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A Reader[1]

Resources on Climate Change, Agriculture and ACP Countries

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[1]Most text in this reader has been directly taken from the original documents or websites and is intended not to exhaustively cover the issue of Aid for Trade but to give a brief overview of it and information resources. For any input, kindly contact at CTA Isolina Boto (boto@cta.int) or Camilla La Peccerella (lapeccerella@cta.int). The Reader and the main resources are also online at http://brusselsbriefings.net

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CLIMATE CHANGE

1. Climate Change at a glance[2]

- Increased warming: Eleven of the last twelve years rank among the warmest years in global surface temperature since 1850. The rate of warming averaged over the last 50 years is nearly twice that for the last 100 years. The average global temperature went up by about 0.74°C during the 20th Century with the warming affecting land more than ocean areas.
- There is more carbon dioxide in the atmosphere: Carbon dioxide is the dominant contributor to current climate change and its atmospheric concentration has increased from a pre-industrial value of 278 parts-per million (ppm) to 379 in 2005.
- More water, but not everywhere: More precipitation has been observed in the eastern parts of North and South America, northern Europe and northern and central Asia in recent decades. But the Sahel, the Mediterranean, southern Africa and parts of southern Asia have experienced drying. More intense and longer droughts have been observed over wider areas since the 1970s.
- Sea level is rising: The Intergovernmental Panel on Climate Change is highly confident that the rate of observed sea level rise increased from the 19th to 20th century, and the total 20th century rise is estimated to be 0.17 metre. Geological observations indicate that sea level rise over the previous 2,000 years was far less. The average temperature of the global ocean has increased to depths of at least 3,000 metres.
- Less snow cover: Snow cover is decreasing in most regions, particularly in spring. The maximum extent of frozen ground in the winter/spring season has decreased by about 7 per cent in the Northern Hemisphere since 1900, and on average rivers that freeze do so some 5.8 days later than a century ago and their ice breaks up 6.5 days earlier.
- Glaciers are melting: Mountain glaciers and snow cover have declined, on average, in both hemispheres, and have contributed to sea level rise by 0.77 millimetres a year from 1993 to 2003. Shrinkage of the ice sheets of Greenland and Antarctica have contributed to a sea level rise of 0.4 millimetres a year between 1993 and 2003.
- Arctic is warming: Average Arctic temperatures increased at almost twice the global average rate in the past 100 years. Satellite data since 1978 show that the average Arctic sea ice extent has shrunk by 2.7 per cent per decade.

New projections indicate faster warming...

Continued greenhouse gas emissions at or above the current rates would cause further warming and induce many changes in the global climate system during the 21st century that would very likely be larger than those observed during the 20th century.

The degree of warming depends on the degree of emissions: If carbon dioxide concentrations were stabilized at 550 ppm — double the pre-industrial levels — the average warming expected would likely be in the range of 2-4.5°C, with the best estimate of 3°C, or 5.4°F. A warming of 0.2°C per decade is expected for each of the next two decades for a range of scenarios that do not include deliberate reductions in greenhouse gas emissions.

Other greenhouse gases contribute to warming and if their combined effect were equivalent to a carbon dioxide level of 650 ppm, the global climate would "likely" warm by 3.6°C, while a level of 750 ppm would produce warming of 4.3°C. Projections depend on factors such as economic growth, population, new technologies and other factors.

..and greater consequences

Warmer global temperatures are already causing profound changes in many of the earth's natural systems. Approximately 20-30 per cent of plant and animal species assessed so far are likely to be at increased risk of extinction if increases in global average temperature exceed 1.5-2.5°C.

A temperature increase of 3°C during this century would have largely negative consequences for biodiversity ecosystems that produce essential goods and services, such as water and food supply.

As a result of warmer temperatures, springtime events are occurring earlier, such as increased run-off and peak discharge in many glacier- and snow-fed rivers, "greening" of vegetation and migration and egg-laying by birds. More animal and plant species have also been observed shifting toward higher latitudes.

More precipitation in the high latitudes: Increases in precipitation are very likely in the high latitudes while decreases are likely in most subtropical land regions.

Model based estimates for sea-level rise due to ocean expansion and glacier melt by the end of the century (compared to 1989-1999 levels) have narrowed from previous assessments to 18-58 cm. However, larger values cannot be ruled out if recently observed movements of ice sheets were to increase as temperature rises.

Contraction of the Greenland ice sheet is projected to contribute to sea level rise into the 22nd century and the ice sheet could face complete elimination if global average warming of 1.9-4.6°C is maintained for a millennium. In that case, sea level would rise by up to 7 metres.

1.1. The causes of Climate Change

> *Climate change refers to 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 (United Nations Framework Convention on Climate Change)*

[2] Source: UNEP, Climate Change at a glance, 2007 http://www.unep.org/Themes/climatechange/PDF/factsheets_English.pdf

The Earth's average temperature seems to have been remarkably stable for the past 10,000 years, varying by less than 1°C, allowing human civilization to thrive at what is today a comfortable 15°C. But the very success of our civilization risks disrupting the climate that has served us so well until now.
The "blanket" of greenhouse gases that occurs naturally in the troposphere — representing less than one per cent of the entire atmosphere — serves the vital function of regulating the planet's climate. When solar energy in the form of visible light strikes the Earth, it warms the surface. Being much cooler than the sun, the Earth emits this energy back out to space in the form of infrared, or thermal, radiation. Greenhouse gases block the infrared radiation from escaping directly into space. The resulting "natural greenhouse effect" keeps the planet some 30oC warmer than it would otherwise be, which is essential for life as we know it.
The problem we now face is that since the start of the industrial revolution some 250 years ago our emissions of greenhouse gases have been making this blanket thicker at an unprecedented speed. This has caused the most dramatic change in the atmosphere's composition for at least 650,000 years. Unless we make significant efforts to reduce our emissions of greenhouse gases, the global climate will continue to warm rapidly over the coming decades and beyond.

The Enhanced Greenhouse Effect
The reason these "artificial" emissions are such a problem is that, in the long term, the Earth must get rid of energy at the same rate at which it receives energy from the sun. Since a thicker blanket of greenhouse gases helps to reduce energy loss to space, the climate system must adjust somehow to restore the balance between incoming and outgoing energy. The result is known as the "enhanced greenhouse effect".
The climate adjusts to the thicker blanket of greenhouse gases in large part through a "global warming" of the Earth's surface and lower atmosphere. This rise in temperature is accompanied by other changes, for example in cloud cover and wind patterns. Some of these changes may enhance the warming further (positive feedbacks), while others may counteract it (negative feedbacks). These various interactions complicate scientists' efforts to determine precisely how the climate will change over the decades to come.

Greenhouse Gas Emissions
Fossil fuels formed by long-dead plants and animals are the single biggest source of humanity's greenhouse gas emissions. Burning coal, oil and natural gas releases billions of tons of carbon every year that would otherwise have remained hidden in the Earth's crust, as well as large amounts of methane and nitrous oxide. More carbon dioxide is released when trees are cut down and not replaced.
Meanwhile, massive herds of livestock emit methane, as do rice farms and waste dumps. The use of fertilizers produces nitrous oxide. Long-lived gases such as CFCs, HFCs and PFCs, used in air conditioning and refrigeration, are manufactured by industry and eventually enter the atmosphere. Many of these greenhouse gas-emitting activities are now essential to the global economy and form a fundamental part of modern life.

Assessing the Science: The Intergovernmental Panel on Climate Change (IPCC)
The United Nations, through the United Nations Environment Programme and the World Meteorological Organization, established the Intergovernmental Panel on Climate Change (IPCC) in 1988 to investigate and analyze the best published science on the issue[3]. Since 1990 the IPCC has produced authoritative reports every five or six years assessing the state of the science through observations and projections of future trends[4].
The IPCC does not conduct new research, but rather, its mandate is to make policy-relevant assessments of the existing worldwide literature on the scientific, technical and socio-economic aspects of climate change. The IPCC reports draw on the work of thousands of experts from all regions of the world.
The Fourth Assessment Report is coming out during 2007, in four volumes, each prepared by a separate working group[5]. In preparing the reports, drafts are circulated to specialists with significant expertise and publications in the field. Their comments go back to the IPCC authors who in turn prepare a second review to governments and to all authors and expert reviewers. Governments and expert reviewers can provide comments restricted to the accuracy and completeness of the scientific/technical/socio-economic content and the overall balance of the drafts. The final document reflects differing views that are supported either scientifically or technically.
Each report has a Summary for Policymakers, approved line by line by the government delegations of IPCC member countries during a plenary session of the Working Group who produced it. Lead authors of the report are present, ready to explain the scientific facts supporting the statements contained in the Summary. Changes can only be made if there is agreement with the lead authors, to make sure that they are consistent with the underlying scientific and technical assessment. The Summary represents the point of agreement on the report's key findings: participating governments acknowledge that there is enough scientific evidence worldwide to support the document's statements.

1.2 The consequences for the future

Higher Temperatures, More Risk - In all regions of the world, the faster temperatures rise, the greater the risk of damage. The climate does not respond immediately to emissions, which can last for years or decades in the atmosphere. And because of the delaying effect of the oceans – which absorb and eventually release heat more slowly than the atmosphere – surface temperatures do not immediately respond to greenhouse gas emissions. As a result, climate change will continue for hundreds of years after atmospheric concentrations have stabilized.

[3] Source: http://www.ipcc.ch/
[4] Source: http://www.ipcc.ch/ipccreports/index.htm
[5] Source:http://www.ipcc.ch/ipccreports/assessments-reports.htm

Adverse Changes in the Hydrological Cycle - Rising temperatures are already accelerating the hydrological cycle. A warmer atmosphere holds more moisture, becomes less stable and produces more precipitation, particularly in the form of heavy rain bursts. Greater heat also speeds up evaporation. The net effect of these changes in the cycling of water will be a decline in the quantity and quality of freshwater supplies in all major regions. Meanwhile, wind patterns and storm tracks are likely to change. The intensity (but not the frequency) of tropical cyclones is expected to increase, with larger peak wind speeds and heavier rains.
Increased Health Risks - Climate change will increasingly alter the distribution of malarial mosquitoes and other carriers of infectious diseases affect the seasonal distribution of some allergy-causing pollen and increase the risks of heat waves. On the other hand, there should be fewer deaths due to the cold.
Threats to Biodiversity - Wildlife and biological diversity – already threatened by habitat destruction and other human-generated stresses – will face new challenges from climate change. Many ecosystems are already responding to higher temperatures by advancing towards the poles and up mountainsides. Some species will not survive the transition, and 20-30 per cent of species are likely to face an increased risk of extinction. The most vulnerable ecosystems include coral reefs, boreal (sub-arctic) forests, mountain habitats and those dependent on a Mediterranean climate.
Rising Sea Level - The best estimate for how much further the sea level with rise due to ocean expansion and glacier melt by the end of the 21st century (compared to 1989-1999 levels) is 28-58 cm. This will worsen coastal flooding and erosion. Larger sea-level increases of up to 1 metre by 2100 cannot be ruled out if ice sheets continue to melt as temperature rises. There is now evidence that the Antarctic and Greenland ice sheets are indeed slowly losing mass and contributing to sea level rise. About 125,000 years ago, when the polar regions were significantly warmer for an extended period than at present, melting polar ice caused the sea level to rise by 4 to 6 metres. Sea-level rise has substantial inertia and will continue for many centuries.
The oceans will also experience higher temperatures, which have implications for sea life. Over the past four decades, for example, North Atlantic plankton have migrated pole-ward by 10 degrees of latitude. Similarly, the acidification of the oceans as they absorb more carbon dioxide will impair the ability of corals, marine snails and other species to form their shells or skeletons.
Hitting the Most Vulnerable - The poorest communities will be the most vulnerable to the impacts of climate change as they have fewer resources to invest in preventing and mitigating the effects of climate change. Some of the most at-risk people include subsistence farmers, indigenous peoples and coastal populations.

2. Reducing the Emissions that cause Climate Change: Mitigation[6]

> *In the context of climate change, mitigation is a human intervention to reduce the sources or enhance the sinks of greenhouse gases. (United Nations Framework Convention on Climate Change)*

Without additional action by governments, emissions of the six main greenhouse gases - carbon dioxide, methane, nitrous oxide, sulphur hexafluoride, PFCs and HFCs - are set to rise dramatically. Between 1970 and 2004, emissions of these gases increased by 70 per cent.
By adopting stronger climate change policies, governments could slow and reverse these emission trends and ultimately stabilize the level of greenhouse gases in the atmosphere. For example, stabilizing greenhouse gas levels at 445-490 ppm (parts per million) — the most ambitious target that was assessed – would require global CO2 to peak by 2015 and to fall to 50-85 per cent of 2000 levels by 2050. This could limit global mean temperature increases to 2-2.4°C above pre-industrial levels.
Stabilizing greenhouse gases levels at 535-590 ppm would require global CO2 emissions to peak by 2010-2030 and return to -30 per cent to +5 per cent of 2000 levels by around 2050. This could limit the temperature increase to 2.8-3.2°C. If emissions peak later, more warming can be expected. By way of comparison, the current (2005) level of greenhouse gases is about 379 ppm.
Mitigation efforts over the next two to three decades will determine to a large extent the long-term global mean temperature increase and the corresponding climate change impacts that can be avoided. Properly designed climate change policies can be part and parcel of sustainable development and the IPCC's findings confirm that sustainable development paths can reduce greenhouse gas emissions and reduce vulnerability to climate change.

Reducing Emissions Requires Help from all Sectors of the Economy

The IPCC concludes that no single economically and technologically feasible solution would, on its own, suffice for reducing greenhouse gas emissions from different sectors. At the same time, it is clear that coordinated action at the international level is needed to harness the full effect of clean technologies and energy efficiency. Among them:
Agriculture — Sequestering carbon in the soil represents about 89 per cent of the mitigation potential in this area. Other options include improved management of crop and grazing lands (e.g. improved agronomic practices, nutrient use, tillage and residue management), restoration of organic soils that are drained for crop production, and restoration of degraded lands. Lower but still significant reductions are possible with improved water and rice management; set-asides, land use change (e.g. converting cropland to grassland) and agro-forestry; and improved livestock and manure management.
Forests — arresting today's high levels of deforestation and planting new forests could considerably reduce greenhouse gas emissions at low costs. About 65 per cent of the total mitigation potential for forests lies in the tropics and 50 per cent can be achieved by simply avoiding deforestation. In the longer term, the best way to maintain or increase the ability of forests to sequester carbon is through sustainable forest management, which also has many social and environmental benefits. A comprehensive approach to forest management can ensure an annual sustained yield of timber, fibre or

[6] Source: UNEP, Climate Change at a glance, 2007 http://www.unep.org/Themes/climatechange/PDF/factsheets_English.pdf

energy that is compatible with adapting to climate change, maintaining biodiversity and promoting sustainable development.

3. Living with Climate Change: Adaptation[7]

> *Adaptation is an adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities. United Nations Framework Convention on Climate Change*

Humans have been adapting to changing climatic conditions for centuries. However, the climate change that the world is presently experiencing is occurring far more rapidly than anything the Earth has experienced in the last 10,000 years.
Vulnerable countries, communities and ecosystems are already feeling the effects of climate change. The risks associated with the climate-related changes are real and are already happening in many systems and sectors essential for human livelihood, including water resources, food security and health. Developing countries are the most vulnerable to these risks. In the most vulnerable communities, the impacts of climate change pose a direct threat to people's very survival. The devastating effects of extreme events, temperature increases and sea level rise will worsen with consequences for everyone, particularly the poor.
Coping with an uncertain future — Adaptation is a process through which societies make themselves better able to cope with an uncertain future. Adaptation options are many and range from technological options such as increased sea defences or flood-proof houses on stilts, to behaviour change at the individual level, such as the sparing use of water in times of drought. Other adaptation strategies include early warning systems for extreme events, improved risk management, insurance options and biodiversity conservation to reduce the impacts of climate change on people.
Affected countries must develop strategies to effectively adapt to the impact of climate change, now and in coming years. Because of this many developing countries have given adaptation action a high, even urgent, priority. The international community is identifying resources, tools and approaches to support this effort.
Sustainable development is vital — According to the IPCC, future vulnerability depends not only on climate change but also on the type of development that is pursued. Sustainable development can reduce vulnerability and to be successful, adaptation should be implemented in the context of national and international sustainable development plans.

Early Action Needed
Taking early action can improve seasonal climate forecasts, food security, freshwater supplies, disaster and emergency response, famine early-warning systems and insurance coverage. These actions can minimize the damage from future climate change while generating many immediate practical benefits.
Ability to adapt — While adaptation to climate change is important to all countries, it is particularly important to developing countries, whose economies heavily depend on climate-vulnerable sectors such as agriculture, and which have less capacity to adapt than industrialized countries.
Averting economic loss — without adaptive efforts, a 2.5ºC increase in temperature is likely to result in a 0.5-2 per cent decrease in gross domestic product, with higher losses in most developing countries. As an example, Sierra Leone estimated that the full protection of all its vulnerable shores will require an estimated amount of US$ 1,100 million, which is about 17 per cent of its GDP. Making development projects more resilient to climate impacts is expected to increase project costs anywhere between 5 and 20 per cent.
Limited assistance so far for planning — Estimates show that only a small portion of official development assistance financed projects currently incorporate climate risk into planning.
Delays mean greater risks — Delays in implementing adaptation, including delays in finance and support for adaptation in developing countries, ultimately means increased costs and greater dangers to more people in the future. Major events, such as droughts, monsoon failure or loss of glacial meltwater, could trigger large-scale population movements and large-scale conflict due to competition over scarcer resources such as water, food and energy.
Adaptation strategies vital — Adaptation, at the national level, includes initiating an effective implementation strategy for adaptation, including enhancement of the scientific basis for decision making; methods and tools for the assessment of adaptation; education, training and public awareness on adaptation, including for young people; individual and institutional capacity-building; technology development and transfer; and promotion of local coping strategies. Beyond that, possible initial activities on adaptation could include appropriate legislation and regulatory frameworks, which promote adaptive-friendly action. Using climate change as a driver to undertake activities with multiple benefits can actually catalyse progress in achieving a country's sustainable development goals, while contributing to adaptation objectives.

Resources for Adaptation
Without targeted funding, adaptation runs the risk of not being effectively addressed and funding may be largely limited to "reactive" funding, such as short-term emergency relief, which would be unsupportive of sustainable development approaches and be very costly.
The member Governments of the UN Framework Convention on Climate Change (UNFCCC) have established a number of funding opportunities for adaptation projects including through the Global Environment Facility (GEF) Trust Fund and three special funds: the Least Developed Countries Fund, the Special Climate Change Fund and the Adaptation Fund under the Kyoto Protocol.

[7] Source: UNEP, Climate Change at a glance, 2007 http://www.unep.org/Themes/climatechange/PDF/factsheets_English.pdf

Examples of Adaptation
Kiribati is one of the world's most vulnerable countries, spread over 33 low-lying atolls in the central and western Pacific region. An adaptation programme is providing vulnerable communities with the information and means to enhance adaptive capacity, including improved management, conservation, restoration and sustainable use of biodiversity, improved protection and management of mangroves and coral reefs, and strengthening government capacity by fully integrating adaptation into economic planning.
In Mozambique, a GEF project is integrating climate into sustainable land management practices to reduce the impacts of extreme weather events on populations and ecosystems.

4 - United Nations Framework Convention on Climate Change (UNFCC)[8]

4.1. A summary of the Convention

In 1994, 189 countries around the world have joined an international treaty that sets general goals and rules for confronting climate change, the United Nations Framework Convention on Climate Change.
The Convention sets an ultimate objective of stabilizing greenhouse gas concentrations "at a level that would prevent dangerous anthropogenic (human induced) interference with the climate system." It states that "such a level should be achieved within a time-frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened, and to enable economic development to proceed in a sustainable manner."
The Convention requires precise and regularly updated inventories of greenhouse gas emissions from industrialized countries. The first step in solving a problem is knowing its dimensions. With a few exceptions, the "base year" for tabulating greenhouse gas emissions has been set as 1990. Developing countries also are encouraged to carry out inventories.
Countries ratifying the treaty - called "Parties to the Convention" - agree to take climate change into account in such matters as agriculture, industry, energy, natural resources, and activities involving sea coasts. They agree to develop national programmes to slow climate change.
The Convention recognizes that it is a "framework" document – it may be amended or augmented over time so that efforts to deal with global warming and climate change can be focused and made more effective. The first addition to the treaty, the Kyoto Protocol, was adopted in 1997.
The Convention places the heaviest burden for fighting climate change on industrialized nations, since they are the source of most past and current greenhouse gas emissions. These countries are asked to do the most to cut what comes out of smokestacks and tailpipes, and to provide most of the money for efforts elsewhere. For the most part, these developed nations, called "Annex I" countries because they are listed in the first annex to the treaty, belong to the Organization for Economic Cooperation and Development (OECD). These advanced nations, as well as 12 "economies in transition" (countries in Central and Eastern Europe, including some states formerly belonging to the Soviet Union) were expected by the year 2000 to reduce emissions to 1990 levels. As a group, they succeeded.
Industrialized nations agree under the Convention to support climate-change activities in developing countries by providing financial support above and beyond any financial assistance they already provide to these countries. A system of grants and loans has been set up through the Convention and is managed by the Global Environment Facility. Industrialized countries also agree to share technology with less-advanced nations.
Because economic development is vital for the world's poorer countries -- and because such progress is difficult to achieve even without the complications added by climate change -- the Convention accepts that the share of greenhouse gas emissions produced by developing nations will grow in the coming years. It nonetheless seeks to help such countries limit emissions in ways that will not hinder their economic progress.
The Convention acknowledges the vulnerability of developing countries to climate change and calls for special efforts to ease the consequences[9].

4.2. Bodies of the Framework Convention, actors in the negotiation process, and the UNFCCC Secretariat.

The functioning of the Convention depends on a series of groups and agencies.
The Conference of the Parties (COP) is the prime authority of the Convention. It is an association of all member countries (or "Parties") and usually meets annually for a period of two weeks. These sessions are attended by several thousand government delegates, observer organizations, and journalists. The Conference of the Parties evaluates the status of climate change and the effectiveness of the treaty. It examines the activities of member countries, particularly by reviewing national communications and emissions inventories; it considers new scientific findings; and it tries to capitalize on experience as efforts to address climate change proceed.
A Subsidiary Body for Scientific and Technological Advice (SBSTA) counsels the Conference of the Parties on matters of climate, the environment, technology, and method. It meets twice a year.
A Subsidiary Body for Implementation (SBI) helps review how the Convention is being applied, for example by analyzing the national communications submitted by member countries. It also deals with financial and administrative matters. The SBI meets twice each year[10].

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[8] UNFCCC, Feeling the heat. http://unfccc.int/essential_background/feeling_the_heat/items/2918.php
[9] For further details, see the text of the Convention. http://unfccc.int/resource/docs/convkp/conveng.pdf
[10] Several expert groups exist under the Convention. A Consultative Group of Experts (CGE) on National Communications from "non-Annex 1 Parties" helps developing countries prepare national reports on climate change issues. A Least Developed Country Expert Group (LEG)advises such nations on establishing programmes for adapting to climate change. And an Expert Group on Technology Transfer (EGTT) seeks to spur the sharing of technology with less-advanced nations. Partner agencies include the Global Environment Facility (GEF), which has existed since 1991 to fund projects in developing countries that will have global environmental benefits. The job of channelling grants and loans to poor countries to help them address climate change, as called for by the Convention, has been delegated to the GEF because of its established expertise. And the Intergovernmental Panel on Climate Change (IPCC) provides

Countries belonging to the Convention hold the real power - they take decisions at sessions of the Conference of the Parties and most decisions are reached by consensus. Member countries often form alliances to increase efficiency and maximize influence during negotiations. The Conference has several groupings representing the concerns of developing countries, least-developed countries, small-island states, Europe (through the European Union), non-European industrialized nations, oil-exporting nations, and nations committed to "environmental integrity."
"Observer" is the official term for groups and agencies allowed to attend and even speak at international meetings, but not to participate in decision-making. Among observers permitted by the Convention are intergovernmental agencies, such as the United Nations Development Programme (UNDP), the United Nations Environment Programme (UNEP), the World Meteorological Organization (WMO); the Organization for Economic Cooperation and Development (OECD); the International Energy Agency; and the Organization of Petroleum Exporting Countries (OPEC). To date, over 50 intergovernmental agencies and international organizations attend sessions of the Conference of Parties. Observers also include a lively crowd of non-governmental organizations, known as "NGOs." These represent business and industrial interests, environmental groups, local governments, research and academic institutes, religious bodies, labour organizations, and population groups such as indigenous peoples.
A secretariat staffed by international civil servants supports the Convention and its supporting bodies. The UNFCC Secretariat makes practical arrangements for meetings, compiles and distributes statistics and information, and assists member countries in meeting their commitments under the Convention. The secretariat is based in Bonn, Germany.

4.3. The Rio Conventions

Three international treaties showcased at the United Nations Conference on Environment and Development in 1992 in Rio de Janeiro, Brazil -- a conference popularly known as the "Rio Earth Summit." The Framework Convention on Climate Change (UNFCCC), the Convention on Biological Diversity (CBD), and the United Nations Convention to Combat Desertification (UNCCD) have been known ever since as the Rio Conventions.
Parties to the biodiversity treaty undertake to conserve species, transfer technology, and share in a fair way the benefits arising from the commercial use of genetic resources.
Parties to the desertification agreement carry out national, sub-regional, and regional action programmes and seek to address causes of land degradation ranging from international trade patterns to unsustainable land management.
The three Rio Conventions are related. Climate change affects biodiversity and desertification. The more intense and far-reaching climate change is, the greater will be the loss of plant and animal species and the more dryland and semi-arid terrain around the world will lose vegetation and deteriorate.
A Joint Liaison Group, or JLG, was established in 2001 to boost collaboration between the secretariats of the three Conventions. Through the Group, information is shared, activities are coordinated, and measures are identified that can simultaneously attack all three problems -- a benefit known in international jargon as "synergy."

5 - The Kyoto Protocol[11]

5.1. A summary of the Protocol

The Kyoto Protocol builds on the United Nations Framework Convention on Climate Change and sets legally binding targets and timetables for cutting the greenhouse-gas emissions of industrialized countries.
Its adoption was celebrated in 1997: it took all of one year for the member countries of the Framework Convention on Climate Change to decide that the Convention had to be augmented by an agreement with stricter demands for reducing greenhouse-gas emissions. The Convention took effect in 1994, and by 1995 governments had begun negotiations on a protocol -- an international agreement linked to the existing treaty, but standing on its own. Finally, the text of the Kyoto Protocol was adopted unanimously in 1997; it entered into force on 16 February 2005.
The Protocol's major feature is that it has mandatory targets on greenhouse-gas emissions for the world's leading economies which have accepted it. These targets range from -8 per cent to +10 per cent of the countries' individual 1990 emissions levels "with a view to reducing their overall emissions of such gases by at least 5 per cent below existing 1990 levels in the commitment period 2008 to 2012." In almost all cases -- even those set at +10 per cent of 1990 levels -- the limits call for significant reductions in currently projected emissions. Future mandatory targets are expected to be established for "commitment periods" after 2012. These are to be negotiated well in advance of the periods concerned.
Commitments under the Protocol vary from nation to nation. The overall 5 per cent target for developed countries is to be met through cuts (from 1990 levels) of 8 per cent in the European Union (EU 15)[12], Switzerland, and most Central and East European states; 6 per cent in Canada; 7 per cent in the United States (although the US has since withdrawn its support for the Protocol); and 6 per cent in Hungary, Japan, and Poland. New Zealand, Russia, and Ukraine are to stabilize their emissions, while Norway may increase emissions by up to 1 per cent, Australia by up to 8 per cent (subsequently withdrew its support for the Protocol), and Iceland by 10 per cent.
To compensate for the sting of "binding targets," as they are called, the agreement offers flexibility in how countries may meet their targets. For example, they may partially compensate for their emissions by increasing "sinks" -- forests, which remove carbon dioxide from the atmosphere. That may be accomplished either on their own territories or in other countries. Or they may pay for foreign projects that result in greenhouse-gas cuts. Several mechanisms have been set up for this purpose: "emissions trading," the "clean development mechanism," and "joint implementation".

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services to the Convention, although it is not part of it, through publishing comprehensive reviews every five years of the status of climate change and climate-change science, along with special reports and technical papers on request

[11] UNFCCC, Feeling the heat. http://unfccc.int/essential_background/feeling_the_heat/items/2918.php

[12] The EU has made its own internal agreement to meet its 8 per cent target by distributing different rates to its member states. These targets range from a 28 per cent reduction by Luxembourg and 21 per cent cuts by Denmark and Germany to a 25 per cent increase by Greece and a 27 per cent increase by Portugal

The Kyoto Protocol is a complicated agreement that has been slow in coming. The Protocol not only has to be an effective mean against a complicated worldwide problem, it also has to be politically acceptable. As a result, panels and committees have multiplied to monitor and referee its various programmes, and even after the agreement was approved in 1997, further negotiations were deemed necessary to hammer out instructions on how to "operate" it. These rules, adopted in 2001, are called the "Marrakech Agreements"[13].

5.2. Emissions trading

Broadly speaking, under the Kyoto Protocol countries may buy and sell greenhouse-gas emissions "units" and "credits."
The limits on greenhouse-gas emissions set by the Kyoto Protocol are a way of assigning monetary value to the earth's shared atmosphere -- something that has been missing up to now. Nations that have contributed the most to global warming have tended to benefit directly in terms of greater business profits and higher standards of living, while they have not been held proportionately accountable for the damages caused by their emissions. The negative effects of climate change will be felt all over the world, and actually the consequences are expected to be most severe in least-developed nations which have produced few emissions.
The Kyoto Protocol sets limits on total emissions by the world's major economies, a prescribed number of "emission units." Individual industrialized countries will have mandatory emissions targets they must meet., but it is understood that some will do better than expected, coming in under their limits, while others will exceed them.
The Protocol allows countries that have emissions units to spare, emissions permitted them but not "used", to sell this excess capacity to countries that are over their targets. This so-called "carbon market" - so-named because carbon dioxide is the most widely produced greenhouse gas, and because emissions of other greenhouse gases will be recorded and counted in terms of their "carbon dioxide equivalents" - is both flexible and realistic. Countries not meeting their commitments will be able to "buy" compliance but the price may be steep. The higher the cost, the more pressure they will feel to use energy more efficiently and to research and promote the development of alternative sources of energy that have low or no emissions.
A global "stock market" where emissions units are bought and sold is simple in concept -- but in practice the Protocol's emissions-trading system has been complicated to set up. The details weren't specified in the Protocol, and so additional negotiations were held to hammer them out. These rules were among the workaday specifics included in the 2001 "Marrakesh Accords." The problems are clear: countries' actual emissions have to be monitored and guaranteed to be what they are reported to be; and precise records have to be kept of the trades carried out. Accordingly, "registries"-- like bank accounts of a nation's emissions units -- are being set up, along with "accounting procedures," an "international transactions log," and "expert review teams" to police compliance.
More than actual emissions units will be involved in trades and sales. Countries will get credit for reducing greenhouse-gas totals by planting or expanding forests ("removal units"); for carrying out "joint implementation projects" with other developed countries, usually countries with "transition economies"; and for projects under the Protocol's Clean Development Mechanism, which involves funding activities to reduce emissions by developing nations. Credits earned this way may be bought and sold in the emissions market or "banked" for future use.
Some national registry systems under the Protocol have already been set up, as countries are eager to "bank" emissions reductions already accomplished while they wait for the Protocol to win its final ratifications and become legally binding. Smaller "carbon markets" were established by the European Union and other groups of countries; they were operating before the Protocol entered into force. These emissions-trading systems were intended to start the process and to link up with the Protocol's global market once it becomes operational.

5.3. Clean development mechanism

As far as developing nations are concerned, the Kyoto Protocol does not set limits on the greenhouse-gas emissions but provides a system for financing emissions-reducing or emissions-avoiding projects Yet the greenhouse-gas emissions of developing countries are growing, especially in the case of enormously populous states such as China and India, which are rapidly expanding their industrial output.
Because the atmosphere is equally damaged by greenhouse-gas emissions wherever they occur and equally helped by emissions cuts wherever they are made, the Protocol includes an arrangement for reductions to be "sponsored" in countries not bound by emissions targets. The so-called Clean Development Mechanism is loaded with complicated details and acronyms, but in simplified form it works this way: Industrialized countries pay for projects that cut or avoid emissions in poorer nations - and are awarded credits that can be applied to meeting their own emissions targets. The recipient countries benefit from free infusions of advanced technology that allow their factories or electrical generating plants to operate more efficiently - and hence at lower costs and higher profits. And the atmosphere benefits because future emissions are lower than they would have been otherwise.
The mechanism has drawn extensive interest from rich and poor countries alike, and steps have been taken to put it into operation even before the Protocol takes effect. In particular, it is cost-effective and offers a degree of flexibility to industrialized countries trying to meet their targets. It can be more efficient for them to carry out environmentally useful work in developing countries than at home, where land, technology, and labour are generally more costly. The benefits to the climate are the same.
The system also appeals to private companies and investors. The mechanism is meant to work bottom-up - to proceed from individual proposals to approval by donor and recipient governments to the allocation of "certified emissions reduction" credits. Countries earning the credits may apply them to meeting their emissions limits, may "bank" them for use later, or may sell them to other industrialized countries under the Protocol's emissions-trading system. Private firms are interested in the mechanism because they may earn profits from proposing and carrying out such work and because they may develop good reputations for their technology which will lead to further sales. A possible benefit for everyone is that the potential for profits may lead these businesses to develop even more useful technologies.

[13] For the full details of the Kyoto Protocol, see the text at http://unfccc.int/resource/docs/convkp/kpeng.pdf

The Clean Development Mechanism is overseen by an Executive Board. To be certified, by the Clean Development Mechanism Executive Board, a project must be approved by all involved parties, demonstrate a measurable and long-term ability to reduce emissions, and promise reductions that would be additional to any that would otherwise occur. A special provision allows credits earned under clean-development schemes to be valid and "bankable" now, although the Protocol has yet to take legal effect.
Options to the programme are being considered. Less red tape, for example, may be required for small-scale projects, such as renewable energy facilities below 15 megawatts of installed capacity. Another proposal is to allow afforestation and reforestation projects to be included in the scheme.

5.4. Joint implementation

Under the "Joint implementation" programme of the Kyoto Protocol, industrialized countries are granted "emissions reduction units" that allows them to meet part of their required cuts in greenhouse-gas emissions by financing projects that reduce emissions in other industrialized countries.
The sponsoring governments will receive credits that may be applied to their emissions targets; the recipient nations will gain foreign investment and advanced technology (but not credit toward meeting their own emissions caps; they have to do that themselves). The system has advantages of flexibility and efficiency. It often is cheaper to carry out energy-efficiency work in the transition countries, and to realize greater cuts in emissions by doing so. The atmosphere benefits wherever these reductions occur.
The operation of the joint implementation mechanism is similar to that of the "clean development mechanism" (see above), and similarly complicated. To go ahead with joint implementation projects, industrialized countries must meet requirements under the Protocol for accurate inventories of greenhouse-gas emissions and for detailed registries of emissions "units" and "credits" (steps that also are required for the international trading of emissions on the "carbon market"). If these requirements are met, countries may carry out projects and receive credits beginning in 2008.
If industrialized countries have not yet set up approved registries and greenhouse-gas inventory systems - complicated technical and bureaucratic hoops some nations still have to jump through - they may carry out joint-implementation projects under a "second track" process that involves greater international oversight. The oversight, which may be assigned to private companies, will ensure that emissions actually are reduced, and will certify by how much.

6 - The Bali Conference

Official negotiations under the UNFCCC have been carried on during the UN Climate Change Conference held in Bali on 3-14 December 2007[14] and resulted in an agreement to launch negotiations towards a strengthened international climate change deal. Adopted by 187 countries, the Bali Action Plan[15] set the stage for a two-year negotiating process leading to a new legally-binding instrument to replace the Kyoto Protocol after 2012 and commits all developed country parties to "Measurable, reportable and verifiable nationally appropriate mitigation commitments or actions, including quantified emission limitation and reduction objectives." From their part, emerging economies should make "nationally appropriate mitigation actions… in the context of sustainable development, supported and enabled by technology, financing and capacity-building, in a measurable, reportable and verifiable manner." This language was claimed as necessary by developing countries to ensure that they would be able to maintain space for development policy and obtain the technological and financial backing they need.
While a new global deal is envisioned for 2013, countries also agreed on a number of steps that need to be taken immediately to further implement the existing commitments of Parties to the UNFCCC. These issues are particularly important for developing countries and include:

a) Adaptation funding - Governments decided that funding for adaptation projects in developing countries, financed by the Kyoto Protocol's clean development mechanism (CDM), would begin under the management of the Global Environment Facility (GEF). This ensures that the Adaptation Fund will become operational in an early stage of the first commitment period of the Kyoto Protocol (2008-2012). The fund is filled by means of a 2% levy on CDM projects. Currently the fund is worth about 37 million euros. Considering the amount of CDM projects in the pipeline, this figure will rapidly increase to an estimated 80- 300 million USD in the period 2008-2012.

b) Technology transfer - The Bali Conference also made important progress on the issue of technology, one of the key concerns of developing countries. Governments agreed to kick start strategic programme to scale up the level of investment for the transfer of both the mitigation and adaptation technologies that developing countries need. The aim of that programme is to give an extra push to concrete demonstration projects, to create more attractive environments for investment, as well as to provide incentives to the private sector for technology transfer. The GEF will start setting up this programme together with international financial institutions and representatives of the private financial sector.

c) "Reducing emissions from deforestation in developing countries" (REDD) - "Reducing emissions from deforestation in developing countries" (REDD) was a key issue at Bali. Parties affirmed the urgent need to take further meaningful action to reduce emissions from deforestation and forest degradation and adopted a work programme for further methodological work. That programme will focus, for example, on assessments of changes in forest cover and associated green house gas emissions, methods to demonstrate reductions of emissions from deforestation and the estimation of the amount of emission reductions from deforestation. The decision furthermore encourages Parties to support capacity building and to undertake efforts, including demonstration activities, to address the drivers of

[14] Notably, the two week period included the sessions of the Conference of the Parties to the UNFCCC, its subsidiary bodies as well as the Meeting of the Parties of the Kyoto Protocol.
[15] See http://unfccc.int/files/meetings/cop_13/application/pdf/cp_bali_action.pdf

deforestation. This is important to address the needs of local and indigenous communities who depend on forests for their livelihoods. Deforestation is regarded to be an important component of a future climate change regime beyond 2012 - in both mitigation and adaptation strategies[16].

7. Climate change, Agriculture and ACP countries

Five main climate change related drivers – namely temperature, precipitation, sea level rise, atmospheric carbon dioxide content and incidence of extreme events - may affect the agriculture sector in the following ways:

- **Reduction in crop yields and agriculture productivity**: there is growing evidence that in the tropics and subtropics, where crops have reached their maximum tolerance, crop yields are likely to decrease due to an increase in the temperature. This may well force large regions of marginal agriculture out of production in Africa.
- **Increased incidence of pest attacks**: an increase in temperature is also likely to be conducive for a proliferation of pests that are detrimental to crop production.
- **Limit the availability of water**: it is expected that the availability of water in most parts of Africa would decrease as a result of climate change. Between 75 and 250 million people in Africa will be at risk of increased water stress with a one degree C rise; between 350 and 600 million with a two degree C climb and up to 1.8 billion if temperatures rise by three degrees C which could happen by around 2080[17].
- **Fisheries and aquaculture**, which provide the main source of animal protein for a billion people worldwide. Higher sea temperatures are already a major cause of damage to coral reefs, which serve as fish breeding habitats. Rising sea levels will also likely damage or destroy wild fish stocks as well as ponds in coastal areas. In addition, changes in inland temperatures and rainfall, together with extreme weather events, could substantially reduce fish stocks. Much further research is needed to better understand the complex impacts of climate change on fisheries and aquaculture and to devise coping strategies.
- **Exacerbation of drought periods**: an increase in temperature and a change in the climate throughout the continent are predicted to cause recurrent droughts in most of the region.
- **Reduction in soil fertility**: an increase in temperature is likely to reduce soil moisture, moisture storage capacity and the quality of the soil, which are vital nutrient for agricultural crops.
- **Low livestock productivity and high production cost**: climate change will affect livestock productivity directly by influencing the balance between heat dissipation and heat production and indirectly through its effect on the availability of feed and fodder.
- **Health and disease patterns**: Climate change is likely to cause the manifestation of vector and vector born diseases, where an increase in temperature and humidity will create ideal conditions for malaria, sleeping sickness and other infectious diseases that will directly affect the availability of human resources for the agriculture sector.

7.1 Africa[18]

The impact of these adverse climate changes on agriculture is exacerbated in Africa by the lack of adapting strategies, which are increasingly limited due to the lack of institutional, economic and financial capacity to support such actions.
Africa's vulnerability to climate change and its inability to adapt to these changes may be devastating to the agriculture sector, the main source of livelihood to the majority of the population. The utmost concern should therefore be a better understanding of the potential impact of the current and projected climate changes on African agriculture and to identify ways and means to adapt and mitigate its detrimental impact.
Though changes in the climate may affect the whole continent, its distribution may vary across the continent. Climate change in the already arid northern sub-region of the continent is expected to enhance desertification and bring a gradual decrease in forest cover. In the Sahara and Sahel sub-regions, rainfall is predicted to drop, resulting in soil degradation and an increasing number of dust storms. East and Central Africa will also see its agricultural capacity decline. In West Africa, more frequent and longer dry periods are expected, again threatening crop failures. Coastal areas may also be affected by rising sea levels and intrusion of salt water into inland freshwater resources[19].

Adaptation tools - A suite of options may assist Africa to cope with climate change with some research indicating that these could be cost effective. Sea level rise in coastal countries may cost up to 14 per cent of GDP. Adaptation may cost less—between five to 10 per cent of GDP.
Adaptation to and coping with climate change is complex and will involve a range of social and economic factors including education and literacy as well as creative financial and technological solutions including a better understanding and application indigenous knowledge and traditional coping strategies.

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[16] See 'UN Breakthrough on climate change reached in Bali', UNFCCC Press release 15 December 2007 http://unfccc.int/files/press/news_room/press_releases_and_advisories/application/pdf/20071215_bali_final_press_release.pdf
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[17] Source: http://www.sciencedaily.com/releases/2007/04/070410141336.htm (adapted from materials provided by United Nations Environment Programme)

[18] Source: http://www.sciencedaily.com/releases/2007/04/070410141336.htm

[19] For an Evidence of Climate Change and Adverse Impacts in Africa, see Vital Climate Graphics Africa website's Maps: http://www.grida.no/climate/vitalafrica/english/evidence.htm and Regional Climate Maps – Africa: http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/regional_monitoring/africa.html

In the Sudan, for example, women are directly responsible for selecting sorghum seeds for planting. They select a variety of seeds with different characteristics that ensure resistance to a variety of conditions they may emerge in the next growing season.
In semi-arid areas, rainwater harvesting can play a role as an irrigation and drinking water source. Improved early warning systems may improve health care planning. In terms of malaria, which in semi arid areas is linked with excessive rain fall "it may be possible to give outlooks with lead times of between two to six months," says the report.
In agriculture, the report says other factors could be investigated to "enhance resilience to shocks such as droughts which include national grain reserves, grain futures markets, weather insurance, cash transfers and school feeding schemes".
Climate-Resilient Crops - If farming communities are to adapt successfully to climate change, they will need crop varieties with greater tolerance to stresses such as drought and heat. New scientific tools are proving to be helpful in speeding the progress of crop
Shifts in Pest and Disease Pressures - Apart from causing direct damage to crops and animals, higher temperatures and other changes in the global climate may cause them to suffer more from the depredations of diseases and pests. These biotic stresses – including cassava mosaic disease, potato blight, rice blast, wheat stem rust, whiteflies and many others –already take a heavy toll on developing country agriculture.
Quickening the Pace of Change - To foster the use of technology, knowledge and practices that can enhance the resilience of agricultural systems is a complex challenge for developing countries.
Three conditions must be met to heighten their chances of success: (1) strong market incentives, (2) able institutions and (3) supportive policies that foster positive change.
Forging market links: To create new incentives for change, rural communities need to be linked more strongly with markets for products and services, including staple foods, horticultural crops, tropical fruits, livestock products, ecotourism and a variety of environmental services. Without such links, the rural poor will be hard pressed to afford the luxury of investing in better management of natural resources.
Stronger rural institutions: To enable small farmers to derive significant benefits from market links requires stronger rural institutions. These are also critical for ensuring that market-driven growth is linked with improved natural resource management. A key function of rural institutions is to offer people opportunities to shape decisions and draw on services that can better enable them to build and maintain sustainable livelihoods. One such service that could provide small farmers with a new option for managing risk involves innovative weather insurance schemes, linked to micro-credit finance. Improved availability of climate data, together with better models for predicting weather, have made possible the development of scientifically sound insurance schemes, in which the risks for both farmers and insurers are manageable.
Developing appropriate policies: Enhancing the effectiveness of rural institutions at the local, national and international levels will be a central concern of policy makers, as they seek to speed the pace of agricultural adaptation in the face of global climate change.

7.2 Caribbean[20]

Over the past decade, the Caribbean has experienced extensive social, economic and environmental impacts of intensive storms and hurricanes, with consequent significant loss of life, and major set backs in the national and regional development programmes. Ignoring the specter of climate change and its anticipated impacts, would truly expose the region to unprecedented consequences, and display poor stewardship in our responsibility for the natural and built environment and the regional patrimony.
Coastal Erosion - Sea level rise is a particularly acute problem for the Small Island States of the Caribbean. A small increase in sea level would erode away significant portions of island nations. The loss of desired beachfront also negatively affects tourism, which is one of the largest economic activities in the Caribbean.
More than 95 per cent of the tourism infrastructure in many CARICOM Member States is located within 10km of the coastline, thus rendering the industry highly susceptible to the effects of exaggerated wave action and tidal surges.
Climate variability, as expressed by changing and unpredictable weather patterns, already represents a major challenge for the agriculture sector as well as for planners generally in the community. Both the tourism and agriculture sectors will be severely affected by declining water availability and by extended periods of drought.
Sustainable tourism - The tourism sector makes the greatest use of the coastal and marine resources and many of the region's adaptation efforts can be seen through the response of this major economic sector. The tourism sector is highly dependent on infrastructure. This includes airports, coastal protection structures, natural amenities, beaches, reefs and wetlands, access to clean and adequate supply of water, reliable energy and food. Even before climate change issues were on the regional and global agenda, the tourism sector was turning its attention to sustainable tourism. While much emphasis has been placed on training, there are also many practical examples of adaptation measures being implemented.

7.3 Pacific[21]

Low lying coastal areas of all islands are especially vulnerable to a rising sea level, as well as to changes in rainfall, storm frequency and intensity. Inundation, flooding, erosion and intrusion of sea water are among the likely impacts. These catastrophes would result in economic and social costs beyond the capacity of most Pacific island countries and threaten the very existence of small atoll countries. Shifts in rainfall regimes and any increase in tropical cyclone intensity

[20] Source: http://www.climateactionprogramme.org/features/article/progress_in_climate_change_adaptation_in_the_caribbean_community/
[21] See http://www.scoop.co.nz/stories/SC0704/S00020.htm and http://www.unescap.org/mced2000/pacific/background/climate.htm

and frequency greatly amplify the impact of sea level rise. A rise of average sea level by one meter, when superimposed on storm surges, could easily submerge low-lying islands.

Climate change challenge for small Pacific islands

***Marine resources* -** Climate change is likely to heavily impact coral reefs, fisheries and other marine-based resources of small islands of the Pacific. There is likely to be a decline in the total tuna stocks and a migration of these stocks westwards, both of which will lead to changes in the catch in different islands.

***Sea-level rise* -** Sea-level rise is expected to exacerbate inundation, storm surge, erosion, and other coastal hazards, thus threatening vital infrastructure, settlements, and facilities that support the livelihood of island communities.

***Water resources* - C**limate change is expected by mid-century to reduce water resources in many small islands, including those in the Pacific, "to the point where they become insufficient to meet demand during low rainfall periods.

7.4 Climate change and strategies for agricultural R&D in ACP countries[22]

There is now enough convincing scientific evidence from direct surface air and ocean temperatures, increases in average global sea levels and retreating glaciers that the global climate is warming, and that most of this warming can be attributed to human activities. Though greenhouse gases (GHGs) are crucial to maintain life in the atmosphere, the concentration of GHGs, especially carbon dioxide, methane, and nitrous oxide is rising well above pre-industrial levels. It has been reliably predicted that by 2010, if current trends continue, the average global surface temperature will increase between 1.4 and 5.8 °C above 1990 levels causing major economic and ecological disruptions.

ACP countries, like other developing countries, with very low fossil fuel consumption contribute very little to these emissions but will bear the brunt of the consequences of climate change due to their inability to respond adequately to projected changes. Most ACP countries are lagging behind other developing regions and are expected to suffer the most adverse effects. Improving the situation in ACP countries and managing GHG emissions can be achieved by using more environmentally sound options which, however, might prove to be expensive.

Unfortunately, the slow response by the global climate system will make stabilization of GHGs difficult, and it will therefore take time for the climate system to adequately adapt. A further change in climate is inevitable if the increasing trend in concentration of GHG levels continues. The expected changes will have adverse effects on the water resources, agriculture, natural ecosystems and human health with serious social and economic consequences. Therefore, regions and countries around the world must be prepared for the expected changes, especially developing countries with their relatively weak adaptive capacities and infrastructure.

Climate variability especially with respect to changing temperature and rainfall patterns is of more immediate relevance to ACP agriculture. Recent, extreme climatic conditions namely unusual floods, severe drought and violent storms have resulted in serious disruptions in the ACP agricultural sector. These have had far reaching consequences for ACP regional food security and agricultural trade.

Agriculture is an ancient activity that is important for human survival, economic prosperity and trade. It is a significant contributor to national economies worldwide, but more so in ACP countries that have relatively lower levels of industrialization and are highly dependent on natural systems. The future development of the agricultural sector, if not properly managed can further escalate climate change with the resulting negative impacts of reduced availability of cultivated land, decreased crop yields and food insecurity. Intense farming methods using fossil fuels, commercial fertilizers and pesticides and requiring high consumption of water can lead to increased atmospheric concentration of GHGs with consequences of sea-level rise, and migration of population due to environmental stresses.

Areas for R&D Concern

Although agriculture, on the one hand, contributes to climate change it can on the other hand support countries and regions, especially ACP countries, in adapting to and mitigating climate change. Beneficial strategies include the following:

- Development and introduction of crop varieties that require longer or shorter growing season and high yields under adverse conditions e.g. high yielding rice varieties that are well-suited for un-flooded areas can contribute to reducing methane emissions.
- Increased fertilizer management and efficiency through deep displacement in the soil or use of nitrification inhibitors, reduced-release-rate fertilizers and fertilizer coatings can contribute to reducing GHGs.
- Use of feed additives to increase digestion efficiency of livestock and so increase animal productivity.
- Use of appropriate agricultural technologies to discourage shifting agriculture.
- Identification and use of indigenous knowledge systems that are systematically recorded so that they are accessible to R&D personnel or policy-makers.

Suggested R&D Strategy for Capacity Building

Capacity building should seek to build, develop, strengthen, enhance, and improve existing scientific and technical skills and capabilities of individuals, institutions or societies to perform the actions needed to monitor and mitigate the effects of climate change. However, capacity building is a long-term process for ensuring the availability of adequate indigenous S&T capacity which can benefit from external facilitation.

The political and financial role of government in ACP countries in creating an 'enabling environment is a prerequisite in the capacity building strategy, and refers to the laws, regulations, financing mechanisms, attitudes and values that foster capacity building. Clear and sound policies, financial and political commitment, effective coordination and collaboration within a stable macroeconomic environment will greatly enhance capacity building, while the reverse can be constraining.

[22] Source: http://knowledge.cta.int/en/content/view/full/2121

Employing the capacity building strategy above will put responsibility on all the groups to effectively participate in collaborative R&D. The R&D institutions of countries in sustainment should be encouraged to support the agenda of survival countries and those in development, and enhance the use of local capacities in those countries. They should develop R&D programmes in a flexible manner to cope with those of the other group of countries. The R&D institutions of countries that are in development should be prepared to forge networks and partnerships with similar institutions in survival countries. All these institutions should promote shared responsibilities, and make long-term commitments. The most important responsibility of R&D institutions in survival countries including ACP countries is to create a more receptive environment for collaboration. Tasks required include: identification of local capacities while recognizing constraints and resources, enhance and utilize local skills, abilities and resources, identify external resources to cope with gaps, and strengthening understanding and relationships.

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ACRONYMS

AR	Assessment Report
CBA	Community Based Adaptation
CBO	Community Based Organization
CBDP	Community-based Disaster Preparedness
CBDR	Community-based Disaster Reduction
CCAA	Climate Change Adaptation in Africa
CDM	Clean Development Mechanism
CLACC	Capacity Strengthening of Least Developed Countries for Adaptation to Climate Change
CO2	Carbon dioxide
COP	Conference of the Parties (to the UN Framework Convention on Climate Change)
GEF	Global Environment Facility
IPCC	Intergovernmental Panel on Climate Change
RCCCC	Red Cross Climate Change Centre
SSN	SouthSouthNorth
SADC	Southern African Development Community
LDCF	Least Developed Countries Fund
LULUCF	Land-Use, Land-Use Change and Forestry
M&E	Monitoring and evaluation
NAPA	National Adaptation Programmes of Action
NGO	Non-governmental Organization
PV	Photovoltaic
REDD	Reducing emissions from deforestation and ecosystem degradation
SPA	Strategic Priority on Adaptation
UNEP	United Nations Environmental Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNITAR	United Nations Institute for Training and Research
WG	Working Group
WMO	World Meteorological Organization

GLOSSARY[23]

Adaptation - Initiatives and measures to reduce the vulnerability of natural and human systems against actual or expected climate change effects. Various types of adaptation exist, e.g. anticipatory and reactive, private and public, and autonomous and planned. Examples are raising river or coastal dikes, the substitution of more temperature-shock resistant plants for sensitive ones, etc.

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.

Afforestation - Planting of new forests on lands that historically have not contained forests (for at least 50 years).

Annex I countries - The group of countries included in Annex I (as amended in 1998) to the United Nations Framework Convention on Climate Change (UNFCCC), including all the OECD countries in the year 1990 and countries with economies in transition. Under Articles 4.2 (a) and 4.2 (b) of the Convention, Annex I countries committed themselves specifically to the aim of returning individually or jointly to their 1990 levels of greenhouse gas emissions by the year 2000. By default, the other countries are referred to as Non-Annex I countries.

Annex II countries - The group of countries included in Annex II to the United Nations Framework Convention on Climate Change (UNFCCC), including all OECD countries in the year 1990. 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.

Annex B countries - The countries included in Annex B to the Kyoto Protocol that have agreed to a target for their greenhouse-gas emissions, including all the Annex I countries (as amended in 1998) except for Turkey and Belarus.

Arid region - A land region of low rainfall, where low is widely accepted to be <250 mm precipitation per year.

Assigned amount units (AAUs) - The three mechanisms under the Kyoto Protocol are based on the Protocol's system for the accounting of targets. Under this system, the amount to which an Annex I Party (with a commitment inscribed in Annex B of the Kyoto Protocol) must reduce its emissions over the five year commitment period (known as its "assigned amount") is divided into units each equal to one tonne of carbon dioxide equivalent. These assigned amount units (AAUs), and other units defined by the Protocol, contribute the basis for the Kyoto mechanisms by providing for a Party to gain credit from action taken in other Parties that may be counted towards it own emissions target.

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 vapour, whose amount is highly variable but typically 1% volume mixing ratio. The atmosphere also contains clouds and aerosols.

Barrier - Any obstacle to reaching a goal, adaptation or mitigation potential that can be overcome or attenuated by a policy, programme, or measure. Barrier removal includes correcting market failures directly or reducing the transactions costs in the public and private sectors by e.g. improving institutional capacity, reducing risk and uncertainty, facilitating market transactions, and enforcing regulatory policies.

Baseline - Reference for measurable quantities from which an alternative outcome can be measured, e.g. a non-intervention scenario used as a reference in the analysis of intervention scenarios.

Biodiversity - The total diversity of all organisms and ecosystems at various spatial scales.

Biofuel - 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. The quantity of biomass is expressed as a dry weight or as the

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energy, carbon, or nitrogen content

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.

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.

Carbon cycle - The term used to describe the flow of carbon (in various forms, e.g., 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 sequestration - The process of increasing the carbon content of a reservoir/pool other than the atmosphere.

Clean Development Mechanism (CDM) - Defined in Article 12 of the Kyoto Protocol, the CDM 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 CDM projects undertaken in Non-Annex I countries that limit or reduce GHG 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 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 for averaging these variables is 30 years, as defined by the World Meteorological Organization. The relevant quantities are most often surface variables such as temperature, precipitation and wind. Climate in a wider sense is the state, including a statistical description, of the climate system. In various parts of this report different averaging periods, such as a period of 20 years, are also used.

Climate-carbon cycle coupling - Future climate change induced by atmospheric emissions of greenhouse gases will impact on the global carbon cycle. Changes in the global carbon cycle in turn will influence the fraction of anthropogenic greenhouse gases that remains in the atmosphere, and hence the atmospheric concentrations of greenhouse gases, resulting in further climate change. This feedback is called climate-carbon cycle coupling. The first generation coupled climate-carbon cycle models indicates that global warming will increase the fraction of anthropogenic CO_2 that remains in the atmosphere.

Climate change - Climate change refers to a change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forcings, or to persistent anthropogenic changes in the composition of the atmosphere or in land use. Note that the Framework Convention on Climate Change (UNFCCC), in its Article 1, defines climate change as: 'a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods'. The UNFCCC thus makes a distinction between climate change attributable to human activities altering the atmospheric composition, and climate variability attributable to natural causes.

Climate change commitment - Due to the thermal inertia of the ocean and slow processes in the biosphere, the cryosphere and land surfaces, the climate would continue to change even if the atmospheric composition were held fixed at today's values. Past change in atmospheric composition leads to a committed climate change, which continues for as long as a radiative imbalance persists and until all components of the climate system have adjusted to a new state. The further change in temperature after the composition of the atmosphere is held constant is referred to as the constant composition temperature commitment or simply committed warming or warming commitment. Climate change commitment includes other future changes, for example in the hydrological cycle, in extreme weather and climate events, and in sea level change.

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

Climate change Impacts - The effects 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.

Climate prediction - A climate prediction or climate forecast is the result of an attempt to produce an estimate of the actual evolution of the climate in the future, for example, at seasonal, interannual or long-term time scales. Since the future evolution of the climate system may be highly sensitive to initial conditions, such predictions are usually probabilistic in nature.

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 socioeconomic and technological developments that may or may not be realised and are therefore subject to substantial uncertainty.

Climate (risk) management - A systematic process of implementing policies, strategies, and measures to reduce the impacts of natural hazards and related environmental and technological disasters. This includes, among other things, disaster risk reduction, preparedness, response, recovery and rehabilitation.

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 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 anthropogenic forcings such as the changing composition of the atmosphere and land use change.

Climate/climatic 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 spatial and temporal scales beyond that of individual weather events. Variability may be due to natural internal processes within the climate system (internal variability), or to variations in natural or anthropogenic external forcing (external variability).

Compliance - Compliance is whether and to what extent countries do adhere to the provisions of an accord. Compliance depends on implementing policies ordered, and on whether measures follow up the policies. Compliance is the degree to which the actors whose behaviour is targeted by the agreement, local government units, corporations, organisations, or individuals, conform to the implementing obligations.

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.

Deforestation - Conversion of forest to non-forest.

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.

Disaster (risk) management - A systematic process of implementing policies, strategies, and measures to reduce the impacts of natural hazards and related environmental and technological disasters. This includes, among other things, disaster risk reduction, preparedness, response, recovery and rehabilitation.

Disaster preparedness - Activities that contribute to the pre-planned, timely and effective response of individuals and communities to reduce the impact and deal with the consequences of a (future) disaster.

Disaster rehabilitation - The set of actions taken after a disaster to enable basic services to resume functioning, to repair physical damage and community facilities, to revive economic activities and support the psychological and social well-being of the survivors.

Disaster Risk Reduction - People and institutions involved in preparedness, mitigation and prevention activities associated with extreme events. These include hazard forecasting and immediate relief efforts for major disasters resulting from floods, cyclones and, in some cases, pollution events. This community is being enlarged to include specialists in the longer-term strategy of disaster prevention by anticipatory actions such as improved land-use planning, the establishment and enforcement of higher building codes, and modes of cost sharing such as insurance.

Drought - In general terms, drought is a 'prolonged absence or marked deficiency of precipitation', a 'deficiency that results in water shortage for some activity or for some group', or a 'period of abnormally dry weather sufficiently prolonged for the lack of precipitation to cause a serious hydrological imbalance' (Heim, 2002). Drought has been defined in a number of ways. Agricultural drought relates to moisture deficits in the topmost 1 metre or so of soil (the root zone) that affect crops, meteorological drought is mainly a prolonged deficit of precipitation, and hydrologic drought is related to below-normal streamflow, lake and groundwater levels. A megadrought is a long drawn out and pervasive drought, lasting much longer than normal, usually a decade or more.

Early warning - Providing timely and effective information about an imminent hazard that allows people to take action to avoid a disaster or prepare for effective response. Early-warning systems depend on a chain of things: understanding and mapping the hazard; monitoring and forecasting; processing and disseminating understandable warnings to political authorities and the population; and undertaking the right, timely actions in response to the warnings.

Ecosystem A system of living organisms interacting with each other and 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.

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 trading - A market-based approach to achieving environmental objectives. It allows those reducing GHG emissions below their emission cap 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 intra-company, domestic, and international levels. The Second Assessment Report by the IPCC 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.

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 sect oral (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.

Emission 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 socioeconomic development, technological change) and their key relationships. Concentration scenarios, derived from emission scenarios, are used as input to a climate model to compute climate projections.

Emissions tax - Levy imposed by a government on each unit of CO2-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 behaviour (specifically economic behaviour) 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.

Energy - The amount of work or heat delivered. Energy is classified in a variety of types and becomes useful to human ends when it flows from one place to another or is converted from one type into another. Primary energy (also referred to as energy sources) is the energy embodied in natural resources (e.g., coal, crude oil, natural gas, uranium) that has not undergone any anthropogenic conversion. This primary energy needs to be converted and transported to become usable energy (e.g. light). Renewable energy is obtained from the continuing or repetitive currents of energy occurring in the natural environment, and includes non-carbon technologies such as solar energy, hydropower, wind, tide and waves, and geothermal heat, as well as carbon neutral technologies such as biomass. Embodied energy is the energy used to produce a material substance (such as processed metals, or building materials), taking into account energy used at the manufacturing facility (zero order), energy used in producing the materials that are used in the manufacturing facility (first order), and so on.

Energy efficiency - The ratio of useful energy output of a system, conversion process or activity to its energy input.

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.

Equivalent carbon dioxide (CO2) concentration - 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.

Equivalent carbon dioxide (CO2) emission The amount of carbon dioxide emission that would cause the same integrated radiative forcing, over a given time horizon, as an emitted amount of a well mixed greenhouse gas or a mixture of well mixed greenhouse gases. The equivalent carbon dioxide emission is obtained by multiplying the emission of a well mixed greenhouse gas by its Global Warming Potential for the given time horizon. For a mix of greenhouse gases it is obtained by summing the equivalent carbon dioxide emissions of each gas. Equivalent carbon dioxide emission is a standard and useful metric for comparing emissions of different greenhouse gases but does not imply exact equivalence of the corresponding climate change responses.

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.

Fossil CO2 (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.

Global Environmental Facility (GEF) - The Global Environment Facility (GEF), established in 1991, helps developing countries fund projects and programmes that protect the global environment. GEF grants support projects related to biodiversity, climate change, international waters, land degradation, the ozone layer, and persistent organic pollutants.

Global surface temperature The global surface temperature is an estimate of the global mean surface air temperature. However, for changes over time, only anomalies, as departures from a climatology, are used, most commonly based on the area-weighted global average of the sea surface temperature anomaly and land surface air temperature anomaly.

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 gas (GHG) - 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 (H2O), carbon dioxide (CO2), nitrous oxide (N2O), methane (CH4), and ozone (O3) 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 CO2, N2O, and CH4, the Kyoto Protocol deals with the greenhouse gases sulfur hexafluoride (SF6), hydrofluorocarbons (HFCs), and perfluorocarbons (PFCs).

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."

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

Implementation - Implementation describes the actions taken to meet commitments under a treaty and encompasses legal and effective phases. Legal implementation refers to legislation, regulations, judicial decrees, including other actions such as efforts to administer progress which governments take to translate international agreements into domestic law and policy. Effective implementation needs policies and programmes that induce changes in the behaviour and decisions of target groups. Target groups then take effective measures of mitigation and adaptation.

IPCC Intergovernmental Panel on Climate Change - The most credible source of knowledge on climate change, IPCC is a panel established in 1988 to assess scientific, technical and socio-economic information. Every five or six years, it produces assessments based mainly on peer reviewed and published scientific/technical literature on climate change, its potential impacts, and options for adaptation and mitigation.

Joint Implementation (JI) - A market-based implementation mechanism defined in Artiche 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 (UNFCCC)

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), 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 in 1997 in Kyoto, Japan, at the Third Session of the Conference of the Parties (COP) to the UNFCCC. It contains legally binding commitments, in addition to those included in the UNFCCC. Countries included in Annex B of the Protocol (most Organisation for Economic Cooperation and Development countries and countries with economies in transition) agreed to reduce their anthropogenic greenhouse gas emissions (carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulphur hexafl uoride) by at least 5% below 1990 levels in the commitment period 2008 to 2012. The Kyoto Protocol entered into force on 16 February 2005.

Kyoto Protocol's Adaptation Fund - In Bali, the COP decided that developing country Parties to the Kyoto Protocol that are particularly vulnerable to the adverse effects of climate change are eligible for funding from the Adaptation Fund to assist them in meeting the costs of adaptation; the Adaptation Fund shall finance concrete adaptation projects and programmes that are country driven and are based on the needs, views and priorities of eligible Parties. Furthermore, Bali Conference finalised governance arrangements for the Kyoto Protocol's Adaptation Fund for developing countries, many of which are particularly vulnerable to the impacts of climate change. The agreement clears the way for the Fund to become operational and begin financing adaptation programmes and projects in developing countries. It will be financed mainly through a levy on the value of emission credits generated by clean energy projects undertaken under the Protocol's Clean Development Mechanism and Joint Implementation instrument.

Land use - Land use refers to the total of arrangements, activities and inputs undertaken in a certain land cover type (a set of human actions). The term land use is also used in the sense of the social and economic purposes for which land is managed (e.g., grazing, timber extraction and conservation). Land use change refers to 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 surface albedo, evapotranspiration, sources and sinks of greenhouse gases, or other properties of the climate system and may thus have a radiative forcing and/or other impacts on climate, locally or globally.

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.

Mitigation - Technological change and substitution that reduce resource inputs and emissions per unit of output. Although several social, economic and technological policies would produce an emission reduction, with respect to Climate Change, mitigation means implementing policies to reduce greenhouse gas emissions and enhance sinks.

Mitigative capacity - This is a country's ability to reduce anthropogenic greenhouse gas emissions or to enhance natural sinks, where ability refers to skills, competencies, fitness and proficiencies that a country has attained and depends on technology, institutions, wealth, equity, infrastructure and information. Mitigative capacity is rooted in a country's sustainable development path.

Mitigation Potential - In the context of climate change mitigation, the mitigation potential is the amount of mitigation that could be - but is not yet– realized over time. Market potential is the mitigation potential based on private costs and private

discount rates, which might be expected to occur under forecast market conditions, including policies and measures currently in place, noting that barriers limit actual uptake. Private costs and discount rates reflect the perspective of private consumers and companies. Economic potential is the mitigation potential that takes into account social costs and benefits and social discount rates, assuming that market efficiency is improved by policies and measures and barriers are removed. Social costs and discount rates reflect the perspective of society. Social discount rates are lower than those used by private investors. Studies of market potential can be used to inform policy makers about mitigation potential with existing policies and barriers, while studies of economic potential show what might be achieved if appropriate new and additional policies were put into place to remove barriers and include social costs and benefits. The economic potential is therefore generally greater han the market potential. Technical potential is 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. No explicit reference to costs is made but adopting 'practical constraints' may take implicit economic considerations into account.

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, methyl chloroform, carbon tetrachloride and many others.

National Adaptation Programmes of Action (NAPAs) - NAPAs (national adaptation programmes of action) provide a process for Least Developed Countries (LDCs) to identify priority activities that respond to their urgent and immediate needs with regard to adaptation to climate change. The rationale for NAPAs rests on the limited ability of LDCs to adapt to the adverse effects of climate change. In order to address the urgent adaptation needs of LDCs, a new approach was needed that would focus on enhancing adaptive capacity to climate variability, which itself would help address the adverse effects of climate change. The NAPA takes into account existing coping strategies at the grassroots level, and builds upon that to identify priority activities, rather than focusing on scenario-based modelling to assess future vulnerability and long-term policy at state level. In the NAPA process, prominence is given to community-level input as an important source of information, recognizing that grassroots communities are the main stakeholders.
The NAPAs focus on urgent and immediate needs – those for which further delay could increase vulnerability or lead to increased costs at a later stage. NAPAs should use existing information; no new research is needed. They must be action-oriented and country-driven and be flexible and based on national circumstances. Finally, in order to effectively address urgent and immediate adaptation needs, NAPA documents should be presented in a simple format, easily understood both by policy-level decision-makers and by the public. The steps for the preparation of the NAPAs include synthesis of available information, participatory assessment of vulnerability to current climate variability and extreme events and of areas where risks would increase due to climate change, identification of key adaptation measures as well as criteria for prioritizing activities, and selection of a prioritized short list of activities. The development of a NAPA also includes short profiles of projects and/or activities intended to address urgent and immediate adaptation needs of LDC Parties.

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

Reforestation - Direct human-induced conversion of non-forested land to forested land through planting, seeding and/or the human-induced promotion of natural seed sources, on land that was previously forested but converted to non-forested land. For the first commitment period of the Kyoto Protocol, reforestation activities will be limited to reforestation occurring on those lands that did not contain forest on 31 December 1989.

Region - A region is a territory characterised by specific geographical and climatological features. The climate of a region is affected by regional and local scale forcings like topography, land use characteristics, lakes, etc., as well as remote influences from other regions.

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.

Reservoir - A component of the climate system, other than the atmosphere, that has the capacity to store, accumulate or release a substance of concern (e.g., carbon or a greenhouse gas). Oceans, soils, and forests are examples of carbon reservoirs. 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 or water supply.

Resilience - The ability of a social or ecological system to absorb disturbances while retaining the same basic structure and ways of functioning, the capacity for self-organisation, and the capacity to adapt to stress and change.

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 reaches 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 quickly (e.g., to droughts), but also very slowly to imposed changes.

Scenario - A plausible and often simplified description of how the future may develop, based on a coherent and internally consistent set of assumptions about driving forces and key relationships. Scenarios may be derived from projections, but are often based on additional information from other sources, sometimes combined with a narrative storyline.

Sea level change/sea level rise - Sea level can change, both globally and locally, due to (i) changes in the shape of the ocean basins, (ii) changes in the total mass of water and (iii) changes in water density. Factors leading to sea level rise under global warming include both increases in the total mass of water from the melting of land based snow and ice, and changes in water density from an increase in ocean water temperatures and salinity changes. Relative sea level rise occurs where there is a local increase in the level of the ocean relative to the land, which might be due to ocean rise and/or land level subsidence.

Sea level equivalent (SLE) - The change in global average sea level that would occur if a given amount of water or ice were added to or removed from the oceans.

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

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

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.

Solar radiation - Electromagnetic radiation emitted by the Sun. It is also referred to as shortwave radiation. Solar radiation has a distinctive range of wavelengths (spectrum) determined by the temperature of the Sun, peaking in visible wavelengths.

Storm tracks - Originally, a term referring to the tracks of individual cyclonic weather systems, but now often generalised to refer to the regions where the main tracks of extratropical disturbances occur as sequences of low (cyclonic) and high (anticyclonic) pressure systems.

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

Sustainable Development (SD) - The concept of sustainable development was introduced in the World Conservation Strategy (IUCN 1980) and had its roots in the concept of a sustainable society and in the management of renewable resources. Adopted by the WCED in 1987 and by the Rio Conference in 1992 as a process of change in which the exploitation of resources, the direction of investments, the orientation of technological development and institutional change are all in harmony and enhance both current and future potential to meet human needs and aspirations. SD integrates the political, social, economic and environmental dimensions.

Tax - A carbon tax is a levy on the carbon content of fossil fuels. Because virtually all of the carbon in fossil fuels is ultimately emitted as CO2, a carbon tax is equivalent to an emission tax on each unit of CO2-equivalent emissions. An energy tax - a levy on the energy content of fuels - reduces demand for energy and so reduces CO2 emissions from fossil fuel use. An eco-tax is designed to influence human behaviour (specifically economic behaviour) to follow an ecologically benign path.
An international carbon/emission/energy tax is a tax imposed on specified sources in participating countries by an international authority. The revenue is distributed or used as specified by this authority or by participating countries. A harmonized tax commits participating countries to impose a tax at a common rate on the same sources, because imposing different rates across countries would not be cost-effective. A tax credit is a reduction of tax in order to stimulate purchasing of or investment in a certain product, like GHG emission reducing technologies. A carbon charge is the same as a carbon tax.

Thermal expansion - In connection with sea-level rise, 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.

Tradable permit - A tradable permit is an economic policy instrument under which rights to discharge pollution - in this case an amount of greenhouse gas emissions - can be exchanged through either a free or a controlled permit-market. An emission permit is a non-transferable or tradable entitlement allocated by a government to a legal entity (company or other emitter) to emit a specified amount of a substance.

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 'stabilisation 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 (all OECD 954 countries and countries with economies in transition) aim to return greenhouse gas emissions not controlled by the Montreal Protocol to 1990 levels by the year 2000. The convention entered in force in March 1994.

Vulnerability and Adaptation Resource Group (VARG) - Vulnerability and Adaptation Resource Group (VARG) was formed as an informal network of bi- and multilateral institutions. The mission of VARG is to facilitate the integration of climate change adaptation in the development process through the sharing, assessment, synthesis, and dissemination of existing knowledge and experience. The target audience are developing countries, the UNFCCC process, civil society, and development agencies. A core group of bi-lateral and multi-lateral agencies are supporting VARG as an open knowledge network on vulnerability, adaptation and development. All bilateral and multi-lateral agencies with an interest in climate change adaptation are welcome to join and contribute to this group. The following agencies have been participating in this knowledge exchange: BMZ, CIDA, DFID, DGIS, EC, GEF, GTZ, KfW, OECD, Red Cross/Red Crescent (Climate Center), SIDA, UNDP, UNEP, UN/ISDR, USAID, USEPA, the World Bank, WMO and WHO.

Vulnerability - Vulnerability is the degree to which a system is susceptible to, and 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 change and variation to which a system is exposed, its sensitivity, and its adaptive capacity.

Water consumption - Amount of extracted water irretrievably lost during its use (by evaporation and goods production). Water consumption is equal to water withdrawal minus return flow.

Water stress -A country is water stressed if the available freshwater supply relative to water withdrawals acts as an important constraint on development. In global-scale assessments, basins with water stress are often defined as having a per capita water availability below 1,000 m3/yr (based on long-term average runoff). Withdrawals exceeding 20% of renewable water supply have also been used as an indicator of water stress. A crop is water stressed if soil available water, and thus actual evapotranspiration, is less than potential evapotranspiration demands.

World Bank's Forest Carbon Partnership Facility - Launched in Bali on December 2007, the World Bank Carbon Finance Unit (CFU) uses money contributed by governments and companies in OECD countries to purchase project-based greenhouse gas emission reductions in developing countries and countries with economies in transition. The emission reductions are purchased through one of the CFU's carbon funds on behalf of the contributor, and within the framework of the Kyoto Protocol's Clean Development Mechanism (CDM) or Joint Implementation (JI). Unlike other World Bank development products, the CFU does not lend or grant resources to projects, but rather contracts to purchase emission reductions similar to a commercial transaction, paying for them annually or periodically once they have been verified by a third party auditor. The selling of emission reductions - or carbon finance - has been shown to increase the bankability of projects, by adding an additional revenue stream in hard currency, which reduces the risks of commercial lending or grant finance. Thus, carbon finance provides a means of leveraging new private and public investment into projects that reduce greenhouse gas emissions, thereby mitigating climate change while contributing to sustainable development.