

How to help Ukrainian scientists overcome Russia's invasion and advance sustainability

Garry Sotnik^{a,1}, Yuliia Spinova^b, Tetiana Sotnik^c, Olga Polotska^d, Oksana Kysil^e, Svitlana Krakovska^{f,g}, Oleksandr Diachuk^h, Yulia Bezvershenkoⁱ, Oleksandr Berezko^j, Vidvuds Beldavs^k, and Andriy Andrushevych^l



Russia's current invasion of Ukraine is devastating Ukraine and its people. As scientists living and working in Ukraine or working closely with Ukrainians, we see two critical paths through which the international science community and funding organizations can help Ukrainian scientists help Ukraine. One path involves supporting new partnerships between Ukrainian scientists, their international counterparts, and Ukrainian civil society and government. Such partnerships can help tackle the extreme challenges posed by the invasion as well as prepare Ukraine for sustainable recovery and development. The second path involves supporting the development of a new sustainability science curriculum in Ukraine to prepare local expertise for driving the country's recovery and development. Action now can help the Ukrainian science community overcome Russia's invasion and, in the process, emerge more robust and better prepared to advance its country's sustainable development.

From Hope to Destruction

In 2015, the Ukrainian government introduced legislation that solidified the importance of sustainability in Ukraine's socioeconomic development and launched corresponding multi-sector reforms. By 2020, Ukraine had progressed toward achieving 15 of the 17 sustainable development goals. The country reduced poverty from 58.3% in 2015 to 43.2% in 2018 (1), doubled the share of its electricity production from renewable energy sources to 12.4% from 2016 to 2020 (2), reduced its CO₂ emissions by 8.6% from 2015 to 2019 (3), and committed to reaching carbon

Other countries and institutions can help the Ukrainian science community overcome Russia's invasion and, in the process, emerge more robust and better prepared to advance the nation's sustainable development. Image credit: Shutterstock/Drop of Light.

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¹To whom correspondence may be addressed. Email: gsotnik@stanford.edu.

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neutrality by 2060 (4). The coronavirus (COVID-19) pandemic slowed Ukraine's reforms and progress in sustainable development. Nevertheless, in 2021, Ukraine joined the Global Methane Pledge Program, the Net Zero World Initiative, and the United Nations Partnership in Action on Science, Technology, and Innovation for Sustainable Development Goals Roadmaps Program. That same year, Ukraine joined the Powering Past Coal Alliance and committed to phasing-out coal use by 2040 (5).

Russia's 2022 invasion upended Ukraine's progress toward sustainability. It caused widespread destruction of entire regions in the east and south of Ukraine. The invasion now includes frequent bombardment of major civilian centers throughout the country, targeting residential areas and critical (energy, heating, and water) infrastructure. More than 7.8 million people have left Ukraine, an estimated 8 million are displaced internally, and approximately 11 million are stranded or are unable to leave their locations (6, 7). Poverty, hunger, and poor health are rampant in invaded and adjacent regions of the country. The operations of all businesses and nonprofits throughout the country have been substantially disrupted, with those who remain open facing significant financial and staffing challenges. If Russia's invasion deepens, up to 90% of the population in Ukraine could face poverty and extreme economic vulnerability (8).

Russia's invasion will further strain Ukraine's ecosystems for years to come as ruined cities and villages are rebuilt, requiring the extraction of sand, granite, wood, and many other natural resources.

The invasion is also destroying Ukraine's ecosystems. Impacts include significant water and soil pollution from explosions and damaged infrastructure and extensive destruction of forests and steppes by fires from explosions and military fortification and movement. The invasion is threatening aquatic ecosystems of rivers and the Azov and Black seas (9) and also substantially increases the chance of radiation hazards (as a result of Russian attacks on nuclear power plants/stations (10) and threats of nuclear weapon use) and the extinction of rare plant species (11). Russia's invasion will further strain Ukraine's ecosystems for years to come as ruined cities and villages are rebuilt, requiring the extraction of sand, granite, wood, and many other natural resources (12).

A Science Enterprise Curtailed

Before Russia's initial 2014 invasion, Ukrainian scientists actively collaborated with their counterparts in post-Soviet countries. Research with scientists from other countries and engagement with Ukraine's civil society and government were minimal (13). After the initial invasion, the existing research collaborations fell apart, gradually replaced by new collaborations with scientists from the European Union and the United States (14). The invasion also displaced multiple higher education institutions, causing universities and colleges from the Donetsk, Luhansk, and Crimea regions to relocate to other parts of the country. Russia's full-scale 2022 invasion is having a devastating effect on the Ukrainian

science community in particular. Ten months into the invasion, Russia's shelling damaged 48 higher education institutions, destroying eight entirely (15). For scientists whose institutions Russia has not shelled, continuing to conduct research or teach under the regular threat of bombardment, as well as intermittent loss of electricity, heat, and water, has been a significant challenge.

The international science community's response has been unprecedented. The European Commission launched the European Research Area for Ukraine portal to provide Ukrainian researchers with information and support services. The Horizon Europe and Euratom Research and Training programs offered Ukrainian scientists free participation until 2023 (16). Clarivate and Elsevier started providing Ukrainian scientists free access to databases, such as the Web of Science and Scopus. Governments, institutions, and universities in the United States, European Union, and other countries (e.g., Brazil, Canada, Israel, Japan, Taiwan, and the United Kingdom) have created support programs for Ukrainian scientists that provide accommodations, scholarships, employment, and grants (17). Nevertheless, only 15% of Ukrainian scientists have moved abroad; the rest remain in Ukraine, and most have expressed readiness to defend and rebuild their country (18).

There are two additional paths through which the international science community and funding organizations can help Ukrainian scientists—especially those who remain in Ukraine—help their country overcome Russia's invasion and develop sustainably. One path involves supporting new partnerships between Ukrainian scientists, their international counterparts, and Ukrainian civil society and government. Such partnerships are highly beneficial when public goods and services are under enormous strain (19) and can play a critical role in advancing sustainability (20–22). We have already seen robust voluntary collective action emerge throughout Ukraine as civil society mobilized to support essential government services. Such collective action has been crucial for completing many general tasks and has provided Ukrainian scientists with opportunities to contribute as civilians. However, opportunities for Ukrainian scientists to contribute as scientists—especially in collaboration with their international counterparts and Ukrainian civil society and government—remain scarce, mainly because such collaborations require connections as well as financial and other kinds of support (22) that do not yet exist in Ukraine.

Such partnerships could be essential as Ukraine seeks to respond to a worsening humanitarian crisis. Members of Ukraine's civil society and international humanitarian organizations are struggling to provide even temporary assistance. The worsening scarcity of critical medical supplies, limited healthcare capacity, lack of safe drinking water, and winter weather are among the immediate challenges facing the most vulnerable in Ukraine and will put further strain on those providing assistance. Partnerships that reinforce the existing assistance through logistical and coordination support could be the quickest and most promising response to the crisis.

We also need partnerships to plan sustainable recovery and development. Early planning driven by sustainability goals could open new opportunities for Ukraine and drive real

recovery and development while also helping to avoid the often frantic, corruption-tainted efforts that can occur without well-vetted plans. Some partnerships of this kind have already formed, such as Ro3kvit—a coalition of academic and non-academic architects, artists, and urban and regional planners committed to developing methods to rebuild Ukrainian cities (23). Ro3kvit envisions city development that meets the urgent needs of Ukrainians while simultaneously setting the foundation for future sustainability. Toward this end, the coalition has already formed partnerships with several Ukrainian city councils. Developing a network of such partnerships that includes other Ukrainian nonprofits (e.g., Energy Efficient Cities of Ukraine Association, Ukrainian Nature Conservation Group) can ensure that the broadest range of sustainability goals drives recovery and development. We call on the international science community and funding organizations to partner with Ukraine's National Research Foundation to create a program that explicitly supports the formation and functioning of such collaborations.

The second path involves supporting the Ukrainian science community in developing a sustainability science curriculum for preparing local expertise to drive the country's sustainable recovery and development. The curriculum could follow the framework created for Stanford University Doerr School of Sustainability's Change Leadership for Sustainability Program. That framework features three core elements (24):

- understanding complex social–environmental systems,
- understanding decision-making and strategies for leading change, and
- innovating system transformations for sustainable futures.

The first element develops student understanding of social human and natural systems' complex, adaptive, and interconnected nature. The second develops an understanding of how to make decisions and plan under extreme degrees

of uncertainty. The third develops an understanding of how to drive social transformation while being mindful of its impact on inter- and intragenerational well-being (25).

Students could study these core elements in the context of the challenges Ukraine will need to overcome to recover and develop sustainably. The students should tackle questions such as: How does Ukraine heal a severely traumatized population and eradicate poverty while transitioning away from its heavy reliance on fossil fuels? How does Ukraine rebuild its industry and infrastructure while improving the health of its ecosystems? Or, how does Ukraine move beyond its commitment to phase-out coal and towards achieving net-zero emissions? We call on the international science community and funding organizations to partner with Ukraine's Ministry of Education and Science to create a program that explicitly develops and implements a sustainability science curriculum that addresses these and other critical questions.

Now more than ever, the Ukrainian science community needs support from its international colleagues to help the country overcome this senseless onslaught and pursue the well-being of its people and the health of its ecosystems for the current and future generations. Robust partnerships and a sustainability science curriculum can help Ukrainian scientists achieve both and advance their country as an equal contributor to the pursuit of global sustainability.

Author affiliations: ^aDoerr School of Sustainability, Stanford University, Stanford, CA 94305; ^bDepartment of Environmental Studies, National University of Kyiv-Mohyla Academy, Kyiv 04070, Ukraine; ^cDepartment of Philosophy and Social and Humanitarian Disciplines, Zaporizhzhia Regional Institute of Postgraduate Education, Zaporizhzhia 69035, Ukraine; ^dDirectorate of the Foundation, National Research Foundation of Ukraine, Kyiv 01001, Ukraine; ^eCovenant of Mayors East, Lviv 79005, Ukraine; ^fUkrainian Hydrometeorological Institute of the State Emergency Service of Ukraine and National Academy of Sciences of Ukraine, Kyiv 03028, Ukraine; ^gNational Antarctic Scientific Center, Ministry of Education and Science of Ukraine, Kyiv 01601, Ukraine; ^hInstitute for Economics and Forecasting, National Academy of Science of Ukraine, Kyiv 01011, Ukraine; ⁱCenter on Democracy, Development and the Rule of Law, Stanford University, Stanford, CA 94305; ^jInstitute of Humanities and Social Sciences, Lviv Polytechnic National University, Lviv 79000, Ukraine; ^kRiga Photonics Center, Riga 1050, Latvia; and ^lLaw School, Ukrainian Catholic University, Lviv 79011, Ukraine

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