SPECIAL EDITION

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Entreprises, territoires et environnement

Symposium
Biodiversity and climate before and after Copenhagen

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Intégrer **la biodiversité** dans **les stratégies des entreprises**

Integrating ***biodiversity*** *into* ***business strategies***

Réconcilier activités économiques et biodiversité nécessite à la fois de mobiliser les entreprises et de créer de nouveaux outils. Le guide « Intégrer la biodiversité dans les stratégies des entreprises » relève de ce double défi. Les travaux du groupe de travail Institut français de la biodiversité (IFB) – *Orée* ont permis de confirmer que la biodiversité conditionne l'évolution d'un très grand nombre d'entreprises. Les retours d'expérience, rédigés à partir d'une auto-évaluation portant sur l'Indicateur d'Interdépendance de l'Entreprise à la Biodiversité (I.I.E.B.), présentent l'image que diverses entreprises et collectivités se font de leur interdépendance à la biodiversité. Ces organisations se sont aperçues que l'ensemble de l'économie interagit, de manière directe et indirecte, avec le monde vivant.

Mettre un prix sur la biodiversité pour assurer sa viabilité serait contreproductif contrairement à cette idée reçue. La méthode proposée par le Bilan Carbone permet d'évaluer les émissions de gaz à effet de serre engendrées par l'ensemble des processus physiques qui sont nécessaires à l'existence d'une activité ou organisation humaine. Celle-ci ne permet pas, et n'a pas pour objet, de prendre en compte les interactions entre le monde vivant et celui des entreprises. C'est pourquoi nous proposons le Bilan Biodiversité, outil interdisciplinaire, dont les contours et frontières renvoient à la responsabilité écosystémique des organisations.

Pour que sa mise en place soit rentable, que les entreprises s'approprient pleinement la démarche, il s'agit de repenser les modes de régulations contemporains. Face à l'urgence de la situation mise en exergue par l'Evaluation des écosystèmes du millénaire (Millennium Ecosystem Assessment, 2005) et confirmée par les premiers résultats de l'étude COPI (2008) portant sur les coûts de l'inaction en matière de biodiversité, ce guide vise à condenser le temps de réflexion nécessaire pour réintégrer les activités économiques au coeur de la biodiversité. Dans une logique de co-viabilité biodiversité – entreprises, il suffit de se demander comment faire du profit un instrument de diversification du monde vivant, et de la diversité biologique une source d'accroissement des profits.

Reconciling economic activity with biodiversity calls for a twofold initiative: firstly encouraging businesses to take action and secondly creating new methods for them to do so. « Integrating biodiversity into business strategies » is designed to meet this dual need.

The research performed by the Orée-Institut français de la biodiversité Working Group has confirmed that biodiversity determines the development of a great number of enterprises. Self-assessments, through the application of the Business and Biodiversity Interdependence Indicator, present the self-perceptions of a range of businesses and local governments relative to their interdependence with biodiversity. These self-perceptions underline the fact that the economy as a whole interacts directly and indirectly with living systems.

It is commonly supposed that biodiversity can be sustained by putting a price on it. In reality this is a counterproductive approach. The method proposed by the 'Bilan Carbone' measures the amount of greenhouse gases emitted by all the physical processes required to sustain specific human activities or organisations, insofar as their boundaries are clearly definable. It does not, and is not designed to take account the interactions between living systems and businesses. The Biodiversity Accountability Framework is thus proposed as an alternative, interdisciplinary method, structured to highlight and delimit the responsibility of organisations to ecosystems.

For its implementation to be profitable, and for companies to adopt this approach in a thoroughgoing way, it requires rethinking the present modes of regulation. The Millennium Ecosystem Assessment (2005) underscored the urgency of the situation, as did the preliminary results of the COPI study (2008) bearing on the costs of inaction relative to biodiversity loss. This guide aims to shorten the time needed for the discussions that will lead to the reintegration of economic activity within biodiversity. When the underlying goal is the co-viability of biodiversity and business, the question is simple: How can profits be used to diversify living systems, and how can biodiversity become a source of increased profits?

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Foreword

Ghislaine HIERSO

President of Orée[1] , Veolia Environmental Services Vice President Public Affairs

Climate change is a direct threat that will change temperature, rainfall, acidity of oceans and the frequency of extreme events. The indirect effects of climate change on biodiversity are even more worrying; firstly they exacerbate the effect of other factors now responsible for the biodiversity loss, and secondly they induce strategies to adapt human activities that can create external factors tending to reduce biodiversity. Humanity is not spared by the biodiversity loss, of which it itself forms part. Climatic refugees illustrate the effort to adapt to a new environment. Social and ecological inequalities reinforce each other and the poor are most severely exposed, in industrialised countries and also in developing countries. In countries in which farming is a leading sector, farmers are the first to suffer from the consequences of biodiversity loss related to climate change.

However, international, European and national authorities have not taken sufficient account of the question of biodiversity loss in recent years, despite studies carried out and targets including the worldwide objective of significantly reducing the rate of loss of biodiversity by 2010, adopted by the CDB (Convention on Biological Diversity) in 2002 and the Johannesburg summit on sustainable development.

Orée has been studying biodiversity since 2006 with its "Business and Biodiversity" working group. This working group was initiated by Orée and IFB (French Biodiversity Institute) that has then become the Foundation for Research on Biodiversity (FRB) of which Orée is an active member. It is chaired by Jacques Weber (CIRAD)[2] and Mathieu Tolian (Veolia).

Orée wanted to put climate at the heart of the public debate in readiness for the United Nations Conference in Copenhagen next December. We are convinced that the financial crisis is an opportunity to help us find a path towards sustainable development.We hope that the Copenhagen Conference will be successful and will lead the countries towards bold commitments. The European Union – United States summit that is now being held in Washington should encourage America to accept its responsibilities.

[1] OREE = French organisation involving business and local authorities working together for the environment

[2] CIRAD = French Agricultural Research Centre for International Development

Introduction

Danielle NOCHER
Founder and Director of the Valeurs Vertes magazine
Organiser of the conference

Every living species and every organism within a particular species are entities distinct from the rest of nature. This is particularly true of human beings, whose evolution has been almost entirely cultural rather than biological. We need to continuously review our method of perceiving reality, if we do not want to separate human life from the rest of nature. The current crisis arose because men have been unable to predict the consequences of their acts. We are naturally obliged to live together symbiotically in harmony with the climate and biodiversity, resulting in a changing and non-destructive world.

Jacques WEBER
Co-president of the Orée work group on biodiversity
Research worker at the CIRAD

It is time to understand that climate and biodiversity can be seen as the two faces of Janus and changes in lifestyle have just as much effect on the climate as climate has on lifestyle. This is why we wanted to bring together specialists to examine one or the other of the two faces of this reality. "If humanity is to have a future on earth, it is important for it to become aware that it interacts with all living beings (human and non-human) on the planet. This is why I am not optimistic. The world began without man and will probably end without man, if things continue to change as they are changing now". I would like us to be able to prove this citation by Claude Lévi-Strauss wrong.

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Climate change: the stakes at Copenhagen

Hervé LE TREUT
Director of the Institute Pierre-Simon Laplace,
Research Director at CNRS
Professor at the Ecole Polytechnique
Member of the Académie des Sciences, member of the IPCC

I Introduction

The Copenhagen conference is a very special occasion. It represents the 15th "convention of parties» of the Climate Convention that followed the 1992 Earth Summit in Rio. One of these conventions had been followed by the signature of the Kyoto protocol which programmed efforts to reduce greenhouse effect gas emissions until 2012. Not all countries signed it, and some refused to ratify it; others (emerging countries) were not included among the States to which it was proposed for ratification.

II Climate and scales

The climate problem is partly a problem of scale. Time scales are particularly badly understood and often lead to misunderstandings. The climate on our planet has been interglacial and fairly warm for the last ten thousand years. Analyses made on air bubbles in ice show that a sudden change that is completely inconsistent with the relatively stable phase during which our civilisations have developed, has occurred during recent years.

This change began with the Industrial revolution and the beginning of the demographic explosion. However, it has accelerated sharply during recent decades and particularly after the Second World War. The diagram showing the proportion of CO2 emissions due to changes in the combustion of coal and natural gas confirms this spectacular acceleration. A reference level equal to 3 or 4 billion tonnes of CO2 is often mentioned. This figure was exceeded during the 70s and 80s, and our world has no longer been sustainable since then.

III Greenhouse effect gases and effects on climate

The increase in greenhouse effect gases is like turning up the heat under a saucepan that takes time to boil. This effect can be measured by observing ocean surfaces and climate changes have been clearly perceived during recent decades. However, there is still another problem; we cannot evaluate the magnitude of the climate change based solely on what we can see. All we can see are the first signs of a phenomenon that will increase in the future. Consequently, there is a great deal of confusion in what we are told and how it is presented to us; is the question about what we can see today or what we should worry about in the future, which is a different order of magnitude ?

The nature of the problem that will arise in Copenhagen is new. CO2 emissions per country in billions of tonnes and in tonnes per inhabitant show that the two main emitting countries are the United States and China, and that the number of billions of tonnes emitted in these two countries is very similar, but the ratio of the number of tonnes emitted per inhabitant is 20 to 1.

Therefore one of the main stakes of the Copenhagen conference will be to reintegrate these two countries into the framework of the Kyoto protocol, because until now they have not been present. The objective defined in preparation for the Copenhagen conference is to halve CO2 global emissions around the world. This assumes that the average emission per person is half a tonne of carbon. The effort to be made per inhabitant by the different countries on the planet can thus be measured; for an American, this means dividing his emissions by a factor of ten; a Chinese person's emissions would have to be divided by two and a European person's emissions would have to be divided by four. Therefore, efforts must be important. Many even consider that they have been underestimated considering the capacity of the atmosphere to store CO2 for more than a century.

IV The carbon cycle

We are seeing a disturbance in a natural system that has strange characteristics. The carbon cycle includes exchanges between oceans, vegetation and the atmosphere. We might think that changes imposed by human activities are relatively small. In reality, the CO2 concentration in the atmosphere demonstrates an absolutely exceptional equilibrium over the last ten thousand years, remaining between 270 ppm and 280 ppm. In comparison, disturbances imposed by man to environments over the last hundred and fifty years are considerable.

The planet's temperature would be – 18°C if there were no greenhouse effect gases. In fact, the average temperature is 12 or 15°C. The system is regulated by very small quantities of gas present in trace quantities in the atmosphere preventing infrared radiation to escape from the earth.

The water vapour cycle is very fast and human activities are not likely to modify water vapour directly. Other "greenhouse effect gases» make a 30% contribution to the mechanisms that make the planet liveable. They

include CO2, methane, nitrous oxide (N20), CFCs (that have a life of between a few tens and a few hundreds of years) and ozone. Human activities affect all these gases and their concentrations in the atmosphere have increased sharply. In terms of energy, the impact of the natural greenhouse effect is about 150 W/m2 and the additional effect represents about 3 W/m2. This may appear very small. In fact, a change of 3 W will modify the temperature by a few degrees over the entire planet, which is a serious disturbance.

The emission of greenhouse effect gases is accompanied by the emission of dust which tends to cool the planet. Dust remains present in the atmosphere for about fifteen days and masked the effect of greenhouse gases for a certain time because it remained permanently present. However, the effect on the climate will be increased when the influence of greenhouse effect gases becomes predominant and this dust is eliminated.

Modelling exercises

We need models to predict the future. A model is an attempt to simulate an artificial planet from equations. Atmospheric circulation is organised on a large scale, and models with a relatively low scale spatial resolution were defined at an early stage. This grid size was 500 km when the first IPCC report was produced around 1990. The spatial resolution has been improving gradually. At the same time, models have been extended to include the oceans, and then integrated chemical elements (sulphates, ozone, carbon, etc.). They were used to study the manner in which the effect of greenhouse effect gases can be influenced. This was done by inputting reference scenarios of changes to emissions of greenhouse effect gases (considering their stability, assuming an increase by a factor of three or four, etc.) into models.

The four IPCC reports show that messages obtained from the models used are very consistent; these studies all agree that a temperature increase of 2 to 6°C is probable before the end of the century (half of this range representing the margin of manoeuvre still remaining for Man, and half representing remaining scientific uncertainties in the models). They also show that we are only seeing the very beginning of the changes.

According to a simulation made in the last IPCC report, the average annual warming map shows that there will be some inertia in the climatic system over the 2020-2029 period related to the slow storage of greenhouse effect gases and the role of oceans. Therefore a reduction in greenhouse effect gases assumes that simulations should be studied over a longer scale. The spatial scheme observed in temperature variations over the last fifteen years agrees fairly well with predictions made using models. Very good correspondence is found between the set of simulations that take account of greenhouse effect gases and the range of temperature changes after 1970. However, the capability of these models to make regional scale predictions is still limited, and this makes it difficult to simulate the effects of climate change.

The observed curve representing the rise in sea level shows that the average annual value of this rise around the world is 3.3mm. Simulations in the last IPCC report concluded that the level could rise by 20 to 60cm. Many experts believe that the acceleration of observed phenomena makes it more probable that the high level of the range will be reached. The fact that Greenland has started to melt, although this was not predicted a few years ago, tends to confirm this assumption.

There are many methods for changing from global scales to local scales. Studies that have been carried out have confirmed the existence of a danger threshold, firstly set equal to 2°C. This figure was defined to be halfway between changes that it is known would be very important, and other changes that it is thought would be less important. In any case, it seems that the process would no longer be the same beyond 2 or 3°C, and changes would be less controllable. This conclusion has considerably shortened the time left for taking action; the limitation of global warming to less than 2°C makes it necessary to take action within the next few years, and in any case before 2050 by which time it would be too late.

Conclusion

We are facing a recent phenomenon about which we have neither sufficient hindsight nor experience. In any case, the climatic problem is urgent and imposes a change in the time scale; we must act in the very next few decades. Waiting will increase adaptation problems and could see a divergence in the positions of the different countries. Therefore the next few years are key years for making decisions on these subjects.

Climate, ecosystems and society: the context of climate change

Sylvie JOUSSAUME
Research Director at CNRS(National Centre for Scientific Research) ,
Pierre-Simon Laplace Institute
Director of the "Climate-Environment-Society" GIS (Scientific Interest Group)
Member of the IPCC

Challenges

Global warming has now been proved and the most recent IPCC report has estimated it to be equal to 0.7°C on average over the last one hundred years. The second phase of climate change, since the 1970s, is very probably caused by the increase in greenhouse effect gas emissions due to human activities. This is the second firm conclusion of the most recent IPCC report.

Climate models simulate possible climate changes using economic scenarios. A "high" scenario predicts warming of the order of an additional 3.4°C around 2100. A "low" scenario based on a CO2 concentration of 550ppm in 2100 would result in warming equal to about 2°C. Therefore, whatever happens, warming will continue during the 21st century and will be critically dependent on the level of greenhouse effect gas emissions. This is the central challenge of the Copenhagen conference.

Impacts of climate change on ecosystems and society

The "high" scenario would result in a larger temperature increase on continents than in oceans. However, the average temperature is only one element of climate change; climate extremes will also be modified and we are extremely sensitive to these extremes. The probability of heat waves is likely to increase, even in countries like France. A "high" scenario for changes in greenhouse gas effect emissions could thus lead to temperatures during heat waves very much higher than what happened in 2003 (the so-called "heat wave" episode). A "low" scenario that would require very strong international effort would see frequent heat waves in which temperatures would be similar to what happened in France in 2003.

At the same time, increasing rainfall, particularly in equatorial areas and at high latitudes, would be accompanied by a reduction in the amount of water available in already relatively dry areas, for example the Mediterranean region.

The increased rainfall would also be accompanied by an increase in violent phenomena such as torrential rain, which is already becoming significantly more frequent. Similarly, although the frequency of cyclones is not expected to change significantly, their intensity is expected to increase significantly as we have already seen in the North Atlantic.

The increase in sea level by 2100 should be between 18 and 59cm, and the level will continue to rise after this date. There are several concomitant risks, particularly of regular flooding; for example, when a low pressure area arrives close to a coast, it can make the sea flood the continent. Coastal erosion and salination phenomena might also occur, as has already been observed in Tuvalu in the Pacific, where a population migration plan is currently in place due to the increasingly frequent invasion of land by the sea. Several hundred million persons will be affected by the rising sea levels if no measures are taken. Major efforts would significantly reduce the sensitivity of populations to this phenomenon.

Impacts on ecosystems also affect farming production; while average production would be expected to increase at medium latitudes, production in dry tropical regions should be reduced. Another worry is the extinction of species that could reach between 20 and 30% of all species according to IPCC work, assuming moderate warming of 2 to 3°C. Furthermore, acidification of oceans under the effect of absorbed carbon dioxide would affect the calcium skeleton of some species.

There are even greater uncertainties about the impacts on health than on ecosystems. The climate can affect health directly (cardiovascular risks, respiratory risks, etc.), but also indirectly; for example, a change to the quantity of water on land can degrade the water quality and create

different health problems. A change to ecosystems or the temperature may also cause increased prevalence of a number of diseases such as dengue in tropical areas. These elements can be combined with other environmental constraints as we saw during the 2003 heat wave that was concomitant with a degradation in air quality and relative disorganisation of how the elderly were looked after during the summer, with dramatic consequences. On a worldwide scale, the United Nations Environment Program (UNEP) published a «climate in peril» brochure that summarised these various impacts. For example in Africa, there is a fear about the effects not only on water availability but also bleaching of corals, rising sea level, modification to ecosystems and an increased intensity of cyclones.

Work shows that economically, the drop in the GDP would be greater when the intensity and frequency of extreme events are high. It also shows that countries with a strong capacity to invest will be able to mitigate these economic effects, while countries that do not have this capacity are likely to be affected in the longer term. An example of such consequences lies in the torrential rain that fell in September this year in Niger, Burkina-Faso and Senegal, destroying the homes of thousands of inhabitants. This climatic episode occurred in regions in which rain is rare, and its consequences were particularly dramatic because the dwellings are not at all adapted to the occurrence of such rain.

An integrated system to be studied globally

We are facing two types of challenges :

- firstly, a challenge to reduce (mitigate) climate change in order to limit the amplitude of changes, which depends on a reduction of emissions;
- secondly, a challenge to adapt in order to reduce the vulnerability of the planet to climate change.

Therefore, it is essential to stabilise the carbon dioxide concentration in the atmosphere. To achieve this, we have no choice other than to take immediate action by reducing global CO2 emissions by a factor of four. It will not be easy to adapt; the "climate" will have to be considered in all choices. In any case, increased awareness will be essential, knowledge will have to be extended and efficient monitoring and alert systems will have to be set up.

The global carbon balance in billions of tonnes per year offers an opportunity; only half of all emissions remains in the atmosphere (namely 4.2 billion tonnes), while the other half is «cleaned» by the action of the continents and oceans. However, the efficiency of these "carbon sinks" may reduce under the effect of climate change which will tend to accelerate global warming.

Taking account of this risk has an effect on carbon trading; the quantity of carbon that we can still emit and achieve stabilisation is even less than the estimated amount if this retroaction between the climate and carbon is ignored. The accumulated quantity of greenhouse effect gas emissions should be as high as 490 billion tonnes in the 21st century, compared with 630 billion tonnes if this retroaction effect is not taken into account.

Reaching the end of this presentation, we clearly see that an interaction loop is developing between the social system, climate and climate change. The challenge that we have to face is to determine how we can best develop this integrated system in the future, facing global changes.

Danielle NOCHER

Let us hope that the planet's decision makers understand the force of words, because the presentations could not be clearer.

The economic stakes at Copenhagen and beyond

Christian de PERTHUIS
Professor at Paris IX Dauphine University
Author of "For a few degrees more, ..." (Pearson, 2009)

Challenges related to the source of greenhouse effect gas emissions

The previous presentations showed that we have no choice other than to take bold action on greenhouse effect gas emissions. About two-thirds of these emissions result from the manner in which we produce and use energy in today's world; 80% of our energy is derived from fossil fuels and whenever we use these fuels we release CO2 into the atmosphere that remains there for an average of about a hundred years. Therefore, we need to make profound modifications to the energy system during the next twenty years to reduce emissions.

The final third of worldwide greenhouse effect gas emissions originate from the farming-forestry system and the distribution between deforestation and farming is about half and half. We cannot dissociate these two aspects, because the main cause of deforestation is an extension to cultivated surfaces. An ambitious international agreement would require that the international community deals with both aspects of the problem. We are starting to become aware of the energy part and set up effective economic instruments, but we still have a long way to go with the farming-forestry system.

The end of free use of nature

Since the beginning of the Industrial Revolution, our societies have been functioning assuming that the atmosphere is an infinite reservoir in which we can release greenhouse effect gases indefinitely free of charge. At the moment, emitters do not pay the costs of the damage caused by these emissions. The efficiency of action against emissions of greenhouse effect gases will depend on the capacity of human societies to set up instruments to limit this unlimited free use of the atmosphere. The Kyoto protocol was a first step in this direction. The 32 industrialised countries that ratified it agree to reduce their emissions by 5% below 1990 values, during the 2008-2012 period. They thus fix a scarcity ceiling on their emissions. This volume fixes the global level of emission permits distributed to countries, which can then be traded. These transactions determine the "price of carbon". For France, this ceiling is equal to 565 million tonnes of CO2 equivalent per year.

Moreover, an emission price ceiling system generates considerable retro-distributive effects. It actually creates a rent, called the "carbon rent". In Europe the emission quotas exchange system (the largest system of this nature in the world) was set in 2005. It covers 2 billion tonnes of CO2, which were worth nothing until December 31st 2004. This CO2 now has a value, that can be estimated at 40 billion Euros per year for a carbon price of 20 Euros per tonne. The right to use the atmosphere was unlimited before Kyoto and before the European quota exchange system was set up. We are restricting this usage right, thereby creating a new "carbon rent". However, the Kyoto protocol has two important limits.

The first is related to the fact that not enough commitments have been made; the only emissions that have been taken into account are greenhouse effect gas emissions in industrialised countries. In any case, the United States has not made any real commitment by signing the protocol (not ratified by Congress), and nor have countries like Russia and the Ukraine. The second limit of the Kyoto protocol is due to a new difficulty created by the introduction of an income; how should it be shared. And yet, the question of how to share the carbon rent and economic transfers that it can create between rich and developing countries is nevertheless essential.

The Copenhagen challenges

I have attended all conventions of parties since the Montreal convention, and I have never seen a situation in which there is so much tension between Northern and Southern countries. There are objective reasons for this. Firstly, there is the economic and financial crisis. Our contacts in developing countries are not failing to remind us about the inability of rich countries to find financial means to help developing countries deal with the consequences of climate change or to make investments to reduce them, while they have spent hundreds of billions of Euros to rescue banks and financial institutions. The increase in tension in all international negotiations is proportional to the stakes involved. The presence of strong tensions also reflects the increased awareness of our leaders that the time for talking is behind us and the time has arrived for the climate to be introduced into the economic system. Therefore everyone is defending his own interests. The situation was very different when the Kyoto protocol was signed, when only a limited number of experts fully understood the data describing the problem.

The objective of the Copenhagen conference is not to determine whether or not the principal countries have decided to take action to mitigate climate change; it is to determine whether or not policies against climate change will be organised within the multilateral framework of the United Nations. If the Conference fails, climate policies will be maintained in Europe, the United States and China, etc., but without any UN coordination, and some experts believe that it would be more efficient if this coordination did not exist. I do not believe this; if there is no post-Kyoto agreement, developing countries apart from the large emerging countries could be completely excluded from the discussions.

The Kyoto protocol predicts that emission rights in industrialised countries will be restricted. This is derived particularly from the basic principle of "common and differentiated responsibility" announced in the 1992 outline agreement. Any party that ratifies the outline convention recognises that it bears a part of the global responsibility for climate change. However, it is impossible to put highly developed countries, medium developed countries and slightly developed countries on an equal footing. This is why we talk about «differentiated» responsibility. The Kyoto protocol made a binary interpretation of this principle by defining two categories of countries, firstly those that should take restrictive commitments (industrialised countries) and countries that should not and for which no commitment is requested (there is a long list of these very diverse countries including Singapore, Bahrain, South Korea, China, India, Mali, Inner Mongolia, etc.). Thus, application of the principle of shared but differentiated responsibility has put emerging countries in a very comfortable situation.

The Copenhagen conference could be considered to be successful if it leads to a system that carries on where the Kyoto protocol left off, but is more efficient than the Kyoto protocol. This would mean that four different aspects of the system would have to be modified.

- Broaden commitments

Debates currently on going in the American Senate are very important. An international treaty will not come into application in any democracy unless it is ratified by Parliament. Therefore, before the United States can achieve any international credibility, it is essential for the Senate to ratify the internal plan to regulate greenhouse effect gas emissions that it is currently discussing. Europe already has this credibility because it has set up tools that regulate emissions of greenhouse effect gases. A discussion can be initiated with the emerging countries once industrialised countries have achieved sufficient credibility. This is why it is crucial for the United States to move forwards in this debate. For emerging countries, it is important to favour gradual entry into a system of commitments, starting by fixing a ceiling for industrial emissions of greenhouse effect gases. Oil producing countries (Saudi Arabia, Bahrain, etc.) should not be forgotten. It will no doubt be extremely difficult to include them in a post-Kyoto agreement because the «carbon" income forms a serious threat to their long term oil income. Nevertheless, we need to increase their cooperation in the management of carbon income. Finally, the least developed countries might find it difficult to join a commitment system immediately, but they will play an important role in the negotiations because they have very large needs for adaptation to climate change.

- Set up economic and financial transfers

State coffers are empty. Therefore, the carbon income will have to be used for setting up intelligent mechanisms. The possibility of transferring income from auctions is being discussed in Europe. Emerging countries could be included in such a system.

- Integrate farming and forestry

Deforestation has formed a new chapter in the negotiations since the Montreal conference in 2004. This is a major step forward and a sign of the intention to finally consider economic instruments that could effectively halt deforestation. The plan to discourage deforestation that will be discussed in Copenhagen could lead to a major step forward on this subject.

- Integrate questions of adaptation

Until now, the official doctrine put forward by experts has led us to take action on the causes of climate change before considering its effects. The question of adaptation was thus relegated to the back seat for many years. It will be an important aspect of the Copenhagen conference. The objective will be to identify economic and financial mechanisms to be set up internationally to finance studies and projects so that the most vulnerable countries can adapt to climate change. This creates the question of financial transfers that we are ready to allocate for this purpose. I cannot see how these transfers could be financed except through the carbon income.

Questions/Answers

Michel SALOFF COSTE

I have been working within the Budapest club on these challenges for thirteen years. You mentioned many figures and you mentioned the point about the inertia of the system. But no figures have been put forward to evaluate this inertia. In other words, what period in the past corresponds to the warming that we are seeing today?

Hervé LE TREUT

This inertia can be evaluated through two parameters:

- persistence time of greenhouse effect gases in the atmosphere, that we have seen is about a hundred years;
- time necessary for the climate system to change once the greenhouse effect gases are present in the atmosphere, that can no doubt be estimated at a few decades.

Considering these two effects, we can suggest an inertia time of about forty or fifty years.

Christian de PERTHUIS

There is also the inertia of energy systems; the life of a refinery is forty years and the life of a nuclear power station is between 60 and 80 years. Therefore, the reaction time of human society towards the energy system is extremely long. I am worried that it will take even longer to change farming and forestry systems.

Jean-Charles LARDIC Director of sustainable development in the City of Marseille

You clearly explained to us that developing countries would benefit from a "carbon income" through quotas that could be allocated to them (some of which would correspond to CO2 emissions already produced). What can be done to assure that the income corresponding to these past emissions is actually used for adaptation to climate change rather than being monopolised by holders of the industrial equipment that created these emissions?

Christian de PERTHUIS

In reality, there are two parts to transfers authorised by the quota system. The first part concerns the allocation of quotas and the second part applies to the redistribution of income from auctions.

The most important part for negotiations related to adaptation will apply to the auction of a number of emission quotas in rich countries, enabling transfers of financial income from these auctions from State to State, to countries with the greatest needs; distributing quotas to China and India will not provide resources to less developed countries such as African countries to help them adapt. A completely new element that is developing in European policy is that 40 to 50 billion Euros of CO2 will be auctioned every year starting from 2013. The size of the carbon market could be multiplied by three if the Senate ratifies the American project. This would provide an extremely strong action lever.

Sophie GODEUL, CFDT (French Workers Trade Union)

An economic system dependent on income is necessarily expressed in currency. How will the efficiency of the system be guaranteed in the case of a monetary crisis?

Christian de PERTHUIS

At the present time, the carbon economy is one of the few international economies for which the reference currency is the Euro. Having said this, actions taken to mitigate climate change do not solve all the world's problems and certainly not the instability of exchange rates and the volatility of financial markets.

The impact of biodiversity on the climate

Paul LEADLEY
Director of the systemic and evolutive ecology laboratory, University of Paris XI Orsay

The impact of climate change on biodiversity

Studies intended to illustrate the impact of climate change show that the rate of extinction of different species is likely to increase drastically during the next few decades. Factors causing extinctions are known (loss of habitat, invasive species, over-exploitation, pollution), but climate change could become the leading global factor affecting the biodiversity loss. Nevertheless, there is much controversy within the scientific community about the rate of loss of biodiversity that could be said to be caused by climate change and no consensus has been reached about an estimate of this rate of loss.

One thing is sure : climate change results in many changes and migrations of species. For example, a simple and empirical model shows that moderate global warming of the order of 2°C would cause a complete disappearance of beech trees in France by 2050. A study of the productivity of beech trees also shows that this productivity should be strongly affected in France and particularly in South and West parts of the country. All models predict that climate change will have major impacts on the composition of French forests. A slight modification of the rainfall alone would limit this impact.

In terms of marine environments, the rise in sea level and the increase in temperature will cause severe bleaching of coral reefs, to the extent that the reefs will probably be dead by about 2100, assuming a CO_2 concentration in the atmosphere equal to 500ppm and an average temperature rise of 2°C. It is essential that the Copenhagen negotiation should take account of this type of effect.

The impact of biodiversity on climate change

One aspect that is less frequently studied concerns the impact of biodiversity on climate change. There are three main mechanisms by which the biosphere can modify the climate.

- The biosphere can modify the flows of greenhouse effect gases by modifying the nature of the vegetation and the composition of aquatic systems.
- The height of vegetation can modify water and heat exchanges between vegetation and the atmosphere.
- Emission of particles into the atmosphere by living beings and by human activities (for example volatile organic compounds) can modify cloud formation.

The Amazon forest provides a first example of these effects.

There is no doubt that the use of primary forests for intensive crops or pasture modifies rainfall on a local and regional scale. The climate thus becomes drier and several models suggest that this drought on a regional scale can cause the death of forests, thus creating a vicious circle, the final result of which could be total destruction of the Amazon forest. There is no consensus within the scientific community about this hypothesis, but nevertheless it seems quiet plausible. One of the few models that take account of this effect predicts a change in the rainfall on a regional scale (as far as the United States) and consequently a significant increase in the Earth's temperature, due to the total disappearance of the Amazon forests.

Another example of these effects is given by Arctic tundra, where bushes are already gaining ground at the expense of grasses. The tundra could eventually and gradually be invaded by trees and some models predict that this environment will be transformed into a Northern forest by the end of the century. The replacement of grasses and herbaceous plants by trees and bushes would encourage warming of the tundra thus triggering another vicious circle, with warming accelerating the change in the vegetation. There are also very large stocks of carbon trapped in the tundra sub-soil. This phenomenon is already taking place and will naturally contribute to climate change. Therefore, biodiversity is an actual driving force towards climate change.

Impact of decisions that might be taken in Copenhagen on biodiversity

Four major socio-economic scenarios leading up to the year 2050 were studied (Millennium Ecosystem Assessment), particularly studying the role of the transformation of habitats and its global impact on biodiversity.

They show that climate mitigation actions could lead to a loss of biodiversity. Therefore, we should consider the impact of measures that we will take to limit the effects of climate change, because they themselves may have a negative impact on biodiversity. For example, studies show that the impact on biodiversity would be worse as a result of massive deployment of renewable energies than it would be following a scenario nevertheless deemed to be less desirable, namely continuing a fast increase in energy consumption. Finally, it appears that the best option in terms of the impact on biodiversity and the climate involves extensive improvements to the use of energy and agricultural efficiency, combined with determined actions to preserve biodiversity.

The new scenarios suggest that continuation of current trends will result in large-scale destruction of forests on the planetary scale. A change in approach involving a massive increase in agricultural efficiency, reasoned use of biofuels and preservation of biodiversity, would significantly improve the situation. We thus know the themes that should be given priority in the Copenhagen negotiation.

Conclusion

These observations emphasize the importance of a common discussion with climatologists and biodiversity specialists. Debates currently being carried out internationally are taking place in the absence of biodiversity specialists, which could result in preference being given to options that are not optimal for biodiversity.

The scientific community and political decision makers are becoming more aware about the need to broaden our view of the problem. This needs to be materialised at the Copenhagen summit.

Climate change, agriculture and biodiversity

Jean-François SOUSSANA
INRA (French Institute for Agricultural Research)

Introduction

The successive IPCC reports (particularly the water report published in 2008) show that a major drought index increased in many regions of the world during the 20th century. Projections produced for the 21st century show a serious risk of increased drought, particularly around the Mediterranean basin. Such prospects are synonymous of an increasing risk of food insecurity. Under-nourishment is already increasing and now affects a billion persons on Earth, according to the FAO. For example in 2008, world grain stocks were reduced to 40 days consumption, and it is possible that climate change contributed to this situation. 30% of farmers in developing countries are already suffering from food insecurity. Therefore, the question applies to the way in which world food production will or will not successfully adapt to climate change.

Climate change and agriculture

Work done by the IPCC shows that even very moderate global warming would lower wheat yields at temperate latitudes and even more at tropical latitudes. A recent article published in Science predicts insecure food supplies in developing countries by 2030. For example in South Africa, climate change would have very important effects on corn crops through a reduction in yields that should logically be accompanied by a significant rise in the cost of food.

In Europe, the expected variation of yields as predicted by a climatic model show that that a large proportion of European countries should expect their cereal crop yields to drop by 20 to 30% by 2080, assuming a fast increase in emissions of greenhouse effect gases. We can already see precursor signs of this situation : the increase in wheat yields is slowing in Europe and India due to the effects of drought and climate variability. These phenomena are also observed in forests : forest decline is observed in many parts of the world, with increasing mortality occurring after drought episodes.

These different factors contribute to world food insecurity that requires an integrative approach combining the prediction of impacts, adaptation to climate change and a reduction of its effects.

The contribution of agriculture to the production of nitrous oxide, which is an important source of greenhouse effect gas emissions, can also be mentioned. The effects of a nitrogen deposit will be considerably increased during the XXIst century and will affect all parts of the world in the future, while in the 1960s they mainly concerned Europe.

Predictions and uncertainties

The future potential for the attenuation of net CO2 emissions will largely lie in the « agriculture, forestry and land use » sector. The application of measures that become increasingly expensive over time means that we will have to take serious action in this sector, for example by reducing deforestation on the different continents or storing carbon in the organic material of the soil. If we could obtain a net reduction of greenhouse effect gas emissions by 2015, warming would be limited to 2°C in 2065. If these reductions do not begin until 2035, in other words if the Copenhagen conference fails, the probable increase in average temperature is likely to be as much as 3°C, but it is impossible to say that it will not exceed 4°C.

Furthermore, an increase in climate variability can be expected, resulting in an increasing frequency and intensity of extreme events. We should anticipate warmer summers than have ever been observed in most regions of the world. These heat waves will create serious difficulties for biodiversity and for agricultural production. According to two contrasting socio-economic scenarios, Météo France predictions suggest that the consecutive number of hot days when

a heat wave occurs should be close to fifteen, while the average at the moment is four.

Undoubtedly, we need to be cautious about all these predictions, ranging from predictions about major climate change to the impact on small farming regions, considering a cascade of uncertainties applicable particularly to :

- the future of our greenhouse effect gas emissions;
- their conversion into concentration;
- climate models (that can diverge);
- regionalisation of their impacts;
- agronomic or ecological impact models that are still imperfect.

Action levers

We must be able to reduce uncertainties at the scale of a small region in order to anticipate the climate risk, and translate it into agricultural-climate indices that can be used in the field. We thus need to move forwards from knowledge of risks to anticipation of damage. This will require the creation of better integrated infrastructures for research combining observation networks, experiments and digital models that will be continuously improved and evaluated.

We should also adapt ourselves to the dynamics of biodiversity which will show that there are many changes (pathogenic agent distribution areas, physiology of parasites and hosts, strategies for protection of plant health, etc.) that might affect the dynamics of managed ecosystems (soil, grassland, forests, water systems) and plant and animal health.

Finally, we must know how to innovate, through making use of biodiversity. This assumes that we should make better use of genetic diversity within a species or through the mix of species. The plasticity of genotypes, populations and mixes is an asset faced with increased climate variability.

We are thus facing new scientific frontiers such as molecular biology for adaptation for which further exploration is necessary, or concerning biotechnologies for the attenuation of greenhouse effect gas emissions and biotechnologies for adaptation.

Climate change and the world food supply

Philippe CHALMIN
Professor at Paris IX Dauphine University

The world food challenge

A billion people on Earth suffer from malnutrition and unbalanced diets, according to FAO figures. The world population will be composed of 9.1 billion people in 2050 and nearly 10 billion in 2070. I see no reason why the food needs of man a century from now will be significantly different from the food needs of today. This defines the extent of the world food challenge. Its significance is clear: we must be capable of doubling the planet's food production, in other words the planet's agricultural production.

Faced with this challenge, the production tool can be considered as a Useful Agricultural Area (UAA) accompanied by various constraints, an essential raw material (water) and soils for which there is an increasing risk of depletion plus the problems of drought and increasingly recurrent climatic accidents. The previous two speakers have emphasized an important function of agriculture, which is to supply energy. However, the food objective appears sufficiently important that we cannot ask agriculture to supply energy as well. It would be unsustainable to make biofuels a recurrent and important outlet for agricultural production.

Increase the useful agricultural area or increase yields?

The first possible solution would consist of increasing the useful agricultural area on a worldwide scale. But the FAO's approach to this point leaves some ambiguities. The FAO has brought together a high level group of experts and reminded them that the cultivatable potential is equal to 4.2 billion hectares, although only 1.6 billion hectares are cultivated at the present time. This is an old position held by the FAO, which believes that the useful agricultural area could be increased by 1.6 billion hectares by 2050. I myself believe that we should think about constant useful agricultural areas. We lose land every year. China loses an average of 500 000 to one million cultivable hectares every year.

Furthermore, this is high quality land because it is located around the periphery of towns, in areas in which urban development was originally due to the fertility of the land. Undoubtedly we will be able to recover new land. However, it will be limited. For example, this is the case for the cerrado along the Amazon, in which intensive breeding is currently predominant.

Moreover, the increasing use of these lands for growing crops could push breeding further North, thus increasing the risk of deforestation. I am not at all sure that we can globally double the world UAA by 2050. There will undoubtedly be improvements, particularly due to a northwards movement of cereal crops. However, this is a marginal effect which would be compensated by inverse marginal effects in other parts of the world.

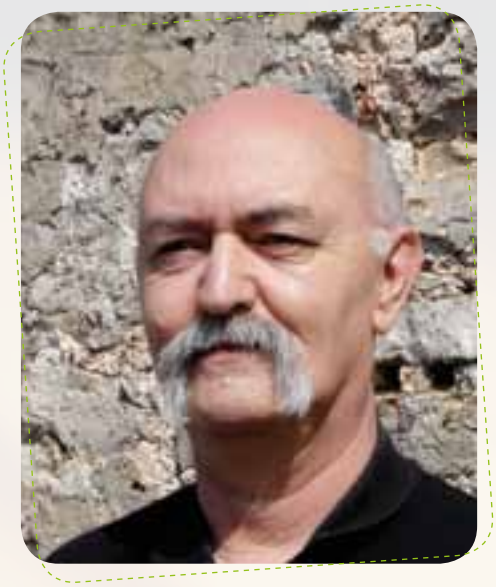
If it is impossible to increase the UAA, the only other possibility is to increase yields. Part of the solution would be better agricultural practice. We have seen a reduction in food self-sufficiency everywhere, particularly in 2008, and major problems of food dependence. We must begin by offering agricultural policies based on the principles of a common agricultural policy, in other words combined with price guarantees, to developing countries. There is a considerable potential here that can be exploited in many developing countries, considering the very low level of current yields. This change could very well be accompanied by more responsible crop practices.

Mr. Soussana praised biotechnologies but avoided talking about GMO. It is true that these crops offer another option that cannot be neglected when considering how to improve crop practices. Undoubtedly, GMOs introduce new problems that the international community must face. However, does this mean that they should be forbidden and that an ideological combat should fight against them, as it is happening in France? I am a member of the biotechnologies Senior Council which will soon have to make a decision about the first request for approval of a GMO, and I am convinced that the world cannot refuse biotechnologies during the 21st century, if only to develop plants with a better resistance to water stresses and better ability to capture nitrogen from the atmosphere. Biological agriculture cannot feed ten billion people. Climate change adds an additional constraint on agriculture, in that it will shift crop areas. We should not imagine a return to a kind and helpful nature: Man has always manipulated nature and new changes are inevitable.

Jacques WEBER

I do not believe that criticisms made about GMOs in France apply to the principle on which they are based, I think it is more about how they are used. On the other hand, I am still looking for a study on the costs and benefits of a changeover from traditional agriculture to agriculture based on GMOs for corn. Everything I have read on this subject up to now is based on myth and fantasy. I have only found two studies published on this subject during 7 years of research, and both of these were financed by companies producing GMOs.

What will the world be like after Copenhagen?



Jacques WEBER
Co-president of the Orée work group on biodiversity, research worker at CIRAD
Member of the CAS (French Strategic Analysis Centre) commission

Accepted ideas and new prospects

This afternoon, we saw the extent to which the rates of change of biodiversity and climate are inter-dependent. We tend to think about society first, and then biodiversity and climate change. But human beings are themselves part of biodiversity and of the "nature" that they exploit and on which they live. Shifting our viewpoint suggests that biodiversity leads to climate change – and that climate has a reverse influence on biodiversity. This is not simply a matter of turning the proposal upside down; this view must profoundly modify our scientific approaches.

Several presentations currently emphasise the importance of interactions that are not always taken into account as much as they should be. Biodiversity does not lie in species but rather in the dynamic of interactions between organisms in environments which are themselves changing. We need models to study such complex phenomena. This is why the scientific community has praised the creation of the biodiversity modelling chair at the Museum National d'Histoire Naturelle in Paris with the support of Veolia.

We often hear that biodiversity is a local problem, while climate change is a global problem. Argentine soya export flows show that the Argentine pampas has been profoundly transformed (generating more CO2 emissions) by this search for farming outlets. Argentine exports soya and imports upsets to its pampas landscapes.

The decline in animal populations introduces a number of problems including the challenge of the acceleration of processes, also observed for climate change. The problem is not so much in the disappearance of a species, but rather in the sum of interactions with other species and we do not know all of these interactions – either at a given instant or in the long term. If life is adaptive, we might wonder to what maximum acceleration of changes it could adapt. Will biodiversity be able to adapt to continuously accelerating processes? Some species of orchids have demonstrated such a capacity. De-synchronisation proved to be irreversible in other cases. In any case these changes have very specific consequences, for example the increasingly early harvest start dates in French vineyards. Such phenomena have been observed in the past, however they have never been observed before over such short periods.

Another accepted idea is to congratulate ourselves on the increase in the content of CO2 in the atmosphere that would fertilise the forest. Christian Körner, a Swiss scientist, has studied the consequences of "forcing" a sample of a Nicaraguan forest with CO2. The main beneficiaries are moss and liana, but they weaken tree growth. Körner's team also demonstrated threshold effects beyond which massive areas of wind destruction occur more frequently, releasing greenhouse effect gases at the end of each cycle. Everything takes place as if the ecosystem cycles were in shorteneing and accelerating.

Taking account of climate change in politics

Political studies on climate began in 1972. Political studies on biodiversity started in 1992 in Rio. The IPCC was created in 1988 to provide a driving force for scientific progress, and its work demonstrated the validity and robustness of scientific work. The method has been tested, in other words it offers a rigorous basis on which it could be refuted. Without such means, there could be no debate. The political macro-economy work began with the Stern report in 2005. Faced with the impact of this report illustrating the cost of inaction, the European Commission initiated similar work (economy of biodiversity and ecological services) under the responsibility of Pavan Sukhdev. Clear objectives for the climate were fixed; the objective was to reduce greenhouse effect gases by 5% in 2012 and 20% in 2020.

States decided to halt the biodiversity loss in 2012. Although this injunction has created a very large increase in research work, we still need to invent refutable methods at world scale. The IPBES (Intergovernmental Panel on Biodiversity and Ecosystem Services) plan put forward by France since 2005 in close cooperation with the world Diversitas program, involves many players. Considering the complexity of the problems, the creation of a sort of worldwide "network of networks" could be envisaged in order to answer questions raised by public or private decision makers. And a capability for making an inventory like what the IPCC is doing could be developed later.

Another factor has arisen, namely the crisis from which we have not yet escaped. We should not forget its effects including expropriations, collapse of the

gross domestic product, drop in financial markets, but all these effects are only symptoms. They reflect objective economic shortages (that economically measure the difference between supply and demand). They are now combined with physical scarcities. For example, the regular and continuing reduction in world fish stocks. At least 40% of catches are still thrown back into the sea (although the fish are already dead). Another example consists of oil and fossil resources, for which the supply will quickly peak. A recovery will increase demand for these resources, accelerating their depletion.

Rethinking the evaluation of the world surrounding us

We live in a world in which the creation of wealth depends essentially on the erosion of a natural capital. Destruction of this natural capital, and the repair of previous destruction increase the GDP. The GDP concept was created to monitor progress with reconstruction after the Second World War. Therefore, it satisfies a clear logic that was relevant. We will not move towards a viable world as long as we follow this trend.

However, is it possible to envisage a world in which the creation of wealth depends on maintenance or improvement of the natural potential? All negative impacts on natural environments would remain possible, but at costs that could be so prohibitive that players would be deterred from doing so. It is quite likely that players will follow the rules if it is in their real economic interest. Therefore economic incentives can form a powerful instrument.

Non-human life is in a situation of free access, often created by public policies; such life is composed of "things" that we use as we wish without paying the costs of managing the ecosystems that host them. How can we confer an intrinsic value onto things that do not have one?

The scales at which these questions are studied are tightly nested. They are neither global nor local; "glocal" might be more appropriate. This is why international organisations must be reformed to define common rules throughout the world and principles for international equity. We could thus create a World Environment Organisation that would include the FAO, the UNDP (United Nations Development Program) and UNEP (United Nations Environment Program). This organisation should then have a real capacity to apply decisions taken by its members at world scale.

For example, this might concern the creation of a world tax and redistribution of income from it. Remember that there are four main types of capital, namely manufacturing capital, human capital, social capital and natural capital. At the present time, most regulations apply to manufacturing capital and human capital. Changes should be made such that most regulations are applicable to consumptions of nature, replacing contributions applied to work facilities and work. Therefore, existing taxes need to be replaced by others (the need is not to create new ones). In the energy industry, we could envisage creating a worldwide tax on added energy, and income from this tax could be redistributed in inverse proportion to energy consumption. Redistribution would thus benefit countries with the lowest energy consumption. Worldwide solutions cannot be identified unless there is a tool capable of applying worldwide regulation of this level; all national regulations taken together will never lead to worldwide regulation.

Indirect mechanisms such as rights markets (originally invented for the fishing and dairy production sectors) could be adopted for renewable resources that are technically difficult to tax directly. As soon as regulations increase the price of energy and make labour less expensive, labour should reappear where it was becoming more and more rare.

Summary

Marie BLANDIN
Senate, Vice-President of the Committee for biodiversity

Carbon has been present on Earth for a long time, but it was buried. The appearance of a single species (man) has destabilised the equilibrium in biodiversity that had in place for hundreds of millions of years. We thus extracted carbon, and ever since we have never stopped extracting it. Hervé Le Treut and Sylvie Joussaume gave us a glimpse of the certainty of global warming and the role of human activities in global warming. They announced a major acceleration of these phenomena and explained that the objective to stabilise the CO2 concentration in the atmosphere requires immediate action to significantly reduce emissions. On a planetary scale, we are suffering from a disease that can be compared with cholesterol that affects some of us; we know what we should be doing, but a small voice inside doesn't want to know and atheromatous plaque forms gradually, until the cardiac accident occurs. We are thus sabotaging the system based on which the planet developed, knowing it but without really wanting to believe it.

Mr. Leadley presented us with four scenarios, one of which was based on a principle of energy sobriety. I would like to call it the «Lévi-Strauss» scenario which demonstrated the capacity of some people to live in harmony with their environment, maintaining the oral tradition of taboos in accumulating property and waste. Our survival depends on it. It is also a question of justice because, as mentioned by Ghislaine Hierso, the poorest are often the first to pay the price for our irresponsibility. A billion people are already undernourished. We have seen how displaced people are welcomed. Obviously, we need to make progress in our respect for each other.

Fortunately paths other than the "Lévi-Strauss" scenario have been mentioned, for example the carbon market mentioned by Christian de Perthuis and the increased useful agricultural area supported by M. Chalmin. We also heard Jacques Weber's case for new world rules and for setting up a worldwide tax. Finally, the technological and decision making inertia of energy production systems and methods of supply or changes to crop practices were discussed. We should also mention the inertia of elected Members of Parliaments. A Sciences Po (Paris Institute of Political Studies) study made five years ago showed that 80% of Members of Parliaments believed that there is no need to slow down the motorway program, although ordinary citizens questioned in the street showed more awareness about environmental challenges.

I would like to conclude with an observation. People who resist sustainable development and change simply resist their own happiness; anyone who successfully changes his or her enterprise, lifestyle, relations with others, etc., confirms that following this option made him or her happier.

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