Socio-economic inequality exacerbated by climate change

Jiabo Yin,[1,*] Louise J. Slater,[2] Pan Liu,[1] Dedi Liu,[1] and Jingqing Cheng[3]
[1]State Key Laboratory of Water Resources Engineering and Management, Wuhan University, Wuhan 430072, China
[2]School of Geography and the Environment, University of Oxford, Oxford OX1 2JD, UK
[3]Jiangxi Academy of Water Science and Engineering, Nanchang 330029, China
*Correspondence: jboyn@whu.edu.cn

Received: February 8, 2024; Accepted: May 21, 2024; Published Online: May 27, 2024; https://doi.org/10.59717/j.xinn-geo.2024.100078

Citation: Yin J., Slater L. J., Liu P., et al., (2024). Socio-economic inequality exacerbated by climate change. The Innovation Geoscience 2(3): 100078.

In December 2023, after prolonged negotiations, the United Nations Climate Change Conference (COP28) reached a pivotal agreement that signaled the “beginning of the end” of the fossil fuel era. Almost 200 nations, representing approximately 90% of worldwide carbon dioxide (CO_2) emissions, acknowledged the need to shift away from fossil fuels. A significant achievement of COP28 was including the first ‘global stocktake’ —a comprehensive review of international climate action under the Paris Agreement designed to assess collective progress towards achieving its goals. However, COP28 only partially addressed a critical issue: the exacerbation of socio-economic inequality by climate change, and particularly the way in which present-day emissions put the next generation at risk. Here we outline the rapid global warming background, its implications, and the resulting exacerbation of inter-generational inequality and regional disparities. Moreover, we discuss several approaches to reduce socio-economic disparity, including the improvement of taxation systems, the revitalization of abandoned croplands, and the advancement of more flexible renewable energy infrastructure.

INCREASING EXTREME HAZARDS UNDER CLIMATE CHANGE

In 2022, global energy-related CO_2 emissions reached a new high of over 36.8 Gt. In September 2023, the global mean near-surface air temperature reached 1.8°C of additional warming compared with the pre-industrial 1850-1900 baseline, and many locations documented record-breaking extreme heat. The World Meteorological Organization reported that the global average temperature in 2023 was approximately 1.45°C above the 1850-1900 average value, and designated 2023 as the warmest year on record. Moreover, the global mean sea level has been reported to a new high in 2023, since the beginning of satellite altimetry measurements in 1993. The warming temperature and rising sea levels are elevating risks of climate and weather-related hazards. In China alone, the extraordinary drought in the Yangtze River basin in 2022 posed significant threats to environmental sustainability: for instance, Poyang Lake, China’s largest freshwater lake, shrank by 90% in surface area. In 2023, a drought that lasted the first three quarters of the year put over 20 million people at risk and damaged 31.87 million ha of cropland in China, resulting in economic losses of nearly 2.8 billion USD. The same year, the U.S.A. experienced 28 weather and climate hazards with individual economic losses of over $1 billion. Overall, the year 2023 marked the highest number of billion-dollar disasters on record in any calendar year. More recently, Hubei province, known as the "land of a thousand lakes" and a major producer of grain and cotton in China, experienced an unprecedented cold wave. The extreme cold waves caused substantial damage to grain yields, transports, and threatened the food security. During such extreme weather events, economically disadvantaged populations tend to suffer larger economic losses than the more affluent populations, due to their lower adaptive capacity. Farmers who rely mostly on crops for income are most susceptible to such cold shocks. Therefore, as the climate changes, it is important to pay attention to both heat-related extremes, namely hot hazards (e.g., heatwaves and droughts) and cold hazards (e.g., cold waves).

SOCIO-ECONOMIC INEQUALITY DUE TO THE CLIMATE CRISIS

Under global warming, extreme climatic events such as heatwaves, droughts, precipitation extremes, typhoons, flash floods, cold waves, wildfires and compound events are projected to intensify in occurrence, intensity, duration, severity, and spatial extent.[1,2] The next generations are therefore expected to experience far more severe weather-related hazards during their lifetimes compared with previous generations. As the planet warms, exposure to extreme climate hazards over the course of a lifetime increases drastically for the younger generations relative to previous generations (Figure 1). This is especially true in developing regions where stronger climatic extremes are affecting a rapidly growing young population. For example, a child born in 2020 might face between two to seven times more heatwaves, compared with a child born in 1960. Over ninety percent of the world’s population and economic productivity could become exposed to growing compound heatwave-drought hazards by the late 21st century.[3] Food security is also increasingly under strain. In recent years, rapid urbanization and increasing food demand are rising in tandem, and about 9.8% of the global population is still undernourished. Against the backdrop of escalating agricul-

Figure 1. The next generation might experience more severe climate extremes.

tural land scarcity, an increasing share of land is being abandoned for cropland due to land degradation, climate hazards, armed conflicts, and urban expansion. Cropland abandonment is projected to continue in many regions of the globe, especially in those abandonment hotspots, potentially exacerbating global food security threats, with more severe impacts on future generations in less developed areas. These questions raise important issues regarding climate inequality and show that solving the climate crisis is inextricably connected with the wellbeing of both the current and next generations.

Besides inter-generational inequality, regional socio-economic inequality due to the climate crisis is also a major challenge. Globally, the top 10% of the population, when measured by income, consumption or emissions, is responsible for 43 to 49% of total carbon emissions, while the bottom 50% only account for 7 to 13% of emissions. Despite having lower emissions than the rest of the world, poor countries experience some of the worst effects of climate-related hazards, affecting agricultural productivity, water scarcity and electricity shortages. By evaluating the bottom and top income quintiles of the population based on the Gross Domestic Product (GDP) per capita, we found that poorer regions are likely to face greater exposure (~44%) of their population and GDP to compound heat-drought hazards than regions with higher incomes (~39%) by end of this century under the highest emission pathway.[4] More recently, studies have highlighted the geographical inequality between high-emission nations in the Global North and low-emission nations in the Global South. This regional disparity is exacerbated by climate change, because low-income populations are more likely to live in high-risk areas and are more vulnerable to extreme climate-related hazards.[5] Hence, addressing intergenerational and socio-economic inequality resulting from the climate crisis deserves significant attention, especially to protect future generations in economically disadvantaged regions.

IMPLEMENTING COP28 PLEDGES TO ADDRESS CLIMATE INEQUALITY

International efforts since the Paris Agreement have shown that our world is capable of change. Greenhouse gas emissions were projected to grow by 16% by 2030, based on policies in place, at the time of the agreement's adoption in 2015. Currently, the projected increase has been narrowed to approximately 3%. However, current climate pledges under the Paris Agreement put the world on track for a 2.5-2.9°C increase in temperature above the pre-industrial level by end of the 21st century. The UN Environment Programme (UNEP) alerts that emissions must fall by 28-42% by 2030 to constrain global warming to 2°C and 1.5°C. The remaining carbon budget for a 50% chance of constraining warming below 1.5°C was approximately 250 $GtCO_2$ as of January 2023. This is equivalent to very few years of present-day CO_2 emissions, largely constraining the emissions allowance for future generations. Achieving the 1.5°C goal will be impossible without phasing out all fossil fuels on a timeframe consistent with this limit. Therefore, it is essential to accelerate the transition away from fossil fuels to safeguard the current and next generations as well as our planet. Since high-income countries are major CO_2 emitters in terms of total accumulated emissions, these countries could help bridge the finance gap in developing countries by providing climate investments. Additionally, wealth taxation may also offer a viable solution. To address the crisis threatening food security, it is important to explore the reuse of abandoned cropland, which is important for supporting food production and aiding in climate change mitigation. For example, the 101 million hectares of cropland abandoned between 1992 and 2020 could deliver between 29 to 363 peta-calories of food production annually, significantly influenced by the choice of land management strategies. In countries experiencing rapid urbanization in the Global South, governments could integrate cropland recultivation into their climate policy designs. For example, they could adopt more stringent measures to preserve cropland, to combat the food crisis under climate change.

The COP28 agreement proposed ambitious goals to end fossil fuels, but it is just a beginning and does not set a strict timeline or roadmap for all countries. There is an urgent need to turn the COP28 pledges into action by taking immediate steps to reduce current greenhouse gas emissions in order to leave a larger emissions budget for the next generations. About eighty percent of people live in countries that are net importers of fossil fuels. In contrast, clean and renewable energy sources are available in all countries, but their potential is yet to be fully harnessed. The world needs a more flexible renewable energy system, especially in the Global South, where significant untapped potential exists for solar, wind, biomass, hydropower, and geothermal energy sources. Nuclear energy, as a low-carbon energy source, could contribute to decreasing dependence on fossil fuels, particularly in countries where renewable energy options are less viable. To fully exploit renewable energy sources, it is essential to enhance the efficiency of electricity grids and management systems globally, addressing intermittency issues and ensuring efficient energy distribution. For example, with over 50,000 reservoirs in China's Yangtze River basin, there exists significant potential to amplify socio-economic benefits by exploring the combined functions of these hydraulic engineering structures. Artificial intelligence (AI) techniques can support the identification of optimal operation strategies for achieving multiple objectives such as flood control, irrigation, and hydropower generation. AI-based solutions could be developed to devise more versatile methods for multi-reservoir operation, enhancing hydropower generation while minimizing flood risks.

CONCLUDING REMAKRS

After a heated debate in December 2023, COP28 closed with an agreement marking a pivotal step towards the end of the fossil fuel era. COP28's legacy includes the first 'global stocktake' of international efforts to mitigate climate change under the Paris Agreement. To implement the COP28 pledges, efforts are required globally. We suggest accelerating the phasing out of fossil fuel, improving wealth taxation, recultivating abandoned cropland, developing a more versatile renewable energy system, and alleviating socio-economic disparities engendered by the climate crisis.

REFERENCES

1. Yin, J., Guo, S., Yang, Y., et al. (2022). Projection of droughts and their socioeconomic exposures based on terrestrial water storage anomaly over China. Sci. China Earth. Sci. **65**: 1772–1787. DOI: 10.1007/s11430-021-9927-x.
2. Yin, J., Guo, S., Wang, J., et al. (2023). Thermodynamic driving mechanisms for the formation of global precipitation extremes and ecohydrological effects. Sci. China Earth. Sci. **66**: 92–110. DOI: 10.1007/s11430-022-9987-0.
3. Yin, J., Gentine, P., Slater, L., et al. (2023). Future socio-ecosystem productivity threatened by compound drought–heatwave events. Nat. Sustain. **6**: 259–272. DOI: 10.1038/s41893-022-01024-1.
4. Yin, J. and Slater, L. (2023). Understanding heatwave-drought compound hazards and impacts on socio-ecosystems. The Innovation Geoscience **1**: 100042–100043. DOI: 10.59717/j.xinn-geo.2023.100042.
5. Thiery, W., Lange, S., Rogelj, J., et al. (2021). Intergenerational inequities in exposure to climate extremes. Science **374**: 158–160. DOI: 10.1126/science.abi7339.

FUNDING AND ACKNOWLEDGMENTS

J.Y. is supported by the Open Research Funds for the Hubei Provincial Key Laboratory of Water Resources & Eco-environmental Sciences, Changjiang River Scientific Research Institute (CKWV20231195/KY). This work is also supported by the National Natural Science Foundation of China (52361145864; 52261145744). The numerical calculations in this paper have been done on the supercomputing system in the Supercomputing Center of Wuhan University. The funders had no role in study design, data collection and analysis, decision to publish or preparation of the manuscript.

DECLARATION OF INTERESTS

The authors declare no competing interests.