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EDITED BY
Ruilian Zhang,
The University of Queensland, Australia

REVIEWED BY
Ziheng Shangguan,
Hohai University, China
J. Abbas,
Shanghai Jiao Tong University, China

*CORRESPONDENCE
Taoan Ge
690777142@qq.com

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A conceptual framework for assessing social and environmental impacts of belt and road initiative and just energy transition

Taoan Ge*

Changzhou Academy of Governance, Changzhou, China

To address the social and environmental impacts of China's Belt and Road Initiative (BRI) and just energy transition, this research provides a conceptual framework to assess social and environmental impacts by selecting socioeconomic and environmental indicators through a literature review. The framework highlights that assessment indicators should include quantitative and qualitative dimensions. We also discussed the similarities and differences in foreign aid between developed countries and China's BRI, the relationship between the BRI, just energy transition and globalization, sustainable development goals (SDGs), and social-environmental resilience. This conceptual assessment framework and discussion provides stakeholders with an approach to contribute to mitigating the socio and environmental impacts of project development.

KEYWORDS

belt and road initiative, social-environmental impacts, sustainable development goals, globalization, just energy transition, foreign aid

Introduction

The energy transition affects the social-environmental system by changing traditional patterns of energy use across the globe, especially where production is highly dependent on fossil fuels (Wang and Lo, 2021). Its impacts include broader consequences across the equitable distribution of negative effects on land, livelihood, food security, and positive opportunities. The "just" and systemic transition will reduce inequalities that already affect the existing food system and will not rely on a resource-intensive model. However, it is a big challenge to assess its impact. Importantly, China's going out policy, especially Belt and Road Initiative (BRI) will level up these impacts during the energy transition.

The "BRI," launched by the Chinese government in 2013, aims to promote joint development, common prosperity, and cooperation between China and other Asian, European, and African countries. Geographically, the BRI includes six major infrastructure corridors, namely, the New Eurasian Continental Bridge Economic

Corridor, the China-Mongolia-Russia Economic Corridor, the China-Central Asia-West Asia Economic Corridor, the China-Pakistan Economic Corridor (CPEC), the China-India-Burma Economic Corridor, and the China-Indochina Peninsula Economic Corridor. In 2017, there were ∼7,300 contracted projects in these countries with a total investment of $144 billion, accounting for 54.4% of China's foreign contracted projects (Ministry of Commerce of the People's Republic of China, 2018).

Concerns on the environmental impacts of BRI have recently attracted considerable global attention (Ascensão et al., 2018; Hughes, 2019; Liu et al., 2019; Turschwell et al., 2020). Direct and indirect impacts from infrastructure development can negatively affect all components of the earth system from the atmosphere to the biosphere. Impacts from linear infrastructure such as roads and rail are a particular concern for biodiversity as they cause habitat loss and fragmentation, increase wildlife mortality, and open up frontier landscapes to illegal activities such as poaching (Ascensão et al., 2018; Hughes, 2019). However, increased economic development, especially development that relies on carbon-intensive growth models, will result in a range of environmental impacts including increased greenhouse gas emissions. The likelihood and magnitude of impacts from infrastructure development is the property of not only the Chinese government and financiers but also the host country's environmental standards, regulation, and enforcement (Zhang et al., 2018; Abbasi et al., 2021; Aman et al., 2022).

Belt and Road Initiative projects are funded by foreign aid and foreign investment, which in turn can be an important factor in determining social and environmental risks. Foreign investment, especially when focused on primary infrastructure, promotes the movement of people, influences trade decisions and patterns, and accelerates urbanization. Each of these changes has a determinable effect on the social-environmental systems of recipient countries. Foreign aid and foreign investment involve the transfer of funds, capital, and resources from one country to another and are recorded in a country's balance of payments. While technically different, scholars have argued that both foreign investment and aid are motivated by the strategic interests of the source country (Selaya and Sunesen, 2012). To date, few studies have considered the impacts of foreign investment or foreign aid on environmental and social issues from a long-term perspective.

In this study, we developed a framework to assess the social and environmental impacts of BRI and just energy transition. Moreover, we discussed our framework in the contexts of the similarities and differences in foreign aid between developed countries and China's BRI initiative, the relationship between the BRI initiative, just energy transition and globalization, sustainable development goals (SDGs), and social-environmental resilience.

Literature review

As energy transition mainly requires reducing the use of fossil fuels, which will lead to coal phase-out or coal transition step by step. BRI will start large-scale infrastructure development as well as renewable energy development. There will be more projects developed under BRI and just energy transition globally. In this study, we used BRI projects as our cases due to their accessibility. As Chinese enterprises invest in major infrastructure projects abroad, problems are emerging. The Myitsone hydropower station investment failure in Myanmar and the railway storm between China and Thailand are two recent examples (Zhang et al., 2017). Proposals for CPEC indicate that many projects are to be scheduled, suggesting further environmental, social, and governance pressures for countries within the corridor's catchment. The following review provides an outline of socio-environmental effects identified by scholars across the hydropower, infrastructure, coal mining, and power plant sectors.

Hydropower projects

Perhaps more than any other large infrastructure project, large dams represent a complex network of social, economic, and environmental processes. Large hydrological project construction is often accompanied by impacts on environmental and local communities. Studies investigating the environmental and social impacts of hydropower projects have mainly focused on the hydropower dams of the upper and lower Mekong River Basin (MRB) and Yangtze River Basin (Three Gorges Dam, TGD). The Mekong is the world's ninth largest river, flowing for over 4,900 km from its source on the Qinghai Tibet Plateau (QTP) at a 5,200 m elevation to the Mekong Delta in Vietnam (Kuenzer et al., 2013). Large-scale dams on the MRB will inevitably lead to environmental and social costs, rendering these ambitious hydropower plans highly controversial and politically charged (Barrington et al., 2012). The Xayaburi Dam in the Lao PDR on the MRB resulted in the forced migration of 18 villages, leading to the resettling of at least 2,100 people, and 202,000 people living near the dam site will be directly affected.

The negative environmental impacts of dam construction, mainly including the loss of migratory fish species, reduction of hydroelectric capacity, and salt intrusion, have severe consequences on the environment and livelihoods of the rural Mekong population (Pearse-Smith, 2012). Dam construction in the MRB mainly impacts capture fisheries and agriculture, leading to food security issues that threaten the underlying stability of nearby communities (Kibler and Tullos, 2013). In the Nu River of China, the installed capacity of the four large dams is 10,400 MW, and the capacity of the 31 small dams is 417 MW. The cumulative biophysical impacts include issues related to habitat loss, catchment connectivity, and landscape stability

(Wang et al., 2013). The Manwan Dam has effects on the rural economy, transportation, housing for affected persons, culture, health, and gender issues with a 1,500 MW installed capacity and 7,260 relocations (Orr et al., 2012). The TGD is likely to flood ∼34,000 ha of agricultural land, leading to livelihood impacts for almost 1.5 million displaced people (Jackson and Sleigh, 2000). Disease risks are important social effects of TGD, and the cumulative impacts are related to the issues of flora, terrestrial fauna, and aquatic fauna (Zhang and Lou, 2011). In total, the area expanded for new cities and towns is 54.95 km^2 (Beck et al., 2012), which has changed the geographical landscape of Chongqing and Hubei. The development of the TGD is accompanied by negative biophysical, socioeconomic, and geopolitical impacts, mainly including relocation from affected areas, decline in aquatic fisheries, reduction in downstream flows, and loss of culture and social disintegration (Xu et al., 2013).

Infrastructure projects

The literature on the social outcomes of high-speed railways (HSRs) can be divided into the following five main headings: accessibility, movement, and activities, and health-related, finance-related, and community-related impacts. Social impacts are influenced by the following three factors, namely, people, transport, and land use. Uncertainty may lead to psychosocial impacts, fear, aggression, annoyance, and discomfort among affected persons (Karst et al., 2009). After the opening of the Tohoku Shinkansen, nearby cities grew in population by 32%, whereas those in the same region but in more remote locations saw no growth (Preston and Wall, 2008).

Public acceptance of the HSR was high due to perceived low environmental and social risk and high economic and social benefits. The main studies investigating the social-environmental impacts of transportation in China focus on the Qinghai Tibet Railway (QTR). The QTR will cause a dramatic influx of people from inland China and attract tourists worldwide. The increase in tourists will also result in a substantial increase in population, infrastructure, and related human activities, which will in turn have dramatic impacts on local and regional environments.

In the best-case scenario, the HSR is likely to be a catalyst rather than a determinant of growth (Zhang et al., 2008). The highway portion of the planned infrastructure would cause 120,000–270,000 km^2 of additional deforestation over 20–30 years. Deforestation inevitably leads to the loss of the opportunity for the sustainable use of the standing forest, including tapping the value of environmental services (Fearnside, 2002). The impacts of highways and railways on wildlife include the direct loss of habitats, degradation of habitat quality, habitat fragmentation, and increased human exploitation (Yin et al., 2015).

Coal mining and coal power plant projects

The coal mining industry is an underlying driver of employment and economic conditions in many local and regional communities. More importantly, this industry has direct and indirect social and environmental impacts. The Bowen Basin is a large coal mining region in Central Queensland, Australia. Coal mining firms directly employed ∼16,400 people, who were paid almost $1,000 million in salaries in 1999/2000. It is estimated that up to 60,000 full-time and part-time jobs are involved in the provision of goods and services to the mining industry (Ivanova et al., 2007).

In the short-term, Coppabella coal mining has led to a population decrease of 5%, but in the long term, the population has increased by 21% and the coal mining industry contributes ∼1.8% of GDP (Lockie et al., 2008, 2009). The Warkworth Mine and Drayton open-cut mine could provide 975 and 224 direct jobs, respectively, and in Muswellbrook, the mining industry directly employed 13%−16% of the total Shire workforce between 1996 and 2006 (Bian et al., 2010; Morrice and Colagiuri, 2013). PM_{10} emissions from coal mining and electricity generation facilities in the Muswellbrook and Singleton areas have steadily increased from 37,200 tons in 2002–2003 to 55,160 tons in 2007–2008 (Franks et al., 2010). Mining 10,000 tons of raw coal will result in 0.2 hectares of subsiding land in China. Land subsidence not only reduces crop production but also causes other environmental problems, such as utility failures, plant death, surface fracture, and soil loss (Singh, 2008).

Research context

Study area

The study area is located in the Indus River Basin between the 23°13′N and 40°18′N latitudes and the 60°00′E and 79°57′E longitudes and has a total geographical area of 992,048 km^2 and a population of almost 190 million persons (Figure 1).

According to a development memorandum between the governments of China and Pakistan, the CPEC includes Pakistan, Kashgar, and China's Tumxuk City, Artux City, and Akto County. The CPEC starts in Xinjiang in China and ends at Gwadar Port in Pakistan and has a total length of 3,000 km. The territory of Pakistan consists of four provinces, two federal territories, and two special regions of Kashmir. Detailed socioeconomic information for the CPEC region is described in Table 1, which indicates that the southeastern region has the largest population and the highest GDP per capita in Pakistan. The southwestern and northern regions have a lower population density and GDP. GDP in the Kashgar region of China is significantly higher than that in other Pakistani provinces.

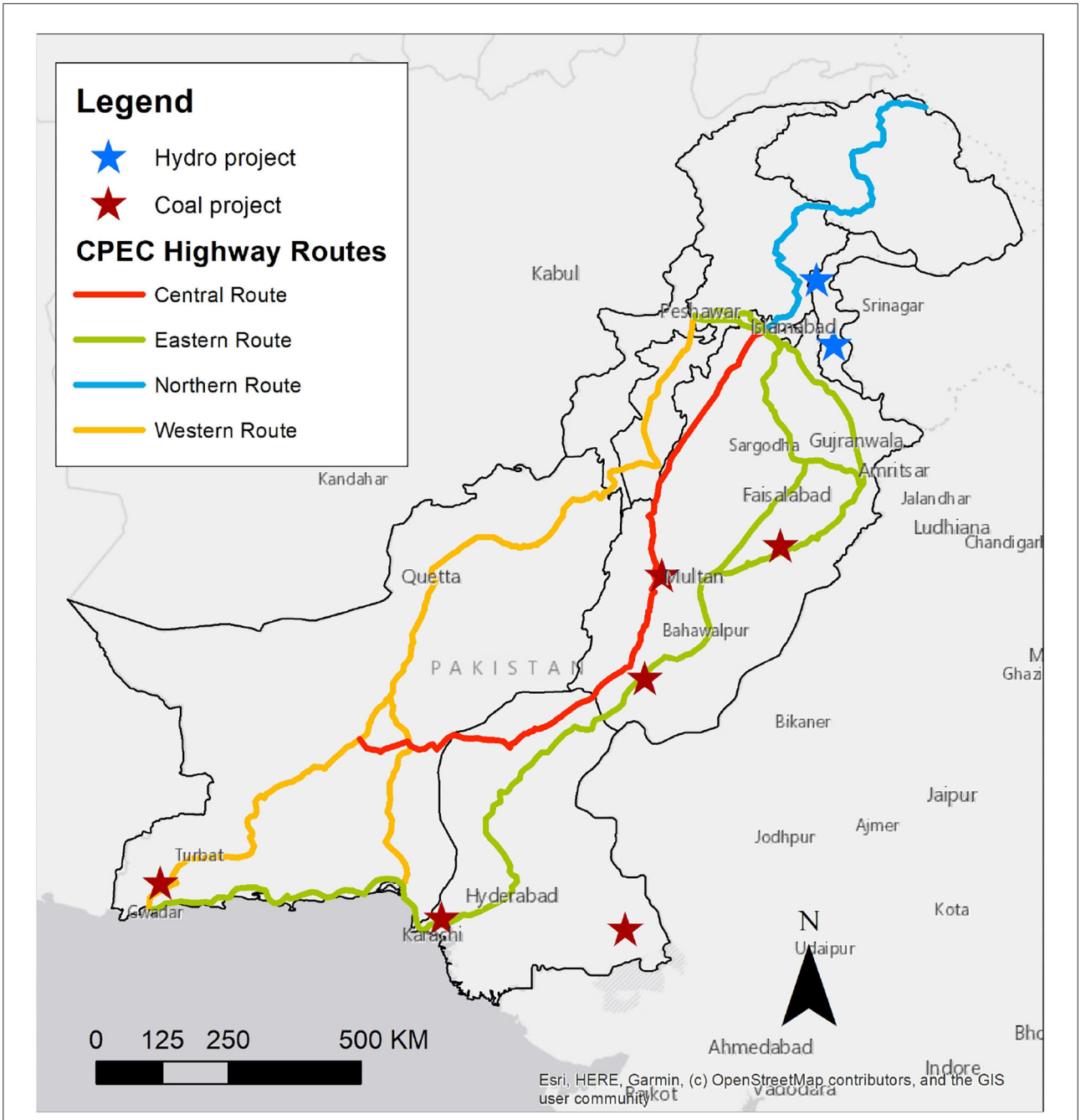

FIGURE 1
Map of the China-Pakistan Economic Corridor (CPEC). Adapted from Farooqui and Aftab (2018) The CPEC is one of six economic corridors of the Belt and Road Initiative (BRI) initiative, which is located in the Indus River Basin between latitudes 23°13′N and 40°18′N and longitudes 60°00′E and 79°57′E, linking the city of Gwadar in southwestern Pakistan to China's northwestern Kashgar of the autonomous region of Xinjiang *via* a vast network of highways and railways.

BRI projects

Energy shortages and poor infrastructure are fundamental challenges in Pakistan. It is estimated that inefficiency in the transportation system imposes a cost of 4%–6% of GDP and that electricity shortages cause an annual loss of 7% of GDP. BRI projects in the CPEC include projects related to the construction of highways, railways, and cable channels between Western China and Pakistan. These projects will be implemented in different phases according to the CPEC plan. The power

TABLE 1 Socioeconomic data of the China-Pakistan Economic Corridor (CPEC) regions.

Regions	Major provinces	Major cities	Population (Millions)	Population density (P/km^2)	GDP ($ Millions)	Per capita GDP ($)
Southwestern region	Baluchistan province	Quetta	9.71	38.55	6,458.75	665.47
	Khyber-Pashtun province	Peshawar	23.28		17,223.76	739.84
Southeastern region	Punjab province	Lahore	10.01	331.4	122,723.94	1,215.09
	Sindh province	Karachi	55.24		59,208.19	1,071.73
Northern region	Kashmir	N/A	5.33	62.77	N/A	N/A
Chinese region	Xinjiang autonomous region	Kashgar	22.98	14.06	136,443.96	5,937.5

The data were derived from the Pakistani and Chinese government websites and calculated by the authors. "N/A" means not available or applicable.

TABLE 2 Planned projects in the CPEC.

Phases	Hydropower projects (MW)	Coal-fired projects (MW)	Infrastructure projects (KM)
2015–2020	1,590	6,900	830
2020–2025	1,100	1,320	1,830
2025–2030	180	N/A	N/A
Total	2,870	8,220	2,660

The data were derived from the Pakistani government's websites (http://cpec.gov.pk/index) and calculated by the authors. "N/A" means not available or applicable.

generated from hydropower, coal-fired plants, and wind farms between 2015 and 2020 will be 1,590, 6,900, and 300 MW, respectively; between 2020 and 2025, these values will be 1,100, 1,320, and 100 MW, respectively. The installed hydropower between 2025 and 2030 will be 180 MW. The infrastructure construction length is 830 and 1,830 km over the short- and long-term periods, respectively (Table 2).

Social-environmental assessment frameworks for BRI and just energy transition

Despite all theoretical and empirical criticism of the GDP as a social welfare indicator, its role in economics, public policy, politics, and society continues to be influential (Muazzam and Nasrullah, 2011). Therefore, GDP was chosen as an economic indicator. Land values and population growth are reflections of economic development, urbanization, and social welfare, and these indicators were also chosen for this study. To achieve a better distribution of the benefits of economic growth and reduce the number of the relatively poor, countries must adopt effective employment policies (Cantillon, 2011); therefore, the employment rate was chosen for this study. Accessibility is a powerful concept used to measure transportation system performance, guiding transportation and land-use planning (Miller and Wu, 2000). Therefore, accessibility was chosen as a socioeconomic indicator. Population displacement is the most important impact of reservoir construction, which leads to joblessness, homelessness, landlessness, and income loss. However, hydropower stations generate power despite their negative impacts (Singh, 2008). Therefore, power generation and displaced populations were also chosen as indicators.

Reservoir construction currently represents the most important influence on land-ocean sediment fluxes. Sedimentation is a notable threat to the sustainability of reservoirs that may negatively impact the ecosystem (Kummu and Varis, 2007). High evaporation rates threaten water retention in storage (Celeste and Billib, 2010). Infrastructure construction could lead to deforestation, which increases the cultivated area but reduces land productivity over the long term (Angelsen, 2010). Infrastructure emissions occur during the construction phase, the use phase, and the end-of-life phase (Müller et al., 2013). Cumulative carbon emissions contribute to global environmental change. Therefore, sedimentation, evaporation, deforestation, and carbon emissions were chosen as indicators. Landscape change has extensive impacts on the Earth's climate, hydrology, water resources, soils, and biota (Mahmood et al., 2014). Landscape change plays an increasingly important role in urban land resource management, urban expansion, and damage assessment, while subsided land is an important negative impact of mining construction (Lv et al., 2017). Therefore, landscape

change and subsided land were chosen as environmental indicators. Most new urban land is converted from arable land, which reduces the productive land available to rural residents. Therefore, land loss was chosen as an indicator. Soil erosion (SE) was also chosen because it is one form of soil degradation induced by human activities and has become one of the most serious environmental problems attracting attention worldwide. The selected indicators of the socioeconomic and environmental impacts are shown in Table 3.

In addition to the quantitative indicators mentioned above, we also considered qualitative indicators. These indicators include the issues of ethnic minorities, women's rights and interests, regional economic development, and biodiversity, which are difficult to calculate. Large hydrological project construction is often accompanied by impacts on the issues of ethnic minorities (indigenous peoples' interests, religious beliefs, and culture or social disintegration) and vulnerable groups (women, children, and the elderly). As a reflection of regional economic development, leisure industry development and changes in urban spatial structure are positive social outcomes of infrastructure construction. Losses of migratory fish species, fish spawning grounds, and nutrient-rich soil deposits are some of the types of biodiversity changes induced by hydropower construction that have severe impacts on the environment and the livelihoods of affected persons (Orr et al., 2012).

The qualitative socioeconomic impacts of hydropower projects mainly include indigenous peoples' interests, gender issues, religious beliefs, and economic distortion. The environmental impacts of hydropower projects are mainly related to biodiversity loss (Kuenzer et al., 2013). The socioeconomic impacts of infrastructure projects mainly involve disruption of the social structure and restructuring of the urban spatial structure. The environmental impacts of infrastructure include dust, noise, and increased human exploitation (Gillespie and Bennett, 2012). The socioeconomic impacts of coal mining projects include increases in displaced persons, land requirements, and local business. The environmental impacts of coal mining projects include coal slurry spill, health costs, mining waste disposal, mine fires, noise, and vibrations (Yin et al., 2015).

Implications

In this section, we discussed the similarities and differences in foreign aid between developed countries and China's BRI, the relationship between the BRI, just energy transition and globalization, SDGs, and social-environmental resilience.

Similarities and differences in foreign aid between developed countries and China's BRI

Foreign aid has traditionally flowed from developed countries to developing countries and regions, especially from the United States, Japan, England, and Australia to Africa, Asia, and South America. However, recently, developing countries with rapid economic growth have started to provide foreign aid to countries suffering from poverty, hunger, conflict, and war. China began to provide some types of foreign aid several years ago. We discussed the similarities and differences in foreign aid between developed countries and China to shed light on improving the BRI (Table 4).

The purpose of foreign aid has always been to improve the social, economic, cultural, and educational status of aid-recipient countries. As shown in Table 4, the modes and contents of foreign aid differ among the four countries and are more complex in Japan and Australia than in the other two countries. In Japan, bilateral aid is provided in the following three modes, namely, technical cooperation, finance and investment cooperation, and grants. In Australia, the aid program is delivered through partnerships with the private sector, multilateral organizations, NGOs, volunteer organizations, philanthropic organizations, and partner governments. China and the United States are simpler. China's BRI has changed the previous grants and interest-free loans to concessional loans. The United States focuses on loans and grants. The foreign aid contents of China and the United States are more concise than those of the other countries. The BRI aims to invest in the construction of infrastructure, hydropower, energy resources, and industrial zones. In the United States, foreign assistance is categorized as either economic assistance or military assistance. Japan and Australia have greater variety in the contents of their foreign aid. Both Japan and Australia focus on infrastructure development to increase rural and urban connections. Japan and Australia also address social issues through social and economic development.

The developed countries have similar reasons for providing foreign aid. These countries are pursuing SDGs aiming to promote prosperity, reduce poverty, and enhance stability. Therefore, the BRI should focus on gender equity and cultural diversity compared with the foreign aid provided by developed countries. Furthermore, it is known that the BRI emphasizes investment in infrastructure and energy projects, and the results show that this type of investment inevitably increases the negative impacts on the social-environmental system of aid-recipient countries. This study highlights that the social-environmental impacts of the BRI should be considered when redesigning and implementing planned projects in the future.

TABLE 3 Assessment indicators for Belt and Road Initiative (BRI) projects and just energy transition.

Impacts	Dimensions	Hydropower	Infrastructure	Coal mine
Quantitative	Social dimensions	Population displacement/Population growth/Power generation/GDP growth/Employment growth/Accessibility growth/Land values		
	Environmental dimensions	Sedimentation/Evaporation/Soil erosion/Deforestation/Landscape change/Subsided land/Land loss/Carbon emissions		
Qualitative	Social dimensions	Indigenous peoples' interests/health impacts/gender issues/religious beliefs/loss of culture/social disintegration/irrigation/fishing/ Economic distortion/income loss for communities/livelihoods	Disruption of social structure/restructuring the urban spatial structure/Modal share changes in railways/goods interaction/labor/commercial	Landlessness/joblessness/displaced person/land requirement and forestland requirement/Increases in rents and local business
	Environmental dimensions	Aquatic ecosystems change/noise/landslide and excavation debris/loss of migratory fish species and nutrient-rich soil deposits/biodiversity loss	Dust/noise/increased human exploitation	Coal slurry spill/health cost/mining waste disposal/mine fires/water regime change/noise and vibrations

BRI, just energy transition, and globalization

Rather than completely shifting from one set of dominant energy resources to another, energy transition involves the phasing out of fossil fuels, while increasing renewable energy resources such as solar and wind, which used to occupy only a small share of the energy mix (Wang and Lo, 2021). The world has become a global village, and globalization creates substantial challenges, such as the liberalization of markets, intense competition, declines in domestic job opportunities, and economic volatility of integrated markets. In addition, the BRI includes six economic corridors involving more than 60 countries worldwide. The impacts of the BRI initiative will be important globally. Just energy transition has been developed globally. Its impacts have been examined in the past four decades. With the development of BRI, we can see that the impacts of the energy transition will be bigger than ever before as globalization development.

Air pollution is not the concern of a single country and can affect the air quality of neighboring countries that are thousands of miles away. Considering the six economic corridors, there might be more severe environmental impacts. Additionally, in most countries, current globalization has been accompanied by increasing concerns regarding its impacts on human rights and environmental considerations (Lee and Vivarelli, 2006). The countries involved in the BRI, such as those in Central Asia, West Asia, and South Asia, are underdeveloped, with social and environmental conditions resulting in vulnerability; therefore, the BRI should focus on its purposes and impacts in the context of globalization.

BRI and SDGs

Sustainable development goals are a new universal set of goals, targets, and indicators used for framing the agendas and political policies of the United Nations (UN) member states, and SDGs have been shown to benefit social and economic development. The purpose of most foreign aid programs is the pursuit of SDGs (Table 4). Regarding the development plan for the six economic corridors, the SDGs might be hampered by an emphasis on economic growth over social wellbeing and environmental viability. In addition, the BRI will accelerate the pace of climate action, responsible consumption and production, justice, and strong institutions. Therefore, it is necessary to consider the SDGs of the aid-recipient countries when redesigning and implementing the planned projects of the BRI.

BRI and social-environmental resilience

It is well recognized that social-environmental resilience, which is the capacity and ability of a system or group to absorb disturbances, is an important indicator for assessing and managing the responses of social-environmental systems to external stresses due to social, political, and environmental changes (Walker et al., 2004). For aid-recipient countries, the BRI represents both a development motivation and an external disturbance (Zhang et al., 2018). Infrastructure construction, energy, and industrial zone projects will have important impacts on the original social-environmental systems in aid-recipient countries, such as increases in population, deforestation,

TABLE 4 Similarities and differences in foreign aid between developed countries and China.

Areas	Modes	Contents	Purposes	Impacts	Sources
China	Grants, interest-free loans, concessional loans	Infrastructure, hydropower, energy resources, and industrial zone	Policy coordination, facilities connectivity, unimpeded trade, financial integration and people-to-people bonds	Concerning education, health care, poverty reduction, biodiversity and environmental protection for the benefit of the general public and improving production and living conditions in poverty-stricken areas along the BRI	Ministry of Foreign Affairs of the People's Republic of China, 2015
Japan	Technical cooperation, finance and investment cooperation, grants, disaster relief, public-private partnerships (PPPs), and citizen participatory cooperation	Poverty reduction, peace building, gender equality development, climate change, infrastructure, urban and regional development, transportation, human resource development, global environment, rural development, industrial development and public policy	Sustainable development goals	Strengthening the human capacity of individuals who will be key players in their countries' development, promoting "quality growth," promoting human-centered development, contributing to peaceful and secure societies, and strengthening the response to global challenges	Japan International Cooperation Agency, 2017
United States	Loans and grants	Foreign assistance categorized as either economic assistance or military assistance	Sustainable development goals	Agency investments save lives, foster inclusive economic growth, reduce poverty, and strengthen democratic governance	U.S. Agency for International Development, 2017
Australia	Public and private partnerships (PPPs) Delivered through partnerships with the private sector, multilateral organizations, NGOs, volunteer organizations, philanthropic organizations and partner governments	Infrastructure, trade facilitation and international competitiveness, agriculture, fisheries and water, effective governance, education and health, building resilience (humanitarian assistance, disaster risk reduction and social protection), gender equality and empowering women and girls	Sustainable development goals; promoting prosperity, reducing poverty, enhancing stability to promote Australia's national interests by contributing to sustainable economic growth and poverty reduction	Pursuing national interests and extending Australia's influence, impacts on promoting growth and reducing poverty, Australia's value-adding and leverage, and making performance count	Department of Foreign Affairs and Trade of Australia Government, 2017

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evaporation, and SE and decreases in natural resources, job opportunities, and income. In a vulnerable social-environmental system, even small disturbances may cause dramatic social and environmental consequences (Adger, 2006). Therefore, it is critical to consider the vulnerability and resilience of the social-environmental systems in aid-recipient countries when redesigning and implementing the planned projects of the BRI.

Conclusion

With the development of BRI and just energy transition, there will be more renewable energy projects. This study outlines the implications for stakeholders in which the BRI could be designed and implemented to prevent social-environmental impacts. The results show that the implementation of the CPEC and BRI will have different social-environmental impacts in the BRI countries. Stakeholders should consider globalization, SDGs, and social-environmental resilience in aid-recipient countries when redesigning and implementing the planned projects of the BRI.

The main contributions of this study consist of two aspects. First, this study provides a new framework for examining the relationship between human behavior and social-environmental systems. Second, this study evaluates the relationship between the BRI and globalization, SDGs, and social-environmental resilience, which aims to attract stakeholders' attention to balanced development. The results also highlight two important research limitations that should be addressed in future studies. First, to ensure data consistency and comparability, restrictions were applied to the indicator selection. Additional indicators should be explored and incorporated into the assessment in the subsequent steps. Second, it is necessary to develop a precise assessment model for determining the reference scale of the social-environmental impacts of the projects.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Author contributions

Conceptualization, methodology, formal analysis and investigation, writing—original draft preparation, writing—review and editing, and resources: TG.

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Conflict of interest

The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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