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Entreprises, territoires et environnement

Climate and Biodiversity

Stakes and solutions

Actors of today
and the future
at the interface
of climate
and biodiversity stakes

Under the scientific direction of Michel Trommetter
Director of research at INRA

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A Word from our Chairwoman

“The biodiversity risk is a heavy issue in the climate dossier. I do not need to remind you that global warming, and more generally speaking, planetary change, seriously point to a sixth massive extinction of species. Among the red-listed threatened species there are already a quarter of all mammals, one in ten birds, a third of amphibians, a large number of plant species and whole ecosystems.

Climate change and the erosion of biodiversity are both environmental stakes which are also human stakes. Our way of life is largely responsible for these global charges and our development choices are disrupting the planet’s ecology heavily and in depth. We are to blame, whether we are aware of this or not.

The environmentally displaced are a painful testimony to this and a legal status must be found for them.

As an enterprise-territorial authority multi-stakeholder association, the reflections conducted for more than 20 years by ORÉE, its members and experts are continuing herein and make up ORÉE’s contribution to the COP 21 climate negotiations. An awareness-raising tool and a perspective on the stakes and solutions, this document is part of the work involved in the international scientific conference entitled « Our common future », in the framework of an event organised jointly by FRB and ORÉE on the topic of the interactions between Climate and Biodiversity. In addition to this, it is important to remember that the French platform of the Global Partnership for Business & Biodiversity developed by ORÉE enables all the actors to report on their good practices and actions: this platform must be used to the full to make up the indispensable network of biodiversity solutions.

Through their interdependency, Climate and Biodiversity are the basis of all life on Earth. It is absolutely necessary that Biodiversity be a guest at the COP 21 negotiations Table as Climate and Biodiversity go together. We hope to contribute with this document. Our thanks go to all those who have contributed for the relevance of their analyses and outlook.

Today we are at a Crossroads. We must all, individually and together, make our common Future possible: new production methods and consumer patters, strengthening of CSR and respect for biodiversity. There is no time to lose; it is Time for necessary and vital Action.”

« As far as the future is concerned, it is not a question of forecasting it, but more of making it possible » Antoine de Saint Expiry…

Warm thanks to all.

Patricia Savin
Chairwoman of ORÉE

Edito

“Biodiversity has been a major topic in ORÉE’s works for over ten years. As a pioneer in 2006, the association created a Biodiversity and Economy working group with a dual aim: to demonstrate the interdependency between organisations and biodiversity and integrate it into economic strategies. The network’s contributions have already been published, and particularly in two extensive books: “Integrating biodiversity into business strategies” which was published in 2008, and “Management of biodiversity by actors: from awareness to action” in 2013.Today, a thesis by ORÉE entitled « Biodiversity and strategy of organisations: building tools to manage multiple and intertemporal relationships » lays the groundwork for integrating biodiversity into financial accountability and the think-tank is now dedicated to forward-thinking, specifically on the interface between stakeholder dynamics and territorial dynamics. In this framework, the evolution of the biosphere under the effect of climate disruption and the stakes this represents for human beings fit perfectly into our reflections.

Whether to remind us to what extent climate and biodiversity depend on each other or to highlight the considerable environmental and human upheaval at play, the subject of this new book is informed by reports from the experts who accepted to be a part of our thought-process. Subsequently the book offers several avenues for action based on practical feedback from our members.

The stakeholders here at ORÉE are already initiating and implementing practical actions regarding the management of climate change (directly or indirectly, and relative to mitigation or adaptation) and that of biodiversity. We therefore believe that it is essential to valorise these initiatives which are also beneficial from an economic point of view: we have noticed during our different works that organisations which take a strategic ecosystemic view into consideration belong to a trajectory of strong sustainability.

Through this document which shows the ability of stakeholders to innovate and make recommendations to decision-makers and other economic agents, we hope to help others want to commit themselves in favour of the climate and biodiversity.

Looking forward to seeing you again soon.
Best regards to all. Good reading!”

Nathalie Boyer
General Delegate of ORÉE

Interdependence between climate and biodiversity

Earth, the blue planet of the Solar system, hosts life under the protection of its atmosphere. The relationships between atmosphere and biosphere have been woven over a history of thousands of years as is shown by the ices and fossils. It is currently possible for us to read this complex system by speaking on the one hand of climate and biodiversity on the other, but we must not forget that due to their multiple interactions and interdependencies neither one nor the other can be taken separately. It is moreover impossible to imagine human beings without their environment; they are dependent on it first and foremost for the air they breathe and whose composition they modify.

The climate: a dynamic life-supporting balance

All beings live on the Earth in a well-defined climate (continental, ocean, tropical, etc.) which conditions the weather on a daily basis, but nowadays climate change has become the major topic - climate change on a global scale: a rapid, strong modification of all the elements which govern the air and water masses of this planet.

Since « time immemorial », the Earth has experienced a wide variety of global climates, rhythmed by several ice ages as evidenced by « paleoclimatology ». The axial tilt of the planet in relation to the sun, the greenhouse effects of several atmospheric gases, ocean masses and currents, the capacity of its surface to absorb or reflect the sun's rays (albedo) are all just some elements of what makes up global climate.

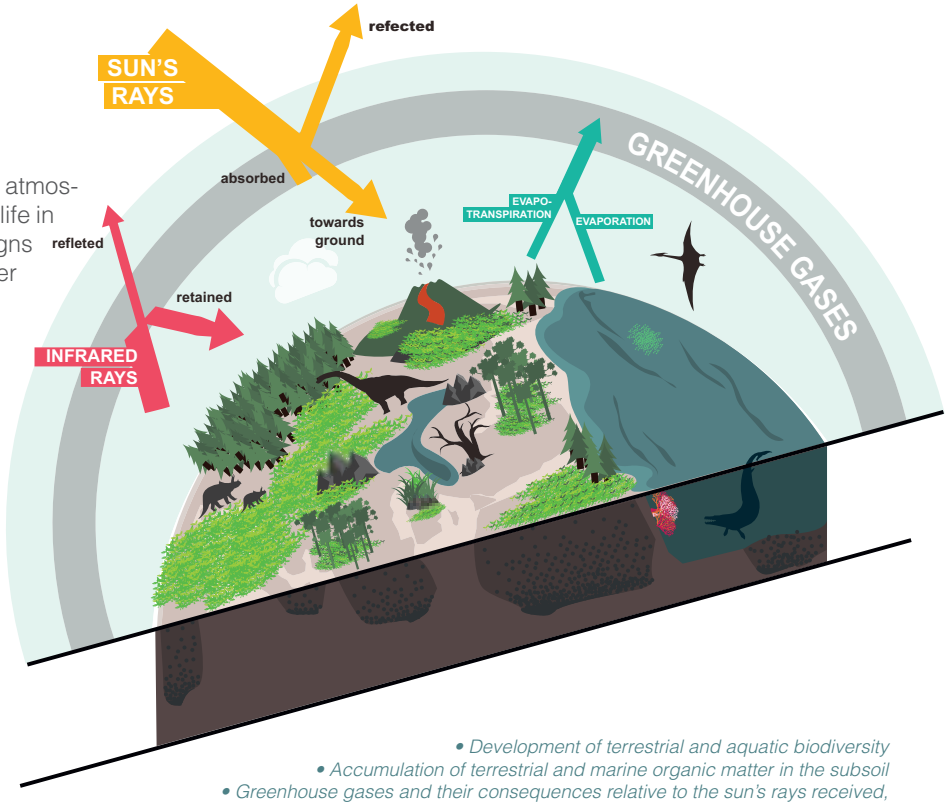
From the moment the primitive atmosphere formed and up to the appearance of life, the sun's activity was supposedly weaker, supplying less energy and heat, whereas the greenhouse effect was greater: the atmospheric gases from telluric activity and the evaporation of the oceans absorbed and reflected most of the heat given off by the Earth (infrared radiation). Since then, the heat exchanges between the earth's surface and the solar system have been confined by the layer of greenhouse gas in the atmosphere.

Among the great cycles of matter (the biogeochemical cycles), the cycle of water and that of carbon are paramount in understanding the past and future evolution of the climate. Water vapour and CO_2 enter into the composition of the atmosphere and contribute to its greenhouse effect.

This greenhouse effect is responsible for a relative stability of temperatures on Earth, and enabled life to appear. The living world takes part in and modifies the relationships between the earth's surface and the atmosphere, the heat and gas exchanges conditioning life in return. Thus the presence of the living world redesigns the surfaces and their albedo. The cycle of water now includes evapotranspiration from plants and animals. That of carbon is deeply modified by the photosynthesis of chlorophyllous plants and enables them to sequester atmospheric carbon to build (organic) living matter and release oxygen. The living world participates in the production of heat and CO_2 by breathing. The fluxes, quantities and ratios of greenhouse gas then evolve. Part of the CO_2 is therefore captured by the earth's surface, stored in living matter (plants and the whole resulting food network). This organic matter was to be partly integrated into the earth's crust in the form of fossil matter over the centuries. On the surface of the Earth the exchanges continued. The quantity of greenhouse gas allows the average global temperature to balance out at around 15°C and keep water in liquid form.

This global balance between the earth's surface and the atmosphere has undergone a few variations (for example, the Little Ice Age), but remains sufficiently stable to allow the development of a rich planetary diversity.

Diagram showing the planet in the Jurassic period



• Development of terrestrial and aquatic biodiversity
• Accumulation of terrestrial and marine organic matter in the subsoil
• Greenhouse gases and their consequences relative to the sun's rays received, infrared rays emitted by the biosphere, of water vapour from the evaporation of aquatic surfaces and evapotranspiration from living beings.

Weather is not climate

The word weather relates to the state of the atmosphere (atmospheric pressure, humidity, etc.) at a given time on a particular territory. The time and space scales are limited. It's what we see when we look up at the sky and what the daily weather forecast shows.

The climate is an average of meteorological data. The time scale is longer (tens of years at least) and the same goes for the spatial scale (country, continent, large region). The study of the climate is taken up and synthesized in IPCC reports (Intergovernmental Panel on climate change) to qualify and quantify climate change.

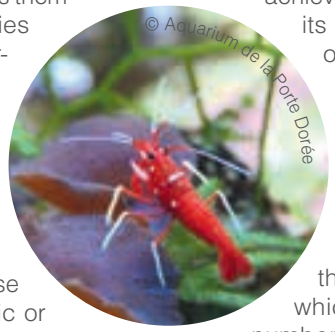
Greenhouse gases: positive or negative?

The gaseous composition of the atmosphere gives it the capacity to preserve part of the heat that the sun procures for the planet and the heat produced by the biosphere. This natural phenomenon, this « greenhouse » effect, limits the temperature variations on the Earth's surface and allows life to develop. The main gases responsible for this « greenhouse effect » are water vapour, carbon dioxide, methane, nitrous oxide, stratospheric ozone and fluorinated gases. As biodiversity takes part in the cycles of water, carbon and nitrogen, it influences this planetary cover by the exchanged flux as well as the stocks (organic matter) that it supplies to the chemical elements involved. But current human, industrial and agricultural, etc. activities… (specifically those using fossil organic matter) rapidly produce a large quantity of greenhouse gases which increase the natural greenhouse effect (additional greenhouse effect) and contribute to the acceleration of climate change.

Biodiversity: the combined evolutions of the living world and the climate

From the dark hot depths of ocean faults to the deserts and from soils to intestinal villi, the living world inhabits the Earth and fashions it according to its evolutionary capacities. This incredible diversity and the multiple interactions underlying it and connecting it to the atmosphere and the lithosphere make up «the living material of the planet».

Around 4 billion years ago, the first life forms appeared. Our planet's mass and distance from the sun enable it to host water in its three forms (ice, liquid and water vapour) and all life forms are made up of water and take part in the cycle of water. It is also the average temperature of the Earth, which is temperate in its variations thanks to the atmosphere, which enables life to exist. Whether they have the temperature of the external environment or their physiology allows them to control it (warm-blooded), species are closely dependent on the external temperature and its variations. Therefore any rise in temperature will accelerate chemical reactions, including those within the cells of the organism, and too sharp a drop could be lethal if the water becomes ice and disrupt the smallest elements which make up living matter. Likewise the pH, which determines the acidic or alkaline character of an aqueous environment, plays a major role in the development of life. The pH of aquatic environments is fundamental for the organisms which inhabit them and also intervenes in a number of cellular operations in all living beings. The pH of cells and that of the ambient environment is particularly impacted by the phenomena of photosynthesis and respiration.



Thus, during life and on death, each individual contributes to the cycles of energy and matter of the living world. Photosynthesis and breathing are important processes for the cycle of carbon and water and therefore for the exchanges of gas and heat between the earth's surface and the atmosphere. According to constraints and its reproductive capacities, DNA is the elemental part of a wonderful diversity of forms and ways in which the living world works. A simple examination of the diversity of the known living world shows this great capacity for adaptation and physiological and organisational achievement. Unceasingly interacting with its inert medium and the other forms of life, each individual, whether it is microscopic or as imposing as the dinosaurs, interacts with this planet. It takes part in the construction of a living world, and to the emergence of diversity in changing environments.

The human species is one of the threads in this living planetary fabric which both progressively colonises a number of territories and diversifies in its crops and lifestyles and with the biodiversity it occupies. The hunter-gatherer nomad becomes sedentary and a farmer-breeder, as he fashions the landscapes, selecting part of this biodiversity which then becomes known as domestic. Through his developments and practices he will participate in the evolution of the biosphere on a territorial scale (for example: by building dams which modify the flood rhythms of rivers, forest management, crops, etc.).

An incredible… but fragile fabric of interactions between the climate and biodiversity

Major stakes and inseparable challenges

With climate disruption under way, the biodiversity extinction crisis, a circle of feedbacks and the frittering of the adaptive capacities of the living planetary material, the basis of life for the human species is being swept from under its feet. Since the late XVIIIth century we have entered «the Anthropocene» epoch. Humans are now a planetary force but they are nonetheless vitally dependent on this planet and its future. The challenges are many and varied, to be attacked head on and together due to the underlying interactions. The stakes are simple and concern all humankind: the future of living together, the future of living on this planet full stop.

Climate stakes

Today, the causes of climate change are far removed from the atmospheric strata, and must be sought at a human level- IPCC (Intergovernmental Panel on climate change) is calling urgent attention to this. Our societies have shared a history going back thousands of years with this planet, but have recently disrupted on a large scale a dynamic which was structured by a certain inertia, chain reactions, cascading sequences... that of the climate.

From the end of XVIIIth century, during the Industrial Revolution, using fossil materials to produce energy went hand in hand with the development of technologies and gave the illusion of possibilities without limitations or constraints. Considered as a horn of plenty, both the fossil materials extracted and the biosphere were then «consumed» on such a scale that the great climate balances are now highly disrupted.

The consumption of gas, oil or coal, the destruction of forests, and all the activities which release large quantities of carbon and particularly of carbon dioxide into the atmosphere reinforce the greenhouse effect.

Human activities and consumption patterns contribute to the excessive production of greenhouse gases. Among those which emit the most, so-called modern agriculture, with its cultivation and breeding practices, particularly those which destroy forest environments… and the use of phytosanitary products, is responsible for considerable quantities of CO_2, CH_4, N_2O. Industry and the production of consumer goods also require huge amounts of fossil material, and go hand in hand with large-scale urbanisation, transport and exchanges which lead to modifications in the territories involved in biogeochemical cycles.

So greenhouse gases accumulate in the atmosphere and increase this «blanket» which surrounds the Earth, while human activities are simultaneously producing heat. The average temperature of the planet is rising. This phenomenon shows a global change in the cycles of matter, resulting in a modification of the great balances between oceans, atmosphere and land masses. The global climate and its local forms are changing. Atmospheric currents such as those of the ocean are therefore disrupted. Knowledge of the climate, current observations and theoretical models make it possible to announce a climate change, a change in the natural variability of current climates.

Even though it is not easy to forecast on a local scale, all agree that the consequences will be a sharp increase in risk for the living world. Acidification of the oceans, rising water levels, ice melt, more extreme events and increased desertification represent global changes which are currently occurring faster than ever on Earth and are increasing with the accumulation of greenhouse gases, with rebound and delayed effects which more than ever justify IPCC's alarm.

Jean Jouzel,
Director of Research for the CEA,
Vice-Chairman of IPCC Scientific,Group

Climate? What are we talking about?

"As a climatologist, involved in the reconstruction of past climates from the analysis of polar ices, I became interested in the future of our climate in response to an increase in the human activity-related greenhouse effect. There is a very simple reason for this: the past is a source of information for those who are interested in current and future global warming. But for a long time I contented myself with the «physical science» aspect of this warming and its consequences in terms of temperatures, rainfall, atmospheric circulation, sea level, etc. Remarks – which were probably justified – were made that I didn't talk enough about the living world and particularly the link between global warming and the loss of biodiversity.

I now talk about it at every conference by using IPCC's 5th report executive summary. It specifically compares the maximum migration speed of species – animal or plant – with that of climate displacement. For some of them – trees, herbaceous plants, rodents, primates – the ability to move around has become, in the second half of our century, lower than the speed of isotherms in the case of the most highly-emitting scenario. Except in the case of human intervention, if nothing was done to fight climate change, these species would probably not even be capable of surviving. The loss of biodiversity, which is already considerable, will be increased by the warming to come.

According to studies, between a fifth and a third of species will be threatened with extinction by 2050, and the phenomenon will amplify up to the end of the century. The first ecosystems tol be in danger will be mountain ecosysems (specifically amphibians in tropical forests), polar species (bears, sea birds, sea mammals), the southern ocean and coral. This observation is all the more painful when you know that from a certain threshold of disappeared species, the whole ecosystem will collapse."

Biodiversity stakes

Human beings have become an unequalled disruptive force in the biosphere, modifying all the living material in all its nooks and crannies. Biodiversity is directly and indirectly affected by our activities on a scale and at a speed never reached in the past. Both overharvesting and the disruption of environments are undermining organisms' capacities for life and reproduction, the interaction networks are unstructured and all the ecosystems affected. It is the living world's potential for evolution which is at stake, a living world to which we belong, a living world which is our foundation.

Human beings' capacity to settle and develop on a planet experienced a sharp acceleration from the late XVIIIth century onwards with technology and continued to grow with no awareness of the risks and limits which are inherent to such an extension. Nevertheless, all organisms are limited in their development by the resources available to them (in terms of space, food, etc.) and their interactions with the biosphere.

Long distances have become shorter, enabling exchanges and transport between environments which were up to then remote and which possessed very different living fabrics. The mosaic of the biosphere then began to become standardized. The strength of machines increased ten-fold our capacity to modify the ecosystem (e.g. transport, major food crops and urbanisation). That of industry brought us products in such large quantities that the biogeochemical cycles could not absorb them (e.g. CO_2, nitrogen-based fertilisers) when they are not artificial and just build up in ecosystems and are responsible for pollution and the disruption of biogeochemical cycles (e.g. plastics, endocrine disrupters, the hole in the ozone layer).

Access to fossil energies and to the metals contained in the earth's crust, which have become indispensable to produce even more energy and materials, justified the destruction of a large number of ecosystems (e.g. forests for their subsoil) involved not only in the survival of biodiversity and that of local populations but which also have a role in the climate and the capacity of territories to meet the changes to come.

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Our life and survival are wholly linked to the future of other living organisms and the robustness of this living planetary material. The oxygen we breathe, our food and its digestion, our living environment and our crops, all connect us with biodiversity and therefore with its future. Currently there is talk of a 6th extinction crisis but the phenomenon is very different from previous crises, because this time we are a part of it and the prime culprit. As a planetary force, human beings are threatening biodiversity by directly destroying it (excessive extraction, pollution) and/or modifying environments to such an extent that it is no longer possible for other organisms to settle, grow and reproduce there (destruction of habitats, of ecological continuity). Locally or on a global scale, the whole system is breaking down, unravelling and is in danger of collapsing even though it is vital to us. Therefore global changes such as climate change or the destruction of the resilience of environments contribute to strong imbalances which can result in a shift in the way ecosystems function, their destruction and/or their invasion by uncontrollable species.

Gilles Boeuf,
Chairman of MNHN (French National Museum of Natural History

Biodiversity? What are we talking about?

"Biodiversity? A list of species? No, it's much stronger and more subtle than that. It has been defined as being all the genetic information contained in an individual, a species, a population and an ecosystem. In fact it is all the interactions that all living beings (bacteria, protists, mushrooms, plants and animals) have established between each other and with their environment. It's the living fraction of nature!

It was born in the ocean, nearly 4 billion years ago when the first living cell separated (cloned) into two «daughter» cells, exact copies of the «mother» cell. All the living world then left to conquer the ocean, and later, around 450 million years for animals, the continents. Using photosynthesis, marine micro-algae produced oxygen which was to saturate the ocean, and later leave it, making life on land possible. We currently know of around two million species, of which 250 000 are marine (13 % of the whole), and 23 % are in the soils. Several thousands of species of bacteria live on human skin and in the digestive tract.

We all know of the fabulous wealth of the great ecosystems, the tropical forests in the Congo, the Amazon and the large islands of South-East Asia, and the coral reefs of the ocean. But what about towns? In 2007, for the first time, there were more human beings in towns than in the country. From being rural, Man has become a town-dweller and this has changed lifestyles and relationships with nature. The urban ecosystem must be taken into account, with all the humans (who contaminate each other!), pets and «wild» animals that enter it as well, and its attendant plants, mushrooms, bacteria, etc.

Nature is fundamental in towns for the well-being of humans and their health: they feel better, protected from the thermal effects of heatwaves or cold spells, and being able to access a big park in a town reduces social inequalities!

We are biodiversity; we live on it and must, intelligently, and with no cupidity or arrogance, make the most of the superb gift of renewability of the living world, without destroying it or overexploiting it."

Major stakes and inseparable challenges

Climate-biodiversity system feedbacks

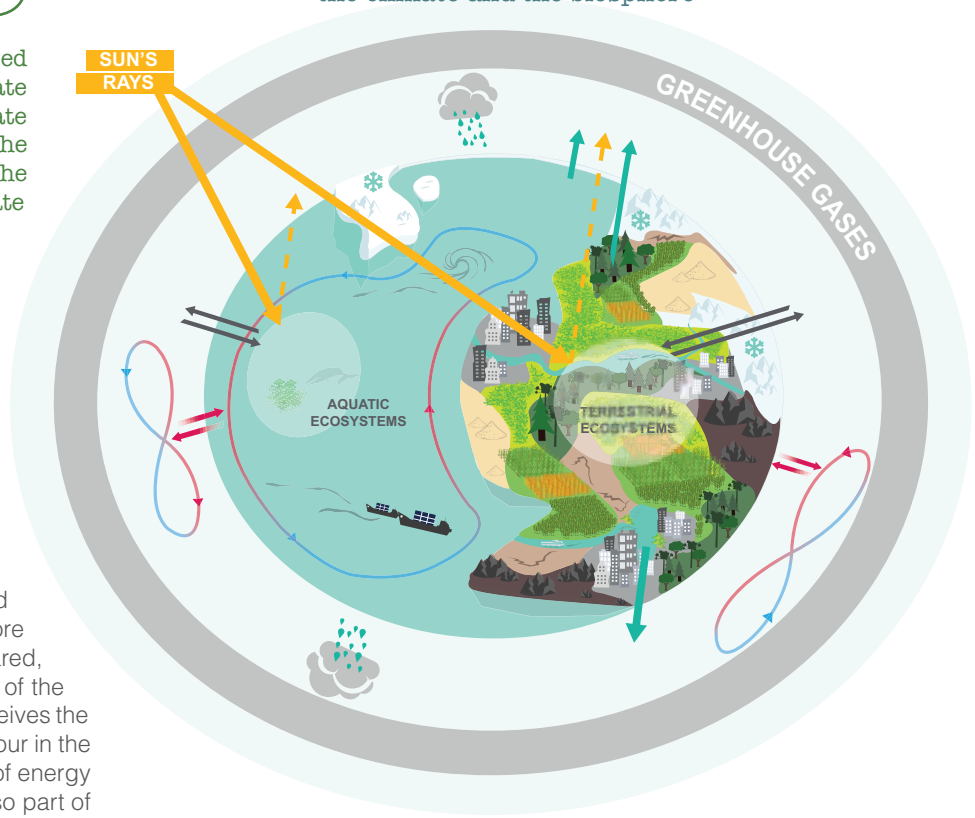
Consequently a fatal circle has been initiated. If polar bears are seeing their environment reduced to peanuts, the modification of polar ecosystems in return contributes to the amplification of climate change. And the drama is the same at international level. The rapid and brutal evolution of the climate impacts a living world which is already undergoing a crisis and can no longer play its role in the exchanges of energy and matter between biosphere and atmosphere, and this further amplifies the effects of climate change. The feedbacks between terrestrial and aquatic ecosystems and the climate point to an increase in the risks for the biosphere.

Human beings' use of fossil energies and the associated patterns of production and consumption have triggered a high increase in greenhouse gases. The biogeochemical cycles have become unbalanced, and the average global temperature is increasing. These changes are rapidly disrupting the living world and to a vast extent. The temperature, the distribution of fresh water and the pH of aquatic environments are evolving at rates much higher than those previously seen in the history of the biosphere, even during the extinction crises: a few dozens of years for the current change, as opposed to hundreds or even thousands of years at the time when the dinosaurs disappeared. An extremely heavy pressure imposed on biodiversity whose development and adaptation capacities are already strained by human activities. The living fabric is moth-eaten, ecosystems are becoming deserts or are subjected to invasion by often unwanted and uncontrollable organisms (e.g. the water hyacinth imported from Latin America which is asphyxiating all the great lakes of Africa), soil erosion, etc., and it is all the living world with its incredible resources and capacities which is being swept from under us. In the oceans, a higher CO_2 dissolution due to the increase in temperature is accompanied by a modification in the pH, with a pernicious acidification particularly for coral environments or for the metabolism of plankton.

But the erosion of biodiversity also contributes to this climate change as much as it contributed to the forming of a climate favourable to its development. Water withdrawals for artificialized ecosystems, territorial modifications and pollution impact terrestrial and aquatic biogeochemical cycles. The disappearance of the forest and advancing deserts reduce the quantities of water vapour from evapotranspiration along with the capacities for storing carbon in organic matter. Urbanization, land-use change and land cover change modify the albedo and the heat flux between the land and the atmosphere. The ocean which covers more than 2/3 of the globe, and where life first appeared, is home to a formidable biodiversity and one of the major components in climate machinery. It receives the sun's rays, takes part in the production of vapour in the water cycle and in the storage and transport of energy around the globe with ocean currents. It is also part of the carbon cycle, through the CO_2 which is dissolved in its waters and that which is captured by plankton during photosynthesis. The increase in temperature will cause the ocean to dilate and the waters to rise, resulting in a modification of the CO_2 dilution capacities which will lead to acidification of the water, plankton disruption and coral bleaching.

The fragility of ecosystems adds to the disruption of the climate machine and contributes to the changes taking place.

Diagram showing the main interactions between the climate and the biosphere



Focus on the interactions between the climate and terrestrial and marine ecosystems

Sun's rays

Sun's rays reflected by surfaces

Carbon flux

Water flux (evapotranspiration, evaporation, rainfall)

Ozone versus Ozone

Hidden behind the word «ozone» (O_3) is the gas formed naturally at high altitude (stratosphere) and also ozone from human activity and near the ground (troposphere).

Stratospheric ozone, the ozone of the «ozone layer», absorbs ultraviolet rays and protects the biosphere (at altitudes between 15 and 20 km). This layer is heavily affected by certain human activities which release aerosol particles (ex : chlorofluorocarbons-CFC), which rise and create a «hole» in the ozone layer and a decrease in the absorption of ultraviolet rays.

Troposheric ozone, considered as «bad ozone » is found in the first layers of the atmosphere. This ozone is coming from the nitric oxide (NO) emitted by automobiles and the volatile organic compounds (VOC) from industries. This ozone can trigger eye and respiratory tract irritation in sensitive subjects.

Bruno David,
Director of research CNRS (National Centre for Scientific Research)

Biodiversity-climate feedbacks: the example of phytoplankton

« The atmosphere and the oceans are decisive elements in terrestrial climate and the question of the role of marine currents in the distribution of heat masses is regularly raised, but we rarely talk about that of phytoplankton, which is actually a major player in climate regulation.

Phytoplankton has first and foremost a proven impact on the carbon cycle, and activates, using photosynthesis, the ocean's biological pump. All phytoplankton cells capture CO_2, whereas in terrestrial plants only the leaves are capable of this. In terms of flux, it therefore represents a carbon trap that is almost the equivalent to that of terrestrial vegetation, which is however much more imposing. Moreover, phytoplankton has a very high productivity. The microalgae die and are rapidly renewed, and for each generation around 20% of their mass falls to the ocean floor, i.e. 10 Gt/year.

Moreover, phytoplankton triggers cloud formation. Indeed, the formation of clouds requires water vapour condensation in the form of droplets. This phenomenon takes place thanks to an activating element: the dimethylsulphide, which is a sulphur compound, produced naturally in large quantities by phytoplankton. This is how clouds form above the ocean. A precise regulation is established. The sun promotes photosynthesis and the development of microalgae, which produce more dimethylsulphide. The gas then furthers cloud formation, which in turn limits sunshine and therefore restricts photosynthesis along with the production of dimethylsulphide. Hence, the sky clears, etc. This self-regulated process may be disturbed if the physiology and the survival of phytoplankton were to be damaged. But in the scope of climate change, the acidification of the oceans endangers phytoplankton and the mechanisms it contributes to.

In the medium and long term phytoplankton is a precious climate regulator through its ability to trap carbon, and in the shorter term to control cloud formation, the possibility of rains and their role in the temperature regulation of the lower layers of the atmosphere, those which are our living environment. »

Major stakes and inseparable challenges

Human stakes in the light of gobal change

Human beings, both «at the wheel» and «on the branch», are contributing to global change. And the issue on this little planet is our common future. Our societies have to face up to their limitations and if the changing living world can recover from this climate change, we are really talking about the survival of the human species.

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As any other terrestrial organism we depend on climate conditions. The lack of clean, healthy fresh water, too high temperatures, etc. puts lives in danger. But like any other organism we depend on our environment and the destruction of the earth that feeds us through the progressive or brutal loss of soil (desertification) during climatic events, the difficulty of accessing resources, etc., all the faces of climate change and the erosion of biodiversity involve our daily lives and our future on Earth. These major disruptions, the resulting fragility and rarity of lands and resources are already outlining the fundamental stakes, those of sharing the planet while the migratory flux and conflicts for resources increase from one day to the next.

Mitigation

The current climate change is first and foremost linked to the increase in the production of greenhouse gases. It is therefore primarily a question of drastically reducing our emissions in order to mitigate a phenomenon which has already been launched, in order to limit the rise in temperature of the globe. This mitigation means saving energy by rethinking our relationship with fossil energies along with our production and consumption patterns and our development choices.

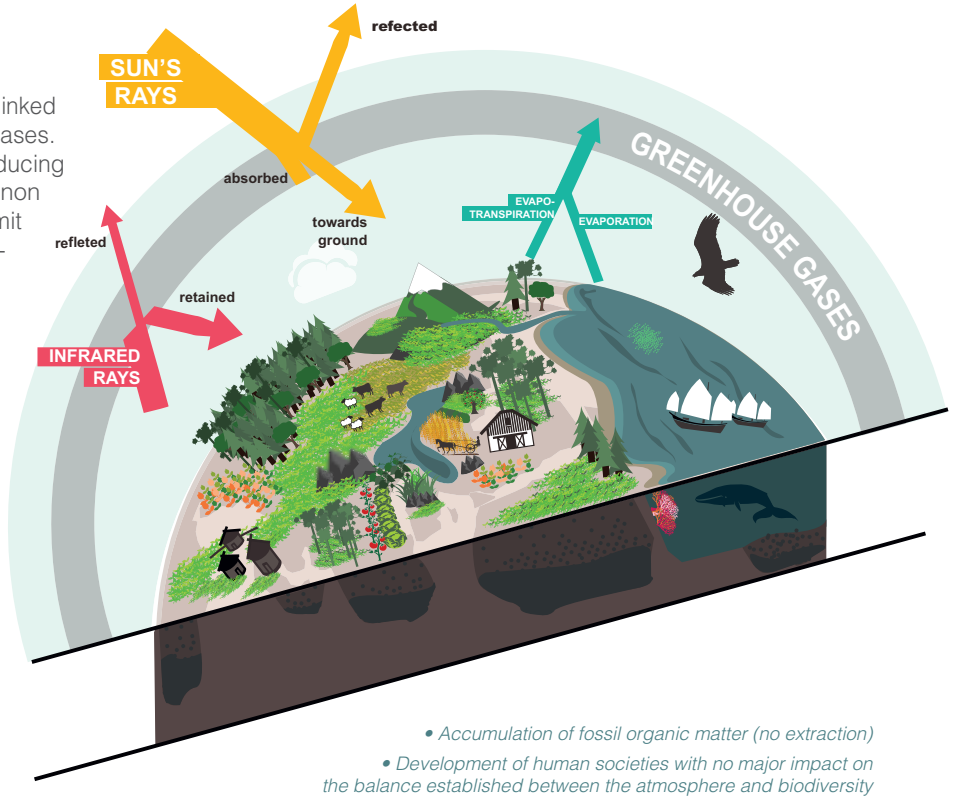
Adaptation

But the phenomenon is already under way and the biosphere is undergoing considerable visible (erosion) or more muted (ocean warming) disruptions which undermine its capacity to limit climate change and resist the destruction of biodiversity.

As an example, the capacities of absorption of the CO_2 by the ocean by dissolution and photosynthesis could reach their limits if the ocean does not then itself become a producer of CO_2 due to the increase in temperature. The greenhouse effect would be even greater.

Changes to the climate suggest a multiplication of extreme climatic events, a rise in the waters, etc. which will thus affect environments which have been weakened

Diagram showing the planet before the Industrial Revolution



• Accumulation of fossil organic matter (no extraction)

• Development of human societies with no major impact on the balance established between the atmosphere and biodiversity since the Jurassic period

because they have been managed on a short-term basis, with no consideration for the risks and the capacities of the ecosystem to survive and continue to evolve after disruption (resilience). Thus mangroves which are so often decimated to develop aquaculture and urban development remain the best form of coastal protection, vegetation, the best way of protecting the soil from leaching and erosion and the biodiversity of ecosystems the best means of avoiding or limiting invasion by unwanted species.

The issue is therefore our relationship with the biosphere, and our development choices. We must adapt our territorial management to these major stakes - climate and biodiversity - by considering their role in climate change and the question of their robustness in the face of climatic risks and erosion of biodiversity.

Awareness

Many people had already voiced their fears in the past, but it was the world summit in Rio in 1992 which presented the state of the planet to the whole world and identified three major stakes during international conventions: climate, biodiversity and desertification. These interdependent global challenges are more prominent than ever and justify the commitment of all human structures because it is the human future of this planet which is at stake. These conventions serve to remind us of the major role we have both in the emergence of these stakes and in their daily resolutions. The common property of humanity, this planet or at any rate our future on its surface is in human hands.

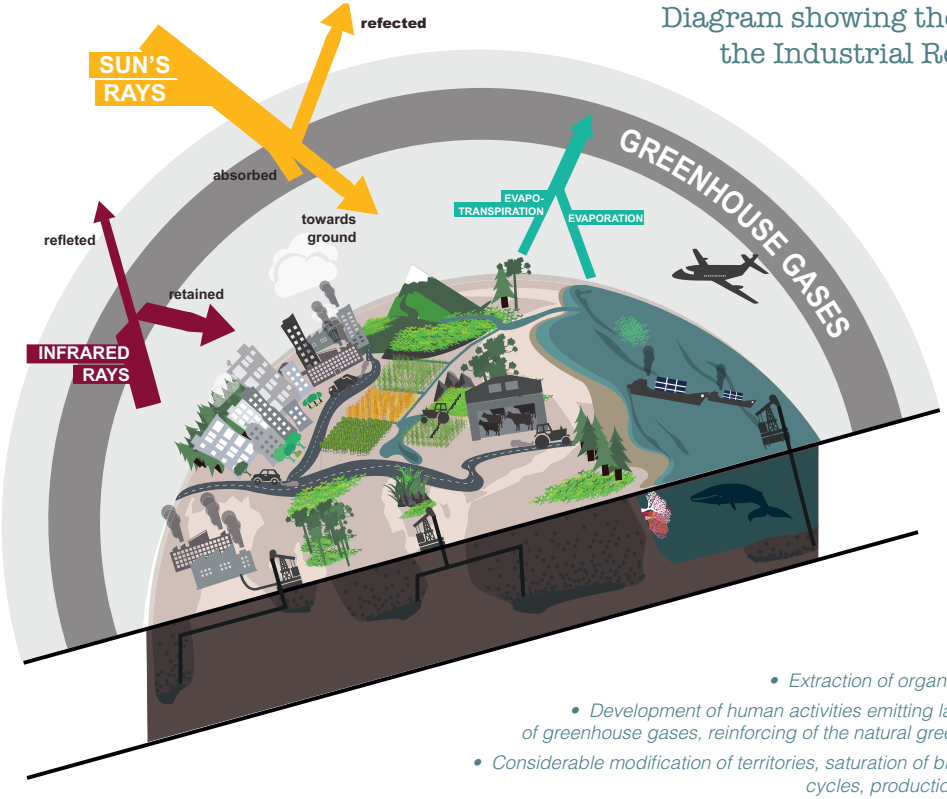


Diagram showing the planet after the Industrial Revolution

- *Extraction of organic fossil matter*
- *Development of human activities emitting large quantities of greenhouse gases, reinforcing of the natural greenhouse effect*
- *Considerable modification of territories, saturation of biogeochemical cycles, production of pollutants*

Luc Abbadie,
Professor at UPMC (Paris),
Director of the Institute of Ecology and Environmental Science

Climate and biodiversity: two interdependent systems

"The relationships between the living world and the mineral world are organized following two logics. The first is to limit the field of possibles for the living world by the physico-chemical characteristics of the environment. The second aims at developing possibles in the form of an infinity of life forms engendered by the network of interactions in which each participates.

In this way, an organism can be considered as an answer provided by the living world to the set of constraints and resources of what is commonly known as its environment (temperature, water, nutrients, light, space, etc.). But each organism itself is an element of the environment of the others, and thus modifies the resources and constraints of all. Organisms fashion their environment as much as they are subjected to it. It isn't just a question of container and contents, but rather an environment-biodiversity system.

Due to the mechanics of natural selection, the organisms whose characteristics are optimal in relation to an environment have more descendants than the others. Any modification of the physico-chemical characteristics of the environment such as any change in an organism triggers therefore a different evolutionary pressure and an evolution of all the other living beings, that is to say, the environment, which acts on organisms, and so on… This environment-biodiversity system is, at its own pace, constantly changing.

The speed and amplitude of climate change will trigger, and is already triggering, modifications in the distribution of species and certain of their characteristics (morphology, physiology, behaviour, genotype) and, consequently of the albedo of continents, evapotranspiration, CO_2 sequestration and greenhouse gas emissions, … all the expressions of the living world which contribute to the energy balance of the Earth and its climate.

Biodiversity and the climate act and have retroactive effects on each other, forming a complex system. The future of biodiversity and that of the climate are steadfastly linked."

Vital stakes to which we must find solutions

Ways of solving climate change

As actors, we can be concerned and responsible and humbly influence as best as we can the complex phenomena at stake to guarantee a desirable future. By their diversity, all human beings can take part in the rebalancing of the great cycles, from the controlling of the production of greenhouse gases to the strengthening of the capacity of the biosphere to support and limit these changes in the working. Several voices have already been heard and a number of initiatives are enabling other possibilities to emerge. Knowledge, the frameworks that human activities build for themselves (political, legal, economic), field experience, etc., are all now a part of this formidable challenge.

If the preliminary to any action is awareness of the situation, stakes and difficulties, its development is conditioned by the different frameworks and incentives developed by societies. This structured field of possibilities and the different stakeholders involved in an actor's projects make it possible to design many projects and territorial trajectories. Whether the starting point is a will to take part in the fight against climate change, to stop the erosion of biodiversity and/or develop their economic activity in this context of global change, a number of actors are already implementing inspiring projects which illustrate some of the possibilities. They also contribute to the reduction of the production of greenhouse gases (mitigation) and the strengthening of the role of ecosystems in the great biogeochemical cycles. They also participate in the reduction of risks relative to climate change and the erosion of biodiversity (adaptation) by monitoring, preserving and restoring the territories' working dynamics.

Global momentum

Faced with the global stakes of climate change for our societies, we have to come up with a planetary answer. But it must identify with the society's different political, economic, and social dimensions and on the different scales of the biosphere. Governance and actions must supplement each other, and mirror each other at international, regional and national levels including that of an actor's sphere of influence.

Raising awareness is the first step, and the interface between science and society which has been set up since 1988 with the IPCC for the climate issue and which was joined in 2010 by IPBES (Intergovernmental Scientific and Political Panel on Biodiversity and Ecosystem Services) for biodiversity stakes. These two international structures record and synthesize knowledge in order to enlighten policies. Within IPBES actors take part in scientific questioning and the development of savoir-faire because biodiversity is complex and inseparable from our activities. Local savoir-faire and scientists get together to establish the state of biodiversity and also to build avenues for research into its preservation and therefore that of the human activities which depend on it.

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Jean-François Silvain,
Chairman of the Foundation for Research on Biodiversity

Knowledge as the basis of all actions

"The only establishment of its kind in France, FRB (Foundation for Research on Biodiversity was set up to enable the development of research on biodiversity in connection with civil society actors by specifically encouraging the joint construction of projects. Following the IEB (Institut Français pour la Biodiversité – French biodiversity Institute), it played an important role in the setting up of an Intergovernmental Platform for Biodiversity and Ecosystemic services (IPBES) in which French research is heavily involved. The vocation of IPBES : to synthesize knowledge in order to enlighten decision-makers and economic actors at a global level.

Currently, faced with the great stakes which are climate change and the erosion of biodiversity and the services it provides Man with, scientists must help the public to understand and meet these closely linked challenges. Society's actors have to meet these interdependent challenges: attacks on biodiversity can be accentuated by climate change and the changes that biodiversity is undergoing can impact the climate at a local and regional level.

FRB and ORÉE wish inform the actors, make the processes involved easier to understand in order to produce an agenda as much for the climate as for biodiversity. Grouped under the Strategic Orientation Council of FRB, society's actors dialogue with the scientific community and take part in the development of strategic choices.

From the international point of view, FRB hosts the scientific secrearíat of the French committee for IPBES which is in charge specifically of the mobilisation of French expertise. It encourages dialogue between the scientific communities on climate (GIEC) and biodiversity under the scrutiny of the civil society's actors in order to improve knowledge transfer and the consideration of all the stakes."

Frameworks and incentives

Since the Rio Earth Summit in 1992, other international conventions have been held. States, major enterprises, representatives of the civil society take stock and work on finding solutions. But any community, enterprise or citizen in their daily activities can participate in these climate and biodiversity stakes. And whatever the scale, the political, regulatory and economic scenarii can and must encourage us to rethink our societies and the way they work to contribute towards **mitigating** climate change and **adapting** to the related risks.

Monique Barbut,

Executive secretary for the United Nations Convention on the fight against desertification

International conventions: a necessary synergy of actions

“The Rio process has raised awareness about the importance of environmental issues and the risk of environmental crises irrespective of where you are on the planet.

However, the three conventions stemming from Rio evolved independently from each other and in a «vertical» manner. The Convention on Climate Change has first and foremost been centred on energy and the importance of the energy transition; the Convention of Biological Diversity was built with a highly environmental approach while the Convention on Desertification and Land Degradation has evolved with a fairly agricultural perspective. These Conventions are all supposed to define the future of the planet and that of global ecosystems. Synergies must be found between these three approaches. An example: international food security. While the conversion of land for food production is carried out, currently, to the detriment of forests and wetland areas; the rehabilitation and restoration of land would enable not only increased agricultural production but also biodiversity preservation and carbon sequestration. This would be a clear course of action that would allow us to resolve several priorities at the same time. The current challenge is not that of fossil fuels but the use of our planets’ natural resources.

The interest of these international conventions is above all to create a common framework and then to impose standards accepted by all. These standards would make it easier to measure and follow-up on impact and progress. As an example, European standards and taxes should use these conventions to rebalance an adverse situation. Even though, since the Kyoto protocol, in France a 20% reduction in the carbon emissions of production has been achieved; the carbon share of consumed products rose by 30%. Countries must therefore use this framework to develop economic rules and strategies which could substantially change society’s choices in order to modify our impacts.”

Climate, biodiversity: global, local?

Because it involves the atmosphere and its greenhouse gases, the climate has an obvious global dimension. This raises the issue of the climate at world level but we cannot ignore its close connections with the local elements of the biosphere along with the role of forests in evapotranspiration, of the air masses in atmospheric currents or that of plankton in the forming of clouds… thus questioning the role of local actors in the future of the climate.

On the other side, and because it is often mentioned through an endangered plant, animal, or a territory, biodiversity has an obvious local dimension. Nevertheless the biodiversity stakes are well and truly worldwide stakes. The management of ecosystems (e.g. deforestation, urbanisation) and the biodiversity hiding behind our consumer choices (e.g. importing palm or soya oil, produced on unlicenced sites to the detriment of local biodiversity) have planetary-scale consequences.

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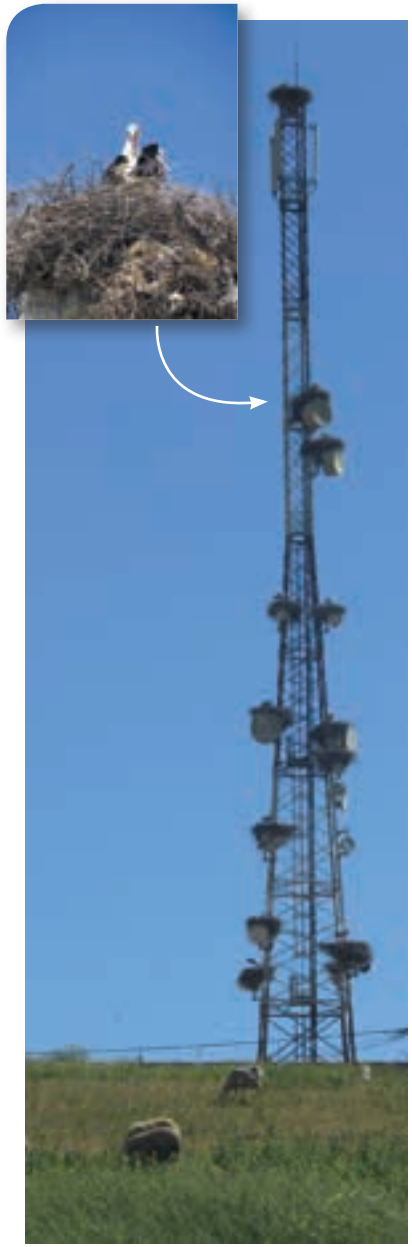
Ways of solving climate change

Gilles Martin,

Professor emeritus at the University of Nice-Sophia Antipolis, Associate professor at Sciences Po Paris

Global stakes: legal solutions

If we take the following three observations: that climate- and biodiversity preservation-related issues often intersect, that the needs of the actors in the field are extraordinarily diversified and that they have a tremendous creative ability, which are the best paths to follow for finding solutions offered by law? First, it is necessary to identify the legal provisions or juridical principles which are preventing us from finding solutions. As an example, the exclusivism of property rights may be an obstacle to finding innovative solutions which consist, for example, of recognizing competing rights to a property. Current reflexions on «commons», and particularly where they exceed the private/public denomination, are an encouraging sign that the limits are changing. The next step is to make sure that the operators can express their creativity, specifically with the use of contractual tools. The variety of contracts whose object is the management of environmental risk or more directly environmental protection is currently undergoing a number of analyses and inventories which show the creative imagination of the actors in the field and their corporate legal experts. Public order, even if it remains unavoidable, is clearly not the only doorway towards a more sustainable society. With this in mind, and by consecrating the possibility of creating real environmental obligations with a contract, the biodiversity bill actually discussed by the Parliament, makes an interesting instrument available to operators, if national representation is wise enough not to hide it behind dissuasive regulatory constraints. Lastly and more generally speaking, it can be hoped that environmental preoccupations will penetrate, to a higher degree than currently, regulatory devices, whether they are transversal such as competition law or sectorial such as transport law, agricultural activity law or energy law.



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Michel Trommetter,

Director Research at INRA

Global stakes: A challenge for economists

It is currently recognized that the Climate and Biodiversity interact. What does this mean to economists: what are the questions and the ways to answer them? How can we slow down climate change and biodiversity erosion when we know that they can each in turn vary the speed of the others? How can we accelerate the possibilities of adaptation given that we can, for example, much more easily, adapt locally to climate change with a good management of biodiversity?

Possible answers to these two questions rely both on macroeconomic approaches (revision of GDP calculation) and microeconomic approaches (new ways of calculating profit). It is not a question of challenging the capitalist model, but more the way of calculating GDP and profit. Therefore these concepts must be defined to encourage countries, enterprises and all organisations to invest in biodiversity and the reduction of greenhouse gas emissions. The polluter pays principle, alone, cannot solve everything. Investing to limit global change and its effects must be a factor of profit for organisations. This means, for example, that at the level of enterprises new forms of amortization on consumptions of natural capital need to be set up and also the possibility of increasing natural capital when the investments have produced results, for example, by restoring sites with the help of ecological engineering.

The issue of reforming economic tools, such as accountability framework, can only be tackled at an international level if we want the answers provided to be more or less efficient both on the reduction of biodiversity erosion and on greenhouse gas emissions. We are capable of doing this rapidly, and to varying degrees, in financial crises. We are in the middle of an environmental crisis, and it is time to take action before its ecological, economic and social consequences become irreversible.

Actors' initiatives

It is firstly on a daily basis and a local scale that climate and biodiversity stakes become apparent. By our life choices each of us is part of these dynamics, and we can therefore now limit the production of greenhouse gases, the consumption of resources and take part in the preservation or even strengthening of biodiversity to allow environments to evolve.

Some actors have already opened pathways according to their activities and their territories in order to reconcile economic activities and climate and biodiversity challenges. These are real economic choices which provide an idea of some of the possibilities for others.

Nicolas Buclet,

Professor at the Institute of Urbanism in Grenoble, Université Grenoble Alpes, Director of the Pacte laboratory

Environmental stakes: the necessity for a circular economy suited to the territory

"Industrial ecology, or as it is known in French institutions, circular economy, was inspired by natural ecosystems in which there is no waste, only organic residues which represent resources for other living species. Close-looping and the creation of synergies between actors which allow the waste of some to become the resources of others, have become the leitmotiv of this disciplinary field. Even though it gets its inspiration from the way ecosystems work, industrial ecology deals only very little with ecological issues, and particularly the preservation of biodiversity. In practice, interesting synergies are set up between industrial activities (sometimes linked to urban heat networks), which make it possible to save matter, energy, and therefore, indirectly, to reduce the impact of the industrial society on its environment and the climate. This is not taking things far enough. The real challenge is to take the concept of biodiversity seriously at all levels, but biodiversity is not encouraged by the adopting of standardized solutions or by the promotion of large-scale industrialized systems. With a territorialisation of human activities, understood as the geographical focus of synergies between human activities in a particular context, and taking into consideration the specifics of each situation, the networks of actors, the savoir-faire and the natural environment, the interactions between man and his environment engender a multitude of possible balances. By taking care that technologies no longer focus on the use of standardized resources, mobilized on a large scale, but on solutions which are adapted each time to a local context, we can both take into consideration the balance of local biogeochemical cycles, encourage the preservation of local biodiversity and create a «biodiversity» of economic and social activities, as opposed to the massive and generalized solutions as being the few solutions face with the stakes of sustainable development."

Mitigation solutions: practical answers

Given that we know the anthropic causes of climate change, it is first and foremost a question of acting at source to drastically reduce the consumption of fossil energy. This therefore entails a sobriety and energy efficiency which is a mirror image of the living world. But such a constraint may actually turn out to be an opportunity in terms of human activity and will allow us to rethink our relationship with the territory.

An enterprise concerned with limiting energy losses and expense can set up activities and partnerships and help towards the emergence of a new beneficial economic territorial model which is also beneficial for biodiversity on a local and a worldwide scale.

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Better management of energy, and more globally a better management of resources, may result in synergies between actors emerging, synergies which will allow them to cooperate in order to improve their economic activities on a territory. The range of possibilities is wide and there is a solution for each situation, whether in local roots, the reduction of distances, an optimized management of effluents, coupling of activities, etc. Six accounts illustrate some of the different possible solutions.

Thus, helping a local economic model to emerge enables the preservation of local biodiversity in the same way as for a more remote biodiversity. It is also with the aim of reconciling economic development and lesser impact on global change that actors are rethinking their projects and even diversifying their activities regarding the other actors on the territory. And to accompany the choices of both individuals and enterprises, tools are being developed which seek to reconcile economic development and fighting global change in the best possible way by making it possible to identify projects with a lesser environmental impact.

Mitigation solutions for climate change

Because fighting climate change means managing energy and taking biodiversity into consideration from a local point of view, synergies between

How energy and territorial development work together to counter the erosion of biodiversity and fight against climate change

In the framework of energy recovery of non-hazardous waste near Laval, Séché environnement and local farmers, grouped into a cooperative (CODEMA), have developed a win-win partnership, a partnership which is also beneficial for the Mayenne landscape, biodiversity and the fight against climate change.

The methanisation of household waste is an approach to energy recovery which is particularly well adapted to rural areas. The energy produced is renewable and easily distributed in the form of electricity. However, this cogeneration operation also produces heat which can only be used in the vicinity.

Traditionally, the Mayenne is a breeding department with medium-sized farms in the bocage - a landscape of small irregular-shaped fields where slopes, hedges and paths surround parcels of cultivated alfalfa. This forage which is rich in proteins is the basis of animal feed during spring and summer. To feed the stabled cattle when winter arrives, it is necessary to preserve the forage without damaging its nutritional qualities. The solution was to dehydrate this alfalfa using the heat produced by the neighbouring Séché environnement site.

The social impact for the territories is patent. Seven hundred farmers now use this service which allows a perfect traceability of their forage as a basis for their recognition as organic-approved producers. In this way their outlets are better valorised and their income improved. Faced with land consolidation and intensive farming, they were thus able to develop their activity and avoid the destruction of biodiversity (ponds filling up, trees and hedges being cut down) and using soya cakes to feed the livestock in winter. Soya cakes are imported mainly from South America with heavy logistics, and the soya to make them is grown with heavy use of pesticides and fertilizers on lands which have often been deforested for this purpose. Harmful impacts on both biodiversity and the climate are thus avoided.

© Séché Environnement

© Séché Environnement

Particularly as alfalfa, like all legumes, has a metabolism which helps to fix nitrogen in the soil, avoiding the use of fertilizers and which is beneficial for crop rotation. Its root structure also stabilises the soil, preventing erosion…

The use of soya contributes to the destruction of biodiversity and climate change (deforestation, fertilizers and transport), whereas the local growing of alfalfa encourages biodiversity (e.g. pollinisers, soil biodiversity), with low CO_2 emissions and which does not require a lot of water. Maintaining the parcels and the bocage also plays an important role as ecological corridors for the circulation of species.

A 360° win-win development:

Production of renewable energy, local development, fight against the erosion of biodiversity and climate change, this is a win-win project whichever way you look at it!

The dehydration of alfalfa is limited to the dry season, so another use of the heat out of season was sought: the installation of an urban heating network which made it possible to supply 15 000 homes. This increase in calorie needs will be carried out by the valorisation of Solid Recovered Fuels (SRF) which are made up of waste deemed non-recyclable from the selective collection set up in the waste sorting unit to recover waste which can be considered as a secondary raw material.

actors are emerging and giving birth to new activities on a territorial scale. They thus contribute to energy saving and the preservation of biodiversity.

A local and responsible production to preserve biodiversity and lessen the impact on the climate

Pierre Fabre

A-DERMA
AVOINE RHEALBA®

The story of Rhealba® oats has its origins in the values of the Pierre Fabre Group. Since its implantation in the south of France, the Group's A-DERMA brand wanted to produce a range of quality treatments from oats that where grown in respect of the environment. In order too control the whole process of production, they decided to have Rhealba® Oats cultivated by local farmers through organic farming on around 30 hectares, under the responsibility of Pierre Fabre Agronomie, the respective specialized department within Pierre Fabre Laboratories. The crops were planted near the two manufacturing units of the company in Soual and Gaillac in the Tarn area. The AB brand, which is the French abbreviation for organic farming, serves as a guarantee that the agriculture is more respectful of the environment and biodiversity due to the fact that it specifically excludes the use of synthetic chemicals such as agricultural input (fertilizers and pesticides) and genetically modified organisms (GMO).

The Pierre Fabre group wished to favour the local establishment of its production from field to product, which makes it possible to lower greenhouse gas emissions released by transport due to the short distances travelled. On a local scale, the Pierre Fabre group and

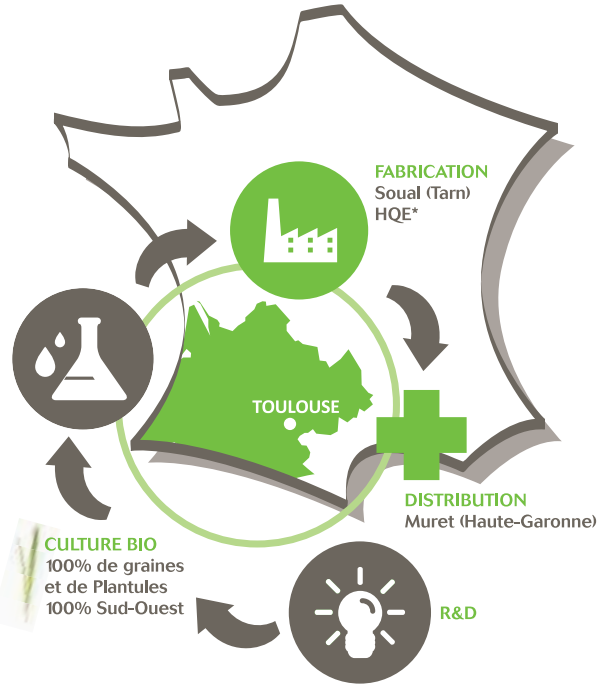
© Arnaud Späni

A-DERMA brand are fighting against global climate change.

The Group's CSR (corporate social responsibility) approach goes even further by voluntary seeking the certification of the Pierre Fabre Agronomie structure as being of a « high environmental value » (HEV). This label which is based on indicators of results relative to biodiversity preservation, agrochemical strategy, management of fertilization and irrigation, along with the « AB » label result in a more sustainable land management. Rhealba® oats are grown from February to July. The straw is buried after the harvest by the farmers who then sow legumes in winter to enrich the soil in organic matter and nitrogen.This practice avoids the use of chemical fertilizers.

In the framework of this HEV certification, several initiatives have been launched in favour of biodiversity, and in particular the installation of solitary bees' nests.Bees, as pollinators, have an important role in the preservation of plant species, which gives them a function as a biodiversity indicator. The biodiversity inventory carried out on the « Terre d'Avoine » site where the Rhealba® oat seeds are grown has detected the presence of Nigella gallica, a vegetal species that is protected on a national scale. Because it develops only on the edge of untreated cereal fields, its presence in the site is the demonstration that this method of cultivating oats has a low impact and that the agricultural soils are in good condition.

Joint actions are being led to fight against climate change and the retrieval of plant residue from the plants grown (plant residue after processing)belongs to a circular economy approach. These plant residue, combined with wood chips from sustainably managed forests in the Tarn (certification), are used to feed the Soual factory's biomass boiler., this local addition brings the site's gas consumption down by 60%, lowering the carbon impact of the products manufactured. To compensate part of the inevitable greenhouse gas release related to the manufacture of certain products in the A-DERMA brand, Pierre Fabre, with the « Local Carbon » brand, is planting hedgerows which include 10 local species of shrubs on its territory. These hedgerows not only provide carbon compensation but also increase biodiversity and fight soil erosion on the land in this area, which tend to be steep.



A complete approach that combines territorial development as well as global biodiversity and climate stakes, all initiated through the determination of a group.

Mitigation solutions for climate change

Because fighting climate change means rethinking our fossil energy

A global approach with a low impact on biodiversity and the climate

To prove the possible adequacy of environmental protection, fight against climate change and human well-being, the Yves Rocher brand has founded La Grée des Landes, an Éco-Hôtel Spa in Bretagne despite preliminary studies showing an uncertain economic cost-effectiveness of the project. The project's approach consists in reducing the ecological and climate footprint at each stages, from the infrastructure to the services provided by the establishment.

To reduce its climate change impact, resources consumption (water, energy, etc.) was reduced and low impact energies were preferred: the energy consumption of the Eco-Hôtel Spa is particularly low for an infrastructure of this kind (29 rooms, swimming pool, spa), thanks to its bioclimatic architecture and its operation which provides natural heat and lowers heat loss. The hotel was oriented in such a way as to receive as much solar energy as possible. Autoclaved cellular concrete walls with good insulating properties, associated with hemp for better humidity and double glazing with reinforced insulation, all these solutions limit heat loss. The energy requirements are decreased (for heating or air-conditioning) along with the environmental impact.

Running mainly on renewable energy with its two wood-burning boilers and 35m² of solar panels, the infrastructure reduces its impact on the climate by avoiding the use of fossil energies. The low rate of greenhouse gas emissions (diagnostic carried out in 2014) shows this (< 10 t/year). In addition to this, the wood used for the boilers comes from the management and maintenance of forests located in the vicinity (pruning, cutting, maintenance, etc.), from pine residue mainly, in compliance with the specifications imposed by Yves Rocher.

The water of the infrastructure, at the heart of climate and natural processes, is saved: the spa water is re-used for the toilet flushes in the bedrooms, saving around 1000 litres of water per day; the swimming pool water is recycled and supplies the rainwater collection tank for watering the gardens and cleaning the outside terraces.

In addition to this, all the water discharged by the Eco-hôtel Spa is purified by a filter garden made up of reeds and layers of sand, which avoids more expensive artificial treatment of effluents. These purifying capacities are checked during three-monthly inspections. The creation of the pool moreover encourages biodiversity, in particular odonates (dragonflies and damselflies) and amphibians.

In order to preserve and increase the biodiversity of the premises (numbers of species and interactions), Yves Rocher has worked with the LPO (Ligue pour la Protection des Oiseaux – French Bird Protection League) to plant fruit trees, flowering shrubs and nesting boxes. Management practices also increase the potential biodiversity-hosting capacity: high mowing, hedge maintenance, no weed killers used, creation of a pond. In 5 years this has resulted in the doubling of the diversity of species of butterflies has doubled (from 19 to 36).

The Yves Rocher initiative also takes into consideration the activities of the Eco-hôtel Spa as the food served in the restaurant is made up only of organic products (certified organic category 3 – 100% - by Ecocert), whether they are from the hotel's garden or from the 45 suppliers who are all certified organic (food, wine). The brand's will to use « organic » products has encouraged local producers to modify their cropping practices. The Eco-hôtel Spa Yves Rocher also encourages localisation by collaborating with 25 to 30 local organic producers in a radius of 30 to 40 km which limits the energy expenditure due to transport and therefore greenhouse gases.

The Eco-Hôtel Spa Yves Rocher, due to its consideration of the environmental issues and its low impact on climate change and biodiversity, is High Environmental Quality certified (at the French level), European Écolabel approved and Green Globe certified on an international scale. Because it corresponds to a need to reconnect with Nature, the Eco-hôtel Spa has been highly successful despite the forecasts of preliminary studies.

© La Grée des Landes, Eco-Hôtel Spa Yves Rocher

expenditure, opportunities for new activities are appearing.

Activity diversification for economic profit and for biodiversity and the climate

As administrators of Saf agr'iDées, the Quaak brothers – also owning the Arcy farm based in the French department of Seine-et-Marne - are currently developing two ambitious projects in order to save energy while exploiting waste generated by the farm.

The first one involves a 1800 square metres installation of solar panels introduced in 2009. Sold to EDF, the electricity generated by solar energy is a way to avoid costs associated to roof maintenance. Such a process also has the benefit of supplying farms with more power thus providing them an opportunity to achieve energy self-suffiency.

Launched in 2008, the second initiative tends to bring heavier changes to the farm's activities. The project is about recovering both emissions generated from animal materials and agricultural waste. Within its almost 400 hectares, the farm dedicates 280 hectares to agriculture while 500 heads of cattle release nearly 3500 tonnes of effluents per year. Excess effluents such as industrial inputs used in agriculture constitute a serious burden to biodiversity given the significant role these effluents play in oil and underground water pollution.

As a consequence, the Brothers Quaak rapidly started looking into the window of opportunity opened by methanisation: this natural, biological process enables the recovery of waste of agricultural origin and breeding activities. It has the advantage of processing the waste into biogas thus making the recovery of the digestate possible in order to enrich soils. Such a process is based on the way living organisms function: it reproduces the rumen, this natural fermentation operating in ruminants' fore-stomach and producing enormous quantities of gas.

Why did they choose biomethane?

First, the injection of this purified biogas into GrDF's gas distribution network involves a high energy yield (90%). The injection into the gas distribution grid also allows an interesting diversification of the farm's activities thereby generating additional income: the biogas produced by the Quaak brothers can not only be stored, it can also be delivered to five municipalities according to their energy needs. As a sound alternative to fossil fuels exploitation, this alternative weakens the farm's carbon footprint. For its part, the use of digestate provides a natural fertiliser and a good substitute for industrial inputs causing important greenhouse gas emissions: from April to September the use of digestate as a fertiliser allows to reduce industrial inputs by up to 90%. Less polluted, the soils are thus once again conducive to life.

© Mauritz Quaak

In the same way, IBPC (Intermediate biofuel-producing crops), includes legumes, fixes the nitrogen in the soil, and are planted after the main crop in order both to reduce more the need for inputs and to avoid soil erosion.

Among the advantages of IBPC are: energy recovery from effluents, a more sustainable management of lands encouraging biodiversity, a diversification of the farm's activities directly linked to energy independence and a significant reduction of greenhouse gases.

The Arcy farm was the first French farm to produce biomethane and to inject it into the gas distribution network. Four years were required for the project to be validated and to obtain funding, three more years for its implementation. Such an initiative has very widely contributed to the development of a new legal framework thus facilitating the emergence of similar projects, encouraging both the development of biodiversity and the fight against climate change.

Following this experiment, GrDF collaborated with the French *Museum national d'histoire naturelle* to develop and set up a diagnostic tool to assess the ecological sensitivity of its worksites, including the connection of methanisation facilities. The aim of this initiative is to reduce the impact of GrDF's activities on the environment.

Residue of methanisation, made up of non-biodegraded organic matter, mineral matter or water.

Mitigation solutions for climate change

Because fighting climate change means accompanying actors in their choice of funding or purchases in order to

A collective initiative for responsible forest management

The Forest Stewardship Council (FSC) NGO was created following the 1992 Rio de Janeiro conference to fight deforestation and give back environmental social and economic value to forests. FSC groups together both environmental NGOs such as WWF or Greenpeace as well as representatives of social rights, native peoples and companies who wish to develop sustainable forest management. All of this using a strict certification system based on three pillars: the management must be environmentally appropriate, socially beneficial and economically viable. A forester obtains FSC certification when he has met all the specifications requirements. The adequacy of the management methods and certification criteria are checked by an independent organization every year.

Thanks to FSC's good management principles and particularly the fact that they encourage in-depth territorial dialogue, FSC certifications have resulted in a forest management which meets the socio-economic stakes of the territory and preserves local biodiversity in many forests in the world. Here are a few examples:

© Elie Hakizumwami

In Gabon, commercial hunting for bush meat and ivory poachers are the biggest threats to the biodiversity heritage. FSC certified foresters are committed to monitoring access to forest roads, registering the firearms of personnel who might be involved in trafficking and inspecting vehicles to detect bush meat. To reduce the pressure exercised by hunting, the foresters must also supply domestic meat at a competitive price. These actions are part of a global approach as they contribute to fight against the erosion of biodiversity of Gabon's forests, while helping the local population.

© Igor Zhorov

In the forests of the Russian Far East, the main issues are the generalized illegal logging operations, those legalized but destructive and the easy access to the forests for poachers. The delimitation of forests with a high conservation value (FHCV), part of FSC certification, protects these habitats: over 125,000 hectares are banned to logging operations and road building! This is a considerable advantage provided by the certification, as the protection of habitats is practically non-existent in this region. Besides the FHCV, 3 770 000 hectares are managed by certified foresters, who must ensure that a wildlife protection system is implemented and that the national and international standards and/or regulations are known and respected.

In the Solomon Islands, FSC provides a long-term economic contribution, maintains a rich biodiversity and supports the native people. The FSC certification of Kolombangara Forest Products Limited (KFPL) bring value to their wood products, allowing them to connect with niche markets and thus remain competitive despite their small size and distance from markets. The certification requirements protect the virgin mountain regions of the islands and their rich biodiversity: the forester must protect the rare and threatened species as well as the habitats, using conservation, protection and connectivity areas. This protection has attracted the attention of the native people of Kolombangara and led to the forming of the KIBCA NGO, which by collaborating actively with KFPL offers them a realistic way of being involved in the management of a large part of their island.

Thanks to the protection of forest habitats, (protected areas, connectivity between areas, diversity of tree species, anti-poaching actions, etc.), FSC certification fights against deforestation and related greenhouse gas emissions (GGE), and also helps to preserve biodiversity. The preservation of natural forests and the certification of plantations is crucial in combating climate change because the preservation of these ecosystems maintains the biogeochemical cycles (carbon, Nitrogen, water, etc.) running, in close relationship with GGE emissions.

© Andrew Cox, Technical Officer, KIBCA

The number of FSC certifications is steadily growing and is proof of the correlation between the environmental, social and economic stakes of this management.

limit their impacts on the climate and biodiversity, actors are setting up tools to help in decision making.

A bank's development of ecological transition projects

Whatever the project, it is necessary to fund it to be able to develop it, hence the essential role of banks. Banks can choose to support certain projects rather than others and because of this, they are capable of boosting the development of initiatives in favour of biodiversity and fighting climate change. Crédit Coopératif has chosen to finance social and solidarity economy and projects which contribute to a more sustainable world.

In the field of energy, Crédit Coopératif mainly accompanies renewable energy development projects: 98.3% of all the projects financed in the field of energy are renewable energy installation projects. In 2014, 45 projects were financed, which represents an installed power of 139 megawatts capable of supplying electricity to several thousands of homes per year. This production of renewable energy avoids part of the greenhouse gas emission from the use of fossil energies.

In addition to this, the fact that the bank orients financing to the field of energy limits investment in fossil energies: the bank finances neither the extraction of oil, coal or natural gas, nor the production of agrofuel from crops which can be used for food and which occupy farming land.

Crédit Coopératif encourages enterprises and individuals to lower their environmental impact by offering more attractive services to those whose projects take their environment into consideration. For example, the eco-habitat housing loan is an incentive for borrowers to improve the project's « ecological value »: the higher the grade, the lower the loan rate. Ecological value is calculated according to criteria which make it possible to limit consumption and loss of energy and improve water management, thereby reducing its consumption. Not only are good actions valorised, but the bad ones are penalized.

Biodiversity is taken into consideration in the calculation of the ecological value through the attention shown to the origins of materials and water management: Crédit Coopératif will focus, in as far as is possible according to clients' budget constraints, on short circuits and so-called responsible products (labelled or certified) such as wood from local sustainably-managed forests, used for biomass boilers. A project using exotic wood from deforestation will be penalized. This way of functioning helps to preserve habitats and biodiversity. Moreover, the grid analysis evaluates the water management of the facility: rain water collection systems, pressure reducing valves, etc. Using less drinking water preserves part of the groundwater and surface water on which species depend for their development.

Regarding the reduction in energy consumption loss, the criteria assessment grid evaluates the devices set up for this purpose: for example, autoclaved cellular concrete walls reduce heat loss thanks to better insulation which lowers the home's consumption ; the installation of a green roof limits the use of heating and air-conditioning thanks to its insulating properties; the type of heating installed (heat pumps, geothermal heating, etc.) influences the building's carbon footprint, etc. These reductions in the use of energy contribute to the fight against climate change by reducing greenhouse gas emissions.

Through its financing stance and policies, Crédit Coopératif favours financing projects with reduced environmental impact. Through client accountability and a better accounting of the environmental stakes, these incentives and choices of energy policies help to preserve biodiversity and combat climate change.

Adaptation solutions for climate change

Adaption solutions: practical answers

But «things are under way» and while we are trying to limit the average rise in temperature on the planet, we have to adapt to current changes and prepare for those to come, and also manage the risks as best we can. This capacity for adaptation is not possible without the biosphere. And by preserving the adaptive capacities of biodiversity and gaining inspiration from those it has developed over close on 4 billion years it is possible to strengthen the resilience of the living world, and that of humans too.

The interdependencies between biodiversity and the climate also bring into question our land-use planning and land-use choices and the importance of helping ecosystems to regenerate. The role of the territory and of the different ecosystems in the management of global stakes reminds us that it is also a question of human choices regarding a common property, the planet. The consequences of climate change on ecosystems necessitate a steering of ecological systems and therefore rethinking territorial policies especially where land-use change is concerned. The stakes are now the resilience of socio-ecological systems.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The very large number of approaches and experiments is as diversified as that of actors and territories. On a regional scale, that of a mountain range, the setting up of biodiversity monitoring and involving the inhabitants in these approaches makes it possible to reflect on global stakes and question behaviour as well as strengthening the capacity of all to take part in territorial management. Faced with the dangers of climate change and the compelling need to manage heavy rainfall, restoring areas can be carried out on the scale of the floodplain of a watercourse to manage flood risks in the best possible way but also on more limited surfaces such as parks and gardens which have an important role in over-artificialized and fragile town areas. Climate change may turn out to be an even stronger constraint for special ecosystems such as islands or towns. Isolated and limited in size, their sensitivity to climate change is much larger than for vast or connected territories. Whether it is to manage optimally the adaptability of an island territory or to lessen the consequences of climate change in towns, such as heat islands, tools for analysis and choice are being developed to enable managers to manage these living areas in the best possible way.

James Aronson,
Researcher in Restoration Ecology ;
CNRS and Missouri Botanical Gardens

Adaptation through the restoration of ecosystems

“The unprecedented erosion of biodiversity we have caused, the widespread desertification and degradation of ecosystems we have wrought, and the vastly increased ecological footprint on our biosphere we human now have finally made it clear to international policy-makers that repairing some of the damage through ecological restoration is now a global priority. Given the large spatial and temporal scales involved, and the complexity of the task, this is no simple task. Fundamentally, we must learn from science and practical experience how to facilitate and accelerate, if possibly, the process of regeneration and recovery of impaired ecosystems of all types so they can function as habitat for biodiversity, and also continue supplying ecosystem services to humans for generations to come. They also must be helped to recover their innate ability to change and adapt in a rapidly changing, and increasingly crowded world. For this, they require resilience, the ability to absorb shocks or “insults” to a system, and then recover in terms in structure and functioning.

But in addition to ecological factors, ecological restoration has social, economic, political and cultural dimensions; the decision to undertake it is inevitably based on human values and to be sustainable must be incorporated into institutional, political, and legal frameworks. Only in this way will it be possible to decide, if natural regeneration, alias “passive” restoration does not occur when and where we wish, what type and how much human effort, investment and intervention should we undertake? To answer this question it can help to recall that ultimately we are testing the resilience of the socio-ecological systems to which people belong. We must manage our ecosystems from the inside out. Therefore in such a situation, resilience – and sustainability – depend very simply on the capacity of humans to anticipate and plan for the future.”

Nathalie Frascaria-Lacoste,
Professor at AgroParisTech – Deputy-Director UMR Ecology, Systematics and Evolution

Ecological engineering: a multidisciplinary adaptation answer

Climate conditions, the length of growing seasons, winter temperatures and seasonal rains have a considerable impact on the cycles of animal and plant species (Woodward et al., 1995). Due to this strong dependency, it is currently agreed that climate changes have enormous consequences on terrestrial ecosystems. Analyses of past climate conditions have shown how the distribution and structuring of terrestrial ecosystems have been deeply transformed over time by climate variations.

Even though it is of course obvious that the climate undeniably affects terrestrial ecosystems, what is less known is that these terrestrial ecosystems could in turn affect the climate according to the types of vegetation, cover or soils (Foley et al., 2003). For example, a bare soil and a forest do not have the same albedo, which therefore ultimately modifies the energy balances in local or even regional temperatures. A number of different scenarii from modelling work were built to observe the potential effects of the plant cover and its involvement in future climates (Levis et al., 2000) by varying the possible types of vegetation (forest/tundra/snow/ice, etc.). If research is making slow progress on these issues due to the fact that modelling is complex and difficult to represent on these scales because of the multitude of parameters to be taken into account, a parallel thought-process must be led on territorial policies of land-use change related to these putative effects on the climate.

Could reasoned and reasonable ecological engineering change global warming? And what would the ecological, ethical and socio-economic conditions be?

A real field of inter and transdisciplinary and investigation is necessary firstly in a framework of assessment (see the link between the change in land use and its impact on the current climate) but in the long term in a potential regulation framework to be designed (for example by applying the principle of prevention and/or precaution?) with all the possible limits of what this manipulation of the living world would be at all imaginable scales (local, territorial, national, global).

This field of research-action to be built corresponds well to a field that ecological engineering must take an active part in quite urgently considering the complexity it represents and the real consequences of global warming which, in some regions of the world, are already dramatic.

«Green» means «biodiversity»?

Biodiversity as a living planetary material is structured by the interactions existing between organisms in changing environments. This supposes time, a wide variety of living elements which little by little establish connections between each other (predation, competition, cooperation, etc.) which make the cohesion and evolution of the whole possible. As the basis of most of the food networks , plants often lend their green colour to territories which are rich in biodiversity.

But here we must exercise caution, because green does not necessarily mean strong biodiversity. A single-species plantation of trees does not have much in common with a real forest ecosystem which is filled with the diversity of the living world in its soils and in its shade. The management and preservation of the territory, that of a forest for example, will show it as just a green patch which is often susceptible to climate hazards or on the contrary as a hotspot of biodiversity and an ecosystem participating in biogeochemical cycles, particularly those of the climate (carbon sequestration, water filtration, …).

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Actors are already a driving force behind proposals with win-win strategies.

Adaptation solutions for climate change

Because the effects of climate change affect entire regions, taking the stakes of adaptation to risks

Involvement of the population on a territorial scale for better action against climate change

Several consequences of climate change can already be seen in the Rhône-Alpes region: the melting of glaciers, changes in animal and plant species, etc. Modifications to the environment can have harmful consequences on biodiversity and human health, such as the proliferation of invasive plants which favour allergies to pollen. To mitigate these consequences, the Region finances and develops actions to generate a change in the population's behaviour through the campaign to fight the spread of ragweed, an allergising invasive plant, and the development of PHENOCLIM participative science, developed hereafter.

Rhône-Alpes, one of the regions which is most affected by ragweed, with an estimated cost for health of over 10 million euros in 2012, involves actors at departmental, municipal and individual levels. Large awareness-raising campaigns have been broadcasted and the Region supplies a mobile application for the inhabitants to make them actors in the struggle, through the collection of data, geographical positioning and the methodical pulling up of scrapweed roots. Helping the population to understand the stakes of managing invasive species enables more efficient action. Moreover, the plants prosper on the territory to the detriment of local species, which may lead to a decrease in the biodiversity of these environments. Managing scrapweed in this way limits health consequences and helps to fight against the loss of local biodiversity.

This biodiversity suffers from climate change and through the PHENOCLIM project, supported by the CREA (Centre de Recherche sur les Écosystèmes d'Altitude – Centre for Research on high mountain ecosystems), its effects are becoming visible in the Alps. This scientific and participative programme, financed by the Region, has been inviting the general public to monitor the impact of climate change on mountain wildlife for over ten years. Thanks to regular observation and scientific monitoring protocols, changes in the development of several animal and plant species over the years (bud-burst dates, migration dates, etc.) can be correlated with the temperatures measured in the Alps (750 research areas spread over six ranges). This highlighting of the consequences of climate change supply the critical awareness needed to challenge elements of our daily behaviour which contribute to current global changes.

In addition to this, in 2013, the Rhône-Alpes Region inaugurated an *Observatoire Régional des Effets du Changement Climatique* (ORECC – Regional Observatory on the Effects of Climate Change) to foster the knowledge of these effects and adapt regional initiatives in the best possible way. Thanks to the early establishment of their SRCAE (Schéma Régional Climat-Air-Énergie – Regional Climate-Air-Energy Scheme) and SRCE (Schéma Régional de Cohérence Écologique – Regional Ecological Coherence Scheme), local authority policy reinforces the resilience of ecosystems and their adaptability to climate change.

By increasing knowledge by means of participative science programmes and an ambitious policy, the Rhône-Alpes Region contributes to adapting to climate change and the fight against biodiversity erosion by raising the awareness of citizens and involving them. These approaches must result in the sustainable change in the behaviour of the population regarding these stakes.

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into consideration must be supported by better knowledge and management of local biodiversity.

Setting up an high mountain lakes observatory (HMLO) in the framework of global change

High mountain lakes, emblematic areas of the Alps, are recognized as being of « high environmental value » and « highly sensitive to environmental changes ». These ecosystems symbolize the purity and beauty of the Alps and represent a strong patrimonial challenge for a number of actors in the mountains including, first and foremost, local populations. For scientists, these are outstanding research sites and interdisciplinary founts of knowledge. They are also a challenge for managers seeking to acquire a better comprehension of these unique environments and to define management solutions adapted to climate and biodiversity challenges.

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Subject to both local and global disturbances, their functioning is complex and makes it difficult to offer efficient protection and restoration programmes, programmes which are nevertheless indispensable to reach the good ecological status of bodies of water imposed by the European Water Framework Directive (DCE, 2000/60). There has been little monitoring in the framework of the directive of high mountain lakes, of which there are a considerable number and which have a rich biodiversity, and they are still under-researched.

Considering this, the Sentinel Lakes network which has been structured around the creation of a *Groupement d'Intérêt Scientifique* (Scientific Interest Group) for the last 2 years, coordinated by Asters (CEN74), has set itself the target of developing, centralizing and pooling knowledge on high mountain lakes in order to identify which types of factors (forcing) can be influenced to be able to offer relevant management measures in the context of climate change in the long term.

L'Observatoire des lacs d'altitude (High Mountain lakes Observatory) was thus set up to provide actors in the management of aquatic environments (protected areas, national agencies, associations, EDF, etc.) with tools and methodologies enabling them to monitor and qualify the evolutionary trends of the high mountain lakes they manage, relative to local activities (grazing, fishing, huts, hydroelectric operations, atmospheric fallout) in a context of global change (modification of snow cover, thermal unit, etc.). This availability of tools and the strengthening of these actors' capacities are perpetuated by the network of 'Sentinel Lakes' partners which is boosted by the organisation of seminars and dialogue on web platforms.

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L'Observatoire has 22 Alpine lakes to date (see map); 3 are managed by EDF. Water quality measurements (physico-chemical and biological parameters of the body of water) are carried out and related to the characteristics of the watershed (land-use planning, uses, geology, climate, etc.) and the hydrodynamics of lakes (freeze-over). Some lakes are « Workshop sites » which make it possible to explore in greater detail how they work through the precise characterisation of the current biogeochemical processes and their evolution (paleolimnology); multi-year measurements and monitoring by managers and research laboratories have been implemented there for several years; EDF's contribution will be to model the functioning of these lakes on the basis of these data in order to test scenarios for future change in relation to global change and the possible changes in watershed management.

Adaptation solutions for climate change

Because enabling ecosystems to adapt to climate change means a better restoration

Faced with flood risk, how to adapt territorial dynamics

In 2002, following the recurring floods in the Merville sector upstream of la Bourre, a river in the Nord-Pas de Calais, and in anticipation of the probable increase in these phenomena due to climate change, territorial actors launched a scheme for the overall management of the water runoff and flooding of this river and its tributaries. This ambitious project around the Borre Becques river (tributary of the Bourre), co-financed by FEDER, the Region and *l'Agence de l'Eau* Artois Picardie and supported by USAN (Union Syndicale d'Aménagement Hydraulique du Nord), reduces the risk of flooding and allows biodiversity to develop which in turn improves the territory's capacity to face up to climate change.

The project on the dynamic slow-down for flood mitigation upstream of la Bourre by restoring the ecological functionalities of the natural environments of floodplains. Climate change can amplify the intensity of rain events and therefore water course overflow, and the creation of four floodplains of close to 500 000 m^3, will contribute to reducing risk for the territory and its inhabitants.

The connections between these environments participate in the circulation and preservation of life and makes it easier to adapt to climate change (for example, in its movements): the opening of la Borre Becque, which was initially dyked up on both sides, enables the lateral passage of species between the river and its floodplain; the reworked banks improve connection between wetlands; hedges of local trees surrounding the four floodplains over more than three kilometres act as green corridors and enrich biodiversity with the mixture of species.

Inside the floodplain, several types of restored environments encourage the installation of biodiversity, increasing the capacity of resilience of living systems: six spawning grounds for pike cover two hectares which encourages the development of aquatic biodiversity; six wetlands and a permanent pond host the species which are dependent on these environments; two floodplains dedicated to the formation of a reed bed (marsh where reeds make up the majority of the vegetation) where many birds nest and which purifies the water; USAN preserves and installs riparian areas (wooded areas, herbaceous plants, etc. along the riverbanks) and plants alluvial woods on three floodplains with an enrichment of the diversity of the species in the environment.

© Fabienne Ferrante

In addition to this, 41 hectares previously dedicated to field crops will be used for extensive livestock farming, reducing the need for inputs and subsequently water, soil and air pollution. USAN makes contact with breeders of local races and/or organic breeders to preserve the local heritage and biodiversity.

The project contributes towards the adaptation of the living world to global change through the installation of biodiversity and the restoring of species' transit routes. It won a prize in the national grand prix « Le Génie Écologique au Service de la Politique de l'eau » (Ecological Engineering for Water Policies) organised by the French Ministry for Ecology, sustainable Development and Energy, on 21st October, 2014.

of the way they function, the human management of environments is evolving.

A modification of gardening practices for a better consideration of natural cycles

To counter the loss of biodiversity noted in gardens, Vertdéco is changing their management practices. The enterprise is promoting a policy for the development of the living world, which implies new training for the gardeners and raising public awareness. The aim is to return a natural functioning of biodiversity in the garden to the heart of the approach, retaining its aesthetics and enabling the deployment of an often-neglected wildlife at the same time. To reach this objective, biodiversity gardener-developers do away with the use of pesticides and reduce mechanization to let the processes of the living world express themselves. The largest margin of progression is in urban gardens.

The garden of a residence in Suresnes is one example: made up of four 500m² gardens separated by residential buildings,

© Lucie Chauvet, Vertdéco, 2015

it had several problems that the gardeners at Vertdéco were Abe able to solve.

The density of shrubs in the garden was far too high. This meant that they were intercepting the light necessary for the development of perennials. The exotic plants, fast to grow and with little interest in terms of flowers, which had initially been planted were then replaced by local species better adapted to the narrow garden, and which were more interesting from the point of view of the food chain by their flowers and production of seeds and fruits. These species adapted to the urban environment need less maintenance, and the approach therefore encourages the preservation of local biodiversity.

Another problem encountered: the soil being poor in organic matter was not very fertile. The gardeners raised the beds in the garden by adding extra layers of substrate: the first layer provided organic matter due to its content in compost from horse manure and its attendant insects. The second layer was made up of shredded wood and ensures the protection of the soil against erosion and desiccation. Gaining inspiration from ecosystems, the gardeners restored a litter and a layer of humus (the first layers of soil in a forest, made up of organic matter). The organic matter contributes to the natural dynamics and provides the elements which are necessary for plants to develop. The garden's biodiversity is enriched. For the last two years, no chemicals have been used for the garden's maintenance. This prevents the pollution of the soils, underground water and the air (the use and manufacture of inputs are responsible for greenhouse gas emissions).

Vertdéco encourages wildlife to return to the garden by setting up strategically-placed insect hotels and nesting box. The colonies of insects and spermatophytes (seed-producing plants) bring birds back to the garden.

All these changes in practices are part of a global approach towards understanding how an ecosystem works, limiting the consumption of resources and the impact of human intervention to a minimum. Vertdéco's change in practices for managing gardens encourages the development of biodiversity and the preservation of local species adapted to the environment: since this work was carried out, the gardeners have noted the presence of a considerable number of birds and insects, and particularly butterflies. So what is the relationship with climate change? Restoring the garden's natural processes (specifically the return of organic matter to the soil and its decay in the litter) are part of the way less-disturbed cycles of matter and biogeochemical cycles (carbon, nitrogen and water) work. Vertdéco's practices, for the "good" state of gardens, make it easier for species to move around and create green corridors in the urban network. These areas help species to adapt to climate change and accompany them in climate evolution. Biodiversity gardener-developers work both for their clients and for the planet.

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Adaptation solutions for climate change

Because the effects of climate change are foreseen as being even more extreme in constrained

The study of insular ecosystems to meet global challenges

By their size and isolation, islands are very special ecosystems which are even more vulnerable to disturbance (arrivals of new species, pollutions, destruction of habitats, etc.) than continental ecosystems. Insular regions are remarkable for the species which are intrinsic to them (endemic), and present a challenge to the preservation of biodiversity and the development of human activities such as the sharing of resources, land occupation or even energy or food independence, etc. They are particularly vulnerable in climatic accidents and global changes weaken these inhabited territories - socio-ecosystems - even more. A socio-ecosystem is made up of the interactions between social dynamics (which integrate the complex relationships between the actors and organisations of human society) and ecological dynamics (which integrate the inter and intraspecific interactions with their physico-chemical environment).

On the islands of Brittany, the EnezGlaz initiative supported by Éco-origin offers, study into the interactions existing between ecology, economy and society (sociological, political and cultural data) as a preliminary to any strategy of adaptation to climate change, interactions whose physicochemical, biological and anthropogenic components are known. By analysing the flux (of people, species, goods, waste, energy, etc.) between the islands and the continent and the relationships between the various actors, Éco-origin tries to find ways of improvement for a more sustainable development by identifying the anthropogenic pressure placed on the biosphere, and thus biodiversity and the climate.

The approach is based on an analysis grid structured around five themes (lodging/habitat, work/economy, education, health and access to goods, services and leisure activities) currently being formulated by the consortium for the different actors (elected representatives, citizens, enterprises, etc.), to create an offer to suit their expectations. These five themes are classified by Éco-origin according to the territorial stakes.

© Éco-Origin

Particular attention is paid to the field of energy: the networks (electricity, gas, etc.) must meet expectations regarding energy transition in order to reduce loss and limit greenhouse gas emissions. The main test fields of the project are the management of the intermittency of renewable energy production sources, the quality of the energy to be supplied and controlling the demand and safety of systems and networks.

Regarding the protection of ecosystems, focus is placed on the ecological restoration of ponds and pools and the creation of areas with an ecological and landscape vocation, the setting up of agroecology programmes, the development of urban « ecological » projects and the valorisation of the island heritage.

This approach helps to have a wider picture over the long term of the system studied and to reduce the harmful effects of social dynamics on biodiversity and the climate. Through humans' dependency on the diversity of the living world and climate conditions, global changes unavoidably trigger negative consequences on the way societies function.

© Éco-Origin

This insular experiment is a true laboratory and the method developed may make it possible, on different scales, to accompany territories towards a sustainable development in view of global stakes.

environments (towns, islands), analysis and prospective tools are helping to prepare a better adaptation.

Reducing urban heat islands with the help of three cooling devices

Temperature increases in urban environments, by comparison with neighbouring rural environments, are triggered by urban planning and human activities and represent a major stake in terms of mitigation of the effects of climate change. The latter may actually increase the frequency and intensity of these phenomena, known as urban heat islands.

These islands have important consequences on the urban ecosystem: consumption of cooling energy which favours air pollution (aggravation of the smog phenomenon – atmospheric pollution mist), leading to harmful effects on health. Decision-makers, whether public or private sector, must know the benefits and costs of the different existing cooling devices, to make the relevant choices on their territory, along with a comparison of these facilities.

To do this, Veolia's EVA project, in partnership with IRSTV (Institut de recherche sur les sciences et techniques de la ville – Institute of research on urban sciences and techniques), studies and compares the benefits and costs of three cooling devices in the Part-Dieu quarter in Lyon: the modification of the albedo (a surface's ability to reflect sunlight), the wetting of streets surfaces and re-vegetation. This study is carried out using modelling, which is supported by field studies to measure the impact of different types of re-vegetation and street wetting on urban climate (VegDUD project steered by IRSTV).

Study of albedo modification is based on hypotheses taken from what we know of the physical phenomenon involved: when the sun's rays reach a surface, part of the rays is reflected, and another part is absorbed and re-emitted in the form of heat. The hypothesis tested in the EVA project is to decrease the part of the rays absorbed to decrease the heat re-emitted in the island. How can we increase the reflectivity of surfaces in towns (roads, roofs, wall, etc.): their albedo? Through the choice of building materials and their colour (white objects reflect more of the sun's rays than black objects).

Tests carried out on wetting the road surface by means of water sprays built into the pavements reduced the surface temperature and the temperature perceived by passers-by (known as UTCI) by 3 to 5°C. This device reduces the effects of urban heat islands but consumes large quantities of water.

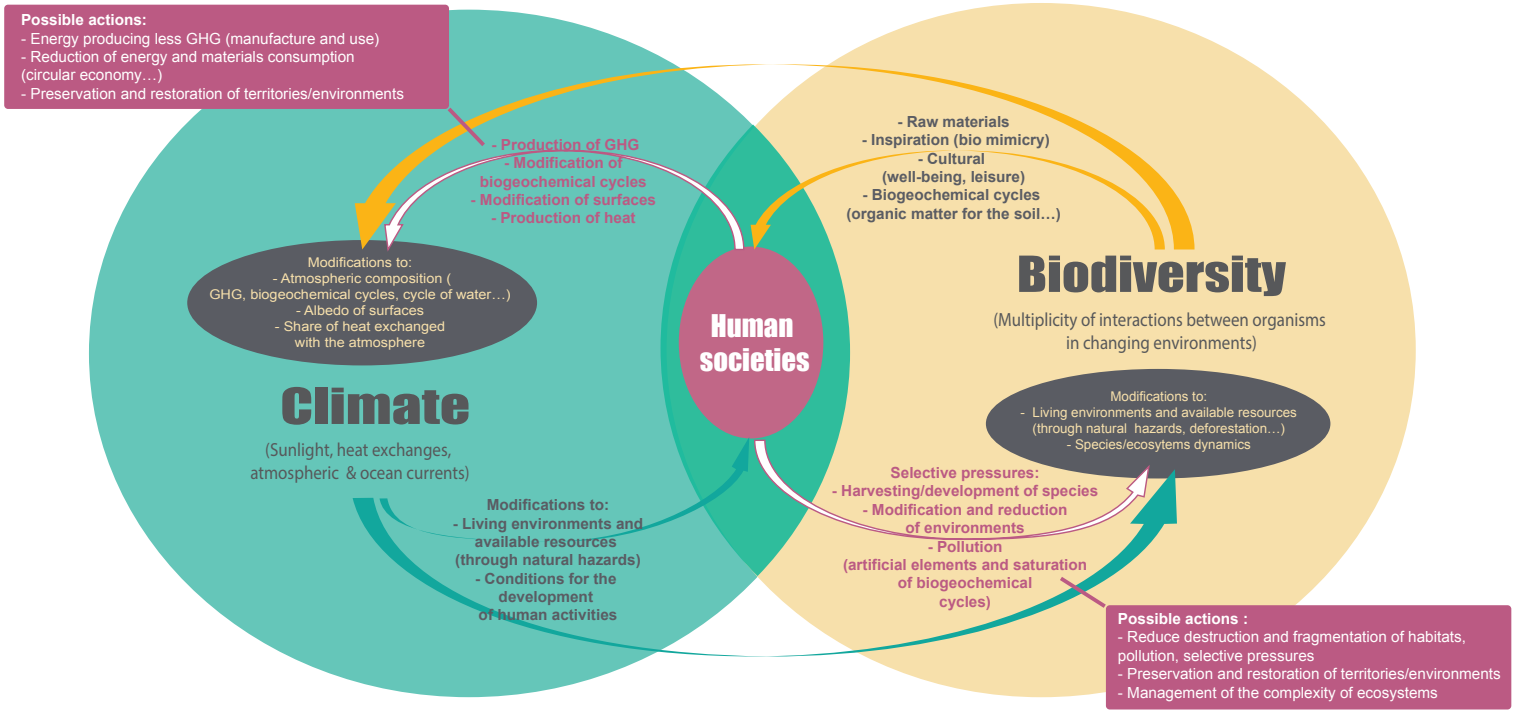
The re-vegetation of surfaces includes grassed surfaces, green facades (including roofs) and rows of trees. The more received by a grassed surface, the more efficient the mitigation effect: the lowering of the UTCI varies from 2°C to 14°C! Rows of trees lower the temperature by a few degrees by evapotranspiration and up to 10°C in shady areas. The green surfaces, according to the types and species planted, encourage the development of biodiversity in towns. These devises tangibly mitigate the effects of urban heat islands.

© Veolia

Modelling of different scenarii by Veolia and IRSTV are undergoing analysis. Comparisons between the different cooling devices also take into consideration economic and energy costs and water consumption. A synthesis report and a guidebook for local authorities and developers will be drafted to help set up efficient devices in terms of climate change mitigation, some of them particularly beneficial for biodiversity.

Conclusion

Interdependencies between the climate, biodiversity and human societies



The biosphere in which human societies have developed was created by feedbacks between the climate and biodiversity. The formidable material of interactions between the climate and the living world is however extremely fragile and currently heavily affected by our activities.

Consequently climate change and the erosion of biodiversity are first and foremost the stakes which condition the human future of this planet. If our societies are responsible for this global change they should also be able to provide solutions.

Already, each at their own level, actors are creating initiatives and are becoming the driving force behind proposals for making economy and environmental issues compatible.

Climate change and the erosion of biodiversity are drawing our attention to the multiplicity of space and time scales to be taken into consideration to be able to embed ourselves in the evolution of the planetary system.

The system's inertia, cascading reactions both in the atmosphere and the biosphere, delay, rebound or threshold effects, shifts in the trajectory of ecosystems … our living environment is neither frozen nor controllable.

We are a species among others, subjected to our environment and the stakes are how we will adapt to this system. It is therefore very much a question, in different spatial dimensions, of being both an actor in world dynamics and in our daily lives, of being a territorial actor, with the environment and those who share it.

Our ability to imagine, create organisational innovation, cooperate with others, including biodiversity, will be fertile in possibilities

«It is not the strongest species that survive, nor the most intelligent, but the ones most responsive to change»

L. C. Megginson 's interpretation of Darwin'Origin of the Species 1859