Recommendations for Action

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1 Introduction

On March 20–22, 2019, a workshop was held at the premises of the TUM Science and Study Center Raitenhaslach, addressing the questions raised above. The event's title, "Violated Earth, Violent Earth" was intended to remind of James Lovelock's book "The Revenge of Gaia" (2007). Of note, this book is not about intentional "revenge."

Based on intensive discussions in small groups and the plenary, the participants formulated the following recommendations for action with corresponding elaborations.

2 Recommendations for Action

1. **Stop Biodiversity Loss**: To enable humankind's continued existence on planet Earth, it is as important to preserve on the global scale biodiversity function as to prevent further global warming.
2. **Avoid Tipping Points**: To properly describe the Earth system, its dynamics, and changes, chaos theory must be taken into account, especially when it comes to explaining the exceeding of tipping points.
3. **Reformulate Societal Ethics**: To ensure the health of planet Earth, the development of adapted social ethics must go hand in hand with technical and economic efforts to maintain global health.

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4. **Employ Artificial Intelligence**: To avoid ending up existing in artificial-intelligence-dominated slavery, ways must be found to utilize the new tools of the digital age to reinforce human governance of socio-technical and Earth systems.
5. **Fight Ignorance**: The diminution of human misbehavior is to be considered a cornerstone of sustainable development of society, ecology, and human health.
6. **Foster Democracy**: To overcome barriers of existential relevance, humankind is well advised to orient itself toward science-based future perspectives, legitimated by democratic processes.
7. **Counter Alarming Evolution**: To ensure the continuing emergence of creative and inclusive approaches to overcoming existential threats caused by climate change causing global warming, the creation of effective strategies and their successful implementation is a must.
8. **Redefine Global Health**: The human health dimension must be understood as a fundamental assumption for keeping the planet Earth our common home. This means the assurance of human physical and psychological health is a factor of equal importance to protecting biodiversity, stabilizing climate change, and respecting planetary boundaries.
9. **Facilitate Circular Economy**: Based on the assumption that the environment can be considered our "second skin," it is obvious that humankind at large needs to take full responsibility for the preservation of the ecosystem function.
10. **Shape and Create Innovation**: With the risk of a complete breakdown of the Earth system at hand, a proactive approach toward shaping technology satisfying the actual needs of humanity and nature alike must be the leading principle of the "New Enlightenment."
11. **Redefine Education**: To cultivate a sustainable and adaptive form of "New Enlightenment," a strong focus is to be placed on education, which has to transfer not only factual knowledge but also fundamental principles of ethics, arts, and humanities.
12. **Embrace Vulnerability**: Beyond all threats vulnerability of the Earth system and its inhabitants also is to be regarded as a fundamental openness for change and as a basic aptitude for recognizing in time where and how the change of thinking and acting has to take place.

3 Explanations

Ad 1: Stop Biodiversity Loss

To enable humankind's continued existence on planet Earth, it is as important to preserve on the global scale biodiversity function as to prevent further global warming.

Sustaining a critical diversity of species and metabolic processes is a natural provision to prevent a systemic collapse in case environmental conditions suddenly change. In the past, humankind has demonstrated its ability to adapt to very different climatic conditions, hot and cold periods included. The animated nature also is able to adapt. However, processes of adaptation were mostly associated with the elimination of species in favor of those, which demonstrated specific carrying capacities. Species got extinct but not life itself. Obviously, the Earth system has been able to heal itself and maintain a state of resilience. As Ernst v. Weizsäcker in his introductory speech insisted, time is ripe to understand but not undermine the self-regulation capacity of the Earth system. It is more than necessary to take action to understand the intrinsic dynamics of the animated nature instead of discussing shortsighted pros and cons.

Monocultures in agriculture, for instance, are comparatively susceptible to external impacts. They need chemical or microbiological interventions to maintain stable conditions. The results of unstable conditions are well known, for example in the case of agricultural monocultures. Likewise, a kind of "monoculture" in economic systems is taking hold in the assumption that growth of such systems guarantees efficiency. To keep such systems in a stable state, for example in the form of subsidies, interventions are unavoidable, thus leading eventually to collateral damages. The global community is called upon to steer away from entertaining economic monocultures for the sake of short-sighted financial advantages.

Ad 2: Avoid Tipping Points

To properly describe the Earth system, its dynamics, and changes, chaos theory must be taken into account; especially when it comes to explaining the exceeding of tipping points.

General properties of many if not all physical and biological processes, even though extremely complex, may be described by effects from *Systems Dynamics.* As Patrick Dewilde outlined in his introductory lecture, most natural processes are highly nonlinear and chaotic, meaning that at any moment small fluctuations can be exponentially amplified under the right propagation conditions. "Tipping points" by which all of a sudden new forms of life appear to arise in this way, or, on the contrary, violent destruction annihilates life.

Run-away evolution can only be controlled by an emergent effect, such as "survival of the fittest" or, from a human point of view, human intelligence capable of activating a proxy that leads to a tipping point (e.g., the school strike initiated by Greta Thunberg, or the rise of Facebook, the iPhone, or even the acceptance of Pythagoras' theorem). Nature owes its ubiquitous and continuous creativity to chaos, and it is a major challenge to human intelligence to generate the necessary momentum, i.e., the tipping point, to counteract the destructive effects of the careless exploitation of resources, and the poisoning of the biosphere has created. Even so, there will never be a final solution, and humanity has to keep on evolving with the evolving Earth, using its collective intelligence toward sustainability and optimization of the overall quality of life.

Ad 3: Reformulate Societal Ethics

To ensure the health of planet Earth, the development of adapted social ethics must go hand in hand with technical and economic efforts to maintain global health.

The ongoing developments in science and technology lead to a certain resistance within society, which is often referred to as "Angst" of a potential dominance of autonomous machines. As Klaus Mainzer mentioned in his keynote lecture, we live in an increasingly complex world. An enormous, ever-growing number of data are available ready to be used for solving the pressing problems of today and tomorrow. It appears that the "old" world is disrupted—similar to the situation after the Thirty Year's War when the first Enlightenment commenced. From that time on, science became the driving force of knowledge gain and technology development. We certainly have not reached the point of ultima ratio, yet. But we are now in the position to enter a new era of science and AI technology which could help us to master the increasing complexity of our civilization. Nevertheless, human governance and responsibility are still indispensable. In this sense, we need a new phase of Enlightenment.

Ad 4: Employ Artificial Intelligence

To avoid ending up existing in artificial-intelligence-dominated slavery, ways must be found to utilize the new tools of the digital age to reinforce human governance of socio-technical and Earth systems.

To reach sustainable development for consistency and purposefulness, it appears reasonable to use the new tools of the information age (artificial intelligence, simulation, scenario analysis, etc.) to, for example, carefully analyze the ever-tighter net of global and regional environmental regulations and incentives set up by different sectors. The purpose is to ensure that they together reach their intended goal and do not unintentionally counteract each other.

Mathis Wackernagel pointed out that regulations resolved by state authorities are only executed and willingly accepted when citizens and executive managers alike realize existential, long-term advantages. Regulations are to be rated as the proverbial "skin in the game." They become effective by subcutaneous application, as medical doctors might say. The focus must lay on future perspectives rather than on solutions that proved effective in the past.

In this context, it is worthwhile to recall that nature is not a museum but a system in continuous alteration, responding to changing ambient conditions and possibilities. Facing the challenges of the upcoming decades, any legal processes resolved by democratic institutions must provide development processes that appear successful under stressful conditions but allow adjustments and reorientations once novel impacts and scientific knowledge become available. Centrally planned economies, for example, have already demonstrated their inefficiency in many historical cases.

Ad 5: Fight Ignorance

The diminution of human misbehavior is to be considered a cornerstone of sustainable development of societies, ecology, and human health.

The underlying reason for our concurrent global problems is the stone-age old human agency to act against generally approved ethical norms and—more recently—against scientifically proven facts. Just three examples: We know that emissions of greenhouse gases lead to global warming, climate change, and eventually natural catastrophes. We know that agricultural monoculture drives loss of biodiversity and, as a consequence, destabilizes the ecosystem that humankind is dependent. We know that excessive consumption of sugar combined with little physical exercise can lead to diabetes and premature death. We know all this—and much more—but we act against it and then complain about the consequences. Planet-violating forms of consumption have become accepted as a proxy for economic success, although we know that nature is our true indispensable second skin. To break such vicious cycles, it is advisable to use modern communication systems by which means the information does not stay at the cognitive surface but goes "under our skin." Developing means that can positively alter the behavior of individuals and humankind, in general, must be an integral part of the "New Enlightenment" that Ernst Weizsäcker calls for in his report to the Club of Rome.

Ad 6: Foster Democracy

To overcome barriers of existential relevance, humankind is well advised to orient itself toward science-based future perspectives, legitimated by democratic processes.

With democracy, we refer to a process that includes self-determination, inclusion, the opportunity to make up one's own mind, as well as transparency beyond majority voting. We understand democracy as the social decision-making process that is proven to best ensure the emerging of creative and inclusive approaches to problem-solving, the creation of effective strategies, and their successful implementation. Democracy needs to rely on scientific facts that are established through robust, transparent, and testable processes. This enables a society to react open and creatively to changing conditions rather than succumbing to predetermined and imposed choices. This call ("come on") is not only directed at policymakers but at the main acting groups like agriculture, industry, energy, transport, media, the bankers, and, last but not the least, the consumers and voters.

Ad 7: Counter Alarming Evolution

To ensure the continuing emergence of creative and inclusive approaches to overcoming existential threats caused by climate change causing global warming, the creation of effective strategies and their successful implementation is a must.

Our planetary environment changes in an alarming way. Experts assume the carrying capacity of the (global) environment has already been exceeded and the survival of human civilization is ultimately endangered. Global warming and climate change represent just one range of threats planet Earth is confronted with. The human species itself may be able to adapt to higher atmospheric temperatures as well as environmental destruction. Those damages are caused by heavy storms, excessive rainfalls, or flooding, for instance, and also the loss of human lives and property

value. The recovery of biodiversity loss may take much longer than human civilization is able to compensate for artificially. In essence, it lies in our own interest to take good care of our "second skin." Proactive health care of our "skin" must play a leading role in the "game!".

Ad 8: Redefine Global Health

The human health dimension must be understood as a fundamental assumption for keeping the planet Earth our common home. This means the assurance of human physical and psychological health is a factor of equal importance to protecting biodiversity, stabilizing climate change, and respecting planetary boundaries.

The working group dealing with public health identified the topics below as the most pressing aspects to address immediately and crucial to reconsider in future dialogues.

Nutrition

Increasing national income correlates with increased consumption of meat. This induces an expansion of the agricultural industry that endangers the climate, the biodiversity, the supply of drinkable water, and the effectiveness of antibiotics. Excessive consumption of meat also implies risks to individual health with increased mortality. We recommend information and education measures, transnational optimization of policies, and market design strategies to limit the damage inflicted on individual health and natural resources.

Aging

The impressive extension of the human life span during the twentieth century relates to the unsustainable use of natural resources. This unsustainable use is aggravated by the lack of evidence-based medicine for the elderly, which in turn results in erroneous and unnecessary therapies. Therefore, we recommend enhancing medical research on multi-morbid old patients.

Public Health

Prevention does not require as many natural resources as therapy. Therefore, we recommend expanding and improving public health efforts in Germany so that the health system reaches the quality found in comparable European nations, whilst keeping in mind that the benefits of a natural environment, that invites us to exercise and enjoy and provides beautiful healthy landscapes, is deeply underestimated.

Allergies

We currently observe an epidemic of allergic diseases such as asthma. This relates to a Western lifestyle implying little contact with a rural environment. The increased frequency of severe disease episodes can be linked to climate change because plants release stress factors with high immunological potential, and thunderstorms drive the distribution and the impact of these factors. In view of this epidemic, we need more specialists for Allergology and environmental medicine.

Pediatrics

Nowadays, children spend most of their time indoors with near-work such as computers and smartphones. This behavior directly relates to the worldwide epidemic of shortsightedness that can be stopped when children spend sufficient time in bright daylight with large distant objects. The effect of smartphones on the mental development of young children requires further research. There might be positive effects because by using the smartphone the child has an additional channel for early interaction with the world at its hand even before being able to speak sufficiently well.

Artificial Intelligence

Artificial intelligence is a highly versatile tool to use big data in prevention, diagnostics, and therapy. However, big data and artificial intelligence are problematic with regard to energy demand and data protection. The further development of AI has to take these problems into consideration—for instance by including analog information coding.

Research

Crises always come along with opportunities. In fact, they frequently provoke the emergence of new development. We, therefore, recommend an optimistic view toward the future instead of fear-driven policies. Research needs to be interdisciplinary, however, so that unexpected side-effects in a complex natural and societal system can be recognized early. Interdisciplinary approaches must, therefore, include the humanities and social sciences, as they have a long tradition of observing the societal part of this complex system.

Ad 9: Facilitate Circular Economy

Based on the assumption that the environment can be considered our "second skin," it is obvious that humankind at large needs to take full responsibility for the preservation of the ecosystem function.

We need to establish a true, circular economy, i.e., a system that lives from within itself and, does not consume resources from the planets' stores or sends waste to third world countries, and that strives to radically extend the lifespan of the products we use. While this is not a new thought, this is now crucial in the light of the increasing speed of innovation and the magnitude of the impact that some of these innovations may have on the planetary system.

The economic system can provide the means and framework for the necessary changes, and concurrently induce corrections to harmful forms of established decision-making.

Economy is a tool, which helps regulate the exchange of goods and services. On the other hand, the Earth system including biodiversity and ecosystems are the baseline for our economic systems. If they collapse, the economic system also collapses. Correction measures are mandatory. Integrating biodiversity and ecological concerns requires an overhaul of the taxation and subsidy system. In this context, it is necessary to consider the dangers associated with the volatility of the financial markets and the resulting threat for the sustainability of any system. This is best addressed on the EU level or higher.

While from a general direction it may be clear, what needs to be done, in detail this is much more difficult and additionally complicated by the human factor human and the human-to-human relationships. We need leadership and the courage to step forward. Especially the young generations are demanding this. While stepping into leadership may feel risky, not doing so will probably not be much riskier either the greater risk. Changing the system and implementing measures will require smart tactics, including hard measures as well as soft ones, and strong consideration of collaboration techniques making sure that all interest groups feel heard.

Ad 10: Shape and Create Innovation

With the risk of a complete breakdown of the Earth system at hand, a proactive approach toward shaping technology satisfying the actual needs of humanity and nature alike must be the leading principle of the "New Enlightenment."

We have to recognize that human demands are overwhelming the capacity of the natural systems, putting at risk our life support system. Apparently, the original concept of the "Enlightenment" no longer suffices to react adequately to the concurrent global challenges.

In this context, one key element is a prospective shaping of technology to humanities actual needs, in German "Technikgestaltung." Elements to successfully implement solutions for a robust, sustainable Planet Earth depend on taking a proactive approach toward shaping and creating innovation, policy, design and technology development (as opposed to post-mortem technology assessments). Examples include assessments that required greenlighting from technology teams, financial viability teams as well as ELSA (ethical, legal, ecological, and societal) teams. A meaningful Technikgestaltung requires interdisciplinary and holistic education in natural science, technology, and humanities.

Ad 11: Redefine Education

To cultivate a sustainable and adaptive form of a "New Enlightenment," a strong focus is to be placed on education, which has to transfer not only factual knowledge but also fundamental principles of ethics, arts, and humanities.

Enhancing environmental education is the main "soft sustainability" measure that can be taken. Education has to take place at all ages, countries, and professions. Advanced methods of education are especially important, as current regulatory systems are much slower than the rate of innovation. A strong focus is to be placed

on sustainability within all curricula developing human consciousness and responsible behavior. This could be done through education and training from the earliest age, not only on sustainability at large, but also risk evaluation, and complexity understanding.

This is not only about children, but very much about adults too—learning to ask the question: how do we want to live in the future?

Ad 12: Embrace Vulnerability

Beyond all threats, vulnerability of the Earth system and its inhabitants also is to be regarded as a fundamental openness for change and as a basic aptitude for recognizing in time where and how the change of thinking and acting has to take place.

The vulnerability of the Earth system and its inhabitants corresponds, on the one hand, to the very real dangers and potentially catastrophic developments in the ecological crisis. On the other hand, vulnerability represents a fundamental capability to sense and to adapt to novel developments. In the case of humans, it is their vulnerability that drives them to come up with countermeasures in time. This may mean that they enter proactively into the era of a "New Enlightenment." However, their vulnerability does not predetermine the specific kind of their response. Consider the following controversy: Many assume that the Earth system is basically good and that to end human ecological misbehavior is all what is needed to overcome the current environmental crisis and to return to the paradise they imagine to have existed before man misbehaved. This stance amounts to a fundamental conservatism and, in fact, can claim some good reasons since the Earth system as it used to be, has been working up to now. Thus, a "New Enlightenment" may just end in strict conservatism. Yet, upon more extended inspection of the planet's past, the Earth system turns out to be not so friendly after all, having a history of horrific catastrophes, which endangered large parts of mankind but were not man-made. In view of this history, some people strongly argue against a conservative retreat to the deceptive mother Earth. Instead, they see the current period of unprecedented scientific and technological productivity as an opportunity to prepare for coming disasters, man-made or not, so as to be able to defend mankind against any detrimental conditions to which it will be exposed. This stance amounts to a progressive technicism that will not shrink from global interventions if they appear rational. Such technicism builds on the characteristic feature of man to shape the conditions of his life. However, it tends to misjudge its ability to detect side effects, as the twentieth century has shown. A "New Enlightenment" that deserves the name will stay clear of paralyzing conservatism on the one side and uncontrolled technicism on the other (Fig. 1).

Fig. 1 Participants from Left to Right: Dr. Ulrich Hildebrandt, Prof. Dr. Eckehard Binas, Prof. Dr. Konrad Oexle, Prof. Dr. Felix Unger, Dr. Birgit Herbst-Gaebel, Prof. Dr. Markus Disse, Prof. Dr. Michael Molls, Prof. Dr. Heidrun Behrendt, Dr. Agnes Limmer, Gabi Toepsch, Prof. Dr. Klaus Mainzer, Prof. Dr. Mathis Wackernagel (front), Dr. Martin Wilderer, Jessica Westermayr, Paul Beckh, Dr. Klaus Arzet, Prof. Dr. Hans-Curt Flemming, Prof. Dr. Jörg Völkel, Prof. Dr. Wolfram Mauser (front), Prof. Dr. Ernst von Weizsäcker, Jaroslava Wilderer, Prof. Dr. Peter A. Wilderer, Prof. Dr. Martin Grambow, Dr. Jane Korck, Prof. Dr. Michael von Hauff, Prof. Dr. Andreas Klinke, Willi Kiefel, PD Dr. Jörg Wernecke, Prof. Dr. Hans-Peter Zenner, Prof. Dr. Patrick Dewilde; not in the picture: PD Dr. Ingo Borggräfe, Prof. Dr. Radu Grosu, Prof. Dr. Florian Heinen, Dr. Marcel Huber, Prof. Dr. George Illiakis, Prof. Dr. Eva Lang, Prof. Dr. Jutta Roosen

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