Climate Change 2001: Synthesis Report

Annexes

An Assessment of the Intergovernmental Panel on Climate Change

The glossary and companion annexes were not submitted to the Panel for action, consistent with normal practice within the IPCC.

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Annex B. Glossary of Terms

This Glossary is based on the glossaries published in the IPCC Third Assessment Report (IPCC, 2001a,b,c); however, additional work has been undertaken on consistency and refinement of some of the terms. The terms that are independent entries in this glossary are highlighted in *italics*.

Acclimatization

The physiological adaptation to climatic variations.

Activities Implemented Jointly (AIJ)

The pilot phase for *Joint Implementation*, as defined in Article 4.2(a) of the *United Nations Framework Convention on Climate Change*, that allows for project activity among developed countries (and their companies) and between developed and developing countries (and their companies). AIJ is intended to allow Parties to the United Nations Framework Convention on Climate Change to gain experience in jointly implemented project activities. There is no crediting for AIJ activity during the pilot phase. A decision remains to be taken on the future of AIJ projects and how they may relate to the *Kyoto Mechanisms*. As a simple form of tradable permits, AIJ and other market-based schemes represent important potential mechanisms for stimulating additional resource flows for the global environmental good. See also *Clean Development Mechanism* and *emissions trading*.

Adaptability

See *Adaptive capacity*.

Adaptation

Adjustment in natural or *human systems* to a new or changing environment. Adaptation to *climate change* refers to adjustment in natural or human systems in response to actual or expected climatic *stimuli* or their effects, which moderates harm or exploits beneficial opportunities. Various types of adaptation can be distinguished, including anticipatory and reactive adaptation, private and public adaptation, and autonomous and planned adaptation.

Adaptation assessment

The practice of identifying options to adapt to *climate change* and evaluating them in terms of criteria such as availability, benefits, costs, effectiveness, efficiency, and feasibility.

Adaptation benefits

The avoided damage costs or the accrued benefits following the adoption and *implementation* of *adaptation* measures.

Adaptation costs

Costs of planning, preparing for, facilitating, and implementing *adaptation* measures, including transition costs.

Adaptive capacity

The ability of a system to adjust to *climate change* (including *climate variability* and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences.

Additionality

Reduction in *emissions* by *sources* or enhancement of removals by *sinks* that is additional to any that would occur in the absence of a *Joint Implementation* or a *Clean Development Mechanism* project activity as defined in the *Kyoto Protocol* Articles on Joint Implementation and the Clean Development Mechanism. This definition may be further broadened to include financial, investment, and *technology* additionality. Under "financial additionality," the project activity funding shall be additional to existing Global Environmental Facility, other financial commitments of Parties included in Annex I, Official Development Assistance, and other systems of cooperation. Under "investment additionality," the value of the *Emissions Reduction Unit/Certified Emission Reduction Unit* shall significantly improve the financial and/or commercial viability of the project activity. Under "technology additionality," the technology used for the project activity shall be the best available for the circumstances of the host Party.

Adjustment time

See *Lifetime*; see also *Response time*.

Aerosols

A collection of airborne solid or liquid particles, with a typical size between 0.01 and 10 mm that reside in the *atmosphere* for at least several hours. Aerosols may be of either natural or *anthropogenic* origin. Aerosols may influence *climate* in two ways: directly through scattering and absorbing radiation, and indirectly through acting as condensation nuclei for cloud formation or modifying the optical properties and lifetime of clouds. See *indirect aerosol effect*.

Afforestation

Planting of new *forests* on lands that historically have not contained forests. For a discussion of the term forest and related terms such as *afforestation*, *reforestation*, and *deforestation*, see the IPCC Special Report on Land Use, Land-Use Change, and Forestry (IPCC, 2000b).

Aggregate impacts

Total impacts summed up across sectors and/or regions. The aggregation of impacts requires knowledge of (or assumptions about) the relative importance of impacts in different sectors and regions. Measures of aggregate impacts include, for example, the total number of people affected, change in net primary productivity, number of systems undergoing change, or total economic costs.

Albedo

The fraction of *solar radiation* reflected by a surface or object, often expressed as a percentage. Snow covered surfaces have

a high albedo; the albedo of soils ranges from high to low; vegetation covered surfaces and oceans have a low albedo. The Earth's albedo varies mainly through varying cloudiness, snow, ice, leaf area, and land cover changes.

Algal blooms
A reproductive explosion of algae in a lake, river, or ocean.

Alpine
The biogeographic zone made up of slopes above timberline and characterized by the presence of rosette-forming herbaceous plants and low shrubby slow-growing woody plants.

Alternative development paths
Refer to a variety of possible *scenarios* for societal *values* and consumption and production patterns in all countries, including, but not limited to, a continuation of today's trends. In this report, these paths do not include additional *climate* initiatives which means that no scenarios are included that explicitly assume *implementation* of the *United Nations Framework Convention on Climate Change* or the emission targets of the *Kyoto Protocol*, but do include assumptions about other policies that influence *greenhouse gas emissions* indirectly.

Alternative energy
Energy derived from non-fossil-fuel sources.

Ancillary benefits
The ancillary, or side effects, of policies aimed exclusively at *climate change mitigation*. Such policies have an impact not only on *greenhouse gas emissions*, but also on resource use efficiency, like reduction in emissions of local and regional air pollutants associated with *fossil-fuel* use, and on issues such as transportation, agriculture, *land-use* practices, employment, and fuel security. Sometimes these benefits are referred to as "ancillary impacts" to reflect that in some cases the benefits may be negative. From the perspective of policies directed at abating local air pollution, greenhouse gas mitigation may also be considered an ancillary benefit, but these relationships are not considered in this assessment.

Annex I countries/Parties
Group of countries included in Annex I (as amended in 1998) to the *United Nations Framework Convention on Climate Change*, including all the developed countries in the Organisation for Economic Cooperation and Development, and *economies in transition*. By default, the other countries are referred to as *non-Annex I countries*. Under Articles 4.2(a) and 4.2(b) of the Convention, Annex I countries commit themselves specifically to the aim of returning individually or jointly to their 1990 levels of *greenhouse gas emissions* by the year 2000. See also *Annex II*, *Annex B*, and *non-Annex B countries*.

Annex II countries
Group of countries included in Annex II to the *United Nations Framework Convention on Climate Change*, including all developed countries in the Organisation for Economic Cooperation and Development. Under Article 4.2(g) of the Convention, these countries are expected to provide financial resources to assist developing countries to comply with their obligations, such as preparing national reports. Annex II countries are also expected to promote the transfer of *environmentally sound technologies* to developing countries. See also *Annex I*, *Annex B*, *non-Annex I*, and *non-Annex B countries/Parties*.

Annex B countries/Parties
Group of countries included in Annex B in the *Kyoto Protocol* that have agreed to a target for their *greenhouse gas emissions*, including all the *Annex I countries* (as amended in 1998) but Turkey and Belarus. See also *Annex II*, *non-Annex I*, and *non-Annex B countries/Parties*.

Anthropogenic
Resulting from or produced by human beings.

Anthropogenic emissions
Emissions of *greenhouse gases*, greenhouse gas *precursors*, and *aerosols* associated with human activities. These include burning of *fossil fuels* for energy, *deforestation*, and *land-use* changes that result in net increase in emissions.

Aquaculture
Breeding and rearing fish, shellfish, etc., or growing plants for food in special ponds.

Aquifer
A stratum of permeable rock that bears water. An unconfined aquifer is recharged directly by local rainfall, rivers, and lakes, and the rate of recharge will be influenced by the permeability of the overlying rocks and soils. A confined aquifer is characterized by an overlying bed that is impermeable and the local rainfall does not influence the aquifer.

Arid regions
Ecosystems with less than 250 mm precipitation per year.

Assigned amounts (AAs)
Under the *Kyoto Protocol*, the total amount of *greenhouse gas emissions* that each *Annex B country* has agreed that its emissions will not exceed in the first commitment period (2008 to 2012) is the assigned amount. This is calculated by multiplying the country's total greenhouse gas emissions in 1990 by five (for the 5-year commitment period) and then by the percentage it agreed to as listed in Annex B of the Kyoto Protocol (e.g., 92% for the European Union, 93% for the USA).

Assigned amount unit (AAU)
Equal to 1 tonne (metric ton) of CO_2-*equivalent emissions* calculated using the *Global Warming Potential*.

Atmosphere
The gaseous envelop surrounding the Earth. 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* such as *carbon dioxide* (0.035% volume mixing ratio) and *ozone*. In addition, the atmosphere contains water vapor, whose amount is highly variable but typically 1% volume mixing ratio. The atmosphere also contains clouds and *aerosols*.

Attribution
See *detection and attribution*.

Banking
According to the *Kyoto Protocol* [Article 3(13)], Parties included in Annex I to the *United Nations Framework Convention on Climate Change* may save excess *emissions* allowances or credits from the first commitment period for use in subsequent commitment periods (post-2012).

Barrier
A barrier is any obstacle to reaching a potential that can be overcome by a policy, program, or measure.

Baseline
The baseline (or reference) is any datum against which change is measured. It might be a "current baseline," in which case it represents observable, present-day conditions. It might also be a "future baseline," which is a projected future set of conditions excluding the driving factor of interest. Alternative interpretations of the reference conditions can give rise to multiple baselines.

Basin
The drainage area of a stream, river, or lake.

Biodiversity
The numbers and relative abundances of different genes (genetic diversity), species, and *ecosystems* (communities) in a particular area.

Biofuel
A fuel produced from dry organic matter or combustible oils produced by plants. Examples of biofuel include alcohol (from fermented sugar), black liquor from the paper manufacturing process, wood, and soybean oil.

Biomass
The total mass of living organisms in a given area or volume; recently dead plant material is often included as dead biomass.

Biome
A grouping of similar plant and animal communities into broad landscape units that occur under similar environmental conditions.

Biosphere (terrestrial and marine)
The part of the Earth system comprising all *ecosystems* and living organisms in the *atmosphere*, on land (terrestrial biosphere), or in the oceans (marine biosphere), including derived dead organic matter such as litter, soil organic matter, and oceanic detritus.

Biota
All living organisms of an area; the flora and fauna considered as a unit.

Black carbon
Operationally defined species based on measurement of light absorption and chemical reactivity and/or thermal stability; consists of soot, charcoal, and/or possible light-absorbing refractory organic matter (Charlson and Heintzenberg, 1995).

Bog
A poorly drained area rich in accumulated plant material, frequently surrounding a body of open water and having a characteristic flora (such as sedges, heaths, and sphagnum).

Boreal forest
Forests of pine, spruce, fir, and larch stretching from the east coast of Canada westward to Alaska and continuing from Siberia westward across the entire extent of Russia to the European Plain.

Bottom-up models
A modeling approach that includes technological and engineering details in the analysis. See also *top-down models*.

Burden
The total mass of a gaseous substance of concern in the atmosphere.

Capacity building
In the context of *climate change*, capacity building is a process of developing the technical skills and institutional capability in developing countries and *economies in transition* to enable them to participate in all aspects of *adaptation* to, *mitigation* of, and research on climate change, and the *implementation* of the *Kyoto Mechanisms*, etc.

Carbonaceous aerosol
Aerosol consisting predominantly of organic substances and various forms of black carbon (Charlson and Heintzenberg, 1995).

Carbon cycle
The term used to describe the flow of carbon (in various forms such as as *carbon dioxide*) through the *atmosphere*, ocean, terrestrial *biosphere*, and *lithosphere*.

Carbon dioxide (CO_2)
A naturally occurring gas, and also a by-product of burning *fossil fuels* and *biomass*, as well as *land-use changes* and other industrial processes. It is the principal *anthropogenic greenhouse gas* that affects the Earth's *radiative balance*. It is the reference gas against which other greenhouse gases are measured and therefore has a *Global Warming Potential* of 1.

Carbon dioxide (CO_2) fertilization
The enhancement of the growth of plants as a result of increased atmospheric *carbon dioxide* concentration. Depending on their mechanism of *photosynthesis*, certain types of plants are more sensitive to changes in atmospheric carbon dioxide concentration. In particular, plants that produce a three-carbon compound (C_3) during photosynthesis—including most trees and agricultural crops such as rice, wheat, soybeans, potatoes, and vegetables—generally show a larger response than plants that produce a four-carbon compound (C_4) during photosynthesis—mainly of tropical origin, including grasses and the agriculturally important crops maize, sugar cane, millet, and sorghum.

Carbon leakage
See *leakage*.

Carbon taxes
See *emissions tax*.

Catchment
An area that collects and drains rainwater.

Certified Emission Reduction (CER) Unit
Equal to 1 tonne (metric ton) of *CO_2-equivalent emissions* reduced or sequestered through a *Clean Development Mechanism* project, calculated using *Global Warming Potentials*. See also *Emissions Reduction Unit*.

Chlorofluorocarbons (CFCs)
Greenhouse gases covered under the 1987 *Montreal Protocol* and used for refrigeration, air conditioning, packaging, insulation, solvents, or aerosol propellants. Since they are not destroyed in the lower *atmosphere*, CFCs drift into the upper atmosphere where, given suitable conditions, they break down *ozone*. These gases are being replaced by other compounds, including hydrochlorofluorocarbons and *hydrofluorocarbons*, which are greenhouse gases covered under the *Kyoto Protocol*.

Cholera
An intestinal infection that results in frequent watery stools, cramping abdominal pain, and eventual collapse from dehydration.

Clean Development Mechanism (CDM)
Defined in Article 12 of the *Kyoto Protocol*, the Clean Development Mechanism is intended to meet two objectives: (1) to assist Parties not included in *Annex I* in achieving *sustainable development* and in contributing to the ultimate objective of the convention; and (2) to assist Parties included in Annex I in achieving *compliance* with their quantified emission limitation and reduction commitments. *Certified Emission Reduction Units* from Clean Development Mechanism projects undertaken in *non-Annex I countries* that limit or reduce *greenhouse gas emissions*, when certified by operational entities designated by *Conference of the Parties/ Meeting of the Parties*, can be accrued to the investor (government or industry) from Parties in *Annex B*. A share of the proceeds from the certified project activities is used to cover administrative expenses as well as to assist developing country Parties that are particularly vulnerable to the adverse effects of *climate change* to meet the costs of *adaptation*.

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 is 30 years, as defined by the World Meteorological Organization (WMO). These 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
Climate change refers to a statistically significant variation in either the mean state of the *climate* or in its variability, persisting for an extended period (typically decades or longer). Climate change may be due to natural internal processes or *external forcings*, or to persistent *anthropogenic* changes in the composition of the *atmosphere* or in *land use*. Note that the *United Nations Framework Convention on Climate Change* (UNFCCC), in its Article 1, defines "climate change" as: "a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods." The UNFCCC thus makes a distinction between "climate change" attributable to human activities altering the atmospheric composition, and "climate variability" attributable to natural causes. See also *climate variability*.

Climate feedback
An interaction mechanism between processes in the *climate system* is called a climate feedback, when the result of an initial process triggers changes in a second process that in turn influences the initial one. A positive feedback intensifies the original process, and a negative feedback reduces it.

Climate model (hierarchy)
A numerical representation of the *climate system* based on the physical, chemical, and biological properties of its components, their interactions and *feedback* processes, and accounting for all or 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 "hierarchy" of models can be identified, differing in such aspects as the number of spatial dimensions, the extent to which physical, chemical or biological processes are explicitly represented, or the level at which empirical *parametrizations* are involved. Coupled atmosphere/ocean/sea-ice *general circulation models* (AOGCMs) provide a comprehensive representation of the climate system. There is an evolution towards more complex models with active chemistry and biology. Climate models are applied, as a research tool, to study and simulate the climate, but also for operational purposes, including monthly, seasonal, and interannual *climate predictions*.

Climate prediction
A climate prediction or climate forecast is the result of an attempt to produce a most likely description or estimate of the actual evolution of the *climate* in the future (e.g., at seasonal, interannual, or long-term *time-scales*). See also *climate projection* and *climate (change) scenario*.

Climate projection
A *projection* of the response of the *climate system* to *emission* or concentration *scenarios* of *greenhouse gases* and *aerosols*, or *radiative forcing scenarios*, often based upon simulations by *climate models*. Climate projections are distinguished from *climate predictions* in order to emphasize that climate projections depend upon the emission/concentration/radiative forcing scenario used, which are based on assumptions, concerning, for example, future socio-economic and technological developments that may or may not be realized, and are therefore subject to substantial *uncertainty*.

Climate scenario
A plausible and often simplified representation of the future *climate*, based on an internally consistent set of climatological relationships, that has been constructed for explicit use in investigating the potential consequences of *anthropogenic climate change*, often serving as input to impact models. *Climate projections* often serve as the raw material for constructing climate scenarios, but climate scenarios usually require additional information such as about the observed current climate. A "climate change scenario" is the difference between a climate scenario and the current climate.

Climate sensitivity
In IPCC assessments, "equilibrium climate sensitivity" refers to the equilibrium change in global mean surface temperature following a doubling of the atmospheric (*equivalent*) CO_2 concentration. More generally, equilibrium climate sensitivity refers to the equilibrium change in surface air temperature following a unit change in *radiative forcing* ($°C/Wm^{-2}$). In practice, the evaluation of the equilibrium climate sensitivity requires very long simulations with coupled *general circulation models*. The "effective climate sensitivity" is a related measure that circumvents this requirement. It is evaluated from model output for evolving non-equilibrium conditions. It is a measure of the strengths of the *feedbacks* at a particular time and may vary with forcing history and climate state. See *climate model*.

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

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

CO_2-equivalent
See *equivalent CO_2*.

CO_2 fertilization
See *carbon dioxide (CO_2) fertilization*.

Co-benefits
The benefits of policies that are implemented for various reasons at the same time—including *climate change mitigation*—acknowledging that most policies designed to address *greenhouse gas mitigation* also have other, often at least equally important, rationales (e.g., related to objectives of development, sustainability, and equity). The term co-impact is also used in a more generic sense to cover both the positive and negative sides of the benefits. See also *ancillary benefits*.

Co-generation
The use of waste heat from electric generation, such as exhaust from gas turbines, for either industrial purposes or district heating.

Compliance
See *implementation*.

Conference of the Parties (COP)
The supreme body of the *United Nations Framework Convention on Climate Change (UNFCCC)*, comprising countries that have ratified or acceded to the UNFCCC. The first session of the

Conference of the Parties (COP-1) was held in Berlin in 1995, followed by COP-2 in Geneva 1996, COP-3 in Kyoto 1997, COP-4 in Buenos Aires 1998, COP-5 in Bonn 1999, COP-6 Part 1 in The Hague 2000, and COP-6 Part 2 in Bonn 2001. COP-7 is scheduled for November 2001 in Marrakech. See also *Meeting of the Parties (MOP)*.

Cooling degree days
The integral over a day of the temperature above 18°C (e.g., a day with an average temperature of 20°C counts as 2 cooling degree days). See also *heating degree days*.

Coping range
The variation in climatic *stimuli* that a system can absorb without producing significant impacts.

Coral bleaching
The paling in color of corals resulting from a loss of symbiotic algae. Bleaching occurs in response to physiological shock in response to abrupt changes in temperature, salinity, and turbidity.

Cost-effective
A criterion that specifies that a *technology* or measure delivers a good or service at equal or lower cost than current practice, or the least-cost alternative for the achievement of a given target.

Cryosphere
The component of the *climate system* consisting of all snow, ice, and *permafrost* on and beneath the surface of the earth and ocean. See also *glacier* and *ice sheet*.

Deepwater formation
Occurs when seawater freezes to form sea ice. The local release of salt and consequent increase in water density leads to the formation of saline coldwater that sinks to the ocean floor.

Deforestation
Conversion of *forest* to non-forest. For a discussion of the term forest and related terms such as *afforestation*, *reforestation*, and *deforestation*, see the IPCC Special Report on Land Use, Land-Use Change, and Forestry (IPCC, 2000b).

Demand-side management
Policies and programs designed for a specific purpose to influence consumer demand for goods and/or services. In the energy sector, for instance, it refers to policies and programs designed to reduce consumer demand for electricity and other energy sources. It helps to reduce *greenhouse gas emissions*.

Dengue Fever
An infectious viral disease spread by mosquitoes often called breakbone fever because it is characterized by severe pain in joints and back. Subsequent infections of the virus may lead to dengue haemorrhagic fever (DHF) and dengue shock syndrome (DSS), which may be fatal.

Deposit–refund system
Combines a deposit or fee (tax) on a commodity with a refund or rebate (*subsidy*) for *implementation* of a specified action. Se also *emissions tax*.

Desert
An *ecosystem* with less than 100 mm precipitation per year.

Desertification
Land degradation in arid, *semi-arid*, and dry sub-humid areas resulting from various factors, including climatic variations and human activities. Further, the United Nations Convention to Combat Desertification defines land degradation as a reduction or loss in arid, semi-arid, and dry sub-humid areas of the biological or economic productivity and complexity of rain-fed cropland, irrigated cropland, or range, pasture, *forest*, and woodlands resulting from *land uses* or from a process or combination of processes, including processes arising from human activities and habitation patterns, such as: (i) soil *erosion* caused by wind and/or water; (ii) deterioration of the physical, chemical, and biological or economic properties of soil; and (iii) long-term loss of natural vegetation.

Detection and attribution
Climate varies continually on all *time scales*. Detection of *climate change* is the process of demonstrating that climate has changed in some defined statistical sense, without providing a reason for that change. Attribution of causes of climate change is the process of establishing the most likely causes for the detected change with some defined level of confidence.

Disturbance regime
Frequency, intensity, and types of disturbances, such as fires, inspect or pest outbreaks, floods, and *droughts*.

Diurnal temperature range
The difference between the maximum and minimum temperature during a day.

Double dividend
The effect that revenue-generating instruments, such as *carbon taxes* or auctioned (tradable) carbon emission permits, can (i) limit or reduce *greenhouse gas emissions* and (ii) offset at least part of the potential welfare losses of climate policies through recycling the revenue in the economy to reduce other taxes likely to be distortionary. In a world with involuntary unemployment, the *climate change* policy adopted may have an effect (a positive or negative "third dividend") on employment. Weak double dividend occurs as long as there is a *revenue recycling* effect—that is, as long as revenues are recycled through reductions in the marginal rates of distortionary taxes. Strong double dividend requires that the (beneficial) revenue recycling effect more than offset the combination of the primary cost and, in this case, the net cost of abatement is negative.

Drought
The phenomenon that exists when precipitation has been significantly below normal recorded levels, causing serious hydrological imbalances that adversely affect land resource production systems.

Economic potential
Economic potential is the portion of *technological potential* for *greenhouse gas emissions* reductions or *energy efficiency* improvements that could be achieved *cost-effectively* through the creation of markets, reduction of market failures, or increased financial and technological transfers. The achievement of economic potential requires additional *policies and measures* to break down *market barriers*. See also *market potential*, *socio-economic potential*, and *technological potential*.

Economies in transition (EITs)
Countries with national economies in the process of changing from a planned economic system to a market economy.

Ecosystem
A system of interacting living organisms together with their physical environment. The boundaries of what could be called an ecosystem are somewhat arbitrary, depending on the focus of interest or study. Thus, the extent of an ecosystem may range from very small *spatial scales* to, ultimately, the entire Earth.

Ecosystem services
Ecological processes or functions that have *value* to individuals or society.

El Niño Southern Oscillation (ENSO)
El Niño, in its original sense, is a warmwater current that periodically flows along the coast of Ecuador and Peru, disrupting the local fishery. This oceanic event is associated with a fluctuation of the intertropical surface pressure pattern and circulation in the Indian and Pacific Oceans, called the Southern Oscillation. This coupled atmosphere-ocean phenomenon is collectively known as El Niño Southern Oscillation, or ENSO. During an El Niño event, the prevailing trade winds weaken and the equatorial countercurrent strengthens, causing warm surface waters in the Indonesian area to flow eastward to overlie the cold waters of the Peru current. This event has great impact on the wind, sea surface temperature, and precipitation patterns in the tropical Pacific. It has climatic effects throughout the Pacific region and in many other parts of the world. The opposite of an El Niño event is called *La Niña*.

Emissions
In the *climate change* context, emissions refer to the release of *greenhouse gases* and/or their *precursors* and *aerosols* into the *atmosphere* over a specified area and period of time.

Emissions permit
An emissions permit is the non-transferable or tradable allocation of entitlements by an administrative authority (intergovernmental organization, central or local government agency) to a regional (country, sub-national) or a sectoral (an individual firm) entity to emit a specified amount of a substance.

Emissions quota
The portion or share of total allowable *emissions* assigned to a country or group of countries within a framework of maximum total emissions and mandatory allocations of resources.

Emissions Reduction Unit (ERU)
Equal to 1 tonne (metric ton) of *carbon dioxide emissions* reduced or sequestered arising from a *Joint Implementation* (defined in Article 6 of the *Kyoto Protocol*) project calculated using *Global Warming Potential*. See also *Certified Emission Reduction Unit* and *emissions trading*.

Emissions tax
Levy imposed by a government on each unit of *CO_2-equivalent emissions* by a *source* subject to the tax. Since virtually all of the carbon in *fossil fuels* is ultimately emitted as *carbon dioxide*, a levy on the carbon content of fossil fuels—a *carbon tax*—is equivalent to an emissions tax for emissions caused by fossil-fuel combustion. An *energy tax*—a levy on the energy content of fuels—reduces demand for energy and so reduces carbon dioxide emissions from fossil-fuel use. An ecotax is designated for the purpose of influencing human behavior (specifically economic behavior) to follow an ecologically benign path. International emissions/carbon/energy tax is a tax imposed on specified sources in participating countries by an international agency. The revenue is distributed or used as specified by participating countries or the international agency.

Emissions trading
A market-based approach to achieving environmental objectives that allows, those reducing *greenhouse gas emissions* below what is required, to use or trade the excess reductions to offset emissions at another source inside or outside the country. In general, trading can occur at the intracompany, domestic, and international levels. The IPCC Second Assessment Report adopted the convention of using "permits" for domestic trading systems and "quotas" for international trading systems. Emissions trading under Article 17 of the *Kyoto Protocol* is a tradable quota system based on the *assigned amounts* calculated from the emission reduction and limitation commitments listed in *Annex B* of the Protocol. See also *Certified Emission Reduction Unit* and *Clean Development Mechanism*.

Emissions scenario
A plausible representation of the future development of *emissions* of substances that are potentially radiatively active (e.g., *greenhouse gases*, *aerosols*), based on a coherent and internally consistent set of assumptions about driving forces (such as demographic and socio-economic development, technological change) and their key relationships. Concentration scenarios, derived from emissions scenarios, are used as input

into a *climate model* to compute *climate projections*. In IPCC (1992), a set of emissions scenarios were used as a basis for the climate projections in IPCC (1996). These emissions scenarios are referred to as the IS92 scenarios. In the IPCC Special Report on Emissions Scenarios (Nakicenovic *et al.*, 2000), new emissions scenarios—the so-called *SRES scenarios*—were published. For the meaning of some terms related to these scenarios, see *SRES scenarios*.

Endemic
Restricted or peculiar to a locality or region. With regard to human health, endemic can refer to a disease or agent present or usually prevalent in a population or geographical area at all times.

Energy balance
Averaged over the globe and over longer time periods, the energy budget of the *climate system* must be in balance. Because the climate system derives all its energy from the Sun, this balance implies that, globally, the amount of incoming *solar radiation* must on average be equal to the sum of the outgoing reflected solar radiation and the outgoing *infrared radiation* emitted by the climate system. A perturbation of this global radiation balance, be it human-induced or natural, is called *radiative forcing*.

Energy conversion
See *energy transformation*.

Energy efficiency
Ratio of energy output of a conversion process or of a system to its energy input.

Energy intensity
Energy intensity is the ratio of energy consumption to economic or physical output. At the national level, energy intensity is the ratio of total domestic *primary energy* consumption or *final energy* consumption to *Gross Domestic Product* or physical output.

Energy service
The application of useful energy to tasks desired by the consumer such as transportation, a warm room, or light.

Energy tax
See *emissions tax*.

Energy transformation
The change from one form of energy, such as the energy embodied in *fossil fuels*, to another, such as electricity.

Environmentally Sound Technologies (ESTs)
Technologies that protect the environment, are less polluting, use all resources in a more sustainable manner, recycle more of their wastes and products, and handle residual wastes in a more acceptable manner than the technologies for which they were substitutes and are compatible with nationally determined socio-economic, cultural, and environmental priorities. ESTs in this report imply mitigation and adaptation technologies, hard and soft technologies.

Epidemic
Occurring suddenly in numbers clearly in excess of normal expectancy, said especially of *infectious diseases* but applied also to any disease, injury, or other health-related event occurring in such outbreaks.

Equilibrium and transient climate experiment
An "equilibrium climate experiment" is an experiment in which a *climate model* is allowed to fully adjust to a change in *radiative forcing*. Such experiments provide information on the difference between the initial and final states of the model, but not on the time-dependent response. If the forcing is allowed to evolve gradually according to a prescribed *emission scenario*, the time-dependent response of a climate model may be analyzed. Such an experiment is called a "transient climate experiment." See also *climate projection*.

Equivalent CO_2 (carbon dioxide)
The concentration of *carbon dioxide* that would cause the same amount of *radiative forcing* as a given mixture of carbon dioxide and other *greenhouse gases*.

Erosion
The process of removal and transport of soil and rock by weathering, mass wasting, and the action of streams, *glaciers*, waves, winds, and underground water.

Eustatic sea-level change
A change in global average sea level brought about by an alteration to the volume of the world ocean. This may be caused by changes in water density or in the total mass of water. In discussions of changes on geological time scales, this term sometimes also includes changes in global average sea level caused by an alteration to the shape of the ocean basins. In this report, the term is not used in that sense.

Eutrophication
The process by which a body of water (often shallow) becomes (either naturally or by pollution) rich in dissolved nutrients with a seasonal deficiency in dissolved oxygen.

Evaporation
The process by which a liquid becomes a gas.

Evapotranspiration
The combined process of *evaporation* from the Earth's surface and *transpiration* from vegetation.

Exotic species
See *introduced species*.

Exposure
The nature and degree to which a system is exposed to significant climatic variations.

Externality
See *external cost*.

External cost
Used to define the costs arising from any human activity, when the agent responsible for the activity does not take full account of the impacts on others of his or her actions. Equally, when the impacts are positive and not accounted for in the actions of the agent responsible they are referred to as external benefits. *Emissions* of particulate pollution from a power station affect the health of people in the vicinity, but this is not often considered, or is given inadequate weight, in private decision making and there is no market for such impacts. Such a phenomenon is referred to as an "externality," and the costs it imposes are referred to as the external costs.

External forcing
See *climate system*.

Extinction
The complete disappearance of an entire species.

Extirpation
The disappearance of a species from part of its range; local extinction.

Extreme weather event
An extreme weather event is an event that is rare within its statistical reference distribution at a particular place. Definitions of "rare" vary, but an extreme weather event would normally be as rare as or rarer than the 10th or 90th percentile. By definition, the characteristics of what is called extreme weather may vary from place to place. An extreme *climate* event is an average of a number of weather events over a certain period of time, an average which is itself extreme (e.g., rainfall over a season).

Feedback
See *climate feedback*.

Fiber
Wood, fuelwood (either woody or non-woody).

Final energy
Energy supplied that is available to the consumer to be converted into usable energy (e.g., electricity at the wall outlet).

Flexibility mechanisms
See *Kyoto Mechanisms*.

Flux adjustment
To avoid the problem of coupled atmosphere-ocean general circulation models drifting into some unrealistic climate state, adjustment terms can be applied to the atmosphere-ocean fluxes of heat and moisture (and sometimes the surface stresses resulting from the effect of the wind on the ocean surface) before these fluxes are imposed on the model ocean and atmosphere. Because these adjustments are pre-computed and therefore independent of the coupled model integration, they are uncorrelated to the anomalies that develop during the integration.

Food insecurity
A situation that exists when people lack secure access to sufficient amounts of safe and nutritious food for normal growth and development and an active and healthy life. It may be caused by the unavailability of food, insufficient purchasing power, inappropriate distribution, or inadequate use of food at the household level. Food insecurity may be chronic, seasonal, or transitory.

Forest
A vegetation type dominated by trees. Many definitions of the term forest are in use throughout the world, reflecting wide differences in bio-geophysical conditions, social structure, and economics. For a discussion of the term forest and related terms such as *afforestation*, *reforestation*, and *deforestation*: see the IPCC Special Report on Land Use, Land-Use Change, and Forestry (IPCC, 2000b).

Fossil CO_2 (carbon dioxide) emissions
Emissions of *carbon dioxide* resulting from the combustion of fuels from fossil carbon deposits such as oil, natural gas, and coal.

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

Freshwater lens
A lenticular fresh groundwater body that underlies an oceanic island. It is underlain by saline water.

Fuel switching
Policy designed to reduce *carbon dioxide emissions* by switching to lower carbon-content fuels, such as from coal to natural gas.

Full-cost pricing
The pricing of commercial goods—such as electric power—that includes in the final prices faced by the end user not only the private costs of inputs, but also the costs of externalities created by their production and use.

Framework Convention on Climate Change
See *United Nations Framework Convention on Climate Change*.

General circulation
The large scale motions of the *atmosphere* and the ocean as a consequence of differential heating on a rotating Earth, aiming to restore the *energy balance* of the system through transport of heat and momentum.

General Circulation Model (GCM)
See *climate model*.

Geo-engineering
Efforts to stabilize the climate system by directly managing the energy balance of the Earth, thereby overcoming the enhanced *greenhouse effect*.

Glacier
A mass of land ice flowing downhill (by internal deformation and sliding at the base) and constrained by the surrounding topography (e.g., the sides of a valley or surrounding peaks); the bedrock topography is the major influence on the dynamics and surface slope of a glacier. A glacier is maintained by accumulation of snow at high altitudes, balanced by melting at low altitudes or discharge into the sea.

Global surface temperature
The global surface temperature is the area-weighted global average of (i) the sea surface temperature over the oceans (i.e., the sub-surface bulk temperature in the first few meters of the ocean), and (ii) the surface air temperature over land at 1.5 m above the ground.

Global Warming Potential (GWP)
An index, describing the radiative characteristics of well-mixed *greenhouse gases*, that represents the combined effect of the differing times these gases remain in the *atmosphere* and their relative effectiveness in absorbing outgoing *infrared radiation*. This index approximates the time-integrated warming effect of a unit mass of a given greenhouse gas in today's atmosphere, relative to that of *carbon dioxide*.

Greenhouse effect
Greenhouse gases effectively absorb *infrared radiation*, emitted by the Earth's surface, by the *atmosphere* itself due to the same gases, and by clouds. Atmospheric radiation is emitted to all sides, including downward to the Earth's surface. Thus greenhouse gases trap heat within the surface-troposphere system. This is called the "natural greenhouse effect." Atmospheric radiation is strongly coupled to the temperature of the level at which it is emitted. In the *troposphere*, the temperature generally decreases with height. Effectively, infrared radiation emitted to space originates from an altitude with a temperature of, on average, -19°C, in balance with the net incoming *solar radiation*, whereas the Earth's surface is kept at a much higher temperature of, on average, +14°C. An increase in the concentration of greenhouse gases leads to an increased infrared opacity of the atmosphere, and therefore to an effective radiation into space from a higher altitude at a lower temperature. This causes a *radiative forcing*, an imbalance that can only be compensated for by an increase of the temperature of the surface-troposphere system. This is the "enhanced greenhouse effect."

Greenhouse gas
Greenhouse gases are those gaseous constituents of the *atmosphere*, both natural and *anthropogenic*, that absorb and emit radiation at specific wavelengths within the spectrum of *infrared radiation* emitted by the Earth's surface, the atmosphere, and clouds. This property causes the *greenhouse effect*. Water vapor (H_2O), *carbon dioxide* (CO_2), *nitrous oxide* (N_2O), *methane* (CH_4), and *ozone* (O_3) are the primary greenhouse gases in the Earth's atmosphere. Moreover there are a number of entirely human-made greenhouse gases in the atmosphere, such as the *halocarbons* and other chlorine- and bromine-containing substances, dealt with under the *Montreal Protocol*. Besides CO_2, N_2O, and CH_4, the *Kyoto Protocol* deals with the greenhouse gases *sulfur hexafluoride* (SF_6), *hydrofluorocarbons* (HFCs), and *perfluorocarbons* (PFCs).

Groin
A low, narrow jetty, usually extending roughly perpendicular to the shoreline, designed to protect the shore from *erosion* by currents, tides, or waves, or to trap sand for the purpose of building up or making a beach.

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 of time, normally 1 year. It is calculated without deducting for depreciation of fabricated assets or depletion and degradation of natural *resources*. GDP is an often used but incomplete measure of welfare.

Gross Primary Production (GPP)
The amount of carbon fixed from the *atmosphere* through *photosynthesis*.

Groundwater recharge
The process by which external water is added to the zone of saturation of an *aquifer*, either directly into a formation or indirectly by way of another formation.

Habitat
The particular environment or place where an organism or species tend to live; a more locally circumscribed portion of the total environment.

Halocarbons
Compounds containing carbon and either chlorine, bromine, or fluorine. Such compounds can act as powerful *greenhouse gases* in the *atmosphere*. The chlorine- and bromine-containing halocarbons are also involved in the depletion of the *ozone layer*.

Harmonized emissions/carbon/energy tax
Commits participating countries to impose a tax at a common rate on the same *sources*. Each country can retain the tax revenue it collects. A harmonized tax would not necessarily require countries to impose a tax at the same rate, but imposing different rates across countries would not be *cost-effective*. See also *emissions tax*.

Heat island
An area within an urban area characterized by ambient temperatures higher than those of the surrounding area because of the absorption of solar energy by materials like asphalt.

Heating degree days
The integral over a day of the temperature below 18°C (e.g., a day with an average temperature of 16°C counts as 2 heating degree days). See also *cooling degree days*.

Hedging
In the context of climate change mitigation, hedging is defined as balancing the risks of acting too slowly against acting too quickly, and it depends on society's attitude towards risks.

Heterotrophic respiration
The conversion of organic matter to CO_2 by organisms other than plants.

Human settlement
A place or area occupied by settlers.

Human system
Any system in which human organizations play a major role. Often, but not always, the term is synonymous with "society" or "social system" (e.g., agricultural system, political system, technological system, economic system).

Hydrofluorocarbons (HFCs)
Among the six *greenhouse gases* to be curbed under the *Kyoto Protocol*. They are produced commercially as a substitute for *chlorofluorocarbons*. HFCs largely are used in refrigeration and semiconductor manufacturing. Their *Global Warming Potentials* range from 1,300 to 11,700.

Hydrosphere
The component of the *climate system* composed of liquid surface and subterranean water, such as oceans, seas, rivers, freshwater lakes, underground water, etc.

Ice cap
A dome shaped ice mass covering a highland area that is considerably smaller in extent than an *ice sheet*.

Ice sheet
A mass of land ice that is sufficiently deep to cover most of the underlying bedrock topography, so that its shape is mainly determined by its internal dynamics (the flow of the ice as it deforms internally and slides at its base). An ice sheet flows outward from a high central plateau with a small average surface slope. The margins slope steeply, and the ice is discharged through fast-flowing ice streams or outlet *glaciers*, in some cases into the sea or into *ice shelves* floating on the sea. There are only two large ice sheets in the modern world, on Greenland and Antarctica, the Antarctic ice sheet being divided into East and West by the Transantarctic Mountains; during glacial periods there were others.

Ice shelf
A floating *ice sheet* of considerable thickness attached to a coast (usually of great horizontal extent with a level or gently undulating surface); often a seaward extension of ice sheets.

(Climate) Impact assessment
The practice of identifying and evaluating the detrimental and beneficial consequences of *climate change* on natural and *human systems*.

(Climate) Impacts
Consequences of *climate change* on natural and *human systems*. Depending on the consideration of *adaptation*, one can distinguish between potential impacts and residual impacts.

- Potential impacts: All impacts that may occur given a projected change in *climate*, without considering adaptation.
- Residual impacts: The impacts of climate change that would occur after adaptation.

See also a*ggregate impacts*, *market impacts*, and *non-market impacts*.

Implementation
Implementation refers to the actions (legislation or regulations, judicial decrees, or other actions) that governments take to translate international accords into domestic law and policy. It includes those events and activities that occur after the issuing of authoritative public policy directives, which include the effort to administer and the substantive impacts on people and events. It is important to distinguish between the legal implementation of international commitments (in national law) and the effective implementation (measures that induce changes in the behavior of target groups). Compliance is a matter of whether and to what extent countries do adhere to the provisions of the accord. Compliance focuses on not only whether implementing measures are in effect, but also on whether there is compliance with the implementing actions. Compliance measures the degree to which the actors whose behavior is targeted by the agreement, whether they are local government units, corporations, organizations, or individuals, conform to the implementing measures and obligations.

Implementation costs
Costs involved in the *implementation* of *mitigation* options. These costs are associated with the necessary institutional

changes, information requirements, market size, *opportunities* for *technology* gain and learning, and economic incentives needed (grants, subsidies, and taxes).

Indigenous peoples

People whose ancestors inhabited a place or a country when persons from another culture or ethnic background arrived on the scene and dominated them through conquest, settlement, or other means and who today live more in conformity with their own social, economic, and cultural customs and traditions than those of the country of which they now form a part (also referred to as "native," "aboriginal," or "tribal" peoples).

Indirect aerosol effect

Aerosols may lead to an indirect *radiative forcing* of the *climate system* through acting as condensation nuclei or modifying the optical properties and lifetime of clouds. Two indirect effects are distinguished:

- First indirect effect: A radiative forcing induced by an increase in *anthropogenic* aerosols which cause an initial increase in droplet concentration and a decrease in droplet size for fixed liquid water content, leading to an increase of cloud *albedo*. This effect is also known as the "Twomey effect." This is sometimes referred to as the cloud albedo effect. However this is highly misleading since the second indirect effect also alters cloud albedo.
- Second indirect effect: A radiative forcing induced by an increase in anthropogenic aerosols which cause a decrease in droplet size, reducing the precipitation efficiency, thereby modifying the liquid water content, cloud thickness, and cloud lifetime. This effect is also known as the "cloud lifetime effect" or "Albrecht effect."

Industrial Revolution

A period of rapid industrial growth with far-reaching social and economic consequences, beginning in England 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* and emission of, in particular, fossil *carbon dioxide*. In this report, the terms "pre-industrial" and "industrial" refer, somewhat arbitrarily, to the periods before and after the year 1750, respectively.

Inertia

Delay, slowness, or resistance in the response of the *climate*, biological, or *human systems* to factors that alter their rate of change, including continuation of change in the system after the cause of that change has been removed.

Infectious diseases

Any disease that can be transmitted from one person to another. This may occur by direct physical contact, by common handling of an object that has picked up infective organisms, through a disease carrier, or by spread of infected droplets coughed or exhaled into the air.

Infrared radiation

Radiation emitted by the Earth's surface, the *atmosphere*, and clouds. It is also known as terrestrial or long-wave radiation. Infrared radiation has a distinctive range of wavelengths ("spectrum") longer than the wavelength of the red color in the visible part of the spectrum. The spectrum of infrared radiation is practically distinct from that of solar or short-wave radiation because of the difference in temperature between the Sun and the Earth-atmosphere system.

Infrastructure

The basic equipment, utilities, productive enterprises, installations, institutions, and services essential for the development, operation, and growth of an organization, city, or nation. For example, roads; schools; electric, gas, and water utilities; transportation; communication; and legal systems would be all considered as infrastructure.

Integrated assessment

A method of analysis that combines results and models from the physical, biological, economic, and social sciences, and the interactions between these components, in a consistent framework, to evaluate the status and the consequences of environmental change and the policy responses to it.

Interaction effect

The result or consequence of the interaction of *climate change* policy instruments with existing domestic tax systems, including both cost-increasing tax interaction and cost-reducing revenue-recycling effect. The former reflects the impact that *greenhouse gas* policies can have on the functioning of labor and capital markets through their effects on real wages and the real return to capital. By restricting the allowable greenhouse gas *emissions*, permits, regulations, or a *carbon tax* raise the costs of production and the prices of output, thus reducing the real return to labor and capital. For policies that raise revenue for the government—carbon taxes and auctioned permits—the revenues can be recycled to reduce existing distortionary taxes. See also *double dividend*.

Internal variability

See *climate variability*.

International emissions/carbon/energy tax

See *emissions tax*.

International Energy Agency (IEA)

Paris-based energy forum established in 1974. It is linked with the Organisation for Economic Cooperation and Development to enable member countries to take joint measures to meet oil supply emergencies, to share energy information, to coordinate their energy policies, and to cooperate in the development of rational energy programs.

International product and/or technology standards
See *standards*.

Introduced species
A species occurring in an area outside its historically known natural range as a result of accidental dispersal by humans (also referred to as "*exotic species*" or "alien species").

Invasive species
An *introduced species* that invades natural *habitats*.

Isostatic land movements
Isostasy refers to the way in which the *lithosphere* and mantle respond to changes in surface loads. When the loading of the lithosphere is changed by alterations in land ice mass, ocean mass, sedimentation, erosion, or mountain building, vertical isostatic adjustment results, in order to balance the new load.

Joint Implementation (JI)
A market-based implementation mechanism defined in Article 6 of the *Kyoto Protocol*, allowing *Annex I countries* or companies from these countries to implement projects jointly that limit or reduce *emissions*, or enhance *sinks*, and to share the *Emissions Reduction Units*. JI activity is also permitted in Article 4.2(a) of the *United Nations Framework Convention on Climate Change*. See also *Activities Implemented Jointly* and *Kyoto Mechanisms*.

Known technological options
Refer to technologies that exist in operation or pilot plant stage today. It does not include any new technologies that will require drastic technological breakthroughs.

Kyoto Mechanisms
Economic mechanisms based on market principles that Parties to the *Kyoto Protocol* can use in an attempt to lessen the potential economic impacts of *greenhouse gas* emission-reduction requirements. They include *Joint Implementation* (Article 6), the *Clean Development Mechanism* (Article 12), and *Emissions Trading* (Article 17).

Kyoto Protocol
The Kyoto Protocol to the *United Nations Framework Convention on Climate Change* (UNFCCC) was adopted at the Third Session of the *Conference of the Parties* to the UNFCCC in 1997 in Kyoto, Japan. It contains legally binding commitments, in addition to those included in the UNFCCC. Countries included in *Annex B* of the Protocol (most countries in the Organisation for Economic Cooperation and Development, and countries with *economies in transition*) agreed to reduce their *anthropogenic greenhouse gas emissions* (*carbon dioxide*, *methane*, *nitrous oxide*, *hydrofluorocarbons*, *perfluorocarbons*, *and sulfur hexafluoride*) by at least 5% below 1990 levels in the commitment period 2008 to 2012. The Kyoto Protocol has not yet entered into force (September 2001).

La Niña
See *El Niño Southern Oscillation*.

Land use
The total of arrangements, activities, and inputs undertaken in a certain land cover type (a set of human actions). The social and economic purposes for which land is managed (e.g., grazing, timber extraction, and conservation).

Land-use change
A change in the use or management of land by humans, which may lead to a change in land cover. Land cover and land-use change may have an impact on the *albedo*, *evapotranspiration*, *sources*, and *sinks* of *greenhouse gases*, or other properties of the *climate system*, and may thus have an impact on *climate*, locally or globally. See also the IPCC Special Report on Land Use, Land-Use Change, and Forestry (IPCC, 2000b).

Landslide
A mass of material that has slipped downhill by gravity, often assisted by water when the material is saturated; rapid movement of a mass of soil, rock, or debris down a slope.

Leakage
The part of *emissions* reductions in *Annex B countries* that may be offset by an increase of the emission in the non-constrained countries above their *baseline* levels. This can occur through (i) relocation of energy-intensive production in non-constrained regions; (ii) increased consumption of *fossil fuels* in these regions through decline in the international price of oil and gas triggered by lower demand for these energies; and (iii) changes in incomes (thus in energy demand) because of better terms of trade. Leakage also refers to the situation in which a carbon *sequestration* activity (e.g., tree planting) on one piece of land inadvertently, directly or indirectly, triggers an activity, which in whole or part, counteracts the carbon effects of the initial activity.

Lifetime
Lifetime is a general term used for various *time scales* characterizing the rate of processes affecting the concentration of trace gases. In general, lifetime denotes the average length of time that an atom or molecule spends in a given *reservoir*, such as the *atmosphere* or oceans. The following lifetimes may be distinguished:

- "Turnover time" (T) or "atmospheric lifetime" is the ratio of the mass M of a reservoir (e.g., a gaseous compound in the *atmosphere*) and the total rate of removal S from the reservoir: T = M/S. For each removal process separate turnover times can be defined. In soil carbon biology, this is referred to as Mean Residence Time.
- "Adjustment time," "response time," or "perturbation lifetime" (T_a) is the time scale characterizing the decay of an instantaneous pulse input into the reservoir. The term adjustment time is also used to characterize the adjustment

of the mass of a reservoir following a step change in the source strength. Half-life or decay constant is used to quantify a first-order exponential decay process. See *response time* for a different definition pertinent to *climate* variations. The term "lifetime" is sometimes used, for simplicity, as a surrogate for "adjustment time."

In simple cases, where the global removal of the compound is directly proportional to the total mass of the reservoir, the adjustment time equals the turnover time: $T = T_a$. An example is CFC-11 which is removed from the atmosphere only by photochemical processes in the *stratosphere*. In more complicated cases, where several reservoirs are involved or where the removal is not proportional to the total mass, the equality $T = T_a$ no longer holds. *Carbon dioxide* is an extreme example. Its turnover time is only about 4 years because of the rapid exchange between atmosphere and the ocean and terrestrial biota. However, a large part of that CO_2 is returned to the atmosphere within a few years. Thus, the adjustment time of CO_2 in the atmosphere is actually determined by the rate of removal of carbon from the surface layer of the oceans into its deeper layers. Although an approximate value of 100 years may be given for the adjustment time of CO_2 in the atmosphere, the actual adjustment is faster initially and slower later on. In the case of *methane*, the adjustment time is different from the turnover time, because the removal is mainly through a chemical reaction with the hydroxyl radical OH, the concentration of which itself depends on the CH_4 concentration. Therefore the CH_4 removal S is not proportional to its total mass M.

Lithosphere

The upper layer of the solid Earth, both continental and oceanic, which is composed of all crustal rocks and the cold, mainly elastic, part of the uppermost mantle. Volcanic activity, although part of the lithosphere, is not considered as part of the *climate system*, but acts as an *external forcing* factor.

Leapfrogging

Leapfrogging (or technological leapfrogging) refers to the opportunities in developing countries to bypass several stages of technology development, historically observed in industrialized countries, and apply the most advanced presently available technologies in the energy and other economic sectors, through investments in technological development and capacity building.

Level of scientific understanding

This is an index on a 4-step scale (High, Medium, Low, and Very Low) designed to characterize the degree of scientific understanding of the *radiative forcing* agents that affect *climate change*. For each agent, the index represents a subjective judgement about the reliability of the estimate of its forcing, involving such factors as the assumptions necessary to evaluate the forcing, the degree of knowledge of the physical/chemical mechanisms determining the forcing, and the uncertainties surrounding the quantitative estimate.

Local Agenda 21

Local Agenda 21s are the local plans for environment and development that each local authority is meant to develop through a consultative process with their populations, with particular attention paid to involving women and youth. Many local authorities have developed Local Agenda 21s through consultative processes as a means of reorienting their policies, plans, and operations towards the achievement of *sustainable development* goals. The term comes from Chapter 28 of Agenda 21—the document formally endorsed by all government representatives attending the United Nations Conference on Environment and Development (also known as the Earth Summit) in Rio de Janeiro in 1992.

Lock-in technologies and practices

Technologies and practices that have market advantages arising from existing institutions, services, infrastructure, and available resources; they are very difficult to change because of their widespread use and the presence of associated infrastructure and socio-cultural patterns.

Maladaptation

Any changes in natural or *human systems* that inadvertently increase *vulnerability* to climatic *stimuli*; an *adaptation* that does not succeed in reducing vulnerability but increases it instead.

Malaria

Endemic or *epidemic* parasitic disease caused by species of the genus Plasmodium (protozoa) and transmitted by mosquitoes of the genus Anopheles; produces high fever attacks and systemic disorders, and kills approximately 2 million people every year.

Marginal cost pricing

The pricing of commercial goods and services such that the price equals the additional cost that arises from the expansion of production by one additional unit.

Market barriers

In the context of *mitigation* of *climate change*, conditions that prevent or impede the diffusion of *cost-effective* technologies or practices that would mitigate *greenhouse gas emissions*.

Market-based incentives

Measures intended to use price mechanisms (e.g., taxes and tradable permits) to reduce *greenhouse gas emissions*.

Market impacts

Impacts that are linked to market transactions and directly affect *Gross Domestic Product* (a country's national accounts)—for example, changes in the supply and price of agricultural goods. See also *non-market impacts*.

Market penetration
Market penetration is the share of a given market that is provided by a particular good or service at a given time.

Market potential
The portion of the *economic potential* for *greenhouse gas emissions* reductions or *energy-efficiency* improvements that could be achieved under forecast market conditions, assuming no new *policies and measures*. See also *economic potential*, *socio-economic potential*, and *technological potential*.

Mass movement
Applies to all unit movements of land material propelled and controlled by gravity.

Mean Sea Level (MSL)
Mean Sea Level is normally defined as the average r*elative sea level* over a period, such as a month or a year, long enough to average out transients such as waves. See also *sea-level rise*.

Methane (CH_4)
A hydrocarbon that is a *greenhouse gas* produced through anaerobic (without oxygen) decomposition of waste in landfills, animal digestion, decomposition of animal wastes, production and distribution of natural gas and oil, coal production, and incomplete fossil-fuel combustion. *Methane* is one of the six *greenhouse gases* to be mitigated under the *Kyoto Protocol*.

Methane recovery
Method by which *methane emissions* (e.g., from coal mines or waste sites) are captured and then reused either as a fuel or for some other economic purpose (e.g., reinjection in oil or gas *reserves*).

Meeting of the Parties (to the Kyoto Protocol) (MOP)
The *Conference of the Parties* of the *United Nations Framework Convention on Climate Change* will serve as the *Meeting of the Parties (MOP)*, the supreme body of the *Kyoto Protocol*, but only Parties to the Kyoto Protocol may participate in deliberations and make decisions. Until the Protocol enters into force, MOP cannot meet.

Mitigation
An *anthropogenic* intervention to reduce the *sources* or enhance the *sinks* of *greenhouse gases*.

Mitigative capacity
The social, political, and economic structures and conditions that are required for effective *mitigation*.

Mixed layer
The upper region of the ocean well-mixed by interaction with the overlying *atmosphere*.

Mixing ratio
See *mole fraction*.

Model hierarchy
See *climate model*.

Mole fraction
Mole fraction, or mixing ratio, is the ratio of the number of moles of a constituent in a given volume to the total number of moles of all constituents in that volume. It is usually reported for dry air. Typical values for long-lived *greenhouse gases* are in the order of mmol/mol (parts per million: ppm), nmol/mol (parts per billion: ppb), and fmol/mol (parts per trillion: ppt). Mole fraction differs from volume mixing ratio, often expressed in ppmv, etc., by the corrections for non-ideality of gases. This correction is significant relative to measurement precision for many greenhouse gases (Schwartz and Warneck, 1995).

Monsoon
Wind in the general atmospheric circulation typified by a seasonal persistent wind direction and by a pronounced change in direction from one season to the next.

Montane
The biogeographic zone made up of relatively moist, cool upland slopes below timberline and characterized by the presence of large evergreen trees as a dominant life form.

Montreal Protocol
The Montreal Protocol on substances that deplete the *ozone layer* was adopted in Montreal in 1987, and subsequently adjusted and amended in London (1990), Copenhagen (1992), Vienna (1995), Montreal (1997), and Beijing (1999). It controls the consumption and production of chlorine- and bromine-containing chemicals that destroy stratospheric ozone, such as *chlorofluorocarbons* (CFCs), methyl chloroform, carbon tetrachloride, and many others.

Morbidity
Rate of occurrence of disease or other health disorder within a population, taking account of the age-specific morbidity rates. Health outcomes include chronic disease incidence/prevalence, rates of hospitalization, primary care consultations, disability-days (i.e., days when absent from work), and prevalence of symptoms.

Mortality
Rate of occurrence of death within a population within a specified time period; calculation of mortality takes account of age-specific death rates, and can thus yield measures of life expectancy and the extent of premature death.

Net Biome Production (NBP)
Net gain or loss of carbon from a region. NBP is equal to the *Net Ecosystem Production* minus the carbon lost due to a disturbance (e.g., a *forest* fire or a forest harvest).

Net carbon dioxide emissions
Difference between sources and sinks of carbon dioxide in a given period and specific area or region.

Net Ecosystem Production (NEP)
Net gain or loss of carbon from an *ecosystem*. NEP is equal to the *Net Primary Production* minus the carbon lost through heterotrophic *respiration*.

Net Primary Production (NPP)
The increase in plant *biomass* or carbon of a unit of a landscape. NPP is equal to the *Gross Primary Production* minus carbon lost through autotrophic *respiration*.

Nitrogen fertilization
Enhancement of plant growth through the addition of nitrogen compounds. In IPCC assessments, this typically refers to fertilization from *anthropogenic sources* of nitrogen such as human-made fertilizers and *nitrogen oxides* released from burning *fossil fuels*.

Nitrogen oxides (NO_x)
Any of several oxides of nitrogen.

Nitrous oxide (N_2O)
A powerful greenhouse gas emitted through soil cultivation practices, especially the use of commercial and organic fertilizers, fossil-fuel combustion, nitric acid production, and biomass burning. One of the six *greenhouse gases* to be curbed under the *Kyoto Protocol*.

Non-point-source pollution
Pollution from *sources* that cannot be defined as discrete points, such as areas of crop production, timber, surface mining, disposal of refuse, and construction. See also *point-source pollution*.

No-regrets opportunities
See *no-regrets policy*.

No-regret options
See *no-regrets policy*.

No-regrets policy
One that would generate net social benefits whether or not there is *climate change*. No-regrets opportunities for *greenhouse gas emissions* reduction are defined as those options whose benefits such as reduced energy costs and reduced emissions of local/regional pollutants equal or exceed their costs to society, excluding the benefits of avoided climate change. No-regrets potential is defined as the gap between the *market potential* and the *socio-economic potential*.

No-regrets potential
See *no-regrets policy*.

Non-Annex B countries/Parties
The countries that are not included in Annex B in the *Kyoto Protocol*. See also *Annex B countries*.

Non-Annex I countries/Parties
The countries that have ratified or acceded to the *United Nations Framework Convention on Climate Change* that are not included in Annex I of the Climate Convention. See also *Annex I countries*.

Non-linearity
A process is called "non-linear" when there is no simple proportional relation between cause and effect. The *climate system* contains many such non-linear processes, resulting in a system with a potentially very complex behavior. Such complexity may lead to *rapid climate change*.

Non-market impacts
Impacts that affect *ecosystems* or human welfare, but that are not directly linked to market transactions—for example, an increased risk of premature death. See also *market impacts*.

North Atlantic Oscillation (NAO)
The North Atlantic Oscillation consists of opposing variations of barometric pressure near Iceland and near the Azores. On average, a westerly current, between the Icelandic low pressure area and the Azores high pressure area, carries cyclones with their associated frontal systems towards Europe. However, the pressure difference between Iceland and the Azores fluctuates on *time scales* of days to decades, and can be reversed at times. It is the dominant mode of winter *climate variability* in the North Atlantic region, ranging from central North America to Europe.

Ocean conveyor belt
The theoretical route by which water circulates around the entire global ocean, driven by wind and the *thermohaline circulation*.

Opportunity
An opportunity is a situation or circumstance to decrease the gap between the *market potential* of any *technology* or practice and the *economic potential*, *socio-economic potential*, or *technological potential*.

Opportunity costs
The cost of an economic activity forgone by the choice of another activity.

Optimal policy
A policy is assumed to be "optimal" if marginal abatement costs are equalized across countries, thereby minimizing *total costs*.

Organic aerosol
Aerosol particles consisting predominantly of organic compounds, mainly C, H, and O, and lesser amounts of other elements (Charlson and Heintzenberg, 1995). See *carbonaceous aerosol*.

Ozone (O_3)
Ozone, the triatomic form of oxygen (O_3), is a gaseous atmospheric constituent. In the *troposphere* it is created both naturally and by photochemical reactions involving gases resulting from human activities (photochemical "smog"). In high concentrations, tropospheric ozone can be harmful to a wide-range of living organisms. Tropospheric ozone acts as a *greenhouse gas*. In the *stratosphere*, ozone is created by the interaction between solar ultraviolet radiation and molecular oxygen (O_2). Stratospheric ozone plays a decisive role in the stratospheric *radiative balance*. Its concentration is highest in the *ozone layer*. Depletion of stratospheric ozone, due to chemical reactions that may be enhanced by *climate change*, results in an increased ground-level flux of *ultraviolet-B radiation*. See also *Montreal Protocol* and *ozone layer*.

Ozone hole
See *ozone layer*.

Ozone layer
The *stratosphere* contains a layer in which the concentration of *ozone* is greatest, the so-called ozone layer. The layer extends from about 12 to 40 km. The ozone concentration reaches a maximum between about 20 and 25 km. This layer is being depleted by human *emissions* of chlorine and bromine compounds. Every year, during the Southern Hemisphere spring, a very strong depletion of the ozone layer takes place over the Antarctic region, also caused by human-made chlorine and bromine compounds in combination with the specific meteorological conditions of that region. This phenomenon is called the *ozone hole*.

Parameterization
In *climate models*, this term refers to the technique of representing processes, that cannot be explicitly resolved at the spatial or temporal resolution of the model (sub-grid scale processes), by relationships between the area- or time-averaged effect of such sub-grid-scale processes and the larger scale flow.

Pareto criterion/Pareto optimum
A requirement or status that an individual's welfare could not be further improved without making others in the society worse off.

Perfluorocarbons (PFCs)
Among the six *greenhouse gases* to be abated under the *Kyoto Protocol*. These are by-products of aluminum smelting and uranium enrichment. They also replace *chlorofluorocarbons* in manufacturing semiconductors. The *Global Warming Potential* of PFCs is 6,500–9,200 times that of *carbon dioxide*.

Permafrost
Perennially frozen ground that occurs wherever the temperature remains below 0°C for several years.

Perturbation lifetime
See *lifetime*.

Photosynthesis
The process by which plants take *carbon dioxide* (CO_2) from the air (or bicarbonate in water) to build carbohydrates, releasing oxygen (O_2) in the process. There are several pathways of photosynthesis with different responses to atmospheric CO_2 concentrations. See also *carbon dioxide fertilization*.

Phytoplankton
The plant forms of *plankton* (e.g., diatoms). Phytoplankton are the dominant plants in the sea, and are the bast of the entire marine food web. These single-celled organisms are the principal agents for photosynthetic carbon fixation in the ocean. See also *zooplankton*.

Plankton
Aquatic organisms that drift or swim weakly. See also *phytoplankton* and *zooplankton*.

Point-source pollution
Pollution resulting from any confined, discrete source, such as a pipe, ditch, tunnel, well, container, concentrated animal-feeding operation, or floating craft. See also *non-point-source pollution*.

Policies and measures
In *United Nations Framework Convention on Climate Change* parlance, "policies" are actions that can be taken and/or mandated by a government—often in conjunction with business and industry within its own country, as well as with other countries—to accelerate the application and use of measures to curb *greenhouse gas emissions*. "Measures" are technologies, processes, and practices used to implement policies, which, if employed, would reduce greenhouse gas emissions below anticipated future levels. Examples might include carbon or other *energy taxes*, standardized fuel-efficiency *standards* for automobiles, etc. "Common and coordinated" or "harmonized" policies refer to those adopted jointly by Parties.

Pool
See *reservoir*.

Post-glacial rebound
The vertical movement of the continents and sea floor following the disappearance and shrinking of *ice sheets*—for example, since the Last Glacial Maximum (21 ky BP). The rebound is an *isostatic land movement*.

Precursors
Atmospheric compounds which themselves are not *greenhouse gases* or *aerosols*, but which have an effect on greenhouse gas or aerosol concentrations by taking part in physical or chemical processes regulating their production or destruction rates.

Pre-industrial
See *Industrial Revolution*.

Present value cost
The sum of all costs over all time periods, with future costs discounted.

Primary energy
Energy embodied in natural *resources* (e.g., coal, crude oil, sunlight, uranium) that has not undergone any *anthropogenic* conversion or transformation.

Private cost
Categories of costs influencing an individual's decision making are referred to as private costs. See also *social cost* and *total cost*.

Profile
A smoothly changing set of concentrations representing a possible pathway towards stabilization. The word "profile"is used to distinguish such pathways from emissions pathways, which are usually referred to as "*scenarios*."

Projection (generic)
A projection is a potential future evolution of a quantity or set of quantities, often computed with the aid of a model. Projections are distinguished from "predictions" in order to emphasize that projections involve assumptions concerning, for example, future socio-economic and technological developments that may or may not be realized, and are therefore subject to substantial *uncertainty*. See also *climate projection* and *climate prediction*.

Proxy
A proxy *climate* indicator is a local record that is interpreted, using physical and biophysical principles, to represent some combination of climate-related variations back in time. Climate-related data derived in this way are referred to as proxy data. Examples of proxies are tree ring records, characteristics of corals, and various data derived from ice cores.

Purchasing Power Parity (PPP)
Estimates of *Gross Domestic Product* based on the purchasing power of currencies rather than on current exchange rates. Such estimates are a blend of extrapolated and regression-based numbers, using the results of the International Comparison Program. PPP estimates tend to lower per capita GDPs in industrialized countries and raise per capita GDPs in developing countries. PPP is also an acronym for polluter-pays-principle.

Radiative balance
See *energy balance*.

Radiative forcing
Radiative forcing is the change in the net vertical irradiance (expressed in Wm^{-2}) at the *tropopause* due to an internal change or a change in the external forcing of the *climate system*, such as, for example, a change in the concentration of *carbon dioxide* or the output of the Sun. Usually radiative forcing is computed after allowing for stratospheric temperatures to readjust to radiative equilibrium, but with all tropospheric properties held fixed at their unperturbed values.

Radiative forcing scenario
A plausible representation of the future development of *radiative forcing* associated, for example, with changes in atmospheric composition or *land-use* change, or with external factors such as variations in *solar activity*. Radiative forcing scenarios can be used as input into simplified *climate models* to compute *climate projections*.

Rangeland
Unimproved grasslands, shrublands, savannahs, and tundra.

Regeneration
The renewal of a stand of trees through either natural means (seeded onsite or adjacent stands or deposited by wind, birds, or animals) or artificial means (by planting seedlings or direct seeding).

Rapid climate change
The *non-linearity* of the *climate system* may lead to rapid *climate change*, sometimes called abrupt events or even surprises. Some such abrupt events may be imaginable, such as a dramatic reorganization of the *thermohaline circulation*, rapid deglaciation, or massive melting of *permafrost* leading to fast changes in the *carbon cycle*. Others may be truly unexpected, as a consequence of a strong, rapidly changing, forcing of a non-linear system.

Rebound effect
Occurs because, for example, an improvement in motor efficiency lowers the cost per kilometer driven; it has the perverse effect of encouraging more trips.

Reference scenario
See *baseline*.

Reforestation
Planting of *forests* on lands that have previously contained forests but that have been converted to some other use. For a discussion of the term forest and related terms such as *afforestation*, *reforestation*, and *deforestation*, see the IPCC Special Report on Land Use, Land-Use Change, and Forestry (IPCC, 2000b).

Regulatory measures
Rules or codes enacted by governments that mandate product specifications or process performance characteristics. See also *standards*.

Reinsurance
The transfer of a portion of primary insurance risks to a secondary tier of insurers (reinsurers); essentially "insurance for insurers."

Relative sea level
Sea level measured by a *tide gauge* with respect to the land upon which it is situated. See also *Mean Sea Level*.

(Relative) Sea level secular change
Long-term changes in relative sea level caused by either eustatic changes (e.g., brought about by *thermal expansion*) or changes in vertical land movements.

Renewables
Energy sources that are, within a short time frame relative to the Earth's natural cycles, sustainable, and include non-carbon technologies such as solar energy, hydropower, and wind, as well as carbon-neutral technologies such as *biomass*.

Research, development, and demonstration
Scientific and/or technical research and development of new production processes or products, coupled with analysis and measures that provide information to potential users regarding the application of the new product or process; demonstration tests; and feasibility of applying these products processes via pilot plants and other pre-commercial applications.

Reserves
Refer to those occurrences that are identified and measured as economically and technically recoverable with current technologies and prices. See also *resources*.

Reservoir
A component of the *climate system*, other than the *atmosphere*, which has the capacity to store, accumulate, or release a substance of concern (e.g., carbon, a *greenhouse gas*, or a *precursor*). Oceans, soils, and *forests* are examples of reservoirs of carbon. *Pool* is an equivalent term (note that the definition of pool often includes the atmosphere). The absolute quantity of substance of concerns, held within a reservoir at a specified time, is called the stock. The term also means an artificial or natural storage place for water, such as a lake, pond, or *aquifer*, from which the water may be withdrawn for such purposes as irrigation, water supply, or irrigation.

Resilience
Amount of change a system can undergo without changing state.

Resource base
Resource base includes both *reserves* and *resources*.

Resources
Resources are those occurrences with less certain geological and/or economic characteristics, but which are considered potentially recoverable with foreseeable technological and economic developments.

Respiration
The process whereby living organisms converts organic matter to *carbon dioxide*, releasing energy and consuming oxygen.

Response time
The response time or adjustment time is the time needed for the *climate system* or its components to re-equilibrate to a new state, following a forcing resulting from external and internal processes or *feedbacks*. It is very different for various components of the climate system. The response time of the *troposphere* is relatively short, from days to weeks, whereas the *stratosphere* comes into equilibrium on a *time scale* of typically a few months. Due to their large heat capacity, the oceans have a much longer response time, typically decades, but up to centuries or millennia. The response time of the strongly coupled surface-troposphere system is, therefore, slow compared to that of the stratosphere, and mainly determined by the oceans. The *biosphere* may respond fast (e.g., to *droughts*), but also very slowly to imposed changes. See *lifetime* for a different definition of response time pertinent to the rate of processes affecting the concentration of trace gases.

Revenue recycling
See *interaction effect*.

Runoff
That part of precipitation that does not evaporate. In some countries, runoff implies *surface runoff* only.

S profiles
The carbon dioxide concentration *profiles* leading to stabilization defined in the IPCC 1994 assessment (Enting *et al*., 1994; Schimel *et al*., 1995). For any given stabilization level, these profiles span a wide range of possibilities. The S stands for "Stabilization." See also *WRE profiles*.

Safe-landing approach
See *tolerable windows approach*.

Salinization
The accumulation of salts in soils.

Saltwater intrusion/encroachment
Displacement of fresh surfacewater or groundwater by the advance of saltwater due to its greater density, usually in coastal and estuarine areas.

Scenario (generic)
A plausible and often simplified 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 *technology* change, prices) and relationships. Scenarios are neither predictions nor forecasts and sometimes may be based on a "narrative storyline." Scenarios may be derived from *projections*, but are often based on additional information from other sources. See also *SRES scenarios*, *climate scenario*, and *emission scenarios*.

Sea-level rise
An increase in the mean level of the ocean. Eustatic sea-level rise is a change in global average sea level brought about by an alteration to the volume of the world ocean. *Relative sea-level* rise occurs where there is a net increase in the level of the ocean relative to local land movements. Climate modelers largely concentrate on estimating eustatic sea-level change. *Impact* researchers focus on relative sea-level change.

Seawall
A human-made wall or embankment along a shore to prevent wave *erosion*.

Semi-arid regions
Ecosystems that have more than 250 mm precipitation per year but are not highly productive; usually classified as *rangelands*.

Sensitivity
Sensitivity is the degree to which a system is affected, either adversely or beneficially, by climate-related *stimuli*. The effect may be direct (e.g., a change in crop yield in response to a change in the mean, range, or variability of temperature) or indirect (e.g., damages caused by an increase in the frequency of coastal flooding due to *sea-level rise*). See also *climate sensitivity*.

Sequential decision making
Stepwise decision making aiming to identify short-term strategies in the face of long-term uncertainties, by incorporating additional information over time and making mid-course corrections.

Sequestration
The process of increasing the carbon content of a carbon *reservoir* other than the *atmosphere*. Biological approaches to sequestration include direct removal of *carbon dioxide* from the atmosphere through *land-use change*, *afforestation*, *reforestation*, and practices that enhance soil carbon in agriculture. Physical approaches include separation and disposal of carbon dioxide from flue gases or from processing *fossil fuels* to produce hydrogen- and carbon dioxide-rich fractions and long-term storage in underground in depleted oil and gas reservoirs, coal seams, and saline *aquifers*. See also *uptake*.

Silt
Unconsolidated or loose sedimentary material whose constituent rock particles are finer than grains of sand and larger than clay particles.

Silviculture
Development and care of forests.

Sink
Any process, activity or mechanism that removes a *greenhouse gas*, an *aerosol*, or a *precursor* of a greenhouse gas or aerosol from the *atmosphere*.

Snowpacks
A seasonal accumulation of slow-melting snow.

Social cost
The social cost of an activity includes the *value* of all the *resources* used in its provision. Some of these are priced and others are not. Non-priced resources are referred to as externalities. It is the sum of the costs of these externalities and the priced resources that makes up the social cost. See also *private cost* and *total cost*.

Socio-economic potential
The socio-economic potential represents the level of greenhouse gas *mitigation* that would be approached by overcoming social and cultural obstacles to the use of technologies that are *cost-effective*. See also *economic potential*, *market potential*, and *technology potential*.

Soil moisture
Water stored in or at the land surface and available for evaporation.

Solar activity
The Sun exhibits periods of high activity observed in numbers of *sunspots*, as well as radiative output, magnetic activity, and emission of high energy particles. These variations take place on a range of *time scales* from millions of years to minutes. See also *solar cycle*.

Solar ("11 year") cycle
A quasi-regular modulation of *solar activity* with varying amplitude and a period of between 9 and 13 years.

Solar radiation
Radiation emitted by the Sun. It is also referred to as short-wave radiation. Solar radiation has a distinctive range of wavelengths (spectrum) determined by the temperature of the Sun. See also *infrared radiation*.

Soot particles
Particles formed during the quenching of gases at the outer edge of flames of organic vapors, consisting predominantly of carbon, with lesser amounts of oxygen and hydrogen present as carboxyl and phenolic groups and exhibiting an imperfect graphitic structure (Charlson and Heintzenberg, 1995). See also *black carbon*.

Source
Any process, activity, or mechanism that releases a *greenhouse gas*, an *aerosol*, or a *precursor* of a greenhouse gas or aerosol into the *atmosphere*.

Southern Oscillation
See *El Niño Southern Oscillation*.

Spatial and temporal scales
Climate may vary on a large range of spatial and temporal scales. Spatial scales may range from local (less than 100,000 km^2),

through regional (100,000 to 10 million km^2) to continental (10 to 100 million km^2). Temporal scales may range from seasonal to geological (up to hundreds of millions of years).

Spill-over effect
The economic effects of domestic or sectoral *mitigation* measures on other countries or sectors. In this report, no assessment is made on environmental spillover effects. Spillover effects can be positive or negative and include effects on trade, carbon *leakage*, transfer, and diffusion of *environmentally sound technology* and other issues.

SRES scenarios
SRES scenarios are *emissions scenarios* developed by Nakicenovic *et al*. (2000) and used, among others, as a basis for the *climate projections* in the IPCC WGI contribution to the Third Assessment Report (IPCC, 2001a). The following terms are relevant for a better understanding of the structure and use of the set of SRES scenarios:

- ***(Scenario) Family***: Scenarios that have a similar demographic, societal, economic, and technical-change *storyline*. Four scenario families comprise the SRES scenario set: A1, A2, B1, and B2.
- ***(Scenario) Group***: Scenarios within a family that reflect a consistent variation of the storyline. The A1 scenario family includes four groups designated as A1T, A1C, A1G, and A1B that explore alternative structures of future energy systems. In the Summary for Policymakers of Nakicenovic *et al*. (2000), the A1C and A1G groups have been combined into one "Fossil-Intensive" A1FI scenario group. The other three scenario families consist of one group each. The SRES scenario set reflected in the Summary for Policymakers of Nakicenovic *et al*. (2000) thus consist of six distinct *scenario groups*, all of which are equally sound and together capture the range of uncertainties associated with driving forces and emissions.
- ***Illustrative Scenario***: A scenario that is illustrative for each of the six *scenario groups* reflected in the Summary for Policymakers of Nakicenovic *et al*. (2000). They include four revised *scenario markers* for the *scenario groups* A1B, A2, B1, B2, and two additional scenarios for the A1FI and A1T groups. All *scenario groups* are equally sound.
- ***(Scenario) Marker***: A scenario that was originally posted in draft form on the SRES website to represent a given *scenario family*. The choice of markers was based on which of the initial quantifications best reflected the storyline, and the features of specific models. Markers are no more likely than other scenarios, but are considered by the SRES writing team as illustrative of a particular storyline. They are included in revised form in Nakicenovic *et al*. (2000). These scenarios have received the closest scrutiny of the entire writing team and via the SRES open process. Scenarios have also been selected to illustrate the other two *scenario groups*.
- ***(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.

Stabilization
The achievement of stabilization of atmospheric concentrations of one or more *greenhouse gases* (e.g., *carbon dioxide* or a *CO_2-equivalent* basket of greenhouse gases).

Stabilization analysis
In this report, this refers to analyses or *scenarios* that address the *stabilization* of the concentration of *greenhouse gases*.

Stabilization scenarios
See s*tabilization analysis*.

Stakeholders
Person or entity holding grants, concessions, or any other type of *value* that would be affected by a particular action or policy.

Standards
Set of rules or codes mandating or defining product performance (e.g., grades, dimensions, characteristics, test methods, and rules for use). International product and/or *technology* or performance standards establish minimum requirements for affected products and/or technologies in countries where they are adopted. The standards reduce *greenhouse gas emissions* associated with the manufacture or use of the products and/or application of the technology. See also *regulatory measures*.

Stimuli (climate-related)
All the elements of *climate change*, including mean *climate* characteristics, *climate variability*, and the frequency and magnitude of extremes.

Stock
See *reservoir*.

Storm surge
The temporary increase, at a particular locality, in the height of the sea due to extreme meteorological conditions (low atmospheric pressure and/or strong winds). The storm surge is defined as being the excess above the level expected from the tidal variation alone at that time and place.

Storyline
See *SRES scenarios*.

Streamflow
Water within a river channel, usually expressed in m^3 sec^{-1}.

Stratosphere
The highly stratified region of the *atmosphere* above the *troposphere* extending from about 10 km (ranging from 9 km in high latitudes to 16 km in the tropics on average) to about 50 km.

Structural change
Changes, for example, in the relative share of *Gross Domestic Product* produced by the industrial, agricultural, or services sectors

of an economy; or more generally, systems transformations whereby some components are either replaced or potentially substituted by other ones.

Submergence
A rise in the water level in relation to the land, so that areas of formerly dry land become inundated; it results either from a sinking of the land or from a rise of the water level.

Subsidence
The sudden sinking or gradual downward settling of the Earth's surface with little or no horizontal motion.

Subsidy
Direct payment from the government to an entity, or a tax reduction to that entity, for implementing a practice the government wishes to encourage. *Greenhouse gas emissions* can be reduced by lowering existing subsidies that have the effect of raising emissions, such as subsidies to *fossil-fuel* use, or by providing subsidies for practices that reduce emissions or enhance *sinks* (e.g., for insulation of buildings or planting trees).

Sulfur hexafluoride (SF_6)
One of the six *greenhouse gases* to be curbed under the *Kyoto Protocol*. It is largely used in heavy industry to insulate high-voltage equipment and to assist in the manufacturing of cable-cooling systems. Its *Global Warming Potential* is 23,900.

Sunspots
Small dark areas on the Sun. The number of sunspots is higher during periods of high *solar activity*, and varies in particular with the *solar cycle*.

Surface runoff
The water that travels over the soil surface to the nearest surface stream; runoff of a drainage *basin* that has not passed beneath the surface since precipitation.

Sustainable development
Development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

Targets and time tables
A target is the reduction of a specific percentage of *greenhouse gas emissions* from a *baseline* date (e.g., "below 1990 levels") to be achieved by a set date or time table (e.g., 2008 to 2012). For example, under the *Kyoto Protocol's* formula, the European Union has agreed to reduce its *greenhouse gas emissions* by 8% below 1990 levels by the 2008 to 2012 commitment period. These targets and time tables are, in effect, an emissions cap on the total amount of greenhouse gas emissions that can be emitted by a country or region in a given time period.

Tax-interaction effect
See *interaction effect*.

Technological potential
The amount by which it is possible to reduce *greenhouse gas emissions* or improve *energy efficiency* by implementing a *technology* or practice that has already been demonstrated. See also *economic potential*, *market potential*, and *socio-economic potential*.

Technology
A piece of equipment or a technique for performing a particular activity.

Technology or performance standard
See *standards*.

Technology transfer
The broad set of processes that cover the exchange of knowledge, money, and goods among different *stakeholders* that lead to the spreading of *technology* for adapting to or mitigating *climate change*. As a generic concept, the term is used to encompass both diffusion of technologies and technological cooperation across and within countries.

Thermal erosion
The *erosion* of ice-rich *permafrost* by the combined thermal and mechanical action of moving water.

Thermal expansion
In connection with sea level, this refers to the increase in volume (and decrease in density) that results from warming water. A warming of the ocean leads to an expansion of the ocean volume and hence an increase in sea level.

Thermohaline circulation
Large-scale density-driven circulation in the ocean, caused by differences in temperature and salinity. In the North Atlantic, the thermohaline circulation consists of warm surface water flowing northward and cold deepwater flowing southward, resulting in a net poleward transport of heat. The surface water sinks in highly restricted sinking regions located in high latitudes.

Thermokarst
Irregular, hummocky topography in frozen ground caused by melting of ice.

Tide gauge
A device at a coastal location (and some deep sea locations) which continuously measures the level of the sea with respect to the adjacent land. Time-averaging of the sea level so recorded gives the observed *relative sea level secular changes*.

Time scale
Characteristic time for a process to be expressed. Since many processes exibit most of their effects early, and then have a long

period during which they gradually approach full expression, for the purpose of this report the time scale is numerically defined as the time required for a perturbation in a process to show at least half of its final effect.

Tolerable-windows approach

These approaches analyze *greenhouse gas emissions* as they would be constrained by adopting a long-term *climate*—rather than greenhouse gas concentration *stabilization*—target (e.g., expressed in terms of temperature or sea level changes or the rate of such changes). The main objective of these approaches is to evaluate the implications of such long-term targets for short- or medium-term "tolerable" ranges of global *greenhouse gas emissions*. Also referred to as safe-landing approaches.

Top-down models

The terms "top" and "bottom" are shorthand for aggregate and disaggregated models. The top-down label derives from how modelers applied macro-economic theory and econometric techniques to historical data on consumption, prices, incomes, and factor costs to model final demand for goods and services, and supply from main sectors, like the energy sector, transportation, agriculture, and industry. Therefore, top-down models evaluate the system from aggregate economic variables, as compared to *bottom-up models* that consider technological options or project specific *climate change mitigation* policies. Some technology data were, however, integrated into top-down analysis and so the distinction is not that clear-cut.

Total cost

All items of cost added together. The total cost to society is made up of both the *external cost* and the *private cost*, which together are defined as *social cost*.

Trade effects

Economic impacts of changes in the purchasing power of a bundle of exported goods of a country for bundles of goods imported from its trade partners. Climate policies change the relative production costs and may change terms of trade substantially enough to change the ultimate economic balance.

Transient climate response

The globally averaged surface air temperature increase, averaged over a 20-year period, centered at the time of CO_2 doubling (i.e., at year 70 in a 1% per year compound CO_2 increase experiment with a global coupled *climate model*).

Tropopause

The boundary between the *troposphere* and the *stratosphere*.

Troposphere

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

Tundra

A treeless, level, or gently undulating plain characteristic of arctic and subarctic regions.

Turnover time

See *lifetime*.

Ultraviolet (UV)-B radiation

Solar radiation within a wavelength range of 280-320 nm, the greater part of which is absorbed by stratospheric *ozone*. Enhanced UV-B radiation suppresses the immune system and can have other adverse effects on living organisms.

Uncertainty

An expression of the degree to which a value (e.g., the future state of the *climate system*) is unknown. Uncertainty can result from lack of information or from disagreement about what is known or even knowable. It may have many types of sources, from quantifiable errors in the data to ambiguously defined concepts or terminology, or uncertain *projections* of human behavior. Uncertainty can therefore be represented by quantitative measures (e.g., a range of values calculated by various models) or by qualitative statements (e.g., reflecting the judgment of a team of experts). See Moss and Schneider (2000).

Undernutrition

The result of food intake that is insufficient to meet dietary energy requirements continuously, poor absorption, and/or poor biological use of nutrients consumed.

Unique and threatened systems

Entities that are confined to a relatively narrow geographical range but can affect other, often larger entities beyond their range; narrow geographical range points to *sensitivity* to environmental variables, including *climate*, and therefore attests to potential *vulnerability* to *climate change*.

United Nations Framework Convention on Climate Change (UNFCCC)

The Convention was adopted on 9 May 1992 in New York and signed at the 1992 Earth Summit in Rio de Janeiro by more than 150 countries and the European Community. Its ultimate objective is the "stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system." It contains commitments for all Parties. Under the Convention, Parties included in *Annex I* aim to return *greenhouse gas emissions* not controlled by the *Montreal Protocol* to 1990 levels by the year 2000. The Convention entered into force in March 1994. See also *Kyoto Protocol* and *Conference of the Parties (COP)*.

Uptake
The addition of a substance of concern to a *reservoir*. The uptake of carbon-containing substances, in particular *carbon dioxide*, is often called (carbon) *sequestration*. See also *sequestration.*

Upwelling
Transport of deeper water to the surface, usually caused by horizontal movements of surface water.

Urbanization
The conversion of land from a natural state or managed natural state (such as agriculture) to cities; a process driven by net rural-to-urban migration through which an increasing percentage of the population in any nation or region come to live in settlements that are defined as "urban centres."

Value added
The net output of a sector after adding up all outputs and subtracting intermediate inputs.

Values
Worth, desirability, or utility based on individual preferences. The total value of any resource is the sum of the values of the different individuals involved in the use of the resource. The values, which are the foundation of the estimation of costs, are measured in terms of the willingness to pay (WTP) by individuals to receive the resource or by the willingness of individuals to accept payment (WTA) to part with the resource.

Vector
An organism, such as an insect, that transmits a pathogen from one host to another. See also *vector-borne diseases*.

Vector-borne diseases
Disease that is transmitted between hosts by a *vector* organism such as a mosquito or tick (e.g., *malaria*, *dengue fever*, and leishmaniasis).

Volume mixing ratio
See *mole fraction*.

Voluntary agreement
An agreement between a government authority and one or more private parties, as well as a unilateral commitment that is recognized by the public authority, to achieve environmental objectives or to improve environmental performance beyond *compliance*.

Vulnerability
The degree to which a system is susceptible to, or unable to cope with, adverse effects of *climate change*, including *climate variability* and extremes. Vulnerability is a function of the character, magnitude, and rate of climate variation to which a system is exposed, its *sensitivity*, and its *adaptive capacity*.

Water stress
A country is water-stressed if the available freshwater supply relative to water withdrawals acts as an important constraint on development. Withdrawals exceeding 20% of renewable water supply has been used as an indicator of water stress.

Water-use efficiency
Carbon gain in *photosynthesis* per unit water lost in *evapotranspiration*. It can be expressed on a short-term basis as the ratio of photosynthetic carbon gain per unit transpirational water loss, or on a seasonal basis as the ratio of *net primary production* or agricultural yield to the amount of available water.

Water withdrawal
Amount of water extracted from water bodies.

WRE profiles
The carbon dioxide concentration *profiles* leading to stabilization defined by Wigley, Richels, and Edmonds (1996) whose initials provide the acronym. For any given stabilization level, these profiles span a wide range of possibilities. See also *S profiles*.

Zooplankton
The animal forms of *plankton*. They consume *phytoplankton* or other *zooplankton*. See also *phytoplankton*.

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Annex C. Acronyms, Abbreviations, and Units

Acronyms and Abbreviations

AA	Assigned Amount
AAU	Assigned Amount Unit
AD	*Anno Domini*
AIJ	Activities Implemented Jointly
A-O	Atmosphere-Ocean
AO	Arctic Oscillation
AOGCM	Atmosphere-Ocean General Circulation Model
Bern-CC	Bern Carbon Cycle
BP	Before Present
C_2F_6	Perfluoroethane / Hexafluoroethane
C_3	Three-Carbon Compound
C_4	Four-Carbon Compound
CANZ	Canada, Australia, and New Zealand
CBA	Cost-Benefit Analysis
CCC(ma)	Canadian Centre for Climate (Modeling and Analysis) (Canada)
CCGT	Combined Cycle Gas Turbine
CDM	Clean Development Mechanism
CEA	Cost-Effectiveness Analysis
CER	Certified Emission Reduction
CF_4	Perfluoromethane / Tetrafluoromethane
CFC	Chlorofluorocarbon
CGCM	Coupled GCM from CCC(ma)
CGE	Computable General Equilibrium
CGIAR	Consultative Group on International Agricultural Research
CH_4	Methane
CHP	Combined Heat and Power
CMIP	Coupled Model Intercomparison Project
CO_2	Carbon Dioxide
COP	Conference of the Parties
DAF	Decision Analysis Framework
DES	Development, Equity, and Sustainability
DES GP	Guidance Paper on Development, Equity, and Sustainability
DHF	Dengue Haemorrhagic Fever
DMF	Decision Making Framework
DSS	Dengue Shock Syndrome
ECE	Economic Commission for Europe
EIT	Economy in Transition
ENSO	El Niño Southern Oscillation
ERU	Emissions Reduction Unit
ES	Executive Summary
ESCO	Energy Service Company
EST	Environmentally Sound Technology
FCCC	Framework Convention on Climate Change
FSU	Former Soviet Union
GCM	General Circulation Model
GDP	Gross Domestic Product
GFDL	Geophysical Fluid Dynamics Laboratory (USA)
GHG	Greenhouse Gas
GNP	Gross National Product
GP	Guidance Paper
GPP	Gross Primary Production
GWP	Global Warming Potential

H_2O	Water Vapor
HadCM	Hadley Centre Coupled Model
HFC	Hydrofluorocarbon
IAM	Integrated Assessment Model
ICSU	International Council of Scientific Unions
IEA	International Energy Agency
IET	International Emissions Trading
IGCC S	Integrated Gasification Combined Cycle or Supercritical
IPCC	Intergovernmental Panel on Climate Change
IPCC TP3	Technical Paper on Stabilization of Atmospheric Greehouse Gases: Physical, Biological, and Socio-Economic Implications
IPCC TP4	Technical Paper on Implications of Proposed CO_2 Emissions Limitations
ISAM	Integrated Science Assessment Model
JI	Joint Implementation
LCC	Land-Cover Change
LSG	Large-Scale Geostrophic Ocean Model
LUC	Land-Use Change
MAC	Marginal Abatement Cost
MOP	Meeting of the Parties
MSL	Mean Sea Level
MSU	Microwave Sounding Unit
N_2O	Nitrous Oxide
NAO	North Atlantic Oscillation
NBP	Net Biome Production
NEP	Net Ecosystem Production
NGOs	Non-Governmental Organization
NO_x	Nitrogen Oxides
NPP	Net Primary Production
NSI	National Systems of Innovation
O_2	Molecular Oxygen
O_3	Ozone
ODS	Ozone-Depleting Substance
OECD	Organisation for Economic Cooperation and Development
OPEC	Organization of Petroleum-Exporting Countries
OPYC	Ocean Isopycnal GCM
PFC	Perfluorocarbon
PMIP	Paleoclimate Model Intercomparison Project
PPM	Processes and Production Method
PPP	Purchasing Power Parity
R&D	Research and Development
RCM	Regional Climate Model
SAR	Second Assessment Report
SF_6	Sulfur Hexafluoride
SME	Small and Medium Sized Enterprise
SO_2	Sulfur Dioxide
SPM	Summary for Policymakers
SRAGA	Special Report on Aviation and the Global Atmosphere
SRES	Special Report on Emissions Scenarios
SRLULUCF	Special Report on Land Use, Land-Use Change, and Forestry
SRTT	Special Report on the Methodological and Technological Issues in Technology Transfer
SST	Sea Surface Temperature
TAR	Third Assessment Report
TCR	Transient Climate Response
THC	Thermohaline Circulation
TP	Technical Paper
TS	Technical Summary

TSI	Total Solar Irradiance
UNEP	United Nations Environment Programme
UNESCO	United Nations Education, Scientific and Cultural Organisation
UNFCCC	United Nations Framework Convention on Climate Change
UV	Ultraviolet
VA	Voluntary Agreement or Value-Added
VOC	Volatile Organic Compounds
WAIS	West Antarctic Ice Sheet
WGI TAR	Working Group I Contribution to the Third Assessment Report
WGII SAR	Working Group II Contribution to the Second Assessment Report
WGII TAR	Working Group II Contribution to the Third Assessment Report
WGIII TAR	Working Group III Contribution to the Third Assessment Report
WMO	World Meteorological Organization
WRE	Wigley, Richels, and Edmonds
WTA	Willingness to Accept
WTP	Willingness to Pay
WUE	Water-Use Efficiency

Units

SI (Systeme Internationale) Units

Physical Quantity	*Name of Unit*	*Symbol*
length	meter	m
mass	kilogram	kg
time	second	s
thermodynamic temperature	kelvin	K
amount of substance	mole	mol

Fraction	*Prefix*	*Symbol*	*Multiple*	*Prefix*	*Symbol*
10^{-1}	deci	d	10	deca	da
10^{-2}	centi	c	10^{2}	hecto	h
10^{-3}	milli	m	10^{3}	kilo	k
10^{-6}	micro	µ	10^{6}	mega	M
10^{-9}	nano	n	10^{9}	giga	G
10^{-12}	pico	p	10^{12}	tera	T
10^{-15}	femto	t	10^{15}	peta	P

Special Names and Symbols for Certain SI-Derived Units

Physical Quantity	*Name of SI Unit*	*Symbol for SI Unit*	*Definition of Unit*
force	newton	N	kg m s^{-2}
pressure	pascal	Pa	kg m^{-1} s^{-2} (=N m^{-2})
energy	joule	J	kg m^{2} s^{-2}
power	watt	W	kg m^{2} s^{-3} (=J s^{-1})
frequency	hertz	Hz	s^{-1} (cycles per second)

Decimal Fractions and Multiples of SI Units having Special Names

Physical Quantity	*Name of SI Unit*	*Symbol for SI Unit*	*Definition of Unit*
length	Ångstrom	Å	10^{-10} m = 10^{-8} cm
length	micron	µm	10^{-6} m
area	hectare	ha	10^{4} m^{2}
force	dyne	dyn	10^{-5} N
pressure	bar	bar	10^{5} N m^{-2} = 10^{5} Pa
pressure	millibar	mb	10^{2} N m^{-2} = 1 hPa
mass	tonne	t	10^{3} kg
mass	gram	g	10^{-3} kg
column density	Dobson units	DU	2.687x10^{16} molecules cm^{-2}
streamfunction	Sverdrup	Sv	10^{6} m^{3} s^{-1}

Non-SI Units

°C	degree Celsius (0°C = 273 K approximately) Temperature differences are also given in °C (=K) rather than the more correct form of “Celsius degrees”
ppmv	parts per million (10^{6}) by volume
ppbv	parts per billion (10^{9}) by volume
pptv	parts per trillion (10^{12}) by volume
yr	year
ky	thousands of years
bp	before present

Annex D. Scientific, Technical, and Socio-Economic Questions Selected by the Panel

Question 1

What can scientific, technical, and socio-economic analyses contribute to the determination of what constitutes dangerous anthropogenic interference with the climate system as referred to in Article 2 of the Framework Convention on Climate Change?

Question 2

What is the evidence for, causes of, and consequences of changes in the Earth's climate since the pre-industrial era?

a) Has the Earth's climate changed since the pre-industrial era at the regional and/or global scale? If so, what part, if any, of the observed changes can be attributed to human influence and what part, if any, can be attributed to natural phenomena? What is the basis for that attribution?
b) What is known about the environmental, social, and economic consequences of climate changes since the pre-industrial era with an emphasis on the last 50 years?

Question 3

What is known about the regional and global climatic, environmental, and socio-economic consequences in the next 25, 50, and 100 years associated with a range of greenhouse gas emissions arising from scenarios used in the TAR (projections which involve no climate policy intervention)?

To the extent possible evaluate the:

- Projected changes in atmospheric concentrations, climate, and sea level
- Impacts and economic costs and benefits of changes in climate and atmospheric composition on human health, diversity and productivity of ecological systems, and socio-economic sectors (particularly agriculture and water)
- The range of options for adaptation, including the costs, benefits, and challenges
- Development, sustainability, and equity issues associated with impacts and adaptation at a regional and global level.

Question 4

What is known about the influence of the increasing atmospheric concentrations of greenhouse gases and aerosols, and the projected human-induced change in climate regionally and globally on:

a. The frequency and magnitude of climate fluctuations, including daily, seasonal, inter-annual, and decadal variability, such as the El Niño Southern Oscillation cycles and others?
b. The duration, location, frequency, and intensity of extreme events such as heat waves, droughts, floods, heavy precipitation, avalanches, storms, tornadoes, and tropical cyclones?
c. The risk of abrupt/non-linear changes in, among others, the sources and sinks of greenhouse gases, ocean circulation, and the extent of polar ice and permafrost? If so, can the risk be quantified?
d. The risk of abrupt or non-linear changes in ecological systems?

Question 5

What is known about the inertia and time scales associated with the changes in the climate system, ecological systems, and socio-economic sectors and their interactions?

Question 6

a) How does the extent and timing of the introduction of a range of emissions reduction actions determine and affect the rate, magnitude, and impacts of climate change, and affect the global and regional economy, taking into account the historical and current emissions?

b) What is known from sensitivity studies about regional and global climatic, environmental, and socio-economic consequences of stabilizing the atmospheric concentrations of greenhouse gases (in carbon dioxide equivalents), at a range of levels from today's to double that level or more, taking into account to the extent possible the effects of aerosols? For each stabilization scenario, including different pathways to stabilization, evaluate the range of costs and benefits, relative to the range of scenarios considered in Question 3, in terms of:
   - Projected changes in atmospheric concentrations, climate, and sea level, including changes beyond 100 years
   - Impacts and economic costs and benefits of changes in climate and atmospheric composition on human health, diversity and productivity of ecological systems, and socio-economic sectors (particularly agriculture and water)
   - The range of options for adaptation, including the costs, benefits, and challenges
   - The range of technologies, policies, and practices that could be used to achieve each of the stabilization levels, with an evaluation of the national and global costs and benefits, and an assessment of how these costs and benefits would compare, either qualitatively or quantitatively, to the avoided environmental harm that would be achieved by the emissions reductions
   - Development, sustainability, and equity issues associated with impacts, adaptation, and mitigation at a regional and global level.

Question 7

What is known about the potential for, and costs and benefits of, and time frame for reducing greenhouse gas emissions?

- What would be the economic and social costs and benefits and equity implications of options for policies and measures,

and the mechanisms of the Kyoto Protocol, that might be considered to address climate change regionally and globally?
- What portfolios of options of research and development, investments, and other policies might be considered that would be most effective to enhance the development and deployment of technologies that address climate change?
- What kind of economic and other policy options might be considered to remove existing and potential barriers and to stimulate private- and public-sector technology transfer and deployment among countries, and what effect might these have on projected emissions?
- How does the timing of the options contained in the above affect associated economic costs and benefits, and the
- atmospheric concentrations of greenhouse gases over the next century and beyond?

Question 8

What is known about the interactions between projected human-induced changes in climate and other environmental issues (e.g., urban air pollution, regional acid deposition, loss of biological diversity, stratospheric ozone depletion, and desertification and land degradation)? What is known about environmental, social, and economic costs and benefits and implications of these interactions for integrating climate change response strategies in an equitable manner into broad sustainable development strategies at the local, regional, and global scales?

Question 9

What are the most robust findings and key uncertainties regarding attribution of climate change and regarding model projections of:
- Future emissions of greenhouse gases and aerosols?
- Future concentrations of greenhouse gases and aerosols?
- Future changes in regional and global climate?
- Regional and global impacts of climate change?
- Costs and benefits of mitigation and adaptation options?

Annex E. List of Major IPCC Reports

Climate Change—The IPCC Scientific Assessment
The 1990 Report of the IPCC Scientific Assessment Working Group (also in Chinese, French, Russian, and Spanish)

Climate Change—The IPCC Impacts Assessment
The 1990 Report of the IPCC Impacts Assessment Working Group (also in Chinese, French, Russian, and Spanish)

Climate Change—The IPCC Response Strategies
The 1990 Report of the IPCC Response Strategies Working Group (also in Chinese, French, Russian, and Spanish)

Emissions Scenarios
Prepared for the IPCC Response Strategies Working Group, 1990

Assessment of the Vulnerability of Coastal Areas to Sea Level Rise–A Common Methodology
1991 (also in Arabic and French)

Climate Change 1992—The Supplementary Report to the IPCC Scientific Assessment
The 1992 Report of the IPCC Scientific Assessment Working Group

Climate Change 1992—The Supplementary Report to the IPCC Impacts Assessment
The 1992 Report of the IPCC Impacts Assessment Working Group

Climate Change: The IPCC 1990 and 1992 Assessments
IPCC First Assessment Report Overview and Policymaker Summaries, and 1992 IPCC Supplement

Global Climate Change and the Rising Challenge of the Sea
Coastal Zone Management Subgroup of the IPCC Response Strategies Working Group, 1992

Report of the IPCC Country Studies Workshop
1992

Preliminary Guidelines for Assessing Impacts of Climate Change
1992

IPCC Guidelines for National Greenhouse Gas Inventories
Three volumes, 1994 (also in French, Russian, and Spanish)

IPCC Technical Guidelines for Assessing Climate Change Impacts and Adaptations
1995 (also in Arabic, Chinese, French, Russian, and Spanish)

Climate Change 1994—Radiative Forcing of Climate Change and an Evaluation of the IPCC IS92 Emission Scenarios
1995

Climate Change 1995—The Science of Climate Change – Contribution of Working Group I to the IPCC Second Assessment Report
1996

Climate Change 1995—Impacts, Adaptations, and Mitigation of Climate Change: Scientific-Technical Analyses – Contribution of Working Group II to the IPCC Second Assessment Report
1996

Climate Change 1995—Economic and Social Dimensions of Climate Change – Contribution of Working Group III to the IPCC Second Assessment Report
1996

Climate Change 1995—IPCC Second Assessment Synthesis of Scientific-Technical Information Relevant to Interpreting Article 2 of the UN Framework Convention on Climate Change
1996 (also in Arabic, Chinese, French, Russian, and Spanish)

Technologies, Policies, and Measures for Mitigating Climate Change – IPCC Technical Paper I
1996 (also in French and Spanish)

An Introduction to Simple Climate Models used in the IPCC Second Assessment Report – IPCC Technical Paper II
1997 (also in French and Spanish)

Stabilization of Atmospheric Greenhouse Gases: Physical, Biological and Socio-economic Implications – IPCC Technical Paper III
1997 (also in French and Spanish)

Implications of Proposed CO_2 Emissions Limitations – IPCC Technical Paper IV
1997 (also in French and Spanish)

The Regional Impacts of Climate Change: An Assessment of Vulnerability – IPCC Special Report
1998

Aviation and the Global Atmosphere – IPCC Special Report
1999

Methodological and Technological Issues in Technology Transfer – IPCC Special Report
2000

Land Use, Land-Use Change, and Forestry – IPCC Special Report
2000

Emission Scenarios – IPCC Special Report
2000

Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories
2000

Climate Change 2001: The Scientific Basis – Contribution of Working Group I to the IPCC Third Assessment Report
2001

Climate Change 2001: Impacts, Adaptation, and Vulnerability – Contribution of Working Group II to the IPCC Third Assessment Report
2001

Climate Change 2001: Mitigation – Contribution of Working Group III to the IPCC Third Assessment Report
2001

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