Environmental and Sustainability Implications of the Ukraine War for East and South Asia: Sustainability and Decarbonisation Should Be Accelerated Not Paused

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December 2022

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Main Messages

- The economic disruptions from the Ukraine war have intensified short term concerns about energy and food security, as well as access to critical minerals. Climate security is also increasingly urgent. This paper urges governments to speed up, not slow down, transitions away from fossil fuels and toward more sustainable development patterns. The war is not a reason to "hit pause" on decarbonisation or the Sustainable Development Goals (SDGs).

- Major solutions commonly recommended before the Ukraine war are more relevant and urgent than ever: (1) energy/resource conservation, (2) energy/resource efficiency, (3) renewable energy, (4) circular economy, (5) sustainable lifestyles, and (6) the SDGs. The current economic disruptions are similar to past ones, and they will recur in the future, so the war is an opportunity to accelerate these solutions.

- For both energy and climate security, energy, conservation and efficiency will produce the quickest short-term results. Investments in new fossil fuel production take a long time to complete so they cannot solve short-term disruptions. New energy investment should be shifted from fossil fuels to renewable energy, which is now more price competitive in many situations. Solutions for energy, food, and climate security need to be sustainable.

- Food security has long been a global problem, worsened by the Ukraine war. Therefore, as called for in SDG 2 on zero hunger, more sustainable solutions to achieve food security for vulnerable populations are needed, such as those recommended above.

- The war may limit Russian exports of some critical minerals needed for clean energy transitions, but supplies are available in other regions, including Asia, so this is not a reason to increase investment in fossil fuels. The quickest solutions are resource conservation, efficiency, and the circular economy. Stronger environmental safeguards for mining are also needed.

- The diversity across Asia suggests that sustainable solutions in the region would also apply beyond it. All countries can benefit from sustainable and resilient solutions like resource efficiency regardless of their geopolitical orientation, and faster and more widespread adoption of sustainable solutions will produce quicker and more substantial benefits.

1. Introduction

This paper examines the environmental and sustainability implications of the Ukraine war for East and South Asia. It also recommends policy responses to this conflict in the context of its economic disruptions in the region, especially those related to energy, food, and climate security, and critical minerals.

At the war's start in February 2022, the world was starting to recover from the economic slowdown caused by the COVID-19 pandemic. The war caused another global economic shock, especially to energy and agricultural markets, triggering fresh worries about energy, food, and resource/mineral security, and imperilling the economic recovery. These disruptions are mutually reinforcing, compounding their impacts—for example energy shortages contribute to rising food costs.

While much discussion has focused on geopolitical and economic impacts of these disruptions, there are also important environmental and sustainability implications. Therefore, it is important to ensure that related policy responses are sustainable. Especially regarding energy, the war is creating pressures to expand investment in fossil fuels and roll back climate commitments, based on a mistaken idea that the war is a short-term priority while climate and sustainability are long-term issues which can be postponed. Thus, the war and accompanying economic disruption may also create pressures to slow sustainability initiatives, including the Sustainable Development Goals (SDGs), and redirect resources to fossil fuel investment and consumption.

Nevertheless, the climate crisis is worsening (IPCC 2022), and the world is still on track to cross several planetary boundaries (Steffen et al. 2015; Rockstrom et al. 2009). Climate and environmental security are also increasingly urgent. These sustainability crises, which threaten the earth's safe operating space for human civilization within planetary boundaries, (Raworth 2012) are becoming more severe in the short term, as they cause increasing infrastructure and health damage along with their associated economic costs and human suffering. These crises will not stop damaging human prosperity and well-being while the world focuses on the Ukraine war. The SDGs aim to address these sustainability crises, but limited progress has been made, not just on the environmental aspects, but also issues such as food security and poverty reduction (Sachs et al. 2022; UNESCAP 2022a).

For East and South Asia, the environmental and sustainability implications are mainly connected to the war-related economic disruptions, particularly energy but also agriculture/food and other major sectors, and the region's responses to them. Since these economic changes and the region's responses to them will have important environmental and sustainability implications, the policy responses should be in a sustainable direction. The diversity across Asia also suggests that sustainable solutions in the region would apply elsewhere. All countries can benefit from sustainable and resilient solutions like resource efficiency regardless of their geopolitical orientation, and faster and more widespread adoption of sustainable solutions will produce quicker and more substantial benefits.

The direct environmental impacts of the war's military operations are not the main focus of this paper, but they are also addressed. Certainly, these impacts are significant, such as greenhouse gas (GHG) emissions; air, land, and water pollution; waste; and biodiversity loss (OECD 2022). Many of these impacts occur in and near Ukraine and not near East or South Asia, but others have transboundary impacts. Moreover, local environmental impacts such as air, land, and water pollution and biodiversity

loss, are increasingly becoming global concerns, as their cumulative damage is added up in global assessment reports (UNEP 2019b; IPCC 2022; IPBES 2018).

Overall, this paper argues that the best response to the Ukraine war for East and South Asia, as well as the rest of the world, is to accelerate the energy transition away from fossil fuels and strengthen efforts to promote environmental and social sustainability, especially through the SDGs. Moreover, this is the best direction for the short term; sustainable policies are not just something to be put off for the long term. The Ukraine conflict is not a reason to "hit pause" on decarbonisation or the SDGs.

The paper also recommends general solutions in the following six areas: energy/resource conservation, energy/resource efficiency, renewable energy, circular economy, sustainable lifestyles, and the SDGs. These are the main sustainability solutions which were being recommended before the war. They are just as relevant now as they were before the war. The war should be seen as a reason to fast track these solutions, not slow them down. The highest prioritization should be put on conservation and efficiency, of energy as well as other resources, since they can be implemented the fastest and at the lowest cost.

The next section of this paper explains the overall linkages between war, economy, environment, and sustainability. Then three key sectors – climate/energy, food/agriculture, and mining/critical minerals – are explored in more detail in the following three sections, respectively. This is followed by a section on direct environmental impacts. The last section concludes.

2. What is "New" About the Ukraine War for the Environment and Sustainability?

Nature of the Ukraine War's Disruption

The Ukraine war is "new" in a military and geostrategic sense, including large scale testing of new weapons and tactics in battle. But it is not new in terms of its economic disruption and damage to the environment and overall sustainability. Rather, it is simply the latest in a series of major global crises. The economic disruption of the COVID-19 pandemic was still lingering at the start of the Ukraine war, as global supply chains had not fully recovered. Major global economic disruptions in recent decades include the Asian financial crisis of 1997-1998 and the Lehman shock of 2008. Global food security is regularly threatened by extreme weather and steadily eroded by the climate crisis. Fossil-based energy markets are frequently disrupted by wars and imbalances in supply and demand.

It is not clear whether the magnitude of the Ukraine war's economic disruptions is greater than previous crises, but this time the disruptions come on top of the lingering effects of the COVID-19 pandemic. They occur over several dimensions simultaneously including both fossil fuel and agricultural trade. The main differences this time may be the non-economic and geopolitical aspects, especially the large military dimension which may increase the perception of risk compared to past economic crises. The Ukraine war challenges the fundamental principle of state sovereignty and highlights international institutions' and neighbouring countries' limited ability to curb violations. The magnitude of the economic sanctions on Russian trade, especially its energy exports, may be larger than other cases of sanctions since the end of the Cold War, and many countries have incurred significant costs. However,

none of these points fundamentally affect the nature of the war's economic implications, which are essentially supply and price shocks, and the war's environmental implications, mainly pollution and ecosystem damage. Basically, the effects of sanctions are similar to other types of economic shocks.

Whether the Ukraine war ends soon or is prolonged also does not change the fundamental implications for the environment and sustainability or the recommended responses. It is difficult to predict when the war will end, but the economic disruptions will not necessarily end at the same time as the war. The disruptions may temporarily subside, but new disruptions will inevitably recur with the next economic or geopolitical crisis, intensification of the climate crisis, or the breaching of more planetary boundaries.

Globalization, Resilience, and Self-Reliance

Globalization and its accompanying interdependence have measurably slowed (Olivié and Gracia 2020), although absolute levels of trade, financial, and other linkages remain high. This trend began before the Ukraine war and gained momentum especially during US President Trump's term with trade wars and the COVID-19 pandemic. In recent months, global economic flows have recovered somewhat as countries move beyond COVID, but the Ukraine war has intensified efforts by companies and countries to strengthen their economic resilience and reduce economic interdependence. The war has also reinforced an increased emphasis on geopolitical considerations in international economic relations, and a decreased emphasis on short-term cost minimization. Many countries and companies are increasing their domestic production, or at least shifting their supply sources of many inputs and products to less risky countries ("friend shoring") to some extent. This may also increase domestic employment. It is important to keep in mind that 100 percent self-reliance may not achievable by any country or sector, even for the largest countries, although significant increases from current levels might be achievable in some cases.

The environmental and social sustainability of these trends is not clear. Considerable research has been conducted on the environmental and social sustainability of globalisation, including trade and investment liberalisation, but the results have not been conclusive – there is a mix of positive and negative implications (Copeland and Taylor 2004; Frankel 2009). Therefore, the sustainability implications of the current slowdown of globalisation are also likely to be mixed. On one hand, transport and shipping-related economic and environmental costs may be reduced by sourcing more production domestically and shifting away from just-in-time production methods. On the other hand, increased local production and consumption will generally reduce production efficiency and increase costs due to a smaller scale of production. Reduced production efficiency also negatively affects environmental sustainability—for example, through overall increased pollution. Greater self-reliance may also result in bottlenecks and shortages. Therefore, detailed analysis of specific trends and cases is needed to assess the environmental sustainability of current shifts in globalisation.

The environmental and social sustainability implications of the trend towards greater economic resilience and self-reliance, and slowdown of globalisation need to be considered when developing recommended responses. Life cycle analyses will be needed to assess the environmental implications of more resilient and domestically sourced supply chains. At the same time, environmental and social sustainability should be implemented in a way that contributes to economic resilience. The integrated approach encouraged by the SDGs—an approach that involves understanding interactions across multiple concerns—is a good way to achieve these objectives. Sustainable solutions like the transition to renewable energy and SDGs need to be accelerated, not put on hold.

Consumption and Inequality

The cumulative economic disruptions from the COVID-19 pandemic and now the Ukraine war, including supply chain disruptions, have reduced consumption, especially for food and fuel, particularly among middle class and vulnerable populations, exacerbating inequality. In the case of the middle class, some of this may be experienced as inconvenience or higher prices rather than hardship, but for vulnerable populations, the impacts may be severe or disastrous. Even before the conflict in Ukraine, the world was suffering from a food crisis, and the disruption in agricultural exports from Ukraine made the situation much worse.

Food and fuel shortages, combined with the longer-term trends towards greater economic resilience and domestic production, will lead to corresponding higher prices and reduced supply of many products, due to reduced economies of scale and economic efficiencies. The increase in prices could act as a kind of consumption tax to reduce long-term rates of consumption of material goods, and so this aspect may have a positive impact on the environment, but it may also have a negative effect on well-being of vulnerable populations. It is also not clear how long increased prices will hold down consumption. Higher energy prices especially will create political pressure to increase fossil fuel production and investment, which would worsen the climate crisis.

A more sustained effort is needed to achieve food and energy security in an environmentally sustainable manner while protecting vulnerable populations and reducing inequality. These were already major problems before the Ukraine war, which only worsened the situation and increased the urgency of finding and implementing solutions.

Priority Solutions

Environment and sustainable development issues have been discussed by the global community since the Stockholm Conference in 1972. Many initiatives and solutions have been proposed since then such as Agenda 21, the Millennium Development Goals, and the SDGs. These solutions are still relevant, and the Ukraine war has not changed this.

However, there are two new implications from the Ukraine war, which has worsened the already-existing problems. First, sustainability solutions are more urgent; and second, the benefits of sustainability solutions are even greater than before. Conversely, reinforcing the fossil fuel economy and other unsustainable production and consumption patterns would only make matters worse.

Overall, overall solutions can be organised into six main areas:

1. Conservation (e.g. energy, resource conservation)
2. Efficiency (e.g. energy, resources, etc.)
3. Renewable energy
4. Circular economy / sustainable consumption and production
5. Sustainable lifestyles (sufficiency)
6. SDGs

In the short term, resource conservation and resource efficiency should be the priorities, as they can be implemented faster than the others, with quicker results. The other four solution areas generally take longer to implement and may require larger investments. Before the Ukraine war, resource conservation may have been less politically popular since it could mean reduced consumption. However, conservation and efficiency measures can result in substantial cost savings, and they can be implemented much more quickly than investment in new renewable energy production, which also may require greater investment. Also, countries which implement these solutions more quickly and effectively will enjoy more substantial benefits sooner.

It is important to note that these solutions are not unique to Asia. Any country which adopts them will benefit, regardless of geopolitical orientation or even fossil fuel production capacity. The benefits of implementing these solutions in Asia will also be large due to the size of the region's population and economy.

3. Climate and Energy

The Ukraine war has disrupted supplies of fossil fuels from Russia due to sanctions by Western countries. This has led to increased fossil fuel prices, thereby reducing consumer welfare. Less economically developed countries such as Bangladesh (Stapczynski, Shiryaevskaya, and Mangi 2022), Sri Lanka (Lo 2022), and Pakistan have been more severely affected (Nicholas 2022) as imports of coal and natural gas (LNG) become unaffordable, or even unavailable at any price as European countries replace their imports of natural gas from Russia by outbidding other countries for existing supplies of LNG purchased on global markets. The disruption has created pressure on political leaders to take short-term actions to relieve the disruption.

Regarding climate and energy, some may argue that the response to the Ukraine war should be to expand investment in fossil fuels and roll back climate commitments. For example, China increased coal output in response to the war's uncertainty, "keeping the lights on over cutting dirty fuel sources", even while rapidly expanding its renewable energy production (Ghosal and Arasu 2022). India announced plans in May 2022 to construct new coal fired power plants in response to severe heat waves and power blackouts (Singh 2022a). In some countries it may be possible to increase fossil-based energy in the short term based on existing sources and facilities. However, in many cases, new energy investment would be necessary. In many East and South Asian countries, as elsewhere, increasing overall energy supply is a priority in order to expand energy access to low-income populations and support increased economic growth. Therefore, the key question is whether new energy investment should focus on fossil fuels or renewable energy.

Investment in increased fossil fuel production is a false solution that cannot provide short term benefits, even though it may be advocated as a short-term solution. Investment in fossil fuel production as well as related infrastructure such as LNG import terminals takes several years to complete, so it cannot provide any relief to short-term fuel shortages and price increases. Even Germany's plan to fast track construction of floating LNG import terminals, which usually take several years, will take at least 10 months (Dezem 2022). Moreover, from a global standpoint, this would only redistribute existing natural gas (LNG) supplies not create new supplies. Therefore, neither floating nor land-based LNG import terminals would be realistic options especially for developing countries in Asia which may not have

enough financial resources to outbid the European countries for limited LNG supplies. Some countries are reconsidering plans to rely more on LNG; the Philippines delayed its first import terminal and Vietnam is considering reducing the capacity of gas-fired power plants (Stapczynski, Shiryaevskaya, and Mangi 2022).

It is also important to note that high fossil fuel prices were hurting many developing countries even before the Ukraine war started in February 2022 due to the global economic recovery from the COVID-19 pandemic. For example, India experienced shortages of coal in 2021 (Varadhan and Ahmed 2022). In Bangladesh, independent power producer costs increased by 58 percent in 2020/2021, largely due to a new coal-fired power plant, so the bulk power tariff was increased by 64 percent one month before the start of the Ukraine war (Nicholas 2022).

Still, the degree to which energy security has been negatively impacted by the Ukraine war varies, and some countries have been affected less than others. In 2022, after the start of the war, India's coal imports from Russia significantly increased from 579,000 tonnes in February to 2.4 million tonnes in August, while India's total coal imports in August were estimated to fall from 15 million to 13 million tonnes as demand declined due to the slowing economy and receding temperatures (Varadhan and Ahmed 2022). Indonesia increased its coal exports by over 20 percent between January and May 2022 compared to the previous year after the Ukraine war increased demand from Europe (Munthe 2022).

For several countries in the region, the war may not have adversely affected some aspects of energy security such as oil. As Russian exports to Europe have been redirected away from Europe and some Asian countries such as Japan and South Korea due to sanctions (Menon 2022), other countries such as China, India, Sri Lanka, and Myanmar have been able to purchase Russian oil and coal at discounted rates (J. Lee 2022a). The overall decline in Russian oil exports has been minimal (J. Lee 2022b).

Solutions

In the short-term, energy conservation and energy efficiency are the recommended priority solutions which can be implemented expeditiously and will produce quick results in reducing shortages with relatively low investment. These are the quickest solutions to increase energy security, and they will also reduce costs and generate profits. Frans Timmermans, Vice President of the European Commission in charge of the European Green Deal, wisely observed that "saving energy, not using energy, is the cheapest energy obviously" (Kurmayer 2022b). Of course, this is difficult for countries with high levels of energy poverty, which need more assistance to overcome these energy market disruptions. Nevertheless, even in developing countries, more sustainable lifestyles involving energy conservation and efficiency could be adopted (Akenji et al. 2021), for example by middle-and-upper class citizens, which would reduce energy consumption.

In Europe, initially, there was some reluctance to prioritise energy conservation in order to avoid inconveniencing consumers. However, the EU recommended energy conservation measures (Dalton and Mackrael 2022), and several European governments began to adopt them as the high risk of a major shortage of natural gas in the winter of 2022-2023 became clear (Jack and Zimmermann 2022). New energy saving and energy efficiency laws in Germany are one example (Kurmayer 2022a).

Recent examples in East Asia include South Korea, which capped temperatures in public buildings and schools at 17 degrees Celsius from October to March and placed restrictions on indoor and outdoor lighting (H. Lee 2022). Japan enacted a new law strengthening building efficiency regulations in June 2022 (Nippon.com 2022) and implemented energy conservation measures to encourage households and businesses to conserve electricity (Oda 2022). Indonesia is developing new regulations on energy management and conservation as well as new financing schemes (Purnama and Resinta 2022).

For the longer-term, new energy investment should be allocated to renewable energy, not fossil fuels. Renewable energy is already cheaper than fossil fuels, and the Ukraine war is likely to expand its cost competitiveness as fossil fuel prices increase faster than prices of renewable energy. The International Renewable Energy Agency (IRENA) has concluded that "utility-scale solar PV and onshore wind projects are, on average, able to produce power for less than the cheapest new fossil fuel-fired cost project," and new renewable energy capacity "increasingly undercuts the operating costs alone of existing coal-fired power plants" (IRENA 2021).

Moreover, clean energy will be a major source of jobs. In 2019, it already accounted for more than half of global energy-related employment, while fossil fuels accounted for less than half, including in China, India, and "other Asia Pacific", and after 2019, clean energy accounted for "virtually all of the growth in energy employment" according to the International Energy Agency (IEA 2022b).

Increased wind and solar capacity between March and September 2022 saved the EU the equivalent of eight billion cubic meters of avoided gas imports, about 11 billion euros in avoided costs, while the total installed wind and solar capacity saved 70 billion cubic meters of gas and 99 billion euros (Lombrana 2022). Similarly, UNESCAP recommended to "accelerate the transition towards renewables" which would help to reduce energy costs, dependence on imported energy, and impacts from future supply disruptions. UNESCAP also recommended "developing subregional power grid connectivity based on renewable energy sources" (UNESCAP 2022b). For Indonesia, a scenario analysis by IRENA concluded that it will be cheaper to meet the country's rising energy demand with renewable energy, which could account for two-thirds of its energy mix by 2050 (IRENA 2022).

Some Asian countries are increasing renewable energy generation. India is developing plans for large-scale production of green hydrogen considering capacity target of 25 million tonnes by 2047 (Sing and Srivastava 2022). In China, the National Development and Reform Commission's (NDRC) plans a major expansion of coal fired power plants, but in the long run, they are intended as backup power since renewable energy will also be expanded; eventually the coal power plants' capacity utilisation will be reduced since their operating costs will be much higher than RE power (Murtaugh and Chen 2022). China's renewable energy investment more than doubled in the first half of 2022 to USD 89 billion (Murtaugh and Chen 2022). Indonesia will receive USD 500 million in concessional loans from the Climate Investment Funds, affiliated with the World Bank, "to accelerate the closer of 2,000 megawatts of coal-fired generation in five to ten years" (Sguazzin 2022). Nevertheless, efforts to expand renewable energy need to be greatly accelerated. Some countries are still simultaneously increasing fossil fuel production.

One of the main obstacles to expanded renewable energy is domestic regulation (Khuong, McKenna, and Fichtner 2019) especially policy and regulatory uncertainty (IEA 2022a). In principle, policies and regulations can be reformed much more quickly than new fossil fuel projects can be constructed, if governments prioritise reforms. Reforms cannot be simply blocked by distant wars or changes in global

market conditions. For example, the largest US grid operator, PJM, has a backlog of about 2,500 renewable energy projects awaiting approval, and it is proposing a two-year moratorium on new projects in order to expand its administrative capacity to review new projects (Bruggers 2022); without this unnecessary regulatory obstacle, these 2,500 projects would already be producing substantial amounts of clean electricity. India has started some deregulation to make it easier for commercial and industrial users to shift to greener sources of electricity including a quicker approval process and lower surcharges (Singh 2022b). Upgrading grid infrastructure will also facilitate the adoption of renewable energy in both developed and developing countries (IEA 2022a), so this should also be a focus of funds available for new investments.

Sustainable lifestyles, circular economy, and SDGs can also contribute to climate change mitigation. Citizens' actions to make their lifestyles more sustainable, for example having more sustainable diets, can also improve their own health and well-being, not just the climate (Akenji et al. 2021; IGES 2021b, 2021a). Sustainable lifestyles and circular economy measures often focus on energy and resource conservation and efficiency.

Many SDGs contribute to climate mitigation, not just SDG 13 which focuses on climate, but also SDG 2 (sustainable agriculture), SDG 4 (education for sustainable development), SDG 7 (energy efficiency, renewable energy), SDG 12 (sustainable consumption and production), and SDG 11 on cities, with targets on sustainable transport and sustainable buildings. Other SDGs benefit from climate action including SDG 1 (poverty reduction), SDG 2 (food security), SDG 3 (health), SDG 14 (oceans), and SDG 15 (life on land) (Akenji et al. 2018).

Strengthened regional cooperation is also desirable. For example, a new initiative to develop an ASEAN Climate Change Strategic Action Plan 2023-2030 (ACCSAP) and Guideline on the Long-Term Roadmap for Mitigation and Adaptation Synergy is underway, and the ASEAN Regional Action Plan for Adaptation and Drought has been adopted. ESCAP has adopted a new Regional Action Programme for Sustainable Transport Development in Asia and the Pacific (2022-2026) (UNESCAP 2022b). Another ESCAP initiative is the Regional Road Map on Power System Connectivity, which is needed to upgrade electrical grids to support more renewable energy (Alisjahbana 2022). The Asia Cobenefits Partnership (ACP) promotes solutions which simultaneously address both climate change and air pollution (ACP 2020).

The increase in fossil fuel prices could be considered as a kind of carbon tax, except the revenue goes to the companies producing fossil fuels instead of the government. Higher fossil fuel prices would reduce their use, making a positive contribution to the climate crisis and air pollution reduction. People with low incomes could be assisted by taxing and redistributing fossil fuel profits.

Fossil fuels need to be "left in the ground" to avoid climate disaster. A recent landmark IEA report's key implication is that the energy transition to "net-zero" requires a halt in new investments in oil and gas fields and coal mines; the report also outlines the conditions under which this would be physically possible while achieving energy access for all (IEA 2021a). Some market trends also encourage a shift away from fossil fuel investment – higher fossil fuel prices encourage energy consumers to prefer renewable energy, while lower fossil fuel prices discourage energy producers from increasing investment in them (as happened during the COVID-19 pandemic). As the price competitiveness of renewable energy increases, fossil fuel investment will continue to decline, and possibly be phased out. At that time, new fossil fuel investments made during the Ukraine war would become stranded assets.

It is also important for governments to try to maintain policy coherence and provide consistent signals and incentives to economic actors in order to avoid unnecessary wasted investments and economic losses. Measures to promote climate security are also the best measures to promote energy security, while measures that harm climate security need to be avoided or at least minimised. A short-term pause in climate action to increase fossil fuel investment would take a few years to generate production. However, by that time, the European countries would have significantly increased their use of renewable energy and reduced their dependence on fossil fuels, while Russian fossil fuels may return to global markets. Energy policies will also need to shift back to supporting climate action. Thus, when Russian fossil fuels return to global markets, European demand for them may be negligible, and climate policies will further depress demand, putting downward pressure on fossil fuel prices. In a few years, today's new fossil fuel investments may become uneconomic and result in stranded assets. Therefore, it would be more economical to maintain a consistent and coherent policy to support the clean energy transition and renewable energy rather than take a detour back to fossil fuels.

4. Food and Agriculture

Food security has long been a global problem, and the second Sustainable Development Goal (SDG 2) focuses on ending hunger and achieving food security. Climate change is already a major threat to food security, and its impacts will steadily worsen as temperatures continue to rise, weather becomes more extreme, and droughts and floods worsen. On top of these long-term pressures, the Ukraine war has precipitated an immediate global food crisis, especially in developing countries (Ben Hassen and el Bilali 2022). Ukraine is one of the world's largest food exporters, and the war caused a substantial reduction in its exports. Ukraine's agricultural exports resumed in August 2022, but not to prewar levels, and Russia's exports began to fall (Quinn 2022), so the situation remains very serious.

The extent of military and environmental damage to Ukraine's agriculture sector will also influence the pace of recovery of exports. Military operations caused many fields to be damaged by craters from ordnance explosions and military vehicle tracks. Fields have also been littered by debris from artillery shells, damaged or destroyed military vehicles, and other military waste. Much of the waste contains leaking toxic and polluting chemicals and materials. Farming operations are also at risk from unexploded ordnance. Major agricultural infrastructure has been damaged, such as grain silos, warehouses, railways, and ports (Welsh 2022). According to one estimate, Ukraine has lost 14 percent of its grain storage capacity (McBride 2022).

The magnitude and duration of the food disruption is highly uncertain and depends on how long the Ukraine war lasts, the military/diplomatic situation, and the extent of the damage to agricultural lands, infrastructure, and processing facilities. The disruption may or may not be long-term, and it may be a one-time issue. But even if Ukraine's and Russia's agricultural exports recover to their prewar levels, the longstanding global problem will remain, and agricultural supply disruptions could easily recur in the future due to other reasons.

Therefore, a more sustained effort to achieve food security in an environmentally sustainable manner for vulnerable populations is needed, as called for in SDG 2, regardless of the duration of the war. The problem is especially severe for lower-income countries and people, as those with higher incomes can afford to pay a higher price to import food from alternative sources, if necessary.

A major underlying factor behind the food crisis is the globalisation of food systems resulting in a high level of dependence on imported food in many areas. Especially low-income consumers may have difficulties finding alternative sources of imports at previous price levels. In fact, many countries in the region such as Cambodia, Thailand, Vietnam, and Singapore are already experiencing sharp increases in food prices (UNESCAP 2022c). Further, efforts to keep food prices low for essential products such as cooking oil can trigger protests from small-scale farmers, for example in Indonesia (Christina and Asprihanto 2022). Moreover, even before the Ukraine crisis, global food production systems had become very resource intensive, with rapidly expanding production inputs – water, energy, land, chemicals – causing serious environmental impacts. While efforts to make food production sustainable are high on the global agenda, progress has been slow and often disproportionally focused on promoting organic agriculture, which is difficult to expand on a large scale.

Due to the crisis, there may be pressure to expand unsustainable resource-intensive agriculture in the short term, although this will be difficult if shortages or high prices of fossil fuels needed to produce conventional fertilisers and other inputs continue. Increasing food production would require shifting land use, including possible deforestation or other habitat destruction, and may also require shifting scarce water allocations from other sectors. Generally, it may be difficult to increase domestic food production significantly as the available land and water is very limited in Asian countries, as elsewhere.

Solutions

Nevertheless, countries could take several measures to modestly expand food availability and domestic food production to strengthen resilience against external shocks in the short to medium term. Related capacity building assistance to farmers to enable them to implement and take advantage of these measures would also be needed.

Reducing food waste may be the easiest and quickest option. About one-third of food is wasted globally (UNEP 2021), and in ASEAN, most food loss is related to production rather than consumption (FAO 2011). In some developing countries, as much as half of the harvest is lost before it reaches the market (Mandyck and Schultz 2015). Upgrading crop distribution systems in developing countries could considerably reduce post-harvest loss. Reducing food waste would make more food available for consumption, and it can be considered as a kind of efficiency measure. Eating less meat would also reduce demand for food with high energy inputs while improving health and contributing to climate change mitigation. These are examples of more sustainable lifestyles, which contribute to resource conservation. Food security is an urgent problem in developing countries, but there may still be room for food-related lifestyle changes among upper-and-middle income people. For example, citizen surveys in New Delhi, India and Nonthaburi, Thailand indicated willingness to take some measures such growing some of their own food, eating more organic food, and reducing oversized food portions, frequency of eating at restaurants, sweets, and soft drinks (IGES 2021b, 2021a).

Increasing resource efficiency (Prabhakar and Elder 2009) is another easily available option. Agriculture requires considerable amounts of energy and water. If these resources were used more efficiently, then more would be available to increase agricultural production. Investment in agricultural resource efficiency would also pay for itself as the cost savings offset the initial investments.

Weather forecasting (short, medium and long) and climate forecasting, as well as climate change impact assessments need to be strengthened in some countries so that farmers and input markets can respond appropriately well in advance of shocks. The resulting improved management would directly increase the productivity of existing agricultural land.

Climate smart agriculture should be expanded (Hengesbaugh, King, and Zusman 2020; Lipper et al. 2014; FAO 2010). This can help buffer production shocks at the local level and increase resilience. Breeding for stress tolerance and developing cropping systems and cropping calendars that are adapted for changing climate conditions is necessary to prevent climate change from further degrading agricultural production. Climate-smart agriculture may be difficult to implement over the short term, but could produce significant results in the medium term.

Air pollution also reduces crop yields, including through acid rain and tropospheric ozone (Avnery et al. 2011; Nawahda et al. 2013; Landrigan et al. 2018). Therefore, reducing air pollution could improve crop yields. A report published by UNEP highlights 25 measures that would reduce air pollution in the region, and many would also have co-benefits for climate mitigation and economic development such as strengthening renewable energy, energy efficiency, and public transport (UNEP 2019a).

Renewable energy could help expand energy access in rural regions of developing countries, especially in more isolated areas (Palit 2013). It can be difficult and expensive to extend the electric grid to rural areas, so off-grid renewable energy could be a quicker and more cost-effective way to promote rural electrification, which in turn could enable increased agricultural production.

SDG implementation also contributes to food security. The main focus is SDG 2 on ending hunger, which also includes a target on sustainable agriculture. Agriculture and food security are also related to SDGs 6 and 7 on water and energy, respectively, as well as SDG 13 on climate and SDG 15 which focuses on land ecosystems. Sustainable water management practices called for under SDG 6 help to maintain sufficient water availability for agriculture as well as household use, while at the same time minimizing pollution from agricultural activities which may threaten the quality of water supplies. Moreover, the SDGs also show how the agricultural sector is linked to climate change, since it not only produces GHG emissions, but also suffers from the effects of climate change, which may reduce agricultural productivity (Chopra et al. 2022) or even change which crops could be feasibly cultivated on specific areas of land.

5. Critical Minerals

The green transition, especially the shift to renewable energy and electric vehicles, needs a range of critical minerals. These minerals are also important for other economic sectors as well as for national security. The Ukraine war has raised questions about the stability of supply of these critical minerals, especially as the green transition increases demand for them. Thus, some may suggest that these supply concerns could be a reason to revitalize investment in fossil fuels and pause investment in renewable energy. This argument fails to address similar supply concerns for fossil fuels, whose production cannot be rapidly increased in the short term. This paper shows that the supply concerns resulting from the Ukraine war for critical minerals may be overstated, since there are major supply alternatives to Russia and Ukraine in different geographic regions.

The key materials are copper, lithium, nickel, cobalt and rare earth elements (IEA 2021b), although there are many others. Different materials are needed for different technologies. Massive increases in some materials may be required. According to the OECD, "since 2010, the quantity of minerals required to generate power has increased by 50 percent, and a net-zero scenario would quadruple that amount"(OECD 2021), while the amount of nickel needed for global carbon neutrality will be nearly 20 times greater than present consumption (Johnston 2022).

The potential for the war to restrict supplies of these critical minerals is a significant concern, as Russia is a major producer of many of them, especially palladium, scandium, titanium, nickel, and cobalt (Covatariu 2022). Last year Russia, the world's third largest producer of copper, accounted for one tenth of global output (Johnston 2022). Ukraine, in contrast, is not currently a major producer, but it has significant reserves, and could be a major source of future output. The country "is among the most richly endowed European countries when it comes to rare earth metals and lithium reserves" (valued as high as $11.5 trillion), and has numerous locations where rare earth minerals can be mined in the future (Covatariu 2022). In addition, Ukraine accounts for 6 percent of the world's titanium reserves (Fant 2022).

A more detailed look at the current overall conditions of three cases – nickel, lithium, and rare earth metals – shows that each has a very different situation in terms of the global distribution of production and reserves or resources.

Nickel. Currently, global production of nickel is largely concentrated in Asia and the Pacific, as shown in Table 1. In 2021, while Russia was the third largest producer, at 9.1 percent, it was overshadowed by Indonesia (36.4 percent) and the Philippines (13.5 percent) (U.S. Geological Survey 2022). Global reserves for nickel are also aligned with these production numbers. Indonesia and Australia each have 21 million metric tonnes, Brazil 16, Russia 7.5, the Philippines 4.8, China 2.8, and Canada 2.0 while the rest of the world, including the US, has just over 20 combined (U.S. Geological Survey 2022).

Table 1: Nickel – Share of Global Production and Reserves (2021)

Country	Mine Production (2021)	Share of Global Mine Production (2021)	Reserves (2021)	Share of Global Reserves (2021)
Name	*Metric tonnes*	*%*	*Metric tonnes*	*%*
Indonesia	1,000,000	36.4%	21,000,000	22.0%
Philippines	370,000	13.5%	4,800,000	5.0%
Russia	250,000	9.1%	7,500,000	7.9%
New Caledonia	190,000	6.9%	NA	NA
Australia	160,000	5.8%	21,000,000	22.0%
Canada	130,000	4.7%	2,000,000	2.1%
China	120,000	4.4%	2,800,000	2.9%
Brazil	100,000	3.6%	16,000,000	16.8%
United States	18,000	0.7%	340,000	0.4%
Other countries	410,000	14.9%	20,000,000	21.0%
Total	2,748,000	100.0%	95,440,000	100.0%

Source: (U.S. Geological Survey 2022). Note: Beyond this, "identified land-based resources averaging approximately 0.5% percent nickel or greater contain at least 300 million tons of nickel, with about 60% in laterites and 40% in sulfide deposits" (p.115).

Lithium. According to calculations by McKinsey, in 2020, 98 percent of lithium mining took place in Latin America, Australia, and China (Azevedo et al. 2022). The key Latin American countries, known as the "lithium triangle", are Argentina, Bolivia, and Chile. As seen below in Table 2, they possess the greatest percentages of lithium "resources", and combined count for more than half of this material worldwide (U.S. Geological Survey 2022). Table 2 shows that although there are not many major sources of lithium, they are geographically dispersed and do not include Russia or Ukraine.

Table 2: Lithium – Share of Global Production and "Resources" (2021)

Country	Mine Production (2021)	Share of Global Mine Production (2021)	"Resources" (2021)	Share of Global "Resources" (2021)
Name	*Metric tonnes*	*%*	*Metric tonnes*	*%*
Australia	55,000	52.5%	7,300,000	8.2%
Chile	26,000	24.8%	9,800,000	11.1%
China	14,000	13.4%	5,100,000	5.8%
Argentina	6,200	5.9%	19,000,000	21.5%
Brazil	1,500	1.4%	470,000	0.5%
Zimbabwe	1,200	1.1%	500,000	0.6%
Portugal	900	0.9%	270,000	0.3%
Bolivia	0	0.0%	21,000,000	23.7%
United States	Withheld	Withheld	9,100,000	10.3%
Democratic Republic of the Congo	0	0.0%	3,000,000	3.4%
Canada	0	0.0%	2,900,000	3.3%
Germany	0	0.0%	2,700,000	3.0%
Mexico	0	0.0%	1,700,000	1.9%
Czech Republic	0	0.0%	1,300,000	1.5%
Other countries	0	0.0%	4,420,000	5.0%
Total	104,800	100.0%	88,560,000	100.0%

Source: (U.S. Geological Survey 2022). *Note:* Mine production for the United States was withheld. "Resources" may include not only reserves, but also lithium in forms such as "continental brines, geothermal brines, hectorite, oilfield brines, pegmatites, and searlesite" (p.101).

Rare Earths. The global powerhouse in terms of many critical minerals, especially rare earths, is China. The shares of global production and global reserves are shown in Table 3. In 2021, China accounted for both the largest share of global production (over 60 percent) and reserves (35.2 percent). Currently, other Asia-Pacific countries are also major suppliers, especially Myanmar and Australia, with additional contributions from Thailand, India and Vietnam. Together, these countries also have significant reserves, with Vietnam listed as holding 17.6 percent of them. Russia, in contrast, accounts for 1.0 percent of global production, although it has 16.8 percent of global reserves. An important note is that rare earths are a group of special metals, and so the aggregated numbers in the table below obscure variations for each specific element.

Table 3: Rare Earth Metals – Share of Global Production and Reserves (2021)

Country	Mine Production (2021)	Share of Global Mine Production (2021)	Reserves (2021)	Share of Global Reserves (2021)
Name	*Metric tonnes*	*%*	*Metric tonnes*	*%*
China	168,000	60.6%	44,000,000	35.2%
United States	43,000	15.5%	1,800,000	1.4%
Myanmar	26,000	9.4%	NA	NA
Australia	22,000	7.9%	4,000,000	3.2%
Thailand	8,000	2.9%	NA	NA
Madagascar	3,200	1.2%	NA	NA
India	2,900	1.0%	6,900,000	5.5%
Russia	2,700	1.0%	21,000,000	16.8%
Brazil	500	0.2%	21,000,000	16.8%
Vietnam	400	0.1%	22,000,000	17.6%
Burundi	100	>0.0%	NA	NA
Greenland	0	0.0%	1,500,000	1.2%
Tanzania	0	0.0%	890,000	0.7%
Canada	0	0.0%	830,000	0.7%
South Africa	0	0.0%	790,000	0.6%
Other countries	300	0.1%	280,000	0.2%
Total	277,100	100.0%	124,990,000	100.0%

Source: (U.S. Geological Survey 2022). *Note:* also, "in North America, measured and indicated resources of rare earths were estimated to include 2.4 million tonnes in the United States and more than 15 million tonnes in Canada" (p.135).

Therefore, from the perspective of countries in East and South Asia, concerns about the stability of supply of nickel, lithium, and rare earths due to the Ukraine war may be somewhat overstated. While Russia is an important supplier of nickel and rare earths, it is not dominant, and it is not among the top suppliers of lithium. In contrast, much of the world's production and reserves of these minerals are in the Asia-Pacific, especially China and Australia.

Countries may still worry about the security of supplies of critical minerals based on broader geopolitical considerations, and/or due to the substantial overall increase in the demand for these minerals due to the green transition. However, these concerns existed before the Ukraine war, and they will continue after it ends. The conflict in Ukraine increases the seriousness of these concerns to some extent, but it does not fundamentally change the nature of the problem, or the direction of the solutions.

Solutions

Solutions should focus on four key elements. The first priority should be to alleviate demand pressures through resource conservation, including more sustainable and less resource-intensive lifestyles, and investments in resource efficiency. Investment in recycling these critical minerals would reduce the need for new supplies. These measures are part of a broader circular economy approach to sustainable consumption and production.

Second, countries worried about stability of supply may need to diversify their sources or increase domestic production. There are various alternative sources besides Russia, and Ukraine may be a potential new source of critical minerals.

Third, mining requires significant amounts of energy. Therefore, there is potential to enhance both energy and climate security by shifting from fossil-based energy to renewable energy (McLellan et al. 2012).

Fourth, mining critical minerals is also environmentally damaging, so environmental safeguards need to be strengthened, and environmental justice principles need to be followed including when developing new projects. Otherwise, mining may solve some problems but worsen others. These solutions are not new, and the Ukraine war has not changed them, but just made them even more relevant and urgent. The environmental impacts of mining and refining critical minerals are significant. For example, in some cases as many as 160 tonnes of mineral ores must be mined in order to produce 1 tonne of rare earth minerals (Talens Peiró & Villalba Méndez 2013, p.1331). The increased demand for these minerals has already raised concerns that some countries in the region may weaken environmental regulations to accelerate the pace of excavation. Fossil fuel extraction and refining also has major negative environmental impacts, so increasing fossil fuel development instead of renewable energy would not reduce the overall environmental damage from energy production.

Mining is also related to SDGs, even though mining is not explicitly mentioned in them. Mining creates jobs, and therefore contributes to SDG 1 (poverty reduction), SDG 8 (economic growth and decent work), SDG 7 (material for renewable energy equipment), and SDG 9 (sustainable industrialization) (Monteiro, da Silva, and Moita Neto 2019). Mining also creates pollution which needs to be managed sustainably in order to meet environmental and health related targets in SDG 3 (health), SDG 6 (water ecosystems), SDG 14 (ocean ecosystems), and SDG 15 (land ecosystems) (de Mesquita et al. 2017). Therefore, SDG implementation will help to optimize the benefits of mining while minimizing its environmental impacts.

6. Direct environmental and sustainability impacts

Wars cause a wide range of environmental damage, but even before a war starts, there are already large environmental impacts from the build-up and maintenance of military forces, including both operations and weapons procurement (Weir 2020). Military operations cause extensive land and water pollution as well as waste, including toxic and hazardous waste, especially from damaged and destroyed vehicles, buildings, and other infrastructure. Much of the effects are felt locally, but as mentioned earlier, agricultural produce can be affected, which would extend the impacts to importing countries.

The war in Ukraine has already significantly damaged environmental and social sustainability (Rawtani et al. 2022). Major environmental damage from the Ukraine war includes GHG emissions; air, land, and water pollution; waste; and biodiversity loss (OECD 2022).

Large amounts of GHGs are emitted by military vehicles, aircraft, ships, and missiles, although these can be difficult to accurately estimate. Fuel consumption estimates for some Russian tanks used in the Ukraine war by both sides range from 3 litres/km for the T-62, 3.5 litres/km for the T-72, 4 litres/km for the T-64A, to 6.4 litres/km for the T-80 (Tank Archives 2021). At a global level, it is estimated that 5.5

percent of carbon emissions are attributable to militaries (Parkinson and Cottrell 2022). Effects of GHGs are felt worldwide.

Significant air pollution is emitted by military operations, although this is also difficult to measure. Air pollution is caused not only by military vehicles, aircraft, and ships, but by military ordnance which creates dust when exploding and damaging buildings, infrastructure, or in the middle of fields. Attacks on oil and gas facilities and industrial plants are especially polluting. Wartime air pollution is more dangerous than ordinary air pollution from vehicles and industry because it contains a wider range of particles, including the full range of building materials, possibly asbestos, as well as toxic chemicals in the explosives (Barber and Simon 2022). Attacks on fuel depots and refineries have caused large fires releasing air pollutants such as soot, CO_2 and methane (Subbaraman 2022). Again, much of the effect is local, but air pollution can also move significant distances, crossing national boundaries.

Many aspects of the war cause or worsen water pollution (Subbaraman 2022). Damage from military attacks to industrial infrastructure such as chemical and fertilizer plants, chemical storage facilities, and coal mines are especially dangerous. Many water treatment plants and dams have also been damaged.

Ukraine's forests have suffered substantial damage during the war. Large forest fires have occurred, and legal and illegal logging has increased. About 37,000 fires were observed in the war's first four months (Pearce 2022). This further contributes to climate change, and harms biodiversity. According to Ukraine's Ministry of Environmental Protection and Natural Resources, about 30 percent of the country's protected areas, about 3 million acres have been damaged (Pearce 2022).

Biodiversity has suffered extensive damage from the war (Pereira et al. 2022). Ukraine accounts for 35 percent of Europe's biodiversity, including 70,000 plant and animal species. These are being threatened by military operations including vehicle movement as well as bombing. At least 14 Ramsar sites are threatened (Beckmann and Vykhor 2022).

The prospect of radiation risk and a potential nuclear disaster is especially worrying (CEOBS and ZOI 2022). The area around Europe's largest nuclear power plant in Zaporizhzhia is a battle zone, and the plant is at risk of damage from military operations. The plant's external electricity sources have been cut off several times, risking a loss of cooling power to the reactor as well as the cooling pools for the spent nuclear fuel, which could precipitate a nuclear disaster (Pearce 2022).

It is also self-evident that war severely damages economic and social sustainability (Rawtani et al. 2022). Loss of life, physical injury, and illness from military operations, both by combatants and civilians, has been enormous. Many people have been displaced, both internally and as refugees. Current estimates are that of the more than 100 million people displaced worldwide, 8 million are within Ukraine, and an additional 6 million are Ukrainians who fled the country (Taylor 2022). There has been extensive physical damage to infrastructure, housing, transport, and utilities. No war can be sustainable. Among SDGs, SDG 16 on peace is the first casualty of the Ukraine war, but Ukraine also suffered regression on all of the other SDGs as well as a result of the war, with increased poverty, hunger, and all forms of pollution as well as worsened health and damage to cities, ecosystems, and industry.

7. Conclusion

In conclusion, the best response for countries in East and South Asia – as elsewhere – to the crisis is to accelerate the energy transition away from fossil fuels and strengthen efforts to promote environmental and social sustainability. The war in Ukraine is not a reason to "hit pause" on decarbonisation or the SDGs; rather, their importance and urgency have increased. The climate crisis and other sustainability crises have not paused for the Ukraine conflict; instead, they are worsening. Climate security is needed just as much as energy and food security.

Economic disruptions caused by the war are similar to other disruptions that have happened in the past; after the Ukraine war is over (or even before), similar disruptions will continue to occur. What is new about the Ukraine war is that it has increased the urgency of environmentally sustainable solutions. Fossil fuels are becoming increasingly expensive as well as geopolitically unstable.

Increased investment in fossil fuels is not an effective solution for the region, as it cannot relieve shortages or price pressures in the short run. Moreover, the price competitiveness of renewable energy is increasing as are the economic benefits of investments in energy efficiency and conservation. There are no good reasons to expand investment in climate-destroying fossil fuels. As explained by the International Energy Agency, after the Ukraine war, "the economic arguments in favour of cost-competitive and affordable clean technologies are now stronger – and so too is the energy security case," leading to "an alignment of economic, climate, and security priorities" (IEA 2022c).

Therefore, the sustainability solutions recommended before the Ukraine war are the same as the ones recommended as a response to the war. Energy and resource efficiency and conservation will make the quickest contributions to energy security, and they will also reduce costs. The money which is proposed for new investments in fossil fuels should simply be shifted to renewable energy and energy efficiency. The circular economy and sustainable lifestyles will further promote resource and energy conservation and efficiency. SDGs provide a holistic perspective to encourage integrated approaches to sustainability issues, including climate, energy, and food security. False tradeoffs between the Ukraine and climate/sustainability crises need to be avoided. More fossil fuels will not solve either crisis.

All countries can benefit from these solutions regardless of their geopolitical orientation. Faster and more substantial adoption will produce faster and more substantial benefits. SDG implementation should also be continued. Thus, the crises caused by the war have also become an opportunity, as they can help policymakers to see the benefits of more sustainable policies more clearly and hopefully encourage their accelerated and widespread implementation.

Enhanced international cooperation would help to further accelerate the implementation of these measures and enhance their effectiveness. The countries in the region may also benefit from taking stronger leadership roles in the transition to decarbonization and circular economy pathways, both individually and through regional frameworks such as ASEAN+6.

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Acknowledgments

The authors express their sincere appreciation for the helpful comments and feedback provided by Tsuyoshi Kawakami, Naoki Matsuo, Koji Yonetani, Erin Kawazu, Kazuo Matsushita, Yasuhiko Hotta, Yosuke Arino, and IGES Executive Director Yasuo Takahashi.

DOI

DOI: 10.57405/iges-12623

Suggested Citation

Elder, Mark, Sussman, David D., Prabhakar, S. V. R. K., Zusman, Eric, & Tamura, Kentaro. 2022. Environmental and Sustainability Implications of the Ukraine War for East and South Asia: Sustainability and Decarbonisation Should Be Accelerated Not Paused. IGES Issue Brief (December). Hayama, Japan: Institute for Global Environmental Strategies. DOI: 10.57405/iges-12623.

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