Limits to the Anthropocene: geopolitical conflict or cooperative governance?

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In the Anthropocene the world is facing an acceleration of human growth and its impact on nature. The expansionist world order which emerged from Europe since colonial times is reaching multiple limits (environmental, economic, social, political and scientific-technical), increasing marginal costs and risks which trigger multiple crises, conflicts and catastrophes that challenge this world order. Alternative futures range from a collapse of human civilization to geopolitical power competition and conflict between rivals to disruptive technical innovations and systemic transformation of the economy and society within natural boundaries. In response to geopolitical conflicts and their consequences, such as climate change and the Russia-Ukraine war, efforts of cooperative governance can help to mitigate, adapt to and manage complex crisis landscapes. Instead of an epochal turn (*Zeitenwende*) for arms race and war, more promising are sustainable climate protection and a peaceful energy transition within planetary boundaries. To further prevent escalating and mutually enforcing crisis dynamics and geopolitical conflicts in the Anthropocene, cooperative governance needs to adjust to the world's complexity and move from a negative nexus of problems to a positive nexus of solutions. The interaction between geopolitics and governance and the transition from risk cascades to synergies is discussed for the energy-security nexus and the climate-conflict-migration nexus. Energy conflicts can be contained by diminishing land competition and biodiversity loss, as well as risky dependencies on strategic raw materials and conflict minerals. Measures for a sustainable energy transition include energy efficiency and conservation, renewable energy and decarbonization, a circular economy and nature-based solutions. To prevent risk multiplication in the climate-conflict-migration nexus, synergies in climate, migration and security policy facilitate integrative solutions for a socio-ecological transformation based on mitigation and adaptation, conflict resolution and environmental peacebuilding, aiming for a mutual enforcement of sustainability and peace.

KEYWORDS

limits to the Anthropocene, geopolitical conflict, cooperative governance, energy security, climate-conflict-migration nexus, Russia-Ukraine war, risk cascade, sustainable peace

1. Introduction

In this review article, I explore how the ongoing, seemingly unstoppable, expansionist growth and development model is reaching several limits leading to multiple crises and geopolitical conflicts, and how their possible escalating interactions could be contained by cooperative governance. Within this framework, the interplay between geopolitics and governance is exemplified by two relevant cases: (1) the energy-security nexus; and (2) the climate-conflict-migration nexus.

Since the agricultural and industrial revolutions, humanity has shaped the face of the Earth to such an extent that today's geological age has been called "Anthropocene" (Crutzen and Stoermer, 2000). We are experiencing a "Great Acceleration" (Eriksen, 2016; McNeill and Engelke, 2016) of the expansive development model emanating from European colonial powers based on the exploitation of human and natural resources which is reaching planetary boundaries. These include not only ecological limits to growth, but also economic, social, political and scientific-technical limits which result in growing marginal costs and risks for the current world order, leading to resistance and instability, multiple crises, catastrophes and conflicts (Scheffran, 2022a, 2023). The challenge is to sustainably embed human development into an ever-more "full world" of the Anthropocene within the natural environment (von Weizsäcker and Wijkman, 2018; Dixson-Declève et al., 2022).

The year 2022 marked the 50th anniversary of the 1972 report to the Club of Rome, "The Limits to Growth," which used simple computer models to simulate the future consequences of humanity's growth. In some scenarios, there was a collapse of natural resources, the world economy and the world population; in others, this could be avoided by limiting growth and finding solutions for environmental protection and more efficient use of resources (Meadows et al., 1972).

Fifteen years later, in 1987 the World Commission on Environment and Development (WCED) defined principles of sustainable development. After the end of the Cold War many hoped for a peace dividend that would also benefit environmental protection. At the Rio Conference on Environment and Development in June 1992, agreements were reached to protect the planet's climate and biodiversity, combat desertification, and present guidelines for sustainable development in the Agenda 21. At that time, the issues of war and peace were not included as expected by the UN Department for Disarmament Affairs, which had prepared a report for Rio on the reallocation of military resources for environmental protection (UN, 1991; Scheffran, 1992). Nevertheless, a series of conferences on conversion of the military was set in motion in Dortmund, Moscow and Hong Kong.

How growth limits might look like was not yet foreseeable in 1972; neither climate change nor violent conflicts appeared in the models. For both, the year 2022 provided illustrative examples. In spring 2022, the Intergovernmental Panel on Climate Change (IPCC) with the second and third parts of its sixth assessment report showed how dramatic the consequences of climate change can become and what can be done about it. The report left no doubt about the consequences of uncontrolled heating of our planet: "Climate change impacts and risks are becoming increasingly complex and more difficult to manage. Multiple climate hazards will occur simultaneously, and multiple climatic and non-climatic risks will interact, resulting in compounding overall risk and risks cascading across sectors and regions. Some responses to climate change result in new impacts and risks (*high confidence*)." (IPCC, 2022a).

In this dire situation for the future of planet earth, on February 24, 2022 the world was confronted with a violent geopolitical conflict involving major powers, shifting the coordinates of the international system toward open confrontation. Russia's attack on Ukraine attracted enormous resources and political attention that since then were unavailable for cooperative solutions to climate change and other global problems within the planetary boundaries. The presentation of the IPCC report was almost drowned out by the sounds of war, pushing aside the movement to prevent the climate emergency and humanity's other existential threats. Since then the world is facing competing choices between geopolitical conflict and cooperative governance.

This war had significant impacts on European politics, in particular the German red-green-liberal government, which started 2021 with the primary goal of climate policy and then was subjected to the primacy of war. On February 27, Chancellor Olaf Scholz switched into crisis mode and in his speech to the Federal Parliament declared his response to the "*Zeitenwende*" (epochal turn) induced by Russia's attack, providing 100 billion Euros in special funds for the German Armed Forces (Scholz, 2023).

Alternative futures range from a collapse of human civilization and system-immanent solutions to technical innovations and a deep transformation of the economy and society within the framework of nature. Multiple crises, from armed conflicts and economic challenges to climate change and the COVID-19 pandemic, as well as the reactive crisis mode of politics, undermine the foundations for preventive problem-avoidance, guiding expansive human development into regulated channels. The available environmental space of natural resources available to a country without threatening sustainability should guarantee a decent life for all inhabitants in the common house of planet earth in the long run (Spangenberg, 2002). Sustainable development integrates multiple strategies, an efficient and fair use of natural resources, as well as adaptation of human needs and coexistence in balance with natural cycles (UNGA, 2015; IGS, 2019). To implement the sustainability goals, a major challenge is to prevent conflicts related to environmental change from violent escalation that destroys the conditions for cooperation, and to manage them constructively and peacefully (Scheffran, 2020a).

Asking for explanations of global challenges and governance approaches to contain them, this article follows the hypothesis that globalized expansionism in the Anthropocene is reaching multiple limits and crises that challenge the current world order and induce systemic transitions toward new competing orders which require cooperative governance to contain geopolitical conflicts. The aim is to move from a nexus of problems, including violence and destruction, to a nexus of solutions, based on cooperation and environmental peacebuilding. To discuss the interplay between geopolitical conflict and cooperative governance in the social-ecological transformation, two case studies are used, the energy-security nexus and the climate-conflict-migration nexus, both linking natural science system levels and social science actor levels to move from negative risk cascades to positive synergies between sustainable development and peacebuilding.[1]

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1 The following selective review and synopsis is partly based on three decades of research by the author on environment and security in the framework of limits to the Anthropocene, partly written in German language. The aim is to provide new insights through synergistic knowledge integration, merging historic developments and most recent events. A conference on "Limits to the Anthropocene" was conducted in 2011 at Hamburg University, with Paul Crutzen as speaker. See: https://www.clisec.uni-hamburg.de/research/conferences/limits-anthropocene.html.

2. Expansion and division since colonial times

The past centuries were significantly determined by the colonial expansion, with consequences until recent times. After the voyages of Columbus, poverty, hunger, persecution and war drove millions of people from the crowded European continent to the promised "New Worlds." Here natural and human resources were heavily exploited by conquistadors and settlers, with millions of slaves from Africa, genocides among indigenous peoples and the destruction of traditional livelihoods, the spread of invasive species and deadly diseases (Reinhard, 2016), for instance killing in North America about 90% of the indigenous population (Koch et al., 2019). Technical progress, military superiority and religious justification facilitated the appropriation of foreign wealth and comparative advantages to European economic development, consolidating Western dominance on a global scale. Following the global empires of Spain and Portugal, then the Netherlands and France, Great Britain extended its lead and established a world empire based on the Industrial Revolution since the 18th century and domestic coal, fuelling long-distance transportation and mechanized mass production in the capitalist economy (Menzel, 2015). The colonial powers shaped the economic base in their periphery to become suppliers of raw materials to the center. This structure was inherited by the new politically independent states, and the deeply ingrained economic dependency continued.

In the 19th and 20th century great power competition Germany found itself disadvantaged in the acquisition of colonies and tried in vain to shift the geopolitical power games to its favor by military force in two world wars. The Russian Revolution (1917) established the Soviet Union, which unified large parts of the Eurasian continent, providing a powerful counterweight to the Western world. After World War II, the United States was able to expand its hegemonic power (through the Atlantic Charter, Bretton Woods system and NATO). In the East-West conflict, the ideological competition between capitalism and communism spurred the nuclear arms race and the near extinction of humanity through nuclear war.

Colonialism continues to have an effect until today, dividing the world into a more wealthy Northern hemisphere and the Southern hemisphere with low levels of human development and democracy, social inequality and fragility (Scheffran, 2023). Although many countries of the Global South have been disadvantaged by foreign exploitations and invasions, they are often blamed for their own weaknesses. Perceptions of injustice are relevant until today, as well as the demand for economic growth in the global South, anti-colonial attitudes and the quest for a decolonial turn.

While the prosperity of industrialized nations has often been built upon the exploitation of less-developed regions, it is crucial to acknowledge the complex historical, political, and economic factors on both sides which preclude simplistic distinctions between "good" and "evil." Governments in developing countries cannot easily escape realist power competition and have made strategic choices, like deregulation to attract foreign investments, which contributed to dependence, debt and resource extraction under inequitable conditions. Workers in these regions frequently face low w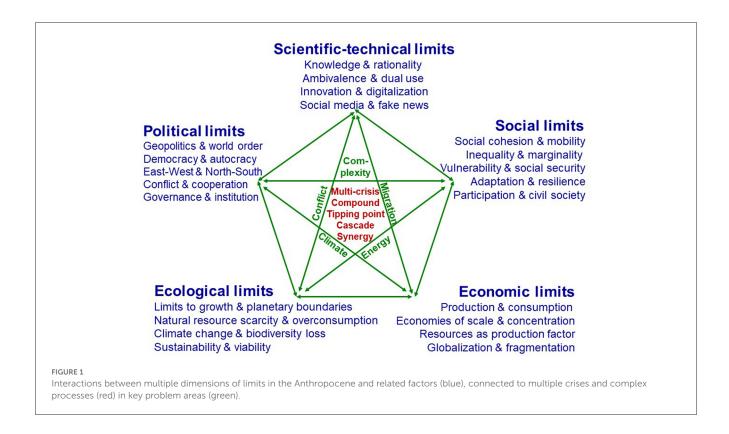ages and hazardous working conditions, and the areas bear a disproportionate burden of environmental degradation and climate change impacts. These countries consistently score poorly on environmental performance indexes for various reasons which endangers their own people and the world. To address these disparities and promote shared responsibility and cooperation, it is important to strive for a more equitable and sustainable global future.

3. Multiple limits and crises in the Anthropocene

Although it appears logical that unlimited expansion cannot go on forever, the question is how far it will continue, where and when limits might occur and what the consequences are when limits are reached. When expansion of a system is constrained or facing a countering process, in the resulting period of crisis the system is reshaping and transforming. This question is not hypothetical in a world reaching multiple limits (environmental, economic, social, political and scientific-technical) and facing multiple crises, conflicts and catastrophes (see Figure 1 and further Scheffran, 2021, 2023), leading to an "Anthropocene crisis" (Valladares et al., 2019; Simon, 2020; Collste et al., 2021; Kennel, 2021; Kim and Kotze, 2021; Kish and Quilley, 2021; Li et al., 2021; Bouchard, 2022).

3.1. Ecological limits

In the course of history, the human population has been growing exponentially by increasing birth rates and lowering mortality rates, leading to the expansion of the human sphere in terms of capital, investments, income, technology, energy and resource flows, political power and violent forces. Two centuries ago Malthusian concerns emerged about an increasing discrepancy between exponentially growing population and linearly increasing food production, potentially leading to resource scarcity and pollution, mass famines, diseases and other catastrophes. Political economists like James Anderson and Karl Marx remained skeptical of simple population theories that justify abstention and poverty. Since then humanity apparently was able to overcome resource constraints and expand into new spaces through problem-solving capabilities, technical and social innovations that generated higher productivity and more wealth on a shrinking natural resource base. In addition, millions emigrated from European countries and exploited the resources in other parts of the world; with growing prosperity birth rates are shrinking in the demographic transition. Despite an eight-fold increase in the world population since 1800 food production was largely able to keep pace, while catastrophes limiting population growth have not yet occurred at the magnitude expected, although many disasters haunted humanity, including the two world wars and the violent struggles for natural resources such as land and fossil energy. Continued pressure on natural resources and ecosystems raises the question when the carrying capacity is reached and whether a sustainable balance between nature and society will be established by limiting the impacts or the causes of growth (Amoiradis and Stankova, 2020).

FIGURE 1
Interactions between multiple dimensions of limits in the Anthropocene and related factors (blue), connected to multiple crises and complex processes (red) in key problem areas (green).

The report to the Club of Rome on "The Limits to Growth" (Meadows et al., 1972) projected the potential for collapse of human civilization and the opportunities to prevent it by resource efficiency, environmental protection and growth limits. So far global development is pretty much in line with the scenario of doubling resources available as compared to 1970. Further development depends on the interaction of socio-economic drivers and political power structures in response to environmental change. From the perspective of political ecology, a key challenge is to prevent the failure of ecosystems to sustain increased economic activities and to illustrate the necessary concept of sustainable development. The task is to adapt and integrate human footprints within viable tolerance limits for different resource types into nature's material and energy flows, including water, forests, soils and arable land, waste and pollutant emissions, species loss, ocean protection and exploitation of raw materials (UNEP, 2019).

Due to accelerating globalization and growing human footprints, nine planetary boundaries have been identified, in the dimensions of climate change, stratospheric ozone depletion, atmospheric aerosol loading, biogeochemical cycles, land-use change, biosphere integrity, introduction of novel substances, freshwater consumption and ocean acidification (Rockström et al., 2009; Steffen et al., 2018). Within these boundaries a "safe operating space" must be guaranteed to maintain security, resilience and sustainability (regarding transgression of boundaries for novel entities see Persson et al., 2022). Certain thresholds and tipping points must not be violated, as they would trigger abrupt and irreversible changes leading to "tipping cascades" that endanger global stability (e.g., Lenton et al., 2008; Milkoreit et al., 2018; Franzke et al., 2022). Due to uncertainties in complex systems, however, thresholds cannot be determined precisely. To increase

time for action, safety margins must be maintained which however are hard to define and protect if humanity pursues exploitation pathways running into them which requires to design safety margins as repellents, resulting in efforts to stay as far as possible away from them. When more and more boundaries are reached, the growing impacts become more imminent, first for the most vulnerable. What is to come has been outlined for climate change in the IPCC (2022b) AR6-WG2 report and for biodiversity loss in the assessment report of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES, 2019). Neither of the problems can be solved without solving the other. It is not enough to deal with the symptoms without tackling the roots of the crisis, resource overconsumption as a common denominator for both problems and as a precondition to find solutions (IRP, 2019).

3.2. Economic limits

In neoclassical economic theory, nature plays only a subordinate role; natural resources, which are essential for the functioning of the economy, are treated as being sufficiently available and not contributing as a production factor to the creation of wealth. The capitalist economy is based on growth and seeks to conquer new and often global markets with new products. To this end, feedbacks promote growth and power: Consumers with higher incomes have more influence to secure their advantage; companies with high profits have more resources to invest in new ways of production. The accumulation of capital corresponds to the principles of exponential growth and the concentration of power, which is based on wealth and ownership of the means of

production. Accordingly, in these concentration processes the strongest have the best chances to acquire capital and power which can be used to influence political decisions.

Globalization contributes to the unequal distribution of wealth and power (Conversi, 2010), exacerbating the tension between rich and poor and the unsustainable exploitation of nature (Klein, 2007; Sachs, 2020). Falling costs and wages and the technical substitution of labor exclude large parts of the world's population from prosperity and drive regions into marginality. Lack of capital, debt and competitive pressures block development in many countries of the Global South, and the interconnected financial system renders political control and governance mechanisms ineffective. Huge investments and money flows in digital worlds are decoupled from material production or the needs of the population—as demonstrated by the financial and banking crisis of 2008, with its knock-on effects in the Greek crisis or the price fluctuations in the run-up to the Arab Spring. While a deeper, more prolonged global recession has then been averted by coordinated stimulus measures, the recovery was fragile and uneven (DESA, 2011). The sequence of crises events in the last decade (war and terrorism in the Middle East and North Africa, refugee crisis, Brexit, Trump election, pandemic, Russia-Ukraine war, energy and food crisis) also had economic consequences. These crises can be seen as indications that limits of economic expansion are being reached and contractions are in effect that induce mechanisms of de-globalization and degrowth (Kallis et al., 2018). The latest Club of Rome study concludes that without additional measures the expansion of the world population will end before the midst of the century, followed by a rapid decline of population as well as wealth (Dixson-Declève et al., 2022). An end of quantitative economic growth and a transition to degrowth will force the entire financial, economic, political and social system to undergo radical change of the economy and reorganization of the flow and usage of resources. Qualitative social development and wellbeing replace gross domestic product as an indicator of prosperity and innovation (Kallis et al., 2018; Murphy, 2022).

3.3. Social limits

The social market economy has brought prosperity to many people, but others do not benefit from the fruits of wealth, are unemployed and excluded, fall through the social security net. As global flows of goods, capital, finance, technology and communications accelerate, social and political systems are falling apart, while social and political rules that could contain the worst are under pressure. The exploitation of human labor divides society into a few winners who accumulate wealth and power, and many losers who are driven into marginalization and poverty. Privatization of social sectors causes a redistribution from the public to the private sector, in favor of high-profit top jobs and investors (von Weizsäcker et al., 2005). While privileged classes with high incomes have greater influence and opportunities, the development prospects of poor classes are limited and exposed to precarious conditions and social problems: hunger, poverty and discrimination, lack of resources and environmental destruction, diseases and epidemics, repression and violence, social exclusions

and inequality, uprooting and forced displacement. Several of these factors culminated in the "refugee crisis" of 2015 when hundreds of thousands of refugees moved to Central Europe via the Mediterranean Sea or the Balkan route. Societal disorder, fragmentation and loss of control weaken the stability of social structures that secure livelihoods and social cohesion, freedom and human rights, shifting the limits to growth to the periphery of society which is particular vulnerable to crises (Dany and Dijkzeul, 2022). Dissatisfied people and victims can be mobilized by illiberal, religious, nationalist, right-wing populist movements, parties and autocratic governments. Fears of globalization trigger counter-movements, against capitalism or immigration which are not controlled by democratic structures, creating a breeding ground for discontent and radicalism, multiplied through social media linking local and global networks of discord and violence.

The 2008 financial crisis was followed by a social crisis, such as food and fuel price hikes, contracting global output and economic slowdown that reduced social spending in developing and developed countries; tens of millions more people fell into, or were trapped in, extreme poverty and hunger (DESA, 2011). The multi-crisis world also has severe implications for health and care, and hence the resilience of societies and political systems, connecting human health and planetary health (see Spicer et al., 2020 and the various Lancet health commissions, in particular Lancet, 2022). The COVID-19 pandemic posed a tremendous social crisis, due to the uneven distribution of goods and burdens, opportunities and resources, leading to disadvantage and marginalization, inequality and injustice from both the crisis itself and some of the policy reactions to it, such as the stay-at-home orders and economic lockdowns (Haase, 2020). Public health crises like the COVID-19 pandemic test the robustness of institutions and show the fragility of government capacities to protect their citizens, people express their frustrations, and social movements call for policy and system change (King and Carberry, 2020).

The double shock of the COVID-19 pandemic and the Russian invasion of Ukraine show how the complexity of overlapping crises can multiply the impact of each crisis, including rising levels of inequality and exclusion. For instance, surging inflation rates, which began in 2021, as well as the food and energy crises set off largely by the war in Ukraine, have precipitated and worsened the debt crisis in many lower income countries. Combined with the existential threat of climate change, a storm of events has been set in motion, including social unrest and political instability in parts of the world. A world in multiple crises has become a backdrop for solving the world problems, but may also trigger new movements to counter this trend (Menon, 2023).

3.4. Political limits

Since the end of the Cold War and in the transition from a bipolar East-West conflict via a unipolar to a multipolar world, complex and destabilizing crisis dynamics have evolved, triggering chain reactions, tipping points and cascading events across political scales (Scheffran, 2008, 2016). Financial crises also affect political instability, not only because citizens blame governments for their loss and oppose bailout decisions (Vaugirard, 2007), but because of

multiplier effects disrupting the fabric of the globalized economy and its wealth production. Globalization out of control and its structural violence put pressure on states, create geopolitical power struggles, violent conflicts and terrorism, and provoke people to move, resist and protest. This was demonstrated by the disintegration conflicts in the Balkans and the former Soviet Union in the 1990s, the wars in Iraq and Afghanistan in the wake of September 11, 2001, as well as the conflict landscapes of the 2010s (Arab Spring, Syria, Ukraine), involving nationalist and autocratic governments. Nationalism is one response to globalization and crisis threatening the nation-state, which is supposed to protect against chaos in the world, although nationalist rivalry turns the globe into a battlefield (Scheffran and Schürmann, 2020). Between the "hammer of globalization and the anvil of nationalism" (Conversi, 2014), international and transnational violence are linked to intra-societal dynamics of violence, including religious and right-wing populist movements against equality and tolerance, radical activism against exploitation and injustice, differences between "modern" urban populations and "traditional" rural populations. Here energy and food crises, climate change and natural disasters combine with war, refugees and political instability. Fractures of tension run through the Mediterranean region and the Arctic, resource-rich areas of Africa and drug-growing areas of Afghanistan and Central America, rain forests and ecologically degraded zones, the slum areas of megacities.

While after 2011 the number of terrorist attacks and their victims increased significantly (mainly due to Islamist terrorism), these numbers decreased recently (Friedensgutachten, 2020). Parallel to nationalism, right-wing extremism has increased in Western democracies, operating through social media with conspiracy theories and hostility to science. Initially decreasing after 1990, the number of armed conflicts rose again in recent years, especially in the Middle East and North Africa. In Libya, Syria and Yemen, global or regional powers such as the U.S., Russia, Iran or Saudi Arabia intervened without managing the conflicts. Great power rivalries determine world affairs and weaken international norms and institutions. In a multipolar world, Western expansionism is facing limits by other major powers, above all China, Russia and India, the Islamic world as well other countries in the Global South which comprise more than three quarters of the world population (on the crisis of the Western liberal order see Jacques, 2009; Morris, 2010; Ferguson, 2012, 2013; Brown, 2019).

3.5. Scientific and technical limits

Science and technology by design seek to move beyond the limits of knowledge and the boundaries of human capacity but at the same time create new ones. They support and expand, but also replace the abilities of the human body, notably hands and feet, sensors and brain, helping to reach out beyond daily experience into remote worlds, expanding knowledge and power or constraining them. They play an ambivalent role as they can create opportunities for both exacerbating and solving problems, change the world constructively and destructively, accelerate and decelerate growth, impinge on ecosystems and their life-support

or address limits and scarcity of resources. They can ease the hardships of human existence and offer solutions for a sustainable relationship between nature and society so that more people can live on earth, but they also enable more effective means of violence and resource exploitation. The more humanity relies on the scientific-technical civilization and the *technosphere*, the greater the temptation is to resort to technical innovations and interventions, which in turn may bring new problems (Ribeiro Mendes, 2021), as raised in critical discourses on genetic engineering, geo-engineering or artificial intelligence. Attempts to control technology by separating beneficial from harmful uses is complicated by the ambivalence of science and the dual-use of technology, notably between civil and military applications (Altmann et al., 1998; Forstner and Neuneck, 2018).

Advanced weapons systems allow the quest for military superiority and force projections across the globe and in space (Scheffran, 2015) but only for those being first until others follow. Different technology fields are merging, including transportation, information, and communication systems as well as micro-, nano-, and bio-technologies, the confluence of globalization and miniaturization of violence, and the linking of information warfare on our home computers through global networks. Interconnected are the automated battlefields of air, water, ground, space and cyberspace. In a complex world with multiple interfaces of human-computer interaction fact and fiction are hard to separate and verify (Redlawsk et al., 2022). In the post-factual age of *fake news* and *hate speech,* multiplied by social media and the internet (Baldauf et al., 2019), science itself is coming under pressure, society is controlled and democracy is at stake (Ibid.). Respecting the limits of bounded rationality, "science for the post-normal age" (Funtowicz and Ravetz, 1993) concerns urgent decisions with high stakes, uncertain facts and disputed values in scientific fields like technology and risk assessment in climate and environmental research, addressing complexity, uncertainty, interdisciplinarity and transdisciplinarity in knowledge production beyond academic disciplines (Lüthje et al., 2011).

4. World order under pressure: loss of control and geopolitical conflict

4.1. Global power shifts

The more the expansive growth model encounters limits, the more evident are marginal costs and risks in a world facing intertwined multiple crises, conflicts and catastrophes that appear as wicked problems (Rittel and Webber, 1973; Scheffran, 2008; Schröder, 2022) which reinforce the erosion of the rule-based international order and loss of control by the Western hegemony (Taylor, 2020). At the end of the Cold War, the U.S. was considered the unchallenged superpower, NATO the dominant military alliance, the Western world and Europe in particular a model of success, and neo-liberal globalization without viable alternatives. Three decades later, they are all in crisis. The world of 1990 has given way to a confusing situation in complex crisis landscapes, where fractures of globalization and systemic turbulence (Brzoska et al., 2019) undermined multilateral institutions. One explanation is that we are experiencing a world in transition, an interim period

in which the old order is challenged by existential problems that can no longer be solved within its framework before a new order is found (Schröder, 2022).[2] Possible options include global power shifts and geopolitical conflicts, especially between China and the United States, or multipolar power constellations with multiple competing orders where the liberal order could persist with limited scope (Flockhart, 2016). Whether the limits to the Anthropocene are largely limits to the expansion of the Western world order or limits to humanity as a whole, depends on the pathways pursued and their impacts on the planet. New solution paths are required without inadmissibly reducing the complexity of the world.

4.2. Geopolitics in the Anthropocene

As the term "*Zeitenwende*" suggests, the on-going developments have the potential for an epochal turn, similar to the French Revolution at the beginning of the 19th century or the beginning of the 20th century. In some regards the sequence of events is reminiscent to the destabilization of the world order a hundred years ago, with World War I, the Spanish flu, the world economic crisis and fascism, which led to World War II. Added to this today are the environmental and climate crises. Long-term trends can densify and intensify in interconnected tipping points and chains to extreme events: Economic crash, climate collapse, pandemics, or nuclear war (Scheffran, 2016, 2023). Spangenberg and Kurz (2023) note: "The perfect storm of converging political, security, environmental and social crises enforces an epochal turn."

Like last century, one response to the crisis is the revival of geopolitics to pursue national interests and regain control in a world of limits and crises (Ioannides, 2022). In contrast to political geography, studying the effect of geography on politics, geopolitics projects political actions in and through geographical spaces. Spatial borders allow for the inclusion of the "own" by exclusion of the "other," aiming to control both. In this regard, geopolitics has historically been used to justify imperial claims over distant territories.

The instrumentalization of geography in the framework of geopolitics has long evoked negative associations in Germany. While the geographer Friedrich Ratzel did not refer to geopolitics in his 1897 work "Political Geography," Karl Haushofer used geopolitical thinking to justify expansion of Nazi Germany's "Lebensraum" (living space) to the East (Herwig, 1999). After World War II, geopolitical ambitions in Germany were discredited by the lost war and regained significance after unification in 1990, now in a European framing. A growing geopolitical role for Europe was envisioned by some leaders, but remains controversial. In the Anglo-Saxon world, geopolitical traditions from Mackinder to Brzezinski, Huntington and Kaplan are continued (Huntington, 1996; Kaplan, 2009), seeing the results of the two world wars and

the Cold War from a winner's perspective. Former U.S. national security adviser Brzezinski (1997) declared the Eurasian continent a chessboard for Western power projections.

With the declining relevance of national borders in a globalized world, the geopolitics of spaces became less important than the geo-economics of markets. When globalized economies triggered social and political crises in fragmented spaces, the nation state celebrated its revival in response. While geographic distances are shrinking through transportation and communication technologies, political distances and fault lines remain. Geopolitics has always been linked to the exploitation of natural resources which in the Anthropocene are in growing demand, especially through investments in land across national borders. With global heating and renewable energy, territoriality is becoming a new target in geopolitics (Burles, 2021). Climate change is creating new high-risk zones (hot spots) on world maps of vulnerability. As renewable energy unfolds as part of a green economy, suitable places with high solar radiation and biomass productivity, strong flows of water, wind, geothermal, tidal, and ocean currents as well as related strategic materials become more valuable. Energy landscapes integrate natural and societal interactions in complex geopolitical frames for control, resistance and conflict, connecting local and global levels (Link et al., 2018). As natural limits to growth are reached, efforts to control and stretch these limits also grow, e.g., the concept of geoengineering to keep the climate system within acceptable boundaries (Maas and Scheffran, 2012; Lawrence et al., 2018; Oomen, 2019).

The mindset of geopolitics has also been spreading in technically constructed spaces. New terrain is claimed not only in distant regions of the world or in outer space, but also in cyberspace, in the biological microcosm or in the nanoworld (Al-Rodhan, 2015; Ruhl et al., 2020). While distances are compressed in mapping the micro-world of genomes and brains, satellites and geographic information systems extend the macro view in connecting all areas globally. With the networked worlds of social media and their two-way windows between internal and external worlds, potentially all connected human beings can be located, accessed and controlled (Zuboff, 2019).

Combining spatial and social network analysis has become a field of research in the systematic study of interstate conflicts, considering relational theories of power through a combination of territorial and network embeddedness. World War I is an empirical example to illustrate how alliance formation between friendly and hostile states can explain the cataclysmic diffusion of conflict within physical and network spaces. Rather than simple contiguity, territorial embeddedness and network density are conceived as components of political relations in interstate rivalries and disputes (Flint et al., 2009; Vasquez et al., 2011). Emerging from the tumultuous 20th century were numerous institutions and organizations, including the United Nations, serving as social and political antibodies to such problems. Their effectiveness is seriously challenged in today's multiple crises (see Posocco and Watson, 2023).

Critical approaches to geopolitics doubt that human behavior is determined by geographical factors and criticize that borders are used for political discrimination, for example against female, ethnic, religious or migrant groups. From a feminist and racial perspective, geopolitics serves to enforce patriarchal structures and

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2   In his famous statement in the Prison Notebooks nearly hundred years ago, Antonio Gramsci spoke of an interregnum: "The crisis consists precisely in the fact that the old is dying and the new cannot be born; in this interregnum a great variety of morbid symptoms appear" (English translation cited in: Hoare and Nowell-Smith, 1971). See also Babic (2020).

white supremacy (Tilley, 2014). In local contexts, participatory approaches and resistance can create free spaces. Where alternative forms of "Anthropocene Geopolitics" (Dalby, 2020) are evolving, remains to be seen. By developing interfaces with other disciplines, geography opens the possibility of their integrative fusion. This would be a different "revenge of geography" than Kaplan (2009) has expected in his work.

4.3. Revival of old geopolitics

In current crisis landscapes, there is a revival of old-fashioned geopolitical strategies of confrontation, militarization, arms race, violence, hot and cold war. Global military spending reached record levels, already before the Ukraine war, and even more in 2022 with USD 2240 billion (SIPRI, 2023). Other crisis indicators also increased substantially in recent years, such as violent conflict and forced displacement. The nuclear arms race has become less regulated following the rejections or non-ratification of arms control agreements (ABM, INF, Open Skies, CTBT, START). While commercialization, militarization and weaponization of outer space proceed among more countries, attempts to enforce arms control in space failed (Meyer, 2020). Militarization also extends to cyberspace and hybrid warfare, attacks through drones, the Internet, civilian infrastructures and social media, where the lines between war and peace are blurred.

From a European perspective, geopolitical challenges emerged in all geographic directions: through Russian threats and power games in the East, US nationalism and hegemony in the West, the destabilization of the Mediterranean region in the South, and climatic change, resource struggles and power rivalries in the Arctic North. Combining economic capitalism and state socialism, China is trying to reshape the international order and expand its global political influence, with economic growth, free trade, advanced technologies, coalition formation, military buildup and the "New Silk Road" connecting infrastructures on land and sea, from East Asia to Europe and Africa. The U.S. is struggling to maintain its leadership role, imposing trade restrictions and forging alliances in the Indo-Pacific region which is becoming highly armed like the transatlantic; some Western narratives project a new Cold War with Russia and China or even a World War (Brands and Gaddis, 2021; MacGregor, 2021) while a new block confrontation is rejected elsewhere. In addition, there is the climate crisis and other environmental changes that combine as crisis multiplier.

4.4. National borders and planetary boundaries: geopolitics in the Russia-Ukraine war

Old and new geopolitical framings interfere in complex ways in Russia's attack on Ukraine. In further shifting the coordinates of world politics toward confrontation, at first glance it seems to resemble 20th century territorial conceptions of geopolitics, like territorial claims, control of national borders, artillery and tank warfare, etc. On the other hand, this war is a burning glass of new geopolitical framings of emerging security issues, such as

cyber and hybrid war, drone and space warfare, anti-globalization and energy transition, environmental and climate change. At the intersection of old and new geopolitics is the nation state (Conversi and Posocco, 2022), as a promoter of territorial expansionism and fossil capitalism benefitting from a warming Arctic on the one hand, and as a defender against globalized expansionism and renewable low-carbon energy transition in Western countries. In its present forms the nation-state is inadequate to handle the global commons and interconnected crises, and nationalism is a major obstacle to effective and coordinated global mitigation strategies against climate change and other crises which "cannot be tackled without combining a diversified set of policies at every level of government and governance" (Conversi and Posocco, 2022).

An additional dividing line is the propagated ideological "battle between democracy and autocracy" which seems to find its geopolitical representation in the Russian-Ukrainian border between the transatlantic Western world and the Eastern Eurasian land mass. Such a rift is constructing and justifying a new Cold War narrative with proxy wars (Scheffran, 2000). This war looks already like a worst-case scenario: destroyed cities with numerous dead and wounded people, millions of refugees, accusations of genocide, attacks on nuclear facilities, spirals of escalation on the threshold of world or nuclear war, economic warfare, volatile food and energy prices as well as increased military spending. It distracts attention and resources away from future challenges to planetary security and constrains the most important resource for solving the environmental and social crises, as well as the willingness to cooperate. The war acts as a crisis multiplier, pouring oil into a world on fire, with unforeseeable tipping points and cascading events, similar to the First World War, reviving realist thinking to explain the Ukraine war as a fault of the Western liberal order and prevent escalation to avoid another World War (Mearsheimer, 2014; Kissinger, 2022). We are witnessing a world in upheaval, deciding whether the old system of fossil capitalism will plunge the world into catastrophe or whether smarter alternatives will prevail. This also depends on three megatrends of future development: the sustainable transformation of fossil capitalism; power shifts in North-South relationships; and the influence of civil society and social networks between democracy and autocracy (Scheffran, 2023).

The above mentioned transformations are impeded by enormous challenges and barriers, such as the effective resistance from fossil fuel industries in line with political forces interested in keeping the status quo, the financial and technological hurdles in scaling up renewable energy infrastructure, or the geopolitical complexities that could arise from shifting dependencies on strategic raw materials and conflict minerals. A small but growing body of literature (including a number of studies in this special issue) are tackling the potential positive role of "green nationalism" (Conversi, 2020, 2021a) that supports national sustainability and is characterized by policies that safeguard the environment and ecosystems. "Exemplary communities" have made a sustainable living possible, at a small, local scale (Levene and Conversi, 2014; Conversi, 2021b) as well as the regional or national level (Posocco and Watson, 2023). Referring to Beck (2004) and reflecting on the limitations of the nation, "*survival cosmopolitanism*" has been suggested that aims for a cooperative, inclusive, coordinated, and solidaristic global order (Conversi, 2020).

5. Mechanisms for cooperative governance

To prevent multiple crises from becoming "normal disasters," experience with complex systems can be used to avoid exponential growth, chain reactions and tipping points, slow down processes and decouple them from risk amplifiers, and protect system-relevant infrastructures. It is possible to learn from one crisis for another. For instance, the experience of the COVID-19 pandemic is also relevant for the climate crisis, which is changing the planet over a longer time horizon. There are many connections between the epidemics and climatic conditions, or between the means to combat viruses and climate-relevant emissions. Whereas, in the climate crisis effective measures were refused, in the case of COVID-19, politicians displayed proactive crisis management and cooperative governance on a large scale (Lin et al., 2021). In both cases there are concerns about inter-generational solidarity, of the young with the old generation in COVID-19, and vice versa in climate change (Vinke et al., 2020). It is not only climate but biodiversity as well which is declining globally, being a breeding ground for viral diseases in a new era of pandemics under business as usual (IPBES, 2019). What can be learned from the crises for shaping the relationship between nature and society, is that hazard prevention is usually cheaper and more efficient than hazard management. There are numerous studies that have explored how the pandemic has not only been a tragedy but has also spurred positive change across various sectors of society worldwide, from education to environmental awareness (e.g., Anjankar Ashish et al., 2020; Posocco and Watson, 2023).

Contrary to geopolitical conflict, cooperative governance can help to mitigate, adapt to and manage complex crisis landscapes which requires coordination among multiple actors regarding goals, efforts and actions (Lele, 2022). Instead of perpetuating the underlying drivers, wasting resources in fighting crisis impacts, from climate change to pandemics to violent conflicts, and treating the Earth as a battleground of antagonistic interests, more reasonable is their preventive avoidance with global cooperation and common security (Olof Palme International Center, 2022). In pursuit of collective interests, governance coordinates, regulates, manages and controls interdependent social and political relations between and among actors, including coalitions, social networks and organizations of state authorities, intergovernmental and non-governmental organizations, private and other civil society actors (Morfi et al., 2021). Cooperative governance networks are essential for providing a "*bottom-up structure of local participation*, which is essential to complement the top-down imposition of a set of global regulations." (Piazza, 2021, p. 10).

Mechanisms aim to strengthen the ability to enforce decisions through rules and regulations, practices and guidelines, formal and informal institutions. To enforce cooperative efforts, policy makers can impose a punishment-reward combination for governing the commons in risky situations, for instance punishing free-riders and rewarding cooperators (Sun et al., 2021). Avoiding the effects of the climate emergency can be framed as a public goods dilemma with substantial future risk. The limited success in reaching global cooperation has been associated with a lack of

sanctioning institutions and mechanisms to deal with those who do not abide by the rules. More effective than global institutions is a bottom-up, self-organization approach of local institutions to sanction non-cooperation in a polycentric approach involving multiple institutions (Vasconcelos et al., 2013).

Effective governance can help to tip the global system into a positive direction by reinforcing and synergizing solution concepts (Scheffran, 2016). Global building blocks are the 2015 Paris Climate Agreement, the 2022 Montreal-Kunming Global Biodiversity Framework (the biodiversity pendant to the Paris agreement) and the 2017 Treaty on the Prohibition of Nuclear Weapons, through an alliance of states and civil society, with an active contribution from the Global South. Countries can make the shift away from fossil capitalism, using transnational cooperation for a carbon-neutral global economy and society with renewable energy and healthy ecosystems, connecting global goals with local actions by governments, companies, communities and NGOs. On the meso level, regional dimensions play a role, such as the relationship between energy and the climate emergency in the Arctic and Mediterranean regions. Rather than continuing the fatal triumvirate of growth, power and violence, where ecological instability can induce social instability and vice versa, it is more promising to establish positive linkages between sustainability, development and peace which strengthen adaptive capacity, resilience and viability as well sustainable peace, environmental peacebuilding and the logic of peace replacing the logic of war (Frey et al., 2014; Brauch et al., 2016; Swain and Öjendal, 2018; Hardt and Scheffran, 2019; Ide et al., 2021). UN Secretary General António Guterres complains about humanity's "war against nature" and calls for "peace with nature" (Guterres, 2021; UNEP, 2021).

To face the common global challenges in a cooperative way, it is important to put hegemonic aspirations and geopolitical conflicts aside. Like in Cold War times, peaceful coexistence can be established in a world with multiple orders, even between rivals like Europe and Russia or U.S. and China. The Global South, civil society and the agents of transformation can play a moderating role and together develop building blocks for a viable world: renewable energy for all, ecological footprint within ecological limits, clean prosperity for all, and cohabitation of nation-states within a world domestic policy (von Weizsäcker and Wijkman, 2018; Scheffran and Schürmann, 2020). To ensure the habitability of the Earth, 17 Sustainable Development Goals seek to use available environmental space sustainably to endure life for all inhabitants in the Earth's common house. This will require large-scale redistribution of wealth and consumption—likely provoking those who try to undermine sustainability. To moderate conflict, a governance lens examines six key characteristics of sustainable development: limits to growth, equity, inclusion, reflexivity, participation, and international solidarity (Baker and Quinn, 2022). In addition to an efficient and equitable use of resources, it is also about adapting human needs to and living together peacefully in balance with nature. Acting with nature is more sustainable than acting against it.

In the following the interplay between geopolitics and cooperative governance is examined for two cases, the energy-security nexus and the climate-conflict-migration nexus.

6. Geopolitics and governance of the energy-security nexus

6.1. Geopolitical conflicts in the fossil-nuclear age

Energy is essential for development and prosperity, but is also a field for security risks and conflicts. Physical forces can be transformed into political power, energy shortages are perceived as security threats. While energy and its inequitable distribution can be a source of violent conflicts, military force can facilitate or impede access to energy resources and is in turn dependent on secured energy supply. In peacetime the energy infrastructure is subject to trade and cooperation, but in times of war a means and target of combat and conflict.

Energy-related geopolitical conflicts have shaped the past century and continue to do so: coal and steam powered the 19th century, oil, natural gas and nuclear energy the 20th century, and renewable energy sources are shaping the 21st century. With the expected end of fossil capitalism, crises are going to rise. Some oil-exporting countries are pursuing the goal of becoming less dependent on oil rents and diversifying their energy supply by renewables, others are promoting carbon capturing and sequestration (CCS) as a means to continue exporting their oil and gas.

Whether the transformation from fossil to renewable and low-carbon energy sources will also change the global balance of power, remains to be seen. Geopolitical fault lines are shifting with growing energy demand, diminish fuel reserves and unequal distribution, and increase environmental damage and climate change, as well as North-South differences. Complex conflict constellations are evident in recent disputes, to mention the gas pipeline controversy between Europe and Russia, territorial conflicts in the South China Sea, between Turkey and Greece in the Eastern Mediterranean or in the Arctic with its suspected gas and oil reserves. The need for strategic materials for the energy transition is creating new dependencies and patterns for conflict and cooperation.

With rising energy prices fossil fuel countries have considerable power and profits, which are invested in socioeconomic development and energy systems, but also in military capabilities. Taking the energy transition and decarbonization seriously, they would loose revenues and geopolitical influence. Amplified by weak governance, this can lead to a power vacuum, with social unrest, right-wing populism, power struggles, and spread of violence across national borders. The collapse of the Soviet Union can serve as an example here.

Hundreds of billions of Euros in investments and subsidies created dependence on the fossil-nuclear energy complex, in particular from Russia as major oil and gas exporter. The vulnerability of the fossil-nuclear energy infrastructure is demonstrated by the Russia-Ukraine war, e.g., through attacks on the whole energy infrastructure such as power generation, gas pipelines and nuclear facilities, or as a financial instrument to fund the war machine by oil and gas revenues. The war also affected the global energy system (sanctions and collapse of energy supplies, price explosion, supply chaos and social upheaval). To reduce dependence and its consequences, several governance measures were taken, including activation of oil and gas reserves, storage facilities with liquefied gas, imports from previously sanctioned countries and postponing the nuclear phase-out (Scheffran, 2022a).

Putin's attack would have been inconceivable without access to Russia's vast oil and gas reservoirs making it the most prominent of various "fossil fuel wars," such as the Persian Gulf wars or the Saudi attack on Yemen. Since the 2000s, Russian national identity and geography have become strongly entrenched in the exploitation of fossil fuels. Adopting an extreme form of resource nationalism, the Russian elites enjoyed a free hand in capital accumulation while mobilizing their citizens under nationalist agendas as Putin redefined Russia as an "energy superpower" (Rutland, 2008).

Both the Ukraine war and the climate crisis are linked in many ways to the problems of the fossil-nuclear age, highlighting its weaknesses as much as the urgency to overcome it, but at the same time it undermines sustainable solutions by redirecting funding and resources, shifting public attention, destabilizing markets, impairing cooperation, geopolitical conflicts, and threatening nature and society through arm race and war (Scheffran, 2022a). The war dramatically highlights past mistakes and failures that have led to the current crisis. The new energy crisis is shaking the global economy. Gas and oil are being used as geopolitical weapons, coal, fracking and nuclear power are back on the agenda (Kemfert, 2023).

6.2. Governing the energy transition

To become less dependent on Russian oil and gas imports, the European Union invested in renewable energy supply and climate protection as part of a Green New Deal. The rapid rise of renewable energies is transforming the geopolitical map, in a race for technological innovation and dominance. Most countries have viable renewable energy potentials to become independent of fossil fuels, create energy security and improve their trade balance. Transformation offers strategic advantages for these countries, making them less vulnerable to supply shortages and price volatility, political instability, terrorist attacks and armed conflict. A fully renewable power supply is technically feasible if different sources are available and the variability of power generation in the grid is mitigated by an energy mix (Breyer et al., 2022). The sharp contrast between "war on oil" or "peace through the sun" (Alt, 2002) indicates that a change in energy supply may be associated with a system change that offers the opportunity for cooperation and peacebuilding.

Renewable energy sources and their infrastructures are not without conflict. They require important natural resources (land, water, food crops, minerals) whose competing uses create tensions. Environmental impacts lead to local protests and resistance against power grids, dams, bioenergy, large wind and solar plants (Scheffran and Cannaday, 2013; Scheffran, 2020c). Although the energy transition will make old geopolitical instruments less important, they will not disappear. Even if we can never "embargo the sun" (Carter, 1979), new dependencies and vulnerabilities could emerge. Solar panels, wind turbines, electric vehicles and energy storage require non-renewable minerals and metals for their production which are found in Latin America and Africa, in China, South and Southeast Asia, and on the ocean floor.

Strategies to control conflict minerals aim to improve transparency along global supply chains. Countries with rich deposits of critical materials could leverage their power, in particular China, the largest producer of rare earths. Mining and production of the materials are expensive, environmentally damaging and subject to price volatility.

Recycling and reusing critical minerals in a circular economy reduce dependence and counteract cartelization. The spread of renewable energy increases electrification and stimulates electricity trade, which promotes regional cooperation, interconnected grids and balancing between energy sources. Regulations can contain the risks. Control of the network infrastructure includes physical assets and virtual connections, as well as manipulation of power grids. An example is the cyberattack on Western Ukraine's power grid in December 2015, which left more than 230,000 people in the dark for up to 6 h. During the 2022 war, disruption of a commercial ViaSat satellite affected thousands of wind power stations in Germany (ESPI, 2022). Consequences could be minimized with "smart grids" or contained with counter-countermeasures and rules. Future energy paths are to be systematically evaluated and compared on the basis of suitable criteria. Finally, renewable energy enables cooperation between alliances of states, transnational and sub-state actors (citizens, cities and companies). Green forms of nationalism are also possible, in "exemplary" nation-states that have achieved the highest levels of sustainability (Conversi and Posocco, 2022).

The new energy diplomacy is about partnerships in sustainable energy landscapes, with connections between city and country, global networks and regional markets. To counteract the usual processes of concentration and accumulation in capitalism, systemic change is based on participatory governance and democratic control of power structures (Kohl, 2002; Walker and Johnson, 2018). Decentralized energy systems and intercontinental distribution networks can be combined, promoting cooperation between civil society, private actors and governments in North and South, acting as "prosumers" (producers and consumers) for own consumption or socializing of energy through the power grid. In such a Viable World, "Power to the People" has a new meaning (Kander et al., 2014; Stephens, 2019).

7. Geopolitics and governance of the climate emergency, conflict and migration: from negative to positive nexus

The greatest security risks and conflict potentials from fossil energy use in the long term may arise from intertwining the energy and climate crisis with militarization and armed conflict.

7.1. Climate change as a risk multiplier

If the average global temperature rises over the 1.5 degree limit above pre-industrial levels agreed in the 2015 Paris climate agreement (one of the planetary boundaries), a vast range of consequences is expected, including sea-level rise, storms, floods, droughts, forest fires and other weather extremes (IPCC, 2023). Tipping points in the climate system and impact chains might lead

to cataclysmic consequences in a "climate endgame" leading to "hot-house" earth (Steffen et al., 2018; Kemp et al., 2022). Without concerted and rapid global action, the window of opportunity for a viable future could close in the coming decades. Billions of people are at risk when the violent power of nature is unleashed in manifold ways and many regions. Then even those parts of humanity in the global North that have contributed most to emissions and are best protected would increasingly suffer the consequences of accelerated heating, directly through climatic impacts or indirectly induced through infectious diseases, economic crises, violent conflicts and refugee movements (IPCC, 2023).

In the complex chain of crises suggested earlier, global heating is connected with other problem areas through multiple linkages from local to global levels, acting as a risk multiplier which disturbs the balance between natural and social systems and amplifies the consequences through complex impact chains. Among key pathways, climate change can affect the functioning of critical infrastructures and supply networks; intensify the nexus of water, energy and food; lead to production losses, price increases and financial crises in other regions through global markets; undermine human security, social living conditions and political stability; and induce or aggravate migration movements and conflict situations (see further Scheffran, 2016). Many of these multiplier effects are related to the unsustainable resource extraction, processing and consumption which is responsible for about half of global greenhouse gas emissions and around 90% of biodiversity loss and water stress which contribute to food security (IRP, 2019).

7.2. Security risks and conflicts in the climate crisis

When ecosystems and vital resources such as water and oceans, arable land and soil, forests and biodiversity are lost worldwide, or weather extremes threaten livelihoods, human security and social stability are at stake (Scheffran, 2020b, 2022b). Climate change insecurities vary regionally and combine with other stressors. In the most affected regions the erosion of social order and state failure may trigger a spiral of poverty, hunger, persecution, corruption, crime, violence and forced displacement, particularly in the equatorial regions which due the combination of temperature and humidity will become literally uninhabitable outside of climatised buildings, potentially driving large fractions of the population away. Particularly critical is the situation in fragile regions with social fragmentation, weak governance and inadequate management capacities. Human insecurity and personal instability interact with social and political instability. The impact of environmental change could undermine the ability to solve problems and further dissolve infrastructures, such as healthcare systems, as a consequence of the collapse of the social fabric, in particular in fragile societies.

Security risks and conflict potentials of climate change undermine economic development and human security, especially for poorer countries and populations. Conflict-relevant mechanisms are the lack of water and food, weather extremes or environmentally induced migration. Storm and flood disasters, for example, cost the lives of many people or displace them to neighboring regions, which contributes to the spread of conflicts.

Although many empirical studies find a statistically significant link between climate risk and conflict risk, others see only an ambivalent or no proven link (Scheffran et al., 2012; Buhaug, 2015; Ide, 2015; Mach et al., 2019; Scartozzi, 2021; von Uexkull and Buhaug, 2021; Scheffran, 2022b). Whether climate change leads to violent conflict depends on the political and socio-economic context. Conflict factors can intensify in hotspots: Most affected are weak countries that depend on agriculture, are vulnerable to weather extremes, and have low levels of aid. Costs and risks are unfairly distributed between those who cause and those who suffer from the consequences of climate change.

7.3. Securitization, militarization and geopolitical conflict

While scientists are still discussing the conflict potential of climate change or resource scarcity, the consequences of a heating planet are considered in geopolitical and military threat analyses (e.g., White House, 2015). As the climate crisis progresses, climate policy is under pressure from securitization and militarization. Attempts to address the security risks of climate change in the UN Security Council have so far failed because of Russia, China and other G77 countries. Military institutions such as the Pentagon see climate change as a threat multiplier that endangers national and international security, complicate military operations—or make them necessary in the first place, from disaster control to conflict management to the assertion of resource interests and claims for power in a world determined by climate chaos (Klare, 2019).

This could trigger a downward spiral of climate risks and conflict risks. The Malthusian fear of climate wars can lead to counterproductive actions that exacerbate the problem. Military instruments could be used to defend against climate and conflict risks, generating fears of threat and diverting more resources, thus preventing cooperative solutions (see Scheffran, 2022b). Climate policies could also be securitized when they lead to risks and conflicts, including mitigation, adaptation and climate engineering (Scheffran and Cannaday, 2013), but in turn the security policy could be "climatized" which means that new practices from the field of climate policy are introduced into the security field, for instance, disaster management, adaptation, mitigation or sustainable development are emerging in the defense sector (Oels, 2012; Aykut and Maertens, 2023). Other examples refer to environmental and resource policies becoming a security issue, e.g., building dams in Turkey, Ethiopia and Laos raising security concerns in downstream countries.

7.4. Environmental and climate impact of warfare

Military, armament and warfare are not only dangerous for humans, but also for the natural environment. Often enough, the environment fell victim to scorched-earth warfare or was manipulated and used for warlike purposes, including ecocides (Scheffran, 2022a). Armed conflict consumes and strains natural resources (air, water, soil, land, forests and oceans), damages related infrastructures and services (energy, food, health, sanitation, waste collection), and has negative impacts on ecosystem conservation. Violence and war affect the living conditions of all lifeforms, armed conflicts threaten biodiversity and its protection, diminish wildlife abundance and species richness. Large areas of land were polluted by poison gas warfare in World War I, pollutions and devastations of World War II, and multiple environmental stresses of the Cold War, from large-scale use of herbicides such as Agent Orange in the Vietnam War to the nuclear arms race.
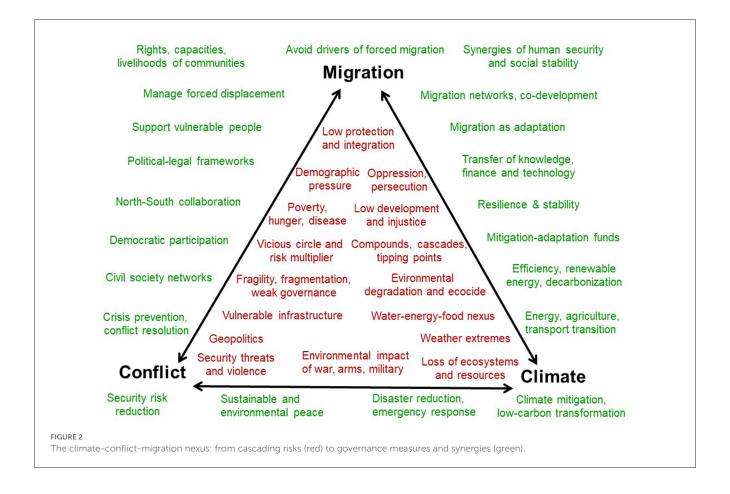
The removal of the dangerous chemical and radioactive legacies alone costs hundreds of billions of dollars until today. High military spending comes at the expense of environmental protection and sustainable resource use, preservation of biodiversity and reduction of pollutants. The 1991 Gulf War brought environmental damage from oil fires in Kuwait and oil releases in the Persian Gulf. In a more crowded world, the high resource intensity and environmental impact of armament, war, and military is an existential problem, even more with a growing resource competition between renewable energy, digitalization, armament and other uses in a resource-constrained world.

Armies are among the largest consumers of energy and other resources and release significant environmental pollutants Fuels and toxic chemicals from military activities can remain in the environment for long periods. Moreover, armed conflicts nourish themselves through the exploitation of valuable resources, from forests to raw materials. Military interventions or deployments, in turn, often serve to secure resource supplies and protect infrastructures against the impacts of climate change. Due to the high dependence on fossil fuels, military activities also cause a considerable share of emissions. The military infrastructures worldwide release large amounts of GHG emissions: "Armed forces have a massive carbon footprint that is absent from global accounting." (Rajaeifar et al., 2022) The carbon footprint of the EU military has been estimated 2019 as nearly 25 million tons CO_2e (Parkinson, 2021). In 2020 the U.S. Department of Defense accounted for more than 50 million tons CO_2e, nearly three-quarters of U.S. government emissions which is nearly 2 percent of global emissions (van Schaik et al., 2022).

The intense warfare in Ukraine poses severe risks for the environment, for example through chemical and radioactive substances, the flooding of areas, growing military spending, production, deployment, operations and destructions of infrastructure that have to be rebuilt (Pereira et al., 2022a; Tollefson, 2022; Shumilova et al., 2023). Like in other violent conflicts, large quantities of fossil fuels and GHGs are being released, through the operation of military systems, the arms buildup before and after the war. The war can both block and initiative cooperative efforts for environmental and climate policies, thus undermine progress in the sustainable development goals (SDGs) (Pereira et al., 2022b).

7.5. The climate-conflict-migration nexus

Compound risks may emerge particularly in the nexus of climate change, conflict and migration, together with other societal problems which affect the living conditions in many parts of the world and could turn into destabilizing security threats. The complex connections in this nexus are still poorly understood,

FIGURE 2
The climate-conflict-migration nexus: from cascading risks (red) to governance measures and synergies (green).

lacking simple causality or determinism. In addition to the direct drivers of forced migration, there are multiple, indirect and mutually reinforcing linkages between low development and poverty, oppression and persecution, armed conflict and violence, environmental degradation and resource depletion, making it difficult to distinguish environmental and societal conditions and mechanisms (Black et al., 2011; Burrows and Kinney, 2016; Scheffran, 2017; Boas et al., 2019; Hoffmann et al., 2020). Similar, climate change and violent conflict are connected through multiple and often indirect pathways (Ge et al., 2022). Less investigated is the impact of migration on either climate change or conflict, e.g., through CO_2 emissions and other pollutions, resource depletion or disputes in countries of origin and destination (BMZ, 2021).

While the negative nexus of problems has attracted considerable attention, the transformation to a positive nexus of interconnected solutions and synergies in related fields of governance, in particular, migration, peace and climate policies and their constructive integration from local to global levels, involves multiple pathways from causes to consequences (Scheffran, 2017; BMZ, 2021). Although security and peace were neglected in the 1992 UNCED agreements, they are back in the 2030 Agenda, in particular in SDG 16 "Peace, Justice and Strong Institutions" which has yet received less attention, and integration with other SDGs (UNGA, 2015). Going beyond averting security threats and building technology-oriented protective measures, it

is sensible to address problems through preventive, constructive and integrative solutions. These include avoiding drivers of forced displacement, in particular armed conflict and violence through peacebuilding, as well as global heating and climate injustice through mitigation and low-carbon transformation. To reduce risk, disaster preparedness, emergency responses, climate adaptation and resilience building are essential. Further measures are strengthening of rights, capacities and livelihoods of affected communities; international cooperation and transfer of knowledge, finance and technology involving civil society and migration networks; co-development, integration and institutions across regions. A humanitarian migration policy would address the concerns of affected people, avoid extreme and risky forms of displacement, and create regulated and legal migration opportunities and pathways. The effectiveness and acceptance of such proposals depends on political and legal frameworks to integrate migration (see Figure 2).

7.6. Cooperative climate governance and sustainable peace

More promising than securitization and militarization are anticipatory strategies and institution building that reduce vulnerability to climate change, strengthen adaptive capacity, resilience, and distributive justice, and rely on cooperation and

conflict resolution to promote a "climate for peace" (Rüttinger et al., 2015). Challenges can lead people to adapt or find innovative, sustainable and cooperative solutions to problems, for example more efficient use of resources and increased cooperation to reduce emissions or risks. To develop synergies and induce positive tipping points (Otto et al., 2020; Juhola et al., 2022), climate policy could support sustainable peacebuilding (Scheffran, 2022a) and conflict transformation which in turn contributes to the social-ecological transformation (Pastoors et al., 2022).

International climate governance includes the 1992 Framework Convention on Climate Change, the 1997 Kyoto Protocol, and the 2015 Paris Treaty which defines boundaries of global mean temperature and national commitments of emission reductions as well as instruments for financial and technology transfer to developing countries. While the scope and effectiveness of these measures may not be sufficient to prevent dangerous climate change, they lay the foundations and attract political support from local to global levels for a sustainable and peaceful transformation governing the Anthropocene.

To this end, climate policies need to be less conflictive. For example, interests in maintaining the climate-damaging fossil economic system, based on prosperity, consumption and profit, are in conflict with the interests of those harmed by it or supporters of an energy transition. In addition, there are disputes about certain alternative energy paths, such as bioenergy, dams and wind turbines. Accordingly, attention must be paid to social and ecological compatibility and conflict avoidance at an early stage, based on a holistic view of material and energy flows, consequential effects and acceptability. Thus, it is important to design mitigation, adaptation and protection measures (also in the context of geoengineering) in a conflict-sensitive manner (Nadiruzzaman et al., 2022) and avoid adaptation limits that trigger systemic risks and tipping points (Juhola et al., 2022). A key question is who should be protected against climate impacts and who should bear the costs and risks. Climate policy will only be successful if the global North takes a greater responsibility for solving the problem and implement stronger restrictions than the global South. While the focus on energy and CO_2 is justified in industrialized countries, in developing countries methane and nitrous oxide from agriculture play a bigger role but have been largely neglected in the North, although they have a higher warming effect and their reduction would buy time for CO_2 emission reductions.

Despite scientific warnings, a global trend toward stabilizing the climate is not yet in sight. To comply with climate safety limits there is no viable alternative to substantially cutting down anthropogenic GHG emissions by half until 2030 and achieve climate neutrality by 2050, implementing new technologies and behaviors in energy, transport and agricultural sectors (Engels et al., 2023). However, the national commitments presented by all countries are only partially met and cannot limit global temperature rise to below 2 degrees. Opportunities were not seized, and valuable time was lost (see the comprehensive assessment in IPCC (2022b, 2023).

8. Discussion and conclusions

Coming back to the initial hypothesis about the limits and crises of expansionism in the Anthropocene, it was shown that the current world order is under stress from a nexus of problems and geopolitical conflicts which require cooperative governance mechanisms to induce a social-ecological transformation toward a nexus of solutions. The case studies on the energy-security nexus and the climate-conflict-migration nexus demonstrate both the possible risk cascades and the opportunities for positive synergies.

The Russia-Ukraine war and the climate crisis once again confirm the conflict-prone dependence on and consequences of fossil energy sources. Accordingly, there is a growing urgency to replace them with a sustainable energy system. The curbing of Russian grain exports due to western restrictions and—lesser in volume—the interruption of Ukrainian exports have led to a global food crisis (in the South) and food price crisis (in the North). In addition, Russia was the largest exporter of fertilizers (due to cheap gas, high energy consumption and CO_2 emissions of the Haber-Bosch nitrogen fixing process), and the export restrictions have led to agricultural crises in wide part of Africa and some regions in Latin America—which in turn indicates a lack of food security by relying on imports.

To further prevent escalating and mutually enforcing crisis dynamics between climate and conflict risk, joint solutions using synergies are beneficial for both, making it counterproductive to play them against each other in the long-term management. In order to achieve peace and climate protection, the known infrastructural measures of a socio-ecological transformation should be implemented consistently. These include the energy, agricultural and transport transition, with energy conservation and efficiency improvements, renewable energy sources and decarbonization, electricity and hydrogen as energy sources, a circular economy and nature-based solutions (Scheffran, 2022a).

Rather than suffering from war, the social-ecological transformation could be accelerated to effectively and quickly implement energy security and sustainable peace. This requires production capacities, materials, raw materials and skilled workers, which takes time. For Europe to become a pioneer of a green transformation, a concerted effort by politics, business, science and society is required. Energy conflicts need to be minimized, as well as risky dependencies on strategic raw materials and conflict minerals. This would be the right response to the warnings of the IPCC as well as to the war, whose shock effects could become a driver for the overdue transformation. Instead of a "Zeitenwende" for an arms race and war, Europe needs an epochal turn for sustainable climate protection and a peaceful energy transition within planetary boundaries. To address the many complex challenges, the Anthropocene requires a new policy design (Sterner et al., 2019) and strengthening of civil society through networking and advocacy to stimulate bottom-up action and mobilize the pressure to induce the needed institutional changes for strong sustainable consumption (Lorek and Spangenberg, 2013).

Author contributions

The author confirms being the sole contributor of this work and has approved it for publication.

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Conflict of interest

The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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