UNDERSTANDING AND BETTER GRASPING CLIMATE RISKS



Understanding and better grasping Climate Risks

Storms, floods, hurricanes, droughts, threats to biodiversity, invasions of harmful species... Climate risks are many and worrying. How better anticipating them to be better protected ? Science provides answers. Let discover six researchers profiles who are supported by AXA Research Fund and engaged in Paris UN Climate Change Conference / COP21



Too many tornadoes in Europe?

The frequency and violence of tornadoes and storms are underestimated in Europe in spite of the human and economic losses in their wake. To find a solution, Bogdan Antonescu wants to understand how, when and why these weather events occur.

hen he was a little boy in the streets of Bucarest, Romania, Bogdan Antonescu used to measure the wind speed with his little weather station. A premonitory toy? Twenty-five years later, the researcher dedicates himself to the study of extreme weather events: high winds, lightning, storms and tornadoes. The physicist claims: "Tornado risks are much underestimated in Europe". Five years ago, he joined the Centre for Atmospheric Science at the University of Manchester, United Kingdom, to devote himself to the study of tornedoes. He took part in the development of climatology in Romania,

with his

thesis on lightning climatology. It is hard to believe that we ignore almost everything about storms on the old continent. "In the United States, the follow-up on cyclones and tornadoes is well organized. Bogdan Antonescu notes: "They have many correspondents and a good database. However, in Europe, we do not have anything like that at all. We are completely unaware of the present situation." Is the ongoing climate change going to increase the frequency or violence of these weather events? With our current scientific knowledge,

"answers remain speculative", the researcher says. The main goal is to set up a full inventory on European knowledge of tornadoes. Where and when did they

«The COP21 is a good time to alert the many players involved in hazards due to storms and tornadoes. Those are underestimated in Europe. To understand climate change, research and collaboration are crucial. Let us share our data!»

> already strike? To answer this question, Bogdan Antonescu searched for two years through scientific literature, historical documents and enthusiasts'

journals published over two centuries. "I wanted to map out the risks." Central Europe is the most affected part. Germany, the North-East of France, North of Italy, the South-East of the United Kingdom. "Central Europe is also a densely populated region", Antonescu adds. Thus, there are more observers who report more events. "However, I've built a statistical model which allows us to correct this bias." Most importantly, the human and economic losses are tremendous, and cities will continue to expand.

Why are there more tornadoes in these regions? What factors influence their formation? Until he can answer these questions, Bogdan Antonescu campaigns for data-sharing and pays tribute to the creation of the European Severe Storms Laboratory in 2006. He urges everyone to join via the Laboratory website: "You must contribute to it! Share your data!" In the future, he wishes to build a large network of observers across Europe, exploring all disciplines. He also wants to deepen his understanding of tornado outbreaks during the 19th century, in collaboration with a historian. Jules Verne, an author who marked his childhood, would not deny this heritage.

UNDERSTANDING AND BETTER GRASPING CLIMATE RISKS

Invaders: are they the major threat to bjodiversity?

Taking advantage of climate change, some species enter new territories. Then, they can threaten the survival of endemic species. To protect biodiversity, Céline Bellard wants to know more about those invaders' characteristics.

he tiger mosquito originally comes from Southeast Asia, and is gaining ground. After spreading in Southern France, it was seen in the Ile de France region, and even in Alsace (France)! According to the International Union for Conservation of Nature, this insect is among the world's one hundred worst invasive species. Many observers blame global warming. "The geographical distribution of species can be limited by climate factors", Céline Bellard says. She is a post-doctoral fellow at the Centre for Biodiversity and Environment Research at the University College of London. "When winter temperatures are too cold, they play an important role in forestalling tiger mosquitos. However, invasive species often demonstrate greater heat tolerance. Increasing temperatures enable them to enter new territories."

This young researcher is truly passionate about macro-ecology. She compiles numerous forms of data on all invasive species, a very meticulous work that does not scare this musician. Since her childhood, the long hours practicing the viola, this relative within the violin family with a tenor voice, taught her rigour and methodology, "as well as creativity, which is necessary to do scientific research", she adds. She has demonstrated with her colleagues that invasive species constitute the second cause of vertebrate species extinction, and the first cause of amphibian, mammal and reptile species

«I hope that the COP21 will be more useful than the earlier sessions of this conference. Unfortunately, commitments were minimal, and constraints to abide by those rules were few. It does not speak ambitiously for the success of the conference. I do hope I am wrong, and that it will prove to be a pleasant surprise!»

extinction, although this threat varies from one continent to another. "Europe, the United States and Australia are the regions that receive a lot of invasive species. The number of species threatened by these invasions is yet distinctly higher in South America, Indonesia or Asia." Thus, the mere presence alone of an invasive species is not a sufficient cause. "Other factors must be studied to determine the impact of a species, among others the habitat-specific diversity, or the ability of native species to adapt". "Invaders" are characterised by high reproductive rates, or short generation time. The selection pressure is, thus, favourable to them. They adapt rapidly to a new environment in which they can settle. "My project is to take into account all plants and animals, compare their characteristics and see which invasion level each of them reaches", the biologist explains. This data, combined with climate change forecasts, will enable us to inform decisionmakers. Will they know how to limit the impact of the worst invasive species? "The five main threats to biodiversity – habitat change, invasive species, pollution, overexploitation of species through excessive hunting and fishing, and climate change - are all due to Human activites. Yet, we may succeed in restoring a balance", Céline Bellard adds, definitely optimistic.

Cities These voracious energy consumers

Faced with climate change, the solutions in favor of the planet are not always technological ones. Some depend more on social changes. Magali Dreyfus, a legal expert, studies the legislative framework developed by some hyper-consuming cities.

ities are beautiful at night. However, everchanging urban areas are voracious energy consumers. Faced with climate change, how do they plan to reduce their energy bills? To answer that question, Magali Dreyfus, working at the Centre d'Etudes et de Recherches Administratives, Politiques et Sociales (CERAPS, a joint research unit of the University of Lille 2 and the CNRS - National Center for Scientific Research) has traveled around the world: Paris, Tokyo, Delhi, and Phnom Penh. How do these very different cities adapt to climate change? The researcher's interests focus on "multi-level governance". How do supranational standards affect local standards?

"For instance, Delhi benefited from the Clean Development Mechanism under the Kyoto Protocol", the legal expert explains. Delhi was thus granted foreign funds to modernize the Delhi metro. By upgrading its public transport system, the Indian megalopolis was able for a while to reduce its atmospheric pollutants and greenhouse gas emissions." Paris and Tokyo's goals are much different. These cities seek to set an example at the international level. "Mayors make commitments, try to innovate", Magali Dreyfus

«The COP21 is an important step, but it does not go far enough. It is mostly a diplomatic event, a negotiation between States. To be efficient, action is required at all levels. We cannot just sit and wait for an answer from the top level.»

explains. For example, Tokyo developed a carbon permits market on the city scale. "This is a legal innovation that affects skyscrapers", she adds. "They consume an enormous amount of power and produce as much greenhouse gas emissions." Occupants were invited to report their energy consumption level. Based on these statements, the Tokyo Metropolitan Government granted them credits allowing to emit greenhouse gas. "If an occupant pollutes above the limit set by its credits, the occupant must buy some from another participant, whose carbon emissions are below. Thus, there is a financial incentive: those who emit less carbon can sell their credits. The results are very positive: 90% of the participants reduced their carbon emissions.

Generally, cities in poorer countries opt for an adaptation strategy, taking into account climate change impacts. Those of industrialized countries rather pursue an impact mitigation strategy, aimed at reducing greenhouse gas emissions. "Adaptation often depends on a social process", Magali Dreyfus notes. "Mitigation is rather based on technologic innovations. However, solutions for the planet can also be found through individual behaviors." Two years ago, the researcher became a vegetarian, a choice strongly influenced by her work. "When you are informed on environmental issues, it is hard to act otherwise." Yet, this tireless traveler, who has lived in Paris, Florence, Austria and Japan, feels guilty when she travels by plane. To compensate for this guilt, she has become a bicycle enthusiast.

Tracing methane emissions in the old-growth forest

The heavy deforestation on the island of Borneo triggers destructive fires. How do they affect carbone and methane natural cycles? Vincent Gauci hopes to understand it, in order to limit global warming and protect this significant biodiversity hotspot.

hat do the different ecosystems have in common? How do these biotopes and the atmosphere interact? How do human activities increase greenhouse gas emissions? According to Vincent Gauci, several answers to these questions can be found at the heart of the Borneo old-growth forest. Devastated by deforestation for the benefit of palm oil, this large South-East Asian island still harbours small pockets of primary forest. The 42 year-old researcher heads the Department of Environment, Earth and Ecosystems Biogeochemistry group of the Milton Keynes Open University, a few miles from London. Together with his students, he wants to understand how natural carbone and methane cycles work.

Naturally erected on very ancient peatlands, a humid ecosystem containing one of the largest pools of carbone, Borneo primary forests were almost entirely decimated. In Kalimantan, on the Indonesian side of the island, the destruction is massive. Without the canopy, the water level of the ground has decreased. Trees grow no longer. Fires spread at an alarming speed, releasing significant quantities of carbon in the atmosphere in the process. Deeply disturbed, the peatlands cannot store anymore carbon. In rivers, emissions have doubled because of deforestation. In order

« We can limit our activities' impact on climate change by modifying our use of lands and forests. This is irrefutable. I hope this great option will weigh in the negotiations within the framework of the COP21. »

to understand the whole system, Vincent Gauci's team also works in the North of the island, in Brunei, where there are still primary forest areas. The researchers measure methane (CH4) emission levels: the impact of this gas on the greenhouse effect is 20 times greater than the one of carbon dioxide (CO2). Big surprise: high trees are the biggest gas emitters.

"To avoid extra damage to the climate, we must limit our gas emissions resulting from factories, cars, cattle breeding and rice fields. We must also understand how our activities affect gas emissions from natural environments", Gauci says. On the short term, this knowledge will also enable us to reduce human damage and economic losses due to fires, which are increased by deforestation." Meanwhile, Vincent Gauci acts on a daily basis, and not only in his laboratory. This lover of nature grew up with books by Commandant Cousteau, thanks to his French grandmother. During his free time, he enjoys gardening. The aim is to relax, as well as to feed organic and local vegetables to his family. However, feeding his English vegetable garden with peat-based compost is not an option! The researcher knows all too well the ecosystems whence the peat came, and how immensely fragile they are.

The water war will not happen

Water resources management has become a crucial issue, and involves many stakeholders. Their different uses of water resources are sometimes at odds with each other. With a specific methodology, Luciano Raso suggests an operational and optimal management of this "blue gold".

o we need to protect Paris against a major flood, at the risk of drying out the water systems necessary to the operation of the downstream nuclear facility? Or do we need to maintain the water supply to the facility, at the risk of possibly flooding the capital city? The answers to this dilemma lie with decisionmakers. Science, for its part, can help to make decisions. "Water resources management affects all of us. It is precious for wildlife, drinking water, hydroelectric power, agriculture, navigation, environment, etc. However, these uses sometimes compete with each other. Moreover, the available water quantities can never be assured", explains Luciano Raso, a post-doctoral fellow at the Institut national de Recherche en Sciences et Technologies pour l'Environnement et l'Agriculture (IRSTEA), in Montpellier, France. With a method specific to stochastic hydrology, meaning that it takes into account statistical uncertainties, this researcher works on the operational management of dams. His aim is to "optimise the management for all parties involved", which, by the way, reduces conflicts over water utilisation.

On the River Seine, upstream from Paris, four dams built during the last century make it possible to manage the river water. "In winter, we must protect towns against floods. In summer, we must prevent drought". Possibilities

«The COP21 gives me little hope. Environmental concerns now meet geopolitical issues. If industrial nations do not reach any agreement, they will be able to keep on polluting the planet, in spite of damages on poorer nations. Political decisions influence research topics as well. This is the very reason why this conference is particularly significant»

offered by the Seine are quite limited. The infrastructure being already well organised, there is not much flexibility. Yet, with his colleagues, Luciano Raso demonstrated that advanced management methods can optimise the situation. In West Africa, the Senegal River has awakened his scientific interest: the source of



the Senegal River is in Guinea, then it runs through Mali, Mauritania, and finally flows to Senegal. "In Europe, water is linked to a notion of protection and prevention", insists the researcher. In Africa, it is linked to development. The water of the Senegal River is used for hydroelectric power and for farmland the irrigation. These are key issues for the sustainable development of the countries in this region. Research can help local decisionmakers to better understand the impacts of their decisions."

Thus environmental engineering finds its place at the heart of today's society. Besides, the scientist is also passionate about social science. He even plans to attend law classes. "This discipline is the codification of relationships between different stakeholders within a given society to handle conflicts more smoothly". "We've often heard about a hypothetical water war", he answers, "but historically, water management has created more cooperation and agreements between countries than wars!"

UNDERSTANDING AND BETTER GRASPING CLIMATE RISKS

The sound of giant waves

To be able to warn populations at risk of giant waves and coastal flooding, Emiliano Renzi is working on the development of an early detection system that captures acoustic waves.

nder water, some listen to whale songs. Emiliano Renzi's approach is more original: he wants to pick up the sound of storm surges, these giant waves triggered by unexpected sea-level rise, causing sometimes the same damage as a small tsunami. Acoustic waves being very fast, the researcher wants to develop a more precise detection system to warn people before these storm surges stack up against shores.

Originally from Rome, he just took a teaching position at Loughborough University, in the centre of England. He discovered the Ocean at a very early age. His parents used to take him there every summer. Later, he got very passionate about mathematics. "I realised that I could use mathematics to understand the world", he explains. It is wonderful to look at waves from a beach. Yet, I wanted to understand how they were created. » How they interact with each other, how they transform themselves, how they move from the Ocean closer to land... "The risk of coastal flooding depends on the combined

effect of three factors: low air pressure, strong winds and large tides", continues this very pedagogical scientist. "When the atmospheric pressure is low above the Ocean, the Ocean swells a little, creating a kind of sea-dome that reaches the coast. It swells increasingly. At

«The COP21 is

a fundamental event to raise public awareness. Some people still deny climate change. They put us at risk, because these changes do occur and they are worrisome. It is high time for each of us to assume responsibility.»

high tide, it can trigger coasting flooding with major damage. The waves can destroy houses and kill people."

Deep below sea level, this phenomenon creates acoustic waves. "They travel very quickly", the researcher adds. "The acoustic waves travel at 1,500 m/s", thus faster than the speed of water masses. To develop this detection system, Emiliano Renzi must study first the characteristics of these waves. To this end, he will use hydrophones. Mounted offshore at a depth of 1,000 meters, these waterproof microphones will capture the arrival of the acoustic waves. Combined to an alarm system based on the coast, the whole system set could provide an efficient detector. A few seconds ahead of the storm surge would be enough to save lives. Eventually, the scientist hopes to detect the incoming storm surge thirty minutes to one hour ahead before they strike the coast. By the end of this year, he will test his model in a huge pool, next to Rome, in Italy. "These are high-speed waves. It is difficult to detect and capture them in a small pool. Rome offers one of the biggest pools in the world: it is 150 meters long." He aims to develop operational detectors within the next four or five years.

UNDERSTANDING AND BETTER GRASPING CLIMATE RISKS 7

"Supporting research to help protect society"

AXA Research Fund originated from the insurer's will. It is committed to scientists' research on climate-related risks. Ulrike Decoene, its brand new Head, provides some details.



Why is the AXA Research Fund committed to climate related projects?

For almost 30 years, those mostly aware of the seriousness and impact of climate change risks were researchers. Today, those risks are at the centre of political debates and international negotiations, which is a very positive point. It is also a priority issue for the insurance sector, whose mission is to accompany our clients, be they corporations or private individuals, to help them face and better protect them against climate-related risks. According to the reinsurance sector, losses due to climate-related severe weather events amount to 100 billion euros every year around

the world. Out of that, only 30 billion euros are covered by insurance policies. Since its creation in 2007, the AXA Research Fund has supported more than 100 projects on climate-related risks. By 2018, the fund plans to allocate 35 million euros to them, covering all aspects of climate change issues: urbanization, migratory flows, impacts on human health and biodiversity, etc.

What kind of support do you provide to the researchers?

We have a wide variety of funding schemes to support researchers at the beginning of their career, through post-doctoral research fellowships (130,000 euros over two years). We have also established long-term institutional partnerships with leading institutions, by supporting AXA research chairs (1.5 to 3 million euros over five to thirty years). We also have the possibility to grant AXA Awards to particularly promising mid-career researchers (250,000 euro for a period of 4 years). Research findings belong to the researchers, which is an essential guarantee in the relationship we develop with them. However, this relationship is not just about funding. The AXA Research Fund

has also created a community of researchers eager to develop and disseminate their knowledge for the benefit of society. We provide scientists with opportunities to impart their knowledge through the media and social networks, and to address international, public bodies such as the UNISDR (United Nations Office for Disaster Risk Reduction). Our role is also to show what science can bring to different sectors such as businesses, the media, schools or public administration.

How do you select these projects?

The AXA Research Fund has succeeded in developing a robust and transparent selection process, recognized and credible in academic circles. After a rigorous preselection phase, the ultimate decision rests with a Scientific Board, two thirds of which are made up of distinguished academic leaders and members of AXA top management team. We assess very carefully the academic excellence of the host institution, its international exposure, its international reach and the working conditions offered to research teams. To select the researcher, we wish to support international experiences demonstrating abilities to take risks. Last, but not the least, we are willing to support innovative scientific projects, which represent a decisive step in the researcher's career and for the institution's prestige.



@AXAResearchFund

AXA Research Alumni & Friends

