Climate justice and digitalization

A plea to consider broader socio-economic implications of digitalization and climate change

Digitalization can be a promising tool in the fight against climate change. Besides influencing greenhouse gas emissions and mitigation strategies, digitalization affects matters of climate justice, including the way the impacts of global warming and the co-benefits of climate protection are distributed. For example, to advance fair benefit sharing of digital climate technologies, the decentralization of technological development must be initiated, and rules for fair competition must be established. Political action and the shaping of digitalization are necessary to govern the societal implications of these urgent developments.

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Climate justice and digitalization. A plea to consider broader socio-economic implications of digitalization and climate change
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Although it remains disputed whether digitalization has an overall net positive effect on the environment (Lange et al. 2020), many believe that it offers the technological solutions desperately needed if society is to avoid a climate crisis (e.g., Digitaleurope 2021, Kaack et al. forthcoming). However, digitalization is not only a question of technology – it also shapes the way in which the burden of climate change impacts societies and how the effects of successful climate policy are distributed. The interrelationship of digitalization with climate justice, which is concerned with the fair burden sharing of the adverse effects of climate change and climate policy, has not been considered in the literature so far. Thus, evolving research on the nexus of digitalization and climate change is much needed. Future research on this nexus should address not only aspects of digitalization related to emissions and climate mitigation strategies, but also the interrelationship of digitalization with questions of climate equity and justice, including climate adaptation strategies, fair burden sharing, and fair (co-)benefit sharing of climate and climate-related digitalization policies.

To shed light on the interplay of digitalization and climate justice, the article starts by presenting a short history of the climate justice debate as well as a summary of the discourse on digitalization and sustainability. In its main part, the article analyses the role digitalization plays in four dimensions of climate justice.

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A short history of climate justice

The debate about climate justice has been advanced by social movements such as *Climate Justice Now!*, *Climate Justice Alliance*, *350.org*, *Extinction Rebellion*, *Ende Gelände* (in Germany), *Fridays for Future*, and many others (Bond and Dorsey 2010). These movements count human rights and distributive effects as key issues related to climate change (Gore 2021), an approach which stands more conventional climate protection, which focusses first and foremost on the technical challenge of reducing CO_2 emissions. To gain a better understanding of the demands of these climate justice groups, it is helpful to take a brief look at the history of the climate justice movement.

Supporters of climate justice consider that ethical issues arising from climate change should be conceptualized in light of a general theory of justice which takes into account existing inequalities and vulnerabilities resulting from capitalism and Western hegemony (Caney 2020). The first two decades of the UN Framework Convention on Climate Change (UNFCCC), including the 1997 *Kyoto Protocol,* focused on the responsibilities of industrialized countries. Yet with increasing pressure on the global South to deliver on climate protection policies as well, and with increasing perception of the impacts both of ongoing climate change and climate policies on marginalized countries and populations, voices for climate justice gained momentum (Agarwal and Narain 1991), and climate justice research increasingly analyzed climate policies in light of development and human rights issues (e.g., Baer et al. 2008). Moreover, approaches that are biased towards techno-fixes to climate change – such as geo-engineering, nuclear energy, or the electrification of vehicles – have been critically dismantled (Arvesen et al. 2011). However, to my knowledge, there are neither research publications nor political declarations considering the role of information and communication technologies (ICT) with regard to climate justice. Because not only do climate change and climate policy have social implications, but digitalization has significant climate and social implications, too.

The rise of the topic nexus digitalization and climate change

The debate on the opportunities and risks of digital technologies for climate change is derived from the wider debate on digitalization and sustainability (Renn et al. 2021). As recently as a decade ago, research on the nexus of digitalization and sustainability began to gain momentum (for an overview, see Hilty and Aebischer 2015). Most of the literature addresses the implications of digitalization for energy demand, resource demand, and carbon emissions. By and large, this debate is limited to academic niches. Only in a few countries (e. g., Germany and France) has the topic nexus of digitalization and sustainability more broadly, and digitalization and climate change more specifically, entered the public and political debate (Lange and Santarius 2020, Shift Project 2019). Accordingly, only a few governments (e. g., Finland and Germany) have started to develop strategies to reduce the environmental impact of the ICT sector and digital applications (Federal Ministry for the Environment, Nature Conservation and Nuclear Safety 2020, Finish Ministry of Transport and Communication 2021). At the European level, decisions have been taken to develop a comprehensive agenda on *Digitalization for the Benefit of the Environment* in the coming years (Council of the European Union 2021) in order to advance contributions of digitalization for the goals of the *European Green Deal*.

Where digitalization is particularly addressed with regard to climate change, a critical discussion of its impacts remains underexposed. The focus is often on the alleged solutions that digitalization presents for energy efficiency and emission reductions. Few publications balance the opportunities and risks of digitalization for climate protection in a scientifically reliable manner (e. g., Freitag et al. 2020, Malmodin and Lundén 2018). However, an increasing number of studies have begun to analyze the implications of digitalization for greenhouse gas emissions (GHG) on a sectoral basis, or with a view to certain fields of actions, for example, regarding consumption or video streaming (e. g., Fletcher et al. 2021, Wilson et al. 2020).

Regarding the nexus of digitalization and climate justice, significant research and public debate have yet to emerge. Given the key topics of the climate justice movement and research, this may include analyzing the opportunities and risks of ICT devices, infrastructures, algorithms, and data on both emissions and adaptation potentials. It may also reflect on ICT-borne "techno-fixes" on a meta level (e. g., Hankey and Tuszynski 2017), for instance, by critically analyzing digitalization as part of a "digital capitalism" (Staab 2017), which may promulgate incremental optimizations and a stabilization of the (unsustainable) status quo to foster green growth, instead of deep sustainability transformations.

Dimensions of climate justice and their interrelations with digitalization

Resource-efficient production and consumption patterns as well as drastic emission reductions are indispensable for securing human rights and improving distributive justice. Climate justice recognizes that a dignified life and social participation necessarily produce some amount of GHG (Baer et al. 2008). To enable a "good life" for all while respecting planetary boundaries (O'Neill et al. 2018) requires a fair distribution of emission rights, mitigation and adaptation burdens (e. g., costs), and the (co-)benefits stemming from climate mitigation and adaptation. Hence, Santarius (2007) conceptualizes four dimensions of climate justice which need to be considered: How to redress 1. the unequal emissions of GHG, and 2. the unequal impacts of climate change; and how to achieve 3. fair burden sharing, and 4. fair benefit sharing of climate action. Digitalization interrelates with each of these dimensions differently:

1 The ***first dimension*** has been part of the public discourse on climate justice for some time. Today, the "global South" emits more than half of all global greenhouse gases – with rapidly developing countries such as China, Brazil, South Africa, and others emitting the majority. However, this statistic is problematic in two regards. First, industrialized countries are responsible for about three quarters of the total emissions accumulated in the atmosphere. Second, country-level data blurs differences in per capita emissions, but per capita emissions are a much better indicator of actual levels of well-being (or luxury) and distributive justice. Indeed, a global comparison of per capita emissions starkly reflects persisting inequalities: on average, a U.S. American emits 16 tons, a German 9 tons, a Chinese 8 tons, an Indian 2 tons and a Bangladeshi 0.6 tons of CO_2 per year.[1]

How does digitalization play into this first dimension of climate justice? The existing inequalities in emissions are indirectly but nonetheless clearly related to the spread of digital devices and online usage. Economic wealth, that is, the level of purchasing power, appears to be a decisive factor for both the degree of digitalization and the level of per capita emissions. For example, there is a similar variation in smartphone ownership as in per capita emissions – with more than three-quarters of the population owning a smartphone in the U.S. and Germany, 55 % in China, 27 % in India and 16 % in Bangladesh in 2021 (Statista 2022). Demand of digital devices (production of hardware plus demand in use phase) makes up approximately 8 to 10 % of global electricity consumption while accounting for 2.1 to 3.9 % of global GHG emissions, and is projected to rise further (Andrae

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1 Note that these per capita emissions are based on a simple calculation of territorial emissions divided by number of inhabitants. Hence, they do not mirror consumption-based versus production-based (i. e., territorial) emissions. For instance, in China roughly three tons of the CO_2 emissions per capita are due to the production of exports (Peters et al. 2011, World Bank 2020).

2020, Freitag et al. 2020). To conclude, emission inequalities correlate with the digital divide, mediated by income inequalities. This correlation could be weakened if "digital sufficiency" (Santarius et al. 2022) was practiced and digital technologies were systematically used to reduce GHG emissions. Global transnational consumers who can afford a highly digitalized life have used digitalization to maintain their high emission levels, or even to further drive emissions through new consumption patterns or higher convenience, rather than to significantly reduce their accountability for anthropogenic climate change.

At the European level, decisions have been taken to develop a comprehensive agenda in order to advance contributions of digitalization for the goals of the European Green Deal.

2 The ***second dimension*** of climate justice refers to the fact that the adverse effects of climate change affect countries and people worldwide in an unequal manner. For example, the consequences for food production are unevenly distributed. Agriculture is affected by extreme weather conditions (heavy rain, droughts), by the spread of new pests in regions where they did not previously exist, and by the general global rise in temperature – and these impacts hit less industrialized countries disproportionately (Kummu et al. 2021). With regard to the first dimension, the following adverse relationship is well known: countries that are largely responsible for generating climate change are less affected by its impacts.

Concerning climate change adaptation, digitalization offers a number of opportunities. Digital tools for observation of the Earth make it easier to identify extreme weather conditions at an early stage, to scientifically support adaptation strategies, and to systematically and rapidly evaluate and disseminate experiences gained from a wide range of adaptation strategies. Geographic information systems (GIS) have long made important contributions in this regard. Increasingly, sensor technology is also being used to collect data and improve ecosystem management. For example, cyber-physical systems (i.e., the "Internet of Things") in forestry can help monitor species and habitat health in timber production, detect soil degradation or droughts in forests at an early stage, or prevent forest fires (Friess et al. 2019). In agriculture, too, hopes are being pinned on sensor- and data-based methods to reduce the use of pesticides and adapt crops and farming practices to increased weather extremes (Addicott 2020).[2]

In particular, questions of economic power in digital capitalism (Staab 2019) in general and of data justice (Dencik et al. 2019) in particular arise, for example, who "owns" (or at least: hosts) the data, who has access and at what cost, and who reaps benefits from the data-based services offered. Regarding climate change adaptation in general, machine learning applications are likely to further improve monitoring and decision-making – especially if data sets from different regions are pooled to enable pattern recognition. However, when production structures as well as public infrastructures increasingly build on ICT in the field, this may also decrease resilience of adaptation strategies, particularly in regions that are exposed to regular power outage or have less capabilities to independently maintain the functioning of complex ICT systems. To conclude, digital technologies may advance the adaptation to impacts of climate change, but careful considerations are needed to ensure that reduced climate-related vulnerabilities are not traded off by new technology-related vulnerabilities and dependencies.

3 The ***third dimension*** of climate justice focuses on equity in burden sharing. Climate policy, although indispensable for ecological and social reasons, initially costs money and therefore entails short-term economic burdens. From an economic point of view, however, there is little doubt that climate protection pays off in the long run (Stern 2007). In recent years, global damage from climate change-related extreme weather conditions have amounted to more than 100 billion US Dollars annually; by 2050, scenarios anticipate that costs could add up to eight trillion US Dollar, which would then represent about 3% of global gross domestic product (GDP) (Kramer and Ware 2020). Apart from mitigating economic damages, climate change mitigation and adaptation policies can also have positive growth effects on their own. Stringent measures, including price-influencing ones such as eco-taxes or emission trading schemes, are having a much lower impact on GDP than previously thought. Investment in climate protection is likely to be growth-promoting in the face of considerable underinvestment in many industrialized economies (OECD 2017).

Nevertheless, today's climate protection and adaptation policies require investments that must first be paid for and will not necessarily have an immediate payback for respective actors. From a climate justice perspective, therefore, the question arises how to fairly distribute these costs, especially since financial capabilities vary considerably between countries. As one could derive from Article 2 of the UNFCCC, industrialized countries, because of their historical responsibility as well as their comparatively large economic capabilities, should bear a significant share of the costs incurred by countries in the global South (Kartha et al. 2009). This is one of the reasons why mechanisms for technology transfer and financial aid to low-income countries are part of the multilateral climate regime.

2 However, precision farming is also being criticized for optimizing monoculture farming practices and generating new dependencies of small-scale farmers vis-à-vis technology firms (Hilbeck and Tisselli 2020).

Digital tools can contribute to fair burden sharing in two ways. First, as explained above, they can help reduce the costs of damage via improved monitoring and evaluation of climate change adaptation policies. Second, since digitalization fosters technological progress and thus increases productivity, it can reduce the costs of climate change policies through efficiency gains. According to exploratory studies by the *Global e-Sustainability Initiative*, for example, digitalization can help avoid up to 20% of global CO_2 emissions by 2030, while generating eleven trillion US Dollars in economic savings and growth effects (GeSI and Accenture 2015). However, digital productivity gains must also be viewed critically: simultaneous increases in carbon productivity and capital and labor productivity can lead to rebound effects. These rebounds can "eat up" potential savings from efficiency gains, because they increase consumption – which in turn impedes the achievement of sustainability goals. To conclude, digital technologies can reduce costs and improve co-benefits of climate change mitigation and adaption measures, but unintended side effects need to be considered.

4 The ***fourth dimension*** of climate justice aims at a fair distribution of the opportunities offered by climate protection, especially economic opportunities but also co-benefits such as improved eco-system stability or human health. Economic opportunities include not only reductions in the costs of damages, but also profits from the businesses of those actors who develop and market climate protection and adaptation technologies. Worldwide, exports of general environmental protection technologies grew by an average of 10.3% per year from 2002 to 2013, that is, significantly faster than the general volume of world trade and the global GDP. However, only a handful of industrialized countries and very few emerging economies – including China in particular, but also Indonesia, Malaysia, and Mexico – are the key beneficiaries of these markets.

While the potentials of digitalization for cost reductions can contribute to fairer burden sharing (see above), the resulting economic benefits still need to be critically reflected against the background of the fourth dimension of climate justice. This is because digital solutions for climate protection in the areas of mobility, energy, agriculture, or housing (e.g., smart home systems) are currently being developed in the high-tech centers of the world. Out of the hundred largest platforms worldwide, most are headquartered in the USA and China, relatively few are in Europe, and only one is in Africa (i.e., South Africa) (United Nations Conference on Trade and Development 2019). The majority of those countries in the global South that primarily suffer from the unequal impacts of global warming have little prospect of a fair share of the economic opportunities stemming from digital climate solutions. It might even be the case that the technological and financial transfers from the global North to the global South via the UNFCCC framework, which are supposed to contribute to fair burden sharing, will in the end predominantly serve the exporting high-tech countries. Thus, if the development of digital climate protection and climate change adaptation applications takes place primarily in the wealthy regions of the world, digitization may exacerbate the unequal distribution of opportunities. Accordingly, mechanisms for technology transfer and capacity building should be earmarked not only to serve climate purposes, but also to increase the technological, institutional, and industrial capacities of the global South to develop solutions themselves and reap the benefits for their economies. For instance, regulation and climate finances may be used to foster the development of platforms for smart cities, energy grids, multi-modal mobility, green shopping, smart agriculture, etc. within countries of the global South. To conclude, in order to advance fair benefit sharing of digital climate technologies, a much more decentral technological development must be established alongside rules for fair competition (Santarius and Lange 2021).

Outlook

In order to make digitalization more compatible with the requirements of climate-just development, research at the topic nexus of digitalization, climate, and sustainability needs to include justice-related challenges. I would like to spark such new research by providing first thoughts on, and systematizing the interface of the two discourses of digitalization and climate justice. Future research as well as policy-making for "sustainable digitalization" must incorporate ethical considerations, including digitalization's impact on and role in climate adaptation, as well as its role in fair burden and benefit sharing strategies in low-carbon transitions. Moreover, stringent political action for the governance of digitalization is necessary not only to advance its potentials for climate protection (i.e., contribution to emission reduction), but to govern its overall societal implications (Digitalization for Sustainability 2022).

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