Greenhouse Gas (GHG) Emission Mitigation and Ecosystem Adaptation along Belt and Road Initiative

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ABSTRACT
Since its launch in 2013, the Chinese Road and Belt Initiative (BRI) has grown into a platform for any countries and regions that wish to participate, with global connectivity as the orienting goal. However, since its inception, concerns over the BRI’s potential impacts on ecology, environment and resilience, as well as its implications for global climate change and sustainability, have gathered force. As this thematic issue goes to press, these already complex BRI issues have been compounded by challenges from the COVID-19 pandemic. Whether and how the BRI can meet these challenges are questions worthy of deep exploration. This emerging BRI scholarship studied various aspects of BRI activities. However, major knowledge gaps remain regarding BRI impacts on GHG emission and on climate adaptation and sustainable resource management more broadly. To this end, this thematic issue aims to contribute to deeper understandings of climate and environmental changes along the BRI by bringing together state-of-art research and views on climate change patterns, trends, risks, impacts and adaptation.

As this thematic issue goes to press, these already complex Belt and Road Initiative (BRI) issues have been compounded by challenges from the COVID-19 pandemic. The combined economic and social shocks from COVID-19 are challenging the will of national leaders to stick to low-carbon, climate-resilient transitions. There is evidence that climate prioritization is slipping in many places (Evans and Gabbitiss 2020). Given pandemic challenges and – in some cases – fraying international norms of cooperation, major foreign policy initiatives to build connective infrastructure and develop effective collaborative relationships that recognize and respond to climate change and sustainability imperatives have perhaps never been more important. Whether and how the BRI can meet this challenge are questions worthy of deep exploration.

Major multilateral organizations, including the United Nations, the World Bank, and the Asian Development Bank, are monitoring and analyzing BRI impacts (e.g., Shichor 2018; Maliszewksa 2019). New research centers and teams have been expanding in universities and institutions in China and abroad. For instance, Belt and Road Think-Tanks Alliance, which includes more than 60 Chinese think-tanks as members, was established in 2015; Belt and Road Studies Network, which includes 15 major Chinese and international think-tanks, was established in 2019 with an aim to promote cooperation and share knowledge. In 2015, Xi’an Transportation and Communication University initiated the New Silk Road University Alliance to engage roughly 100 universities from 22 countries. Academic journals like Nature and Science also responded to BRI development, publishing a series of articles that explore the environmental impacts of the BRI. Masood (2019) concluded that BRI will transform the lives and work of tens of thousands of researchers. This emerging BRI scholarship studied various aspects of BRI activities beyond established geopolitical and economic and trade foundations, including environmental challenges (Ascenso et al. 2018; An et al. 2020) and high-tech growth (O’Meara 2018; Guo 2018; Horvat and Gong 2019).

However, major knowledge gaps remain regarding BRI impacts on greenhouse gas (GHG) emission and on climate adaptation and sustainable resource management more broadly. To this end, this thematic issue aims to contribute to deeper understandings of climate and environmental changes along the BRI by bringing together state-of-art research and views on climate change patterns, trends, risks, impacts, and adaptation.

This issue presents eight original research articles and is cross-scale, multi-sectoral, and interdisciplinary.
Climate trends and patterns

Based on downscaled data from 18 global coupled models, Zhuang and Zhang (2020) conducted high-resolution projections of three climate indicators, including daily maximum temperature ($T_{\text{max}}$), daily minimum temperature ($T_{\text{min}}$), and diurnal temperature range (DTR), in the main BRI regions in the two periods of 2020–2039 and 2080–2099 for the Representative Concentration Pathway (RCP) 4.5 and 8.5 relative to the historical period 1986–2005. Results show that the mean observed $T_{\text{max}}$, $T_{\text{min}}$, and DTR from 1986 to 2005 in main BRI regions are 17.88°C, 6.56°C, and 11.31°C, respectively. Relatively, $T_{\text{max}}$ and $T_{\text{min}}$ will increase by 1.14°C and 1.20°C, respectively, in the next 20 years (2020–2039) under the RCP4.5, while by 2.46°C and 2.54°C under RCP8.5. In the late twenty-first century (2080–2099), $T_{\text{max}}$ and $T_{\text{min}}$ will increase by 1.33°C and 1.38°C under the RCP4.5, while by 4.92°C and 5.03°C under RCP8.5, respectively. An increased DTR will be projected for both periods in many areas surrounding the Black Sea and Caspian Sea, and southeastern China, but DTR in North Asia is projected to significantly decrease. Strong seasonal variations are projected for the three variables. In the Mediterranean and Black sea regions, the DTR will increase largely from June to September and yet decrease from November to March. In the North Asia, there are small changes from May to September, yet a notable decrease from November to March.

Mitigation emergency and low-carbon development challenges

Chai, Fu, and Wen (2020) developed a Belt and Road Integrated Assessment Model to assess the implementation gaps of National Determined Contribution (NDCs) of 121 BRI countries for achieving the temperature goal of Paris Agreement. This multiregional hybrid model is composed of a partial equilibrium module Finance, Infrastructure, and Trade with four subsectors, including economy and trade, energy and power, transportation, and agriculture, forestry, and land use. It also has a soft link with the simplified climate and air pollution model by using the impact/adaptation cost curves. Results showed that the total carbon dioxide (CO$_2$) emission related to fossil fuel and industrial process in the BRI regions will continue to increase from 20 Gt in 2015 to 27.7 Gt in 2030 and 38.1 Gt in 2050 under the business as usual (BAU) scenario. Under the NDC and 2-degree scenarios, the CO$_2$ emission will decrease by 3.2 and 8.0 Gt, respectively, in 2030, and 9.0 and 25.0 Gt in 2050. Current NDCs of the BRI countries are not ambitious enough to achieve the 2-degree temperature goal of Paris Agreement. However, efforts in other countries are also insufficient to fulfill the global 2-degree goal. As the world should achieve climate-neutrality around 2060 to achieve the 2-degree goal, it will bring mega challenges to the developing countries in Belt and Road regions. Spatially, the Middle East and North Africa, sub-Saharan Africa, Latin America, and Association of Southeast Asian Nations are the main contributors to the emission growth, as their growth rate is projected to be 1.8–3.4% for BAU and 0.9–3.3% for NDC from 2015 to 2050. To achieve the NDC objective, BRI countries need an annual investment from US$281.9 billion in 2015 to US$530.1 billion in 2050 in clean energy and related infrastructure. The investments will double each year under the 2-degree scenario.

Hou et al. (2020) applied a global multiregional input–output method to estimate the consumption-based emissions (including CO$_2$ and non-CO$_2$ emissions) as well as emissions embodied in trade in selected 88 BRI countries (BRI-88, including 16 developed countries, 55 developing countries, and 16 least developed countries), and to identify the emission-development characteristics of different countries. Results showed that emissions from BRI-88 continue to grow, but their global share of GHGs will remain stable. Their consumption emissions are growing faster than production emissions, but BRI-88 is a GHG net exporter whose production emissions (12.32 billion t CO$_2$e in 2011) exceeded consumption emissions (12.17 billion t CO$_2$e in 2011). The 55 developing countries are the major emitter of BRI-88, which accounts for 81% and 79% of regional production and consumption emissions, respectively, with huge potential for rigid growth. The per capita production emission and consumption emissions were averagely 4.83 and 4.78 tCO$_2$e, respectively, in BRI-88 in 2011, both lower than the global average of 5.98 tCO$_2$e/person. However, huge heterogeneity exists, with developed countries had a per capital consumption emission of 11.84 tCO$_2$e/person, twice the global average, while developing countries and least developed countries had one lower than global average (5.16 and 1.18 tCO$_2$e/person). In the 6.60 billion tCO$_2$e embodied emissions in global trade, the BRI-88 group rank first and second in the world for embodied import and export emissions.

Gu and Zhou (2020) evaluated the impacts of China’s renewable energy investment in the Belt and Road region on carbon emissions. They found that China’s investment and implementation of green energy in this area will provide a strong impetus for the energy transformation and have sound carbon mitigation benefits. China’s energy investment and capacity cooperation in BRI countries have been increasing. By December 2018, China has invested renewable projects with a total installed capacity of 33.95 GW, 27.0% of which are in operation, 23.8% under construction, and 47.7% at the planning stage. Among the installed capacity of 15.75 GW in operation, solar energy and wind energy account for the 74% and
25% of the investment. The life-cycle analysis shows that renewable energy investment from China in the 36 BRI countries currently reduces emissions by at least 48.69 million tCO₂, which accounts for 0.6% of their carbon emissions. Renewable energy installations are expected to increase by 1940 GW by 2030. If China will participate in the renewable energy projects by 100 GW in 2030, it is estimated that the total investment will reach RMB 500 billion and the carbon emission will be mitigated by 240 million tCO₂e.

Impacts and adaptation

Given the significance of agricultural sector for the social and economic development of Central Asian countries and the vulnerability of their environments to climate change, how to cope with climate change is a key element of policy agendas throughout Central Asian countries. While options, ranging from technical, financial, political, and managerial approaches, have been developed for the agricultural sector to adapt to climate change, Central Asian countries generally lack financial and technical capability coping with increased variability. International agricultural trade is considered as potential adaptation to climate change at some localities. Yu et al. (2020) pointed out that although a few studies have realized the potential adaptation of agriculture trade, far too little attention has been paid to the effect of climate change on cereal trade in Central Asia. Yu et al. took Kazakhstan as an example and applied gravity model incorporating Poisson Pseudo Maximum Likelihood approach to empirically reveal the relationship between climate change and cereal trade. The findings showed that climate change would affect the import and export of rice, wheat, and maize differently. The conclusions indicated that under the increased challenges of climate change, international cereal trade could be an effective adaption to ensuring food supply in Kazakhstan.

Zhang et al. (2020) employed the club-convergence test to uncover the wheat yield convergence of 48 BRI countries and described the status of wheat yield inequality. Three convergence clubs were identified as high-, middle- and low-level yield clubs. Of which, 12 of the 24 countries in high-level club are in Central and Eastern Europe, 7 in Western Asia, 3 in Central Asia, and 2 in Southeast Asia. The middle-level club consists of six Southeast Asian countries, five West Asian countries, one Central Asian country, and five Eastern European countries, which are characterized of temperature continental climate. Seven countries are in low-level club, including Mongolia, Iran, Thailand, Turkmenistan, Jordan, Kazakhstan, and Yemen. The result also indicated that temperature increase had a positive effect on the wheat yield converging to higher yield club. But improvement of technology and inputs played a critical role, such as fertilizer, pesticide, and improved crop varieties.

Southeast Asia, one of the world’s most dynamic and fastest-growing regions in the world today, has seen higher temperature and a sharp rise in the frequency of extreme weather events, including droughts, floods, and tropical cyclones (ADB 2009). An et al. (2020) applied the CV-TOPSIS methods to evaluate the flood risk in the vulnerable region, based on the hazard-exposure-vulnerability framework and multisources data. Results showed that the Southeast Asia will see increasing flood risks due to large population, fast-growing economies, and rapid urbanization. The 11 countries can be divided into three groups according to their varied risks of floods. The first group includes Brunei, Cambodia, Malaysia, the Philippines, Singapore, and Thailand, which are projected to have rising flood risks. The second group includes Laos, Indonesia, Myanmar, and Timor-Leste with almost stable risks. The third group only includes Viet Nam, characterized of stably high flood risk.

International cooperation

The BRI also created new market demand for climate technology and provided new opportunities, mechanism, and channels for technology transfer. Chen et al. (2020) summarized the key global trends and contexts in which technology transfer modes evolved, i.e., ecologization, informatization, and globalization. Based on first-hand survey data and face-to-face interviews with focused groups, they attempted to identify the needs, barriers, and opportunities for climate technology transfer in the BRI region from receivers’ perspectives. They found that the prior technologies for mitigation are public transportation, waste to energy, and solar energy, while those for adaptation include irrigation, conservation agriculture, nutrient management, water recycling and reuse, source water protection, urban drainage management, and disaster prevention, and waste recycling. The top barrier for technology transfer in BRI regions was the high initial investment. Respondents doubted if their country could provide sufficient sources of public and private funds for these technologies. The findings also confirmed that conventional government-dominated climate technology transfer in this region needs to adapt to changing contexts and be complemented with innovative approaches involving multi-actors in different phases of climate technology development.

Knowledge gaps and research needs

Although peer-reviewed publications are emerging, important knowledge gaps existed in the carbon emission and adaptation in BRI regions, including high-resolution climate change projections and impacts in
key regions and countries; the implications of economic development and infrastructure investment in BRI areas on energy consumption and carbon emissions; regional projection of GHG emissions and mitigation trajectory; climate change risks and adaptation options; nexus of low-carbon development, adaptation, and sustainable development goals; and the actors, mechanisms, and modes for enhancing climate cooperation.

The spreading COVID-19 increased the uncertainties on top of these challenges. The accumulation of catastrophes and the multiplicity of systematic threats generated by pandemic, climate change, trade wars, and financial crisis and alike will affect different actors’ responses to the required collective transitions crucial to our common future. Climate mitigation and adaptation need to be reframed as developmental issues, and co-benefits need be pursued whereas possible. Current communication among BRI country governments, international organizations, and other nongovernmental actors is far from being effective. On the one hand, scientific knowledge is available on causes, damages, and risks in many cases; on the other hand, locality-target group-specific solutions and their impacts are largely under studied and communicated. Although much effort has been made at international/regional level, mainly led by international organizations, funds, and programs, there are still many barriers on the way to close the last-mile gaps. Interpretations of scientific knowledge and policies, formulation of communication strategies and plans, co-framing of the issues and visions, multi-perspective evaluations of actions, institutionalized involvement of non-governmental actors in decision-making and implementation process, local capacity building, and technology-empowered tele-coupling would be crucial in this regard.

To address both the COVID-19-induced economic crisis and climate crisis, many governments are making efforts to green their economic recovery plans, from less green American stimulus (Rhodium Group 2020) to EU’s European Green Deal, Green New Deal, and the first draft European Climate Law (EU 2020), to the unfolding China’s 14th Five-Year Planning, in which comprehensive green development will be at the core. Economists believed that economic recovery measures could lead to a rebound in carbon emissions unless they stimulate low-emission or climate-resilient investment flows to clean and resilient sectors instead of traditional “dirty” or “vulnerable” ones (International Energy Agency (IEA) 2020). On 22 September 2020, President Xi Jinping’s pledge for China to be carbon neutral before 2060 was widely welcomed as a nice surprise and triggered lot of discussions, interpretations, and outlooks worldwide (Xi 2020). Globally 126 countries, covering 51% of the total greenhouse gas emissions in the world, have rolled out targets for zero greenhouse gas emissions or agendas of carbon neutrality (UNEP 2020). International cooperation at various levels is crucial to achieve these goals of carbon neutrality and green recovery, as well as broader goals under the 2015 Paris Agreement and United Nations Sustainable Development Goals. As an initiative that is to pose considerable influences on global economy and climate, the greenery of BRI will also call for more active engagement of various actors, including international organizations, nongovernmental organizations, as well as all countries alongside and outside BRI.

This special issue serves as an attempt to discuss some of the abovementioned aspects of climate mitigation and adaptation along the BRI in one volume, with the goal of sparking multidisciplinary cooperation and users-oriented studies in the future. All BRI parties own the challenges of greening BRI projects and strategies in the post-COVID-19 era. Against the trend of reverse globalization, the BRI may offer new opportunities for the international community to cooperate in the face of formidable climate and sustainability challenges.

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