747–756, doi:10.1038/nature08823.
- MRFCJ, 2018: Principles of Climate Justice. Mary Robinson Foundation – Climate Justice (MRFCJ). <http://www.mrfcj.org/principles-of-climate-justice> (Accessed May 15, 2018).
- Niemiec, C.P., 2014: Eudaimonic Well-Being. In: *Encyclopedia of Quality of Life and Well-Being Research* [Michalos, A.C. (ed.)]. Springer, Dordrecht, The Netherlands, pp. 2004–2005, doi:10.1007/978-94-007-0753-5_929.
- O’Neill, D.W., A.L. Fanning, W.F. Lamb, and J.K. Steinberger, 2018: A good life for all within planetary boundaries. *Nat. Sustain.*, **1(2)**, 88–95, doi:10.1038/s41893-018-0021-4.
- Ogle, S.M. et al., 2018: Delineating managed land for reporting national greenhouse gas emissions and removals to the United Nations framework convention on climate change. *Carbon Balance Manag.*, **13(1)**, 9, doi:10.1186/s13021-018-0095-3.
- OHCHR, 2018: What are Human rights? Office of the High Commissioner for Human Rights (OHCHR). <https://www.ohchr.org/en/what-are-human-rights> (Accessed October 11, 2021).
- Park, S.E. et al., 2012: Informing adaptation responses to climate change through theories of transformation. *Glob. Environ. Change.*, **22(1)**, 115–126, doi:10.1016/j.gloenvcha.2011.10.003.
- Pongratz, J. et al., 2018: Models meet data: Challenges and opportunities in implementing land management in Earth system models. *Glob. Change. Biol.*, **24(4)**, 1470–1487, doi:10.1111/gcb.13988.
- Rao, N.D. and P. Baer, 2012: “Decent Living” emissions: A conceptual framework. *Sustainability*, **4(4)**, 656–681, doi:10.3390/su4040656.
- Rao, N.D. and J. Min, 2018: Decent Living Standards: Material Prerequisites for Human Wellbeing. *Soc. Indic. Res.*, **138(1)**, 225–244, doi:10.1007/s11205-017-1650-0.
- Reddy, A.K.N., 2000: *Energy and social issues*. World Energy Council, New York, NY, USA.
- Ryan, R.M. and E.L. Deci, 2001: On happiness and human potentials: a review of research on hedonic and eudaimonic well-being. *Annu. Rev. Psychol.*, **52**, 141–166, doi:10.1146/annurev.psych.52.1.141.
- Sarmiento, H. and C. Tilly, 2018: Governance Lessons from Urban Informality. *Polit. Gov.*, **6(1)**, 199–202, doi:10.17645/pag.v6i1.1169.
- Seto, K.C., R. Sánchez-Rodríguez, and M. Fragkias, 2010: The New Geography of Contemporary Urbanization and the Environment. *Annu. Rev. Environ. Resour.*, **35(1)**, 167–194, doi:10.1146/annurev-environ-100809-125336.
- Seto, K.C., S. Dhakal, A. Bigio, H. Blanco, G.C. Delgado, D. Dewar, L. Huang, A. Inaba, A. Kansal, S. Lwasa, J.E. McMahon, D.B. Müller, J. Murakami, H. Nagendra, and A. Ramaswami, 2014: Human Settlements, Infrastructure and Social Planning. In: *Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Edenhofer, O., R. Pichs-Madruga, Y. Sokona, E. Farahani, S. Kadner, K. Seyboth, A. Adler, I. Baum, S. Brunner, P. Eickemeier, B. Kriemann, J. Savolainen, S. Schlömer, C. von Stechow, T. Zwickel and J.C. Minx (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA, pp. 923–1000.
- Silvertown, J., 2009: A new dawn for citizen science. In: *Trophic Cascades: Predators, Prey, and the Changing Dynamics of Nature* [Terborgh, J. and J.A. Estes (eds.)]. Island Press, Washington DC, USA, pp. 337–352.
- Stokes, E.C. and K.C. Seto, 2019: Characterizing and measuring urban landscapes for sustainability. *Environ. Res. Lett.*, **14(4)**, 045002, doi:10.1088/1748-9326/aafab8.
- Tàbara, D.J., J. Jäger, D. Mangalagu, and M. Grasso, 2019: Defining transformative climate science to address high-end climate change. *Reg. Environ. Change.*, **19(3)**, 807–818, doi:10.1007/s10113-018-1288-8.
- Tajfel, H. and J.C. Turner, 1986: The social identity theory of intergroup behaviour. In: *Psychology of Intergroup Relations* [Worschel, S. and W.G. Austin (eds.)], IL: Nelson-Hall, Chicago, USA, pp. 7–24.
- Termeer, C.J.A.M., A. Dewulf, and G.R. Biesbroek, 2017: Transformational change: governance interventions for climate change adaptation from a continuous change perspective. *J. Environ. Plan. Manag.*, **60(4)**, 558–576, doi:10.1080/09640568.2016.1168288.
- UN, 1992: Article 2: Use of Terms. In: *Convention on Biological Diversity*, United Nations (UN), pp. 3–4.
- UN-OHRLS, 2011: *Small Island Developing States: Small Islands Big(ger) Stakes*. Office for the High Representative for the Least Developed Countries, Landlocked Developing Countries and Small Island Developing States (UN-OHRLS), New York, NY, USA, 32 pp.
- UN-OHRLS, 2018: Small Island Developing States: Country profiles. <https://www.un.org/ohrlls/content/list-sids>.
- UN-REDD, 2009: *Measurement, Assessment, Reporting and Verification (MARV): Issues and Options for REDD*. United Nations Collaborative Programme on Reducing Emissions from Deforestation and Forest Degradation in Developing Countries (UN-REDD), Geneva, Switzerland, 12 pp. https://unredd.net/index.php?option=com_docman&task=doc_download&gid=148&Itemid=53 (Accessed October 11, 2021).
- UNCCD, 1994: *Elaboration of an international convention to combat desertification in countries experiencing serious drought and/or desertification, particularly in Africa*. United Nations Convention to Combat Desertification (UNCCD), Paris, France, 1–58 pp.
- UNCCD, 2020: Achieving Land Degradation Neutrality. United Nations Convention to Combat Desertification (UNCCD). <https://www.unccd.int/>.

- UNDESA, 2018: *World Urbanization Prospects, the 2018 Revision, Technical Report*. United Nations Department of Economic and Social Affairs (UNDESA), New York, NY, USA.
- UNEP, 2016: *Unlocking the sustainable potential of land resources: evaluating systems, strategies and tools*. United Nations Environment Programme (UNEP). <https://www.unep.org/resources/report/unlocking-sustainable-potential-land-resources-evaluating-systems-strategies-and>.
- UNESCO, 2018: Local and Indigenous Knowledge Systems. United Nations Educational, Scientific and Cultural Organization (UNESCO). <https://en.unesco.org/links>.
- UNFCCC, 1992: *United Nations Framework Convention on Climate Change*. United Nations Framework Convention on Climate Change (UNFCCC), 24 pp. <https://unfccc.int/resource/docs/convkp/conveng.pdf>.
- UNFCCC, 2016: *Just transition of the workforce, and the creation of decent work and quality jobs*. United Nations Framework Convention on Climate Change (UNFCCC).
- UNFCCC, 2019: Land Use, Land-Use Change and Forestry (LULUCF). United Nations Framework Convention on Climate Change (UNFCCC). <https://unfccc.int/topics/land-use/workstreams/land-use--land-use-change-and-forestry-lulucf>.
- UNFCCC, 2021a: Reporting and Review under the Paris Agreement. United Nations Framework Convention on Climate Change (UNFCCC). <https://unfccc.int/process-and-meetings/transparency-and-reporting/reporting-and-review-under-the-paris-agreement>.
- UNFCCC, 2021b: Reporting and accounting of LULUCF activities under the Kyoto Protocol. United Nations Framework Convention on Climate Change (UNFCCC). <https://unfccc.int/topics/land-use/workstreams/land-use-land-use-change-and-forestry-lulucf/reporting-and-accounting-of-lulucf-activities-under-the-kyoto-protocol>.
- UNGA, 2016: *Report of the open-ended intergovernmental expert working group on indicators and terminology relating to disaster risk reduction*. United Nations General Assembly (UNGA), 41 pp. https://www.preventionweb.net/files/50683_oiewgreportenglish.pdf.
- UNISDR, 2009: *2009 UNISDR Terminology on Disaster Risk Reduction*. United Nations International Strategy for Disaster Reduction (UNISDR), Geneva, Switzerland, 30 pp. <https://www.unisdr.org/we/inform/publications/7817>.
- WCED, 1987: *Our Common Future*. World Commission on Environment and Development (WCED) Oxford University Press, Oxford, UK, 400 pp.
- WHO, 2018: Malnutrition. World Health Organization (WHO). https://www.who.int/health-topics/malnutrition#tab=tab_1 (Accessed October 11, 2021).
- Wiedmann, T. and J. Minx, 2008: A Definition of "Carbon Footprint." In: *Ecological Economics Research Trends* [C.C. Pertsova (ed.)], Nova Science Publishers, New York, NY, USA, pp. 1–11.
- Wiener, J.B. and J.D. Graham, 2009: *Risk vs Risk: Tradeoffs in Protecting Health and the Environment*. [Wiener, J.B. and J.D. Graham (eds.)]. Harvard University Press, Cambridge, MA, USA, 352 pp.
- Willems, S. and K. Baumert, 2003: *Institutional Capacity and Climate Actions*. Organisation for Economic Co-operation and Development (OECD) International Energy Agency (IEA), Paris, France, 50 pp. Retrieved from: <http://www.oecd.org/env/cc/21018790.pdf>.
- WOCAT, [undated]: Glossary. World Overview of Conservation Approaches and Technologies (WOCAT). <https://www.wocat.net/en/glossary>.