Climate Change and its Challenges

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Climate is essential to human life. Climate determines which plants can grow in a certain region, whether there are lush forests, a diversity of grains, vegetables and fruit, dry savannas, or no plants at all. This in turn determines animal life, which in itself is also dependant on climate. And, of course, human life depends on these resources. Last but not least, vegetation and animal populations in turn influence climate.[1]

When temperatures started systematically dropping at the transition to the last ice age some 100.000 years ago, humans and animals in Europe migrated southward in search of food and warmth. But, one might think, those were primitive tribes, nothing like our highly industrialized and globalized civilisation of today. No need for migration! Were a new ice age to come, should Scandinavia and the Baltic States once more be covered with ice sheets that extend south as far as Denmark, northern Poland and Germany—could we handle this? Wouldn´t all Austrians migrate to the eastern, low lying, ice-free part of the country? Migration would be the only option for a large part of the European population. Migrating might be technically easier than in former times, but would Scandinavians in the millions be welcome in Spain, Italy and Greece? Would Europeans be welcome in Africa and Asia? What used to be an empty world—much space, plenty of resources and few humans—has become a full world—too many people on a limited area of liveable land and with limited resources. This diagnosis by an eminent economist induced him to call for a new type of economy, the present one having been made for an empty world (Daly, 2015).

1 This paper partly draws on previous publications in German language by the author.

In the film "The day after tomorrow", a movie that assumes a rapidly growing ice sheet covering half of north America within days, and Americans being evacuated and fleeing to Mexico, Roland Emmerich has the president of the USA saying in an TV-address: "For years we operated under the belief that we could continue consuming our planet's natural resources without consequences. We were wrong. … Not only Americans, but people all around the globe are now guests in nations we once called the third world. In our time of need they have taken us in and sheltered us and I am deeply grateful for their hospitality." While in the film those forced to migrate essentially caused climate change, in the real world the people most affected have not contributed significantly to climate change and there is no welcoming hospitality when they are forced to migrate.

The world is now experiencing global warming, with a strong likelihood of this getting worse. But within global warming, a collapse of what is commonly called the gulf stream—a section of the global ocean circulation that conveys warm surface waters through the North Atlantic, warming Europe by about 5 °C—could lead to rapidly falling temperatures, increased storm frequency and dryer conditions in Europe within a few years (Thornalley et al., 2018). The weakening or even shutdown of this ocean circulation within this century was a serious consideration in scientific papers some years ago, and an early report to the Pentagon (Schwartz & Randall, 2003) analysed how this would first lead to border disputes, especially over water and farming land, and could end in outright wars. More recent publications do not expect a collapse of the conveyor belt within this century, although a weakening is already observed (IPCC, 2019).

The ficticious scenarios make clear at least two rather obvious things: a) Migration is one form of adaptation to climate change, and in some cases the only option—e. g. in cases of sea level rise, and b) climate change is not just an environmental problem—it is a societal problem with a multitude of interacting consequences.

The Changing Climate

Other than in the ficticious scenarios above, the climate shift experienced in the last decades is one of warming—called by some global heating[2], to avoid the somewhat cosy connotation of the term "warming". While a warming of about 0.17 °C per decade (IPCC, 2021) might seem slow, even negligible to the general public, the scientific evidence is unequivocal that global warming, presently to the extent of about +1.2 °C above pre-industrial levels, has significant consequences. Changing one variable in the climate system has implications for all others, such as moisture, precipitation, pressure and wind systems, and a tendency for extreme events becoming more extreme and often more frequent. In fact, the report by the Intergovernmental Panel on Climate Change (IPCC, 2018) that was produced to clarify whether a 1.5 °C limit to warming would provide significant advantages over the 2 °C goal of the Paris agreement, concluded that every tenth of a degree of warming matters. For example, at +1.5 °C, 700 million people would be affected by extreme heat waves at least once every 20 years; at +2 °C, 2 billion would be affected. At +1.5 °C, about 11% of the land area would be affected by flooding along rivers, at +2 °C it would be 21%; the North Pole would become ice-free in 40 years at the end of summer in one case, in 3 to 5 years in the other. Hence, the difference between 1.5 °C and 2 °C is huge in terms of effects. Many climate elements, as well as parts of the biosphere, respond at even smaller temperature increases than scientists previously expected (IPCC, 2023a, 2023b). Since the reactions are typically exponential rather than linear, even small temperature differences or minor misjudgements can have far-reaching consequences.

Some scientific publications (Kemp et al., 2022; Lenton et al., 2019; Ripple et al., 2023; Steffen et al., 2018) indicate that stabilization of the climate system may not be possible at warming levels above 2 °C. A dynamic of constant warming, "hothouse earth", could emerge because tipping points of the climate system are exceeded, leading to self-reinforcement of warming. Mankind would be powerless against it and the end of our civilization would be the consequence. "Hothouse earth" is not an expected development based

2 E.g. Richard Betts, UK Met Office, and Hans Joachim Schellnhuber, PIK, as quoted in https://www.theguardian.com/environment/2018/dec/13/global-heating-more-accurate-to-describe-risks-to-planet-says-key-scientist

on established knowledge, but it is considered too risky to try ("too risky to bet against").

Current policy indicates a temperature increase of 2.8 °C by the end of the century. Implementing current national pledges will only reduce temperature rise to 2.4 °C for conditional pledges or 2.6 °C for unconditional pledges. However, countries are not currently on the pledged emissions pathway (UNEP, 2022). +1.5 °C is likely to be permanently exceeded by the early 2030s. This means that drastic greenhouse gas emission reductions are needed within this decade to avoid the risk of "hothouse earth".

The fact that the 27th Conference of the Parties to the United Nations Framework Convention on Climate Change (COP27) did not make any progress in this respect is tragic in view of the time pressure: Neither did the parties to the UN Framework convention of climate change (UNFCCC) commit themselves to significantly improving their reduction targets, nor was the phase-out of coal made more concrete. On the contrary, some Glasgow formulations were even weakened (Ramachandran, 2022): Instead of a 45% reduction in emissions by 2030 compared to 2010, only a 43% reduction compared to 2019 is required. Given the increase in emissions between 2010 and 2019, this is a significant step backwards. The timeline for achieving net zero is missing altogether.

Unfortunately, it's not about just one lost year. The success of international climate conferences depends on the host country working hard in the run-up to the conference. The next COP will be held in Dubai. As one of the oil-richest countries in the world, Dubai sees renewable energy as a supplement to, not a replacement for, fossil fuels. But not phasing out fossil fuels makes it impossible to meet the 1.5 °C target. For the COP in 2024, the Czech Republic, Bulgaria and Australia are in discussion; none of them is known to have particularly ambitious national climate goals. Real progress brought by the COPs in the next two years would therefore be a surprise.

Loss and Damage

The COP27 did, however, make progress in one important aspect, even though it is of a more symbolic nature. Following the devastating floods in Pakistan in 2022 which affected 33 million people, killed over 1500 people and caused an estimated US$30 billion in damage (Gerhardt, 2022), Pakistan

has pushed to put the issue of loss and damage on the agenda of COP27, two years earlier than scheduled. The issue had come up at climate conferences since 1991, when it was raised by the small island nation of Vanuatu.

There is no doubt that the industrialized nations have caused a substantial part of man-made climate change, while the developing countries[3] are suffering the most. Regarding a quantification of the share of climate change in damages caused by extreme events, science has made great progress in recent years in an exemplary international and interdisciplinary collaboration termed "attribution science" (van Oldenborgh et al., 2021). One aspect of this new methodology is simulating the actual weather situation in a world that is 1.2 °C cooler, and looking at the differences to calculations based on the current situation. Furthermore, statistical analyses are performed using observed time series. The methodology allows quantifications in many cases, but large uncertainties remain depending on the event considered. Other changes, such as altered building development, or extent of precautions against extreme events must also be taken into account, if the extent of damage is addressed. While there still are fundamental problems in quantifying loss and damage realistically, the quality of the assessments has reached such a level that attribution studies are already finding their way into legal disputes.

The floods in Pakistan, for example, were caused by unusually heavy monsoon rains and melting glaciers due to a severe heat wave in the preceding months, both probably exacerbated by climate change. However, the amounts of monsoon precipitation, which vary widely from year to year, are still poorly captured by climate models, so that model-based confirmation of the rather high contribution of climate change inferred from observed time series is only tentative. Undoubtedly, however, according to the scientists of the world weather attribution project, the proximity of settlements, infrastructure and agricultural land to the floodplains, inadequate infrastructure, limited ex ante risk mitigation capacity, an outdated river management system, vulnerability due to high poverty rates and socioeconomic factors, and ongoing political and economic instability, all contributed to the magni-

3 The terms developing countries and Third World have largely been replaced in migration discourse by the term Global South, distinguished from the Global North. These terms are not geographical but a description of global inequality. If this article also refers to developing countries, it is because policy measures and funds are named this way.

tude of the disaster. Hence, it is difficult to put a number on the damage or the loss due to climate change in this case. (Otto et al., 2022)

Thus, while there is little question about the fundamental legitimacy of developing countries' demands for compensation for loss and damage, industrialized nations resist a formal recognition of an obligation to pay. Since the damage is becoming greater and more diverse as climate change progresses, and an increasing number of areas is affected, the industrialized countries also fear that admitting a payment obligation would open up a bottomless pit.

Due to massive pressure from the Alliance of Small Island States (AOSIS), supported by the G77, it was finally agreed to create a fund from which aid payments would be made, but not by whom and how it would be filled[4]. The terms of disbursement also remained open. In view of the hesitancy with which the Green Climate Fund (GCF), which was already agreed in Paris, is being stocked and the fact that the volume falls well short of the original pledge[5], it is to be feared that the new fund will only divert further resources from the GCF. The number of relevant funds is growing: In addition to the Green Climate Fund and now the Loss and Damage Fund, the Least Developed Countries Fund, the Special Climate Change Fund, the Adaptation Fund and the Global Environment Facility are waiting to be filled to the agreed extent.

In 2015, the industrialized nations' generous funding commitments to the Green Climate Fund were a condition of the developing countries' agreement to the Paris Agreement. Not surprisingly, developing countries are assessing their levers to achieve real support, and thinking aloud about a global creditor strike: breach of promise versus breach of promise. Developing countries' refusal to make interest payments on their debts could create movement in the political arena via the financial sector. As US climate activist Bill McKibben notes: "Justice makes progress only through politics. Balancing the world's wealth even a little is the most difficult of all political tasks. But our chances for a liveable world may depend on it". (McKibben, 2022)

4 https://unfccc.int/sites/default/files/resource/TC1%20Paper%203%20Workplan%2029%20March%20rev3.pdf?download

5 https://www.greenclimate.fund/about/resource-mobilisation/gcf-1

Climate Change Is not Just an Environmental Problem

While it has been clear from the outset that climate change is not just an issue of rising temperatures and enhanced extreme events, but has far reaching societal, economic, and political implications, this does not seem to have been understood by the general public and possibly not sufficiently by politicians. The interaction of the natural environment with economic, societal and political activities makes climate change a societal problem. In a recent article some of these interactions and their feedbacks were described in a more systemic way, using a simplified causal loop diagram (Kemp et al., 2022) to show how risk cascades could unfold: Global warming causes sea level rise and extreme weather events that both can lead to displacements and thus to international and local conflicts. These also become more likely as economic inequality increases, which again can be the result of global warming and e. g. extreme heat waves. Resource shortages, such as water, food and fuel can be intensified by sea level rise and extreme weather events, but also as a consequence of political instability and state fragility resulting from displacements and conflicts. All these factors increase mortality. The positive feedbacks in this system—e. g. displacements causing political instability and state fragility undermining law and order and the ability of states to feed their population, which in turn increased migration—exacerbate the problems.

What people suffer from most is generally not the change in climate in itself, but its immediate consequences, such as drought and famine, or indirect consequences such as civil war. In addition to the debt trap in which developing countries find themselves, a climate trap has developed, where modest prosperity is lost again with the next extreme weather event (McKibben, 2022). Recovery from devastating events such as hurricanes or floods like those in Pakistan can take years.

Needless to say, within every country it is the poor that suffer most, generally being placed in more exposed locations (flood plains, densely populated cities) and having the least means to cope with gradual changes and disaster (Rigaud et al., 2018). On the other hand, there is plenty of experience that often these people are better equipped to meet smaller scale disruptions by long tested experience of shortages of all sorts and high adaptability than people unused to coping with disruptions and highly dependent on technical support in their daily lives—as is true for many in industrialized countries.

Not only adaptation or its limits make climate change more than an environmental problem, mitigation also is predominantly a societal problem. It is not—as often framed—a purely technological problem.

Mitigation of GHG Emissions

To stay within the 1.5 °C limit with 50% probability, global GHG emissions must be reduced to 50% by 2030, and net zero must be achieved by 2050, at which point the GHG budget will be exhausted (WMO, 2022). The global budget can be calculated for individual countries by population. For Austria (CCCA et al., 2022), e.g., this results in a budget of 430 Mt CO_2 from the beginning of 2022. With annual emissions of about 70 Mt CO_2 per year, the budget would be exhausted in 6 years, i.e. at the end of 2028, without effective mitigation measures. If 50% probability of complying with the Paris Agreement is not deemed enough—at 66% the still permissible emission for Austria drops to 240 Mt CO_2. Staying within this budget requires a reduction of half of the emissions about every 2–3 years. The situation is similar for other European countries. It is obvious that this is an almost unmanageable challenge.

These budget considerations show that there is no time to wait for new technologies to emerge: Emission reductions to 50% within less than ten years can only be achieved with existing technologies such as renewable energies and higher efficiency and must essentially rely on existing infrastructure. The hydrogen economy or nuclear developments such as small modular nuclear reactors (SMR) or fusion energy—even if their sustainability were not questionable and they were considered highly desirable—would not penetrate the market in time. Hydrogen will play a role in some niches, such as powering energy intensive machines, but it will not be a panacea for all energy problems. In addition to renewable energy large contributions through increased efficiency and sufficiency will be needed.

Chancellor Angela Merkel noted in 2021, when visiting the Ahrtal after it was devastated by a deathly flood "We need a full transformation of our economy, of our way of doing business."[6] The encouraging aspect is that the

6 https://www.wiwo.de/politik/deutschland/merkel-in-den-usa-kampf-gegen-klimawandel-erfordert-eine-volltransformation-der-art-des-wirtschaftens/27426772.html

necessary changes can lead to a more equitable and just world with higher quality of life, albeit lower standards of living as measured by goods and services.

The energy sector was already addressed—a decentralised system based on renewable energy would not only stop money drain from communities and states, but also dramatically change the geopolitical situation, possibly bringing peace to regions that have been in turmoil over fossil resources for decades. An industry producing more durable, high quality products that can be repaired and recycled in a circular economy, with possession in many cases less attractive than rental (e.g. drills, cars) would mean enormous savings in resources, including energy. Though the individual product might have a higher price, such a system could bring financial relief to low income families.(Kirchengast et al., 2019)

This is not the place to enlarge upon similar schemes for mobility systems that are conductive to improved health and safety, agriculture that is resilient and produces healthy soils and food, a health system that focusses on prevention and health rather than on costly remedies shifting money from the state to the pharmaceutical industry, an educational system fostering creativity, self-efficacy, confidence and cooperation in the young, a financial system that serves the real economy, possibly based on a biotope of currencies, and democracies reverting to their original intent, fostering participation and ethics of responsibility.

Fundamentally, all these changes are directed towards two agendas that are also at the root of the UN 2030 Agenda and the Sustainable Development Goals (SDGs): Ensuring or enabling a "good life for all" (human well-being) while respecting ecological limits. The challenge is to pursue both synergistically and not play them off against each other. In past decades, a common idea based on the environmental Kuznet´s curve as interpreted by (Grossman & Krueger, 1991), was that a society must first become more prosperous to then take care of the environment. This has proven to be a fallacy, because as prosperity has increased, so has resource use, and none of the nations that have achieved the desired prosperity—as measured, for example, by the "human development index," HDI,—have reduced their ecological footprint to the required level (Kromp-Kolb & Formayer, 2018). This is not proof that it cannot be done, it just has not been seriously attempted to date. Thus, the task of the industrialized nations is to reduce the ecological footprint back to a sustainable level and at the same time improve the quality of life of its citi-

zens to make the transformation attractive. The challenge for the developing countries is to create at least a minimum of quality of life for all their citizens without increasing the ecological footprint significantly.

These are fundamental changes, but necessary, as nature is not an inexhaustible reservoir of resources that humans can use at will, but a complex system of which humans are a part. Nature is the basis of human life—we must therefore learn to want only what we can achieve within the limits set by nature. For humanity as a whole, but especially for people in industrialized countries, this means learning to be satisfied with less, i.e. to accept a sufficiency principle. Some of the things we thought we were entitled to will not be attainable—such as the German dream of a private home in the countryside for everyone, or the annual flight to some far away vacation paradise, meat three times a day or even every fruit in every season. Although this may sound like renunciation and doing without, in essence it is a matter of change from a but recently acquired culture of plenty and waste and a matter of change of habits.

A Path Forward?

There is no doubt that the framework conditions for the COP27 were not favourable with the energy and food crisis as a result of the Ukraine war that preoccupied especially Europe, the USA and Russia. Sustainability is intimately tied to peace—not only in Europe, but worldwide. In the long run, peace and sustainability are inseparable. Therefore, efforts to achieve peace are a step towards resolving the climate issue that cannot be overrated. Peace is important and it is urgent!

On the practical level of international climate negotiations, one must seriously ask whether it is still justifiable to tie the development of climate policy to the COPs, indeed whether the COPs themselves still make sense. It seems very questionable whether *the great leap forward*, that is now asked for (Dixson-Declève et al., 2021) with five major turnarounds (poverty, inequality, empowerment, food, and energy, as well as a major restructuring of the economic system) can be achieved collectively, or whether it is up to individual countries to demonstrate, at least selectively, that this leap can be made without social disruption and economic catastrophe.

Several options are being discussed (see e.g. McKibben, 2022), apart from continuing as before, with even more concerted effort to convince the nations of the world that common long-term goals are more important than national short-term successes. Some form of coalition of the willing to make real progress on emissions reductions within this group, even if not all nations participate, might bring the issue forward; the Beyond Coal and Gas Alliance is a step in that direction. Bilateral agreements, such as between the U.S. and China, could be systematically advanced and play a more important role. Teaming between individual or groups of industrialized and developing countries to transfer technology and funds to developing countries to enable development without depleting their greenhouse gas budgets, and, in return, entitling the industrialized nations to use the unspent part of the budget of the respective partners might enable a realistically achievable emission reduction path for industrialized countries. Helping developing countries become more attractive for private investments could funnel money in the Global North seeking investment opportunities, such as pension funds, to the Global South to develop renewable energy there. Cushioning the risks of such investments through international development banks or the World Bank could go some way to achieving this. The Bridgetown Agenda of the Prime Minister of Barbados would be an example.

None of these options may be convincing, but until better ones are found, they should be pursued in parallel. Otherwise, the only option left is to abandon the idea of meeting the 1.5 °C target, accepting the ethically unacceptable risk of ending up in a hothouse earth state. But nobody can seriously want that. In Greta Thunberg's words: It is a matter of making the necessary possible!

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