BASQUE CENTRE
FOR CLIMATE CHANGE
Klima Aldaketa Ikergai

Climate Change and Its Socioeconomic Importance

Ibon Galarraga and Anil Markandya

October 2009

BC3 WORKING PAPER SERIES

2009-08

The Basque Centre for Climate Change (BC3) is a Research Centre based in the Basque Country, which aims at contributing to long-term research on the causes and consequences of Climate Change in order to foster the creation of knowledge in this multidisciplinary science.

The BC3 promotes a highly-qualified team of researchers with the primary objective of achieving excellence in research, training and dissemination. The Scientific Plan of BC3 is led by the Scientific Director, Prof. Anil Markandya.

The core research avenues are:

- Adaptation to and the impacts of climate change
- Measures to mitigate the amount of climate change experienced
- International Dimensions of Climate Policy
- Developing and supporting research that informs climate policy in the Basque Country

The BC3 Working Paper Series is available on the internet at
http://www.bc3research.org/lits_publications.html

Enquiries (Regarding the BC3 Working Paper Series):

Roger Fouquet

Email: roger.fouquet@bc3research.org

www.bc3research.org

Note: If printed, please remember to print on both sides. Also, perhaps try two pages on one side.

Climate Change and Its Socioeconomic Importance

Ibon Galarraga and Anil Markandya[1]

Climate change has played an increasingly key role in recent years and is now one of the leading political priorities worldwide. This article illustrates the scope of the problem, its causes and its impacts, along with the possible solutions that are being considered on the international stage. The existing information regarding these topics is summarised, together with the associated costs and the scale of the effort required to tackle climate change. The article explains why climate change can be seen as a market failure, the importance of public policies to correct this problem and its impact on international trade. The last section considers the international debate taking place in the United Nations Conferences and the Kyoto Protocol as well as what is expected with respect to the future post-Kyoto negotiations.

Keywords: Climate change, policy

JEL Classification: Q54

Cite as: Galarraga, I. and A. Markandya (2009) *Climate Change and Its Socioeconomic Importance*. BC3 Working Paper Series 2009-08. Basque Centre for Climate Change (BC3). Bilbao, Spain.

A Spanish version of this paper will be published in Ekonomiaz: “Economía Baja en Carbono”, third quarter 2009.

[1] Basque Centre for Climate Change (BC3), Gran Via, 35 – 2, 48009 Bilbao, Spain. Corresponding author E-mail: ibon.galarraga@bc3research.org

1. Introduction: Raising Concerns

Nowadays, nobody doubts that climate change is one of the greatest challenges facing humanity or that it is man-made in origin. Yet, climate change also has three characteristics that make it particularly important and unique:

- First, and even though there has been considerable scientific progress regarding knowledge on climate change, there continues to be great uncertainty regarding the future impacts on a planetary scale and, of course, regarding the extent that each eco-system and each region will be affected. However, it is clear that the consequences will be of great magnitude.
- The second characteristic is to do with the fact that the impacts, even though they have already begun to be noted, are going to have very long-term consequences in 2050, 2100 and beyond.
- And thirdly, that although it is a global problem, the responsibility of some countries and others is not the same, in fact far from it. Therefore, the distribution of the burden to deal with it cannot be the same.

These characteristics mean that climate change is an area where it is extremely complex to transmit the increasing concern in the world of science regarding how this problem is progressing to society, to politicians and to other stakeholders.

The concern about climate change emerged for the first time on an international scale during the World Climate Conference held in Geneva in 1979. Since then, some milestones that are examples of the awakening of the deep concern about this phenomenon have included:

- the 1985 United Nations Conference on the Greenhouse Gas Emissions in Austria,
- the setting up of the Intergovernmental Panel on Climate Change (IPCC) as the Intergovernmental Working Group on Climate Change in 1988, and
- the creation of the United Nations Framework Convention on Climate Change (UNFCCC) in 1992 during the Rio de Janeiro summit (and its implementation in 1994).

There have been other milestones, such as the signing of the Kyoto Protocol (KP) or the different Conferences of the Parties (CoP) and Conferences of the Protocol Parties, as the politicians around the world have discovered the scope and seriousness of the problem.

The successive IPCC reports (1990, 1995, 2001 and 2007) analysed the existing scientific knowledge on topics such as potential impacts, possibilities for adaptation and vulnerability, or the opportunities to reduce Greenhouse Gas (GHG) emissions. These reports have decisively contributed to generating current world consensus regarding the seriousness of the situation and the burning need to act in a decisive manner. Other reports, such as the well-known Stern report (2006), have also significantly helped to put climate change on the list of the top policy priorities.

2. Climate Change and Scientific Knowledge

2.1 Evolution of climate, impact and causes

The IPCC has clearly stated that there is sufficient scientific evidence regarding the unequivocal warming of the climate on all continents, particularly in the upper northern areas and in the majority of seas (IPCC, 2007a).

This change has been more intense during the last century and continues to speed up. The rise in sea levels, the disappearance of ice, changes in precipitation or even increased tropical cyclone activity seem to endorse this fact. Specifically, it can be said that “the average Northern Hemispheres temperatures during the second half of the 20th century were higher than during any other 50-year period in the last 500 years. It is possibly the highest in at least the past 1,300 years.” (IPCC, 2007a).

The warming is affecting nearly all marine and terrestrial eco-systems, beginning with the Arctic and Antarctic eco-systems and even including tropical marine environments. Regional climate changes already affect (or will affect) nearly all human and natural environments.

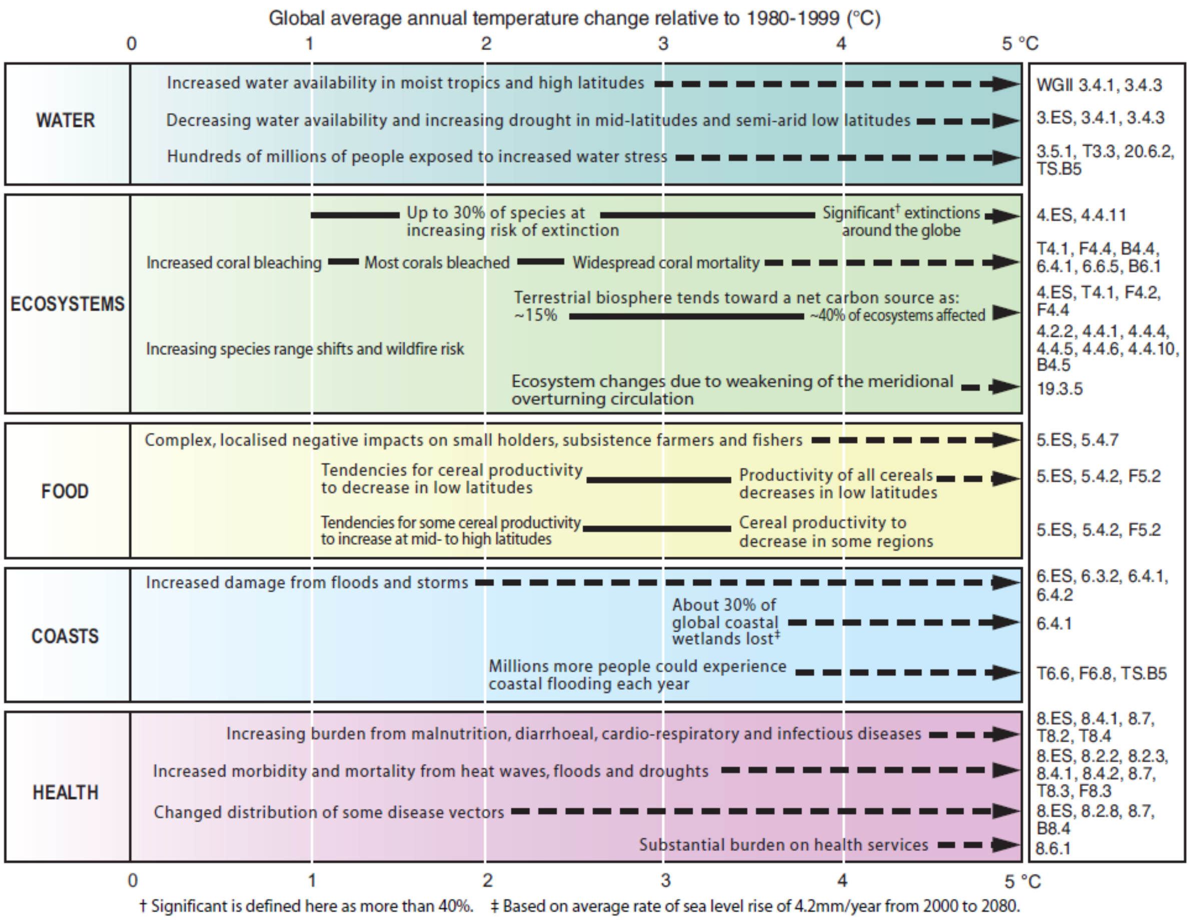
Other impacts analysed include the changes in the availability of fresh water, droughts or floods, the loss of any type of species and eco-systems, the dramatic changes in agricultural productivity, increased storm activities and sea flooding, the rise in the incidences of tropical diseases, malnutrition and infections, the change in the disease vectors or the changes in mortality or morbidity. The majority of these are negative, large-scale impacts that will affect most of the planet. (See Table 1).

Some of the scenarios developed by scientists forecast impacts that may even be catastrophic. The greatest impact will be on the poorest and more vulnerable regions and may lead to increases in the migratory processes and social instability. (IPCC, op. cit.).

The IPCC also points out that much of this rise in global temperature is highly likely to be explained by the observed increase in GHG concentrations as the result of human activities, mainly due to the use of fossil fuels and the changes in land use. Increases in these emissions began to be noted from the pre-industrial era onwards, but shot up by 70% between 1970 and 2004. These gases, along with aerosols, changes in land coverage and solar radiation are responsible for changes in the balance of the climatic system. (IPPC 2007a).

The accelerated increase in the emissions has meant that concentration levels that were around 280 parts per million (ppm) at the start of the century had risen to 379 for 2005, which is much higher than the natural levels over the last 650,000 years. It is estimated that this trend for increased GHG concentrations may lead to a rise in temperatures of between 1.1 and 6.4 degree Celsius by 2100 (IPCC 2007b).

Table 1: Examples of impacts associated to Climate Change



Source: IPCC 2007a

Authors such as Weizmann (2008) note the worrying fact that some of the IPCC scenarios also include rises in GHG concentrations that would mean temperature increases of up to 4.5ºC with a probability of 17%. Or even 8 ºC with a probability of 2%. These scenarios, even though less likely than more favourable ones, are rather more alarming and would mean that many regions of the planet would become inhabitable.

With global GHG emission rates on the scale that has recently been observed, changes in the world climatic system during the 21st century may be much greater than those that occurred in the 20th century. And that is cause for great concern.

2.2 Required actions

In order to respond to this situation, the scientific community has set the world target of limiting GHG concentrations in the atmosphere to 550 ppm by the year 2100. This would mean an average temperature rise of 2ºC (with a range of between 1.5 and 4.5 ºC). The choice of this target dramatically conditions the whole discussion regarding the policies to fight against climate change given that they determine the emission flows that are acceptable, and subsequently the emissions reduction targets (Stern, 2008). The latter likewise conditions the policies aimed at technology and establishing prices for CO_2e (Stern, 2008)

As far as global emissions are concerned, this means a dramatic change in the trend, with maximum world emissions being reached by 2020. They would then be reduced by between 1% and 2.5% per year from then onwards (Stern, 2006).

“As a rule of thumb one can think of emissions declining by 50 percent relative to 2000 levels by 2050 for the planet to be on this stabilization path” (Markandya 2009).

Taking into account fairness in sharing the burden among rich and poor countries, these targets suggest that the developed countries must reduce their global emissions by a percentage of around 60-90% by 2050. These reduction targets are truly important and illustrate the size of the challenge to be undertaken.

2.3 Adaptation and mitigation measures

When we speak about the measures that can be adopted to tackle this phenomenon, there are, on the one hand, the adaptation measures, in other words, all those aimed at preparing for the changes that are occurring and are going to occur. And, on the other hand, there are the mitigation measures, which are those aimed at reducing the amount of GHG in the atmosphere, either by reducing the emissions and/or by increasing the capacity of the ecosystems to absorb those gases.

The number of measures that can be applied in both groups is really wide. They are closely linked to the economic and social development of each region or country and lead to significant differences between regions.

Table 2: Examples of adaptation policies

Sector	Adaptation option/strategy	Underlying policy framework
Water (WGII, 5.5, 16.4; Tables 3.5, 11.6,17.1)	Expanded rainwater harvesting; water storage and conservation techniques; water reuse; desalination; water-use and irrigation efficiency	National water policies and integrated water resources management; water-related hazards management
Agriculture (WGII 10.5, 13.5; Table 10.8)	Adjustment of planting dates and crop variety; crop relocation; improved land management, e.g. erosion control and soil protection through tree planting	R&D policies; institutional reform; land tenure and land reform; training; capacity building; crop insurance; financial incentives, e.g. subsidies and tax credits
Infrastructure/ settlement (including coastal zones) (WGII 3.6, 11.4; Tables 6.11, 17.1)	Relocation; seawalls and storm surge barriers; dune reinforcement; land acquisition and creation of marshlands/wetlands as buffer against sea level rise and flooding; protection of existing natural barriers	Standards and regulations that integrate climate change considerations into design; land-use policies; building codes; insurance
Human health (WGII 14.5, Table 10.8)	Heat-health action plans; emergency medical services; improved climate-sensitive disease surveillance and control; safe water and improved sanitation	Public health policies that recognise climate risk; strengthen health services; regional and international cooperation
Tourism (WGII 12.5, 15.5, 17.5; Table 17.1)	Diversification of tourism attractions and revenues; shifting ski slopes to higher altitudes and glaciers; artificial snow-making	Integrated planning (e.g. carrying capacity; linkages with other sectors); financial incentives, e.g. subsidies and tax credits
Transport (WGII 7.6, 17.2)	Realignment/relocation; design standards and planning for roads, rail and other infrastructure to cope with warming and drainage	Integrating climate change considerations into national transport policy; investment in R&D for special situations, e.g. permafrost areas
Energy (WGII 7.4, 16.2)	Strengthening of overhead transmission and distribution infrastructure; underground cabling for utilities; energy efficiency; use of renewable sources; reduced dependence on single sources of energy	National energy policies, regulations, and fiscal and financial incentives to encourage use of alternative sources; incorporating climate change in design standards

Note:
Other examples from many sectors would include early warning systems.

Source: IPCC 2007a

The first (adaptation) includes all those aimed at recovering the affected ecosystems, redesigning energy, transport or water supply infrastructures or adapting agricultural crops to the new conditions (see Table 2). The second (mitigation) include all those measures to save and ensure efficient use of energy resources, promote renewable energies and sustainable transport or the use of market instruments as incentives to decarbonise the economy (see Table 3).

Table 3: Examples of mitigation policies

Sector	Key mitigation technologies and practices currently commercially available. *Key mitigation technologies and practices projected to be commercialised before 2030 shown in italics.*	Policies, measures and instruments shown to be environmentally effective
Energy Supply (WGIII 4.3, 4.4)	Improved supply and distribution efficiency; fuel switching from coal to gas; nuclear power; renewable heat and power (hydropower, solar, wind, geothermal and bioenergy); combined heat and power; early applications of carbon dioxide capture and storage (CCS) (e.g. storage of removed CO_2 from natural gas); *CCS for gas, biomass and coal-fired electricity generating facilities; advanced nuclear power; advanced renewable energy, including tidal and wave energy, concentrating solar, and solar photovoltaics*	Reduction of fossil fuel subsidies; taxes or carbon charges on fossil fuels Feed-in tariffs for renewable energy technologies; renewable energy obligations; producer subsidies
Transport (WGIII 5.4)	More fuel-efficient vehicles; hybrid vehicles; cleaner diesel vehicles; biofuels; modal shifts from road transport to rail and public transport systems; non-motorised transport (cycling, walking); land-use and transport planning; *second generation biofuels; higher efficiency aircraft; advanced electric and hybrid vehicles with more powerful and reliable batteries*	Mandatory fuel economy; biofuel blending and CO_2 standards for road transport Taxes on vehicle purchase, registration, use and motor fuels; road and parking pricing Influence mobility needs through land-use regulations and infrastructure planning; investment in attractive public transport facilities and non-motorised forms of transport
Buildings (WGIII 6.5)	Efficient lighting and daylighting; more efficient electrical appliances and heating and cooling devices; improved cook stoves, improved insulation; passive and active solar design for heating and cooling; alternative refrigeration fluids, recovery and recycling of fluorinated gases; *integrated design of commercial buildings including technologies, such as intelligent meters that provide feedback and control; solar photovoltaics integrated in buildings*	Appliance standards and labelling Building codes and certification Demand-side management programmes Public sector leadership programmes, including procurement Incentives for energy service companies (ESCOs)
Industry (WGIII 7.5)	More efficient end-use electrical equipment; heat and power recovery; material recycling and substitution; control of non-CO_2 gas emissions; and a wide array of process-specific technologies; *advanced energy efficiency; CCS for cement, ammonia, and iron manufacture; inert electrodes for aluminium manufacture*	Provision of benchmark information; performance standards; subsidies; tax credits Tradable permits Voluntary agreements
Agriculture (WGIII 8.4)	Improved crop and grazing land management to increase soil carbon storage; restoration of cultivated peaty soils and degraded lands; improved rice cultivation techniques and livestock and manure management to reduce CH_4 emissions; improved nitrogen fertiliser application techniques to reduce N_2O emissions; dedicated energy crops to replace fossil fuel use; improved energy efficiency; *improvements of crop yields*	Financial incentives and regulations for improved land management; maintaining soil carbon content; efficient use of fertilisers and irrigation
Forestry/forests (WGIII 9.4)	Afforestation; reforestation; forest management; reduced deforestation; harvested wood product management; use of forestry products for bioenergy to replace fossil fuel use; *tree species improvement to increase biomass productivity and carbon sequestration; improved remote sensing technologies for analysis of vegetation/soil carbon sequestration potential and mapping land-use change*	Financial incentives (national and international) to increase forest area, to reduce deforestation and to maintain and manage forests; land-use regulation and enforcement
Waste (WGIII 10.4)	Landfill CH_4 recovery; waste incineration with energy recovery; composting of organic waste; controlled wastewater treatment; recycling and waste minimisation; *biocovers and biofilters to optimise CH_4 oxidation*	Financial incentives for improved waste and wastewater management Renewable energy incentives or obligations Waste management regulations

Source: IPCC 2007a

The Kyoto Protocol and the UNFCCC negotiation process are the political setting for all these policy measures on the international stage. Both seek to regulate policies on a global scale. Practically all national governments, many regional and some local ones directly or indirectly participate in this process. Section 5 of this paper considers both the KP and the context of the UNFCCC:

2.4 Cost of the climate change policy

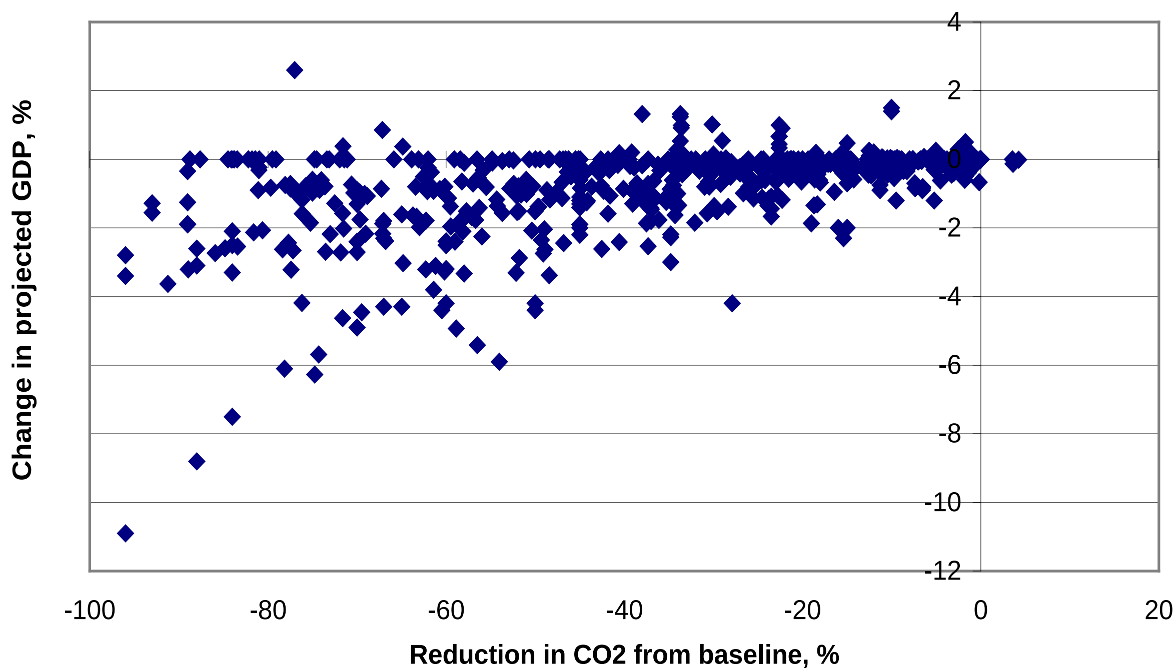
Climate change has acquired an important role in the political-economic debate and, against that background there has been great speculation about the scope of the proposed measures.

The scientific community has established the atmosphere load threshold scenarios, along with the ensuing reductions in emissions required for each case. Many experts consider that these reductions can be viably achieved without imposing an excessive economic cost on the economies of the world. However, it is true that there are huge differences with respect to the effort required by different sectors of activity and, above all, by different countries and regions.

Markandya (2009) recalls that the aforementioned Stern report, after analysing different studies, concludes that a cost of around 3%-5% of the annual gross domestic product in 2050 has to be considered to achieve the 550 ppm target. Consequently, based on an annual increase of the annual GDP of around 2.8% until 2050, he estimates that this target will cost around 7,800 billion US dollars. In other words, in accordance with the World Bank economic data and UN population forecasts, 846 dollars per capita in 2050 on an average income per capita of 24,165 dollars.

The aforementioned author refers to other estimates such as those performed by Golub et at (2006) that quantify a relatively small cost, which is under 0.5% of the gross domestic product of the United States of America in some cases when calculating the environmental benefits arising from this policy.

Figure 1: Costs of Mitigation: Percentage Change in Projected World Product



Source: Stern (2006) quoting a Barker, T., Qureshi, M.S. and Köhler, J. (2.006): "The costs of greenhouse-gas mitigation with induced technological change: A Meta-Analysis of estimates in the literature", 4CMR, Cambridge Centre for Climate Change Mitigation Research, Cambridge: University of Cambridge.

The IPCC (2007a) establishes that the mitigation cost of stabilisation of around 710 and 455 ppm is between 1% and 5.5% of the world GDP for 2050. The comparison of the different studies existing in the literature to estimate the mitigation costs suggests that the majority estimate ranges of between 0.5% and 2% of the world GDP (See Figure 1).

With regards to the costs arising from failing to implement climate change policies and continuing along the present path, the Stern report suggests that they could reach between 5% and 20% of the world GDP once the losses that have no market value (such as the loss of biodiversity or damage to the ecosystems) have been included. Other studies are around the lower limit of the Stern report.

The main reason for this difference in the estimates is to do with the difference in the concepts assessed, but above all, with the use of different discount rates. Even though discounting is standard practice in economics to compare current costs with future profits - in other words, a lower value is allocated to the costs or future profits -, it can be argued that lower discount rates near to zero should be applied in the case of climate change, as was the case in the Stern report. This is justified by the length of the horizons analysed and by the irreversibility of the impact. Other studies such as Yohe et al (2008) have been criticized for undervaluing their estimates by applying discount rates near to 4 or 5%. These are excessively high for this issue.

As far as regional impacts are concerned, some more specific studies exist that seek to measure local impacts. This task is not easy and the reliability of the data being used must still be significantly improved. The regionalisation of the impact is one of the areas where the IPCC insists that significant emphasis must be placed over the coming years.

Specifically, and by way of an example, there are different studies for the Basque Country where it is estimated that, in the case of a hypothetical flood in Bilbao, the costs may increase by 56.4% as the result of climate change, with the figure of 158 million euros a year being cited (IHOBE, 2007). Other case studies have been carried out for the River Urola basin where the increase of the expected annual damage is similar (Oses, 2009). In any case, and despite the existence of these studies, the need to go further into this type of more regionalised analysis of the impact continues to be pressing.

With regards the Willingness to Pay (WTP) of the society for the implementation of plans to combat climate change, a recent study (Longo et al. 2008) shows that the aggregate WTP to implement the Basque Plan to Combat Climate Change (PVLCC) is estimated to be 400.6 million euros, while its costs are calculated to be 79.5 million euro.

2.5. The long-term perspective and uncertainty

The IPCC itself warns that the situation is so serious that many of the long-term impacts are not going to be avoided even if there is an effective implementation of the mitigation policies. This highlights the need to tackle the adaptation policies without further delay.

Many of the impacts may be avoided, delayed or considerably reduced depending on the mitigation measures that are carried out. The effort and the investments needed to tackle these reductions will come to fruition over the coming 20 or 30 years and many of the investment decisions have to be taken today. Any delay in the emissions may help to reduce the impact and it would therefore directly affect the vulnerability of the ecosystems and the success of the adaptation policies.

Yet, the reductions that can be undertaken over the coming 20 or 30 years will also be decisive in terms of the likelihood of achieving greater reductions in the future.

Table 4 shows some stabilization horizons and estimates the emissions reductions that are required to achieve these objectives. The most ambitious stabilization scenario requires the emission levels in 2030 to be similar to those in 2000 and reductions of up to 80% are needed by 2050. Other less ambitious scenarios reflect easier targets.

Table 4: Mitigation efforts for different stabilisation levels

Stabilisation level (ppm CO2e)	**Date of peak global emissions**	**Global emissions reduction rate (% per year)**	**Percentage reduction in emissions below 2005 values**	
450	2010	7.0	70	75
	2020	--	--	--
500	2010	3.0	50	75
	2020	4.0 – 6.0	60 - 70	75
	2030	*5.0(1) – 5.5 (2)*	*50 - 60*	*75 - 80*
	2040	--	--	--
550	2015	1.0	25	50
	2020	1.5 – 2.5	25 - 30	50 - 55
	2030	2.5 – 4.0	25 - 30	50 - 55
	2040	3.0 – *4.5 (3)*	*5* - 15	50 – *60*

Notes: overshoots: (1) to 520 ppm, (2) to 550 ppm, (3) to 600 ppm. 2005 emissions taken as 45 GtCo2e/yr

Source: Stern (2006).

In any case, the challenge facing humanity and the importance of the decisions taken over the coming years require a clearly long-term vocation. The policy to fight climate change must allow the portfolio of options to be kept open so that they can be adjusted to deal with the changes that may arise in the future. Other sections of this article will look into these concepts in greater detail.

3. Socio-Economic Importance

3.1 Market failure

Stern himself (2006) defines climate change as “the greatest market failure ever seen” and a great challenge facing humanity.

It is long ago that economic literature clearly defined the determining factors for the market to allocate the resources in the most efficient way possible. This situation has become known as perfect competition and occurs when there are many players buying and selling, when the information is perfect (real, complete and free), there are no barriers to enter or exit the market and the product is homogeneous.

When any of these determining factors are not met, the market fails to provide these goods or services, either by generating under-provision or over-provision of said goods and services. This is what economists refer to as "market failure".

Public assets are a clear example of this. They are defined as those where there is no rivalry in their consumption and they are not exclusive. In other words, the fact that one individual uses them does not prevent another one from doing so or being able to do so in the future. In terms of the presence of public goods, cases of under-provision can occur with the ensuing need to intervene on the market to correct those "failures" (Samuelson, 1954).

As well as being able to model itself as a global public goods for which no market exists, climate change is the result of a negative externality (Stern, 2006) - greenhouse gas emission – where the parties responsible do not consider this as a cost within their sphere of responsibility. Negative externalities are characterised for generating a loss or damage to a third party who is not the person in charge of the activity.

Climate change stands out from other negative externalities due to some different specific characteristics (Stern, 2006, 2008):

-The global sphere of its causes and of its consequences:

-The impact is long-term, persistent in time and dominated by the relationship between flow and stock or GHG concentration.

-There is a high component of uncertainty and risk.

-There is a serious risk of important and irreversible changes with economic effects that are not marginal.

These characteristics determine the type of economic analysis that must be structured for climate change, but particularly in relation to the policy instruments that must be used.

In this context, the traditional theory of externalities or the use of the Cost Benefit Analysis are highly limited for tackling such a complex problem. It is fundamental that the risk variable and the possibility of such severe impacts are effectively incorporated.

The existence of a high degree of uncertainty, together with the possibility that extreme events may occur, suggests that employing the expected values used in the traditional analysis is not appropriate in this case. Neither does using the CBA seem to be exempt from criticism (Weitzman, 2007)[2].

The long-term nature of the problem suggests, as has already been established in this article, that there are significant reasons for not using standard discount rates as they are deemed to be excessively high. In other words, an excessively low present value for the damages (and benefits) that may occur in the future is imposed. The use of these rates cannot be justified from the perspective of inter-generational ethics. The discussion is open regarding what the appropriate discount rates must be.

While some policy instruments, such as the emissions trading scheme or the CO2 taxes, are based on the well-known (and very valid) Coase (1960) and Pigou (1920) theories to correct externalities, economic analysis needs to effectively settle a high number of issues in this field. Particularly as regards the incorporation of the variables of uncertainty, risk and the very long-term nature of climate change. Answering these questions is no trivial matter.

Nonetheless, the fact that there are these issues to be settled does not invalidate the need for actions to be urgently proposed and the validity of the approaches that require establishing a price for CO2 that force its cost to be internalised.

3.2 Ethics and welfare considerations

The debate about climate change impacts has a very important ethical component insofar as they affect welfare of individuals, inter- and intra-generational and international equity, justice, freedom and human rights.

Even though it is not the aim of this article to go further into these issues, we would like to highlight some of these elements that need to be analysed when talking about policies to combat climate change.

The GHG generate climate change irrespective of the part of the planet where the emissions occur. The developed countries are responsible for the majority of the historical emissions, but, however, developing countries are the most vulnerable in terms of their effects. And they are the most vulnerable, due, mainly, to three factors: (1) their geographical characteristics, (2) their greater dependency on agriculture and (3) their lack of resources to deal with the impacts and/or prevent them. (Stern, 2006).

The treatment of different ethical considerations is relevant in this field as a means to enrich the analysis of traditional welfare. Thus, schools of thought such as "Consequentialism" or “Utilitarianism” have a role in this debate and must be combined, according to Stern, with other more focused approaches in order to achieve the goal of maximising welfare.

In addition, it has to be taken into consideration that climate policy requires to design policies for many sectors and in more than one country and region, and that these interact (positively or negatively) with other policies. Things become even more complex when this dimension is incorporated to the welfare analysis of these policies.

[2] The probability of events occurring whose consequences may be catastrophic is what is known as “Fat Tail” of the distribution of probability. One criticism of the author about the Stern report regards the importance of assessing the possibility of catastrophic effects occurring. This possibility invalidates the probabilities approach traditionally used in risk analysis.

Other important issues that must be highlighted are to do with how to compare concepts as complex as the “quality of life" or "welfare", or the difficulty of comparing these concepts between countries and people with very different ways of understanding life. This all makes combating climate change a field where economic analysis techniques must be adapted and substantially improved.

The long-term, uncertainty and the risk also have implications that directly affection ethical issues as we have already mentioned (discount rates, for example), but also other questions relating to how to apply the precautionary or proportionality principle have to be considered.

Many of these issues were discussed in the Stern report in relative detail. The report itself received a wide range of criticism[3] –both positive and negative— from very different areas of the economy, even though nobody questioned the political importance of its conclusions that have triggered the debate in different fields of economic analysis.

3.3 Impact on international trade

The overall dimension of climate change is also clearly reflected in the debate regarding the impacts that the policy to fight climate change may have on international trade.

Policies such as the CO2 taxes[4], the “cap and trade” systems[5], the energy efficiency standards for household appliances or light bulbs[6] and other measures may be generating significant distortions on the international markets.

Thus, a recent study (World Bank, 2007) analyses how taxes and standards are affecting competitiveness on national markets by means of the flows of international trade. The results indicate that using a carbon tax in the importing countries affects the competitiveness of the exporting countries, but not significantly. Both the use of efficiency standards and the joint use of taxes and efficiency standards could reduce international trade by up to 10%. The study concludes that as a generalisation, and with some exceptions, the impact on international trade of the use of emission standards is greater than that of the use of taxes.

Another of the concerns are to do with the fact that the policies implemented in the most advanced countries may become less effective due to what is known as “carbon leakage”: This refers to the fact that the production of certain products or services may be moved to another country where climate policies are not implemented, and the CO2 emissions therefore increase in the receptor country. Obviously, this effect makes the policies to combat climate change less effective and may affect the competitiveness of the country that imposes the climate measures.

Specifically, some studies suggest that up to 20% of the emissions reduction may leak to countries where the regulation is more lax (World Bank op. cit.). In other words, for every 5 tons of GGE that are reduced in the country that implements the policy, an additional ton is emitted in the other country.

If we analyse the import-export ratio of energy intensive products, we can see that it has steadily fallen since 1990 in developing countries while it has increased in developed countries. In other words,

---

[3] See, for example, Weitzman (2007), Nordhaus (2007), and Tol and Yohe (2006).

[4] Introduced in countries such as Austria, Belgium, Denmark, Estonia, Finland, Germany, New Zealand, Norway, Sweden, the Netherlands or the United Kingdom.

[5] Its maximum exponent is the European Union Emission Trading Scheme (ETS).

[6] Operating in most EU and developed countries.

that exports in developing countries seem to have increased with regard to imports. However, this type of simple analysis also requires other more complex questions to be answered. For example, the import-export ratios in USA-Europe relations increases for the USA, while the ratio decreases for Europe, which is not in line with the increasingly more ambitious standards that are being laid down in Europe. However, the USA ratio with respect to China or other Asian countries seems to fall in those countries and it therefore does seem that relocations of production processes in those countries is happening. No clear trend seems to exist for other developing countries.

Therefore, there seems to be some evidence with respect to these leakages being real, although they are significantly less than what is usually feared in any event.

This is a highly interesting debate as it may back positions that suggest the use of trade barriers for those countries that are reluctant to implement measures to combat climatic change.

International trade rules generically forbid this type of measures even though the World Trade Organisations considers the jury to be still out. Some similar precedents seem to suggest that this type of measures may be deemed legal and also relatively effective to boost climate change policies.

4. Getting Closer to the Solution

4.1 The importance of public policy

The fact that climate change is seen as a market failure suggests that it is necessary to have public policies that adjust the inefficient assignation of the market. The magnitude of the impacts, the planetary scale of the challenge and the consequences for future generations are more than sufficient additional reasons to demand an institutional architecture to regulate the intervention of private and public players.

This fabric is particularly complex to design and to be made to operate efficiently as it must work with policies in numerous fields (environment, health, energy, industry, transport, housing, research and development, land use, etc.) and which directly or indirectly interact. And above all, because it requires an unprecedented level of coordination and co-responsibility at all level of international, national and local government when designing other public policies. (Gallastegui et al). The vertical and horizontal dimension of climatic policy is a huge challenge for designing and executing public policy.

The range of policy instruments is really wide and includes CO2 taxes to internalise the negative effects, quality standards that require certain emission levels not to be exceeded, transferable emission rights market to achieve reduction efficiently, energy saving and efficiency subsidies, climate change legislation, etc. These instruments must also be applied in international contexts and the impacts of the policies of certain countries on others must always be assessed. Inter- and intra-generational or even international equity or fairness questions must also be analysed from a global perspective.

Public policy is therefore necessary to correct the "market failure", even though it is difficult to design and complex to implement and monitor. The interaction of the instruments designed in one field (energy, for example) with the policy targets in other fields (environmental or industrial, for example) make combating climate change a complex policy design exercise.

Choosing some instruments over others and their medium-term impacts determined the emissions reduction paths. The possibilities to substitute one path by another in the short medium-term are very limited and the decisions taken today must consider the effect that they generate with respect to the range of possibilities to refine the policy in the future. Perhaps in the next 50 or 100 years. There is an opportunity cost of the policies not implemented that must be taken into account and internalised in the decision-making process. In other words, to opt decidedly for nuclear energy today, for example, could mean moving away from other investment goals in renewable energy if both policy objectives are not duly weighted, while totally ruling out this source of energy may considerably limit the real possibilities to move towards a decarbonised economy. Opting for providing transport infrastructures may be at odds with the appropriate management of the demand for mobility, a key element in a sustainable mobility policy and often overlooked. Keeping a balance portfolio of policy options is one of the greatest public management challenges in any field of action, and this is particularly important when it comes to combating climate change.

4.2 The role of the Governments and other stakeholders

The implementation of measures to fight climate change that are effective in the medium long-term requires agreements being entered into and support sought from among the different public-socioeconomic players: from local and regional governments to the international sphere involving the States, and private players, from academia and research to business sectors, without forgetting ecologist collectives and trade unions. In short all the stakeholders.

The governments must undertake the designing of the plans, put forward solutions and take the major policy decisions, by means of widely participative processes that guarantee a plural vision and that particularly contribute in some way to achieving far-reaching consensus. These participative processes shall partly determine the effectiveness of the policy in the execution phase and shall condition the feedback and fine tuning processes.

Other collectives, such as the trade unions or business associations, have the opportunity to foster constructive criticism by ensuring that their vision of the problem is included in the discussion. But they must also assume their share of co-responsibility in the setting up and contribute to an effective implementation of the measures.

The scientific world is expected to help to shed some light on the main questions that still remain unanswered, by contributing accurate, understandable and useful information to the decision-taking process. This collective has an opinion leader role towards society that it must not forget. The support that the scientific-academic world may provide to overcome the short-term vision of the policy must not be undervalued. Specifically, the effect that the last IPCC report and the Stern report had on the political community may be highlighted as an example of this role.

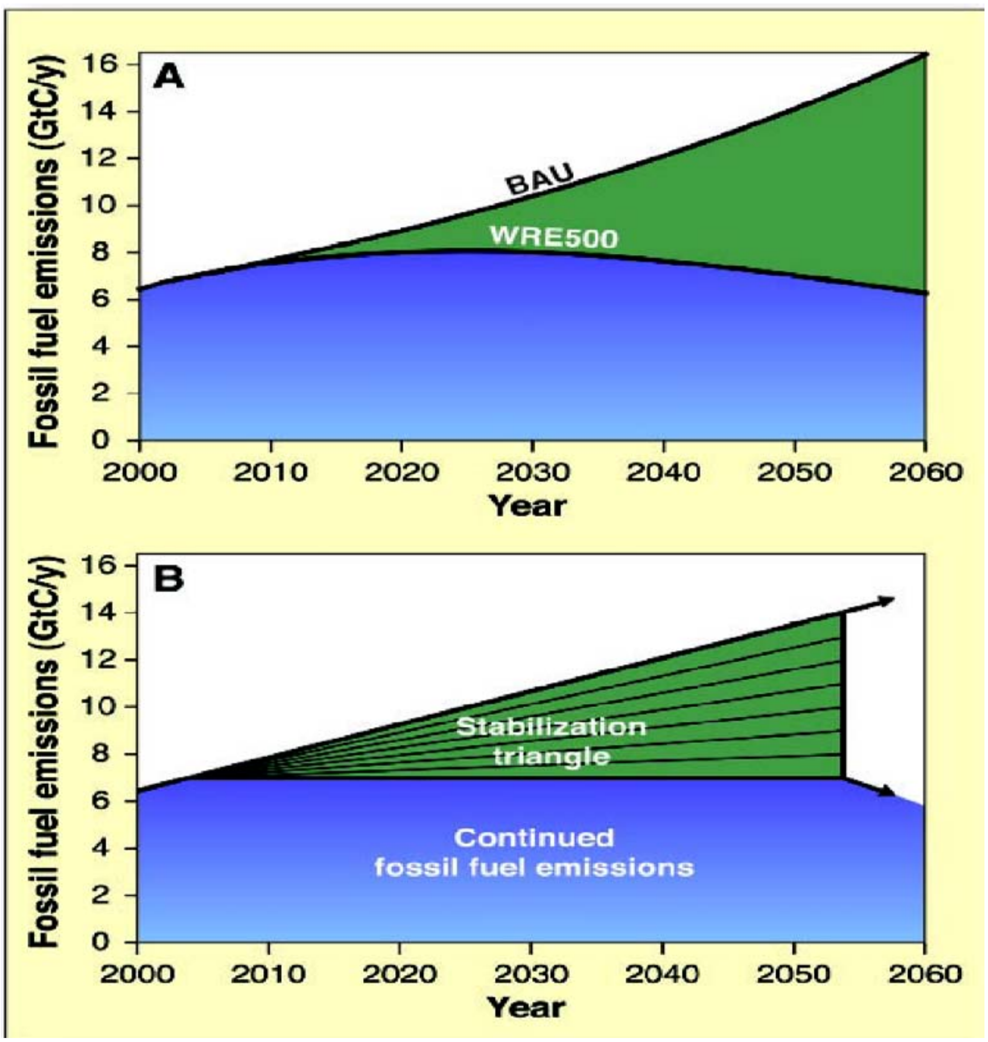
Other interest groups, such as ecologist groups, also help to generate opinion and it is therefore essential that they are involved in designing and executing the policy. From a perspective of co-responsibility and team work, they can influence political decisions and raise awareness among citizens about this subject.

The citizens have in their hands, in the last instance, the possibility to support (or not) the managers of the environmental policy on the elections and thus unmistakably contribute to implement long-term policies and structural changes to the detriment to more immediate or short-term approaches.

4.3 The role of technology and R&D&I

The scientific community has regularly warned that technology and innovation have a fundamental role in achieving the ambitious emission mitigation targets that are being negotiated on a global scale. Specifically, if the technological improvements and the potential future improvements are not considered, the maximum ceiling for emissions reduction in the field of energy may be near to 30%, while reduction of up to 60% may be achieved with appropriate technological development in developed countries, such as the United Kingdom or Germany. In the case of developing countries, technology transfer is a determining factor to tackle mitigation policies with certain guarantees.

Figure 2: The 'Stabilization Wedges'



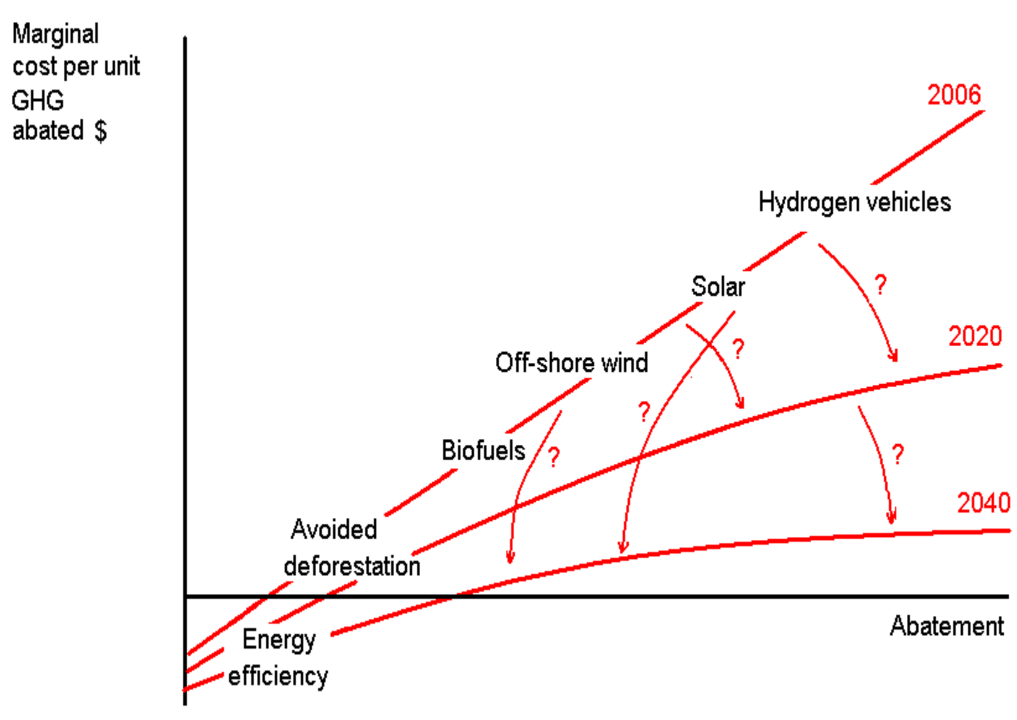
Source: Pacala and Socolow (2004)

Authors, such as Pacala and Socolow (2004), have established the necessary emission reduction in order to work towards the goal to reduce the emissions dramatically over the coming 50 years. Figure 2 summarises the main conclusions of this study that establishes that with the existing technologies, emissions may be reduced by 7 GtC/year (equivalent to ~3.67 Gt CO2). A truly significant number. They establish the burden that each of the following measures should share.

- energy efficiency (efficient vehicles, reduction in use of vehicles, efficient building, coal plant efficiency)
- decarbonising energy (replacing coal by gas, CO2 capture, replacing coal by nuclear energy, replacing coal by wind energy, replacing coal by solar energy)
- decarbonising fuels (CO2 capture in H2 plants, biofuels, hydrogen for hybrid vehicles, etc.)
- and agriculture and forestry resources (reduction of deforestation, reforestation, new groups, etc.).

What seems to be clear in the literature is that the role of technology will be fundamental in order to work towards decarbonising the economy over the coming 30-50 years, both with regard to the role of technological transfer to developing countries and with respect to technological research and development.

Figure 3: Illustrative Marginal Abatement Option Cost Curve



Source: Stern (2006).

Eliminating the obstacles to technology transfer by means of reducing custom tariffs, technical standards, bureaucratic processes and other obstacles is fundamental to achieve GHG emission reductions in developing countries. Working on technological development in the different emission mitigation fields will decisively help to reduce the associated costs. Figure 3 provides an example of a marginal abatement cost curve. It shows how the cost of reducing an additional ton of CO2 will dramatically decrease as technological development in each field progresses. Those fields where less development has taken place have greater potential to reduce marginal costs.

Technology and R&D&I thus become core points in any policy to combat climate change and we will therefore move on to considering the Kyoto Protocol in the next section.

5. The International Context

5.1 Kyoto and international negotiations

The introduction of the UNFCCC Framework Convention in 1994 and the releasing of the second IPCC report in 1995 underpinned the negotiations that would end in 1999 with a major agreement between 38 industrialised countries and the European Union being adopted in Japan. This agreement requires industrialised countries to reduce the emissions of the so-called GHG (carbon dioxide, CO2, methane, CH4, nitrous oxide, N2O, Hydrofluorocarbons, HFC, perfluorocarbon, PFC, and Sulphur Hexafluoride, SF6) in the period 2008-2012 by 5.2% with respect to 1990 levels. The Kyoto Protocol was thus born. The division of this target established a 8% reduction for the EU countries overall, which in terms of the different member states allows Spain an increase in emissions of 15% for the 2008-2012 period.

After several years of hard negotiating regarding the legal aspects and mechanisms of the Protocol at the different Conferences of the Parties (CoP) – CoP 4 in Buenos Aires (Argentina), CoP5 in Bonn (Germany) and CoP 6 in The Hague (The Netherlands) - the KP came into force on the 16 February 2005. The United States, which is responsible for 25% of the world's emissions, and Australia did not ratify it. The refusal of these countries almost prevented the KP from coming in force as it had to be ratified by 55 countries that represented over 55% of global emissions. Fortunately, Russia's decision at the end of 2004 to ratify the Protocol allowed it could come into force.

The Nairobi Summit (CoP 12) in 2006 was used to amend the protocol and it was agreed that a new protocol for the post-Kyoto period would be approved at the CoP15, which will be held in Copenhagen in 2009. The ratification of the KP by Australia in 2007 was a decisive boost to this major global agreement.

During the 2007 Bali Summit (CoP 13), the Bali Road Map (including the Bali Plan of Action) was adopted. It set out the path for the culmination in 2009 of the post-Kyoto negotiations, agreed the launch of the Adaptation Fund, fostered measures for the effective technology transfer to developing countries and agreed policies to reduce emissions due to deforestation. The latest summit in Poznan in 2008 (CoP 14) ratified the commitment to set up a negotiation process that would culminate with the adoption of the new protocol at the 2009 Copenhagen Summit (CoP 15). Some significant progress was also made with respect to the adaptation fund and other issues of great interest for developing countries, such as funding fighting climate change, technological transfer, managing natural disasters or the role of deforestation and the degradation of forests.

5.2 CoP 15 Copenhagen 2009

Although no major decisions were adopted at the last summit (CoP 14) nor was a clear political leadership set up to take on the ambitious mitigation and adaptation targets recommended by the IPCC, it was not a significant step backwards in international negotiations (Santarius et al. 2009). The summit was a milestone without any particular importance along the path to the long-awaited Copenhagen summit.

For this coming summit (Copenhagen Cop 15), developed countries are seeking clear commitment from developing countries to achieve significant emissions reductions, particularly from rapidly growing countries (China, Brazil and India), while the latter are expecting important commitments from the developed countries in terms of reducing emissions and providing real technological, political and economic support for the targets of the developing countries. The lack of leadership that Europe has shown over the last year and the historical absence of the USA during the Bush's term of office in the group of driving forces behind the international agreements have hindered the possibilities of breaking this vicious circle. The undertakings of the new president of the USA, Barack Obama, and the triumph that the vision that climate change is not a zero-sum game but rather that it is fundamental to develop geo-political strategies in cooperation leaves some room for hope for the Copenhagen summit (Santarius op cit).

In the words of Yvo de Boer7, the CoP15 will be successful if it answers the following four questions: What is the emission reduction undertaking that the industrialised countries are willing to reach? What are the targets that developing countries such as China and India are willing to assume? How will the aid be funded that developing countries need to achieve ambitious reduction targets? And how are all these economic resources going to be managed? The first step should come from the developed countries in the form of mitigation targets in accordance with the IPCC recommendations and the clear commitment of technological and financial support for the developing countries.

An optimistic view of the summit suggests that it will enable these questions to be positively resolved for the new agreement that succeeds the Kyoto Protocol to be valid. The global crisis scenario will undoubtedly be another obstacle to get over, in that it will hinder the investments required to deal with this huge global challenge. Many of the investments in energy, transport and other infrastructures that are decided today will condition the emissions scenarios over the coming 20 or 30 years.

6. Conclusions

Very few people doubt, nowadays, that climate change is already a scientific reality that represents a huge challenge facing humanity. A challenge that requires our full attention and skills to avoid impacts that could be far reaching. Impacts on the health of people, the environment, the inhabitability of some geographical zones or the validity of the transport or energy infrastructures. Some of the proposed scenarios involve catastrophic impacts.

The reduction of GHG emissions as a formula to reduce the gas concentration levels in the atmosphere (and thus climate change) is one of the approaches that must underpin the policies. But even though these could be highly effective, some changes and impacts are already occurring and will continue

[7] http://en.cop15.dk/news/view+news?newsid=876

to take place. Therefore adaptation measures are also vital. Mitigation is in line with the undertaking to the planet while adaptation to the undertaking with our most immediate environment and its inhabitants.

Economic analysis is not exempt from difficulties or criticism. Selecting the appropriate discount rates illustrates the difficulty to include the long term (or the very long term) to the economic analysis. The use of standard discount rates is not acceptable from the perspective of inter-generational equity. The uncertainty that surrounds the impacts that must be assessed advises against the use of the expected values approach.

Public intervention is necessary to correct this market failure and it is also not exempt from difficulties. Such a policy must combine many areas of intervention like environment, energy or transport, and requires efforts to be coordinated at all levels of the public administration.

The ethical considerations must be incorporated in the analysis to guarantee fair treatment for future generations, but also for developing countries whose contribution to global emissions has historically been far lower than that of developed countries. Transfer technology towards these countries and the role of innovation and technological development must not be avoided.

Climate change policies may lead to changes in the flows of international trade as a consequence of the distortions that are generated from the fact that different policies are implemented in different countries. This point must also be taken into account.

The Kyoto Protocol has marked the start of a global negotiating process that must end in highly significant reductions of GHG emissions, but the challenge is still greater for 2020, 2050 or 2100. Today's decisions will condition the future and the possibilities of achieving greater progress over the coming decades and therefore the design and execution of the policies is fundamental. The Copenhagen summit in December 2009 must establish the Post-Kyoto regime and the path from 2012 onwards. The new US policy, the credibility of developed countries regarding the mitigation targets, but also with respect to the effort to ensure that the developing countries assume their part of the process (mainly financial and technological) will determine the success or failure of the long-term climate policy.

References

Buchanan, J. M. (1968) The Demand and Supply of Public Goods. New York.

Coase, R. (1960) “The Problem of Social Cost”. Journal of Law and Economics, nº1.

Galarraga, I. (2007) “La Apuesta del País Vasco en la lucha contra el cambio climático”. En Ekonomi Gerizan: “Desarrollo Sostenible and cambio climático editado por la Federación de Cajas Vasco-Navarras.

Gallastegui, M.C., I. Galarraga and M. González-Eguino (2009, forthcoming) “La Ciencia del Cambio Climático: Una Visión General”. Papeles de Economía Española.

Golub, A., A. Markandya and D. Marcellino (2006) “Does the Kyoto Protocol Cost Too Much and Create Unbreakable Barriers for Economic Growth”. Contemporary Economic Policy, 24, 4, 507-519.

Ihobe (2007) Metodología para Valorar los Costes del Cambio Climático en el País Vasco: el Caso de Bilbao.

IPPC (2007a) Climate Change 2007: Synthesis Report, Intergovernmental Panel on Climate Change, Paris.

IPPC (2007b) Climate Change 2007: The Physical Science Basis, Working Group I, Intergovernmental Panel on Climate Change, Paris

Longo, A., Hoyos, D. and Markandya, A. (2009) “Concienciación pública y aceptabilidad de medidas para la reducción de emisiones de gases de efecto invernadero”. Papeles de Economía Española, 121. (Próximamente).

Nordhaus, W. D., 2007 "A Review of the Stern Review on the Economics of Climate". Journal of Economic Literature, Vol. 45 Issue 3, p686-702;

Markandya, A. (2009) “Can Climate Change Be Reversed Under Capitalism?”, Forthcoming, Development and Change.

Markandya, A. (2008) “Perspective on Climate Change and Policy: Copenhagen Consensus”. Forthcoming Cambridge University Press.

Oses, N. (2009) “Costes del Cambio Climático en Euskadi”, Ekonomiaz (forthcoming).

Pacala, S. and Socolow, R. (2004) “Stabilization Wedges: Solving the Climate Problem for the Next 50 Years with Current Technologies”. Science, Vol. 305, nº 5686, pp 968-972.

Pigou, A. (1920) The Economics of Welfare. London: Macmillan and Co.

Samuelson P.A. (1954) “The Pure Theory of Public Expenditure". Review of Economics and Statistics 36 (4): 387–389.

Santarius, T., Arens, C., Eichhorst, U., Kiyar, D., Mersmann, F., Ott, H. E., Rudolph, F., Sterk, W and Watanabe, R. (2009) “Pit Stop Poznan. An Analysis of Negotiations on the Bali Action Plan at the Stopover to Copenhagen”. Wuppertal Institute Working paper series.

Stern, N. (2008) “Richard T. Ely Lecture: The Economics of Climate Change”. American Economic Review, 98:2, 1-37.

Stern, N. (2006) The Stern Review: the Economics of Climate Change, HM treasury, UK Government.

Tol, R.S.J. and G. Yohe (2006) "A Review of the Stern Review" World Economics 7(4): 233-50. See also other critiques in World Economics 7(4);

Weitzman, M., L. (2007) “A Review of the Stern Review on the Economics of Climate Change”. Journal of Economic Literature, vol. XLV, pp. 703-724.

World Bank (2007) Institutional Perspectives International Trade and Climate Change: Economic, Legal and Institutional Perspectives.

Yohe, G., Tol, R.S.J., Richels, R.G., and Blanford, G.J.(2008) “Problem Paper Topic 9 – Climate Change”, Copenhagen Consensus 2008, Copenhagen.

BC3 WORKING PAPER SERIES

Basque Centre for Climate Change (BC3), Bilbao, Spain

The BC3 Working Paper Series is available on the internet at the following address:

http://www.bc3research.org/lits_publications.html

BC3 Working Papers available:

2009-01 Valentina Bosetti, Ruben Lubowski, Alexander Golub and Anil Markandya: *Linking Reduced Deforestation and a Global Carbon Market: Impacts on Costs, Financial Flows, and Technological Innovation*

2009-02 Mikel González-Eguino: *Market Instruments and CO2 Mitigation: A General Equilibrium Analysis for Spain*

2009-03 Aline Chiabai: *Analysis and Use of Information and Communication Tools in Economics of Climate Change*

2009-04 Ibon Galarraga, Mikel González-Eguino and Anil Markandya: *The Role of Regions in Climate Change Policy*

2009-05 M.C. Gallastegui and Ibon Galarraga: *Climate Change and Knowledge Communities*

2009-06 Ramon Arigoni Ortiz and Anil Markandya: *Literature Review of Integrated Impact Assessment Models of Climate Change with Emphasis on Damage Functions*

2009-07 Agustin del Prado, Anita Shepherd, Lianhai Wu, Cairistiona Topp, Dominic Moran, Bert Tolkamp and David Chadwick: *Modelling the Effect of Climate Change on Environmental Pollution Losses from Dairy Systems in the UK*

2009-08 Ibon Galarraga and Anil Markandya: *Climate Change and Its Socioeconomic Importance*