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Environmental Concerns of China- Pakistan Economic Corridor (CPEC) on Gilgit Baltistan

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Abstract

The China-Pakistan Economic Corridor (CPEC) has sparked significant infrastructure development in Gilgit-Baltistan, but it has also raised profound environmental concerns. This study examining the main environmental issues of China Pakistan Economic Corridor by focusing its impacts on deforestation, habitat destruction, soil erosion, landslides, and elevated pollution levels in water bodies. The specific vulnerability of Gilgit-baltistan is also brought into consideration by analysis the similar programmes in other mountainous region. Examining this issue, the study also assesses the effectiveness of current environmental policies and regulations in mitigating the negative environmental impacts associated with CPEC projects in Gilgit-Baltistan. This research is based on qualitatively gathering ideas and insights from existing sources such as research articles, books, reports, and journals and the analysis is informed by conceptual framework to create the link between environmental issues with the projects under CPEC. It has been identified that there is critic need of strong environmental legislation, improve regulatory frame work, environmental educations, awareness and community involvement to promote sustainable development. This research aims to educate local communities, government agencies, and environmental organizations about the critical need of strong environmental protection policies that will support sustainable development and guarantee the long-term health of Gilgit-Baltistan's natural and human resources.

Keywords CPEC, Gilgit-Baltistan, EIA, Climate Change, Environmental Measures.

INTRODUCTION

China-Pakistan Economic Corridor (CPEC) has become a historic project of the 21st century in a bid to establish a strong economic and strategic relationship between China and Pakistan. It has been conceived as a network of infrastructure development projects connecting the Gwadar Port in Pakistan and the city of Kashgar in China and has been perceived to be a significant boost to the economies of both nations in terms of offering improved trade routes, energy security and employment. Nevertheless, the sheer magnitude of this project, especially its intended infrastructure expansion in Gilgit-Baltistan (GB), brings about serious environmental issues that are supposed to be given a careful thought (CPEC, 2024). GB is a Pakistani jewel lying in the glorious hug of the Karakoram and Himalayas. It is home to some endangered species such as the snow leopard and Marco Polo sheep, and it boasts of spectacular sceneries, untouched glaciers and a variety of ecosystems. In addition to its ecological value, GB has a rich cultural heritage, strong communities whose living depends on the fine-tuning of natural resources of the area. The fast pace of infrastructural growth envisaged in CPEC is a sword that cuts both ends; for GB. Although, it may have the potential of opening up new opportunities in economic

growth and development of the region, environmental impacts of the huge construction projects are likely to destabilize the ecological sustainability of the region. Building of highways, power plants and industrial areas inevitably will cause in the loss of forests, soil erosion and habitat fragmentation, which will endanger the unique biodiversity of the region. Moreover, there is a high possibility that more traffic along the new routes will cause air pollution, which is another strain to the existing fragile ecosystem. Large scale construction of projects may also contribute to the rate of glacial meltdown, destabilizing, essential water sources in the downstream populations and worsening water scarcity in the area (Ali, shkil, Iqbal, & Javid, 2015)

What worsens these environmental issues is the insufficiency of the current environmental protection and the inability of local communities to influence the decision-making processes. According to critics, the environmental impact assessments (EIAs) conducted for CPEC projects have been expedient and not transparent. Additionally, the issues have been raised regarding the low consultations with local communities on the project planning and their concerns on ways that their lives and their cultural heritages may be adversely impacted (salman, et al., 2018)

Though CPEC brings severe problems to the environment in GB, but possible methods of reducing the problems can make CPEC more sustainable in its development strategy. First of all, there must be strict and transparent environmental impact assessments (EIAs) (Pakistan Environmental Protection Agency, 2023). All these analyses should be conducted in a comprehensive way to consider the potential ecological impact of all the projects based on the perceptions of the local communities as well as the findings of independent environmental analysts. Secondly, environmental degradation can be greatly minimized by sustainable practices that include, use of local material and minimizing deforestation. The green technology solutions to reduce carbon footprint of the project may enhance through the establishment of renewable energy as the source of power (Asian Development Bank., 2015).

In addition, it is important to encourage local involvement in decision making processes to instill a sense of ownership and an assurance that development projects are presented in ways that meet the real needs of the communities in GB. This may include the creation of local environmental committees that have the authority of overseeing project execution and raising the concerns. This can also be achieved by empowering local communities to enjoy the economic opportunities associated with CPEC by capacity building programs and vocational training programs, to create the sense of shared accountability towards sustainable development. Following these mitigation practices, CPEC can be an agent of positive change in GB that will contribute to economic prosperity and protect the ecological integrity of the region (Yin et al., 2025; Qadiret al.,2024). The effectiveness of CPEC will depend on the possibility to reach a delicate compromise between the actual development and environmental safety. This paper focused on the specific CPEC projects established in GB, examine their possible impacts on the environment, and existing mitigation measures to ensure a prosperous future of the area.

ENVIRONMENTAL CONCERNS IN GILGIT BALTISTAN UNDER CPEC

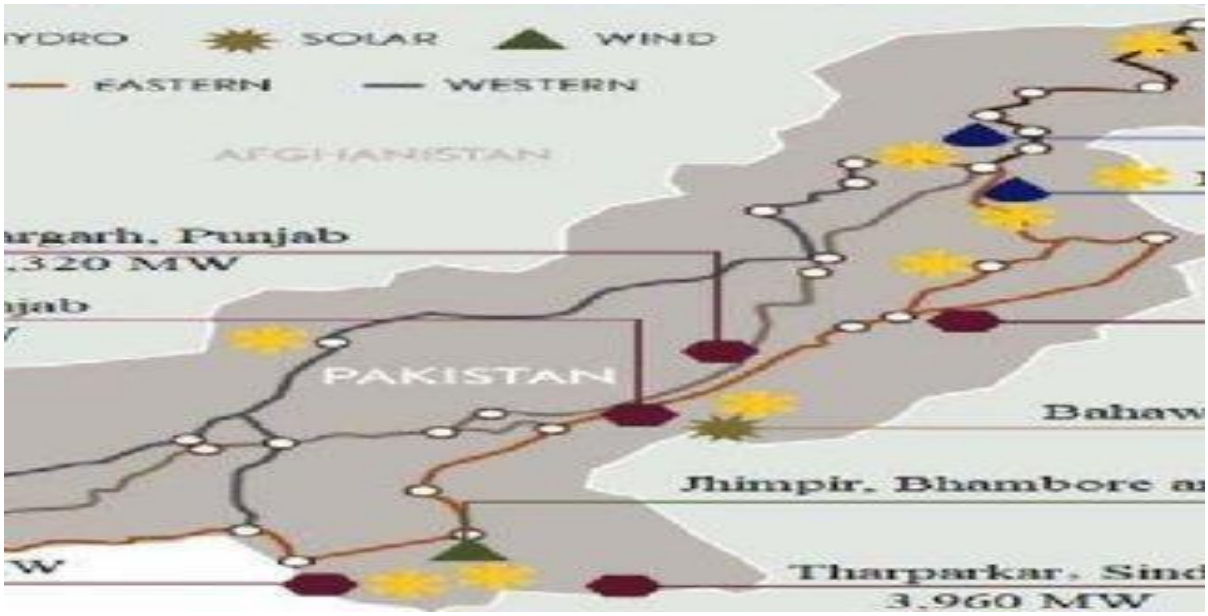
Gilgit-Baltistan (GB) is enclosed by Himalayan, Pamir, Hindu Kush and Karakoram Mountain ridges that create a rocky landscape. Its diverse topography that is between 914 meters and 8,763 meters above the sea level consists of some of the largest glaciers outside polar regions in the world. These glaciers play a significant role to the Indus River that is vital to the agricultural of Pakistan. The woods of Great Britain

provide the much-needed watershed areas, resources to local communities and a wide variety of plants and wildlife that exist across four different biological regions, including the alpine scrub, sub-tropical mountain regions. Due to the diverse fauna of the region that consists of species like ibex, brown bears, and snow leopards, both conservation parks and controlled trophy hunting are held in this region.

Climate change has greatly changed weather patterns in GB, which has resulted in melting of glaciers and upsurge in Glacial Lake Outburst Floods (GLOFs). These changes, including deforestation, destruction of the habitats, rising tourism pollution, and automobile emissions threaten the biodiversity of the region. (Qayyum Durani & Bashir Khan, 2018). It is commonly believed that the China-Pakistan Economic Corridor (CPEC) can radically improve the socioeconomic situation in China and Pakistan. Beside the mentioned goals of development, CPEC has certain environmental issues that need to be addressed. Gilgit Baltistan is among the areas that have been greatly hit by these issues. The aim of this writing is to explore the environmental issues raised by CPEC, especially in the region of Gilgit Baltistan.

Geopolitical Position of Gilgit Baltistan for CPEC

Gilgit-Baltistan (GB) is strategically positioned and thus plays a central geopolitical role in the China-Pakistan Economic Corridor (CPEC). GB had a major role in the history of the Silk Route, facilitating trade between China, Central Asia and the Northern Subcontinent. Being a entry point of the China-Pakistan Economic Corridor (CPEC) in Pakistan, it enables China to reach the Middle East, Africa and Europe. Pakistan has a number of benefits due to the inclusion of GB in CPEC like greater trade, foreign investment, and employment. It also provides China with a safer and faster route instead of the longer maritime route through the Malacca to transits energy. On the other hand, the political conditions in the region remain controversial and effects these projects, as the locals demand constitutional rights and representation in Pakistan's parliament. This problem is further complicated because India does not want the CPEC passed through GB which it regards as a constituent of Jammu and Kashmir. Nonetheless, the geopolitical role of GB cannot be underestimated as a bridge between Central and South Asia, and through CPEC, it can transform the balance of trade and economics in the region.



(Hussain, Hussain, Hussain, Hussain, & Jaffar, 2021)

Deforestation and Habitat Destruction

Forests occupy one third of the land of the Earth and maintain most of the terrestrial life, including human health, by cleansing the air and the water. They give more than 86 million green jobs, vital resources and they serve as carbon sinks alleviating climate change. However, deforestation and degradation is a threat to forests, primarily due to agribusiness and substandard infrastructure design. In 2022 more than 16 million acres forests were lost. Road development, logging and livestock grazing are also causes of forest degradation. Cattle ranching and the mining activities are severe contributors to forest clearance in tropical rainforest, especially to the Amazon forest. For more than 50 years, WWF has collaborated with a range of partners to preserve forests through ethical management, the eradication of illicit logging, the amendment of trade laws, and conservation of wooded areas. (Deforestation and forest degradation, 2018)

China-Pakistan Economic Corridor (CPEC) is one of the major economic prospects of Pakistan as the project will help the country overcome the energy crisis and enhance the development of infrastructure. But with these economic benefits, one cannot ignore the effects on the environment especially deforestation. The clearing of large expanses of agricultural lands and forests that are linked to CPEC construction of highways and rail systems only contributes to an already severe problem of deforestation in Pakistan (Li et al.,2024; Huo et al., 2024). Deforestation in Pakistan does not come as a surprise; Pakistan has a forest cover of only 5.1 percent of the total land within a country which is far below the global benchmark of 25 percent. Some of the causes of this decline include poverty, energy crisis and the presence of a strong mafia in the timber industry. Destruction of forests, particularly on areas such as the upper Punjab and lower Himalayas has some far-reaching consequences such as soil erosion, floods, and disturbance of the local ecosystem.

CPEC implementation also exacerbates these challenges to the environment. The intended paths of the corridor pass through highly covered forests and farms, which causes widespread deforestation. In addition, the subsequent growth of the vehicular traffic along these paths is a further threat, as well as air and noise pollution. Some studies argue that some parts of the routes of CPEC are deserted, and cultivated, however, the total effect on climate and biodiversity cannot be ignored (Tabassum, 2020). The massive construction processes involved in the CPEC, such as road networks, dam constructions and oil and gas pipelines require the removal of vast forested lands. The consequences of this deforestation are instability of the environment as the disappearance of trees affects the local ecosystem and also results to soil erosion. Destruction of natural habitats due to loss of forest cover in Gilgit Baltistan is disadvantageous to the biodiversity of the region.

Forests offer vital habitats to other species and their destruction causes depletion in the number of wildlife. The effect of this loss of biodiversity can be trickle down to the whole ecosystem where not only the plant life will be impacted but also the animals that will need these habitats to survive. Moreover, the non-presence of trees that is important in stabilizing soil and stopping the erosion process predisposes the landslides. Already vulnerable to landslides by virtue of being mountainous, Gilgit Baltistan is even more at risk as it loses forests. Landslides do not only create a threat to the local communities but also cause frequent road accidents that interfere with the daily life and put human lives in danger (Ali & Askari, 2023). Large-scale deforestation is unavoidable as CPEC builds its three-tiered network of roads and highways spanning Western, Eastern, and Central routes. Pakistan's environmental

degradation and susceptibility to climate change are intensified by this deforestation. Threats to critical ecosystems provide a further hazard to biodiversity, as seen in the cases of the Himalayan brown bear and the snow leopard. When cultivated lands and forests are cleared to build CPEC projects, it will decrease the already low forest cover of Pakistan to only 5.1 percent of total land. This will result in increase in pollution, destruction of ecosystems and also reduction in natural carbon sinks which are fundamental in controlling the climate. The above challenges require holistic environmental management practices. These impacts could be minimized through replanting, habitat protection and Strategic Environmental Assessment (SEAs). It is necessary that sustainable biodiversity corridors and other joint projects be set between China and Pakistan so that a middle ground is reached between environmental protection and economic growth(Tabassum, 2020).

Impact of CPEC infrastructure projects on forests and wildlife habitats

The China-Pakistan Economic Corridor (CPEC) significantly impacts forests and wildlife habitats, particularly in the ecologically rich Himalayas. CPEC's infrastructure projects, including extensive road networks, necessitate large-scale deforestation, exacerbating habitat destruction and threatening local biodiversity. Notable mammals, such as the snow leopard, Himalayan brown bear, and Siberian ibex, are increasingly at risk, many already listed as endangered by the IUCN. The environmental degradation not only affects wildlife but also disrupts ecosystem services vital for local communities. Even though Pakistan has been working with organizations such as the WWF on conservation, environmental policies and impact assessments (EIAs) are not considered sufficient to lessen the negative consequences of these large-scale projects. In order to more effectively handle these complex issues, the government has therefore mandated the adoption of Strategic Environmental Assessments (SEAs). In order to combine development with ecological preservation, China and Pakistan are working together to create sustainable biodiversity corridors and rehabilitation projects. They emphasize the importance of comprehensive environmental management plans and stakeholder engagement (Lashari, et al., 2020)

All Types of Pollution: Water, Air, Land and Noise Pollution

The mega project China Pakistan Economic Corridor (CPEC) are imposing impacts on Gilgit-Baltistan's environment to uncontrollable pollution and irreversible depletion of aquatic ecosystem. China and Pakistan have started work on mega dams, gas and oil pipelines, and the extraction of uranium and heavy metals in Gilgit-Baltistan all under the CPEC umbrella. Gilgit Baltistan also supplies more than half of the water needed for irrigation and drinking to projects in China and Pakistan, however this project is negatively affecting the local climate, resulting in unchecked pollution and permanent loss of aquatic ecosystems, according to Global Order.

Besides, the greatest danger is posed by coal power plants due to their pollution and CO2 emission. Second, the CPEC route will be characterized with the increased concentration of CO2 since over 54,000 trees will be removed to construct road infrastructure. Third, the Karakorum Highway alone will have 7,000 trucks on its daily traffic, which will lead to the emittance of an extra 36.5 million tonnes of CO2. (Khalid, Ahmad, & Ullah, 2021). The construction of roads like the Chitral CPEC Link Road is expected, but it might contribute to noise pollution in the region (Baussart, 2021).

(China's CPEC damaging environment in Pakistan's Gilgit-Baltistan, 2024)

Moreover, the deforestation caused by CPEC projects may lead to increased noise levels due to the removal of natural sound barriers (AlJazeera, 2022)

Infrastructure Development

Building infrastructure in areas like Gilgit-Baltistan is fraught with serious difficulties. Building roads, highways, and other infrastructure results in deforestation, which clears trees and endangers the biodiversity of the area. In addition to causing soil erosion, this deforestation exacerbates environmental degradation (Mustafa, 2019). Huge infrastructure projects have the potential to destroy a variety of species by upsetting natural habitats. Furthermore, more building activity leads to higher air and noise pollution, which has an impact on both human populations and animals (Sarfraz, & Wang, 2021). In contrast, areas with pre-existing infrastructure can see less severe incremental environmental effects. However, the advent of large-scale infrastructure projects implies a severe disruption to the ecology in relatively virgin places such as Gilgit Baltistan.

Natural Resource Management

In Gilgit-Baltistan, there is a major challenge in controlling natural resources. Construction projects such as water course diversion and tunnels have seriously affected the water resources in the area. The concerns regarding the water pollution by the construction runoff are a serious issue affecting the reliability of water supply (Khan, 2020). The glaciers located in the region are particularly vulnerable to climate change and thus melt faster due to increased industrial activity. This phenomenon jeopardizes water security in the region, which is of paramount importance to livelihoods and agriculture (Ali and Jaffri, 2018). Additionally, resources exploitation and construction activities contribute to land degradation, which threatens the local livelihoods and agricultural performance (Mustafa, 2019). Comparative analysis shows that such effects would be mitigated more effectively in areas where resource management procedures have been well established. Conversely, the environment and deterioration of resources are more prone in Gilgit-Baltistan because of its fragile ecology and lax regulatory observation.

Ecological Balance

In Gilgit-Baltistan, there are a number of challenges to overcome in the effort to conserve the natural balance. Construction activities alter the local ecosystems and biodiversity by introducing invasive species by materials and human presence

(Sarfraz, & Wang, 2021). Moreover, enhanced industrialization is one of the primary causes of greenhouse gas emissions that intensifies the impact of the climate change, such as altered weather conditions and the increase of natural disasters (Pak-EPA, 2022). Good environmental legislations and an equilibrium of the ecosystem ensures that a region is more capable of absorbing the pressures of development. On the other hand, Gilgit-Baltistan remains very susceptible to adverse environmental factors by virtue of a fragile biological balance.

Socioeconomic Impact

In Gilgit-Baltistan, infrastructure development presents socioeconomic difficulties. Among the main issues raised by such initiatives are the uprooting of local communities and the disturbance of customary means of subsistence (Khan, 2020). Furthermore, building operations jeopardise historical and cultural monuments, affecting the rich cultural legacy of the area (Ali & Jaffri, 2018). Greater industrial capacity may yield more obvious economic gains, but Gilgit-Baltistan's socio-economic fabric which depends on customs and cultural heritage is more vulnerable. One of the biggest obstacles to the region's continued development is finding a way to maintain socio-cultural identities while promoting economic development.

Glacial Melting and Climate Change

According to a survey conducted by the NGO Focus Pakistan, 36 glacial lakes located in different valleys of Gilgit-Baltistan have been deemed unsafe, with seven of them presenting a significant risk to human safety. Since the commencement of the multibillion-dollar China-Pakistan Economic Corridor (CPEC), a project related to infrastructure and development, Gilgit-Baltistan has been confronted with a number of environmental risks. Glaciers are seriously threatened by the region's increased heavy vehicle traffic and clearing of mountains and jungles. There are three glaciers in Shimshal Valley, one of which is forming a lake. The entire Gilgit-Baltistan, including Hunza, is under danger due to the lake's rapid expansion. Since the beginning of the CPEC project, environmental protection has received no attention. Since thousands of tankers are passing through the area, which has a direct impact on the glaciers, no survey about the project's aftermath has been conducted (News, 2018)

Comparative Analysis of Environmental Challenges

As it is well known landslides threaten the local population and the development of the mountain, particularly in developing countries, such as Pakistan. This has provided a way to have extensive knowledge of the numerous nature of landslide sites in such locations. Yet, such studies are not numerous in the Karakorum region, and thus more research is required to learn the consequences of landslides in this region. Consequently, a disaster risk assessment map in the form of GIS has been developed for the Hunza-Nagar districts of Gilgit-Baltistan, Pakistan. The area under study lies on the path of the most important trade route of the China-Pakistan Economic Corridor (CPEC) and a landslide in the area could have disastrous implications on the locals and financial damages (Abbas, Jan, Afsar, & Nawaz, 2022). The environmental effect of CPEC projects may not be so outrageous in other regions of Pakistan such as Punjab or Sindh where industrialization has already become a reality and the infrastructure development is more widespread. Already over the years, land use changes, industrialization, and urbanization are already occurring in these areas at large scales and are compromising the ecosystems and worsening the environment. Due to relatively clean and less degraded natural environment in Gilgit-Baltistan, more

infrastructure development under the CPEC may not lead to such devastation of forests, disruption of wildlife, and soil erosion (Mustafa, 2019)

In addition, there are possibilities that other regions of Pakistan possess better institutional abilities, environmental regulations, and governance systems to overcome and effectively manage environmental effects. This involves increased adherence of environmental impact assessment (EIA), enhanced observance of environmental laws, and enhanced monitoring and management of industrial and construction activities. Ali & Jaffri (2018) further explains, 9 concerns regarding the potential impact of infrastructure development are exacerbated by the fact that Gilgit- Baltistan has a delicate ecology that is characterized by high mountain ranges, glaciers, and unique biodiversity. The vulnerability of the region to climatic change adds more challenges to environmental management in CPEC particularly on meltage of glaciers and water supply (Ali & Jaffri, 2018).

Conversely, the China-Pakistan Economic Corridor (CPEC) will have a dire impact on Gilgit- Baltistan due to the virgin ecosystem, susceptibility to climatic changes, and weaker regulatory mechanisms when compared to more advanced regions of Pakistan, despite the fact that there are no environmental issues that are not prevalent in all parts of the country. This perspective highlights the importance of applying tailored mitigation strategies, environmental assessments, and better governance as a means of ensuring sustainable growth in all the affected regions of CPEC.

MEASURES FOR SUSTAINABLE DEVELOPMENT AND ENVIRONMENTAL PROTECTION

In order to advance the overall human wellbeing without contradiction with the demands of the future generations, sustainable policies addressing the environmental challenges involve integration of the economic, social and environmental goals. These policies include the promotion of technology to separate economic growth and environmental degradation, government decision-making reforms to introduce more complete impact assessment, the emergence of international trade and investment to advance global sustainability, and imposing the price system on the overall cost of environmental degradation. These steps to conserve the natural resources by enacting laws, encouraging sustainable methods in agriculture, and providing incentives to renewable energy are important. Another key focus of these rules is the conservation of the biodiversity and other natural resources including clean water and air.

Such policies should be done more efficiently through enhanced collaborations between governments and non-governmental organization and civil society which will ensure best resilient and balanced ecosystems and processes on social and economic stability (Policy to enhance Sustainable Development, 2001). CPEC needs to be sustainable in order to balance between environmental protection and economic development (Abaidullah & Basheer, 2024). One of the central aims is to learn the experience of the Ecological Red line strategy of China, which also tries to preserve the natural capital and develop the inclusive growth. To achieve 2025 Vision and the Sustainable Development Goals, this will involve consideration of the environment in the development planning process. Some particular strategies are conducting comprehensive environmental impact analysis, promoting production resource-efficientness, and providing financial incentives to green energy technologies. In addition, assessing the impacts on the surrounding communities and the natural resources would ensure more effective decisions to be made in

management, which would be helpful in alleviating poverty and enhancing the welfare of the people. The benefits of integrating environmental conservation with economic plans can be demonstrated in pilot programmes, such as the one in Gwadar. Through such approaches, CPEC will be able to reduce its adverse impact on nature, promote sustainable economy development, and introduce the Belt and Road Initiative as the model of development that is equal (Aslam, 2019).

Renewable Energy Integration

The unbalanced demand and supply, high cost of fuel imports and increasing CO2 emissions are only some of the biggest problems of the electrical industry in Pakistan. In this regard, the government has implemented several energy legislations to assist in the incorporation of renewable energy sources. Thermal generating now contributes over 63 percent to the electric mix, however, renewable energy sources such as wind, hydro power and solar remain highly promising. In order to promote development of energy sources with low carbon content, Pakistan has introduced renewable energy policies like the Renewable Energy Policy 2006 and the Alternative and Renewable Energy Policy 2019. These policies aim to decrease CO_2 emission by decreasing the use of fossil fuels and increasing the rates of renewable energy in the energy mix. To achieve its carbon cut goals under the Paris agreement, Pakistan should incorporate renewable power. By focusing on its own renewable resources and by leveraging its current nuclear potential, Pakistan can develop a sustainable electricity supply mix that will not only meet the growing electricity demand but also reduce the electricity bills paid by consumers and the impact it has on the environment (Hassan Qudrat-Ullah, 2022). China Pakistan Economic Corridor aim at renewable power project to reduce the environment impacts. Some of these projects are as follow.

Table 1.
Energy Projects under CPEC

#	Project Name	MW
	Complete Projects	
1	1320MW Sahiwal Coal-fired Power Plant	1320
2	1320MW Coal-fired Power Plant at Port Qasim Karachi	1320
3	1320MW China Hub Coal Power Project, Hub Balochistan	1320
4	660MW Engro Thar Coal Power Project	660
5	1000MW Quaid-e-Azam Solar Park (Bahawalpur)	400/600
6	50 MW Hydro China Dawood Wind Farm, Gharo, Thatta	50
7	100MW UEP Wind Farm, Jhimpir, Thatta	100
8	50MW Sachal Wind Farm ,Jhimpir, Thatta	50
9	100MW Three Gorges Second and Third Wind Power Project	100
10	Matiari to Lahore ±660 KV HVDC Transmission Line Project	4,000 MW Evacuation Capacity
11	720MW Karot Hydropower Project, AJK/Punjab	720
12	330MW HUBCO Thar Coal Power Project (Thar Energy)	330
13	1320MW SSRL Thar Coal Block-I 7.8 mtpa & Power Plant (2×660MW) (Shanghai Electric)	1320
14	330MW HUBCO ThalNova Thar Coal Power Project	330
	Under construction	
15	884MW Suki Kinari Hydropower Project, KP	870
16	300MW Coal-Fired Power Project at Gwadar	300

Source: (Energy Projects Under CPEC)

Other than this, the China-Pakistan Economic Corridor (CPEC) has also enjoyed the benefits of having independent power projects (IPPs) commissioned by the Private Power and Infrastructure Board (PPIB) of approximately 8,000 MW that utilize conventional, alternative, and renewable power resources. Due to the efforts of PPIB, the proportion of renewable energy will reach 62 per cent by the year 2031. In 2021, the 4,000 MW HVDC transmission line between Matiari and Lahore started operation as a component of the CPEC (Private Power and infrastructure Board).

A flagship initiative of the Belt and Road Initiative (BRI), the China-Pakistan Economic Corridor (CPEC) aims to prioritize green and sustainable growth between China and Pakistan through the implementation of renewable energy projects. Large-scale renewable energy projects like the Karot and Suki Kinari Hydropower Projects, which are expected to lower CO2 emissions and provide clean electricity for millions of people, have been started by CPEC. Just the Karot Hydropower Project seeks to reduce CO2 emissions by 3.5 million tonnes per year, while the soon-to-be-completed Suki Kinari project will help Pakistan's energy problems and create jobs in the area. The Matiari to Lahore Transmission Line and the Thar Block-1 Integrated Coal Mine Power Project, which create jobs and clean electricity, are two more examples of the move towards sustainable energy.

Furthermore, CPEC has turned underutilized areas into hotspots for renewable energy; initiatives like the Quaid-e-Azam Solar Park and several wind generating plants in Jhimpir have made a substantial contribution to Pakistan's potential for renewable energy. These programmes raise living conditions, provide jobs, and solve Pakistan's serious energy shortages and climate issues. Launched in 2022, the Green CPEC Initiative upholds the dedication to carbonizing the energy industry, guaranteeing development and growth that is sustainable (Javed, 2023). In building CPEC, Pakistan is making monumental strides towards renewable sources of energy. Even though coal still dominates the energy mix in modern times, the CPEC projects are becoming more focused on sustainable sources of energy. The most successful examples of such change can be the Suki Kinari and Karot Hydropower Projects, which will provide millions of people with clean electricity and reduce the CO 2 emission significantly. The transition to the sustainable energy is further emphasized by the employment opportunities provided by Matiari to Lahore Transmission Line and Thar Block-1 Integrated Coal Mine Power Project as well as the use of clean electricity. Also, CPEC has transformed underutilized regions into renewable energy hubs such as the Quaid-e-Azam Solar Park and the wind farms at Jhimpir.

Through these, Pakistan hopes to accomplish its 20X25 and 30X30 objectives that involve increasing renewable energy by 20 and 30 percent respectively by 2025 and 2030 respectively. In order to address the issues of climate, energy crisis, and socioeconomic development in Pakistan we need to fight against green energy (Cheng, Ma,, Kong, Gu, & Du , 2024).The Gilgit-Baltistan (GB) region is one of the strategically located areas of northern Pakistan and has high potential of renewable energy. The power sector of GB has a strong opportunity to make considerable advancements in the context of the China-Pakistan Economic Corridor (CPEC) with hydro power focus because of the rich water supply in the area. The LEAP-based regional power-generation system model forecasts the procession towards 100% renewable energy in 2050, and pays a greater attention to Variable Renewable (VRE) and Best Available Technologies (BAT). According to the model, the arrival of BAT would contribute to the reduction of the expected. electricity consumption by 41 percent, hydropower would become the main source of renewable energy. Energy

efficient home appliances and home lights are examples of some of the energy saving measures. The shift to least-cost constraints is a sign that the application of the large-scale and small-scale renewable energy has grown. The reasons to this change are in the form of increased emission fees and expenses of environment externalities. The energy planning in GB is sustained using the report and also helps Pakistan in an effort to cut its greenhouse emissions as per the Paris Agreement (Basheer et al., 2024).

Pollution Control Measures

Considering that Gilgit-Baltistan (GB) is the gateway to the China-Pakistan Economic Corridor (CPEC), a lot of efforts have been undertaken to reduce pollution in the area. The Gilgit-Baltistan Environmental Protection Agency (GB-EPA) and SUPARCO partnered on the Baseline Environmental Profiling along CPEC in Gilgit-Baltistan to tackle the environmental concerns and to provide baseline data which may be used in future.

Important GB pollution control measures under CPEC include:

Monitoring of Water Quality: In-depth field investigations carried out in 28 places during the winter and summer have evaluated the chemical, biological, and physical characteristics of the water. Proactive studies on watershed management are among the recommendations made to counteract the deterioration of water quality brought on by an increase in human activity.

Air Quality and Noise Level Monitoring: Particulate matter (PM2.5) and gaseous pollutants (CO, SO 2, NO, NO 2 and O 3) were monitored in five cities (Sost, Hunza, Gilgit, Jaglot and Chilas). Gilgit and Chilas had higher PM2.5 in winter than were allowed by National Environmental Quality Standards (NEQS), despite the gaseous pollutants being in the acceptable range. It is recommended that permanent air quality monitoring stations be installed along the CPEC to solve the air pollution problem. Also, strategies are suggested like introduction of mass transport system to reduce the use of Non-Custom Paid (NCP) vehicles and discouraging the heating of solid waste through burning.

Control of Noise Pollution: When noise levels in residential and commercial areas were compared, it was found that while residential areas frequently exceeded NEQS guidelines, commercial areas largely met them. Stricter noise levels laws are one of the specific recommendations, especially in the vicinity of airports and other sensitive regions.

Land Cover Mapping: A thorough categorization and mapping of the land cover along the CPEC in GB was carried out using SPOT satellite data. This mapping identified a variety of land types, such as forests, rangelands, and glaciers. This mapping facilitates the identification of regions susceptible to environmental deterioration and supports the development of conservation plans (GB-EPA & SUPARCO).

CONSERVATION OF NATURAL RESOURCES

Gilgit-Baltistan (GB) has a unique natural terrain, making it an important place to safeguard biodiversity under the China-Pakistan Economic Corridor (CPEC). Though it also puts GB's delicate environment at danger, the infrastructural expansion of CPEC creates prospects for economic growth. In order to reduce these dangers, sustainable practices are crucial, according to the Gilgit-Baltistan Environmental Protection

Agency (GB-EPA) and other stakeholders. One of the most important aspects of CPEC's development strategy is ecotourism, which creates jobs and helps preserve biodiversity. Efforts include evaluating land cover changes using high-resolution satellite images and doing extensive baseline environmental profiling, which include measuring air, water, and noise levels. GB seeks to strike a balance between environmental preservation and economic development through boosting tourism. This involves discouraging the burning of solid waste and introducing mass transportation systems to minimize vehicle emissions in addition to the permanent installation of air quality monitoring stations. Furthermore, by using ecotourism to make money from controlled activities like hiking and wildlife viewing, the area makes sure that tourism helps both biodiversity and local populations. Together, these actions seek to protect GB's natural heritage and promote sustainable development within the framework of the CPEC (Nigar, 2018)

Sustainable water resource management

Gilgit-Baltistan (GB) is the home of the second tallest mountain of the world with over 7000 glaciers. The snow and glacier resources located in the Himalayan region are one of the main fresh water resources in the irrigation system in the Indus basin. In Gilgit-Baltistan, the water to the population is directly sourced by glacial runoffs into valley streams. With the anthropogenic activities that include usage of pesticides in agricultural lands, the disposal of untreated sewage and mining of effluents in the upper Indus catchments among other activities, the physical, chemical and biological properties of the surface water resources have been modified. Moreover, the high Indus basin is experiencing widespread developmental activity in terms of industry, transport, energy and infrastructure within the framework of China-Pakistan Economic Corridor (CPEC). They may considerably impact the quality of the water resources in the country, especially in Gilgit-Baltistan region (Ahsan, Rasheed, Ashraf, & Anwaar, 2021).

With a lot of water resources in its hands, Gilgit Baltistan must use the water resources effectively with the help of strategic planning and technology. Development of hydro electrical power generation of large scale will be enhanced through the development of dams such as the Diamer Bhasha and Bunji to cater to the local demand and also export the surplus energy. Existing crop watering systems and artificial groundwater recharge among other modern irrigation methods will streamline the use of water in agriculture, lowering the impacts of the glacial melt and ensuring the quality of water. Afforestation and replanting plans will stabilize the water cycle in the region and reduce soil runoff. With the CPEC framework, collaboration with China can offer monetary and technological support in the sustainability water projects to ensure that GB is assured of economic and environmental benefits in the long run. The imposition of local community participation and policies is essential to maintain sustainability of the water and safeguard the natural ecosystem of GB (Khalil, 2021).

Environmental Education and Awareness

Environmental education enables individuals to explore and address environmental issues through critical thinking, problem-solving, and informed action. Deeper understanding and responsible decision-making are fostered by the increased awareness, knowledge, attitudes, skills, and engagement in environmental activities that result from it. Environmental education fosters critical thinking and problem-solving abilities, in contrast to environmental information, which offers facts or

viewpoints (What is Environmental Education, 2023). To put it briefly, Pakistan is receiving assistance from China and the CPEC in a number of areas, but the most important one is education. An estimated 32,000 students from Pakistan are enrolled in Chinese universities. Pakistan's front-line troops in the workforce, as mandated by CPEC, are the graduates of China. They serve as China and Pakistan's ambassadors of friendship. The true key to CPEC's success is its graduating population from China (Awan, 2020).Therefore, CPEC can only be beneficial if education is upgraded, modernized, and the level of literacy rises (Anwar, Saif Alvi, Anwar, Karamat, & Yasmin, 2023).

Research findings indicate that China Pakistan Economic (CPEC) indirectly fund education sector, Although direct environmental education programs that can be attributed to CPEC are not widely recorded, overall economic and social development initiatives of the project may indirectly lead to the promotion of environmental awareness and education.

Moreover, hundreds of millions of women and girls cannot work or even attend school, which makes them impossible to become independent. Through CPEC, women are expected to escape the poverty cycle and establish a new future. Most importantly, the CPEC project and women in Pakistan are vital. Women education positively affects a population that is healthier and better fed, and increases national productivity, income, and economic development (Khaskheli, Wang, Yan, & He, 2023).

CONCLUSION

The research is to examine the environmental problems exist with the development and maintenance of infrastructure projects under CPEC in Gilgit Baltistan, draw camprisions between this issues and projects of similar nature in other areas, and asses the effectiveness of current measures and policies to mitigate the impacts and to promote environmental protection and sustainable developments. The results provide that there is significant deforestation, habitat destruction, soil erosion, frequent landslides and pollutant due to constructive activities in Gilgit-Baltistan, especially in the Karakorum Range. Due to its unique biological sensitivity, Gilgit Baltistan's infrastructure projects have more severe environmental effects than those of other mountainous regions, such the Himalayas and the Andes. Additionally, similar to Baluchistan, GB has high security threats because of foreign interest in its prime location for the CPEC and potential for instability due to economic disparities.

Moreover, it is determine that there is shortfall of environmental protection and sustainable development policies. Reforestation and other conservation initiatives are underfunded and badly managed. Even though CPEC has considerable investment, there has not been enough funding allocated specially for environmental education and awareness to overcome the projects negative outcomes. To protect GB's vulnerable environment, CPEC projects must be attach with multi- pronged sustainable strategies, one that prioritize advance monitoring and regulation, install more renewable energy projects, enhance local governance and communities involvement, provide special education and awareness, green infrastructure and use of modern technologies. Only then infrastructure growth be balanced with ecological resilience and wellbeing of local communities.

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