UNEP e-Learning Course on

Insurance Risk Management for Renewable Energy Projects

Module 1 – Climate Change

Overview

The training is organized in 6 modules and fits into a 2-day training schedule:

Module	Main Content	Length of Module
1 – Climate Change	**Briefing, policy frameworks and business impact**	**2 hours**
2 – Renewable Energy Technologies and Risks	Renewable Energy technologies policy, investment trends and risks	3 hours
3 – Underwriting Guidelines and policy	Underwriting information, guidelines, risk evaluation, coverage evaluation	5 hours
4 – Claims handling and policy	Claims information, management, reserving, legal and payment	2 hours
5 – Intermediaries and networks	Project development, information and consultation	1 hour
6 – Case study	Renewable Energy case study, risk assessment, impact and suitability of instruments	3 hours
Total		16 hours

Module 1 Contents

Learning Objectives	
Evidence	**To understand why scientists believe the Earth's climate is changing.**
Impacts	**To understand how climate change affect natural systems and human society.**
Relevance	**To understand how climate change is approaches through inter-governmental treaties, and how insurance companies can adapt to the risks and embrace new opportunities.**

Introduction

Since the emergence of large-scale industrial activities, billions of tons of carbon dioxide and other greenhouse gases have been emitted into the earth's atmosphere – leading to a disturbance in the natural long-term pattern of global warming and cooling. The average temperature of the planet today is 0.7 ℃ (33.27 ℉) higher than100 years ago . Looking forward, scientists expect an additional warming of between 2 and 5 ℃ (35.6 to 41 ℉) by th e middle of this century. Global warming increases the likelihood of disturbed weather patterns. The melting of the ice caps and glaciers, sea level-rise, and the faster-moving change of geographic range in biodiversity distribution patterns are expected in the future. Due to the fact that global warming is a long-term and global externality no single actor, neither political nor economic, is able to mitigate the problems alone. It is only a coordinated effort, shared by the global community, which can lead to a sustainable reduction of carbon dioxide and other greenhouse gas emissions. The UN has created a strong body of institutions and frameworks, most prominently the Kyoto Protocol to tackle climate change.

A key strategy for sustainable emission reductions is the use of Renewable Energy Technologies (RETs). RETs open the door to a future where human activities and the global energy consumption are in balance with the earth's sensitive environment. Insurance companies play a key role in mitigating risks for projects and operations where these new energy technologies are applied.

Section 1 – Definition of Climate Change

This section explains the main elements of climate change. It focuses on the greenhouse effect, the greenhouse gases and the sun, the anthropogenic factors, and methods to measure climate change.

Section 2 – Impact of Climate Change

This section walks through the main impacts of climate change, such as sea level rise, river floods, drought, ocean-related phenomena, storms, ice covers, heat waves and other extreme climate change event. These impacts are predominantly considered to be risks with regards to higher temperatures on earth.

Section 3 – Climate Change Policy Frameworks

This section explains the responses provided by political and other institutional players. A strong policy framework has been developed in the last 15 years led by the UN. With the Kyoto protocol, clear mitigation goals and activities have been defined for the period of 2008 – 2012. Activities focus on the reduction of greenhouse gas emissions and on the installation of global project and trading mechanisms that should support an efficient reduction.

Section 4 – Climate Change and the Insurance Industry

This section provides an introduction into strategies that the insurance industry and other business players can use to adapt to climate change. Insurance companies are main innovators and drivers in terms of risk management. The insurance industry has a major role regarding the risk mitigation considerations of climate change. This section highlights the main consequences of global warming for the insurance industry and related lines of business.

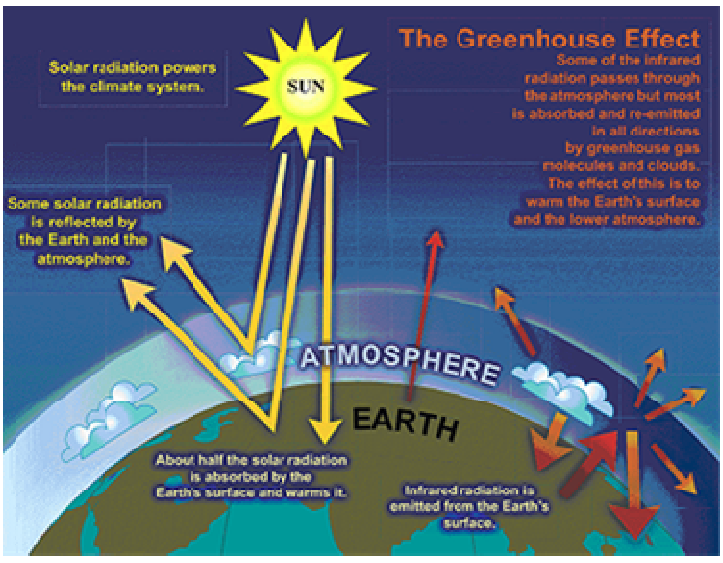
1 Definition of Climate Change

1.1 Explanation of climate change

The earth's current climate ensures its inhabitability. With the help of the atmosphere the energy from the sun's rays can be trapped and a temperature where humans can live is achieved. The average temperature of the earth is currently about 14℃. Without the blanketing effect by the atmosphere, the earth's temperature would be at least 30℃ (86 ℉) lower. This natural balancing of the earth's temperature by the gases in the atmosphere is caused by the Greenhouse Effect.

Greenhouse Effect	The greenhouse effect is due to the trapping of the solar rays in the atmosphere: 1. Solar radiation passes through the atmosphere and warms the surface of the earth. 2. Infrared radiation is given off from the earth. 3. Most infrared radiation escapes to outer space, thus cooling the earth. 4. Some infrared radiation is trapped by greenhouse gases, thus reducing the cooling.

Figure 1 – An idealized model of the Greenhouse Effect[1]



The earth's climate is constantly changing. Fluctuations in solar radiation, major volcanic eruptions and variations in the earth's orbit cause climate to change on a continuous basis. These natural variations influence daily weather patterns and create short-term patterns such as the seasons, as well as long-term climate shifts like the Ice Ages.

[1] See IPCC Assessment Report 4, Working Group 1 Report, Chapter 1, p. 115.

However, some of the changes in climate intensify the natural patterns of the weather as a result of anthropogenic behavior. Since the middle of the 18th century, human activity started to alter the natural climate pattern. Human-caused, or anthropogenic, climate change is due to the fact that fossil fuel energy consumption and changes in land use (deforestation) create large quantities of greenhouse gases as by-products. Greenhouse gases (GHG) are atmospheric gases that absorb heat. The most significant GHG is carbon dioxide (CO_2), which is released whenever organic material decays or is burned.

Anthropogenic climate change	Human-induced, or anthropogenic, climate change is due to the fact that energy consumption and changes in land use produce large quantities of greenhouse gases as byproducts.

The increased levels of greenhouse gases accelerate the natural greenhouse effect and global warming occurs.

Warming	Global warming is the recent warming of the earth's lower atmosphere. It is believed to be the result of an enhanced greenhouse effect due to increased concentrations of greenhouse gases in the atmosphere. The increase of greenhouse gas concentrations is scientifically proven. There are two key measurements: 1. Concentration of greenhouse gas, especially the most prominent, CO_2. Since pre-industrial times (mid-eighteenth century) the concentration of CO_2 has risen from 280 parts per million (ppm) to 380 ppm today. 2. Earth's average temperature measurement. Since 1900 the earth has warmed about 0.7℃. An additional warming of 2 to 5 ℃ is expected by the middle of this century.

Greenhouse gases have different severities in terms of the duration they live in the atmosphere and therefore enhance global warming. This is the so-called Global Warming Potential (GWP).

GWP	GWP is Global Warming Potential. Indicates the period of the 100-year lifetime of a gas in the atmosphere. The gases are rated in reference to carbon dioxide that is given a GWP of 1. Example: 1 ton of Methane reduction corresponds to 23 tons of CO_2 reduction.

The most common greenhouse gas is water vapor, which has a short lifetime in the atmosphere. It is generally ignored in terms of global warming. In the context of the global greenhouse gas policy (see below section 3), the following gases are considered to be the main agents of climate change:

Overview of major greenhouse gases relevant for global greenhouse gas policy

Greenhouse Gases	Description	GWP	Caused by
$C0_2$	Carbon dioxide	1	Fossil fuel burning.
CH_4	Methane	23	Agriculture, waste management, fossil fuel extraction.
N_2O	Nitrous oxide	298	Agriculture, fossil fuel combustion.
PFCs	Perfluorocarbons	5'900-12'200	Alternative to ozone depleting CFCs and HCFCs, aluminum production, semi-conductor manufacturing.
HFCs	Hydrofluorocarbons	124-14'800	Substitutes for CFCs and HCFCs, refrigeration, foam blowing, air conditioning.
SF_6	Sulphur hexaflouride	22'800	Insulator for electrical equipment, semi-conductor manufacturing.

While human activity releases many greenhouse gases into the air, there are some processes that can remove these chemicals from the atmosphere. A process that removes greenhouse gases from the atmosphere is called a greenhouse gas sink.

Greenhouse gas sink	Sinks refer to processes or activities that remove greenhouse gases from the atmosphere. Forests and other vegetation are important sinks. Green plants remove CO_2 from the atmosphere through photosynthesis.

1.2 Evidence and prediction of climate change

Most studies and reports today do confirm that the scientific case of anthropogenic climate change is proven. Scientists have shown that the climate change related to global warming is caused by the increased rates of release of greenhouse gases into the atmosphere by human activities and energy consumption.

The most prominent report on the effects of climate change and necessary adaptation and mitigation measures has been released by the IPCC (Intergovernmental Panel on Climate Change). The IPCC is a scientific body tasked to evaluate the risk of climate change caused by human activity. The panel was established in 1988 by the United Nations World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP). The IPCC was awarded the Nobel Prize on October 2007, along with former U.S. Vice President, Al Gore, for its work on bringing attention to climate change issues. It publishes regular assessment reports, the latest being Assessment Report 4 (AR4) in 2007. These reports also discuss the connection between global warming and the frequency and severity of extreme atmospheric events. These events have significant impacts on the calculation models for natural catastrophe (or "nat cat") events.

IPCC Reports[2]	The IPCC (Intergovernmental Panel on Climate Change) publishes regular reports on the situation of climate change, called Assessment Reports (AR). These reports are generated with the help of working groups. Working groups focus on sub-topics such as scientific evidence, climate impacts and vulnerability, and mitigation.

The Fourth Assessment Report (AR4) was completed in early 2007. The full report was published on March 2007 and the key conclusions of the Summary for Policy-Makers (SPM) were that:[3]

Assessment Report (AR4) Conclusions:

- Warming of the climate system is unequivocal.
- The probability that climate change is caused by natural climatic processes alone is less than 5%.
- Global atmospheric concentrations of carbon dioxide, methane, and nitrous oxide have increased markedly as a result of human activities since 1750 and now far exceed pre-industrial values that were stable for over the past 650,000 years.
- Most of the observed increase in globally averaged temperatures since the mid-20th century is very likely due to the observed increase in greenhouse gas concentrations, produced by humans.
- Atmospheric warming and sea level rise would continue for centuries due to the timescales associated with climate processes and feedbacks, even if greenhouse gas concentrations were to be stabilized immediately. The likely amount of temperature and sea level rise varies greatly depending on the intensity of human activity and fossil-fuel use during the next century.
- Both past and future anthropogenic greenhouse gas emissions will continue to contribute to global warming and sea level rise for more than a millennium.
- Average global temperatures could rise by between 1.1 and 6.4 ℃ (2.0 and 11.5 ℉) during the 21st century and:

  a. Sea levels will probably rise by 18 to 59 cm (7.08 to 23.22 inches).

  b. There will be more frequent warm spells, heat waves and heavy rainfall (confidence level >90%).

  c. There will be an increase in droughts, tropical cyclones and extreme high tides (confidence level >66%).

Another important publication is the Stern Report. The report provides the main analysis for the climate change rationale and was published by Sir Nicholas Stern on behalf of the British government in 2006. The Stern report makes significant statements regarding the investment needs of today in order to mitigate the negative effects of climate change tomorrow.

[2] Further detailed information can be found at http://www.ipcc.ch/ipccreports/assessments-reports.htm.

[3] See also at http://ipcc-wg1.ucar.edu/wg1/wg1-report.html - In IPCC statements "most" means greater than 50%, "likely" means at least a 66% likelihood, and "very likely" means at least a 90% likelihood.

Stern Report[4]	The Stern report explains the main contributors to climate change based on the scientific evidence. It sets up an economic model to evaluate uncertain future costs of climate change and how to tackle the issues by investing a fraction of the GDP into mitigating activities. One of the key statements of the report is that a continuous investment of 1% of today's GDP is required in order to avoid the negative effects of climate change and to reduce the greenhouse gas emissions in a sustainable way. Negative effects are predicted as up to 20% of the future GDP.

The effects of climate change are predictable and measurable. In order to measure the impact of climate change a system of control points are linked and computer programs are used. These computer programs are based on General Circulation Models (GCM).

GCM	General Circulation Models (GCM) are weather-forecasting programs. They are computer programs that deliver results in terms of changes in weather systems and rising sea level for the next decades. They calculate the weather conditions at thousands of grid points in the air, at the surface and beneath the sea. There are over 20 principal GCMs in use across the globe today. The result of the measures is analyzed and assessed by global panel on climate change directed by the IPCC (see below in Section 3).

Besides measurement of past and current conditions, future climate changes can be predicted. Most models show an acceleration of greenhouse gas concentration and a subsequent rise of future temperature. It is clear that predictions are depending on the input factors and assumptions of how the world will develop. The following variables are mostly used in prediction models:

Major factors affecting future predictions in climate change

Factor	Impact on climate change	Rationale
Economic growth	Increase	Economic activity within the current economic framework results in higher GHG emissions.
Population growth	Increase	Assuming constant GHG emission per head growth leads to higher overall GHG emissions.
Degree of globalization	Increase	Global knowledge and application of best available resources and technologies create opportunities to reduce GHG emissions.
	Increase	More trading and transport within current economic framework resulting in higher GHG emissions.
Degree of fossil-fuel use intensity	Decrease	Higher degree of fossil usage has a direct impact on increase of GHG emissions.

[4] Further details can be found at http://www.hm-reasury.gov.uk/independent_reviews/stern_review_economics_climate_change/stern_review_Report.cfm.

Degree of RET	Higher degree of renewable energy technologies has a direct impact on decrease of GHG emissions in case they replace fossil energies.

Most studies predict a growth of GHG concentration, especially CO_2, from 380 ppm as of today to more than 500 ppm. It is assumed that with the current patterns, at some stage the CO_2 emissions will be stabilized. Higher GHG concentrations will cause a temperature rise of between 0.6℃ and 17.1℃. Depending on the level of stabilization, st udies calculate the implied temperature change as follows:

Figure 2 – Temperature Increase[5]

Stabilisation level (ppm CO_2 equivalent)	Temperature increase at equilibrium relative to pre-industrial (°C)		
	IPCC TAR 2001 (Wigley and Raper)	Hadley Centre Ensemble	Eleven Studies
400	0.8 – 2.4	1.3 – 2.8	0.6 – 4.9
450	1.0 – 3.1	1.7 – 3.7	0.8 – 6.4
500	1.3 – 3.8	2.0 – 4.5	1.0 – 7.9
550	1.5 – 4.4	2.4 – 5.3	1.2 – 9.1
650	1.8 – 5.5	2.9 – 6.6	1.5 – 11.4
750	2.2 – 6.4	3.4 – 7.7	1.7 – 13.3
1000	2.8 – 8.3	4.4 – 9.9	2.2 – 17.1

1.3 Impact of Climate Change

Global warming means higher atmospheric and ocean temperatures as well as a higher temperature variability. This increases the likelihood of climate-sensitive conditions such as sea level, ice cover, storms, floods, droughts, heat waves, and ocean-atmosphere circulation oscillation patterns.

Major impacts of climate change on the earth

Main Climate Driver	Impact	Description
Warmer water temperature	Ice cover loss	The earth's cryosphere (glaciers, ice-caps and tundra permafrost) are expected to melt due to accelerated warming in the pole and high-altitude regions.
Warmer water temperature	Sea Level Rise (SLR)	It is expected that the sea level will rise in future. Impacts are variable and will be higher in river deltas due to low elevation and increased coastal erosion. Many highly populated areas lie on deltas and are of great concern.
Warmer water temperature	Storms	Projections are for much more frequent and intense storm activity in various areas due to a rise in sea-surface temperatures. Different patterns will develop between regions.

[5] See Stern Report, Chapter 1, p. 12.

Warmer air temperature	River Floods	Floods are caused by snowmelt, rainfall, and impervious surfaces. Heavy precipitation events will increase because warmer air can carry more moisture.
Warmer air temperature	Drought	Although global rainfall will increase, some areas will experience much less rainfall. Evaporation is enhanced in warmer climate.
Warmer air temperature	Heat waves	Heat waves will accelerate; cold spells will become less common. Peak temperatures during heat waves are expected to rise about 11℃.
Higher temperature variability	Climate oscillation	Changes in climate will trigger changes in ocean-atmosphere relationships. Circulation patterns and currents such as El Nino-Southern Oscillation and North Atlantic Oscillation (e.g. Gulf stream) will change with yet-to-be-seen consequences.
Higher temperature variability	Climate Discontinuities	Due to complex interactions between land, sea, atmosphere, and cryosphere, some outcomes cannot be predicted. The following four events might, however, create a permanent shift: ice-sheet collapse, Gulf Stream slowdown or reversal, Amazon Rainforest destruction, and ocean acidity.

A temperature rise of significantly more than 1℃ (33.8 ℉) has serious negative effects on vulnerable regions and scarce resources. There are five key economic impacts that can be directly linked to climate change. These are the main vulnerabilities or key exposure areas of climate change.

Major vulnerabilities and key exposures of climate change

Region / industry	Economic Issue	Impact of climate change
Coastal Cities	Growing size of megacities in the coastal areas	Higher vulnerability due to SLR, storms, water temperature rise, water quality decrease and inland runoff.
	Water scarcity	Accelerated by climate change due to more extreme events (flood, heat waves) as well as long-term trends (melting of glaciers).
Food and forests	Global food supply and biodiversity	Drought will negatively impact the output of agriculture and have a negative impact on the survival of tropical rainforests.
Energy	Global energy demand and supply	Heat waves generate energy demand surges. This combined with the low reserves of fossil fuels, create tremendous opportunities for renewable energy markets.
Tourism	Local dependency on tourism-friendly climate	Bleaching and extinction of coral reefs reduce local tourism.

The impacts on the insurance industry are permanently evaluated and measured. Further details are provided in Section 4.

2 Climate Change Policy Framework

Climate change is caused by the increase of greenhouse gas emissions. This is considered to be a negative externality since the producers of the greenhouse gas do not fully carry the embedded costs.

Term	Description
Externality	A negative externality occurs when the costs of a good or service are not (fully) paid by those who produce them. Typical negative externalities are water pollution, road accidents causing third party casualties, over-fishing of oceans, moral hazard in insurance, greenhouse gas emissions, etc. There are also positive externalities when the benefits of a good or service are not (fully) rendered to those who produce the externality. Typical positive externalities are beekeepers' activities, public parks in nearby cities, landscapes, knowledge spin-over and innovations.

There are four main challenges faced when trying to tackle climate change:

Externality aspects of climate change	
Aspects	**Description**
Global scope	Climate change is global when considering its causes, consequences, and solutions.
Long-term scope	Climate change causes long-term and persistent changes.
Impact uncertainties	The calculation of economic impacts still has many uncertainties and risks.
Potentially non-reversible	One of the most significant risks of climate change is that its consequences are non-reversible and create a non-marginal economic effect.

There are no standard political and economic recipes to tackle this situation. Political frameworks must take into account that the externality factors mentioned above produce four serious consequences:

Consequences of climate change in the policy action framework	
Consequence	**Description**
Climate change is not distributed equally across the globe.	The impact of one ton of GHG emission produces more potential social costs in developing countries than in developed countries. This is mainly due to the fact that developing countries are set in geographic locations that are more prone to the negative climate impacts. They also have a higher dependency on agriculture and a lower ability to protect against natural catastrophes.
Climate change affects the current and future generations.	The impact of one ton of GHG emission produces social costs for our current but also for our future generations. This is mainly due to the long-term impact of global warming. Also there is an ethical question if the costs embedded to the future generations should be considered with the same value as the costs to the current generation. Normally in economic analysis, future income and expense streams are discounted. However this ethical dimension does question if this discounting is the right approach.
Climate change has uncertainties in costs and benefits that must be explicitly considered.	Due to the large uncertainties about costs and benefits, it is difficult to set up a coherent planning and investment base for policy makers and economic actors. A typical example in the insurance industry is the link of asbestos to lung diseases. This link was discovered around the beginning of the 20th century. However, uncertainties persisted about the embedded costs of asbestos to society. Therefore it took dozens of years to turn the scientific evidence into political action (prohibition) and economic activities (dismounting).
Climate change has potential of a huge negative economic impact.	Without action today, the impacts on the global economy might be far more negative than for other more local environmental problems (such as pollution). It is clear that action must be taken in two forms: ▪ Mitigation activities to reduce the greenhouse gas emissions. ▪ Adaptation activities to minimize the effects of climate change.

Public policies are developed by national, regional and international institutions within the context of agreed frameworks and with the objective to take action.

: Policy Tools	Description

Institutions, conventions and activities	Political and globally recognized institutions that have mandates to take action. Agreements between parties for joint coordination of goals and activities. They establish a price for the negative externalities caused by fossil fuel production and consumption e.g. GHG emission price that can be measured and traded. They execute activities within the boundaries of the institutions and frameworks: ▪ Mitigation: Activities directed to reduce GHG emissions or to enhance greenhouse gas sinks. ▪ Adaptation: Activities directed to adapt to the effects of climate change e.g. reducing the vulnerability of natural and human systems against the negative effects of climate change.

Public Policy Tools

The Intergovernmental Panel on Climate Change (IPCC) is the primary scientific body to monitor and report on climate change. It was founded in 1988 by the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP). The information presented by the IPCC in its first Assessment Report (AR) was key in the UN Framework Convention on Climate Change (UNFCCC) in the early 1990s. The UNFCCC is the main intergovernmental treaty between UN members to address climate change. It is guided by a so-called ultimate objective to stabilize the greenhouse gas concentration. It defines what is understood as dangerous climate change. It addresses the question of responsibility, especially in the relationship between developed and developing countries. It defines specific commitments for its members and establishes clear processes.

UNFCCC Content	Description
Ultimate Objective	The ultimate objective is the “stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system“. This objective must be reached in a time frame that allows the eco-systems to adapt, ensures food production and enables economic development in a sustainable manner.
Dangerous climate change	Two ways to define dangerous climate change: Temperature-related: To stop global temperature from rising more than 2 degrees higher than pre-industrial levels. Concentration limit: CO_2 concentration should not reach above 550 ppm and be leveled at 450 ppm. This means that GHG emissions should peak around 2025 and go back down to 50% by 2050 compared to 1990 levels.

Responsibility	The UNFCCC requires that reduction targets be met by all countries (equity principle). Developed countries, as the historically major producers of GHG emissions, have a greater responsibility. It is accepted that developing countries have less restrictions on their emissions on the short term as they are still in a economic development phase. However political tension arises when discussing how much developing countries should commit to limiting their emissions (mainly emerging markets such as China and India) and how developed countries should support climate change mitigation and adaptation in the developing world financially and through technology transfer.
Commitments	Key commitments by the parties are: ▪ Set up a national inventory of greenhouse gas emissions and greenhouse gas sinks (e.g. forests, vegetation). ▪ Take measures to mitigate climate change by promoting sustainable management, technology transfer, and further activities. ▪ A non-binding commitment by a list of developed countries to stabilize greenhouse gas emissions at 1990 levels. ▪ To further review these stabilization commitments and set up a specific framework, such as the Kyoto Protocol. ▪ To provide funds to developing countries and also to take into consideration the adverse effects of climate change.
Processes	The UNFCCC establishes and organizes the Conference of the Parties (COP), establishes a secretariat and further specific working groups (e.g. subsidiary bodies to implement and to provide scientific advice), , and processes amendments and dispute-settlement provisions.

The United Nations Climate Change Convention (UNFCCC) members meet every year to analyze climate change and detail methods of addressing greenhouse gas emissions, using the scientific knowledge provided by the IPCC. The annual conference of these participating countries is known as the Conference of Parties (COP) and is the highest body of the UNFCCC which allows environment ministers who meet once a year to discuss the convention's developments. Notable outcomes have resulted from some of these conventions, most importantly the Kyoto Protocol, the Marrakech Accords, and the Bali Roadmap.

Term	Description	Definition

UNFCCC	UN Framework Convention on Climate Change	Over a decade ago, most countries joined an international treaty -- the United Nations Framework Convention on Climate Change (UNFCCC) -- to begin to consider what can be done to reduce global warming and to cope with whatever temperature increases are inevitable. More recently, a number of nations approved an addition to the treaty: the Kyoto Protocol, which has more powerful (and legally binding) measures. The UNFCCC secretariat supports all institutions involved in the climate change process, particularly the COP, the subsidiary bodies and their Bureau.
IPCC	Intergovernmental Panel on Climate Change	UN scientific body to analyze and report on the current state of knowledge on global climate change.
AR	Assessment Report	IPCC produces regular updates on the status and subject of climate change. There are currently four reports called assessment reports with the latest one (AR4) published in 2007.
COP	Conference of the Parties	Annual conference of UNFCCC parties (the governments of the participating countries). The first COP met in 1995. COP3 signed the Kyoto Protocol in 1997. COP7 further detailed the execution of the Kyoto Protocol in the Marrakech Accords in 2001. COP13 met in 2007 in Bali, and laid out the Bali Roadmap for the post-Kyoto time. COP 14 is taking place in Poznan, Poland in 2008 COP 15 is taking place in Copenhagen, Denmark in 2009 and aims to establish an ambitious global climate agreement for the period from 2012 (post Kyoto).
Kyoto Protocol	UNFCCC agreement at the COP3 conference in Kyoto, Japan, in 1997	Legally binding targets to reduce greenhouse gas emissions for a list of developed countries. Has been ratified by 178 countries plus the European Union by 2008.
Marrakech Accords	Kyoto Protocol extension agreement at the COP7 conference in Marrakech, Morocco, in 2001	Rulebook to further clarify the flexibility mechanisms in the Kyoto Protocol.
Bali Roadmap	Agreement reached at the COP13 conference in Bali, Indonesia, in 2007	Formalization of processes to make possible deeper cuts in global emissions to reach the UNFCCC ultimate objective as part of a post- 2012 roadmap.

Annex I and Annex II countries and Developing countries	Signatories to the UNFCCC are split into three groups: ▪ Annex I countries (industrialized countries) ▪ Annex II countries (developed countries which pay for costs of developing countries) ▪ Developing countries.

The Kyoto Protocol was set up at the third COP conference in Kyoto in 1997 and has been ratified by 182 parties (including all European Union members) as of May 2008.

Kyoto Protocol Content	**Description**
Legally binding targets	The Kyoto Protocol lists the so-called Annex I parties, representing the developed world. The ratifying Annex I parties have committed to achieve certain targets in GHG reduction based on 1990 levels in a timeframe between 2008 and 2012. This is a much more binding mechanism than the previous UNFCCC commitments were.
Means to achieve targets	Means are domestic measures and so-called flexibility mechanisms. Primarily domestic measures must be taken to reduce greenhouse gas emissions. Flexibility mechanisms should be used to supplement domestic ones. Flexibility mechanisms are ways to reduce greenhouse gas for developed (Annex 1) countries in another country where the same emission reduction amount can be achieved with lower costs. Businesses, environmental NGOs and other legal entities are allowed to participate in the mechanisms and are accounted for their government's reduction targets.
Flexibility Mechanisms	Clean Development Mechanism (CDM) is a project-based mechanism between Annex 1 and non-Annex 1 countries. Achieved emission reductions are accounted in CERs (Certified Emissions Reduction). The CDM Executive Board is the main governing institution. Joint Implementation (JI) is a project-based mechanism between Annex I parties. Achieved emission reductions are measured in ERUs (Emission Reduction Unit). The JI Supervisory Committee is the main governing institution. Emissions Trading enable trading of emission reductions between governments. A trading unit is called an Assigned Amount Unit (AAU). Removal or sink activities are treated in a special way. Corresponding reduction units are called Removal Units (RMUs).

Monitoring and Compliance	Monitoring must ensure that parties follow their reduction commitments and that reduction data reported is reliable. Parties must establish and maintain a national registry to track all flexibility related transactions (CER, ERU, AAU, and RMU). All national registries are compiled in a central International Transaction Log (ITL) that is maintained by the Kyoto secretariat. Further mechanisms ensure that parties do not oversell reductions and there is a penalty system for failing to meet targets.
Post 2012 Bali Roadmap	With the timeframe from 2008 to 2012 approaching an end, the UNFCCC has taken action to define goals past 2012. During the COP13 conference in Bali in 2007, a new plan was developed (Bali Roadmap). This roadmap encompasses following key measures: 1. Agreement that deeper cuts in emission reduction targets are necessary to achieve the UNFCCC ultimate objective. This should be achieved through mitigation, adaptation, technology transfer and financial investment. 2. For developed countries quantified emissions limitations and reductions must be set and timeframes to achieve this must be defined. Developed countries also include the USA in this context. 3. For developing countries, appropriate mitigation activities need to be implemented with some technology transfer and financing as enabling factors. 4. Merge the Bali Roadmap with a potential post-Kyoto track. 5. Technology transfer especially from developed to developing countries must be further defined in terms of what it is and how much of it is required to commit developing countries to reduction emission targets. Further aspects such as the nature of the adaptation fund, the role of deforestation in developing countries, and the understanding of what emissions peak and stabilization means in terms of scale and timeframe are critical.

It is essential to understand how international agreements can be turned into real action. The following elements are guidelines for setting up an emission reduction framework enabling hundreds of nations and thousands of companies and NGOs to participate.

Key elements of international climate change activity

Element	Rationale	Policy measures
Mitigation actions	Activities directed to reduce greenhouse gas emissions or to enhance greenhouse gas sinks.	Project mechanisms to take reduction emissions into account. Technology transfer for renewable energy technologies.

Adaptation actions	Activities are directed to minimize the effects of climate change e.g. reducing the vulnerability of natural and human systems against the negative effects of climate change.	▪ Adaptation finance mechanisms between developed and developing world. ▪ Know-how and technology transfer from developed to developing world.
Definition of Reduction Units	Greenhouse gas reduction units are required to measure and compare reduction targets between countries.	Define and certify reduction units (see "Flexibility mechanisms" above for details on acronyms): ▪ CER for CDM mechanism. ▪ ERU for JI mechanism. ▪ AAU for trading mechanism. ▪ RMU for sinks.
Trade and pricing of Units	▪ Establish a pricing mechanism for GHG emissions. ▪ Establish a trading mechanism for GHG trading, enabling purchase or sale of emission allowances.	▪ Private and national initiatives and exchanges for price finding. ▪ European Union Emission Trading Scheme. ▪ Further national schemes in UK, New Zealand, USA (California). ▪ Further private initiatives and offerings.
Validity of Units	▪ Establish a validity date for a reduction unit. ▪ Establish a reliable baseline to calculate the reductions.	▪ Kyoto Protocol – Framework to achieve reductions between 2008 and 2012. ▪ Baseline is emission levels from 1990. National inventory must be maintained and reported.

3 Climate Change and the Insurance Industry

The insurance industry offers risk management and risk transfer solutions. Climate change has direct impacts on the way insurance businesses will evolve. As mentioned in the previous sections, climate change impacts on risks, on vulnerabilities and on the frequency of natural catastrophe events cannot be understated. Global warming creates new risks such as heat waves in Europe, sea-level rise enhances vulnerabilities in the area of growing coastal cities, and natural catastrophe events are predicted to happen much more frequently with declining return periods. Many global mitigation activities to tackle climate change promote new RET which are critical parts of infrastructure and engineering projects.

Overall, the insurance industry requires a well-founded knowledge base to start underwriting new risks. The following is a short introduction to the main trends and consequences of climate change for the main lines of the insurance business.

3.1 Insurance Opportunities

Insurance companies must cope with the side effects of weather-related large-scale catastrophic events such as Hurricane Katrina. They require their own emergency management plan with regards to computer and information technology back-up facilities, service operations in the affected area, as well as access to public disaster management systems.

In times of large loss events, insurers must balance their attitude towards the affected insured clients, especially between generosity and cross-subsidy. ”Unsocial behaviour” is a key reputation risk, especially with regards to the corporate political and communication agenda.

Part of the global adaptation and emission reduction strategy is the transfer of clean technologies to the developing world. Once established, insurance services must follow. Insurers should be prepared to serve developing countries with adequate insurance protection.

Over the longer term, various new risks emerge such as social unrest after disasters, macroeconomic downturns, and less predictable impacts on the global markets.

3.2 Property Insurance

As seen in Section 2, climate change has a direct impact on the severity and frequency of extreme events. A series of concentrated events in one area or in a short time frame might disrupt solvency of regional and specialist insurance companies. It is even possible that some markets become uninsurable due to the uncertainties in quantifying an adequate premium, or because of too-high premium rises due to past loss experience.

Factors	Major underwriting / pricing challenges
Severity	Higher than historically assumed costs caused by extreme events.
Frequency	Higher than historically assumed rate of change of extreme events / shorter return periods.

With regards to risk and hazard assessment, shrinking return periods have key consequences on modeling projections. Historic patterns might not adequately capture the new scientific knowledge and underestimate the frequency. Pricing, however, must be tracked precisely in order to avoid public accusations such as scare mongering and unfair pricing.

The role and activity of regulators must be taken into account. The regulatory framework should make sure that risks are not ignored, and prices not undercut by political action.

Insurance companies should also actively market liberalization and cover new markets and new products. There must be some public/private partnerships when it comes to “uneconomic“ risks that are not underwritten by insurers. Insurers still can contribute in disaster relief activities with knowledge transfer and fee-based servicing.

On the long-term, the pricing of natural catastrophe risks should be in line with the long-term dimension of possible disasters. Insurance contracts are renewed on an yearly basis and regulatory profits and losses are accounted for in the same one-year timeframe. However this yearly perspective does not fully account for the long-term impact of catastrophic losses.

3.3 Casualty Insurance

As of today, cases of liability for climate-change-related damage caused by greenhouse gas emissions are not yet a reality. Climate change torts are still at a very early and unlikely stage, and it is currently only a theoretical exercise to assess the likely probabilities of success for tortuous actions. What can be expected, however, are claims due to abnormal climatic conditions. These can be situations such as disrupted transport, product failures, and professional negligence. Typically there might be specific insurance products, coupled with reinsurance coverage, to cover these possibilities.

Opportunities for the casualty insurance business can be found in so-called “green“ road vehicle products that produce fewer emissions during operation and manufacturing. The insurance industry can promote low emissions and low-mileage motor policies.

3.4 Life and Health Insurance

Climate change will trigger more catastrophic events. The 2003 heat wave in Europe caused several thousands of deaths, mainly among the elderly. Hurricane Katrina was responsible for 2000 casualties in the USA. On the other hand, warmer winters in cold countries could accelerate longevity. In general, incomes will be less disposable after catastrophic events.

On the opportunity side, health coverage due to exotic diseases might be more in demand, as the geographic range of insects and germs expands into new parts of the world. Also with the transfer of renewable technologies and growth in developing countries, new demands might arise. Life and pension insurers should also actively cover and promote climate change policies.

3.5 New Lines of Insurance

Insurance companies that offer coverage for things like business interruption, agriculture, engineering, construction, and event cancellation will face new risks but also new opportunities. Additional products such as weather derivatives and catastrophe bonds can be innovative offerings to hedge climate change related risks. Renewable energy technologies will need to be covered by engineering insurance. Kyoto-specific projects (like CDM) add new opportunities for underwriting. Carbon and other greenhouse gas ingredients might acquire a tradable value and must be covered in current policies. Emissions trading might involve insurance products for credit risks. Global energy technology exports give rise to trade risks but these must be seen in conjunction with political risks.

3.6 Insurance for Climate Change

The impacts on the insurance industry already have been measured. Studies by Swiss Re and Munich Re clearly show an increase in the occurrence of extreme events. Extreme heat waves, such as the European Heat Wave of 2003, which historically happened every 400 years, are now more common. According to global climate change predictions, by 2060 this type of event will occur every two years. Similarly in the UK, high summer temperatures that once used to occur every 100 years now happen every 14 years. This reduction in the length of time between extreme events, or return period, is an important concern to the insurance industry.

Key insurance terms related to climate change events	
	Description
Return period	The return period is also known as recurrence period. In insurance it is used for the calculation of natural catastrophe events such as earthquakes, floods, storms, etc. It is a statistical measurement denoting the average recurrence interval over an extended period of time, and is usually required for risk analysis (i.e. whether a project should be allowed to go forward in a zone of a certain risk). It is also used to analyze the stability of physical structures in order to verify their capability of withstanding an event of a certain return period (with its associated intensity). With regards to climate change, shorter return periods are expected for major weather-related events such as heat waves, floods, and storms.
Vulnerability	Vulnerability is the weakness of a human or physical system facing a hazard or a disaster or any other defined reason of concern. In the climate change debate the IPCC has laid out following reasons of concern: ▪ The relationship between global mean temperature increase and damage to or irreparable loss of unique and threatened systems. ▪ The relationship between global mean temperature increase and the distribution of impacts. ▪ The relationship between global mean temperature increase and global aggregate damages. ▪ The relationship between global mean temperature increase and the probability of extreme weather events. ▪ The relationship between global mean temperature increase and the probability of large-scale singular events such as the breakup of the West Antarctic Ice Sheet or the collapse of the North Atlantic thermohaline circulation. The relationship between impacts and temperature for each reason for concern is verified and conclusions are drawn about the potential severity and risk of impacts for the individual reasons for concern.

In the last years there have been two major events, the European Heat Wave of 2003, Hurricane Katrina in 2005, the severe draught in Africa that caused a major humanitarian crisis in 2006 and the unusually hard-hitting monsoon season in India, Nepal, Bangladesh and Pakistan in 2008. These natural disasters, caused by climate change, in the eyes of many leading scholars provide reliable insights and lessons highlighting the impact of climate catastrophes and the role that the Insurance industry can play to relieve populations, governments and aid and development agencies.

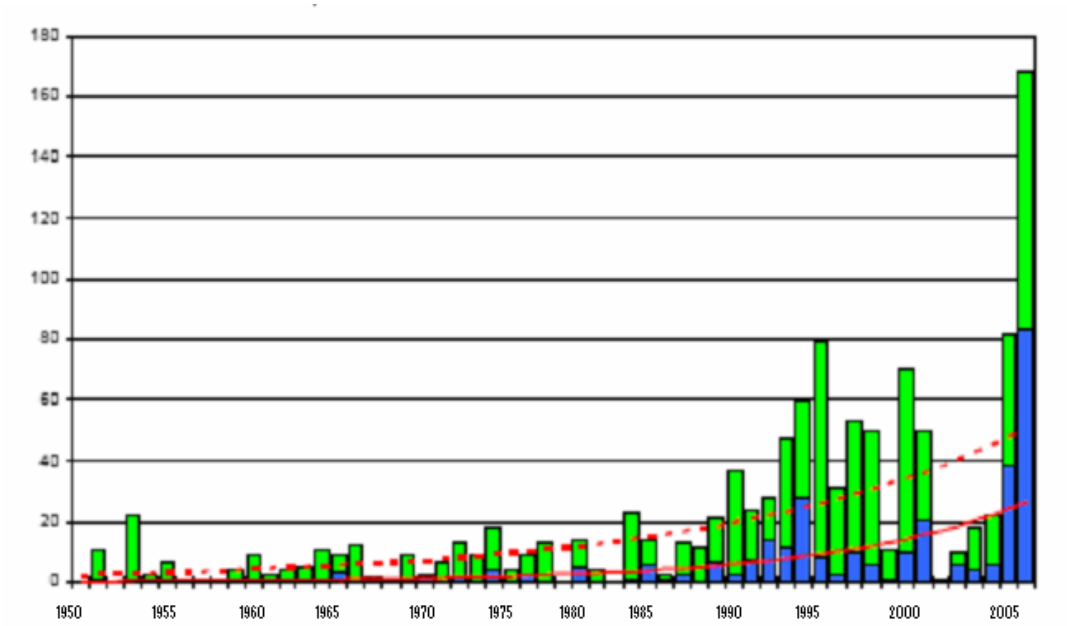
Examples of insurance industry involvement in climate change events

	Description
European Heat Wave of 2003	During the summer of 2003, severe heat waves occurred across Europe. Historically it was the hottest summer in at least 500 years. The probability that this will occur again in the next 40 years is increased by a magnitude of one hundred. Munich Re summarized the various negative impacts as being property damages (agriculture, forest fires), power-plant production issues due to too-warm water, reduced worker efficiency, shortfall in some retail businesses, and a revised death toll of over 70'000.
Hurricane Katrina August 2005	Hurricane Katrina gave a tragic example of how developed countries can be negatively affected by climate disasters. New Orleans was hit by a storm surge of up to 8.5 meters. Up to 80% of the city was flooded, with more than 50% of the properties under 1.2 meters of water. The city was compulsorily evacuated due to pollution from leaking sewage, chemical and oil facilities. Access to the city was only restored by the end of the year. For the insurance industry several key lessons regarding risk management can be applied: storm surge risk had been underestimated, zoning maps were not up-to-date, and vulnerability of certain high-exposure facilities should have been better analyzed. Also there are some insights with regards to risk transfer: absence of flood coverage in private policies created economic hardship and contingent business interruption coverage in case of economic losses for businesses that are only affected indirectly was too low for many.
Severe draught in East Africa, Year 2006	Three years of draught in East Africa have caused a major humanitarian crisis in 2006 in the region. Many scientists attribute the origin of this draught to climate change, as one effect of climate change is that it intensifies the climate trends (rainy countries will get more rain and dry countries will get more droughts). Experts with the World Food Program (WFP) and the World Bank (WB) have tried to identify a solution with the Insurance industry in order not to rely only on international aid to solve future draught disasters. Their plan was to create famine insurance for developing countries. In 2006, the WFP took out the "world's first insurance policy for humanitarian emergencies" to address the risk of draught in Ethiopia with the French reinsurance company Axa Re (now ParisRe). In return for the substantial premium of €772,000, which the WFP is financing with donations, Axe Re provided a maximum of €5.8 million in coverage should Ethiopian crops fail. The benefit would only be paid in the event of severe drought occurs.

Hard-hitting monsoon seasons in India, Nepal, Bangladesh and Pakistan in 2007 and 2008	By the end of year 2007, the cost of South Asia's worst flooding in decades has reached nearly one billion dollars. Losses in India's worst hit northeast amounted to over 900 million dollars, including damage to crops and property, while Bangladesh counted crop damage of at least 86 million dollars. The floods killed more than 2,400 people in India, Bangladesh and Nepal and displaced millions of others. These floods had a direct consequence on the prices of commodities worldwide that increased drastically following the floods. Though Asia is the most flood-affected continent in the world, flood insurance is still at its nascent stage in the region. Flood insurance can be adapted from the developed world to the Asian setting, but a "one-size-fits-all" approach is not appropriate due to the specific contexts of flooding. Insurance for flooding should be designed with country-specific conditions in mind, and tested for its feasibility.

Besides the two examples above, costs of key weather events have risen particularly strongly since the middle of the 1990's. Figures are based on analysis provided by Munich Re (blue pillars are insured values, green pillars are uninsured values):

Figure 3 – Growth of costs of weather disasters between 1950 and 2005 in USD billion[6]



The insurance sector has a very important role for the development of renewable energy projects. The availability and suitability of effective financial risk management instruments and structures in developing countries are key factors for the further development of renewable energy.

Modules 2 through 5 will further evaluate the key aspects of risk management, underwriting and claim handling requirements, and the role of intermediaries and networks. Finally Module 6 will examine lessons learned during a renewable wind energy project in China.

[6] Figures from Munich Re, derived from UNEP FI (2006) CEO Briefing: Adaptation and Vulnerability to Climate Change: The Role of the Finance Sector, p. 14.

Key Terms

Term	Definition
Adaptation actions	Activities are directed to minimize the effects of climate change e.g. reducing the vulnerability of natural and human systems against the negative effects of climate change. Two key mechanisms are adaptation finance mechanisms between developed and developing world, and know-how and technology transfer from developed to developing world.
Anthropogenic climate change	Human-induced, or anthropogenic, climate change is due to the fact that energy consumption and changes in land use produce large quantities of greenhouse gases.
Externality	A negative externality occurs when the costs of a good or service are not (fully) paid by those who produce the externality and that the cost to society is greater. Typical negative externalities are water pollution, road accidents causing third party casualties, over-fishing of oceans, moral hazard in insurance, greenhouse gas emissions. There are also positive externalities when the benefits of a good or service are not (fully) rendered to those who produce the externality. Typical positive externalities are beekeepers' activities, public parks in nearby cities, great views and landscapes, knowledge spin-over and innovations.
Flexibility Mechanisms	Clean Development Mechanism (CDM) is a project-based mechanism between Annex 1 and non-Annex 1 countries. Achieved emission reductions are accounted in CERs (Certified Emissions Reduction). The CDM Executive Board is the main governing institution. JI or Joint Implementation is a project-based mechanism between Annex I parties. Achieved emission reductions are measured in ERUs (Emission Reduction Unit). The JI Supervisory Committee is the main governing institution. Emissions' Trading enables trading of emission reductions between governments. A trading unit is called an Assigned Amount Unit (AAU). Removal or sink activities are treated in a special way. Corresponding reduction units are called RMUs or Removal Units.
Global warming	Global warming is the recent warming of the earth's lower atmosphere. It is believed to be the result of an enhanced greenhouse effect due to increased concentrations of greenhouse gases in the atmosphere. The increase of greenhouse gas concentrations is scientifically proven.
Greenhouse Effect	The greenhouse effect is due to the trapping of the solar rays in the atmosphere: 1. Solar radiation passes through the atmosphere and warms the surface of the earth. 2. Infrared radiation is given off the earth. 3. Most infrared radiation escapes to outer space, thus cooling the earth. 4. Some infrared radiation is trapped by greenhouse gases, thus reducing the cooling.

IPCC Reports	The IPCC (Intergovernmental Panel on Climate Change) publishes regular reports on the situation of climate change, called Assessment Reports (AR). These reports are generated with the help of working groups. Working groups focus on sub-topics such as scientific evidence, climate impacts and vulnerability, and mitigation.
Kyoto Protocol	UNFCCC agreement at the COP3 conference in Kyoto, Japan, in 1997 The Kyoto Protocol sets legally binding targets to reduce greenhouse gas emissions for a list of developed countries. Has been ratified by 178 countries plus the European Union by 2008.
Mitigation actions	Activities directed to reduce greenhouse gas emissions or to enhance greenhouse gas sinks. Two key mechanisms are project mechanisms to take reduction emissions into account, and technology transfer for renewable energy technologies.
Return period	The return period is also known as recurrence period. In insurance it is used for the calculation of natural catastrophe events such as earthquakes, floods, storms, etc. It is a statistical measurement denoting the average recurrence interval over an extended period of time, and is usually required for risk analysis (i.e. whether a project should be allowed to go forward in a zone of a certain risk). It is also used to analyze the stability of physical structures in order to verify their capability of withstanding an event of a certain return period (with its associated intensity). With regards to climate change, shorter return periods are expected for major weather-related events such as heat waves, floods, and storms.
Stern Report	The Stern report explains the main contributors to climate change based on the scientific evidence. It sets up an economic model to evaluate uncertain future costs of climate change and how to tackle the issues by investing a fraction of the GDP into mitigating activities. One of the key statements of the report is that a continuous investment of 1% of today's GDP is required in order to avoid the negative effects of climate change and to reduce the greenhouse gas emissions in a sustainable way. Negative effects are predicted as up to 20% of the future GDP.
Ultimate Objective	The ultimate objective is the "stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system". This objective must be reached in a time frame that allows the eco-systems to adapt, ensures food production and enables economic development in a sustainable manner.
Vulnerability	Vulnerability is the weakness of a human or physical system facing a hazard or a disaster or any other defined reason of concern. In the climate change debate the IPCC has laid out a list of various reasons related to the relationship between global mean temperature increase and impacts on extreme weather event probabilities, distribution, damages and large-scale singular events. The relationship between impacts and temperature for each reason for concern is verified and conclusions are drawn about the potential severity and risk of impacts for the individual reasons for concern.

Lesson Review

Section 1 – What is climate change?

Climate change occurs independently from human activities. Fluctuations in the solar radiation, meteoroid impacts, major volcanic eruptions and the earth's uneven orbit cause climate to change on a continuous basis. The natural greenhouse effect provides a climate where humans can live. The greenhouse gases in the atmosphere capture some of the radiation that would otherwise be released into space and make sure that the earth's average temperature remains around 14℃.

Since the mid-eighteenth century, anthropogenic activities have contributed to the growth of greenhouse gases in the atmosphere. The most important greenhouse gas in the context of human-induced climate change is CO_2. Higher concentrations of greenhouse gases accelerate the greenhouse effect and causes global warming. Since 1900 it is assumed that human activities have led to a global temperature increase of 0.7℃. In the same time period, the concentration of CO_2 in the atmosphere has risen from 280 ppm to 380 ppm.

Global warming measures and predictions are scientifically proven and consistently tracked. There are two key sources of evidence: the Stern Report, released by Sir Nicholas Stern on behalf of the British Government in 2006, and the Assessment Reports published by the UN's IPCC (Intergovernmental Panel for Climate Change). The reports predict that global temperatures will increase by 2 to 5℃ by 2050 and the concentration of CO_2 will continue to rise to over 550 ppm. These predictions are based on various factors such as economic and population growth, degree of globalization, and energy use. The Stern Report stipulates that there is a need to invest at least one percent of the GDP from now on to avoid a long-term decline of GDP by 20% due to the negative effects of climate change.

Section 2 – What is the impact of climate change?

Climate change negatively impacts the weather patterns due to the higher air and water temperatures. Major impacts are the melting of ice covers, rising sea levels, more storms, floods, droughts, heat waves, climate oscillations, and not yet defined climate discontinuities. With these temperature-related impacts, the vulnerability and exposure of sensitive regions and industries accelerate. Negative impacts are expected for coastal cities, clean water supplies, food and forest supplies, energy supply and demand, and tourism.

The insurance industry's calculations are based on the frequency and severity of events. With climate change, much lower return periods for catastrophic weather events such as heat waves and storms are predicted. Also it is assumed that exposure and vulnerability in certain areas and industries do have a strong impact on severity.

Section 3 – What is the policy in climate change?

Climate change is an externality with specific characteristics. It is global, it affects the current and future generations, there are high uncertainties with regards to risks and benefits, and there is the potential that changes will become non-reversible. No single actor is able to mitigate the negative effects of climate change. Therefore, globally coordinated action is necessary. The UN has created the Intergovernmental Panel for Climate Change (IPCC) and has set up key treaties to mitigate the negative consequences of climate change. Most notable are the UNFCCC (UN Framework Convention on Climate Change) and the Kyoto Protocol.

The UNFCCC is a global treaty that lays the foundation of why climate change must be tackled and what the future goals are. It has the ultimate objective of "stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system". It is the main framework that sets the fundamentals for further agreements such as the Kyoto Protocol.

The Kyoto Protocol sets binding reduction targets for developed countries with regards to greenhouse gas emissions, and is valid for the time period between 2008 and 2012. To achieve this, the Protocol defines two sets of measures: domestic reduction of greenhouse gas emissions, and mechanisms to reduce emissions abroad, the so-called flexibility mechanisms. There are four flexibility mechanisms in place: Clean Development Mechanism (CDM), Joint Implementation (JI), Emission Trading, and Sink/Removal projects.

Policy action is directed towards mitigation (such as activities directed to reduce greenhouse gas emissions or to enhance greenhouse gas sinks), and adaptation (such as activities directed to minimize the effects of climate change by reducing the vulnerability of natural and human systems against the negative effects of climate change). It is accompanied by trading mechanisms to buy or sell emission allowances under emission regimes. The most prominent trading schemes are the European Union Emission Trading Scheme as well as national programs in the UK, New Zealand and in the USA (California).

Section 4– What is the business implication?

Insurance companies offer risk management and risk transfer solutions. With regards to the effects of climate change, insurance companies are faced with new and growing risks, as well as opportunities. Global warming creates new risks such as heat waves in Europe, sea-level rise, enhanced vulnerabilities in coastal cities, and more frequent natural catastrophe events. In addition, many global mitigation activities to tackle climate change promote new renewable energy technologies that are critical parts of infrastructure and engineering projects. Shrinking return periods and growing vulnerable exposure are key challenges for adequate pricing and policy definition for insurance companies. Climate change primarily affects property insurance, however casualty, life, health and other specific lines of insurance are affected. Striking examples that provide a wealth of insurance-related information are the European Heat Wave of 2003 and Hurricane Katrina in 2005.

Renewable energy technologies will need to be covered by engineering insurance. Projects under the scope of the Kyoto Protocol such as CDM, JI, Emissions Certificates and trading, add new opportunities for underwriting.

Further Readings and Related Links

Reading

UN Publications

UNEP DTIE	http://www.unep.fr
UNEP FI	http://www.unepfi.org

CEO Briefing: Adaptation and Vulnerability to Climate Change: The Role of the Finance Sector. Climate Change Working Group, 2006.

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Insuring for Sustainability: Why and How Leaders are doing it, Insurance Working Group, UNEP Finance Initiative (UNEP FI), 2007.

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Energy and Climate Change, Facts and Trends to 2050, World Business Council for Sustainable Development, 2004.	http://www.wbcsd.com
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Working Group I Report – Physical Science Basis	
Working Group 2 Report – Impacts, Adaptation and Vulnerability Working Group 3 Report – Mitigation of Climate Change	
International Energy Agency (IEA), Implications of climate change for energy industries, especially World Energy Outlook series.	http://www.iea.org

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Reducing Greenhouse Gas Emissions – Addressing the New Business Imperative, Rueschlikon Centre for Global Dialogue, 2003.	http://www.swissre.com
Survey of Insurance Availability for Renewable Energy Projects, Marsh Marine and Energy Practice, together with UNEP, 2006.	http://www.marsh.com

Test

Question 1

Climate change can be measured. What are the two key measures used today?	
Answers:	
Concentration of GHG gases, Thermal radiation into space.	☐ Check if Correct
Concentration of GHG gases, Solar radiation absorbed by earth.	☐ Check if Correct
Average Temperature on Earth, Concentration of GHG gases.	☑ Check if Correct
Average Temperature on Earth, Solar radiation absorbed by earth.	☐ Check if Correct

Question 2

What are the six greenhouse gases relevant in the context of global GHG policy?	
Answers:	
CO2, CO, CH4, PFC, HFCs, SF6.	☐ Check if Correct
CO2, CH4, N2O, PFC, HFCs, SF6.	☑ Check if Correct
CO2, SO2, N20, PFC, HFCs, SF6.	☐ Check if Correct
CO2, CH4, SO2, PFC, HFCs, SF6.	☐ Check if Correct

Question 3

What is meant with “GCM”?	
Answers:	
A computer based algorithm to calculate the probability and severity of climate change related catastrophic events on a global scale.	☐ Check if Correct
A weather forecasting model delivering results in terms of changes in the weathers systems and rising sea levels.	☑ Check if Correct
GCM are Greenhouse Control Mechanisms and are used to measure the local greenhouse gas emissions of a plant.	☐ Check if Correct
An economic model to measure the financial impact of climate change in terms of IRR and default rate.	☐ Check if Correct

Question 4

Which observed climate and geo-specific impacts are primarily caused by global warming?

Answers:

Sea level rise, river floods, heat waves.	☐ Check if Correct
Heat waves, storms, ice cover loss.	☐ Check if Correct
River floods, draughts, ice cover loss.	☐ Check if Correct
River floods, draughts, heat waves.	☑ Check if Correct

Question 5

What is the “ultimate objective” according to the UNFCCC?

Answers:

The stabilization of greenhouse gas variations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system.	☐ Check if Correct
The stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system.	☑ Check if Correct
The stabilization of greenhouse gas concentrations in the stratosphere at a level that would prevent dangerous anthropogenic interference with the climate system.	☐ Check if Correct
The reduction of greenhouse gas variations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system.	☐ Check if Correct