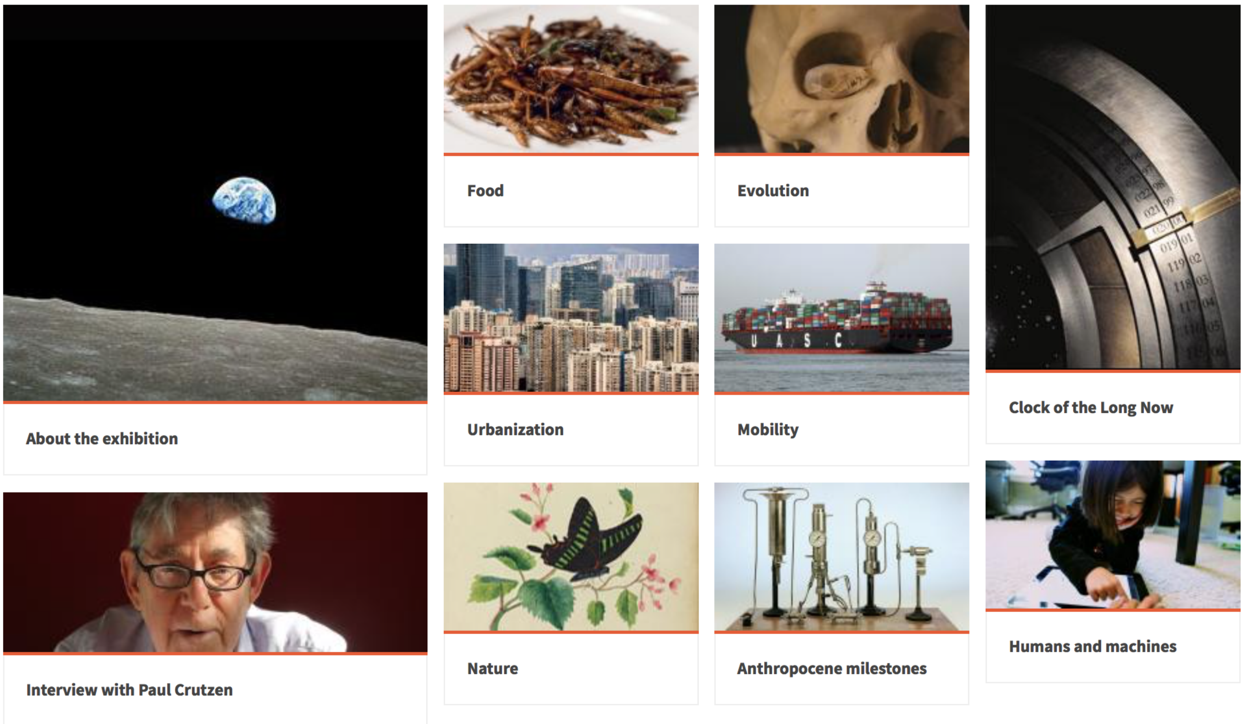
Welcome to the Anthropocene: The Earth in Our Hands

Nina Möllers

Together with the Rachel Carson Center for Environment and Society, the Deutsches Museum hosted a major special exhibition on the Anthropocene from December 2014 – September 2016, which was curated by Nina Möllers. Coined by the atmospheric chemist and Nobel Prize laureate Paul J. Crutzen, the term "Anthropocene" describes the idea of a new geological era shaped by deep interventions into nature by humans as biological and geological agents.



How to cite:

Möllers, Nina. "Welcome to the Anthropocene: The Earth in Our Hands." Environment & Society Portal, *Virtual Exhibitions* 2014, no. 2. Rachel Carson Center for Environment and Society. doi.org/10.5282/rcc/6354 .

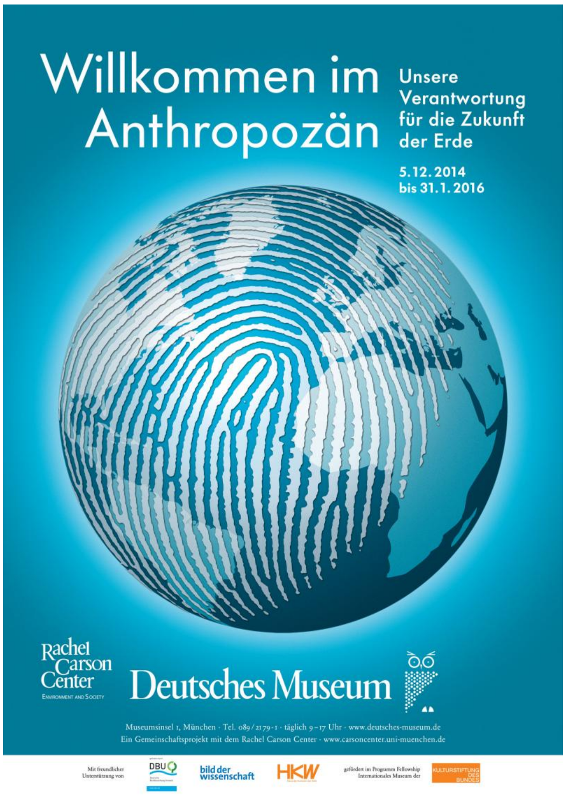
ISSN 2198-7696 Environment & Society Portal, Virtual Exhibitions

About the exhibition

The original virtual exhibition features an external link to the film "Welcome to the Anthropocene." by Own Gaffney and Félix Pharand-Deschênes. 2012. Length: 3:38 min. Follow this link (http://player.vimeo.com/video/39048998) to view the film.

Crumbling skyscrapers, crushed soda cans, and worn-out car tires: concrete, aluminum, and plastic are the physical traces of our time. It is a time in which humans intervene in nature, and thus change and shape it. A world has developed in which humans and their needs play a dominant role in the ecological system. The human influence is so great that man-made changes are becoming visible in the geological record and there is talk that a new geological era has arrived: welcome to the Anthropocene.

This thesis was first introduced 15 years ago and has been the topic of much debate since then. At first, the idea of an "Age of Humans" was only discussed among geologists, but now it has evolved into a multidisciplinary mental framework which links scientific and engineering theories and approaches to social and culture scientific concepts. Humans in the Anthropocene not only intervene in nature as geological and biological actors, they also initiate mental processes in order to reinterpret the relationship of nature and culture, of environment and society.



Poster for the special exhibition on the Anthropocene at the Deutsches Museum in Munich.

Courtesy of the Deutsches Museum.

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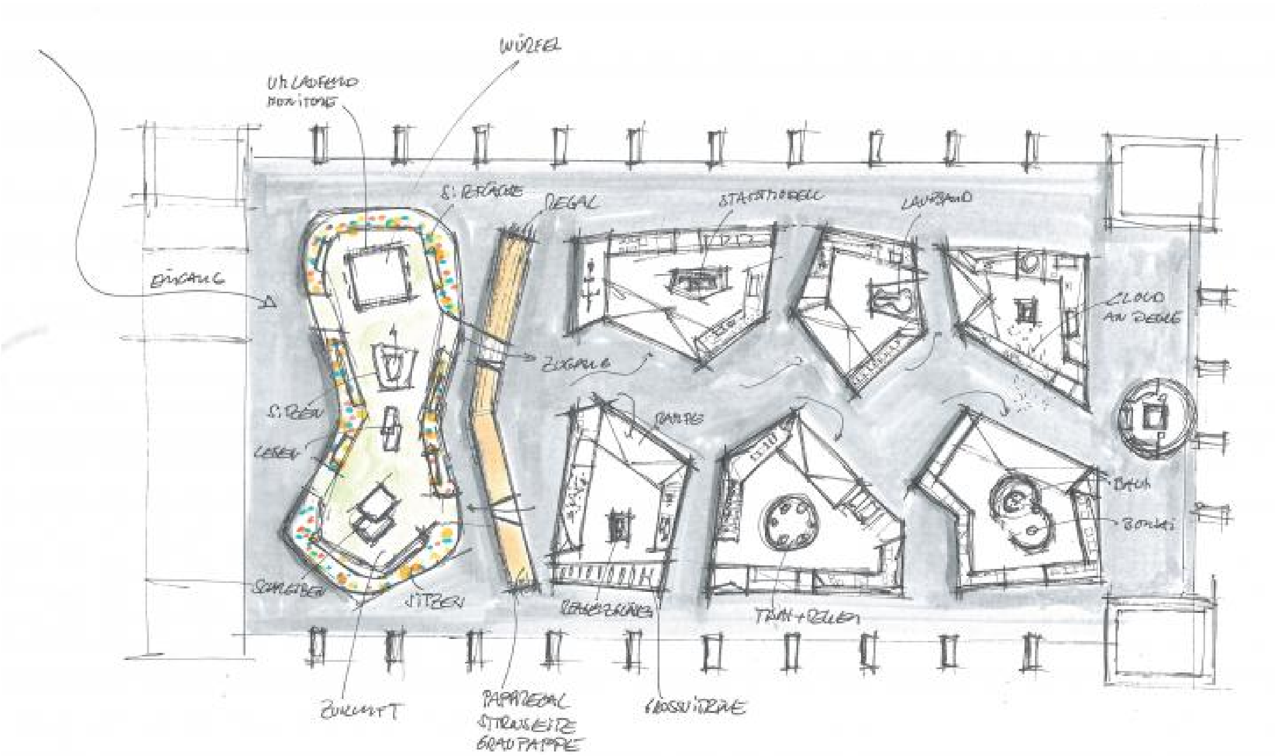
So far, the Anthropocene is only a hypothesis and there is no consensus about its temporal scope or its scientific status. With a special exhibition on the Anthropocene, the Deutsches Museum took part in the global debate on this topic. In cooperation with the Rachel Carson Center for Environment and Society, the Deutsches Museum was the first museum to present the Anthropocene in an exhibition. Thus we created a space for reflection, interpretation, and discussion.

The exhibition room had a size of 1,450 m² and inspired visitors to ponder various questions: How could humans gain such an enormous influence on the ecological system? What is typical in the world of the Anthropocene? What will we eat? What will our cities look like? Will machines take control of our world, which is already highly automatized and regulated by algorithms?

At the entrance, a supersized media-cube familiarized visitors with the Anthropocene by showing short video clips and an additional movie on this topic. The object shelf, which embraced the whole exhibition room and resembled a huge notebook or diary, presented real objects that traced the increasing influence of humans on the natural world.

Six large islands addressed the following topics in detail: urbanization, mobility, humans and machines, nature, food, and evolution. They highlighted the Anthropocene's effects and interactions on a global, biological, and social level. Carefully selected objects in combination with the central installation of film and media stations illustrated the spatial and temporal dimensions of human-caused global change and the chances and challenges we face in the Anthropocene.



Drawing showing the participation area, the object shelf, the six islands, the Clock of the Long Now, and the cube

Designed by Klaus Hollenbeck Architekten & krafthaus Das Atelier von facts and fiction. Courtesy of the Deutsches Museum.

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The final part of the exhibition, which was located adjacent to the entrance area, offered visitors the opportunity to participate by sharing their visions of the future and the Anthropocene. A large bed of white paper flowers invited visitors to write down their own thoughts, fears, wishes, and hopes and thus let them add their voices to the exhibition and the Anthropocene.

The Deutsches Museum, located at Museumsinsel 1 (Munich, Germany) and open every day between 9 a.m. and 5 p.m., hosted the exhibition from 5 December 2014 until 30 September 2016.

For further information on the exhibition and its reception, please visit the Deutsches Museum archive .

Acknowledgment

The essays and images on this website presented a small sample of the objects on display at the Deutsches Museum, Munich.
This digital companion to the exhibition was prepared by the Environment & Society Portal and the Deutsches Museum.

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ISSN 2198-7696 Environment & Society Portal, Virtual Exhibitions

Websites linked in this text:

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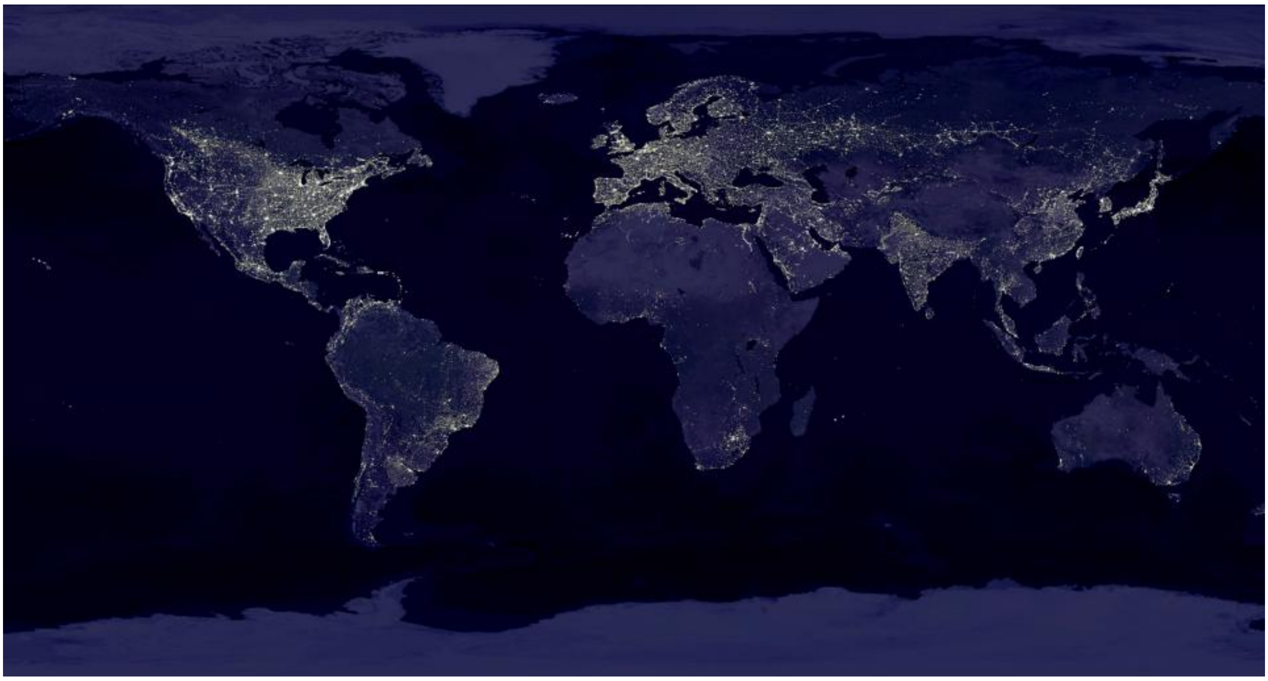
- http://www.deutsches-museum.de/en/exhibitions/special-exhibitions/archive/2015/anthropocene/
- https://doi.org/10.5282/rcc/6354

Urbanization

A photograph of the Earth by night shows an impressive picture: Europe, India, Japan, the coasts of North America, and the southern tip of Africa are illuminated by bright points of light. Areas where many people live in a relatively small space are extremely bright; those are the big cities that are the economic, social, and creative centers of today's world.



Planet Earth by night: cities are the points of intersection in the age of the Anthropocene.

Created by woodleywonderworks.
View source .

We live in an urban era. Uruk, Constantinople, and Rome were the ancient models for our urban community life. More than half of the world's total population lives in cities, and this figure is increasing due to population growth and urbanization. In the year 2025 there will be about 600 cities with more than one million inhabitants.

The world's cities, which are connected to each other like nodes in a giant web, can be seen as processors of resources. Cities are the places where most resources and mineral deposits are transported to and later transformed. But less tangible things such as money flow through cities as well. Today's global finance system is heavily computerized. Money is made all over the world, but it is in cities that the majority of money is transferred, distributed, multiplied—and lost.

From 1894 gas boilers have provided people in cities with warm water and heated rooms, and those boilers are connected to gas and electricity networks. In Germany, 60 percent of the total energy consumption in private households is for heating. Altogether cities consume close to two-thirds of the world's total energy and thus account for more than 70 percent of the world's total greenhouse gas emissions and a large portion of its waste.

Urban sprawl in Mumbai, India: one problem of urbanization is the increasing number of slums.

Created by John Hurd. View source .

Cities function as microcosms of global change and thus the problems of the Anthropocene are particularly acute in cities: overpopulation, greenhouse gas emissions, scarcity of resources, pollution, and social inequality. In developing countries, a large portion of the urban population often lives in informal settlements such as slums with no direct access to drinkable water or sanitary facilities. Experts on climate change agree that solving these problems will require the development and implementation of a complex plan for sustainability.

In the concrete jungle of cities, people easily lose a sense of connection with nature. But the cities of the future could grow out of precisely this interaction between people and nature. Clean energy sources like biomass, wind, geothermal, and solar energy, combined with carbon-free transport and building methods, could transform the city smog into a carbon-neutral, environmentally friendly atmosphere. If we think of the city as an organism, we see the importance of preserving ecological and social diversity in order to find creative solutions suited to the individual needs of each city. Creative concepts are already in use all over the world: in 1997 women in the Philippines began to turn discarded juice containers, which had previously littered their neighborhood, into stylish bags. In Australia, a company called Gideon Shoes produces shoes from cane toad and kangaroo hide. Both animals are so abundant that they have developed into a threat to humans and various ecological systems.

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Gideon Shoes uses fair paid labor and creates their shoes under ethical work conditions; its revenue was used to found the Street University, which provides community services and education to disadvantaged children. Both examples follow a simple and symbiotic principle where ecological thinking and social activities are linked together. By using regional, renewable resources, jobs are created, social services are financed, and the ecological system is strengthened.

Victor Sonna's recycled art bike "Guernica" is on display at the Deutsches Museum.

Transforming something that already exists into something new is the idea that the artist Victor Sonna applies in his piece of artwork "Guernica," which you can see in this exhibition. This functional bicycle is made from trash and discarded metal and is thus a new version of a basically familiar object. At the same time it makes us think about how we move through the city in the age of the Anthropocene.

To see more examples of artists who deal with the complex human-environment relationship, please visit the Environment & Society Portal's Multimedia Library collection on "Green Art ."

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Mobility

Wardian cases

Wardian cases, facing page 128 from *The New Practical Window Gardener* (1877by John R. Mollison.
The Natural History Museum, London / Universal Images Group
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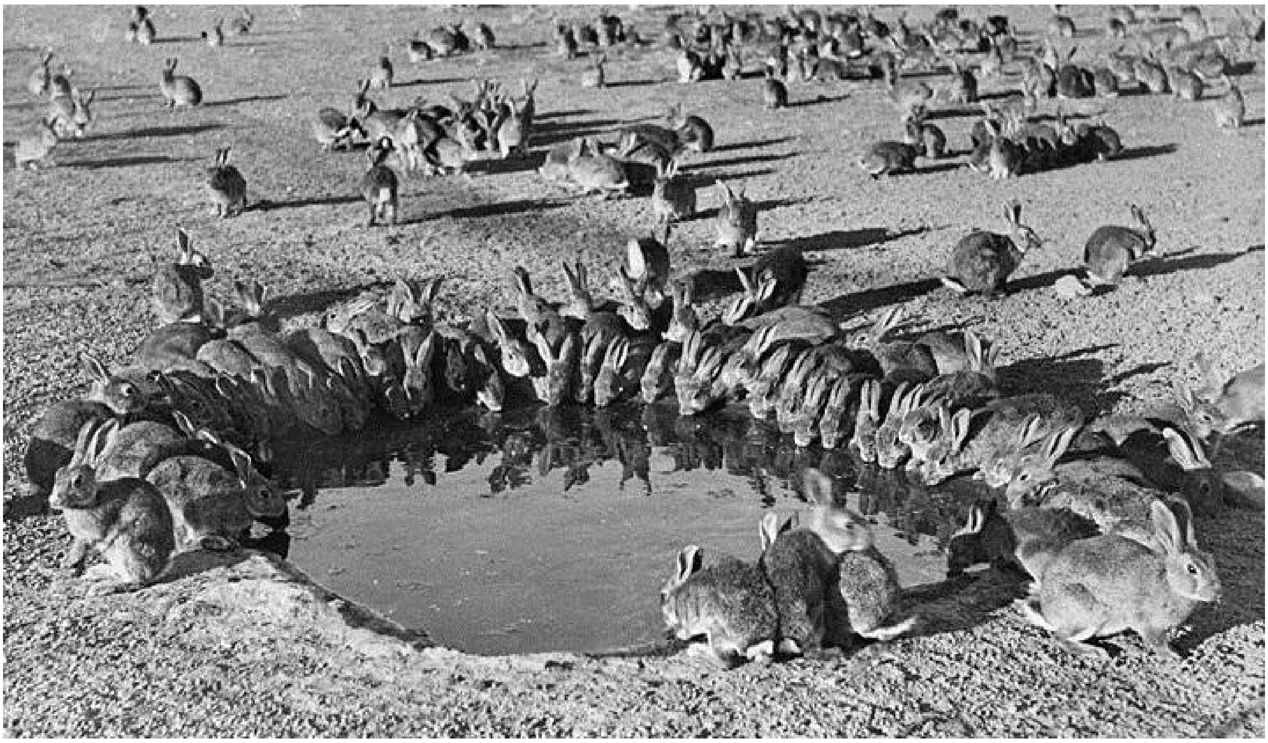
Source: Encyclopædia Britannica ImageQuest

Whether by land, by sea, or in the air, humans move around the Earth more frequently, in greater numbers, and further than ever before. Wittingly or unwittingly, plants and animals are carried with us onboard aircraft or in our luggages.

The Wardian Case , which was on display at the exhibition at the Deutsches Museum , is one of the earliest examples of the impact that human technologies have had on the global mobility of plants. Using this portable greenhouse, which was invented in 1829 by Nathanial Bagshaw Ward, it became possible to convey plants by ship and to plant and cultivate them on new continents.

New commercial, industrial, and environmental opportunities arose. Scottish botanist Robert Fortune disguised himself as a Chinese trader and used the Wardian Case to smuggle tea plants from China to India. A few years later, rubber trees (*Hevea brasiliensis*) were shipped from the Amazon River via London to Sri Lanka and Singapore. These cases of botanical espionage resulted in the beginning of the tea industry in India and the latex industry in Asia.

Nowadays huge container ships provide the basis for international trade and globalization. Ninety percent of international trade uses ships for transport. Shipping has tripled since 1970 and it continues to grow. In 1956, a container ship could transport only about 500 to 800 containers, while today 18,000 containers can be transported around the globe on a single ship. The water ballast tanks that stabilize ships may contain up to 1,000 different species, who thus hitch a ride into new habitats.



An invasive species: 24 rabbits were brought to Australia by a European in the nineteenth century; the population increased by 600 million within just 50 years.

View source .

Even small, unremarkable items that humans use every day can serve as transporters for various species. Tourists transport pollen, blossoms, and seeds on their Velcro fasteners, camera bags, and shoe soles from one place to another; 70,000 seeds and plants thus arrive in the Antarctic every year, and dandelions and hairy bittercress grow

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there today.

Transporting plants and providing new habitats is a mixed blessing. Invasive species spread quickly and replace domestic species, thus endangering the ecological system of their new habitat. Japanese knotweed is greatly feared in Great Britain: it damages foundations and reduces land prices. Giant hogweed, an invasive flowering plant from the Caucasus, is toxic and grows up to six meters in height.

The Hoover Dam in the Colorado River on the border between Nevada and Arizona, USA

Created by Airwolfhound. View source .

Humans are not only carriers of invasive species; they also create barriers to the mobility of plants and animals. Dams, for example, stop natural water circulation in rivers, as well the movement of aquatic species; they have effects on the ecological system of animals living in the water and they can cause enormous ecological disasters.

With globalization and the witting or unwitting interference of humans, the migration of animal and plant species into new ecological systems has increased on a scale that has never been seen before.

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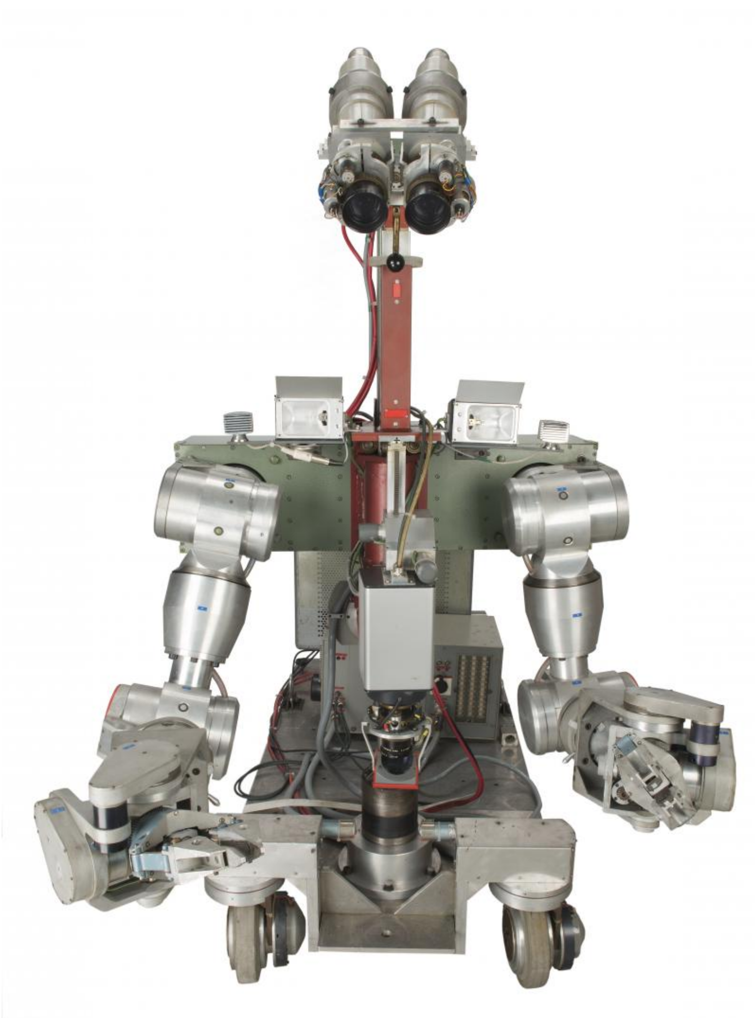
Humans and machines

The original virtual exhibition features an embedded external film of the live performance of the remastered 2013 studio version of Kraftwerk's "The Robots" from the 1978 album "The Man-Machine." Follow this link (https://www.youtube.com/embed/i-R7t-ihoT4) to view the film.

Flashing, shimmering, rattling, whirring, and buzzing all around us: life seems unthinkable without all the small and large machines that accompany our everyday routines; for each task there is a specially designed device. Herds of machines populate the Earth, connected to one another and permeating our lives and activities. Whether they move, assemble products, make calculations, think, or fight—all have been programmed, automated, and authorized by us.

Who influences whom? Do machines influence humans—or vice versa? How will the technosphere change us, and how will the biosphere change in the Anthropocene?

These questions are typical of the Anthropocene. The mechanical duck developed by the engineer Jacques de Vaucanson at the end of the eighteenth century was a milestone in robotics. This duck contained hundreds of movable parts and thus was able to move its wings, to drink and—due to a chemical reaction—to digest food.



The Syntelmann was constructed in 1973.

Courtesy of the Deutsches Museum.

Large eyes, clunky feet, and a stylish scarf around his neck: this was the “Maschinen-Mensch” MM8, a creation of the Viennese designer Claus Scholz-Nauendorf in the 1960s, a machine that brought humanity one step closer to fulfilling the dreams of a useful artificial human being. He could shake hands and pour drinks but had difficulty walking. The energy supply was quite costly, which is why this robot did not gain wide acceptance.

The Syntelmann, also on display in this exhibition, was a human-operated exoskeleton that could be controlled from a distance in order to perform tasks in environments too hazardous for humans, such as the deep sea, outer space, or nuclear power plants. Movements were transmitted electronically from the “master,” a human-operated exoskeleton controller, to the mechanical manipulator (the “slave” up to 100 meters away; the electromotive joints of the manipulator copied the movements of the human controller.

However, robots are not able to copy a human’s ability to make decisions and act spontaneously. Robots were initially used in the cleanup of the nuclear reactor in Fukushima, destroyed in 2011. However, the unpredictable conditions and degree of rubble were beyond the robot's abilities. Instead, 25,000 human workers had to clean up the ruined nuclear reactor.

Even before the era of science fiction movies, humans were fascinated by the idea of creating artificial intelligence. Hardly any other technical device has changed the world as drastically as the computer. The digitally based, electronically run machines can be custom programmed to meet individual needs: writing, making calculations, drawing, planning, or running simulations; they handle tasks of a complexity that we once could only have imagined.

From the minicomputer that runs our washing machines to the supercomputers used for climate or medical research—life without digital computers has become unthinkable. Ever faster, more powerful, and better connected, they shape our lives and—intentionally or not—the Anthropocene era.

With this experiment Otto Hahn succeeded with nuclear fission in 1938.

Courtesy of the Deutsches Museum.

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The Human Brain Project is situated in Lausanne and funded by the European Commission to unravel the complexity of the human mind. Hundreds of scientists from 24 countries are working to model that "magical machine," the human brain, on a supercomputer in order to gain knowledge of diseases and to develop new computer and robotic technologies. It is still uncertain whether the attempt will be successful, but it will have enormous consequences for both humans and machines.

In the 1930s Otto Hahn, Lise Meitner, and Fritz Straßmann at the Kaiser Wilhelm Institute for Chemistry attempted to create "transuranium" elements, atoms with a nucleus heavier than that of uranium. Instead, they discovered nuclear fission, which turned out to be one of the most momentous discoveries for the development of humankind and of the Earth. Many people believed that it would answer all the world's energy needs: the enormous energy released during nuclear fission seemed to offer a nearly endless source of power that could be harnessed for industrial production, transportation, and domestic use.

1945: Trinity test—the first detonation of a nuclear bomb

Created by Jack W. Aeby, July 16, 1945. View source .

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Attitudes towards nuclear technology underwent an abrupt shift after atomic bombs were developed during World War II and deployed against Japan. In the exhibition at the Deutsches Museum, fragments of rubble from Hiroshima and Nagasaki remind us of these momentous days, which had a determining influence on the Cold War. In the 1950s, Otto Hahn fought against nuclear weapons and bomb tests that contaminated the Earth with radioactivity. But, like many others, he continued to have a positive view of nuclear power. By 1956, the first commercial nuclear power plant was connected to the electrical grid in England, followed by many others around the world. Today, nuclear weapons continue to be a threat to world peace. Nuclear energy is a heavily debated topic, as the risks are weighed against the problems of replacing limited fossil fuel reserves. A safe and permanent way of disposing of radioactive waste has still not been found, 75 years after the discovery of nuclear fission.

On 16 July 1945, the Trinity test—the first test detonation of a nuclear explosive—took place in New Mexico. Since then, levels of radioactivity have increased substantially all over the world due to the use of nuclear technology. The global, human-caused spread of radionuclides can be demonstrated over the long term and has been proposed as a marker of a new geological period. Thus, the official beginning of the Anthropocene could be set as 16 July 1945, 11:29 GMT—the time of the first nuclear explosion.

Websites linked in this text:

- https://www.youtube.com/embed/i-R7t-ihoT4
- https://www.humanbrainproject.eu/

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Understanding and shaping nature

Pristine nature?

Created by Michael Kappel. View source .

As long as humans have existed, we have lived in and with nature. But what does nature mean in the Anthropocene? Is it an urban wood or the uninhibited wilderness of the backlands? Does nature even exist without its human counterpart—culture? Even before the Anthropocene, humans used and interpreted nature. Our conceptions of nature are quite varied and have changed over the course of time. Nature not only provides us with what we need for our daily life, with food and resources; it is also a place to relax, a source of inspiration and dreams. Even in the fast-paced world of the Anthropocene, being connected to nature is considered something worth striving for—even if we are no longer exactly sure what "nature" is.

In the Anthropocene, there is no such thing as nature without humans: we investigate nature, use it, control and alter it. The ways in which we can affect nature have constantly increased and our actions leave deep, often long-lasting marks. Natural catastrophes such as floods and droughts are nowadays seen as evidence of the human impact on the Earth. What we think of when we imagine "nature" is to a high degree a new, culturally reshaped kind of nature.

Drilling tower of the German Continental Deep Drilling Program.

Created by Kreuzschnabel. View source .

A sparkling crystal clear stream, the clouds gathering before a thunderstorm, or the enormous rock formations of the Alps—such impressive panoramas are called "wonders of nature." In many religious cultures the power and beauty of nature is still seen as coming from God. Social and religious upheavals, but also scientific insights, have changed our view of nature over time. In the mid-eighteenth century Carl Linnaeus developed a new classification system that opened a new chapter in botany and zoology. Since the nineteenth century, curiosity and a thirst for knowledge have fueled science: humans began to explore the interior of the Earth, the depths of the sea, and flora and fauna on a large scale.

We are fascinated by nature and we try to understand it. Humans always investigated the world with the means

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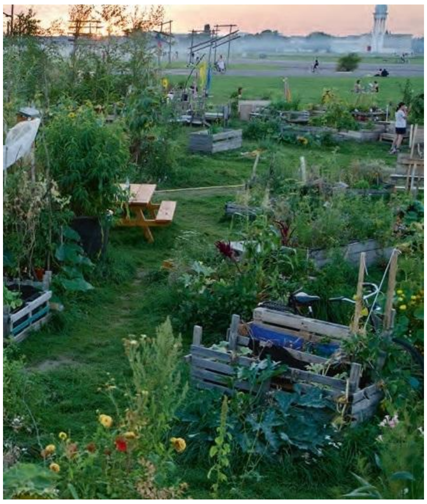
that were available: expeditions, mapping and survey projects, as well as experiments have led to new insights, which have frequently proved controversial.

The more we know about nature, the more we want to use the resources provided by it. One example of this development is the German Continental Deep Drilling Program, which was conducted between 1987 and 1994 and ended with a 9,101 meter borehole: the deepest in Germany and one of the deepest on Earth.

Although it was dedicated to basic research on climate and seismic activity, scientists, politicians, and companies hoped that this project would also provide insights into the location of mineral deposits and sources of geothermal energy.

Seemingly contradictory pictures of nature are melding in today's Anthropocene and globalized world. Urban nature has developed into a typical and new form of nature shaped by humans. Urban ecosystems today are often more biodiverse than rural habitats of past eras: foxes, tawny owls, and raccoons are no longer an unusual sight in Munich or Berlin. As cities expand they replace important ecosystems.



New forms of nature: urban gardening in Berlin

Photo created by Kilian Müller. View source .

For a description of the book in English, please visit The City of Commonists: New Urban Spaces of the Do-It-Yourself .

Children in Berlin try to stop the extinction of bees.

Photo created by Mathias Walendy. View source .

For a description of the book in English, please visit The City of Commonists: New Urban Spaces of the Do-It-Yourself .

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Bees suffer considerably from the destruction of their natural habitats and from monocultures and climate change. But bees are important. Albert Einstein thought that if bees vanished, humankind would perish within four years. The reason for this assumption is that if bees become extinct, many plants will lack pollinators and also become extinct; as a consequence humans and animals will die. In China, whole swaths of land are now pollenized by people instead of insects. Some cities are trying to counteract this development: in Munich, for instance, beehives have been installed on the rooftop of the Gasteig and the Deutsches Museum.

Birds, too, are struggling: every seventh bird species is threatened with extinction; in Germany 110 out of 260 local breeding birds are threatened. Nature protection programs are using modern techniques—drones, robots, and computer simulations—to try to stop this development.

Ecologists are not the only ones who care about nature. Artists also pose questions such as "What does nature mean to us in the Anthropocene?" and "How do we deal with nature in the future?" The Anthropocene exhibition at the Deutsches Museum featured artwork by the Next Nature Network, a group of Dutch artists and designers: they exhibited different generations of razors in order to illustrate how they developed similarly to organic living creatures. Next Nature Network also repurposed a survival blanket in an artistic way. Originally developed to protect its user from the forces of "old" nature such as cold, heat, rain, and wind, it now offers protection from the forces of "new" nature: electrosmog, drone attacks, and radio waves. Thus the question arises: Who is fighting against whom? Are we at odds with nature—or with ourselves?

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Tomorrow's diet: Food from the laboratory

Cattle factory farming causes many problems such as the production of large amounts of methane.

Created by Socially Responsible. View source .

Large-scale monocultures, genetically modified breeds, and meat rolling off the assembly line are distinctive of today's food production. At the same time, enormous amounts of resources are wasted, habitats are destroyed, metabolic cycles are disturbed, and dangerous dependencies are created, damaging both humans and their environment. Due to excessive fertilization and the use of pesticides in intensive industrial agricultural systems, the ecological balance of the surrounding land is disturbed. Factory farming creates numerous problems: feeding animals antibiotics causes antibiotic resistance in animals and humans, soil and groundwater become toxic due to the huge amounts of liquid manure, and rainforests are cut down in order to create more space to breed cattle, which releases carbon dioxide emissions. Cattle also contribute substantially to the greenhouse effect by producing methane gases. Genetically modified seeds reduce biodiversity and create social disparity.

Every day and everywhere people eat and drink. Peter Menzel's project "What I Eat: Around the World in 80 Diets ," shows how varied these meals may be. A meal is more than just food on a plate. Whether breakfast, lunch, or dinner, meals tell a story of wealth and poverty, regional and climatic differences, and local customs and traditions.

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As the world's population grows, global hunger is also growing. The demand for meat, sweets, and instant meals grows, in particular in areas where the Western lifestyle is spreading. But this trend cannot continue, for the Earth cannot support an unlimited amount of consumption. We have to search for alternative food sources that are more environmentally friendly, sustainable, and healthier. Some of the alternatives to meat require us to keep an open mind and reconsider how we think of food. In August 2013 the first in vitro hamburger was presented to the public. But synthetic in vitro meat can also potentially be developed into new and exciting products that bear little resemblance to the meat we are familiar with.

Another alternative protein source is insects: in Asia and many other parts of the world insects are a common food source, and they could be adopted in Western cuisine. Insects offer many advantages: they are a rich source of protein and energy, require little space, and eat plant remains—in contrast to pigs or chickens, they do not compete with humans for food—and they are highly biodiverse. What we will eat in the future is up to us. Food is just a matter of habit.

This tarantula appetizer is rich in protein.

Created by istolethetv. View source .

The aquaponic system produces tomatoes and fish at the same time.

Created by Ryan Somma.View source .

There is increasing competition for the use of the Earth's land area. Fish farming has to become more sustainable. One solution that conserves both resources and space is aquaponics. The Leibniz-Institute of Freshwater Ecology

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and Inland Fisheries (IGB) developed this aquaponic system in which tomatoes and fish are farmed together in a self-contained artificial environment—water waste, use of mineral fertilizers, and carbon dioxide emissions are minimal.The nutrient-rich water from the fish tanks is purified, then circulated via pipes to the tomatoes, which are planted in mineral wool. The plants extract the nutrients they need from the water. The system does not require a large water supply and is thus suitable for use even in arid regions. An area of 1,000 m^2 produces 15 tons of fish and tomatoes annually—and it can be run without fossil fuels: the warmth from municipal biogas plants and solar panels is used to heat the water.

Whatever forms of food production and consumption are chosen for the future of the Anthropocene, one thing seems clear: it is very important to develop local concepts, to shorten routes of transport, and to strengthen local agriculture.

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Evolution

Cows that produce human breast milk, fish that glow in the dark, and sheep that shed their wool without being sheared: in the Anthropocene humans have learned to modify animals and plants for their own benefit. By doing so, humans affect not only nature on its surface, they also alter the DNA, the building blocks of living organisms. Since the discovery of the double helix and the decoding of genetic sequences, it has become possible to insert foreign DNA sequences into the cells of completely different organisms.

Selective breeding has also changed the flora and fauna around us. The human-caused process of evolutionary assimilation is exemplified by "man's best friend": the dog. Domestic dogs have changed substantially since humans started breeding them 15,000 years ago. Originally selected for their traits as hunting companions or as watchdogs, today dogs are pets and an expression of individual identity. They might be bred to fit in people's handbags, as for example chihuahuas or miniature pinschers.

Corn is another example of the extent of human modification of nature. No one could have foreseen the worldwide success of corn when indigenous peoples in Central America began to cultivate its ancestor, the wild grass teosinte, 10,000 years ago. Nowadays corn is not only used for food, it is also a component of disposable dishes, packing material, and t-shirts, and it is also used for fuel. Corn makes up a quarter of grain crops worldwide and is grown in large monocultures. Hybrid corn produces especially large harvests. However, hybrid and transgenic corn have one big disadvantage compared to traditionally bred corn: they do not propagate well and farmers have to buy seeds for planting every year, which causes ecological and societal problems.

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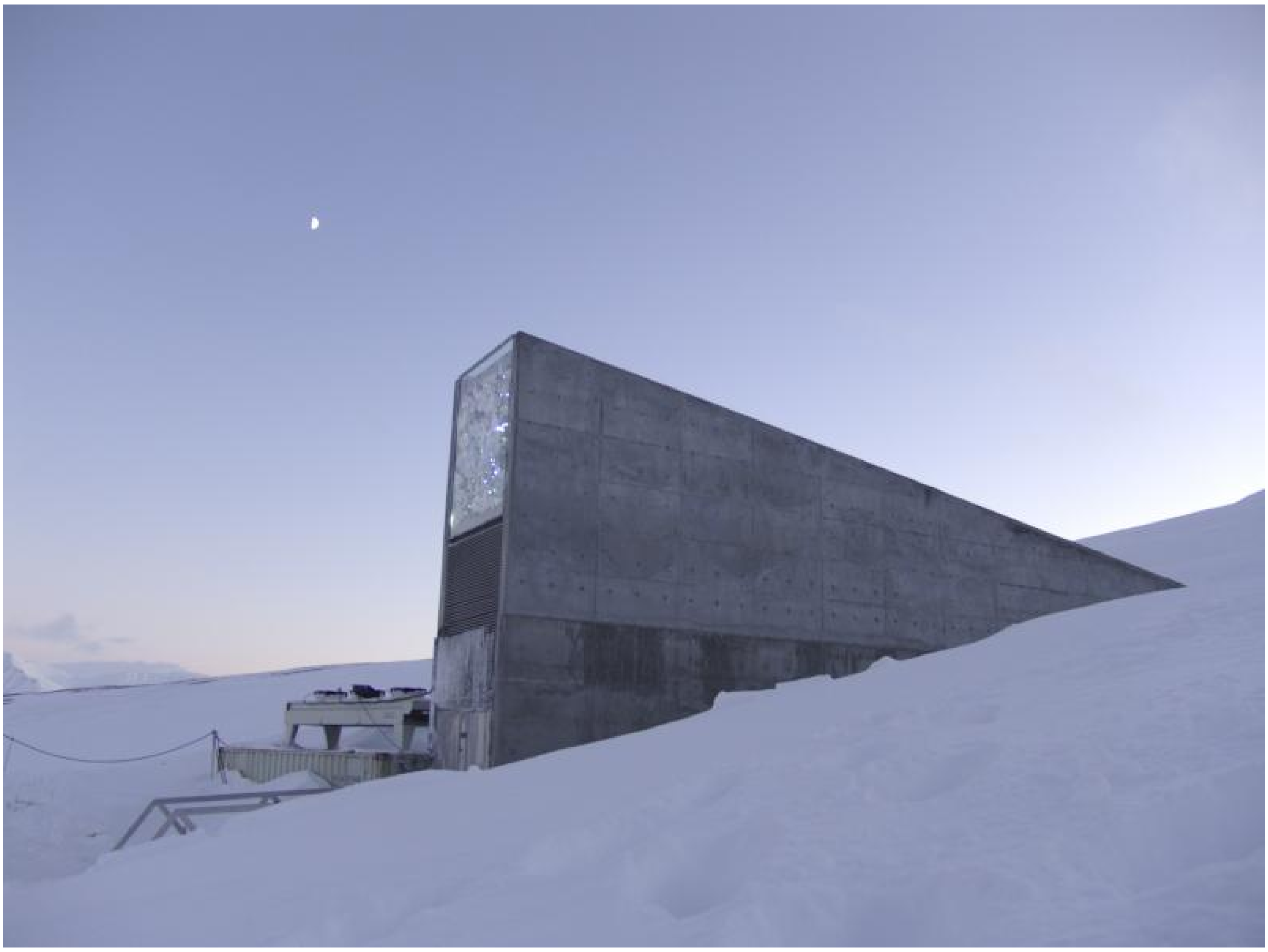

The seed bank “Svalbard Global Seed Vault” in Spitzbergen, Norway

Created by Mari Tefre/Svalbard Globale frøhvelv. View source .

Humans are dependent on agricultural crops. But crops that are grown in monocultures are susceptible to diseases, pests, heat, and drought. In 2009 the Svalbard Global Seed Vault was created. It is a well-protected underground seed bank in Svalbard in Norway and contains all local varieties of known agricultural crops. In a cold, earthquake-proof zone at -19 degrees Celsius, 750,000 seed specimens are stored deep in solid rock. Steel airlocks keep the sealed seeds safe for decades. It will stay frozen in the permafrost even if the electricity fails.

Preserving the knowledge of the world’s farmers is at least as important. For many generations, farmers have grown the plants currently in use and have cultivated their seeds. Their local knowledge is one of the most valuable and most endangered resources of our time.

Humans nowadays are changing the mechanisms of evolution in other ways as well: not through direct breeding, but by changing the environmental conditions in which species live. For example, codfish from heavily fished populations mature more quickly than specimens from unfished populations, because this increases their chances of reproducing before they are harvested.

Because man-made changes to nature happen quickly and destroy natural habitats, many living organisms are threatened by extinction. Evolutionary assimilation requires generations, and many species cannot adapt quickly enough.

Crocheted coral reef

Created by le Liz. View source .

The oceans are particularly threatened by human activity. Worldwide, the coral reefs, a beloved attraction for divers because of their bright colors and their varied forms, are endangered. Coral reefs are a very sensitive ecosystem and are important birthing grounds for a wide variety of species. But fishing, pollution, and acidification of the ocean—the result of increasing amounts of carbon dioxide dissolved in the water—have destroyed the reefs; protected conservation areas may be the only remaining natural refuges where corals can survive.

To remind people of the ecological threat to reefs worldwide, a 30m^2 reef made of crocheted "corals" was created at the Museum Kunst der Westküste . This ecological memorial, which you can see in the exhibition of the Deutsches Museum, brings together mathematics, science, handicraft, and environmental protection in a collective project.

Genetic engineering and hybrid corn, seed banks and coral extinction, chihuahuas and oversized salmon—these are examples of man-made variety. We must ask ourselves the question: as the dominant force shaping the Earth's environment, how will we deal with the responsibility that comes with our actions? What are the limits to our biological creativity?

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Milestones of the Anthropocene

Our faces are illuminated by the screen of a smartphone while we fly over entire continents in an airplane in the space of a few hours. High in the air, we snap a photo that we can upload to the Internet in the space of a few seconds: an image of the world beneath us with its large, intensively cultivated fields, giant industrial parks, and container ships 400 meters in length. Ever faster, ever farther, this world keeps turning in a whirlwind of technology and progress, humans and machines.

How did the world come to be the way it is today? What are the defining characteristics of the Anthropocene?

Steam engine, ca. 1850

Courtesy of the Deutsches Museum.

There is no question that the industrialization of the nineteenth century paved the way for the beginning of the

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Anthropocene. The steam engine was and is the emblem of this era. It was the technological catalyst and driving force behind the economic and technological achievements of the nineteenth century and it set in motion the Industrial Revolution. Steam engines powered machines in the mining, textile, and steel industry. They mechanized and accelerated tasks that previously had to be completed by hand and made energy available anywhere, regardless of location. New forms of transportation—railways and steamships—altered our experience of space and time. In the second half of the nineteenth century, the railroad became one of the leading economic sectors in Germany and its nearly insatiable appetite for coal and steel gave further impetus to industrialization.

Industrialization and mechanization brought new inventions in their wake: Cars and airplanes replaced the railroad, even though they produce substantially more pollution. Today, the steam engine has been replaced by gas, water, wind, and shaft turbines, as well as internal combustion engines. The invention of the diesel motor in 1893 triggered new innovations in shipbuilding. The diesel engine was superior to steam engines in many ways. It could be started immediately without having to be warmed up, it required only a fraction of the space and a third of the operating crew, and it could travel over much longer distances. What it did require, however, was oil as fuel—enormous quantities of it. As merchant shipping expanded it literally fuelled the world economy.

The constant demand for more petroleum was by no means only positive, however. It is a much fought-over resource, costing the lives of humans in wars and causing environmental disasters. In spite of strict safety standards, tanker accidents release many millions of liters of oil into the seas.

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The gasoline-powered tractor Bulldog manufactured in 1921.

Courtesy of the Deutsches Museum

Like shipping, agriculture also underwent profound changes as a result of mechanization. Motorized machines, in particular gasoline-powered tractors such as this "Bulldog," first manufactured in 1921 in Germany, were the beginning of a revolution in speed and efficiency for agriculture.

Artificial fertilizers, too, are just as important as when they were first used. Thanks to them, it is possible to feed a world population that is now approaching 7 billion. But the increase in productivity has negative consequences for the environment: The loss of biological diversity due to monocultures, overfertilization of the soil and eutrophication of the water, and the ethics of factory farming and green genetic engineering. To counteract these developments, people are turning to organic farming and projects such as the "Slow Food" movement.

Gasoline pump "Iron Maiden", ca. 1927

Courtesy of the Deutsches Museum.

Every day, there are more people who want to eat. And many of them want a car to drive as well. By the mid-twentieth century there will be an estimated 10 billion cars in the world—all with combustion engines that require large amounts of gasoline and emit immense quantities of polluted gases. The "Eiserne Jungfrau" (Iron Maiden gasoline pump developed by Shell in 1926 was installed in easily accessible locations on the roadside and designed to withstand a direct impact. It facilitated the sale of gasoline in larger quantities. Previously, gasoline could only be bought at drugstores in small quantities. Infrastructure and technological developments made the automobile what it is today: a symbol of freedom and individuality. Cars, but especially airplanes, contribute substantially to climate change. Therefore it is important to find more economical ways to travel in the Anthropocene.

Although energy-efficient fluorescent lights are beginning to replace traditional light bulbs, many other appliances of our time require immense amounts of electricity. More "power guzzlers" are being sold all the time:

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in 2012 alone some 350 million personal computers were sold. And disposal of these appliances is a substantial environmental problem. Most of these appliances are used in the Global North. But they are broken down into their components and recycled as e-scrap primarily in the Global South, usually with a high price for humans and their environment.

Today, scarcely anyone under the age of 25 can imagine everyday life in a world without modern technology: cell phones, computers, GPS devices. Other, more mundane appliances such as refrigerators and hair dryers have become standard components of Western households and it is difficult to imagine doing without them. All are the result of important developments and inventions.

Tiros, the first American meteorological satellite (1960)

Courtesy of the Deutsches Museum

Satellite technology is a child of the Cold War, born from the competition between the United States and the Soviet Union to conquer outer space. Refrigerators arrived in Germany only in the 1950s, bringing a taste of the

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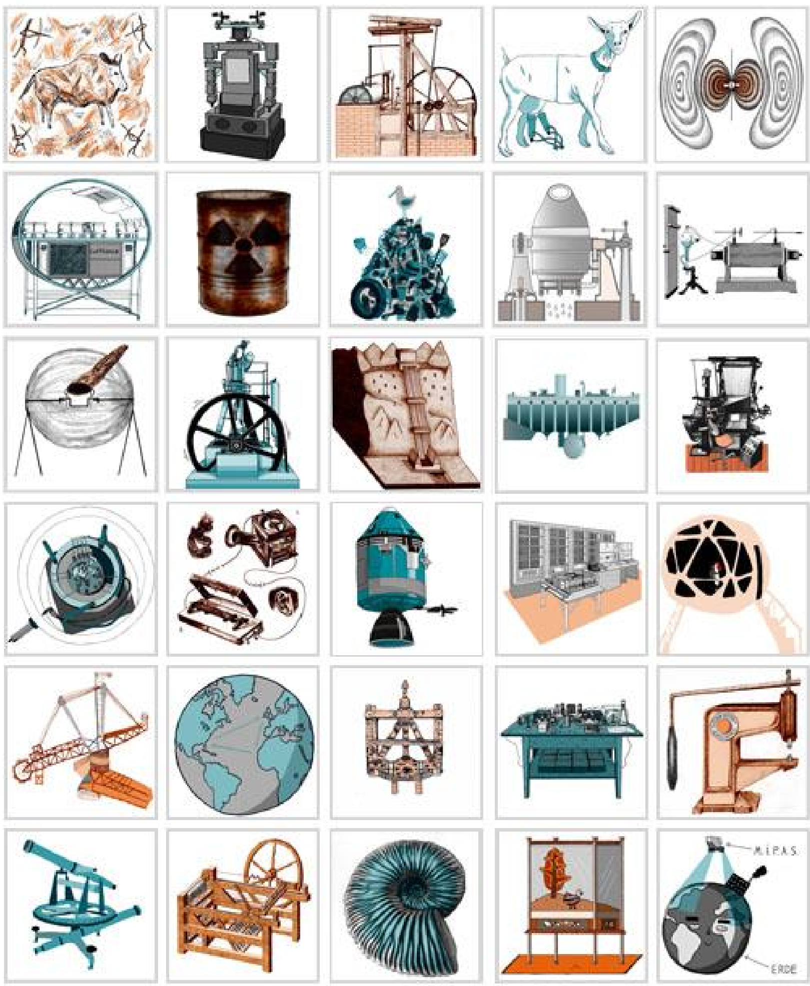
"American way of life" into German households. With the release of the first Macintosh in 1984—the cult product of our information society—Apple made available the first personal computer for home use.

But even these splendid inventions that make our lives so much easier are also a source of problems. It was not until the end of the 1980s that refrigerators with chlorofluorocarbons were banned because of their harmful effect on the climate. Today, debris from old satellites orbits the Earth, while humans and the environment become ill from unrecyclable e-waste. The story of the technological achievements of the Anthropocene is also a story of the problems that they bring with them.

Technology is inextricably part of a culturally determined socio-technical system that interacts with nature at all levels. In the Anthropocene our task is to find a new system in which technological progress is more environmentally friendly and sparing of resources.

The Anthropocene comic project



Milestones of the Anthropocene
Courtesy of the Deutsches Museum, Munich.

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What do the Altamira cave, the spinning jenny, the scanning tunneling microscope, the telephone, and the Apollo mission have in common? One, these items and events are on display at the Deutsches Museum, and two, they represent important milestones that have paved the way to a new geological "age of humans."

Unfortunately, many of the objects representing historical Anthropocene milestones are on permanent display at the Deutsches Museum and cannot be removed. With this in mind, Henning Wagenbreth, a professor of illustration in visual communication at the University of the Arts (UdK), Berlin, and his students bring us closer to these revolutionary innovations by illustrating them in 30 eight-panel comic strips.

This project, completed with the editorial work of Alexandra Hamann, the academic supervision of Reinhold Leinfelder, and professional guidance of Helmuth Trischler, presents in a creative way the increasingly significant geological footprints of humans on the planet. The comics strips were on display from 5 December 2014 until 31 January 2016 alongside the actual objects exhibited at the Deutsches Museum, in cooperation with the Rachel Carson Center for Environment and Society, in the special exhibition "Welcome to the Anthropocene: The Earth in Our Hands ".

They have also been published in German on the website of the Deutsches Museum and as a book accompanying the Anthropocene exhibition. To read the comics in English, please browse through the Art & Graphics collection in the Multimedia Library of the Environment & Society Portal. The comics have been translated by Oliver Liebig and edited by Iris Trautmann and Marielle Dado.

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Clock of the Long Now

> *Now* is the period in which people feel they live and act and have responsibility. For most of us now is about a week, sometimes a year....Just as the Earth photographs [taken from the Apollo space missions in the 1970s] gave us a sense of the big here, we need things that give people a sense of the long now.
>
> –Stewart Brand, US author and initiator of the Clock of the Long Now

"Live in the here and now" is a common expression in our time. Over the course of the twentieth century in particular, the intervals in which we experience time have become increasingly shorter. New technologies frequently become obsolete within a single year, fashion trends last no more than a single season, companies think in terms of quarters, and politicians only until the next election season. The US computer engineer Danny Hillis and the author and environmental activist Stewart Brand wanted to do something to counteract this habit of short-term thinking. We need something to encourage us to think over the long term and remind us of the far-reaching temporal effects of our actions: the idea of the Clock of the Long Now was born.

The Idea

Installed in a vertical shaft drilled into a mountain in Texas, the giant mechanical clock will tick only every ten seconds. Visitors that climb the strenuous path to the Clock provide its chiming mechanism with energy, which results in a melody playing at noon. A special algorithm calculates the melody—a different one each time.

The clock is both an ambitious engineering project and a symbol. It should last for the extent of the "long now," that is, at least 10,000 years. But this is not really the reason that the Long Now Foundation has undertaken this complex project. Instead, it should encourage people today to reflect upon their world and expand their temporal horizons: "By building something like a 10,000 year clock, you start to get a different perspective on how you might change those options [of generations of the far future]." (Alexander Rose, Clock Project Manager, Introduction to the Long Now Foundation , 2010

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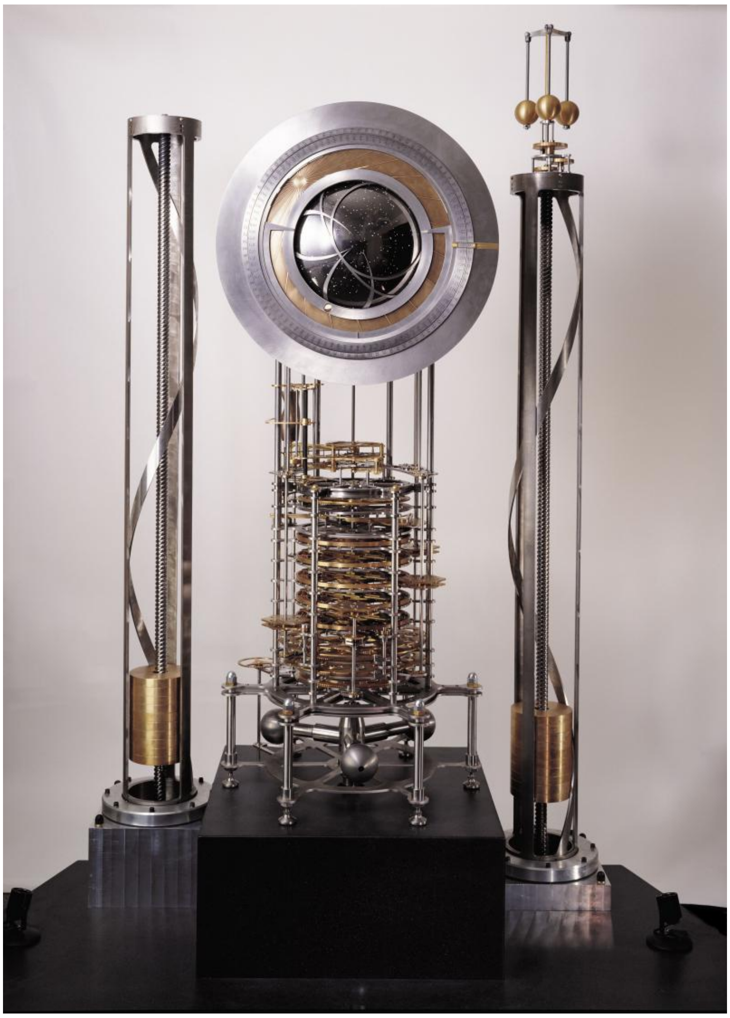
The monumental Clock, some 60 meters in height, will be built into a remote limestone mountain in Texas. To reach it, visitors will have to walk through a tunnel into the mountain to reach continuous spiral staircases carved out of the rock. During the ascent, they will pass the different parts of the Clock until they reach its face at the top.

Courtesy of the Long Now Foundation

From Idea to Reality

Much thought must go into the construction of a machine that will remain functional longer than any object that has yet been made by humans. Danny Hillis and his team developed a set of fundamental principles to ensure its accuracy and durability. The clock should be made of long-lasting materials such as stainless steel and titanium; it should able to be maintained using Bronze Age technology if needed. Its manner of operation must be clear and capable of being improved, and it should be possible to construct clocks of various sizes based on the same basic design.

One of the most important considerations, however, is how to provide the clock with a constant source of energy. How can the Clock of the Long Now continue to operate for hundreds of years? The Clock's engineers have decided to use human visitors as a source of power as well as other natural energy sources. Part of the energy comes from using temperature differences. A window cut into the mountain peak lets in sunlight, which heats a sealed air chamber; the resulting pressure difference drives a piston which adjusts the Clock and provides energy. The clock face shows the year written in five digits; after all, the Clock has to be able to show dates past the year 10,000. In addition, it shows astronomical events, such as the sun's position during the course of the 24-hour solar day, the moon phases, and the position of sunrise/sunset and moonrise/moonset, which change during the course of the year along with the seasons.



This 245 cm tall prototype of the Clock was finished in 1999. At the stroke of midnight on 31 December 1999, it bonged twice, ringing in the new millennium.

Courtesy of the Long Now Foundation

The chimes are created from more than 3.5 million different combinations using 10 bells. But it only chimes when the Clock has stored enough excess energy, or when human visitors have wound it.

Although the Clock keeps time even when humans are absent, to save energy its hands only move to display the time when visitors wind up the dials. If no humans visit, the display remains still, but the Clock does not. Thanks to stored energy, it will continue to operate even if the sun is hidden for a time and the sky darkens, for example, due to volcanic eruptions, a nuclear winter, or meteorite impacts.

For Alexander Rose, manager of the project, the Clock is, above all, about hope, for it suggests that there will still be humans on the planet even in the far future. But the lives of these humans 100, 1,000, or 5,000 years from now will be shaped by the decisions that we make today.

Websites linked in this text:

- http://vimeo.com/11177662

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Chapter: Clock of the Long Now
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PDF created on: 08 March 2021 11:33:47

“A huge variety of possibilities”: Interview with Nobel Laureate Paul Crutzen on his life, his career in research, and his views on the Anthropocene idea

Mr. Crutzen , you grew up under dire circumstances in Amsterdam in World War II…

Oh yes, I have some bad memories of the wartime. In May 1940 Holland was occupied by German troops. Our school building was turned into barracks for the Germans. The situation was especially difficult for my mother. She had all her relatives, including her mother, in Germany. Every evening we heard the sound of Allied bombers flying over Holland towards Germany to drop their bombs on cities. So in addition to our lives we feared for our family members in Germany. However, a child’s perspective on a war may be different from that of an adult. We played a lot, and war games were amongst our favorites, which appears strange from today’s perspective. Some experiences were very sad. For example, I had a cat called Peter, who was like a good friend to me. Every afternoon he sat on the windowsill waiting for me to come home from school and then ran to the door and jumped on my shoulder to welcome me home. One day Peter was gone and I was very sad. Only after the war did my mother tell me that the neighbors had eaten him. Several of my schoolmates died from starvation. The *Hongerwinter* in Amsterdam was awful! Schooling could take place for only a few hours a week and most children lost at least a year. With some help from the headmaster, who gave extra lectures in his home for the best three pupils, I managed to make it to high school.

In those dark days, was there anything that hints at your later career as a scientist?

I loved observing the world around me and trying to explain it. My parents told me funny stories of that. One evening I was looking at the moon, which was not round, like I thought the moon should be, so I said: “maan is stuk” (“moon is broken”. On a walk along a *gracht*, as we call canals in Amsterdam, I saw somebody’s head on the water. I did not know that people can swim, so I thought there was a man without a body in the water. One wintry night my parents found me standing in front of the window of a cold bedroom admiring my very first snowfall. I was shivering with cold, but I didn’t care. Also I loved dictionaries. When I had learned to read, I wanted to learn foreign languages by studying dictionaries. I could read the words, but of course I did not even know how to pronounce them.

What did you long for in your early days?

Apart from basic needs like food and peace I longed for snow-clad mountains. But there are no mountains in Holland. During the war we could not travel outside Holland. I looked at the clouds instead and I imagined that they were mountains.

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Paul Crutzen at the reception following the award of the Nobel Prize for Chemistry in Mainz, 1995.

After the war, you didn't go into natural sciences immediately. Could you describe your path towards becoming a Nobel Laureate in Chemistry?

Chemistry was not at all my favorite subject in my high school, the Hogere Burgerschool. I was much more interested in physics, astronomy, and mathematics. In my free time I read books about astronomy and about voyages around the world. I played soccer and chess and skated along the canals whenever that was possible. After high school I would have wanted to go to university, but I didn't get a scholarship, because I was very ill with high fever during the entrance exam and my grades were not good enough. I could not ask my parents for the money needed for studies. We were not a particularly rich family. My mother kept the family together in difficult times, as my father was often unemployed both during and after the war. My mother worked as a

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cleaning woman in the kitchen of a hospital. I entered engineering school and worked in bridge construction for the city of Amsterdam, interrupted by two years in the military service. That was a tense time because of the uprising in Hungary against the communist regime.

So how did you land a job in meteorology and how did you enter atmospheric chemistry?

During a short vacation I hitchhiked through Germany and France. I also went to Switzerland, where I was at last able to see the mountains I had dreamed about in my childhood. At the top of Mount Pilatus I met a Finnish student working as an au pair in Lucerne. When my military service was over, I went to Helsinki to see her again. For two years we kept in touch by writing letters; in this way we got to know each other quite well. Terttu and I married in February 1958 and moved to Gävle, Sweden, where I got a job at a house construction firm. But I wanted to do something more interesting. I was lucky to notice in the newspaper that Stockholm University was looking for a computer expert. I applied and got the job, even though I was no expert at all. We moved to Stockholm, and alongside the job I was able to study mathematics and meteorology at the university. It was my first step in my academic career. My wife Terttu was always there for me, from the time I was a working student and she took care of our two daughters. She gave up her studies in Finnish history and literature so I could pursue my scientific work. So no, I did not have a straight career path at all.

You then entered atmospheric research. Was that pure science for you or were you already concerned about the environment?

Before about 1970, when I was a postdoc in Oxford, the environment was not high on my list of interests. Scientists in general did not show much interest in the environment then. The general feeling at that time was: "nature is so big and humankind so small." Maybe the realization that this assumption was wrong turned me into an "anthropocenist"— an "Anthropozäniker," as one might say in German—40 years later. It was actually my involvement as a computer programmer in the supersonic transport program (SST that got me gradually interested in environmental issues. Harold Johnston and I looked at the danger of a large fleet of supersonic aircraft flying in the stratosphere, because they would emit nitric oxide (NO and could deplete the ozone layer that protects Earth from solar ultraviolet radiation. Luckily the large fleets of SSTs were never built, mainly because of the high cost. However, that did not mean that stratospheric ozone was safe.

Before your research, it was not known that the ozone layer could be damaged...

Indeed, nobody had thought that small man-made substances could have a large effect on stratospheric ozone. My main supporter was Professor Bert Bolin, the head of the Stockholm department of meteorology and a world expert in CO_2. He gave me a lot of freedom to begin my own independent research. My early papers were all concerned with the natural chemistry of the stratosphere, with an emphasis on ozone. But I realized that the soil could be a large source of nitrous oxide (N_2O, which is converted to NO in the stratosphere, which then acts as catalysts to destroy ozone. Thus I discovered how the biosphere exerts an influence on ozone.

Did you realize how dangerous this effect could be?

Yes, absolutely, and shortly after that an even greater danger was discovered in the shape of almost inert chlorine in organic molecules, the so-called chlorofluorocarbons (CFCs), which are broken down by solar ultraviolet radiation above about 25 kilometers. They were used in spray cans and refrigerators without analysis of the impact of the chlorine on ozone. In fact, people believed that they were absolutely safe. How wrong they were! When I read the paper by Rowland and Molina in 1974, I knew immediately that they were right, and I developed a photochemical model to show this.

As a consequence of this ozone research, a global political fight started over banning the most dangerous CFCs. What made you participate in that controversy?

The chemical industry denied the connection between their substances and the ozone layer, because they wanted to keep selling them. I felt that it was my duty to make my research in this area known. Loss of ozone in the stratosphere allows more ultraviolet radiation to reach the Earth's surface and cause skin cancer. The consequences of major ozone depletion would have therefore been disastrous. The appearance of the ozone hole over Antarctica during springtime was the greatest surprise in atmospheric chemistry. It implied an almost complete destruction of ozone in the stratosphere over Antarctica, at a location where it was least expected. Since then, I frequently ask myself what other surprises may await us.

In 1988 the United Nations outlawed the most dangerous CFCs with the Montreal Protocol. Is the ozone layer now safe?

The protocol is doing its job. But it will take a long time for the ozone layer to fully recover. We can't do much more at the moment than wait for positive effects. It's impossible to pull CFCs out of the atmosphere—like so many other substances that shouldn't really be there.

Years after your ozone findings you coined the word Anthropocene. How would you explain that idea to a school child?

That's actually a more difficult task than giving a scientific talk. But let me try: Anthropocene means that, in today's world and for the foreseeable future, what is happening on Earth is strongly determined by what humans do. Humans like you and me are shaping our home planet to a greater degree than other natural processes. That is a huge responsibility.

When and how exactly did the Anthropocene idea enter your life?

At an Intergovernmental Geosphere Biosphere Program (IGBP) in Mexico in the year 2000, in which I participated, the chairman mentioned the Holocene again and again as our current geological epoch. After hearing that term many times, I lost my temper, interrupted the speaker, and remarked that we are no longer in the Holocene. I said that we were already in the "Anthropocene." My remark had a major impact on the audience. First there was a silence, then people started to discuss this. In the coffee break, somebody approached me and said I should patent the term. After my talk I looked to see whether the term Anthropocene had been used before. Indeed it had, by a limnologist of the University of Michigan, Eugene F. Stoermer.

So you didn't take the idea from Stoermer, who had used it earlier, but you had the idea to speak of an "Anthropocene" independently from him?

Yes, I came up with the idea independently and I think that my impetus made it possible for the Anthropocene idea to take off in the public and scientific arenas. I contacted Stoermer and we published a paper together in the IGBP Newsletter. I don't really know how Stoermer got his idea. We have never met.

Do you consider the Anthropocene a scientific fact by now or do you see big unanswered questions around whether it really amounts to a new geological epoch?

Yes, the Anthropocene is derived from fossil records, just like the earlier geological periods. The pressures exerted by human activities have strongly increased. This includes the manufacturing of many synthetic compounds that will leave long-lasting traces, which can also be used to measure our influence.

Is the Anthropocene idea a purely scientific hypothesis or is it more?

It also develops into a metaphor about the relationship between nature and humankind, with the latter initially on the receiving end. This changed with the growth in world population due to medical and technical advances. The human race increased its power over nature, a landmark of the Anthropocene era. But if we just keep increasing our power, both nature and humankind will become losers.

Do you consider the Anthropocene idea to be a beautiful idea?

Beauty or ugliness are not sharply-defined properties; they depend on times and locations. The Anthropocene is not a single identity that can be beautiful or ugly, but a huge variety of possibilities that cannot be ranked.

In 2002, you wrote an article in *Nature* magazine, "The Geology of Mankind," in which you assign scientists and engineers a central role in solving humankind's problems. Are they more important than politicians?

Ultimately politicians will have to make some bold decisions to change course. Scientists and engineers can help but their real power lies in making positive innovations possible, not in decision making. However, those innovations are central to our future—and like it or not, some of them will come from technocrats or even the military.

Could geo-engineering be such a case? Should it be developed and deployed?

I would not apply geo-engineering at present, but research should be carried out. I'm already surprised by how many pursue it as a research topic. I share the fear, however, that researching geo-engineering will lead to an attitude that CO_2 reductions can be postponed because sulfur injection technology will save us from dangerous climate change. That would be totally wrong. I am doubtful that geo-engineering will be used because of its cost and its side effects. We should definitely not count on it.

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Paul Crutzen © Christian Schwägerl (2013. Used by permission.

In late 2013 the IPCC published a new comprehensive report on climate change. Critics argue that warming has paused for 15 years. Is it possible that something is wrong with some of the basic assumptions of the IPCC?

The Earth's climate system is very complicated, so I am not at all surprised that there is some deviation between reality and the models. But there's already a pretty good explanation of why warming happens slower than projected: it has to do with cooling processes in the tropical Pacific. But such phenomena will not permanently halt warming because of increasing amounts of CO_2 and methane in the atmosphere. It would be a huge mistake to lean back now and think that climate change is a minor problem. That would be hugely risky. I am fully on the side of the IPCC here.

How should politicians react to the IPCC warnings?

Every politician would be well advised to really look into this matter, study all IPCC publications thoroughly, and then act and adapt policies accordingly. It is incomprehensible, for example, that governments around the world still subsidize the consumption of fossil fuels with a staggering $500 billion annually. This money could indeed be better invested elsewhere.

When you give talks on the Anthropocene, you often present a long list of daunting problems, like climate change, resource consumption, and biodiversity loss. In your eyes, is the Anthropocene a purely negative event?

No, it's not only negative. I see many positive changes. Solar energy is becoming more affordable for many people, global health is improving, and there is less poverty in the Third World. There hasn't been a nuclear war. Thus I have not lost hope. But humankind faces huge problems. The Anthropocene will not be an easy ride at all.

How could the Anthropocene idea itself contribute to a better world?

We must emphasize the tremendous achievements of humankind so we get a stronger feeling that we aren't doomed but can make smart decision for a smart future.

What are the key political and economic changes that need to happen for a "Smart Anthropocene"?

I still think that one of the most important tasks is to abolish or hinder the spread of the "ABC" weapons: the atomic, biological, and chemical weapons. If that does not happen, they will be used eventually. Together with colleagues I have researched intensively how disastrous a nuclear winter—caused by the large amounts of black smoke produced by the many wartime fires, which block out sunlight—would be. My research findings haunt me. Another topic that is widely ignored is the looming shortage of the element phosphorus. We need this element to produce fertilizer and to feed humans into the future. In order to avoid turmoil, recycling procedures should be developed and implemented globally for phosphorus, and also for the rare earth elements used in the electronic industry. There are so many things that need to be achieved: national and international budgets need to be kept under control, so debt does not increase and burden future generations even more. Also, we can never do enough to enhance freedom of speech and the press, to promote equal rights, and to end racial discrimination. We need to bring much more respect into our lives. Respect for humans, for nature and all animals, for art, culture, and education. We need to place respect at the center of our culture.

Today, more than 1 billion people still live in absolute poverty. At the same time, the United Nations has revised its forecast and now projects 11 billion people for the year 2100. What needs to be done to address both problems?

That's a real dilemma and I am afraid to say that there is no easy option. Many countries are confronted with both famine and overpopulation. China, with its government-enforced one child per family policy, is demonstrating one possibility. Likewise, the high-income democracies have seen birth rates decrease because of increasing wealth and consumption levels. There's no straightforward answer I could give.

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The Anthropocene idea is now widely used in the environmental debate—are you surprised by how popular it has become?

Yes. I really thought it would be something only for the scientific community because it's such a vast and complex topic. But obviously I underestimated the power of this idea. The Anthropocene idea is now animating many people in many places in new ways and I am very happy about that.

There's criticism that the Anthropocene idea is anthropocentric. Critics like Andreas Weber say that it will make humans feel more important than we are and neglect nature even more. What's your response?

I was not aware of that criticism. But when people examine whether the Anthropocene idea is a symptom of human hubris or of anthropocentric thinking, I am happy to join the debate, because those are good points to discuss. However, what humankind has achieved during such a geologically very short period is so unique that it deserves a special place in any discussion like this. We humans only have our human brains and through them we understand the world. So even when you take into account the perspectives of other species, you are using a human brain. The situation would be totally different if there was another species on Earth that could say "I." Then we would face a totally different—and very interesting—situation.

When people start thinking on the huge geological timescale, might that make today's problems look smaller?

This is a very important point that needs further debate. How long are the timescales on which we can think and act? Currently, scientists and engineers add to Earth's knowledge pool year by year, in a catalytic fashion.

For instance, one could say that climate change might be bad now but that it will stop the next ice age and thus be a good thing in the long term...

Through most of human history much wider parts of Earth were covered with ice than today. But now our civilization is attuned to the post-glacial climate in which it thrived. If another ice age was starting, our descendants would probably do everything in their power to stop it. And that may actually be okay. But I don't think one can justify today's global warming with the argument that it will stop another ice age. Global warming will probably play out on such a long time scale, but we are not yet in a position to make conscious and educated decisions about questions like this.

If you had the chance to start your scientific career again, which field would you choose today?

I quite liked building bridges when I was young. When I am in Amsterdam, I sometimes go to bridges that I helped construct. So I might be tempted to go into bridge building again. However, I think that I would choose astronomy. I love gazing into the universe, knowing these are distances of many light years. And actually I quite like the idea of spreading life from Earth to other parts of the cosmos.

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What's your key message for young people of today, those pioneers of living in the Anthropocene?

Discover the beauty of our planet; there is so much of it on our planet. Be proud of unique, great human achievements. Use your innovative power. Ask yourself what you can do to eradicate poverty and how you can share the beauty and the wealth of planet Earth with others.

Do you think it is necessary to reduce consumption, like becoming a vegetarian or reducing car use to a minimum? Or will we innovate our way out of the problems with new technologies and efficiency?

We definitely must reduce consumption. As Mahatma Gandhi pointed out, the Earth provides enough to satisfy every person's needs, but not for every person's greed. In order to accommodate the current Western lifestyle we would need several more Earths, which we will never have.

Please allow yourself to speculate. How long do you think will the Anthropocene last?

If you view the Anthropocene as the sum of all human impact, the geological signs that last for a long time will certainly strengthen over time if the human population grows to 10 or 11 billion and Western consumption levels spread globally. If you view it as an opportunity for smart development, then everything depends on how wisely and fairly we use the Earth's resources, and how good we are at developing smart technology and medicine. If humanity does not change its mode of operation, the future of the Anthropocene might be very short.

So imagine you are a geologist one million years from now. Which geological signals would you see from our current "mode of operation" and which different geological signals would you like to see from the better "mode of operation" that you ask for?

One million years? You assume that there is intelligent life around to collect and interpret the signals. That is a very optimistic assumption, looking at the situation right now.

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Paul Crutzen at the European Parliament at a seminar on the future of oil in 2010

Have you remained an optimist?

Did I say I am an optimist?

But what makes you feel optimistic?

All the beautiful things around us like arts and literature that make us feel happy. There are so many beautiful things humankind is creating that I wonder when we will make Earth more beautiful again instead of depleting everything. Another thing that makes me feel better is that our negative impacts might actually help us understand the world. My research on our vulnerable atmosphere has really terrified me. But eventually I thought: What would we have known about our atmosphere if it had not been polluted? Because pollution gave us the impetus and triggered the funding to study the workings of the environment.

The interview was conducted by Christian Schwägerl (2013).

Christian Schwägerl is a journalist and author. His publications include "Menschenzeit" (in English: "The Anthropocene: The Human Era and How it Shapes our Planet"), which significantly contributed to the Anthropocene Project at the Haus der Kulturen der Welt in Berlin and the special exhibition at the Deutsches Museum.

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Paul J. Crutzen: “Mister Anthropocene”

Paul Crutzen at the University of Helsinki in May 2010

Created by Teemu Rajala (2010. View image source .

Born in 1933 in Amsterdam, Crutzen studied engineering before turning to atmospheric science. His research specialties include the ozone hole, nuclear winter, and global environmental change.

In the 1970s Crutzen discovered that certain substances cause damage to the ozone layer. He campaigned for a worldwide ban on all substances dangerous to the atmosphere that protects the Earth. The Montreal Protocol —the most successful international environmental treaty to date—is also largely the result of his efforts.

Crutzen and his colleagues Mario J. Molina and Frank Sherwood Rowland received the Nobel Prize for Chemistry in 1995 in recognition of their work in protecting the ozone layer.

At a conference in Mexico in 2000, Crutzen coined the term “Anthropocene”; the idea has been closely associated with his name ever since.

Crutzen has worked at many prestigious research institutions, including the Scripps Institution of Oceanography at the University of California, San Diego, and the Seoul National University in South Korea. He is most actively involved with the Max Planck Institute for Chemistry in Mainz, where he served as director.

The Nobel Laureate is the patron of the “Anthropocene Project ” organized by the Haus der Kulturen der Welt, Berlin, the Deutsches Museum, the Rachel Carson Center for Environment and Society, and the Max Planck Society.

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Nina Möllers

Nina Möllers

Dr. Nina Möllers

Dr. Nina Möllers is head curator and project manager of the special exhibition "Welcome to the Anthropocene: The Earth in Our Hands." She studied in Palo Alto, Tübingen, and Nashville, Tennessee and received her PhD in 2007 with a dissertation on "Creoles of Color in New Orleans."

As part of a post-doc project at the Deutsches Museum she curated a special exhibition on the history of energy consumption in private households. Her publications include the exhibition catalogs *Kabelsalat: Energiekonsum im Haushalt* (2012) and *Willkommen im Anthropozän: Unsere Verantwortung für die Zukunft der Erde* (2015).

She is grateful to Josephine Musil-Gutsch, Vanessa Osganian, Brenda Black, Helmuth Trischler, Iris Trautmann, Eliza Encheva, and Dorothea Föcking for their collaboration on this digital companion exhibition.

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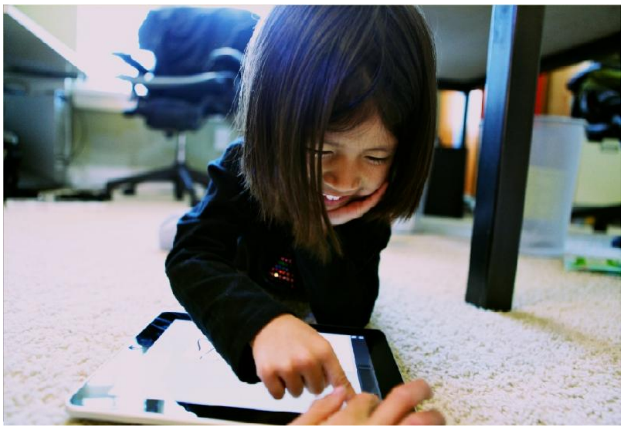

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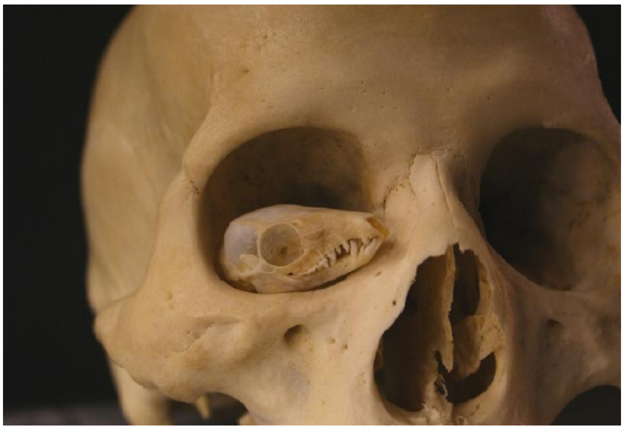

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