INSTITUT DE FRANCE
Académie des sciences

*Les traductions des*
*Comptes Rendus*
*Géoscience*
*Sciences de la Planète*

# Science is not Fuzzy...

Article translated by Romain Dziegielinski
Translation posted online: 2023-12-11
https://doi.org/10.5802/crgeos.31-en

***Abstract:***

Original article:
Etienne Ghys; Ghislain de Marsily, "La Science n'est pas Floue ...". *Comptes Rendus Géoscience*, vol. 352, issue 4-5 (2020), p. 247-249. https://doi.org/10.5802/crgeos.31

A recent article in the newspaper *Libération* headlined « Les savants flous ». The public image of science has been considerably disrupted by the Covid epidemic. Suddenly, within a few weeks, the world became aware that science is not only made of certainties. Worse still, experts of all kinds, including some prominent scientists, have presented conflicting views. For several decades, science had had a bad press and many ills were being attributed to it, often irrationally: GMOs, nuclear energy, vaccines, etc. But we still believed in the scientific truth: scientists, sometimes seen as sorcerer's apprentices, developed undisputed theories but whose applications could sometimes go against the public good. And now disagreements between scientists gained exposure...!

However, scientists know it well: research has always been based on debates between different opinions, which tend towards a form of truth never really achieved. There are countless examples of quarrels in all sciences. In physics, the debate raged in the 19$^{th}$ century at the French Académie des sciences around the existence of atoms. In biology, it is the theory of evolution or microbes that have been questioned. In Earth sciences, plate tectonics took a very long time to be accepted in the 1960s, and the origin of global warming was still the subject of heated debate very recently. Even mathematical science, though regarded as the temple of truth, is not exempt from such questions and has had to refine the concept of truth. The Pythagorean theorem is true in the Euclidean geometry taught in school but becomes false in the hyperbolic geometry widely used today in mathematical research. In each discipline, the word "true" has an extremely precise meaning, well known to specialists, but which must be explained to the neophyte. Newton's theory of gravitation has been dethroned by Einstein's theory of relativity, but it is nonetheless true and useful in innumerable situations, just as modern theories of gravitation specify Einstein's theory. Of course, we must not conclude from this that the scientific truth is relative and that its conclusions are not solid. The theory of evolution, plate tectonics, or global warming will never again be questioned: these are now established and indisputable facts. The points under discussion are "new" facts, such as the appearance of a virus, which will subsequently turn into "scientific truth" after going through an often constructive controversy. It is on the research front that struggles and discussions take place. At the back, the land is secure and that's good!

Scientists have a lot of responsibility in this distorted image of their disciplines. In most cases, they are careful not to show their disagreements publicly and they rarely explain the scientific method, made up of trial and error. They like to show successes and hide the tortuous paths they have followed to achieve them. School textbooks recount the glory of a Le Verrier who discovered the planet Neptune in the 19th century "with the tip of his pen", as Arago said, by making calculations of celestial mechanics, but they forget to say that the same Le Verrier, caught up in his momentum, later "discovered" another planet... which does not exist (and which he had even named Vulcan)! It is true that, very slowly, the scientific community has become aware of the need for the dissemination of science, not only as a list of magnificent results, but also as a set of hypotheses and provisional conclusions which are in the process of being validated, sometimes contradictory. In a way, the small Corona virus is similar to the child in Andersen's tale who cries that the king is naked: the epidemic has suddenly forced scientists to unveil themselves and publicly show the complexity of their world. It's a shame because science in the making is even more beautiful and exciting when it is revealed.

The climate issue is analogous, but on a different time scale. It took the French three weeks to understand what an epidemic, a virus, or a zoonosis is, but it took them thirty years to understand what global warming and the greenhouse effect are. Debates among climate scientists were fierce and when the public became aware of them, he often concluded that science is decidedly fuzzy, unable to predict the future, and that experts disagree. Here again, scientists have a share of responsibility. They have only rarely been able to explain the complexity of the issues, the large number of indisputable truths, but also the non-final nature of some of the conclusions under discussion. The media tend to forget consensus and love to highlight disagreements.

If there was no science, we would have become aware of global warming only too late. It is indeed only an increase of a few fractions of degrees each year, immersed in the midst of greater, essentially random, temperature variations: the phenomenon only becomes noticeable in the long term. If we hadn't invented the thermometer, who could have said with certainty that it's warmer today than it was a hundred years ago? Science played the role of whistleblower, before the disaster.

The symposium "Facing climate change, the range of possibilities" is an attempt to remedy this problem. This is to offer the public an inventory of what is acquired and solid, but also what is being done, and what should be done in the future to avoid the worst. It is not easy because the functioning of the Earth system is extremely complex and its understanding involves almost all sciences: physics, meteorology, climatology, thermodynamics, astronomy, chemistry, geology, biology, not to mention mathematics, always useful and necessary. Each of these sciences operates on their own time and space scales. Geology with its millions of years, climatology with hundreds of years, or the meteorology for which we rather speak of days. Space units also vary a great deal, from thousands of kilometers to microscopic sizes, for example for cloud physics. All this interacts in complicated ways and is certainly not easy to explain to the general public. We are a long way from Galileo's easy-to-understand science, which allows us to accurately predict the time it takes for a pebble to fall from the top of the tower of Pisa. Today, we can easily predict the position of the Moon in a thousand years to within a few meters, but we understood that such accuracy would be illusory if it were a million years. Similarly, we can predict with a very good probability if it will rain tomorrow, but it is almost impossible to know if it will rain in a month. What will be the climate in fifty years? It is this complexity, combining certainties and probabilities, that is difficult to convey to the general public.

It is also a question for scientists to make known the risks revealed by their research, knowing that this notion of risk necessarily approaches that of uncertainty. Uncertainty is not ignorance, but the recognition of a variety of possible futures, the importance of which is assessed in relation to the vulnerability of the ecological, economic and social systems that may be affected. This duty to alert, which affects a very wide range of situations in our daily lives, can therefore take extremely precise forms here.

The stakes are high. The scientific community has a duty to communicate the state of knowledge to the public, emphasizing both well-established facts and issues that remain unresolved or subject of debate. The difficulty of the work and diagnosis of researchers does not absolve them from the duty of being citizens, which everyone must perform to the extent of their skills. This duty is enshrined in our Constitution, via the precautionary principle.

Once the public has been informed of the situation by scientists, it is up to society as a whole, represented by its elected representatives, to make decisions. Elected officials must also take into account other elements, of an economic or ethical nature, for example. This was very clearly illustrated recently in the context of the confinement imposed on the population: science can only be one of the arguments used by policymakers. This may be only one of the arguments, but it is essential.

Etienne Ghys
Permanent Secretary of the First Division
French Académie des sciences
France
etienne.ghys@academie-sciences.fr

## 1. Special issue "Facing climate change, the range of possibilities"

This special issue comes from the homonymous symposium organised by the French Académie des sciences at the Institut de France on 28 and 29 January 2020. This symposium, coordinated by Sébastien Balibar, Jean Jouzel and Hervé Le Treut, with the assistance of Didier Roux (members of the French Académie des sciences) brought together about 600 people, not to mention the people who followed the symposium on their computer… The full program is available on the Académie's website[1] as well as the full recording of presentations and discussion sessions.[2] The organization of the symposium was made possible thanks to the support of Compagnie Financière Jacques Cœur and the Saint-Gobain company. The texts compiled in this

[1] https://bit.ly/30efHIN

[2] https://www.academie-sciences.fr/fr/Colloques-conferences-et-debats/changement-climatique.html

special issue have been prepared by the speakers of the symposium who have been kind enough to draft a written text a posteriori containing the content of their oral presentation; these texts thus provide an excellent insight into the content of the symposium. Their authors are hereby thanked for their contribution. These texts have been reviewed and edited by the CR-Géoscience Editorial Committee and the Reports Department. The purpose of the symposium was to provide an overview of what is known or anticipated about the effects of climate change, as well as potential means to reduce its effects.

Ghislain de Marsily
Editor-in-Chief
Geoscience Reports
French Académie des sciences
France
Ghislain.deMarsily@academie-sciences.fr

## 2. Table of contents