FRENCH STUDIES RELATED TO CLIMATE CHANGE ADAPTATION

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RÉPUBLIQUE FRANÇAISE
Ministère de l'Écologie, de l'Énergie, du Développement durable et de la Mer

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OBSERVATOIRE NATIONAL SUR LES EFFETS DU RECHAUFFEMENT CLIMATIQUE

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GICC

3 SÉRIES TRIMESTRIELLES DES
ANNALES DES MINES
FONDÉES EN 1794

Preface

*By **Madame Chantal Jouanno**, Secretary of State for Ecology*

The challenges of climate change are beyond measure. Everyone should be alarmed by this reality: alarmed by the magnitude of climate warming, and by the multiplication of extreme events, if nothing is done; alarmed by the violence and the multiplicity of impacts on our climate, our ecosystems, our lifestyles, our civilization. There is urgency to act, now. The cost of inaction will be higher than the cost of the action, recalled Sir Nicolas Stern. We must act, on both fronts: mitigation and adaptation.

To mitigate climate change, France found the means to meet its international commitments. With already one of the lowest emission rates of greenhouse gases relative to our GDP, we have set ourselves, as the entire European Union, very ambitious reduction targets. These targets have been not only met, but even exceeded. This is an encouragement to continue our efforts, relentlessly.

The front of adaptation to climate change is also fundamental. Adapting to climate change means anticipating, despite the uncertainty of its impacts, on spontaneous reactions of eco-systems and society throughout all its components. It represents a difficult exercise, involving many disciplines, taking into account specificities of each territory, to be considered on a case by case basis. In France, adaptation is driven by the National Observatory on the Effects of Climate Warming (ONERC). A national strategy was adopted in 2006. ONERC is now working towards the adoption in 2012 of a national climate plan; as a preparatory step, a national dialogue is being conducted in 2010.

This publication, prepared in preparation for the Copenhagen UN Conference on Climate Change (2009), includes various national studies about adaptation to climate change. It illustrates the willingness of France to mobilize all actors in society, including scientific, institutions and civil society, in the debate about climate change mitigation and adaptation.

The findings are unanimous: climate change will severely impact territories: rising sea levels, increased probability of heat waves and droughts, increased frequency and intensity of natural disasters ... We have a responsibility to act, not for our grandchildren, but for our children. Our citizens now understand. Their concerns and their demands are strong in the field of disaster risk reduction. Let us live up to their expectations. Understanding these phenomena is a starting point of any effective prevention policy. This publication is developed as a contribution.

Chantal Jouanno
Secretary of State for Ecology

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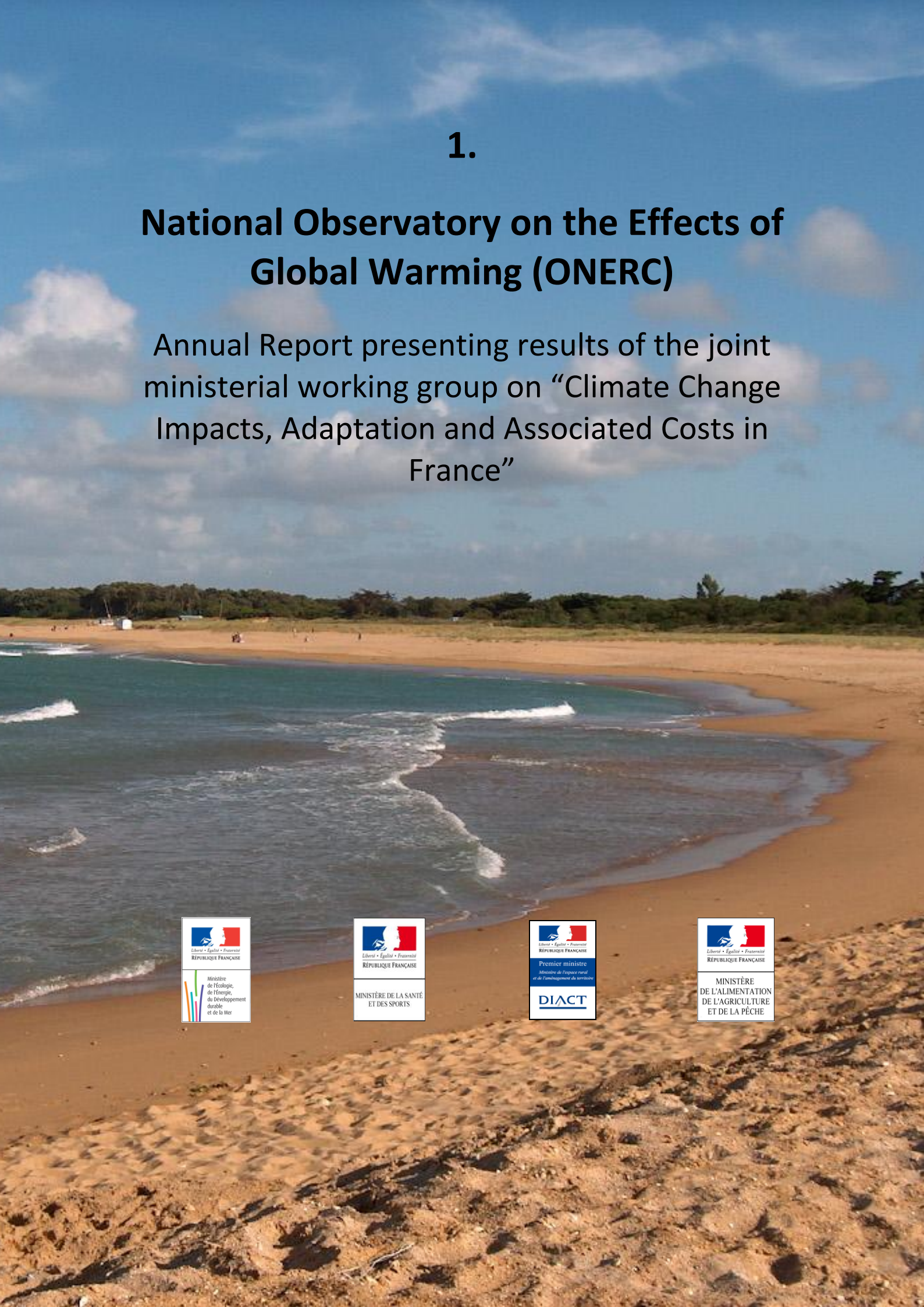
1.

National Observatory on the Effects of Global Warming (ONERC)

Annual Report presenting results of the joint ministerial working group on “Climate Change Impacts, Adaptation and Associated Costs in France”



Introduction by Paul Vergès, President of ONERC

The conclusions of the Intergovernmental Panel on Climate Change (IPCC) set out in its last report for 2007 are final: man is indeed responsible for the climate change that is affecting Earth. Despite this observation, the acknowledgement has yet to be transformed into concrete actions: greenhouse gas emissions have soared since 1990, and even in the period of global economic crisis which we have been experiencing since 2008, the trend in the levels of CO_2 concentration in the atmosphere has not shown any change.

Taking into account climate system inertia, global warming will increase during the coming decades, even if emissions drop sharply. The continued increase in emissions at the current rate could lead us to a catastrophic climatic disturbance. At a meeting in Copenhagen in March 2009, several researchers observed that the emissions of the last few years and certain aspects of the climate were approaching the worst case scenario considered by the IPCC.

Our societies must react in order to keep global warming within limits that enable the effects of climate change and the resulting catastrophic consequences for the world's populations to be avoided. The effort to be made is essential and vast, so as to limit our greenhouse gas emissions considerably. This requires radical transformations of our economic, industrial and agricultural systems, our way of life and our behaviour.

The awarding of the Nobel Peace Prize to IPCC researchers and to Al Gore has great symbolic value, because the ravages that could accompany a radical change in our climate are comparable to those of a war. It is time to move into action: the next meeting, in Copenhagen, of the conference of the parties to the United Nations Framework Convention on Climate Change, must lead to an ambitious agreement between all countries in order to meet this challenge.

This is not the first time that humanity has been confronted by the need to adapt to new living conditions, and several societies have been able to overcome considerable difficulties thanks to a change in their practices. This is how man has been able to colonise particularly inhospitable lands, such as the arctic regions or certain tropical deserts. Yet conversely to these examples given to us by history, modern man has the chance to be able to anticipate the changes and to organise his adaptation thereto. We must seize this chance and plan right now the changes to be made in our behaviour.

Since its creation in 2001, ONERC has been an essential tool for providing public authorities and elected officials the necessary bases for strategic choices and for steering political decisions. After having suggested a national strategy for adaptation to climate change for France, ONERC, together with the Ministry for Ecology, Energy, Sustainable Development and the Sea, responsible for Green Technologies and climate Negotiations, steered a joint ministerial working group on the impacts of climate change, adaptation and associated costs.

Unlike the works carried out over the last few years, for example those by the World Bank, the United Nations Framework Convention on Climate Change or the Stern Review, the aim was not to obtain a global estimate of cost, but to create the most exhaustive description possible of impacts

and to give the basic costs of these impacts by sector, as well as some adaptation measures. The exercise proved to be innovative, particularly for the large numbers of players mobilised, but it came up against a lack of data and references, which proves how far we still have to go. There is great uncertainty over climate projections, and even more so when we try to quantify the impacts that climate change will have, but it does not justify a wait-and-see attitude or lack of decision.

Paul Vergès

President of ONERC

President of the Region "La Réunion"

ONERC Annual Report 2009

Summary for decision makers

Climate change is today a reality, and its consequences will have a significant medium-term impact on our environment and our ways of life. The Grenelle Environment Forum recommended anticipating these as of now, in order to minimise the resulting socio-economic impacts and reduce the vulnerability of the players concerned. Defining and evaluating the impacts of climate change that players will have to confront allows the most suitable adaptation measures to be planned.

In March 2007, the Ministry for Ecology, Energy, Sustainable Development and the Sea (MEEDDM) formed an interministerial group under the name "Impacts of climate change, adaptation and associated costs in France", thus undertaking a project to evaluate the damage and the measures that will allow the cost of impacts to be limited.

One of the characteristics of this task resides in the fact that it is, for the most part, carried out by the services concerned, with research organisation and private player collaboration. It must be considered as a stage in an ambitious public action gauging process: **it leads to temporary results that remain open to discussion, for development in later stages.**

Methodological frameworks

The decision has produced sectoral evaluations at Horizons 2030, 2050 and 2100, without wanting to aggregate the results. At this stage, the thematic works have not been designed to be exhaustive: only certain impacts have been assessed in a quantitative fashion.

The group chose to work from the **IPCC A2 and B2 scenarios,** in accordance with the simulations created by CNRM/Météo-France using the Arpège-Climate model. A2 is a rather pessimistic scenario, B2 an optimistic scenario: these two scenarios are generally those adopted in climate change impact analysis.

In the absence of a long-term socio-economic outlook for France per region and per sector, it was decided to work using the current French socio-economic situation (scenario known as "constant economy"). This choice allows the impact of climate change to be isolated from that of other developments and does not add macroeconomic uncertainties to uncertainties relating to climatic aspects. Nevertheless, this choice remains restrictive and limiting for some sectors, for which a socioeconomic change is already anticipated or for which these changes constitute a determining factor in the vulnerability to climate change.

Scope and results of thematic works

Only a limited number of sectors have been studied and within these the analysis only concerned a selection of climate change impacts. The estimated costs must be considered as **rough estimates,** due to the limits of the methodologies used and the non-exhaustive nature of the evaluations carried out. The detail of the quantitative evaluations is recorded in the general report.

Water resources

If we consider demand as being stable, a deficit of **2 billion m^3 per year** in meeting the current needs of industry, agriculture (irrigation) and drinking water supply will be seen at **Horizon 2050.** The projections indicate that the zones most affected will be those already concerned by structural deficits. Estimating the compensation for the potential deficit in water resources at Horizon 2050 only represents a "visible" part of the adaptations needed and an extremely partial evaluation of the need to adapt water-related activities. All sectors will be affected by this change, which will mean an increase in conflicts of use, a decrease in water quality and therefore a disturbance to aquatic ecosystems or part of the water resources. The adaptation of each sector to climate change will include better management of water consumption: adaptation of water demands and requirements is a priority theme. As to the adaptation of the offer, this will have to come within a planned adaptation, in order to study the impacts in advance. The evaluation of the potential cost of these adaptation measures can only be made via local enquiries. They may represent very high operating investments and expenditures.

Natural hazards and insurances

The analysis focused on four hazard types: flooding, coastal hazards, clay shrinkage and swelling and gravitational hazards. For example, the average annual damage to housing generated by the risk of **clay shrinkage and swelling** could exceed **EUR one billion per year in 2100** (compared to EUR 200 million per year today) in France, based upon constant urbanization projections**.** This cost could be multiplied by a factor of 4 to 5 if urbanisation continues to happen in high-risk zones, if no specific policy could deal with reducing that risk. Without adaptation, the decline of the coastline by marine erosion or flooding as a result of climate change (rise of sea level), should ultimately cover about one hundred thousand people and lead to the **destruction of housing for cost amounting to several tens of billions euros across the century, for the only region of Languedoc-Roussillon**. The **cost of flood damage from overflowing rivers** may also increase in several watersheds, with important uncertainties remain regarding the expected impact. An evaluation at the national level would be, at this stage, risky, because of the difficulty of treating and aggregating costs on all watersheds, including in small ones in which the impact could be high. As to the cost relating to gravitational hazards, this has not been assessed, because of a need for more information. However, the heavy impact on society of catastrophes arising from these hazards should be underlined, as these can lead to the loss of human life and very high localised costs.

Biodiversity

Even though it is sometimes difficult to isolate the impacts of climate change from other pressures suffered by ecosystems, and even though the problems are very different depending on the ecosystem and the species concerned, **signs of changes in biodiversity attributable to the gradual modifications caused by climate change can already be seen.** Biodiversity is directly affected by the changes in temperature and rainfall amounts in particular, but the **indirect effects** could be at least as high. It is therefore essential to know more about the cross effects of climate change impacts on one hand, and spontaneous or planned adaptations on the other, in order to prevent negative consequences for biodiversity. Furthermore, the **preservation of natural ecosystems and their resilience may also constitute an adaptation action** (combating flooding, for example). The economic assessment of biodiversity losses is based on the concept of ecosystem services. This approach, applied to coral ecosystems and non-goods services provided by forests shows clearly negative impacts. On a more global scale, **significant economic losses related to the reduction, and even disappearance of regulation services** are to be expected, in particular in the second half of the 21st century. Giving priority to territorial governance may enable the better integration of biodiversity protection and the various challenges to be met, on relevant spatial scales.

Health

The economic assessment task concerned the impact of two major extreme events (heatwave in 2003 and flooding of Gard in 2002). The measurement of the impact of the heatwave took into account the real costs and the costs saved for health insurance, the indirect costs (loss of human life, non-productive time) and the intangible costs (estimated value of the loss of quality of life and suffering linked to a decline in health). If the impact for health insurance does not seem significant, the global cost for society as a whole is nevertheless considerable. We estimate the value lost by our society because of the **2003 heatwave** as being a little **more than EUR 500 million** on the basis of an average loss of one year of lifespan[1]. During the floods, three major danger to health phases were noted: an immediate danger phase (injury and death), a short-term danger phase (risks of infection), and a danger phase regarding the psychological problems relating to post-traumatic stress. The group's evaluation task concentrated on this last phase. With regard to the **Gard floods,** the cost of taking care of people presenting psychological disorders has been estimated at approximately **EUR 234,000 (for 953 people).** This is a low estimate, since it only concerns the cost of treatment (the indirect and intangible costs not having been calculated).

Agricultural Sector

The growth models for the field crops used show an increase in yield in response to climate change (notably for wheat up to horizon 2100). This increase does not take into account inter-annual variability and the drop in water availability. The inclusion of these variability factors, which are still badly integrated into the growth models, could enable the results to be refined and the anticipated increase in yield to be moderated. For example, increased events like the **2003 heatwave** could, in 2100, represent a cost of up to more than **EUR 300 million per year for a crop such as wheat** in the absence of any adaptation measure. **Viticulture** will also be affected by climate change, with high territorial differences and effects on the quality of the wines. In the case of **meadows,** the exercise carried out for the **peri-Mediterranean area** gives a loss-compensation cost of **EUR 200 million per year** over the second half of the 21st century. It is therefore necessary to adapt to these forecast changes as of now.

Forest sector

An increase in productivity (volume of wood) is expected in the short and medium terms because of the increase in temperatures and rates of CO_2 in the atmosphere. Therefore, the additional annual gross production will reach almost 30 million m^3 in 2050. Nevertheless, over this same period, the **expected gains in productivity are on the same scale as possible losses** through wilting, fire, drought, etc. After 2050, the trend will be unfavourable because of water stress, particularly in the south of France, with an increased risk of drought and fire; suggesting **clearly negative impacts in the long term.** In order to compensate for these effects, adaptation by the forest sector will have to make all parties in the field play their part. With regard to **forest fires,** a study led by the interministerial Mission on the risk climate change-related fires is currently underway. According to the initial results, the expected climate change will be accompanied by an **increased hazard in areas that are already at risk** (where systems protecting forests from fires are in place), as well as by a **regional spread (towards the North and at altitude)** of the "forest fire" hazard.

Energy

Climate change will have consequences on demand, with a drop in energy consumption in winter, but an increase in summer because of the need for air conditioning in housing and vehicles. The

[1] Calculated in accordance with the recommendations of the Boiteux report (2001)

economic assessment of these impacts reveals **an energy saving trend of around 3%** in the constant economy scenario, i.e. 1.8 to 5.9 Mtoe/year according to the scenarios and horizons, but the spontaneous development of residential and automotive air conditioning will cut global warming-related energy savings by half. In terms of electricity production, because of the restrictions relating to water resources, we must expect a **drop in production of around 15% from hydroelectric plants,** for which water is the "raw material", and **yield losses** for production and energy transport infrastructures.

Tourism

The results provided by a study carried out by the *Centre International de Recherche sur l'Environnement et le Développement* (CIRED – International Research Centre on Environment and Development) and Sogreah, based on the summer tourist comfort index (ICT), highlight **a drop in summer climate comfort** throughout mainland France, with maximum temperatures reached becoming too high to afford tourists maximum comfort. This deterioration is less marked in the Northern half of France (Northwest Coast specifically), as well as in certain mountainous departments (particularly in the Alps). **In 2100, a significant impact on summer turnover** is to be expected, because of a drop in attractiveness to tourists, except in the north of France and certain departments in the Alps. On the other hand, an improvement in conditions will be seen in the inter-seasons. With regard to winter sports, an OECD study in 2006 indicated that, in the Alps, **the reduction in snow cover will reduce the reliability of the depth of snow.** In the French Alps, 143 skiable resorts currently have a low snow depth. In the event of warming by +1°C, this will be the case for only 123 resorts; for 96 resorts if warming reaches 2°C and for only 55 resorts in the event of warming by 4°C. In a general fashion, this work indicated that, in all geographical areas of mainland France, the tourism sector must adapt to future indications of climate change in order to limit the negative impacts and seize the potential opportunities.

Transport infrastructures

The predicted climate change could mean adaptations are required at road infrastructure level. If the 2003 heatwave did not seem to cause generalised disorders that call into question the permanence of the roadway or civil engineering structures, the effects of **repetitive periods of heatwave** are not known at this time. As far as the risk of **permanent marine submersion** linked to an overall rise in sea levels by one metre is concerned, this would represent a property cost, for the mainland A-roads (excluding motorways and other roads), excluding loss of use and outside of the "network" effect (for example the submersion of a limited length of road could cause an entire section to be unavailable but only the property value for the submerged length has been calculated) that falls in a range between **EUR 500 million and 1.2 billion.** It could reach EUR 2 billion if the current protections prove to be insufficient. For reasons of data availability, infrastructures outside the public national network and port, rail and river infrastructures have not been studied.

Territories

The words specifically concerned the question of the pertinent scale of analysis, sectoral interaction on a territorial scale, and the concept of **transition towards change.** The importance of the time interval needed for what we could call **"the vulnerability apprenticeship"** was highlighted. This conversion will last as long as the public is likely to be affected by the impacts of climate change are not, on the face of it, uniform. For these reasons, the informing, awareness raising and mobilising of players and populations in relation to climate change and adaptation constitute fundamental aspects. In addition, it has been proved that adaptation will above all include a better knowledge of climate change and its challenges, with **organisation of skills** also playing a major role. In view of

these observations, it is necessary to take the measure of **social rhythms** useful for making concrete the common objective of a non-fractured development towards new lifestyles.

Analysis elements

The works carried out highlight the costs, but also the benefits linked to climate change in mainland France, depending on the sector considered, climate scenarios and time horizon. For some sectors, we will see both costs and opportunities depending on the impact studied, so much so that it is sometimes difficult to determine the sign of the "net" impact of climate change. Nevertheless, in view of the qualitative and quantitative analyses carried out by the study groups, we can expect a negative global impact from climate change; the **costs could reach several hundreds of millions of euro per year for various sectors if no adaptation is undertaken.**

Seen as an additional policy to mitigation, **adaptation will allow the costs of climate change impacts to be limited significantly,** and even transformed into opportunities in some cases. If **spontaneous adaptation** can already enable the negative impacts of climate change to be limited, we should note that unorganised adaptation could also cause these to be increased or the benefits to be limited: this is the case with energy, with the spontaneous development of air conditioning, which plays a part in significantly increasing energy consumption in summer, and therefore greenhouse gas emissions; or for agriculture, where a spontaneous increase in irrigation cannot be compatible with the reduction in water availability. This **highlights the importance of coordinating and organising adaptation** in order to avoid these pitfalls.

The impacts of climate change will not be spread evenly or fairly across the territory:

- from a **geographical** point of view, some regions could find themselves severely affected by the changes, whereas others will be less so and may even turn this to good account, these differences being due as much to climatic hazards as to territorial geographical and socioeconomic characteristics likely to influence the vulnerability of systems;
- from an **individual** point of view, players will not be equally subject to climate change. Depending on the sector of economic activity and the social vulnerability of households, the effects will not be redistributed in the same way. **The most disadvantaged individuals will probably be the most and the quickest affected** by the impacts of climate change.

Adaptation to climate change must therefore be contextualised and make sure **inequalities in view of risk are reduced.**

Several uncertainties remain over what the consequences of climate change will be: it is therefore necessary to plan governance methods that **can be both planned for the long term and progressive** over the short term.

Identified lines of adaptation

While the works were mainly focussed on the impacts of climate change, some lines of adaptation were listed or suggested. These options **do not, at this stage, constitute recommendations, but rather lines to be considered within the framework of adaptation planning studies.** Their relevance, efficiency and feasibility must be studied in an integrated fashion, in particular by taking into account local context.

There follows some non-exhaustive examples of lines identified:

- General: organise availability of climate model results – in particular the collapses on a local level - and impact studies;
- Water: implement alternative agricultural systems that are more robust and less demanding on water resources (already included in Objective Earth 2020);
- Natural hazards: take into account climate change in planning and development documents;
- Biodiversity: enhance protected spaces as preferred areas for observing the impacts of climate change and monitoring adaptation strategies;
- Health: integrate health risks of climatic origin in basic and ongoing training for healthcare professionals;
- Agriculture: diversify the crop systems, allowing “evasion”, “avoidance” and “tolerance” to be combined;
- Energy: ease the development of a building and urbanism framework that reduces the demands on energy, particularly that of air conditioning;
- Tourism: develop “four-season tourism”, in order to reduce the dependence on snow.

Perspectives

For reasons of feasibility and data availability, some points could not be tackled. These choices do not prejudge the importance of the impacts of climate change on these sectors, which merit being treated in future stages.

The fields that were not handled in this study and that must form the subject of specific attention in future stages were as follows:

- **“Urbanism”**, as well as the **air, port, river and rail** sectors;
- The **maritime, fishing and aquaculture** sector;
- **Tertiary sector** activities (other than the tourism sector);
- **Industrial sector** activities (other than the energy sector);
- The impacts of climate change on **cultural heritage.**

The integration of **Overseas territories** in the quantitative evaluation of impacts and adaptation measures constitutes a major priority. The problems of climate change in the Overseas Departments and Collectivities and in New Caledonia are different from those affecting mainland France. This involves, as of now, works resulting in particular in a better knowledge of the development of climatic parameters and their consequences in these areas.

The **crossover knowledge and observation requirements** have been identified in order to advance understanding of the economic impacts of climate change.

- **Improving knowledge** about climate changes, in particular for the hazards that remain subject to major uncertainty:
  - change in rainfall patterns;
  - rise in sea levels;
  - consequences of climate change on the hydrological regime;
  - highly localised climatic hazards, i.e. gravitational hazards;
  - changes to sun and wind patterns;
  - changes to the physico-chemical characteristics of marine habitats.

- Improve the characterisation of certain hazards – droughts or heatwaves for example – in terms of intensity or even territorialisation;
- Produce **territorialised data,** whether this is for hazards, models, climate scenarios or socio-economic development scenarios;
- Improve the **characterisation and quantification of non-goods impacts;**
- **Integrate the problems of adaptation and mitigation,** via research aimed at better identifying their synergy and conflicts;
- Improve understanding of the **spontaneous adaptation** behaviour of the various players;
- Lead a discussion on the feasibility and acceptability of implementing **planned adaptation** measures;
- Continue works on **adaptation costs,** little touched on here, on the junction between **the economics of uncertainty** and **long-term economics,** involving the availability of economic analysis tools for adaptation;
- Improve the **inclusion of sectoral interactions:** the impacts of climate change on one given sector will in fact be largely influenced by the impacts affecting other sectors;
- Launch a global discussion and a planning effort with regard to **the questions of water availability and use** within the context of climate change;
- Continue a **multi-risk and multi-sector discussion** on adaptation.

Finally, in general, the steps must be **produced on other scales,** in particular for local authorities.

Complements

Water resources

Key messages

- The impacts of climate change on water resources will be multiple, both in terms of the offer (quantity and quality) and demand.
- One of the main challenges of the future will be to merge a decreasing offer with a demand that, in places, is already unsatisfied and that will increase with the impacts of climate change.
- At horizon 2050, we can estimate the deficit in water to satisfy current uses, without adaptation, at some 2 billion m^3.
- These changes will generate restrictions on users: agriculture, drinking water supply, waste water treatment, energy production, and rainwater drainage.
- In order to prepare adaptation, it is necessary to improve knowledge of impacts and environments, and the modelling of systems in interaction with water, and organise monitoring of water (surface and underground) and environments (humid and coastal zones).

Scope of study

Several economic sectors will be impacted by a change to the water cycle: agriculture; the production of energy for cooling production units or operating flow volumes; drinking water supply; supplying canals, etc.

The estimate of the deficit for water users at horizon 2050 has been made on the basis of an extrapolation of the results of a Boe study (2007), relating to a change in flows. The impacts of climate change on the resources will not be limited to this quantitative aspect, as *Table* 1 indicates.

Table 1 - Impacts identified and studied : Water

	Quantified	Non quantified
Increase in demand (rise in temperatures)		X
Change to the available resources	X	
Reduction in water quality		X
Increase in the vulnerability of certain ecosystems		X
Increase in cost for access to water, restrictions on use, treatment, etc.		X

Quantitative impacts: deficit in available resources

The impacts of climate change on flows will be multiple. **At horizon 2050,** Boe (2007) highlights:

- In winter, a moderated reduction, as an overall average, in flows, except for the south-east of the country and the Alps, where they will increase. In spring, slight changes in general;
- In summer and autumn, a major reduction in flows;
- A high increase in the number of low-water level days;
- A reduction in flood flows well below average, but an increase in some cases;
- A reduction in soil humidity regardless of the season, except in mountain areas in winter and/or spring;
- A sharp decrease in snow precipitation and maximum height of accumulated snow at low altitude, which lessens the higher you go.

If we presume that the water resources are today fully exploited in water division zones (ZRE) during the spring and summer and that everywhere else the resources allow drawing to be doubled, it is estimated that **the deficit in water to satisfy the current requirements for drinking water, industry and irrigation will be in the order of 2 billion cubic metres in 2050.**

The territories will not be affected in a uniform fashion: the most vulnerable zones will be the zones already concerned by structural deficits. The cost of the deficit will reach **EUR 5 to 10 billion** if the volumes of water must be fully compensated and additional treatments implemented. Other scenarios include adapting economic activities are foreseeable and may prove to be less costly.

Limits of the exercise

One of the main limits is due to the constant economy hypothesis, which does not allow changes in use to be taken into account when calculating the deficit. However, **the role of socioeconomic developments** is essential: depending on the population dynamics, for example, without adaptation, the deficit would be much greater than the result shown.

Restrictions on use

Such a deficit will have an impact on all sectors dependant on the resources.

Agricultural restrictions

The agricultural sector, the main user of water resources, with 48% of total consumption, will be particularly affected by the impact of climate change on resources. The initial results of the INRA Climator programme (Brisson & Itier, 2009) on wheat and maize show that the greatest part of the drop in rainfall will mainly lead to a hydrological drought and in part to a soil drought in both rainfed

(wheat) and irrigated (maize) crops. Hydrological comfort during the production period will fall in general, with an **increased need for water support** in order to keep current production conditions. However, the **reduction in** water **availability** will cause stricter drawing restrictions. Several crop alternatives with cereal-based one-crop systems are possible and may be favourable for adapting to these changes.

Drinking water restrictions

The drinking water supply (AEP) represents almost 18% of water drawn. While there are currently no major AEP problems, the basins will be faced with more frequent water shortages because of climate change, even in the absence of increased demand. **The reduction in the quality of the resources, accentuated by climate change, will again reduce the amount of fresh water available for domestic purposes.** These developments may lead to an increase in water prices (difficulties in distribution, treatment costs).

Waste water treatment restrictions

In the event of a drop in the watercourse regime, maintaining environmental standards will mean **more intense treatment of waste water and therefore greater treatment costs.** Some impacts of climate change on the water treatment networks will be positive (faster biological reactions), others negative (additional energy consumption, problems relating to odours, increased corrosion phenomena). Crisis management policies will have to be organised to tackle the increased risks – particularly sanitary ones.

Rainwater treatment restrictions

Faced with an increased risk of urban run-off (violent rain, swollen evacuation networks), it will be necessary and without regret to **review the rules on sizing spillways and rainwater recuperation.**

Industry and energy production restrictions

While the quantitative impact of the energy production sector on water resources is currently relatively moderated, **its qualitative impact is not insignificant** (water temperature, contamination by biocides). The impacts of climate change on water will affect energy production in two ways:

- Reduction in cooling yield in the case of a combined increase in air and water temperatures associated with a weak flow;
- Repercussion from conflicts of use on managing hydroelectric plants.

Civil engineering work management restrictions

The modification of run-offs and external flows is likely to affect the **management of major dams.** This will require a specific outlook.

Significant impacts on quality

Water quality and quantity are interdependent. Ducharne *et al.* (2004) studied the impact of climate change on soil nitrogen mineralization in the form of nitrates, modulated by the changes in rainfall and by agricultural activity. According to their results, in average for the free groundwater, the concentration of nitrates will increase at horizon 2100 by 0-33% in relation to the current concentration. In the water courses, the impact of climate change means an increase in nitrate concentration, but this is less severe than in the aquifers.

Adaptation

Adaptation measures will be local and will affect ecosystems, agriculture, drinking water, flood management, demographics, energy, etc., and they will be based on a complex alchemy between the adaptation of needs and the adaptation of the offer. The adaptation measures identified are set out in table 2.

Table 2 – Recommended adaptation measures

Adaptation of demand	**By savings, modification of activities or substitution of another resource** Reduce domestic consumption: - Active and passive savings (modification of technologies and manufacturing standards) Reduce agricultural consumption: - Reduce irrigation water requirements by accepting a loss in yield less than proportional to the reduction in volume produced - Reduction in irrigation volume - Diversification of watering calendars - Optimise efficiency of water supplied when watering is justified - Implement agricultural systems that are more robust and less demanding on water resources - Nitrogen input reduction policy
	By town planning - Promote efficient town planning at the appropriate levels
	By adapting energy demands - Improve production station yields - Set up management per chain of hydroelectric plant - Limit the installation of new thermal or nuclear power stations in coastal areas
Adaptation of offer	**By developing new infrastructures** - Set up additional water supply infrastructures in order to relieve severe droughts
	By intervening on target flows - Review the flow targets in low-water level and crisis periods by respecting the DCE provisions

Perspectives and recommendations

The research perspectives for improving **understanding of the impacts of climate change** on water are numerous. They are set out in the following table:

Table 3 – Research, follow-up and observation requirements

Research requirements	**Improve knowledge** of the impacts observed and predicted for water quality, past hydrology, environmental operation, and water use
	Better characterise **droughts**
	Improve hydrometeorological **models,** take into account transfers to underground waters and the variations in soil occupation and condition of the vegetation.
	Improve **low-flow planning,** and regionalisation of studies
	Characterise the territory in uniform **hydro-eco-regions**
	On a basin-wide scale, carry out **cost-benefit analyses**
	Carry out research into **technologies for water saving,** treating or recycling
Follow-up and observation requirements	Improve the **monitoring network** for surface and underground waters
	Map humid zones (inventory, characterisation and monitoring)
	Map resource pressures (drawing, river traffic, etc.)

Natural hazards and insurances

Key messages

- Climate change has a definite impact on natural hazards, and must **affect specific territories** (coastal, clay zones, etc) **more** than the mainland territory as a whole.
- The cost of damage to housing in relation to the risk of clay soil **shrinkage and swelling** could be **multiplied by a factor of between 3 and 6 by 2100,** depending on the scenario, without taking into account changes to urbanisation.
- With reference to **floods caused by rivers bursting their banks,** there are no clear strong signals of average annual damage in the examples adopted for illustration purposes, even if, for certain basins (Orb, Meuse), a significant increase can be predicted.
- An essential question is posed for **coastal hazards,** which without adaptation, for the Languedoc Roussillon region alone, could cost almost **EUR 15 billion by 2100** in terms of housing destroyed.
- Lastly, with regard to **gravitational hazards,** the impacts of climate change remain uncertain.

Scope of study

Four hazards have been studied in detail: **the risk of flooding** in 5 catchment basins, **the coastal risk** in Languedoc-Roussillon (submersion and erosion), the risk linked to the **shrinkage and swelling of clay soils** (SSCS) due to drought and **gravitational hazards** (torrential floods, avalanches, landslides, subsidence, rockfalls).

Only the damage to housing and buildings has been evaluated[2]: the direct impacts on infrastructures, in terms of health or even biodiversity have not been evaluated.

[2] The impacts of SSCS and submersions on transport infrastructures were studied by the Transport Infrastructure and Building Framework group. The impacts of floods on health were studied by the Health group. The Forest Fire theme was tackled by the Forest group.

Table 4 - Impacts identified and studied: natural hazards

	Quantified	Non- quantified
Hazards studied		
River floods	X (partially, with certain basins only)	
Floods from increasing groundwater		X
Coastal hazards	X (partially, only for Languedoc-Roussillon and without taking erosion into account)	
Clay shrinkage and swelling	X	
Forest fires		X
Storms		X
Impacts studied		
Direct costs for housing	X	
Direct costs for companies		X
Health impacts		X
Indirect impacts		X

The consequences of the temporal development of hazards have not been taken into account, in quantitative terms, with the exception of one comparative study of the impacts of climate change and the development of hazards on the risk of SSCS at horizon 2030. However, it should be pointed out that, in many cases, it is expected that **this hazard development will have a greater impact on the development of risks than will climate change;** this is what we have seen over the last few years.

Clay soil shrinkage and swelling

Summer droughts are responsible for the majority of claims linked to SSCS. Almost all departments are concerned to various degrees, and almost 400,000 single-family dwellings are located in high risk areas. The increase in climate change-related drought frequency and intensity must increase the risk of SSCS. In the absence of new urbanisation, the analysis carried out **cites an annual damage cost going from approximately EUR 220 million (reference to the period 1989-2003) to EUR 700 million (scenario B2) or EUR 1,300 million (scenario A2) in 2100; it is therefore multiplied by a factor of between 3 and 6.**

If we take into account increased challenges by 2030 (urbanisation), despite adaptation efforts, the costs increase significantly. **The cost increases by approximately 17% for the period 2010-2030 when the number of individual houses increased by 0.925%.**

When posing the hypothesis that, for new single-family dwellings, the extra cost of adaptation increases to 15% (**adaptation of foundations),** climate change increases the scope of zones for which this is profitable.

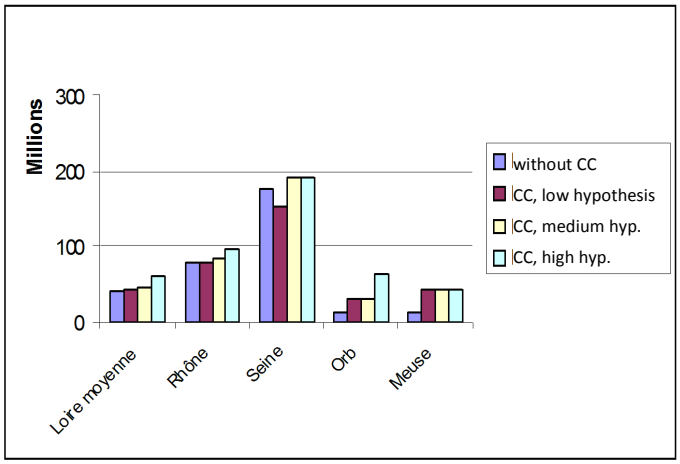
Floods

The impact of climate change on extreme precipitation and thus on flooding is **difficult to evaluate** from climate model simulations. A quantified evaluation exercise has nevertheless been carried out on a selection of catchment basins for which there is data relating to damage observed: **the Seine in Ile-de-France, the Meuse in the Ardennes, the mid-Loire between Nevers and Angers, the Rhône and the Orb.** On the basis of expert opinions and in view of current knowledge, reasonable scenarios for the impacts of climate change on hydrology have been defined for these catchment basins.

Table 5 – Peak flow variation: low, average and high hypotheses adopted for pilot catchments

	Low hypothesis	Average hypothesis	High hypothesis
Loire	+ 5%	+ 10%	+ 20%
Seine	- 10% (from Q100[3])	+ 10% (from Q100)	
Rhône	5% (from Q100)	10% (from Q100)	20% (from Q100)
Meuse	10%		
Orb	10%	25%	50%

Under these hypotheses, we can conclude that damage development **is not significant for the Seine, the Rhône and the mid-Loire; and is very severe for the Meuse and the Orb.** These estimates must, however, by **interpreted with caution.**



Graph 1 - average annual damage in five watershed (million euro 2007)

Coastal hazard

Based on the hypothesis of an increase in sea level of 1 metre, coastal hazards increase significantly, especially for sandy coasts and soft rock cliffs. Low coasts will suffer erosion or permanent submersion and new zones will be subject to temporary submersions. **140,000 homes and 80,000 people** (as against 15,000 homes today) and 10,000 businesses (employing 26,000 workers) are located in a zone affected by a risk of permanent submersion or erosion by 2100 **in the Languedoc-Roussillon region.** In the absence of a coastline management policy, the cost of damage linked to "permanent submersion" and erosion hazards is evaluated between **EUR 15 and 35 billion for the Languedoc-Roussillon region alone.**

Gravitational hazards

The impact of climate change on gravitational hazards is **difficult to assess,** because of the very nature of the phenomena in play, the complexity of the links between the hazards considered and the various predisposition and trigger factors. At this stage, it is not proposed that a calculated evaluation be carried out for this hazard. As an initial approximation, we could, however, consider **the possible increase in** superficial and/or frequent **events that are most directly related to winter precipitation** and the major financial consequences in the event of communication routes becoming blocked in the mountains and in winter. We can also note the potential impact of climate change on glaciers and permafrost, on the intensity of torrential floods and lava flows and on the stability of rock walls.

[3] Q10 = current return period of 10 years, Q100 = return period of 100 years

Limits of the exercise

The proposed evaluation limits are mainly due to:

- The restricted scope of costs studied;
- The uncertainty over risk development and the hypotheses put forward;
- The constant economy scenario;
- The various timescales preventing any aggregation;
- The knowledge about the sometimes rough timescales in relation to the phenomena involved.

Adaptation

Adaptation to climate change must enable preventative action to be continued, and even strengthened by implementing “no regrets" strategies. The following table presents the recommended lines of adaptation:

Table 6 – Recommended adaptation measures

Adapting the current catastrophe risk management policy to a changed climatic situation	Improve knowledge, measurement and monitoring networks, multirisk approaches, increasing detection and warning systems, reinforcing current policies with “no regrets” measures, global and coordinated management over the basins at risk
Clay shrinkage and swelling	Adapting the foundations of single-family dwellings
	Implementing more global provisions, such as those recommended in the PPRN regulations
Coastal hazards	Take into account climate change in planning and development documents;
	Development of detection and warning systems
	Analysis of the effects of strategic withdrawal/natural operation restoration/coastline maintenance-type measures
Floods	Formulate suitable responses in accordance with each catchment basin (within the framework of plans such as flood prevention action programmes and management plans for major rivers)
	Adaptation of actions to situations encountered (preparation of crisis management, prevision, awareness, protection devices, adaptation of the soil use regulations)
	Study responses to the risk of urban run-off

Perspectives and recommendations

The works carried out have revealed the following needs and lines for continuing the analysis of the impacts of climate change on natural hazards:

Table 7 – Research, follow-up and observation requirements

Research requirements	Improve knowledge of climatic variability over the coming decades Improve knowledge about urban run-off, soil reactions and gravitational hazards
	Analyse the **“network”** aspect and intangible impacts
	Characterise the escalation of damage resulting from a **“generalised” event**
	Carry out an exhaustive analysis of the impact on **hydrological regimes**
	Carry out an exhaustive analysis on **coastline disappearance**
	Lead studies into the **role of insurance**
Follow-up and observation requirements	Carry out an inventory/**full mapping of the hazards**
	Implement monitoring and national **databases** of the damage; map current damage
	Improve **observation of the economic cost** of run-off
	Improve the precision of **altimetric data**

Agriculture

Key messages

- If only the gradual changes (temperatures, precipitation) are considered, the effects of climate change on maize and wheat crops remain **moderated up to a certain threshold, above which they become clearly negative. The reduction in water availability** and **the multiplication of heatwaves** will themselves have **a highly negative impact on yields.**
- In viticulture, strong **territorial differences** will be observed: the analysis carried out cites, for example, an increase in Burgundy yield, but a sharp drop in Languedoc-Roussillon. The **quality and typical features** of wines could find themselves negatively **affected;**
- With regard to meadows, the southern half, and especially the peri-Mediterranean arc will see its **vulnerability increase** due to more frequent droughts in summer, with strong consequences on the profitability of livestock farming;
- The **limits of the exercise** carried out here are **major** and are due to both the hypotheses put forward and the uncertainties present throughout the chain of evaluation. The analysis of these uncertainties and discussions with experts reveals a certain number of requirements to improve knowledge and encourage adaptation in the agriculture sector;

Scope of study

For reasons of representativeness and feasibility, the works related to the study of three specific crops: field crops (wheat and maize in mainland France), viticulture (Burgundy and Languedoc-Roussillon) and meadows (South of the Massif-Central). The analysis carried out was not exhaustive: the impacts studied remain partial.

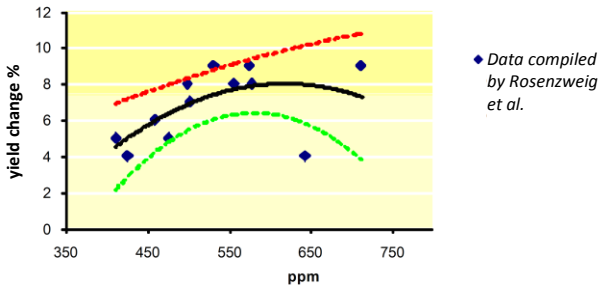
Table 8 – Impacts identified and studied: Agriculture

	Quantified	Non-quantified
Increased yield linked to CO_2 concentration	X	
Changes to plant phenology		X
Effects on production of the increase in temperature and the change to precipitation	X	
Effects of the reduction in water availability on yield and production techniques		X
Impacts of heatwaves on crops	X	
Impacts on bioagressors		X
Loss of yield linked to extreme events and the rise in sea levels		X

** for maize and wheat only.*

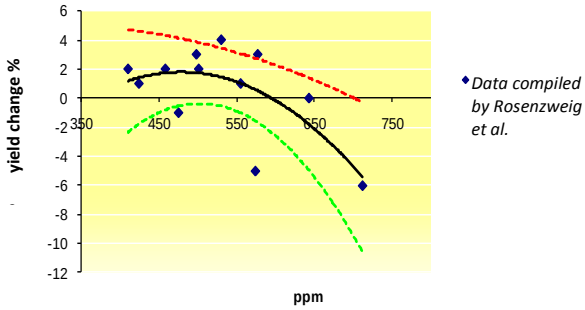
Moderated positive impacts on field crops, up to a certain threshold

The analysis carried out for field crops[4] recorded an increase in yield for wheat up to a certain temperature threshold, which, under scenario A2, will be reached between 2050 and 2100. Above this threshold, **yields would diminish, but the impact would remain moderated**. The results are more contrasted for maize: yields increase slightly until 2030, then begin to drop between 2030 and 2050 regardless of the scenario considered, the impact of climate change tending largely towards the negative in 2100. In terms of costs, this corresponds for **maize in 2100 to a loss that could reach almost EUR 113 million per year**. This development only concerns gradual changes (changes to temperature and precipitation) and does not take into account the reduction in water availability or droughts. However, the multiplication of events such as **2003 heatwave** could represent, in 2100, a cost reaching more than **EUR 300 million per year for a crop such as wheat** under scenario A2, if no adaptation is made, **calling into question some of the optimistic results set out above**.



Data source: Rosenzweig & Iglesias

Graph 2 : Effect of CO2 concentration on wheat yields



Graph 3 : Effect of CO2 concentration on maize yields

A strong territorial effect on viticulture

Viticulture will also be impacted by climate change[5]. We may see an increased yield in **Burgundy** (+35.2% additional yield according to scenario A2 in 2080 and +41.7% according to B2, without adaptation). These results must, however, be qualified: **it will not be possible under these conditions to produce as many high quality wines as today**. **Languedoc-Roussillon** may in its turn **suffer considerable reductions in yield without adaptation** (up to -26%).

4 Rosenzweig & Iglesias, "Potential Impacts of Climate Change on World Food Supply" (1999).

5 Inaki Garcia de Cortazar-Atauri (2006) http://www.inra.fr/ea/fichier_these/These_Inaki_GarciadeCortazar.pdf

Technical lines, including irrigation, may, however, change the data (transform a situation from a loss in yield of -18% to an increase of 11% over the period 2070-2099 compared to the reference period, for the useful "grande reserve" land). In this study, the main limit rests in the fact that the reduction in water resource availability is not taken into account.

A possible increase in yield for meadows in the Northern area; increased vulnerability in the peri-Mediterranean arc.

In the departments of the peri-Mediterranean arc, from 1980 to a date between 2050 and 2090, the changes underway will lead to a very steep drop (approximately -70%) in yield from meadows in the summer period – droughts such as those in 2003, 2005 and 2006 having become the norm; and an increase in yield of 10 to 20% in the winter period because of more favourable temperatures and CO_2 concentration levels. In total, a drop in annual fodder production of between -20 and -25% may be seen. The cost of compensating for these drops in yield (by purchasing fodder) could reach some EUR 200 million per year in the second half of the 21st century.

Limits of the exercise

The quantification work presented here comprises a certain number of limits.

These are due to:

- the hypotheses put forward (in particular, constant economy);
- the uncertainties over climate changes and the response of agricultural production to these changes;
- the not taking into account of the water parameter in the quantified assessments;
- the very partial nature of the assessment.

These uncertainties affect **not only the values, but also the sense of variation of the results** by interaction, especially with the regional variability of the impacts of climate change.

Adaptation

The following table sets out the planned adaptation lines suggested.

Table 9 – Recommended adaptation measures

Field crops	- Diversify the crop systems, enabling "evasion", "avoidance" and "tolerance" to be combined - Increase the duration of vegetation in order to enable the succession of summer-winter crops - Lead a discussion on the relevance of implanting new crops, by adopting a "field" approach
Viticulture	- Carry out genetic research for new grape varieties suited to the lands - Lead a discussion on the changes to AOCs - Perfect new irrigation technologies
Meadows	- Extend use to adjustment areas if these exist (summer at altitude) or create these areas - Reanalyse the long-term water management policies in order to improve the irrigation of small areas - Help implement adaptation actions within the framework of collective contracts - Anticipate the consequences of climate change on livestock and adapt, in particular, farm buildings in order to limit the impacts of heatwave on animal performance.

Perspectives and recommendations

Research lines and follow-up and observation requirements have also been identified.

Table 10 – Research, follow-up and observation requirements

Research requirements	Lead/continue research to increase knowledge of: - integrating the water factor into the crop models - bioagressors - the nitrogen aspect and the use of mineral inputs - CO_2 provision - the impact on product quality - erosion of arable lands - pollinators
	Draw up refined forecasting approaches per region and per type of agricultural system
	Take into account the degree of farmers' aversion to risk
Follow-up and observation requirements	Encourage relationships and interconnection between research, development and the professional world in order to ensure knowledge sharing
	Collaborate with other countries facing the same adaptation problems
	Have network monitoring and alert systems developed for pathogenic agents
	Have management methods developed in the fight against the emergence and implantation of pathogenic agents and exotic diseases
	Know and monitor the changes to known vector implantation areas
	Encourage collaboration between the monitoring systems for animal diseases and those dedicated to human illnesses

The ADAGE (*Agriculture Durable par l'Autonomie, la Gestion et l'Environnement* = Sustainable Agriculture through Autonomy, Management and the Environment) Prospective Discussion Workshop (ARP), launched on the initiative of the national research agency and for which the results should be available by 2010, aims to identify and mutually insure the needs for studies and research on this topic. Its conclusions will enable this initial list to be completed.

INSTITUT DE FRANCE
Académie des sciences

2.

Academy of Sciences

Science and Technology Report

Reducing the vulnerability of ecological and social systems to extreme weather event

Introduction by Jean Dercourt

Permanent Secretary of Academy of Sciences

Climate change and related risks have been a key concern for the *Academy of Sciences* over the past decades. Already in 1990, the report ***Greenhouse effect and climate impacts*** was published, led by Robert Dautray (updated in 1994).

For fifteen years, the *Academy of Sciences* has devoted several symposia and thematic issues of the journal *The Proceedings of the Academy of Sciences – Geoscience* to this issue.

In 2006, the *Academy* published the report ***Inland Waters***, coordinated by Ghislain de Marsily; with the same perspective, it initiated in 2007 three books related to environment and sustainable development, which are currently under development:

- ***Demographics, Climate and Global Food Supply*** (edited by Henri Leridon and Ghislain de Marsily);

- ***Soil Management and Ecosystem Services*** (coordinated by Patrick Lavelle and George Pédro); and

- ***Reducing Ecological and Social Systems' Vulnerabilities to Extreme Weather Events***: the working group, led by Henri Décamps, developed a report assembling forty contributions, which was submitted in October to a peer review and will be finalized early next year. The abstract, not yet final, is included in this folder.

Climate variability and change, and the analysis of the many causes of these trends over time, are the focus of ongoing studies that, in addition to climate, are also related to internal and external geophysics and Earth sciences.

Major meetings such as Copenhagen provide a unique opportunity to discuss about scientific studies and significant work remaining to be conducted to better understand this system, still very incompletely known.

Jean Dercourt

Permanent Secretary of the *Academy of sciences*

Executive summary of the report[6]

« Reducing the vulnerability of ecological and social systems to extreme weather events »

The importance of issues related to extreme climatic events has been astonishingly underestimated considering the figures that we have at our disposal. In France, the heat wave of August 2003 led to extra 15,000 deaths between August 1st and 20th, 55% more than would otherwise be expected. The storms of 1999 caused over 10 billion € in forestry damage to owners, insurers, society and the State.

On a global scale, twenty-five of the most expensive disasters for the insurance sector in the last 39 years all happened after 1987. More than half of them occurred since 2001. Twenty-three of the 25 disasters have been linked to climatic conditions. Their effects can be long-lasting. One year after the Nargis typhoon of May 2008 in Burma, 350,000 persons still depended on free food distribution.

We can no longer hesitate. Scientific data show that a significant number of events that were once considered exceptional, i.e. classified as intense with low probability, are now occurring with increasing frequency and considerable human, financial and environmental cost. Time has come for the highest political authorities and the business sector to take into account the threat posed by an increasing number of particularly destabilizing and costly extreme events.

In this context, is France prepared to face such events, from the ordinary citizen to decision-makers at the highest levels of government? Does it contribute enough to international efforts to reduce the risk of disasters? Does it have the necessary scientific data to make informed decisions?

As a response to these questions, the first important message of this report by the French Academy of Sciences is that reaching absolute certainty about the risk of extreme climatic events is an illusion and that it is not possible to wait to have an always perfectible knowledge of their mechanisms before acting. Prevention to climatic hazards must be made with a full awareness of the limits of scientific knowledge – by taking into account *what we know* and most importantly *what we don't know*[7]. Efforts to prepare for climatic hazards must be taken only after careful review of the lessons learned from mistakes made during other extreme events, regardless of their nature and location.

The second message is that we cannot satisfy ourselves with sectoral approaches. The problems posed by extreme climatic events inherently affect many sectors and are highly linked together in near inextricable way. This interdependence of hazards is a true threat to the viability of ecological and social systems that are facing multiple hazards as a result of loss of biodiversity, deterioration of ecosystem services, high human concentration in risk zones and global warming. Surprisingly, the interdependence of hazards is a hardly recognized factor and our approaches to managing extreme events remain isolated one from the other.

Some might say that the number of disasters is no higher today than a few decades ago and that they are just more visible because of today's more modern means of information and communications. Is this really true and doesn't the real issue lie somewhere else? The hurricanes that hit the Louisiana coastline in the 1800s, whatever their number, hit sparsely populated areas. Today, over half the human population lives in urban areas and the world will have 60 cities of over 10 million inhabitants by 2015, mostly located in high risk coastal areas, especially in Asia and Africa.

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6 Coordinated by Henri Décamps

7 Bracing for the unknown. (2009). Editorial, *Nature*, 459 (7244).

The fundamental question is to know what the consequences of extreme climatic events will be, whether they are catastrophic or not. The increase in human population, industrial activity and valuable assets exposed in high risk areas does not lead us to predict a calm future. On the contrary, we foresee an increase of our vulnerability to extreme events and we will need to better prepare ourselves to face climatic events keeping in mind the limits to our knowledge.

This report arose from the willingness to examine interdependent problems and not treat just the singular issue of climate change, in spite of its importance. Other issues such as social and environmental justice are just as important and must not be neglected. From this viewpoint, extreme climatic events have revealed the problems that our societies must solve urgently at different national and international levels.

Extreme climatic events to which the continental part of France is exposed to are doubtlessly less intense than for example in the United States, in Southern Asia, in China, in the poorest African countries and in northern countries. However, we are in a position of great vulnerability due to our parceled territorial organization, an unwise urban development, high population densities along some of our coastlines, human impacts on the environment, and difficulties in engaging in public debate and consultation. Our overseas territories, which are of modest geographic size, can suffer very severe extreme climatic events and are true laboratories for cumulated risks.

At the international level, the inequalities between rich and poor countries are widening. The poor are becoming more vulnerable to current global phenomena, whether climate change, increasing population or disappearance of natural environments. In such a context, many extreme climatic events become catastrophes with countless economic and political consequences: famine, epidemics, wars, dictatorships and migration. All these are poverty traps that make sustainable development impossible and, by extension, also affect developed countries.

France must start mobilizing itself for concrete action against extreme climatic events. In this context, we put forward in particular six recommendations that will help our country effectively respond to the next big disasters.

Before continuing, we must stress that these recommendations will be in vain without a continuous effort to educate the younger generations and the public. Such an effort depends on a badly needed shared global vision of extreme climatic events as well as a real capacity to face the increasing situations of multiple hazards with solidarity.

1. Ensuring the viability of socio-ecological systems

To prepare ourselves to extreme climatic events, we must first ensure the viability of socio-ecological systems. This viability depends mainly on the role ecosystems have in regulating the climate and protecting against natural hazards. Fundamental to this role is biodiversity – the number of and variability between individuals of the same species, of different species and different ecosystems. The current trend of biodiversity loss can affect the ability of ecosystems to regulate climate and protect us against natural hazards and it will lead to unpredictable and irreversible changes of socio-ecological systems. To ensure the viability of these systems in the face of extreme climatic events requires large-scale action to protect biodiversity – an action undertaken at the international level following France's initiative and which should be urgently expanded.

2. Adapting socio-ecological systems to the threat of imminent severe climatic events

Such an adaptation cannot ignore the connection between the trends that are already transforming our environment, from an increasing population to the disappearance of natural environments and global warming. Thus, water use conflicts between several economic sectors, which will only get

worse with future droughts, will not be solved solely through managing the resource, such as building reservoirs. Limiting demand and a precise evaluation of risks are also necessary. More generally, it is necessary to reduce exposure and vulnerability to severe climatic events, facilitate the management of emergency response when such events occur and increase the economic capacity for reconstruction afterwards, through adequate insurance policies, risk sharing and support for the affected individuals and sectors. Within this new context, a commitment at the highest level of government is necessary to develop engineering projects, warning systems and preparedness strategies.

3. Anticipating health problems and minimizing human loss

Anticipation must be associated with monitoring and intervention. Effective meteorological forecasting and medical preparedness systems will permit an early mobilization of response plans (against for example heat waves, severe colds or cyclones). The aim is to reach efficient prevention as well as management of the risks, in particular through the organization of emergency services, whenever possible. The first measures taken in France towards this goal have proven their effectiveness: close to 4,400 lives were saved during the 2006 heat wave compared to the numbers that might have been lost considering the temperatures that were recorded. Many academic disciplines must be called upon, for example to anticipate the appearance of the H5N1 virus and the urgency associated with it (virology, epidemiology, ornithology, climatology, zootechnics, simulations). We should also avoid making simple correlations between rising temperatures and the encroachment into temperate regions of what are today considered to be tropical diseases. Man-made and/or entomological factors can have significantly variable impacts depending on local – and often micro-local- conditions.

4. Reorganizing solutions for financial coverage

The international community must redefine the role and responsibility of the public and private sectors in developing appropriate financial responses to large-scale disasters. A complete transformation of the financial response system is required. This transformation is already under way[8], and an increasing number of countries are becoming aware of the importance of bringing it to the highest decision level. France has a risk-sharing scheme based on national solidarity that protects against small risks but is not adapted to the new dimensions of the disasters requiring the state to pay in the end. Adapting this system in a novel way would lead to the development of an European initiative that would be in line with the strategy that our country has started to promote concerning measures to face crises of all nature.

5. Developing a global security concept

According to the 2008 Report of the French Committee for Civil Defense (Haut Comité Français pour la Défense Civile), a developed country cannot remain unprepared to exceptional events whether they are economic, social or political[9]. Much work has been undertaken at the ministerial and inter-ministerial level to strengthen France's preparedness for crisis situations. French monitoring systems have shown their merit, whether it is the meteorological warning systems of Météo-France or the health monitoring systems. The basic problem is that of a global approach to security. Much more must be done to make global preparedness to threats better understood, to end piecemeal efforts and multiplication of institutions, to acquire a true ability to face multiple hazard situations. Taking into account the monitoring systems that already exist in France, any development of a global

[8] The White House (2007). *Economic Report of the President.* Council of Economic Advisors, Washington, DC.

[9] HCFDC (2008). Constats et propositions pour une vision globale de la sécurité. Rapport Défense Civile, Paris.

approach to security would put our country at the forefront of research in early warning systems, which is becoming a topic of increasing preoccupation at the international level.

6. Creating unifying programs of research

Preparing for severe climatic events cannot be done without undertaking research on their fundamental mechanisms. France lacks unifying programs in particular in areas aimed at:

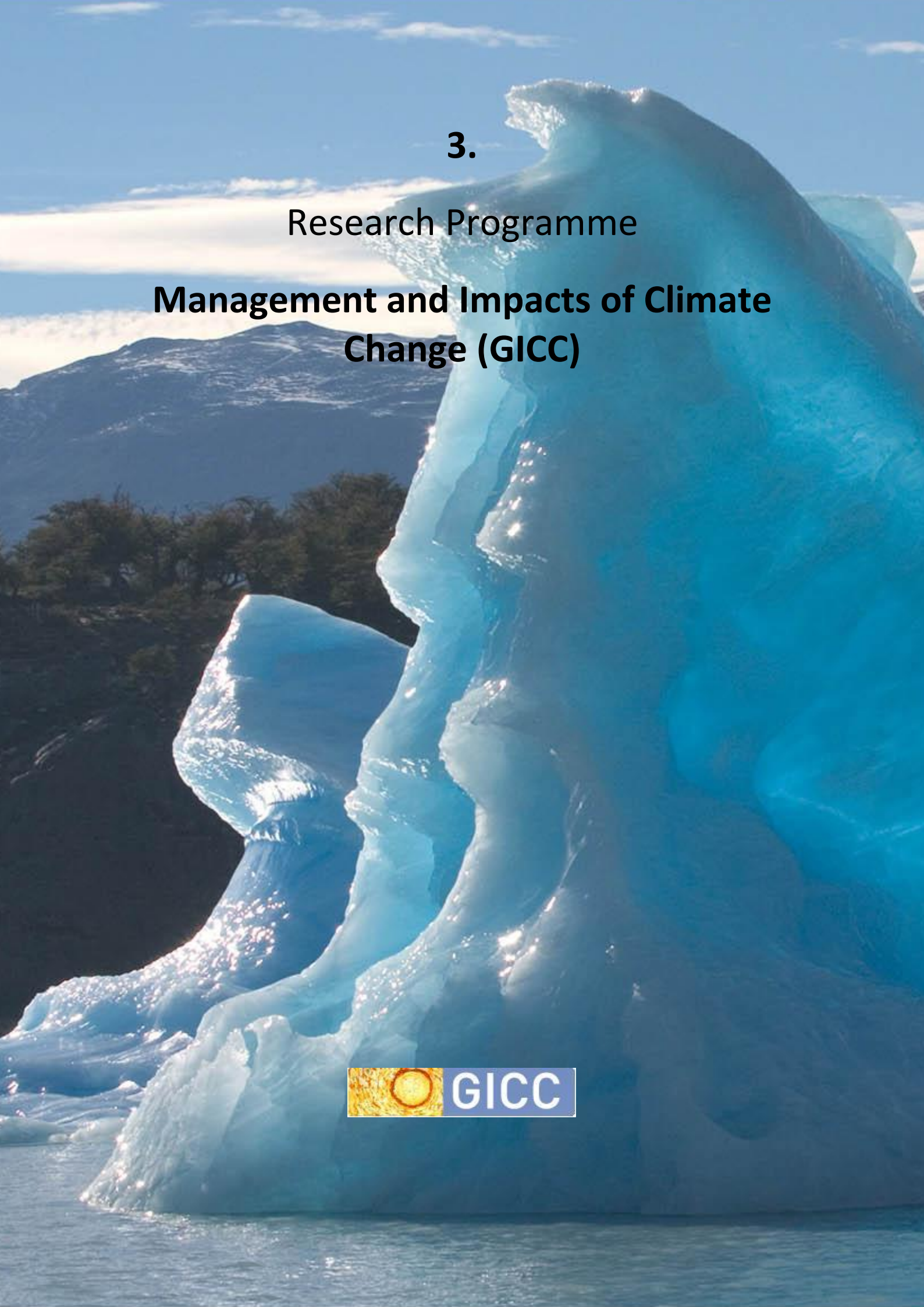
1) Research on the role of ecological and social systems in regulating extreme climatic events;

2) Understanding the worldwide dynamics of the hydrological cycle, including changes in water phases linked to the greenhouse effect;

3) Creating new approaches to planning land-use, urbanization and construction;

4) Identifying the physical, behavioral and organizational mechanisms involved in alertness, warning, disaster emergency measures, real-time monitoring tools and financing required to cover the damage from future extreme events.

From a methodological point of view, the humanities and social sciences must take a full part in such programs. From a theoretical viewpoint, the reliance on modeling methods to help decision-making in situations of great uncertainty and multiple choices should become the rule.



3.

Research Programme

Management and Impacts of Climate Change (GICC)

Presentation by Claude Millier

Chairman of the Scientific Council of the GICC Program

Climate research requires a multidisciplinary approach. In France, several national programs contribute, managed by the Ministry of Education and Research, the National Agency of Research, CNRS and the Ministry of the Ecology, Energy, Sustainable Development and the Sea (MEEDDM). Several research organizations are involved including: CNRS-INSU, CEA, IFREMER, METEO-FRANCE, CERFACS, INRA, CEMAGREF, IRD, CNES...

The MEEDDM launched in 1999 the programme "Management and Impacts of Climate Change (GICC)" in partnership with ADEME, ONERC, French Institute of Biodiversity, Ministry of Agriculture. The objective is to develop knowledge to support public policies in considering climate change, both in terms of mitigation and adaptation to new circumstances and risks.

The programme is managed by the Directorate of Research and Innovation (under the General Commission on Sustainable Development) with support from the GIP ECOFOR (Forest Ecosystems). It is led by a steering committee composed of representatives of applicant organizations and a Scientific Council composed of experts.

Projects last two to three years. During a first phase (1999-2003), the GICC has launched five tenders, a typical project was the project IMFREX, Impact of anthropogenic change on the frequency of extreme wind temperature and precipitation coordinated by Michel Dequé Météo-France. A second phase was launched by tenders in 2005 and 2008, and a new call will be broadcast in 2010. While programs of the first phase were mostly oriented towards climate knowledge and mitigation of greenhouse gas emissions, those of the second phase (2005, 2008, 2010) are mainly focused on climate change adaptation. The 2008 appeal focuses on the issues of scale, extreme, socio-economic scenarios, and dealing with uncertainty.

During a seminar held in October 2009 progress made with programs selected in 2005 and issues related to those selected in 2008 were exposed and discussed. In this meeting, adaptation-related themes have been classified into five groups:

- transportation, housing, tourism, planning
- hydrology
- biodiversity
- health
- social and human sciences

These five groups have also been selected as topics of interest for the inter-ministerial group for evaluation of the impacts of climate change.

The first document below is a brochure describing GICC and a sampling of results from seven completed projects in the areas of biodiversity, health, regional approach, hydrology and transportation. In addition, a list of eight projects selected in 2008 is presented.

In addition, the DRIAS Initiative targeting the setting up of climatic service and a brief presentation of the CIRCLE program is included, of which the Mediterranean component (MED CIRCLE) is coordinated by MEEDDM. This is to acknowledge the contribution of French research coordinated at European level in the context of the ERA-NET CIRCLE.

Selected Projects' summaries and results

Background

The federating research programme 'Management and Impacts of Climate Change' (GICC - Gestion et Impacts du Changement Climatique) is one of the research programmes supported by the French Board for Economic Studies and Environmental Evaluation. It was launched in 1999 by the ministry concerned, now called the Ministry of Ecology, Energy, Sustainable Development and Seas (MEEDM). Several other organisms also contributed to the programme: the Ministry of Agriculture, the Environment and Energy Conservation Agency (ADEME), the National Climate Warming Effects Monitoring Agency (ONERC), the French Foundation for Biodiversity, etc.

Objectives

The stated objectives of the programme have always been to develop knowledge to back public policies, considering climate changes from the perspective of their impacts as well as from that of greenhouse gas limitation measures and climate change adaptation measures. This requires the mustering of research teams from a wide range of academic fields: on the one hand, the physical and biological sciences for a better knowledge of the impacts and, on the other, social studies to explore mitigation and adaptation possibilities.

Operation and implementation

Scientific knowledge is steadily progressing within this multidisciplinary and interdisciplinary approach. The Scientific Council is careful to take into account the validated research results as well as the societal concerns voiced by the Steering Committee to define the major orientations of each oncoming Calls for Research Proposals (CRPs). Research activities on climate change undertaken at the European level are also taken into account. The French Ministry of Ecology, for example, is involved in the European programme ERA-NET CIRCLE[10] that aims to coordinate the funding agencies of national research in Europe, thus facilitating links between this type of programme and GICC. The MEEDDM coordinates the Mediterranean group call[11] focused on the "water management and coastal zones" on the Mediterranean area.

The GICC programme operates through CRP yearly. CRPs were issued in 1999, 2000, 2001, 2002, 2003, 2005 and 2008, as was a joint call for tenders with the French Foundation for Biodiversity (FRB) on the theme of 'biodiversity and global change'.

The research projects selected as a result of these CRPs cover several years (3 years), so the different programmes overlap in time. CRP 2005, now under way will last until the end of 2009, CRP 2008 is currently ongoing. On 2010, a new CRP will be launched.

[10] http://www.circle-era.net/

[11] http://www.circle-med.net/

1. List of Projects linked to adaptation of climate change since 2003

Before 2003, the calls for Research proposals (CRP) did not concern specifically adaptation topics. In the 2008 CRP, adaptation has been taken into account and thus, from now on, many projects deal with adaptation issues.

CRP Biodiversity

- ***Evolutionary and Mechanistic Approach to the Adaptation of Lepidoptera to Environmental Change.*** *Coordinator: Jean-François Martin (INRA)*

It is increasingly clear that today's global warming has an influence on ecosystems and, in particular, causes the displacement of certain animal groups toward cooler regions. This is the case with Lepidoptera for which significant displacement in excess of 30 km on average has been demonstrated, for the European and North American species. Out of all Lepidoptera, the Colias genus is a model organism for studying adaptation to climate variations. In particular, partners to the programme have succeeded in showing the impact of natural selection due to thermal stress and the increase in thermal stochasticity on the polymorphism of an enzyme that controls metabolism: phosphoglucose isomerase.

Previous studies in enzymology (Ward B. Watt), molecular biology (Chris Wheat) and functional ecology (Jean-François Martin) have made it possible to develop an overall milieu/individual/thermal stress flow chart, which selects particular genotype compositions by microclimate niche.

This phenomenon has been demonstrated for a species of North American butterfly. During the course of this programme, our objective will be to check the possible spread of the mechanism, whether across space, by studying a wide distribution, present both in the Alps and the Rocky Mountains, or through genus evolution, or even across the Lepidoptera species in the broadest sense.

The multi-disciplinary and mechanistic approach to Lepidoptera adaptation to environmental changes and, in particular, to stochasticity and warming, will make it possible to understand the parallel global mechanisms that influence the group's current distribution and evolution, which is also a classic bioindicator in many fields.

- ***Demographic Vertebrate Responses to Climate Change, Relevance of Environmental Indicators, Influence of Demographic Strategies and Consequences for Biodiversity Dynamics.*** *Coordinators: Coordinateurs Henri Weimerskirch, Christophe Barbraud, Stéphanie Jenouvrier (CNRS)*

The CLIM POP working group is made up of several French teams with access to long-term data series and skills in biometrics, studying the ecological effects of climate variations and global change through a range of biological models on higher vertebrates, living in land and marine environments.

The objective is to bring these teams together around a common theme and harmonise and standardise their analysis methods in order to compare the potential effects of the said climate changes on vertebrates with contrasting life history traits and different living environments.

In response to the IFB's call for research proposals, we wish to address two questions in particular:

1. Are certain species or zoological groups more vulnerable than others to climate change, depending on their demographic strategy, and

2. What are the most relevant climate indicators? Is it better to use global descriptors (such as NAO or ENSO) or local descriptors to explain the influence of environmental variability on the demographics of species?

In order to address these questions, the authors performed cross-cutting analysis on all of their databases, using the most recent methods available today, during a number of workshops that will bring together the CLIM POP group as a whole, as well as the top specialists in Europe.

CRP 2003

- ***Measuring and Preventing the Effects of Extreme Hot Weather: Improving Heat Regulation Ability in High-Risk Subjects.*** *Coordinator: Jean Louis SAUMET (University of Angers)*

Meteorological studies are anticipating climate change that will bring further periods of extreme hot weather combined with air pollution. At the same time, epidemiological studies of the effects of extreme hot weather are helping to identify the most at-risk groups, including the elderly, people suffering from heart disease or diabetes or people with a neuropsychiatric disorder who are taking antipsychotic drugs.

In order to devise a prevention strategy aimed at the vulnerable groups who will need first aid, we first need to understand the mechanisms that the human body uses to counteract excessive environmental heat, how these are defective in at-risk individuals, and how this deficiency can be remedied.

In order to do this, the following have been proposed:

1. A clinical approach: In human beings experiencing a rise in internal temperature, physiological thermolysis mechanisms come into play, mainly via increased skin blood flow and perspiration. Vasodilation of cutaneous blood vessels occurs via the suppression of vasoconstrictive tonus, followed by a powerful vasodilatory mechanism, known as active vasodilatation, which is also controlled by nerve impulses. We are aiming to develop a method for observing the effects of heat stress in man by using a suit infused with hot water and recording heart rate, blood pressure, skin blood flow and perspiration. A drug trial will then be carried out to test the effects of aspirin and paracetamol on the above parameters against a placebo, to find out whether these compounds are able to slow down the effects of extreme hot weather in order to gain time before suitable prevention can be put in place.

2. Experimental studies: This is an initial attempt to look at problems associated with extreme hot weather. The study we are proposing relates to diabetes, as it is a risk factor in itself, added to which it is often accompanied by cardiovascular, renal and neurological complications. Diabetic mice and healthy mice will be exposed to a very hot environment. The heat setting will be adjusted until the mortality rate of the diabetic mice exceeds that of the healthy mice, which will act as a control. A drug trial using the same compounds as those given to human subjects (aspirin, paracetamol & placebo) will then be carried out in this environment.

3. Other diabetic and healthy mice will be exposed to prolonged heat stress. Tiny blood vessels responsible for active vasodilation will be sampled as isolated organs and their vasomotor properties analysed. The cell cascades responsible for vasomotricity will be analysed.

4. Setting up a think-tank on the subject, which will organise a conference calling on the expertise of scholarly associations, the physiological society in particular. Informal meetings will be held before and after the conference to organise it and then reflect on its conclusions in terms of overall preventive strategy. We feel it will be important to combine ideas from life sciences with those from other disciplines concerned with managing the effects of extreme hot weather, which have already worked on the previous project. Subsequent clinical and experimental studies will then be able to take their observations into consideration.

Outcomes:

1. Devising a methodology for observing the pathophysiological effects of extreme hot weather that can be applied in humans and can be used in future to test other hypotheses in addition to the one proposed in point 2.

2. Understanding whether administration of antipyretics can diminish or slow down the effects of extreme hot weather in healthy subjects. A study of this nature could be repeated with at-risk subjects in the context of another project.

3. Understanding whether these drugs could be used in diabetics to combat the effects of extreme hot weather. These findings should pave the way for a clinical trial such as the one proposed in point 2.

4. Building up information about the precise vasomotor mechanisms at work during hot weather, which could pave the way for new research avenues into prevention of the risks associated with hot weather.

5. Establishing a think tank on the pathophysiological effects of extreme hot weather and linking the discussions of the life science community with those of other scientific disciplines concerned with hot weather.

- ***Management of the Greenhouse Effect at the Local and Regional Authority Level. An Analysis Based on Climate Policy.*** *Coordinators: Corinne Larrue (University of Tours), François Bertrand (CNRS)*

The aim of the research project entitled "Management of the Greenhouse Effect at the Local and Regional Authority Level: An Analysis Based on Regional Policy" (under the Ministry of Agriculture and Sustainable Development GICC programme) is to observe the way in which climate change is incorporated into local and regional public policy. The main question is to find out in what ways local and regional authorities can participate effectively in reducing global impacts.

The research relates essentially to the regional level and aims to identify and understand the obstacles to and catalysts for integrating climate change into regional policy: what conditions determine whether concerns relating to climate change make it onto the regional scene and how are they incorporated into local and regional authority policy? How are local and regional climate policies formulated and on what elements are they based? Who are the players and what action do they take?

CRP 2005

- ***Impact of Climate Change on Water Resources and Hydrological Extremes in the Seine and Somme River Basins (RExHySS).*** *Coordinator: Agnès Ducharne (CNRS – UPMC, UMR Sysiphe)*

This project's aim is to assess the impact of climate change due to anthropic activity on hydrological extremes in the Seine and Somme River drainage basins. We will take advantage of two new climate change simulation disaggregation methods (the weather regime method and variable correction method), which are used to reflect changes in climate variability, at a daily and inter-annual scale, in addition to average climate change.

We will first look to characterise how climate change can modify the breakdown of these extremes, in terms of flooding, low water and drought (frequency analysis and predetermination). These analyses will be supplemented by flow rates, soil humidity and piezometric levels simulated by various hydrological models. We will then turn to certain manifestations of these extremes with a particular impact on society. With regard to flooding, we will determine how their extension into key areas of the basins is changing (Somme River Valley upstream from Abbeville, a river corridor of the Seine, including Paris and the Bassée alluvial plain), for certain return periods. We will also look at connections between agriculture and continental hydrosystems, as regards irrigation needs, their impact on water resources and agricultural production, and pollution diffused by nitrates, which can be simulated in the Seine River Basin thanks to the coupled STICS/MODCOU model. We will go on to assess how these processes and interactions therein can be changed under the effect of climate change, distinguishing between the effect of average climate change and that of change in variability.

The final component of the project will be dedicated to retroaction between changes in the hydrosystem and social systems. We will offer to disseminate our findings to those involved in land development and water management in the drainage basins studied, in a form suited to a socio-economic audit of the changes in hydrological extremes, defined with them. One of the sensitive topics in this respect is the urban waste discharged during rainfall, and the influence of flooding on infrastructures, transport or energy production. Such analysis, even qualitative is important to substantiate climate change adaptation strategies, though these will not be broached in this project.

- ***Preventing the Effects of Heat Wave: Optimising Cutaneous Circulation in Individuals at Risk.*** *Coordinator: Jean Louis SAUMET (University of Angers)*

Epidemiological studies of the effects of heat wave have made it possible to identify at-risk populations: the elderly or those with cardiovascular disease, diabetes, or a neuropsychiatric affliction treated by neuroleptic. All of these populations are frequently under a variety of drug treatments that can influence their thermoregulation.

Even though the human body does have the physiological means for fighting excessively-high environmental heat, this ability is impaired in at-risk populations. One of the ways in which the body fights is to vary blood circulation in the skin (in conjunction with sudation), which makes it possible to regulate the heat lost by the body. This study of how ageing and medicines frequently used on the elderly affect cutaneous blood circulation should enable better drug prescription. This can mean changing dosage or discontinuing dangerous treatments should a heat wave alert or forecast be issued, as this would have side effects on thermoregulation. For this purpose, we propose:

1. <u>A clinical approach:</u>

Vasodilatation of cutaneous blood vessels facilitates heat exchanges between the internal environment and the external environment and contributes to regulating body temperature. A test has been designed in our laboratory on cutaneous vasomotricity in response to stimulation by a low-

intensity Galvanic current. Moreover, we know how to measure dependent endothelium vasodilatation, using a Doppler laser flow-meter and iontophoresis. We propose to study the effects of platelet anti-aggregants, both antipyretic and non-antipyretic, on cutaneous vasodilatation in healthy and elderly subjects. This study will make it possible to modify prescriptions for this treatment.

2. A multi-disciplinary think-tank network:

A first symposium was held last year and included a range of parties involved in work on thermoregulation. We plan to hold another symposium, to forward the launch of the think-tank network and bring together knowledge and thinking from different fields involved in managing the effects of heat wave.

Outcomes:

- To determine whether taking platelet antiaggregants, some of which are also antipyretics, can change the effects of the heat wave in healthy subjects.

- To determine whether, in elderly subjects, such medicines, which are prescribed chronically, could modify the deleterious effects of the heat wave. This study will thus help issue guidelines so as to adapt treatment when a risk of heat wave is announced. Drug treatment, often prescribed to prevent atherosclerosis or thrombosis risk, could often be discontinued temporarily, until such time as the weather becomes more favourable.

- To continue discussion about the physiopathological effects of the heat wave with the few teams involved in such work.

- ***Energy Transport Housing Environment Locations - ETHEL II.*** *Coordinators: Charles RAUX (CNRS)*

The fight against greenhouse gases is a national priority, as reasserted in the 2004 Climate Plan, in particular in the Residential/Services and Transport sectors. With their growing greenhouse gas (GHG) emissions, both these sectors tend to wipe out the progress achieved between 1990 and 2001 in Industry (-17.1%), Energy Production (-16%) and Waste Treatment (-5.7%) sectors. Meanwhile, the Transport (+21.6%) and Construction (+18%) sectors display worrying trends, despite technological advances on both new automobiles and buildings. The growing distances travelled by individuals and surfaces requiring heating, in a sprawling urban environment dominated by individual homes and the sharp rise in distances covered by merchandise transport, with the growing preponderance of road transport, have contributed to the unchecked rise of fossil energy consumption. Reducing consumption in the housing and transport sectors would also contribute to the country's energy independency.

The ETHEL research project is aimed at understanding the factors determining the growth of GHG emissions through interaction between transport and land usage so as to be able to act on determinants and, thereby, deter the growth dynamic. Ultimately, the aim is to help decision-makers "choose the best strategies for preventing the increase in the greenhouse effect".

Phase II of the ETHEL programme is aimed at supplementing Phase I on two specific points: merchandise transport in cities and the residential sector.

The issues addressed in ETHEL-I, namely, the impact of societal and technological assumptions on ways of life, activity locations, the related types of housing, transport supply and the related travel

behaviours, will be extended to include merchandise transport, in particular on the city deliveries aspect, in interaction with shifting household purchasing behaviours.

The resulting findings will be applicable in that they will identify and quantify the energy issues related to transport, locations and housing, as well as room for manoeuvre in terms of public policy. From the scientific standpoint, the main expected outcome is methodological progress in medium- and long-term modelling of the impact of economic, societal and technological factors on the behaviours studied.

The main innovation here lies in the fact that the project brings together, in a joint forward-looking effort, different proven forecasting models (in particular, the merchandise transport models intended for use) that are not merely forecasts based on previous trends, and sector-specific approaches to housing and transport, the models of which are not commonly brought into interaction.

Two activities are proposed: the first on merchandise transport in cities, and the second on fine-tuning energy models on housing their spatial morphologies.

2. CRP 2008

The projects selected on 2008 will start by the end of 2009. First results are expected by the end of 2011.

- SAOPOLO: Adaptation strategies for marine protection works and costlines tenure face to sea levels rise. Coordinator: Philippe SERGENT (CEMTEF)
- DRIAS: Providing access to French regionalized climate scenarios useful for adaptation strategies and impacts management. Coordinator: Philippe Dandin (MeteoFrance)
- Alpine lands adaptation to frequent droughts in the context of global change. Coordinator: Sandra Lavorel (CNRS)
- Managing population displacements due to extreme events (EXCLIM). Coordinator: François Mancebo et Chloé Vlassopoulou (CURAPP, CNRS & PACTE)
- AdaptFVR: Impacts of climate change on emergence of Rift Valley Fever vectors in Senegal: adaptation and strategies of pastoralism in Sahel regions. Coordinator: Murielle LAFAYE (CNES)
- Adaptation of climate change: Integrated approach challenge in French Regions. Coordinator: François Bertrand (UMR CITERES/Université François Rabelais)
- Adaptation capacities of coastal Human communities to erosion and submersion of coastlines due to climate change. Coordinator: Anne Tricot (CNRS)
- Adaptation of climate change in the French Alpine Region « Rhône-Alpes »: partnership between scientists and local authorities. Coordinator: Claire MORAND, Rhônalpénergie–Environnement (RAEE).

The DRIAS initiative

(DRIAS : Donner accès aux scénarios climatiques **R**égionalisés français pour l'**I**mpact et l'**A**daptation de nos **S**ociétés et environnements : **Provide access to French Regional climate scenarios for Impact studies and Adaptation).**

DRIAS objective: Provide an easy access to French regional climate data and products & the associated expertise to facilitate impact and adaptation studies:

- Several Greenhouse gas emission scenarios, using different regional climate models and downscaling methods,
- Standard formats, easy access, quick looks and simple products, for a wide range of users,
- Expertise and guidance, especially addressing the various uncertainty sources, and promoting best practices and know-how.

DRIAS is a facility. It will be based on Météo-France Climathèque http://climatheque.meteo.fr/:

- Generic system with internet up to date technologies,
- Providing access to different climate data and products,
- A familiar framework, easy to enrich and host new services.

Co-Funding: French Ministry of Environment and Sustainable Development (GICC program)

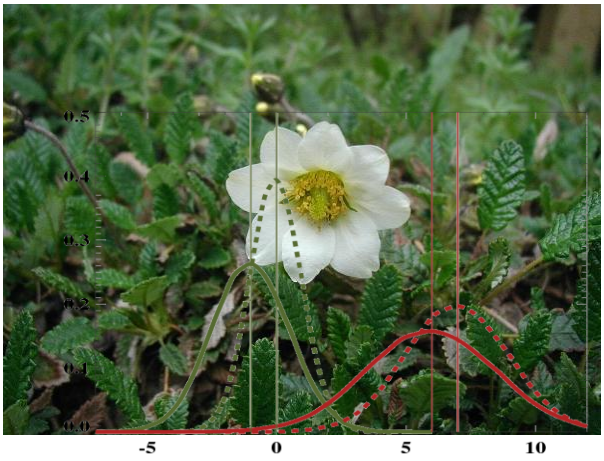
Coordination: Météo-France (Direction de la Climatologie)

Partners:

- Météo-France – CNRS GAME
- IPSL (Institut Pierre-Simon Laplace)
- CERFACS (Centre Européen de Recherche et de Formation Avancée en Calcul Scientifique)

Duration: 2009-2012

Contact: drias@meteo.fr



Networking project CIRCLE MED

The CIRCLE-MED research call stresses the importance for **early collaboration of the funded projects with decision makers** in order to effectively disseminaterecommendations from the call projects and its results to policy practitioners decision makers/ developers. Research projects should aim at identifying andproviding information to help solve practical adaptation problems.

The **policy context** includes a Mediterranean Strategy for Sustainable Development, adopted in 2005, and a Mediterranean Water Strategy in preparation for an adoption in 2010. Discussions on the latest particularly underlined the necessity to find synergies between integrated coastal zones management (ICZM) and integrated water resources management (IWRM), especially in the context of growing demographic and touristic pressures on the coasts, the urgency to develop and implement climate change adaptation and mitigation measures, and the importance of the implication of all governance levels and functions in the process.

Another aspect of the CIRCLE-MED research call is the emphasis of the importance **of multi-disciplinary approaches** with a good balance between biotechnical sciences (from hydrogeology to agronomy) and social sciences.

CIRCLE is an EC FP6 funded Networking project aiming at implementing a European Research Area (ERA-Net) in the field of climate change impacts and adaptation research. The CIRCLE-MED geographical group addresses issues of common interest to the Mediterranean countries. It aims at creating a Mediterranean research community network through collaborative projects on Climate Change Impact Research, with the objective to bring the results to policy and decision-makers.

Funding partners:

XUNTA DE GALICIA
CONSELLERÍA DE INNOVACIÓN E INDUSTRIA
Dirección Xeral de Investigación, Desenvolvemento e Innovación

שלום עם הסביבה
המשרד לאיכות הסביבה

Ministero dell'Ambiente e della Tutela del Territorio e del Mare

FCT
Fundação para a Ciência e a Tecnologia

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CIRCLE MED

Climate Impact Research Coordination for a Larger Europe

Coping with Climate Change in the Mediterranean

Integrated coastal zone management and water management

www.circle-med.net

CIRCLE MED

Climate Impact Research Coordination for a Larger Europe

According to the 4th IPCC (Intergovernmental Panel on Climate Change) report, the environment and human activities of the **Mediterranean area will be among the most affected in the world by global warming.** It will change precipitation and evaporation rates over land and sea, creating even drier conditions. Coastal zones both to the north and the south of the basin are particularly vulnerable and this is aggravated by significantly increasing pressures on water resources due to the socio-economic developments in these areas. The consequences are severe risks in the long term such as the destruction of coastal aquifers through seawater intrusion, the degraded quality of water and aquatic systems, reduced flows and the drying up of wetlands (Blue Plan's sustainable development outlook for the Mediterranean, July 2008).

In this context, the first research call of the CIRCLE-MED group focused on **adaptation strategies in the water sector and coastal zones** and on finding a new equilibrium in the Integrated Management of Water Resources and Coastal Resources.

Eight projects were selected for a total budget of 1,65 M€ and associating research bodies from France, Italy, Portugal, Spain, Israel, Morocco, Tunisia, Croatia, and Albania. The projects duration is 2 years, with first results expected in 2010.

ACIDBIV: The integrated impacts of marine acidification, temperature and precipitation changes on bivalve coastal biodiversity and fisheries: how to adapt?
Partners: Centre of Marine Sciences of Algarve (Portugal); Consejo Superior de Investigaciones Cientificas (Spain); Department of Biology - University of Padova (Italy); Faculty of Science of Bizerta (Tunisia)
Contact: lchichar@ualg.pt

AQUIMED: Participatory design of adaptive groundwater management strategies and instruments in Mediterranean coastal water scarce areas as a response to climate change.
Partners: **CIRAD (France);** SOCIUS (Portugal); BRGM (France); CEMAGREF (France); École Nationale d'Agriculture (Morocco)
Contact: fayssel@cirad.fr

CANTICO: Climate and local ANthropogenic drivers and impacts for the Tunislan COastal area.
Partners: **Centro Euro-Mediterraneo per i Cambiamenti Climatici (Italy);** Météo-France – CNRM (France); Institut National des Sciences et Technologies de la Mer (Tunisia); Israel Oceano-graphic & Limnological Research (Israel); Istituto Nazionale di Oceanografia e Geofisica Sperimentale (Italy); Institut Pierre Simon Laplace, CNRS (France)
Contact: fsantoro@unive.it

CLIMBIOMEDNET: Climate change influence on biodiversity, goods and services of Mediterranean lagoons.
Partners: **Laboratoire "Écosystèmes lagunaires", Univ. of Montpellier (France);** Dip.Scienze e Tecnologie Biologiche ed Ambientali, Univ. of Salento (Italy); Dep. De Ecologia y Biologia Animal, Univ. of Vigo (Spain); Dept. of Bio-technologies, Tirana Univ. (Albania); Lab. Ecosystèmes et Ressources Aquatiques, INA (Tunisia)
Contact: mouillot@univ-montp2.fr

CLIMWAT: Assessing and managing the impact of climate change on coastal groundwater resources and dependent ecosystems.
Partners: **CVRM/Geo Systems Centre, Instituto Superior Technico (Portugal);** Fundação de Faculdade de Ciencias e Technologia, Dept. de Ciencias e Engenharia do Ambiente (Portugal); Dept. de Technoloxia da Construcion da Coruña (Spain); Faculté des Sciences Semlalia, Université Cadi Ayyad (Morocco)
Contact: luis.ribeiro@ist.utl.pt

INTERMED: The impact of climate change on Mediterranean intertidal communities: losses in coastal ecosystem integrity and services.
Partners: **Animal Biology Dept., Univ. of Palermo (Italy);** Recanati Institute for Maritime Studies, Univ. of Haifa (Israel); Dept. of Aquaculture, Univ. of Dubrovnik (Croatia)
Contact: gsara@unipa.it

MEDCODYN: Climate change impacts in transitional water systems in the Mediterranean.
Partners: **Dipt. Di Scienze e Technologie Chimiche e dei Bioistemi, Univ. of Siena (Italy);** Consiglio per la Ricerca e la Sperimen-tazione in Agricoltura, Labo-ratorio Centrale di Idrobio-logia (Italy); La Tour du Valat (France), Univ. Aïn Chock of Casablanca (Morocco)
Contact: rossi@unisi.it

WATERKNOW: Integrated Water Management in Coastal Drainage Basins: challenges and adaptation strategies within the framework of climate change.
Partners: **Alma Mater Studiorum, Univ. of Bologna, CIRSA (Italy);** Univ. des Sciences et Technologies de Lille, Labo. Territoire, Ville, Environne-ment, Sociétés (France); Dept. de Ciencias Agrarias da Universidade dos Açores, (Portugal); École nationale Forestières d'Ingénieurs (Morocco)
Contact: m.antonellini@unibo.it

4.

French Association for Natural Disaster Risk Reduction (AFPCN)

Association Française
pour la Prévention des
Catastrophes Naturelles
(AFPCN)

Presentation by Christian Kert, Member of Parliament (Bouches du Rhône)

President of AFPCN and of the Orientation Council for the Prevention of Major Natural Risks (COPRNM)

Member of the Parliamentary Office for Evaluation of Scientific and Technological Choices (OPECST)

AFPCN's purpose is to involve civil society in the natural disasters' prevention policy led by public authorities coordinated by the Directorate General for Risk Prevention (DGPR) of the Ministry of Ecology, Energy, Sustainable Development and Sea. According to the UN, it is the operator of the French national platform formed by the Orientation Council for the Prevention of Major Natural Risks (COPRNM), which I'm chairing with secretariat support from DGPR.

For the three past years, AFPCN has been very actively engaged in the French policy for climate change adaptation by participating in the work of the inter-ministerial group for the Assessment of Climate Change Impacts, established under the auspices of the DGPR in the preparation of a national climate adaptation plan.

AFPCN has established, as part of its Scientific Council, a working group on adapting disaster reduction to climate change, which held regular meetings since 2007. It contributed to the reflections of a group of the Academy of Sciences led by Henri Decamps, a member of its Scientific Council, and to publications of the journal Environment and Responsibility. Initiator and currently President of a European network of national platforms for disaster reduction, AFPCN has contributed with partners a common response to the Green Paper of the European Commission, and is intensifying its discussions on adaptation with European countries.

AFPCN fulfils, in the field of risk management and in the context of climate change, a mission as animator of exchanges and contributor to public policy.

Three extracts from AFPCN's publications, reflecting its approach, are proposed in this document:

- A note from the DGPR presenting the ***Orientation Council for the Prevention of Major Natural Risks*** and the Working Group on ***Natural Hazards, Insurance and Adaptation to Climate Change*** hosted by the DGPR in the context of the evaluation of climate change's effects on natural hazards patterns; both participate in the development of the future adaptation plan.

- Introduction and conclusion of a ***Synthesis meeting*** on the different aspects of adaptation. Held in February 2008, this event used the fourth IPCC report published late 2007 and proposed guidelines for prevention. The proceedings were presented at a meeting in Davos, during a side-event organized by Swiss and German national platforms (and Planat DKKV), and at the conference which is the subject of the second document.

- Extracts from the proceedings of the international conference titled "***From past natural disasters to the challenge of climate change in Europe***", convened in November 2008 by the Ministry of Environment, Sustainable Development and Spatial Planning (currently MEEDDM), in collaboration with AFPCN's Scientific Council. The event was held in the context of the French Presidency of the European Union which, as we all know, intended to give a

strong impetus to the policy developments in the field of climate and risks. This symposium brought together representatives from over twenty European countries, showcased the actions of the network, and opened discussions on major issues. Workshops have led to formulation of detailed recommendations about adaptations to climate change in coastal zones, mountain, transboundary river valleys, mega-cities, and about training. A session was devoted to public-private partnerships with insurers. The minutes of the first plenary meeting and of the panel discussion on resiliency, as well as the conclusions on scientific approaches and techniques, illustrate the quality of the exchanges among participants.

I hope this overview gives an idea of the voluntarist and dynamic contributions of our association and of its French and European partners in the vital domain of adaptation to climate change.

Christian KERT

Member of Parliament (Bouches du Rhone)

President of AFPCN and COPRNM

Member of the Parliamentary Office for Evaluation of Scientific and Technological Choices (OPECST)

Note from the Directorate General for Risk Prevention of the Ministry of Ecology, Energy, Sustainable Development and Sea

Consultative bodies for natural disaster risk reduction and climate change[12]

The Advisory Council for the Prevention of Major Natural Disaster

The *Advisory Council for the Prevention of Major Natural Disaster* (COPRNM in French) is a French national structure, created by decree on 1 August 2003, in charge of providing advices and proposals to the French Government. Members include elected representatives, experts and professionals, the civil society and State's services. Regular meetings are a place for exchanges and debates, orientation and advice, with direct applications in terms of governance.

The Natural hazards, Insurance and Adaptation to Climate Change Working Group

The *Natural Hazards, Insurance and Adaptation to Climate Change Working Group* (RNACC in French) is part of the joint ministerial working group on "*Climate Change Impacts, Adaptation and Associated Costs*" (see report summary in the ONERC's Summary for Decision Makers and in the complement "Natural Risks and Insurance").

This theme lies at the heart of current international focus (draft IPCC special report, revised mid-term review of the Framework Hyogo example) as both as a receiver (risk being broken down in this context into of hazards such as extreme weather events, elements exposed and their vulnerability), and as a source of strategies and best practices in risk management.

The group focused on the study of climate change impacts on natural risks, which are a combination of natural meteorological hazards and vulnerable exposed elements, and on associated damage costs. In France, the Insurance Code defines natural disasters as the result of a "natural agent with an unusual intensity", which correspond among others to meteorological and climatic extreme events as defined by the IPCC. Since 1982, insurers support the natural disaster compensation scheme, are key stakeholders of the national risk prevention and management policies and are particularly paying attention to the potential consequences of climate change. The work of the group was able to rely on economical figures from the insurance market.

The working group's objective has been to propose, when necessary, relevant adaptation measures – including adaptation of risk reduction measures –, and assess them. The hypothesis that given hazards may not change or reduce as a result of climate change has not been excluded, but evaluated in light of available knowledge.

The GT RNACC studied in particular the risk of flooding, coastal risk (flooding and erosion) and the risk of the withdrawal-swelling of clay soils under the effect of drought. It did not incorporate the risk of storms, whereas in the light of current knowledge on the subject, an assumption of no evolution of this hazard was considered as possible. It has nonetheless given particular attention to solid flows (avalanches, floods and mudslides, mudflows and landslides and slope movement, underground collapse), specifically in mountain areas. Indeed, despite some difficulties related to the nature of

[12] Text prepared by Sylvie de Smedt, DGPR, secretary of the RNACC working group.

these hazards, including their high spatial and temporal discontinuity and their potentially high socio-economic impacts, the objective was to give an overview of possible interactions between climate change, climatic and solid flow hazards, without considering any quantification at this stage.

Pluvial floods have not been taken into account, even if these phenomena could increase in intensity and frequency as a consequence of climate change. The reason was the lack of economic data available. It is therefore difficult, in the current state of knowledge, to integrate them into an assessment of impacts trends, however they are recognized to have a significant impact.

The establishment of quantitative assessments across the country was often uncertain, given the current knowledge on the impacts of climate change on hazards, as well as on hazards and elements exposed themselves. It is important to note here are several limitations to the study presented:

- Climate change scenarios provide relatively clear guidance on global and regional trends, but are very difficult to apply to the very small geographical scale of some hazards;
- Uncertainty of climate change scenarios vary depending on locations and variables chosen: analysis and simulations for the 4th IPCC report on France shows good consistency in modelled temperatures; models however provide very uncertain predictions related to precipitation, an essential variable for this study.

In conclusion, beyond the importance of vulnerability, one of the most climate-sensitive and difficult to manage hazard for the next 100 years is the general decline of low-lying coasts. Geotechnical drought should nonetheless be neglected in terms of costs, but (expensive) adaptation solutions already exist. As for solid flows and flood hazards, a key factor seems to be climate variability evolution (amplitude of diurnal variation in temperature, precipitation extremes, etc.), which remains for further studies.

The work also identifies a need for knowledge development (data gaps in information about hazards and elements exposed), for establishing sustainable networks and monitoring indicators, for continuing and strengthening "no regrets" prevention policies and management strategies, in line with a comprehensive and coordinated approach to risk management. They are the three first elements of an adaptation policy.

This work has been the launch of a multi-stakeholder process that will continue, particularly through the development of the national adaptation plan, the implementation of the "Grenelle of the sea", and of the flood directive.

The following needs were highlighted:

- Need to study regionalized (but consistent) climate change impacts on water systems;
- Need for additional research on extreme events, taking into account socio-economic parameters (specifically when different areas are affected at the same time);
- Need to improve the way to use research results in an operational way.

The RNACC WG, chaired by Thierry Hubert, deputy of the chief of the Natural and Hydrological Risks Department, has been participated by relevant government institutions (BRGM, INERIS, CEMAGREF, Meteo-France, NFB, CSTB), administrations (CNRS, DGPR/SRNH, CGDD, CETMEF, CETE Lyon et Méditerranée, Direction régionale de l'équipement Languedoc-Roussillon), the Insurers' Natural Hazards Mission (MRN), the French Association for Natural Disaster Prevention (AFPCN), the Center for the Prevention of Flood Risk (CEPR) and Public Territorial Basin Facilities (EPTB).

Introduction and Conclusion of the 6 February 2008 Synthesis Meeting on Climate Change Adaptation: Natural Hazards

Organised by AFPCN Scientific Council

Introduction

Cyclone Katrina, August 2005

Climate change is now a major issue for scientists, professionals in disaster-prone sectors, public policy makers from the local to the international levels, and ultimately people and communities. The *French Association for the Prevention of Natural Disasters* (AFPCN)[13], an exchange and action platform bringing together representatives of civil society and public authorities, has given prominence to climate change in its program of activities.

In 2007, a working group on "*Adapting disaster management to climate change*" was launched as part of AFPCN's Scientific Council. A majority of its members participate. The group has organized several thematic sessions, led a conference in Guadeloupe on tropical storms, worked with the joint

[13] The *French Association for the Prevention of Natural Disasters (AFPCN)* was created in 2001 to take over the *French Committee of the International Decade for Natural Disaster Reduction (IDNDR)*. It is part of the structure of the French platform, operator for the Ministry of Energy, Ecology, Sustainable Development and Sea. With a NGO status, it organizes meetings and debates, at national, European and international levels, between governments and members of civil society, towards strengthened prevention of disaster risk.

The AFPCN Scientific Council, registered in the rules of the Board, was established in June 2004. It is composed of twenty independent experts, French and foreigners. According to the vocation of AFPCN, its composition is balanced between scientific disciplines of nature (hazards) and those of society (vulnerability, resilience). Its missions are to provide advice and support, to organize conferences and seminars, and to provide a scientific watch on risks.

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ministerial group on "*Impact of Climate Change, Adaptation and Associated Costs*". At the same time, the group "*Ecosystems and Extreme Climate Events*" was established by the *Academy of Science*.

These exchanges have resulted on 6 February 2008 on a day that was placed chronologically after the publication of the 4th IPCC report, the UN meeting in Bali, and the decisions of the "*Grenelle for Environment*".

The objective was to cross the approaches that are often too compartmentalized and sometimes divergent, while diversity is inherent to scientific approach, to reach a collaborative vision for future activities, and to look collectively on various programs contributing to disaster risk management, in the context of a changing climate. Following this exchange, AFPCN outlined several recommendations. As part of the outcomes, a conference was decided to be co-organized with MEEDDAT[14], bringing together national platforms for disaster risk reduction of Europe, on 26-28 November 2008 (during the French Presidency of the EU).

AFPCN considers adaptation to climate change, as adaptation to any major change, in terms of risks to manage and opportunities to exploit. Climate change-related risks result from continuous environmental pressure (seasonal temperatures, rainfall, sea level, concentration of atmospheric CO2 and other gases, biological contamination ...) and extreme events (storms, heat waves or sequences of intense cold, drought or rainfall causing runoff or flood, meteorological conditions favourable to the spread of fires, landslides ...). Adaptation affect every living species, some suffer from negative impacts, or are forced to migrate, others benefit from increased competitiveness; the history and geological paleo reconstructions, including studies of past weather-related disasters, have enlighten mechanisms involved. Societies, including the most advanced ones, need to assume their responsibilities and mobilize their resources to cope and exploit opportunities, as they have done in the past; they will succeed in doing so only if they can take timely measures.

Conclusion

Paul-Henri Bourrelier
Chairman of AFPCN Scientific Council

General Comments

In concluding today's discussions, I would first like to thank all those who contributed, by delivering presentations or setting out their viewpoint. Hailing from very different backgrounds, they came together to make this event a success. I would also like to thank them for having kept to a very tight schedule, which endeavoured to take stock of all of the scientific approaches to the topic: "adapting prevention to climate change".

I would first like to come back to four points that are vital to understanding this event and putting its success to use.

1. Uncertainties

Much has been said over the course of these sessions about uncertainty. We wanted to lay emphasis on this aspect, not to take away from the demonstrations about climate change, but rather to uphold

[14] The MEEDDAT became MEEDDM in 2009 following the inclusion of competences related to the sea.

the scientific rule by which figures and prognoses should never be issued without a margin of uncertainty. The explanations given here did shed light on the questions, limits and most serious gaps in our knowledge, which result from measurements themselves, as well as climate models, the related scenarios and impact models.

As regards complex systems involving the non-linear laws of physics and chemistry, life sciences and societies, climate models have become remarkable but simplified tools, which make it possible to better understand how retroaction loops work, or make forecasts showing how certain assumptions impact our actions; obviously, they cannot be expected to depict reality and make long-term forecasts, particularly as they refer to socio-economic scenarios that do not loop in with the retroactions (shock effects on the markets and greenhouse gas mitigation policies, in particular). The explanations given here did shed light on the questions, limits and most serious gaps in our knowledge[15].

2. Controversies

Science progresses through such questioning and through the debate that it stirs within each specialised scientific community and between experts from different disciplines. We made the gamble that discussion on climate change has reached a stage of maturity, in research and discussion, such that mutual understanding is possible and the persisting controversies are reined in, acting more as a helpful and ultimately constructive stimulant, for scientists working in good faith[16] (*). This proved true today.

[15] A modelling system designed to encompass the main retroactions would have to combine four models at least: a climate model (atmospheric and oceanic retroactions), an energy and market resource model (oil rarefaction, greenhouse gas alleviation policy), a water and continental biosphere model, and a societal demographic and economic development model.

[16] The most recent models (see GICC) give reason to believe that climate change could decrease flooding in the major drainage basins across France; however, increased occurrences of quick, lowscale events are to be feared. The cooperation between climatologists and hydrologists, who have tended to have different views up to this point, was deemed highly desirable in Session 3; it might give rise to convergence on these trends.

(*) The current state of major controversies on climate change are synthesized in the following table:

Issue	**Reason for debate**	**Critical view**
1 The complexity of the climate system	Cannot be dominated by the complication of the models; transitions through chaotic states are inherent in the climate system.	Recognised in principle by all, but it is still sometimes implied that this is a classic area of uncertainty which progress will gradually decrease
2 Forecasts	The models cannot act as forecasts; they provide projections based on artificial scenarios	A recognised fact, but one soon forgotten in discourse and, above all, through the copying of maps without warning
3 Earth's average temperature	A summarised indicator	Debate as to the basis for calculation and the extent of its significance
4 Developments over the last 20 years	Statistically, often insignificant, especially at the regional level	Often unfounded assertions on the developments
5 Climate variability, meteorological hazards	Considerable, with developments ill-determined by climate models	Increase often claimed, but without substantiation. The caution displayed in the IPCC's report is quickly forgotten
6 Cyclone hazard	Uncertainty, even in the North Atlantic, the only area where an increase has occurred recently	Often stated to be on the rise
7 Flooding or drought hazards	Variable trend, depending on the type of event: in France, negative growth in plain flooding, heightening of quick, one-off events	Extreme hazards have always been stated to be on the rise (by commentators more than by climatologists)
8 The water cycle and its impact on the greenhouse effect	Much remains unknown	Relatively hidden
9 Sea level	Definite rise, multi-secular effect of warming; great uncertainties as to 100-year projections and impacts	Sometimes very high forecasts announced on a 100-year timeframe; IPCC accused of not having selected higher recent forecasts
10 Acidification of ocean water	Definite effects on coral reef; outlook?	Not always mentioned
11 The carbon cycle and biosphere	Many unknowns	Generally hidden by overall balance figures
12 The extinction of species	Definite, but doubts remain on what percentage is to be ascribed to climate change. Adaptation responses are poorly estimated.	Misplaced oversimplification, attention focused on a number of stand-out species, positive effect on the evolution of ecosystems unknown
13 The opinion of the climatologist community	Majority	The consensus system and expression of subjective probabilities by the IPCC are hotly contested. The opinions intended for decision-makers in the IPCC reports are written with the politicians, hence possibly leading to insidious denaturing
14 The opinion of the entire scientific community	Not stated	Ambiguity of the term "scientific community"; many of the areas where reservations are expressed about the IPCC's assertions are not appropriately involved (could they be ?)
15 The role of the markets following the rarefaction of fossil fuels	Vital but inadequate for mitigation; the effects of shocks and conflicts are major.	Certain aspects are always left out of scenarios and general presentations; the markets are addressed only with respect to emission rights
16 Promotion of nuclear energy	Nuclear power is one out of many possible responses	Nuclear power, often hidden, has its own controversies
17 Adaptation versus mitigation	Two responses, two complementary policies of equal importance and urgency	Both have their proponents. The IPCC has really focused on mitigation. Heightened imbalance in France.
18 Economic models versus climate models	The economic models do not cover all scales; the climate models wipe out the effects of temporary chaos	The IPCC's scenarios ignore the economic retroaction of the markets and mitigation policies. Ideological bias in the models integrated (Stern, for instance). Dead-end debate on actualisation rate.

3. The relationship between adaptation and mitigation policies with regard to climate change

Because of the AFPCN's vocation, adaptation is relevant to it. Clearly, and as the IPCC has asserted, adaptation and mitigation are complementary and of equal necessity and urgency. For tactical reasons, some parties prefer one over the other, but this is a mistake that harms the credibility of the announced policy:

- both need to be launched with equal urgency and preparations need to begin in order to step them up as soon as this becomes possible, thanks to the institution of emission- and impact-reduction technologies, as the measures of greatest scale will have impacts only over the long term: restructuring the urban environment, reclaiming land and gaining control over water will require as much time and investment as changing the energy consumption system; moreover, many of the measures involved are common to both sides.

- the combination of spontaneous response and planned measures is the key to success: climate change triggers spontaneous adaptation mechanisms in species and Man, just as the increase in fuel prices following their rarefaction brings about spontaneous moves toward mitigation. However, these are haphazard, often erratic responses, which lack coordination and will definitely be inadequate. They need to be orchestrated and synchronised: Kyoto on the one side and Hyogo on the other need to combine their effects to ensure global monitoring.

4. Representations of Change: Denying or Blowing Up Risk

Climate change is not only a more or less concrete physical and biological reality, it is just as much a mental representation and a social and geopolitical construct. Like all major changes and like all hazards, it can be seen as an opportunity or as a threat of disaster. Mitigation policies, and even more so adaptation policies, can only be designed and instituted on the basis of such representations.

Today's discussions have helped us broach this essential aspect. However, there is much more research to be done on the topic.

First of all, it is important to understand the denial involved if we are to effectively fight passiveness. This is all the more vital as the reasons behind people's reluctance are often hushed up, buried from view and contradictory, but not always without reason: the instrumentalisation is frequent and deserves to be detected, analysed and denounced; why is adaptation explored so little in the IPCC's studies and at such a late date in France, such that, for instance, the local authorities' Climate Action Plans are only mitigation plans, when at that level of responsibility, the opposite could have been expected?

Climate change also appears to play a part in revealing the errors of our technological society, wasteful in resources, reckless in its growth and unwise in its action: it could provide the healthy impetus needed for a technological system capable of effectively addressing its challenges; similarly, it is important that it not serve as an alibi and provide an additional demonstration of its powerlessness in shouldering its responsibilities.

Five Recommended Avenues

Throughout the day, we have heard recommendations made from session to session: I will set forth five of them, without purporting to be comprehensive in my coverage.

1. Incorporating all disciplines

The stunning progress achieved by climatologists as of today has a downside, in that the other disciplines involved in achieving a greater understanding of nature are now out of touch, even though they are just as essential: this applies, to a certain extent, to hydrology and, more generally speaking, to any field that works toward understanding the water cycle at all levels (from the particular to the global). Yet life sciences have even more trouble changing scale, and shifting from specific observations to overall assessments and forecasts (for instance, carbon sequestering in the ground) and in which certain branches, in particular descriptive entomology, have been left too long by the wayside, at a time when their knowledge is needed to build alert indicators. Naturally, this is also true of history, which finds itself faced with the challenge of linking up time scales and making use of the vast stores of information built up in the archives.

2. Geographical scales, from the global to the local

From the planetary level to the national level, with the continental organisations along the way, there can be no break: discussions and negotiations are needed at all levels. The larger countries at least have scientific tools and international cooperation is currently effective. France has two teams that have each developed a climate model and qualified organisations act as the liaison between the various fields.

Mitigation and adaptation both require strong regionalised cooperation, whatever the sector involved:

- energy production (solar, wind, biomass, geothermal, etc.).
- energy efficiency and emission reduction in housing and transport,
- intelligent improvement on thermal comfort.
- activity adaptation and risk prevention.
- species adaptation and biodiversity protection.

Yet there is a paradox here: the local decision-makers carry national efforts on and take action on energy, while they watch, passively and reluctantly, as national policy decisions on adaptation are made, knowing that the greatest impact will be on their constituents.

Whether at the level of the administrative entities, major conurbations, geographic units such as mountain ranges, continental basins, coastal areas or the seas, it is more difficult to take climate change into account, for the climate models derived from global-level models are of little significance. This may explain why adaptation is not on the agenda at this level of decision-making. A tightly-run effort to bring together data, build specific models on the various forms that evolution can take on, and develop tools for action is vital if we are to avoid abstention or anarchy. For instance, the research program "Management and impacts of climate change (GICC)", launched by the Ministry of the Environment ten years ago is a strategic tool that should be promoted with Meteo France and research and implementation agencies such as CEMAGREF, the BRGM, INRA etc. The ANR, which has launched programmes on certain aspects, might be of great help in uniting the French scientific community around this central programme.

3. Societal engineering of risk treatment, a democracy of responsibility

Climate change triggers complex interaction between the players involved and it is vital that this be understood and guided, as Sessions 6, 7 and 8 show. The adaptation tools exist and are better-used in some countries than they are in France: one needs only cross the English Channel for this.

One observation stands out: climate change does an excellent job of uncovering the deficiencies in the social system. A community's vitality and resilience can be measured in its ability to adapt to risks, as well as the creativity it shows in seizing the opportunities that change offers, by envisioning them as assets. Social engineering needs to be redesigned with regard to health-related, technological and natural risks, and perhaps with regard to other risks as well. This mobilisation can march under the banner of sustainable development.

4. Beneficial crisis management

One of the speakers suggested the idea that adaptation might be targeted specifically at rescue services and what is more generally referred to as crisis management[17]. This idea deserves to be explored in greater depth, for surprises probably await on the other end. Coordination and integration into a global strategy are currently far from adequate. The Conference organised by the AFPCN' a few months ago in Divonne-les-Bains paved the way toward this. However, such measures will only be acceptable if society is willing to enforce them in time and if it is able to extend crisis management forward, through reconstruction initiatives specifically-tailored to step up resilience. This takes us to the heart of the balance that risk management needs to find, between post-disaster response, rescue and foresight.

5. New vigilance with regard to extreme risks

Regular data collection and aggregation, aimed at monitoring the phenomena on which climate change will have an impact, is a general necessity. GMES could serve as the lasting framework for part of this watch effort, though it cannot stand in for the ground measurement systems that better reflect the complex interactions that take place at the local level.

One of the benefits of approaching natural risk from the standpoint of climate change is that it forces the distinction between common risks and extreme risks:

- there does not seem to be, for the time being, any reason to change the reference hazards set out for managing common risks, but they do need to be better negotiated at the local level, abide by them more consistently, all the while better measuring natural variability and better maintaining protective structures.

- where extreme risks are concerned, there would be a case for instituting the most appropriate watch tools, particularly those aimed at the extremes of the frequency/intensity curves, with particular attention to vulnerability coagulations (overlapping demographic and social factors, domino effects with industrial risks, etc.). It would also be a priority to trigger special watch systems and respond quickly if events boding of significant unexpected (as it always is) change were to occur.

[17] I have indeed made this kind of suggestion in the past, indicating that "prepared" crisis management was an avenue for responding to the disasters that arise from "chaotic" climate change scenarios (see above). However, it is important to specify that this suggestion should not be an excuse for ignoring the clear lack of protection currently with regard to foreseeable natural risks, leaving aside any climate-related considerations (Gérard Brugnot).

Extracts from conference « From past natural disasters to the challenge of climate change in Europe » (November 2008)

Organised by AFPCN Scientific Council and
the MEEDDM Directorate General for Risk Prevention (DGPR)

Plenary Session: From the Past to the Future, European Challenges in Reducing Disaster Risks in the Context of Climate Change

Flooding 1910, Paris

Chairperson: **François Ewald**, philosopher and legal historian, professor at the Conservatoire National des Arts et Metiers & **Riccardo Petrella**, European Commission councillor, Professor of Economics at the University of Louvain.

This session involving European experts and researchers will break down into three main themes: geographical, historical and prospective in an approach that will therefore be both retrospective and prospective, explained **François Ewald**.

We must be able to detect the climate change related differences in current disasters, as compared to past disasters. Our ability to forecast or anticipate these risks, even if reducing them is still difficult, is a very new phenomenon in our societies.

Does the multiplication of these little natural disasters preface a catastrophe of enormous proportions able to bring about the extinction of species and even the disappearance of humanity

itself from this planet, asked François Ewald, who noted that according to the philosopher J-P Dupuy, thinking through disasters is the best way to arm oneself against it.

One ambiguity subsists however the true issue: natural climate disasters can be disastrous, affecting economic assets created by human activities. Re-insurers note that human and economic activity has a tendency to center on areas that are particularly prone to disaster, such as Florida. Humankind is therefore familiar with natural risk, but there is a chance that climate change will increase the scale of these disasters.

Insurance was invented in order to allow humans to live with the risk of disaster. There is a debate process between insurance and prevention, due to the fact that being insured in itself reduces the incentives to prevent.

The question is henceforth whether allowing areas threatened by climate change –flooding, drought, etc- to retain their value is an act of solidarity, or whether a range of value should be actively introduced to reflect pro rata the risks identified by mapping; such a policy would cause assets to lose value according to their level of exposure to risk. Should we also implement a land use policy by actively managing value in these areas, or by coping with the risks? Past and future experience should enable us to answer these questions, stated François Ewald by way of introduction to the first plenary session.

Riccardo Petrella took over the podium, firstly noting that the European environmental policy was, along with agriculture and commerce, part of a body of joint policies that have marked the path to European integration. The paradox is that this policy also highlights the enormous diversity within Europe, with such very diverse environments: Mediterranean Europe, Northern Europe, Eastern Europe, by their very nature these differences fragment the perception of climate risks. He noted however that some progress had been made in European environmental policy, particularly on the legal front with the implementation of a framework directive on water; this is now a central reference document for all Member States' policies.

European failing on the subject is not a lack of knowledge of the risks or challenges, nor of the solutions put forward (technical, financial, legal), but a failing of European policy that renders the knowledge useless. The fundamental challenge in risk reduction is to bring about a truly European policy. It is the existence of national sovereignty, and competitiveness between countries that exacerbates the joint policy failing. The speaker lamented the competitiveness in operation between nations, even on issues of risk management and reduction. Europe's weakness is built into its political, economic, social and scientific ruling classes, far too imbued with the cult of national sovereignty and territory on the world markets. The future will depend on this solving issue, stated the EC councillor.

Christian Van Der Motten, president of the Belgian national geographical committee, Professor at the Université Libre de Bruxelles

The speaker outlined a summary of the environmental challenges in the different parts of European Community, examining the initial potential of the area, then overlaying the human pressures, along with the new threats that have appeared due to climate change and the new ways of consuming, and land use; finally he outlined the political and economic responses that must be brought to these environmental challenges.

In order to simplify his presentation, the speaker divided Europe up into six main areas: Mediterranean Europe, North Western Europe (ie British Isles, Benelux countries, Germany, France),

Alpine Europe (Switzerland, Austria), Northern Europe, Central Eastern Europe, and Balkan Europe (Romania, Bulgaria).

Europeans' ecological footprint is far smaller than that of the Americans; Europe nevertheless emits 15 to 20% of the world total of CO2, ie roughly as much as China.

The greatest ecological potential, before human pressures have been factored in, is found in North-Western European countries that have a humid temperate climate; the lowest is in Northern Europe and Mediterranean Europe (due to water shortages) and in mountainous areas.

Human pressures are closely linked to population density: the United Kingdom, Benelux countries and Germany have the largest loads to bear from this point of view. Another human pressure is that economic and industrial development can herald an increase in CO2 per km2 and a raise in the percentage of ecological footprint versus biocapacity. Mediterranean Europe has the worst results by a long stretch, with an ecological footprint four times higher than its biocapacity. Only Northern Europe achieves a footprint lower than its biocapacity, due to its low population density. Poor and mediocre air quality betray a large-scale recourse to fossil fuels: this is the case in Mediterranean and Balkan countries.

Climate Threats and technological challenges

	Threats and challenges		
	Potential impact of climate change	**Production of greenhouse gas emissions per capita**	**Major technological threats**
Mediterranean Europe	Increase in droughts, forest fires (especially that poor forest management)	97 +++	Coastal artificialisation, overload of touristic concentration and of road traffic on coastal roads, overconsumption of water resources by agriculture
British Isles	Increasing storms, river and coastal flooding	108 ++++	Pollution and erosion risks associated with large-scale agriculture, general suburbanization, concentration of industries at risk, road traffic congestion
Benelux - Germany	Increasing storms, river and coastal flooding	119 ++++	Pollution and erosion risks associated with large-scale agriculture, general suburbanization, concentration of industries at risk, road traffic congestion
France	Increased storminess, river and coastal flooding in the north, increased droughts, forest fires in the South	87 ++	Pollution and erosion risks associated with large-scale agriculture, concentration of industries at risk
Alpine Europe	Landslides and avalanches	90 ++	Mountain artificialisation, overload of touristic concentration and of road traffic on arterial roads
Northern Europe	Rather positive	91 ++	
Northern Central-Eastern Europe and Baltics	Increased storms along the coasts of the Baltic local river floods, increased summer temperatures	98 +++	Pollution and erosion risks associated with large-scale agriculture, local concentration of industries at risk and over-consumption of polluting fuels (a)
Balkan Europe	Increase in droughts, forest fires	72 +	Locally concentration of industries at risk and over-consumption of polluting fuels (a)
UE 27		100	

Extract from the presentation "Threats and pressures on the environment in Europe: a regionalization" by Christian Van Der Motten

Only in Northern Europe would climate change be a positive development; every other area has witnessed an increase in the number of storms, floods (British Isles, Benelux, France, Germany) and widespread drought and forest fires. Major technological and urban threats are more pronounced in the most densely populated, most artificial and most concreted over parts of Europe (coasts and

rivers). Here again, Northern Europe is the least affected, unlike Mediterranean Europe that remains, as is too often the case in these lists, the dirty man of Europe.

Responses to environmental challenges are political, as strong or as weak as individual countries' ecological and technological policies (management of waste, used water etc...). Europe is improving overall even we are still far from achieving the Kyoto objectives, already inadequate; the exception again is Mediterranean Europe where indicators show a deterioration.

Christian Van Der Motten noted that North-Eastern Europe, with its heavy human and environmental loads, has begun to deal with its environmental problems; some are still not being tackled, such as land use, with the relentless concreting over of land. Alpine Europe, with its heavy natural constraints, is dealing well overall with its environmental problems. Northern Europe is the only part of the EU with a positive ecological balance. Mediterranean Europe, with its fragile natural environment, will doubtless be the worst affected by climate change. Responses are inadequate to deal with environmental challenges and to reverse trends. The new EU Member States are not producing adequate political and technological responses to properly address their disastrous environmental heritage. Progress in emissions reductions are mainly due to a cessation of Soviet heavy industrial activity, and not to an improvement in environmental responses.

In conclusion the speaker estimated that the handling of environmental risks and impacts is progressing overall in the most developed European countries. On the issue of risk production however, progress is largely unsatisfactory. The purely economic angle is set against land use, environmental and agricultural policies... In the future, we must tackle the source of risk production, by making the economy more and more subject to environmental constraints.

René Favier, Professor of Modern History, Grenoble University

René Favier, whose area of speciality is the social history of disaster, attempted to introduce some perspective into today's climate change debate by comparing it to historical debates, specifically those of the 18th century, a century that unusually marked by disaster: multiple floods on all the main rivers, the unusually cold winter of 1709, storm of 13th July 1788, etc... Even at that time, the feeling was that these were exceptional times, "unheard of in human memory".

In reality, people of the time accepted and endured these disasters without fatalism but with very rational and reactive behaviours. It is important to access past experience when considering climate change issues; as far back as 1701, the French Duke St Simon had noticed irregularities in the seasons. Climate disaster arises firstly as the result of a storm, i.e. an irregularity. Meteorologists of the time started by setting down rules for climate behaviour by gathering a large amount of observational data in order to outline the various climate types. In the 18th century, the word climate was defined in the first instance as a geographical area, an area of the globe contained between two parallels. Climate comparison is therefore the comparison of one zone with another.

There was no questioning of the fact that climates were stationary; for this reason, during the Little Ice Age, during which glaciers advanced, the predominant notion was not one of climate cooling but of a continual and progressive accumulation of ice in the coldest areas. Exceptional years were not seen as an irregularity but bore witness to an inadequate knowledge of natural laws.

Was it nevertheless possible to conceive of climate change at the time? A number of theories were evolving during the 18th century on the idea that human action could influence climate; these mainly concerned deforestation. First Montaigne, then Buffon asked questions about the interactions between human action and climate warming.

The speaker quoted a decision by the Grenoble Parliament in 1651, the day after a terrible flood: this forbad the cutting and deforestation of woods, actions deemed to have caused the flood by removing the trees that had formerly retained the water. During the 19th century, engineers added that effects might not be merely localised but could be much wider-reaching.

René Favier concluded his presentation by noting that physicists confirmed during the course of the 19th century that the effects of human action were not necessarily localised but may have wider-reaching effects. The Swedish scientist Arrhenius was the first, on the cusp of the 20th century, to identify that greenhouse effect was due to the carbon cycle, and to link it to the use of fossil fuels. Climate change was at the time perceived as a promising a glorious future, with gentler climate conditions enabling even cold areas to grow better crops, for the good of an expanding population.

Henri Decamps, CNRS Emeritus Research Director, Academy of Sciences

As an ecologist and naturalist, Henri Decamps manages a working group at the Academy of Sciences on ecosystems' vulnerability to extreme climate events. He focussed his presentation on the issue of coping with extreme climate events, inasmuch as some, such as the 2003 heat wave, are harbingers of future trends on a warmer planet. He firstly reminded the floor that extreme events are characteristic of series of events, in which there is a relationship between the largest and a typical event in the series. He then set extreme climate events back into their historical context in a geological time frame, and pointed out that since the Cambrian Era, life has evolved, driven by five cataclysmic events that nearly wiped out the planet. This history of life on Earth is essentially driven by a series of challenges from extreme and catastrophic events. For example, the acidification of the seas brought about the extinction of half of the living species on Earth at the end of the Triassic period; the shift eleven thousand years ago towards forest and tundra of the great grassy plains of Northern Europe brought about the disappearance of woolly mammoths.

To state that a species is adapted to life in a particular environment means that this environment acted on the ancestors of that species and caused them to evolve by natural selection, explained Henri Decamps. A species retains its capacity to survive in an environment as long the variability if that environment remains within tested limits. Questions may then be asked about the ability of species to adapt in the face of hitherto unknown catastrophic events; these represented major shifts. According to some specialists such as Stephen Gould, eco systems have survived catastrophic events in the past more by chance than by adaptation. According to others, such as Geerat Vermeij, adapting to frequent events that have already been experienced predisposes to being able to adapt to hitherto unknown catastrophic events. These two viewpoints are probably not incompatible with each other, but the second one encourages us to take advantage of normal events in developing longer-term solutions to future extreme events- by using the calm between storms so to speak, and by strengthening our capacities for adaptation and reduction (or adaptation and mitigation)- this integration is the basis of the AFPCN thought process.

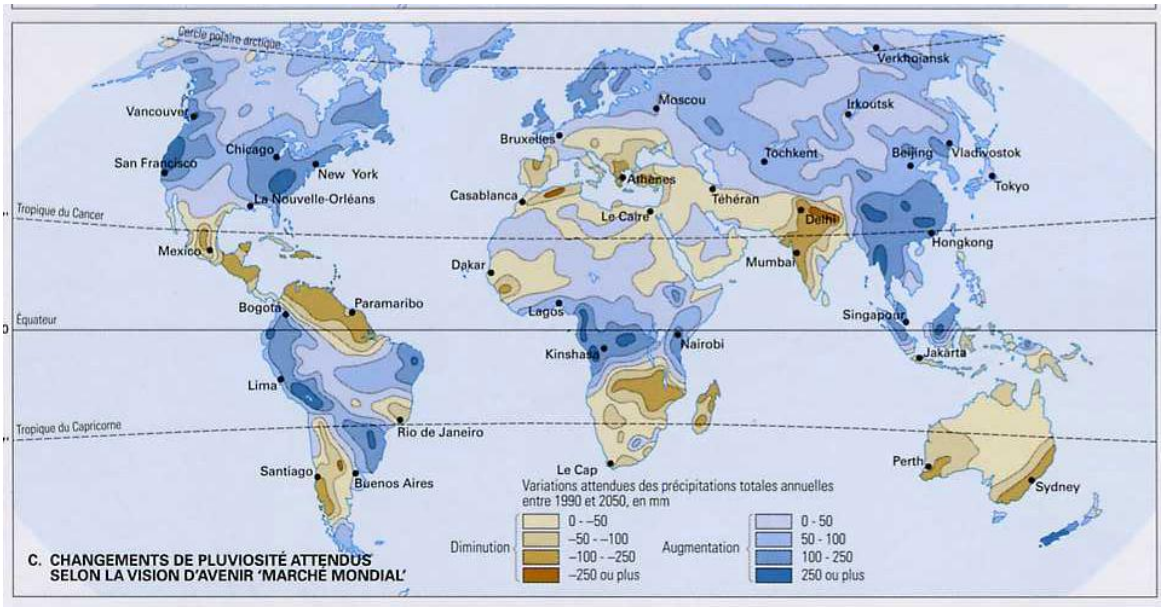
The speaker continued his presentation by asking questions on the possibility of developing coping parameters to climate change inspired by the structures of living systems that have had to face extreme climate events. Bio-mimicry for example encourages us to take inspiration from nature and to privilege innovation and creativity; this is based on the idea that nature favours cooperation, uses only the energy it needs, makes the most of diversity and uses local expertise, and that imitating natural processes can contribute to finding solutions to climate change problems. Similarly, other biologists suggest using nature for inspiration in order to maintain security in an unpredictable, complex and dangerous world, and to respond to the most present threats of by world terrorism, the emergence of infectious disease and natural disasters.

Henri Decamps examined two living system organisational structures, at the whole population and community levels. The characteristics of a system that enable it to face a sudden shift in its living environment may be characterised by redundancy, modularity, flexibility, speed, suppleness and semi-autonomy- all these characteristics increase resilience, including in human societies. The speaker noted however that each of these characteristics has a cost, and that their application to human society may not be automatic- he called this the Human Exception.

As humans we are alone in dealing with the climate change for which we are partly jointly responsible. We know what the consequences might be of an ever-warmer world, and we know that there is still time to choose alternative scenarios from those predicted by the models. The speaker urged the floor to read two recently published books, should they need more convincing: “Six Degrees” by Mark Lynas, and “The Hot Topic” by Gabrielle Walker and Sir David King. These two works presented two key questions: “How to reduce the fear of the unpredictable?” and “How to conciliate lucidity and hope, the two inseparable faces of the human exception?” According to Henri Decamps, science represents an answer to these questions if it is part of culture, takes part in it and remains attentive to ethical questions. Ethics remains at the heart of the human exception, and urges us to leave no-one behind, concluded the speaker.

Thierry Gaudin, founding president of Prospective 2100

Rainfall and drougth



Extract from Thierry Gaudin's presentation

The problem of foresight is not so much accuracy in its predictions but to be heeded, stated Thierry Gaudin in his preamble. Who is heeding together scientific prospective studies warning of climate change?

This is the issue raised by the futurologist, who quoted a study by Jared Diamond, “Collapse: How Societies Choose to Fail or Succeed”, and the work of Alvin Toffler, another well-known global futurist who predicted the arrival of a knowledge-based, post-industrial society, focused on information technologies.

Structures based around nation States and old-fashioned centralised systems waste a large part of the new efficiency contributed by the new technologies.

In conjunction with Prospective 2100, Thierry Gaudin will soon present to the Club of Rome a report for the EC Research directorate general on the world in 2025. Sustainable development figures as an impossible oxymoron. “Sustainable society” may be allowable as a term. Prospective 2100 prefers the term Garden Planet: a gardener is a guardian of nature and takes pleasure in cultivating his or her garden. There is still of lot of work to do on changing our perspective on the economy and society as a whole, and broadening the concept to all life-forms not just humankind. Species are becoming extinct faster since the start of the industrial era, stated the speaker, whose personal opinion is that man should not be spared. Einstein predicted that humankind would not last long after the extinction of bees, as we all form part of the same system and need other species in order to survive.

A slight rise in temperatures in the near future would not be a problem for humans used to temperature changes, but our entire world vision may be overturned between now and 2025, threatening the existence of quite a few existing institutional organisations.

Is global warming necessarily a bad thing? The Swedish scientist Arrhenius saw it in a very favourable light in his country. The effects will evidently not be the same in all parts of the world; differences will be far more complex than a simple north/south divide. The issue of migration will be crucial in the future: in the event of a rise in sea levels caused by melting of the Greenland and Antarctica ice caps, the OECD estimates that there will be more than 150 million climate refugees.

Conclusion from Riccardo Petrella, EC councillor, Professor of Economics in the University of Louvain

By way of summary, Riccardo Petrella put a few thoughts to the floor:

If the IPCC theories on global warming are realised, nearly 60% of the world’s population, or 5 billion people, will by 2032 live in areas with insufficient water; this means that they will lack the most basic element for life. These simple figures are enough in themselves to cause us to tackle head-on the issue of global warming.

In the coming decades, European history will be overshadowed by significant tensions between the various visions of the world; these will be divided between on the one hand those in favour of a privatisation of the world’s destiny in tackling vulnerabilities and threats, by strength and personal security, with the planet falling under the grip of domination and appropriation by the strongest; and on the other hand by the proponents of *res publica*, those who feel that earth, water and air are assets jointly owned by all of humankind. The speaker set technocratic oligarchies currently focussed around corporations and state structures that dominate and dictate their standards to the rest of the world, against joint construction approaches. Europe seems to favour asymmetrical adaptive security solutions, but it falls to leaders to encourage a move towards a more open approach, concluded Riccard Petrella, closing the first day’s proceedings.

Round table discussion: a path to resilience for Europe?

Chairperson: Christian Kert, Member of Parliament, elected as deputy for the Bouches-du-Rhône administrative unit, vice-president of the AFPCN, rapporteur for the parliamentary office for the assessment of scientific and technological choices.

This round table debate concluding the three days of this conference explored possible pathways to resilience in Europe. Hazards and crises are not inevitable, and it falls to Europe, with its experience and risk culture, to implement the best strategies in mapping out a joint response and finding joint resilience resources. Resilience in ecological terms is the capacity of an ecosystem or a species to revert to normal behaviour after a crisis. It may be defined as the opposite of vulnerability, explained Christian Kert by way of introduction. The various speakers at the round table will bear witness and contribute their experiences in tackling this issue of resilience.

Christine Lagarenne, deputy director of the Sustainable development service at the MEEDDAT (see below her second intervention)

The representative of this new and cross-disciplinary unit at the MEEDDAT will address this notion of resilience to natural disaster through the perspective of sustainable development; the unit promotes sustainable development among socio-economic actors and public authorities, explained Christine Lagarenne in her introduction. The definition of sustainable development, as outlined in the Bruntdland report, is to “respond to the need of current generations without compromising the ability of future generations to respond to theirs”.

Resilience is a component of sustainable development: it enables a response to a potential crisis to be planned, by organising and developing systems within society such as town planning and institutions. This requires preparation against future threats that are as yet unidentified but that we know are inevitable. Sustainable development and reinforced resilience are two practises that benefit from a long-term perspective. They rest on the same three pillars: social, environmental and economic. In these two approaches, the micro and macro levels go hand in hand. As was pointed out by the minister at the start of this conference, sustainable development and resilience are both a local and a global concept, and can only be effective if the relationships between the stakeholders – State, ministries, NGOs, organisations and insurers both at the national and international levels have been adequately thought out. Implementing these two concepts can only be carried out with the participation of all the local actors. The sustainable development unit works with this aim in mind along several axes: a research directorate is the French representative for European programmes such as Eranet flood that coordinates research programmes on flood risk from eleven European countries. The CGDD promotes sustainable development charters with involved parties, and ensures data availability for improved risk knowledge. Some studies have been carried out, for example on about the insurance scheme called “How can insurers encourage natural disaster prevention in France?” presented here for the first time by Christine Lagarenne.

Pierre Verger, member of the Prevention and Precaution committee, deputy director of the PACA regional health observatory, INSERM

The Prevention and Precaution Committee (CPP) is made up of around twenty experts, hosted by the MEEDDAT, with three functions:

- contributing better to basing ministry policies on the twin principles of precaution and prevention;
- monitoring and issuing warnings on health problems linked to environmental problems;
- ensuring the link between research and scientific knowledge on the one hand and regulation on the other.

The speaker focused his speech on the health and social consequences of disasters. Health consequences may be somatic, very diverse, short or long term, and can depend on the type of disaster and the protection steps taken during and after it. Consequences can affect mental health, bringing about depression, anxiety, post-traumatic stress, again in the short and long term. Assessments on the issue are still inadequate, noted Pierre Verger.

Social consequences can include loss of accommodation, material loss, loss of employment, family breakdown, closure of schools and businesses. Feedback sessions after the AZF factory explosion showed that victims can find themselves competing in responding to the disaster. Material problems mean that health issues often have to take a back seat, heaping disaster upon disaster. Again, there is not enough long-term assessment of these effects. These consequences do not affect everyone in the same way: mental health effects are more pronounced if there are pre-existing psychological problems and in disadvantaged social groups. Disasters really highlight social inequalities: the sick, the disabled, the isolated, and the vulnerable and particularly exposed.

The speaker underlined the need to better prepare for assessing the effects of a disaster in order to respond to it in an emergency, but also to better prepare for it in the future through feedback sessions (epidemiology, risk assessment, environmental sciences, social sciences, etc...). Assessment is also crucial in identifying victims and in the democratic debate process on land use and environmental law. In order to better evaluate the effects of disaster, Pierre Verger said that it was crucial to be prepared before the event. Mandated by the Ministry in 2006 to study the subject, the CPP has published a document that will be handed out to those attending the conference, called “Environmental disasters: drawing up assessments of their effects and using feedback”; this report recommends developing a database, reinforcing the coordination and synergies between the various actors, developing the training of those who will be called to act in the future, particularly by means of systems testing exercises, and to take advantage of and disseminate further the lessons learned from these feedback sessions.

It is crucial to be able to learn wide-reaching lessons on how well society is prepared to manage the effects of disasters, as it is the only way to begin a public debate on the topic.

The speaker quoted the presentation from Jean François Grelier, founder of “Collectif des sans-fenêtres”, an AZF victims’ association that proved that a disaster reveals inequality; the State has a crucial role to play in compensating for these inequalities.

Patrice Dallem, Director of emergencies and first aid, French Red Cross

The Red Cross Movement is working with 92 million volunteers in 186 countries. In France, the Red Cross has 45,000 volunteers, including 10,000 first-aiders who are active during all natural disasters.

The 1999 storm was the first conscience-raising climate change event, followed by flooding in the Somme, the heat wave, the Haumont tornado that razed 200 houses; all disastrous events that were previously unheard of in France. During all these natural disasters, nothing has indicated any real progress in resilience among populations, apart from in areas faced with regular flooding.

Instead of reducing risks, we are still under-informing people on the reality of risks, said Patrick Dallem, whilst simultaneously approving planning in flood or mudslide risk areas. There is still a huge amount of education carry out among citizens in introducing the concepts of risk reduction and resilience into society. A virtuous circle would be to train citizens, who would elect representatives whose policies matched their own worries and beliefs about risk.

“How do we build resilience?” asked the Red Cross representative. Firstly through suffering; a victim of a natural disaster will ensure that they are ready for the next one; by training citizens and through exercises; by the campaigning of victims such as those involved in the AZF factory disaster, who simply want to get back to normal after such a trauma.

The 2004 law on civil security encourages every citizen to become an actor in their own security. To achieve this they must be trained throughout their life to face situations which State is not capable of managing alone, due to a decrease in funds and to the multiplication of natural disaster. The law states that children should be taught at school about risks and best ways to react to them. The Red Cross has created a website for Europe called “Disaster self-protection” in order to distribute information about how to protect oneself against risk. Alongside this site, the humanitarian organisation is to begin training people in self-protection, inspired by the training on the “steps that save”. Seven thousand people have already undergone this training on a trial basis. This training should be rolled out during the course of 2009 across the whole territory in order to spread the message to the population on the basic behaviours to adopt in the event of a disaster (warning, quarantine, evacuation, etc...) The French Red Cross will during 2009 launch a programme called “Self-protection of children and the community” by involving older people, who will play an educative role among children.

On the humanitarian level, actions carried out by the Red Cross among disaster victims involve a lot of psychological support for vulnerable people, who need someone to listen to them. Actions will also include assistance for elected representatives, to whom the Red Cross will offer its experiences of crises and its human resources not only during the emergency, but also in the long-term by supporting fragile and struggling families made vulnerable by a disaster.

Marc Gillet, director of ONERC (National Observatory on the Effects of Climate Change)

The National Observatory on the Effects of Climate Change aims, explained its director, to collect information, studies and research on the risks related to climate change and extreme weather events, in order to distribute them among the government, local parliamentarians and the general public. ONERC produced in 2006 the French adaptation strategy and is currently working on a

national adaptation plan requested by the Grenelle Environment Forum[18]; this will firstly involve analysing the costs of climate change.

The concept of resilience is interesting by encouraging reconstruction, but also gives the impression that everything is reparable, although some damage, as was mentioned in the IPCC report, are irreversible, such as human losses and damage to the environment and heritage. Climate change risks were first identified on the global level. Climate predictions are more reliable on a global level than on a local level, which complicates coping strategies as uncertainty is greater locally. Internationally, coping has become more important. This is one of the four wings of the future Copenhagen negotiation, along with mitigation, technology and funding. ONERC has put forward a coping strategy, passed by the government in 2006: this strategy is broken down per sector, environment, resource, area; these four approaches lead to a more global, more exhaustive analysis of climate change risks.

The Observatory underlines the importance of knowledge on the issue of climate change and resilience. A joint ministerial project is currently underway under the aegis of ONERC, aimed at collecting all the data on the financial impact of climate change. This process is crucial in mobilising elected representatives over issues of coping with climate change, and raising funds to cover the anticipated costs.

The governance of resilience is extremely complex, and a European White Paper should tackle this issue to share responsibilities in a coherent fashion between the various levels, from Europe to the regions.

Pierre Alain Schieb, councillor, project head at the OECD

The projected OECD unit is looking ahead to 2030 in order to identify and explore questions that are central to governments. Work was carried out in 2003 on emerging risks that gave rise to around twenty recommendations on public policies, of which some covered reconstruction and resilience. Starting from this principles table, around a dozen cases were studied to order to improve risk reduction and reconstruction. Every case is then published: the speaker cited a study carried out in 2005 in Norway on the protection of critical infrastructure, as well as the study to due appear in 2009 on the earthquake risk in Japan.

Pierre Alain Schieb then put forward a far more ambitious definition of resilience, that widened the concept of restoring the system to the concept of th capacity for self-organisation in the event of a crisis, going outside preset plans. This ambitious approach to resilience presupposes involving the whole of chain of involved parties, and strong capacities for improvisation.

The speaker noted that the OECD estimated the capacity of reinsurance around USD 200 billion, whereas USD 400 to 500 billion would be needed to achieve the capacity to quickly restore damaged systems, whilst taking more precarious financial resources into account.

[18] The Grenelle Environment Forum is a series of political meetings, bringing together government representatives, professional associations and NGOs, held in France in October 2007. It developed recommendations related to the long term environmental and sustainable development. It resulted in two Bills ("Grenelle I", adopted by Parliament on 23 July 2009 and "Grenelle II", being considered by Parliament) who will both result in Orders of application.

Alex Nickson, strategy manager for climate change adaptation and water for the greater London authority

The London area was the first British urban area to establish a climate change adaptation strategy. Risks have been subdivided according to their level of probability in order to determine their vulnerabilities under different climate change scenarios and thereby determine priorities. Winters should be warmer and damper and summers drier and hotter. London, lying as it does on the Thames and near the sea, has considerable limits on land use; adaptation is therefore crucial. London is under threat from rising sea levels, from flooding from the Thames and its tributaries, from excessive levels of waste water and underground water. Some Thames tributaries have been concreted; in the event of large amounts of rain they would overflow in under two hours. Re-establishing natural processes could be the solution to some of the problems caused by poorly controlled urbanisation.

One and half million people, or 15% of the London population live in the Thames flood plain, protected by the Thames barrier. One hundred thousand households are in a high flood risk area, in which the Association of British Insurers cannot guarantee people insurance at a reasonable price. Key infrastructures in the continuity of activity are also located in this flood plain: 75 underground stations, 14% of the schools, 25% of the police stations and 10 of the largest hospitals in the Greater London area are located here. To map the risks in such a complex environment, an index has been established to determine the risk factors that increase vulnerability and thereby define priorities in the actions to be implemented. Systematic crisis has been studied: flooding has a repercussion on the electricity supply, which impacts in turn on the operation of hospitals, etc...

The speaker noted that due to the construction of the Thames Barrier, vigilance and the culture of risk prevention had noticeably regressed among the population. It is important to renew public awareness of the risks; if and when a disaster occurs, only the most vulnerable would be rescued; the rest of the population would have to look after themselves. The population cannot count only on the State to respond in a disaster. Alex Nickson thereby agreed with the previous speaker on the need for self-organisation of populations in responding to a crisis in an emergency and ensure their own resilience.

In the event of flooding, a successful warning system has been developed by the Environment Agency; this warns the population of the level of risk, and monitors especially carefully populations identified as vulnerable. Finally, to encourage populations to adapt their dwelling to flooding, advice has been distributed about how to reinforce houses. A resilient house also gains financial value compared to a vulnerable house.

In his conclusion, Alex Nickson insisted on the importance of adequately identifying levels of vulnerability in creating models, and of gaining a good awareness of the critical tipping point. The notion of resilience does not only apply only to the day to day; although the Thames Barrier protects London at the moment, but we must plan for the uncertainties of the future right now.

Eric Morvan, director of major risk for the town of Arles

Arles is a small town of 53,000 inhabitants located on the mouth of the Rhône river; it has the particularity of being the largest commune in France in surface area, and having this temperamental river running through it. The Camargue region has been protected by dikes since 1856; these were however breached by two floods in 1993 and 1994, causing major flooding. This was later found to be caused by poor maintenance. A mixed syndicate to maintain the dikes was then set up between local authorities, the Bouches-du-Rhône regional authorities, and the PACA region. Dikes must be

maintained, and are undermined by trees and animals digging burrows. Earthen dikes must be passable by motor vehicle, to enable rapid intervention should a dike require emergency maintenance. A flash flood breached the dikes again in 2003, flooding the north of Arles and requiring the evacuation of 7000 residents.

A Rhône plan was set up in 2004 to warn of flooding along the whole length of the river from Switzerland to the sea.

The new ministerial service Vigicrues will enable the population to be informed well enough in advance of any changes in the river. Arles is also served by a voice alert system, able to make 2500 calls every 15 minutes, and enabling vulnerable people to be warned, such as those who live in the flood plain of a river, and the livestock farmers in the Camargue. Flood evacuation, earthquake, and curfew exercises are carried out every month in the schools in Arles in order to train the population. Exercises are also carried out with residents via the voice alert system, in order to drill them in culture of risk and maintain permanent vigilance to the temperament of the Rhone.

Morgan Hervé-Mignucci, project head at the Climate unit, Caisse Nationale des Dépôts (National Provident Fund Deposits)

The Caisse Nationale des Dépôts (National Provident Fund Deposits) is a banking institution with a public interest and territory development mission. Its Climate Unit is a centre for study and research into the economics of climate change, into aspects of greenhouse gas emission reduction at the European and global levels, and into adapting infrastructures to climate change with the “Cities, Territories, and Climate Change” project.

The speaker noted the issue of funding resilience at a local level, along with the problems of including uncertainties in climate change. There is however a whole range of funding mechanisms that are well known by local representatives. He noted the problem of conciliating at Member State level the various encouragement methods to invest in resilience. There are very diverse protection mechanisms between the State as buffer, intervening only in the last resort, the PPP and the regularly reviewed notion of acceptable risk, and the French system of franchises.

There is a great demand for innovation in funding at the local level. We can imagine a system in which some dwellings would be insured only if certain building regulations were respected that would be dictated by insurers, as is the case in Australia.

At the international level, there are financial mechanisms for international cooperation on climate change. The United Nations adaptation fund that is funded only by Kyoto credits, or assets that are realisable only on the quota market; this market has however collapsed with the credit crisis, withdrawing the funds from the adaptation fund. Room for manoeuvre can now be found in negotiating the climate-energy package, that enables the adaptation fund to ensure stable and sustainable funding for resilience at the international level by recycling its income.

Christine Lagarenne, deputy director at the sustainable development unit

To conclude this final round table debate, Christine Lagarenne reiterated the main ideas expressed during the debates: the importance of solidarity in the event of disaster, with particular attention to social actions with victims; support for populations via economic assistance delivered as part of the emergency crisis management system, with institutions federating risks via the insurance system. Solidarity is implemented beyond people, particularly via local authorities, for public assets that are not insurable, for which the State deploys national solidarity, especially via the *ad hoc* programme.

Some disasters do not benefit from public assistance, so finance laws set up in 2008 a solidarity fund of 20 million Euros per year, to benefit local authorities affected by natural disaster.

Apart from solidarity, the response is implemented by federating risks. There are three main models in Europe within the various compensation schemes for natural disaster:

- the private model, with a free competitive British style market;
- the model based on public intervention without competitive insurance market, such as in Italy;
- the model that involves a compulsory public, monopolistic insurance scheme, frequently topped up with direct public assistance. The part-public/part private French system is similar to this model, and runs by a combination of disaster expertise contributed by the insurance sector, with and a high proportion of public cover. The French system excludes no type of natural disaster, and national solidarity is expressed in three ways: a law creating a legal obligation to be insured against natural disaster, a Catnat extra premium paid at a fixed level by every insured person, and the national re-insurance fund that benefits from State backing.

Within the EU, Community solidarity can be concretised via NGOs such as the Red Cross, but also via an emergency fund, the European Union Solidarity Fund, that grants assistance to any Member State struck by natural disaster in order to help it financially to re-instate its uninsurable assets, mostly vital in tackling a crisis: transport, water, energy, communications and health networks. This solidarity may also be expressed by federating knowledge and resources through the centralised civil protection system, the Monitoring and Information Center, that federates resources and warnings for the whole of Europe.

Christine Lagarenne concluded her intervention by reminding the floor that sustainable development is a federative, moral and concrete concept of resilience. The European development of platforms is a lever for reinforcing European resilience. The CGDD has declared itself ready to take part in a European network of risk economists.

Conclusions on Knowledge and policy tools

Preamble

The AFPCN Scientific Council is composed of independent experts from France and other countries, operating as a network. The Council prepares publications such as the blue paper on adaptation to climate change, a copy of which was provided to participants at the conference.

Several members of the Council (Mssrs Favier, Décamps, Wagner, Michel-Kerjan, Drobenko and Bourrelier) as well as moderators from the five workshops representing partner scientific and technical centres (BRGM, CEPRI, CEMAGREF, CERTU and EISTI) spoke at the conference. The Scientific Council also benefited from the support of the *Académie des Sciences* and international organisations (WMO, UNESCO).

The council met on November 28 prior to the afternoon session, which enabled the chairman to speak subsequently to participants on behalf of the Council as a whole on four main topics:

1° Agreement on the main findings

1.1. Concerning disaster risk reduction, the views expressed by different speakers' converged on the fact that we do not know everything but that we nevertheless know a lot about DRR and we already have tools in place as well as experience in using such tools. However, the main issues for consideration remain:

- how to put disaster risk reduction back on the political agenda (the issue of governance);
- how to genuinely and systematically involve industry as well as local and regional authorities
- how to take action on individual behaviour in terms of explaining, communicating and educating.

1.2. There was also significant agreement on the fact that the issues of DRR and adapting to climate change had areas of overlap, for example in terms of the requirement for a strategy and the long-term perspective, which does not mean that there is confusion between the two. It is therefore necessary to work in a concerted manner, since climate change serves to trigger and highlight the insufficiency of measures taken to date as well as the worrying growth of vulnerabilities.

1.3. There is a recognised need to define and implement integrated policies at regional level. However, the diversity and complexity of circumstances means that we need to present the problems in a new way and define priorities in order to break the deadlock.

1.4. As a result, there is a need to stress the following:

- exchanges of experience, lessons learnt and joint pilot demonstrations,
- improving communication, specifically through the development of local debate and a system of bottom-up feedback,
- developing and testing strategies in situations of great uncertainty.

2° Essential fields and disciplines

2.1. Action should focus on updating knowledge on an ongoing basis; it should be adjusted to changing circumstances.

Effective measurement methods as well as implementing, maintaining and making reliable data banks available to users in an appropriate fashion (specifically through mapping) are still the bases of effective risk management and knowledge. European research programmes are helping to organise networks and compare methodologies in fields such as flooding. Work should be extended to other hazards and carried out over time so that trends due to climate change and the modification of society's activities are reflected in the data.

2.2. More sophisticated management tools must be developed and tested for efficacy

Economic strategy models for situations of great uncertainty should be developed and inter-comparisons, carried out.

It is necessary to test and improve the application of Hyogo protocol principles and implementation tools on a regular basis.

In particular, early warning systems should be developed and shared more extensively. They should also be made more generally accessible.

2.3. The human and social sciences are still insufficiently applied.

Deliberations and debate on risk perception and decision-making tools are essential.

Resilience is a key area, which is based in particular on individuals' and systems' capacity for autonomy. It needs to find new areas of application so that people can take ownership of it and it can be developed. It must therefore combine different disciplines relating to the concept of risk prevention.

Debate with partners from developing countries opens up productive perspectives, and the development of such partnerships is strongly recommended.

2.4. Examples of governance through public-private partnerships show the extent of progress that is possible in line with the specific features of the European context

3° Major areas for vulnerability studies and action strategies

The five workshops confirmed the relevance of chosen topics, and specific recommendations led to them being categorised in three groups:

3.1. Cross-border rivers and mountainous areas are more consistent zones, which are already linked, specifically for crisis management purposes. Progress should involve the development of strategies and better communication, in particular using joint standards and tools,

3.2. The coastline on one hand and urban areas on the other are two very different regional divisions that both involve significant stakes and give rise to complex and specific problems.

For these regions, progress should involve setting out a general methodological approach supported by the development of more systematic debate.

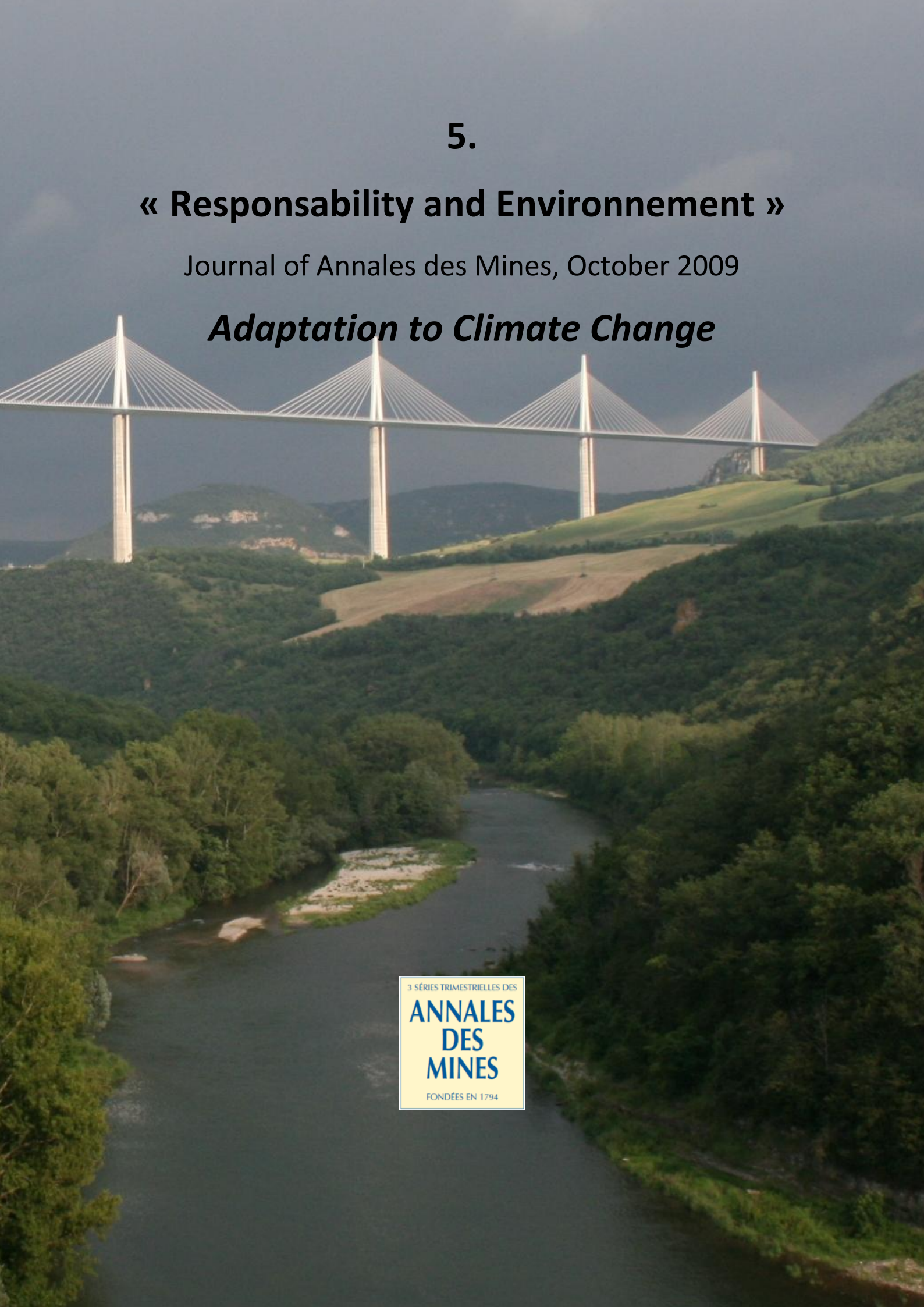
3.3. The training workshop referred to convergence between various stakeholders (local and regional authorities, central governments, the European Commission) on the notion of establishing a strong and dynamic training network on risks at European level.

4° European level

The European aspect brings definite added value due to the diversity of circumstances and cultures, which are its major asset, as well as a range of dimensions through which it can tackle problems and mobilise resources.

4.1. The scientific interface should be activated in such a way so as to encourage the establishment of scientific networks around the different platforms. By way of example, the AFPCN Scientific Council will request that platforms in the network put forward members or correspondents, which will help it to keep up to date with demands.

4.2. The EU should provide strong backing to the movement which was first initiated via a number of programmes under the Commission's DG for Research.



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« Responsability and Environnement »

Journal of Annales des Mines, October 2009

Adaptation to Climate Change

3 SÉRIES TRIMESTRIELLES DES
ANNALES DES MINES
FONDÉES EN 1794

Editorial

By **Pierre Couveinhes**, Editor of *Annales des Mines*

Even though climate change is now a hackneyed topic in the mass media, this special issue of *Responsabilité et environnement* approaches it from a seldom adopted angle: adaptation. It thus raises several novel questions:

- Climate change is often said to result from an aggression by humanity against a reputedly "good" nature. But is humanity, as Michel Juffé asks, not a part of nature? Is our species something on the outside that is "confronted" with nature?

- Although the prospects of climate change usually stir up vivid fears, might we not see them as a new challenge to humanity — one that ultimately enables us to make progress? Has Emmanuel Le Roy Ladurie not shown how humankind has previously coped with quite severe climate changes?

In this issue, the concept of *adaptation* implies reducing the vulnerability of natural systems to the eventualities stemming from modifications of the climate. For a long time, scientists, nongovernmental organizations and political officials in countries in the "North" have viewed this concept with suspicion. They feared lest it divert attention from another way of fighting against climate change, *attenuation*, which involves acting on the causes of global warming by, in particular, reducing greenhouse gas emissions.

Countries in the "South" now harshly criticize the priority given to policies for attenuating climate change. They suspect that the latter will hamper their development and that we are, after all, asking them to help find a remedy for a phenomenon for which they are hardly to blame.

What about countries in the "South", already faced with difficulties (in health, education and food supply), lacking necessary means? What about Africa, one of the principal victims, experts predict, of global warming?

There is no simple solution to these problems. Although climate change is a global phenomenon, policies of adaptation must be applied at lower levels. They require an amount of funding that stands no comparison with what is now devoted to aid for development.

In any case, as Marc Gillet points out, it now seems accepted that global warming "has already started […] and will intensify during the coming decades". We must adapt to it, as several developing countries are already doing. Articles in this issue describe the policies being adopted, in particular concerning the coastline and big urban agglomerations.

In the discussion at the end of this issue, Paul-Henri Bourrelier points out that most of the articles ultimately raise ethical questions. Can we, without any reaction, leave the poorest, hence most vulnerable, countries, endure the tragic consequences of a phenomenon for which they have a slight share of responsibility? Is it acceptable that part of our planet will become inhospitable for humanity because our nations are unable to collectively work out a response or because the wealthiest lands are egoistic?

Climate change, because it is global, can serve as an opportunity for Earth's inhabitants to become aware of the pressing need for solidarity. Let us hope that this will occur and that climate change will become the driving force in a new phase of humanity's development.

Summary of articles

I. Adaptation

Reflections on the climate, *Emmanuel Le Roy Ladurie, Historian, member of the Academy of Moral and Political Sciences of the Institute of France*

Emmanuel Le Roy Ladurie's *Histoire humaine et comparée du climat* counts three major volumes on the history of the climate and, like Montesquieu, on the relations between history and climate: *Canicules et glaciers XIIIe-XVIIIe*, *Disettes et révolutions (1740-1860)* and *Le réchauffement de 1860 à nos jours*. In an article in the summer 2009 issue of *Commentaire*, he presented his "reflections on the climate", which mainly focuses on the 20th century.

After recalling the medieval optimum and the "little ice age", which started during the 14th century in Europe, the author points out that: the "routing of the glaciers" began in 1860, the last major cold period occurred in 1887-1891, and temperatures slowly warmed till 1950, followed by thirty cooler years. The warming process resumed even faster after 1981 (with three exceptionally warm years: 1988-1989-1990); and higher temperatures have prevailed since. He concludes by addressing the CO_2 controversy:

> "I am not a full-fledged scientist, I am only a historian. Nevertheless, I am also convinced, I must say, by the evidence brought by the Intergovernmental Panel on Climate Change about the dangers, after all, of the excessive warming that will affect humanity during the 21st century owing to the excessive emission of greenhouse gases, CO_2, methane, etc.
>
> It is better to look back nostalgically on the recent past, 1990-2000. Can we say that Europe, except for the Balkans, was ever as happy as during the vintage years 1988-2001? […] As for the temperatures, they were mild, not scorching. It was truly an optimum, temporary of course. Springs, summers and autumns too were of the Tuscany type, halcyonic; winters, milder than ever compared with the nine previous decades of what we now call the 'previous century'. Although wines lacked the exquisite quality of the 1980s, they were very often quite full-bodied, of excellent caliber, especially as of 1995. The stock market was turning profits at full speed, at least for those who could enjoy the benefits. It would take the blood-chilling peal on 11 September 2001 and the deadly hot spell in 2003 to arouse our fellow-citizens in Europe from this delightful, end-of-century torpor (belied by terrorism and the heat wave) to the beginning of a new millennium."

Ideas about the changing climate: From God's creation to man's responsibility*, René Favier, CNRS, Université Pierre Mendès-France, Grenoble*

Is the climate changing? Do human actions affect this change? Such questions amount to a sacrilege. A short while ago, *Courrier International* ran on its cover the headline "Climate: Global warming does not exist". However an asterisk, prudently placed after this title, referred to a politically correct subtitle at the bottom of the page: "At least, some thinks so."

After presenting ancient conceptions of the climate and its imbalances, the author recounts the quest, following the birth of modern science during the Enlightenment, for identifying factors regulating the climate. Given the implied stationary hypothesis, advancing glaciers, for instance, were not evidence of a major change in the climate. Nonetheless, Montesquieu and then Buffon started asking questions about the impact of human actions, in particular on forests — a line of

inquiry pursued by engineers. In 1824, Joseph Fourier worked out the idea that the atmosphere and ocean altered the effects of the sun's rays. Other physicists, like Tyndall, an Irishman, followed up on this idea. The Swedish scientist Arrhenius was the first to relate warmer temperatures to the use of fossil fuels, which he saw as an improvement in the population's well-being.

***Lessons from geological history and the great extinction of species**, Patrick de Wever, National Museum of Natural History*

Talk about biodiversity often brings up the question of endangered species, such as the Pyrenees bear (since Cannelle died in November 2004) or the comeback of the wolf in the Alps or the elephant in Africa… symbolic, nearly mythical animals — the teddy bear of our younger years, held in our arms while listening to stories about the big, bad wolf and Little Red Riding Hood, or Babar. Now that we have grown up, let us not forget that other living beings — worms, insects, bacteria, etc. — are becoming extinct. Whether deemed useful, pleasant or harmful, they are a part of biodiversity.

Defined in relation to a classification of living beings, biodiversity, is now presented as the number of species, a figure with, unfortunately, a high degree of uncertainty — from 3 to 100 million! Species have quite different life-spans, on the average a few million years. The history of life on Earth evinces a trend toward increased biodiversity owing to diversification, but is also marked by episodes of massive extinction. We can, in fact, distinguish five major crises. Research has considerably advanced in assessing them, their causes and phases of recuperation, thus enabling us to assess the biosphere's reactions to major disturbances. What characterizes our era is a rate of extinction ten thousand times faster than the average in history. The hegemonic rise of the human species, before its inevitable extinction, will have wrought significant damage on our planet with its limited resources.

***Climate, adaptation, evolution and biodiversity**, Gilles Escarguel, CNRS, université Claude Bernard Lyon*

The biosphere — the thin layer surrounding our planet wherein living beings evolve — is a complex adaptive system, a network of multiple interactions where the existence of each being, regardless of its attributes, links to the existence of surrounding beings. We have identified the major physical, mathematical properties of this complexity: nonlinearity, metastability, self-organization, emergent properties, invariance to scale, irreversibility, sensitivity to initial conditions, chaos… Their biological, ecological and environmental implications are numerous.

The biological and geographical parameters of the evolution in biodiversity are listed; and the grounds for a new discipline — macro-ecology — laid out. A "geophyletic" model representing the gradients of biodiversity is presented with a two-dimensional application in the Atlantic Ocean. Variations over time on several scales are studied in parallel so as to determine the controlling parameters, in particular climate and adaptation, a decisive pair.

A global increase in temperature associated with a reduction of the latitudinal gradient of temperature — in line with the predictions of all simulations for the current century — will result in lesser global biodiversity because of the homogenization of groups of species between regions. During the past few decades, the increasing pressure exerted by humanity in all latitudes on most land and water ecosystems has furthered fragmented local environments, a cause of decreasing local biodiversity. These two factors are combining to plunge the biosphere into its sixth major crisis and extinction of species. The effects differ depending on the scale used. Any generalization that overlooks this is mistaken. This scale-dependence is a critical parameter for implementing strategies and effectively preserving our current level of biodiversity. It implies close international cooperation

on conservation policies, in particular for establishing permanently open corridors between protected zones.

***Localities faced with climate change**, Martine Tabeaud, Université Paris Panthéon Sorbonne, UMR CNRS ENEC.*

Among the parties acting to attenuate global warming and adapt to a changing climate are: international organizations, groups of nation-states, regions, local authorities, nongovernmental organizations, political parties, labor unions, banks, insurance companies, researchers, transnational firms, small businesses, mass marketing, transportation, the media and citizens. The dangers depend on the place.

Adaptation implies adopting an integrated approach. Actions can be undertaken at sites, in relation to the type of habitat and function. Owing to climate change, certain areas will be less able to support new carrying loads, while other areas will be relieved. There are reasons to reconsider the barriers that authorities often erect to keep populations from moving. Relying on decentralized governance, adaptation should involve everyone in their immediate vicinity. It implies overcoming several forms of egocentrism. Pragmatically, it takes individuals and social groups to be what they are. Small groups thus take a conscious part in a macro-action for curbing future risks. Local action does not at all preclude solidarity toward poor countries or regions that are more exposed to risks.

Strategies of acclimatization			
Attitudes	***Strategies***	***Examples***	***Time of implementation***
Coping	(-) *Laisser-faire*, abandon	Polders taken back by the sea, a return to coastal marshlands	Immediate
	(+) Limit losses, protect	Make dikes higher, build breakwaters to prevent flooding	From several months to years
Preventing	(-) Share losses, insure	Overtax if risks are high but share losses	Several years
	(+) Move people and activities out of the area	Raze houses and build elsewhere	Several months to raze buildings, several decades to rebuild
Improving	(-) Create new activities, change	Plant vineyards in Normandy instead of apple orchards	Gradual with a lag of several years
	(+) Increase the benefits, become richer	Innovate, invest	From several years to several decades

***From extreme events to figures of catastrophes**, Paul-Henri Bourrelier, General Engineer of Mines, President of AFPCN Scientific Council, and Jean Dunglas, President of the Academy of Agriculture*

Major climate-related events have a place in myths about the world's origin and destruction. There are equivalents in all religions to the biblical Flood. It is not surprising that the announced climate change has revived literally apocalyptic predictions, which are, in fact, revelations.

Extreme events are defined by the tails in their statistical distribution. Attention is drawn to events with non-Gaussian distributions and to the potential effects of climate change. Among meteorological hazards are: those stemming from climate-related factors, those that generate

classical risks by dissipating pent-up energy, and suspected cases of major ruptures. Regardless of the intensity of these events, even if they correspond to a power law's maxima, they will be limited.

The risk related to catastrophes lies downstream in this process: in what is at stake and in systemic weaknesses. This gives us a key for identifying risks, defining an appropriate strategy for reducing them and, on this basis, arousing a general awareness of them.

Adapting to what? What place for humanity in nature?, *Michel Juffé, Philosopher, Adviser to the Vice President of the General Council of the Environment and Sustainable Development (CGEDD), Ministry of Ecology, Energy, Sustainable Development and the Sea (MEEDDM)*

Adapting to a changing climate or to any other disturbance in the biosphere does not involve just technical or economic considerations, nor a "political economy". Everyone around us is talking about "sustainable development", about the need to more "soberly" consume energy and imagine an "alternative growth (often without providing any specifics). We are under pressure from two sources: those who invoke a "natural" world whose equilibrium we must preserve and those who advocate a "cultural" (*i.e.*, human) world whose originality we must maintain.

This analysis — based on three propositions: the infinity of nature, the perseverance of beings and the limits of omnipotence — concludes that it will not suffice to adopt preventive or adaptive measures to cope with menaces, such as global warming. Only our forbearance from the exaltation of raw power, which is still ingrained in human societies, will enable us to orient production toward something other than the ongoing misuse of resources, goods and beings. This implies that we stop seeing nature as actively harboring an intention to harm or satisfy us. In other words, we must stop seeing the dangers we encounter as menaces. It also implies that we curtail the menaces stemming from our own actions, not by battling whoever is suspected of threatening us but by no longer overinterpreting the behavior of others. The most urgent problem to settle on Earth is not to reduce the scope of climate change or its impact but to modify our own inner climate, the climate that prevails in all human relations.

II. Public policies and civic actions

The place of adaptation in climate policies, *Marc Gillet, Focal Point with the Intergovernmental Panel on Climate Change (IPCC), former director of the National Observatory on the Effects on Global Warming (ONERC), Director of International Affairs with Météo-France*

Released in 2007, the fourth report by the Intergovernmental Panel on Climate Change has dispelled any doubts that might yet exist about whether or not global warming has started or is caused by human activities, and about whether or not it will intensify during the coming decades. Two forms of prevention — adaptation and attenuation — can be imagined to cope with inevitable changes.

There are several types of adaptation: adaptation by anticipation, occurring before an event's effects are felt, and its opposite, adaptation in reaction. Adaptation might be spontaneous (*e.g.*, the reaction of ecosystems) or planned (*i.e.*, resulting from public policies for augmenting spontaneous adaptation). The conceptual difficulties of adapting to climate change should not serve as excuses for not doing anything.

Substantial progress can be achieved by describing future climates and calculating the probabilities of the ensuing eventualities: droughts, floods, etc. Progress should also be made in our understanding of vulnerability. Even though our knowledge of climate trends and extremes does not enable us to optimize adaptation, we can work out a policy under conditions that lessen uncertainty.

Adaptation is of overriding importance for poor countries. Although it has not been a priority for those who donate aid for development, it now figures among the objectives of most development agencies. The latter are backing climate-related actions by, for example, helping countries identify climatic trends. Agencies are also taking factors related to adaptation into account in development projects (for example, the rising sea-level in plans for developing a port).

Attenuating policies that have to do with energy, agriculture and forestry are not necessarily any easier to implement, but they are easier to define than actions having to do with adaptation. However adaptation is relevant to all sectors of activity. It mainly occurs at the local level; and it is either spontaneous or activated through the insurance market. For efficiency's sake, adaptive actions should be planned at all levels (local, national and international); and adequate funds must be channeled toward them.

***France's policy for adapting to climate change**, Pascal Dupuis, Head of Climate and Energy Efficiency Unit, MEEDDM*

The French policy for coping with climate change has two pillars: reduce greenhouse gas emissions (attenuation) and prepare for the inevitable (adaptation). Given the compulsory objectives set at the international and European levels, most sectors of the economy now feel concerned with attenuation, but they should also become more involved in adaptation.

The stakes of adaptation are high, comparable to those of attenuation. In November 2008, the United Nations Framework Convention on Climate Change estimated that, by 2030, from US$49 to $171 billion in supplementary funds will be needed for adaptation to climate change, whereas the additional funds needed for attenuation will amount to approximately $200 billion.

The arrangements for drawing up and conducting a policy of adaptation in France are presented: the institutional framework, the national strategy designed in 2006, and the work under way for fleshing out and "territorializing" this strategy. The setting in which a national program is to be drawn up by 2011 is described, along with the measures taken in compliance with the act ensuing from the Grenelle of the Environment, which assembled officials and organizations for a wide-ranging discussion on environmental issues. A communication to the 13 February 2009 cabinet meeting outlined a "road map". The Ministry of Ecology, Energy, Sustainable Development and the Seas (MEEDDM) is coordinating preliminary studies along with the National Observatory on the Effects of Climate Warming (ONERC). The Ministry of Agriculture has made a start at a plan for adapting agriculture. The High Council of Public Health is giving thought to adaptation, and its initial conclusions should be available in late 2009.

All this work will foster discussions during a process in 2010 modeled on the aforementioned Grenelle. After drawing up a national plan of adaptation and regional blueprints, these proposals will serve to mobilize all parties and make the compromises necessary for coping with the issues before us.

***Tilling the planet: More biomass, less greenhouse gas**, Francois Papy, Academy of Agriculture*

The 21st century will have to take up two challenges. The production of crops on the planet will have to increase to satisfy a population of about eight or nine billion by 2050, to satisfy the needs for food (which might well double) and for energy, textiles and industrial products derived from agriculture. The second challenge is to attenuate already under-way climate changes and adapt to them: attenuate in order to remain within the limits allowing for adaptation. We should, wisely, foresee an always possible acceleration of the processes under way.

During the historical era, food biomass has been produced by clearing forests and grasslands, thus releasing CO_2. Since 1950, agriculture has been consuming ever more fossil fuels in industrialized lands, owing to the use of fertilizers and other input factors for heating greenhouses, drying silage, etc. Emissions of CO_2 have increased fast, as well as those of nitrogen protoxide and methane, the former due to nitrogen-based fertilizers and the latter to ruminants. Although agriculture currently consumes but 4% of fossil fuels, it must contribute to overall efforts for saving on such fuels.

As we see, the complicated relations between the production of biomass and gaseous emissions are worth studying. Plant canopies are increasing used in quite different ways. In some places, an agriculture with low yields still has room to develop to the detriment of forests, whereas, in other places, an agriculture that intensively consumes resources is being installed on clearings. In some places, an intensive use of tilled lands for food allows for planting trees; but in other places, the room for feeding the population is so limited that the tiniest surface is intensively farmed.

The challenge is to produce twice as much food while halving greenhouse gas emissions and saving fossil fuels, all this in situations where resources are put to quite different uses. To this end, three axes are proposed:

- revive agricultural/silvicultural/pastoral systems;
- halt the race toward maximum yields; and
- improve the balance between regions, crop yields and greenhouse gas emissions.

Imagining and planning urban agglomerations: A few examples from Europe*, Brigitte Mazière, Inspector General of Equipment (retired)*

More than 70% of the European population — and 80% of the French — is concentrated in an urban environment. The growth of urban areas is a general trend. A few major events have illustrated how natural catastrophes affect urban agglomerations: the December 1999 storms that swept over western Europe, the exceptional flooding in central Europe during the summer of 2002, and the heat wave in the summer of 2003. Outside Europe, other recent events come to mind: the December 2004 tsunami in Asia or hurricane Katrina's devastation of New Orleans in August 2005.

The common points of actions undertaken in the Prague, Hamburg, London, Lyon, and Seville agglomerations are analyzed.

First of all, the arrangements made, despite the diverse situations, are coherent at the scale of the agglomeration:

- protective measures for all of the potentially affected area. Improving the management of these measures starts by identifying the parties who will intervene, thus clarifying (or sometimes redefining) the chain of responsibility between territorial authorities and designating the level assigned to coordinate actions;
- information and communication so as to involve all parties while taking into account individual and group behaviors during exceptional events;
- combined risks and their effects, a point calling for research given our lack of knowledge.

Secondly, these plans reduce vulnerabilities, even thought these cities do not perceive the latter alike. There is a shared need to be well-informed about weak points (especially in society, technical systems and organizations) and their effects during a catastrophe. Crises have brought to light underassessed or unidentified vulnerabilities, and shown how important and far-reaching the social consequences can be in the case of a strong disparity among inhabitants. Solidarity refers to public authorities' obligations and role for ensuring the safety of everyone in times of danger. In this respect, the case of greater London merits thought.

Thirdly, urban plans have not yet adequately reckoned with the inseparable relations between prevention, adaptation and regional planning. Despite the highly uncertain effects of climate change, we must adapt to it through long-term regional planning.

Urban plans take into account indispensable measures, such as the reduction of CO_2 emissions, actions for saving energy (self-sufficient buildings, environment-friendly neighborhoods, alternative forms of transportation), climate plans, the adoption of easements, etc. The implementation of sectoral policies and the arrangements foreseen in local plans of urbanism cannot, by themselves, have an effect at the metropolitan scale. If future cities are to have the requisite qualities, current practices and forms of development must be modified. Above all, urban sprawl must be restricted since it devours space and resources; and the areas best served by public transportation must become denser. Although no model of spatial organization is valid in all areas, nor capable of being both "sustainable" and "adaptable", the examples cited prove the necessity of a framework and strategic orientations so as to endow urban plans with visibility in the long run and ensure coherence at the scale of the metropolitan area or even beyond.

For metropolitan areas, predicting and managing potentially dangerous events and adapting to climate change are two aspects of a single challenge. Adaptation provides powerful leverage for rethinking how to develop the wide range of fields it covers: housing, transportation, business, social activities, the location and organization of public services, the protection of key points, etc. The authority to be put in charge varies depending on the country's institutions, decentralization and the distribution of powers between the central state and local authorities. It will be responsible for drafting a "framework document" and applying its provisions, while both leaving room for local initiatives and ensuring their coherence with national and international objectives. The exercise of this responsibility for urban governance is the decisive factor in the evolution of big urban agglomerations.

***For a dynamic management of coastal areas**, Nicole Lenôtre, Bureau of Geological and Mining Research (BRGM)*

The coastline increasingly attracts the attention of policy-makers and citizens. According to UN estimates, 80% of the world's population will be living on a 100 km-wide coastal strip by 2010. Eight out of ten of the biggest agglomerations are located on the coast: New York, Tokyo, Bombay…. France cannot dodge this trend: the coastal population is growing at an annual rate of 3,8% as compared with only 3,3% for the country as a whole.

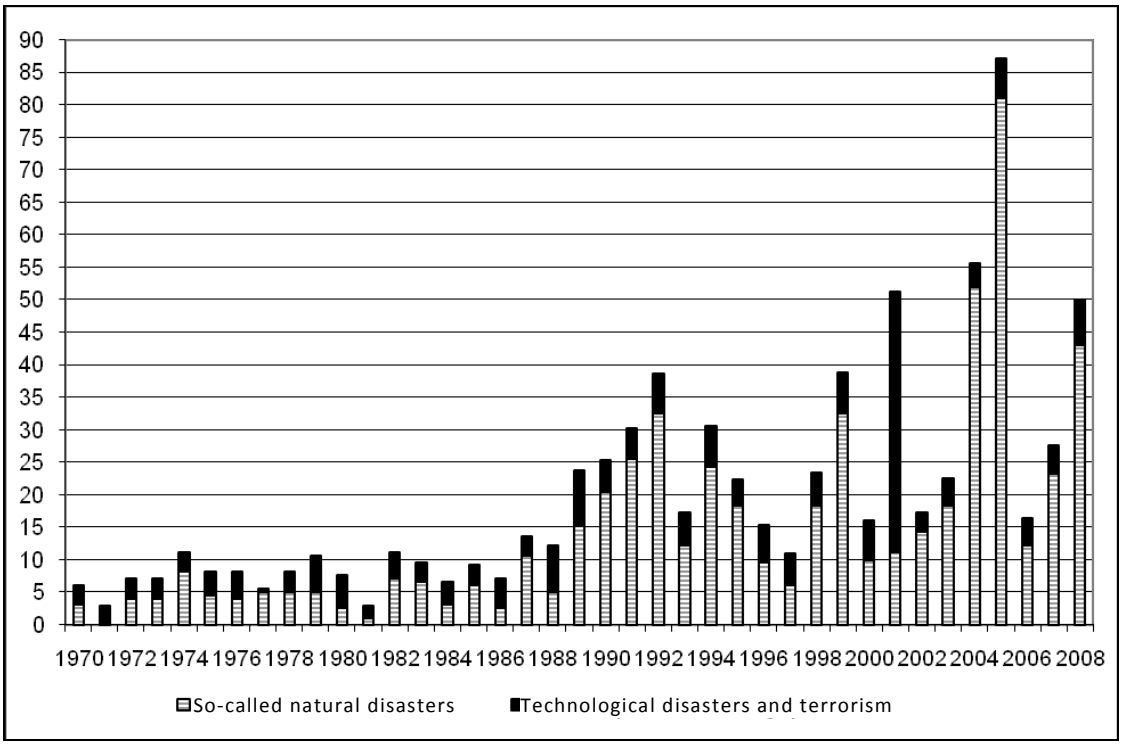
Given coastal phenomena (such as erosion, submersion and the rising sea-level) due to climate change and human activities, we must monitor risks and adopt specific management practices, which should take place at the appropriate scales. Furthermore, this management should use innovative techniques, such as the "soft" or "flexible" ones that do not set a limit for the high-water mark but do slow down under-way trends, namely: "beach nourishment" (increasingly practiced around the world), the stabilization of dunes, drainage, geotextiles and breakwaters. Plans should be drawn up: to manage as best possible the stock of sediments, given the shortage, on land or in the sea. More needs to be known about the natural sources that nourish beaches; and strategic stocks must be identified. Natural areas on the coast must be preserved as buffer zones between sea and hinterland; this is the assignment of the Conservatoire de l'Espace Littoral et des Rivages Lacustres in France.

These managerial strategies should apply, first of all, to new installations, which must draw lessons from the past about erosion, submersion and the rising sea-level. Starting with the initial phase of design, such installations should take into account prevention-related parameters. In zones already protected, there is a choice between several strategies. *1)* We can, at the very least, avoid new constructions in high-risk zones. *2)* We can organize a strategic retreat by moving what is endangered

and identifying a new line of defense. *3)* We can maintain a level for the high-water mark while improving breakwaters, a choice adapted to zones where what is endangered is valuable and can hardly (or not at all) be relocated. *4)* We can limit interventions by monitoring natural processes so as to palliate eventualities. *5)* We can simply monitor an area as needed whenever nothing at the site justifies further action. Proposals of this sort were made during the Grenelle de la Mer, a meeting of officials and organizations on issues related to the sea and coastal areas.

***Financial coverage of extreme events related to the climate**, Erwann Michel-Kerjan, The Wharton Business School, University Of Pennsylvania, USA and Department of Economics, Ecole Polytechnique, France. President of the High Council on the Financing of Large-Scale Disasters with the Secretary General of the OECD*

Given that climate-related events will be potentially ever more devastating, who will cover the costs of disasters? In industrialized lands, insurance traditionally plays a leading role by covering individuals and firms in the case of major natural risks with an economic impact. Parties to an insurance contract pay moderate premiums compared with potential losses. Although insurance is now a major revenue-generating industry worldwide, traditional insurance systems are showing their limitations in dealing with major disasters. Catastrophes no longer happen on the average of once every twenty years (thus allowing the companies time to collect enough premiums), but more and more often, as show in a table and a graph:



Cost (billions of US$ 2007)	Events	Casualties (dead or missing)	Year	Major zones of impact:
48,1	Katrina, hurricane	1836	2005	USA, Gulf of Mexico
36,8	Terrorist attacks	3025	2001	USA
24,6	Andrew, hurricane	43	1992	USA, Bahamas
20,3	Northridge, earthquake	61	1994	USA
16	Ike, hurricane	348	2008	USA, Caribbean Basin
14,6	Ivan, hurricane	124	2004	USA, Caribbean Basin
13,8	Wilma, hurricane	35	2005	USA, Gulf of Mexico
11,1	Rita, hurricane	34	2005	USA, Gulf of Mexico
9,1	Charley, hurricane	24	2004	USA, Caribbean Basin
8,9	Mireille, typhoon	51	1991	Japan
7,9	Hugo, hurricane	71	1989	Puerto Rico, USA, Caribbean Basin
7,7	Daria, storm	95	1990	France, UK, etc.
7,5	Lothar, storm	110	1999	France, Switzerland, etc.
6,3	Kyrill, storm	54	2007	Germany, UK, Netherlands, France
5,9	Storm and flooding	22	1987	France, UK, etc.
5,8	Frances, hurricane	38	2004	USA, Bahamas
5,2	Vivian, storm	64	1990	Central and western Europe
5,2	Bart, typhoon	26	1999	Japan
5	Gustave, hurricane	153	2008	USA, Caribbean Basin
4,7	George, hurricane	600	1998	USA, Caribbean Basin
4,4	Alison, tropical storm	41	2001	USA
4,4	Jeanne, hurricane	3034	2004	USA, Caribbean Basin
4	Songda, typhoon	45	2004	Japan, South Korea
3,7	Storm	45	2003	USA
3,6	Floyd, hurricane	70	1999	USA, Bahamas, Colombia

Note: Prix indices 2008

A paradox in the land of free enterprise: several of the principal catastrophes since 2001 in the United States have dramatically raised questions about how to financially cover major risks. Who should pay? How to use insurance to motivate prevention? Ultimately, roles and responsibilities have to be redistributed between the private and public sectors, for the time being in favor of the latter.

The *cat.nat* system in France, based on a principle of national solidarity, makes coverage compulsory. Insurers are able to reinsure themselves with the Caisse Centrale de Réassurance, which enjoys unlimited state backing. Even though there is not a genuine market, the cost of this insurance has increased considerably, a trend laden with problems for the future.

As this brief overview lets us see, a new era of large-scale risks has commenced. It calls for a new model of governance and funding. The financial, social and political issues are of utmost importance in OECD lands, where insurance plays a key role, and also in poor countries, where an extreme climatic event causes a human tragedy interrupting economic growth. The UN recently decided to place at the center of negotiations during the conference of Copenhagen (December 2009) the question of insurance as a means for adapting our societies to climate change. This is a direct, official recognition of the new era. It points toward working out new, joint solutions in response to extreme events during the coming years.

***Ethics, the guideline for adaptations**, A discussion between Paul-Henri Bourrelier (chairman of AFPCN scientific council), Alain Grimfeld, (chairman of the National Consultative Committee on Ethics for Life Sciences and Health), Yves le Bars (president of GRET, a professional association of solidarity and international cooperation) and Claudine Schmidt-Lainé (scientific director of CEMAGREF)*

This exchange, presented in the conclusion of this special issue, pursues the questions raised in several articles:

- International fairness (mentioned by Marc Gillet). Since the Bali conference, as Yves le Bars stated, this point has come under consideration and led to drafting plans of adaptation under the auspices of the World Bank. There is, however, a contradiction between earmarking aid for adaptation and the integrated nature of development. Emerging countries must be told,"Don't do like us, don't make mistakes when giving a form to your lifestyles and economies lest you pay a high bill during the 21st century." Let us hope that lucid leaders will find an educational approach for quelling any (quite understandable) impatience and exploring original models for development.

- The viability of ecosystems and societies. This idea, as Claudine Schmidt-Lainé explained, "dynamically" extends the notion of resilience. Open systems are faced with their environment. It imposes external constraints to which they must adapt by adjusting their consumption of resources and production of wastes, whence questions about viability.

- Financial tools.

- Scientific ethics. As Alain Grimfeld indicated, this ethics has three axes in the case of adaptation: taking into account the situations of developing and/or poor countries; financial aspects, in particular the budgets allocated for research; and the application of the principle of precaution.

- Humanity's integration in nature.

- Utopia and "catastrophism". Paul-Henri Bourrelier argued for a balanced view of environmental pressures and convulsions, of those that destabilize and of those that are beneficial. Changes on a planetary scale are stimulants with an effect in both the concrete world and the imagination. They are a call to order that challenges our species. A narrow road separates illusory, hence dangerous, efforts to subjugate the world from a passiveness that just as surely leads to disaster. Every step in the progress of our knowledge or technology brings along additional risks of material as well as moral catastrophes (for instance, the immoderate recourse to the markets to stimulate artificial needs and speculative bubbles, or the general rarefaction of petroleum and water in certain areas). The climate's warning signs might be life-saving, forcing us to develop early warning systems and return to the values that make us human.

In conclusion, Alain Grimfeld pointed out that the ideas of progress and development must now include the individual's access to well-being and fulfillment, especially in poor, "developing" lands.

Sources and contributions

General coordination: French Association for Reduction of Natural Disasters (AFPCN).

Paul-Henri Bourrelier, president of the Scientific Council.

Jean-Baptiste Migraine, international affairs representative.

Realisation: Julie Pétrelle, representative.

The French Association for the Prevention of Natural Disasters (AFPCN) was created in 2001 to take over the French Committee of the International Decade for Natural Disaster Reduction (IDNDR). It is part of the structure of the French platform, operator for the Ministry of Energy, Ecology, Sustainable Development and Sea. With a NGO status, it organizes meetings and debates, at national, European and international levels, between governments and members of civil society, towards strengthened prevention of disaster risk.

The AFPCN Scientific Council, registered in the rules of the Board, was established in June 2004. It is composed of twenty independent experts, French and foreigners. According to the vocation of AFPCN, its composition is balanced between scientific disciplines of nature (hazards) and those of society (vulnerability, resilience). Its missions are to provide advice and support, to organize conferences and seminars, and to provide a scientific watch on risks.

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National Observatory on the Effects of Climate Change (ONERC) and **Joint Ministerial Working Group on "Climate Change Impacts, Adaptation and Associated Costs"**

Nicolas Bériot, secretary-general of ONERC.

Michel Galliot, representative.

The ONERC is attached to the Directorate General for Energy and Climate (DGEC) Department of Ecology, Energy, Sustainable Development and the Sea (MEEDDM).

ONERC's missions include:

- Collect and disseminate information, studies and research about risks related to global warming and climate extremes.
- Develop recommendations on prevention and adaptation measures to limit climate change related risks.
- Contribute to climate change dialogue with developing countries.

Joint Ministerial Working Group was constituted by the MEEDDM (then MEEDDAT) and piloted by the D4E (Economic Research and Environmental Assessments Department) and the DGEC in collaboration with ONERC. .

Pierre Franck Chevet, Director General of DGEC and Director of ONERC.

Pascal Dupuis, Head of Climate and Energy Efficiency Service.

Daniel Delalande, Head of the Greenhouse Effect Fighting Department .

With the contribution of Stéphane Hallegatte, CIRED.

Contact : ONERC, Arche Nord, 92055 La Défense Cedex

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Academy of Sciences, Institut de France.

The Academy of Sciences brings together French scholars, and associates foreign scholars chosen each other and among the most prominent. Its missions are:

- Promote the development of science for the benefit of society.
- Bring together French and foreign scholars.
- Keep the memory of science and scientists.
- Publish reports and recommendations, summaries and original studies.
- Being a place of lectures and discussions.
- Rewarding French and foreigners scientists.
- Participate in international life.
- Promote education of science.

Henri Décamps, a member of the Academy of Sciences, Laboratory for Functional Ecology - CNRS.

Contact: Académie des Sciences, 23 quai de Conti, 75006 Paris

Website: http://www.academie-sciences.fr

Research Programme : Management and Impacts of Climate Change (GICC), Sustainable Development Authority, MEEDDM, with technical support provided by the Public Interest Group Forest Ecosystems (GIP ECOFOR)

The GICC program is driven by the MEEDDM and supported by ADEME and ONERC.

Working themes**:** socio-economics, climate change, impacts on ecosystems, health, adaptation, mitigation...

Objectives**:** development of knowledge in support of public policies.

Daniel Martin, Climate Change representative, Department of Research and Innovation, Sustainable Development Authority, MEEDDM.

Natacha Massu, GIP ECOFOR representative.

Philippe Dandin, Météo-France, Director of Climatology, DRIAS project manager.

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Website: http://www.gip-ecofor.org/gicc

Directorate General for Risk Prevention (DGPR) of MEEDDM.

The Directorate General for Disaster Risk Reduction is responsible for coordinating the prevention related to all types of hazards, natural and technological, to ensure consistency in risk management.

It is responsible for the prevention of natural risks, and for the management of all water hazards, towards an integrated approach to flood risk, involving the relevant departments (flood prevention, flood forecasting, safety of hydraulic infrastructures).

It promotes the inclusion of issues related to emerging risks and contributes to health policy, as the latter is related to the environment.

Anne-Marie Levraut, Chief, Natural and Hydraulic Risks Department.

Thierry Hubert, Deputy Chief, Natural and Hydraulic Risks Department.

Sylvie de Smedt, Secretary of the RNACC Working Group, Deputy Chief of the Meteorological Risks Department.

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Responsibility and Environment, Quarterly Series of the Journal of Mines.

This series of Annales des Mines, created in 1996, brings together, wherever possible, the various points of view and analyzes likely to base choices and industrial policy balanced on their consequences in terms of environment and risks.

Pierre Couveinhes, editor.

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