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Whether we want it or not, whether we accept it or not, times have changed. Within a few weeks, a new form of chaos has unsettled our lives, individually and collectively, making uncertainties even more tangible. Without really knowing what this post-crisis period, which is only just beginning, holds in store, there is nevertheless a gradual return to “normal” activity. This normalisation, both anticipated and worrying, cannot erase our questions and fears. Rather, it must remind us, once again, of the fundamental and decisive role of scientific research in dealing with it.

During this period, there was no interruption of the activities of the FNRS as a whole. On the contrary! The administration has pursued all of its missions, the Board of Directors has taken all possible flexibility measures with regard to researchers and applicants, the Scientific Commissions (for the call for “Scholarships and Fellowships”) took place on the usual dates, via video conference, and obviously with the same level of quality and confidentiality requirements, and other juries were held in the context of “Prizes and Endowments” activities. With a sense of urgency, faced with the pandemic, the FNRS has also provided additional funds, financed from donations and private bequests, for Urgent Research Credits (CUR) and Exceptional Research Projects (PER), which will be allocated shortly. Also, a fund-raising campaign has been launched to appeal to the generosity of the public to help scientists fight against coronavirus.

Research activities have continued, even though they have been impeded by the closure of labs, the inaccessibility of libraries and the impossibility of travel and missions abroad. Yet in some areas, directly or indirectly affected by the pandemic, some research has been particularly dynamic, fruitful and visible. The website www.covid19-wb.be is a perfect example of this, making public the inventory of hundreds of research projects, expertise and business initiatives deployed in Wallonia and Brussels to combat the COVID-19 pandemic and its consequences on health, society and the economy. This site was designed and developed by the FNRS, on the initiative of the Royal Academy of Medicine and the Royal Academy of Sciences, Letters and Fine Arts, supported by the universities of the Wallonia-Brussels Federation and the Biowin competitiveness cluster.

Since the beginning of this crisis, a large number of researchers, in particular from the FNRS, have also been approached by the media for their expertise. By issuing measured, balanced and responsible opinions, they have played several essential roles: an educational role vis-à-vis the general public, an expert role in political decision-making processes, and an enlightening role by highlighting certain unknown aspects of the crisis’ impacts and future consequences. And they have also, inevitably, played an extraordinary role as promoters of science and scientific research as we conceive it at the FNRS: free research, characterised by requirements of transparency, data sharing, exchange of experiences, but also and above all disinterested fundamental research, which is both long-term and forward-looking.

It is therefore necessary to repeat and assert the following once again: in the face of the magnitude of this crisis, in the face of other crises that we often approach with too much recklessness, in the face of the lies that maintain the most dangerous beliefs and ideologies, science, more than ever, must be defended, supported, considered in its rightful place and, above all, funded in line with the barrage of threats we face. Without awareness of these crises, without conviction of its importance, science will be disarmed and powerless, and humanity will be in ruins.

Véronique Halloin,
Secretary-General of the F.R.S.-FNRS
The last months have forced the impromptu meeting of three worlds: that of scientists, that of the media and that of politicians. “Unprecedented networking”, observes Guillaume Grignard, FNRS Research Fellow in political sciences at ULB, “but quite successful”. For the specialists called to the fore, including FNRS Senior Research Associate Marius Gilbert, the communication challenge was as colossal as it was essential: “As an epidemiologist, I know that containing an epidemic depends on the adoption of certain behaviours by the entire population. However, the public can only buy into such disruption to their habits if they understand precisely what is at stake. While official communication was initially very limited, I decided to occupy a role that should not remain empty. ” From as early as February, the researcher was convinced that he would be more useful in the media than in his lab, and this is how he gradually stood out as an indispensable expert, the subject of the headline “Beacon in the Belgian night of the coronavirus” in Le Soir, in mid-March.

From communication to becoming a star

It is by hitting the right tone that Marius Gilbert won the trust of journalists, viewers and politicians. And therein lies the complexity of expertise in the media: “You need to provide short answers to complex questions, which is very different for us from our scientific practice”, he notes. “As researchers, we are used to communicating with peers and drawing on a wealth of common knowledge. As teachers, we introduce complexity and present concepts gradually as the discourse develops. ” In the media, you have to be precise without always having the framework to be so. So the epidemiologist set himself two rules for communicating: accepting the limits of his knowledge and setting boundaries for interviews. “It is important to distinguish between categories of information and attaching a graduated level of confidence to them when presenting them to the public. There are reliable data, which are the subject of a broad scientific consensus, there are credible data, based on sets of assumptions, and there are data that remain unknown, which are the subject of speculation and are then subject to divergent analyses – there is nothing more confusing for the population than multi-faceted communication. To remain credible, you need to have the intellectual honesty to acknowledge that there are uncertainties or that we simply do not know. ” It is with this in mind that Marius Gilbert takes the time to prepare his interaction with journalists. “I try to have a clear view of the questions that will be asked and I suggest the names

What the experts say

With Marius Gilbert and Guillaume Grignard

They have become points of reference. During the long period of lockdown and management of the coronavirus pandemic, scientists, including many FNRS researchers, provided precise analyses that supported comprehension and action on the part of citizens and authorities. Written press interviews, appearances on television, advice to political authorities: they played a crucial role. What was the role of scientific discussion, how did the experts make it audible to the general public and what will remain of it in the future? Marius Gilbert and Guillaume Grignard provide an account and analysis.
of colleagues when points for analysis do not seem to fall within my remit."

In this way, invited several evenings a week into the living rooms of locked-down Belgians, Marius Gilbert ended up being part of their daily routines. And there is also some hype. "But it is low-level", he tempers, modest and almost uncomfortable: his photo on the front page of Paris Match, the flattering caricatures of Kroll and Vadot, the t-shirts depicting his face, the passionate comments on Facebook and the sharing of his very popular epidemic curves on Twitter, are all evidence that the phenomenon of becoming a star proceeds rapidly. It has reached the point that when the epidemiologist appears less on TV, viewers worry and enquire with the RTBF about his state of health.

Freedom of thought

We then move on to phase two of Marius Gilbert’s involvement. When he agreed, following a telephone call from the Prime Minister, to join the Group of Experts responsible for the Exit Strategy (GEES), the researcher placed greater restrictions on himself. Firstly, because deciphering the situation for the media is time-consuming and energy-intensive. Secondly, because “when you are involved in a decision, I feel that it is no longer my role to comment on it”, he explains. This collaboration with the political world was a “very big responsibility” but, once again, it was not something you turn down. In short, this is part of “service to the community”, in line with his mission as an FNRS researcher. "And I must say that I really tested the freedom of expression that we enjoy as researchers and academics. We are not afraid of displeasing a minister and losing our jobs. I believe that it is valuable for us, but also for politics and therefore for society as a whole, to have representatives whose freedom of thought is guaranteed."

Epiphenomenon

A meeting of different worlds, therefore. An ephemeral marriage? “Probably. The omnipresence of scientific discussion in the media is an epiphenomenon linked to periods of crisis”, explains Guillaume Grignard. “We saw this at the time of the terrorist attacks in 2016 or, more recently, at the time of the fire at Notre-Dame de Paris. Terrorism and cathedral experts were mobilised in numbers before returning to the shadows. " The same observation applies to politics: “It is only in crisis situations that the government needs to surround itself with experts”, states Marius Gilbert. “The financial crisis, the terrorist attacks or this epidemic are all contexts that required short-circuiting long-term science to rely on immediate expertise. " Does this mean that the opinion of scientists counts less outside of crises? That without a crisis, there is no need? That we should not aim to listen to scientists in a structured manner? “I think we should... that there are many issues at stake”, Marius Gilbert replies. And that, without becoming a technocratic state, the consultation of experts always makes sense."

Which experts?

It is still necessary to determine which experts to call upon. Here Marius Gilbert concedes, for example, that in such a crisis, his expertise allows him to define the epidemiological constraints, but that on other issues related to the lockdown, many other scientists, if not all citizens, have things to say.

This is also the main criticism heard about the “Lockdown exit group”: it consists mainly of experts in health and the economic sphere, thus reflecting the very strong dominance of medical sciences among the scientific disciplines on show in the media. “We have heard very little from sociologists, philosophers, anthropologists or political scientists in this crisis, on television in any case, which dominates the media world”, regrets Guillaume Grignard. " On the other hand, they are widely read; these researchers in the human sciences have never written so many opinion pieces as during the lockdown – spontaneous, unprovoked discussion... “We found ourselves in an unprecedented situation in which everyone wanted to react, all needing to express themselves on equally fundamental aspects of the lockdown: teleworking, the psychological impact, the organisation of the entrepreneurial world, etc.” Since February, not a day has passed without the social networks of the FNRS relaying the expertise or opinion of its grant holders and fellows: researchers in life sciences, but also in psychology, labour law, climatology, politics, sociology, philosophy, legal sciences, history, etc. They have all given food for thought to millions of Belgians. Thank you to all of them.

"In a crisis like this, we all navigate by sight. All of us – politicians, journalists and the general public – need beacons that guide us. We need experts. We were looking for scientists who know how to use plain language and who do not exaggerate or minimise. We found them."

Julie Morelle, RTBF journalist
It is two minutes to midnight. Scientists from the *Bulletin of the Atomic Scientists* (including 15 Nobel Prize-winners) have delivered their annual conclusions on the time we have left until the apocalypse: according to this conceptual clock, created at the beginning of the Cold War to warn of the danger of nuclear weapons, humanity has only two minutes left to live. The hand has moved dangerously close to midnight this year – midnight signalling the end of the world – given how the threats of climate change and nuclear war are endangering the Earth.

The Doomsday Clock was set at 11:58 p.m. in early 2020.

That was before the coronavirus crisis. Since then, the COVID-19 pandemic has occurred, which has given the whole planet the feeling of going through something from a work of fiction. The lockdown has provided a more specific idea of what this really means: the Earth is exhausted and humanity is falling apart. Scientists are the least surprised since they provide regular warnings: the human race is faced with dangers that are often caused by it. Burning forests, depletion of natural resources, loss of biodiversity, insect swarms, epidemics, declining birth rates: 20 FNRS researchers shed light here on bleak scenarios from the past and for the near and distant future. They recall that the end of the world has been in the making since the dawn of time and, each in their own field, consider the following question: is our civilisation doomed? Is it too late to move the hands back from midnight?
“Revelation”
Introduction to the apocalyptic literary genre

by Baudouin Decharmeux

Traditionally, it is considered that between the 2nd century BC and the 1st century AD, the apocalyptic genre appeared in veterotestamentary and intertestamentary literature. From the Greek *apokalypsis* “unveiling” or “revelation”, the idea of apocalypse, originating from the Christian tradition, suggests that a specific message has been given to a person (a visionary) in order for him or her to attest to events that have occurred or are yet to occur and have remained secret for the most part. The theme of the little book that the visionary eats as if to incorporate the Scriptures seems to suggest that he had access to “God’s hidden agenda”; a revelation that, at first, is sweet as honey, then creates bitterness in the insides. The eschatological dimension, mythological-symbolic narration revealing the end of time, is predominant; these poetic texts, supported by powerful symbolic images, often mysterious and enigmatic, are infused with epic inspiration that shakes up literary conventions.

It is important to note that the apocalyptic genre, a later incarnation of the prophetic genre, involves visions/revelations that are not directly understood by the visionary who receives them and, consequently, they require an interpreter (often an angel) who explains to him or her the meaning they convey. Thus, the apocalyptic genre begins at a time when the idea of the drying up of prophetic inspiration was spreading: as if, exhausted by the test of time, or by a change in temporality, the voice of the prophets had fallen silent, while a last generation took over, aware of the imminence of the end of time and its intrinsic weakness.

Texts generally considered to be apocalypses therefore share a number of specific traits that distinguish them from other literary genres. If we take the most common definition, we will consider apocalypses as literature taking the form of a revelation, with a narrative framework, in which a revelation is passed on by an otherworldly being to a human recipient, revealing a transcendent reality.
The fact that the apocalyptic genre, with its visions and predictions, especially of the end of time, can give meaning to lived experience, especially in times of crisis, explains the success of this means of expression.

These apocalyptic texts are frequently placed under the authority of a prestigious figure from the past who is beyond reproach because of the high scriptural reputation he or she enjoys (Apocalypses of Adam, Abraham, Enoch, Moses, etc.). For the Ancients, it was less a process of falsification of memory than the desire to show that such closeness to the divine was only conceivable on the part of an Ancient endowed with an indisputable spiritual aura. Thus, historical criticism refers to pseudepigrapha (writings placed under a pseudonym). Finally, from a methodological point of view, the main categories that help us to read and understand biblical texts (propheticism, apocalyptic, stories, hymns, etc.) essentially have a heuristic value. It is examination and its dynamics that prevail in terms of research, not stereotypical responses.

The fact that the apocalyptic genre, with its visions and predictions, especially of the end of time, can give meaning to lived experience, especially in times of crisis, explains the success of this means of expression. Thus, the Byzantine world of the 6th and 7th centuries was marked by an intensification of eschatological expectations: the dramatic events of the 7th century – the Persian conquest of Jerusalem, then the liberation of the city, and once again the conquests, by Arabs this time with the gradual establishment of a Muslim power – gave rise to rich apocalyptic literature, both Jewish and Christian.

The Apocalypse of John is certainly the only text considered to be an apocalypse in New Testament (canonical) literature; however, critics consider that several passages of the gospels of Mark, Matthew and Luke, and the epistles attributed to Paul of Tarsus or Peter, are apocalyptic texts. The various evangelical texts concerned prophesise about the destruction of the Temple, the return of the Son of Man and the symbolism of the fig tree; the letters refer to the appearance of the Saviour, the suffering of Christ and his triumph (Paul), as well as the punishment of the wicked and the rewarding of the righteous (Peter). These various passages show that we are in the presence of a literary genre in its own right, perhaps linked to preaching, which was widespread in the early Christian communities.

Among all the texts considered to be apocalyptic, the Apocalypse of John is the main source relating to the figure of Jesus. The first part of the text (the letters sent to the seven communities), which can be described as ecclesiological, does not belong to an apocalyptic source as such. It has been integrated into visions that are arranged on a level that is still the subject of scientific debate among exegetes. It should be noted that nominal quotations from the figure of Jesus are rare in Revelations, which prefers to use titles, qualifications and symbols, and therefore proceeds using allusions and analogies: Christ, prince of the kings of the earth, the faithful witness, the firstborn of the dead, the Son of Man, the First and Last, the Living One, etc. This non-exhaustive list includes the main references to the figure of Jesus, and each of the verses concerned can be the subject of a multitude of interpretations, meaning it has heuristic value because it questions the methodology implemented by the author (or the authors). It is the whole question of the relationship of Jesus to time (cyclical or not), but also of his Churches in relation to their own temporality that is addressed here, from an eschatological and soteriological perspective.

Historical-critical research has strongly emphasised the Sitz im Lebem, the epochality, of apocalyptic texts. It is clear that the wars against the Hellenistic kingdoms and the reign of the Hasmoneans (164 BC), the Roman protectorate in Judea that led to armed conflict and the destruction of Jerusalem, and the early persecutions of Christians, were major historical events that partly explain the success they met and the hopes they gave rise to. However, the connection with a historical period and its political issues, as enlightening as it is with regard to the theological-political intentionality of the writers, does not explain, for example, the choice of form or even the spiritual scope of this type of writing. Cross-referencing certain passages from these narratives with the data gleaned by contemporary anthropology, for example on possession states (the connection to exorcism and adorcism), can also be fruitful, especially if we bear in mind that exorcisms were part of the daily life of certain early Christian communities.

From a literary point of view, apocalyptic narratives are always fascinating because they implement a multitude of symbols, mysterious words and secret signs, which are a form of esotericism (so language reserved for insiders). These texts, somewhere between fear and fascination, raise questions to the point of having occupied a central place in iconography. An example of this is the multiple representations of apocalyptic visions that adorn Romanesque and Gothic churches and cathedrals.

Baudouin Decharneux

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1. This text was reviewed and expanded by Guillaume Dye, whom I would like to thank.
Why do we enjoy pretending it’s the apocalypse?  
with Fanny Barnabé

There was no need to wait for video games to make the end of the world a promising subject, and literature and cinema in particular have already made good use of it. To transpose our societal fears and our criticisms of self-destructive practices, and to feed the metaphor of what will lead to our downfall, apocalyptic imagery, so that of the undead, mutants and planetary disasters, is a staple. “The theme of the apocalypse is an important motif of popular culture, and video games have of course appropriated it,” notes Fanny Barnabé, FNRS Postdoctoral Researcher and member of the Liège Game Lab at the ULiège Laboratory of Media and Mediation Studies. “For this, the game S.T.A.L.K.E.R is fairly typical: set in Chernobyl, it was released in 2007 and inspired by the 1979 film of the same name, itself taken from a science fiction novel published in 1972.” What is more intriguing is that there has been a resurgence, in recent years, in the popularity of post-apocalyptic video games. Thus, Fallout, Fortnite, Minecraft, The Last of Us, PUBG, Days Gone are particularly popular video game licences.

A crisis-related resurgence

“This resurgence is due in particular to the emergence of new “gameplay” (a game mechanics), that of the “battle royale”. It is a game mode - mainly used in shooting games - in which 100 players are plunged into a space and only one must survive. The genre is sometimes traced back to DayZ, the development of which began in 2012, a world populated by zombies in which players are thrown without supplies. They need to find weapons, medicine and food to survive. But the genre became popular in particular with the releases of PUBG and then Fortnite, in which 100 players fight each other in a small space. This has revived the post-apocalyptic genre”, explains the ULiège researcher.

However, the game’s mechanics are not the only driver of this popularity. It is also due to sociological factors. “It is a genre that is always linked to anxieties and fears deeply rooted in society. It crosses all disciplines: cinema and literature have long echoed our anxieties. Its re-emergence is linked to the social crises we are experiencing. Researcher Oliver Pérez Latorre argues that a re-emergence of the post-apocalyptic genre originated in the 2008 financial and economic crisis. It can also now be fed by the anxiety about the
The apocalypse: such a practical subject

Beyond societal trends, there is in particular a practical argument: end of the world themes perfectly match the requirements of video games. These are both gameplay and narrative requirements. “Since video games are an interactive medium, you cannot do without player action. This is the concept of an action imperative (developed in particular by researcher Sébastien Genvo). And this explains that fiction that presuppose action can be much more easily adapted into video games. Of course, combat, escape or survival are better suited to them than nostalgia or melancholy. The post-apocalyptic world is fairly easy to grasp because it is a setting with a pretext for action: you fight either to gain your freedom, or to rebuild a society”, points out Fanny Barnabé.

Post-apocalyptic worlds also have the big advantage of being perfectly suited to the storytelling method of video games. “In a video game, you do not know where the player will go and, as a result, the story told by the game cannot be completely linear. It is therefore fragmented and distributed throughout the game. And this works well with apocalyptic worlds because the player collects objects and messages here and there. This fragmentation of the narrative is easy to justify: you cannot have access to the whole narrative because the world is destroyed. It is therefore normal for the narrative to be dispersed through documents, recordings and objects”, she explains. And by using them, the player can gradually reconstruct the story of what has or has not happened. This technique is not only specific to post-apocalyptic games, but it is particularly useful for them.

Players more nimble in the event of a real crisis?

In looking at these games of survival, resourcefulness and extreme moral choices (“do I save my childhood friend or humanity?”, as in Life is Strange), the question of the effect on players inevitably arises. Through playing, do they sharpen their survival skills and their ability to make choices that are as crucial as they are complex? In short, are they training for real-life situations? “The question of the effect of video games on players has been around for a long time. It has always been asked, either negatively – they were very quickly suspected of causing violence, without there being any consensus on the answer – or enthusiastically – they could facilitate learning or serve as training for certain situations, which has also not been categorically proven. So, whether post-apocalyptic games could be a training ground for ethical decisions... I doubt that making moral choices in a game can be compared to making choices in reality because video games are characterised as entertaining and fictional environments, in which the actions performed are “fake”; these are game environments one of the fundamental principles of which is that it is always possible to go back and make a different choice”, points out the Liège Game Lab researcher.

An area of freedom

It should be pointed out that, fundamentally, a game creates a space for freedom within the everyday world. “It is a margin for manoeuvre that we open up in the space of reality. We see here the analogy with the notion of “play” in a mechanism, in the sense of a space of freedom allowing the cogs to turn (analogy developed in particular by philosopher Jacques Henriot). Do these types of games promote awareness? Hard to say. On the other hand, they have a cathartic or at least reassuring quality. In these games, we control the direction that events take. A game offers us the tools to create these spaces of freedom that do not exist in reality. And that would certainly not exist in the context of the end of the world.”

Madeleine Cense

Fanny Barnabé

Postdoctoral Researcher, Liège Game Lab, ULiège

Games have a cathartic or at least reassuring nature. We control the direction that events take and we create a space of freedom for ourselves.
An inexorable demographic decline?

with

Thierry Eggerickx

“Demographic decline is nothing new!” For Thierry Eggerickx, FNRS Research Fellow at the UCLouvain Demographic Research Centre, it is rather the two centuries of rapid growth that we have just experienced that constitute “an anomaly, a parenthesis in the history of humanity”.

Over the course of millennia, demographic change has been characterised by very low growth rates, i.e. a small gap between otherwise very high birth and mortality rates, with alternating peaks and period of collapse “relating to the “three scourges”: famines, epidemics and wars”, explains Thierry Eggerickx. The objective of the demographic system of ancient populations was to ensure the survival of humanity by maintaining the balance between the growth of the population and the available resources. Any threat to this balance led to the use of economic strategies – land clearing, deforestation, the development of activities parallel to agriculture, the introduction of high-yield crops, such as potatoes, etc. – but also demographic strategies. “Above all, this involved an increase in the marriage age for women to 26 or 27, or even 30 in the event of a serious crisis, but also permanent celibacy, imposed on a certain number of young women and young men through family, social and religious control.”

Three phases

In the 19th century, in the context of a radical change in Western societies – resulting from industrialisation, urbanisation, development of means of transport, de-Christianisation, etc. – the demographic transition began. “This phenomenon is taking place in three phases. During the first period, between 1800 and 1870-1880, mortality decreased while the birth rate remained high, resulting in strong population growth. In the second phase, from 1880 until the inter-war period, fertility and birth rates began to decline, but, since mortality continued to decline, growth rates remained relatively high. And the third phase is the one we are currently experiencing in most Western countries, including Belgium, with similarly low birth and mortality rates, and therefore low or even negative growth rates in certain countries and regions.”

Individualisation

For Thierry Eggerickx, the key factor in the demographic transition is therefore the decline in the birth rate, which occurred in Belgium, and more specifically in Wallonia, in around 1875-1880, in response in particular to the major economic depression of 1873-1892. “This first major crisis in industrial society triggered wait-and-see reflexes: there was no question of having children before knowing how the situation would develop. Within a generation and without modern contraceptives, these populations reduced their birth rate by half! And the same thing happened in the inter-war period, with fertility levels equivalent to those of today: 1.8 children per woman. But the demographic transition is also the transition from an era in which the birth rate and marriage rate were subject to a kind of moral control by society to the current situation, in which birth rate norms, in particular the choice of the number
of children and the age at which one has them, are the result of individual choices, in competition with other options: education, career prospects, as well as the purchase of a house, a car, etc."

**Lag effect**

Beginning in France at the end of the 18th century, the decline in birth rate was interrupted after the Second World War, with the baby boom, before declining again more sharply in the 1970s. "It has now extended to most countries on the planet (even to sub-Saharan Africa, despite a lag effect). And neither the projections of the United Nations nor those of the Planning Bureau in Belgium foresee its reversal. By 2050, the population is expected to decline by at least 1% in 55 countries or regions, 26 of which could experience a decrease of at least 10%. In China, for example, the population is expected to decline by 31 million, or more than 2%.”

**Cars or babies?**

Is this a good or bad thing? “For me, it is neither one nor the other. But this is obviously an important topic, consisting of many issues. In 2017, the manifesto of the World Scientists’ Warning to Humanity alliance, published in the journal BioScience and signed by more than 15,000 researchers from 184 countries, deemed population growth the main factor behind environmental and societal threats: the more human beings there are, the greater environmental and societal threats: the population growth the main factor behind researchers from 184 countries, deemed BioScience and signed by more than 15,000 all alliance, published in the journal Humanity. World Scientists’ Warning to..."

**Retirement at 80**

This is especially the case since negative growth and a decreasing birth rate can have negative effects on the functioning of our societies. So, in a pay-as-you-go pension system, such as in Japan and Korea, but also in France, Germany, and Belgium, who will pay for pensions and health care? “Japan, for example, which is today the country with the oldest population on the planet, with 28% of its people aged over 65 (compared with 19% in Belgium), plans to raise the retirement age to 70, or even 80 for those who wish it, in particular civil servants. And, because pensions are clearly insufficient to live on, many older people are already forced to work, which partly blocks up the system, impeding young people’s access to employment. “

**Immigration**

If Belgium is not there yet, it is not only because its birth rate, although lower than the generation replacement level (2.1 children/woman), is still relatively "high" (1.7 children/woman, compared to 1.3 for Japan and 1.1 for Korea), but also because three-quarters of its population growth is due to immigration, to which Japan and Korea are firmly closed.

“Belgium has always needed migration, for economic reasons: in the inter-war period, when Belgians no longer wanted to go down the mines, we imported" Italians, North Africans and Poles to do the work that the Belgians no longer wanted. However, today, many Belgians see immigrants as a threat, even though they are essential in the hotel and catering sector, the care sector, the construction sector, etc.”

Rather than advocating a reduction or even a ban on births, production and consumption patterns should be changed. The polluters are not babies, but cars!

**From the bottom up**

According to the Planning Bureau’s projections, the population of Belgium, which today is 11,430,000, is expected to reach 12,700,000 in 2070. “For this to happen, the birth rate must not fail, and also life expectancy must continue to increase at its current rate (with an increase of 0.2-0.3 years per year). However, the current, particularly worrying, context of an environmental and health crisis is not conducive to procreation. Moreover, a recent study showed that increases in life expectancy vary widely across social groups and that social inequalities in relation to mortality have increased in recent decades. For example, comparing the 5% of the population at the bottom of the social ladder with the 5% at the top results in a difference in life expectancy of 14 years for men and 10 for women! " To secure our future, we must therefore move towards an egalitarian and multicultural society that rejects exclusion, ghettoisation and marginalisation. It remains to be seen whether the change in philosophy required by this evolution is within our reach...

Marie-Françoise Dispa

The current, particularly worrying, context of an environmental and health crisis is not conducive to procreation.
The theory of the great replacement or the obsession with foreigners with François Gemenne and Jean-Philippe Schreiber

Among alarmist scenarios, there is one that, peddled by the extreme right, feeds violence that is no longer theoretical: the gradual replacement of the European population by an immigrant population and, in the process, the decline of “Western values”. Two FNRS researchers, Jean-Philippe Schreiber, a historian, and François Gemenne, a political scientist, analyse the origin and drivers of this discourse, which is admittedly euphemistic in Belgium but nevertheless dangerous in a context where, with an epidemic crisis in mind, foreigners are quickly regaining their historical status of a “stain” on the national identity.

It is one of the most common ruminations in history: the fear that a foreign population will imperceptibly work its way into our society, like a poison, and transform it both biologically (with respect to race) and in terms of values. The so-called “great replacement” theory consists of attributing this intention to Muslims, based on two arguments. One is demographic: “In most European countries, we are seeing a decline in birth rates, explains François Gemenne, FNRS Research Associate at ULiège, while at the same time these states are recording substantial immigration from North Africa and sub-Saharan Africa.” The second element is cultural or religious: “This theory combines fear of demographic decline with fear of a disintegration of Western values and culture”, observes the political scientist. Behind this discourse lies a conspiratorial dimension: it is thought that the replacement process is deliberate. Politicians and scientists – the globalised intellectual elites – are thought to be organising the phenomenon because they need a “replaceable” man of the people, stripped of any ethnic and cultural specificity, who can be moved on the chessboard at will according to political and economic interests.

Historical enemies

Formulated by the French philosopher Renaud Camus in 2010, the term “great replacement” is recent, but the concept is an old one. “The rejection of Islam, which has been at work for some twenty years, draws as much from the current geopolitical situation in Europe as from its history”, analyses Jean-Philippe Schreiber, FNRS Research Director at ULB. “The collective unconscious remembers the wars waged by the Ottoman Empire in the 16th and 17th centuries against a Europe that developed a fear of the creeping Islamisation of Christian society”. Basically, Islamophobia is fuelled by the same tradition of fear that fuels anti-Semitism. “Since the end of the Middle Ages, our Western societies have marginalised Jews, vectors of change, making them scapegoats for serious economic, social and health crises. For example, during the great plague of the 14th century, Jews were accused of poisoning wells and introducing the disease. Whether it involved filth or vermin, the Jews were responsible for all the misfortunes of the world and had to be eliminated. Hence expulsions and massacres that have taken
You cannot counter irrational fears with rational arguments.

Place throughout the modern era, recalls the historian. At the end of the 19th century, racial and political anti-Semitism replaced theological and popular anti-Semitism, and inspired the Nazi theorists of the following century. This then led to extermination.

From words to actions

These fears, transformed into fantasies, are therefore dangerous when actions accompany the discourse. Thus, the theory of the great replacement is more catastrophic due to the scenarios it engenders than the one it denounces. In Belgium, while it is expressed by a narrow section of the population which sometimes does not even know its name, which lets itself be persuaded by certain journalists on French television channels, this theory has little resonance in political circles. “This is due to the fact that there are very few far-right ideologues in our country”, explains François Gemenne, who nevertheless notes the dangerous nature of this discourse on an international level, “it’s a real source of inspiration for violence”.

“The need to protect Western civilisation from foreign invasion is an idea that permeates the writings of far-right terrorists throughout the world”. The manifesto of Brenton Tarrant, the perpetrator of the Christchurch massacre in New Zealand in March 2019, is actually entitled “The Great Replacement”. A few months later, the killer in El Paso, Texas, used the same theory as inspiration to commit his “hate crime” against Mexicans. In the United States and Australia, the grand replacement theory has taken a broader and more extreme turn denouncing a genuine “white genocide” perpetrated from time to time by “invaders.”

In the future, this discourse could inspire more people because circumstances could strengthen it. “There may be a kind of natural connection between theories of collapse and the theory of the great replacement”, the political scientist analyses. “Pushed to the limit of their political logic, theories of collapse involve withdrawal into oneself, identity seclusion and rejection of the outside, which is seen as a threat. The climate crisis or the health crisis linked to COVID-19 are likely to reinforce this tendency that some already have of switching to “survivalist” mode.” And the historian confirms: “In times of crisis, democratic vulnerability increases, resistant individuals become sensitive to social anxiety and believe extremist discourse. Epidemics have often intensified the search for a scapegoat and the obsessive fear of foreigners”, notes Jean-Philippe Schreiber.

From the figures to the narrative

So what is the remedy for this evil? Specialists can put forward scientific arguments against each of the arguments of the great replacement: “It is today estimated that immigration accounts for only one-fifth of the growth of the European population: most of this growth is therefore still due to birth rates, even though they are in decline”, François Gemenne adds. “Although the migration phenomenon is marked by peaks in the influx of refugees and dramatic images, the fact remains that refugees represent only around 10% of migrants and that international migration is less directed towards Europe than towards other countries in sub-Saharan Africa. Finally, the theory is wrong to assume that the immigrant population maintains the birth rate of its country of origin once settled in Europe.” And what about the annihilation of “our” Western civilisation? “Talking about a decline in values is... a value judgement”, the scientist replies. “Societies change over time and history, cultural practices are transformed by a series of developments – look at how the internet has impacted our practices and relationships! The fear of the great replacement conveys an imaginary ideal past, a kind of nostalgia for a bygone time that never actually existed.”

But putting forward figures and facts is not enough. “Irrespective of the reality, the imagination is more powerful. Deconstruction discourses do not work very well because they do not use the same rhetorical register”, the historian observes. “You cannot counter irrational fears with rational arguments”, agrees the political scientist. Especially since statistics, which are often national, do not reflect the heterogeneity of the realities of populations. “You could assert that in Belgium, only 16% of the population consists of immigrants. You would be right. But the father who lives in Saint-Josse, and who sees that his children’s class is made up of 85% immigrants, will not believe you.”

So, while identifying prejudices and contradicting false allegations about immigration is a necessary step, it is not enough to combat the popularity of far-right theories, according to François Gemenne, who believes that “we will also have to build a new narrative”. “We must propose a positive narrative showing that immigration is a structural transformation of our societies that, by conducting it in an organised way, we can make the most of.” This is a real challenge, which he will address at the start of the literary season with his next book “On a tous un ami noir”.

Epidemics have often intensified the search for a scapegoat and the obsessive fear of foreigners.
Collapsology: explaining the term
with Chloé Deligne

While humans aspire to peace and security, historical and even prehistoric societies seem doomed to endure political, social, economic or ecological crises. Are today’s crises “only” cyclical phenomena, like the growth rings of a tree, or a sign of the end of our time, as predicted by “collapsology”?

“Collapsology is a term proposed by Pablo Servigne and Raphaël Stevens in their book “Comment tout peut s’effondrer” published in 2015. It is based on the English word, “collapse”. According to these authors, collapsology is “a transdisciplinary exercise to study the collapse of our industrial societies”, explains Chloé Deligne, historian and FNRS Research Associate at ULB.

Dual temporality

This proposal is part of a body of work that questions how and why societies collapse. This work is written by authors, most often American, English or more recently French or Belgian, and Western in any case, and is the result of the worry and anxiety caused by the accelerated deterioration of terrestrial environments, a process that has been underway for nearly two centuries (loss of biodiversity, global warming, acidification of the oceans, soil impoverishment, etc. resulting from massive pollution, the ever-increasing consumption of fossil fuels, the overexploitation of certain resources, deforestation).

This work is part of a dual temporality. In the short time of “our era” that, since the 1970s, has revived old questions about the limitations of a socio-economic model that became hegemonic in the 20th century, based on the exploitation of fossil fuels.

These questions are often traced back to the publication of the Meadows Report of the Club of Rome, The Limits to Growth, in 1972, but recent historical research has considerably revisited this “origin story” of concerns about the sustainability of the capitalist economic model. Indeed, from the early decades of the establishment of the industrial capitalist system in the 19th century, voices were raised in concern about or to denounce the effects of this model on human lives and environments. These voices have today been put in context, in particular through the research of Serge Audier and Jean-Baptiste Fressoz. Yet the work on collapse is also part of a long period of fundamental examination of human societies with respect to their own future. This recurring and old examination has been fuelled by the production of myths, apocalyptic narratives and catastrophic predictions that serve as reflections or deterrents for the societies that create them, and must lead them to adopt new moral behaviours.”

Four points of criticism

For the historian, however, there is no moral lesson intrinsic to what is incorrectly seen as the end of time. “We can criticise this concept of collapse. One: it adopts an anthropocentric point of view, i.e. one that is only interested in the
The work on collapse is part of a long period of fundamental examination of human societies with respect to their own future. This recurring examination has been fuelled by the production of myths and catastrophic predictions that serve as reflections or deterrents for the societies that create them.

The choice of narratives

Here the researcher reveals an underlying mechanism: “Is the concept of “collapse” not rather the cornerstone of new apocalyptic narratives that should encourage us to adopt new moral behaviours? Throughout history, there have been profound transformations that have led to the disappearance of complex socio-political systems. Various examples haunt our imaginations: the disappearance of the Mayan civilisation, of the prosperous societies of the Indus Valley or of the Roman Empire. While these “disappearances” occupy our imagination more, this is also due to the narratives we have chosen to make of them. Hundreds more historical cases could be added to the list. The fall of this Chinese dynasty or that African kingdom, the destruction of Native American societies, the disappearance of the Mongol Empire, etc. And if these narratives have not managed to find a place in our “collapse” imagination, it is because they have not been presented as narratives of collapse. This illustrates the fact that these narratives are not chosen or constructed at random; they must correspond to what one wants to see or demonstrate.”

“Ultimately, it is absurd to think that “everything” can collapse. There is no such thing as a clean slate in history. Despite many threats to our way of life and the ruins left behind by two centuries of extractive industrial capitalism, many things can nevertheless be reinvented. But it is important to ask ourselves what we want to continue or reinvent and, on the contrary, what we want to abandon, what we want to take care of and are ready to fight for, and what we want to do without. These are choices and not laws of nature.”

Frederic Soumois

These are choices and not laws of nature.

Chloé Deligne
Research Associate,
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Most viruses infecting humans first circulate in an animal reservoir, particularly in bats and rodents, as in the case for the SARS-CoV-2 coronavirus. Identifying these reservoirs and the mechanisms that allow the “species barrier” to be crossed is essential to contain new pandemics.

In virology, emergence can refer to two phenomena: the appearance of a virus in a new geographic niche or in a host species in which this virus had not previously been identified (new host-pathogen interface). “Emergence is a natural, dynamic, perpetual and multifactorial phenomenon that, on the one hand, is promoted by the disruption of one or more factors within an ecosystem and that, on the other hand, is the consequence of effective adaptation of viruses through genetic variability”, explains Carine Van Lint, FNRS Research Director at the Department of Molecular Virology at ULB. “Thus, most viruses currently considered to be emerging contain genetic material consisting of ribonucleic acid (RNA), a characteristic that promotes genetic variability.” More precisely, RNA is a medium with a high frequency of mutations and/or recombinations and reassortments. These viruses therefore have an intrinsic ability to adapt, evade an immune response, create resistance to antiviral treatment and modify their external structure to adapt to new species.

Species barriers
Viruses are responsible for 25% of emerging human infectious diseases. Most of them are called “zoonotic”: they circulate first in an animal reservoir before infecting humans, such as in swans in the case of Hong Kong flu or in bats and rodents for certain haemorrhagic fevers. “In general, the virus is typically well adapted to the animal and non-pathogenic in this natural reservoir: it is during inter-species transmission to a new host that it can become pathogenic”, explains Carine Van Lint. Transmission can take place either directly from the animal reservoir to humans, or involve several host species, known as “intermediate species”. When introduced into a new host, the virus is however poorly adapted to this new host and it comes up against “species barriers” that consist of differences between the original host and the new host, i.e. cellular factors that interfere with the viral cycle. “We refer to limiting factors: mutations in the virus (which replicates ineffectively at first) can lead to an adaptation of the virus to the new host. After crossing the species barrier, the virus is then said to be “emergent.”

Viral replication continually leads to the appearance of mutations and therefore to genetic variability (resulting from the cumulative action of mutations, recombinations or reassortments of viral genomes). To counteract the limiting factors, the virus must replicate itself at a sufficient level to allow the accumulation of adaptive mutations. These mutations make it possible to deal with selection pressures that are either natural (adaptation to limiting factors) or artificial (adaptation to antiviral drugs). For this reason, the emerging virus may be associated with a pathogenicity in humans that differs from that observed in the reservoir animal. However, the transition of a virus to a new host remains a rare event due to the existence of species barriers.”

The case of coronaviruses
In December 2019, the Chinese authorities informed the WHO of grouped cases of pneumonia of unknown etiologies: the vast majority of patients had been exposed to live animals from a market in the city of Wuhan, in China. On 7 January 2020, the emergence of a new coronavirus was identified: this virus was called SARS-CoV-2, due to its phylogenetic link to SARS-CoV-1 and other related coronaviruses. “Coronaviruses are very widespread, especially in animals and in particular bats, which seem to be their major reservoir”, explains Carine Van Lint.
Four seasonal human coronaviruses (HCoV 229E, NL63, OC43 and HKU1) are endemic worldwide, causing simple colds or mild influenza-like syndromes. However, some coronaviruses, through various mutations, have acquired more pathogenic properties, such as SARS-CoV-1 and MERS-CoV that are associated with acute respiratory distress syndromes. Thus, the SARS-CoV-1 epidemic, which emerged in 2002 in China, caused more than 8,000 infections and nearly 800 deaths. “The animal reservoir of this coronavirus was identified as an insectivorous bat. The intermediate host that allowed the virus to pass to humans was the masked palm civet, a wild animal sold in markets and eaten in southern China”, notes Carine Van Lint. This episode highlighted how knowledge of the animal reservoir is essential to put in place appropriate prophylactic measures to protect populations. “After identifying the masked palm civet as an intermediate host, the cessation of the breeding of wild civets, the closure of animal markets and the order to stop eating these animals enabled the SARS epidemic to stop spontaneously.” In 2012, another coronavirus, MERS-CoV, emerged in Saudi Arabia, affecting nearly 2,500 people and causing 850 deaths. In this case, it appears that recurrent passages of the dromedary virus (intermediate host to which the bat transmitted its virus) to humans – sometimes followed by chains of limited human-to-human transmission – were the cause of the epidemic. In 2020, sequencing of the SARS-CoV-2 genome showed its great similarity to an endemic virus found in bats in China: this is the animal reservoir from which the epidemic originated. It is likely that the Malayan pangolin played the role of intermediate host.

Bats and rodents

Bats and rodents are considered major viral reservoirs of coronavirus. “However, recent analyses suggest that these animals are not actually more likely than others to host viruses that infect humans. On the other hand, these are groups that in themselves contain a large number of species. And statistically, animal groups containing more species have more viruses and therefore a larger number of viruses that can infect humans. In short, they represent a greater potential for crossing the species barrier”, analyses the Research Director. Hence the importance of targeted monitoring of areas of high biodiversity of bats and rodents to prevent future outbreaks.

“Animals play a key role in the early stages of viral emergence in humans. If the virus is controlled in the animal reservoir, then the human host is protected.”

Nevertheless, it should be noted that not all emerging viruses are destined to result in a pandemic: some do not cross the species barrier, restricted by specific factors in the new host, while others only lead to sporadic human infections. But a better understanding of emergence mechanisms, reservoirs and dynamics of virus populations will make it possible to better deal with those capable of massively breaking away from their animal context.

Julie Luong

Carine Van Lint, FNRS Research Director, DBM, ULB
Vaccines and antibiotics have for decades raised hopes that humanity would overcome infectious diseases. However, today, resistance phenomena, the rapid spread of pathogens and certain economic challenges are undermining the effectiveness of both strategies. However, they remain the only weapons available.

The metaphor of war that frequently dominates discourse on epidemics might suggest the possibility of a final victory: the total and definitive eradication of the enemy, the closing of the chapter on infectious diseases. In reality, this is a poor understanding of the capabilities of pathogens and also a misunderstanding of the current capacities of medicine and researchers. Apart from the very specific case of smallpox – which only had a human reservoir – eradication is generally never achieved. At best, the frequency of a pathogen declines, but it will inevitably resurface locally or be replaced by others. “From the 1940s to the present day, it is estimated that more than 300 new pathogens that infect humans have emerged. And 70% of these pathogens were of animal origin”, recalls Éric Muraille, FNRS Senior Research Associate in immunology and a specialist in the host-pathogen relationship. “For example, the recombination of different viruses in animals is a phenomenon that, although rare, leads to the emergence of new viruses that are unknown to the immune system. Thus, most studies suggest that SARS-CoV-2, the COVID-19 agent, is a recombination of two different coronaviruses, one infecting bats and the other pangolins.”

The Holy Grail of the vaccine

Faced with this continuous surge, a protective and safe vaccine appears to be a precious but rare Holy Grail. For around 1,400 pathogens that now infect humans, fewer than a hundred vaccines are available. Moreover, in each case, it was often difficult and time-consuming to develop them: six or seven years on average and sometimes more than 20 years. This timeframe has become far too long given the rapid globalisation of epidemics. “Things have completely changed”, continues Éric Muraille. “Infections that previously might remain local for several years no longer do so. Today, for certain highly transmissible infectious agents such as influenza or SARS-CoV-2, a pandemic develops in less than six months. With 4 billion people flying every year, for pathogens the world has become a village that can be colonised in no time at all. “In 2003, the SARS-CoV-1 virus took 24 hours to make its way from China to Canada.”

There are also infections for which researchers have yet to produce an effective vaccine. “Many pathogens do not naturally lead to the development of effective immunity. Yet the principle of vaccination is partly to copy natural immunity. For these pathogens, we would then have to make a huge leap since it would be necessary to create immunity from scratch, which we have never really managed to do”, explains Éric Muraille.

Finally, the development of a vaccine is highly dependent on political and economic factors. “SARS-CoV-1 appeared in 2003, MERS-CoV in 2012 and we still do not have a coronavirus vaccine”, stresses Éric Muraille. “Historically, the first vaccines were mainly developed by laboratories subsidised by the States and they operated from a public service perspective. This is rarely the case today. For a private company, a vaccine represents a significant, risky and very long-term investment. It is therefore imperative that it be profitable,

Vaccines and antibiotics: strategies at risk?

with Éric Muraille and Régis Hallez
i.e. that it helps enough people in rich countries. Also, countries only invest heavily in developing vaccines such as for malaria, tuberculosis and HIV if the epidemic is widely publicised and affects a substantial number of people.”

Multi-resistance

Alongside the vaccines which are effective against viral or bacterial infections, antibiotics represent the other main strategy for fighting pathogens, but only bacterial ones in this case. Inspired by natural antibiotics produced by bacteria or fungi with the aim of preventing the growth of or killing other bacteria with which they compete in the environment, antibiotics have been synthesised on a large scale and widely used in human health since the mid-20th century. However, the effectiveness of these antibiotics is challenged by the emergence of multi-resistance. There is also a phenomenon of resistance to antivirals, but which is much more limited because their use has always been confined to the area of human health, unlike antibiotics. “One of the major problems is the widespread use of antibiotics in intensive aquaculture and livestock farming”, says Régis Hallez, FNRS Research Associate at UNamur, specialising in microbiology and bacterial genetics.

Used since the 1960s as growth factors for rapid weight gain in animals and limiting the spread of infectious diseases within farms, antibiotics have since continued to be released massively into the environment. “The concentration of antibiotics in soil and water has increased to reach a critical threshold called “sub-inhibitory”, i.e. insufficient to block the growth of bacteria or to kill them, but high enough to select resistance. In these same environments are bacteria and fungi that naturally produce antibiotics and the mechanisms that enable resistance to them. Once selected, these resistance mechanisms will spread vertically and horizontally within bacterial populations”, explains the researcher.

Vertical transfer means “hereditary transmission”: a resistant bacterium gives rise to a large population of other resistant bacteria. Horizontal transfer, which is more complex, refers to processes by which genetic material can be transmitted between bacteria of different species that coexist in the same environment. “One thing leads to another and we end up with dangerous pathogenic bacteria equipped with just about everything that exists in nature to resist antibiotics. If nothing is done to combat antibiotic resistance, the World Health Organization (WHO) predicts that by 2050, bacterial infectious diseases may again become the leading cause of death worldwide, far ahead of cancer”, stresses Régis Hallez.

“Not to mention that we now know that many diseases, previously classified as having a non-infectious origin, are actually linked to viral or bacterial infections: more than 20% of cases of human cancers – cervical cancers, stomach cancers, etc. – are of infectious origin”, adds Éric Muraille. Some perspective would therefore seem necessary: the health emergency is not limited to COVID-19 and it is important to remove the fight against infections from the strict imperatives of productivity or profitability. On the basis of this minimum requirement, researchers will be able to deploy their inventiveness in the face of the unpredictability inherent in nature.

If nothing is done to combat antibiotic resistance bacterial infectious diseases may again become the leading cause of death worldwide, far ahead of cancer.

Éric Muraille addresses the issue of vaccines, particularly as part of his brucellosis research.

Régis Hallez presents his FNRS/WELBIO research project focusing on antibiotic resistance.
A recent study, carried out by researchers from ULB and KU Leuven, with the support of South African colleagues, recently demonstrated that a virus has no interest in killing its host. “This study was carried out on a virus that infects maize plantations, but the principle is the same for viruses infecting humans”, explains Simon Dellicour, co-author of this study and researcher specialising in molecular epidemiology. “A virus that kills its host is less likely to be transmitted elsewhere since the host is no longer mobile. The virus therefore has no interest in eradicating a population.” “Interest”? Let’s clarify! The virus has no will of its own. It even barely clings to life in the sense that it is unable to reproduce on its own and that, without finding an organism to be a host, it usually dies very quickly. “A virus that will survive the longest is one that will successfully infect a very large part of the population”, explains the FNRS Postdoctoral Researcher at ULB. The virus responsible for COVID-19 (SARS-CoV-2) is of this calibre, i.e. highly transmissible. “In reality, there is an “evolutionary trade-off” between the amount of harm caused by a virus to its host and the effectiveness with which viruses position themselves to enable subsequent transmission.” The virus must somehow strike the right balance between the intensity of the symptoms it causes (in particular because of its reproduction) and its own survival.

A virus capable of decimating humanity in a few weeks or months? While this worse-case scenario floods our imaginations, what does the science say about it? This is a possibility, in theory. But most of the time, viruses have every interest in sparing their hosts.

Mutations that provide information

Each epidemic addressed in the media generates the same fear in imaginations: that of mutation. A mutation that would make the virus more dangerous, more lethal and/or more transmissible. A mutation that would make things worse. “From a scientific point of view, mutation is a one-off change in the genome and does not necessarily represent a source of concern. The virus mutates continuously and even very quickly, especially because generation times are very short and population sizes are very large. Most of the time, however, these mutations do not affect the virulence of the virus or its transmission capacity.” Not only do mutations generally have no impact on virulence, but even when they do, they can also cause it to be less dangerous. The fear associated with this idea is therefore largely unjustified. “I think it comes from the world of Hollywood, from the association with mutants and superheroes. This creates a recurring misunderstanding that can frighten people”, analyses the researcher.

Mutations, on the other hand, are a valuable source of information for molecular epidemiologists like Simon Dellicour to trace the history of transmission of the virus. More precisely, without changing the physical form of a virus, successive mutations lead to variations in its genome. “Based on mutations, we can trace the history of the virus just as we could trace the origin of a text passed between copyist monks. If one copyist monk makes a mistake while copying, this mistake will normally be repeated by the next one.” Thus, molecular epidemiology involves using the genetic information contained in the genomes of pathogens to answer epidemiological questions. “Given that genetic mutations

Based on mutations, we can trace the history of the virus just as we could trace the origin of a text passed between copyist monks.
are observed over a very short period of time, it is possible to estimate what is known as a “molecular clock”, i.e. the speed at which these genetic mutations take place. Using this estimate, we are also able to assess the time of divergence between two viruses from the same epidemic. In other words, comparing the genome of a virus extracted from patient A with that of a virus extracted from patient B makes it possible to estimate how long ago they diverged from a common ancestor in the epidemic. So, molecular epidemiology enables the development of phylogenetic trees that represent the evolutionary relationships between the different viruses within the same epidemic. The history of the evolution of species is based on the same principle, but the difference is that in this case we apply this analysis to an epidemic of a few months and not to evolution over a few million years. These phylogenetic trees can then be placed on a geographic map and used to study the impact of environmental factors on the circulation of the virus or to test the success of potential intervention strategies. "If you do not have the genetic information contained in the viruses, it is very difficult to know where the transmission chain has gone and therefore to estimate the propagation dynamics of viral lineages within the infected population", explains Simon Dellicour.

The need for a scenario

While a virus theoretically has no interest in being too deadly, the appearance of a devastating virus cannot however be ruled out. "If you have a virus with a high mortality rate but that takes time to truly threaten the survival of its host, i.e. that maintains the possibility of transmission from one person to another for a long time, the worst-case scenario is possible." A virus such as Ebola, with a mortality rate of around 50% and risk of transmission during incubation, has given a glimpse of this spectre. Faced with this, only drastic health and quarantine measures and are able to quickly reverse the inevitable. The COVID-19 virus imposed another necessity: preventing the congestion of hospitals, and in particular intensive care units. "Unlike the Ebola virus, which almost systematically causes dramatic symptoms, the specificity of a virus such as COVID-19 is very likely its capacity for transmission by asymptomatic or mildly symptomatic people, even if the exact proportion and role of these people in the transmission chains is not yet known", says Simon Dellicour. This coronavirus, which is potentially fatal for the healthcare system, as the Italian situation has shown, has succeeded in causing an epidemic that is both “distressing and tedious”. A thousand miles from a Hollywood screenplay, it would be more at home in art film that drags on for a long time and continually dispenses its malaise. It also reminds us that to avoid worst-case scenarios it is necessary to consider them as possible and to plan for them ahead of time, in the same way as the emergency plans, stocks of masks and other lockdown plans that go with them. This could be termed the art of reasonable pessimism.

Julie Luong

Simon Dellicour
FNRS Postdoctoral Researcher, SpELL, ULB
The wall of biodiversity is in danger of collapse

with Johan Michaux and Denis Fournier

The disappearance of many families of plants and animals, which has accelerated since the last century, is threatening biodiversity. The latter, like a wall from which bricks are gradually removed, could collapse if our lifestyles do not change. The upshot would then be disastrous consequences for the world. The crisis caused by the new coronavirus, resulting from this loss of biodiversity, is only the tip of the iceberg.

Climate change, the over-exploitation, destruction and fragmentation of habitats, and pollution, are all threats to biodiversity. This is the biodiversity that provides us with the clean water, oxygen and food we need to live. “The extinction of pollinating species would, for example, mean the disappearance of 90% of flowering plants and 70% of food crops (fruits, vegetables, oilseeds, etc.),” explains Johan Michaux, zoologist, FNRS Research Director and creator of Gecolab, the genetics and conservation laboratory of ULiège.

A threat to health

Johan Michaux studies, among other things, the relationship between wildlife species, biodiversity and health, sometimes in Europe, sometimes in Africa and South-East Asia. In this part of the world, the researcher analysed the risks of coming into contact with mammal species living in the heart of the forest, far from humans, compared to commensal species, which live in direct contact with humans. “We have discovered that mammals living in the depths of the forest are frequently reservoirs of pathogens, unlike commensal species, which are not usually carriers.”

In principle, therefore, there is no reason to panic: species carrying pathogens that are potentially dangerous to humans live far from civilisation. The problem is that the human race is increasingly coming into contact with these species, particularly through deforestation and habitat degradation. “This creates a series of problems. First of all, for people involved in deforestation: they are in direct contact with these reservoir animals, which are real time bombs. Then, through hunting, facilitated by deforestation, which opens up a wide path through the heart of the forests,” says Johan Michaux. In a snowball effect, this increase in hunting leads to an increase in bushmeat and wildlife trafficking in Asia, Africa and the Amazon. Meat and live animals are brought to local market stalls, but also to those in large cities sometimes on the other side of the planet. With them arrives a biological hotchpotch that is a potential vector of pathogens. This situation is all the more exacerbated by the soaring demographics of many regions of the world and therefore by an increasing demand for animal protein.

The Amazon, Africa, Asia… Emerging diseases appear to be far from our countries. Moreover, some people believe that infectious diseases have disappeared from industrialised regions. But emerging diseases are on Europe’s doorstep too. “In our regions, the prevalence of chikungunya, malaria and dengue is likely to grow in the future due to global warming. Specifically, the latter facilitates the survival and dispersion of their main vectors: the tiger mosquito and mosquitoes of the Anopheles genus. In Belgium, new pathogens could also emerge, via mosquitoes or ticks, which are vectors of viral encephalitis in
The COVID-19 pandemic is also the result of over-exploitation of biodiversity. “In one of the markets in Wuhan, the presumed origin of the pandemic, the trafficking of wildlife has brought species into contact with each other that should not be brought together. Pangolins, presumed to be intermediate hosts of the virus, live on the ground and eat ants; and bats, a likely reservoir of coronavirus, are an insectivore species living in the rainforests of South-East Asia. Natural contacts between the two species are therefore very limited, if they occur at all. We are currently studying these risks of natural transfers between different organisms, including humans, but they are much lower than when two caged live species are artificially brought into contact in a market in Wuhan.”

COVID-19: the tip of the iceberg

Disaster is not inevitable, but it is time to act. “What we can hope for, in a somewhat idealistic way, is a completely different relationship to biodiversity. In any case, wildlife hunting must be managed more effectively and rationally. We obviously need to protect our forests and limit global warming in order to avoid “snowball” effects. Wildlife trafficking must also be monitored and stopped. In China, where the state has banned trade in wildlife, bats have again been found on market stalls. So there is still a world of difference between words and deeds. Finally, regulation of global human demographics, the main cause of the disappearance of biodiversity and increasing contacts with wild species, should be urgently implemented”. Johan Michaux concludes: “What is positive about this recent crisis is that, for the first time, we are calling on scientific society and listening to its opinion.”

What are the solutions?

Invasive species

After habitat modification, biological invasions are the second biggest cause of biodiversity loss. More than 50% of listed extinctions are linked to biological invasions, and researchers estimate that 17% of the planet’s surface is threatened. Behind the biological invasions are invasive species. “As a general rule, these species that leave their native area, settle discreetly in a new environment and, due to their dispersive, predatory and competitive and reproductive capacities, gain ground until they become dominant in an environment that was not originally theirs”, explains Denis Fournier, FNRS Research Associate at ULB.

While the phenomenon may be of natural origin, human activity has greatly accelerated the introduction of invasive species. This can be either voluntarily (biological control of a parasite for example), or involuntarily, notably through the transport of goods. “This is how we find the Argentine ant, which, as its name suggests, comes from South America, throughout the Mediterranean basin where it forms a single colony of millions of queens and billions of workers that do not attack each other. This supercolony stems from a very small number of queens (about ten) that took advantage of the trade in exotic plants to be transported.”

The way of life of our societies unfortunately leads to increased risks of pandemics and natural disasters. “It is clear. This pandemic is only the beginning. There will be increasing numbers of emerging diseases. Loss of biodiversity and increasing demographics are leading to humans coming into contact with species that usually live far away from them. Moreover, current means of transport are facilitating the spread of emerging diseases at an extremely rapid rate.”

The problem with invasive species is that they enter a new habitat unnoticed. “Another solution is to predict future introductions. This is also the most economical method. For example, we can predict the establishment of a species based on the environmental conditions that are favourable to it today, or model what the conditions will be in the coming years based on the effects of climate change.”

Predicting is one thing, but action is still needed. “The idea is to implement protection and conservation policies ahead of time.” Fortunately, it is not too late.
Since the end of December 2019, East Africa has faced an invasion of billions of locusts, specifically desert locusts that have already destroyed thousands of hectares of crops. In early February 2020, a single one of these insect swarms covered 2,400 km², the size of the Grand Duchy of Luxembourg, made up of around 200 billion individuals. They could potentially eat the equivalent of 400,000 tonnes of food per day. It was quickly said by some to be “devastation of biblical proportions” or the “the latest African plague”. While the phenomenon is extremely dramatic, is it resurging or of unprecedented intensity?

Insect swarms: the weapon of yesterday, the scourge of today
with Claire Detrain and Michèle Broze

A swarm is an aggregation of insects of the same species, which is often temporary, even though it can last several months or even several years. These swarms can consist of a few hundred individuals up to several hundred million, explains Claire Detrain, FNRS Research Director and an entomologist at ULB.

Insect aggregations are not uncommon. Some gather to promote genetic mixing during reproduction (e.g. dipterans), while others gather to migrate (bees that change nesting sites in particular). However, no species is comparable to desert and migratory locusts, which make a big impression owing to their number and density.

A special species

Locust swarms capture the imagination because they can cover several tens of square kilometres, or the equivalent of the city of Paris, states Claire Detrain. “Locusts are also able to travel a hundred kilometres each day. They do so in a coordinated way, even though there is no leader. This is by means of the self-organisation of the group, which moves collectively using simple local rules for alignment and proximity between individuals.” They can then number hundreds of millions, with each individual being able to consume the equivalent of its own weight in food per day. With each animal weighing two grammes, this amounts to two tonnes per day per million insects.

However, desert and migratory locusts are usually solitary animals. But under certain conditions, local populations begin to grow exponentially. “Locusts are semi-arid region animals. When very heavy rains follow a period of drought, there is very significant vegetation growth. The animal will then find itself in conditions that are particularly conducive to its reproduction and development. It will reach a critical threshold of individuals and especially density, at which point it will change behaviour and appearance”, explains the entomologist. “This is called phenotypic plasticity: it is the same species, but it will fundamentally change its behaviour – becoming highly gregarious – and will even change its morphology. In the solitary phase, individuals have cryptic colours: green, brown, etc. In the gregarious

Swarms cannot kill humans, but they can prevent humans from eating.
Egyptian armies can be metaphorically described as swarms of locusts striking their enemies.

"Locust swarms are threats in Africa, the Middle East and Asia", the researcher replies. "When we look at the dates when swarms are observed, we see that there is a phenomenon approximately every ten years. The previous locust infestation, before the one in late 2019, dates back to 2003-2005."

Nevertheless, when a locust infestation occurs, the food and economic consequences for the countries concerned are considerable. The current infestation has affected many countries in East and Central Africa: Kenya, Ethiopia, Eritrea, Dibouti, Somalia, Uganda, Tanzania, Sudan and South Sudan, as well as the Democratic Republic of Congo, even though the country had not been infested by the desert locust since 1944, or for 76 years. Combined with the COVID-19 pandemic, which has not spared these countries, the locust infestation may plunge millions of people into poverty and famine. "Swarms cannot kill humans, but they can prevent humans from eating", summarises Claire Detrain.

An enormous amount of research focuses on locusts, given the significant economic challenges. "Once they enter the migration phase, these millions of insects, which move very quickly, are almost invincible", notes the entomologist. "It is therefore essentially a question of monitoring the growth of potentially dangerous populations and taking action before the swarm forms. This involves chemically treating populations the density of which is approaching a critical threshold."

The heralding of a disaster?

The international press uses strong terms to describe the scourge. It is indeed a disaster in East Africa, but the phenomenon, while appearing regularly (every ten or fifteen years), is not resurging. In this respect, the impact of global warming on the intensification of the phenomenon remains an open question. "Global warming increases the frequency of extreme events. Population growth often correlates with periods of severe drought followed by periods of heavy rain. If global warming increases the frequency of these extreme phenomena, the critical density threshold for locusts to swarm may be exceeded more frequently. This is a possible scenario, but there is currently no data to prove that there is a higher frequency", adds Claire Detrain.

The phenomenon has moreover been known for millennia. It is a subject that concerned ancient Egyptians, for example, without it turning into disaster-mongering. "Among the disadvantages associated with farming is the damage caused by, in particular, hippopotamuses, birds, mice, but also locusts that descend on fields. This scourge was therefore well known in ancient Egypt, but was one of several and was not distinguished from those other elements", confirms Michèle Broze, FNRS Senior Research Associate and Egyptologist at ULB.

Rather than fearing swarms of locusts, the Egyptians used them. Metaphorically, of course. Redirecting a dangerous animal to protect oneself from enemies was common practice in ancient Egypt. "This is the case, among other things, with the cobra. This is why the Uraeus, a representation of an upright cobra, can be found on the forehead of the pharaoh. This snake is a deity that spits fire on its enemies. " The swarm of locusts is used in this way in warrior texts. "The Egyptian armies can be metaphorically described as swarms of locusts striking their enemies. The number and destructive nature of swarms serve Egypt and protect against its enemies. The scourge is thus converted into a weapon against the enemy. " It was not uncommon, too, for locusts or grasshoppers – because the word is the same in ancient Egyptian – to be used for apotropaic purposes, to ward off curses, against diseases or other scourges. "This explains why, in iconography, a human being can be represented worshipping a locust/grasshopper."

Michèle Broze, FNRS Senior Research Associate, History of Religions, ULB

Claire Detrain, FNRS Research Director, USE, ULB
Kangaroos emerging from flames, koalas trapped by fire, aerial views of fires as far as the eye can see, opaque smoke engulfing major cities, etc. The first devastating fires in Australia started in New South Wales in August 2019 and continued until early 2020. Do these dramatic fires herald the end of our world? Are they the starting point for “megafires” that could burn the entire planet?

Let’s put things into context!

On this issue, climatologist François Massonnet, FNRS Research Associate at UCLouvain, proposes putting things into context: “Firstly, fires in Australia are an annual, natural and regular phenomenon. And after any fire, the vegetation replenishes itself. In the long term, on average, there are no CO₂ emissions that are associated with such a fire since the vegetation grows back and recaptures the CO₂ released during combustion. Then, what was striking in the Australian fires was the size of the flames, their intensity and the speed of their progression. They have therefore been described as an extreme climate event, but they have a rational explanation.” Michel Crucifix, FNRS Research Director and also a climatologist at UCLouvain, recalls that “the concept of balance is one of the first concepts taught in climatology. Very early on, however, researchers learned that sometimes very rapid and sudden fluctuations occur around a balance, and that, sometimes, these fluctuations lead to a permanent shift in the balance. So we need to understand whether the fires in Australia can be interpreted as heralding such a change in circumstances. In other words: has a new phase been entered?”

Structural phenomena...

The rational explanation for these fires is based on structural and cyclical phenomena. A fire is more difficult to model than precipitation or temperature variation. Fire is a combination of factors that develop under very specific conditions and depend in particular on soil conditions. “In late 2019 and early 2020, all these elements came together, triggering these dramatic fires”, says François Massonnet.

In terms of structural phenomena, Australia is experiencing annual warming similar to the global average, i.e. around one degree over the last one hundred years. This large country in Oceania has also been subject to a rainfall shortage in recent years, especially in areas affected by fires. The last 10 warmest
years in Australia occurred within the last 15 years. And 2019 was the country’s warmest year.

...that combine with cyclical phenomena

Against the backdrop of these structural phenomena, two major cyclical phenomena contributed to the fires. The natural phenomenon of the Indian Ocean Dipole: “All tropical ocean basins have natural variability expressed in the form of a dipole. Differences in ocean temperature between east and west fluctuate from year to year. This phenomenon also affects the Indian Ocean. During spring in the southern hemisphere, the temperature difference was greater than normal, contributing to moving rainfall systems towards the west and therefore drying out the entire eastern part, including Australia”, explains François Massonnet.

Added to this dipole was sudden stratospheric warming: “Above the first layer of the atmosphere (the troposphere), there is a layer called the stratosphere. Within this layer, there is a system of very strong winds called the polar vortex. In the northern hemisphere, this vortex regularly slows down due to sudden stratospheric warming. In the southern hemisphere, this phenomenon is much rarer but occurred in 2019. Wind systems began to migrate towards the equator, coming from the west, and heading towards Australia. So, in late 2019, there were very strong winds in Australia.”

From fires to megafires

For Michel Crucifix, what surprised experts was the scale of the fires: “Fire is part of a cycle that is in keeping with biodiversity. Fire destroys many trees, but allows other species to develop. The real problem is that, in Australia, we were no longer talking about fires, but “megafires” which burn the land very deeply and actually destroy biodiversity by sterilising the soil.” Could these “megafires” occur near us? “This is a concern in the Mediterranean region”, notes Michel Crucifix. “As summers there are warmer and drier, “megafires” could occur.”

Towards the apocalypse?

Do fires of such magnitude, caused by the sudden change in our climate, herald the apocalypse? “The end of the world or of humanity? I find that hard to believe”, says Michel Crucifix. “Our societies can change very quickly, but in the face of these changes, individuals have immense resources.” The very idea of talking about a “climate apocalypse” is counter-productive, according to François Massonnet, the researcher whose mission it is to inform the general public, in a measured and nuanced manner, about real future risks and those that are unknown. He adds that the development of observation systems in recent years has made it possible to “over-document” our knowledge about the current climate. “This is a good thing because we can analyse extreme events in real time. But the drawback is that we know everything right away. The social networks and information overload do the rest. This contributes to the catastrophic and anxiety-inducing context of the extreme event. Fifty years ago, these fires might only have been the subject of a radio news headline...”

Their role as researchers

Faced with this anxiety-inducing climate, FNRS researchers rightly have a role to play. François Massonnet remembers that, 10 years ago, climatologists had to counter climatosceptics. In recent years, there have also been climate and environmental extremists who oversimplify and compound the message. “My role, as a scientist, is to walk the tightrope between these two camps, by providing scientifically verified, correct and not over-interpreted information, while refusing to play on emotions and instead alerting people to the truth.” For Michel Crucifix, “what makes being a scientist challenging today is that every word is important and must be used wisely, in the right context. So my job as a researcher is to monitor the changing climate while carefully choosing my words. The utmost rigour must be used.” And we know that climate studies still have many years of work ahead...

Lauranne Garitte

The perception of our researchers

Or how the two climatologists experience this stressful climate context on a daily basis.

“At first, I explained to people that they had to make an effort to gift their children a healthy planet. But that is too abstract. Now, I outline concrete steps that people can take to impact not only the climate, but also their quality of life.”

Francois Massonnet
FNRS Research Associate, Earth and Life Institute, UCLouvain

“Our daily work as researchers constantly exposes us to the issue of climate change. So it is additional stress to be managed on a daily basis, also in our private lives. For example, we over-react to certain actions by those around us.”

Michel Crucifix
FNRS Research Director, Earth and Life Institute, UCLouvain

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On the scale of the lifespan of planet Earth, “major disasters” are common. Over the past 500 million years, life on Earth has almost completely died out five times due to climate change: an intense ice age, the awakening of volcanoes and the well-known meteorite that crashed into the Gulf of Mexico 65 million years ago, wiping out entire species such as the dinosaurs. These events are referred to as the five mass extinctions.

“It is thought that the Permian-Triassic mass extinction 252 million years ago was the most serious of them all; it wiped out 95% of marine species and 70% of terrestrial species. It was due to prolonged and intense volcanism that left behind the Siberian Traps. A trap is a massive stack of lava flows forming staircase cliffs. Researchers have noted a peak in mercury, with levels 3 to 8 times higher in that period. It was apparently released into the air in the form of steam, at very high altitude, which suggests a link to large-scale volcanic activity”, describes Vinciane Debaille, FNRS Senior Research Associate at ULB. “These phenomena in particular left a trace, called the Deccan Traps, in western India, made up of a stack of lava flows over 2,400 metres thick. This volcanism is linked to the Réunion hotspot, above which India was located 65 million years ago. Again, very large amounts of volcanic gas were emitted, and then the Chicxulub meteorite fell on Yucatan, projecting large amounts of sulphur into the atmosphere by falling on sulphur-rich rocks. The meteorite itself was a disaster of its own, with an estimated diameter of between 10 and 80 kilometres, and created a crater 180 kilometres in diameter, carving out part of the current Gulf of Mexico. The power of the explosion, estimated at 5 billion times the Hiroshima bomb, caused apocalyptic tidal waves and earthquakes. It also released huge amounts of dust into the atmosphere, causing a sharp reduction in sunshine and a massive loss of plants. “

In the face of meteors

Could humans, who are so intent on causing the sixth mass extinction themselves, avoid such an unforeseen disaster if it were to happen again? “We have a very large capacity for self-destruction, but this does not prevent us from thinking about ways to prevent external phenomena, such as the fall of the Chicxulub meteorite, from reoccurring. First of all, it is important to note that we are unfortunately short-sighted when it comes to the meteors travelling through space. They emit neither sound nor light, so we only see them when they are close and illuminated by the light of the Sun. As a result, this lack of vision prevents us from accurately assessing their size and speed. On top of that, we only see the large rocks. The smaller ones are invisible... but could still trigger cataclysms on a global scale. “

Is it too late, then, to avoid the extinction of the human race, along with perhaps most of the life on Earth? “There are numerous programmes out there. Of course, it is not enough to land on it, like Bruce Willis in the film “Armageddon”, to drill a small hole and place explosives in it. Work is being done on the possibility of diverting the trajectory of the meteor with a “small impulse”, like a pool ball, with an explosive charge...
sent from the Earth. Or, if there is more time, of attaching solar sails to it, which capture solar particle flows consisting mainly of ions and electrons ejected from the upper atmosphere of the Sun, to provide an impulse in another direction. Or also of sending one or more probes the impact of which would sufficiently throw off the trajectory of the object. Obviously, this cannot be done in three days. This explains why we are monitoring identified near-Earth objects very closely. If we have certainty about an impact in a ten-year time-scale, it is reasonable to think that interventions could be attempted. This is the purpose of the European Hera mission, which should approach Didymos, a system of two asteroids near Earth, in 2026. Didymos consists of a main celestial body, an asteroid the size of a mountain (780 metres in diameter), around which orbits a small moon of 160 metres. This small moon is nicknamed "Didymoon". The main objective of the Hera mission will be Didymoon, the smallest asteroid ever observed: the probe will carry out scientific mapping of the moon. When Hera arrives near Didymos in 2026, Didymoon will be the only object in the Solar System the orbit of which has been displaced by human intervention. NASA’s DART (Double Asteroid Redirection Test) mission is due to collide with Didymoon in October 2022.

Frederic Soumois

Vinciane Debaille presents her geochemical research on meteorites as well as the project "Evolution and Tracers of the Habitability of Mars and Earth".

"Legitimate fears of militarised space"

"It is an open secret that major military manoeuvres take place in space. There are two types of militarisation. Passive militarisation is the use of space to support the increasing of power on the ground; for example, by using a navigation system like GPS to enable troops to best navigate a theatre of operation. In practice, satellites are envisaged as dual systems, i.e. for military and civil use", explains Lou Villafranca Izquierdo, FNRS Research Fellow at ULB in political sciences. "Active militarisation means transforming space into a veritable theatre of operations by operating directly within it. The risk of escalation leading to conflicts of unknown magnitude cannot be ruled out. Added to this is the fact that the current legal arsenal cannot keep pace with technological developments."

Is there no space regulator, an interstellar UN? "There is the 1967 Outer Space Treaty and a few other instruments. The militarisation of space, and even its weaponisation, are not prohibited per se. Few things are prohibited, such as militarising the Moon and other celestial bodies or placing weapons of mass destruction into orbit that could be launched at Earth. A war in space may have serious consequences for our terrestrial systems, from transport to telemedicine to securities trading systems, and so on the interconnected global economy. In fact, a growing part of modern society relies on resources located in space."

So was the vision in 20th century science fiction right? "This dystopian vision of a collapsing world is a situation frequently present in contemporary science fiction, from Orwell to Philip K. Dick. We are witnessing an acceleration in technological development that was still unimaginable twenty years ago. Extreme miniaturisation and artificial intelligence now make this situation possible, if not probable. This does not mean that we should fall into a phantasmagorical mindset, but we must realise that this is a systemic risk that could have a chain of consequences, in particular because the debris of a satellite turns into a multitude of destructive objects if they collide with other satellites, including those of the power that initiated hostilities. Space is becoming increasingly crowded. Of course, there is the US space location system Space Track and initiatives being implemented at the European level with the Space Traffic Management programme that aim to carry out in-orbit location monitoring. But in 20 years, the risk of collision between space objects – which have lifespan of 7 to 12 years – will have become exponential."

Fr. So
Will the sky fall down on our heads? Astrophysicist Valérie Van Grootel reviews the threats that await us from above. A reassuring analysis: “If we exclude impacts by asteroids, we have little to fear from space.” At least for a few billion years... “The celestial object that presents the most danger to us by far is the Sun.” And this includes its disappearance.

Our planet is continuously bombarded by particles, often very high in energy, from the cosmos and of course from the Sun (solar wind). We are protected from this influx, which is harmful to life, by the Earth’s magnetic field. But the latter is not stable. “It can even sometimes reverse itself”, explains Valérie Van Grootel, FNRS Research Associate at the STAR (Space Sciences, Technologies and Astrophysics Research) Research Unit at ULiège. “When this happens, the Earth may have a weaker field or even be without a magnetic field for a few thousand years.”

Reversal of Earth’s magnetic field

French physicist Bernard Bruhnes discovered this phenomenon in 1905 while observing rocks in the Massif Central region containing grains sensitive to the magnetic field. It is now estimated that over the last 150 million years, the Earth’s field has reversed itself around 300 times. This would appear to occur randomly, even if precursor signs do seem to exist: passage through a multipolar phase (there are then several magnetic north and south poles) and prior slow decline in field intensity (but there can also be decline without reversal).

The latter phenomenon has been occurring for about 1,500 years, which could lead to cancellation of the intensity of the Earth’s magnetic field within 2,000 years! So it is a long way off. And what if this did happen? “No need to panic”, reassures the astrophysicist from Liège. “It is almost certain today that there is no link between this phenomenon and the mass extinctions of living species, and the human race has already survived several reversals of the Earth’s magnetic field. The Earth’s atmosphere, more specifically the ionosphere, protects us too; above all, there would be superb polar auroras and major disruptions to electricity and communication networks.”
Cataclysmic explosion

A supernova is the cataclysmic explosion of a supergiant star the core of which collapses as it ejects large amounts of energy. Could this happen “near” the Earth? “This could indeed considerably alter or even blow away the earth’s atmosphere and pose problems for life. But there have been no sufficiently close candidates identified in the vicinity of Earth for a problematic event in the not too distant future”, notes Valérie Van Grootel. “We have said a lot recently that Betelgeuse would be one of them, but this is probably not at all imminent and it is sufficiently far away from us”. This scenario can therefore be set aside.

Solar storm

Let us then return to our main “enemy”: the Sun. What if it really blows its top? Solar meteorologists know that our star has an activity cycle of about 11 years. The Sun’s magnetic field reverses itself in line with this period, causing an increase in particle eruptions until a peak is reached shortly after reversal, followed by a decrease in activity until the next reversal. Thus, a new cycle (the 25th since the beginning of observations) appears to have begun in March 2020; the eruption peak should be reached in July 2025. “However, these eruptions generally have little or no consequences for terrestrial life and in particular generate magnificent polar auroras”, explains Valérie Van Grootel. “But the Sun can experience bigger storms.”

A solar storm is characterised by a kind of explosion, often where there is a “spot” (places on the Sun that appear darker to us because they have a slightly lower temperature). During a normal solar eruption, it is X-rays and UV rays that reach the Earth first (they travel at the speed of light), then energy particles. During a solar storm in 2012, it was estimated that around one billion tonnes of material were ejected at a speed of around 2,000 kilometres/second, in two eruptions occurring around 10 minutes apart. While this did not cause a disaster, the reason is that these jets of particles cut through the Earth’s orbit in an area where our planet had passed... nine days earlier! “A major solar storm can disrupt satellites (in particular geostationary satellites, located 36,000 kilometres from Earth) and more generally all terrestrial radio transmissions. In 1989, recalls Valérie Van Grootel, a much smaller storm caused a nine-hour blackout in Quebec! Since our civilisation is now much more dependent on satellites and technological equipment in general, a large solar storm could have a significant economic impact, but it does not threaten our survival as a species.”

The real apocalypse

Perhaps the only thing responsible for the real apocalypse will be the Sun. Without the Sun, there is no more Earth. As a small star, the sun has an estimated lifespan of around 10 billion years. “Good news,” smiles Valérie Van Grootel, “it is therefore barely half way through its life!” The only issue is that it is destined to evolve into a red giant and become increasingly bright (about 10% more every billion years). So the problems for the human species – and all others – will begin long before the final explosion. Probably a billion years from now. The solar system’s habitability zone will have shifted at that point and the Earth will no longer be part of it, unlike Mars, which will be much more habitable than today. But the potential colonisation of the red planet will only be a temporary setback. After that, everything will happen very quickly. When it has finished burning its hydrogen, the Sun will have a helium core that will contract on itself while the Sun’s outer layers are pushed back: the Sun will have become a red giant. “It is still not clear whether the Earth will then be incorporated into the Sun, since we are at the exact limit”, Valérie Van Grootel wonders.

What happens next? The helium core will quickly turn into carbon and oxygen. Then, nothing, because it will not have sufficient mass for other transformations. The Sun will then become a white dwarf of the current size of Earth while its outer layers, expelled at the beginning of the process, dissolve into space.

A wandering Earth

Before describing the final, inevitable apocalypse, there is one last hypothesis to consider. There are stars and planets in the universe that are not gravitationally attached to any stellar system and therefore wander freely in space. What if one of these objects gets too close to the solar system? “According to certain characteristics of size, speed and distance, tempers Valérie Van Grootel, this object could push our planet out of its current orbit, distance it from the sun, and, why not, out of what is called the habitability zone, or even catapult it out of the solar system, leaving it in turn to wander in space. But simulations show that this scenario is extremely unlikely in the near future.” The apocalypse will probably not come from the heavens... but from humanity itself.

Henri Dupuis

A large solar storm could have a significant economic impact, but it does not threaten our survival as a species.
The evaluation of applications by remote experts and within Scientific Commissions is one of the key missions of the FNRS. At the beginning of July, some 390 grant letters will leave the FNRS, for grants decided by the Board of Directors a few days earlier. They are all for researchers who will begin or continue their fellowships, for a limited or indefinite period. Following the Board’s decisions, the FNRS begins in-depth analysis and evaluation work.

At the end of each call, the Analysis, Evaluation & Prospects department starts a statistical study gathering the raw data from the e-space database. This analysis, carried out year after year, makes it possible to verify the alignment of the funding instruments with the needs of researchers and research as well as the quality of the evaluation procedures. In September, a report is systematically sent to the FNRS Board of Directors.

In a few months, the results of the analysis of the 2020 call for Scholarships and Fellowships will therefore refine those obtained in previous years, which already reflect general trends. For example, data relating to the 2,129 applications submitted in the context of the 2019 call for Scholarships and Fellowships have made it possible to highlight the links or lack of links between certain application parameters and the granting of a scholarship or fellowship. Thus, the age, gender or bibliometric indicators of the candidate, the language chosen to write the application, the continuity of the career within the FNRS and the re-submission of the same application are all factors that, it is often thought, influence the results. These are preconceptions that need to be put into perspective.

Age of applicants

One clarification is necessary from the outset: remote evaluators and members of the Scientific Commissions do not have access to personal data. Certain eligibility criteria also have an impact on the age of applicants: for example, an applicant for a Research Fellow (ASP) fellowship, i.e. a 4-year doctoral grant, must have received his or her Master’s degree at most 3 years before. An applicant for a Postdoctoral Researcher (CR) fellowship, i.e. a 3-year post-doctorate, must have defended his or her doctoral thesis no more than 5 years before, while an applicant for a Research Associate (CQ) fellowship, the first grade of permanent FNRS researcher, must have received his or her doctorate no more than 10 years before.

During the 2019 call for Grants and Fellowships, ASP applicants had an average age of 26, CR applicants an average age of 32 and CQ applicants an average age of 36: this has not changed significantly over time. With the removal of age rules for eligibility, applicants of very different ages may find themselves competing. A trend appears to be emerging: the older the applicants, the less likely they are to obtain a fellowship in the various instruments.

1. See FNRS.news 118
2. The call for Scholarships and Fellowships concerns the following research instruments: Research Fellow (ASP), Postdoctoral Researcher (CR), Research Associate (CQ), Senior Research Associate (MR), Research Director (DR), Clinical Master Specialist Applicant to a Ph.D (SD), Medical Doctor Applicant to a MSc and a Ph.D (CSD), Post-doctorate Clinical Master Specialist (SPD), Clinical Researcher (CCL) and the Ulysse Incentive Grant for Mobility in Scientific Research (MISU). ASP, CR and CQ applications represent over 80% of the applications submitted in the context of this call; they are therefore the focus of this analysis.
Gender of applicants
The breakdown of applications is relatively balanced in terms of gender. Thus, the proportion of female applicants for a new fellowship in 2019 was 43.8%. On the other hand, the statistics show a continuous decrease in the proportion of women among applicants the further one goes up the levels of fellowships (women represent 48.5% of ASP applications compared with only 30% of CQ applications). Female researchers are also under-represented in the field of exact and natural sciences (with only 14% female applications in engineering sciences, for example). Female scientists are more attached to life and health sciences (62% of applications) and, among human and social sciences, to psychology and educational sciences (67%).

Language of the application
The majority of applications (72%) are written in English. This proportion is stabilising, after an increase in recent years, probably due to the change in regulations that now make it possible to require applicants in exact and natural sciences and in health and life sciences to submit English versions of their application. Thus, more than 95% of applications in these scientific fields are written in English, which makes it impossible to assess the impact of language on grants. In human and social sciences, on the other hand, the majority of applications are still written in French (55%). In this field, it should be noted that ASP applications written in English have higher success rates than those written in French, but that CR applications written in French and English have similar success rates. It should also be noted that three-quarters of human and social sciences applicants granted a CQ fellowship had written their application in French.

Bibliometric indicators
Applicants who consider it relevant may provide their bibliometric indicators (number of publications, number of citations, h-index) in a dedicated section of the application form. The h-index makes it possible to quantify the productivity and citation level of scientific publications but, as it is a cumulative index, it is above all an indicator of career maturity. In certain fields, particularly in human and social sciences, the h-index is perceived as non-relevant and is not even provided by applicants.

Career continuity at the FNRS
The figures reveal a certain stability of careers at the FNRS: Some 52% of the 123 applicants for a CQ position have received a CR fellowship in the past; 37.4% of them had obtained an ASP, FRIA or FRESH grant. In 2019, the success rates of CR applicants who received doctoral funding from the FNRS were higher than for those who had completed their thesis by other means. This data also reveals a certain consistency in the assessment of excellence.

Re-submission of applications
Of the 1,219 candidates evaluated during the 2019 call for Grants & Fellowships, 310 had already submitted a similar application in previous years, i.e. 25.5% of them. Statistical analyses show that the probability of being funded by re-applying differs from one instrument to another: candidates re-applying for at least the second time for the same CR and CQ fellowship have higher success rates, but those re-applying for an ASP fellowship for the second or third time have lower success rates than those having applied for the first time in 2019.

Continuous monitoring
By investing in the longitudinal evaluation of its calls, the FNRS ensures the absence of bias in granting decisions. The following should however be noted: a link with one of the factors can be identified occasionally without however constituting a significant trend or alerting to a bias to be corrected. Hence, a correlation must only be analysed in depth if it is systematic. Coupled with monitoring of the literature and methods of partners, this continuous evaluation contributes to strengthening the FNRS call and evaluation procedures.
Remote Commissions

The 14 Scientific Commissions of the FNRS just met in May-June, which is normal, except that this year, further to the coronavirus pandemic and lockdown, the experts held discussions via video conferencing. They therefore met virtually in the FNRS Board room. These Commissions 2.0 have been established to meet all the quality and confidentiality requirements that usually prevail during the application selection process. Test sessions were organised to familiarise any expert who so wished with the use of the digital tool. A methodology was also designed and provided to the members to ensure the smooth running of discussions (preparation of applications, differences in time zones, balancing of discussion time between applications, etc.) and avoid a racket (How to raise your hand? How to use the chat function to speak without interrupting another expert? Etc.). New to the FNRS, it was possible for these virtual Commissions to be held thanks to the adaptability of the administrative and IT staff of the FNRS, but also to the excellent collaboration of their members, aware that it was necessary to build on a plan B, and making every effort, each at their own level, to achieve this.

THE 2020 CALL FOR GRANTS AND FELLOWSHIPS: APPLICATIONS IN FIGURES

As part of the 2020 call for Grants and Fellowships, the virtual Scientific Commissions were held from 7 May to 5 June. They brought together:

- 210 members
- 126 international experts
- 84 experts from the Wallonia-Brussels Federation
- 1,185 applications reviewed
- 19 Commission days
1. ASP, CR and CQ applications represent over 90% of the applications submitted in the context of this call. The remaining applications concern the following instruments: MR, DR, SD, SPD-REN2, SPD, CSD, CCL, MISU, VETE-CCD.

3 MILLION FOR A CORONAVIRUS CALL

In April, the FNRS announced that it was spending €3 million on coronavirus research, using bequests and donations. This investment involved the rapid implementation of the Urgent Research Credits (CUR) call, enabling teams that have started research on coronavirus to benefit from reimbursements for the costs incurred, and an Exceptional Research Projects call (still in progress at the time of publication of this FNRSNEWS).

Eligible CUR applications were submitted

**Breakdown of all applications by gender**

- **55.9%** from men
- **44.1%** from women

**Breakdown of applications by field of research**

- **557** in human and social sciences
- **354** in exact and natural sciences
- **244** in health and life sciences
- **30** in FORESIGHT

**Breakdown of applications by research instrument**

- **499** applications for the Research Fellow fellowship
- **478** applications for the Postdoctoral Researcher fellowship
- **130** applications for the permanent position of Research Associate

**Evolution of applications by research instrument**

- **2010**
- **2011**
- **2012**
- **2013**
- **2014**
- **2015**
- **2016**
- **2017**
- **2018**
- **2019**
- **2020**

- **Research Fellow**
- **Postdoctoral Researcher**
- **Research Associate**

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CERN and the FNRS, represent a history with reciprocal benefits that began over fifty years ago with monumental ambitions: to explore the basic constituents of matter. While the world’s largest particle accelerator is currently shut down for a “major” update, physicist Christophe Delaere, FNRS Senior Research Associate, describes the operation of this underground complex and explains how this huge machine could revolutionise our knowledge of the infinitely small.

CERN is the European Organization for Nuclear Research, currently the benchmark laboratory in the world for the study of the infinitely small via particle collisions. It is a huge complex, an actual town built on the French-Swiss border, just a stone’s throw from Geneva; a vast estate composed of an enormous number of offices, workshops, laboratories and everything needed to support the 4,000 people who pass through the site every day, whether permanent staff or guests: mini-markets, a crèche, a fire station, hotels and restaurants. And inside, technicians, physicists and Nobel laureates meet and mingle.

That is all on the surface, but the belly of CERN, its complex of particle accelerators, is housed 100 metres underground.

Sheltered from space radiation and cosmic particles, the LHC (Large Hadron Collider), “the baby” of Christophe Delaere, who, along with thousands of other physicists, participated in its design in the early 2000s: “It is a bit like a circular metro tunnel within which a ring with a circumference of 27 kilometres is located, consisting of several thousand superconducting magnets and accelerating structures”, describes the FNRS Senior Research Associate. “The accelerators carry beams of high energy particles to make them collide with other beams or with fixed targets. Detectors observe and record the results of these collisions. The idea is that, thanks to the energy that it has been possible to accumulate in a collision of protons, it may be possible to produce particles that have never been seen before and understand new phenomena. It’s fascinating”, says Christophe Delaere.

Specifically, four particle detectors are installed within the LHC: ATLAS, Alice LHCb and CMS, the latter (involving more than 5,000 employees) being the only one to involve scientists from Belgian universities. The Compact Muon Solenoid is a huge cylindrical magnet weighing 14,000 tonnes and measuring 15 metres in diameter and 21 metres in length. Built around a crossing point of the beams of particles circulating in the LHC ring, it records the 40 million proton collisions that occur there every second. The physicists who collect the data can in this way compare the results with their model and validate or invalidate their theories.

Solving the enigmas of the Universe

For this is the aim of this arsenal of fundamental research: to ensure that the laws of physics are correct and to develop a new physics. “In the 1960s, a very effective theory was established to describe all the matter around us, the infinitely small in terms of elementary particles, known as “the standard model of particle physics””, explains Christophe Delaere. “This model describes all the particles, including the Higgs boson, predicted by Brout, Englert...”
One of the hopes with the LHC is to produce, during collisions, particles of dark matter in significant quantities in order to study them and thus solve one of the fundamental puzzles of the universe.

and Higgs in 1964 and observed at the LHC in 2012. Our task today is to refine our understanding. We find ourselves in the situation of the first observers of electricity: the Higgs boson is a completely new interaction, unobservable less than 10 years ago, the properties of which still need to be measured, for example. "

And, in particular, this theory has its limits. "It fails, for example, to include gravitational interaction. Nor does it provide an explanation concerning dark matter, an invisible material never observed on Earth, the existence of which is nevertheless suggested by various astronomical observations", notes the FNRS Senior Research Associate. "One of the hopes with the LHC is therefore to produce, during collisions, particles of this dark matter in significant quantities in order to study them and thus solve one of the fundamental puzzles of the Universe."

Towards a new LHC

It is therefore from his office that he is participating in the development of the next generation of detectors for the so-called "high luminosity" phase. In spring 2021, the LHC will resume operations, boosted by the improvements made during this break period. Later, in 2027, a new trajectograph (elementary particle trajectory detector) will replace the central part of the CMS with the aim of multiplying the number of collisions by ten, and therefore its discovery potential by the same magnitude.

Belgium, one of the 12 founding countries of CERN, contributes financially to the construction and support of the installations. In this way, the federal government contributes nearly €30 million per year to the CERN budget, or 2.67% of the contribution of the 23 Member States. Added to this are the contributions of the financing agencies. Over the period 2018-2022, the FNRS will provide approximately €4.95 million for the optimisation of the CMS experiment, in which Belgian researchers have significant involvement. "We are only half way through this LHC project, which will become the HL-LHC in around ten years", summarises Christophe Delaere.

CERN has

2,667 members of staff, including 104 Belgians
12,569 users, including 141 with an affiliation in Belgium
25 FNRS researchers (PhD students, post-doctoral students and permanent researchers) working on CERN-related projects

1. According to the latest available statistics (2018)