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Innovation has had a profound impact on our human civilization. And while the types and varieties of these innovations may constantly change, the fact remains that as humans, we are driven to push boundaries and alter the way we interact with the world around us. Now, research into one of the potential causes of innovation suggests implications that are truly global in nature.

Our history as humans is driven by important scientific and technological discoveries. The discovery of fire and tools brought us out of the forest. The switch from hunting and gathering cultures to agricultural societies set the stage for an explosion of innovative growth. And nobody can argue with the fact that the enlightenment, the industrial revolution, and now the information and digital age, have all dramatically changed the way we interact with one another and with society in general. But countless other innovations have also paved the way for progress. It is not an understatement to say that humans can almost

be defined by their unstoppable creativity and innovation – innovation that while sometimes risky can also lead to undeniable benefits.

Sudden innovation

These scientific discoveries and technological innovations have prevented and cured disease. They have enabled us to produce food more efficiently. They have helped us take care of increasing populations with rising life expectancy rates, and they have helped the world become more interconnected.

The prevailing notion when it comes to this multitude of innovations is that

they are the result of moments of inspiration that come “out of the blue”. Others may say that they are 99 per cent perspiration and one per cent inspiration. But wherever our inspiration comes from, it is surprising to find that these discoveries don’t follow a consistent pattern. Instead, we see long periods of relative stability followed by sudden surges and advancement. And these advances vary across cultures and time.

External pressure

Experts don’t understand much about why this happens, but some wonder whether external situations such as threats or pressures might play a role. During a visiting fellowship at the Netherlands Institute for Advanced Study (NIAS), which brought together a variety of disciplines from the social sciences and humanities to promote interdisciplinary research, I ran into co-author Carsten K. W. De Dreu. Carsten is a professor of social and organizational psychology at Leiden University and a recent recipient of the prestigious *Spinoza Prize*. I had been studying competition as an external force inducing businesses to innovate, and Carsten is a leading expert in creativity and innovation within organisational teams, especially in the area of external pressure and innovation. Carsten’s great idea was to look at climate change as an exogenous pressure that might spur innovation, and he began collecting historical data documenting innovations across Europe.

Climatic change has often been associated with economic pressures and resource scarcity. For instance, it has ▶



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Does climate change affect global innovation? *(continued)*

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resulted in impeded crops, increased food shortages and famine. Climate change has also been associated with migration, group conflict and warfare. Innovations often result from such external pressures. For a recent example of this, we don't have to look far. Many living Dutch remember the North Sea storm tide in 1953 that resulted in a considerable loss of life, extensive damage to farmland, and national trauma. The Dutch response? A technologically brilliant strengthening of coastal defences through an innovative system of dams and storm surge barriers.

We thought we would take a deeper look at this phenomenon. The result was our recent study: *Climatic shocks associate with innovation in science and technology*. This study looked at annual rates of scientific discovery and technological innovation and their association with often unanticipated and sometimes rather abrupt changes in climatic conditions, and surface temperature in particular.

Climatic shocks

More specifically, we looked at four annual time-series covering almost 500 years of human history. Within these time periods, we examined 5,000 individual scientific discoveries and technological innovations across Europe. We found that, statistically speaking, the prevalence of these developments correlated with a prolonged decrease in temperature.

Simply put, we found that more innovation took place the colder it was. These colder temperatures were often caused by climatic shocks – volcanic



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eruptions that create what are known as “volcanic dust veils” – that in turn lower average temperatures. This was true when we looked at Europe between 1500 and 1900 CE: innovation was more prevalent during prolonged periods of cold and when volcanic dust veils filled the air. We also found a similar link between temperature and innovation when we looked at France, Germany, and the United Kingdom between 1901 and 1965 CE. Our study deliberately stopped in 1965 – a year marked as the beginning of the “Anthropocene” era (the era of significant human impact on the Earth’s geology and ecosystems), after which the climate-innovation link may well run the other way.

We did find one piece of evidence to make the external pressure underlying this correlation more concrete: wheat prices as an indication of resource scarcity. In colder periods, wheat crops tended to falter, leading to price increases. This put direct external pressure on a variety of areas, including agriculture, transport, storage, and so on, stimulating innovations in these and other areas.

Defining innovation

Of course, other people have looked at this issue. However, they often defined innovation in a very specific way, limiting it to areas such as agriculture or tools. We defined innovation in a much broader way. Why? Because the previous approaches were limited to innovations that addressed specific, local problems. We looked at the full range of human ingenuity and innovation, experimentation and exploration. Examples included the development of production facili-

ties, new modes of transportation, new or improved communication technologies, and discoveries in biochemical and medical sciences. After all, innovation can be costly on an individual level – you don’t always know how things are going to turn out – so it makes sense that groups and societies will only innovate when they need to. And it turns out that this “need” might result from changing climatic conditions and economic hardship.

We’ll be the first to admit that we only looked at Western Europe’s temperate climate, and that our results are correlational, not causal. But our data does support the idea that climatic shocks affect innovation through socio-economic pressures.

Parallels today

This is certainly an area that deserves more attention. Our team is currently working on more detailed data collection, as we try to narrow down types of innovation and where they took place. We’re also expanding beyond Western Europe, and even looking at temperature and innovation in specific cities. We hope other researchers will do the same.

In the meantime, isn’t it interesting that climatic shocks may cause social and economic pressures that in turn trigger scientific inquiry and technological innovation? After all, we can see parallels in today’s business world – studies show that innovation often arises in the face of *external organisational pressures*. It could be that causes of innovation in a business setting have – at their core – a truly global and widespread source. ■

The paper *Climatic shocks associate with innovation in science and technology*, written by Carsten K. W. De Dreu and Mathijs A. van Dijk, was published in PLoS ONE 13(1): e0190122. DOI: <https://doi.org/10.1371/journal.pone.0190122>

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