
SURVIVING THE ANTHROPOCENE

Humans have taken dominion over the Earth – and have done so to an extent that threatens the basis for human life itself. From the perspective of our author, the development of scientific and technical knowledge has played a key role in the transition to the Anthropocene, the geological epoch of humankind. But we still need to learn more about the close interrelationship between the Earth and humans to be able to actually understand and overcome the crises that we create through our own actions.

18

Has there ever been a time when the dependence of our globalized societies on knowledge was so clearly evident as today? Infection rates and epidemiological models, rapid mass testing and global vaccine research in a continuous sprint are deciding the fate of the global population. Chinese biomedical scientists were able to identify the genome of the newly emerged coronavirus and convey that information to the World Health Organization in only a few days. Continually warning about the preliminary nature of their knowledge, epidemiologists around the world are advising their respective political leaders, who must in turn protect their citizens from the lethality of an exponential spread and from societal collapse. Economists, educators and social scientists are measuring the effects of stopping entire nations in their tracks.

Crises brought on by epidemics have always made history. One need only consider the plague in Europe or the mass deaths that smallpox, measles and flu viruses caused when they were brought from the Old World and introduced into the indigenous populations of North and South America. However, the current pandemic is certainly assuming unprecedented proportions due to today's circular interdependence of global economic and knowledge systems. What's more, considering the deep impact it will have on our collective world, it will be important to draw lessons for the future from our experience with the Corona crisis and its causes.



VIEW POINT

JÜRGEN
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19

Jürgen Renn received his doctorate in mathematical physics from the Technische Universität Berlin in 1987, before he turned his focus to the history of science. He conducted research and taught in Boston, Tel Aviv and Zurich, and became the founding Director of the Max Planck Institute for the History of Science in Berlin in 1994.

His research focuses on topics including the long-term development of knowledge and the dynamics that have led to the Anthropocene. Renn is a member of the German National Academy of Sciences Leopoldina and of the International Academy for the History of Science. January of 2020 saw the publication of his book, *The Evolution of Knowledge: Rethinking Science for the Anthropocene*. In it, he warns of crises such as a global spread of infectious diseases, which has already become a reality with COVID-19. His book is currently being translated into German.

THE DIVIDING LINES BETWEEN NATURE AND CULTURE HAVE BECOME PROBLEMATIC

The advent of the Corona crisis will not simply displace other challenges humanity is already facing. On the contrary, the virus only intensifies our focus on the profound threats to our highly modern societies posed by the increased use of previously undisturbed animal habitats, the weakening of ecosystems and – likely the most overarching of all threats – climate change. As long as our view of the Earth's natural realm remains one of an inexhaustible resource and waste dump, it will be difficult at best to extricate ourselves from the headlong growth of mutually reinforcing crises. It cannot be ruled out that this continual exposure to crises will ultimately overwhelm our societies.

So from now on, science and research must do more to confront the challenge of contributing to the resilience of our globalized world, and put all of their previously imposed disciplinary boundaries and methodological blinkers behind them. At the present time, when our problems can only be understood from a comprehensive perspective, it is an existential imperative that we investigate the complex interactions between society, technology, the environment and a global system that is in continual overall flux.

The Earth has been radically altered by human encroachments. We are currently leaving a geological epoch behind that, for roughly 11,000 years, has provided human cultures with largely stable climatic conditions, giving them a time window in which to develop and expand around the globe. For our departure from this unusually stable “Holocene” epoch, Paul Crutzen, Nobel Prize Laureate in Chemistry and former Director of the Max Planck Institute for Chemistry, coined the term “Anthropocene,” a term that no longer permits the trivialization of the influence humans have on the Earth system.

In the Anthropocene, humans are no longer acting against the backdrop of an unchangeable natural system, but rather are profoundly intertwined in its structure and impacting both the immediate and distant future. The fundamental revision of our understanding of this planet's condition can only be compared to the overturning of the physical concepts of space and time that occurred in the wake of Einstein revealing his theory of relativity. In classical physics, space and time seemed to be the fixed stage upon which world events took place. In contrast, according to Einstein's theory, this stage is no longer an unchanging framework, but rather is itself part of the play. There is no absolute distinction between actors and stage. The changes in the Earth system are confronting us with the similarly radical necessity to rethink our situation: we are not living in a stable environment that serves only as a stage

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and as a resource for our actions. Instead, we are part of a dynamic system in which humans and the non-human world play equal roles. As it is used today, the term “Anthropocene” is also the result of a new type of Earth science, a transition from geology to the science of the Earth system, which views our planet as a complex, nonlinear system with many interactions and feedback loops in which human intervention is playing an increasingly important role.

The concept of the Anthropocene has established a bridge between geological and historical time. It has become clear that the time scale of human history is inextricably linked with the geological time scale. In view of the massive effects of human intervention in the environment, the traditional dividing lines between nature and culture have become problematic.

What roles have science and technology played in this transition? Were they the accelerants that will have enabled colonialism and industrial capitalism to eventually destroy the Earth? Or were they our Cassandra, giving us fateful warnings well in advance, but whose advice was tragically ignored? Humans have certainly become a planetary force, but we have yet to develop any sensibility for our planet.

How society, science and our shaping of the future fit together can only be assessed by focusing on the development of the Anthropocene. The question of which processes and dynamics have brought us into the Anthropocene is currently a subject of broad discussion. Suggestions range from the extinction of the megafauna in the late Pleistocene as a result of humans' new hunting skills and further environmental and climatic factors, to the advent of agriculture and animal husbandry, the early modern era and the Industrial Revolution, to the so-called Great Acceleration since the mid-20th century, which geologists are currently focusing on.

All of these historic interventions have left their traces in Earth's history: the increasing dominance of domesticated animals and cultivated plants in the biosphere; the transfer of species (and of lethal pathogens) caused by European colonialism between biospheres that had been separated for millions of years; the rapid rise in CO₂ concentration in the atmosphere and oceans since the Industrial Revolution and the exponential increase in consumption of global resources since the Great Acceleration.

All of these interventions have simultaneously changed and reinforced the possibilities for human action: early advanced civilizations would have been



inconceivable without agricultural settlements and animal husbandry. Modern science would probably never have flourished without these advanced cultures, and both colonialism and the Industrial Revolution may have been impossible without the Scientific Revolution of the modern era. This long-term, concurrent development shows how our knowledge and hence our creative power have increased, while the associated, unintentional or consciously accepted consequences have simultaneously been amplified.

Our modern societies are deeply rooted in this interaction between knowledge, cultural technology and intervention in the natural environment. We are currently caught up in an escalation of this interrelationship and are actually in the process of conducting a global experiment on an entire planetary system that we still only poorly understand. The effects of this experiment and whatever measures we take in the future to mitigate these effects will depend profoundly on the available knowledge of the interaction between the Earth system and its human components. In any event, if we are to successfully shape the Anthropocene future, it is essential that we understand the evolution of our knowledge.

But what exactly is knowledge? Individual knowledge is based on the encoding of experiences that enable Individuals to solve problems as part of their adaptive behavior. While knowledge enables individual persons to plan their actions and to consider the results, a society or an institution cannot “think” but rather can only anticipate the consequences of its actions within a “knowledge economy.” The knowledge economy represents the sum of the societal institutions and processes that convey, accumulate and propagate the knowledge available to a society – especially the knowledge with which a society can ensure its own preservation and growth. The limits of knowledge economies are likely to have been a critical factor in the collapses of historic societies, like those evolutionary biologist Jared Diamond examined in his book, *Collapse*. A knowledge history of the Anthropocene therefore includes a history of our knowledge economies, in which knowledge has been produced, distributed and reproduced – or has not been produced or has even been suppressed, ultimately with global consequences.

From an evolutionary perspective, knowledge is one of the structures, along with social institutions, that govern human behavior. At the same time, human activity affects the environmental conditions under which people live. Thus, environmental conditions also embody the structures of human behavior. Conversely, this human-influenced physical environment serves in

FROM CULTURAL TO EPISTEMIC EVOLUTION

turn as the starting point for new knowledge processes and societal formations. This engenders a constant interplay between the material embodiment of regulative structures that govern behavior and the changes in these structures based on new experiences. This interplay determines the general dynamics of cultural evolution.

Under given environmental conditions, societies can reproduce some of these conditions but not others. For example, in the transition to an agricultural society, humans learned to recreate the environmental conditions that enabled them to produce their own food. In this way, naturally given external conditions, such as the local availability of plants and domesticable animals, ultimately became dominant characteristics of further global development.

The transition to the Anthropocene can hardly be traced back to a single cause or moment in time. Rather, it can best be described as a cascade of evolutionary processes, from biological via cultural to an “epistemic evolution.” With this epistemic evolution, human societies – dependent on the use of fossil energy and on infrastructures and technologies that are increasingly science-based – have entered into an interdependency with the Earth system as a whole. What stone tools, hunting and gathering were for the Pleistocene, and arable crops, clothing and dwellings were for the Holocene, science-based technologies are now for the Anthropocene: critical conditions for human life and human survival. This process can be observed at the latest since the Industrial Revolution, and has reached a preliminary peak under the present conditions of digitalization, mobility, global supply chains, technocratic governance and, last but not least, high-performance medical research on an international scale.

23

While the possibility of reproducing external conditions contributing to livability was once primarily a question of circumstances in times of cultural evolution, it will increasingly have to be a question of knowledge in the age of epistemic evolution. This especially applies to the consequences of our actions for the coupled human-Earth system. Our understanding of this complex system requires new scientific approaches that help to better understand and mitigate systemic shocks in our highly industrialized and extremely fragile age: a “geoanthropology” or human-Earth science of the Anthropocene. The goal of such scientific approaches – which are currently also under discussion in connection with the founding of a new Max Planck Institute – is to effectively combine the necessary adaptation to the systemic risks of the present with the elimination of their causes.

