English through Climate Change

Editors

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Preface

Climate change is a matter of great concern to society as a whole and one of the most important challenges of modern times. Due to its scope and importance, it is important to foster a greater understanding of what climate change is and what it means to people, as well as its impacts on the environment and ecosystems.

Along with the need to address global challenge, this book contains texts written by a set of specialists. It may not only be used as a tool towards greater understanding of different variables associated with climate change, but it is also suitable for teaching the English language. The rationale behind this book is simple, yet effective: by providing texts carefully prepared for an international audience consisting of people whose first language is not English, this book opens greater possibilities for a broader understanding of this subject matter, in a way never seen before.

This book has three main aims:

1. to provide examples with basic texts on climate change, thus providing an introduction to this important topic;
2. to show how language skills may be developed parallel to the study of climate change, and
3. to provide university students with exercises which will allow them to practice the skills needed in order to be able to read and explore similar or more difficult texts.

This book has been prepared under the assumption that students have on the one hand basic knowledge of the English grammar and syntax, and that they have sufficient knowledge of the vocabulary of everyday use on the other. We also assume that most of the students are beginners in the study of climate change texts and need or have to familiarize themselves with basic climate change terminology. Keeping the above concerns in mind the book may be suitable for:

- Students of environmental science departments in which English is not the official medium of instruction. For such students successfully completing courses of English terminology in environmental science and particularly English terminology in climate change may be of paramount importance for their careers since English is a truly international language and hence most scientific literature in the field is in English.
- University graduates of a variety of scientific disciplines who wish to pursue post-graduate degrees in environmental subjects and particularly climate change. For such people this book may be useful in showing to them how climate change texts are written and in preparing them for working on similar or more difficult texts.
- Students who just wish to learn the English language. Such students are taught all sorts of subjects with environmental subjects and particularly climate change being increasingly one of them. As such, this book may be useful to the teacher of English Language Schools since he will be able to choose a chapter or chapters from the book to cover his teaching needs for a week or two during a semester or even an academic year in his or her school.

The pattern followed in each chapter of the book is the following: First a text of three to six pages is provided. The climate change terms or other related environmental science terms in each chapter are given in italics in order to draw the attention of the reader. Then these terms are defined in the vocabulary notes section of each chapter. Many terms are repeated and defined more than once in the book's chapters but this should not be taken as a weakness but as strength since it helps in the consolidation of important terminology. Then each chapter contains exercises on consolidating the material of the chapter both with regard to climate change and with regard to grammar and syntax. Every chapter ends with a references section so that the reader can pursue the subject further if he or she so wishes.

Finally, we wish to thank all the authors who have provided chapters in this book for their time and effort. Their cooperation was crucial in preparing this book for publication.

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The Challenge of Climate Change

Walter Leal Filho and Evangelos Manolas

Abstract

Climate change is among the greatest challenges of modern times. Today, there is very strong scientific evidence of human interventions which have been leading to long-term changes in the world's climate. Since there is a need to explain this process in some detail, this chapter first of all discusses the causes of climate change, its real or potential impacts and the solutions needed in order to deal with climate impacts already occurring as well as prevent even more damaging climate change in the next forty or fifty years. Secondly, the chapter provides a glossary with some of the most important terms used in the text presented in the first part. The third part provides different exercises aiming either to further consolidate student understanding of these terms or / and strengthen student grammatical and syntactical skills.

Due to its scope, magnitude and impact in the livelihood of millions of people, climate change can be considered to be one of the greatest challenges of modern times. According to the Intergovernmental Panel on Climate Change (IPCC), global mean temperatures have risen approximately 0.76° C since the mid-1800s (IPCC, 2007).

The last decade has been the warmest ever recorded instrumentally (0.42° C above the 1961-1990 baseline), followed by the previous two decades (0.18 and 0.05° C respectively). On the other hand, the last 100 years were the warmest of the millennium. This warming cannot be explained by natural causes alone. There is at present very strong scientific evidence of human interventions which have been leading to long-term changes in the world's climate. Climate change should not be confused with climate variation, which refers to short-terms fluctuations in climate conditions.

The Causes

The scientific community now accepts that global warming is caused by the increased concentration of *greenhouse gases* in the atmosphere, mainly carbon dioxide, methane and nitrous oxide. Approximately 70% of the increase in carbon dioxide is caused by the use of fossil fuels for energy purposes while 30% is related to other causes including *deforestation*, agricultural practices and cement production. Since the mid-1800s, the concentration of carbon dioxide in the atmosphere has gone up to 370 parts per million (ppm). Historically, this type of variation has only ever happened over a period of millions of years.

So, how can we explain global warming? The sun sends energy to the Earth in the form of solar radiation. The Earth's energy balance is dependent on the ratio between this incoming energy and the energy re-emitted. This ratio is influenced by the composition of the atmosphere, in the phenomenon known as the *greenhouse effect*, which makes possible the maintenance of an average temperature of around 15%. Without the atmosphere, the average temperature on the planet would be approximately -18° C. Since the 1850s, the increasing concentration of greenhouse gases in the atmosphere, mainly carbon dioxide, has changed the Earth's energy balance, causing anomalous warming (Maracchi, Genesio and Vaccari, 2006; Perlmutter and Rothstein, 2011, Botkin and Keller, 2003).

The history of Earth includes several notable changes in climate conditions, but the alarming aspect of the present shift is its speed and consistency. What is more, this appears to be much beyond the adaptation capacity of ecosystems. The point is not whether the Earth's climate will change but rather how much and how fast.

The Impacts

The IPCC (2007) has summarized many real or projected impacts of climate change and highlighted "key vulnerabilities". These include rising sea levels, extreme weather events, ocean acidity and biodiversity loss.

Rising sea levels

IPCC data show that over the last 100 years, the global sea level has risen by about 12 to 22cm. In the period from 1961 to 2003, the global average sea level rose by 1.8mm per year with the fastest rate being observed between 1993 and 2003 of 3.1mm per year. The 1993-2003 rate is made up of the following contributions: thermal expansion of the ocean contributed

1.6mm per year (~50%); Antarctic ice sheet 0.21mm (~7%); Greenland *ice sheet* 0.21mm (~7%); and *glaciers* and other *ice caps* 0.77mm per year (~25%); with around 0.3mm per year unaccounted for (Maslin, 2009). The IPCC 2007 report estimated that sea levels will increase by 0.18m to 0.59m by 2100. Although a few centimeters may not seem important, nevertheless, they are capable of generating some alarming scenarios: flooding of coastal areas, contamination of ground water, an increase in the saltiness of estuary waters. The rise will not be the same everywhere, due to the unevenness of the seabed, the impact of gravity on the oceans and the tectonic movements which push some areas of the Earth's crust up and others down (Boyd and Tompkins, 2010).

Extreme weather events

Climate change has also been linked with the increase in frequency and intensity of extreme weather events. Hurricane Katrina in the US is responsible for the death of at least 1200 people; Hurricane Mitch, in 1998, caused the death of more than 10000 people in Central America, while in 1970 one storm alone killed 300000 people in Bangladesh (Emanuel, 2008). In England in 2000, floods classified as 'once-in-30-years events', occurred twice in the same month. In addition, the winter of 2000/1 in Britain was the wettest six months since records began in the 18th century. August in 2008 was the wettest month ever recorded. The *floods* and *landslides* in October 2000 in Switzerland, France and Italy are responsible for almost € 6 billion worth of damage, the floods in summer 2002 cost over € 14 billion. The 2003 heat wave in Europe killed approximately 50000 people, 15000 in France alone – a 50% increase in the mortality rate (Maracchi, Genesio and Vaccari, 2006).

Ocean acidity

The increased concentration of carbon dioxide in the atmosphere can also affect the composition of the oceans. More dissolved carbon dioxide makes them more acidic. The oceans are mostly alkaline, helping organisms such as *corals* and *algae* to extract calcium from seawater and deposit it as solid calcium carbonate rock. More acidic water will probably dissolve these carbonate sediments critically affecting coral reefs which are a valuable resource for fisheries, recreation, tourism and coastal protection. Moreover, reefs are one of the largest global stores of marine biodiversity. The declines in the health of coral reefs in the last few years have been without precedent. In 1998, *El Nino* was associated with record sea-surface temperatures and associated coral bleaching, which is when the coral expels the algae which live within it and which are necessary to its survival. In some regions, even

70% of the corals may have died in a single season. There has also been a sudden large increase in the variety, incidence, and virulence of coral disease in recent years, with major die-offs in Florida and much of the Caribbean region (Maslin, 2009; Boyd and Tompkins, 2010).

Biodiversity loss

As far as *biodiversity* is concerned, climate change has potentially irreversible effects on plant and animal *habitats* and *life cycles*, forcing some species poleward or up mountain slopes, and hastening the arrival of certain biological events each spring. Depending on the severity of its impacts and the rates of response among different individual *species*, climate change could damage the natural functioning of existing plant and animal communities, making *extinctions* much more probable. For example, over the past several decades, warming has caused the early arrival of some birds which migrate in the spring. If those arrivals are no longer in sync with the emergence of the required vegetation for nesting or hatching of bugs, which are prey for these birds, then the interlocked life cycles of these co-dependent species can be disrupted (Mastrandrea and Schneider, 2010).

The Solutions

Extensive and sustained global action is necessary in order to do both: to deal with climate impacts already occurring and to prevent even more damaging climate change in the next forty or fifty years. The international goal is to reduce greenhouse gas *emissions* and eventually bring those emissions significantly below current levels. Efforts to achieve this goal are called mitigation. Mitigation is different from adaptation, which involves acting to address the impacts of climate change on people, ecosystems and communities. Most often, climate change mitigation efforts are about reductions in the concentrations of greenhouse gases, either by reducing their *sources* or by increasing their *sinks.*

The IPCC defines *mitigation* as "an anthropogenic intervention to reduce the sources or enhance the sinks of greenhouse gases". Examples include using fossil fuels more efficiently for industrial purposes or electricity generation, switching to *renewable energy*, e.g. *solar energy* or *wind power*, improving the insulation of buildings, and expanding forests and other sinks to remove more carbon dioxide from the atmosphere (Glossary of climate change acronyms, 2012).

According to the IPCC, *adaptation* is the "adjustment in natural or human systems in response to actual or expected stimuli or their effects, which

moderates harm or explores beneficial opportunities". An example of an adaptation strategy is shore protection, e.g. *dikes, bulkheads,* which can prevent sea level rise from covering low-lying coastal property with large amounts of water, eroding beaches, or make flooding worse. An alternative adaptation measure would be a planned retreat, which means relocating structures inland as shores retreat. In unmanaged natural systems, adaptation is not planned but takes place when forced to do so. For example, as the climate gets warmer, tree and animal species may migrate northward to remain in suitable climatic conditions and habitats (to the extent that human barriers, such as roads and cities, make such migration possible) (Adaptation, 2011).

As Mastrandrea and Schneider (2010) point out, an important tool for the development of climate change policies, particularly adaptation strategies, is *vulnerability* assessment. Vulnerability is often defined with reference to three components: exposure, sensitivity, and adaptive capacity. *Exposure* is about how much a system experiences stress and the nature of such stresses: the frequency and intensity of heat waves in a particular area, the level of the sea. *Sensitivity* refers to the extent to which a system is affected or modified by that exposure, and varies across different regions, populations, and sectors: the elderly are more vulnerable to the negative consequences of heat waves; flat coastlines are more vulnerable to rising sea water than are steep ones. *Adaptive capacity* is defined as the ability of a system to adjust to change, in terms of expanding the range of impacts with which it can cope, reducing its sensitivity to the changes, or both.

Mitigation reduces vulnerability by reducing exposure, while adaptation reduces vulnerability by converting adaptive potential into adaptive capacity, thus reducing sensitivity. The distinction between adaptive potential and adaptive capacity is important. We are aware of the fact that the vulnerability of New Orleans to a direct hit by a Category III hurricane was much higher than was generally believed before Katrina (although there were warnings of this result for decades but these were not taken into account). Adaptive potential was quite high – e.g., levees could have been strengthened in advance – but this potential was not realized, and as a result adaptive capacity was low. Generally, adaptive capacity is linked with the level of development of a country. But events such as Katrina, which mostly affected poor people and the 2003 heat wave in Europe, which mainly affected the elderly, clearly illustrate the vulnerability of specific populations and regions, even within developed countries.

Conclusion

The scientific community now accepts that global warming is intimately associated with the increased concentration of *greenhouse gases* in the at-

mosphere, mainly carbon dioxide, methane and nitrous oxide. The point is not whether the Earth's climate will change but rather how much and how fast. Real or projected impacts of climate change include rising sea levels, extreme weather events, ocean acidity and biodiversity loss, among others. There is a need to reduce greenhouse gas *emissions* and efforts to achieve this goal are called mitigation. Mitigation is different from adaptation, which involves acting to tolerate the effects of climate change. An important tool for the development of climate change policies is *vulnerability* assessment. Vulnerability is often defined in terms of three components: exposure, sensitivity, and adaptive capacity. Mitigation reduces vulnerability by reducing exposure, while adaptation reduces vulnerability by converting adaptive potential into adaptive capacity, thus reducing sensitivity.

Vocabulary Notes

Greenhouse gases: The suite of gases which have a greenhouse effect, such as carbon dioxide, methane and nitrous oxide.

Greenhouse effect: Process of trapping heat in the atmosphere. Carbon dioxide, methane and several other gases warm the Earth's atmosphere because they absorb and remit radiation; that is, they trap some of the heat radiating from the Earth's atmospheric system.

Deforestation: Harvesting trees for commercial and other uses and burning forest to convert lands to agricultural purposes.

Ice sheet: A layer of ice which covers a large area of land for a long period of time.

Glacier: A large body of ice moving slowly down a slope or valley or spreading outward on a land surface.

Ice cap: A layer of ice permanently covering parts of the Earth, especially around the North and South Poles.

Flood: A large amount of water covering an area which is usually dry.

Landslide: A mass of earth, rock, etc. which falls down the slope of a mountain or cliff.

Coral: A hard substance which is red, pink or white in color, and which forms on the bottom of the sea from the bones of very small creatures.

Algae: Very simple plants with no real leaves, stems or roots which grow in or near water, including seaweed.

El Nino: Natural perturbation of the physical earth system that affects global climate. Characterized by development of warm oceanic waters in the eastern part of the tropical Pacific Ocean, a weakening or reversal of the trade winds, and a weakening or even reversal of the equatorial ocean currents. Reoccurs periodically and affects the atmosphere and global temperature by pumping heat into the atmosphere.

Biodiversity: The existence of a large number of different kinds of animals and plants which make a balanced environment.

Habitat: Where an individual, population, or species exists or can exist.

Life cycle: The series of forms into which an organism changes as it develops.

Species: A group of organisms which can interbreed and produce offspring capable of reproduction.

Extinction: Disappearance of a life-form form existence; usually applied to a species.

Emission: The production or sending out of light, heat, gas, etc.

Adaptation: Adjustment in natural or human systems in response to actual or expected stimuli or their effects, which moderates harm or explores beneficial opportunities.

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

Renewable energy: Alternative energy sources which can be regenerated continuously by natural processes.

Solar energy: Collecting and using energy from the sun directly.

Wind power: Using the wind to produce energy.

Source: A process or activity by which carbon dioxide (or other greenhouse gases) is released into the atmosphere, such as driving a car which runs on petrol or burning coal to produce electricity in a power station.

Sink: A reservoir which absorbs carbon dioxide from another part of a natural cycle, e.g. a rainforest.

Dike: 1. An artificial watercourse, 2. A wall or fence of turf or stone, a bank usually of earth constructed to control or confine water.

Bulkhead: 1. An upright partition separating compartments, 2. A structure or partition to resist pressure or shut off, 3. A retaining wall along a

waterfront, 4. A projecting framework with a sloping door giving aces to a cellar stairway or a shaft.

Vulnerability: The extent to which climate change may damage or harm a system.

Exposure: How much a system experiences stress and the nature of such stresses: the frequency and intensity of heat waves in a particular area, the level of the sea.

Sensitivity: The extent to which a system is affected or modified by that exposure, and varies across different regions, populations, and sectors: the elderly are more vulnerable to the negative consequences of heat waves; flat coastlines are more vulnerable to rising seas than are steep ones.

Adaptive capacity: the ability of a system to adjust to change, in terms of expanding the range of impacts with which it can cope, reducing its sensitivity to the changes or both.

Levee: 1. An embankment for preventing flooding, 2. A river landing place, 3. A continuous dike or ridge (as of earth) for confining the irrigation areas of land to be flooded.

Answer the following questions:

1. What is causing the increase of carbon dioxide in the atmosphere?
2. How can we explain global warming?
3. What would be the effects of rising sea levels?
4. How can the increased concentration of carbon dioxide in the atmosphere affect the composition of the oceans?
5. How can climate change affect biodiversity?
6. What is mitigation?
7. What is adaptation?
8. What specific examples of mitigation and adaptation strategies, other than those discussed in the text, can you think of?
9. Define the terms exposure, sensitivity and adaptive capacity as components of vulnerability.

10. What specific examples of exposure, sensitivity and adaptive capacity, other than those discussed in the text, can you think of?

EXERCISES

A. *Match the words or phrases of Column A with the words of Column B.*

1. greenhouse	a. bleaching
2. carbon	b. loss
3. activity to tolerate the effects of climate change	c. effect
4. key	d. dioxide
5. biodiversity	e. adaptation
6. reducing the sources or enhancing the sinks of greenhouse gases	f. capacity
7. coral	g. vulnerabilities
8. adaptive	h. mitigation

B. *Find if the following are True or False.*

1. Global warming is caused by the increased concentration of greenhouse gases in the atmosphere
2. Approximately 70% of the increase in carbon dioxide is caused by the use of fossil fuels for energy purposes.
3. Without the atmosphere, the average temperature on the planet would be approximately -18° C.
4. According to the IPCC, sea levels will increase by 0.18m to 0.59m by 2100.
5. The increase in frequency and intensity of extreme weather events is not an important sign of the increasing greenhouse effect.
6. The declines in the health of coral reefs in the last few years have been without precedent.

7. Over the past several decades, warming has caused the early arrival of some birds which migrate in the spring.
8. A planned retreat, which means relocating structures inland as shores retreat, is an example of a mitigation strategy.
9. Adaptive capacity is about how much a system experiences stress and the nature of such stresses.
10. Mitigation reduces vulnerability by reducing exposure, while adaptation reduces vulnerability by converting adaptive potential into adaptive capacity, thus reducing sensitivity.

C. *Complete the following chart:*

Verb	**Noun**	**Adjective**
accept	_____	_____
_____	variation	_____
explain	_____	_____
depend	_____	_____
_____	contamination	_____
_____	intensity	_____
_____	_____	classified
_____	adaptation	_____
_____	_____	modified

D. *Fill the blanks with a suitable word.*

Extensive and sustained global _____ is necessary in order to deal with climate impacts already occurring and to prevent even more damaging climate change in the next forty or fifty years. The aim is to reduce greenhouse gas _____ and eventually bring those emissions significantly below current _____. Efforts to achieve this goal are called _____. Mitigation is different from _____, which involves acting to tolerate the effects of climate change. Most often, climate change mitigation efforts are about _____ in the concentrations of greenhouse gases, either by reducing their _____ or by increasing their _____.

E. *Put the verbs in parenthesis into their correct form.*

1. Global mean temperatures (rise) _____ approximately 0.76° C since the mid-1800s.
2. Around 70% of the increase in carbon dioxide (cause) _____ by the use of fossil fuels for energy purposes.
3. Since the 1850s, the increasing concentration of greenhouse gases in the atmosphere, and in particular carbon dioxide, (change) _____ the Earth's energy balance, (cause) _____ anomalous warming.
4. In the period from 1961 to 2003 the global average sea level (rise) _____ by 1.8mm per year, with the fastest rate (observe) _____ between 1993 and 2003 of 3.1mm per year.
5. In England in 2000, floods (classify) _____ as 'once-in-30-years events' (occur) _____ twice in the same month.
6. The declines in the health of coral reefs in the last few years (be) _____ without precedent.
7. Efforts to achieve this goal (call) _____ mitigation.
8. The IPCC defines mitigation as "an anthropogenic intervention (reduce) _____ the sources or (enhance) _____ the sinks of greenhouse gases".
9. Vulnerability often (define) _____ with reference to three components: exposure, sensitivity, and adaptive capacity.
10. Generally, adaptive capacity (link) _____ with the level of development of a country.

F. *Finish the following sentences:*

1. Global warming is caused by the increased concentration of
2. Approximately 70% of the increase in carbon dioxide is caused by
3. Without the atmosphere, the average temperature on the planet
4. Reefs are one of the largest global stores of
5. Adaptation involves acting to
6. Mitigation is an anthropogenic intervention to

7. Forests and other sinks help to remove greater amounts of

8. Exposure is about how much a system

9. Sensitivity refers to the extent to which a system

10. Adaptive capacity is defined as the ability of a system to

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Psychology and Climate Change

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Abstract

Essentially, the climate change discussion assumes that people will behave in the desired way if we only inform them about climate change and use economic tools to guide their behaviour. This perspective leads to increasing the cost of unwanted behaviour (or reducing the cost of wanted behaviour) or informing people about climate change and possible scenarios. Psychology has a broader perspective on what influences people's behaviour in relation to climate change. Understanding people's behaviour seems important for successfully dealing with future challenges such as voting, support for climate lobbyists, individual consumption, taking new technology into use, and taking actions to adapt to climate change effects. This chapter shows how several psychological processes relate to people's climate-related behaviour. These processes are (1) experiencing climate change, (2) developing an understanding of climate change, (3) building up knowledge about climate change, (4) reacting emotionally to climate change, (5) perceiving risks related to climate change, (6) making behavioural decisions, and (7) evaluating behavioural outcomes. The chapter also explains why people think the *risk* of climate change is rather low and offers some ideas for climate policy.

Different psychological processes are related to climate change. People's reactions to climate change start with single or multiple experiences of a changing climate in their everyday lives. These experiences can be either direct—for example, personally witnessing extreme weather events or changes in the local flora and fauna—or mediated by media or conversations with other people. Both kinds of experiences can lead to *emotional responses* as well as *cognitive processes*. Often, people's reaction to climate change depends on whether they understand the processes by which climate change is caused. Over time, individual knowledge about climate change builds up.

People form *mental models* of causes and effects and make assumptions about effective behaviour which are usually simplified and somewhat incorrect, even if the person is an expert in climate change.

Both emotional reactions and knowledge start an evaluation of the risk to be affected by climate change. Ultimately, risk evaluation, emotional responses, and other factors lead to a motivation in order to to personally contribute to *mitigation* of climate change, to personally take *adaptive action*, or under certain conditions to *deny* climate change or become resigned to it. People evaluate the outcomes of their behaviour and this evaluation changes how they decide the next time they have to make a decision.

Understanding climate change – human difficulties with complexity

The world's climate is so complex that it challenges the human mind. An uncountable number of variables influence each other. The causes and effects are often separated both geographically and temporally. Most processes are slow, indirect and have long delays, while others show stability for a very long time and then suddenly destabilize (for example, the melting of the summer ice cap on the North Pole). Most of the mechanisms are still not fully described scientifically. Because some systems are too complex for the human mind to comprehend, humans cannot predict how those systems will behave over time. If a system involves a large number of variables that interact, if *feedback loops* lead to unpredictable processes in the system, or if relations between variables are not linear, then human strategies for understanding those systems fail (Forrester, 1971). As people cannot fully understand the climate system, communication about the changing climate should much more actively provide clear *analogies* or *metaphors* (Sterman and Booth Sweeney, 2002). A good example is the ozone hole problem where scientists used easy to understand metaphors from the very beginning. This made the public understand the problem much better than climate change.

Forming individual knowledge

Studies demonstrate that people consistently tend to confuse "climate change" with "*ozone layer depletion*" and local *weather* phenomena with *climate* (Bostrom, Morgan, Fischhoff and Read, 1994). People construct their knowledge about something like climate change by integrating new information into their already existing *knowledge structures*. When climate change began to make headlines, ozone layer depletion had already success-

fully been communicated and most people had knowledge structures for that phenomenon. People form what is referred to as a mental model - a simplified system of assumptions about how the different aspects of climate change work together (Böhm and Pfister, 2001). Therefore, analysing what people know about climate change and how they conceptualize climate change is highly important.

Emotional responses to climate change and their role in motivating behaviour

The aspect of emotional responses to events and their importance for motivating people's behaviour is well researched in psychology. Some studies directly link climate change, emotional responses, and people's behaviour. In one study, researchers induced fear by showing a short emotional video about climate change (Meijnders, Midden and Wilke, 2001). The participants in that experiment processed information about energy saving more deeply and developed a more positive attitude to energy saving than participants who were shown a neutral video providing the same information. Fear, therefore, seems to motivate the search for information about what to do. In another study, the investigators found that children, who experience a feeling of guilt when confronted with the discussion about climate change, have a higher motivation to engage in everyday pro-climate behaviour than children who react with fear or denial (Klöckner, Beisenkamp and Hallmann, 2010).

Compared to cognitive judgements about climate change, emotional judgements are less strong. Women, however, had stronger worries about climate change than men, and worry about the changing climate was greater when people knew more about causes and consequences of climate change (Sundblad, Biel and Gärling, 2007). Researchers analysed what images laypeople in the US and the UK associate with climate change and what their affective reaction to those images was and found astonishing differences beween the two countries (Leiserowitz, de Franca Doria, Poortinga and Pidgeon, 2006). For people in the US, ice melting, heat, impacts on non-human systems, and ozone were the most important images, while for people in the UK the responses referred to changes in weather, global warming, ozone, and changing climate. Most people react either weakly or with emotions that do not lead to individual changes in behaviour. This reaction might stem from the way people perceive individual risk related to climate change and the fact that most experiences of climate change are indirect.

The perception of individual risk related to climate change

An interesting question is why laypeople estimate climate change-related risks to be relatively low in spite of scientists' alarming findings. A bundle of psychological explanations based on risk research might account for that perception (Fischhoff, Slovic, Lichtenstein, Read and Combs, 1978; Leiserowitz, 2006). (1) People tend to show an *optimistic bias*, usually downsizing personal risks compared to risks for others. (2) The visible signs of climate change are ordinary natural phenomena (melting ice, storms, heavy rain falls, droughts, flooding, etc.), people are familiar with. (3) Although climate change has clearly the potential for dreadful outcomes, who might suffer from climate change, and when and where, is extremely uncertain. Furthermore, changes usually occur over decades or even centuries, making the detection of dreadfulness hard. Dreadful events can easily be attributed to normal variations in weather. (4) If climate change is understood as a natural variation in the world's climate, then the risk should be evaluated to be lower. (5) The scale of climate change is so much beyond the ordinary risks humans usually deal with that people do not have the emotional or cognitive capacities to make an adequate risk evaluation.

Motivation of behaviour – the multi-determination of behaviour

Behaviour is very seldom determined by a singular cause. A recently proposed model of ecological behaviour combines earlier theories (Klöckner and Blöbaum, 2010). The model conceives of behaviour as being directly predictable by three motivational paths: (1) people's *intentions* about what to do, (2) *situational conditions* and people's perception of them, and (3) development of *habits*. What people intend to do depend partially on their attitudes toward a certain action. Because people make assumptions about possible positive or negative outcomes of the action, an attitude is directly linked to perceptions of risk. People's behaviour also depends on the objective situational conditions and people's subjective perception of them. If people cannot perform a pro-climate action (if, for example, no modes of transport that saves CO_2 emissions were available) or if they perceive it as impossible, they will not take action even if they intended to do so. If people perform an action repeatedly, they start building routines and habits that over time take control of their actions. Problems occur when our habits contradict new intentions (which often occur when people try to change behaviour). This model is one example of environmental psychological action models, and it shows that people's decision making is a complex process in which several aspects might contradict each other. It assumes that *values*, *subjec-*

tive norms (which are the social pressure), and *personal norms* do not directly influence behaviour but determine intentions together with attitudes. Therefore, developing strategies to change people's behaviour with respect to pro-climate actions requires an analysis of all influencing aspects.

Another model assumes that people's intention to take adaptive action is predicted both by a high perceived risk and high potential to do something against that risk (Grothmann and Patt, 2005). That is, people take action if they feel threatened by climate change but also feel capable of taking effective actions. If a high risk is combined with low capabilities, the model predicts fatalism, denial, or wishful thinking. The two models show some similarities in that both models underline the complexity of human behaviour, and that simple intervention strategies are likely to fail because people have the strong ability to shape reality according to their perceptions and mental models.

Evaluation of behavioural outcomes

So far, this chapter has described the processes outlined in the introduction as linear processes leading from experiences with climate change to action through a series of well-defined steps. However, cognition and behaviour are not linear but in fact influence each other. The "*foot-in-the-door*" intervention technique builds on self-perception theory and works like this. First people are asked for a small favour (e.g., to save energy) but so small that hardly anyone denies it. After people have committed to the first action, they are usually more likely to take another, much more demanding action. The assumption is that people observe their own behaviour concerning the small favour and infer a positive attitude toward the behaviour and related behaviours. Researchers used this technique to motivate people to save energy in their homes by first asking the participants to answer a questionnaire about energy saving (Katzev and Johnson, 1983). Then they asked them to commit to saving 10% on the energy used in their homes. Compared to control groups, the foot-in-the-door group had the highest percentage of energy conservers.

Direct versus mediated experiences of climate change

The final aspect of climate change relates to the fact that climate change cannot be perceived directly by the individual. Unlike other risks, such as car traffic, the impact of the changing climate cannot be experienced directly. People may experience weather events like storms, floods, or droughts, but

no single event can be clearly linked to climate change. This means the single experiences people have are only with a high degree of *uncertainty* related to climate change. Possibly climate change does not concern most of us (yet), because we lack direct experience of single events with serious consequences and because climate-related risk perception is based on descriptions and not experiences (Weber, 2006). Impressive simulations might be a stand-in for a direct experience, and artistic approaches (films, music, paintings) could be another way of offering people direct emotional experiences related to climate change.

Conclusion

Clearly, psychology has a lot to say about how to design policy which deals successfully with climate change. A careful analysis of behaviour is necessary, since people's behaviour is related to climate change in many ways. People vote for parties that support more or less extreme climate change strategies, support (or not) lobbyists for climate protection measures, make decisions about what cars, household equipment, or insulation they want to use, make decisions about new technology they adopt, implement (or not) CO_2-saving behaviour into their everyday life, and decide where they want to live and how to protect themselves against predicted changes in their local climate. Understanding all those different types of behaviour and influencing them might be a key for successful mitigation and adaptation to climate change.

If we want people to adequately mitigate and adapt to climate change, we have to ensure they understand the basic principles of climate change. As the climate system is highly complex, laypeople need helpful but still sufficiently correct metaphors to understand climate change. In particular, people's mental models must become more integrated, especially with respect to the link between personal behaviour and global processes.

Climate change also needs to be experienced more directly and more emotionally by ordinary people. Powerful images, art, simulations, documentaries, or the use of symbolic icons that are emotionally loaded (like the polar bear) may help to achieve this more direct and emotional experience of climate change. Even a single hurricane, while probably not directly connected to climate change, could become a symbol for a possible future where such events are much more likely. Examples of climate change effects "in the individual's own backyard" might help increase the personal relevance of climate change compared to the effects on people at other places in the world or non-human nature.

Finally, intervention strategies have to be tailored carefully, as one intervention package does not fit all people at all points in time. Success requires taking people's feedback and experiences seriously, as these determine how people organize their future behaviour. Clearly, the climate change debate would seem to benefit from incorporating much more psychology.

Vocabulary Notes

Risk: The possibility of being harmed or experiencing loss.

Emotional responses: A response to certain events based on feelings.

Cognitive processes: Mental processes such as gaining knowledge, thinking, reasoning, remembering.

Mental models: Simplified models about how complex systems work that people have in their minds. Mental models allow people to handle complex systems without having to understand them completely.

Mitigation: Actions that can be taken to prevent climate change from happening, to slow down climate change or to limit the extent.

Adaptive action: Protection against predicted effects of climate change, e.g. building flood protection systems.

Denial: Not believing in climate change or not accepting that it will have a relevant impact.

Feedback loops: Effects that something has on itself, either directly or through other variables.

Analogy: A similarity between two things that otherwise are different. Often used to explain one thing by another that people know better. Example: The human brain works like a computer.

Metaphor: A figure of speech that uses analogies to explain something.

Ozone layer depletion: The process that reduces the thickness of the ozone layer, which is a layer of the gas ozone (molecules of three oxygen atoms) about 15-30 kilometers high in the atmosphere. The ozone layer protects the earth surface from ultraviolet radiation from the sun. Holes in the ozone layer lead for example to higher risks of sunburn and skin cancer. Ozone layer depletion is **not** related to climate change.

Weather: The state of the atmosphere (temperature, humidity, etc.) at a given time and place. That means that weather is local and a phenomenon at a specific point in time.

Climate: The patterns of meteorological conditions in a region (e.g., average temperatures and rainfalls during the year). The climate of a place is the average of individual weather conditions over a long time.

Knowledge structures: Structures in the brain that store information.

Optimistic bias: A well-known phenomenon from risk psychology that describes how people tend to think that they are less vulnerable to negative events than other people and more likely to experience something positive.

Intention: A state of wanting to do something, a goal, an objective.

Situational condition: The sum of all external influences minus influences by other people.

Habit: The automatic performance of a behavior after that it has been performed successfully, very often, and in always the same situation. If habits guide behavior, people do not think about what they are doing.

Value: Important and stable beliefs shared by many people in one culture about what is good and desirable and what is not.

Subjective norm: The social pressure that a person experiences because of the expectations other people have.

Personal norm: A value or a subjective norm that has been integrated into a person's own value system. The feeling of being morally responsible to behave in a certain way.

Foot-in-the-door technique: An intervention technique that asks a small favor first that people usually fulfill. After which a larger favor is asked for that people usually decline. Because people complied with the first request they are more likely to also comply to the second to appear consistent.

Uncertainty: Not knowing if, when or where something will happen.

EXERCISES

A. *Complete the following chart.*

Verb	**Noun**	**Adjective**
behave	_____	behavioural
succed	_____	successful
challenge	challenge	_____
consume	_____	consuming
perceive	perception	_____
assume	_____	assumed
evaluate	_____	evaluated
delay	_____	_____
determine	_____	determined
intervene	intervention	_____
adapt	_____	adapted
protect	protection	_____
relate	_____	related
_____	to predict	_____
_____	emotion	emotional
support	_____	supportive
predict	prediction	_____
perceive	_____	perceived
judge	judgement	_____
conceive	_____	conceived
intend	_____	intended
decide	decision	_____
influence	_____	influenced

B. *Take a look at these sentences from the text. Choose the correct word to fill in the gaps. You may go back to the text to check your answers.*

behave behaviour
Mostly, the climate change discussion assumes that people will _____ in the desired way if we only inform them about climate change and use economic tools to guide their _____.

relate related
This chapter shows how several psychological processes _____ to people's climate-_____ behaviour.

decide decision
The model in Figure 1 assumes that people evaluate the outcomes of their behaviour and that this evaluation changes how they _____ the next time they have to make a _____.

predict predictable
Because some systems are too complex for the human mind to comprehend, humans cannot _____ how those systems will behave over time. The model conceives of behaviour as being directly _____ by three motivational paths:

emotion emotional
Compared to cognitive judgements about climate change, _____ judgements are less strong. (…) Most people react either weakly or with _____ that do not lead to individual changes in behaviour.

perceive perception
This reaction might stem from the way people _____ individual risk related to climate change and the fact that most experiences of climate change are indirect. Because people have assumptions about possible positive or negative outcomes of the action, an attitude is directly linked to _____ of risk.

influence influencing
The model assumes that values, subjective norms, and personal norms do not directly _____ behaviour but determine intentions together with attitudes. Therefore, developing strategies to change people's behaviour with respect to pro-climate actions requires an analysis of all _____ aspects.

C. *Fill in the table with the opposites of the words provided. Refer to the example.*

success	*failure*
to delay	_____
recently	_____
increasing	_____
broad	_____
global	_____
linear	_____
to deny	_____
complex	_____
direct	_____
emotional	_____

D. *Use the pairs from the table to fill in the gaps in these sentences.*

This perspective leads to _____ the cost of unwanted behaviour (or _____ the cost of wanted behaviour) or informing people about climate change and possible scenarios.

These experiences can be either _____ —for example, personally witnessing extreme weather events or changes in the local flora and fauna— or _____ by media or conversations with other people.

Both kinds of experiences can lead to _____ responses as well as _____ processes.

The two models show some similarities in that both models underline that human behaviour is _____, and _____ intervention strategies are likely to fail because people have the strong ability to shape reality according to their perceptions and mental models.

These experiences can be either direct—for example, personally witnessing extreme weather events or changes in the _____ flora and fauna—or mediated by media or conversations with other people.

In particular, people's mental models must become more integrated, especially with respect to the link between personal behaviour and _____ processes.

E. *Match the 'if-clauses' with their corresponding 'main clauses'.*

If-clause	**Main-Clause**
1. If we only inform people about climate change	a. , then the risk should be evaluated lower.
2. If a system involves a large number of variables that interact	b. people start to take action
3. If climate change is understood as a natural variation in the world's climate	c. , we have to ensure they understand the basic principles of climate change.
4. If people cannot perform a pro climate action	d. , they will behave in the desired way.
5. If people perform an action repeatedly	e. , they will not take action even if they intended to do so.
6. If they feel threatened by climate change but also feel capable of taking effective action	f. , then human strategies for understanding these systems fail.
7. If a high risk is combined with low capabilities	g. , they start building routines and habits that over time take control of their actions.
8. If we want people to adequately mitigate and adapt to climate change.	h. , the model predicts fatalism, denial, or wishful thinking.

F. *Fill in the gaps in this text. Try not to look at the original text while doing the exercise but rely on the things you learned while reading the text and doing the exercises.*

Clearly, psychology has a lot to say about how to design policy that deals _____ with climate change. A careful analysis of _____ is necessary, since people's behaviour is _____ to climate change in many ways. People vote for parties that _____ more or less extreme climate change strategies, support (or not) _____ for climate protection measures, make decisions about what cars, household equipment, or _____ they want to use, make decisions about new technology they adopt, _____ (or not) CO_2-saving behaviour into their everyday life, and decide where they want to live and how to _____ themselves against _____ changes in their _____ climate. Understanding all those different types of behaviour and _____ them might be a key for successful _____ and _____ to climate change.

If we want people to adequately _____ and _____ to climate change, we have to make sure they understand the _____ of climate change. As the climate system is highly _____, _____ need helpful but still sufficiently correct _____ to understand climate change. In particular, people's _____ must become more _____, especially with respect to the link between personal behaviour and _____.

Climate change also needs to be experienced _____ and more _____ by ordinary people. Powerful images, art, _____, documentaries, or the use of _____ that are emotionally loaded (like the polar bear) may help to achieve this more direct and emotional experience of _____. Even a single _____, while probably not directly connected to climate change, could become a symbol for a possible future where such events are much _____. Examples of climate change effects "in the individual's own backyard" might help _____ the personal relevance of climate change compared to the effects on people at other places in the world or non-human nature.

Finally, _____ strategies have to be tailored carefully, as one _____ does not fit all people at all points in time. Success requires taking people's _____ and experiences seriously, as these _____ how people organize their future behaviour. Clearly, the climate change debate would seem to benefit from _____ much more psychology.

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Climate Change and Marine Ecosystems

Konstantinos Kougias

Abstract

Coastal and marine ecosystems support diverse and important fisheries, hold vast storehouses of biological diversity, and provide unparalleled recreational opportunities. Climate change will create novel challenges for coastal and marine ecosystems that are already stressed from human development, land-use change, environmental pollution, and over-fishing. The chapter has three main sections. The first examines the interconnection between marine ecosystems and climate change, discusses its real and potential impacts and describes coastal adaptation strategies to sea level rise. The second provides a glossary of the most important terms used in the text presented in the first section. The third provides a set of exercises aiming to consolidate and improve student vocabulary, grammatical and syntactical skills.

Introduction

The world's oceans cover approximately 70 percent of the Earth's surface, indicating their importance to the global environment. In addition to having a large influence on global *heat transport* and *precipitation*, the oceans are comprised of diverse *habitats* that support a wealth of *marine wildlife*. They also provide humans with a wide variety of goods and services including but not limited to food, tourism, coastal development, commercial and recreational fisheries, aquaculture, *biodiversity*, *marine biotechnology*, navigation, and mineral resources.

Currently, more than forty four per cent of the global population lives within 150 kilometers of a coast, and demographic trends suggest that coastal populations are rapidly increasing (UN Atlas of the Oceans, 2010). By the year 2025, coastal populations are expected to account for 75% of the total world population. Some 53% of the total US population lives on the

17% of land in the *coastal zone*, and these areas become more crowded every year (National Ocean Service, 2011). Over the past 50 years, the population living in European coastal municipalities has more than doubled to reach 70 millions inhabitants in 2001 and the total value of economic assets located within 500 meters from the coastline have increased to an estimated 500-1000 billion euros in 2000 (EC, 2006a).

Demands on coastal and *marine resources* are rapidly increasing, and as coastal areas become more developed, the vulnerability of human settlements to hurricanes, storm surges, and flooding events also increases. The number of extreme weather events and climate-related disasters has increased with different configuration for northern Europe (10-40% wetter) and southern Europe (up to 20% drier). This north-south cleavage is expected to strengthen during the course of this century (EC, 2006b).

The interconnection between marine ecosystems and climate change

Coastal and marine environments are intrinsically linked to climate in many ways. The impact of climate change pressure to the coastal system is mainly acting through sea level rise and *storm surges* (also increasing wave height) which can result in *shoreline recession*, flooding, and salt intrusion inland, with further consequences on infrastructure and human life. The coastal vulnerability to such pressures depends on the natural properties of the environment (physical, chemical, biological), as well as the socio-economic elements that contribute to modify its natural dynamics.

According to the Fourth Assessment Report of the The Intergovernmental Panel on Climate Change (IPCC), the total temperature increase from 1850–1899 to 2001–2005 is 0.76°C [0.57°C to 0.95°C], representing, at least for the Northern Hemisphere, the largest increase within the past 1,000 years. Rising sea level is consistent with warming. Global average sea level has risen since 1961 at an average rate of 1.8 [1.3 to 2.3] mm/yr and since 1993 at 3.1 [2.4 to 3.8] mm/yr, with contributions from *thermal expansion*, melting glaciers and ice caps, and the polar ice sheets. The IPCC suggests that the global average sea level will rise by 18 to 59 cm by 2100, while by 2080 sea level rise could convert as much as 33 percent of the world's coastal wetlands to open water.

Observations since 1961 show that the average temperature of the global ocean has increased to depths of at least 3000 m and that the ocean has been absorbing more than 80% of the heat added to the climate system. Such warming causes seawater to expand, contributing to sea level rise (IPCC, 2007b).

The impacts of climate change on marine resources

Several studies suggest that considerable physical impacts along coasts can occur as a result of climate change (IPCC, 2007b; Kling, 2009; UNEP, 2010; Gregg *et al*. 2011).

Such impacts include ecological impacts: increased water temperature, reduced sea-ice coverage, *water chemistry* and pH, sea level rise, reinforcement of *water stratification*, modification of the frequency and distribution of extreme conditions (e.g. storm surges, heat waves) reflecting changes in the atmospheric pressure systems, and the wind field at local, regional and global scales, changes in net primary productivity, survival of *calcifying organisms*, changes in species distribution and diversity, increased frequency of *coral bleaching*, diseases and species invasions, and changes to arctic ecosystems, as well as specific impacts on the land–sea margin including the erosion of beaches, inundation of *coastal wetlands*, and property damage.

In addition to changes in the mean climatic forcing, episodes of extreme events (downpours, droughts, storm surges, floods) have become more frequent, affecting human life and causing considerable damage to the environment on land and sea. These transformations are most clearly observable in *low-lying coastal systems*, *deltas*, *coastal lagoons*, *estuaries* with higher vulnerability to environmental changes, often aggravated by a severe anthropogenic pressure (Kennedy *et al* 2002; Gregg *et al* 2011). Identified trends/impacts due to climate change and variability of marine ecosystems include

- *Circulation changes*, climate change is likely to alter patterns of wind and water circulation in the ocean environment. Such changes may influence the vertical movement of ocean waters (i.e., *upwelling* and *downwelling*), increasing or decreasing the availability of essential nutrients and oxygen to marine organisms. These changes, in water characteristics and circulation may isolate deeper waters that are important in supplying nutrients to shallower areas. Furthermore, changes in ocean circulation patterns can also cause substantial changes in regional ocean and land temperatures and the geographic distributions of marine species (Kennedy *et al* 2002; Kling, 2009; Gregg *et al*. 2011).
- *Temperature changes in coastal and marine ecosystems will influence organism metabolism and alter ecological processes such as productivity and species interactions* (Kennedy *et al* 2002; UNEP, 2010; Kling, 2009). As temperatures change, species' geographic distributions will expand or contract, creating new combinations of species that will interact in unpredictable ways. Species which are

unable to migrate or compete with other species for resources may face local or global extinction.

- *Changes in ocean chemistry (pH and salinity)*. A direct effect of increasing carbon dioxide concentrations that are beyond the absorption capacity of natural systems is the increasing *acidity* of the oceans. Globally, the ocean absorbs roughly 30 per cent of the annual worldwide emissions of CO_2. As the oceans take up CO_2, pH drops and *seawater chemical speciation* changes in ways that make the calcium carbonate ion less available for marine organisms to form. Changes in pH affect biological processes as basic as *respiration* and *fertilization* in organisms as diverse as fish, squid, algae, and sea urchins (Gregg *et al.* 2011). Species that have calcium carbonate skeletons and *shells* may be unable to build those structures, in a worst-case scenario. The global atmospheric concentration of carbon dioxide has increased from a pre-industrial value of about 280 ppm to 379 ppm[3] in 2005. The atmospheric concentration of carbon dioxide in 2005 exceeded by far the natural range over the last 650,000 years (180 to 300 ppm) as determined from ice cores. (IPCC, 2007b).
- *Critical coastal ecosystems such as wetlands, estuaries, and coral reefs are particularly vulnerable to climate change* (Kennedy *et al* 2002; Kling, 2009; Gregg *et al*. 2011). Such ecosystems are among the most biologically productive environments in the world. Their existence at the interface between the *terrestrial* and marine environment exposes them to a wide variety of human and natural stressors. The added burden of climate change may further degrade these valuable ecosystems, threatening their ecological sustainability and the flow of goods and services they provide to human populations.
- *Ecosystem modifications with distinct shifts northward of warm-water species associated to a decrease in the mean number of cold water species.*
- *Phenological perturbations leading to a mismatch between trophic levels and functional groups*
- *Coastal floods and other environmental hazards/disasters as a result of tidal/storm surges.*

Adaptation Strategies

The IPCC identifies three standard strategies of coastal adaptation to sea level rise: (planned) retreat, accommodation, and protection (IPCC, 2007). A

retreat strategy would prevent or discourage major developments in vulnerable coastal areas and could include rolling easements, which allow development but explicitly prevent property owners from preventing the upland migration of wetlands and beaches. An accommodation strategy might elevate land surfaces or human structures, modify drainage systems, or otherwise change land use practices, thus allowing many coastal ecosystems to be maintained. A protection strategy could utilize beach nourishment and dune stabilization, as well as dikes, bulkheads, *seawalls* and *revetments*, to form a barrier between water and land. This might generally lead to a loss of natural functions for beaches, wetlands, and other *intertidal zones*, but would be capable of roughly maintaining the coastline in place.

Even before the advent of climate change concerns, many countries had adopted Integrated Coastal Zone Management (ICZM) strategies to address the complex challenges of sustainable coastal development. ICZM strives to balance environmental, economic, and social objectives within the limits set by natural dynamics. It aims to draw on the participation of all stakeholders to define and achieve these objectives and to resolve potential conflicts among competing interests.

Other models have also come into use recently in coastal zone management and adaptation to climate change, including the following:

- Adaptation can take place at many different levels—global, national, regional, and local. *Community-based adaptation* (CBA) is an innovative approach enabling communities to enhance their own adaptive capacity, empowering them to increase their resilience to climate change impacts. CBA focuses on activities carried out by highly vulnerable and poor communities, mostly in developing countries.
- *Ecosystem-based management* takes a broader view of management decisions in order to understand the ecosystems themselves. Ecosystem-based management looks to take account of potential future changes that may be larger than those induced by present stresses, adopting a longer perspective that includes non-climate issues.

Conclusions

Climate change affects ecosystems from pole to pole. The impacts of climate change are extremely varied. Their effects back up and amplify one another, and also amplify the impacts of coastal development and activities. This climate change linked effect (temperatures, rainfall, winds, sea level rise) and human-origin change (pollution, coastal development, over-

exploitation of natural resources, introduction of species) impact and will increasingly impact both the socio-economic sectors and the natural systems.

Adaptation has been increasingly viewed as an essential component of an effective climate change response strategy. Adopting action plans stemming from holistic concepts such as integrated management or the ecosystem approach are absolutely vital even if it means having complex governance mechanisms at several spatial levels (regional, trans-national, national, local and pluri-thematic). Moreover, adaptive policies should be flexible, more climate savvy and designed to facilitate learning about the system given that the present state of knowledge is still insufficient as the challenges are relatively recent.

Nevertheless, it should be stressed that adaptation to global climate change should not be viewed as a substitute for mitigation; greenhouse gas emissions must be reduced to prevent further damage while increasing resilience and reducing vulnerability.

Vocabulary notes

Heat transport: The transport of heat between the ocean surface and the atmosphere, between the surface and lower layers, and between individual regions of seas and oceans.

Precipitation: Rain, snow, sleet, or hail that falls to the ground.

Habitat: An ecological or environmental area that is inhabited by a particular species of animal, plant or other type of organism.

Marine wildlife: Plants and animals that live in the sea.

Biodiversity: Totality of genes, species, and ecosystems of a region.

Marine biotechnology: The use of living marine resources at (eco-) system, concept, organism or molecular level to provide beneficial solutions for the society.

Coastal zone: It is a spatial zone where interaction of the sea and land processes occurs. A majority of the world's population inhabit such zones which are continually changing because of the dynamic interaction between the oceans and the land.

Marine recourses: Living organisms, materials or substances that can occur in sea and can be used for economic gain.

Storm surge: A rise above normal water level on the open coast due only to the action of wind stress on the water.

Shoreline recession: The long term permanent landward movement of the shoreline in response to a net deficit in sediment budget over time.

Salt water intrusion: The mixing of saltwater with freshwater. It can occur in either surface-water or groundwater bodies.

Thermal expansion: The tendency of matter to change in volume in response to a change in temperature.

Water chemistry: The study of the fundamental chemical property and information about water (total hardness, carbonate hardness, non-carbonate hardness, ammonia, nitrate, nitrite, carbon dioxide, oxygen, pH, and temperature).

Water stratification: Water masses with different properties -salinity, oxygenation, density- form layers that act as barriers to water mixing.

Net primary production: Measure of the rate at which new organic matter is developed through photosynthesis and chemosynthesis in producer organisms based on the oxygen released and carbon taken in.

Calcifying organisms: Marine organisms that have calcium carbonate skeletons ($CaCO_3$ and shells, they include some phytoplankton, and many invertbrates such as corals, sponges, marine worms, mollsks and crustaceans.

Coral bleaching: The corals lose their colour under stressful environmental conditions. The major causes are unusually high water temperature and light intensity.

Coastal wetlands: Habitat found along a coastline and is covered with ocean salt water for all or part of the year. Examples of this type of habitat include tidal marshes, bays, lagoons, tidal flats, and mangrove swamps.

Low-lying coastal areas: Areas lying close to water or ground level.

Delta: A landform that is formed at the mouth of a river where that river flows into an ocean, sea, estuary, lake.

Coastal lagoon: A body of shallow sea water or brackish water separated from the sea by some form of barrier.

Estuary: A partly enclosed coastal body of water with one or more rivers or streams flowing into it, and with a free connection to the open sea.

Upwelling: The process of upward movement to the ocean surface of deeper cold usually nutrient-rich waters especially along some shores due to

the offshore movement of surface waters (as from the action of winds and the Coriolis force).

Downwelling: A downward current of surface water in the ocean, usually caused by differences in the density of sea water.

Salinity: The salt concentration (e.g., Sodium and Chlorure) in sea water.

Acidity: The reduction in pH value of the water as the oceans absorb certain amount of carbon dioxide from the atmosphere that is released during combustion of fossil fuels.

Seawater chemical speciation: The composition (i.e., types and concentration of chemical compounds) in seawater.

Respiration: 1. The act or process of inhaling and exhaling; breathing, 2.The act or process by which an organism without lungs, such as a fish or plant, exchanges gases with its environment.

Fertilization: 1. The act or process of initiating biological reproduction by insemination or pollination, 2. The union of male and female gametes to form a zygote, 3. The act or process of applying a fertilizer.

Shell: Hard outer covering that encases certain organisms, such as mollusks, insects, and turtles.

Coral reef: Underwater structure made from calcium carbonate secreted by corals. They are colonies of tiny living animals found in marine waters that contain few nutrients.

Terrestrial: 1. Living or growing on land; not aquatic, 2. Relating to the earth or its inhabitants, 3. Relating to, or composed of land.

Phenological perturbation: Changes in periodic biological phenomena that are correlated with climactic conditions.

Trophic level: An organism's hierarchical ranking among species in the food chain.

Seawall: Shore parallel structure at the transition between the low-lying (sandy) beach and the (higher) mainland or dune in order to protect against erosion, storm surges and currents.

Revetment: Shoreline protection structure just as a seawall. The main difference is that it is more sloping than a seawall.

Intertidal zones: the area between the land and sea that is covered by water at high tide and uncovered at low tide.

Answer the following questions:

1. How important is the ocean to the global environment?
2. How are coastal and marine environments linked to climate?
3. What are the main impacts of climate change on marine resources?
4. Which areas are most vulnerable?
5. How can an increasing carbon dioxide concentration affect ocean chemistry? Describe the process of acidity.
6. How can changed wind and water circulation patterns affect ocean environment?
7. Which are the three standard strategies of coastal adaptation to sea level rise, according to the IPCC?
8. Describe the terms *community based adaptation* and *ecosystem based management*.
9. Adaptation alone, mitigation alone or a combination of them? Think of examples of successful environmental interventions in your area.

EXERCISES

A. *Match the words or phrases of Column A with the words of Column B.*

1. marine	a. pH
2. storm	b. circulation
3. shoreline	c. adaptation
4. ice	d. barrier
5. acidity	e. ecosystem
6. retreat strategy	f. surges
7. seawalls	g. recession
8. wind	h. sheet

B. *Find if the following are True or False.*

1. The world's oceans cover approximately 55 percent of the Earth's surface, indicating their importance to the global environment.
2. By the year 2025, coastal populations are expected to account for 60% of the total world population.
3. Observations since 1961 show that the average temperature of the global ocean has increased to depths of at least 3000 m.
4. Climate change impacts are most clearly observable in low-lying coastal systems, deltas, coastal lagoons, estuaries.
5. Climate change is not likely to alter patterns of wind and water circulation in the ocean environment.
6. Globally, the ocean absorbs roughly 30 percent of the annual worldwide emissions of CO_2.
7. Changes in pH affect biological processes as basic as respiration and fertilization.
8. The atmospheric concentration of carbon dioxide in 2005 exceeds by far the natural range over the last 650,000 years.
9. ICZM strategies aim to address the complex challenges of sustainable coastal development.
10. Adaptation to global climate change should not be viewed as a substitute for mitigation.

C. *Complete the following chart.*

Verb	**Noun**	**Adjective**
_____	navigation	_____
expect	_____	_____
_____	observation	_____
absorb	_____	_____
_____	_____	determined
elevate	_____	_____
adopt	_____	_____
_____	_____	varied

D. *Fill the blanks with a suitable word.*

The IPCC identifies three standard strategies of _____ adaptation to sea level rise: (planned) retreat, _____ and protection. A retreat strategy would prevent or _____ major developments in vulnerable coastal areas and could include _____ easements, which allow development but explicitly prevent property owners from preventing the upland migration of _____ and beaches. An accommodation strategy might _____ land surfaces or human structures, modify drainage systems, or otherwise change land use practices, thus _____ many coastal ecosystems to be maintained. A protection strategy could utilize beach nourishment and dune stabilization, as well as dikes, bulkheads, seawalls and revetments, to form a barrier between _____ and land. This might generally lead to a _____ of natural functions for beaches, wetlands, and other intertidal _____ but would be capable of roughly maintaining the coastline in place.

E. *Put the verbs in parenthesis into the correct form.*

1. By the year 2025, coastal populations (expect) _____ to account for 60% of the total world population.
2. Globally, the ocean (absorb) _____ roughly 30 percent of the annual worldwide emissions of CO_2.
3. The number of extreme weather events and climate-related disasters (increase) _____ with different configuration for northern Europe and southern Europe.
4. Coastal and marine environments (link) _____ to climate in many ways.
1. 5. The IPCC (suggest) _____that the global average sea level (rise) _____ by 18 to59 cm by 2100.
5. Changes in the mean climatic forcing, episodes of extreme events (downpours, droughts, storm surges, floods) (become) _____ more frequent.
6. As the oceans (take up) _____ CO_2, pH (drop) _____ and seawater chemical speciation (change) _____.
7. The atmospheric concentration of carbon dioxide in 2005 (exceed) _____ by far the natural range over the last 650,000 years.

8. Adaptation (view) _____ as an essential component of an effective climate change response strategy.
9. Adaptive policies (be) _____ flexible, more climate savvy and (design) _____ to facilitate learning.

F. *Finish the following sentences.*

1. The world's oceans cover approximately
2. Over the past 50 years, the population living in European coastal municipalities
3. The impact of climate change pressure to the coastal system is mainly acting through
4. The coastal vulnerability to these pressures depends on
5. The average temperature of the global ocean has increased to depths
6. Global average sea level has risen since 1961 with contributions from
7. Changes in ocean circulation patterns can also cause
8. As temperatures change, species' geographic distributions
9. Phenological perturbations leading to
10. Ecosystem-based management takes a broader view of

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Knowledge and Awareness about Climate Change around the World and its Impacts on Natural and Human Systems

Dieter Gross

Abstract

First, results are presented on worldwide knowledge and awareness about climate change and its causes, supplemented by surveys showing how much people feel threatened by it. Climate change's ranking and changes within global issues are revealed and reasons regarding the gap between one's awareness and one's inability to cope with these issues are discussed. Second, the chapter lists the impacts of climate change on natural ecosystems and human systems by presenting processes with regional and far-flung effects, e.g. in China. Third, the chapter provides a list of climate change terms used in the preceding text; presenting definitions and hints for research. The fourth part provides exercises for understanding and applying the used terms correctly as well as questions for demonstrating awareness about climate change and its impacts.

Knowledge and Awareness about Climate Change around the World

Climate change is global, intertwined with time and space and interconnected with issues, such as economic development, *social vulnerability* and environmental changes; to illustrate this, its consequences for China will be unfold, where people, although aware of climate change, see least threat from *global warming* and its increasing scarcities and losses.

Knowledge and awareness about global challenges, e.g. climate change, vary worldwide. *Global warming* is one aspect of *climate change* (among others: e.g. oceanic circulation, volcanic eruptions etc.): rising of the average temperature of Earth's atmosphere and oceans, first and foremost by human-

induced alterations of nature. Therefore, climate change is often used to describe human-specific impacts, such as *global warming*.

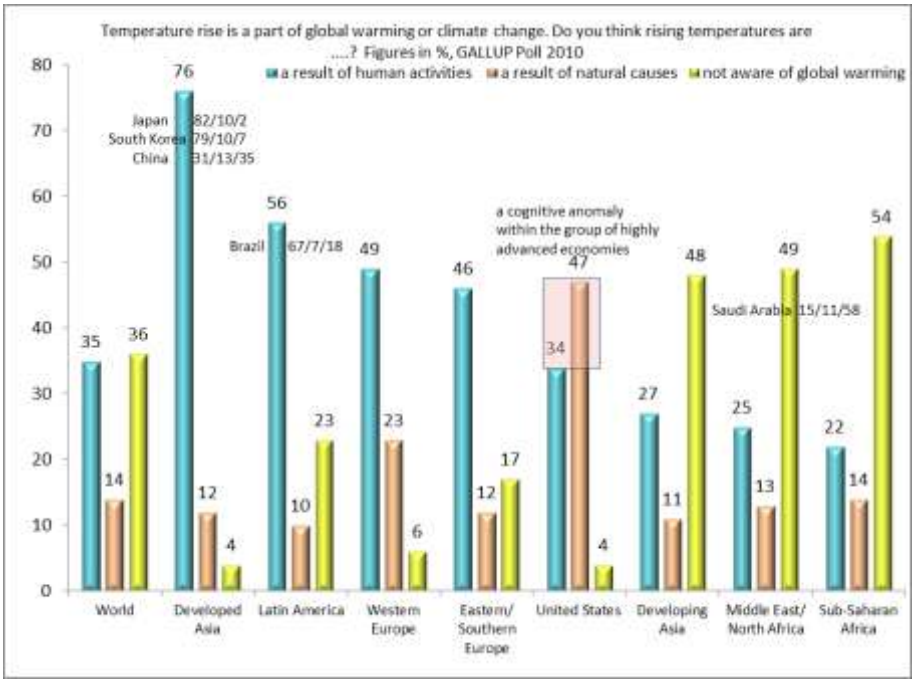


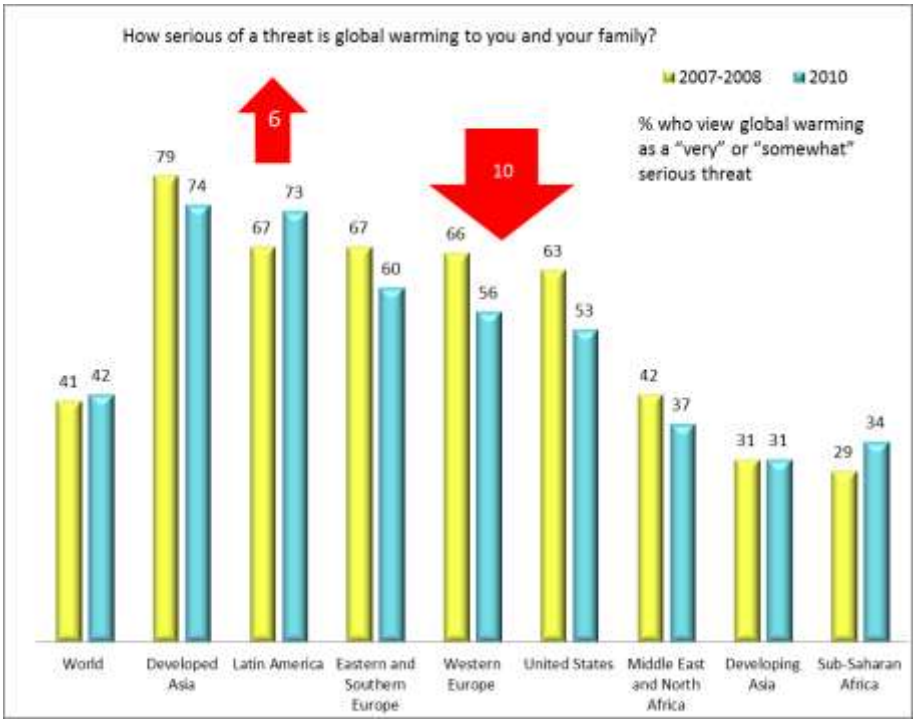
Fig. 1 Worldwide knowledge about the causes of climate change

A third of the world's population has never heard of *global warming*, see Fig.1 Worldwide knowledge about the causes of climate change (Gallup Poll, 2011a) and those who have heard: these figures are higher in highly advanced economies and lower in less developed economies. Respondents of developed economies in Asia, such as Japan and South Korea, rank human-induced causes for *global warming* at the highest levels, strongly shared by Latin Americans. And even in those economies where a considerable number of respondents are not aware of *global warming*, the belief is shared that it is caused by human-induced activities, doubly ranked higher than caused by natural causes. However, the majority of the US people believes that the causes of *global warming* are more induced by natural causes than by human activities.

There are also changes in the global assessment of being threatened by climate change, see Fig. 2 Changes in the global assessment of the personal dangers of climate change. Worldwide, there is 42 % of adults who see *global warming* as a threat; these results haven't changed very much from 2007/08 to 2010, surveyed in 111 countries in 2010 (Gallup Poll, 2011b).

The increases and declines show the gap between the developed and developing world. US -Americans and Europeans feel less threatened, while more Latin Americans and sub-Saharan Africans see themselves at risk. In Peru, for example, the percentage saying *global warming* is a threat has increased from 58% in 2007/08 to 75% in 2010, whereas in France people who see it as a threat has decreased from 75% to 59% and in the Netherlands from 57% to 48%.

Assessment of the personal dangers of climate change:



	Japan 80/75' China 21/21 India 29/30	Brazil 76/78 Peru 58/75	Greece 82/87	France 75/59 Germany 61/59		Saudi Arabia 40/33		South Africa 21/28

Fig. 2 Changes in the global assessment of the personal dangers of climate change

Worldwide Ranking of Global Issues

A survey, see Fig. 3 Individual concerns about global issues, of more than 25.000 internet respondents in 51 countries (Carrington, 2011; A Niel-

sen Report, 2011) documents that 69% of global citizens is concerned about *global warming*, but this concern is decreasing, mainly in the biggest polluting nations.

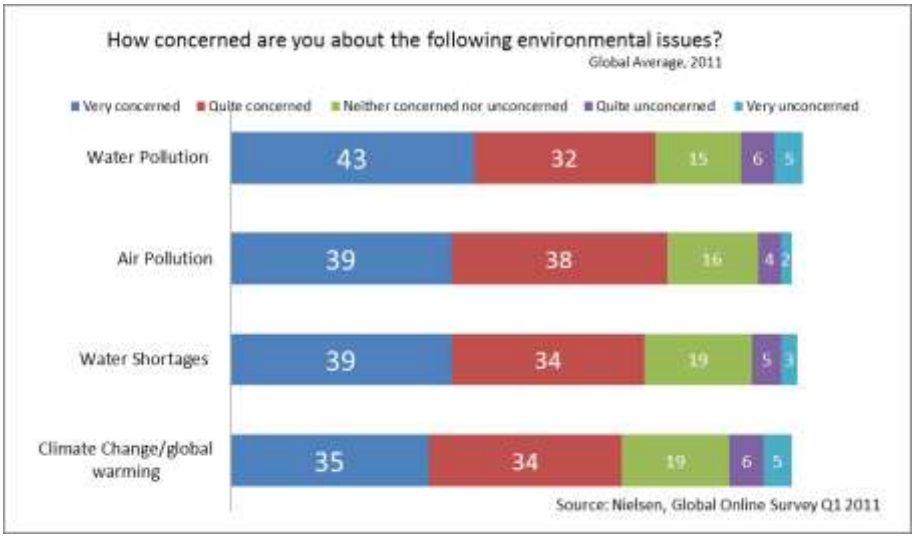


Fig. 3 Individual concerns about global issues

There is a decrease in the threat and extent of climate change and the issue has also lost concern within the group of global issues. Global citizens are more concerned about water and air pollution than climate change. Thus 77% of respondents are very concerned, respectively quite concerned about air pollution whereas 69% about climate change; always keeping up in one's in mind that regional environments and livelihoods will steer people's priorities.

These changes in the threat scenarios have already started some years ago, more with the major stakeholders and less in the public. The world's biggest companies, more than 500 big businesses in Britain, the US, Germany, Japan, India and China have ranked *global warming* far down in 2008 (Davis, Lean and Mesure, 2008). Nine out of ten do not see it as a priority, ranking current issues in the area of world economy as much more challenging and urgent. However, in terms of costs, climate change remains at the top along with the businesses (KPMG, 2012).

But apart from these economic aspects, environmental scientists have also agreed to the 'down-ranking of *global warming*', result of an UNEP survey where 400 scientists had been asked to name the emerging issues of the 21st century (UNEP, 2012).

The first three issues are:

1. Global Sustainability
2. Meeting Global Environmental Challenges and Moving Towards a Green Economy
3. Food Safety and Food Security for 9 Billion People

Climate change takes the7th rank of 21 issues, associating with *mitigation* and adaptation for managing the unintended consequences, e.g. when traditional agricultural practices are replaced by new ones which are better adapted to new climate conditions. These practices could be more expensive, expressing economic impacts, because specific seeds and irrigation system will be required.

Box 1 Climate Change: knowledge and awareness worldwide and ranking within global issues

1. Division of knowledge about climate change between developed and developing nations.
2. Lower awareness about climate change in nations with highest air pollution.
3. Lower ranking of climate change within global issues.
4. Green Economy now ranks before climate change, because it is seen as the key strategy for coping with this issue.

The United Nations Environment Programme defines a green economy as one that results in "improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities."

All together, the downward shift of climate change by the business people and the environmental scientists has influenced the top agenda of Rio+20: global sustainability and *green economy*, both are necessary for coping with the challenges of climate change and in general, 72% of 642 qualified sustainability experts have agreed that "green economy is right theme for the conference" (Survey on Activism and Rio+20, June 2012). However, the hopes that Rio+20 would commit the world to move towards a green economy were diluted by suspicions, among some developing nations. Therefore, the final document merely named the *green economy* an "important tool" that countries could use if they wished.

Awareness about Climate Change and Sustainability

Recent communication about climate change and global changes is focused on its close connection with sustainability, a prerequisite for being able to meet these challenges. But what do people know about sustainability?

Germany in 2011: One out of three Germans state to have definitely come across the term "sustainability", 43% thinks that they have heard this term before, whereas one out of five has never heard of the word. The aforementioned results came out of a recent survey, where almost 1,000 individuals were interviewed in September 2011 (GfK Marktforschung, 2011). Sustainability is predominately related with environmental and nature conservation, only 4% mentioned a key aspect of sustainability, namely the wellbeing of future generations.

Consumers know the consequences of rising and falling emissions on the impacts of climate change but this not the case with social and economic aspects which are less important in their minds. Instead of considering various spatial and temporal dimensions as well interactions between short and long-term processes and connections between local and global phenomena, people react with a break in their awareness. They are not trained to think holistically or globally. This means that within the processes individual activities become dissociated from space and time. Interactions between individual actions and their impacts are not experienced immediately; hence, responsibility is reduced, outwardly manifested by an *awareness-action gap.* A mental change in one's mind towards sustainability should bridge and shorten the gap and enable activities, preferably by ESD.

Box 2 Awareness-Action Gap
1. Coping with climate change demands a mental change towards sustainability.
2. Sustainability is primarily understood by the public as an environmental approach, often neglecting social and economic aspects.
3. Inability to think and act holistically causes a gap between awareness and action; followed by vanishing responsibility.

Impacts of Climate Change on Natural Ecosystems and Human Sytems: China

Climate change is associated with its interrelated issues and impacts on Biosphere and on Men: rising sea levels, *droughts, desertification*, weather-related disasters, including storms and flooding; breakdown of current plant communities and ecosystems and reshaping of the environment by regional vegetation and species shifts.

Society will be affected by reduced agricultural productivity, an increase of heat-related illness, e.g. disease-carrying insects are spreading in regions which have formerly been too cold for them (The Nature Conservancy, 2011). Ultimately, climate change leads to men's *social vulnerability*, loss of viability, possibly accompanied by poverty, conflicts and migration and far-flung impacts on businesses and economies.

China:

Northern China is dominated by arid and semiarid climate events which are, due to the monsoon circulation, characterized by drought and flood. Dust storm frequency has increased in the past decade, also desertification with water shortages, foremost a result of changes in weather and climate, followed by air pollution, destruction of vegetation, erosion of surfaces.

Southern China is facing extensive damage from flooding of its river basins. In particular, flooding of the river valleys will have a significant impact on the country. The Yangtze River flood in 1998 in China submerged more than 21 million hectares of farmland.

Sea level rise, caused by climate change, has also affected China's coastal areas, where the economic losses from flooding from typhoons and flood tides, heavy rains, drought are significant. The Yellow River Delta, Yangtze River Delta, and Pearl River Delta are more vulnerable to coastal flooding, shoreline erosion and losses of wetlands than other coastal places (Joint Global Change Research Institute, 2009).

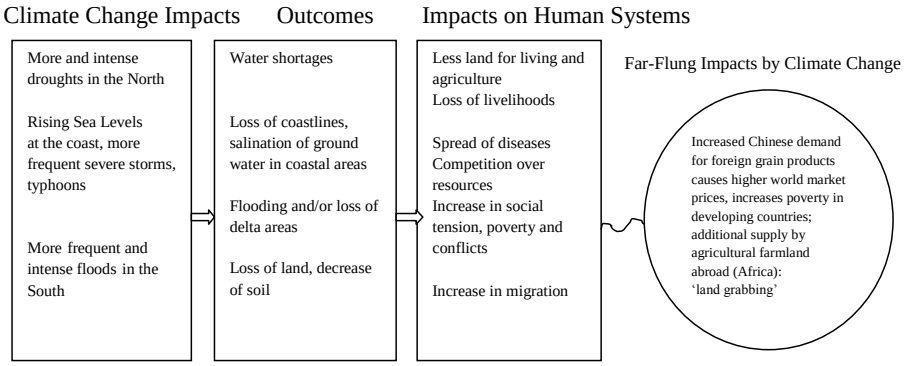


Fig. 4 Links between Climate Change, Natural Ecosystems and Human Systems in China (SEAMEO RECSAM, 2010)

Box 3 Climate Change: China

1. Ecosystems in China are increasingly faced with negative impacts of climate change: droughts, flooding, storms, sea level rise.
2. Certain impacts of climate change reduce agricultural productivity.
3. Impacts of climate change lead to social vulnerability: vanishing viability, poverty, increase of conflicts and migration.
4. Far-flung Impacts of climate change: 'land grabbing' abroad for equalizing the loss of agricultural products at home.

Climate change has substantially stressed China's economic and social development, especially in agriculture, crop production, such as wheat, paddy rice and corn will be reduced. According to the latest Chinese government's report "Second National Assessment Report

on Climate Change" (China Briefing, 2012): If current *global warming* trends in China are allowed to continue unhindered, its grain output could fall by up to 20 percent. This, says the report, could potentially be offset to a degree by the fertilizing effects of more carbon-dioxide in the atmosphere, which would additionally contribute to China's increase of atmospheric temperature between 2.5 and 4.6 degrees Celsius above the 1961-1990 average, followed by drought and flooding, already major issues in China.

Rising sea levels will also make coastal areas more vulnerable. However, defenses to flooding from typhoons are currently "inadequate," says the report. These coastal areas are home to the major cities and Special Economic Zones at the center of China's rapid industrialization. Shanghai is expected to see an increase of 10 to 15 centimeters in its coastal waters over the next three decades; it has already risen by 11.5 centimeters in the previous three.

Given the above facts, how do the Chinese face these issues? They see least threat from *global warming*: 62% is aware of climate change, while 21% feels threatened; corresponding figures for Japan: 99% and 80% (Gallup Poll, 2009): Regarding the Chinese figures, this kind of cognitive dissonance may explain the current *awareness-action gap* here and in other countries.

Summary and Conclusion

Knowledge and awareness about climate change vary worldwide, a third of the world's population has never heard of global warming. Causes of global warming, one aspect of climate change, show a division between developed and developing economies, the first share human-induced causes, the latter mainly natural ones.

People's worldwide concern about climate change's threat has leveled off at 42%, whereas, Europeans and US-Americans felt less threatened in the recent past. This corresponds with climate change's ranking within global issues; people are more concerned about water and air pollution than about climate change. This is also consistent with efforts which are currently more focussed on promoting 'green economy' than on climate change because that is regarded as the appropriate key for dealing with it, an initiative supported by business people and environmental scientists (UNEP) in connection with Rio+20. Current results of the conference: the targets of the *green economy* have been reduced and the details and ambition needed to address the challenges posed by a deteriorating environment lacking in the final document.

However, individual efforts are facing barriers in coping with climate change: people are not trained to think holistically and globally. Individual activities become dissociated from space and time, actions and their impacts

are not experienced immediately, responsibility is reduced, an awareness – action gap will remain. A mental change in one's mind towards sustainability will bridge and shorten the gap and enable activities, preferably by Education for Sustainable Development (ESD).

Impacts of climate change on Chinese natural ecosystems result in scarcities and losses and attacks on people's social vulnerability: loss of viability, increase of poverty and conflicts and far-flung impacts on businesses and economies, 'land grabbing' for compensating the loss of domestic grain output.

Joint efforts in meeting the challenges of climate change have to assume that knowledge and awareness are dependent on the level of economic development. People are increasingly aware of the fact that climate change is part of a cross-cutting issue, where the concept of green economy might serve as a driver for dealing with it. With regard to individual responsibility in facing this issue, education for sustainable development must play a major role in overcoming the barrier of not thinking holistically and thereby, provide a mental change for coping with global changes.

Vocabulary Notes

awareness-action gap: The gap between the percentage of people with an awareness of climate change and those taking action to solve the problem, principally due to the ineffectiveness of typical climate change communication strategies. "Some conventional awareness raising approaches—such as fear creation, moralizing, and information provision—are insufficient in drawing positive behavior changes from the public on climate change issues. Even worse, some of the approaches create undesired effects, such as denial or anxiety".

climate change: Climate change refers to any significant change in measures of climate such as temperature (global warming), precipitation, or wind - lasting for an extended period (decades or longer). Climate change may result from:

natural factors, such as changes in the sun's intensity or slow changes in the Earth's orbit around the sun;

natural processes within the climate system (e.g. changes in ocean circulation);

human activities that change the atmosphere's composition (e.g. through burning fossil fuels) and the land surface (e.g. deforestation, reforestation, urbanization, desertification, etc.) the United Nations

Framework Convention on Climate Change (UNFCCC) defines "climate change" as anthropogenic.

desertification: Persistent degradation of dryland ecosystems, degradation in arid, semi-arid, and dry sub-humid areas resulting from various factors, including climatic variations and human activities; largely caused by unsustainable use of scarce resources.

drought*:* drought is a prolonged absence of precipitation, a deficiency that results in water shortage.

global warming: *Global warming* is one aspect of climate change; it is an average increase in the temperature of the atmosphere near the Earth's surface and in the troposphere, which can contribute to changes in global climate patterns. *Global warming* can occur from a variety of causes, both natural and as a result of increased emissions of green-house gases from human activities.

green economy: The United Nations Environment Programme (UNEP) sees it as an economy that results in improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities.

migration: Land degradation and desertification are environmentally-induced causes for migration, besides economic and social factors. Various studies warn that global environmental change may drive 50 to almost 700 million people to migrate by 2050.

mitigation: Mitigation means implementing policies to reduce greenhouse gas emissions and enhance sinks, ecosystems that are taking carbon out of atmosphere (forests).

social vulnerability: It is the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. Social vulnerability refers to individuals and social groups and how they respond to, that is, to cope with, recover from or adapt to, any external stress placed on their livelihoods and well-being.

Answer the following questions:

1. Why is global warming one aspect of climate change?
2. Why do US-Americans regard global warming more as a result of natural causes than of human activities?

3. Why do Latin Americans feel more threatened by global warming than Europeans and US-Americans?
4. Why is 'green economy' on the top of the Rio+20 Agenda?
5. What is meant by awareness-action gap and what are the reasons for inactivity?
6. Social vulnerability caused by climate change: which regional and far-flung impacts may follow?

EXERCISES

A. *Complete the sentences with the appropriate words.*

1. The earth's climate is changing and the world is becoming _____.
2. Climate change is caused by _____ activities.
3. As a result of global warming, the sea_____ are rising.
4. Climate change can cause f_____, h_____ and d_____.
5. Coping with climate change demands also a m_____ change towards _____.
6. Disease-carrying insects are spreading in regions which have formerly been too _____for them.

B. *Match the words of Column A with the* a *appropriate words of Column B.*

1. highly advanced	a. erosion
2. environmental	b. conservation
3. vanishing	c. scientist
4. sea level	d. effects
5. nature	e. responsibility
6. shoreline	f. rise
7. fertilizing	g. economies

C. *Design an instructive graphic by using the figures of the listed countries in Fig. 2: National Changes in the assessment of the personal dangers of climate change. You may add the figures of additional countries*.
http://www.gallup.com/poll/147203/Fewer-Americans-Europeans-View-Global-Warming-Threat.aspx#2
see *second part. Rank the countries according to a chosen criterion and explain their differing assessment of threat.*

How serious of a threat is global warming to you and your family? % who view global warming as a "very" or "somewhat" serious threat, changes from 2007/2008 – 2010

Countries	***2007-2008***	***2010***
Japan	80	75
China	21	21
India	29	30
Brazil	76	78
Peru	58	75
Greece	82	87
France	75	59
Germany	61	59
Saudi Arabia	40	33
South Africa	21	28
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

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English through Climate Change, pp. 57 – 73

Integrated Assessment of Climate Policy Instruments

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Abstract

Climate policy assessments often appear to lack a multi-analytical approach capable of considering different dimensions of sustainability during the policy design. This paper presents an integrated assessment framework of climate policy instrument interactions by reconciling environmental, socio-economic, political and institutional aspects for the initial stage of policy development. Selected interacting policy instruments are categorised into their policy design characteristics, referring to parameters that describe the institutional context of each instrument. Criteria covering specific environmental, socio – political, macroeconomic, financial and technological objectives for assessing the policy instruments are identified and selected. Complementarities and overlaps between different combinations of instruments are identified. These affect subsequently the likely values of policy instruments against the evaluation criteria. By applying an interactive weighting method, policymakers are able to assign weights on the criteria expressing their perceptions and objectives. An overall assessment of combined instruments from these steps is therefore determined based on the input from policymakers. The developed framework provides a transparent tool to stakeholders capable of highlighting potential synergies and conflicts between environmental, socio-economic, political and technological criteria during the stage of climate policies design.

Background

The energy and climate policy framework of the European Union (EU) consists of a series of regulations and initiatives aiming at different objec-

tives and affect various actors in the energy and climate field. These policies aim to achieve specific objectives set by the United Nations Framework on Climate Change Convention (UNFCCC), which assigns Greenhouse Gas (GHG) emissions reduction targets for all Member States. In December 2008, EU leaders reached agreement over an energy and climate change 'package' to deliver the bloc's ambitious objectives of slashing greenhouse-gas emissions by 20%, boosting renewable energies by 20% and increasing energy efficiency to 20% of the primary energy consumption by 2020. The package has multiple objectives and is designed to increase the EU's share to combat climate change, reduce the Union's dependency on imported fuels, promote green technologies and create new jobs.

Policy instruments addressing such targets are present at EU wide level and on national basis. As far as the latter case is concerned, many instruments are currently incorporated into regulations, economic instruments, voluntary agreements, and market based mechanisms. In the EU wide context, a unified emissions trading scheme (EU ETS) was established as from 2005 based on an EU Emissions Trading Directive (CEC, 2003), followed up by an additional Directive (CEC, 2004) that enables direct links of the EU ETS with the Kyoto Protocol project mechanisms (namely Joint Implementation and Clean Development Mechanism). The climate and energy package lays down certain conditions and requirements for further improvement and amendment of EU ETS specifically for its third phase which starts in 2013. In addition, EU policy focuses also on the promotion of renewable energy sources by adopting various Directives and the recently agreed energy and climate package, which includes new targets for renewable energy sources for Member States.

Numerous *policy instruments* are applied simultaneously at an EU, national and regional level, aiming at often contradictory energy, environmental and economic targets. Given this complex policy environment, it is clear that various objectives are pursued in terms of environmental and energy effectiveness, alongside with economic efficiency. As these policies are designed and implemented in an already policy-crowded environment, interactions of their measures are taking place. These *interactions* can take different forms and shapes and in general can be complementary, overlapping or indifferent. This raises the issue of compatibility of the different policy schemes, which is of crucial importance for further policy design. In this sense, policy interactions can affect the result of the overall targets of climate policy either in a positive or negative way. In addition, policy interactions could be beneficial towards certain policy objectives but on the other hand they might affect negatively other objectives, which consequently would undermine the effectiveness of the overall policy. Thus, during the ex-ante assessment of policy interactions, a systematic way to highlight and an-

alyze trade - offs and synergies between policy objectives, is indispensable. The most common practice in *climate policy assessment* is the use of quantified tools, models and economic approaches to measure the extent of climate mitigation and economic efficiency simultaneously. There is a lack of a unified method that aims to capture the different climate policy objectives in a systematic way and thus reconcile environmental, economic, socio-political and technological aspects.

In order to reconcile the various aspects of climate and energy policy into the evaluation of policy instruments interactions, a *Multi Criteria Analysis* (MCA) approach is deemed appropriate. MCA is a structured approach used to determine overall preferences among alternative options, where the options accomplish several objectives. MCA, although appropriate for the evaluation of policy interactions, should have a properly modeled preference system in order to facilitate the decision making process. In this respect, special attention is paid to distinct stakeholders who tend to weight differently the employed criteria according to their policy objectives and preferences. Therefore, capturing this essential information could be of significant usefulness, especially if it will appropriately feed-in the decision making process.

Methodology

The authors have developed a MCA decision support tool that provides a qualitative framework for analyzing interactions among policy instruments in various policy mixes during the phase of policy design. The key concept is that policymakers and stakeholders are able to examine selected policy instruments for interaction and express their preferences towards certain criteria when assessing options of integrating various instruments.

The developed tool consists of certain features and steps that are described in detail by Oikonomou et al. (2012). In this paper the authors focus on the preference system modeling and more specifically on the elicitation of criteria weights from various stakeholders and the investigation of potential trends according to their specific preferences and objectives.

Design characteristics and areas of policy interaction

Design characteristics refer to parameters that describe several functions of a policy instrument in terms of a measure identification, objectives pursued, scope, market creation, financing, timing, and institutional setup. A detailed explanation of these characteristics is provided in Oikonomou and

Jepma (2008). The most important characteristics taken into consideration at this stage are briefly explained in table 1.

Table 1 Design characteristics of policy instruments (Adapted from Oikonomou and Jepma, 2008)

Characteristic	Explanation
Application	The option for a policy target group to participate or not in the instrument's objective accomplishment (mandatory or voluntary)
Level and kind of target	General objective of a policy translated into targets in different ambient levels (GHG reduction, RE, energy efficiency, etc) and Level of target expressed in terms of high or low stringency
Energy target	Targeting sources of energy (e.g. oil, fossil fuels) leads to substitution effect between them and hence to cleaner production, while targeting final energy use stimulates energy efficiency and reduction of energy use
Obligated entities	Entities that comprise the target group that undertakes the fulfilment of the target, distinguished in: energy producers, industry, energy suppliers, and end-users
Market flexibility	The optional choice of excluding or including some entities or sectors or technologies in the course of time of the policy cycle
Linking commodities	Type of commodity generated, exchanged and traded in a parallel to product market, distinguished in: EUA, WhC, TGC, emissions allowance, CHP certificate
Commodity liquidity	Trading participants can be allowed to bank the commodity and use it in the next compliance period. Trading participants can be allowed to borrow or lend a commodity in order to fulfil their target for the current compliance period
Cost recovery	The way that the target group recovers induced policy costs. There is partial, full or no cost recovery and is determined by market structure and market's degree of liberalization
Technologies	Technologies addressed and eligible for the target fulfilment, distinguished in: fossil fuel, renewable energy, nuclear, all, energy efficiency products
Additionality	Effect of policy if the target group would take actions independently of other policies and measures, and these investments would not have taken place in the absence of the specific policy
Institutional Setup	Entities that design, set the rules for the implementation, monitor, verify the eligibility for target fulfilment, register all actions of a policy instrument

EUA stands for Emission Unit Allowance (under the EU emissions trading scheme), WhC for White Certificates, TGC for Tradable Green Certificates and CHP for Co-Heat and Power

Design characteristics of standalone policies are combined and provide options for the formation of unified policy instruments with areas of design interaction. In a combined option of policy instruments A and B, a design characteristic X is compared in pairs and an area of policy interaction is extracted.

Design characteristics and areas of policy interaction are practically the same, but they are distinguished in the tool since they belong to different processes. Design characteristics refer to parameters of individual policy instruments, while areas of policy interaction to shared characteristics of combined policy instruments. In the options of combined policy instruments, based on the selection of design characteristics and on formulation of areas of policy interaction, the authors classify areas of policy interaction as complementary, overlapping, or indifferent. Complementary means that a design characteristic of policy A enforces the same characteristic of policy B. Overlapping means that a design characteristic of policy A reduces the value of the same characteristic of policy B. Indifferent means that a design characteristic of A and B do not meet or reinforce each other.

Climate and energy policy objectives and criteria

Evaluation criteria are indispensable for both the choice of instruments during the policy design phase and the ex-post assessment of implementation of policy instruments. The evaluation criteria are used to measure the extent of the fulfilment of the policy aspects and objectives taken into account. The main EU climate and energy policy objectives, which the EU climate and energy package aim to achieve, are the following:

- to combat climate change and reduce GHG emissions,
- to secure energy of supply and diversify the energy fuels,
- to reduce the energy consumption by increasing the energy efficiency within the economy,
- to boost technological innovation and competitiveness,
- to create new jobs

In this context, different studies have also identified criteria for the evaluation of climate and energy policy instruments (IPCC, 2007; OECD, 1997, 2001; Bondansky, 2003; Oikonomou and Jepma 2008; Gaiza – Carmenates *et al*. 2010) addressing the different dimensions of climate and energy policy evaluation. Based on review of these studies, the most relevant criteria were selected and clustered in the following five main categories trying to capture all possible aspects of climate and energy policy interactions evaluation:

1) Environmental category

Environmental effectiveness has been emphasized broadly in the environmental and climate change literature as the main criterion able to capture the extent that a policy instrument achieves the environmental goal, such as a GHG emissions reduction target (IPCC 2007; Bodansky, 2003; Oikonomou and Jepma, 2008). 'Environmental awareness' is another environmental criterion which complements the criterion of 'reduction of GHG emissions' in environmental category.

2) Socio – political category

Considering socio – political aspects is often an important issue of climate and energy policies. Blyth and Lefevre (2004) carried out a quantitative study on the interactions between energy security and climate policies highlighting the significance of '*security of energy supply*' as an evaluation criterion. Decoupling economic growth and energy use is one of the main EU objectives and thus 'reduction of *energy intensity*' has been added as a criterion in this category.

3) Financial category

The second assessment report of IPCC identifies *cost-effectiveness* as one of the main criteria for the evaluation of climate policies. Whether the policy instrument achieves the environmental objective (e.g. reduction of GHG emissions) at the lowest cost, taking transaction, information, and enforcement costs into account? 'Administration' and 'compliance' costs have been defined as separate evaluation criteria of climate and energy policy interactions by Oikonomou and Jepma (2008) additional to 'transaction' costs.

4) Macroeconomic category

Administrative and political feasibility includes considerations such as flexibility in the face of new knowledge, understandability to the general public, impacts on the 'competitiveness' of different industries, and other government objectives. "Wider" economic effects include potential effects on variables such as inflation, competitiveness, 'employment', trade, and growth (OECD, 1997). One of the priorities of EC energy policy is the enhancement of energy market liberalization (e.g. Directive 2003b) which can be captured by the 'market competition' criterion (Oikonomou and Jepma, 2008).

5) Technological category

OECD (1997) identifies dynamic effects, which relate to the impact on learning, innovation, technical progress, and dissemination and transfer of

technology. Stimulating technological change is stressed also by Bodansky (2003) as one of the main criteria for evaluating climate policies.

By reviewing the relevant literature, the criteria are categorised according to their association with the climate and energy policy aspects discussed above. Figure 1 illustrates the main climate and energy policy aspects and criteria categories, whereas table 2 provides a brief explanation of each selected criterion employed within the tool.

Figure 1 Major criteria categories and selected criteria

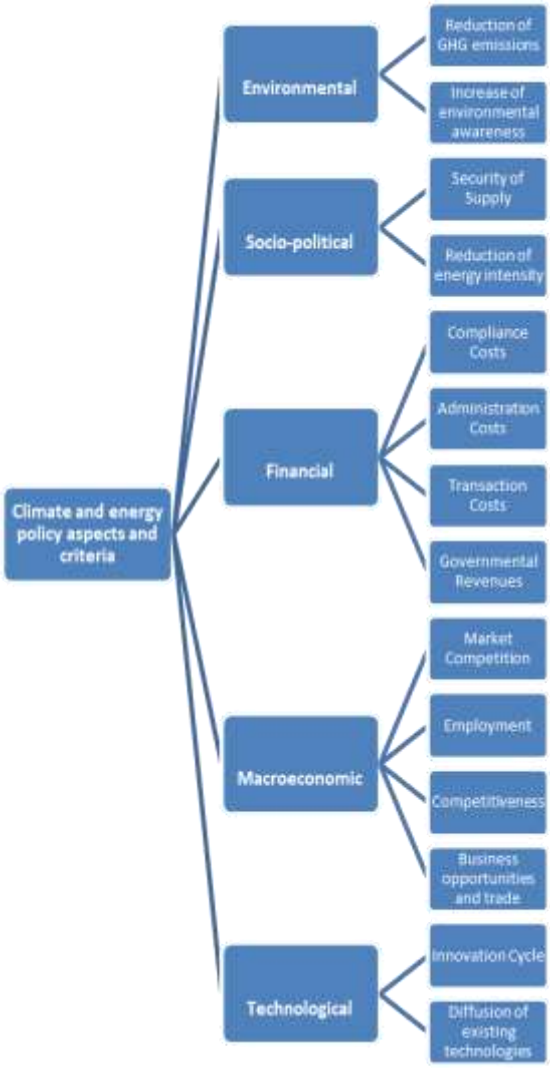

Table 2 Explanation of selected criteria

	Criterion	Explanation	Comments	Objective
Environmental category	Reduction of GHG emissions	Reduction of emissions through policy	A positive sign refers to an **increase** in reduction of GHG emissions	max
	Increase of environmental awareness	All economic actors become more environmental aware through policy	A positive sign refers to an **increase** in environmental awareness	max
Socio-Political category	Security of supply	Non interruption and security of energy supply through policy	A positive sign refers to an **increase** in security of supply	max
	Reduction of energy intensity	Reduction of energy use as input for a given output in total economy due to	A positive sign refers to an **increase** of reduction in energy intensity	max
Financial Category	Compliance costs	Direct costs for obligated parties that need to fulfill policy goals	A positive sign refers to a **decrease** in compliance costs	min
	Administration costs	Costs required from public bodies for implementing a policy based on the institutional set up	A positive sign refers to a **decrease** in administration costs	min
	Transaction costs	Search, information, negotiation, approval, monitoring, insurance costs undertaken by obligated parties due to	A positive sign refers to a **decrease** in transaction costs	min
	Governmental revenues	Revenues generated through policy that can be redistributed for an environmental or other cause	A positive sign refers to an **increase** in governmental revenues	max
Macro - economic Category	Market competition	Compatibility with market liberalization and transparency that enhance competition through policy	A positive sign refers to an **increase** in market competition	max
	Employment	New positions in sectors through policy	A positive sign refers to an **increase** in employment opportunities	max
	Competitiveness	Effects on market prices of domestic industrial products due to policy	A positive sign refers to an **increase** in competitiveness	max
	Business opportunities and trade	Enhancement of trade (national or international) and of investment opportunities (beyond the direct policy goals) due to policy	A positive sign refers to an **increase** in business opportunities and trade	max
Technological Category	Innovation Cycle	Innovation, Invention and Diffusion of new technologies can be enhanced	A positive sign refers to an **increase** in innovation activity	max
	Diffusion of existing technologies	Besides innovation, diffusion of existing efficient technologies in stock due to	A positive sign refers to an **increase** in diffusion of existing technologies	max

Table 3 Measurement scale of criteria performance

Measurement Scale of Criteria performance	Explanation *
-2	Significant decrease of criterion performance
-1	Moderate decrease of criterion performance
0	No change of criterion performance
1	Moderate increase of criterion performance
2	Significant increase of criterion performance
	* this refers to max criteria and the opposite stands for the min criteria

The criteria selected in the tool receive specific values that range from -2 to +2 and reflect the positive or negative effect of each policy instrument on the specific criterion. A zero value reflects that there is no influence on the criterion, which could also illustrate that a policy instrument is not related to targets that the specific criterion represents.

A positive or negative effect does not always mean an increase of a positive or negative value of a criterion.

The tool provides the user with performance values of policy instruments towards the evaluation criteria, as they are assessed from various literature studies and experts' judgements. The performance values for the option of integrating the policy instruments result from the design areas of integrated policy instruments and the degree of influence of areas of policy interaction on the criteria. The measurement scale is the same as of the scale of standalone policy instruments (-2 / +2).

Weighting of criteria

Each policy maker and stakeholder may apply different weights to the evaluation criteria according to policy objectives and preferences while evaluating climate and energy policy options. There are numerous methods to determine *criteria weights* which can be used in various ways for different policy evaluation purposes according to different interpretations of weights (Grafakos et al., 2012). Weights can have different meanings. They can either be perceived as relative importance coefficients stating importance of the criteria, or as scaling factors reflecting impact trade-offs between criteria.

The methodology combines an initial simple ranking criteria exercise and a pair wise comparison technique which results in criteria weights determination and a new criteria ranking. The former is a direct ranking whereas the latter one is indirect, which is determined by the weights derived by the pair wise comparisons of criteria.

Respondents' weighting judgments regarding the criteria are derived by comparing the criteria in pairs in a structured and constructive manner. The authors used the abbreviated pair wise comparison format and thus n-1 pair wise comparisons are performed.

Weighted summation

The value of the overall effect of each policy option to each criterion is multiplied with its respective criterion weight, whereas the summation of these products determines the overall value of each policy option, in our case

of each policy instrument and their combination. This overall value indicates whether two policy instruments should be integrated or not.

Conclusions

Numerous climate policy instruments are applied simultaneously at an EU, national and regional level, aiming at often various and often contradictory energy, environmental and economic objectives. As these policy instruments are designed and implemented in an already policy-crowded environment, interactions are inevitable. A systematic way to highlight and analyze trade - offs and synergies between multiple policy objectives during the ex-ante assessment of policy interactions, is indispensable. The paper presents the development of a Multiple Criteria Analysis decision support tool that provides a qualitative framework for analyzing interactions among policy instruments in various policy mixes during the phase of policy design. The key concept is that policymakers and stakeholders are able to examine selected policy instruments for interaction and express their preferences towards multiple criteria when assessing options of integrating various instruments. By applying a two step weighting process, stakeholders and policy makers have the opportunity to express their preferences in a consistent and transparent way against the multiple evaluation criteria in order to capture the importance of the various aspects of climate change policy interactions.

Vocabulary Notes

Energy efficiency: The goal of efforts to reduce the amount of energy required to provide products and services.

Emissions Trading: A market-based approach used to control pollution by providing economic incentives for achieving reductions in the emissions of pollutants. The central authority creates a market of pollution permits by setting a limit/cap on the emissions and distributes the permits to the various emitting firms. Firms that need to increase their emission permits must buy permits from those who require fewer permits.

EU emissions trading scheme (EU ETS): The largest carbon market in the world to combat climate change. The EU ETS currently covers more than 10,000 installations with a net heat excess of 20 MW in the energy and industrial sectors which are collectively responsible

for close to half of the EU's carbon emissions and 40% of its total GHG emissions.

Joint Implementation (JI): One of three flexibility mechanisms set forth in the Kyoto Protocol to help countries with binding GHG targets (so-called Annex I countries) meet their obligations.

Clean Development Mechanism (CDM): One of the three flexibility mechanisms set in the Kyoto Protocol. Its objective is to (1) assist parties not included in Annex I in achieving sustainable development and (2) to assist parties included in Annex I in achieving compliance with their quantified emission limitation and reduction commitments (GHG emission caps).

Policy instruments: Tools used by governments to implement their policies. Governments may use a number of different types of instruments. Policy instruments for environmental policy vary from economic (taxes, tax exemptions, subsidies, tradable permits), regulatory (standards and regulations) and voluntary (agreements, labelling) instruments.

Policy interactions: Interactions between different policy instruments. These interactions can take different forms and shapes and in general can be complementary, overlapping or indifferent. Policy interactions can affect the result of the overall targets of climate policy either in a positive or negative way.

Climate policy assessment: It refers to the assessment of climate policy against its main objective which is the reduction of GHG emissions. In addition, there are various methodologies, models and economic approaches to measure the extent of climate mitigation but also economic efficiency simultaneously.

Multi Criteria Analysis (MCA): A structured decision analysis approach used to determine overall preferences among alternative options, where the options accomplish several objectives.

Design characteristics: Parameters that describe several functions of a policy instrument in terms of measure identification, objectives pursued, scope, market creation, financing, timing, and institutional setup.

Environmental effectiveness: The extent that a policy instrument achieves its environmental goal (e.g. reduction of pollution).

Energy intensity: The measure of the energy efficiency of a nation's economy. It is calculated as units of energy per unit of GDP.

Security of energy supply: Non interruption and constant flow of energy supply.

Criteria weights: The relative importance coefficients stating importance of the evaluation criteria, or as scaling factors reflecting impact trade-offs between evaluation criteria.

Cost effectiveness: The cost of a policy instrument to achieve the environmental objective (e.g. cost per unit of reduced pollution).

Answer the following questions:

1. What are the objectives of the climate change 'package' agreed by the EU leaders in December 2008?
2. What is the key concept of the multi-criteria decision support tool?
3. Explain the use of evaluation criteria.
4. What is the basic difference between design characteristics and areas of policy interaction?
5. What are the five main categories of the selected evaluation criteria?
6. Explain the method of weighting the evaluation criteria.
7. Explain the terms "complementary", overlapping" and "indifferent" in relation to the areas of policy interaction.

EXERCISES

A. *Match the words of Column A with the words of Column B.*

1. Policy	a. liquidity
2. Criteria	b. recovery
3. Integrated	c. setup
4. Commodity	d. instrument
5. Cost	e. policies
6. Institutional	f. efficiency
7. Standalone	g. weights
8. Energy	h. approach

B. *Find if the following are True or False.*

1. Environmental effectiveness is the main criterion able to capture the extent that a policy instrument achieves the environmental goal.
2. Reduction of energy intensity does not constitute a criterion in the socio-political category.
3. The stimulation of technological change is one of the main criteria for evaluating climate policies.
4. A positive or negative effect means an increase of a positive or negative value of a criterion.
5. Administration costs are the direct costs for obligated parties that need to fulfil policy goals.
6. The developed weighting method is a combination of pair wise comparisons with an initial ranking technique.
7. Security of supply and reduction of energy intensity belong to the environmental criteria category.
8. Evaluation criteria are only used for the assessment of implementation of policy instruments.

C. *Complete the following chart:*

Verb	Noun	Adjective
reconcile	_____	_____
_____	consumption	_____
integrate	_____	_____
_____	_____	developed
_____	interaction	_____
reduce	_____	_____
_____	_____	assessable
_____	mitigation	_____
implement	_____	_____

D. *Fill the blanks with a suitable word.*

Numerous policy instruments are _____ simultaneously at an EU, national and regional level, aiming at often _____energy, environmental and economic targets. Given this complex _____ environment, it is clear that various objectives are pursued in terms of environmental and energy _____, alongside with economic efficiency. As these policies are designed and implemented in an already policy-crowded environment, _____ of their measures are taking place. These interactions can take different forms and shapes and in general can be _____, overlapping or indifferent. This raises the issue of _____ of the different policy schemes, which is of crucial importance for further policy design. In this sense, policy interactions can _____ the result of the overall targets of climate policy either in a positive or negative way.

E. *Put the verbs in parenthesis into their correct form.*

1. Climate policy assessments often appear to lack a multi-analytical approach capable of (consider) _____ different dimensions of sustainability during the policy design.

2. An overall assessment of combined instruments from these steps is therefore (determine) _____ based on the input from policy-makers.

3. There are various aspects (derive) _____ from climate and energy policies that policy makers aim to take into account.

4. One of the EU climate and energy policy objectives is to reduce the energy consumption by (increase) _____ the energy efficiency within the economy.

5. 'Environmental awareness' is another environmental criterion which (complement) _____ the criterion of 'reduction of GHG emissions' in environmental category.

6. One of the priorities of EC energy policy is the enhancement of energy market liberalization, which can be (capture) _____ by the 'market competition' criterion.

7. By (apply) _____ an interactive weighting method, policy-makers are able to assign weighting factors on the criteria expressing their perceptions and objectives.

8. Governmental revenues are those revenues generated through policy that can be (redistribute) _____ for an environmental or other cause.

9. The criteria weights are derived in a constructive way after (complete) _____ certain judgmental steps.

10. The evaluation of climate and energy policies first (define) _____ evaluation criteria and second categorises them into, main policy aspect categories.

F. *Finish the following sentences:*

1. The energy and climate policy framework of the European Union (EU) consists of

2. The climate change 'package' is designed to increase the EU's share to

3. Policy interactions could be beneficial towards certain policy objectives but on the other hand they might

4. There is a lack of a unified method that aims to capture the different climate policy objectives in a

5. A Multi Criteria Analysis (MCA) approach, although appropriate for the evaluation of policy interactions, should have
6. Design characteristics refer to parameters that
7. The evaluation criteria are used to measure
8. Weights can have different meanings, they can either be perceived as

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Climate Change and Wood Production Strategies

Abiodun Oluwafemi Oluwadare

Abstract

Forests contain a substantial part of the planet's carbon; therefore, current rates of forest loss contribute to almost 20 percent of total emissions of carbon dioxide. Climate change and forests are intrinsically linked: climate change is a threat to forests, and protecting forests from conversion and degradation helps mitigate the impacts of climate change. Climate change is a reality and forest trees are a major mitigation factor since they can sequester carbon dioxide and store carbon. The role of forest in the global carbon cycle is its ability to reduce carbon dioxide sources while increasing carbon dioxide sinks. In planting trees therefore, sustainable forest management is the key issue so that forest establishment can sequester more carbon over time than unmanaged forests. Tree planting programmes should be an integral part of policy that will ensure increase of forest cover. This chapter introduces the subject matter of climate change, its causes and attendant effects. Secondly, the need for planting more trees as a major mitigation measure was discussed in the context of sustainable forest management as a tool to increase forest cover. The third part contains vocabulary used with questions and exercises aiming at determining student understanding of the subject matter and to improve their grammatical and syntactical skills.

Introduction

"*Climate change* is generally recognized as one of the greatest challenges of this century. Forests contain a substantial part of the planet's carbon; therefore, current rates of forest loss contribute to almost 20 percent of total emissions of carbon dioxide. Climate change and forests are intrinsically linked: climate change is a threat to forests, and protecting forests from conversion and degradation helps mitigate the impacts of climate change" (ET-

FRN, 2009). Climate change is a phenomenon that has to do with activities which take place in the atmosphere with attendant ecological, economical and environmental effects. The impacts of climate change are various. It has brought about increase in *greenhouse gas* emissions into the *atmosphere*, unstable and unpredictable weather conditions in the areas of rainfall, soil erosion, catastrophic wind actions, increased temperature and water level. Climate change is a reality and forest trees are a major mitigation factor since they can sequester carbon dioxide and store carbon. The terrestrial warming, thawing of ice at North Pole and increasing sea level are all attendant effects of climate change. Climate change has emerged as one of the most important challenges of the 21st century according to the *Intergovernmental Panel on Climate Change* (IPCC), as more areas are getting drier while other areas are experiencing unprecedented precipitation (IPCC, 2007). There are ample evidences that the human influence or activities often referred to as *anthropogenic* causes of climate change cannot be overemphasized. We must all accept the reality of climate change (Adger et al., 2005).

Causes of Climate Change

If climate is changing, the consequence of this change is *global warming*. Global warming is a gradual increase in the earth's temperature. This happens when the emitted radiation passes through the atmosphere and travels back to space. During the process some of it is absorbed by greenhouse gas; this absorbed gas is re-emitted. The *concentration* of these gases increases and thus, it traps heat more effectively than other gases. The trapped heat accumulates near the earth's surface and causes it to heat up, a phenomenon called *greenhouse effect*. Thus, carbon dioxide is the main greenhouse gas. The largest contributors to the greenhouse effect are *water vapour* and *carbon dioxide*.

Other causes are, land-use change, burning of fossil fuel, indiscriminate removal of trees in an area called *deforestation*, bush burning; cement manufacture which can generate 240g of sulphur dioxide and up to 6kg on nitrogen than carbon dioxide per tonne of cement. Disruption of carbon stock on forest floor through excessive logging, ecosystem damage and soil tillage can also add to the amount of CO_2 in the atmosphere. Other anthropogenic sources are manufacturing processes producing airborne solid or liquid particles which are released into the atmosphere and which are called *aerosols.* They are capable of scattering and absorbing radiation and *black carbon* from soot and charcoal (CCIR, 2012).

Effects of Climate Change

The expectation of increase in greenhouse gases is high and both plants and animals may have to adapt to its impacts or effects in order to cope. Andrady et al. (2003) opined that there would be photo-degradation of materials arising from increase temperatures. Other effects include sea-level rise (about 70cm) arising from thawing of ice caps, ice-sheets at polar regions, glaciers, pollution may increase, some species that are unable to adapt will eventually die. Climate change will compound existing food insecurity, vulnerability patterns and biodiversity loss. Extreme weather events such as heat wave, cold, wind and storm, floods and landslides may become more prevalent which could lead to loss of lives and properties as witnessed in major parts of the world like U.S.A., Japan, Bangladesh, and some parts of Europe and Asia.

The Need for Tree Planting in Mitigating Climate Change

Forest ecosystems capture and store carbon dioxide (CO_2), making a major contribution to the mitigation of climate change. When forests are destroyed, over-harvested or burned, they can become a source of CO_2 emissions (ETFRN, 2009). The role of forest in *carbon sequestration* is so beneficial that young forest plantations can act much more as carbon *sink* than old plantations. Carbon sink is the ability of forest area to help the environment by taking in carbon from the air so that the effects of global warming are reduced (Longman, 2003). Trees can do this in four ways namely:

i. Through photosynthetic bio-chemical activities of the trees.

ii. Storing carbon captured in the tree in the form of wood. This makes possible the utilization of the forest for the production of various forest products.

iii. Substitution of wood for items or products that emit high carbon such as steel or aluminium.

iv. In-situ carbon storage of wood in service or out of service until needed.

The role of forest in the global carbon cycle according to Reid, et al., 2004, is its ability to reduce carbon dioxide sources while increasing carbon dioxide sinks. The ability of trees to lock up carbon in wood makes them a veritable tool in climate change *mitigation.* According to Forestry Commission of United Kingdom (2012), a single tree can lock up 2 kg of carbon. Trees and forests have a clear role to play in the mitigation measures against

climate change. Choosing wood to save CO_2 is logical as different manufacturing processes emit different concentration of CO_2. For instance, standard concrete, red brick and sawn timber have net emission of 135, 675, and -1,500g CO_{2e}/kg respectively with wood having the lowest (Macqueen et al. 2004). In planting trees therefore, sustainable forest management is the key issue so that forest establishment can sequester more carbon over time than unmanaged forests. Harvested wood if not destroyed can store the carbon in it for a long period of time thereby having better long life cycle. According to Patossarri (2007), the major advantage of a well managed forest includes *forest regeneration*, health promotion and vitality. This can be achieved by managing forest with high carbon uptake potential, expansion of forest through *reforestation* and *afforestation*, reduction in the rate of deforestation and reversing the loss of *forest cover*, increasing use of forest-based products and provision of enabling environment for investments and market access to sustainable forest-based products. In Nigeria, there has been an increased awareness of tree planting programmes to an extent that individual holdings of planted plantation is more than 20,000 hectares. On the other hand, corporate organisation owns forest plantation of over 10,000ha. This is a welcome development. This initiative is similar to the tree planting project in Mbale, Uganda, a project supported by Wale Government. Tree planting programme should therefore be an integral part of policy that will ensure increased forest cover.

To increase the total land area under forest cover, public awareness should be intensified on *greenbelt* project and giving of *carbon credit* to those who will be ready to give their land up for tree planting should be considered. The greenbelt arrangement would assist in biodiversity conservation, water resources conservation and restoration of damaged ecosystem. In the establishment of trees, preference should be given to indigenous species that have established themselves at various sites rather than exotic species that will require *adaptation* to new sites as a result of climate change effect; though species may have to develop *adaptive capacity* in view of climate change.

Conclusion

The reality of climate change is already starring us at face and its consequences will be tremendous if issues relating to its mitigation are not pursued with all seriousness. The increase in the concentration of greenhouse gases is a result of human-driven (anthropogenic) emissions of carbon dioxide and other greenhouse gases, as well as land-use change.

Since forests have greater potential in storing carbon, it is advocated that more trees should be planted through a well-planned sustainable forest management. The knowledge of terms used to describe climate change is essential to foster greater understanding of what it means and how these terms are to be used in relation to climate change discussions.

Vocabulary Notes

Adaptation: Adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploit beneficial opportunities. It involves practical steps to protect countries and communities from the likely disruption and damage that will result from effects of climate change.

Adaptive capacity: the ability of a system to adjust to change, in terms of expanding the range of impacts with which it can cope, reducing its sensitivity to the changes or both.

Aerosol: A collection of airborne solid or liquid particles, with a typical size between 0.01 and 10 micrometers (μm) and residing in the atmosphere for at least several hours. Aerosols may be of either natural or anthropogenic origin. Aerosols may influence climate in two ways: directly through scattering and absorbing radiation, and indirectly through acting as condensation nuclei for cloud formation or modifying the optical properties and lifetime of clouds.

Afforestation: Planting of new forests on lands that historically have not contained forests.

Anthropogenic: Made by people or resulting from human activities. Usually used in the context of emissions which are produced as a result of human activities.

Atmosphere: The gaseous envelope 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, radiatively active greenhouse gases such as carbon dioxide (0.035% volume mixing ratio), and ozone. In addition the atmosphere contains water vapor, whose amount is highly variable but typically 1% volume mixing ratio. The atmosphere also contains clouds and aerosols.

Black Carbon: Operationally defined species based on measurement of light absorption and chemical reactivity and/or thermal stability; consists of soot, charcoal, and/or possible light-absorbing refractory organic matter.

Carbon dioxide: 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 removing carbon from the atmosphere and depositing it or locking it up in a reservoir in this case wood.

Carbon Sequestration: The uptake and storage of carbon. Trees and plants, for example, absorb carbon dioxide, release the oxygen and store the carbon. Fossil fuels were at one time biomass and continue to store the carbon until burned.

Carbon sink: A large area of forest that is believed to help the environment by taking in carbon from the air so that the effects of global warming are reduced.

Climate change: 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. See also climate variability.

Climate Change: Climate change refers to any significant change in measures of climate (such as temperature, precipitation, or wind) lasting for an extended period (decades or longer). Climate change may result from:

Concentration: Amount of a chemical in a particular volume or weight of air, water, soil, or other medium.

Deforestation: Those practices or processes that result in the conversion of forested lands for non-forest uses. This is often cited as one of the major causes of the enhanced greenhouse effect for two reasons: 1) the burning or decomposition of the wood releases carbon dioxide; and 2) trees that once removed carbon dioxide from the atmosphere in the process of photosynthesis are no longer present.

Forest cover: Forest stands or cover types consisting of plant community made up of trees and other woody vegetation, growing more or less closely together covering a large area of land. It is also defined as an

area more than 1 ha of land and having tree canopy density of 10 percent and above.

Forest regeneration: an act of renewing tree cover by establishing young trees by natural or artificial means.

Global Warming: Global warming is an average increase in the temperature of the atmosphere near the Earth's surface and in the troposphere, which can contribute to changes in global climate patterns. Global warming can occur from a variety of causes, both natural and human induced. In common usage, "global warming" often refers to the warming that can occur as a result of increased emissions of greenhouse gases from human activities.

Greenbelt: An area of land around a city where building are not allowed, in order to protect fields and woods.

Greenhouse Effect: Trapping and build-up of heat in the atmosphere (troposphere) near the Earth's surface. Some of the heat flowing back toward space from the Earth's surface is absorbed by water vapor, carbon dioxide, ozone, and several other gases in the atmosphere and then reradiated back toward the Earth's surface. If the atmospheric concentrations of these greenhouse gases rise, the average temperature of the lower atmosphere will gradually increase.

Greenhouse Gas (GHG): Any gas that absorbs infrared radiation in the atmosphere. Greenhouse gases include, but are not limited to, water vapour, carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), chlorofluorocarbons (CFCs), hydrochlorofluorocarbons (HCFCs), ozone (O_3), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6).

Intergovernmental Panel on Climate Change (IPCC): The IPCC was established jointly by the United Nations Environment Programme and the World Meteorological Organization in 1988. The purpose of the IPCC is to assess information in the scientific and technical literature related to all significant components of the issue of climate change.

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

Reforestation: Planting of forests on lands that have previously contained forests but that have been converted to some other use.

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.

Water Vapour: The most abundant greenhouse gas, it is the water present in the atmosphere in gaseous form. Water vapor is an important part of the natural greenhouse effect. While humans are not significantly increasing its concentration, it contributes to the enhanced greenhouse effect because the warming influence of greenhouse gases leads to a positive water vapour feedback.

Weather: Atmospheric condition at any given time or place. It is measured in terms of such things as wind, temperature, humidity, atmospheric pressure, cloudiness, and precipitation. In most places, weather can change from hour-to-hour, day-to-day, and season-to-season. Climate in a narrow sense is usually defined as the "average weather", or more rigorously, as the statistical description in terms of the mean and variability of relevant quantities over a period of time ranging from months to thousands or millions of years. The classical period is 30 years, as defined by the World Meteorological Organization (WMO).

Answer the following questions:

1. What is causing the increase of carbon dioxide in the atmosphere?
2. Explain the term global warming.
3. List five consequences of climate change.
4. Describe how trees can reduce the concentration of carbon dioxide in the atmosphere.
5. In what ways can trees reduce the effects of climate change?
6. Define the following terms:
    a. Reforestation
    b. Afforestation
    c. Deforestation
    d. Forest regeneration
    e. Forest cover
7. How would you explain anthropogenic activities in relation to climate change?

EXERCISES

A. *Use the word(s) in column B to complete the word in column A.*

1. Climate	a. Gas
2. Unpredictable	b. Fuel
3. Mitigation	c. Change
4. Anthropogenic	d. Factor
5. Global	e. Weather conditions
6. Carbon	f. Loss
7. Fossil	g. Dioxide
8. Biodiversity	h. Sequestration
9. Carbon	i. Causes
10. Greenhouse	j. Warming

B. *Indicate which of the following are True or False.*

1. Global warming is as a result of climate change.
2. Climate change and forests are strongly linked together.
3. Only human activities are responsible for climate change.
4. Disruption of carbon stock on forest floor through excessive logging can increase carbon dioxide concentration.
5. Climate change can lead to biodiversity loss.
6. Carbon sink means dissolving carbon in water.
7. Leaves store carbon in trees.
8. Carbon dioxide and water vapour are major greenhouse gases.
9. Carbon sequestration means uptake and storage of carbon by trees.
10. Older plantations can sequester more carbon dioxide than young plantations.

C. *Complete the following.*

Verb	Noun	Adjective
recognise	_____	recognisable
contribute	contribution	_____
_____	emission	_____
degrade	_____	degradable
_____	_____	absorbent
adapt	_____	_____
mitigate	_____	mitigating

D. *Fill the blanks with suitable word.*

Climate change is generally recognised as one of the greatest _____ of this century. The impacts of climate change are in varied _____. It has brought about increase in _____ _____ emissions into the atmosphere. Forest trees are a major _____ factor. Trees have the ability to _____ carbon dioxide and store carbon.

Carbon sink is the ability of _____ _____ to help the environment by taking in carbon from the air so that effects of global warming are reduced. Sawn timbers have net emissions of _____ CO_{2e}/kg while red brick has _____ CO_{2e} /kg. Greenbelt can lead to increase in _____ _____.

E. *Put the verbs in parenthesis into their correct form.*

1. Current rate of forest (lose) _____ contribute to almost 20 percent of total emissions of carbon dioxide.
2. Climate change and forests are intrinsically (link) _____.
3. There are ample (evidences) _____ that the anthropogenic causes of climate change cannot be set aside.
4. The concentration of greenhouse gases is (increase) _____.

5. Other _____ (cause) of increasing greenhouse gas is land-use changes.
6. Forest ecosystem captures and _____ (stores) carbon dioxide.
7. Sustainable forest management is the key issue in (increase) forest cover to sequester more carbon dioxide.
8. Tree planting programmes _____ (shall) _____ (gives) preference to indigenous species.

F. *Complete the following sentences.*

1. Global warming is caused by _____.
2. Climate change is a reality and forest trees are a major _____.
3. The terrestrial warming and increasing sea level are all attendant effects of _____ _____.
4. The trapped heat accumulates near the earth's surface causing it to heat up, a phenomenon _____ effect.
5. The greatest contributors to the greenhouse effect are _____ _____.
6. Ecosystem damage and soil tillage can _____ _____ of CO_2 in the atmosphere.
7. Plants and animals may have to adapt to climate change impact _____.
8. The role of forest in the carbon cycle is in its ability to reduce _____ _____.
9. Harvested wood if not destroys can store _____ _____ period of time.
10. Tree planting programmes should be an integrated part of _____ _____.

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Climate Change Adaptation

Geoff O'Brien

Abstract

There is increasing urgency in the climate debate of the need for adaptation. It is increasingly clear from Copenhagen through to Durban that reaching an international agreement that will make meaningful gas emission reductions is unlikely. Further, we now realise that the greenhouse gas emissions already loaded into the atmosphere will cause global temperatures to change. We will have to adapt to the consequences of that historical loading and to any further future increases in greenhouse gas levels. In short, we are likely to increase the risk of adverse climate impacts. Adaptation is the vehicle we will have to use in order to respond to those risks. First, this chapter discusses the institutional context for addressing climate risks, the types of changes that are likely, what is meant by adaptation, the costs of adaption and likely adaptation strategies. Second, the chapter provides a glossary of the most important terms used in the text presented in the first part. The third part provides different exercises aiming either to further consolidate student understanding of these terms or / and strengthen student grammatical and syntactical skills.

Introduction

Though there is general agreement that there is an urgent need to reduce greenhouse gas emissions, there is also recognition that we will have to adapt to the changes that will be driven by the emissions already loaded into the atmosphere. In addition, there seems to be little likelihood of an international agreement to reduce emissions before 2020. This means that more emissions are likely to be loaded into the atmosphere, further accelerating climate change. There is a possibility that we will enter an era of dangerous climate change, where extreme events could severely threaten communities

and livelihoods throughout the world or even cause irreversible damage to ecosystems.

Governance of Climate Change and its Impacts

International efforts to address climate change are realised through the *United Nations Convention on Climate Change (UNFCCC).* The signatories to the Convention form a body known as the *Convention of the Parties (COP).* This body meets annually in order to negotiate how the climate problem will be addressed. They base their judgements upon reports prepared by the *Intergovernmental Panel on Climate Change (IPCC).* IPCC produces reports based on peer reviewed science on all aspects of climate change. IPCC acts as an advisory body to COP. Since UNFCCC came into force in 1984 the COP has met 17 times. IPCC has produced 4 Assessment Reports. The last was published in 2007 and the next is due in 2013.

Within the UN, the *United Nations International Strategy for Disaster Reduction (UNISDR)* has responsibility for dealing with hazardous events. Though its remit covers a wide range of natural and technological *hazards*, more recently, there has been a greater focus on climate change impacts. The *Hyogo Framework for Action (HFA)* sets out an agenda for building the resilience of communities (UN/ISDR, 2005). Until recently these two UN bodies did not have a close relationship. This may seem odd given that UN/ISDR deals with Disaster Risk Reduction (DRR) and adaptation is a strategy for reducing the disaster *risk* of climate driven events. In 2006 UNFCCC and UN/ISDR agreed to collaborate. The outcome of this collaboration is a report entitled 'Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation' that sets out how disaster management techniques can be used in climate adaptation (IPCC, 2011). At the time of writing it is too early to judge how effective this collaboration will be, but it does give a new impetus to the adaptation debate.

It is generally recognised that poorer nations will require help to develop adaptation strategies. In 2009, the *Green Climate Fund* was established at the Copenhagen COP as the vehicle for distributing funding to poorer nations (Copenhagen Accord, 2009). The Copenhagen Accord committed developed countries to provide $30 billion in fast-start finance for developing countries in 2010-12 and to mobilize $100 billion a year in public and private finance by 2020 for adaptation and low carbon initiatives. The Durban COP in 2011 finalised the structure and operating procedures for the Green Climate Fund. The Developed World countries are expected to fund their adaptation strategies through national budgets. Typically this will be delivered through *national disaster management platforms.*

Table 1 Examples of possible impacts of climate change due to changes in extreme weather and climate events, based on projections to the mid- to late 21st century. *Adapted from Table SPM.1 (IPCC, 2007)*

Phenomena and direction of trend	Agriculture, forestry and ecosystems	Water resources	Human health	Industry, settlement and society
Over most land areas, warmer and fewer cold days and nights, warmer and more frequent hot days and nights	Increased yields in colder environments; decreased yields in warmer environments; increased insect outbreaks	Effects on water resources relying on snow melt; effects on some water supplies	Reduced human mortality from decreased cold exposure	Reduced energy demand for heating; increased demand for cooling; declining air quality in cities; reduced disruption to transport due to snow, ice; effects on winter tourism
Warm spells/heat waves. Frequency increases over most land areas	Reduced yields in warmer regions due to heat stress; increased danger of wildfire	Increased water demand; water quality problems, e.g., algal blooms	Increased risk of heat-related mortality, especially for the elderly, chronically sick, very young and socially-isolated	Reduction in quality of life for people in warm areas without appropriate housing; impacts on the elderly, very young and poor
Heavy precipitation events. Frequency increases over most areas	Damage to crops; soil erosion, inability to cultivate land due to waterlogging of soils	Adverse effects on quality of surface and groundwater; contamination of water supply; water scarcity may be relieved	Increased risk of deaths, injuries and infectious, respiratory and skin diseases	Disruption of settlements, commerce, transport and societies due to flooding; pressures on urban and rural infrastructures; loss of property
Area affected by drought increases	Land degradation; lower yields/crop damage and failure; increased livestock deaths; increased risk of wildfire	More widespread water stress	Increased risk of food and water shortage; increased risk of malnutrition; increased risk of water- and food-borne diseases	Water shortages for settlements, industry and societies; reduced hydropower generation potentials; potential for population migration
Intense tropical cyclone activity increases	Damage to crops; wind-throw (uprooting) of trees; damage to coral reefs	Power outages causing disruption of public water supply	Increased risk of deaths, injuries, water- and food-borne diseases; post-traumatic stress disorders	Disruption by flood and high winds; withdrawal of risk coverage in vulnerable areas by private insurers, potential for population migrations, loss of property
Increased incidence of extreme high sea level (excludes tsunamis)	Salinisation of irrigation water, estuaries and freshwater systems	Decreased freshwater availability due to saltwater intrusion	Increased risk of deaths and injuries by drowning in floods; migration related health effects	Costs of coastal protection versus costs of land-use relocation; potential for movement of populations and infrastructure; also see tropical cyclones above

Climate Change Risks

Broadly speaking, accelerated climate change risks are *meteorological* in nature. Increased temperatures, drought and floods are likely to be more severe and less predictable. Table 1 highlights some of the possible risks that human societies will have to face.

In 2009, there was great hope that the COP meeting, held in Copenhagen, would produce a successor to the *Kyoto Protocol* (protocols are an instrument that is agreed by members of a convention that binds the signatories to an agreed set of targets; in the case of the Kyoto Protocol this was to reduce global greenhouse gas emission by 5%). To help inform the debate, a group of authors, primarily previous IPCC lead authors familiar with the rigor and completeness, required for a scientific assessment of this nature, produced the Copenhagen Diagnosis (The Copenhagen Diagnosis, 2009). The purpose of this report was two-fold. First, it acted as an interim evaluation of the evolving science midway through an IPCC cycle (IPCC AR5 is not due for completion until 2013). Second, the report served as a handbook of science updates that supplemented the previous IPCC AR4 2007 report. The report discusses the possibility of reaching "*tipping points*" where irreversible damage to ecosystems could occur. A tipping point is where warming, for example, of the tundra releases methane into the atmosphere. *Methane* is a powerful greenhouse gas and this would further accelerate the warming trend. The report identifies several vulnerable elements in the climate system (continental ice-sheets, Amazon rainforest, West African monsoon and others) that could be pushed towards abrupt or irreversible change if warming continues. This would constitute a major challenge (Copenhagen Diagnosis, 2009).

What is clear from this is that we will have to adapt to significant changes and that it may be the case that we have already reached tipping points that could lead to *irreversible* change. It is clear that adaptation is needed urgently. Evidence from the 2009 and subsequent COP meetings is that adaptation is now recognised as being necessary for all nations.

Adaptation

Adaptation is a process of adjustment to disruptive events. It is not a new concept. Societies have adjusted continually throughout human existence. From a climate change perspective adaptation is a *precautionary* or *anticipatory* adjustment(s) to shifts already happening or likely to happen in the near future. It is defined by IPCC in its Third Assessment Report as:

Adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities. Various types of adaptation can be distinguished, including anticipatory and reactive adaptation, private and public adaptation, and autonomous and planned adaptation. (IPCC, 2001)

Adaptation is not just adjustment to an average climate condition but is a response to reduce vulnerability to extremes, variability, and rates of change at all scales (IPCC, 2001). This definition reflects the variety of views of adaptation ranging from an ecological concept in UNFCCC, to a series of actions and more recently to a synonym for development (Schipper, 2006).

Though the aim of adaptation is to reduce or mitigate vulnerability, its focus is on adaptive capacity.

IPCC (2001) defines adaptive capacity as:-

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

IPCC defines vulnerability as:-

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 (IPCC, 2007, p. 883).

IPCC defines sensitivity as:-

The degree to which a system is affected, either adversely or beneficially, by climate-related *stimuli*. Climate-related stimuli encompass all the elements of climate change, including mean climate characteristics, climate variability, and the frequency and magnitude of extremes (IPCC, 2001).

Essentially adaptive capacity refers to the potential or ability of a system, region, or community to adapt to the effects or impacts of climate change. IPCC describes adaptive capacity as the ability of a system to adjust to actual or expected climate stresses, or to cope with the consequences and defines adaptive capacity as being a function of *determinants* such as wealth, technology, education, information, skills, *infrastructure*, access to resources, and stability and management capabilities (IPCC, 2001). Wealthier nations have greater adaptive capacity than poorer nations.

The final term that is important in adaptation is resilience. Resilience is defined by UN/ISDR as:-

The capacity of a system, community or society potentially exposed to hazards to adapt, by resisting or changing in order to reach and maintain an acceptable level of functioning and structure. This is determined by the degree to which the social system is capable of organizing itself to increase this capacity for learning from past disasters for better future protection and to improve risk reduction measures (UN/ISDR, 2005).

It can be seen that building resilience is a function of learning from experience and using the determinants of adaptive capacity to better prepare for future. In this sense resilience is an on-going process. This is an important aspect of adaptation to climate change as we will have constantly assess climate hazards and make judgements about the risks that they will produce.

Costs of Adaptation

Some work has been done in estimating what costs of adaptation might be. Studies by the World Bank and Stern on the costs of adaptation, published in 2006, suggested costs between $4 and 91bn per annum (Stern, 2006; World Bank, 2006). However, estimates were based on climate-proofing investments (FDI, GDI and ODA flows – Foreign Direct Investment, Gross Domestic Investment and Overseas Development Aid). Studies in 2007 from UNDP (UN Development Programme) and Oxfam estimated costs between $50 and 109bn (Oxfam, 2007; UNDP, 2007). These estimates were based on the World Bank method but broadened to include *Non-Governmental Organisation (NGO)* projects and poverty reduction measures. In 2007 UNFCCC (UN Framework Convention on Climate Change) estimated that total funding need for adaptation by 2030 could amount to between $49 and 171bn per annum globally, of which between $27 and 66bn would accrue in developing countries (UNFCCC, 2007). More recent analysis suggests that these figures underestimate the costs of adaptation. One important issue to note is the sector for which estimates are made. Adaptation is complex. Adaptation studies need to include a number of sectors, such as agriculture, water, ecosystems, coastal systems, human health and infrastructure all of which are necessary aspects of human well-being. The UNFCCC study, for example, did not include mining, manufacturing, energy, retailing and tourism. An analysis by Parry et al (2009) of the UNFCCC study, suggest that in some sectors estimates may need to be 2 or 3 times higher.

A 2010 study by the World Bank into the infrastructure costs alone suggest an annual spend between $75 and 100bn (World Bank 2010). One of the

problems is deciding what areas and sectors to protect. This implies that a concerted effort is likely to be much higher that current published estimates. Given that the recent World Bank study only focuses on infrastructure then it is not unreasonable to assume that a comprehensive approach is likely to exceed $100bn per annum.

Adaptation Strategies

Risk to human populations is a function of frequency (occurrence of a hazard), severity and vulnerability. Vulnerability represents a range of factors that express the state of development that determine the amount of damage and loss of human life that a particular hazard can cause. Vulnerability and hence risk are socially determined.

For climate related disasters, hazard represents the likelihood of occurrence, and potential severity of events such as droughts, floods and storms, while vulnerability represents the set of social, economic, political and physical factors that determine the amount of damage a given event will cause. Risk to populations arises from the interaction of hazard and vulnerability. The risks of future climate change will be determined by the evolution of hazards and vulnerability. Patterns of risk will change with changing natural hazards driven by climate change and climate variability. Increased precipitation and coastal surges are likely to become more common. Longer term sea level rise will have major impacts for low lying land and extreme temperatures will heighten the problems of drought prone areas – there is already evidence that impacts are pushing many communities to the edge of their coping capacity.

Adaptation strategies require an assessment of the hazards and consequently the risk that human populations are likely to face. This assessment will lead to the development of solutions. Adaptation measures will be dependent upon location and socio-economic conditions. In short adaptation measure are very likely to be unique to location and should focus on DRR.

UN/ISDR defines DRR as:-

The concept and practice of reducing disaster risks through systematic efforts to analyse and manage the causal factors of disasters, including through reduced exposure to hazards, lessened vulnerability of people and property, wise management of land and the environment, and improved preparedness for adverse events.

UN/ISDR, 2009

Table 1 highlights a number of potential threats such as flooding, storms, droughts, etc. DRR practice means putting in place measures to deal with the threats that are likely. Broadly these can be characterised in 2 ways:-

Structural measures: Any physical construction to reduce or avoid possible impacts of hazards, or application of engineering techniques to achieve hazard-resistance and resilience in structures or systems.

Non-structural measures: Any measure not involving physical construction that uses knowledge, practice or agreement to reduce risks and impacts, in particular through policies and laws, public awareness raising, training and education.

UN/ISDR, 2009

Structural measures refer to any physical construction that will reduce or avoid the likely impacts of climate hazards. These include engineering measures and construction of hazard-resistant and protective structures and infrastructure and can include flood levies, ocean wave barriers and evacuation shelters.

Non-structural measures refer to policies, awareness, knowledge development, public commitment, and methods and operating practices, including participatory mechanisms and the provision of information, which can reduce risk and related impacts. Common non-structural measures include *building codes*, *land-use planning laws* and their enforcement, research and assessment, information resources, and public awareness programmes.

Measures can range from the building of flood defences through to the introduction of drought resistant crops. What is important to note is that adaptation measures will need to build on local knowledge as well as good climate science. In short there will have to be an interchange of information of what works best and why. It will be through that process of learning that adaptation measures will build resilience.

Vocabulary and Terminology Notes (this does not include definitions included in the text)

United Nations Convention on Climate Change (UNFCCC): A Convention sets out a set of rules and procedures to address a particular problem, in this case climate change. The more nations that join a convention the more likely it is to be effective. Almost all nations on earth have joined UNFCCC.

Convention of the Parties (COP): This is the governing body of UNFCCC. Each nation that signs UNFCCC is entitled to be a member of the COP.

Intergovernmental Panel on Climate Change (IPCC): This body is responsible for reviewing of all the science related to climate change. It produces periodic reports that are use by COP as the basis for decision making.

United Nations International Strategy for Disaster Reduction (UNISDR): This body is responsible for developing a global risk reduction strategy.

Risk: This is a socially constructed concept and is function of hazard and vulnerability.

Green Climate Fund: This was established at the Copenhagen COP to provide funding for adaptation and low carbon projects for poorer nations.

National Disaster Management Platforms: These are the legislative and regulatory frameworks established at the national levels for protecting citizens from harm.

Meteorological: This term refers to the weather events.

Kyoto Protocol: Protocols are legally binding agreements that can be established by a Convention. The Kyoto Protocol was established by UNFCCC to reduce global greenhouse gas emissions by about 5 degrees Celsius. Note not all members of UNFCCC signed the Protocol, notably the USA.

Tipping Points: These are points in a system where positive feedback occurs and this tends to reinforce what is happening in the system. In climate change this refers to the release of methane form a melting of the tundra. Equally it can also refer to deforestation which releases carbon dioxide back into the atmosphere.

Methane: A powerful greenhouse gas that occurs naturally.

Irreversible: This means that changes cannot be reversed.

Precautionary: This is an approach which suggests that actions should not be taken until there is sufficient evidence that the action will not cause harm.

Anticipatory: This means doing things in ways that anticipate events.

Stimuli: This refers to a number of different inputs that help to bring about change.

Determinants: This refers to the range of factors that will determine how a system will behave.

Infrastructure: This is the equipments, roads, rail, ports, buildings, etc that have been developed by human populations to facilitate a range of activities and to provide a range of services.

Non-Governmental Organisation (NGO): These are bodies that are independent of national governments and undertake projects that are designed to help people and communities.

Building Codes: These are the set of standards that are used to control the development of buildings.

Land-use Planning: This is the legal framework that determines how land can be used.

Answer the following questions:

1. Why is it important that we focus on adapting to climate change?
2. What is the role of COP in UNFCCC?
3. What is the role of IPCC in UNFCCC?
4. What is the purpose of the Green Climate Fund?
5. Give some examples of the impacts of climate change.
6. What are "tipping points"?
7. What is adaptive capacity?
8. What are the determinants of adaptive capacity?
9. Give an outline of the likely costs of adaptation.
10. Why is risk socially constructed?
11. What are structural measures?
12. What are non-structural measures?

EXERCISES

A. *Match the words or phrases of Column A with the words of Column B.*

1. Adaptive	a. Systems
2. Accelerated	b. Defence
3. Tipping	c. Review
4. Structural	d. Capacity
5. Flood	e. Change
6. Drought	f. Measure
7. Coastal	g. Point
8. Peer	h. Prone

B. *Find if the following are True or False.*

1. Adaptation measures are really needed as a precaution as there is likely to be an effective international agreement to mitigate greenhouse gases.
2. The responsibility for adaptation measures in the developed world rests with national governments.
3. Adaptation will be very costly.
4. UN/ISDR has sole responsibility for dealing with the impacts of climate change.
5. Accelerated climate change and variability will drive extreme events in the weather system.
6. Adaptive capacity is a function of vulnerability.
7. Risk is natural.
8. Structural measures are focused on the use of knowledge, practice or agreement to reduce risks and impacts, in particular through policies and laws, public awareness raising, training and education.
9. COP is the governing body of UNFCCC.
10. A protocol is voluntary agreement.

C. *Complete the following chart.*

Verb	Noun	Adjective
_____	_____	adapted
vary	_____	_____
_____	_____	disruptive
_____	_____	changed
reduce	_____	_____
_____	changing	_____
_____	_____	measured
structure	_____	_____

D. *Put the verbs in parenthesis into their correct form.*

1. The Hyogo Framework for Action (HFA) sets out an agenda for (build) _____ the resilience of communities (UN/ISDR, 2005).
2. In 2009 the Green Climate Fund was (establish) _____ at the Copenhagen COP as the vehicle for distributing funding to poorer nations (Copenhagen Accord, 2009).
3. The report (identify) _____ several vulnerable elements in the climate system (continental ice-sheets, Amazon rainforest, West African monsoon and others) could be (push) …….. towards abrupt or irreversible change if warming continues.
4. The outcome of this (collaborate) _____is a report entitled 'Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation' that sets out how disaster management techniques can be used in climate adaptation (IPCC, 2011).
5. The risks of future climate change will be determined by the (evolve) _____ of hazards and vulnerability.
6. The risks of future climate change will be (determine) _____ by the evolution of hazards and vulnerability.

7. This is an important aspect of adaptation to climate change as we will have constantly assess climate hazards and make (judge) _____ about the risks that they will produce.
8. In 2007 UNFCCC (UN Framework Convention on Climate Change) (estimate) _____ that total funding need for adaptation by 2030 could amount to between $49 and 171bn per annum globally, of which $27 and 66bn would accrue in developing countries (UNFCCC, 2007).
9. Given that the recent World Bank study only (focus) _____ on infrastructure then it is not unreasonable to assume that a comprehensive approach is likely to exceed $100bn per annum.
10. IPCC produces reports that are (base) _____ on peer reviewed science on all aspects of climate change.

E. *Finish the following sentences.*

1. Though there is general agreement that there is an urgent need to reduce greenhouse gas emissions, there is also recognition _____
2. This may seem odd given that UN/ISDR deals with _____
3. The Copenhagen Accord committed developed countries to provide $30 billion in fast-start finance _____
4. To help inform the debate a group of authors primarily previous IPCC lead authors familiar _____
5. The report identifies several vulnerable elements in the climate system (continental ice-sheets, _____
6. This definition reflects the variety of views of adaptation ranging _____
7. Vulnerability is a function of the character, magnitude, _____
8. IPCC describes adaptive capacity as the ability of a system to adjust to actual or expected climate stresses, or to cope with the consequences and defines adaptive capacity as being a function of ….
9. Adaptation studies need to include a number of sectors, such as agriculture, _____
10. Non-structural measures refer to policies, awareness, knowledge _____

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English through Climate Change, pp. 103 – 118

Adaptation is not enough: Why Insurers Need Climate Change Mitigation

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Abstract

Current insurer responses to anthropogenic climate change are generally adaptive and weakly mitigative rather than strongly mitigative. In this chapter, we argue successful insurance system adaptation to anthropogenic climate change depends on returning the climate to a stable, familiar and relatively predictable state. Effective mitigation is therefore a necessary precondition for successful longer-term insurance system adaptation to climate change. To make this argument, we highlight important ways the Earth system, the global economy and insurance are all inter-connected.

Climate change and insurance

This chapter is about climate change (United Nations, 1992) and insurance, and in particular how a changing climate impacts insurers' ability to provide financial *recompense* following climate-implicated damage (Phelan et al., 2011a). Insurance plays an important socio-economic role in managing community risk, especially in industrialised economies (Phelan et al., 2011b). Financial risks can be insured when insurers can calculate risk probabilities, i.e. the chance that a damaging, cost-incurring event could occur. When a risk can be calculated, the risk can be priced, i.e. insurers can work out what *premium* to charge, in order to be able to offer insurance.

Fundamentally, the ability to manage climate-implicated weather risks is possible in the Earth system because the Earth system is stable and familiar (to humans and our civilisations): insurers have access to *meticulous* records of weather patterns and weather extremes. That is, while the Earth system

remains in a familiar and stable state, past experience provides a reasonable guide for future experience; this means risk probabilities can be calculated. Consider extreme weather events for example: a 'one in one hundred year flood' is a flood of such a size that, in the past, has occurred on average once every one hundred years or so. As long as the Earth system remains in its familiar and stable state, such floods can confidently be expected to continue to occur in the future with roughly the same frequency (Phelan et al., 2011a).

We argue that if insurance is to remain viable in the long term, then efforts to mitigate climate change, which would ensure the Earth system returns to a stable and familiar state, must succeed. This might seem obvious, but many insurers have responded to climate change by supporting and undertaking adaptation actions, not mitigation actions (Phelan et al., 2011b). Insurers' adaptation responses include increasing premiums or even withdrawing insurance cover for climate-implicated extreme weather risks. For example, insurers in Florida, USA have responded to increased *hurricane* risks in the area by removing themselves from the market (Mills, 2009). Responses like this reduce insurers' *exposure* to increased climate risk, but they also leave individual communities – and societies overall – increasingly vulnerable to climate risk, and so are really maladaptations. When the insurance industry fails or removes itself from a region or sector, governments are frequently called upon to replace commercial insurance with public (tax-payer funded) insurance. However, governments' capacity to insure against climate risks is also limited.

Adaptation to climate change is essential for human welfare because some climate change impacts are already *manifest* and others are imminent. We are at a point now where *anthropogenic* greenhouse gas emissions into the Earth's atmosphere have been so great that further climate change impacts are inevitable (Hansen et al., 2008). However, mitigation is a strategic response to climate change for human social systems generally, and for the insurance system specifically. That is, mitigation means dealing with the cause of climate risk, not just seeking to *cope* with climate change impacts. Climate change mitigation measures are those aimed at limiting or avoiding dangerous anthropogenic climate change by: (i) significantly and rapidly reducing greenhouse gas emissions; and (ii) protecting surviving *carbon sinks.*

Adaptation depends on mitigation

We argue that mitigation and adaptation approaches are both essential and that they are linked in this way: effective mitigation is a precondition for effective adaptation. Adaptation to anthropogenic climate change in support of human welfare is necessary. Limits to climate change impacts – and there-

fore a basis for effective adaptation over the longer-term – rely on urgent, effective and equitable mitigation action so that the Earth system returns to its familiar and stable state. For insurance, maintaining predictability about future climate and weather risks is essential. Over time, increasing unpredictability will tend to undermine the viability of the insurance system (Phelan et al., 2011b).

We describe *adaptive* responses to climate change as tactical as opposed to strategic because they do not directly address the causes of increasing climate risk. Tactical measures can support strategic action: for example adaptation can 'buy time,' while strategic mitigation measures take effect. However, there is very little time available: mitigating climate change requires fundamental change urgently.

To explain how climate change and insurance interact, in this chapter we conceptualise three linked systems: (a) the Earth system; (b) the global economy; and (c) insurance. We think of each of them as social-ecological systems. Each is a system comprising diverse elements that interact, and each is social-ecological because each includes human-social and *ecological* elements. Relationships between the three systems are key to our analysis; the systems and the ways they are linked are described in the next sections.

Linked social-ecological systems

Our analysis focuses on insurance as part of the global economy, and the global economy as part of the (foundational) Earth system, the largest of the three social-ecological systems. All three systems are closely linked and changes in one of them can have impacts on the others. One example is greenhouse gas emissions from the global economy impacting the stability of the Earth system, leading to, among other things, more frequent and more intense extreme weather events and changes in *rainfall patterns* in some areas (Schneider, 2004).

Three systems

Both Lovelock's concept of 'Gaia' (Lovelock, 1979) and Crutzen's concept of the 'anthropocene' (Crutzen, 2002) convey the sense of a *co-evolutionary process* involving humans and planet Earth, and one in which humans are increasingly dominant. Increasing anthropogenic greenhouse gas emissions cause changes in the Earth's climate, which in turn drive changes in human societies. This is emblematic of the linked and co-evolutionary processes of change at global scale.

The global economy has also been analysed as a social-ecological system. Daly's 'steady state economy' (Daly, 1982) approach clearly recognises the social-ecological character of the economy, and in so doing makes the strong argument for a theoretical understanding of economy that recognises Earth system limits. That is, while economies may be able to grow infinitely in theory, in practice, the global economy is subject to the Earth system's physical limits. In 2010, the global economy was valued at around US$63 trillion. We refer to 2010 figures because this is the most recent year for which *disparate* economic and emissions data are available.

Lastly, we use the term insurance 'system'. We do this because we want to bring focus to the insurance industry (i.e. insurance firms) *as well as* social or public forms of insurance (such as universal health care, unemployment benefits and age pensions). In short, we are referring to the ensemble of all the institutions and practices societies use to manage financial risk through financially viable insurance. A definite figure for the value of the insurance system overall remains elusive: data are available for some elements of the insurance system including both the insurance industry and state-funded social insurance, suggesting that the value for the insurance system overall is large. The insurance industry was valued at around US$5.3 trillion in 2010, making it the world's biggest industry (Swiss Re, 2011 and extrapolating from Mills, 2009). Data for social insurance are even less comprehensive, but available data underscore the magnitude of the insurance system. Health expenditure alone financed through social insurance totalled at least US$2 trillion globally (AARP 2010). Other key areas of state-financed social insurance expenditure are unemployment benefits and age and disability pensions. The modern welfare state, which includes forms of social insurance, is most developed in Europe, and some data and projections are available for European Union (EU) countries: gross public pension expenditure for 2010 is projected at 10.3% of EU GDP, i.e. US$1.8 trillion (OECD, 2007). On the basis of the above – limited – information, we conservatively suggest the value of the insurance system globally was at least US$9.1 trillion in 2010, i.e. comprising at least 14.5% of the value of the global economy and, as such, a significant subsystem of the global economy.

System relationships

The three systems interact in various ways. For example, anthropogenic *greenhouse gases* originate in the global economy and are emitted into the *Earth system* (i.e. the atmosphere). In return, increased atmospheric concentrations of greenhouse gases constitute future climate damages to the global

economy. In 2010, anthropogenic emissions totalled 10 PgC[*], comprising 9.1 PgC of emissions and 0.9 PgC of losses in surviving carbon sink capacity (i.e. destruction of forests that are able to absorb atmospheric carbon dioxide). While these figures present a static 'snapshot' from 2010, it is important to remember that anthropogenic emissions are added into the Earth's atmosphere every year; and usually, the volume of emissions per year increases annually. In 2010, global carbon dioxide emissions (the main greenhouse gas from anthropogenic sources) increased 5.9% from 2009 levels, the highest annual increase since 2003 (Global Carbon Project, 2011).

The Earth system has the capacity to *sequester* some greenhouse gas emissions in oceans and land, but only some. In 2010, the Earth system would have sequestered around 56% of anthropogenic emissions, leaving 4.5 PgC of emissions remaining in the atmosphere (Global Carbon Project, 2011). This may be regarded as 2010's contribution to future climate damages, which will impact the global economy as unexpected changes to familiar and reliable weather and climatic conditions. Future climate damages will result from shocks such as extreme weather events, and stresses such as longer-term impacts including changes in the location and viability of agricultural zones, and ultimately food security.

The inter-system relationship between the global economy and the insurance system is dominated by the cycling of financial risk. The socio-economic function of the insurance system is to assume responsibility for financial risk. The insurance system does so by pooling and transferring risk across the economy. Ultimately, the insurance system is wholly nested within the economy, and therefore financial risks, even when shifted via the insurance system remain internal to the economy. Traditional examples of how the insurance system manages financial risks include insurers' insuring a range of *uncorrelated* risks (e.g. hurricane risks in some areas, and *earthquake* risks in others) and holding substantial investments (in the case of the insurance industry) and governments' treasuries (in the case of social insurance) to *cover* potential losses. More recently, some in the insurance industry have also begun to spread risk outside of the insurance system and onto *capital markets* through *catastrophe bonds* and other financial instruments collectively known as *insurance-linked securities*. This allows insurers access to the greater financial capacity of capital markets, and therefore a greater capacity to assume financial risk. This activity demonstrates a well-utilised way of cycling of financial risk between and across the insurance subsystem and the broader economy (Phelan et al., 2011a; Phelan et al., 2011b).

[*] 1 Pg (petagram) = 1 billion (or 1000 million) tonnes.

Why mitigation is a necessity for insurance systems

The key message from this analysis is that effective climate change mitigation is essential for the long-term viability of the insurance system. Burning *fossil fuels* means increasing atmospheric greenhouse gas concentrations, which leads to a changing climate. A changing climate renders the Earth system unstable and characterised by unpredictable change. In a changed climate, we will not know, for example, how often a 'one in one hundred year flood' will occur because we won't have reliable historical records to refer to. A flood of that size might occur more frequently, less frequently, or with a frequency that is wholly unpredictable. That is why insurers need to strongly support climate change mitigation. For insurance, including both insurance markets and public insurance, maintaining predictability about future climate and weather risks is essential. For societies, the insurance system's capacity to manage financial risk is critical. In our view, this is why insurers need to become involved directly in climate change mitigation.

Acknowledgement

Many thanks to Olivier Rey-Lescure for assistance with the figure in Exercise 3.

Vocabulary notes

Adaptive: adj. to describe an adjustment in natural or human systems in response to actual or expected stimuli or their effects, which moderates harm or explores beneficial opportunities.

Anthropogenic: adj. caused by human activity.

Capital Markets: n. markets where businesses (including insurers) and governments can raise money from investors to fund their operations. Insurers can raise money by selling *insurance-linked securities*, including *catastrophe bonds*.

Carbon Sinks: n. atmosphere reservoir which absorbs carbon dioxide, e.g. a rainforest.

Catastrophe Bonds: n. an example of an insurance-linked security, and used by insurers to transfer excess financial risk away from themselves and to investors.

Co-evolutionary Process: n. a process in which things change and develop together, influencing each other as they do so.

Cope: v. to face difficulties and overcome them.

Cover: n. protection provided by the insurance system against possible future damaging events.

Disparate: adj. various, different, unrelated.

Earth System: n. planet Earth and everything on it, including the *ecological* parts of our world as well as humans and our societies.

Earthquake: n. a shock caused by movements in the Earth's crust.

Ecological: adj. the non-human or 'natural' elements of the Earth system.

Exposure: n. the degree to which an insurance company may be obliged to make financial payments to customers it insures when damaging events occur.

Fossil Fuels: n. coal, oil and natural gas. Burning fossil fuels for energy is currently a key feature of the global economy, but when fossil fuels are burned, *greenhouse gas emissions* are released into the atmosphere.

Greenhouse Gases: n. gases (such as water vapour) which trap heat in the Earth's atmosphere. One key *anthropogenic* greenhouse gas is carbon dioxide.

Hurricane: n. a (US term for a) violent tropical storm with very strong winds, also known as a tropical cyclone (the official term) or typhoon (in Japan).

Insurance-linked Securities: n. a type of financial instrument or tool designed to spread financial risk. An investor can buy insurance-linked securities from an insurer. If a defined, damaging event occurs, the insurer uses the investor's money to pay claims to its customers, and the investor doesn't get their money back. If the defined, damaging event doesn't occur, the investor gets their money back, with interest.

Manifest: adj. become clearly visible, obvious.

Meticulous: adj. very careful, exact.

Mitigative: adj. to describe human actions which are designed to reduce the causes of (climatic) change.

Premium: n. an amount paid to an insurance company to secure *cover* against the risk of future defined, damaging events occurring.

Rainfall Patterns: n. the typical amount and seasonality of rain in a particular area.

Recompense: n. a financial payment to compensate for a financial loss.

Sequester: v. to isolate a gas from the atmosphere and store it elsewhere, e.g. in the oceans and in land.

Uncorrelated: adj. the lack of a relationship between two or more things.

EXERCISES

Exercise 1 – Text summary
Complete the spaces with the appropriate word or phrase from the text.

1. In order to work out premiums, insurers calculate r _____ p _____.
2. To do this for climate-implicated risks, they need to be able to assume weather patterns remain essentially p _____ , which requires the Earth
3. system to maintain its f _____ and s _____ state.
4. However, the effects of climate change are already m _____ ; and further
5. impacts are inevitable, due to g _____ g ____ e _____ _____ into
6. the atmosphere. In order to remain viable, the i _____ s _____
7. needs to engage in effective climate change m _____

Exercise 2 – Argument

(i) Match a beginning of a sentence in column A with the best ending from column B, according to information contained in the text.

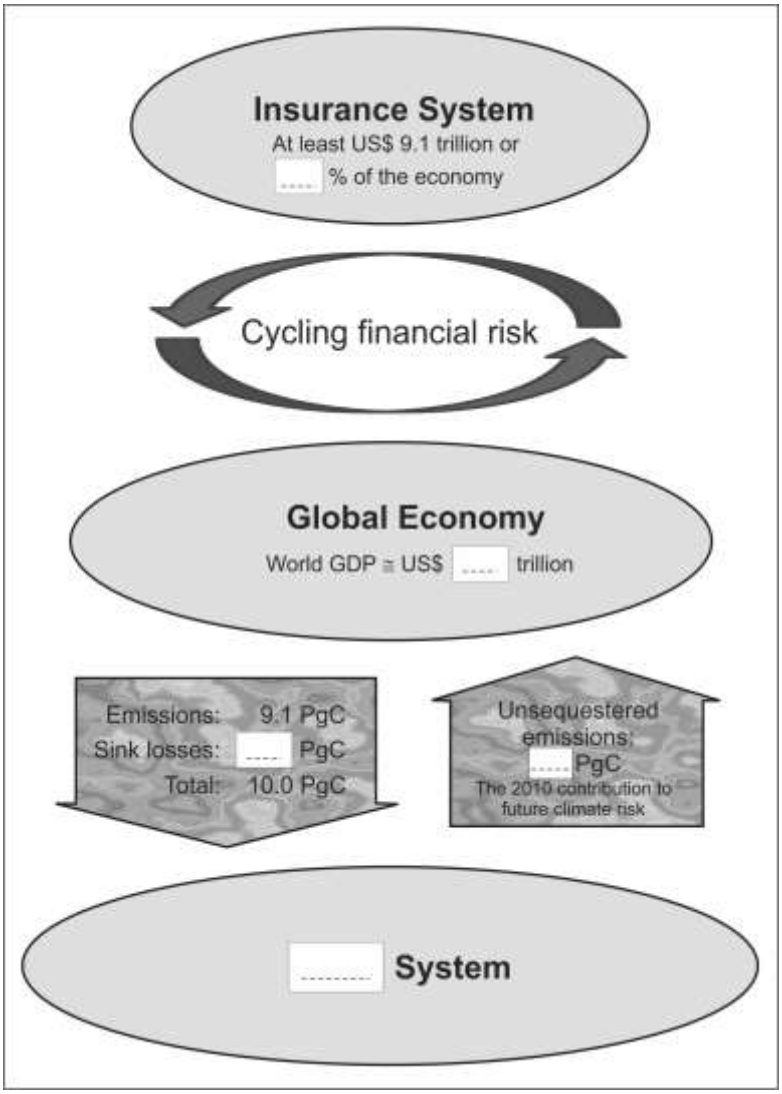
1. A less predictable climate	a) reactive in nature.
2. If insurance firms remove themselves from the market, societies	b) taking responsibility for financial risks resulting from climate-related events.
3. The effects of climate change may be reduced in severity by	c) the contribution the Earth system makes to the global economy.
4. Historically, the insurance system supports the global economy by	d) will not only lead to a collapse of the insurance system model, but also negatively impact the global economy and society.
5. Current insurance industry responses to climate change are primarily	e) the contribution the insurance system makes to the global economy.
6. To ensure the long term viability of the insurance system, their responses need to become	f) reducing greenhouse gas emissions and increasing the environment's capacity to sequester carbon dioxide.
7. It is difficult to quantify	g) more pro-active in nature.
8. It is impossible to quantify	h) will become increasingly vulnerable to the effects of climate change.

(ii) Refer to the text to answer the following questions.

1. How do climate change mitigation measures limit anthropogenic climate change?

2. What is one way in which adaptation responses to climate change are useful?

Exercise 3 – Facts and figures
Complete the diagram below with a number or word from the text.



Insurance, the global economy and the Earth system, and key interactions among them: A 'snapshot' from 2010.

** 1 trillion = 1000 billion*

*** 1 PgC (petagram of carbon) = 1 billion (or 1000 million) tonnes of carbon.*

**** GDP = global Gross Domestic Product.*

Exercise 4 –Commonly confused vocabulary

Complete the sentences below with a word from the choices on the right. You may need to change the form of the word, and there may be more than one possibility.
The words in italics may help.

1. The _____ is the only *planet* in our *solar system* thought to be capable of supporting life.
2. There are approximately 200 *countries in* the _____ _____.
3. Some *people around* the _____ are experiencing more extreme weather conditions.

Earth
globe
world

4. *Levels* of carbon dioxide in the atmosphere _____ _____.
5. Public *support* for action on climate change _____ _____.
6. Some *governments* have responded *by* _____ _____ *taxes* on industries which emit large amounts of carbon dioxide.

grow
raise
rise

7. The insurance industry *has* the _____ to have a *favourable* impact on climate change.
8. In some parts of the world, the _____ of hurricanes occurring *are increasing*.
9. There *is* a lot of _____ for the use of renewable energy sources.

chance
opportunity
potential

10. In spite of efforts to reduce carbon dioxide emissions in developed economies, there has been a _____ ____ *rise* in emissions.

11. Insurance premium calculations are based on a *predictable* and _____ *climate*.

12. Atmospheric climate *forces* are *dynamic rather than* _____.

13. Some insurers have responded to climate change by making an increase *in* the _____ of the insurance premiums they charge.

14. Climate change is such an *important* issue, and the ___ _____ of the *problem* makes action urgent.

15. Solutions to climate change are required *on a global* _____.

stable
static
steady

magnitude
scale
size

Exercise 5 – Common prefixes

(i) Now complete the sentences with an appropriate word from the text by changing the form of the word in bold.

1. Some **adaptations** insurers are currently making in response to climate change are _____ in the long term, in so far as they can leave some communities more vulnerable to climate risks.
2. According to Lovelock and Crutzen, humans and planet Earth are involved in a _____process, whereby they **evolve** together.
3. The Earth system, the global economy and insurance are all _____, i.e. there are **connections** between them.
4. Climate change and insurance _____, i.e. there are **actions** between them.

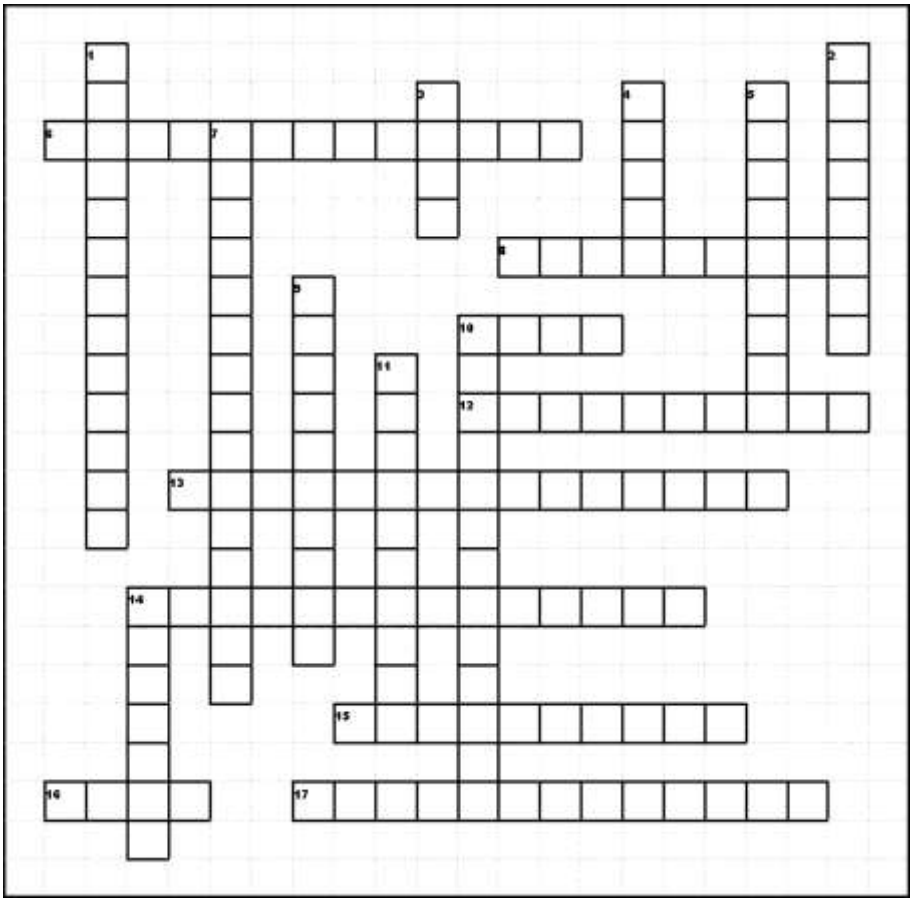
5. Mitigation is a necessary _____ for long-term insurance system adaptation to climate change, i.e. mitigation **conditions** must exist before long-term adaptation can succeed.
6. The Earth system needs to be **turned** back or _____ to its familiar, stable state for effective adaptation to occur.
7. The insurance **system** is a significant _____ of the larger global economy.
8. The insurance system assumes financial risk by _____ it across the economy. This **transfer** makes financial risk more manageable.
9. The lack of climate **stability** is evidence of the Earth system as a whole being _____, and vulnerable to _____ weather events, i.e. those that no-one can **predict**.

(ii) Study the examples in column A. Then match a prefix in column B to its meaning in column C (note: these meanings may not be exclusive).

A	B	C
malfunction, malnutrition	1. mal	a. again
co-operate, co-ordinate	2. co-	b. (move) across
international, interrupt	3. inter-	c. not
prepare, prehistoric	4. pre-	d. between
recycle, respond	5. re-	e. together
subordinate, subsidise	6. sub-	f. badly, wrongly
transport, transmit	7. trans-	g. before
unfriendly, unusual	8. un-	h. secondary, supporting

Exercise 6 – Crossword

Refer to the text and the vocabulary notes and use the clues provided to complete the crossword below.



Across

6 Caused by human activity (13)
8 One name for a tropical storm featuring very strong winds (9)
10 To face difficulties and overcome them (4)
12 An example of a carbon sink (10)
13 An example of an insurance-linked security (11,4)
14 Word to describe a process in which things change over time and influence each other as they do so (14)
15 Careful and exact (10)
16 One source of fossil fuel (4)

17 The process whereby a gas is isolated from the atmosphere and stored, eg. in the ocean or in land (13)

Down

1 What insurance-linked securities aim to spread (9,4)
2 Become clearly visible (8)
3 What greenhouse gases trap in the atmosphere (4)
4 A word to describe the protection provide by the insurance system (5)
5 Various, different (9)
7 The expected amount and seasonality of rain in a geographic area (8,7)
9 Actions to reduce the causes of climate change (10)
10 A key anthropogenic greenhouse gas (6,7)
11 A sudden movement in the Earth's crust (10)
14 A type of market where governments and business raise money from investors (7)

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English through Climate Change, pp. 119 – 126

The Experience of Cap-and-Trade

Julien Chevallier

Abstract

Cap-and-Trade programs have been first introduced in Australia and the USA as an environmental regulation tool designed to fight air pollution externalities. Today, they are broadly used at the international level, with the prominent examples of the Kyoto Protocol and the EU Emissions Trading Schemes. First, this chapter reviews the main characteristics of Cap-and-Trade programs, with respect to temporal, geographical, and allocation provisions. Second, the chapter provides a glossary of the most important terms used in the text. Third, the chapter provides different exercises aiming either to further consolidate student understanding of these terms.

Introduction

A *Cap-and-Trade* program is an environmental regulation tool whereby the *regulator* (i.e. the governmental agency) sets an overall cap (quantitative limit) on a given *pollutant* (e.g. the emissions of carbon dioxide in the atmosphere), and assigns each agent with an initial endowment in *tradable rights* (or permits). Once the cap has been set, market agents are allowed to freely trade their permits based on *demand/supply fundamentals* in the newly created environmental market. The permit *price* is set at the equilibrium of the market.

Once the permits have been distributed, the task of the regulator is strictly limited to verify periodically (e.g. each year) whether or not market agents meet their *compliance requirements* (i.e. the balance between the number of permits distributed and the number of permits used).

Provisions of Cap-and-Trade programs

Various *provisions* that need to be taken care of by the regulator before creating a Cap-and-Trade program (Chevallier, 2009). We review some of them below.

Geographical limits

The regulator needs to set very clearly the geographical perimeter of the Cap-and-Trade program. For instance, is the program limit to a specific city, region, country or group of countries? The regulator needs also to take into account *deposition constraints*, that is to say the likelihood that some pollutants emitted in one geographical zone will have adverse effects in another zone. For instance, in the US "Clean Air Act" program, emissions of sulfur dioxide in the atmosphere from one state would travel and end up in *acid rains* in other states of the country (Ellerman et al. (2000)). Obviously, both zones need to be included in perimeter of the scheme, if the Cap-and-Trade program is to set an effective price between buyers and sellers of the pollutant.

Temporal limits

The regulator has the ability to allow market agents to trade permits (or *allowances*) not only spatially but also through time (Kling and Rubin, 1997). Indeed, it is possible that at one point in time one agent has too many permits compared to his/her needs, and that he/she will not find a suitable occasion to sell it at the right price on the market. *Banking* refers to the possibility for one market agent to save unused permits in the present time for his/her needs in the future. *Borrowing* refers to the possibility for one market agent to borrow permits from his/her future allocation, in case he/she is short of permits in the present time and the price offered on the market is too high.

Note also that the regulator has the possibility to affect a non-unitary *intertemporal trading ratio* (ITR) between banked and borrowed permits, in order to discourage borrowing (Leiby and Rubin, 2001). For instance, a 2:1 ratio for borrowing means that a market agent needs to reimburse two permits in the future for one permit borrowed in the present time. This provision is sometimes necessary to avoid unwanted concentration of pollutants in present time. This may happen when all market agents borrow in the present time from their future allocation, because the current permit price is too high.

Initial allocation

The major challenge for the regulator when creating a Cap-and-Trade program lies in the *initial allocation* of tradable permits. We detail below the two main allocation methodologies (Chevallier et al., 2009).

Grandfathering consists in distributing permits for free to market agents, based on their previous pollution level. This allocation methodology is often preferred, because of the *lobbying* activities of market agents to the regulator. Actually, before the creation of the Cap-and-Trade program, pollution was free in the sense that the pollutant was not limited quantitatively. With the introduction of the environmental market, agents will necessarily need to respect the cap set by the regulator. Hence, pollution is not free anymore, and agents will need to limit their future pollution levels, which makes them even more reluctant to pay for each unit of pollution assigned to them.

Auctioning is the alternative allocation methodology, whereby market agents need to pay for each permit assigned to them in the first place. The price of the permit purchased is determined by an auction mechanism, which is explained in advance to all market participants. The benefits of auctioning are twofold:

1. Agents are revealing their private information on how much they are willing to pay for one permit (i.e. what is the intrinsic value attached to one unit of pollution).
2. The regulator is getting some revenues from the auction, which it is then possible to recycle in the economy. For instance, the regulator may compensate financially some agents for the detrimental consequences of pollution (also known as *double dividend*).

Most of the time, grandfathering is chosen during the creation of the Cap-and-Trade program. Then, progressively, the regulator is able to switch the allocation methodology to auctioning, as the main principle behind *emissions trading* becomes accepted among market agents.

Conclusion

A Cap-and-Trade program is an innovative environmental regulation mechanism which resorts to the market to limit quantitatively a given pollution. This chapter demonstrates the central role played by the regulator to ensure that the cap-and-trade program will be successful. Among others, the regulator needs to be very cautious when designing the various provisions regarding geographical limits, temporal limits, and the initial allocation methodology. The most recent applications of cap-and-trade programs in-

clude the Kyoto Protocol and the European Union Emissions Trading Scheme (EU ETS).

Vocabulary Notes

Acid Rain: The negative consequences in one specific region under the form of acid depositions of sulfur dioxide emitted in another region.

Allowance: One unit exchangeable under a cap-and-trade program, for instance one tonne of carbon dioxide emitted in the atmosphere.

Auctioning: The allocation methodology whereby market agents need to pay for each unit of pollution assigned to them through an auction mechanism.

Banking: The possibility for one market agent to save his/her permits for future use.

Borrowing: The possibility for one market agent to borrow permits from his/her future use.

Cap-and-Trade: Literally, the program in which the regulator sets a quantitative limit on pollution (i.e. the cap) and allows market agents to trade permits based on their respective demand and supply.

Compliance Requirement: The operation during which the regulator verifies that one market agent respects his pollution target, i.e. that he/she has enough permits (either distributed or purchased on the market) to cover his current levels of emissions.

Demand/Supply Fundamentals: The demand for permits comes from the need to pollute. The supply of permits comes from the initial allocation.

Deposition Constraints: The concentration of a large amount of pollutants over one specific geographical zone.

Double Dividend: Operation by which the regulator receives revenues from the auction mechanism, and is able to recycle them to compensate the negative effects of pollution on specific groups of agents.

Emissions Trading: Synonym of cap-and-trade program.

Grandfathering: The allocation methodology whereby market agents receive for free each unit of pollution assigned to them.

Initial Allocation: The procedure used by the regulator to distribute permits to market agents during the creation of the cap-and-trade program.

Intertemporal Trading Ratio (ITR): The possibility to affect banked and borrowed allowances with a constraint on the number of allowances to be reimbursed.

Lobbying: The activity of market participants to influence the choices of the regulator during the creation of the cap-and-trade program.

Pollutant: The environmental target of the cap-and-trade program (for instance emissions of greenhouse gases in the atmosphere).

Price: The price of the permit is set at the equilibrium between demand/supply fundamentals of market agents on the cap-and-trade program.

Provisions: Specific design issues that need to be taken care of by the regulation during the creation of the cap-and-trade program.

Regulation: The procedure by which the governmental agency intervenes to correct the negative effects of pollution.

Tradable Right: Synonym with permit, i.e. one unit of pollution that is transferable between agents in the context of the cap-and-trade program.

Answer the following questions:

1. What is the main objective of a cap-and-trade program?
2. What are the main barriers during the creation of the cap-and-trade program?
3. Why is it important to take into account deposition constraints?
4. How can market agents adjust their emissions through time?
5. How can tradable permits be allocated initially?
6. What is grandfathering?
7. What is auctioning?
8. How is the permit price determined on the market?
9. Define the compliance requirement for each market agent.
10. What specific examples of cap-and-trade programs can you think of?

EXERCISES

A. *Match the words or phrases of Column A with the words of Column B.*

1. emissions	a. dioxide
2. tradable	b. trading ratio
3. Kyoto	c. dividend
4. lobbying	d. right
5. double	e. activity
6. intertemporal	f. trading
7. deposition	g. protocol
8. sulfur	h. constraints

B. *Find if the following are True or False.*

1. A Cap-and-Trade program necessitates the constant intervention of the regulator, even after the creation of the market.
2. Market agents cannot adjust their emissions through time in a cap-and-trade program.
3. Auctioning means that market agents receive permits freely based on their past emissions.
4. The price is determined as the least expensive permit in the cap-and-trade program.
5. The allocation methodology of permits has no distributional consequences.
6. The cap-and-trade program sets a quantitative limit on a given pollutant.
7. The cap-and-trade program sets a fixed price for a given pollutant.
8. A market agent can only sell permits to other agents.
9. A market agent is characterized by a personal emissions target.
10. Borrowing has no potential negative consequences on the environment.

C. *Fill the blanks with a suitable word.*

Cap-and- _____ programs have been successful over the last two decades to regulate the environment. In particular, the U.S. _____ Rain program has been launched by the U.S. Environmental Protection Agency to regulate the emissions of _____ dioxide. In Europe, a similar mechanism has been introduced under the European Union _____ Trading Scheme. This emissions _____ system is designed to fight climate _____, and more particularly the emissions of greenhouse _____ in the atmosphere. It is similar to the _____Protocol launched at the international level.

D. *Put the verbs in parenthesis into their correct form.*

1. Sulfur dioxide (pollute) _____ the environment under the form of Acid Rain.
2. Carbon dioxide (belong) _____ to the class of greenhouse gases.
3. Over the last two decades, many cap-and-trade program (create) _____ by the environmental regulator.
4. Since 2005, the EU ETS (introduce) _____ in Europe to fight climate change.
5. In 2008, the Kyoto Protcol (enter) _____ into force for 168 countries.
6. Banking and borrowing (constitute) _____ flexible forms to adjust the stream of emissions through time.
7. Auctioning (induce) _____ costs for market participants as an allocation methodology.
8. The USA (sign) _____ the Kyoto Protocol, but did not ratify it.
9. The permit price (define) _____ on the cap-and-trade program by the balance between demand/supply fundamentals.
10. Grandfathering (be) _____ equivalent to a free allocation methodology for market participants.

E. *Finish the following sentences:*

1. The Kyoto Protocol concerns developed countries, as well as
2. The EU ETS is another example of
3. Once emitted, greenhouse gases are accumulating into
4. Market agents who are short of allowances can go on the market to
5. The main challenge for the regulator is to choose the allocation
6. A tradable permit is also known as
7. Any kind of pollutant can be concerned by emissions
8. Borrowing is the only solution when the current market price is too
9. The Acid Rain Program has been introduced in the
10. Environmental regulation can be carried out under the form of a cap-and-trade

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English through Climate Change, pp. 127 – 139

An overview of the climate refugees'issues and scenario

Maria Sakellari and Constantina Skanavis

Abstract

Climate change is likely to become the most significant cause of population displacement within the next years. People migrate because they are poor due to environmental degradation factors in their home area. Furthermore, a range of climatic events and conditions, that have stimulated distress migration, are expected to increase in terms of frequency and severity in many regions, mainly as a result of climate change. Moreover, research shows that population mitigation is a response to external pressure, and it is suggested that there is need to accommodate migration as a climate-change adaptation measure rather than as a problem. The paper presents an overview of the climate refugees' issue and reveals the need for a new international legal framework for climate induced migration and a better understanding of the role of institutions in addressing mobility. In an uncertain world, the role of institutions could be to extend the boundaries of climate change refugee policies to take into consideration the role of education and explore the ways in which access to information and education can contribute to climate change adaptation and mitigation.

The climate migration issue

Climate change is likely to become the most significant cause of population displacement within the next years (Myers, 1997, 2001; Bell, 2004). Although developed countries have been almost entirely responsible for greenhouse gas emission, most likely to suffer is any poor country lacking the economic capacity and infrastructure to cope with the worst consequences of climate change (Bell, 2004; Byravan and Chella Rajan, 2006). Due to irreversible climate change, by the end of the century there will be millions

of ‘boat people’ from developing countries looking for safer ground (Byravan and Chella Rajan, 2006).

Africa is frequently cited as an example of a place where environmental scarcity resulting from degradation of natural resources has given rise to violent conflicts forcing millions to flee (Molvaer, 1991; Westing, 1991; Hjort and Shalih, 1989; Hammer, 2004), but there are sizeable numbers of environmental *refugees* in countries, like China, Vietnam, Egypt, Mexico, Haiti and India (Myers, 2001), in small islands in Pacific Ocean and in regions like Alaska, where due to increased temperatures across the state between 2 and 3.5 degrees Celsius since 1974, arctic sea ice is decreasing, wildfires are increasing and permafrost thaws, creating a humanitarian crisis for Alaskan indigenous communities (Bronen, 2008).

Despite significant efforts to define human mobility due to environmental factors (see El-Hinnawi, 1985; Myers and Kent, 1995; IOM, 2007), still, there is no consensus regarding of who the environmentally displaced persons are. Environmental migration, climate change-induced migration, ecological or environmental refugees, *climate refugees*, climate change migrants, environmentally displaced persons and environmentally-induced forced migrants are terms that are found scattered throughout the literature, due to the lack of a generally accepted and precise definition of migration caused by environmental factors and those terminological questions reflect the difficulty of isolating environmental factors from other drivers of migration (Dun and Gemenne, 2008). In particular, the ultimate cause of migration by environmentally-displaced peoples often lies in social, political and economic conditions like population pressures and poverty, malnutrition, landlessness, over-rapid urbanization, unemployment, pandemic diseases and government shortcomings, along with ethnic strife and conventional conflicts and exogenous problems such as foreign debt (Myers, 1997, 2001). Furthermore, a range of climatic events and conditions ─known from past experience to have stimulated distress migration─ are expected to increase in terms of frequency and severity in many regions as a result of climate change (Solomon et al. 2007; Parry et al. 2007). Evidence supports the argument that climate-change related disasters like hurricanes, torrential rains, floods and droughts, do not provoke long-term and long-distance population displacements, because the majority of the displaced people return as soon as possible in the disaster area to reconstruct their home and live hoods (Naik et al. 2007) or because, living mainly in poor countries, people are very poor and vulnerable and therefore, unable to move (Tacoli, 2009). However, in literature, exist significant cases studies of forced massive and long-term migration due to natural disasters from climatic events such as in Ethiopia (Hammer, 2004), in Brazil (Leighton, 2006) and in Bangladesh (Haque, 1997). In this regard and for the purpose of this paper we accept the defini-

tion "climate refugee" as "*people who have to leave their habitats, immediately or in the near future, because of sudden or gradual alterations in their natural environment related to at least one of three impacts of climate change: sea-level rise, extreme weather events, and drought and water scarcity*" (Global Governance Project, 2008), although the term refugee can imply a sense of foreignness and lack of citizenship (Maldonado, 2012).

In spite of the increased attention, interest, and sense of urgency in understanding and responding to climate refugees issue, with the poorest people in all countries to be those most at risk due to their limited capacity to adapt and reduce risk (Baker et al. 2011), the broader social causes and consequences of climate change induced displacement are seldom addressed. Literature lacks attention to micro-level impacts such as household assets, livelihoods, and health, and to macro-level impacts such as the limits of host countries' capacity to take in outsiders, as in the wake of perceived threats to social relationship and national identity, refugees can become an excuse for political disorder (Myers, 1997, 2001). Analysis of how a social relation between the host and newly settled populations influence resource use is lacking (Warner et al. 2010). The inflow of refugees into new areas has been a significant factor in many environmental conflicts over resource access, use, and control issues (Peluso and Harwell, 2001). However, it is the absence of political and institutional responses to new migrants, rather than the existence of migrants, that seems to be most important in cases where migration is a factor in violent conflict (Goldstone, 2001).

In practice, there are no specific legal policies that deal with displacement caused by environmental deterioration (Martin, 2010). Although the United Nations Framework Convention on Climate Change, the Kyoto Protocol (1997) and the Cancun Adaptation Framework (2010) provide some scope for mobilising international action to reduce the risk of climate-induced displacement, the United Nations Guidelines on Internal Displacement (1998) protect those forcibly displaced by immediate onset disasters and do not necessarily account for the range of people impacted within the context of *climate change*, the United Nations Geneva Convention on Refugees (1951) does not apply, the United Nations High Commissioner for Refugees does not protect people displaced by climate change and the Convention for Protection and Assistance of Internally Displaced People in Africa (2009) by the African Union has limited ratification (Schmidt-Soltau, 2010). Moreover, although the European Union Charter of Fundamental Rights provides a normative framework for developing novel political responses to environmentally induced displacement, there are no instruments specifically regulating 'environmental displaced individuals' protection at EU level (Kraler et al. 2011).

Furthermore, as past experience shows that population movement is a response to pressure, researchers suggest that there is need to accommodate migration as a climate-change *adaptation* measure rather than as problem (Tacoli 2009; Biermann and Boas, 2010). The role migration may play in helping home communities adapt requires a new global governance (Biermann and Boas, 2010; Warner, 2010), a change in policy makers' perceptions of migration and a better understanding of the role of institutions in supporting and accommodating mobility (Tacoli, 2009).

The role of institutions: Education as a challenge for a new climate displacement policy formation.

Institutions are useful tools for addressing climate induced migration (Agrawal, 2010; Tir and Stinnett 2012; Adano et al. 2012) implementing climate adaptation and building adaptive capacity for populations vulnerable to climate change (Lynn et al. 2011). In practice, debates about whether and to what extent the international community may act to prevent climate-induced displacement raise some difficult questions about the ethics of supporting policies that would move human populations out of 'high risk' areas on the one hand and the possibility that policies of this kind will undermine historical freedoms and patterns of settlement, mobility and livelihood on the other (Johnson, 2012). Literature on successful *resettlement* suggests that such policies can work when affected populations are well informed about social, economic and environmental conditions, when all stakeholders have the ability to inform and affect the process and when adequate compensation, in the form of assets, incomes and economic opportunities, is provided for affected populations (Raleigh et al. 2008; Cernea, 1997, Cernea and Schmidt-Soltau, 2006; Penz et al. 2011). The role of institutions could be rules, social norms, and systems that guide human behaviour (Gamble et al., 2008) such as information gathering and dissemination, resource mobilization and allocation, skills development and capacity building, providing leadership and relating to other decision-makers and institutions (Agrawal, 2008).

While institutions may potentially play a significant role in building experience of managing the consequences of climate change, there are barriers and limitations to climate change adaptation that institutions are called to overcome. These can come from several fronts including inadequate climate information (Deressa et al. 2009), partial understanding of climate impacts and uncertainty about benefits of adaptation (Hammill and Tanner, 2011). In Bangladesh, one of the most valnurable among the poor countries to climate change effects, almost 70% of the population is unaware of the climate

change issue, along with the 64% of the population in India and 37% of the population in China, a number that represents over 400 million people in China alone, while in a global scale, 40% of the population has never heard of the climate change issue (Leiserowitz and Michaels, 2009).

Engaging in environmental learning requires people to have basic education first, and while this is often assumed in the West and North, it is not universal. Lack of basic human development needs, including limited access to formal educational system, of people living mainly in poor countries and climate change theorists and practitioners that support climate action on the field of different economic and technical fixes, but neglect deeper political and cultural forces at play that hinder deep changes in sustainability behavior among individuals and organizations (Hoffman, 2011; Gray and Stites, 2011) are the reasons for this gap between scientific community and public understanding.

By using the conceptual infrastructure of the Article 6 of The United Nations Framework Convention on Climate Change which recognizes that education, training and public awareness must play a key role in a response to climate change, institutions can extend the boundaries of climate change adaptation to take into consideration the role of education to enhance the adaptive capacity of a society. The notion of Climate Change Education has just recently emerged but lacks of sound pedagogical approaches, curricula and assessment strategies (Shaw and Tran, 2012). Generally, climate change policy and discussion continue to focus on technical solutions or 'knowledge transfer' without seriously engaging with the content of education, although a range of educational and research initiatives already exist which could support effective education responses to climate change (Bangay and Blum, 2009). The fields of *Environmental Education* (EE) and Education for Sustainable Development (ESD) provide valuable educational frameworks that empower people of all ages to deal with uncertain climate in the future. Despite the confusion in the literature about the relationship between EE and ESD, both fields aim at developing environmentally responsible citizens who actively participate in the environmental decision making process and are able to balance environmental protection, social cohesion, development and quality of life (McKeown and Hopkins, 2005).

Conclusion

Climate change impacts are expected to increase the number of refugees in the future. Although the specific nature of climate threats will vary between countries, climate refugees present an international challenge of a magnitude not previously encountered. On the other hand, researchers sug-

gest that there is need to accommodate migration as a climate-change adaptation measure rather than as a problem.

In practice, for institutions dealing with displacement implies addressing problems of freedom, fairness and justice, while accommodating climate refugees requires solving problems of integration, eligibility and burden sharing (Johnson, 2012). Institutions do have a role to play in implementing climate adaptation and building adaptive capacity for populations vulnerable to climate change, but this requires a new international legal framework for climate induced migration and a better understanding of the role of institutions in addressing mobility. In an uncertain world, the role of institutions could be to extend the boundaries of climate change policies to take into consideration the role of education and explore the ways in which access to information and education can contribute to climate change adaptation and mitigation.

Vocabulary Notes

Adaptation: Adjustment in natural or human systems in response to actual or expected stimuli or their effects, which moderates harm or explores beneficial opportunities.

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

Refugee: a person who "owing to a well-founded fear of being persecuted for reasons of race, religion, nationality, membership of a particular social group, or political opinion, is outside the country of his nationality, and is unable to or, owing to such fear, is unwilling to avail himself of the protection of that country".

Climate refugee: "people who have to leave their habitats, immediately or in the near future, because of sudden or gradual alterations in their natural environment related to at least one of three impacts of climate change: sea-level rise, extreme weather events, and drought and water scarcity"

Climate change: 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.

Climate System: The five physical components (atmosphere, hydrosphere, cryosphere, lithosphere, and biosphere) which are responsible for the climate and its variations.

Resettlement: the assisted movement of refugees who are unable to return home to safe third countries.

Vulnerability: The extent to which climate change may damage or harm a system.

Environmental Education: a learning process that increases people's knowledge and awareness about the environment and associated challenges, develops the necessary skills and expertise to address the challenges, and fosters attitudes, motivations, and commitments to make informed decisions and take responsible action.

Answer the following questions:

1. How can we explain environmental migration?
2. How can institutions extend the boundaries of climate change policies?

EXERCISES

A. *Fill in the missing words.*

_____ is likely to become the most significant cause of population displacement within the next years. Although developed countries have been almost entirely responsible for _____ emission, most likely to suffer is any poor country lacking the economic capacity and infrastructure to cope with the worst consequences of climate change. Due to irreversible climate change, by the end of the century there will be millions of _____ from developing countries looking for safer ground.

In particular, the ultimate cause of migration by environmentally-displaced peoples often lies in _____, _____ and economic conditions like _____ and _____, malnutrition, landlessness, over-rapid urbanization, unemployment, pandemic diseases and government shortcomings, together with ethnic strife and conventional conflicts and exogenous problems such as foreign debt.

Literature on successful resettlement suggests that policies can work when affected populations are well informed about social, economic and environmental conditions, when all _____ have the ability to inform and affect the process and when adequate compensation, in the form of assets, incomes and economic opportunities, is provided for affected populations.

While institutions may potentially play a significant role in building experience of managing the consequences of _____, there are barriers and limitations to climate change adaptation that institutions are called to overcome. These can come from several fronts including inadequate climate information, partial understanding of climate impacts and uncertainty about benefits of adaptation.

B. *Define the following:*

- knowledge transfer
- environmental migration

C. *Give synonyms of:*

- climate change-induced migration

D. *Give an example of the following:*

Adaptation:

Mitigation:

Refugee:

Climate refugee:

Climate change:

Climate System:

Resettlement:

Vulnerability:

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Addressing the Impacts of Climate Change in a Caribbean Small Island Developing State

Franziska Mannke

Abstract

Agriculture is regarded as being very vulnerable to changes in weather and climate since many crops are sensitive to changes in temperature and precipitation. Moreover, modern intensive agricultural systems which are characterized by increased use of fertilizers and *irrigation* technology, i.e. nutrients and water, are expected to become more sensitive to future climate change. This may prove critical in tropical regions where most agriculture is in rain-fed systems. Future changes in climate may negatively impact productivity exacerbating *food insecurity* and water scarcity in parts of the world which are already today viewed as extremely vulnerable. Climate change may therefore counteract the efforts made in poverty reduction, economic growth and achievement of further *Millennium Development Goals* such as ending hunger on our planet and achieving environmental sustainability.

Moreover, food systems all over the world are currently experiencing enormous organizational changes, reflected in the ongoing reorganization of the *supply chain*, ranging from farm to fork. Being at the end of the chain, especially small-scale producers have to face challenging global demands, reflected in the consumers' demands for high-quality products all year round and at a low price. These high requirements can represent a serious barrier for the participation of smallholders in globalized market places.

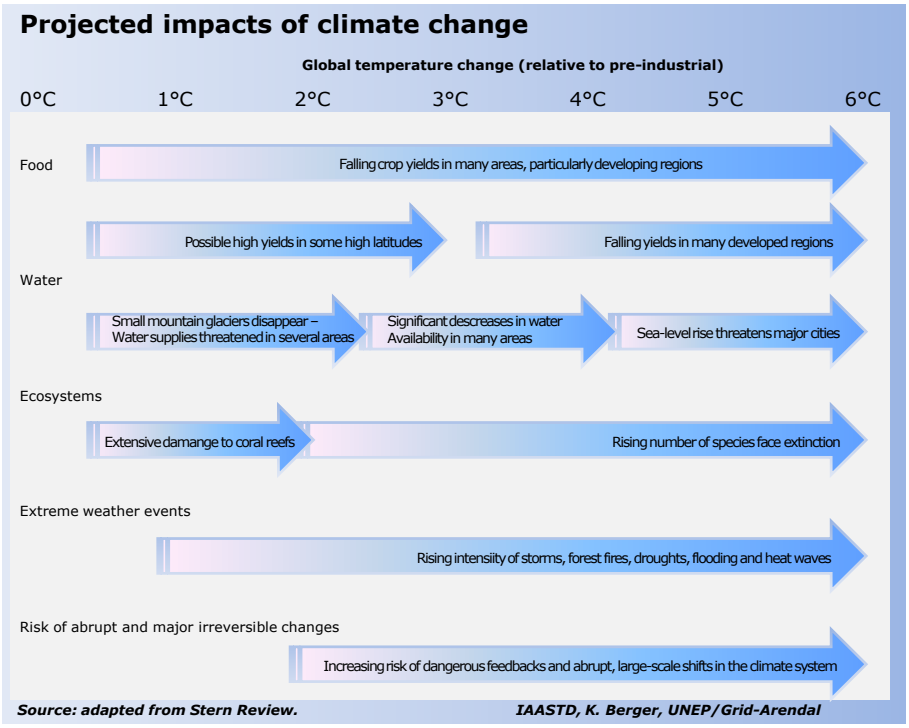
In many Small Island Developing States (SIDS) such as the Caribbean Island of St Lucia, farmers have begun to diversify their production, e.g. by adopting fair trade production standards, growing alternative or additional crops, and tapping new domestic as well as niche markets. Information, training and capacity building are seen as one means for improved diversification and commercialization of agricultural produce. At the same time, it may strengthen the adaptive capacity of farmers by providing sustainable

adaptation options for farm-level diversification in the light of climate change.

Vulnerability of the Caribbean agriculture

The impact of global climate change is manifold: Heat and droughts as results of global warming in parts of the world, changed rainfall patterns often combined with extreme weather events and natural disasters such as hurricanes and *floods* as well as sea-level rise due to the melting of polar caps. All regions worldwide are affected by climate change and will more or less have to adapt to a changing environment. Figure 1 summarizes these projected impacts of climate change. These impacts of global warming can already be noticed in many parts of the world.

Figure 1 Projected impact of climate change



Source: Stern. N. (2005)

SIDS have inherent characteristics which make them especially vulnerable to climate variability and climate change: Characterized by their limited spatial size, they are often located in isolated regions and possess only limited natural and water resources. The low-lying islands show a high susceptibility to sea-level rise as well as natural hazards, for example hurricanes and storm surges. Moreover, the extreme openness of their economies makes SIDS highly sensitive to external market shocks. In addition, limited financial and human resources often hinder these islands to reduce this overall *vulnerability*, leading to a low overall resilience (Nurse et al., 2001).

Due to these inherent characteristics, SIDS are not only extremely vulnerable, but they also lack *adaptive capacity*. This means they have only little capacity to make *"adjustments in (their) ecological, social or economic systems in response to actual or expected climate stimuli, their effects or impacts"* (Nurse et al., 2001 in: Ministry of Physical Development Environment and Housing, 2005:11). Due to their low resilience, they have a limited capability to recover from extreme events. SIDS are therefore highly vulnerable to the threats caused by the impacts of climate variability and climate change.

Agriculture's role for climate change

Agriculture as such is a major source of greenhouse gases and has fuelled climate change in many ways, e.g. through the conversion of forests to farmland and the release of greenhouse gases. According to the *United Nations Framework Convention on Climate Change*, agriculture contributes 14 per cent of global emissions (UNFCCC, 2009). Seen from a different angle, climate change threatens to irreversibly damage natural resources on which agriculture depends. Some regions benefit in that moderate warming may slightly increase crop yields. Overall, however, negative impacts will most likely dominate: Floods and droughts will become more frequent and severe. This is likely to seriously affect the *productivity* on farm-level, impact the livelihoods of rural communities, as well as increase the risk of conflicts over land use and water resources. Furthermore, climate change contributes to the further spread of pests and invasive species and might contribute to the increase of the geographical range of some diseases.

For the small island developing states (SIDS) of the Caribbean region, the impacts of climate change may also lead to social impacts since they are expected to affect all levels of rural poverty, trends in intra-national as well as international migration, the use of marginal lands, national food security, and foreign exchange earnings. Since a vast majority of the Caribbean region's population is relying on subsistence agriculture to at least a certain

extent, the need to adapt to climate change becomes pressing considering the impact of a changing climate regime on food production and supply (GOSL, 2005).

Transformation of food production systems

The *intensification* of food production transformed the formerly traditional small-scale systems to modern large-scale monocultures, e.g. in Latin America. However, banana monoculture production by *smallholders* is also found in many parts of the world, for example in countries such as St Lucia, one of the larger banana producers located in the Eastern Caribbean. In St. Lucia as well as elsewhere in the world, *mono-cropping* farmers increasingly need to deal with the fact that modern intensive agricultural systems which are characterized by monocultures as well as an increased need for fertilizers and irrigation, i.e. nutrients and water, may become more sensitive to climate change. This sensitivity may translate in lower productivity, higher vulnerability and reduced sustainability of production.

Besides, major structural changes in the worldwide agricultural industry can have far-reaching implications, and they may counteract with efforts to develop the agricultural sector in less developed countries, and in particular, SIDS such as St. Lucia. Food systems in developing countries are currently experiencing enormous organizational changes, reflected in the ongoing reorganization of supply chains, ranging from *farm to fork.* Being at one end of the chain especially the small-scale producers have to cope with global consumers' demands, reflected in the necessity to deliver high-quality products on time and at competitive prices. These high requirements can represent a serious barrier to the participation of small farmers in higher *value chains*.

To the disadvantage of St Lucia's banana farmers, other banana exporters from the African-Caribbean-Pacific (ACP) region, e.g. Costa Rica, have increased their exports to the EU market as they can produce at lower cost (Mather, 2008). The relatively higher cost of production as, for example, observed in St Lucia requires that banana farmers increase their productivity, i.e. expand their capacity in terms of production knowledge and application of new technology if they are to successfully stay competitive in the market for bananas. Building this knowledge and capacity involves understanding and anticipating future climatic changes as well as their potential harmful impacts on the banana crop.

Adaptation challenges

SIDS like St Lucia face many challenges at the same time, because they are adapting to a changing environment where climate variability and change are additional stressors among many other development challenges. Many more issues need to be addressed to improve livelihoods in those Small Island Developing States, for example reducing poverty, improving education, fighting crime, and so on.

Focusing on the adaptation challenges related to climate variability and climate change as well as agricultural production, some important aspects will be highlighted below.

Climate variability and climate change

Given the extent of the impacts and the irreversible character of some of the climate change impacts, the Caribbean region needs to prioritize adaptation in its comprehensive climate strategy. Given that no adaptation takes place, the potential economic impact of climate change on the Caribbean Community (CARICOM) countries[*] is estimated at a range of between US 1.4 to 9.0 billion (Worldbank, 2005)[†]. It is estimated that the largest category of impacts were loss of land, tourism infrastructure, housing, other buildings, and infrastructure due to sea level rise. Besides economic impacts, also social and ecologic impacts will occur, for example injuries and deaths due to extreme events, or increased loss of island biodiversity. To tackle these serious challenges, the need for concerted action increases, the government has developed a climate change strategy, and international donors assist St Lucia's steps towards improving its resilience.

Agricultural Production

Owing to their limited *endowments* with land, labor and capital, St. Lucia's banana farmers cannot compete solely on price with the Latin American mainland producers who can exploit economies of scale with their large plantations. Also, former trade preferences, i.e. quotas which guarantee the producer a fixed price, are disappearing in the era of free trade. Consumers also demand high quality produce throughout the year, posing additional

[*] The Caribbean Community (CARICOM) comprises 15 Caribbean nations and dependencies. The organization promotes the economic integration and cooperation among its members and coordinates foreign policy.

[†] The wide range for the estimate is said to originate from uncertainty in values and assumptions, not because of uncertainty about climate change.

challenges to smallholders who often lack efficient production methods and financial resources to guarantee a stable amount of produce of the same quality. Climate variability and climate change pose additional challenges to successful production as extreme events can easily destroy banana fields, as can the increased occurrence of pests and diseases. The current constraints St Lucia's banana farmers experience may worsen given the projected changes in climate, unless *diversification* activities take into account climate change impacts and adaptation options as well.

Conclusion and outlook

SIDS like St Lucia are highly vulnerable to the impacts of current climate variability and future climate change. Not only its economy and, of course, its people, but also its environment is faced with a range of adaptation challenges.

The island's banana farmers have already taken steps towards diversifying their production and reducing some production risks, e.g. by adopting *fair trade* production standards, and tapping into new domestic as well as niche markets. Moreover, improved commercialization of their products can positively contribute to food security and poverty reduction. In this aspect, it is of key importance to consider the future impacts of climate change on agriculture and to develop adaptive capacity among the affected groups of society in order to enable them to cope with the challenges of climate change.

Remaining options for staying in such as globalized agricultural business are twofold: (a) diversification of production, e.g. by adopting fair trade production standards that promise premium prices yet demand compliance to specific production standards as well; and/or (b) tapping new domestic as well as niche markets by means of improved *commercialization*.

To further support the transition of the agricultural sector, St. Lucia has been allocated funds from the European Special Framework of Assistance (SFA). This supporting scheme has been designed to facilitate the economic adjustment and diversification of former colonies such as St Lucia which were (made) dependant on the agricultural exports. In this respect, St Lucia's banana farmers received assistance to adapt to new market conditions and, furthermore, improve their competitiveness in terms of producing high-quality crops through raising the efficiency of production and building capacity for better commercialization as well as supporting agricultural diversification.

Vocabulary Notes

Adaptation: Adjustment in natural or human systems in response to actual or expected stimuli or their effects, which moderates harm or explores beneficial opportunities.

Adaptive capacity: the ability of a system to adjust to change, in terms of expanding the range of impacts with which it can cope, reducing its sensitivity to the changes or both.

Commercialization: The act of commercializing something, often used in relation to products.

Diversification: A risk-reduction strategy that, for example, involves adding products, services, locations, customers or markets to your current product portfolio.

Endowment: A large amount; can be of natural value, e.g. natural resources which are vital for continued existence.

Fair trade: An organized social movement and market-based approach that aims to help producers in developing countries to receive better trading conditions and at the same time promotes sustainability.

Farm to fork: Visualized concept which refers to the human food chain and includes all steps from agricultural production to consumption.

Flood: A large amount of water covering an area which is usually dry.

Food insecurity: When all people at all times have access to sufficient, safe, nutritious food to maintain a healthy and active life.

Intensification: The ongoing and increasing investment of the means of production and labor per unit of ground area (acre, hectar) or, in animal husbandry, per head of livestock.

Irrigation: Agricultural technology for regions with drought risk or erratic rainfall to meet the water needs of the crop.

Millenium Development Goals: Eight international development goals that all 193 United Nations member states have agreed to achieve by the year 2015, e.g, the reduction of poverty.

Mono-cropping: The agricultural practice of growing the same crop year after year on the same land, without crop rotation through other crops.

Productivity: A measure of the efficiency of production. The measure of productivity is defined as a total output per one unit of a total input.

Supply chain: The movement of materials as they flow from their source to the end customer.

United Nations Framework Convention of Climate Change (UNFCCC): An international environmental treaty with the objective to stabilize greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system.

Value chain: The successive stages during which value is created when producing, distributing, and servicing a product.

Vulnerability: The extent to which climate change may damage or harm a system.

Answer the following questions:

1. What are Small Island Developing States?
2. How can we explain their vulnerability?
3. How can we characterize their agriculture?
4. What are smallholders?
5. Describe what is meant by intensification of agriculture.
6. Which other challenges do agricultural smallholders face?
7. How far is agricultural production different in your home country?
8. What specific examples of intensified production can you think of?
9. What is the difference between a supply chain and a value chain?
10. What specific examples of mono-cropped products, other than those discussed in the text, can you think of?

EXERCISES

A. *Find if the following are True or False.*

1. Agriculture is not vulnerable at all to changes in weather and climate since most crops are resilient to changes in temperature and precipitation.

2. Old, traditional agricultural systems which are characterized by increased use of fertilizers and irrigation technology are expected become more sensitive to future climate change.
3. Future changes in climate may negatively impact productivity exacerbating food insecurity and water scarcity in parts of the world which are already today viewed as extremely vulnerable.
4. Not all regions worldwide are affected by climate change and will therefore not need to adapt to a changing environment.
5. In many Small Island Developing States (SIDS) such as the Caribbean Island of St Lucia, farmers have begun to diversify their production.
6. The low-lying SIDS show a low susceptibility to sea-level rise as well as natural hazards, for example hurricanes and storm surges.
7. Due to their high resilience, SIDS have a limited capability to recover from extreme events.
8. In general, SIDS show a low adaptive capacity and are therefore regarded as being highly vulnerable to the threats caused by the impacts of climate variability and climate change.
9. Climate variability and climate change pose additional challenges to successful production in SIDS as extreme events can easily destroy banana fields, as can the increased occurrence of pests and diseases.

B. *Match the words or phrases of Column A with the words of Column B.*

1. fair	a. island
2. food	b. capacity
3. agricultural	c. insecurity
4. mono	d. holders
5. Small	e. standard
6. Caribbean	f. intensification
7. adaptive	g. culture
8. production	h. trade

C. *Complete the following chart:*

Verb	Noun	Adjective
_____	impact	_____
_____	_____	high
_____	provision	_____
_____	_____	extreme
change	_____	_____
_____	shock	_____
_____	vulnerability	_____
value	_____	_____
produce	_____	_____

D. *Fill the blanks with a suitable word.*

The _____ of climate change are manifold, among them floods and _____, changed rainfall patterns, often combined with _____weather events and _____ disasters. Also, _____ due to the melting of the _____ caps can be observed. Given the extent and the irreversible character of some of the projected impacts, the Caribbean region needs to _____ adaptation in its overall strategy. Since a _____ of the Caribbean region's population is relying on subsistence agriculture, the need to _____ to climate change becomes pressing.

E. *Put the verbs in parenthesis into their correct form.*

1. Given the extent of the impacts and the irreversible character of some of the climate change impacts, the Caribbean region needs to (prioritize) _____ adaptation in its comprehensive climate strategy.
2. Agriculture as such (be) _____ a major source of greenhouse gases and (fuel) _____ climate change in many ways, e.g. through the conversion of forests to farmland and the release of greenhouse gases.
3. According to the UNFCCC, agriculture (contribute) 14 per cent of global emissions. (See) _____ from a different angle, climate change threatens to irreversibly damage natural resources on which agriculture depends.

4. The intensification of food production (transform) _____ the formerly traditional small-scale systems to modern large-scale monocultures.
5. Major structural changes of the past (have) _____ far-reaching implications and (may) _____ counteract efforts to develop the agricultural sector in less developed countries.
6. Food systems in developing countries (be) _____ currently experiencing enormous organizational changes.
7. Being at one end of the chain, especially the small-scale producers (have) _____ to cope with global consumers' demands.
8. Owing to limited endowments with land, labor and capital, St. Lucia's banana farmers (not / can) _____ compete solely on price with the Latin American mainland producers who (can) _____ exploit economies of scale with their large plantations.
9. The island's banana farmers (already / take) _____ steps towards diversifying their production.
10. To further support the transition of the agricultural sector, St Lucia (allocate) _____ funds from the European Union.

F. *Finish the following sentences.*

1. Food insecurity is a condition _____
2. Agriculture is very vulnerable to changes in _____
3. Vulnerability can be described as _____
3. Most agriculture is in rain-fed _____
4. Future climate change may negatively impact agricultural _____
5. Fair trade represents _____
6. Diversificatin is a risk-reduction strategy which _____
7. Mono-cropping can be defined as _____

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English through Climate Change, pp. 153 – 165

Adaptation and Governance in Transboundary Water Management

Jos G. Timmerman

Abstract

A large part of the world's freshwater resources is contained in river basins and groundwater systems that are shared by two or more countries. As climate change essentially changes the hydrological situation in many basins, increasing the number of extreme situations of flooding and drought, transboundary management of these water resources has become highly urgent in order to prevent negative effects of unilateral adaptation measures and in order to choose the most effective measures. Transboundary water management is in essence more complex than national water management because the water management regimes usually differ more between countries than within countries. Transboundary water management requires coordination over different political, legal and institutional settings as well as over different information management approaches and financial arrangements. This chapter explains about these elements and the way they play a role in transboundary water management.

Introduction

Observational evidence from all continents and most oceans shows that many natural systems are affected by *anthropogenic* climate changes. The hydrological cycle which encompasses water availability and water quality as well as water services is severely impacted by these changes (IPCC, 2007) and will affect all economic sectors. Adaptation in water management to climate change is, consequently, of central and urgent importance. The impacts vary considerably from region to region and even from basin to basin (Ludwig et al., 2009). A particular challenge for water resources management is connected to the fact that many river basins and *groundwater* sys-

tems are transboundary; i.e. the basin is shared by two or more countries. A total of 279 international river basins (Bakker, 2006) has been identified, draining almost half of the world's total land surface (Wolf et al., 1999). A study done by UNESCO has identified 273 shared *aquifers* worldwide[*]. The amount of water resources, both surface and subsurface, shared by two or more countries is consequently substantial. This makes transboundary water resources management one of the most important water issues today.

Freshwater supplies are limited. Increasing *water scarcity* including the availability of water of sufficient quality, partly as a consequence of climate change, leads to a potential increase in water conflicts between countries that share transboundary waters (Yoffe et al., 2004). On the other hand, shared waters can also be a source of cooperation. In fact, initiatives aiming at *river basin* management *regimes* and institutions committed to bilateral and/or multilateral cooperation regarding transboundary water resources prevail (UNEP, 2002).

But water scarcity is not the only problem confronting neighbours who share transboundary waters. A recent study on floods in a transboundary context concluded that although only 10 percent of all river floods are transboundary, these floods represent a considerable amount of the total number of casualties, displaced/affected individuals and financial damages worldwide (Bakker, 2006). The situation is compounded by the inherent difficulties in managing floods that cross borders.

Thus, where water resources management is complex, water management in a transboundary situation is even more complicated, in particular when this management has to account for the consequences of climate change. As there are many other pressures on water resources next to climate change such as population growth, migration, globalization, changing consumption patterns and agricultural and industrial developments, water management should look at all the pressures in an overall strategy in order to adapt to global changes.

Assets and limitations in transboundary water management

Several factors exist that will support or hinder cooperation between countries in *transboundary water management*. First, if the cooperation incentives are largely symmetric and the problem pressure is high, the prospects for effective cooperation will be good. Second, cooperation between countries in collecting data and performing joint projects builds trust at the

[*] World-wide Hydrological Mapping and Assessment Programme (WHYMAP). http://typo38.unesco.org/en/about-ihp/associated-programmes/whymap.html

technical level and enhances cooperation on political levels. Thirdly, a clear institutional setting that is problem-oriented, flexible and equipped with a centralised organisation structure enhances cooperation. Finally, if bilateral relations exist, effective transboundary water management will be possible (Lindemann, 2006).

Transboundary water management, nevertheless, heavily depends upon circumstances at the national level. Weak social and institutional capacity, poor legal and policy frameworks, and bad management practices bear great consequences in the transboundary context where they are even more amplified by differences between riparian countries. Improving transboundary cooperation is enhanced by promoting development and implementation of (formal or informal) transboundary agreements, accounting for different political and cultural settings in the riparian countries, and involving major *stakeholders* (different national government bodies, regional and local governments, international governments and donors, the media, civic society, individual water users and/or influential individuals) to maximise the likelihood of agreement (Mostert and Barraqué, 2006). The method of achieving this goal is however context-specific; there is no single template that can be applied to all situations.

Water management regimes

Water management is based on certain (implicit or explicit) principles, rules and decision-making procedures that enable convergence of stakeholders' expectations. Such a set of principles, rules and procedures is called a regime. Transboundary water regimes usually include formal rules such as international water conventions, statutes of transboundary water commissions, cooperative agreements adopted by national governments aimed at coordinating national water management activities in transboundary water basins, and relevant national laws and procedures. Regimes also include informal rules such as traditional ways of using natural resources (traditional ways of transport or fishing, for example) that are informally accepted in transboundary water basins but are not documented as formal norms in agreements or contracts (Roll et al., 2008).

Prevention and resolution of conflicts between water uses in riparian countries, and avoidance of severe effects of floodings, *droughts*, accidents, etc., especially in transboundary waters, compels countries to reach agreement on common rules and procedures of cooperation (Nilsson, 2006). This cooperation is a component of the overarching term "water *governance*" which depicts a change in thinking about the nature of policies. The notion of government as the single decision making authority is being replaced by a

more contemporary, multi-scale, polycentric governance. Governance takes into account that a large number of stakeholders in different institutional settings contribute to policy and management of a resource. Governance differs from the old hierarchical model of government in which state authorities exert sovereign control over the people and groups making up civil society. Governance includes the increasing importance of basically non-hierarchical modes of governing, where non-state actors (formal organisations like NGO's, private companies, consumer associations, etc.) participate in the formulation and implementation of public policy. The water management regime is consequently a pivoting point in achieving a well organised water governance system which supports adaptive management of water resources (Timmerman et al., 2008).

The principles of Integrated Water Resources Management (GWP-TAC, 2000) are the generally accepted basis for water management regimes and, if well-implemented, can be very supportive in adaptation to climate change. IWRM includes the water-related sectors such as agriculture and forestry in its approach. Water-related sectors rely on the availability of water resources but should be aware of their responsibility for the water resources as well.

Adaptive water management is advocated as a timely extension of IWRM to cope with the challenges of variability and changing nature of water supplies as a result of climate change as well as with the limited nature of scientific information and technical knowledge. Adaptive water management aims at increasing the adaptive capacity of river basins in which more attention has to be devoted to understanding and managing the transition, the structural change in the way a societal system operates (van der Brugge et al., 2004), towards more adaptive regimes that take into account environmental, technological, economic, institutional and cultural characteristics of river basins (Pahl-Wostl et al., 2005; Pahl-Wostl, 2007). This transition implies a change towards understanding management as learning rather than control (Gleick, 2003).

Thus far, different elements of management and use of water resources have been mentioned. These elements are structured here into five central elements that describe transboundary regimes: policy setting, legal setting, the institutional setting including the actor networks, information management, and financing systems (Anon., 2001; Raadgever et al., 2008). These elements are discussed in detail below.

Policy setting

Water policies that are in place in a country can be found in the formal documents which contain current and future water management strategies.

They refer to the goals of government or other organizations and strategies to reach those goals. As policies have a strategic character, especially in view of climate change, they should have a long-term time horizon. Policy strategies should fulfil current needs and have the ability to perform well in multiple possible futures and in a changing environment.

Because today's information is not sufficient to identify all possible futures, strategies should be flexible and keep as many options open as possible (Raadgever et al., 2006). A major challenge in managing transboundary waters is that no single government has complete control. Using water inefficiently in the upstream country, for instance, can result in water shortages in the downstream country. Harmonisation of policies or at least coordination and consultation is needed to prevent situations in which management actions in one country neutralise or counteract management actions in other countries.

The perspective of dealing with inherent uncertainties implies that water management becomes more and more a learning activity, in which policies become hypotheses and the consequent management actions become experiments to test those hypotheses. This requires continuous monitoring of progress toward achieving policy objectives as well as learning from the results of management actions (Raadgever et al., 2008).

Legal setting

The legal framework consists of the full set of national and international laws and agreements. Laws should be complete and clear and contain sufficient detail to offer guidance and support without being too restrictive. Water laws can establish or influence formal networks, structures for information management and financial aspects of water management. To accomplish this, water management planning and implementation should be based on the existing legal framework and in turn may influence the legal framework. Due to climate variability and the large uncertainty associated with climate change impacts, law should not limit management options but should provide incentives to alter management actions to changing circumstances. This can be achieved by including regulations for (periodical) review and change of laws and regulations including changes in the institutional setting, information management and financial systems (Raadgever et al., 2008).

Institutional setting

Water management in literature is currently described in terms of complexity where problems are termed wicked (Rittel and Webber, 1973) or per-

sistent (van der Brugge et al., 2004). The complexity of water management implies that a wide range of governmental and non-governmental stakeholders should be actively involved (Ridder et al., 2005). They should be invited to share and discuss their perspectives in the subsequent stages of the policy process. These interactions can promote constructive conflict resolution which can result in inclusive agreements that the parties are committed to. In addition to formal networks, informal multilevel actor networks can enhance information flow, ensure collaboration across scales and provide for social memory (Raadgever et al., 2006).

Information collection and management

Information is needed to assess the current situation and existing vulnerabilities to develop understanding of the possible futures and consequently needs extensive monitoring. Next to that, there is also a need to monitor policy progress. All this information should be collected based on an understanding of the need for information for policymaking and policy evaluation. Scientists need to share knowledge between different disciplines (e.g. hydrology and climatology) as well as connect knowledge to the problems decision-makers are facing. Decision-makers should base their decisions as much as possible on scientific results, recognizing however, that science has limitations. All this will require intensive cooperation between the groups (Timmerman and Langaas, 2004) and clear communication about the interpretations and assumptions used, and critical (self-)reflection by the producers (Ridder et al., 2005). In a transboundary context, the situation can become more complex as data need to be shared.

Financial systems

It is important that action regarding climate change adaptation and mitigation should be taken as soon as possible because delay will surely result in increased costs (Stern, 2007). The money, however, should be wisely spent. Sufficient resources should be available to ensure sustainable water management. Financial as well as ecological sustainability can be improved by recognising water as an economic good and recovering the costs as much as possible from the users. It is also directly linked to the intensity of use. However, while water pricing can reduce excessive water use, access to clean water and sanitation should be offered to all humans at an affordable price (GWP-TEC, 2003). Transboundary river basin management faces the costs of producing a diverse set of public goods (e.g., flood protection) and

market goods (e.g., hydropower), as well as the costs of the management process itself (e.g., travel costs). The challenges confronting financing system for transboundary river basin management are to ensure sufficient funding, prevent perverse price incentives, and maximize learning opportunities. Although participatory approaches, experimentation, and monitoring outcomes cost money, in the long run they may prevent costly delays and construction of unnecessary, expensive infrastructure. And financing systems are most robust when they can rely on multiple sources (Raadgever et al., 2008).

Conclusion

While water management is a key-factor for climate change adaptation, adaptation of water management is not a stand alone issue that needs to be tackled: adaptation should be a fundamental part of integrated water resources management. Starting from this premise, policy makers need to be aware that there are five main approaches in the overall water management that will also help in finding solutions for climate change effects.

First is collaborative governance in water management that needs strengthening. Building adaptation measures on a joint effort of government, society and science ensures that measures will become effective and sustainable. This includes harmonisation of political, legal and institutional settings over administrative borders in the case of shared water resources. Second is a paradigm shift from water supply management to water demand management, wherein the use of water by a wide range of sectors is tailored to the availability of water. Thirdly, this entails the need to look for non-structural adaptation measures. Legal, institutional and policy agreements are needed to alter the relation to water, e.g. to improve efficiency in the use of water but also to reduce damage in case of extreme events like prohibiting building activities in flood-prone areas. Fourthly, adaptation to climate change and other drivers of change such as energy and food prices, demographic trends, migration flows, and changing production and consumption patterns should be viewed as a long-term, continuous exercise and not a "one-off" set of measures. Finally, an important principle is that the use of water resources comes with a price, for instance, based on the valuation of the service provided by water and water-related ecosystems.

While all this may appear obvious, implementation of these recommendations are highly demanding and will demand to overcome the inertia of traditional approaches and resistance from various actors. The challenge for politicians is to have the vision of how to put the ideas into practice, as well as the courage to withstand criticism and to share power with other actors.

Vocabulary notes

Anthropogenic: Made by people or resulting from human activities.

Aquifer: An underground geological formation able to store and yield water.

Asset: Any item of economic value owned by an individual or corporation, especially that which could be converted to cash.

Drought: An extended period with little or no precipitation; often affects crop production and availability of water supplies.

Freshwater: Water containing less than 1,000 parts per million (ppm) of dissolved solids of any type.

Governance: The interactions between public and/or private entities ultimately aiming at the realization of collective goals.

Groundwater: Water found in the spaces between soil particles and cracks in rocks underground (located in the saturation zone).

Regime: Sets of implicit or explicit principles, norms, rules, and decision-making procedures around which actors' expectations converge in a given area of international relations.

River basin: The area drained by a river and its tributaries.

Stakeholders: Individuals or groups that are affected by a decision and have an interest in its outcome.

Transboundary water management: The equitable and sustainable allocation and management of water resources across international borders.

Water scarcity: A situation where there are insufficient water resources to satisfy long-term average requirements.

Answer the following questions:

1. Why is transboundary water management essential for countries that share a water resource?
2. What are important barriers for transboundary water management?
3. Why is adaptive water management necessary for climate change adaptation?
4. Name the five elements of a transboundary water management regime.

5. Why is harmonisation of legal frameworks over riparian countries so important?

EXERCISES

A. *Find if the following are true or false.*

1. Governance is what government does as the single decision making authority.
2. The transboundary nature of a river basin complicates its management.
3. A legal framework is a set of national and international laws and agreements.
4. Adaptation to climate change should be viewed as a long-term, continuous exercise.
5. Only few of the river basins and groundwater worldwide are shared by two or more countries.
6. Decision-makers should base their decisions as much as possible on scientific results.
7. A regime is the period that a king or president is in power.
8. Adaptive water management needs to take into account environmental, technological, economic, institutional and cultural characteristics of river basins.
9. Monitoring is needed to provide decision-makers with relevant information.
10. Harmonisation of political, legal and institutional settings over administrative borders is needed in transboundary water management.

B. *Fill the blanks with a suitable word.*

1. A large part of the world's freshwater resources is contained in _____ and _____that are shared by two or more countries.

2. _____water management is in essence more complex than _____ water management because the water management regimes usually differ more between countries than within countries.
3. Weak social and institutional _____, poor legal and policy _____, and bad management practices bear great consequences in the transboundary context.
4. Governance takes into account that a large number of _____ in different institutional settings contribute to policy and management of a resource.
5. Adaptive management aims at _____ the adaptive capacity of river basins.
6. A major challenge in _____ transboundary waters is that no single government has complete _____.
7. The _____ of water management implies that a wide range of governmental and _____stakeholders should be actively involved.
8. Scientists need to share _____ between different disciplines as well as connect knowledge to the problems _____ are facing.
9. Financing systems are most _____ when they can rely on multiple sources.
10. An important _____ is that the use of water resources comes with a price

C. *Put the verbs in parenthesis into their correct form.*

1. Climate change essentially (change) _____ the hydrological situation in many basins.
2. Transboundary water management (require) _____ coordination over different political, legal and institutional settings.
3. Increasing water scarcity, including the availability of water of sufficient quality, (lead) _____ to a potential increase in water conflicts between countries.
4. Transboundary water management heavily (depend) _____ upon circumstances at the national level.
5. Governance (take) _____ into account that a large number of

stakeholders in different institutional settings contribute to policy and management of a resource.

6. Adaptive management (be) _____ advocated as a timely extension of IWRM to (cope) _____ with the challenges of variability and changing nature of water supplies.
7. (Use) _____ water inefficiently in the upstream country can result in water shortages in the downstream country.
8. Governance (differ) _____ from the old hierarchical model of government in which state authorities exert sovereign control over the people and groups making up civil society.
9. From the perspective of (deal) _____ with inherent uncertainties (imply) _____ that water management (become) _____ more and more a learning activity.
10. Financial as well as ecological sustainability can be (improve) _____ by (recognise) _____ water as an economic good.

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English through Climate Change, pp. 167 – 178

Climate Change: A Challenge for Ethics

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Abstract

Climate change – and its most dangerous consequence, the rapid overheating of the planet – is not the offspring of a natural procedure; instead, it is human-induced. It is only the aftermath of a specific pattern of economic development, one that focuses mainly on economic growth rather than on quality of life and sustainability. Since climate change is a major threat not only to millions of humans, but also to numerous non-human species and other forms of life, as well as to the equilibrium and the viability of the very planet, addressing it is of dire importance. In this chapter it will be argued that addressing the threat of climate change is primarily a task and a challenge for ethics, since the stabilization and gradual amelioration of the situation requires abandoning an up to now dominant model of life, long-established customs and a so far cogent system of moral values. It will be further maintained that this for ethics might – or, even, should – become a new categorical imperative, since preserving the viability of the planet is a fundamental moral duty not only towards the existing members of the moral community, but also towards future generations. The chapter provides a glossary of the most important terms used in the text presented in the first part. It also provides different exercises aiming either to further consolidate student understanding of these terms or / and strengthen student grammatical and syntactical skills.

The Western philosophical tradition is largely – and becomingly – indebted to Socrates, for it was with him that ethics as we today know it was born (Russell, 1967). Socrates' main contribution to ethics could be excellently summarized in a wellknown argument of his, namely that "nobody does wrong willingly" (Plato 1998); by this, he is supposed to be suggesting that anyone who acts unjustly does so because he or she is at the moment

unaware of the very fact that his or her deeds are actually unjust. The upshot is that if one has a good understanding of the moral status of each one of his or her options, one will never voluntarily opt for the morally unjustified one, unless, of course, one is mentally deranged. Socrates' view is really optimistic, but by no means stands for an unshakable truth. As early as Aeschylus' *Prometheus* it has been intensely argued that humans might actually "know what is better and approve of it, but pursue what is worse" (Aeschylus, 1990; Ovid, 1998) all the same.The human condition indeed seems to be pointing to the opposite direction from Socrates' intellectualistic optimism. We should, however, credit Socrates with this: knowing that something is wrong is a necessary condition for a moral agent to abstain from it; or, in other words, if one does not know that something is wrong, one has no good reason to avoid it and pursue something else. This is true concerning many aspects of the behaviour of humans, but never truer than when it comes to the human interaction with the non-human environment.

Is there any moral responsibility?

It was only a few decades ago when the disastrous impact climate change may have on people and the environment finally became fully manifest. Now humans know; the veil of ignorance is levied, so moral responsibility may enter the stage. All the more so, because the question concerning what should be done about climate change is a *par excellence* moral one, since it needs to address a major conflict in interests (Grubb, 1995). Climate change is mostly due to global warming, which is a consequence of higher than normal concentrations of greenhouse gases in the stratosphere. This creates "a partial blanketing effect" (Houghton, 1997), which causes the temperature at the surface to be higher than would otherwise be the case. Excessive emissions in greenhouse gases is caused by the constantly increasing use of fossil fuels (Gardiner, 2004) by developing countries that in most cases are utterly dependend on such energy sources for their economic growth and overall well-being. This is mostly because fossil fuels still remain much cheaper than any other energy source, much more reliable than sun and wind energy, and a lot safer than nuclear power.

Developing countries seem justified to claim equal opportunities to growth and a fair share to economic flourishing (Gardiner, 2004), by making use of exactly the same means that less than a hundred years ago allowed their developed neighbours to flourish: hydrocarbons (Lomborg, 2001); this model of growth, on the other hand, is obviously a major threat to the natural equilibrium and, hence, no more sustainable: the average temperature of the planet constantly increases, the polar ice melts, the sea level rises putting at

stake the well-being and, eventually, the existence of millions of people, as well as of incalculable species of flora and fauna. And these are only the dangers that scientists are today aware of (Broome, 1992); if the situation does not drastically change soon, all experts in the field of climate change concur that in the near future no species may feel safe. Then, as long as the question concerning climate change requires – and necessitates – the evaluation and compensation of conflicting interests, and since at the same time considerations of fairness, equity, and justice must also inform any successful international agreement, it seems that the issue of climate change entirely falls under the domain of ethics. No less, it seems to outline an ultimate challenge for ethics: not only it is a highly exigent issue, since it demands that moral agents take into consideration their relations to fellow humans on a par with those to non-human species and the non-human world, but it is also logically prior to any other moral issue. In other words, if the problem of climate change is not promptly, fully and properly addressed, it seems almost non-sensical to attempt to come to grips with other ones: no moral issue would survive the – as it now seems – inevitable overwarming of the planet.

Any moral agent might be held responsible for his or her actions provided on the one hand that these actions have consequences for other human beings, and on the other that one is offered alternatives, among which he or she is free to choose. The former might be regarded as the *sufficient condition* for moral responsibility, while the latter as the *necessary* one. It is obvious now that the way humans have chosen to interact with the environment is the main cause of unforeseen and unwanted climate change that has grave consequences not only to individuals, but also to entire populations. It is also clear that this *modus operandi* – and its main consequence, climate change – is not unavoidable or imperative; other means of pursuing progress could always be employed, provided that moral agents felt they ought to – or should – do this. This is because each one of the ways that might be employed on purpose of interacting with the non-human world obviously implies certain and distinct consequences and, of course, it is not mandatory for humans to live after only a certain fashion or to abide by a given pattern of progress; it might sound like wishful thinking, but humans can always abandon convenient though hazardous or calamituous lifestyles in favour of more moderate but safer ones. The fact that now the consequences of each of these alternatives can precisely be estimated is the safest of grounds for moral responsibility to sprout.

Today, no institution, no state, no coalition of states, no enterprise or individual can invoke ignorance as an excuse, unless one wants to play blind and deaf at the same time. Today, every strategic decision regarding industrial activity or, in general, the patterns of economic growth, is not merely a

technical statement anymore, but also a genuine moral one, for it stands for a certain way of understanding and evaluating rights, duties towards fellow humans and the environment, responsibilities towards non-human life and landscapes, and priorities concerning what should be pursued in life (Jamieson 2003, p. 290). General economic theories have always been incorporating notions of what should be preferred or avoided; they have always rested upon specific sets of moral values and have always discerned the alleged right from the alleged wrong, justifiable policies from unjustifiable ones, proper goal setting from improper. Nevertheless, nowadays, the stake has grown as high as it can get: the dilemma no more regards the flourishing of the few in expense of the many or vice versa, nor any scientific disagreement concerning the selections of the most appropriate means towards progress and development (Jamieson, 2003). Today the dilemma is about the continuation of life on earth as it now is, and it is a *par excellence* moral one.

To whom are moral agents accountable?

Obviously, moral agents are morally responsible to everybody (and, also, to everything) that is – or might be – affected by climate change. Since the continuing emission of greenhouse gases is a strategic and moral choice aiming to specific gains, the actual or potential losses of all affected parts should also be equally considered. The real question, therefore, should be: Who is – or might in the future be – affected or burdened by climate change?

a. Existing fellow humans

Entire populations currently live in areas just a few meters – and in some cases only centimeters – above the sea level. The rapidly melting polar ices threaten not only the natural equilibrium in these landscapes, but also their actual existence, along with the habitats of millions of people. These people, in the near future, should have to be relocated; their way of life will be dramatically changed; local civilizations will perish; the quality of people's lives will be diminished. In short, vast populations will be forced to abolish fundamental rights that humans so far have been free to enjoy and exercise. In addition, it must be mentioned that those who are about to be mostly affected by climate change are mainly the least well-off, to wit the least facilitated to overcome untoward situations or to adapt to new ones. However, it is a commonplace in ethics that the interests of the weak should be taken much more seriously into consideration than those of the mighty. Climate change threatens directly the rights of entire populations that happen to be devoid of any means to protect theirselves; people in threatened areas most

of the times live below the standard of poverty; they are poorly – if at all – politically represented; in a word, they are just "voiceless" people, who are unable of making their stand. An ethic that would fall short of guaranteeing, not just the rights and well-being, but also the very survival of those in need, would be self-defeating.

If today those who inhabit areas that are mostly threatened by climate change face the danger of being deprived of their fundamental moral rights, tomorrow they will not be the only ones to suffer such a loss: as a matter of fact, all the dwellers of this "global village" (McLuhan, 1964) will see some of their basic rights being suspended, and their well-being accordingly diminished. For one, when the ongoing immigration due to the sea level rise has reached its peak, all nations – in varied degrees, of course – will suffer the consequences; most people's right to a standard of living that would be adequate for basic needs and access to services will be drastically limited, along with their opportunity to enjoy "a social and international order in which the rights and freedoms set forth in the Universal Declaration of Human Rights can be fully realized" (COMEST, 2010).

b. Future generations

Future generations can not be considered as right-bearers, simply because they do not still actually exist; they cannot partake in the covenant of ethics as claimants of rights, exactly as they could not be bound with any kind of duties to anybody. This, however, does not mean that they should be excluded from moral consideration. On the contrary, there are good reasons why moral agents ought to make allowance in their moral decisions for respect of the dignity, equal opportunities and the overall well-being of not-yet-born people. First of all, taking into consideration future generations obviously is an inherent tendency of human beings. In Kantian terms, any moral statement that runs contrary to inherent human tendencies neglects an "imperfect duty" of ours, which, however, is exactly as morally binding as a "perfect" one. In other words, confining moral consideration to existing individuals is not what people normally do, nor is it morally justifiable; it seems that there is intrinsing wrongness in this type of reasoning (Peonidis, 2012). Hence, still in the Kantian tradition, any moral statement of the form: "one ought to act as if the human species would cease to exist right after one perishes" could never be morally justifiable or binding; such a will would only conflict with itself, since it would go contrary to the natural wish of humans to secure better opportunities for their off-spring.

One could also take a step further and examine if and in what degree insensibility and unconcern for the future generations is contrary to some "perfect duty" of moral agents. As Kant claims, a prefect duty consists in not act-

ing according to moral principles that are self-defeating. Now, the principle that suggests that moral agents should not take into consideration future generations seems to be utterly self-defeating, because if such a maxim had been widely accepted by previous generations, the human species would have been extinct long ago; further on, if present generations abide by such a principle and do nothing about climate change, this would only be due to their reluctance to abandon an up to now dominant model of life and long-established customs; it would also be because existing at present moral agents would be unwilling to assume the burden of a model shift and would, instead, prefer to transfer the costs of any change to people not yet born. Thus, however, future human beings would be treated as just means to present human beings' ends; nevertheless, in Kant's view this would imply a clear violation of a perfect duty moral agents actually have, to never to treat other human beings merely as means to an end, but always at the same time as ends in themselves (Kant, 1993).

Conclusion

Climate change falls squarely within the domain of ethics: the problem has been human-induced, it affects people all over the planet by violating moral agents' fundamental rights, while it treatens the well-being of future generations. Any efficacious response to the challenge climate change imposes should weigh conflicting interests among different people, and it should incorporate notions of what is morally justifiable or pursuable; such a response should also need to re-examine the entire spectrum of relations between humans, as well as established priorities in life and dominant worldviews. While scientists and experts are able to estimate potential gains and losses and propose solutions accordingly, it is only up to human moral conscience to decide which option amongst the ones that are offered should be morally preferable. It is possible that an effective response to the problem of climate change might imply or necessitate that humans should be deprived of some of their conveniences, and adopt much more moderate – but also more sustainable – lifestyles. If this is the case, the only way to convince moral agents to do so is to invoke some morally compelling duty of theirs to undertake such a burden. And this is a challenge for ethics.

Vocabulary Notes

Argument: (<lat. *argumentum*) a process of reasoning consisting in a connected series of statements or propositions (*premises*), which are intended to provide support, justification or evidence for the truth of the *conclusion*. The most usual forms of argumentation are by deduction, induction and analogy.

Duty: an obligation we have as human beings on the basis of being a part (and in the context) of a moral community, such as to tell the truth or to care for our offspring.

Equilibrium: (<lat. *aequilibrium*) an ideal condition of a system, in which all competing tendencies or influences are balanced due to equal action of opposing forces.

Equity: (< lat. *aequitas*) the quality of being fair, impartial, just.

Ethics: (< gr. *ethika*, *ithiki*) the branch of philosophy dealing with sets of moral values and general theories concerning good and evil, or proper and improper ways of conduct; an individual system of moral principles; rules of conduct applicable to specific branches of human action or groups (Buddhist ethics, dental ethics etc).

Fauna: (< lat. *Faunus/Fauna*: the god/godess of earth and fertility in Roman mythology) all the animal life of a given place or time.

Flora: (< lat. *Flora*: the god/goddess of plant life in Roman mythology) all the plant life of a given place or time.

Fossil fuel: any naturally occurring carbon or hydrocarbon fuel, such as coal, petroleum, peat, and natural gas, formed by the decomposition of preexisting organisms.

Global warming: an increase in the average temperature of the Earth's atmosphere, great enough to cause changes in the global climate.

Greenhouse gases: atmospheric gases that cause – or contribute to – the greenhouse effect by absorbing infrared radiation produced by solar warming of the Earth's surface, such as carbon dioxide (CO_2), methane (CH_4), nitrous oxide (NO_2), etc.

Imperative: *adj*. something that is impossible to evade, deter or avoid; *n.* a command, an order.

Intellectualistic optimism: (<lat. *intellectus*: mind; *optimus*: best) the tendency to expect the best possible outcome out of trust to human intellectual abilities.

Justice: (<lat. *iustitia*) the quality of being just, fair; the administration and procedure of law.

Modus operandi: (lat.) a specific manner of operating, functioning, working.

Moral agent: a person who is capable of understanding the notions of right and wrong and act with reference to them in the context of a specific moral society.

Moral issue: an issue concerning opposing interests, to which conflicting moral theories are applicable.

moral responsibility: the situation in which a moral agent is compelled to act in a certain way.

Moral rights: also called "natural rights"; are rights which are not contingent upon the laws, customs, or beliefs of a particular society or polity.

Moral status: the quality of being a moral agent, or being endowed with specific moral values.

Moral values: variables of a moral system, by virtue of which right is discerned from wrong, preferable from avoidable conduct; qualities ascribed to an individual, usually either as *inherent* (or absolute), or as *instrumental* attributes.

Necessary condition: one that needs be satisfied for the statement to be true. For example, being a mammal is a necessary condition to be a human; it is not, however, a sufficient one (see below *sufficient condition*).

Par excellence: beyond comparison; the most typical example of something.

Stratosphere: the atmospheric layer lying between the troposphere and the mesosphere. The stratosphere is characterized by the presence of ozone gas (in the ozone layer) and by temperatures which rise slightly with altitude, due to the absorption of ultraviolet radiation.

Sufficient condition: one that assures the statement's truth. For example, being intellectually apt is a sufficient condition to grasp sophisticated ideas, but it is not a necessary one.

Upshot: a consequence.

Wishful thinking: a cognitive bias in the context of which one, instead of resorting to evidence or rationality, one decides according to what seems pleasing to believe; the logical fallacy of arguing that because one assumes something to be pleasant, something is also true.

Answer the following questions:

1. How have Socrates' views influenced western ethics?
2. Do people always do what is right and abstain from what is wrong? Try to document your opinion.
3. Why are knowledge and moral responsibility mutually connected? Please provide an example.
4. Why are environmental issues of high priority to ethics?
5. What makes climate change a challenge for ethics?
6. Which are the most significant reasons we continue to use fossil fuels in such a degree?
7. Which are the actual consequences of global warming?
8. Which are the moral implications of climate change?
9. Are we morally accountable to the future generations?
10. Can we have moral duties towards inanimate beings and formations, such as trees, rocks and landscapes?

EXERCISES

A. *Match the words or phrases of Column A with the words of Column B.*

1. global	a. justifieble claims
2. hydrocarbons	b. responsibilities
3. moral rights	c. warming
4. duties	d. fossil fuels
5. balance	e. logical falacy
6. wishful thinking	f. capable of acting in reference to right and wrong
7. moral agent	g. extended moral considera-tion
8. future generations	h. equilibrium

B. *Find if the following are True or False.*

1. No one does wrong willingly.
2. True knowledge of what is right and wrong necessarily leads to the right decision.
3. Climate change is due to strategic decisions concerning the way progress and growth should be pursued.
4. On grounds of equal consideration and equity all people should have a fair share in economical development, irrespective of whether this might threaten the environment or not.
5. The developed countries are morally responsible for providing the developing ones with the means of environmental-friendly and sustainable development.
6. Economic and industrial policies should become issues of international negotiation and consent.
7. The notion of progress at any cost is self-defeating.
8. All existing beings should be granted the right to continue existing.
9. Moral agents might well have duties towards future generations.
10. Reversing the grave situation concerning climate change and saving the planet could be deemed a perfect duty according Kantian ethics.

C. *Complete the following chart:*

Verb	**Noun**	**Adjective**
argue	_____	_____
_____	justification	_____
_____	account	_____
estimate	_____	_____
_____	dominion	_____
_____	development	_____
_____	_____	grown
_____	disagreement	_____
_____	_____	affected

D. *Fill the blanks with a suitable word.*

Socrates has _____ a highly influential figure in ethics. He stressed the role of _____ in moral reasoning. Knowledge is a _____ condition for moral responsibility. People today know that climate change may _____ all life from the face of earth. Therefore moral agents are being held morally _____ for their decisions concerning the continuation of the situation. Apart from the duties they have towards existing fellow humans, they might be acknowledged duties towards future _____, for if the situation is not drastically changed, human off-spring will be _____ of possibilities and _____.

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