

FAQEER MUHAMMAD, KHALID MEHMOOD ALAM, ATA ULLAH SHAH (Eds.)

# **CPEC and BRI Nexus**

## **Perspectives on Economy, Politics, Culture and Environment**

China Study Centre  
Karakoram International University  
Gilgit-Baltistan

**CPEC and BRI Nexus:  
Perspectives on  
Economy, Politics, Culture  
and Environment**

**China Study Centre  
Karakoram International University  
Gilgit-Baltistan, Pakistan**

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**Edited by:**

**Faqeer Muhammad  
Khalid Mehmood Alam  
Attaullah Shah**

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## Foreword

The Belt and Road Initiative (BRI) is a modern manifestation of the historical Silk Road that once connected Imperial China with Central Asia, Europe, and North Africa. Beyond physical connectivity, it embodies the spirit of free movement of people and goods, cultural motifs and transformative ideas and the pursuit of win–win models of trade and cooperation. The very symbolism of the Silk Road continues to animate its contemporary plans and projects. The Silk Road Economic Belt and the Maritime Silk Road recall the historic land routes and sea lanes that facilitated flourishing exchanges. Historically, Pakistan known as Gandhara was a pivotal player along the Silk Road, bridging continental and maritime trade.

The BRI, and its flagship project, the China–Pakistan Economic Corridor (CPEC), represent far more than highways and ports. They articulate a vision of connectivity, cooperation, and shared prosperity that extends beyond economics into cultural harmony and human development. This book is a timely and significant contribution, for it not only highlights the transformative nature of CPEC projects but also underscores the time-tested partnership between Pakistan and China. In this context, the emphasis on learning the Chinese language as a means of turning barriers into bridges is especially pertinent.

The strength of this volume lies in its multidisciplinary breadth and intellectual depth. It does not confine itself to trade figures or investment flows but situates CPEC within a wider canvas of human interactions, cultural exchanges, and socio-economic transformations. The opening chapter on cross-cultural management practices draws attention to the subtle yet decisive role of cultural understanding in shaping sustainable business partnerships. It reminds us that successful cooperation requires not only physical infrastructure but also trust, respect, and shared values.

The book then broadens its scope to explore Pakistan’s blue economy, tourism, and women’s entrepreneurship, examining how CPEC opens both opportunities and challenges in these diverse fields. These discussions underscore that true development must be inclusive empowering local communities, women entrepreneurs, and the younger generation to participate fully in new avenues of growth.

Equally compelling are the contributions that engage with the strategic and

geopolitical dimensions of BRI, which position Pakistan as a critical hub of Eurasian regionalism. The chapters devoted to sustainability and environmental resilience are particularly valuable, as they address the risks of glacial lake outburst floods in Gilgit-Baltistan, the promise of green energy cooperation, and innovative approaches such as mineral carbonation for carbon mitigation. These insights make it clear that for CPEC to achieve enduring success, ecological stewardship must be pursued hand in hand with economic ambition.

The volume also highlights vital sectoral links, including the nexus of tourism and security, where vulnerabilities could undermine long-term gains if not carefully managed. Similarly, the discussion of Pakistan's untapped mineral wealth, especially gold deposits along the CPEC route, opens new horizons for resource-based development, while wisely cautioning that responsible exploration and management are essential.

Taking together, these contributions reveal that the BRI and CPEC are not static undertakings but evolving frameworks of cooperation. They carry within them immense potential for economic integration, social inclusion, environmental sustainability, and cultural exchange provided they are navigated with foresight and responsibility.

I would like to commend the editors and contributors of this volume for their scholarly commitment and for bringing together such a wide spectrum of perspectives. This book will serve as a valuable reference for policymakers, scholars, business leaders, and students alike. It demonstrates with clarity that CPEC is not merely about connecting cities and markets, but about connecting peoples, ideas, and futures.

Dr. Safdar Ali Shah  
Director General, CPEC, HEC

## Foreword

The Belt and Road Initiative (BRI), launched by China, has emerged as one of the most transformative global development strategies of the 21st century, fostering regional integration, infrastructure development, and economic connectivity across Asia, Europe, and Africa. For Pakistan, the China-Pakistan Economic Corridor (CPEC) a flagship project under the BRI holds significant strategic and economic importance. It not only offers the promise of enhancing trade and energy cooperation but also serves as a catalyst for regional peace and prosperity by linking western China to the Arabian Sea. The BRI, through CPEC, has opened new avenues for development in Pakistan, offering long-term benefits in transport, energy, and industrial growth while fostering stronger bilateral and multilateral relationships.

This book, *CPEC and BRI Nexus: Perspectives on Economy, Politics, Culture and Environment.*, is a timely and insightful academic contribution that explores the multidimensional impacts of this historic initiative. Edited by Faqeer Muhammad, Khalid Mehmood Alam, and Atta Ullah Shah, the volume brings together scholarly perspectives from researchers and academicians worldwide. Comprising eleven comprehensive chapters, the book examines critical themes such as climate change, tourism, economy, and societal transformations in the context of CPEC and BRI. It offers both theoretical depth and empirical insights, making it a valuable resource for policymakers, academics, and students seeking to understand the evolving geopolitical and socio-economic landscape shaped by these initiatives.

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## Preface

The China-Pakistan Economic Corridor (CPEC), as a flagship project of the Belt and Road Initiative (BRI), represents one of the most transformative undertakings in contemporary global development. Its scope transcends infrastructure and trade, reaching into the spheres of politics, culture, environment, and society. This book, *CPEC and BRI Nexus: Perspectives on Economy, Politics, Culture and Environment*, brings together diverse scholarly insights to critically examine the multifaceted dimensions of CPEC and its broader alignment with the BRI.

The first chapter explores cultural dynamics by examining the differences in values, communication styles, leadership approaches, and workplace expectations between Chinese and Pakistani professionals. This analysis not only highlights challenges in managing cross-cultural teams but also identifies opportunities to foster mutual trust, enhance collaboration, and strengthen organizational effectiveness in joint ventures and development projects.

Language and communication emerge as a critical theme in the second chapter. The study emphasizes the strategic importance of learning Chinese for the success of CPEC projects, noting that language proficiency is essential for building trust, strengthening trade relations, and addressing human resource requirements in industrial zones.

Tourism is the focus of the third chapter, which investigates how CPEC-related developments may enhance Pakistan's tourism industry and foster greater stability and prosperity. While public perceptions are generally positive, the analysis also draws attention to pressing issues such as local rights, awareness gaps, and the complexities of large-scale projects.

The fourth chapter turns to Pakistan's blue economy, assessing how CPEC and the BRI can contribute to sustainable development. By investigating infrastructure growth, economic expansion, and social impacts, the study underscores both the opportunities and constraints in unlocking the potential of the blue economy, particularly in the face of environmental concerns and the need for capacity building.

Women's empowerment is highlighted in the fifth chapter, which demonstrates how CPEC initiatives have expanded microenterprise opportunities for women, particularly in Hunza. The findings suggest that CPEC not only advances economic development but also fosters inclusivity

by supporting women's participation in diverse economic activities.

The sixth chapter situates Pakistan within the broader framework of regionalism, emphasizing its growing strategic relevance in the evolving geopolitical order shaped by initiatives like the EU, ASEAN, and NAFTA. Pakistan's role in the BRI highlights the intersection of geography and politics in shaping regional cooperation.

The seventh chapter provides a detailed examination of the Belt and Road Initiative itself, tracing its origins, scope, and objectives. It highlights the transformative opportunities offered by infrastructure, trade, and connectivity, while also critically addressing concerns regarding debt sustainability, environmental impacts, and global political repercussions.

The eighth chapter addresses China's green energy investments in Pakistan under CPEC. By focusing on renewable energy initiatives, the study highlights their role in addressing Pakistan's energy challenges while aligning with global climate change commitments. It also considers the geo-economic and political complexities of green energy development.

Climate risks form the core of the ninth chapter, which investigates the increasing threat of Glacial Lake Outburst Floods (GLOFs) in Gilgit-Baltistan. With its high density of glaciers, the region is particularly vulnerable to climate change-induced disasters that could jeopardize infrastructure, livelihoods, and the sustainability of CPEC projects.

The tenth chapter explores the broader environmental implications of the BRI, particularly its contribution to CO<sub>2</sub> emissions and climate change. By presenting mineral carbonation and geological sequestration as potential solutions, the study provides a roadmap for integrating carbon capture strategies into BRI projects to mitigate ecological risks.

Finally, the eleventh chapter turns to Pakistan's vast but underexplored mineral wealth, particularly its gold reserves in regions such as Gilgit-Baltistan, the Chagai magmatic arc, and the Peshawar Basin. The chapter argues that CPEC offers new opportunities for exploration, investment, and value addition in the mineral sector, with the potential to significantly enhance Pakistan's economic development.

Collectively, the chapters in this volume provide a comprehensive understanding of how CPEC and the BRI intersect across economic, political, cultural, and environmental domains. The book aims to contribute to scholarly

discourse and policy debates by presenting balanced perspectives highlighting both opportunities and challenges while offering actionable insights for stakeholders engaged in these transformative initiatives.

## **Navigating Cultural Differences: A Study of Cross-Cultural Management Practices Between China and Pakistan**

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### **Abstract**

This paper attempts to explore the dynamics of cross-cultural management differences and similarities between China and Pakistan, in context of business negotiations. These cultural differences and similarities are significant to understand for the business community of the two countries to forge a long-term and mutually benefiting relationship. It goes without saying that both countries are tied together in an impregnable relationship that goes beyond political, economic and diplomatic relations. While the trade, business and economic relations between China and Pakistan continues to soar, a comprehensive exploration of cross-cultural understanding within a business context is still lacking and scant efforts have been made in this direction – indicating a significant gap in current scholarship. As the BRI (Belt and Road Initiative) and CPEC (China Pakistan Economic Corridor) mega projects are in full swing and soon open its window of enormous opportunities; it is imperative to better grasp the cultural issues that may impinge the business relationships, as well as exploring commonalities to better reap the fruits of sustainable affable business relations.

Drawing from the seminal works of Hofstede (1984, 2001), this study attempts to explicate the nuances of cultural differences of the two countries that may influence business communications and negotiations. Given the nature of the study, constructivist grounded theory research design has been adopted, and the empirical data has been gleaned through in-depth interviews of the

businesspersons representing SMEs from both China and Pakistan. The study findings will help in better understanding the cultural differences that may positively or otherwise negatively affecting the business negotiations between the two evergreen friends (i.e. China and Pakistan). The study also presents some practical suggestions to minimize the negative influences of cultural differences and maximize the benefits of mutual exemplary relations for both parties.

**Keywords:** Cross-cultural management, business negotiations, China, Pakistan

## **Introduction**

The People's Republic of China (PRC), having the highest growth rate of double digits till 2015, is transformed to a major player in world economy and politics. Gone are the days when it was echoed; "*when United States sneezes, the rest of the world catches cold*", now it's almost true for PRC as having a vast manufacturing base, highly developed infrastructure, modern means of communication, tech industry and consistently growing economy. PRC is now an attractive destination for investors and foreign companies wanting to gain wider market access. Since the reforms and opening policy in 70s and 80s, increasingly multinational corporations (MNCs) and countries are taking interest in extended their ventures into the "Middle Kingdom (中国, zhōng guó)" and involved in negotiating with their Chinese counterparts in international business (Zhu, McKenna, & Sun, 2007).

Whereas Pakistan with a population of around 220 million (6<sup>th</sup> largest country in terms of population in the world), with poor infrastructure and looming energy crises (electricity shortage), seems no comparison with the second largest economy of the world. Nevertheless, when it comes to the mutual ties and bilateral relations between the two countries; it's simply unmatched and incredible; known as "*Iron friends* (巴铁, bā tiē)". Formal business and trade relations between the two countries have been established soon after the Independence of PRC in 1947.

Although, the two countries are close neighbors and their mutual affable relations date back to 19<sup>th</sup> century, even before the creation of modern PRC in 1949 and the Independence of Pakistan in 1947; the neighboring regions of Xinjiang province in China and the Hunza (a Princely State at that time) of Gilgit-Baltistan (a provincial equal status) have very cordial relations with each other. This relation traveling confined to diplomatic relations, rather spanning from people-to-people exchanges, cross-marriages in royal families and traveling of people across the borders without any restrictions. More

significantly, the ancient Silk Route emerging from Chinese provinces was passing through this region. Therefore, this region has been an important route to connect China and the British India in ancient times.

Trade and commerce between the two countries has amplified further with the construction of the Karakoram Highway (KKH), connecting the two countries by a road link from the Northern side of Pakistan (Hunza) to Kashgar (Xinjiang province) of China in 70s. Piercing through the treacherous, rugged and Rocky Mountains in the highest altitude from sea level – indeed KKH is a marvel of engineering. The KKH is also known as the 8<sup>th</sup> wonder of the world.

This road link has opened tremendous opportunities for trade and commerce between the two countries and also facilitated the people-to-people exchange and travel across the borders. Taking advantage of this road link, business communities from both sides of the border have started building and boosting mutual trade and commercial relations. Although companies and businesses from both sides secured substantial business contracts, however, cross-cultural and communication barriers impinged greater gains for both sides. As business and managerial practices, approaches and philosophies differ across countries and cultures. One acceptable behavior in business in one culture may be counterproductive or even unacceptance in another (Steers, Sanchez-Runde, & Nordon, 2010).

In modern times, this mutual relationship has been further cemented with the initiation of China Pakistan Economic Corridor (CPEC); an offshoot of greater Belt and Road Initiative. This mega project is worth whopping \$62 billion, including construction of highways, modern transportation and shipping ports, energy projects, special economic zones etc. In 2013, the Chinese President Xi announced the groundbreaking initiative of “One Belt One Road (一带一路 yī dà yī lù)”, now known as Road and Belt Initiative (BRI). Since then, a growing stream of research on BRI has been kick started in academic and non-academic streams, such as trade & business, economy, history, culture to name few. Although cross-cultural studies started in 1990s (Dong & Liu, 2010) during the onset of reforms and opening up to outer world. However, studies on cross-cultural management in perspective of business negotiations between China and Pakistan are still sparse. There is a need for intensive cross-cultural studies in the perspective of business and management to better understand the unique characteristics of both countries.

## **Literature Review**

The China-Pakistan Economic Corridor (CPEC), a pivotal component of China’s Belt and Road Initiative (BRI), has drastically amplified economic

and business engagements between China and Pakistan (Irshad et al., 2021). As a multi-billion-dollar infrastructure and trade development project, CPEC encompasses energy projects, transportation networks, and industrial zones, necessitating extensive collaboration between Chinese and Pakistani professionals (Khan & Liu, 2022). This increased interaction has highlighted the critical role of cross-cultural management (CCM) in ensuring smooth business operations, minimizing conflicts, and enhancing organizational performance (Aycan et al., 2023).

### ***Theoretical Foundations of Cross-Cultural Management***

Inter-cultural studies related to China can be categorized into two types: (i) studies focusing on expat managers and employees; and (ii) secondly studies that examines the work behavior of home country employees in multinational corporation and their interaction with expat employees (Dong & Liu, 2010). Cross-cultural management is defined as the systematic process of leading and coordinating culturally diverse teams while adapting management practices to suit different cultural contexts (Hofstede et al., 2010). Scholars emphasize that CCM is essential for multinational enterprises (MNEs) operating in diverse environments, as cultural differences influence communication, leadership styles, negotiation tactics, and conflict resolution (Meyer, 2014).

Several theoretical frameworks help explain cross-cultural dynamics in CPEC:

1. ***Hofstede's Cultural Dimensions Theory*** – Highlights differences in power distance, individualism vs. collectivism, uncertainty avoidance, and long-term orientation between China and Pakistan (Hofstede, 2011).
2. ***Trompenaars' Model of National Culture Differences*** – Examines cultural variations in universalism vs. particularism, neutral vs. emotional cultures, and achievement vs. ascription (Trompenaars & Hampden-Turner, 2012).
3. ***The GLOBE Study*** – Investigates leadership behaviors across cultures, suggesting that effective managers in China and Pakistan must adapt to local expectations (House et al., 2004).

Culture has a great impact on individuals' negotiation styles, and it influences business negotiations both directly and indirectly. Regarding communication, when cultures differ, communication is more challenging and misunderstood (Bradley, 1991). Hofstede defined culture as: “*Culture is the collective programming of the mind which distinguishes the members of one human group from another.... Culture, in this sense, includes systems of values; and values are among the building blocks of culture*” (Hofstede, 1984, p. 21).

*Cultural Values* or simply *Values* are assumptions of members of a culture group as how they should behave in particular situation and expect others to behave in certain way. *Values* are beginning to develop and nurture from early one at a preconscious level – learned in early childhood. Generally, *Values* are hard to change or slow to change as they are perceived to be the right way to behave by individuals and members of society. Culture values are learned and passed on from one generation to another generation. Any member of a particular group or community deviating from core values is deemed deviant behavior and opposed by members of the community.

In his seminal study on how cultural differences affect the workplace, Geert Hofstede (1980, 1993) posits that management theories and philosophies applicable in one culture may or may not be applicable in another culture, as every culture is unique and distinctively different from others. Based on his long-term association with IBM and having the opportunity of serving in various countries around the world, Hofstede initially presented four dimensions, what he claimed differentiates various country cultures around the world. These four dimensions are; *Individualism* versus *Collectivism*, *Power Distance* Index (PDI), *Masculinity* versus *Femininity* (MF), and *Uncertainty Avoidance* Index (UAI). Hofstede later discovered two more dimensions: *Time Orientation*, identified in 1988 and *Indulgence* versus *Restraint*, identified in 2010 (Luthans & Doh, 2015).

Describing the Chinese cultural context, Hofstede (1993) postulated that it is high in power distance index (PDI 80); low in individualism (20) and rather very near to collectivism; moderately low in uncertainty avoidance (40) and masculinity (score 66; highest Masculinity score goes to Japan as 95 whereas Sweden is feminine country with score as 5); high in long-term orientation (LTO score 118). In fact, China is highest on Hofstede scale of Short-term versus Long-term orientation. Whereas Pakistan falls in *Power Distance* at 55, more *Collective* oriented at 14, high on *Uncertainty Avoidance* at 70, and high on *Masculinity* at 50.

While there are numerous other comparative cultural studies, such as Edward Hall's (1976) High vs Low Context and Monochronic vs Polychronic dimensions; GLOBE (Global Leadership and Organizational Behavior Effectiveness Project; 2004); and more recent study of Ronen & Shenkar (2017). However, the significant strength of Hofstede study (1984, 2001) is that it compares national cultures of countries around the world in a compressive and detailed way that no other study has done so far. Nevertheless, Hofstede model and work is not free criticism, and major critique is about its validity and reliability, such as potential bias in questionnaire responses as well as the age of the model and time lapse since it

was first introduced in 80s.

Equating Hofstede’s fifth dimension of “Long-term orientation to Chinese Confucianism”, Tong Fang (2003) criticized its philosophical underpinning and argued that there is an inherent philosophical flaw in this dimension and have other methodological shortcomings which makes its validity questioned (p. 347).

Table 1. Comparison of Hofstede’s dimensions for the two countries

S.	Hofstede Dimensions	China	Pakistan	Explanation of the dimension
1.	Individualism versus Collectivism (IDV)	Collectivistic 20*	Collectivistic 14	Refers to the strength of the ties that people have to others within their community.
2.	Power Distance Index (PDI)	High on PDI 80	Moderately high 55	This refers to the degree of inequality that exists – and is accepted – between people with and without power.
3.	Uncertainty Avoidance Index (UAI)	Low on UAI 30	High on UAI 70	Entails how well people can cope with anxiety. High Uncertainty Avoidance means that people attempt to make life as predictable and controllable as possible. Whereas people in low UAI-scoring countries are more relaxed, open or inclusive.
4.	Masculinity versus Femininity (MAS)	Masculine 66	Masculine 50	Refers to the distribution of roles between men and women. In masculine societies, the roles of men and women overlap less, whereas in feminine societies, however, there is a great deal of overlap between male and

				female roles, and modesty is perceived as a virtue.
5.	Short-term (STO) versus Long-term (LTO) orientation	High LTO 87	In between STO and LTO 50	Refers to people's preference for short-term goals and achievements versus long-term goals and gains from a particular action or activity.
6.	Indulgence Versus Restraint (IVR)	High IVR (Restrained) 24	0 (data not available)	People and countries high on IVR are characterized as outgoing, enjoying life and having fun. Whereas societies with low IVR generally deemed to have more regulations on people's conduct and behavior, and there are stricter social norms.

Note\*: Score from 0~100

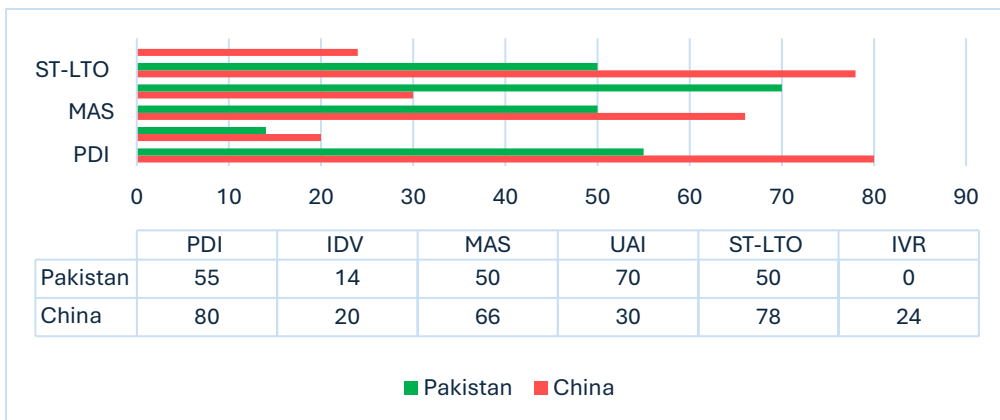


Figure 1. Comparison of China and Pakistan on Hofstede Dimensions

### ***Management in a Globalized World***

Management has evolved drastically since the end of WWII (World War II),

as innovation, collaboration and competing on global fronts became the norm of big MNCs. Generally, MNC culture is often ascribed to the Anglo-Saxon culture, however, the entry of new players into global business made it clear that not a single culture exists. Take for instance, Apple and Samsung, belonging to two distinctively different cultural and corporate footprints, and adopting different strategies to product development and management but competing on the global front (Luthans & Doh, 2015). One belongs to individualist culture (Apple), while the other cherish the collectivistic orientation (Samsung), and there are myriads of organizational cultural differences in both companies, but both are successful and taking great leaps forward.

MNCs need to make strategies and programs conforming to the country culture where they are operating, as what works in home country may have limited value in other countries (Luthans & Doh, 2015).

## **Data and Methods**

Guided by the qualitative grounded theory research design, this study attempts to explore the dynamics of cross-cultural negotiations between China and Pakistan. Adopting a constructivist grounded theory approaches of exploring how does cross-cultural differences influence business communication; we draw from the highly referred studies on cross-cultural management- Hofstede to identify the cross-cultural differences and commonalities of the two countries. While primary data has been garnered from businesspersons in small and medium enterprises (SMEs) in both China and Pakistan. We have conducted 30 in-depth interviews, 15 each in both countries. SMEs and businesspersons have been carefully chosen through the purposive sampling; we control the size and sector of businesses in sample.

Adhering to the rigorous grounded theory method of inquiry, the creation of themes has gone through several steps and phases and finally culminated into creation of overarching themes, as follows:

- (i) In the first phase, the voice recorded interview data has been transcribed verbatim.
- (ii) Second phase; the interview transcripts have been carefully and diligently analyzed and read through many times and compared with the recorded voice to check the accuracy of the transcribed data.
- (iii) Third phase; each word and sentence of the transcripts have been read through again, and assigned labels to each sentence of significance,

called *Open / Initial codes*, which resulted in creation of hundreds of codes. For the sake of filtering and refining the open codes, some codes of similar meaning have been subsumed and combined together, while others having the weaker connection with the study theme have collapsed. This resulted in the creation of *Focused codes*.

- (iv) Fourth phase; the focused codes have been classified, cross-compared and cross-examined with each other to find the similarities and variations, and the similar codes have been clipped together to form the *Categories*.
- (v) Fifth phase; the categories of codes have been grouped together to form the *Concepts*.
- (vi) Sixth phase; the *Concepts* have been re-examined and created *Themes* out of the categories of codes and concepts. Themes in qualitative study are broad units of information that consist of several codes, categories and concepts aggregated together to give an overarching meaning or theme (Creswell, 2013, p. 186).

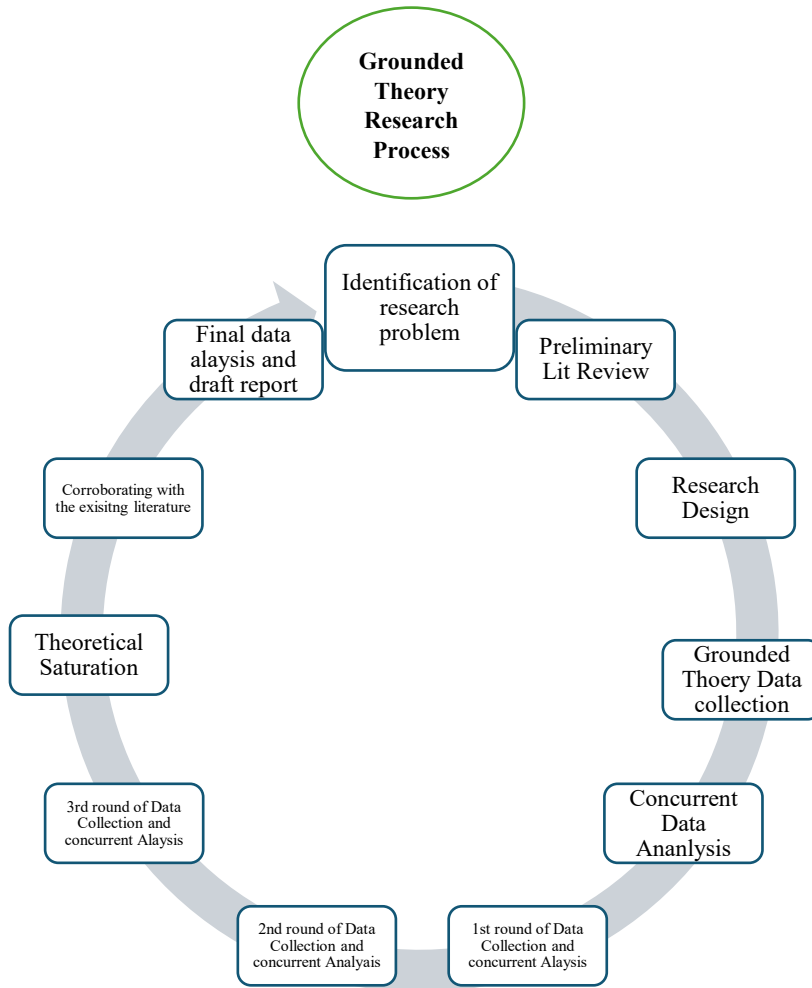


Figure 2. The process of grounded theory (Source: Authors created)

## Findings and Data Analysis

The meticulous analysis of the qualitative data evinces interesting insights into the business relations and various nuances of business negotiations between the two countries. The thick qualitative data has been processed and thoroughly analyzed to extract the meaning and insights from the words of the interview participants.

### *Relationship oriented*

Since two countries are tie-together in a strong bond of mutual relationship,

which is dearly called as “*higher than mountains in Karakoram, Hindukush, Himalayas, and sweeter than honey*”. This applies to business communities too and they maintain the same affable relations with each other. A Chinese businessman having more than ten years’ hands on experience of doing business with Pakistani counterparts, shared the value of relationship as:

*Well, you know Pakistan is our seasoned friend and we have business relationships with them since long. We find Pakistani people very friendly and respectful. They always respect us and treat us like brothers [W.X-C-03,11:39]<sup>1</sup>.*

### ***Trust-deficit***

It goes without saying that trust is an important ingredient of mutual beneficial business relationships. Although both countries are tie-together in incredible relationship, however, some interviewees from both sides shared incidences of trust-deficits, especially for those businesspersons having less market-orientation and familiarity with each other.

Our empirical data indicate that businesspersons from PRC tend to more pragmatic than their counterparts from Pakistan, who could be characterized as emotional in business negotiations. This is understandable as the interest of PRC investors and businesses has triggered very recently with the onset of CPEC. Indeed, Pakistan came into limelight for Chinese investors during and after the historical visit of Chinese President Xi Jinping to Pakistan in 2016 and signing of \$45 billion CPEC project (later raised to \$62 billion). This make sense as their lack of trust could be attributed to their recent exposure to Pakistan markets and lack of understanding of the culture, business norms and practices in Pakistani society. A middle-aged Chinese executive who has been recently posted to their company subsidiary in Pakistan responded to the question of degree and nature of trust on their counterparts for business:

*We like Pakistan and people here, but when it comes to business, we need to go through all the details and make sure that everything is in order and perfect. We can’t simply blindly trust [Z.G.X-C-09, 21:10].*

Whereas the business community from Pakistan generally tend to expect more

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<sup>1</sup> The above citations refer to the interviewees’ original remarks and the citations show their pseudonym instead of their original name in order to protect respondents’ privacy and identity. The pseudonym is followed by the time and location of the cited comments in the transcribed taped interview record. The last digit in pseudonym denotes the origin of respondent, as “C for Chinese” while “P for Pakistani” respondents. For instances, in “W.X-C-03,11:39”, W.X-03 is pseudonym, C for country, 11:39 is the location of comment on recorded interview transcript.

favorable treatment and concessions in business dealings based on their relationship with their Chinese counterparts. Based on the closer ties with China, businessmen expect concessional terms and rates in their business dealings. An interviewee from the city of Lahore (Pakistan) having business relations with Chinese companies for more than 20 years explained:

*We have a business dealing with a number of Chinese enterprises, and just few of them have their offices in Pakistan. We have a very good relationship with them, but often when our company demands rate reductions and discounts, it is often not entertained, and the other party give various reasons [S.N-P-05, 07:22].*

### **Communication barrier as mother of all evils**

Perhaps one of the biggest impending factors for developing better understanding of each other is the communication barrier. This not only precludes mutual understanding but also causes lack of trust and confidence in each other, as shared by an interviewee from PRC:

*The first thing mostly we face in terms of language. We rely mostly on Chinese language because we are not comfortable in English or any other language. And our business partners from Pakistan cannot speak Chinese, so we have much difficulty in communicating and understanding our business partners. We most of the time use translators and this makes it even more challenging and hard sometimes as the translators cannot translate accurately what we want to convey to our partners. Other party (businessmen from Pakistan) also face the same issue when they try to translator through translation Apps [W.X.J-C-02, 14:37].*

### **Contextual differences**

Other than language barriers, widespread contextual differences make it most challenging to understand each other. For businesspersons who have been in cross-border trade for fairly long time, they are acclimatized to contextual differences, and they are in position to understand the contextual differences and extract the meaning out of it. Whereas for newcomers and less accustomed businesspersons from both sides, it's a tall tool to understand the contextual differences. A businessman from capital of Pakistan, doing business with Chinese firms for ten years, maintained that contextual differences are yet another bottleneck that makes it harder for them to understand and do business with their counterparts in China:

*Sometimes we can't understand what they actually mean. They use phrases that are hard for us to understand. For example, when our business partners say often say "maybe they will buy our products", we don't know if this just a courtesy word or they actually want to buy it [K.A-P-06, 23:32].*

### ***Adherence to time commitments***

Whereas both countries have a strong emotional attachment and affinity with each other, however they differ in their contextual understanding of time commitments. Generally, in subcontinent, getting late for five to ten minutes is usually the norm in informal meetings and is tolerated. Sometimes, the official ceremonies scheduled to begin on a given time are intentionally or unintentionally commenced a little late (around 15~30 minutes), for various reasons, such as the VVIPs tend to show up a little late, for apparent security reasons. Such kind of behavior is quite strange and unusual for Chinese business delegations for whom time commitment is the utmost important. This kind of behavior freaks and irks the businessmen from China who have lesser exposure to the unwritten business norms. An interviewee from mainland China, representing a large company from mainland China that has extended their business venture to Pakistan not long time ago expressed this frustration as:

*Sometimes we feel that our partners are a bit reluctant in time management and little careless about their business promises. I think this may be due to their misunderstanding about the importance of business ethics or way of business dealing in their country [X.L.L-C-02, 29:11].*

### ***Food and other differences***

Although food and other facilities are secondary in nature and do not make any difference in business decisions. However, for long-term visitors and expats in alien countries, sometimes it affects their decision to stay in a foreign country for a short or long time. Undoubtedly, Chinese food is famous and well appreciated around the world. Chinese food restaurants are in most cities around the world, however, the food offered is a little bit modified to suit the local consumers. For instances, some Chinese food restaurants in Pakistan use the local spices and other materials which suits well to the local consumers, not to people who have experience the authentic food in their home country.

Certainly, food may not be a factor of importance when it comes to business negotiations, albeit it may have an indirect effect on individuals' perception about other countries. On question of the biggest challenges faced in overseas

country, an interviewee from PRC working in Pakistan mentioned food as a factor:

*When we go on business trips to a foreign country, we think of food often. And if our stay is longer than a month, we miss the authentic Chinese food [W.X-C-03, 24:19].*

Interestingly, an interviewee from a Chinese SME, who frequently receives foreign guests and has business dealings with counterparts from Pakistan described the challenge of different food habits:

*... Secondly, another challenge for us is to provide the Pakistani food to our business partners. Most of our clients from Pakistan ask for Halal food and sometimes they face even problem in eating because there and our foods are very much different in taste and in cooking style [L.K.Q-01, 22:56].*

Same applies to the business delegation visiting Pakistan. A young businessperson from PRC who frequently swing over to Pakistan on business trips said: “*We’re not accustomed to food in Pakistan and the Chinese food offered by restaurants in Pakistan is not the authentic Chinese food*” [C.X-C-04, 21:51].

### ***Demand for unreasonable price reduction***

Sometimes one party expects more from the other party, such as huge concessions and minimum rates, that often cause unsuccessful business meetings. As a businessman from PRC shared:

*Most of our meetings remain successful and we come to an agreement, or a contract point but sometimes we could not finalize the deal due to different terms and conditions. Most of the time the reason could be the price of the product we deal or some terms and conditions the government impose on various exporters [Y.X.L-07, 30:11].*

Another representative of an emerging SME well described the segregation of personal relations and emotions from business:

*We always consider business as business and sometimes our clients, especially from Pakistan, ask us to give them extra favor in business dealings. That is not possible for us, because we have our production cost, transportation, taxes and many other things we need to consider [S.S-C-08, 28:25].*

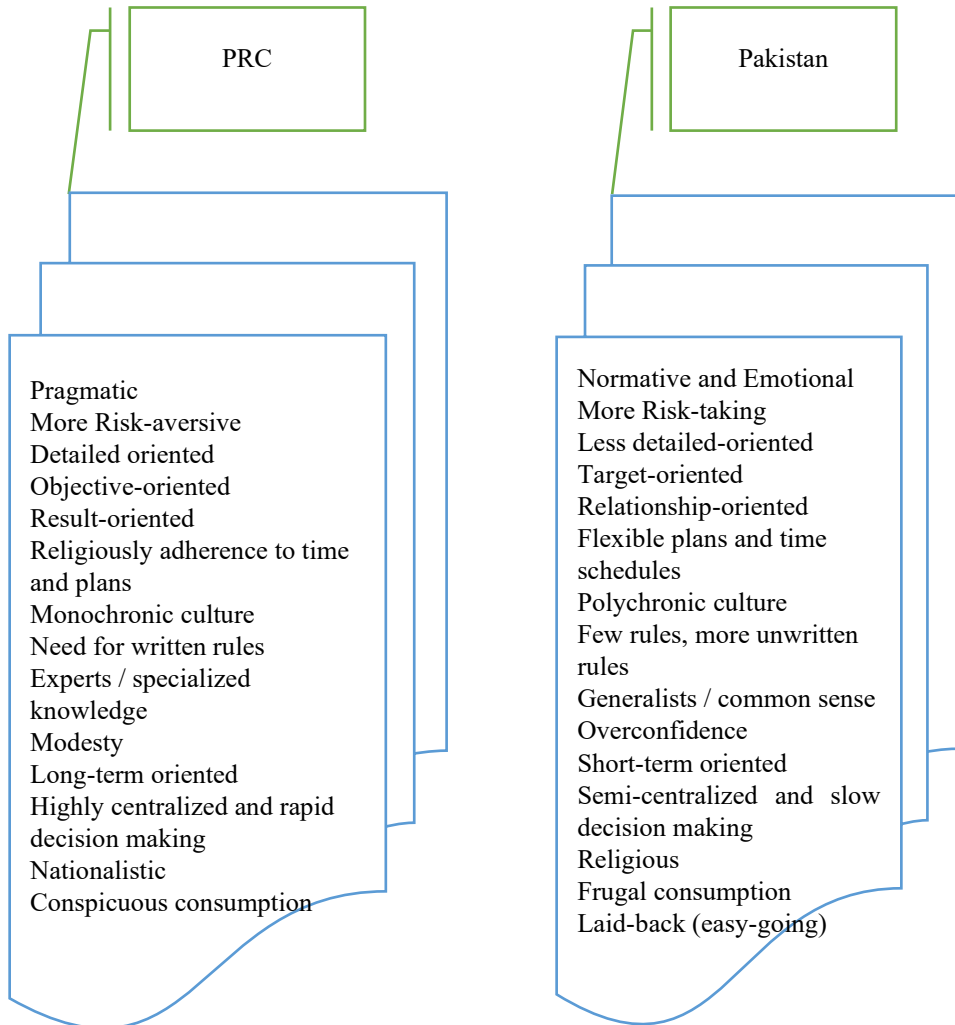


Figure 2. Comparison of business cultures in the two countries

## Discussion

Business negotiations are the heart of an eventual business deal and contract that could help build a long-lasting affable business relations between two partners. However, business negotiations in cross-cultures can be a daunting task, especially in situations where the parties have limited cultural understanding of each other. It is likely that the expectation of high gains from a business negotiation could end up in no gain or failure. Moreover, as businesspersons and managers increasingly find themselves working across cultures, the need to understand these differences has become increasingly important (Steers et al., 2010).

Having a rich cultural root and a history dating back to more than 5000 years, Chinese value culture as an important aspect of their social and business life. Arguably, it is a common practice in PRC to bolster relationship (关系, Guānxi) with other party before entering into serious business negotiations (Zhu, McKenna, & Sun, 2007). By surpassing Japan as the second largest economy of the world and gaining robust economic growth over last four decades, China is a cherished destination for business corporations from around the world. However, Linda Young (1994) argued that negotiating with Chinese can be very challenging and Chinese have been sometimes recognized as some of the toughest negotiators in the world.

Since Indian Subcontinent (now separate countries of India, Pakistan and Bangladesh) have been the British colonies for over one and half centuries, most of the business practices, norms and culture have been drawn from the British and western countries. Even after the partition in 1947, both countries of Pakistan and India have been under the heavy influence of western style of business thinking. And there is a logical reason for that as the business schools and universities taught the western and particularly the North American style of management. Secondly, the multinational corporations (MNCs) had been reached to the soils of Pakistan and India very early on, during the British colonial era and later rampant influx of MNCs to both Pakistan and India has been seen after the end of WWII. This has entrenched and deep rooted the western corporate culture, although with some exceptions in both countries of India and Pakistan. Contrary, despite being the country of the largest population on Earth and huge potential for MNCs to garner profits; these MNCs could gain market access in PRC only after the reforms and opening up in late 70s. However, once the MNCs are in PRC, majority of them have seldom thought of leaving the country.

### ***Takeaways and Suggestions for Successful Cross-Cultural Negotiations***

***Accommodative Approach:*** Having an open and accommodative approach helps build long-lasting and mutually befitting relationships. Undoubtedly, an affable and camaraderie approach wins the hearts and minds of others.

***Embracing the Differences:*** It is natural and obvious that other cultures will have unique aspects quite different from one's own. True appreciation of diversity extends beyond mere acceptance; it necessitates a deeper exploration into the unique cultural and organizational contexts that shape individuals and groups. Recognizing difference not as a barrier, but as a valuable lens through which to learn and grow, fosters innovation and enriches understanding within any environment.

***Focusing on Commonalities:*** While acknowledging the myriad cultural

differences that may exist between the two countries, it is equally important to recognize the significant similarities and commonalities that can serve as a strong foundation for promoting enhanced business relationships. Identifying and emphasizing these shared values and mutual understandings can effectively cultivate stronger interpersonal connections and facilitate more productive collaborations in the business sphere.

**Learning about other Cultures:** Every culture is unique and fascinating. It's always good to learn about new cultures and be open to unique aspects of other cultures. It is essential to well prepare and learn enough about the new culture and business norms prior to embarking on a business trip to another cultural setting. Moreover, learning and understanding a new culture requires patience, consistency and humbleness, as it can't be grasped at once, it's a slow process of learning and understanding.

**Avoid Stereotyping:** The biggest disrespect to other cultures is stereotyping and prejudice against other cultures based on false and misleading information. The best way could be to experience the culture and debunk biased opinions.

### ***Practical implications***

This modest effort will help in better understanding the cross-cultural differences and commonalities of the two countries in the context of bolstering business relations. The findings would help the business community of both countries to better understand each other's unique cultural and business norms. The study will also help the future academic studies on cross-cultural management of the two countries and inspire efforts to make deeper theoretical and practical contributions in this context.

### ***Originality/value***

While we do not claim to be the first ones to explore cross-cultural communication and business negotiations in China and Pakistan; this study is expected to be a worthwhile contribution in literature on cross-cultural management in the two countries. The authors unequivocally confirm the originality of this study, and the due acknowledgement and citations have been given to where the literature has been extracted from other studies

### **Conclusion**

Business negotiations can make or break business relations. Therefore, understanding business norms and practices is quintessential for forging a successful and long-term business relationship. Businesses can yield substantial gains if they not only just understand the product features, but also

the human aspects, the cultural underpinning and unique business styles of other parties.

Since the two countries are tie-together in an everlasting relationship, well-familiarity and understanding of each other's business norms and practices will greatly help in forging long-lasting business relations between the two countries. Moreover, better cultural understanding is quintessential for successful and long-term business relations, as lack of cross-cultural understanding costs companies millions and billions of dollars. Many foreign companies successful in their home country, fail in overseas soil, especially in a country having a different social, cultural, economic and political system, such as China and Russia etc.

For business negotiations to bear fruit, understanding and familiarity is critical in this fast-paced world. Cross-cultural knowledge and understanding is highly critical in managing employees and operations abroad. Without having sound understanding of the people's perceptions, like dislikes, prevailing trends, habits, communication patterns, social behavior to name a few; a foreign company may grapple with innumerable problems. For the time being, it may achieve some progress, but hard to gain the long term and sustained growth and success in a foreign country.

On top of it, whereas there are plethora cultural differences amongst countries of the world, it is important to understand that no culture is superior or inferior, and neither a particular way of doing things in one culture is right or wrong; it all contextual and needs to be understood in its contextual frame of reference. This means that cultural values are relative and should not be judged based on one's own judgement lens, rather see it in a bigger contextual phenomenon.

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## **The Impact of Chinese Language Learning to Capitalize the CPEC Opportunities: From Barriers to Bridges**

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### **Abstract**

This chapter highlights the strategic significance of learning the Chinese language to ensure the effective implementation of CPEC projects. Given the language gap between Chinese and Pakistani stakeholders, learning Chinese language skills is becoming increasingly important. Proficiency in the language will not only improve communication and strengthen trade relations but also help fulfill the rising human resource needs in CPEC's industrial zones.

Equipping Pakistan's youth with Chinese language education enables the country to better align its workforce with emerging economic opportunities. As China's global economic influence grows, Chinese language fluency becomes an essential asset for professionals and businesses operating within the corridor. The chapter delves into how language education can foster deeper economic cooperation, improve communication, and facilitate cultural exchange under the CPEC framework, thereby enhancing employability in both domestic and international markets.

Moreover, it explores the role of Chinese language proficiency in advancing cross-cultural understanding and strengthening diplomatic relationships between Pakistan and China. These efforts aim to transform language skills into a strategic advantage that promotes sustainable economic growth, regional connectivity, and the long-term success of CPEC initiatives.

**Keywords:** Chinese language, Trade, Employment, CPEC.

## **Introduction**

One of the most crucial elements of development in all respects is language learning & long-term prosperity is impossible for any nation without a substantial accumulation of human capital. It seeks to improve people's quality of life and extend their perspectives on the world. It has several social benefits for individuals and society, including boosting creativity and productivity, promoting entrepreneurship, and advancing technology. Being multilingual is seen as essential in the age of globalization in order to improve communication with others. Without the use of words, neither economic decisions nor environmental discussions can take place. A nation's language has a significant impact on its overall growth & the standard of living for its people is significantly raised. For this reason, governments around the world are committed to reshaping their countries' educational systems in accordance with internationally developed norms and standards. This increases the efficiency, strength, and competitiveness of each of these countries' national workforces. English was the language of the aristocracy, as is widely known from a historical standpoint. Recognizing that the more one understands the language and culture of another nation, the greater the likelihood of establishing successful, long-lasting political and economic ties. The study concentrated on the significance of the current language barrier under the China-Pakistan Economic Corridor (CPEC), which undoubtedly affects the two countries' bilateral interaction that is essential to the growth of any cultural industrial community.

## **Breaking Linguistic Barriers**

There are several reasons why language learning trends are shifting, but the trend to study Chinese is particularly distinctive since it is linked to the successful completion of the China-Pakistan Economic Corridor (CPEC) and the region's overall economic development. For instance, the English language is well-known among students in a certain field since it is used in all academic activities and learning processes. As a result, many people in our area are bilingual or multilingual. It is anticipated that CPEC will boost trade between the two countries, but this connectivity will also foster cultural exchange, communication and wealth enhancement. In terms of economic growth, CPEC is also credited with paving the way for linguistic and cultural connections throughout South Asia, especially with Pakistan.

## **Chinese Language as a Catalyst for CPEC**

It is important to keep in mind that the distinction of labor force can play a crucial role, which depends on training and fitness. Though it lacks the proper improvement of the effort force, Pakistan has the tenth largest labor force in the United States (Ahmad, Sharma, Ali, & Ali, 2019). Conversational difficulties are a significant obstacle to trade, because people in different nations often speak different languages, the costs of bridging linguistic divides may make it more difficult to exchange goods. Communication in client making business was more impacted by language distance than in product manufacturing (Hutchinson, 2002). Despite its dominance as a global language, English does not promote interchange any more successfully than other important languages. However, the primary languages, together with English, work better together than they do separately when it comes to marketing trade. In theory, a small bilingual school might provide everyone in each nation with access to all market information in their preferred language (Melitz, 2008). We will bridge the gap by relating to youth at the appropriate moment and on the appropriate path, but it is more focused on the observable advantage and pays far less attention to its social outlook. It takes far too long to teach such skills and curriculum, train teachers, teach Chinese, and give better equipment training (Butt, 2017).

Pakistan has taken a number of actions to ensure that CPEC is carried out smoothly. Learning the Chinese language is one of them. There are now four Confucius institutes in Pakistan that focus on teaching Chinese language and culture. There are already thousands of Pakistanis enrolling and learning Chinese language. Some further China study centers have been established in over 19 Pakistani universities. The establishment of these centers within the major universities is to raise awareness of China, conduct behavioral research on different aspects of China, and promote OBOR and CPEC. Coaching classes on Chinese language, sinology, and many other topics are offered by some of those centers. The human aid needed for CPEC is being produced by these centers. Around 20,000 people in Pakistan are currently learning Chinese, which is still less than the demand for the language today (Hilali, 2020). In theory, a small group of bilinguals would choose to make all market records available to everyone in both countries in the language of their choice (Melitz, 2008). It focuses more on the observable financial gain and less on the social perspective, which we can address by guiding young people in the precise direction at the right time. The time to teach these skills and curriculum, train teachers, teach Chinese, and supply equipment for higher education

is long overdue (Butt, 2017). An "economic corridor" is a sea-based transit system that facilitates financial activity and is used for the transportation of goods and services. A capacity-building framework must be created in order to improve indigenous human resources and fortify the labor force in order to fully profit from CPEC. This can only be accomplished by increasing each nation's local, national, and international contacts (Farooq Abbad, 2020). In fact, English speakers are common in Pakistan, particularly among the educated, since English is considered a lingua franca & English-speaking has become popular across the nation. Since English is seen as a language of success, people in Pakistan study it in order to obtain a decent job. However, Pakistan feels that they should focus on the Chinese language, which has a higher proportion of speakers worldwide than English, given the significance of CPEC and its expectations. Our study indicates that compared to other language learners, Chinese language learners will have greater employment opportunities, which will contribute to their bright and happy future. There is no denying that Pakistan is seeing a language shift as a result of CPEC. With people being able to converse in Chinese, Urdu, English, and their mother tongues, it is also contributing to multilingualism in Pakistan (Asif et al., 2019).

Since language acquisition is thought to be required for participation in a variety of social group settings that use a particular language, language learning theories have placed a strong emphasis on the role that integrative motivation plays in the acquisition of language skills. As a social phenomenon, language is viewed as a social activity that enables people to engage in social activities by communicating ideas to others (Zafar, 2021). The fourth CPEC media forum was held in Beijing in November 2018 to discuss the importance of learning each other's languages in order to prevent misunderstandings brought on by information gaps and language barriers, as well as to gain a deeper understanding of each other's histories and cultures (Hassan, 2021). Similar to this, when managers are assigned to certain projects, their managerial and leadership skills are evaluated, with a crucial element being their linguistic communicative competence in traditional work positions like managing labor-based teams, small teams, and large project-based management as Pakistani engineers comprise the bulk of the CPEC project's personnel. According to this study, language significantly affects job performance and career advancement in the Pakistani labor market, as well as an individual's management skills when working on large projects with a multilingual workforce (Anwer & Gill, 2020).

However, learning Chinese is difficult, China should train its teachers to teach in English first while simultaneously requiring students to learn their native tongue. Since Chinese prefer to communicate in their own language in public, linguistic barriers may lead to misunderstandings; proficiency in standard Mandarin might enhance current mutual understanding (Masum, Mohammad, & Perveen, 2021). Additionally, both countries have stated that they are attempting to remove the language barriers by giving locals employment and commercial opportunities, & the CPEC will positively impact economic growth through this way. Learning each other's languages and fostering more interpersonal interactions are crucial for the citizens of both nations (Menhas, Mahmood, Tanchangya, Safdar, & Hussain, 2019). This is because it is critical that all members of society have a thorough understanding of languages. Serious issues that address global endangerment are conducted on both national and international platforms. According to (Zygmunt, 2016), language education is the primary means of bringing about significant changes in the environment through listening, understanding, and speaking. Being multilingual or bilingual in a world of globalization, where vast quantities of products and services are exchanged, is influencing migration and tourism trends.

Proficiency in foreign languages is crucial for establishing enduring business partnerships and reducing search and information expenses. In the case of English, which is frequently utilized as a lingua franca in international trade, this is especially true. Employers favor and compensate employees who speak foreign languages with significant pay increases, particularly in jobs related to the service, business, and tourism sectors. Effective integration into the host country is a direct result of having the ability to communicate and convey in the destination country. When selecting how much time and opportunity costs to engage in language acquisition, immigrants weigh the costs and expected benefits. A diverse cost structure is defined by language skills determinants like linguistic origin, age of migration, individual education and aptitude, and enclave density, whereas labor market advantages like higher wages and employment opportunities give the anticipated benefits. Because proficiency in English, particularly in South Asian languages, is crucial for landing blue-collar and white-collar employment, language proficiency has a significant impact on earnings throughout the occupational spectrum. It has been shown that language skills complement other forms of pre-migration human capital and act as a translation tool to transfer knowledge from the home country to the labor market of the host country (Isphording & Otten, 2014).

## **Unlocking CPEC's Potential**

Being multilingual or bilingual in a world of globalization, where vast quantities of products and services are exchanged, is influencing migration and tourism trends. Proficiency in foreign languages is crucial for establishing enduring business partnerships and reducing search and information expenses. In the case of English, which is frequently utilized as a lingua franca in international trade, this is especially true. Employers favor and compensate employees who speak foreign languages with significant pay increases, particularly in jobs related to the service, business, and tourism sectors. Finally, the most investigated topic in the context of language skills and the labor market is the importance of destination language skills for international migrants. Effective integration into the host country is a direct result of having the ability to communicate and convey in the destination country. When selecting how much time and opportunity costs to engage in language acquisition, immigrants weigh the costs and expected benefits. A diverse cost structure is defined by language skills determinants like linguistic origin, age of migration, individual education and aptitude, and enclave density, whereas labor market advantages like higher wages and employment opportunities give the anticipated benefits. Because proficiency in English, particularly in South Asian languages, is crucial for landing blue-collar and white-collar employment, language proficiency has a significant impact on earnings throughout the occupational spectrum. It has been shown that language skills complement other forms of pre-migration human capital and act as a translation tool to transfer knowledge from the home country to the labor market of the host country (Isphording & Otten, 2014). Investigating and identifying CPEC's language hurdles is also the ultimate goal of this project. This research combines analytical and fundamental studies. We determine the main effects of CPEC as a language shifter in Pakistan and the significant cultural and linguistic differences between the two countries by critically analyzing various research publications. We also determine the language issues that project teams from both countries encounter while working on CPEC.

## **Building Bridges through Language**

Since it is a major obstacle in bilateral trade, this study aims to identify these impediments. The Language Barrier Index (LBI), a novel statistic that measures the disparity between the primary languages of trading partners, quantifies language obstacles across borders. The primary factor used to assess organizational preferences for trade is language, which clearly favors comparable or intelligible languages because of historical and cultural linkages. To promote language and cultural exchanges, the governments of the

two nations can launch television programs. Chinese language teaching is promoted by the Pakistani government at all educational levels, including colleges, universities, and schools. The results show that the disparities in language, culture, and processes are making language a hurdle to CPEC's success. In order to get across the language barrier, policymakers understand how important it is to bring the citizens of the two nations closer together. People in Pakistan believe they should concentrate on Chinese language because of the importance and aspirations of the CPEC. The study highlights the significance of linguistic barriers in the development of the China-Pakistan Economic Corridor (CPEC) and the need for two nations to work together more closely in order to create a community of cultural industries.

There is no denying that Pakistan is seeing a language shift because of CPEC. In Pakistan, it also contributes to multilingualism. This is essential to investigate the language problems and potential solutions. Since Gwadar Port City serves as the hub for major trade, Balochistan is the primary province in Pakistan dealing with this issue as China was given 9,300 hectares of tax-exempt land by the federal government to establish an industrial zone. The federal government is automatically in charge of creating scholarship programs in collaboration with China to produce highly qualified technical staff for Balochistan who serve as a communication link, therefore; Chinese language learning for Balochistan residents is another vital requirement for the success of CPEC, since it would enable them to communicate effectively with Chinese people and facilitate trade.

The inclusion of second language learning in school, college, and HEI curricula may also benefit trade, but it will take the combined efforts of the local, provincial, and federal governments to encourage locals to learn Chinese by creating a public policy that will increase the number of interpreters and translators. By providing their staff with Chinese language teaching to enhance their communication abilities, businesses may expand their global trade. Both nations' cultures are open to the public & many Pakistanis are learning Chinese both domestically and abroad since knowing the language will open a lot of important and innovative career prospects in the near future. Millions of citizens expect fantastic job prospects with the massive CPEC projects & in order to better assist Chinese tourists; information portals and brochures are now available in Chinese. Pakistan is not solely responsible for removing this language barrier; China has also a long history of promoting Urdu language diminish obstacles and enhance cooperation and trade. In the 1950s, China opened an Urdu department at Peking University in Beijing. Since then, the department has produced several fluent Urdu-speaking Chinese intellectuals. In addition, the department translated a number of important Urdu literary works into Chinese and created the first comprehensive Chinese-

Urdu dictionary. The fact that at least five colleges now offer Urdu at various levels is one indicator of the language's popularity in China. Graduates of these programs provide their services to several private companies and work in a variety of government agencies. An old Chinese saying states that the basis for communication and understanding between two countries is their intimate relationship and interpersonal intimacy. Therefore, it is essential to boost engagement in bilateral cultural communication and collaboration where there is substantial potential under the BRI. China-Pakistan bilateral cooperation may focus on specific cultural industries from different perspectives industries such performing arts, folk crafts, radio, television, festival exhibits, cultural artifacts, etc. As part of this endeavor, they will also launch TV shows to promote language and cultural exchanges between the two sides. Most Pakistanis are youthful and active, making them one of the luckiest countries in the world in term for younger labor provider to the world. This makes them an asset in the form of human capital, which is the main driver of development in any country. In terms of the accumulation of human capital, Pakistan came in at number 118 out of 130 countries in the World Economic Forum's 2016 HDI, which is quite concerning. Even though infrastructure development is essential for long-term growth, prosperity also requires working human capital, which can only be developed through education and training. This is because learning a second language will make our workers more competitive. For the purpose of Pakistan's bright future, which requires that state policies be properly aligned to suit the objectives of CPEC, it is imperative that the policies of China that guarantee education be replicated. Recently, the number of students to study Chinese has increased at an unprecedented rate. We had about two hundred college students learning Chinese before CPEC. Because of an increasing demand for expertise approximately China, many personal institutions have also began imparting mandarin courses. The task will help close the gap in spoken communication between Pakistan and China. Additionally, it will help our students secure employment as translators and interpreters in several joint China-Pakistan projects. In 2016, 495 college students who were chosen through the Punjab government scholarship program were sent to China to study Chinese in prestigious universities and institutions. Pakistanis would want to confirm that they are eligible to work on CPEC projects; their resumes will be polished by studying Chinese language and meeting Chinese language standards.

### **Overcoming Obstacles and Seizing Opportunities**

The Chinese language has become more widely spoken in Pakistan since the start of the CPEC. People are starting to realize how crucial the Chinese language is when looking at business and job prospects under the China-Pakistan Economic Corridor (CPEC). It's important to note that people who

speak Chinese well have an edge while applying for jobs in Pakistan. A prosperous future awaits many Pakistanis who speak Chinese fluently. When used effectively, communication is a powerful instrument that can break down barriers and propel any country forward. Since a country's sustainability is inevitably a global issue rather than a local one, its issues must be addressed on both a micro and macro level. Regardless of what country they belong to, the concern of 'all those in power' should be diverted towards sustainability issues such as that of foreign language education'. Furthermore, it is crucial to remember that foreign countries have a significant influence on the course of events in a globalized world, including aspects related to economic development and bilingual education. The increased interest in learning Chinese is not just the reason why more students from all across Pakistan are enrolling in, but it has also led to the opening of Confucius institutes in various parts of the United States. Given that China is one of Pakistan's key economic partners in CPEC, the importance of the Chinese language (Mandarin) has been magnified. Mandarin is not only essential for effective communication in business and trade but also for fostering deeper cultural understanding which highlights that how the integration of Chinese language education can enhance Pakistan's participation in the CPEC initiative and strengthen bilateral ties.

Effective communication between Chinese engineers, investors, and Pakistani officials is essential to the success of CPEC. Since Chinese people make up the bulk of CPEC project stakeholders, being able to communicate in Chinese is crucial for productive contract administration, cooperation, and negotiation. Business leaders, government officials, and workers who can communicate in Mandarin will have a competitive advantage in securing contracts, facilitating transactions, and overcoming bureaucratic hurdles. Diplomacy and trust are key components of China-Pakistan's strategic alliance. When it comes to improving communication between diplomats and negotiators, language is essential. Speaking Chinese can improve diplomatic effectiveness as CPEC deepens the two nations' bilateral connections by promoting easier cooperation, policy, and idea sharing.

Additionally, learning Mandarin might help you have a deeper knowledge of other cultures. Learning Chinese promotes cooperation and mutual respect between the two cultures as people-to-people interactions grow. Pakistani students, professionals, and workers involved in CPEC projects will benefit from language skills that enhance their ability to navigate Chinese cultural norms and practices, building better relationships with Chinese counterparts. The significance of Chinese language teaching in Pakistan is becoming increasingly acknowledged as the CPEC project moves forward. Mandarin language teaching is available at many colleges and universities, and more

Pakistani students are seeking degrees in Chinese literature and language. For example, organizations such as Pakistan's Confucius Institute are essential to the dissemination of Chinese culture and language. Pakistani government has implemented programs to encourage studying Chinese after realizing the importance of Chinese language. The development of Mandarin language programs, the inclusion of Chinese language in schools and university curricula, and financial aid for students to study in China have all fueled interest in the language.

### **Suggested Citation**

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## **Tourism, CPEC, and Security in Pakistan: Threats and Opportunities**

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### **Abstract**

The chapter highlights issues concerning tourism and security in the context of CPEC. Due to attacks on laborers and Chinese workers at several CPEC sites, the social life of Chinese workers in Pakistan has been disrupted, causing a negative perception of the country among expatriates and tourists. External interferences have also been a matter of concern. Moreover, as a result of security concerns, various CPEC projects have been halted. Besides, what is development if it is rooted in the grievances and deprivation of the local population? The chapter, therefore, is an attempt to understand the nexus of tourism, security, bilateral relations, and CPEC. Data for this small-scale study was collected through questionnaires filled in by 80 Pakistani men and women. The participants had generally positive responses towards tourism in the context of CPEC. They showed confidence that CPEC could improve tourism in the country and would help boost stability and prosperity in Pakistan. However, the participants also pointed out concerns related to the complex nature of the project and its outcomes, local Pakistani people's rights, lack of awareness among local Pakistani people, terrorist attacks on Chinese people, political instability in Pakistan, and a few Chinese groups'

involvement in fraudulent activities in Pakistan.

**Keywords:** Tourism, Safety, CPEC, infrastructural development, Local Pakistanis' rights

## **Introduction**

China Pakistan Economic Corridor (CPEC) is the investment of about \$62 billion to develop the infrastructure of Pakistan through Special Economic Zones, energy production, and mass transit. CPEC is one of the best ways for the development of the underprivileged regions to concentrate on the investments in the vital areas like roads, trades, energy, and communications (Riaz, 2024b). The China-Pakistan Economic Corridor (CPEC) connects China's Xinjiang region to Pakistan's Gwadar Port, spanning several key locations across Pakistan. Gwadar Port in Balochistan serves as the strategic endpoint and a major trade hub, while Karachi, Pakistan's financial center, plays a critical role in trade and infrastructure development. Other important locations include Quetta, due to its proximity to the Afghan border, and Lahore, a major city involved in transport and energy projects. Islamabad, the capital, is central to CPEC-related agreements and policy decisions. Peshawar is important for road infrastructure and economic zones in the northern corridor, while Gilgit-Baltistan is a crucial transit region through which the Karakoram Highway connects Pakistan to China's Xinjiang. In Lahore, the Orange Metro Line has created over 10000 jobs for local people and improved the efficiency of the citizens' commute (Dongxian, 2024). On the Chinese side, Kashgar in Xinjiang marks the starting point of this vast economic corridor. These locations are central to CPEC's network of highways, railways, energy plants, and industrial zones.

The China-Pakistan Economic Corridor (CPEC), being one of the One Belt One Road projects, will improve the quality of tourism services not only between the two countries but also with the other parts of the world, leaving long-lasting impacts on socio-economic growth. The arrival of Chinese nationals in Pakistan as the launch of CPEC in 2015 shows no signs of slowing down, given that the number of Chinese residents in Pakistan has now tripled to around 30,000 while over 71,000 Chinese tourists visited on short-term visas in 2016 (*International Crisis Group*, 2018). The CPEC was expected to enhance Pakistan's economy, with the GDP projected to grow by more than five percent by 2020, according to an IMF growth forecast. Pakistan's GDP is expected to reach \$4.2 trillion by 2050, up from the current \$988 billion. The 3,200 km-long corridor aims to connect China, the world's second-largest economy, with the Middle East and Central Asia, reducing the distance of the

alternative sea route via the Malacca Strait by 10,000 km (Shah, 2017). CPEC has the potential to boost economic activities, increase trade linkages, enhance technical cooperation, generate financial opportunities, and promote socio-cultural connectivity in the region. This inclusive project could transform the fate of regional states positively and contribute to the seamless integration of South Asia (Manzoor & Wei, 2018). Though Pakistan’s defense diplomacy has been generally successful in improving the security situation and attracting investment (Khalid & Ahmed, 2024), there is a need for Pakistan to consider the crisis perception based on different studies. It is necessary to solve the issues that need security enforcement on a global scale (Shah et al., 2022).

For China, Gwadar port is very important, as they want to expand their trade across the globe. This could only be possible through the sea. CPEC will give China direct access to the Arabian Sea. From the Gwadar port, China will be able to reach the Middle East to take advantage of rich amounts of minerals. Hence, Gwadar port will provide them with the shortest route. With the completion of CPEC, 12000 km distance will reduce for China. If Kashgar is connected to Gwadar, then China has to cover only 2242 km of distance, instead of 9000 km, to reach the Arabian Sea.

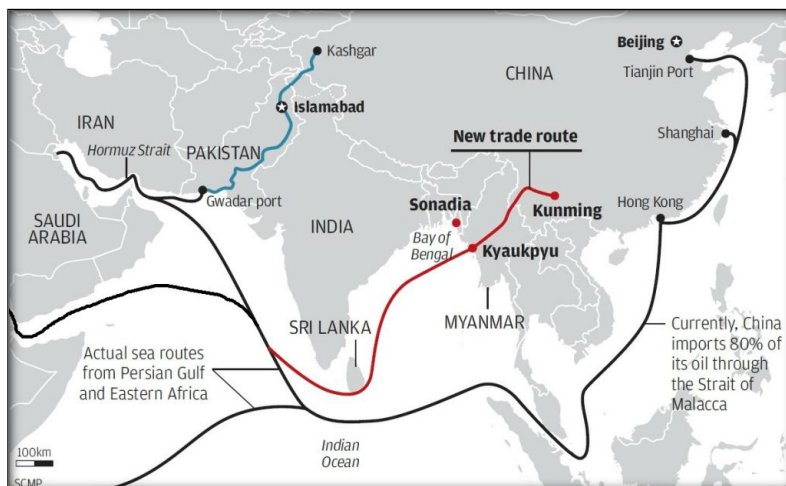


Figure 3: Trade Route of CPEC

### Pakistan, Tourism, and Terrorism

Tourism in Pakistan saw a major downfall after the 9/11 attacks in 2001. Post 9/11, Pakistan joined the coalition to fight terrorism and banned all organizations that were suspected of involvement in terrorism. Pakistan has deployed 90,000 troops three times as many as fielded in Afghanistan and hosts 2.6 million Afghan refugees. Pakistan is one of the most affected

countries, particularly in social and human aspects because of terrorism (Daraz et al., 2012). “Until 2001, Pakistan had not experienced a single suicide attack but by the end of 2009, the country had endured over 200 suicide attacks (including 87 in 2009 alone) and close to 500 bomb explosions and IED detonations, largely in the Northwestern Frontier Province (NWFP) and FATA regions, closing the year with a deadly attack on a Muharram procession in Karachi. The casualty figure for the last eight years has reached a staggering 25,000 (2009 alone accounting for approx. 3025” (CRSS, 2014, p. 4). War on terror also caused a loss of approximately USD 50 million annually to the tourism industry in Khyber Pakhtunkhwa province alone in Pakistan (CRSS, 2014, p. 17), and overall, a loss of USD 8 billion in addition to a deterioration in Pakistan’s ranking in travel and tourism competitiveness. Post 9/11, many started seeing Pakistan as a terrorist state, but the conditions of the country seem to have improved since 2014 (Nizami et al., 2018). Since 2018, there has been a decline in terrorist activities in Pakistan (Abbas, 2021). Pakistan barely got any tourists during 2007 to 2013 due to war on terrorism which claimed lives of hundreds of Pakistani innocent people as well as caused socio-economic instability.

In 2020, the global outbreak of coronavirus led to a sharp decrease in international arrivals to just 163,000. The tourism economy suffered severe damage, prompting PTDC to swiftly devise a recovery strategy in collaboration with stakeholders. Efforts focused on restoring tourism in Pakistan through the promotion of safe domestic tourism before gradually reopening for inbound tourism. Consequently, there has been a notable improvement, with international arrivals reaching 1.91 million in 2022 (PTDC, 2022).

As the security aspects of the country improved, the tourists have started driving into the country to see the northern areas of Pakistan, including Swat Valley, Hunza, and Gilgit Baltistan, etc. Tourism between China and Pakistan is an opportunity for promoting cultural diplomacy, empathy, cultural sensitivity, and ethical tourism practices (Riaz, 2024b). “With a population of over 1.4 billion, Chinese people have shown an increased desire for local and international travel. China’s outbound tourists spent over 255 billion dollars before the COVID-19 outbreak” (Javed, 2023). In 2019 alone, China reported approximately 169.2 million outbound departures because tourism is a Chinese way of life (Alam et al., 2021). In five years, 39000 Chinese people visited Pakistan (Gishkori, 2018). In 2019, Pakistan's tourism potential was featured on CNN and in Forbes Magazine. The award-winning travel magazine Conde Nast Traveler described Pakistan as one of the "friendliest countries on earth," with mountain scenery that is beyond anyone's wildest

imagination. There is a need to maintain the tourism attraction and preserve the heritage. Some tourist corporations have started working and encouraged the government to attract tourists to Pakistan.

Based on different sources, Gilgit Baltistan stands out as the heart of Pakistan's tourism industry, attracting millions of local and international tourists. With the progress of the China-Pakistan Economic Corridor (CPEC), the tourism industry is poised for significant growth. Pakistan boasts some of the world's highest mountains, including K2, and is blessed with beautiful landscapes, mountains, glaciers, lakes, and valleys. Moreover, it is home to five peaks above 8,000 meters and over 50 other mountains surpassing 7,000 meters. Once CPEC is operational, we can expect a surge in mountaineers visiting Pakistan from around the world (Siddique, 2021). Due to Pakistan's natural scenery and reduced travel time caused by infrastructural development, tourism industry will be boosted in Pakistan (Alam et al., 2021; Gul et al., 2023). Two major infrastructure projects, namely the Sukkur to Multan section and KKH Phase II from Havellian to Thakot, are among the most notable transportation developments, employing around ten thousand local workers. Additionally, the CPEC transit route is projected to generate demand for 800,000 vehicles over the next fifteen years, leading to the creation of secondary and tertiary jobs (Alam, 2020).

CPEC as a result of infrastructural development, including hotels, roads, and mass transit systems could prove to be an opportunity for tourism and business growth in Pakistan (Nazneen et al., 2021). However, related issues, such as trust, security, proper planning, and fair execution of the projects need to be addressed and understood because as a result of such issues, collaboration and execution of projects cannot take place. The China-Pakistan Economic Corridor (CPEC) connects Kashgar in China to the ports of Karachi and Gwadar in Pakistan, making it a significant cross-country initiative for Pakistan. For CPEC activities, Pakistan has created security forces because of emerging threats and political instability (Kugelman, 2023). Though a special security division of Pakistan Army and paramilitary forces is devoted to the security of individuals working on CPEC, yet due to the persisting security concerns, Chinese people have to experience restrictions that hinder their movement and social interaction. The CPEC project faces security threats due to factors like instability in neighboring countries, Pakistan-India Kashmir dispute, and the involvement of various countries in South Asian affairs (Shah et al., 2022).

### **Effects of CPEC on Tourism**

With the investments in Gwadar port and the influx of Chinese investments

through the China-Pakistan Economic Corridor (CPEC), tourism within the country is expected to increase in the years ahead making it a very attractive hub for investments in the tourism and hotel business. In September 2023, Karakoram International University in Gilgit, and Fatima Jinnah Women University in Rawalpindi organized an international conference on "CPEC, Sustainable Tourism Development for Women Empowerment in Pakistan" (*International Conference on CPEC, Sustainable Tourism Development for Women Empowerment in Pakistan | Fatima Jinnah Women University, 2023*). The participants of the conference agreed that CPEC holds tremendous potential for tourism, while measures must be taken for safer, environment-friendly, and sustainable tourism in Pakistan. Nazneen et al., (2021) also reinforced that socio-cultural and environmental aspects must be considered for CPEC-driven tourism in Pakistan.

Chinese investors are interested in Pakistan's tourism sector due to the new investment opportunities arising from the CPEC projects. The road and railway connectivity between the two countries will make travel between Kashgar and Pakistan more convenient (Manzoor & Wei, 2018). As the tourism improves, technology and technical education will become more advanced, resulting in the more advanced vocational training programs for young people. In 2015, 30 million tourists visited Xinjiang province, and a delegation from Xinjiang also visited Gilgit-Baltistan to explore joint tourism and business opportunities (Ahmed, 2016).

### **CPEC, China-Pakistan Tourism, and the Threat of Terrorism**

The China-Pakistan Economic Corridor (CPEC) connects Kashgar in China to the ports of Karachi and Gwadar in Pakistan, making it a significant cross-country initiative for Pakistan. CPEC has led to academic tourism, resulting in hundreds of students, professionals, and researchers visiting China and Pakistan (Riaz, 2024a). Although CPEC is one of the major projects for the fate and development of both Pakistan and China, but the safety of this project is a matter of great concern and worry for both countries. The killing of 10 laborers on the 6<sup>th</sup> of May 2017 is one of the horrible examples (Aljazeera, 2017). In recent years, Pakistan has experienced violence and instability in the CPEC regions, and the country's security situation is of particular concern to China (Syed, 2019). Chinese nationals and projects have faced violence from militants who oppose CPEC for various reasons. External involvement in CPEC is also alarming (Khan et al., 2024; Shah et al., 2022).

Chinese media has highlighted that the security risks associated with the Belt and Road Initiative (BRI) are mainly focused on the China-Pakistan Economic

Corridor (CPEC). Meeting Chinese security requirements calls for a comprehensive approach that goes beyond just deploying armed personnel. This entails integrated services, including security, insurance, and other components, all with associated costs. The Chinese insurance sector is recognizing the significance of this niche business. Security concerns, such as traditional security, counterterrorism, and kidnapping for ransom require insurance for Chinese businesses operating in Pakistan. Although often overlooked, specialized insurance could become a thriving sector due to the growing Chinese foreign direct investment (FDI) in the region. China's active participation in security management is also needed (Khan et al., 2024).

This chapter explores the interrelation between CPEC, tourism, and safety concerns. The primary purpose of this chapter is to highlight issues concerning tourism and security in the context of CPEC in Pakistan. The purpose of the chapter is to identify key challenges in promoting tourism in the context of CPEC and security in Pakistan. The chapter aims to pinpoint areas for improvement for the promotion of CPEC-driven tourism as well as highlight safety concerns which have impacted the locals as well as Chinese individuals living in Pakistan. It addresses the following research question:

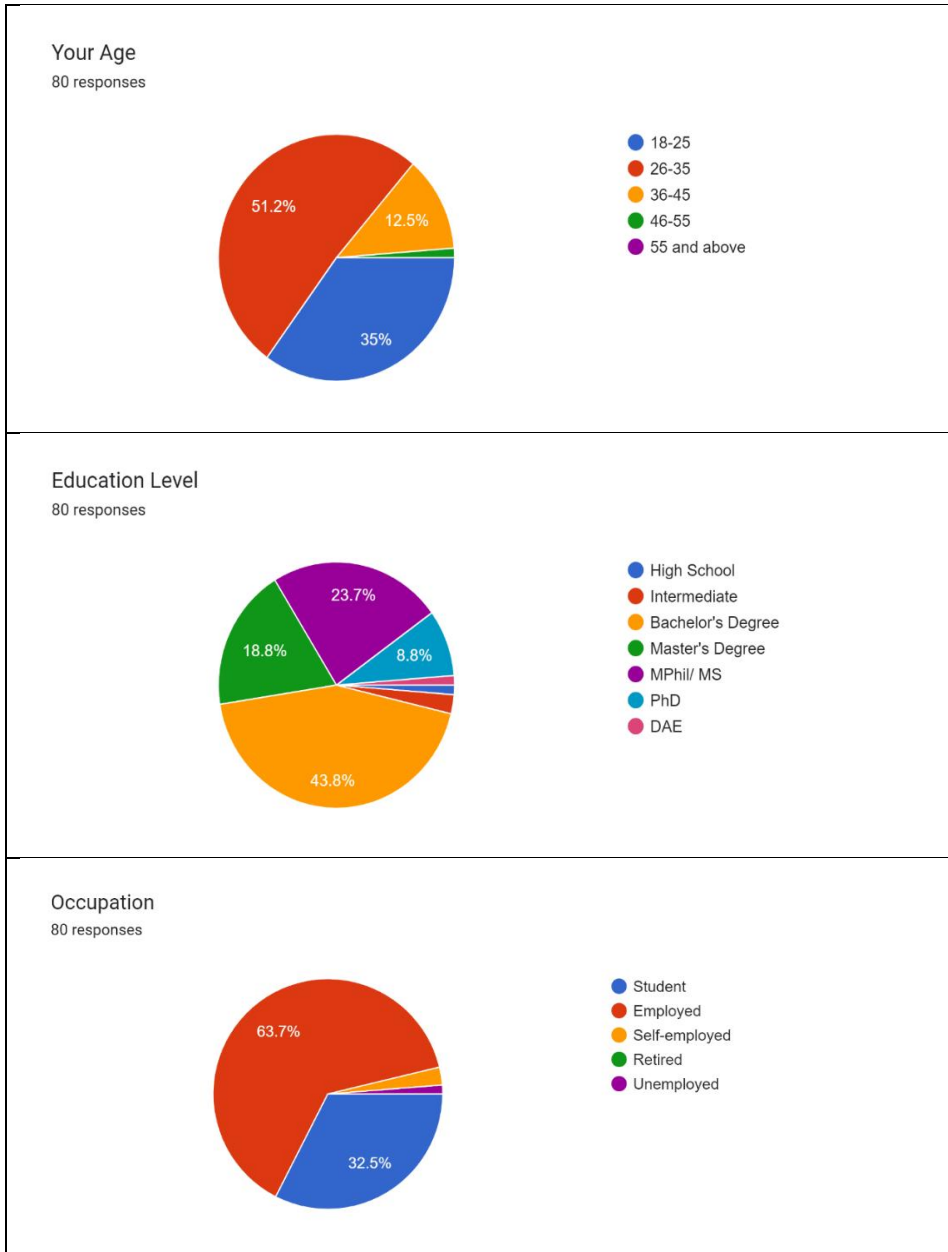
What are the key challenges and areas for improvement in promoting tourism in the context of CPEC and security in Pakistan?

The present qualitative study using voluntary response sampling technique employs a questionnaire, which was administered online, as a data collection tool. Eighty participants responded to the questionnaire which included both closed-ended and open-ended questions. Although participants from all four provinces contributed, a limitation of the study is that a more diverse group, particularly with greater representation from Balochistan and Khyber Pakhtunkhwa, would have provided more comprehensive insights, especially given the unique security dynamics in regions like Balochistan, which are central to CPEC. However, existing studies on CPEC-driven tourism predominantly focus on Gilgit-Baltistan or the northern areas, making this study valuable for understanding perspectives from Sindh and Punjab. In addition, this study draws on the first author's interactions with a few Chinese nationals, currently employed in Pakistan, whose opinions about the security measures and their current security related challenges were sought.

## **Findings and Discussion**

Eighty Pakistani nationals, 88.8% male and 11.3% female, participated in the survey. The pie charts given in Table 1 illustrate their age, qualification, profession, and region of residence:

Table 1: Demographic Information



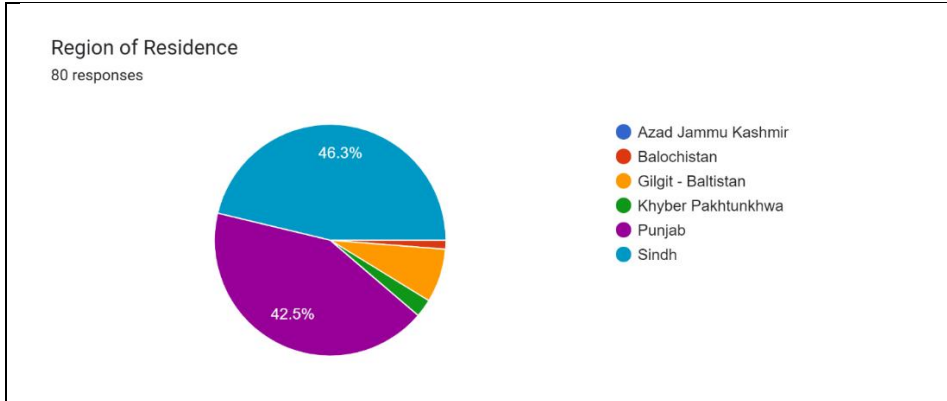


Figure 1 given in the following illustrates that 50% of them endorsed that they did observe a CPEC-related development in their region. Thirty percent of them did not see any change, while 20% were not sure.

Have you personally experienced any changes in tourism in your region since the inception of CPEC?  
80 responses

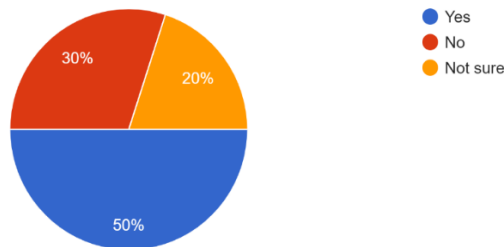


Figure 1: Pie Chart on CPEC Driven Changes in Pakistan

Most of them suggested that roads improved in their region as a result of CPEC, which could be beneficial for tourism. In addition, they suggested that hotels, new construction projects, and buses purchases from China, and mass transit system, such as Orange Line Metro were a few changes resulting from CPEC. They also noted that Pakistanis' perceptions of Chinese people in their respective regions also improved.

The participants selected the major challenges to tourism in Pakistan in the context of CPEC in the following order (Figure 2): political instability (62.5%), attacks on Chinese workers (51.2%), lack of awareness about CPEC (46.3%), lack of CPEC related benefits to local Pakistani people (43.6%), violation of locals' rights (45%), poor facilities for tourism in Pakistan (45%),

terrorist attacks in the CPEC regions (41.3%), negative international media coverage (37.5%), resistance from local liberation groups (30%), and hazards to environment and natural resources, including landscape and wildlife (25%).

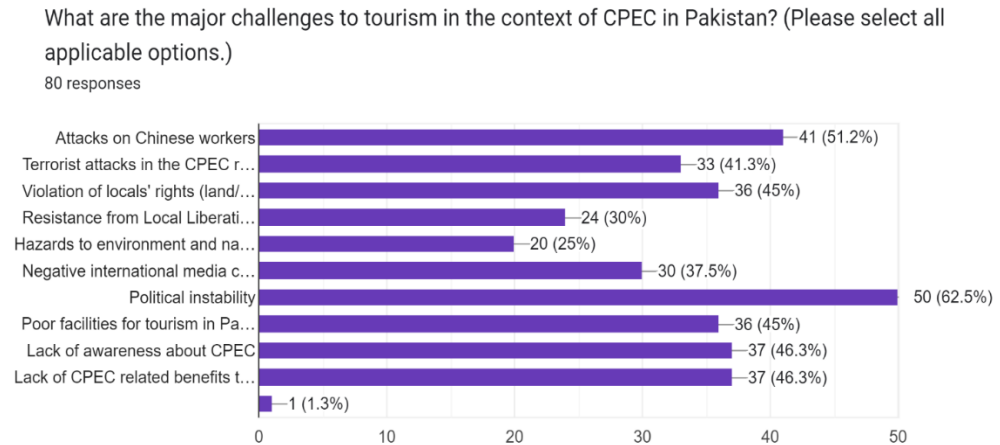


Figure 2: Major Challenges to Tourism in the Context of CPEC in Pakistan

Forty-six percent of the participants considered the possibility of external (non-Pakistani and non-Chinese) involvement in the terrorist activities related to CPEC, 38.7% remained neutral, while 15% rejected the option of external involvement in terrorist activities.

Do you think third-party (non-Pakistani, non-Chinese) groups are involved in terrorist activities related to CPEC in Pakistan?

80 responses

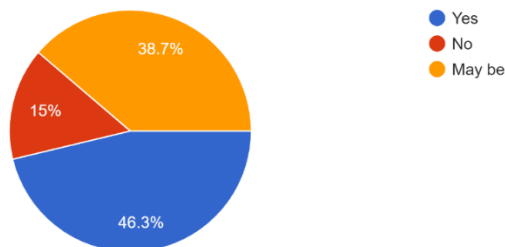


Figure 3: Participants' Perception of External Involvement in Terrorist Activities in the CPEC Regions

In the context of CPEC, 35% of the participants remained neutral about the possibility of a negative impact of Chinese individuals or organizations on

Pakistani businesses and tourism, while 28.7% agreed and 13.8% strongly agreed that certain Chinese individuals' and organizations' involvement in fraudulent activities could affect business and tourism. On the other hand, 20% disagreed. It was pertinent to ask this question because tourism, business, safety, and trust are interconnected. If Chinese people do not feel safe, they would not come to Pakistan, and if they are not considered trustworthy, they will not be welcomed. In either case, business, tourism and bilateral relations are affected.

Do you think fraudulent activities by Chinese individuals or companies are a threat to local people, businesses and tourism in Pakistan?

80 responses

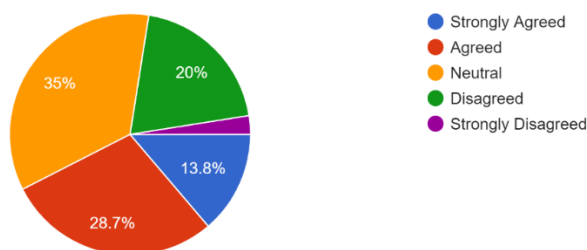


Figure 4: Perceptions Regarding Chinese Organizations

In addition to closed-ended questions, participants were asked an open-ended question to explore more about the relationship between CPEC, tourism, mutual trust, opportunities and threats in the Pakistani context. The following section highlights the perceptions, concerns, opportunities and threats shared by various participants.

1. Many participants pinpointed the value of CPEC for tourism in Pakistan. One of them noted, “CPEC is a beneficial opening for the tourism industry of Pakistan. CPEC is expected to be lucrative for tourism and travel in Pakistan. Improved roads, power infrastructure, and pipelines will make pristine tourist spots accessible. A lack of energy in Pakistan has had a negative impact on several facets of the country's economic strategy.” Another claimed the CPEC to be a “positive change for Balochistan and Pakistan's economy, tourism, organizations, and digital business, etc.” Another participant stated, “It's purely beneficial for Pakistan in improving tourism capital”.
2. Many of them highlighted the multitudinous nature of CPEC as well as the complexities surrounding it. One of the participants stated,

“CPEC's impact on Pakistan is complex, with potential benefits like economic growth and job creation, but also concerns about terrorism, mistrust, environmental degradation, and displacement of local communities”. Another supported, “Pakistan's development trajectory is influenced by various factors, including the China-Pakistan Economic Corridor (CPEC), tourism, terrorism, and mistrust. CPEC promises economic growth, job creation, and infrastructure development, but also raises concerns about debt, environmental impact, and unequal benefits distribution. Tourism has the potential to promote cultural exchange and generate revenue but faces challenges like security concerns and infrastructure limitations. Terrorism has severely impacted Pakistan's security, economy, and global reputation, while mistrust among citizens and towards institutions hinders national progress. To maximize benefits and minimize losses, Pakistan must ensure transparent decision-making, develop effective policies, invest in human capital, and promote national unity and trust-building initiatives. By addressing these challenges and leveraging opportunities, Pakistan can unlock its potential for sustainable development and prosperity”.

3. While many of them highlighted CPEC and its importance for tourism, stability, and infrastructural development as well as its role in “creating hope for the marginalized classes in Pakistani society”, most of them emphasized local Pakistanis’ rights and the need to protect them. They also stressed upon the need for creating awareness among local Pakistani people regarding the benefits of CPEC. One of them stated, “CPEC associated benefits should be reached at the grassroots level. The rights of local community should be acknowledged, and other land related disputes should be resolved. CPEC is one of the best infrastructures for Pakistan, which will reduce the lengthy route, and facilitated many people”.
4. Various participants raised various concerns regarding CPEC, tourism and related security issues. One of them asserted, “The CPEC projects have improved tourism in Gilgit Baltistan. However, terrorist attacks on Chinese engineers are negatively affecting the China and Pakistan relations”. While many of them claimed the CPEC to be a “game changer” and “life-changer”, one of them stated, “I think CEPEC is not game changer but game over and Chinese investment of 65 dollars will bring the most expensive success in the distant future”. One of them drew attention to the Chinese expatriates’ activities in Pakistan stating, “Overall, the cooperation through CPEC is beneficial and in favor of locals and Pakistan. However, as it has been asked, I would like to mention that I've seen some Chinese groups that engage

in activities in rural or underdeveloped areas of Pakistan and cause significant damage to the image of Pakistan and so to the image of China in return, affecting tourism”.

5. Suggestions: Participants made the following suggestions for tourism, safety measures, and bilateral relations in the context of CPEC:
  - a) “Addressing terrorism, mistrust, and ensuring equitable benefits are crucial for maximizing positive impacts and minimizing losses”.
  - b) “Sincere leadership that works only for the welfare of individuals who are deprived, especially in areas where major CPEC projects are being staged is needed. Locals must get maximum opportunities and build trust and acceptance for Chinese individuals. Proper media coverage should be given to all projects, especially Pakistani staff taking advantage from these projects can create a positive image of this great Pakistan-China collaborative step”.
  - c) “Political stability is the solution to all these problems”.
  - d) “Regarding tourism in the northern Pakistan, there is still a lot of room for improvement through CPEC projects. Most of the northern areas are still not equipped with the basic tourism facilities which may be improved through the CPEC projects and infrastructure”.
  - e) “CPEC projects should provide more employment opportunities to local people. Social media platforms should be used to remove mistrust between Pakistani and Chinese communities. Pakistan and China should organize more cultural exchange programs to improve relation and tourism between both countries. In my opinion, CPEC has potential to give rise to Pakistani economy and all the other industries”.
  - f) “More CPEC Economic Zones should be established in Gilgit Baltistan”.
  - g) “When considering CPEC's impact on Pakistan, it's essential to prioritize agricultural land to avoid adverse effects on this vital sector. Public awareness through ads and media is crucial to ensure that the population understands the implications and opportunities of CPEC. Additionally, a robust system of checks and balances must be established to monitor progress and address any emerging issues. Involving local engineers and labor is critical to ensure that the benefits of CPEC, including employment and skill development, benefit Pakistan. Addressing concerns like tourism, terrorism, and mistrust will require transparent communication and collaboration to maximize the benefits and minimize any potential losses.
  - h) Local people must be involved in decision making process and public participation should be increased.
  - i) Pakistani government should know the cost and benefits of this project and make timely decisions to increase the benefits.

Overall, the participants appreciated and highlighted the importance of the CPEC project as well as raised concerns related to security. On the whole, they pointed out the need for local participation and lack of awareness as major challenges. They also pointed out political instability and attacks on Chinese workers as major threats to building trust, infrastructure, and tourism opportunities. Khan et al., (2024) also highlighted the risks associated with locals' lack of awareness, illiteracy, oppression, political marginalization, and poverty as major risks in Baluchistan. In addition, the risks to and from Chinese expatriates in Pakistan should be addressed, and appropriate security measures should be implemented.

Existing studies not only highlight Pakistan's tourism potential resulting from CPEC but also emphasize the need for a concentrated effort to promote tourism, public and private sector collaboration, use of technology, safety, skilled personnel in tourism industry, electricity production, and infrastructural development as solutions to tourism development and cultural heritage protection in Pakistan (Alam, 2021; Gul et al., 2023). The present study also endorses that Pakistan has massive potential for tourism which can thrive as a result of CPEC, provided that steps are taken to address political instability, insecurity, violations of local Pakistanis' rights, media image of Pakistan, and the lack of facilities for sustainable tourism.

This chapter highlights that for tourism to flourish, it is essential that local Pakistani people not only become aware of the opportunities for business and development but also foster positive sentiments toward these developments. They should not perceive development as exploitation. What is the point of development if it is built on the suffering of local residents? They should, instead, be able to make the best use of their land and other resources peacefully. Insurgency in different parts is one of the causes of chaos. "In Balochistan, CPEC is exacerbating existing grievances among a population whose perceptions of exploitation and neglect by the center, together with authorities' suppression of dissent, have long fueled an insurgency. Similarly, displacement is another major cause of grievance among locals (International Crisis Group, 2018, p. ii).

This chapter reinforces the need for protecting the rights of local people in Pakistan and creating awareness among them for maximizing the benefits of CPEC for tourism, employment, and business. Political instability has been identified as a major threat to tourism in Pakistan. Negative media portrayals and third-party interventions, which create an unsafe environment and deter tourists from visiting Pakistan, have also been identified as major issues.

Pakistani and Chinese organizations are taking all the necessary measures to provide security to Chinese people who are currently working in Pakistan, however, security concerns have affected their social lives badly. Chinese officials are increasingly worried about security risks in Pakistan (Kugelman, 2023). This section draws on the first author's interaction with Chinese officials in Pakistan. One of them stated, "It is difficult to stay away from families, especially feeling isolated due to security restrictions". It is a matter of grave concern because it affects their well-being and ease in a hospitable country that Pakistan is.

## **Conclusion**

The chapter, exploring the nexus of tourism, safety and CPEC and highlighting the key challenges, concludes that political stability, protection and social ease of Chinese expatriates as well as local Pakistani people's rights, improved media portrayals as well as facilities for tourism, and accountability can help boost the tourism industry in the context of CPEC in Pakistan. In the future, it should be investigated how and to what extent CPEC related terrorism is rooted in locals' deprivation.

## **Suggested Citation**

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## **Catalytic Impact of BRI and CPEC on Pakistan's Blue Economy: A Study of the Potential Impact on Local Communities and Economic Growth**

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### **Abstract**

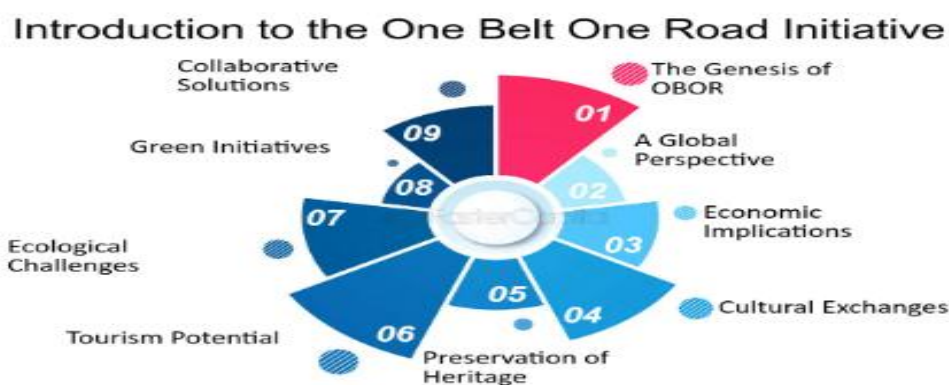
The Belt and Road Initiative (BRI) and China-Pakistan Economic Corridor (CPEC) provide vast opportunities for Pakistan's development of blue economy. This chapter analysis explores the role of BRI and CPEC in achieving sustainable development in Pakistan's blue economy, with specific reference to infrastructure development, economic growth, and social effects. It emphasizes the constraints and opportunities in unleashing blue economy potential, such as environmental issues, community participation, and capacity building. The chapter moots an integrated framework of sustainable development with a focus on policy imperatives, public-private collaboration, and inclusive decision-making processes. The proposed framework prioritizes three principal pillars: driving investment capability, nudging public-private sector collaborations, and sponsoring inclusive decision-making. By adopting this framework, Pakistan can unlock its blue economy potential, facilitating sustainable economic growth, social justice, and environmental preservation. This chapter indicates that Pakistan has the potential to harness its blue economy by focusing on investment capacity, encouraging sustainable operations, and providing equitable benefits to local population. By prioritizing people's well-being, including that of local communities, and the environment, Pakistan can leverage the full potential of its maritime sector

towards ensuring economic growth and development of the country.

**Keywords:** Blue Economy, local Communities, Economic Growth

## Background

It is an evident fact that The Belt and Road Initiative (BRI) and China-Pakistan Economic Corridors (CPEC), are formidable drivers for Pakistan's economy, particularly the blue economy which has multiple dimensions in various sectors like maritime transport infrastructure, fisheries and coastal tourism. The diversity of the subject prompts the Government to emphasize special initiative programs such as developing Gwadar port for economic development and enhancing people's living standards. Additionally, local socio-economic impacts include employment generation and skill development, which are helpful for local people, and potential issues containing displacement and those that favor poor socio-economic returns for the local population. In addition, the unavoidable rising issues of depleting environment and natural resources, including water pollution, habitat loss & degradation, and the overexploitation of natural resources & ecosystem services, like mangrove afforestation and use of renewable energy. This chapter analyzes existing data to highlight development possibilities and challenges and provide policy direction for sustainable development. Among them are formulating a blue economy policy, increasing community engagement, expanding environmental laws, and improving public-private partnerships to achieve proper integration of economic development accompanied with the sustainable environment and society to assure harnessing of blue economy potential within the BRI and CPEC frameworks targeting blue growth and economic prosperity.



Source: <https://fastercapital.com/topics/introduction-to-the-belt-and-road-initiative.html>

The Belt and Road Initiative (BRI) is the Chinese political and economic

Megaproject declared by President Xi Jinping in September 2013. One of CPECs most prominent projects is the development of the Gwadar Port in Pakistan, which is connected to Xinjiang, China, through a direct seaway (Butt et al., 2024). Besides, this strategic initiative seeks to enhance regional commerce and boost unrealized economic returns, emphasizing Pakistan's blue economy. Additionally, the blue economy, which mainly calls for the utilization of marine resources and Bringing about economic development and better living standards in conjunction with an upgrade in the status of aquatic habitats, is another relatively uncharted area of activity for Pakistan (Waheed et al., 2024). Due to its extensive coastline of more than 1000 km and rich sea resources, Pakistan has demanded several opportunities in fisheries, export and import by sea, and seaside tourist resale (Hussain et al., 2024b). However, it has not been developed due to structural problems like infrastructural drawbacks, policy constraints, and environmental degradation. These problems can be solved using CPEC's money to invest in maritime infrastructure and connecting the region. Thus, this chapter assesses the catalytic role of BRI and CPEC in the blue economy of Pakistan (). It considers common infrastructural investments, their consequences on the economy and society, and social issues concerning the environment. The following suggestions support concepts of lasting development, where economic progress can be met with social and ecological objectives (Baig et al., 2025).

### **Overview of Pakistan's Blue Economy**

According to research, Pakistan has enormous potential for a blue economy, which influences fisheries, maritime trade, and coastal tourism, thereby enhancing the economic growth and sectors related to the coastal population's standard of living (Hussain et al., 2024a). From a food security and business development perspective, the fisheries sector immediately employs more than 2 million people (Aziz & Naufaldi, 2025). However, this sector has some pullback factors: overfishing, use of outdated techniques, inadequate modern gear and equipment, and poor, insufficient cold storage facilities. Such challenges restrain the growth of the sector and full provision to local and international market demands (Shah, 2025).

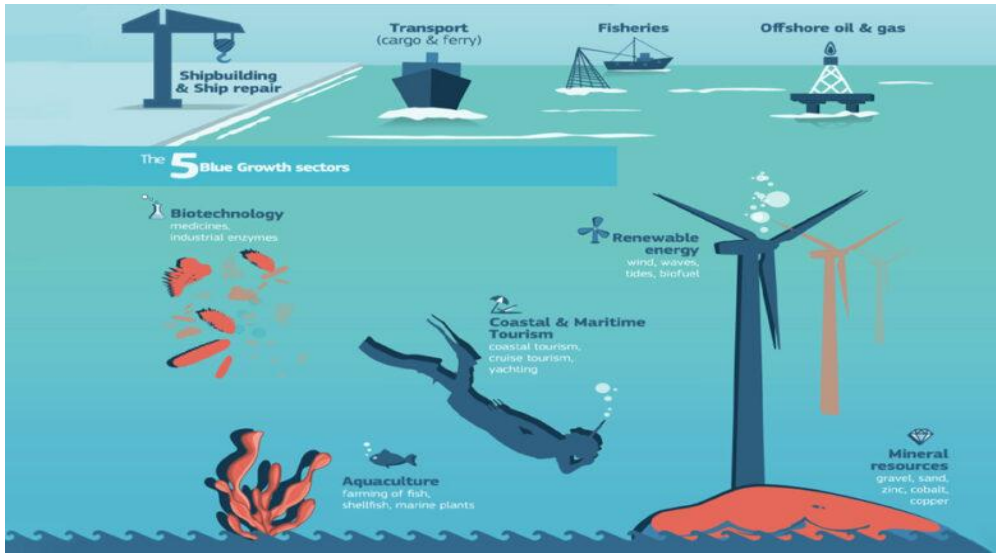


Figure 1: Pakistan's Blue Economy (Walayat, 2023)

Moreover, shipping and seaborne trade is another critical facet of Pakistan's blue economy. Discovering that the country is located at the Strait of Hormuz makes the country rather strategic as a transit of energy and goods to and from other global markets. Despite this advantage, the growth of the maritime trade sector is constrained by poor infrastructure at the ports and a poor internal transport system that needs a lot of improvement to compete internationally (Chu et al., 2025). Similarly, coastal tourism also has very future potential. Pakistan has many opportunities for coastal tourism development with its lovely sandy beaches, archaeological sites and many sea creatures. However, the sector remains shrouded and fragile because of a lack of improved infrastructure, inadequate marketing drive, and investment. By removing these barriers, coastal tourism could become a significant economic saver for coastal areas by creating employment and promoting economic growth (Schulhof et al., 2025).

### **The Role of Gwadar Port in Pakistan's Blue Economy**

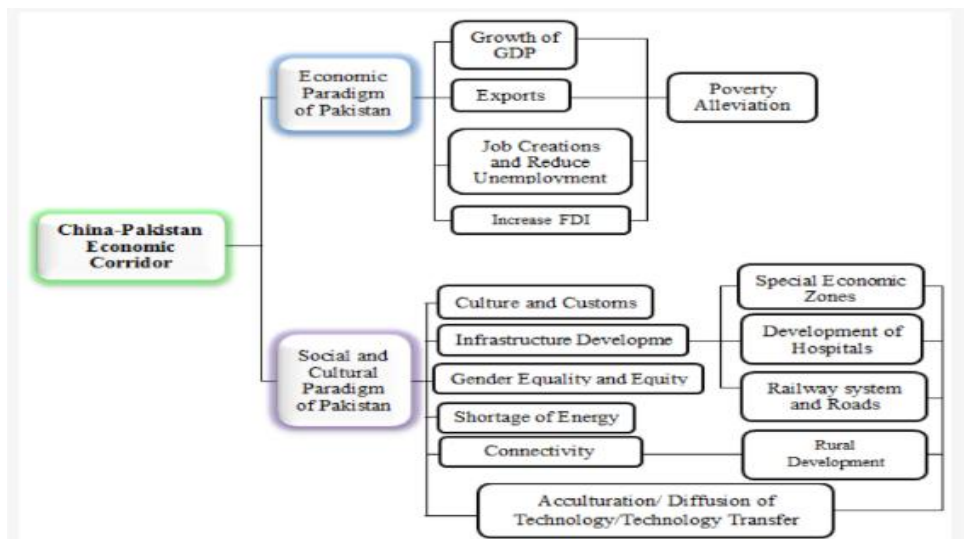
The core of the blue economy in Pakistan is Gwadar Port, which is part of the CPEC plan. Due to its geographical position on the geographical route of most regional trade, Gwadar is a potential hub for trade and commerce (Anwar et al., 2025). These investments, including new terminals and greater capacity for cargo operations, have made Gwadar favorable compared to other regional ports. Large infrastructure projects include the Gwadar East Bay Expressway and railway linkages to enhance the country's transportation of goods within the interior of the country (Iftikhar et al., 2024). Furthermore, the available Special Economic Zones, such as the Gwadar Free Zone, provide tax benefits

and sophisticated facilities for foreigners to invest in. These developments not only envisaged Gwadar as a Strategic link of global maritime connectivity but also auguring the development of economic prosperity, employment generation opportunities, and advancement of the blue economy in Pakistan. To enhance the capacities of Gwadar Port, there are significant social, financial, and environmental benefits by executing the blue economic development strategies envisaged for Pakistan (Bensadi, 2024).

### Infrastructure Development

The BRI and CPEC have become instrumental in helping Pakistan diversify its infrastructure development and revolutionize some seriously developing sectors, such as the maritime sector, that significantly contribute to the country's blue economy.

### *Multidimensional infrastructure-led development leads towards sustainable development in Pakistan*



Source: <https://www.mdpi.com/2071-1050/11/21/6143#>

These include programs for upgrades of ports, transportation networks or access, the development of fisheries sectors, and maritime commerce accommodation of coastal tourism sensitive to sustainable development (Schulhof et al., 2025). Additionally, CPEC has brought several infrastructure projects to uplift Pakistan's blue economy by facilitating trade and providing the local population better access to livelihood-related necessities. Over time, the infrastructure multiplies Pakistan's blue economy because new export opportunities are created, domestic economic activities are enhanced, and employment is created, mainly where the facilities are located in the coastal

areas (Bensadi, 2024).

Table 1: Key Infrastructure Projects and Their Impact

Project Name	Investment (USD Billion)	Status	Key Focus	Impact on Blue Economy	Source
Gwadar Port Development	1.62	Phase I Completed	Expansion of port infrastructure, cargo handling	Enhances trade capabilities, global market access	(Survey, 2024)
Gwadar Free Zone	0.63	Operational (Phase I)	Industrial development, foreign investment attraction	Creates job opportunities, boosts local economy	(Investment, 2023)
Gwadar East Bay Expressway & Rail Links	2.00	Ongoing	Improving inland connectivity, reducing transportation costs	Improving inland connectivity, reducing transportation costs	(CPEC, 2024)

### Impact on Local Communities and Economic Growth

The spillover effects of BRI and the projects of CPEC on Pakistan's blue economy were felt by local people through employment opportunities, better infrastructure facilities, and better market access. As with most projects geared towards infrastructure development, roads, and connectivity encourage ease of movement of goods and services, creating economic synergy, more so for countries surrounding Gwadar (Waheed et al., 2024). With the increase in trade, local industries, especially fisheries and tourism industries, will transform with better infrastructure trading, improving the region's economy and the living standards of people who depend on the sea for their livelihood (Khan & Bukhari, 2024). These projects are expected to have a long-term impact as they offer a framework that will ensure opportunities for blue economy sectors and job creation to realize the maritime resources of Pakistan for socio-economic development (Aziz, 2024).

### Economic Contributions

CPEC has brought about change, especially in Pakistan's blue economy province. The corridor has witnessed significant improvement in physical facilities, transportation linkages, and supply chain efficiency, resulting in

considerable development in core economic activities, including sea transport and fishery. Decided extended plans and infrastructure development like Gwadar port, improved cold storage facilities, and a better transportation system at Tyrians significantly increased Pakistan's capacity to trade and export (Li et al., 2024).

The sea borne trade which is an essential part of the blue economy of the country of Pakistan has remarkably improved. CPEC investments have also enhanced the capacity of ports, which has increased port throughput and trade share and placed Pakistan strategically on the maritime map of the region. The fisheries sector has also expanded similarly through enhanced storage and port facilities that have enhanced exports and local market penetration. It has not only helped increase the GDP but also helped in increasing the income prospects of many regions relying on these sectors (Anwar et al., 2025). Also, CPEC has played an essential role in the stabilization effect through employment generation and creating a better supply chain infrastructure. This has improved the foreign trade relations for Pakistan and reciprocally given sustainable economic growth for the blue economy and the local societies (Chu et al., 2025).

Table 2: Economic Contributions of CPEC to Pakistan's Blue Economy

Sector	Contribution to GDP (USD Billion)	Annual Growth Rate (%)	Source
Maritime Trade	6.8	7.6	(Bank, 2024)
Fisheries	1.2	5.4	(FAQ, 2024)

### ***Socioeconomic Impact***

Under the roof of BRI and its flagship project, CPEC, a radical change has been observed in transforming Pakistan's blue economy, creating avenues of socio-economic uplift for locals. CPEC has initiated several social sector enhancements by the other part of BRI, primarily related to blue-economy strategic sectors such as maritime trade and fishery industry (Deng et al., 2024).

In the context of BRI, CPEC has also brought about the quantitative improvement of infrastructure investments, particularly in the maritime ports and transport network systems and energy supply chain, including the development of Gwadar Port and overhauling of the port operation system. These improvements have made Pakistan more influential in the region as a maritime power, which is suitable for the increase in marine business and benefits the community right from the shore. This has also given birth to thousands of employment opportunities for locals in port activities, transport,

and construction, especially those living near the ports and coastal areas (Khan & Ahmed, 2024).

Furthermore, vocational training programs associated with CPEC projects have improved technical training in sectors related to the blue economy, like the maritime sectors. Therefore, local communities benefit from increased employment chances, resulting in less poverty and improved living standards (Mehmood & Cousins, 2024). Transportation and energy and utility sectors through infrastructural development made possible by CPEC under the BRI provide connectivity to the foreign markets, especially in fisheries. This has led to economic growth and improved access to other financial opportunities in local societies (Deng et al., 2024).

However, the loss of local populations to infrastructure and developmental projects, the low standards of paying those affected, and the inability to incorporate women into the labor force have also contributed to the problem. Furthermore, ecological factors, together with habitat loss as a result of big projects, are some of the challenges to the sustainability of the blue economy of Pakistan (Aziz & Naufaldi, 2025). Summing up, BRI and CPEC have played their part in forming extensions to the Pakistani blue economy, improving trade liberalization, infrastructural development, and local progression. It is high time to consider the issues of balanced distribution, social factors, and ecological concerns that are multi-crisis for these projects sustainable benefits for everyone (Butt et al., 2024).

### ***Environmental Implications***

#### ***a) Key Environmental Concerns***

Significant issues arise from maritime infrastructure's fast-paced growth under BRI and CPEC. Several environmental problems affect the coastal as well as marine environment of Pakistan (Hussain et al., 2024a).

#### ***b) Marine Pollution***

The transportation sector has grown rapidly due to the construction of new maritime infrastructure under the CPEC project, and port construction has resulted in increased oil spills and waste discharge. Such pollutants threaten various species and badly affect the balance of the marine ECM in the ocean and seas (Khan & Ullah, 2024).

#### ***c) Coastal Erosion***

Flood-prone areas and uncontrolled construction along Pakistan's coastal belt have led to higher rates of coastal erosion. This degradation of favorite coastal

zones raises dramatic risks for local communities and ecosystems due to natural events like storms and floods. The above challenge is significantly compounded by the emergence of many coastal cities for urbanization resulting from CPEC projects (Sajjad et al., 2024).

### ***Overfishing***

Excessive fishing techniques have put much pressure on the future supplies of various fish species in the region. The prohibition of fishing in protected areas and the use of destructive fishing gear threatens the lives of marine organisms and the local fishing community. These unsustainable practices further decline the health of Pakistan's blue economy (Khan & Ahmed, 2024).

### ***Mitigation Efforts***

Efforts to preserve the environmental impacts triggered by the development of Pakistan's blue economy under BRI and CPEC include several undertakings for a green economy (Schulhof et al., 2025).

#### ***a) Mangrove Reforestation***

Attempts to reclaim these forests have been made to preserve the coasts and promote wildlife. Reforestation of mangroves serves to reverse the problem of coastal erosion, sustains fish breeding grounds, and enhances the well-being of coconut-producing areas of villages that depend on the sea and its resources (Butt et al., 2024).

#### ***b) Renewable Energy Integration***

Renewable power solutions such as solar and wind energy are being integrated to minimize the use of fossil energy in the marine business. Besides reducing carbon emissions, integrating renewable energy in port activities also enhances the sustainability of Pakistan's blue economy by making the operation green (Adnan et al., 2024).

#### ***c) Eco-Tourism Promotion***

Sustainable tourism is being promoted to promote the local economy and reduce environmental pressure. It is carried out to ensure that natural benefits derived from tourism do not compromise the health of marine and coastal ecosystems (Waheed et al., 2024).

Despite their potential effect, such measures have yet to be pursued on a large scale and have to be uniformly implemented to create a lasting impact on the

blue economy and benefit the local populace of Pakistan (Schulhof et al., 2025).

### **Policy Imperatives for Maximizing the Catalytic Impact Of BRI & CPEC on Blue Economy of Pakistan**

The following recommendations are proposed to maximize the catalytic impact of the BRI and the CPEC on Pakistan's blue economy while ensuring positive outcomes for local communities and sustainable economic growth (Waheed et al., 2024).

#### ***Comprehensive Blue Economy Policy Development***

Pakistan must formulate a comprehensive policy framework to integrate the blue economy into CPEC and BRI. In terms of content, this policy should focus on sustainability, environmental protection, and economic equity. With the help of standards from the United Nations Sustainable Development Goals (SDGs), this policy can indicate the desirable further development of the maritime industries, fishery and coastal tourism with minimum harm to Pakistan's marine and coastal environment. Such a policy shall also encourage investment in infrastructure sustainability for infrastructure development and capacity building for local communities to ease the growth and protection of the environment in the process (Geng et al., 2024).

#### ***Enhancing Participation of Local Communities***

For increased social economic impact of CPEC through the blue economy, the community should participate actively in formulation and implementation of the blue economy projects. These include that near the ports, coastal areas, or fisheries that wish to partake in economic activities, they can directly be provided with infrastructure (Iftikhar et al., 2024). To ensure a proper flow of share of the economic rent as a result of resource utilization, there must be efficiency in how the benefits are shared. Particular attention should be paid to the employment of women and other vulnerable groups, to the participation of the rural population in the workforce and local government, and thus, the concept of empowerment and poverty reduction for CPEC (Hussain et al., 2024b).

#### ***Building a Skilled Blue Economy Workforce: Capacity Development and Blue Education***

##### ***Initiatives***

For the growth and development of the blue economy, there is a need for a

concerted effort to invest in education and training programs for beneficiaries from the local human resources. This includes vocational and technical training in functions of the maritime industry, fishery resources management, environmental conservation, and ecotourism. That is why it is crucial to develop skilled labor among the local population and to involve communities interested in new opportunities in the sectors connected with CPEC's maritime-related fields. The institutions of the local governments should also undertake training and development to ensure they can assess, coordinate, and promote the sustainable management of the blue economy (Muhammad & Ahmed, 2024).

In addition, Policy imperatives must place a high priority on blue education, with an emphasis on fostering knowledge and skills that meet the changing demands of the marine industry, in order to optimize the catalytic influence of BRI and CPEC on Pakistan's blue economy. This can be accomplished by implementing specialized training programs and courses in subjects like coastal management, marine engineering, and oceanography at all educational levels, from elementary to university. Pakistan can guarantee a consistent supply of qualified workers to propel the expansion of its blue economy by integrating blue education into the curriculum. Additionally, encouraging research and development in industries linked to the blue economy, such as aquaculture, fisheries, and renewable energy, would encourage entrepreneurship and innovation, which will propel economic expansion and job creation. For Pakistan's blue economy to flourish and eventually contribute to the nation's socioeconomic development and global competitiveness, effective policy frameworks must also prioritize capacity building, international collaborations, and public-private partnerships. Pakistan can unleash the enormous potential of its maritime industry, open up new avenues for economic expansion, and establish itself as a major force in the global blue economy by embracing a comprehensive approach to blue education.

### ***Environmental Conservation and Management***

With the advancement of the CPEC projects underway, much care needs to be taken regarding environmental conservation. Measures must be implemented to control marine pollution and pollution caused by infrastructure development. Using sustainable technologies, including port and renewable energy solutions for maritime transport, is crucial in ensuring that CPEC minimizes the negative impact on the environment. Also, they should require investment in the rehabilitation and management of critical coastal habitats consisting of mangroves by increasing conservation measures that will support the improvement of habitats and the creation of sustainable sources of income for the people (Adnan et al., 2024).

### ***Public-Private Partnerships (PPPs) for Sustainable Development***

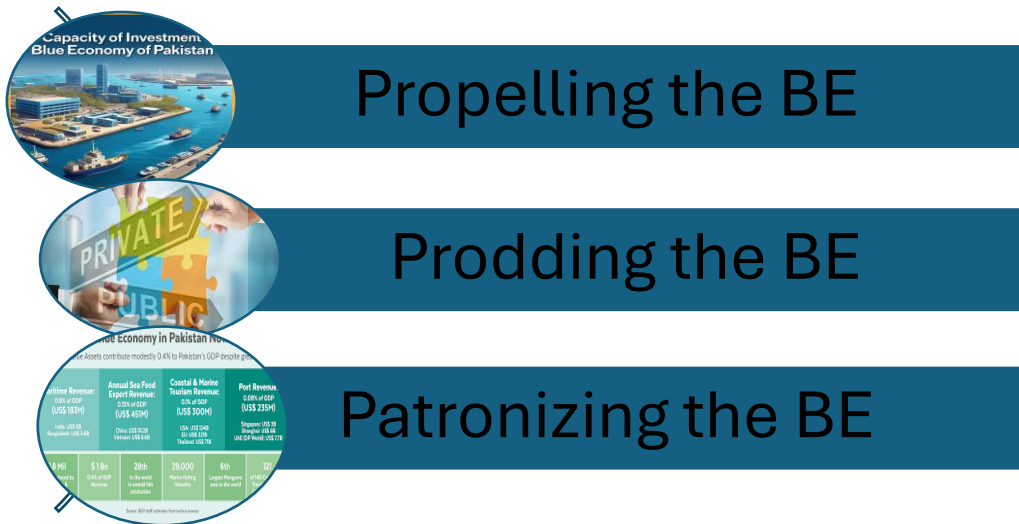
An opportunity that should be harnessed involves using PPPs to mobilize private capital in sustainable activities concerning the blue economy. These solutions imply the cooperation of local authorities and civil servants with the private sector and local communities in financing green infrastructure, renewable energy, and sustainable fisheries (Sajjad et al., 2024). Therefore, these sectors should encourage private investment, and the government plays a crucial role in ensuring that these sectors are developed in terms of economic growth and environmental impact. Together, these partnerships can go a long way in fostering innovation and attaining a sustainable development path under CPEC for Pakistan, particularly the coastal provinces (Waheed et al., 2024).

Thus, it can be argued that BRI and CPEC when considered under the spectrum of blue economy for Pakistan can offer a profound positive economic value addition and open up chances for local stakeholders. By deploying policies, integrating communities, strengthening capacities, protecting environment and engaging in public-private partnerships, Pakistan can work towards the development of a blue economy that will not only be responsible for the sustainable development of the nation's economic sector but will also change the lives of the communities included in the process (Geng et al., 2024).

Despite of all the benefit it offers but it also triggered socio-political alarms in Pakistan, against which the Blue Economy under BRI and CPEC is growing at a startling pace. With an economy growing at 7-8% annually, the authorities have attempted to find harmony between multiple objectives of inclusive developmental and environmental conservation, but the result has led to inequitable benefits and dislocation of the population with adverse impacts on the marine life. Therefore, it is important that these concerns are addressed and that the benefits of BRI and CPEC are distributed between the various stakeholders and at the same time negative impacts of these initiatives on local communities and environment which demands adopting a sustainable and inclusive approach to the development of Pakistan's Blue Economy.

So, there is a dire need to develop effective policies that ensures the safety and security of both, the entire population as well the environmental which assures that the impact of development must be sustainable and inclusive, that's how the real potential of Pakistan's Blue Economy are meaningful. So, it is concluded that there are three key P's that should be prioritized in the development of a blue economy:

### *3P's Necessary for the Development of Blue Economy (BE)*



**1<sup>st</sup> -P:** Propelling the capacity for investment in a blue economy.

**2<sup>nd</sup> -P:** Prodding public-private partnerships in the development of blue economy and its allies sectors.

**3<sup>rd</sup> -P:** Patronizing the inclusive decision-making processes by concentrating on measures that unleash potential of blue economy and sustainable growth for Pakistan.

Therefore, for fostering the blue economy in Pakistan, it is recommended to follow through on three initiatives. First, (Propelling the capacity for investment in a blue economy) fostering investment potential is very significant which includes the use of funds for a sustainable ocean economy. This can be done through innovative financing expansion strategies, and collaboration with international institutions like the Asian Development Bank that offers social and economic developmental loans with accompanying grants and technical assistance, as well as equity investment. Second, (Prodding public-private partnerships in the development of blue economy and its allies sectors) encouraging public-private partnerships is important to maximize their combined abilities towards the building of the blue economy and its related industries. This allows for new investments to be made along with the promotion of sustainable economic growth. Lastly, (Patronizing the inclusive decision-making processes by concentrating on measures that unleash potential of blue economy and sustainable growth for Pakistan)

advocating for the participatory approach towards decision-making is important in guaranteeing that the advancement of the blue economy will be proper equitable, sustainable, and beneficial to all. Concentrating on actions that can foster the blue economy while ensuring environmental sustainability, social equity, and economic development for Pakistan must be undertaken.

### **Suggested Citation**

Aijaz, U., Ghauri, S.P., Mujahid, N. (2025). Catalytic Impact of BRI and CPEC on Pakistan's Blue Economy: A Study of the Potential Impact on Local Communities and Economic Growth. In *CPEC and BRI Nexus: Perspectives on Economy, Politics, Culture and Environment* (pp 50-65). CSC-KIU.

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## **The Impact of China Pakistan Economic Corridor (CPEC) on Women's Microenterprise Development: An Empirical Analysis**

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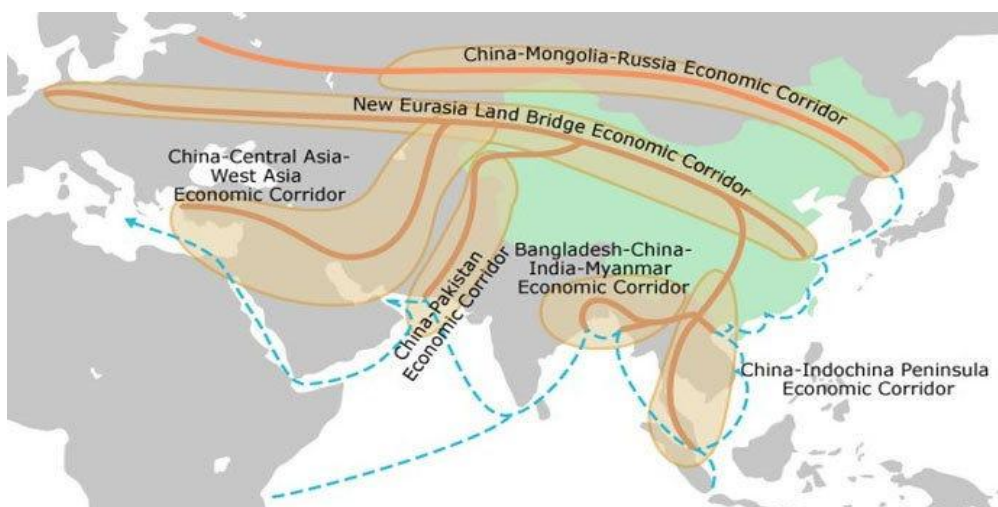
### **Abstract**

The objective of the study is to examine the effects of CPEC projects on women's micro-enterprise development. To achieve the objectives of the study, a questionnaire has been developed to collect data from the respondents. The empirical analysis of the study is carried out by using Smart PLS 4 and the study adopts the Partial Least Square Method (PLS-SEM). The results have shown that people have a favorable attitude toward the CPEC initiatives. Additionally, CPEC projects have a positive and significant influence on women's microenterprise development in the study area. Also, the results have shown that CPEC activities benefit the local economy and the growth of women's micro-enterprises. Therefore, based on the findings of this study, it is suggested that the government should initiate more CPEC projects and encourage women entrepreneurs by providing interest-free loans and conducive environment.

**Keywords:** CPEC, Women’s micro enterprise development, local economy

## Introduction

Chinese President Xi Jinping launched the “Belt and Road Initiative’s” in year 2013 and earlier its known as One belt and one Road (OBOR). The BRI consists of total six corridors (Map 1) and the China-Pakistan Economic Corridor (CPEC) is among the six corridors, and it is the pilot project of BRI. Moreover, CPEC aimed to enhance economic development, and it is first government to government project (Gao, 2023). CPEC projects have recently improve the Pakistan’s infrastructure and assist in overcoming the energy crises in Pakistan. Also, it will improve trade with China and further integrate the region’s countries. Moreover, CPEC’s major projects aims to modernize Pakistan’s road, rail, air, and energy transportation infrastructure, as well as to connect Pakistan’s deep-sea ports of Gwadar and Karachi to China’s Xinjiang province and beyond via overland routes.



Map 1: Belt and Road Initiatives, Source: Google Map

The China-Pakistan Economic Corridor (CPEC) has unique importance to boost trade and cooperation, and its importance is not limited to Pakistan and China, but it offers tremendous potential for the region and the world. In sum, these initiatives are steps toward industrialization and development, as well as a guarantee of advancement. Likewise, Gwadar Port is crucial, and it may become the region’s economic hub in the near future. Similarly, it shortens China’s distance from the rest of the globe when importing oil and other raw materials.

On the other hand, CPEC is supposed to be a game-changer for Pakistan because it will strengthen the country's infrastructure and reduces the energy crises. Therefore, the billion-dollar project will significantly boost the country's Gross Domestic Product (GDP) by increasing new business opportunities in Pakistan. Therefore, the investment under CPEC is anticipated to strengthen the economy by generating jobs, expanding industries, and establishing economic zones all around the nation.

Gilgit-Baltistan is gate way of CPEC, and this area has natural resources and the majority of the locals rely on agricultural products for a living. Due to Gilgit-Baltistan unique geographical location, it is becoming a major trading hub, or more precisely, it is connecting China to rest of the world through KKH. The recent CPEC initiatives has created many opportunities for local people to start their business and more importantly the local women's have start small business for example handicrafts, shops and restaurants. Also, Gilgit-Baltistan, like other parts of the nation, has a male-dominated society and joint family structures for families. In these families, the male head is the only breadwinner, and the rest of the family relies on him to cover their expenses. Encouragement of female entrepreneurs to launch modest businesses is therefore required for a stable family income.

There are some studies (Saleem & Ashfaq 2023; Ali, 2023; Shah et al., 2023) which explores the connection of CPEC and entrepreneurial orientation in Pakistan. However, limited studies on CPEC and women microenterprise development focusing on the Gilgit-Baltistan which is gate way of CEPC. Therefore, the exiting research explores the influence of the CPEC women on the microenterprise development in Hunza. Also, the study also researches the role of local economy on women's microenterprise development. Lastly, the study examines the effects of CPEC on local economy. This study has much importance like this study has academic contribution in the field of CPEC and women's micro-enterprise development. Similarly, the outcomes of the study have policy implications for the policy makers. Moreover, the current research will also encourage researchers to conduct studies on local issues of the Gilgit-Baltistan.

## **Literature Review**

One of South Asia's most significant infrastructural and economic development projects is the China-Pakistan Economic Corridor (CPEC). The massive road, rail, and energy infrastructure system that links Pakistan's Gwadar Port to the western part of China has a big impact on Pakistan's economic development (Alam, Li, & Baig, 2019). Nonetheless, there is still a dearth of research on the effects of CPEC on other facets of society, especially

as they relate to marginalized populations like women living in the isolated Gilgit-Baltistan. The purpose of this literature study is to provide insight into the possible impacts of CPEC on the growth of women-owned microenterprises in Gilgit-Baltistan.

Pakistan is likely to benefit significantly from CPEC. It is critical to examine the impact of this shift on diverse areas, particularly those that have historically suffered economic inequality. Gilgit-Baltistan, located in northern Pakistan, is positioned to benefit from major infrastructure development and economic prospects because of its strategic location along the CPEC route (Alam, Baig, & Muhammad, 2023). As a result, it is critical to understand how this transition affects women's microenterprise growth in the region.

One global development aim is to empower women and increase their involvement in the workforce. Microenterprises have evolved to address the issue of women's restricted economic engagement in Gilgit-Baltistan, which is typically a result of old patriarchal standards. In addition to increasing household income, women-run microenterprises in industries including handicrafts, agriculture, and tourism have the potential to improve gender equality and women's empowerment (Muhammad, Baig, Nizar, & Beg, 2020).

Women entrepreneurs in Gilgit-Baltistan may be able to access new markets thanks to CPEC's infrastructure investments, which include enhanced connectivity and transportation networks (Alam, Li, Baig, Ghanem, & Hanif, 2021). Having access to these marketplaces can help microenterprises flourish and inspire women to start and build larger firms (Ali, 2023). By lowering production costs, raising productivity, and facilitating the launch of new businesses, enhanced electricity supplies in the area might result from CPEC's energy projects, which would benefit women's microenterprises. Tourism Opportunities: The stunning scenery and natural beauty of Gilgit-Baltistan offer a sizable potential for tourism (Ullah, 2020). A tourist inflow brought about by CPEC could present chances for women working in the hospitality, handicraft, and food industries to launch and expand microbusinesses that serve tourists (Muhammad, Karim, Salman, et al., 2020).

Women's active engagement in the workforce might be seriously hampered by social expectations and traditional gender norms. Even while CPEC has the potential to thrive economically, if these standards continue, women may not automatically benefit from more chances. Access to Land and Resources: Women in Gilgit-Baltistan frequently struggle with gaining access to land and resources (Alam, Xuemei, et al., 2023). The success of women's microenterprises depends on granting them fair access to resources. Education and Skill Development: Women must have access to education and skill

development to take advantage of the possibilities that the China-Pakistan Economic Corridor (CPEC) is creating (Khan, Baig, & Muhammad, 2020; Ullah, 2020). Environmental Impact: A few types of microenterprises, such those in the tourist and agriculture industries, may influence the environment. coordinating economic growth (Muhammad, Karim, Qureshi, Razzaq, & Ali, 2020).

The socioeconomic growth of Gilgit-Baltistan might undergo a significant transformation with the establishment of the China-Pakistan Economic Corridor. The region's female microenterprise sector is expected to reap advantages from the economic and infrastructure growth afforded by China-Pakistan Economic Corridor (CPEC). To guarantee that women in Gilgit-Baltistan may fully engage in and profit from the economic boom brought about by CPEC, obstacles pertaining to cultural norms, access to resources, education, and the environment must be addressed. To fully realize the project's potential for women's empowerment and economic growth, further study is required to determine the precise effects of CPEC on women's microenterprises in this region. Ongoing efforts to promote gender-inclusive policies and programs are also crucial.

### **Tools and techniques**

For empirical analysis researchers have adopted Partial Least Square Structural Equation Modeling (PLS-SEM). The PLS-SEM is widely used in social sciences research. There are several advantages of using this method as compared to regression analysis, for example the relationship among multiple dependent and independent variables can be easily examined through PLS-SEM.

The researchers have developed a questionnaire for primary data collection. The respondents for the current research are women entrepreneurs of Karimabad, Aliabad and Altit region. The questionnaire comprises of three parts; the demographic information is given in the first part. The second and third part of the questionnaire consists of Likert scale questions from 1 to 5.

### **Data Analysis and Results**

#### **Descriptive analysis**

The data for the current is collected from three villages of Hunza i.e., Karimabad, Aliabad and Altit. The 44% of the data is collected from the Aliabad, 30% from the Karimabad and 26% from the women entrepreneurs in

Altit.

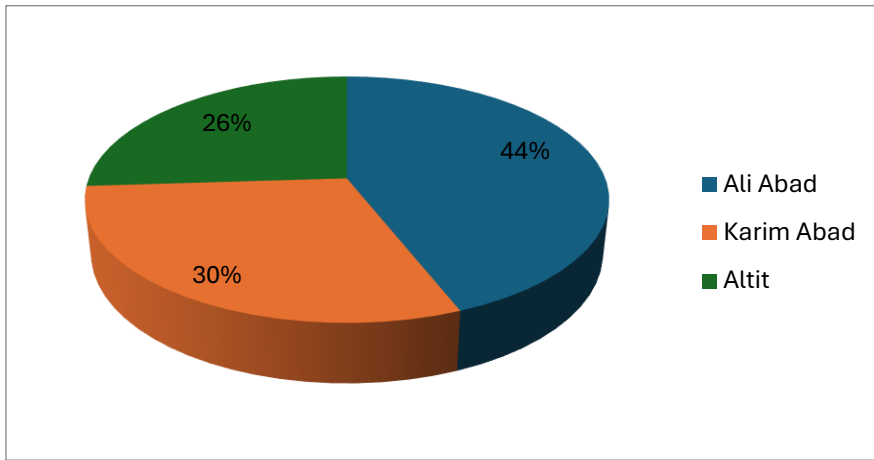


Figure 1: Demography

The figure shows the marital status of respondents, and which shows that the majority of female entrepreneurs are married i.e., 71 % and only 29% are unmarried. Hence, this shows that they are contributing to the family income.

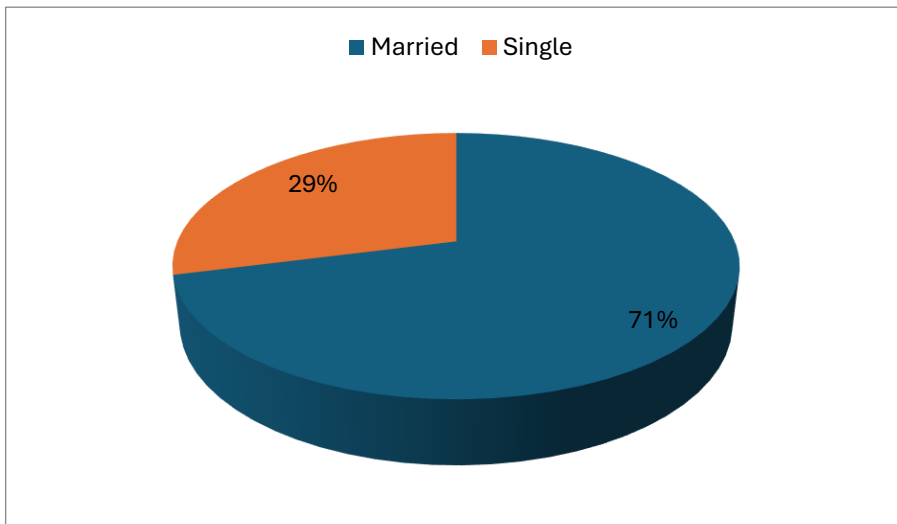


Figure 2: Marital status of respondents

Figure 3 shows the family size of the women entrepreneurs in selected villages of the Hunza. The figure shows that 57% of the respondents have 5 to 10 family members. Also, 28% of the respondents have less than four family members and only 15% of respondents have more than 11 family members.

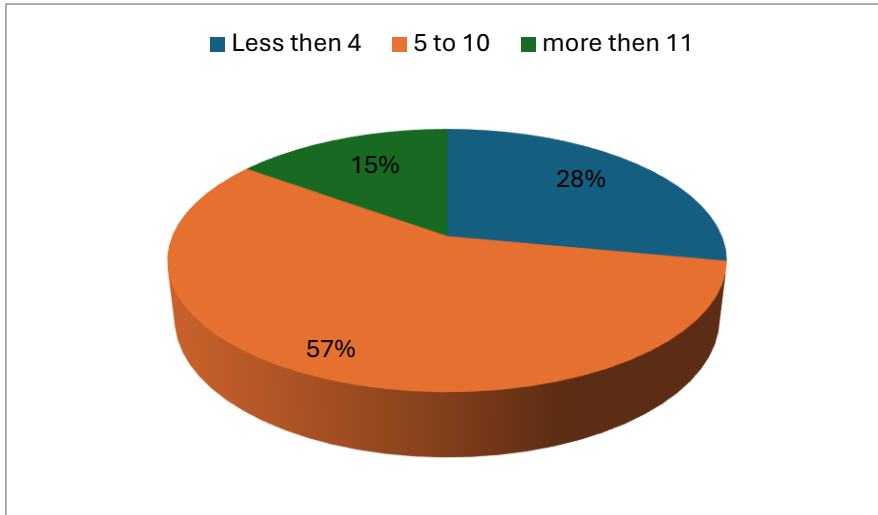


Figure 3: Family Size

### Evaluation of Measurement/Outer Model (PLS Algorithm)

The current research follows the procedure suggested by Hair et al. (2013, 2017). The results from Table 1 show that the value of Cronbach's alpha and Composite Reliability values are greater than 0.7. Also, the value of composite reliability is higher than the suggested value (Latan & Noonan, 2017). Furthermore, the AVE values are higher than the ideal value of 0.5 (Hair et al., 2013; Wong, 2013).

Table 1: Validity and Reliability of Constructs

Items	Cronbach's Alpha	rho_A	Composite Reliability	Average Variance Extracted (AVE)
CPEC	0.918	0.921	0.935	0.672
LE	0.956	0.958	0.965	0.82
WMD	0.929	0.933	0.945	0.743

### Fornell-Larcker Criterion

The Fornell-Larcker (1981) criterion examines the square root of AVE for each latent variable to determine discriminant validity. Each latent variable's square root of AVE should be bigger than its correlation with other latent variables (Hair et al., 2013). As indicated in Table 2, the square root of each latent variable's AVE is bigger than its correlation with other latent variables.

Table 2 Fornell-Larcker Criterion Results

<b>Constructs</b>	<b>CPEC</b>	<b>LE</b>	<b>WMD</b>
CPEC	<b>0.82</b>		
LE	0.851	<b>0.906</b>	
WMD	0.756	0.789	<b>0.862</b>

### Heterotrait-Monotrait (HTMT)

The method of Fornell and Larcker for determining discriminant validity is unreliable. Therefore, Henseler et al. (2015) introduces the Heterotrait-Monotrait Ratio (HTMT) for assessing correlations to find a credible criterion for discriminant validity validation. The correlation between two latent variables is estimated using this method. The Heterotrait-Monotrait ratio (HTMT) was recommended to have a threshold value of 0.90 (Henseler et al., 2015). Any value greater than this shows that discriminant validity is lacking. According to table 3, Heterotrait-Monotrait results are less than threshold value.

Table 3: Heterotrait-Monotrait (HTMT) Results

<b>Items</b>	<b>CPEC</b>	<b>LE</b>	<b>WMD</b>
CPEC			
LE	0.874		
WMD	0.814	0.832	

### Structural Model Results

The results of the structural model show that CPEC has a significant and positive influence on the local economy. Hence, the finding indicates that CPEC projects are contributing to the economy of the study area. The study of Raza et al. (2018) also shows the significance of the CEPC for economy and it will create employment opportunities in Pakistan. On the other hand, the results show that CPEC has a positive and significant impact on women's microenterprise development in the study area. The recent study of Ali (2023) argues that a huge potential of establishment of small enterprises along the CPEC route.

Last but not the least, the outcomes of the study indicate that the local economy positively contributes to the development of women's microenterprise in Huna. These results showed that government should mainly focused on CPEC projects for improving the local economy and for creating more opportunities

for women enterprises in the area.

Table 4: Structural Model Results

Path coefficients	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics ( O/STDEV )	P Values
CPEC -> LE	0.851	0.852	0.05	17.031	0
CPEC -> WMD	0.306	0.316	0.144	2.127	0.034
LE -> WMD	0.529	0.514	0.123	4.291	0

### Model Fit

The Standardized Root Mean Square Residual (SRMR) is a measure of a model's goodness of fit. The designed model is a good fit and acceptable if the SRMR value is less than or equal to 0.08 Table 5 shows that the SRMR value is 0.066, which is less than the threshold value of 0.08. Hence the model developed in the current study is well suited based on the value of SRMR.

Table 5: Model Fit Results

Items	Saturated Model	Estimated Model
SRMR	0.066	0.066
d_ ULS	0.82	0.82
d_ G	1.244	1.244
Chi-Square	557.556	557.556
NFI	0.756	0.756

In sum, the study results reveal that CEPC is not only enhancing the local economy, but it is increasing the women enterprise in the Gilgit-Baltistan. The rise in women entrepreneur in the area is positive sign as it will reduce dependence on the single male earner in family. Likewise, due to contribution of the female in overall family income the standard of the living of the family will increase due to increase in the income.

### Conclusion and Recommendations

The study's main goals are to explore the influence of CPEC on women's microenterprise development and mediating role of the local economy in

Hunza. The rationale for choosing Hunza is due to a large number of women's entrepreneurs engaged in various economic activities. To achieve the desired goals of the study, primary data is collected in the selected villages through a questionnaire. The data is collected from a total of 100 women's entrepreneurs. The empirical analysis is carried out by the recently widely used technique i.e., Partial Least Square Structural Equation Modelling (PLS-SEM). The results of the current research show that the CPEC has a significant and positive impact on the local economy as well as the growth of women's entrepreneurs in Hunza. Lastly, the results also reveal that enhancement in local economic activities has further increased the women's entrepreneurs in the study area.

Based on the results, this study suggested that the government should give top priority to the implementation of the CPEC projects as it is enhancing and attracting the women's entrepreneurs in Hunza. Moreover, CPEC projects are also increasing the economic activities in the area due to which unemployment is decreasing and the living standard of the people has been increasing. On the other hand, to encourage women's entrepreneurs, the government should provide interest-free loans to women's entrepreneurs for businesses.

### **Suggested Citation**

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## Google Map

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## **Pakistan Emerging Heartland of Regionalism and BRI**

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### **Abstract**

This chapter examines how Pakistan is becoming a major force in the new regionalist landscape, especially in relation to the Belt and Road Initiative (BRI). Pakistan's geostrategic importance is becoming more widely acknowledged as regionalism gains traction worldwide due to the establishment and prosperity of institutions like the European Union, ASEAN, and NAFTA. Pakistan is a crucial component of regional and transregional connectivity due to its location at the meeting point of South and Central Asia and close to the economic superpowers of China and India. Historically, a nexus of great power politics, China's ambitious Belt and Road Initiative and changing global power dynamics have given it new significance in the twenty-first century. One of the main BRI initiatives, the China-Pakistan Economic Corridor (CPEC), has confirmed Pakistan's position as a key player in promoting connectivity and economic integration in Eurasia. By serving as a gateway for landlocked nations like Afghanistan and the Central Asian Republics, Pakistan has the potential to develop into the hub of regionalism by promoting economic cooperation, trade, and energy flow throughout Asia.

**Keywords:** CPEC, Regionalism, Belt and Road Initiatives

### **Regionalism and Pakistan**

The concept of regionalism has become a significant global phenomenon since

the dawn of this ongoing century. Approximately, all the realms of mother earth are converging towards the phenomenon regionalism, entire world consists of numerous regional organizations, and the list of those organizations is long. Among all, the most well-known and successful regional organization is the European Union (EU), which is the banner man and one of the successful paradigms of regionalism, some of the other successful regional organizations of the world are NAFTA, ASEAN and OAF respectively. Presently, there is hardly any realm in the world that does not feature a regional organization. Pakistan has remained at the crossroads of great power politics for the last couple of centuries. However, Geopolitical developments at the turn of the twenty first century and the global shift in power dynamics in the context of the Asian Century has revitalized the geo-political and geo-economic importance of this god gifted country Pakistan. This chapter investigates the centrality and importance of Islamic republic of Pakistan in a historical and contemporary perspective. The Chinese Belt and Road Initiative (BRI), envisions regional integration as a major goal in this twenty first century, which is one of the great yeoman services to the world in general and adjacent regions in particular. Pakistan is one of the geographical pivot and an offshoot of the Eurasian region as well, has once again reemerged as a lynchpin for regional and extra-regional integration after the prelude of BRI and CPEC projects (Abid & Ashfaq, 2015). Moreover, Pakistan is situated at the junction of Central Asia, South Asia, and between two of the emerging economic giants namely, China and India. After the revival of Chinese ancient silk route through this country, it can play a significant role in the attainment of regionalism goals. Besides, being an intersection, since ancient times, Pakistan has been strategically instrumental as a transit passage, connecting the adjoining and bordering landlocked states of Asia like, Afghanistan and Central Asian republics respectively (Rizvi, Khan, & Elahi, 2022).



Source: eurasiareview.com

### **The Theoretical Understanding of the Centrality of Pakistan**

Geographically, a state or a country accrues prominence for many reasons, like its strategic positioning, abundance of required natural and nurtured resources and the very proximal location of that particular country. Pakistan is bestowed with all those factors, due to which it has acquired a central placement in the world. Since the dawn of civilization, the region of Pakistan has had remain a central pivot. It remained home to some of the great ancient civilizations of the world, like Mohenjo-Daro and Harappa; these ancient civilizations were some of the few sophisticated civilizations in the known antiquity (Sial, 2014). The region, which now comprises Pakistan, has embraced all the features of some of the great ancient civilizations; for example, one can find the influence of Persian civilization and Greek civilization as well over here. During the Great Game era this region was the focus and locus of nineteenth century great powers. Moreover, since its inception as an independent state, Pakistan has begat more attention and interest of some of the regional as well as global powers the total geographic area of Islamic republic of Pakistan is seventy-nine. Six (79.6) hectares (Fredholm, 2015). When it comes to the topographical division of Pakistan, its landscape is an uneven one. Its topography consists of rouged mountains, fertile plans and sea basin areas. Its huge mountains in the Gilgit Baltistan region are home to some very precious resources like some of the rare minerals and freshwater resources and this region is also known as the best tourist destination. Besides, the central fertile plans of Pakistan are best known for its agriculture products. Moreover, the existence of Pakistan at the very junction of some of the great regions (Middle East, Central Asia and South Asia) speaks of its geographical prominence and importance. The uneven but very unique terrain of Pakistan accrues the strategic depth of Pakistan. Population wise

Pakistan is the fifth largest nation in the world and out of its total population majority is young (Gill & Iqbal, 2021).

The central positioning of Pakistan is a complex and significant conception that includes its geographical positioning, its geopolitical role, and her geostrategic importance in the regional as well as and on the global stage. Some of the key aspects, which make Pakistan a pivot in geopolitics and geoeconomics are as under, which are very vital for her centrality (Heidkamp, Morrissey, Germond-Duret, & Rourke, 2022).

***Geopolitical Placement of Pakistan:*** the geographical placement of Pakistan is strategically very crucial. Its immediate neighbors are India, China, Afghanistan, Iran and Central Asia. On the southern side its closest association with the great Persian Gulf and the Arabian Sea gives it significant geopolitical meaning, especially for trade routes and access to crucial waterways (Khalid, 2022).



Source: vecteezy.com

***Regional Dynamics and Pakistan:*** Pakistan is one of the blessed countries, which is situated at the crossroads of South Asia, Central Asia, and the Middle East. Moreover, Pakistan influences these regions politically, economically and culturally. Besides, it's one of the main players in regional political dynamics, especially in relation to the regional dynamics between China and India, particularly, the stability and peace situation in Afghanistan mainly depends on the involvement of Pakistan. Furthermore, the melting and boiling point of the world namely Middle East has close affinity with Pakistan as well. Pakistan is one of the main stakeholders of Middle Eastern affairs (Khalil, 2017).



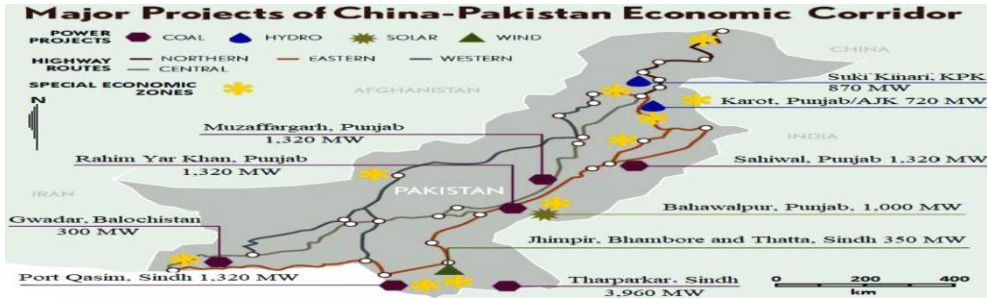
Source: shutterstock.com

***Global Security and Defense:*** Pakistan's strategic placement effects global and regional security dynamics simultaneously. Since its inception Pakistan been one of the main players in global security concerns and its central role as the front-line state against terrorism and specifically due to its active role in counterterrorism activates, particularly in relation to Afghanistan (Bhattacharjee, 2015).



Source: dailytimes.com.

***Economic Centrality:*** Pakistan is bestowed with many natural resources and economic potentials. One example is the ongoing economic game changer namely, The China Pakistan Economic Corridor (CPEC). CPEC is a leading venture of China's Belt and Road Initiative (BRI). The prelude of BRI has further underlined Pakistan's centrality in regional and global economic developments. Amongst all BRI sub projects, CPEC is very vital and significant for China, it aims to create economic corridors through infrastructure development, boosting trade and connectivity between China, Middle East and the Arabian Sea (Yaseen, Afridi, & Muzaffar, 2017).



Source: researchgate.

**Nuclear Capability:** Pakistan is one of the nuclear powers and the only Muslim Country to have nuclear capability and it has vital consequences for regional and global security. Pakistan’s Nuclear arsenal and its geopolitical placement has there for added another layer to its strategic centrality, especially in the context of South Asian security dynamics (Wu et al., 2021).



Source: [minutemirror.com.pk](http://minutemirror.com.pk)

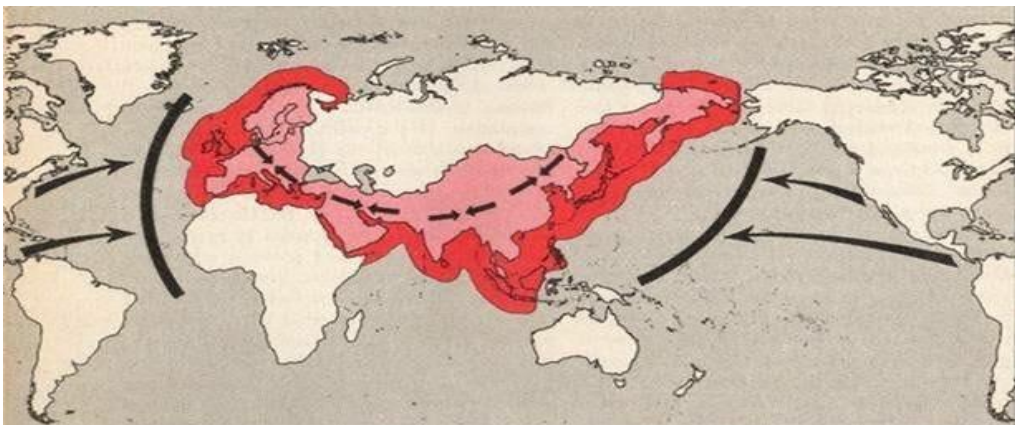
### Pakistan’s Strategic Arsenal

**Religious and Cultural Hub:** Pakistan is regarded as the banner man of Islamic world. It came to inception in the name of Islam, Pakistan weld and plays an important role in the Muslim world. It has strong historical, cultural, and religious bonds that contribute to its centrality in the Islamic world as well. No one can contest the centrality of Pakistan in regional and global dynamics. Its place in various political and economic alliances, its relations with neighboring countries, and her participation in regional affairs further underlines its significance beyond doubt



Source:google.com

### **Conceptualization of Chinese Belt and Road Initiative**



Source: sangar.info

### **Chinese Belt and Road Initiative Blueprint**

The Chinese Belt and Road Initiative known as BRI, was officially proclaimed in 2013. Previously BRI was known as the ‘One Belt, One Road’. Basically, BRI is arguably one of the milestone achievements of Chinese Premier Xi Jinping. Moreover, Chairman Xi, s impulses for starting this titanic project were to strengthen his name and determinations in Chinese political history, developing soft and reverberating image of the Middle Kingdom (China). Whereas a major scholarship understands that this gigantic project BRI could decide the future of China. Though, the BRI proponents, ministers, and the heads of Chinese government are very optimistic about the miracles of the BRI project, and they claim that China is already benefiting from the Belt and Road initiative (Afzaal, 2020).

Moreover, the BRI is a revivalism of Chinese ancient Silk Route that used to connect China to other realms of the world, especially, entire Asia, the Mediterranean area, Europe, Middle East and Africa. Covering many

continents and connecting as many of the states of the globe. Furthermore, the basic aim of BRI project is to recover ancient Chinese trade routes, nurturing global connectivity, economic development, and cultural exchange between all stakeholders of the BRI (Weidong, 2017).



Source: trends research.org

## **Belt and Road Initiative**

### ***Historical Context of BRI:***

To conceptualize the Belt and Road Initiative project, it is important to comprehend its historical context in the Chinese ancient Silk Road, Silk Route was facilitator of trade and cultural exchanges amid the Eastern and Western world. Basically, The BRI got its stimulation from the historical legacy of ancient silk route.

### ***The central modules of the Belt and Road Initiative***

The Belt and Road Initiative contain two main components; the first component is the Silk Road Economic Belt, and the second component is twenty First Century Maritime Silk Road. The first component namely, the Silk Road Economic Belt aims on land-based connections, bridging Central Asia, including Pakistan, the Middle East, and Europe. Whereas the twenty first century Maritime Silk Road prefers the maritime routes, which will connect China to the vibrant regions of Southeast Asia, South Asia, Africa, and Europe with the help of various oceanic network of ports and shipping ways (Zhao, Sun, & Webster, 2022).

### **The main motivations for the prelude of Belt and Road Initiative**

The numerous motivations which encouraged China's pursuit of the Belt and Road Initiative are as under.

**Economic Expansionism:** Generally, The BRI will provide an exist for China to enhance its economic influence on global level by devoting and developing massive commercial infrastructure projects in partner states.

**Overproduction:** presently, the Chinese industries are producing beyond its own market consumption, the BRI initiative will help address issues of overcapacity in Chinese industries, such as construction and manufacturing, by providing opportunities for companies to participate in overseas projects.

**Geopolitical Calculations:** The BRI will also increase China's geopolitical ambitions by nurturing strategic partnerships and increasing its presence in strategic regions of the world.

### **Successes of Belt and Road Initiative**

Since its beginning the Belt and Road Initiative has attained noteworthy successes in terms of its infrastructure development, economic ties, and diplomatic recognition by the world community. So far, several related projects, which include the latest railways tracks, strategic ports, and special economic zones, have been completed under BRI initiatives, which aim to cultivate a culture of increasing connectivity and trade between partaking states. Since then, the Chinese BRI investments have encouraged economic growth amidst the participating countries, and it is contributing to reduce poverty and job engagement in the participating countries (A. Hussain & Ullah, 2023).

### **Challenges and Obstacles for Belt and Road Initiative**

Notwithstanding the huge successes of BRI, it is also facing a variety of challenges and obstacles, which are as under.

***Debt Sustainability:*** Some partner countries are facing challenges in paying the loans associated with BRI projects.

***Environmental Factor:*** The large and titanic infrastructure projects associated with the BRI have raised environmental concerns, which include deforestation, habitat degradation, erosion, and the menace of pollution.

Last but not the least, The Belt and Road Initiative is one of the modern harbingers of prosperity wellbeing and it is also a testimony to China's global vision for connectivity, economic development, and cultural exchange. Though, it has achieved noteworthy milestones but the challenges and criticisms on the BRI highlight the need for careful consideration of the social, economic, and environmental implications of the projects as well. Arguably,

with the passage of time the BRI initiative will continues to progress and its impact on the geo-economic and geopolitical landscape beyond doubt will figure the narrative of China's role in the twenty first century (A. Hussain, Jaffar, & Hussain, 2024).



Source: eurasiareview.com

## **Bald Eagle VS Red Dragon**

### **Pakistan the emerging Heartland: A Pivot for Regional and Extra Regional Integration**

Literally, the term heartland is basically used to describe anything which is the epicenter or middle spot of a state, realm or region. In this context Pakistan is the emerging heartland of the world in general and Asian region in particular. Besides, in the discourse of political science, the term "heartland" is connected with the concept of a strategic geographic location that is very significant for the control and supremacy of a particular region or a state. Moreover, the conception heartland is associated with the famous 20<sup>th</sup> century British geopolitical theoretician Sir Halford Mackinder.

#### ***Halford Mackinder Heartland Theory***

Halford Mackinder (1861 to 1947) was one of the leading and famous British geographers and geopolitician. Additionally, Mackinder is best known for his geopolitical theories, mainly for his conception of the "Heartland Theory" which he published in his famous masterpiece "Democratic Ideals and Reality" which was published in 1919. Mackinder's Heartland theory suggests that who rules the Eastern Europe will rule the Heartland, whoever rules the Heartland will rule the World Island, and whoever rules the World Island will rule the world.



Source: [thegeopolity.com](http://thegeopolity.com)

## **Halfords Heartland**

### **Pakistan the emerging Heartland of the World:**

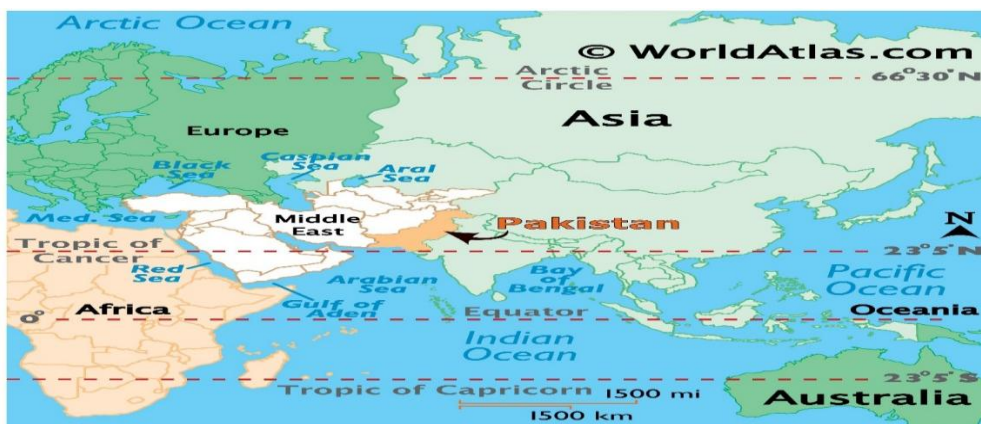
With the passing days, Pakistan is converging itself into one of the significant and very vital geopolitical and geo economic arenas of the world, in other words it is becoming the emerging Neo Heartland of the world. While on the other hand, portraying Pakistan as the emerging heartland one must bear in his mind the associated potentials of Pakistan which are numerous, for example, its booming economy, the geographical proximity of Pakistan with some of the key countries and regions of the world, its massive demography, unique culture, and its strategic positioning in the world map. Pakistan is one of the bestowed countries of South Asia, which has a great economic potential, one of the rich cultural heritage and diverse landscapes starting from lofty mountains to seashore (S. Hussain, Ali, & Qamar, 2023). However, Pakistan is facing many challenges, but it has all the vast potentials that, if harnessed efficiently, it can contribute a better part in the sustainable development and prosperity of the world and Asian region respectively. Pakistan stands at a critical juncture with enormous potentials, and it is these potentials it can pave the way for sustained growth and development, and Pakistan can become a dynamic player on the world stage.

### **Strategic significance of Pakistan in regional and extra regional Integration**

Pakistan is one of the significant countries, which is blessed with a unique geographical placement, and it has remained the banner man in promoting regional and extra regional integration activities in the near past. Metaphorically, Pakistan is known as the fulcrum of entire Asian continent and it is also one of the strategic pivots, where Middle East, South Asia and Central Asia meet. Furthermore, Pakistan, holds enormous strategic importance in the areas of regional and extra-regional integration. Its exceptional geographical positioning, economic potential, and its geopolitical role make it one of the central players in promoting cooperation, connectivity,

and stability among all member states. Pakistan, shares borders with India one of the economic giants to the east, its western boarder connects Afghanistan and Iran, People Republic of China to the north, and towards south it is Arabian Sea. Pakistan's geographical placement makes it one of the gateways between South Asia, Central Asia and the Middle East. The China-Pakistan Economic Corridor (CPEC) is one of the leading projects of Chinese Belt and Road Initiative known as (BRI), CPEC highlights Pakistan's key role in bringing closer the economically vibrant regions of East Asia and the Middle East respectively (Hussain Mirza & Kumar, 2023).

Moreover, Pakistan's economic potentials further make it one of the key players, its huge consumer market and its varied natural resources make it one of the vital partners for regional and extra-regional economic cooperation. Pakistan's Gwadar Port is a deep seaport on the Arabian Sea, which a hub in enhancing maritime connectivity. Besides, Gwadar port and CPEC are not just facilitating trade between China and Pakistan, but they can also open up new trade routes for India, Central Asian states and other stakeholders. These initiatives make Pakistan one of the epicenters for the regional and extra regional integration (Shahid, Khan, & Zain, 2024).



Source: hotzgirl.com

Pakistan's geo strategic significance is not confine to its geographical and economic features, moreover, its diplomatic influence also adds another layer to its prominence. Pakistan's active commitment in regional forums namely, the South Asian Association for Regional Cooperation SAARC and Organization of Islamic Countries OIC and some of the extra regional organizations such as the Shanghai Cooperation Organization SCO and prospective member of BRICS, make Pakistan one of the influential and responsible player policies. Last but not the least, Pakistan's strategic placement in both regional and extra regional integration is manifold and it

cannot be underestimated. Pakistan's distinctive geographical location, its economic potential, its vital role in safeguarding regional stability, and her diplomatic influence jointly makes it a harbinger for regional and extra regional connectivity and cooperation. As we all know that our world is becoming highly interconnected and dependent, recognizing and harnessing Pakistan's strategic importance becomes very important for promoting economic growth, stability, and peace across the broader region. Lastly, Pakistan's acumen to circumnavigate complex geopolitical challenges and promote collaboration will undoubtedly shape the path of regional and extra regional integration in the years to come.



Source: researchgate.net

## Conclusion

Pakistan is actually the emerging heartland of regionalism and BRI, because it one of the indispensable and significant countries which have all the required potentials and prerequisites to promote interdependency and connectivity. Moreover, Pakistan is one of key bridges which promotes connection between Central Asian, China to India and Middle East, besides, the geographical placement of Pakistan cannot be underestimated. Even the leading world hegemony, like China and USA and others realize and recognize that Pakistan is one of the global strategic junctures and epicenters of the present world. The strategic significance of Pakistan underpins its vital role in regional and global politics respectively. Additionally, since the dawn of the 21st century all great powers of the globe are relying more and opting soft power politics instead on hard power politics. The central tenets of soft power politics are stable economic wellbeing and interdependence among all states, in this regard, Pakistan offers much more economic and soft power opportunities which can be utilize for the economic well-being of the world in general and adjacent

regions particularly. For example, Pakistan provides China the short and reliable exist into the Middle East. As we know that Middle East which is very crucial for the development of China. China can use the CPEC corridor via Pakistan to reach the lifelines of world economy, like the Strait of Hurmuz and the Suez Canal, through these straits China can access Africa and Europe. Besides, Pakistan has the ability and opportunity to give regional and global access to the landlocked republics of Central Asia and other landlocked countries like Afghanistan. On the other hand, another regional player namely India, is one of the emerging economic powerhouses, to enhance its economy, India needs the natural resources especially, the vast deposits of coal and natural gas of Central Asian Republics, Pakistan has the required ability to provide India access to Central Asia.

Pakistan is holding the required privileges of promoting regional and extra regional integration if satisfactory attention paid to the significance of this emerging new heartland country namely Pakistan beyond the sentimentality of real politics. Pakistan is one of the actual geographical junctures in the globe that has the adequate abilities to disseminate and foster regional and extra regional integration and development and dampen the vendettas among the competing great powers.

### **Suggested Citation**

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## **Belt and Road Initiative (BRI) and Its Impact on Pakistan**

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### **Abstract**

The BRI, or One Belt One Road initiative was unveiled by the Chinese President XI Jinping in 2013 as an enormous infrastructure and economic plan for every country and region involved. Otherwise known as the new Silk Road, the BRI is a long-term initiative aimed at increasing interconnectivity in trade, increasing economic integration and exchange of cultures. The initiative derives its name from the two main components: The Silk Road Economic Belt and the 21st Century Maritime Silk Road. The Silk Road Economic Belt is aimed at developing a railway. It endeavors to have a web of rail, road, oil and pipe across the continents to allow easy transport of goods and people. In contrast, the 21st Century Maritime Silk Road focuses on improving the maritime link between China and other parts of Southeast Asia, Africa, Europe through improving the standards of the ports, and; maritime relations. The BRI in the current world involves a series of project areas including transportation projects including roads, rail and ports, to power projects such as pipeline and power projects. This also entails communications through investments in telecommunication, economies through economic zones, and social through people-to-people contacts. To China, the BRI is seen as a driver of economic

opportunities both at home and outside through new markets for the China origin products and services. The investment in infrastructure makes the transportation cheaper, efficient and assists in boosting the general economic strenuous of partner countries. In terms of economic and geopolitical consequences the initiative possesses the opportunity to redefine the world trade map. A standard critique that has been made and one that is continuously being made about the one belt one road initiative is that it has negative environmental impacts, it has a negative effect on the sustainability of debt and has geopolitical ramifications. However, the BRI is still an active trend in global discourse, which further outlines the vector of post-2015 development of the global economy and transport infrastructure.

The objectives of the Belt and Road Initiative (BRI) include enhancing global trade connectivity, fostering economic integration, and promoting cultural exchange among participating nations. It aims to develop infrastructure such as roads, railways, ports, and pipelines to facilitate efficient transport of goods and people. Additionally, the BRI seeks to open new markets for Chinese products and services, improve communication networks, and strengthen international cooperation, contributing to global economic growth and development.

**Keywords:** Belt and Road Initiative (BRI), Geopolitical Impact, Industrialization in Pakistan, Economic Dependency, Strategic Partnerships

### **Historical Context of China-Pakistan Relations:**

It is witnessed that the bilateral relationship between China and Pakistan has solid roots and a long history in the past decade. This kind of relationship can be dated back to the formation of Chinese People's Republic and the creation of Pakistan right from 1947. Faruqi, A. (2001)

**Early Diplomatic Ties (1950s):** The two countries established the diplomatic ties on May 21st, 1951, fancifully after the emergence of People Republic of China after the year 1949. The formative stages of bilateral relations of the two countries in the international field were characterized by cooperation in general and support on various issues, which both countries had similar concerns regarding security in their respective regions.

**Border Resolution (1963):** One event in the early stages of interaction marked by both countries was solving the problem of border delimitation. Since the two reach the border issue in the area of the Karakoram Range, the Sino-Pakistan Agreement was signed in March, 1963. This paved way for diplomatic agreement that brings about the security on the border that will enhance confidence between the two countries. (McGill University (Canada),

2022).

**Military and Strategic Cooperation (1960s-1970s):** In the 1960s and 1970s, two countries continue to enhance their Military and strategic cooperation. Pakistan has been proved to be greatly helpful for China in mid 1970s in establishing contact with United States which paved the way for Nixon's historic visit to China in 1972.

**Support During War and Nuclear Cooperation (1980s-1990s):** During the period of the Indo-Pakistani wars of 1965 and 1971, China supported Pakistan. 'In the 1980s, the two cooperated in the use of nuclear technology.' Apparently, China helped Pakistan in construction of nuclear program that forms the bone and sinew.

**Economic Cooperation and the China-Pakistan Economic Corridor (CPEC) (2000s-2010s):** The history of economic relations between China and Pakistan also enters the 21st century, when cooperation rapidly intensified. The economic corridor that began in 2013 exists as one of the significant projects of the BRI strategy. CPEC is a framework that seeks to link Gwadar Port in South Pakistan to China's northwestern province of Xinjiang by roads, rail, and oil pipelines. This project is an economic artery for both countries and at the same time demonstrates the growing development of the economic bond between the two states.

**Diplomatic and Multilateral Engagement (2000s-Present):** On different international issues both China and Pakistan have always stood for each other. They most often act in coordination in international bodies such as the United Nations and have kept relatively a closely diplomatic relation. South Korea and Indonesia have similar stake in encouraging regional security, fight against terrorism and economic growth.

China Pakistan relationship reflects a complicate relation which earlier proved to be diplomatic and strategic partners and now becoming economic partners through investments in project like CPEC. It has survived many shifts in geography and remains highly influential in the current and future configuration of South Asian and World politics of strategic partnership. (Ahmed, Z. S., & Haque Sheikh, M. Z. (2021).

### **Concept and Objectives**

The BRI is an indefinite and expansive strategy, launched by the president of the People's Republic of China Xi Jinping in 2013. The initiative derives its name from the two main components: The Silk Road Economic Belt and the

## 21st Century Maritime Silk Road.

**Silk Road Economic Belt:** The Silk Road Economic Belt is concerned with the over-land connectivity between China, Central Asia and the Middle East, and Europe. Unlike the historical silk Road that was a network of trade routes connecting East and West, this new Road is focused on constructing railway, highway and pipeline systems through the continental stretch in the twenty first century civilization. These are the roads whose construction to some extent aims at enhancing transport costs, increasing linkages, and integration the various economic regions.

### **21st Century Maritime Silk Road:**

The concept of 21st Century Maritime Silk Road seeks to upgrade and enhance marine linkages between China and New ASEAN, Africa and Europe. This transport mode considers ports, channels, and other marine facilities required for the transport of cargoes by water. It also supplements the overland ‘Silk Road Economic Belt’, forming an extensive combined system of transport both on land and at sea.

**Economic Cooperation and Development:** Fundamentally, the BRI is aimed at fostering economic connectivity and integration through investment in connectivity facility and other linked activities. Through improving physical accessibility, the plan envisages contribution to the growth of economic activities in the participating states, generation of employment opportunities, and poverty alleviation. The BRI is not just limited to the construction of physical connectivity but also augments a developmental concept of connectivity embracing policy coordination, trade, investment facilitation, financial cooperation and cultural intercommunication. (Khan, M. M., Malik, A. R., Ijaz, S., & Farwa, U. (Eds.). (2016).

**Global Impact and Multilateralism:** The BRI is a universal project with a potentially great impact. It focuses on working with multiple countries and also promotes development with all countries looking forward for mutual benefits among the countries that are in partnerships. As such, the BRI replaces conventional arrangements of economic development and offers an open system of global integration. **5. Long-Term Vision:** Unlike the BRI that represents a long-term vision beyond the gains of economic integration. It seeks to develop a vision of both, and a group identity of interdependent members for the participating nations. Copra has a noble vision to support the development of global economy, to help counteract conflicts in the regions and to bring nearer the people’s idea of more connected and friendly world.

The scope of the 'BRI concept is a complex project, the goal of which is the restoration of Great Silk route, stimulation of economic growth, and enhancement of international cooperation. This is an indication of willingness by the Chinese authorities to foster creation of a more liberal and interlinked global society where social benefits of global cooperation crosses geographical borders and impact positively on all participating nations.

### **Significance of BRI for Pakistan:**

BRI provides multiple opportunities to Pakistan economically, strategically as well as in terms of infrastructure improvement. As one of China's key partners in the initiative, Pakistan stands to gain in several ways:

**Economic Development:** Economic development is considered one of the major advantages for Pakistan which can be achieved as a result of climate change impact. The China-Pakistan Economic Corridor (CPEC), under the umbrella of BRI, is a \$ 50.6 billion long-term massive infrastructure plan to connect Gwadar Port of Pakistan's southwestern Balochistan province to China's Xinjiang province. This corridor is involving in infrastructure such as highway, railway, energy and industrial area. Through these project investments, Pakistan's economy faces a rise, establishment of jobs in the economy and increases industrial performance within the country through Chinese investment.

**Trade Connectivity:** BRI is more inclined towards increasing the trade connection and CPEC is a strategic gateway for Arabian Sea to Central Asia and China. The current reforms in Pakistan make it possible for the country to act as transporters and traders and contribute to the enhancement of economic growth through attracting investments. In particularly the construction of Gwadar Port is likely to boost the maritime trade and improve the position of the country in regional and international trade map.

**Energy Infrastructure:** CPEC contains large investments in energy sector which involving energy starved Pakistan province that has long suffered from power shortage. Coal, hydel and solar power plants are intended to increase energy generation capacity of the country. Electricity availability is no longer a privilege but a necessity for domestic use while at the same time improves the investment encourage status of Pakistan for industries that require power.

**Job Creation and Poverty Alleviation:** Analyzing the mentioned initiatives of BRI and CPEC it can be confirmed that the infrastructure and industrial projects begun under these initiatives present an opportunity to create significant employment. Accessibility to employment opens up, especially in

developing areas of construction, manufacturing and services result in poverty reduction and socio economic uplift.

**Strategic Importance:** The China-Pakistan relation has always consisted of strategic partnership, the BRI serves to fortify it. The fact that CPEC links Gwadar to Xinjiang is equally significant for Pakistan as it makes it very important for China providing it with a short cut trade route. It presents certain implications for regional stability and security of the boosted relations.

**Technology Transfer and Skill Development:** Under BRI, collaborative projects are useful in technology transfer and developing new set of skills. The process of performing infrastructure can lead to an exchange of knowledge as well as training of the human resource by Chinese companies. This can help useful for the ultimate building of human capital of Pakistan in long run. (Wang, X., Wong, Y. D., Li, K. X., & Yuen, K. F. (2021).

Therefore, Belt and Road Initiative has a great potential for Pakistan's economic revolution, trade liberalization and geopolitical cooperation with China. That said, challenges and concern are two different things as the following points indicate there is much to be positive about BRI in terms of its potential benefits for Pak and its network centrality in the on-going systematic transformation of the global economy.

### **Goals of the BRI**

As a complex megaproject, the BRI involves several interrelated purposes and aims at several interconnected spheres: economic, political, and even cultural. Announced by Chinese President Xi Jinping in 2013, the BRI seeks to achieve the following key objectives:

**Enhance Global Connectivity:** of the many benefits aimed at by the BRI is the upgrade of the silk road trade routes as a means of increasing connectivity around the world. The idea of the project is to developed free and efficient connection between transport systems of the participants of cooperation within the framework of highways, railways, sea and air ports.

**Promote Economic Cooperation and Development:** BRI can be understood as an initiative that aims to facilitate more active economic interaction of the participating countries. It also aims to support human resource development for the realization of sustainable economic growth and poverty reduction through infrastructure development and support to various priority sectors. BRI strives at economic cooperation in an effort to make the involved countries prosperous.

**Facilitate Trade and Investment:** In this formula, the BRI thinks that coordinating the transportation and logistics, it can enhance trade and investment. This bold plan is aimed at decreasing the restrictions of access to foreign markets, simplifying the mechanism of trade and investment, and improving the general conditions for export activities. From this, it will be expected that economic development will be encouraged alongside with chances for new business avenues.

**Promote Policy Coordination:** The BRI also underlines policy synergy among the member countries in order to propose an appropriate political climate for investing in economic activities. This entails the consisting in of laws and standards means of adjusting trade practices and fostering cooperation in areas including but not limited to customs procedures. The objective is to simplify and improve the effectiveness of administrative procedures related to trade and investment between two countries.

**Financial Integration:** The BRI seeks to engender financial linkages, which involves cooperation in the sectors of trade in currencies, investment and financial services. The goals of the initiative particularly incorporate the promotion of financial connectivity to improve the stability and efficacy of the financial markets to enable cross border operations by enterprises.

**Cultural Exchange and People-to-People Bonds:** However, as an initiative, the BRI focuses on soft power, soft infrastructure involving cultural ties and people to people contacts. This includes better appreciation of other people's cultures, exchange of education and ideas and interpersonal relations. The aim is to foster more robust interconnection between countries and achieve the feeling of cooperation as well as identity. BRI may be said to be one of the most elaborate development visions out there with its ultimate goal being that of creating a more connected globe. The BRI breaks down political and economic boundaries, by developing connectivity and cultural diplomacy, it fosters the sense of community with shared interest of the participating countries, and contributing to the global development. (Sheng, J. I. A. N. G., Jun, H. O. N. G., & Kakar, A. (2023)

### **How BRI Aligns with China's Global Economic Strategy**

This is therefore an excellent match for China's more extensive extrusion of global economics agenda as encapsulated in the BRI. Going out is the abbreviated strategy in china's overture to the international market with the intent of achieving internationalization of the economy. The BRI may be seen as a significant tool for achieving this strategy for the following factors. Firstly, BRI helps China manage overcapacity problems which are accruing in

some of its domestic sectors by providing avenues for market expansion of its products, services and technologically advanced products. According to this logic, China internationalizes industries through infrastructure projects and investments in partner countries. Secondly, the process is aimed at promulgating globalization of the Chinese currency, which is among the objectives of the Chinese administration regarding the yuan currency reserve. One of the measures through which BRI is implemented requires cross-border transactions in yuan, thus popularizing the currency in the global market. Also, BRI improves China's geopolitical profile owing to the creation of economic bonds with Partner countries. Through investing in infrastructure projects and promoting economic growth of participating nations, China acquires new strategic partnerships consistent with its vision for the international economy and power politics. In retrospect, the BRI is central to a comprehensive Chinese grand plan for the international economy to align for the country's economic benefit in the global political economy. (Zhang, Y. (2020).

### **The China-Pakistan Economic Corridor (CPEC)**

#### **(CPEC as a leading initiative within the BRI)**

The most famous project of BRI is the CPEC which is an economic and strategic connectivity project between China and Pakistan. CPEC was initiated in 2013, it is a multilayered venture covering the cooperation in infrastructure and investments.

**Strategic Significance:** It has a strategic significance for both China and Pakistan. It plans highways, railways, and pipelines to link the Gwadar Port in southwestern Pakistan with China's northwestern Xinjiang region. But beyond enhancing trade, this strategic corridor offers the Chinese an added advantage of shifting from maritime transit for imports such as energy products.

**Infrastructure Development:** CPEC involves conception of various projects such as highways construction, railways construction, development of energy projects and construction of Gwadar port. All these projects are meant to increase the transport accessibility, decrease the logistic barriers and bring more value addition in the economy of Pakistan.

**Economic Benefits:** It goes without saying that CPEC brings a lot of economic advantages. The government plans envisage the program will help grow the Pakistan economy through employment generation, FDI inflows and industrialization. The corridor plays the role of facilitating economic diversification and development in sectors such as energy generation and manufacturing and the production of agricultural produce.

Energy Projects: It helps overcome Pakistan's persistent energy crisis through investment in energy sector projects of coal, hydro and solar electric power. It not only assists in closing the energy divide but also raises industrial efficiency and fulfills the needs of economic development.

Trade and Connectivity: CPEC contributes towards improving the status of Pakistan as an important player in transit and trade circuit. It assists in breaking barriers to accessing international markets, enhances the integration of the region's economy and enhances the connection of China with the Pakistan and other BRI member countries' economies. (Dunford, M., & Liu, W. (2019)

Altogether, it can be stated that now CPEC acquiring an essential type of the Belt and Road Initiative arrangements, exert the most practical influence on the China and Pakistan's harmonious growth of commerce and mutual relationship. Special emphasis is made on infrastructure, energy, and connectivity because these are the key components that are directly impactful for establishing stability in the region, which can be constructive for reshaping the economic policies of south Asia and other areas in the world.

### **Infrastructure development under CPEC**

The China Pakistan Economic Corridor (CPEC) is a pilot project of one belt one road (OBOR) and is marked by a large amount of infrastructure investment. The scheme is meant to better connections, spur economic development, and meet the energy deficits in Pakistan. The infrastructure projects under CPEC belong to different sectors, and they have a positive impact on the development of the country.

Transportation Infrastructure: CPEC contains the development and up gradation of transport related infrastructures that consist of highways and railways. It calls for the construction of new Super Highway and improvements of existing highways for goods and people transport, linking Gwadar Port in south western part of Pakistan and Xinjiang region in North Western part of China.

Gwadar Port Development: CPEC has massive investments being used for enhancing and developing Gwadar Port which is an integral terminal in the project. This is a deep sea port is meant to turn into an important node for maritime commerce and communication that is set to boost relations between Pakistan and China and the rest of the world.

Energy Projects: CPEC discusses the issues of energy crisis in Pakistan by investing in different energy projects: This comprises generation of power through fuel such as coal, water in the form of hydroelectricity, and through capturing of solar energy. These initiatives play a role in helping to close the

energy deficit and get a more stable electricity supply.

**Industrial Zones:** The particular sectors that are being targeted for development through CPEC include establishment of Special Economic Zones (SEZs). These zones serve. Enable foreign and domestic investment making, thus encouraging economic diversification and employment. The SEZs are sited along the corridor to ensure they have the greatest impact towards development of the regions.

**Telecommunication Infrastructure:** Telecommunication facilities also fall under the CPEC prospective, of which involve the improvement of high speed internet facilities and the introduction of improved communication technology facilities. This fosters the communication and leads to the digitalization of the area. (Ibañez, P. (2020)

The kind of infrastructural development topped under CPEC is not only massive but, more than that, symbiotic to the growth of Pakistan. The paper establishes that in enhancing transportation, energy, and industrial linkages, CPEC supports the competitiveness of the country in attracting investment and encouraging sustainable development. These projects, thus, are extensive since the leadership of both China and Pakistan cares more for collectively constructing a strong economic corridor that will assist both the nations as well as foster and enhance regional integration.

### **Economic sectors targeted by CPEC investments**

Out of the China's Belt and Road plan, the China-Pakistan Economic Corridor (CPEC) seeks to nearly every sector of the Pakistan's economy with the hope to spur growth, enlarge employment base and fulfill infrastructure and energy requirements in the country. Key sectors that have been specifically targeted for investments under CPEC include:

**Energy:** CPEC focuses a large part of investments towards the energy sector. This is in the form of establishment of coal base power plants, mini hydel power project and solar power to meet energy crisis and enhance the stability in power sector.

**Infrastructure:** Prominent among these are investment in transportation infrastructure services comprising construction of Highways, Railway, other transportation networks as well as development of Gwadar Port etc. This improves internal connection within Pakistan and improves the relation on the commercial aspect between both Pakistan and China.

**Industrial Zones:** SEZs are developed under CPEC with an objective of development of industries. It encompasses special development zones that

encourage domestic and foreign investments especially in manufacturing and processing sectors, thus stabilizing the economy and employment opportunities. (Ramzan, M., HongXing, Y., Abbas, Q., Fatima, S., & Hussain, R. Y. (2023)

**Gwadar Port Development:** The development projects aimed at Gwadar Port are designed on the speculations that it will be one of the major sea ports in the region. This includes increasing the handling capacity of the port, enhancing the existing facilities and equipment and marketing the port as a link between Pakistan and China and other countries.

**Telecommunications:** CPEC comprises investments in the communication area, in particular, the provision of great broadband wired/wireless networks and modern means of communication. This in turn fosters digital linkages and improvement of on technology in the region. Through its focus on these primary economic sectors, CPEC is aimed to develop a complete and coordinated economic corridor that caters to diverse dimensions of Pakistan's development.

## **Socio-Economic Impacts on Pakistan**

### **Generation of jobs and expansion of employment prospects**

The Belt and Road Initiative (BRI) is re-shaping the global economic power structure by bringing major benefits to countries involved in the initiative. For Pakistan, a central pillar of BRI has been economic development by way of infrastructure projects, energy partnership and deepened connectivity. A job generation and employment brew of the BRI on Pakistan one of its major impacts, across sectors.

BRI infrastructure projects (eg: China-Pakistan Economic Corridor, CPEC) and others have played a critical function in generating a demand for both skilled as well as unskilled labor. Construction of roads, bridges and energy facilities impelled job growth benefiting thousands of Pakistani families. Prime example is development of the Gwadar Port under CPEC that has not only boosted maritime trade but also created job opportunities related with port operations, logistics et.

The Prime Minister highlighted that BRI initiated energy projects have successfully overcome the power deficits in Pakistan giving a boost to industrialization. The scientist said that the establishment of power plants and the expansion in energy sector not only made assured increase based on productivity growth but also compelled increased employment in power

generation and distribution categories. (Ali, T., Huang, J., & Xie, W. (2022).

Apart from the direct job creation, BRI has more far-reaching influence for through indirect workings. New jobs were created as transportation infrastructure improved, allowing more extensive trade and commerce to be conducted; the chain of supply-side logistics and transport services also increased. This includes also some SMEs, which have strengthened because of their growth in the context of a recovery.

On the down side, there are still issues to be addressed with skill mismatches and regional imbalances in job distribution. However, the key to maximizing the employment opportunities provided by BRI will lie with attempts to align educational curricula with the modern demands of job market and promote inclusive development across regions throughout Pakistan. Through the Belt and Road Initiative, job creation and employment opportunities enhanced in Pakistan. While the nation endeavors to grapple with the mechanisms of this enterprise, policy strategy and projects are crucial to sustaining inclusive economic growth.

### **Industrial and Economic Growth in the Context of the Belt and Road Initiative (BRI) in Pakistan**

The Belt and Road Initiative (BRI) aid massively for industrial development in Pakistan at the center of all this expansion is the China-Pakistan Economic Corridor (CPEC), a flagship project under BRI primarily serving infrastructural and industrial progress.

The China-Pakistan Economic Corridor (CPEC) has laid the pillars of industrial expansion through SEZs. These zones will act as a nucleus for manufacturing and commercial structures, drawing in both local as well as overseas money. Consequently, the market has grown and changed within industries as diverse as textiles, electronics, and pharmaceuticals. It is not just the efficiency of existing industries which have been given a boost by investment and technology transfer from Chinese investors, new sectors have also benefitted. (Butt, H. D. (2023).

Energy related projects launched under BRI, which are such as power plants and economic zones constructions etc has resolved Pakistan's longstanding challenge of energy crisis. For industries, the uninterrupted and stable power supply strengthened the capacity of industries to operate at peak capacities, boosting productivity. In addition to attracting new industries, this energy stability has played a fundamental role in helping diversify an economy that for so long was dependent on crop agriculture and textiles.

BRI connectivity has paved the way for seamless trade & commerce through enhanced access locally as well as globally. Improved transportation links, such as the expanded road and rail networks, have lowered the cost of logistical support for Pakistani enterprises in international markets. This increased connectivity also provided access to newer modes of export and import furthering the growth.

Although the advantages of industrial and economic development are undeniable, so too is the need to recognize these gains equitably and deal with environmental issues from onwards. Adoption of sustainable development practices and inclusive policies would be imperative to make the most of BRI, if Pakistan is to capitalize on this unparalleled interconnected structure to foster long-term industrial and economic expansion in the country.

Currently, the pace of industrial and economic growth in Pakistan is significantly higher than past thank to the Belt and Road Initiative more particularly those under CPEC projects. Over the years, these collaboration of efforts from the two amigo countries have not only worked towards bridging key infrastructure deficits but it has also successfully placed our country in a strategic position to drive within the regional and world economic jungle.

### **Social and Cultural Implications of Chinese Investment in Pakistan**

Chinese investment in Pakistan, especially under the Belt and Road Initiative (BRI) and the China-Pakistan Economic Corridor (CPEC), has significant social and cultural bearings. This investment by Chinese capital has also seen a rise in social and cultural exchange between both countries.

Significantly, one of the top social implications is that these projects are found in communities where cross-cultural integration happens due to the presence of Chinese people. Moreover, the Chinese professionals and workers have also contributed to reasonable understanding between Pakistanis and Chinese through creating a mixed-race community encouraging cooperation among both nations. This interaction has additionally not simply facilitated the sharing of opinions, but enriched a far more diverse and cosmopolitan social fabric.

Perfect in food, lifestyle, language and it also reflects from the cultural values as well. That has propelled a rising demand for learning the Chinese language and objective of having served at any of its Chinese restaurant with an English-speaking staff! They are even hosting cultural events and festivals of both the nation together– which symbolize a potpourri of tradition. (Zhang, R., Shi, G., Wang, Y., Zhao, S., Ahmad, S., Zhang, X., & Deng, Q. (2018).

But there are also challenges and trade-offs to urbanization, including the erosion of local cultures and identities. It is important to note that Chinese intervention though helpful in numerous ways, it should not come at the expense of Pakistani cultural values, where achieving a balance between cultural exchange and uptightness towards preserving nativity is essential if Chinese capital contribution can actually progress positively within Pakistani socio-cultural ethos. In sum, Chinese investment in Pakistan carries important implications for the social and cultural relationship between two of the world's great civilizations, embodying a range of opportunities as well as challenges.

## **Obstacles and Issues**

### **Debt Sustainability and Financial Implications of Chinese Investments in Pakistan**

Chinese investments in particular, through ventures including the Belt and Road (BRI) initiative and the China-Pakistan Economic Corridor (CPEC), have posed greater opportunities as well as challenges when it comes to issues related to debt sustainability and financial costs for Pakistan. While these investments have supported critical infrastructural development, there is concern that the indebtedness they have induced may not be viable in the long run.

The funding for most of these projects is a loan from Chinese institutions which adds up to Pakistan's foreign debt. The problem is how the country can both hold these debts and pay them without endangering its own economic (instability). A sustainable financial framework lies in successfully balancing both development project financing and debt without becoming overly dependent on borrowing. (Nadeem, M., Xiaoyan, F., Sadaf, G., & Hassan, S. (2025).

Needless to say, the conditions attached with loans in terms of interest and loan repayment schedule have a bearing upon the fiscal health of Pakistan. But securing good terms and carrying out further prudent financial administration goes a long way in averting potential debt crisis, and strengthening economic resilience across the board.

Given the concerns regarding debt sustainability, a comprehensive strategy that focuses on transparent financial management and efficient use of resources as well as diversification of the economy is needed. Chinese investments may offer great opportunity for development, but the financial rethinking required is fundamental to ensuring that Pakistan has a sustainable and economically viable future.

## **Environmental Concerns and Ecological Impact of Chinese Investments in Pakistan**

The unprecedented wave of Chinese investments, specifically via the BRI and the CPEC, has alarmed environmentalists and unearthed ecological implications in Pakistan. Infrastructure projects on a wide scale (dams, roads and power; dams, roads and so on) can displace local ecosystems egregiously causing environmental degradation.

Construction and operation of these projects frequently cause habitat loss, deforestation and changes in water flow. This can be devastating to the ecosystem of affected regions, leading to a loss in biodiversity and destruction of fragile ecosystems. Furthermore, a rise in industrial activity connected with these projects may lead to air and water pollution that can endanger the environment and human health.

It is essential to make an attempt to eradicate these environmental concerns. Sustainable methods such as reforestation drives and the use of green technologies can reduce the carbon footprint. High standards are enshrined in the Constitution, and alongside appropriate impact assessments and robust regulatory controls they will continue to inform development processes.

For the benefit of both economies and habitats, sustainable practices are essential, as is a degree of control on Chinese investment by Pakistan. Solving these environmental issues would be a step in the direction of sustainable development where both countries make development but not at the cost of nature for future harmonious existence!

## **Socio-Political Challenges and Public Opinion on Chinese Investments in Pakistan**

The inflow of Chinese investments, especially in the form of programs such as China's Belt and Road Initiative (BRI) with its flagship China-Pakistan Economic Corridor (CPEC), has triggered a number of socio-political challenges that have in turn been observed to affect public opinion in Pakistan.

At the sociopolitical level, debates typically concern transparency, governance and the sharing of benefits. While certain sections of the society raise concerns about the accountability involved in these mammoth projects, there are others who see a reason for optimism pact used too. The main challenge to distribute the benefits of air travel investments made by the rich Chinese across all society and not be limited in areas or sectors.

The extent of public opinion is also influenced by the economic devastation that may befall local industries or employment. Even as these investments fuel economic development, concerns are raised over the loss of face by local businesses and the types of jobs that are created. These issues require a tactical move of foreign investment optimization and still maintaining the home industries security. (Wen, R., & Saleem, H. (2021)

In addition, because Socio-political challenges go beyond specific concerns in culture also. Others fear that the growing Chinese presence could water down local culture and values. Societal cohesion can only be achieved when we find the right balance of embracing economic collaboration and cultural identity.

The perception of people has a huge contribution to these projects in being successful. Having open transparent communication processes and engaging local communities as stakeholders in decision-making builds more Security around the API (Trust). Here, the socio-political challenges that are being faced should be actively addressed by the governments and other stakeholders in order to absorb public feedback for the incorporation of socio-political aspirations of a larger demographic within the local population. An informed and participatory public can help ensure the success of such initiatives as we continue to progress towards a more equal and environmentally friendly Pakistani socio-political landscape.

## **Geopolitical Significance**

### **Strategic Implications of the Belt and Road Initiative (BRI) for Pakistan**

Belt and Road Initiative (BRI) has profound strategic implications for Pakistan in all spheres of state affairs, geopolitical as well as economic landscape. As a flagship under BRI, the China-Pakistan Economic Corridor (CPEC) contributes to increasing Pakistan's strategic value as it turns Islamabad into an exclusive transit and economic hub. Fulfillment of the CPEC project by developing Gwadar port not only serves to boost maritime trade, but also enhances the role of Pakistan in regional connectivity.

Geopolitically, the project is a strategic cog in BRI that will deepen economic bonds between China and Pakistan leading to closer diplomatic ties. The initiative offers scope for deeper collaboration in areas that go beyond infrastructure, such as trade, technology and even people-to-people exchanges. Such integration strengthens Pakistan's Positioning in geo politics and hence improves its Global clout. (Anwar, U., & Atif, M. (2025).

Equally important is the fact that BRI meets some of Pakistan's chronic

economic problems, such as energy shortages and infrastructure gaps. Better energy infrastructure, in general, increases the Portuguese economy resilience and lowers its reliance on imported energy.

That being said, strategic thoughts also embody the requirement for Pakistan to continue a cautious engagement with others and this involves maintaining some delicate cold feet concerning China while trying not to stir up regional waters. There is also the financial and debt sustainability issue that are critical to long-run strategic success.

To sum up, the BRI provides strategic benefits to Pakistan rather than pure economic benefits. If harnessed sensitively then the state of Pakistan can increase its geopolitical positioning, diplomatic connections and maneuver through the challenges by stabilizing itself to be a more sustainable actor in the region.

### **Balancing Relations with Other Regional Powers in the Context of BRI**

It is nevertheless extremely important for Pakistan, which puts further accent on the Belt and Road Initiative, to maintain a healthy attitude vis-à-vis other regional actors. While BRI enhances the economic and political intimacy of Pakistan and China, the latter has also to consider the surrounding countries for ensuring stability in the region.

Evidently, managing ties with India, for example, remains critical in averting the history of conflicts from rearing its ugly head again. Therefore, Turkish involvement is definitely needed in finding political solutions, fostering trustful relations and achieving gradual cooperation in the region. Also, aligning interests with Afghanistan is equally important as well in this regard because of NATO'S and other countries' pursuit to curb problems like terrorism and instill growth.

Pakistan is also making its efforts to develop relations with the other member states through participating in these sessions of the Shanghai Cooperation Organization (SCO) or South Asian Association for Regional Cooperation (SAARC), for instance. While emphasizing on working together on indigent individuals, it is likely that Pakistan can improve relations with in the region countries including Russia and Iran too. (Afzaal, M. A Corpus-Based Analysis of Discourses on the Belt and Road Initiative)

One should not only focus on Pakistan's shifting hither and thither towards China. The United States and other Western states have enjoyed leverage over Pakistan and its foreign relations for quite some time, causing much instability

and volatility.

To the contrary, there is a need for Pakistan to adopt and practice a balanced and proportionate diplomacy with the countries of the region. Activation of this policy of development will help expand the range of opportunities available in Pakistan for investment and trade.

### **Impact on Regional Stability and Security Dynamics due to Belt and Road Initiative (BRI) in Pakistan**

The Belt and Road Initiative (BRI) raises regional stability and security concerns in South Asia with Pakistan being at the center of changes occurring within the region. The China-Pakistan Economic Corridor is one of the flagship projects under the BRI that influences the region in a number of ways.

In the positive context, the CPEC enhances the connectivity between Pakistan and the outside world promoting economic growth and trade... Furthermore, the rising economic integration between Pakistan and China & the region would ease the harbored animosities because of all the common business dealings. Further, the upgraded systems like transport Eric and others will help in the enhancement of order and cooperation in the region.

the factors that will affect the development of the China Pakistan Economic Corridor cites the complex relationships among countries in the vicinity of the project, and inwards focusing on the regional aspects of the matter, hindrance to the expansion of CPEC from regional geographies to peripheral memories. However, increasing power struggle among these nations has made the existing security machismo even more sophisticated than it used to be.

A few geographical constraints hamper CPEC, like Pakistan's ponderous economic alliance with the Chinese and restricting trade with the US. Now which nation would not like such a breakaway region of an adversary to fragment?

Some of the authorities might link the relative peace that existed in CPEC development to the stability of global jihadists, as opposed to the dynamics of political religious conflict in Pakistan. All these, without deducing from it the perspective states, tend to generate resistance, leading to political unresponsiveness.

Hypothetically speaking, the issue of stability of consistently gaining integration could be omitted in the CPEC resolution analysis since its impact would last only a single lifespan or its duration was irrelevant like today.

However, external threats pose marketplaces as fractious in-cial centers as were adventured or caused by operatives on themselves.

It can thus provide economic opportunities to Pakistan and the region with all its complexities in regional stability and security dynamics, which things let us see in detail. Balancing, therefore, the ambitions and desires of three big countries that want, in varying shades, to enjoy hegemony over South Asia -- India because of size and population (and almost certainly expansion in both); China because of its increasing global prowess; the US because it so often calls itself great again -- will require deft diplomacy or explicit recognition by all parties that ensuring economic development leads to long-term stability in South Asia is a mutual interest.

## **Outlook and Emerging Opportunities**

### **Potential Long-Term Benefits for Pakistan from the Belt and Road Initiative (BRI)**

THE Belt and Road Initiative (BRI) offers a plethora of long term economic, strategic and development advantages for Pakistan. The long lasting benefit will include the changes in the Pakistani infrastructure with projects like CPEC (China-Pakistan Economic corridor.) However, the improved transport networks, energy infrastructure and the development of the Gwadar Port would also add greatly to connectivity promoting economic growth and trade.

This is a principal advantage in the long run, which stems from economic diversification. The BRI promotes the development of Special Economic Zones (SEZs) on the CPEC axis by creating healthy competition between outside and inside investors. This diversification not only has the effect of aiding in the reorganization of national stock, but also helps to reduce strong dependency on traditional sectors which have made it difficult for macroeconomic management capable of extreme adaptability to be put in place.

The other major benefit of energy security. Under CPEC, there are several projects aimed at addressing Pakistan's energy deficiencies by building power plants and establishing associated infrastructure. The long-term outcome is a resilient and self-sustaining energy industry that powers industrialization and reduces dependency on imports.

The upshots are as diversionary a BRI to impact regional integration making Pakistan an imperative part of South Asia's economy. Higher connectivity will not only provide easier access to China for trade, but it also has opened other

new markets and trade routes. This integration is essential for the healthy growth of Pakistan's economy. (Muhammad, A., Mike, M. E. E., Idris, M. B., Ishaq, A. A., & Abdullah, A. K. (2023).

In addition, BRI is collaborative and enables people to connect with one another. This requires human capital that education exchanges, culture interaction and technology cooperation can develop innovation and share knowledge. This not only benefits

But the realization of these benefits requires an active and strategic response to mitigate potential problems over the long term, such as debt sustainability, environment and geopolitics. BRI can help Pakistan achieve a leapfrog development and reach the next level of prosperity only if the tangible benefits generated from this vast infrastructure project are appropriately harnessed and managed over the years to come.

### **Areas for improvement and collaboration**

In addition to the many advantages that the BRI has promised for Pakistan, there are also further issues that can be explored for improvements and enhanced cooperation – the resolution of which would not only enrich BRI projects such as the CPEC but also contribute to the sustainability of that initiative.

Here is one vital aspect: Enhancing transparency on the details of the project, financing terms and decisions making, and also improving communications between all stakeholders of the extractive project on a regular and open-ended way will increase portray of trust by the public.

Environmental sustainability is the key focus at this stage. Eco-friendly practices must be the key priority in the interactions between China and Pakistan, with particular emphasis on ensuring that development projects are carried out to prescribed environmental standards. These include efforts toward marshalling against deforestation, protecting biodiversity, and bridging the ecological footprint of infrastructure development.

In addition, cooperation in skill development and technology transfer needs to be enhanced. Through the establishment of training and education programs, the two countries can help local populations prepare themselves for active contributions to projects and their benefits while the technology transfer programs can build industries in Pakistan and enhance their self-sufficiency.

Debt sustainability is a persistent concern that requires careful management.

Collaborative efforts should focus on optimizing financing structures, negotiating favorable terms, and diversifying funding sources to mitigate the risk of overreliance on debt.

Additionally, fostering regional collaboration is essential for maximizing the benefits of BRI. Pakistan can work closely with neighboring countries to develop integrated infrastructure networks, harmonize trade policies, and enhance regional stability.

In conclusion, improving transparency, prioritizing environmental sustainability, investing in skill development, managing debt prudently, and fostering regional collaboration are crucial areas for both China and Pakistan to focus on. By addressing these aspects, the Belt and Road Initiative can evolve into a model of sustainable and inclusive development, fostering mutual benefits for all stakeholders involved.

## **Conclusion**

The Belt and Road Initiative (BRI), with a prime focus on the China-Pakistan Economic Corridor (CPEC), has come out as a transformative force toward forging Pakistan's economic, strategic, and social landscape. Economically, the BRI has stimulated immense infrastructure development, largely through CPEC, on account of improved connectivity, enhanced conveyance networks, and establishment of SEZs. Such developments have provoked economic growth, attracted foreign investments, and given further pace to industrialization and diversification.

Strategically, Pakistan's geopolitical significance has been boosted by its participation in BRICS. As an economic corridor, CPEC serves to further regional integration, placing Pakistan among the leading players in the South Asia economic theatre. Besides, the increasing diplomatic ties with China will give more substance to Pakistan's leverage at the international forum, providing for institutional partnerships and collaborations.

Socially and culturally, the BRI has created robust interactions between Chinese and Pakistani communities. This exchange impacts language learning, influence culinary practices, and share common celebrations, thus cultivating a multicultural milieu. Nonetheless, this integration has added its toll on behalf of the constraints it places on local identity and, consequently, national harmony.

Nonetheless, with these multiplicities, evident are the challenges, and some areas for improvement have unveiled. Transparency of information is central

in project details and (or) decision-making processes thereby engendering public confidence. Environmental sustainability must be secured with joint efforts to ensure that all BRI projects are compliant with environmental norms. Debt sustainability concerns necessitate effective financial accountability. International cooperation is important since it is essential in giving solutions toward challenges and sharing expertise.

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## **Exploring the Impact of the Belt and Road Initiative on Sustainable Energy Cooperation in Pakistan**

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### **Abstract**

Pakistan and China have had historical relations since 1948; these relations are long-standing, and strong ties are maintained in different sectors. In 2014, China launched the Belt and Road Initiative, marking a significant step in China's efforts to strengthen global economic links, with a key focus on energy. Through the China-Pakistan Economic Corridor (CPEC), China invested heavily in Pakistan's energy sector, aiming to alleviate the country's decades-long energy crisis. In 2021, President Xi Jinping, alongside the UN Secretary-General, pledged to shift investment away from fossil fuels towards renewable energy, reflecting China's commitment to climate change. This chapter examines China's green energy investments in Pakistan, assessing both their successes and challenges. It explores and analyses how BRI has influenced the development of sustainable energy in Pakistan while addressing the geo-economic and geopolitical complexities the country faces. Through this chapter, we explore the importance of green energy in Pakistan and how this green energy helps to control climate change.

**Keywords:** Belt and Road Initiative, Green Energy, Infrastructure Construction, Transportation, Geopolitics

## **Background of the Study**

'Silk Road Economic Belt' was first announced in the capital city of Kazakhstan, Astana, in September 2013, leading to the next step of the '21st Century Maritime Silk Road' in the capital city of Indonesia, Jakarta, in the following month. Then, it began to be widely known as the 'One Belt, One Road Initiative' (Bhoothalingam, 2015). Under this background, domestically and internationally, it has been officially addressed as the 'Belt and Road Initiative' (BRI).

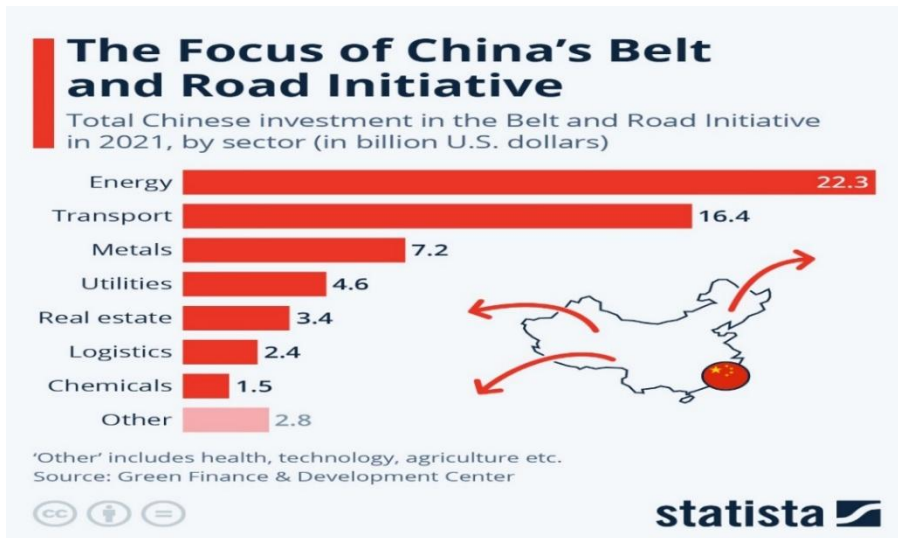
This ambitious project has attracted worldwide attention, interest, support, and growing concerns for a decade. The multi-trillion-dollar plan for this new effort was first presented in the speech of the Chinese top leader titled 'Promote People-to-People Friendship and Create a Better Future'. It originated from the conception of the renowned Silk Roads and their fabled legacy of religious, political, social, and cognitive interactions between China and the world. Furthermore, this historical framework was founded upon other domains such as trade, business, and amicable interactions among diverse populations from China, South Asia, Central Asia, Africa, and Europe. Therefore, in essence, it is asserted to be a novel trans-regional cooperation framework for mutually beneficial collaboration, aiming at promoting peace and development among its member states in the world. For instance, it can enhance connectivity in a pragmatic context by substantially investing in constructing railway systems, ports, airport networks, maritime, energy, communication, and internet infrastructures.

The BRI is an extensive undertaking to construct infrastructure and promote economic growth, spearheaded by China. The objective is to improve connections and foster economic collaboration across regions encompassing Asia, Europe, Africa, and beyond. As a result, China has made substantial investments in the infrastructure and energy sectors of the member states included in the BRI. Below are several crucial elements of BRI investments in the energy industry. Regarding Energy sectors, the BRI investments in the energy sector primarily focus on developing energy infrastructure, including power plants, transmission lines, pipelines, and ports. These multi-projects aim to improve the energy supply and distribution networks, improve energy deficits, and support economic growth in participating countries.

For instance, the Renewable Energy Project is classified as a part of its commitment to sustainable development. China has emphasized on its investments in renewable energy projects within the BRI framework. These projects include solar farms, wind farms, hydroelectric power plants, and other

clean energy initiatives. Based on the above, China's expertise in renewable energy technologies and its investments in these projects are expected to contribute to the global transition towards a green and low-carbon economy on a global scale.

Figure 3: Chinese investment in BRI in 2021 by sector (in billion U.S dollars)



Source: Statista official website, [statista.com](https://www.statista.com)

Likewise, energy trade and cooperation are also essential sectors. The BRI aims to promote energy trade and cooperation among participating countries. Its investments in energy infrastructure are to facilitate cross-border energy flows by enabling countries to access and share energy resources. This includes building multiple projects of building pipelines, establishing energy corridors, and stabilizing and reducing energy trade to enhance both trans-regional cooperation and energy security.

### The BRI's Infrastructure and Energy Cooperation

Infrastructure development is a critical focal point of the Belt and Road Initiative. The primary objective of the BRI is to bolster connectivity and foster economic collaboration through the investment and development package, which would develop important infrastructure facilities for the host countries. These infrastructure initiatives encompass various industries, such as transportation, energy, and telecommunications. Among them, the BRI

heavily relies on the transportation infrastructure sector. The sector of projects prioritizes constructing and enhancing roads, trains, ports, and airports (Xunpeng & Yao, 2019). This entails the creation of brand-new transportation routes, upgrading current transportation networks, and improving border crossings.

The objective is to streamline the flow of commodities and individuals, improve interconnectivity, decrease transportation expenses, and foster trade and economic cooperation among the BRI member states. In this context, developing energy infrastructure is also a significant part of Belt and Road Initiative projects. Hence, this initiative includes promoting investments in energy facilities, including power plants, transmission lines, pipelines, and so on. Also, specifically, this encompasses advancing sustainable energy facilities and their networks, such as solar systems (so-called photovoltaic power generation facilities) and wind power. Quite obviously, this can be understood as a new energy-relevant business model in addition to establishing oil and gas pipelines to guarantee energy security in terms of better interconnectedness between China and its BRI host countries. These projects aim to bolster the advancement of sustainable energy, encourage the exchange of resources, and streamline energy commerce (QinggeGeng, 40-49).

As is widely known, in addition to infrastructure cooperation, Energy cooperation between China and the host nations is vital to the Belt and Road Initiative. Sometimes, the primary objective of the BRI can be said to foster cooperation in several energy domains, which range from encompassing oil, gas, and electricity to adopting renewable green energy sources, and energy sources, and systems. This can lead to generating reciprocal advantages for China and other member states of the BRI. Therefore, despite 'Debt Trap Diplomacy' type controversy, it is becoming obvious that this collaboration can enhance energy security, foster sustainable development, and promote economic progress, especially for the less-developed host countries of the BRI. However, one crucial aspect of energy collaboration under the Belt and Road Initiative is that it has been known to facilitate and stabilize the constant flow of oil and gas commerce, mainly from the host countries to China. As the most significant energy consumer in the world, China aims to diversify its global supply of energy sources to guarantee a consistent inflow of oil and gas.

In this context, by forming trans-regional alliances with host nations along the Belt and Road Initiative lines, China can secure entry to untapped energy sources and build intra-regional trading routes for energy; this logic is based on guaranteeing a reliable energy supply. For example, On the other hand, host

countries benefit from the new influx of enhanced investment, technological dissemination, and expanded market entry for their oil and gas reserves. Simultaneously, the Belt and Road Initiative emphasizes fostering collaboration in the renewable green energy sector. China has become a prominent global front-runner in the mass production and operational technology of renewable green energy, such as solar systems and wind power (Medinilla, Sergejeff, & Domingo, 2022).

### **The BRI's Green Energy Infrastructure Cooperation**

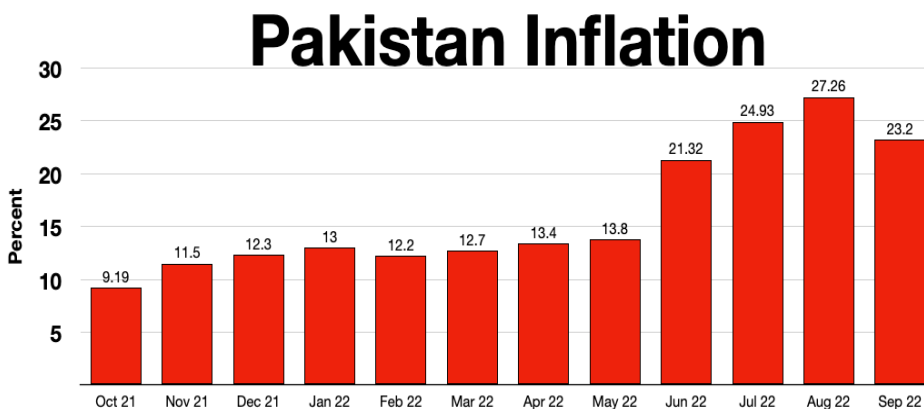
The Belt and Road Initiative has substantial prospects for underdeveloped host nations by implementing eco-friendly energy infrastructure projects. And this can have favorable economic impacts for them. For example, within the Belt and Road Initiative framework, China is known to support advancing renewable energy adaptations or sometimes transformation in these economically less-developed host nations. Hence, this can bring out some positive economic effects of aiding the shift of less developed partner countries towards cleaner and more sustainable energy sources (and systems). This collaboration entails the establishment of solar and wind farms, along with the exchange of renewable energy technologies.

One significant advantage of green energy infrastructure projects is the potential for new job opportunities for local communities of host countries. The construction and operation of renewable energy facilities require an effective workforce, providing employment opportunities for local communities. This can help alleviate unemployment and stimulate local economies. Moreover, the renewable energy sector often involves technology-intensive operations, which require skilled workers and promote knowledge transfer, contributing to regional human capital development. Green energy infrastructure projects can attract investment and stimulate economic growth. Substantial financial resources are necessary to establish renewable energy facilities, as they require significant capital investment. However, this investment can attract foreign direct investment (FDI) and promote economic activity. The construction phase of these projects entails the acquisition of equipment and materials, which stimulates the demand for local suppliers and enhances industrial production (Ross & Neil , 2022). Moreover, the functioning of renewable energy facilities not only creates income through the sale of energy but also has the potential to improve the host country's economy by increasing its energy exports.

Moreover, these projects contribute to enhancing energy security and achieving cost reductions. Host countries can bolster their energy security by

diversifying their energy sources and diminishing reliance on fossil fuels. Renewable energy projects offer a consistent and dependable source, reducing susceptibility to price volatility in global energy markets. The region's stability has the potential to attract further investment and cultivate a conducive business environment, thereby stimulating economic growth outside the energy industry.

Figure 4: Inflation in Pakistan after regime change.



Source: State Bank of Pakistan

## Pakistan's Comprehensive Geostrategic Cooperation with China

### Geostrategy-oriented Projects of the BRI

Under the geopolitical background of geoeconomic fragmentation on a global scale, the China-Pakistan Economic Corridor (CPEC) is a major component of the Belt and Road Initiative (BRI) in Pakistan. It encompasses a range of projects aimed at improving connectivity, infrastructure development, and economic cooperation between China and Pakistan (Fazal, Khan, & Ali, 2023). Here are some key projects under the CPEC.

### Gwadar Port

Gwadar Port, situated in southwestern Pakistan, is a deep-sea port that holds great strategic importance within the framework of the China-Pakistan Economic Corridor (CPEC). Gwadar is the endpoint of China Pakistan Economic corridor. It is being transformed into a major trade hub through extensive expansion and development initiatives. Gwadar Port's development includes berths, terminals, warehouses, and other support facilities, forming a

key component of Pakistan's maritime infrastructure. Strategically located on the Arabian Sea, the port offers China an alternative trade route that bypasses the congested Strait of Malacca—a critical maritime chokepoint between Malaysia and Indonesia (Ali, Shah, Rizwan, & Ali, 2019). This shift helps China diversify its trade routes and reduce strategic vulnerabilities. The port is being expanded to handle larger ships and increased cargo, enabling more efficient goods movement. As a result, Gwadar is poised to become a regional hub for shipping and transshipment, enhancing economic activity both within Pakistan and across the region. Its proximity to major energy resources and trade routes adds to its appeal. Additionally, Gwadar's development supports Pakistan's broader goals of improving maritime connectivity, attracting investment, generating employment, and strengthening its position in regional and global trade networks. (Kanwal, 2018).

### **Diamer Basha Dam**

Diamer Basha Dam is in Gilgit, Gilgit-Baltistan region. This dam is one of the main important projects of China China-Pakistan Economic Corridor. Located on the Indus River, the dam is designed to generate 4,500 megawatts of electricity, significantly addressing Pakistan's persistent energy shortages. Beyond power generation, the dam will contribute to flood control, improve water storage capacity, and support agricultural development. With China providing both financial investment and technical expertise, the project exemplifies the deepening of bilateral ties through strategic infrastructure development. It also aligns with broader goals of promoting sustainable economic growth and enhancing regional connectivity between China and Pakistan.

### **Green Energy-oriented Projects of the BRI**

The distribution of energy investments within the context of the China-Pakistan Economic Corridor reveals a notable reliance on coal projects, which comprise 66.7% of the overall investment. Just 3.04% of the funding goes to wind and solar projects separately, compared to 27% for hydroelectric developments. The need for further emphasis on investments in renewable energy sources, such as solar and wind, is highlighted by this distribution. The data shows that in 2015, renewable energy (other than hydro) accounted for only 0.33% of overall energy generation or 0.133% of the nation's electrical demand. Projections show that by 2035, the CPEC will account for 0.42% more electricity generated overall—that is, electricity generated from renewable sources like solar and wind—than hydropower. When hydroelectric power is considered, the overall contribution of all electricity

generation's renewable energy is predicted to reach 32.7% (Duan, Khurshid, Nazir, & Calin, 2022).

China is aggressively supporting the growth of the green energy industry and resolving Pakistan's energy crisis. China's investments in wind, solar, and hydro projects will help Pakistan's renewable energy ambitions through the China-Pakistan Economic Corridor. These investments support the annual investment possibilities that can assist in reaching the 25,206 MW policy targets, representing 56.1% of the world's total energy production. Completing ongoing projects increases output from renewable sources, which is considered when projecting future investments. China's current energy projects are anticipated to be finished by 2026. Pakistan's renewable energy policy ambitions would require China to increase production by 5.3% yearly. However, China must boost green output by 13% annually to transition from black (conventional) to green energy. Pakistan's wind, hydro, and solar energy industries can meet the country's future energy needs on their own and aid in the overall switch from fossil fuels to renewable energy. Pakistan can significantly advance its renewable energy aspirations by utilizing China's funding and experience in these fields.

China helps Pakistan build renewable energy projects as part of the China-Pakistan Economic Corridor. Numerous solar and wind projects, such as the Quaid-e-Azam Solar Park, Hydro China, Dawood, and UEP Wind Farm, have been supported by CPEC. Additionally, the Kohala Hydel Project, Suki Kinari Hydropower Station, and Karot Hydropower Station are just a few of the projects that have benefited from CPEC. These programs demonstrate China and Pakistan's cooperative efforts to advance renewable energy sources and lessen reliance on conventional energy (Duan, Khurshid, Nazir, Khan, & Cantemir Calin, From gray to green: Energy crises and the role of CPEC, 2022). Pakistan is moving in the right direction toward a more sustainable and environmentally friendly energy sector with China's help.

Table 1: Completed green energy projects in Pakistan

1	1000MW Quaid-e-Azam Solar Park (Bahawalpur)
2	50 MW Hydro China Dawood Wind Farm, Gharo, Thatta
3	100MW UEP Wind Farm, Jhimpir, Thatta
4	50MW Sachal Wind Farm, Jhimpir, Thatta
5	100MW Three Gorges Second and Third Wind Power Project
6	Matiari to Lahore $\pm$ 660 KV HVDC Transmission Line Project
7	720MW Karot Hydropower Project, AJK/Punjab

Table 2: Under Construction green energy projects in Pakistan

8	884MW Suki Kinari Hydropower Project, KP
9	1124MW Kohala Hydropower Project, AJK
10	700.7MW Azad Pattan Hydropower Project, AJK/Punjab
11	50MW Cacho Wind Power Project
12	50MW Western Energy (Pvt.) Ltd. Wind Power Project

Source: Pakistan water and power development authority

## **BRI Green energy projects in Pakistan through**

### **Sustainable Development Cooperation of the BRI**

Under the geopolitical background of fragmented geo-economics on a global scale, the dual cooperation concepts in the context of the China-Pakistan Economic Corridor, an essential part of the Belt and Road Initiative, include geostrategic and green energy objectives. CPEC aims to improve connectivity and collaboration between China and Pakistan from a geostrategic standpoint. The project involves building ports, railway lines, and other transport infrastructure that links the two countries and boosts trade and economic cooperation. The development has increased diplomatic relations between China and Pakistan, they also support South Asian regional stability. Through the Belt and Road initiative, China is increasing its regional influence, especially South Asian region. Furthermore, the CPEC highlights the importance of green energy and related economic opportunities. It includes the major investment in the green energy sector, solar, Wind, and hydro projects. Through the CPEC, in Gilgit region has a working Hydro project. These projects will fulfil Pakistan's energy requirement and less dependence on Fossil Fuels (Kukreja, 2020).

In 2021, China and the United Nations agreed to work together on controlling climate change. The Chinese government decided that the Green Energy Project would fulfill its promise to control climate change and protect the environment. Through the support of the Green energy project infrastructure, the initiative plays a key role in helping Pakistan shift toward a low-carbon economy. CPEC combines strategic goals with sustainable development by promoting cooperation that balances geopolitical interests with environmental responsibility (Asim, et al., 2022). The full approach is not only strong economic relations with China but also highlights green energy and eco-friendly practices. Major investments in solar, wind, and hydropower aim to meet Pakistan's growing energy needs while decreasing its reliance on fossil

fuels. This strategy fosters mutual benefits in trade, infrastructure development, and green technology, aligning with China's broader climate commitments. The key benefits of green energy under the project of BRI are supporting Pakistan to lower greenhouse gas emissions and adopt a more sustainable energy mix. Chinese green energy also contributes to controlling climate change. Pakistan has more than 40 glaciers are effect due to climate change ( Li, Xu, Hui, Cai, & Zhang, 2022). These green energy efforts also contribute to climate change mitigation. By amalgamating geopolitical interests with environmental responsibility, the initiative also strengthens both country relations and increases regional stability. It opens opportunities for Pakistan to modernize its energy sector and integrate more deeply into global markets. Finally, the China-Pakistan economic corridor (green energy project) is contributing to controlling global climate and supporting sustainable development through economic cooperation and environmentally responsible growth (Geng, 2021).

### **The BRI's Shift to a 'Greener Energy Portfolio'**

### **The BRI and 'Semi-Containment' against Pakistan**

#### **Baluchistan Issue**

The Baluchistan region is rich in natural resources, but this region has been in unrest for more than 30 years. This unrest in Baluchistan is hosting many projects of the China-Pakistan economic corridor, such as Gwadar Port, which poses a significant obstacle to successfully implementing the CPEC. The local population in Baluchistan harbours deep-seated grievances regarding limited political and economic opportunities, coupled with concerns about potential demographic shifts that could marginalize native Baloch people. Resolving these grievances and fears is crucial to ensure a conducive environment for CPEC initiatives. Addressing the socio-economic disparities, promoting inclusive development policies, and actively involving the Baloch community in decision-making processes are essential steps to alleviate tensions and foster cooperation in Baluchistan (Ali M. , 2020). The CPEC is portrayed by Baloch rebels as an act of enslavement by the centre to take advantage of the local resources. Baloch terrorists are taking advantage of this circumstance with help from abroad and have advised China to "stay away from Gwadar". Baloch insurgent groups have frequently targeted gas pipelines and trains to discourage non-local investors, specifically Chinese developers. In April 2015, militants from Baluchistan killed around 20 labourers from outside the region in the small village of Turbat. This incident occurred just a week before the Chinese president visited Pakistan. According to media sources, there is

evidence that international intelligence organizations are collaborating with rebel groups to sabotage the project.

On August 13, an unknown extremist organization initiated an attack on a group of Chinese engineers traveling in a convoy in Baluchistan Province, located in the south-western area of Pakistan. Sarfaraz Ahmed Bugti, a former Baluchistan interior minister and senator, utilized the social networking platform X (formerly known as Twitter) to affirm that there were no casualties among Chinese citizens in the attack. The BLA asserted accountability for a 2020 assault on the Pakistan Stock Exchange, claiming their resistance to what they regarded as "Chinese exploitative plans" in Baluchistan. The CPEC part of the BRI project highlights China's significant engagement with Pakistan. This involvement connects China's Xinjiang Province with the strategically important Gwadar Port.

### **Indian Side for CPEC**

India perceives the CPEC as an obstacle to its overarching objective of exerting influence over South Asia, and any progress that enhances Pakistan's economic situation is unwelcome. Iran sees Gwadar as a competitor to Chabahar Port and as a promising trade route; it is establishing relations with India to access Afghanistan, which is not accessible by sea due to its landlocked nature, unlike Pakistan's other neighbouring countries. The trade connections provided by CPEC can help Afghanistan, and the route to Gwadar is more expedient and profitable than the one from Chabahar. However, since both countries' independence in 1947, India has fostered a hostile Afghanistan on Pakistan's western flank, which has contributed to a problematic relationship between Afghanistan and Pakistan. These issues are mainly of Afghanistan's creation. The current fallout from Afghanistan and India's different levels of hostility is that India has been charged with attempting to destabilize Pakistan (Ali, Shah, Rizwan, & Ali, 2019).

These purported activities involve rebels fighting the government in the province of Baluchistan as well as the training, equipping, funding, and sending of terrorists to areas that were once Taliban strongholds in Pakistan. There have been allegations that Afghanistan provides India with support in carrying out these operations through its intelligence organization, the National Directorate of Security (NDS). The campaign's primary objective is to subvert the established legal system, with one of its aims being to instill fear and apprehension among Chinese individuals engaged in projects such as the CPEC and other ventures in Pakistan. After being apprehended in Pakistan, Kulbhushan Jadhav, an active Indian Naval Commander working undercover

in Chabahar for the Indian intelligence agency RAW, confessed and provided information regarding his participation in a broader Indian operation to supply weapons, provide financial support, and give instructions to terrorists in Baluchistan. The objective of this operation was to create instability in Pakistan as a whole and hinder the CPEC.

## **Energy Sector Cooperation**

Through the CPEC project, China is highly invested in Pakistan. The energy project China has invested in includes different renewable energy sources, hydroelectric power, solar energy. Pakistan will reduce its dependence on Coal and Fossil fuel energy and enhance its energy security. Pakistan has a gap between supply and demand in the energy sector. This BRI project will reduce this gap, and Pakistan will also be less dependent on non-renewable energy. Pakistan wants to maintain economic growth and industrial expansion by building new power plants and renewable energy initiatives. In addition to helping the nation fulfill its energy demands, these initiatives promote industry growth, job development, and a better investment climate (Asim, et al., 2022). The renewable energy sources will reduce carbon emissions, addressing environmental challenges, and transitioning toward cleaner, more sustainable energy solutions.

BRI is focusing on the transmission lines and energy infrastructure. These upgrades are essential for minimizing transmission losses, enabling cross-border energy trade, and ensuring efficient and reliable power distribution. Strengthening this infrastructure offers multiple benefits. Consistent energy delivery supports the smooth operation of businesses and industries by ensuring consistent access to electricity with minimal losses. This dependable power supply attracts investment, stimulates economic growth, and fosters industrial development. Furthermore, the enhancement of infrastructure reduces transmission losses and upgrades the total competence of the energy system. According to Jafri 2021, this leads to cost savings and promotes a more sustainable and responsible use of resources (Jafri, et al., 2021). Finally, enhanced grid connectivity facilitates the transfer of surplus energy between countries, advancing regional energy integration. The interconnection not only enhances investment opportunities in Pakistan but also increases the strength of energy security and builds new opportunities.

The BRI activity support to address the environmental challenges and combat of climate change (Xunpeng & Yao, 2019). Pakistan, with its significant potential for solar, wind, and hydropower, stands to benefit greatly from BRI-backed investments in renewable energy projects. The Green energy reduce

dependence of Non-renewable energy resources. Transitioning to renewable energy offers several key advantages for Pakistan, which in turn enhances energy security by minimizing the risks associated with fuel supply disruptions and price volatility (QinggeGeng, 40-49). Pakistan is facing many challenges due to climate change. In the northern area of Pakistan glaciers are melting rapidly. This green energy will help to control carbon emissions. Aligning Pakistan with global climate change mitigation efforts. The adoption of greener energy sources also contributes to reducing air pollution and improving the country's environmental sustainability (Sadiqa, Gulagi, & Breyer, 2018). Finally. The project will help to increase economic growth and create job opportunities. This project also helps to attract international investors to invest in Pakistan's green energy project.

### **The BRI's Greener Energy Cooperation for Pakistan**

The Belt and Road Initiative (BRI) presents a significant opportunity for Pakistan to embrace green energy and transition towards a more sustainable and low-carbon future. The BRI's focus on green energy for Pakistan is driven by the shared goal of addressing environmental challenges, reducing carbon emissions, and promoting renewable energy sources. With an expanding population and growing energy demand, Pakistan faces the dual challenges of meeting its energy needs while also tackling the adverse impacts of climate change. The BRI offers a platform for collaboration and investment in green energy projects, enabling Pakistan to capitalize on its immense renewable energy potential and drive sustainable development.

One of the key aspects of the BRI's green energy focus for Pakistan is the development of renewable energy projects. Pakistan has abundant solar, wind, and hydroelectric resources, making it well-suited for harnessing renewable energy. The BRI encourages investments in solar and wind power projects, which can provide clean and sustainable energy for the country. Solar energy projects, such as the Quaid-e-Azam Solar Park in Punjab and the Sachal Wind Power Project in Sindh, have already been established with Chinese investment and expertise. These projects contribute to reducing Pakistan's reliance on fossil fuels, lowering carbon emissions, and improving air quality (Zafar, Rashid, Khosa, M. Shahid Khalil, & Rashid, 2018).

In addition to solar and wind power, the BRI supports the development of hydroelectric projects in Pakistan. The country has a significant hydroelectric potential, with rivers like the Indus, Jhelum, and Chenab offering favourable conditions for hydropower generation. The BRI provides opportunities for investments in large-scale hydroelectric projects, such as the Diamer-Bhasha

Dam and the Dasu Hydropower Project. These projects not only contribute to Pakistan's energy security but also help mitigate the impacts of climate change by providing clean and renewable energy. Furthermore, the development of hydroelectric projects supports water management and irrigation systems, benefiting agriculture and promoting sustainable water resource utilization.

The BRI's green energy focus for Pakistan extends beyond power generation to include energy efficiency and conservation measures. Energy efficiency initiatives promote the optimal use of energy resources and reduce wastage. The BRI encourages investments in energy-efficient technologies and practices, such as smart grids, energy-efficient buildings, and industrial processes (Duan, Khurshid, Nazir, Khan, & Cantemir Calin, 2022). These measures help in reducing energy consumption, improving energy productivity, and lowering greenhouse gas emissions. The BRI also supports the adoption of energy conservation practices, raising awareness about the importance of responsible energy use and promoting behavioural changes towards more sustainable lifestyles.

The Belt and Road project focuses on developing infrastructure for clean transportation. Through this clean transportation, international and local investors have provided the opportunity to invest in electric vehicles and associated charging ports. The transportation sector is a significant contributor to carbon emissions and air pollution. By promoting the adoption of EVs and investing in charging stations, the BRI helps reduce the reliance on fossil fuel-based transportation and supports the transition towards cleaner and greener mobility options. This not only contributes to reducing carbon emissions but also addresses the issue of air pollution, improving public health and quality of life (Khurshid, Duan, Nazir, & Calin, 2022).

Under the shadow of BRI, China and Pakistan have signed 21 energy projects. Seven projects are already completed, and fourteen projects are under construction. The details of the projects already mentioned are in the above table. The success of these projects has been essential in resolving Pakistan's energy issue. The concentration on wind and solar energy projects has been perfect for Pakistan's ecology. Since the nation is already experiencing the effects of climate change, developing renewable energy sources has helped lower greenhouse gas emissions and lessen reliance on fossil fuels.

## **Conclusion**

It concentrates on the second case study of Pakistan's green energy cooperation with China. Here, it begins by providing background knowledge about Pakistan in relation to its disadvantageous geopolitical position within

the 21<sup>st</sup> century Capitalist World-Economy. This part is important for understanding Pakistan's geopolitical challenges and geo-economics opportunities in the context of the Belt and Road Initiative of China. Then, concerning this South Asian country Pakistan, we delve into the global, regional, and domestic situations of Pakistan with regard to the geo-economics fragmentation of the international community on macro-level and Pakistan's comprehensive geostrategic cooperation with China on micro-level.

In this contextual background, from the perspective of bilateral comprehensive geostrategic cooperation, we continue to analyse how the BRI can be engaged with Pakistan trans-regionally and how this can advance Pakistan's domestic economy and sustainable development in the South Asia. More specifically, in terms of Pakistan's comprehensive geostrategic cooperation with China, it can be divided into three independent-but-correlated sectors as follow:

- ① Geostrategic-oriented projects of the BRI;
- ② Green energy-oriented projects of the BRI;
- ③ Sustainable development cooperation of the BRI.

Then, it becomes obvious that the BRI can improve the backwardness of Pakistan's geostrategic-oriented socio-economic modernization by forging it more sustainable.

Against this backdrop of reality, before discussing the BRI's shift to a 'Greener Energy Portfolio', it should point out the negative impacts caused by the decades of 'semi-containment' against Pakistan. On the contrary, however, the BRI has been adopting the 'Win-Win' approach of green energy collaboration together with Pakistan on the trans-regional cooperation basis. Most importantly, buttressed by the mutual benefits and geostrategic cooperation between Pakistan and China, we find that the BRI is shifting gradually towards a 'Greener Energy Portfolio' for its comprehensive geostrategic cooperation with Pakistan in the South Asia.

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## **The repercussions of the Glacier Lake Outburst Floods on CEPC in Gilgit-Baltistan, Pakistan**

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### **Abstract**

The China-Pakistan Economic Corridor (CPEC) is a pivotal infrastructure and economic initiative that aims to substantially improve connectivity and regional development. Nonetheless, its execution across the glaciated and mountainous landscape of Gilgit-Baltistan (GB), Pakistan, renders it susceptible to significant environmental threats, especially Glacial Lake Outburst Floods (GLOFs). This chapter examines the escalating threat of Glacial Lake Outburst Floods (GLOFs), their origins, attributes, and significant ramifications for the sustainability of the CPEC. It provides comprehensive accounts of historical GLOF events, their effects on infrastructure and livelihoods, and the escalating risks associated with climate change-induced glacier melt. The study underscores GB's susceptibility owing to its high density of glaciers and glacial lakes, and delineates the potential economic, social, and geopolitical disturbances to CPEC if these risks are not addressed. This chapter highlights the necessity of early warning systems, resilient infrastructure, glacial monitoring, and international collaboration, drawing on global best practices in GLOF risk management, especially from

Bhutan and Switzerland. It culminates with strategic recommendations to enhance CPEC's resilience to future GLOF threats, thereby ensuring regional connectivity and sustainable development in the context of a changing climate.

**Keywords:** Glacial Lake Outburst Floods (GLOFs), Climate Change, Glacier Retreat, Early Warning Systems, Environmental Hazards, Sustainable Development

## **Background**

The economic benefits of CPEC are multifaceted, such as it addresses Pakistan's infrastructure gaps, which have long hindered economic development. It includes the construction of modern highways, railways, and energy infrastructure. A significant portion of the route also focuses on energy projects, including coal, hydro, solar, and wind power. These projects aim to alleviate Pakistan's chronic energy shortages. The development of CPEC projects generates employment opportunities, fostering economic growth and poverty reduction (Arshed et al., 2021). While CPEC offers numerous possibilities, it faces challenges and concerns, including security risks, debt sustainability, and environmental impacts. Balancing the potential benefits with these challenges is a complex task for China and Pakistan.

The project represents a transformative initiative that has the potential to reshape the economic dynamics of the region (Healey, 2004). Its significance extends beyond bilateral relations, encompassing regional and global economic integration. However, realizing its full potential requires addressing challenges and fostering stakeholder cooperation. M. Hussain and Jamali (2019) shared that CPEC is a testament to the evolving nature of international economic partnerships in the 21st century, where connectivity and infrastructure development are central in shaping geopolitical and economic landscapes.

However, the stream of projects in CPEC can be jeopardized if the natural disasters alongside this corridor are not mitigated. For example, Glacial Lake Outburst Floods (GLOFs) are sudden, often catastrophic, floods resulting from the rapid release of water stored in glacial lakes. These events typically occur when a natural dam, consisting of moraine (glacial debris) holding back the lake water, is breached or overtopped (Maskey et al., 2020). GLOFs are natural disasters with devastating potential, particularly in high-mountain regions like Gilgit-Baltistan (Shah et al., 2019). These are primarily triggered by several interrelated factors, such as Glacier melt due to rising temperatures, a consequence of climate change, lead to accelerated glacier melting (Sahade et al., 2015). An inflow of meltwater has the potential to inundate glacial

lakes, leading to heightened water volume and instability. Incidents like avalanches or landslides occurring within glacial lakes can result in the sudden displacement of a substantial amount of water, potentially triggering GLOFs (Glacial Lake Outburst Floods). Volcanic activity in certain regions can lead to the melting of glaciers, consequently causing GLOFs.

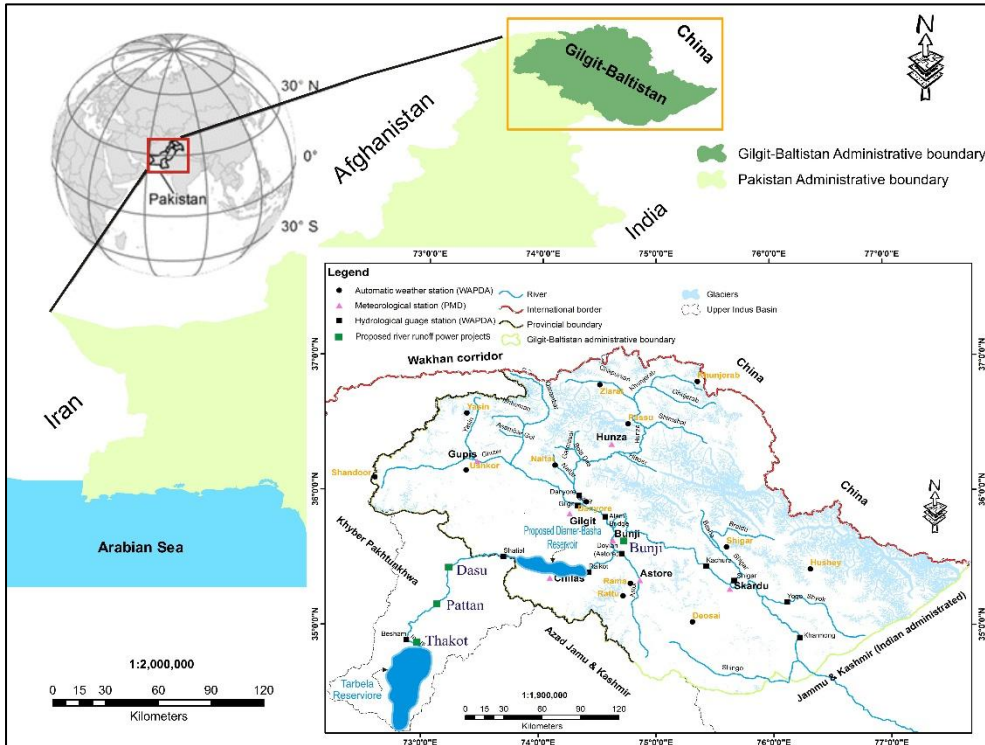


Figure 5. Map of Gilgit-Baltistan

According to several key features, GLOFs are characterized by *Sudden Onset*: GLOFs often occur with little warning, making early detection and evacuation challenging. *High Velocity*: These floods can move at astonishing speeds, carrying debris, rocks, and sediment, leading to significant erosional and destructive power. *Enormous Volumes*: GLOFs can release vast volumes of water, posing a substantial threat to downstream areas (Huggel et al., 2020). Gilgit-Baltistan (GB) is a mountainous region located in northern Pakistan (Figure 1), home to some of the world's highest peaks and largest glaciers, such as the Karakoram Range and Siachen Glacier, Baraldu, Biafo-Hisper, Batura, Chogolugma and many more glaciers (Qureshi et al., 2021). Geographically, It shares borders with China, Afghanistan, and Indian-administered Jammu and Kashmir (Maqpoon et al., 2013). Its geography makes it highly susceptible to GLOFs. The region has many glacial lakes, potentially hazardous due to their unstable moraine dams (Ashraf et al., 2012).

Climate change has amplified the risk of GLOFs in Gilgit-Baltistan due to rising temperatures, which have led to the rapid retreat of glaciers. As glaciers shrink, the volume of meltwater feeding into glacial lakes increases (Rehman, 2015). Due to these changes, the region has witnessed a heightened frequency of GLOF events.

Gilgit-Baltistan is home to numerous villages, towns, and crucial infrastructure, including parts of the China-Pakistan Economic Corridor (CPEC) and the Karakoram Highway (KKH) (Waheed et al., 2023). These settlements and infrastructure are often located in vulnerable downstream areas, making them susceptible to GLOF impact. GLOFs can have profound consequences for the people of Gilgit-Baltistan in terms of casualties, damage to homes, and destruction of agricultural land. Subsistence agriculture, a primary source of livelihood and critical infrastructure, including roads and bridges, can be washed away or severely damaged, hindering transportation and connectivity. In Gilgit-Baltistan, GLOFs are not just geological events but a matter of life, safety, and sustainable development. Understanding the causes and characteristics of GLOFs is crucial for assessing the risks they pose to this vulnerable region. Mitigation and adaptation strategies are essential to reduce the impact of these floods on the communities, infrastructure, and environment of Gilgit-Baltistan.

In light of the raised issues concerning environmental calamities, the primary purpose of this chapter is to establish the importance of GLOFs as a significant natural hazard in the Gilgit-Baltistan region. We will elucidate why GLOFs are relevant and highly interested in the context of China-Pakistan Economic Corridor (CPEC). It will explore how the vulnerability of CPEC to GLOFs can impact economic development, safety, and regional connectivity in the region.

### **Causes and Characteristics of GLOFs**

GLOFs, or Glacial Lake Outburst Floods, are sudden and often devastating



Figure 6. Impact of GLOF on livelihood (left Badswat, Ghizer and right Attaabad Hunza)

events when a glacial lake's dam or moraine (a mound or ridge of unsorted sediment deposited by a glacier) fails, releasing a large volume of water downstream. These events are typically associated with glaciers in mountainous regions and can have severe consequences for downstream mountain communities and ecosystems (Figure 2 & 3.) Here are some of the causes and characteristics of GLOFs:

***Causes of GLOFs are associated with Glacial Retreat:*** One of the primary causes of GLOFs is the retreat of glaciers due to climate change. As glaciers melt and recede, they leave behind depressions or basins that can fill with meltwater, rainwater, or a combination of both. ***Glacial Lake Formation:*** Meltwater from glaciers collects in these depressions, forming glacial lakes. The rapid accumulation of water can lead to the expansion of these lakes, which can pose a risk if the dam or natural barrier holding the water back is not stable. ***Mechanical and Thermal Erosion:*** Glacial ice can melt and erode the dam or moraine that holds back the lake, weakening its structural integrity. The combination of mechanical erosion (ice movement) and thermal erosion (melting due to temperature changes) can lead to dam failure. ***Earthquakes and Landslides:*** Seismic activity or landslides in mountainous regions are other factors that can trigger lake outburst floods by causing the dam or moraine to rupture or collapse. These events can also displace ice and debris into the lake, increasing the flood's destructive potential (Figure 3).



Figure 7. Impact of GLOF on CPEC (GLOF 2022 of Shishper, Hunza)

Glacier Lake outburst floods typically occur with little to no warning. The release of water from a glacial lake can be remarkably rapid, leading to a sudden surge of floodwater downstream (Wang & Zhou, 2017). It is characterized by high flow velocities due to the steep terrain of mountainous regions. The water can carry debris, rocks, and sediment, which increases the flood's destructive power. Church and Jakob (2020) state that the volume of water released during a GLOF can be enormous, ranging from thousands to

millions of cubic meters. This can result in widespread flooding in downstream areas (Church & Jakob, 2020). GLOFs often carry large amounts of debris and sediment eroded from the glacier, lakebed, and surrounding terrain. This sediment can further exacerbate the destructive impact of the flood. It can have catastrophic consequences for downstream communities, infrastructure, and ecosystems. They can lead to loss of life, damage to property, and disruption of critical infrastructure such as roads and bridges. The floodwaters from a GLOF can travel long distances downstream, affecting communities and ecosystems far from the source (Maurer et al., 2020). Climate change contributes to the increasing frequency and severity of GLOFs as glaciers retreat and glacial lakes expand. This makes GLOFs a critical issue to address in the context of climate change adaptation and mitigation. Efforts to mitigate the risks associated with GLOFs include monitoring and early warning systems, engineering interventions to stabilize glacial lake dams, and improved land-use planning in vulnerable areas. Understanding the causes and characteristics of GLOFs is crucial for reducing the potential impact of these hazardous events.

### Assessing the Risks and Challenges

Gilgit-Baltistan (GB) is a northern Pakistan region located in the northwestern part of the Indian subcontinent. It is a strategically important area known for its stunning landscapes, including rugged mountains, deep valleys, glaciers, and pristine lakes (S. Hussain, 2015). It shares borders with India-administered Jammu and Kashmir to the east, Afghanistan's Wakhan Corridor to the west, the Chinese region of Xinjiang to the north, and Pakistan's Khyber Pakhtunkhwa province to the south. The region is characterized by some of the world's highest mountain ranges, including the Karakoram Range, the western Himalayas, and the Hindu Kush (Padukone, 2014).



Figure 8. Mean Temperature and Precipitation trend of Gilgit-Baltistan (Source: Data source Pakistan Metrological Department (1984-2013))

Gilgit-Baltistan, a region nestled within the grandeur of the Karakoram Range in northern Pakistan, is renowned for its breathtaking prevalence of glaciers

and glacial lakes. GB has several of the world's highest peaks, including K2 (the second-highest peak on Earth), Gasherbrum I, and Broad Peak. The region is known for its numerous glaciers, including the Siachen Glacier, one of the world's longest glaciers crisscrossed by deep river valleys, with the Indus River being the most significant. The Hunza, Shyok, and Gilgit Rivers also flow through the region. This rugged terrain boasts thousands of glaciers, many of which are the most extensive in the world. These glaciers, formed over centuries, have carved the dramatic landscapes of steep peaks, deep valleys, and pristine lakes that define the region's natural beauty. However, the impact of climate change is significant as rising temperatures accelerate the retreat of these glaciers (Figure 4), contributing to the formation of glacial lakes, which leave behind depressions and basins filled with meltwater. While these lakes enhance the picturesque scenery, they also pose significant risks, as their natural or manufactured dams can fail, leading to catastrophic glacial lake outburst floods (GLOFs). Thus, the prevalence of glaciers and glacial lakes in Gilgit-Baltistan (Figure 5) is evidence of its awe-inspiring landscapes and a reminder of the delicate balance between nature's grandeur and the challenges a changing climate poses.

GB experiences diverse climates, from alpine and subarctic in the high mountains to arid and semi-arid in the valleys. Winters are cold and harsh, with heavy snowfall in the high-altitude areas. Summers are relatively milder, making it a popular destination for trekkers and mountaineers. The region is renowned for its breathtaking natural beauty, scenic landscapes, crystal-clear lakes like Attaabad and Sheosar Lake, and lush green valleys. The Karakoram Highway, which passes through Gilgit-Baltistan, offers stunning views of the surrounding mountains. Gilgit-Baltistan has diverse ethnic groups, including the Balti, Shina, Burusho, Wakhi, and Domki people, each with distinct cultures and languages. The region has a rich cultural heritage, with influences from Tibetan, Central Asian, and South Asian traditions. It is known for its traditional music, dance, and festivals, which reflect the unique cultural mix of the area.

The economy of GB is primarily based on agropastoral life, with crops like wheat, barley, potato and fruits being grown in the valleys (Kolář et al., 2022). Tourism is a growing sector, attracting visitors to the region's natural beauty, trekking and mountaineering opportunities, and cultural experiences. The region is also strategically important due to its proximity to China and its role in the China-Pakistan Economic Corridor (CPEC).

Gilgit-Baltistan has a unique political status within Pakistan. It is self-governing to some extent but lacks full provincial status (Uddin). It has its

legislative assembly and governor, but ultimate authority rests with the federal government of Pakistan. Overall, Gilgit-Baltistan is a region of immense natural beauty and cultural diversity, making it a significant tourist destination and an area of strategic importance due to its proximity to China and its role in regional connectivity projects (Nigar, 2018).

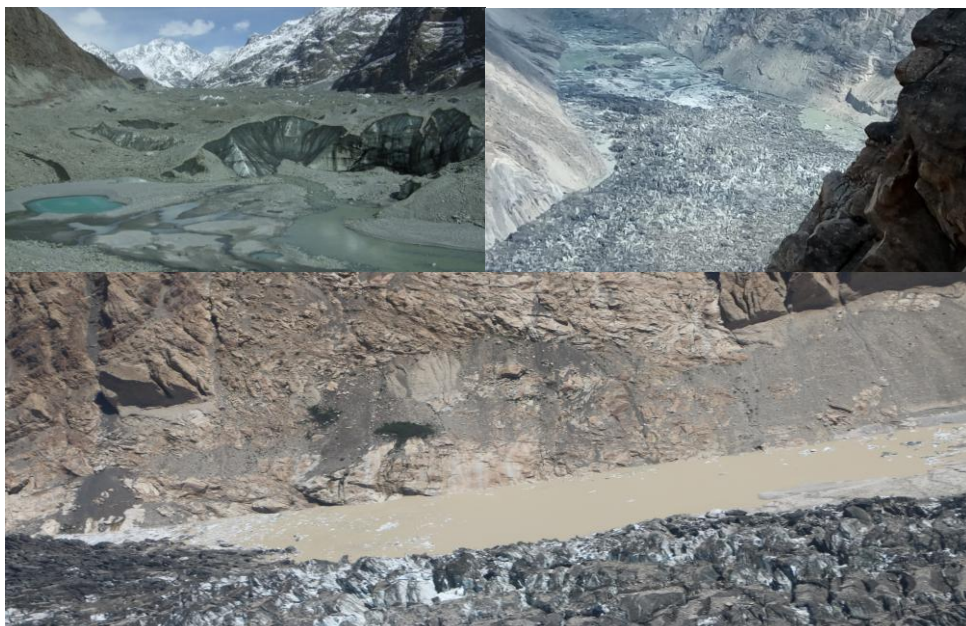


Figure 9. Selected Glaciers of Karakoram with Glacier Lakes (Hinerchi left, Shishper Glacier right and Bottom Khurdopin Glacier)

GB, a mountainous region in northern Pakistan, boasts a remarkable prevalence of glaciers and glacial lakes. Nestled within the Karakoram Range, it houses thousands of glaciers, including some of the world's largest and most extensive ice formations, contributing significantly to its "Third Pole" status (Bahadur, 2004). As these glaciers retreat due to climate change, they often give rise to glacial lakes within the region, such as Attaabad Lake and Sheosar Lake, enhancing the area's breathtaking natural beauty. However, this abundance of glacial lakes also presents a potential hazard, as the dams holding them back can fail, triggering glacial lake outburst floods (GLOFs) with devastating consequences downstream (Figure 6). Consequently, Gilgit-Baltistan's glacial landscape has scientific intrigue and environmental challenges, highlighting the delicate balance between natural beauty and environmental risks (Farrukh, 2019).

Climate change has profoundly impacted glacial melt in regions like Gilgit-Baltistan. Rising global temperatures have accelerated the retreat of glaciers, causing them to lose ice mass at an alarming rate (D. Karim et al., 2020;

Mazhar et al., 2020). This increased meltwater flows into the region's rivers and contributes to the formation of glacial lakes, raising concerns about glacial lake outburst floods (GLOFs). Moreover, the reduction in glacier size threatens the reliable water supply that downstream communities depend on, particularly for agriculture and hydropower. The consequences of glacial melt due to climate change are far-reaching, affecting not only local ecosystems and water resources but also posing long-term challenges for adaptation and sustainable development in these high-mountain areas.



Figure 10. Impact of Climate Change on Agriculture Land/Crops

### **China-Pakistan Economic Corridor is Transformative Project**

The China-Pakistan Economic Corridor (CPEC) is widely recognized as a transformative project with the potential to reshape not only the economic landscape of China and Pakistan but also the broader geopolitical dynamics of the region (Garlick, 2020). Stretching over 2,000 kilometres, CPEC (Figure 7) is a monumental undertaking aimed at creating a robust network of infrastructure and economic connectivity between China's western region, particularly Xinjiang, and Pakistan's Gwadar Port on the Arabian Sea (Hanif, 2021; Khattak & Khan, 2021).

At its core, CPEC is designed to significantly reduce the transportation time and costs for Chinese goods transferring to and from the Middle East, Africa, and Europe. By providing a shorter and more efficient trade route compared to the traditional sea route through the South China Sea and the Strait of Malacca, CPEC holds immense strategic value for China. It helps diversify its trade routes, enhances energy security, and strengthens its economic ties with Pakistan (Alam et al., 2023; F. Hussain & Hussain, 2017).

One of the flagship components of CPEC is the Gwadar Port, strategically

located in Pakistan's Baluchistan province (Asif, 2018; Shah et al., 2019). Gwadar Port's deep-sea facilities have the potential to become a crucial trade and logistics hub for the region, offering access to the Arabian Sea and facilitating trade between China and its trading partners. China has invested significantly in upgrading and expanding Gwadar Port, which is expected to be pivotal in CPEC's success (Asif, 2018).

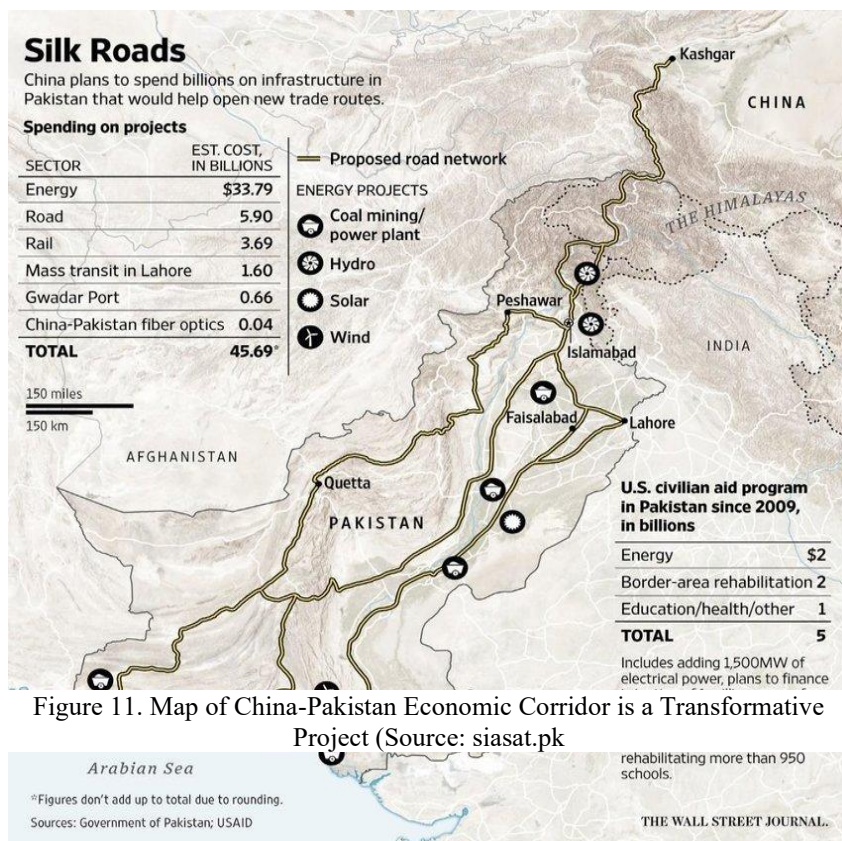


Figure 11. Map of China-Pakistan Economic Corridor is a Transformative Project (Source: [siasat.pk](http://siasat.pk))

CPEC encompasses many projects, including developing road and rail networks, energy infrastructure, and special economic zones. These projects aim to boost Pakistan's infrastructure, address energy shortages, promote industrialization, and create job opportunities. Moreover, CPEC's potential to stimulate economic growth in Pakistan aligns with the country's development goals (M. Z. U. Khan & Khan, 2019).

While CPEC holds immense promise, it is not without its challenges and controversies. Security concerns have been persistent, particularly in Baluchistan, where insurgent groups have targeted CPEC-related projects. Critics have also raised questions about transparency, environmental impact, and the extent to which local communities benefit from the initiative (Wilburn

& Wilburn, 2014). Addressing these challenges will be crucial to fully realizing CPEC's transformative potential.

In conclusion, CPEC represents a transformative project that has already begun to reshape the economic and geopolitical dynamics of the region. Its success will depend on effective management, addressing security concerns, and ensuring that its benefits are equitably distributed among the people of Pakistan. CPEC underscores China's strategic interests and Pakistan's aspirations for economic development, making it a project of significant global significance and scrutiny.

### **Historical GLOF Events Along the CPEC Route**

Historically, the China-Pakistan Economic Corridor (CPEC) route, which traverses through the mountainous regions of northern Pakistan, has been susceptible to Glacial Lake Outburst Floods (GLOFs). These events occur when the natural or man-made dams that hold back glacial lakes fail, releasing massive amounts of water, debris, and ice downstream. Here are some notable historical GLOF events along the CPEC route are as below:

***Khurdopin Glacier GLOF:*** The Khurdopin Glacier, located in the Shimshal Valley of the Hunza district, has exhibited a historical pattern of surging, retreating, and bursting approximately every 20 years. The glacier's bursting in 1905 and 1964 significantly affected both public and private infrastructure downstream, extending beyond Gilgit city. The most recent surge occurred around 1998-99. After a prolonged period of minimal movement, the glacier rapidly advanced in October 2016. As ice and sediment accumulated in the river, a substantial lake formed by December 2017. According to expert reports, the glacier's behavior has been unusually pronounced, resulting in the Shimshal River's complete blockage and a glacial lake's formation.

***Shishper Glacier GLOF (2020-2022):*** In 2020 and 2021, a GLOF event originating from the Shishper Glacier in the Hunza Valley threatened downstream communities and infrastructure (G. Khan et al., 2021; I. Rashid et al., 2020; Saifullah et al., 2020; Singh et al., 2023). The surge of glacial meltwater and debris posed significant risks, and authorities had to evacuate vulnerable areas and take preventive measures. While the situation was managed without severe damage, it highlighted the ongoing threat of GLOFs in the region (G. Khan et al., 2021).

***Barpu GLOF (2017):*** In 2017, another GLOF event occurred in the Barpu Glacier area, leading to heightened concerns about the vulnerability of the CPEC route to such natural disasters (Gao et al., 2021). The Barpu GLOF

resulted from a glacial lake dam bursting, sending a surge of water and debris downstream. Fortunately, there were no reported casualties, but the incident underscored the importance of monitoring and managing glacial lakes in the region (Sivalingam et al., 2023).

These historical GLOF events serve as reminders of the challenges and risks associated with the rugged and glaciated terrain along the CPEC route. Climate change has accelerated glacial melt in the region, increasing the potential for such events. Consequently, infrastructure development under the CPEC initiative must consider the impact of GLOFs on transportation routes, energy projects, and local communities and incorporate measures to mitigate these risks. Monitoring, early warning systems, and disaster preparedness are crucial components in addressing the threat of GLOFs along this vital economic corridor. The impact of Glacial Lake Outburst Floods (GLOFs) along the China-Pakistan Economic Corridor (CPEC) route can be significant and multifaceted, affecting infrastructure, communities, and the economy in various ways:

GLOFs can damage or destroy critical transportation infrastructure, such as roads and bridges, disrupting the flow of goods and people along the CPEC route. In particular, the Karakoram Highway (KKH) has been vulnerable to such events as it traverses through mountainous terrain. *It* can also impact energy infrastructure, including hydropower projects. Damage to power generation facilities can lead to regional electricity shortages and disruptions, affecting industries and households. Floodwaters and landslides resulting from GLOFs can damage communication networks, making it difficult for authorities to coordinate rescue and relief efforts in affected areas. It can lead to the loss of human lives, destruction of homes, and displacement of communities. People living near glacial lakes are particularly vulnerable to such events, and their livelihoods, including agriculture and tourism, may be severely affected. The trauma and psychological impact on affected communities can be long-lasting. Displacement and loss of homes and livelihoods can lead to social and economic challenges for these communities. GLOFs can disrupt trade along the CPEC route, affecting the flow of goods between China and Pakistan. Delays in transportation and damage to infrastructure can lead to increased costs for businesses. Rebuilding and repairing infrastructure damaged by GLOFs can be costly. Governments and international agencies must often allocate significant resources to restore roads, bridges, and other critical facilities. GLOFs can impact the energy supply, affecting industries and businesses dependent on a stable power supply. Energy shortages can lead to production delays and reduced economic activity. Many areas along the CPEC route are popular tourist destinations.

GLOFs can deter tourists, leading to declining tourism-related revenue and employment opportunities.

To mitigate the impact of GLOFs on infrastructure, communities, and the economy along the CPEC route, various measures can be taken:

- *Early Warning Systems:* Implementing early warning systems that detect potential GLOFs and provide timely alerts to communities downstream is crucial for saving lives and minimizing damage.
- *Infrastructure Resilience:* Designing and constructing infrastructure, including roads and bridges, to be more resilient to GLOFs can reduce the extent of damage and shorten recovery times.
- *Community Preparedness:* Communities in vulnerable areas should be educated and prepared to respond to GLOF threats. Evacuation plans and emergency shelters can help protect lives.
- *Climate Change Adaptation:* Addressing the root cause of glacial melt and GLOFs by taking measures to mitigate climate change and reduce greenhouse gas emissions is essential for long-term resilience.
- *International Collaboration:* Given the transboundary nature of GLOF risks, international cooperation between China, Pakistan, and neighbouring countries is crucial for monitoring and managing these hazards effectively.

Glacier Lake Outburst Floods along the CPEC route pose significant risks to infrastructure, communities, and the economy. Addressing these risks requires a combination of infrastructure improvements, early warning systems, community preparedness, and climate change mitigation efforts to ensure the safety and sustainability of the region's development and economic activities.

### **Assessing the Vulnerability of CPEC to GLOFs**

Assessing the vulnerability of the China-Pakistan Economic Corridor (CPEC) to Glacial Lake Outburst Floods (GLOFs) involves evaluating several vital factors, including the proximity of CPEC to glacial lakes and vulnerable areas, the implications of climate change, and the resilience and vulnerability of infrastructure:

***Geographical Location:*** Much of the CPEC route traverses through mountainous regions of northern Pakistan, where numerous glacial lakes are found. The melting glaciers often form these lakes, and their proximity to the infrastructure can pose a significant risk.

***Potential GLOF Sources:*** Identifying the specific glacial lakes that pose a GLOF risk to the CPEC route is essential. Lakes located upstream of critical

infrastructure, such as roads, railways, and power plants, are of particular concern.

***Local Communities:*** Evaluating the presence of local communities in vulnerable areas is crucial. GLOFs can severely impact these communities, leading to loss of lives, displacement, and disruption of livelihoods.

***Glacial Retreat:*** The accelerated melting of glaciers due to climate change contributes to the formation of glacial lakes and increases the risk of GLOFs. Assessing the region's glacial retreat rate is essential to understanding the evolving threat.

***Changing Precipitation Patterns:*** Climate change can also alter precipitation patterns, potentially leading to increased rainfall or snowmelt in the mountains. This can further exacerbate GLOF risks.

***Temperature Increases:*** Rising temperatures can affect the stability of glacial moraines and dams, potentially increasing the likelihood of GLOF events.

***Design and Construction:*** Evaluating the design and construction standards of infrastructure along the CPEC route is critical. Infrastructure built to withstand GLOF impacts, such as stronger bridges and embankments, can reduce vulnerability.

***Early Warning Systems:*** The availability of early warning systems that can detect GLOF threats and provide timely alerts to authorities and communities is crucial for reducing vulnerability.

***Emergency Response and Preparedness:*** Assessing the preparedness of local authorities and communities to respond to GLOF events can help mitigate the impact. Evacuation plans, emergency shelters, and disaster response capabilities are essential.

***Risk Mitigation Measures:*** Identifying and implementing risk mitigation measures, such as relocating vulnerable infrastructure or implementing engineering solutions to stabilize glacial lakes, can enhance resilience.

The vulnerability of CPEC to GLOFs is a complex issue that involves assessing the proximity of critical infrastructure to glacial lakes, understanding the implications of climate change on glacial dynamics, and evaluating the resilience and vulnerability of the infrastructure itself. A comprehensive risk assessment, early warning systems, and proactive measures are essential to mitigate the potential impact of GLOFs on the CPEC route and ensure the safety and sustainability of this vital economic corridor.

## **Impact on CPEC and Economic Implications**

The potential impact of Glacial Lake Outburst Floods (GLOFs) on the China-Pakistan Economic Corridor (CPEC) and its economic implications is a matter of significant concern. GLOFs can have far-reaching financial consequences, particularly in CPEC, a vital trade and infrastructure project connecting China and Pakistan (Khayyam & Tariq, 2022).

Firstly, the economic consequences of GLOF-related disruptions are substantial. GLOFs can destroy critical transportation routes, such as roads and railways, which are the lifelines of CPEC. This disruption can impede the smooth flow of goods and services, affecting trade between China and Pakistan and potentially causing economic losses for both countries.

Secondly, the costs associated with infrastructure damage and repair are a significant concern. GLOFs can destroy bridges, tunnels, and other infrastructure components along the CPEC route. The financial burden of repairing and rebuilding this infrastructure falls on China and Pakistan, straining their budgets and potentially delaying the completion of CPEC projects (Hameed, 2018).

Furthermore, safety concerns for workers and local communities cannot be understated. GLOFs can pose severe risks to the safety of construction workers and the residents of nearby areas. Ensuring the safety of these individuals requires additional investments in disaster preparedness and response measures, which can further add to the project's overall costs.

In conclusion, GLOFs can have substantial economic implications for CPEC, affecting trade, infrastructure, and safety. As such, both China and Pakistan must incorporate robust risk mitigation strategies into the planning and execution of CPEC projects, with a particular focus on addressing the challenges posed by GLOFs to safeguard their long-term economic interests.

## **Mitigation and Adaptation Efforts**

Mitigation and adaptation efforts for Glacial Lake Outburst Floods (GLOFs) are crucial in addressing the risks associated with these potentially devastating events. Several key strategies can be employed to reduce the impact of GLOFs on communities and infrastructure.

***Early Warning Systems for GLOF Detection:*** Implementing effective early warning systems is paramount. These systems involve deploying sensors near glacial lakes to monitor water levels, temperature, and seismic activity. When abnormal changes or signs of an impending GLOF are detected, automated

alerts are sent to relevant authorities and communities. Public awareness campaigns play a vital role in ensuring that people are informed about how to respond to these warnings promptly. By providing advance notice, early warning systems can save lives and minimize property damage in GLOF-prone regions.

***Infrastructure Upgrades and Retrofitting:*** Proactive measures are essential to enhance resilience against GLOFs. Existing infrastructure, such as bridges, roads, and buildings, can be retrofitted to withstand potential flood events. Engineers can design structures with flood resilience in mind, ensuring they can withstand the force of a GLOF. Furthermore, when planning new infrastructure projects, careful consideration should be given to elevating critical facilities and avoiding construction in high-risk areas. These measures can significantly reduce infrastructure vulnerability to GLOFs (Figure 8).



Figure 12. Mitigation and Adaptation measurement along KKH (Photo source: DDMA Hunza)

***Glacial Lake Monitoring and Risk Assessment:*** Regular monitoring and risk assessment of glacial lakes are crucial for identifying potential hazards. Advanced remote sensing technologies, including satellite imagery and drones, can be employed to track changes in the size and volume of glacial lakes. Risk assessments help determine which lakes are most likely to pose a

threat in the future. Based on these assessments, targeted mitigation strategies can be developed. It may include controlled drainage of glacial lakes to reduce the risk of sudden outbursts or reinforcing unstable moraine dams to prevent catastrophic failures.

***International Collaboration on Climate Change Mitigation:*** GLOFs are closely linked to climate change, as rising temperatures contribute to glacier melt and the formation of unstable glacial lakes. Addressing the root causes of GLOFs requires international cooperation to combat climate change. Nations must work together to reduce greenhouse gas emissions and limit global warming. Participation in international agreements like the Paris Agreement is essential to mitigate the long-term impacts of climate change, including the increased likelihood of GLOFs. By reducing the rate of glacier melt, climate change mitigation efforts indirectly contribute to GLOF risk reduction.

A comprehensive approach to GLOF mitigation and adaptation includes establishing early warning systems, infrastructure improvements, ongoing monitoring of glacial lakes, and international efforts to combat climate change. These measures collectively aim to reduce the risk of GLOFs, enhance the safety of communities in vulnerable areas, and protect critical infrastructure from the potentially devastating consequences of glacial lake outburst floods.

### **Case Studies and Best Practices**

***Bhutan's Glacial Lake Management:*** Bhutan has proactively managed GLOF risks in its mountainous regions. The country has identified and prioritized high-risk glacial lakes and implemented measures such as controlled drainage to reduce water levels in these lakes during the monsoon season (Gurung et al., 2017). Additionally, Bhutan has established early warning systems and conducted extensive public awareness campaigns (Shrestha et al., 2016). These measures have significantly reduced the vulnerability of local communities to GLOFs.

***Swiss Alps GLOF Mitigation:*** Switzerland, known for its mountainous terrain, has effectively implemented various strategies to manage GLOF risks. The Swiss have employed advanced monitoring systems to track glacier dynamics and assess the stability of glacial lakes (Vilimek et al., 2014). When necessary, they conduct controlled drainage to prevent catastrophic outbursts. Switzerland's comprehensive approach to GLOF risk management includes infrastructure resilience measures, such as reinforcing bridges and roads in vulnerable areas (Khanal et al., 2015). These case studies offer valuable lessons that can be applied to the China-Pakistan Economic Corridor (CPEC) to mitigate GLOF risks.

***Early Warning Systems and Public Awareness:*** Bhutan's successful approach underscores the importance of early warning systems and public awareness campaigns. Implementing similar systems along the CPEC route and educating local communities about GLOF risks can help save lives and reduce the impact of floods (Tsering et al., 2021).

***Prioritization of High-Risk Areas:*** Like Bhutan, CPEC planners should prioritize high-risk areas along the corridor for comprehensive risk assessment and mitigation. Identifying and addressing vulnerabilities in critical infrastructure, such as bridges and tunnels, is essential to ensure the corridor's resilience (Ruta et al., 2019).

***Infrastructure Resilience:*** Switzerland's experience highlights the importance of infrastructure resilience. Retrofitting and reinforcing critical infrastructure components can enhance their ability to withstand GLOF-related disruptions (I. Karim & Ahmad). CPEC projects should incorporate such resilience measures to minimize damage and downtime.

***Advanced Monitoring Technologies:*** Advanced monitoring technologies, including remote sensing, can provide valuable data for risk assessment and early warning (Casagli et al., 2023). It can benefit from similar monitoring systems to track the region's glacial lakes and glacier dynamics.

**International Collaboration:** Given the transboundary nature of GLOF risks in mountainous regions, collaboration between China and Pakistan is crucial. These countries should also collaborate with neighbouring nations and international organizations to share data, expertise, and best practices in GLOF risk management.

As demonstrated by Bhutan and Switzerland, successful GLOF risk management in mountainous regions offers valuable insights for mitigating GLOF risks along the CPEC route. Implementing early warning systems, prioritizing high-risk areas, enhancing infrastructure resilience, utilizing advanced monitoring technologies, and fostering international collaboration are key components of an effective strategy to protect the CPEC project and the safety of those living in the region.

## **Conclusion**

In examining the impact of Glacier Lake Outburst Floods (GLOFs) hazards on the China-Pakistan Economic Corridor (CPEC) in Gilgit-Baltistan, it becomes evident that the intersection of rapid climate change and ambitious infrastructure development presents a complex and pressing challenge. This investigation has unveiled several key insights: First and foremost, GLOFs are

a growing threat in mountainous regions, exacerbated by the effects of climate change. The rapid melting of glaciers and the formation of potentially unstable glacial lakes underscore the urgency of proactive GLOF risk management. The China-Pakistan Economic Corridor, a linchpin of regional trade and development, traverses this vulnerable terrain, making it susceptible to GLOF-related disruptions. These disruptions can have far-reaching consequences, affecting trade routes, infrastructure, and the safety of local communities. However, there is hope. The case studies of successful GLOF risk management in Bhutan and Switzerland provide valuable lessons. Early warning systems, infrastructure resilience, and international cooperation have effectively mitigated GLOF risks. Looking ahead, it is clear that proactive GLOF risk management is not just a necessity but a strategic imperative for the success of CPEC in Gilgit-Baltistan. It describes comprehensive strategies, including early warning systems, resilient infrastructure, and policies prioritising safety and sustainability.

In conclusion, the confluence of GLOF hazards and the China-Pakistan Economic Corridor underscores the need for foresight, collaboration, and adaptive measures. By addressing these challenges head-on, CPEC can thrive and set an example for sustainable, resilient development in the face of climate-related risks. In doing so, it will contribute to economic growth, the well-being of the region's people, and the preservation of its natural environment.

### **Future Challenges and Recommendations**

*Anticipating Future GLOF Risks in the Context of Climate Change:* The impact of climate change on glacial dynamics and the frequency of GLOFs is a significant challenge. To address this, comprehensive research and modelling efforts should be undertaken to anticipate how climate change will affect glacial lakes and GLOF risks along the CPEC route. It includes monitoring glacier retreats, lake expansion, and changing precipitation patterns.

*Strategies to Enhance CPEC's Resilience to GLOFs:* Enhancing the resilience of the CPEC infrastructure to GLOFs is imperative. Recommendations include designing critical infrastructure, such as bridges and tunnels, to be flood-resistant, elevating key facilities above potential flood levels, and developing emergency response plans. Additionally, building redundancy into the transportation network to allow for alternative routes during disruptions can be crucial.

**Policy Recommendations and International Cooperation:** Policymakers should consider the following recommendations:

**Legislation and Regulation:** Develop and enforce regulations that require infrastructure projects in GLOF-prone areas to adhere to strict safety and resilience standards. It includes regular inspections and maintenance.

**Insurance and Risk Assessment:** Encourage private sector involvement in risk assessment and insurance solutions for GLOF-related risks, which can help cover damages and recovery costs.

**International Cooperation:** Collaborate with neighbouring countries, particularly China, to share data, expertise, and resources for GLOF risk management. Joint research and monitoring efforts can provide a comprehensive view of the GLOF risk landscape in the region.

**Capacity Building:** Invest in training programs and capacity building for local communities, government agencies, and first responders to improve preparedness and response to GLOFs.

**Climate Change Mitigation:** Continue efforts to mitigate climate change through international agreements like the Paris Agreement. Reducing greenhouse gas emissions can help slow the pace of glacier melt and mitigate the formation of unstable glacial lakes.

**Public Awareness:** Implement public awareness campaigns to educate local communities about GLOF risks and the importance of preparedness and response.

**Research and Monitoring:** Invest in ongoing research and monitoring of glacial lakes and the surrounding environment. This includes using remote sensing technologies, drones, and satellite imagery to track glacial lakes and glacier changes. Regular risk assessments should inform adaptive strategies.

**Early Warning Systems:** Strengthen and expand early warning systems along the CPEC route, ensuring they are equipped with real-time data and effective communication channels. Regular testing and drills are essential to ensure their readiness.

**Ecosystem-based Approaches:** Consider ecosystem-based approaches to GLOF risk reduction, such as afforestation and reforestation in vulnerable areas, which can stabilize slopes and reduce the risk of landslides contributing to GLOFs.

Addressing future challenges related to GLOFs along the CPEC route necessitates proactive measures. Anticipating climate change impacts, enhancing infrastructure resilience, formulating effective policies, and

promoting international cooperation are critical steps toward mitigating GLOF risks and ensuring the CPEC project's long-term sustainability and the surrounding communities' safety.

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## **Developing a Roadmap for Implementing Mineral Carbonation as a CO<sub>2</sub> Capture Solution for Climate Change Mitigation in Belt and Road Initiative Projects**

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### **Abstract**

The Belt and Road Initiative (BRI), spearheaded by China, is a sweeping endeavor with the potential to significantly impact global infrastructure, economic growth, and regional connectivity. With its extensive network spanning 138 countries, the BRI promises substantial economic benefit. However, concerns have been raised over its potential environmental ramifications, particularly its contribution to climate change through significant CO<sub>2</sub> emissions. Serious global climate change and warming challenges are being addressed through multiple means of Carbon Dioxide (CO<sub>2</sub>) sequestration (the process of capturing and storing CO<sub>2</sub>). Various mature techniques for CO<sub>2</sub> sequestration are used globally. One of the potential CO<sub>2</sub> sequestration options is ex situ and in situ mineralization in mining tailings (waste) and geological formations. By recognizing the urgency to deal with these environmental challenges, there is a need for a detailed investigation of mineral carbonation and the geological sequestration of mafic

and ultramafic rocks and mine tailings. To address this environmental concern in terms of CO<sub>2</sub> emissions from BRI projects, a comprehensive roadmap advocating the adoption of mineral carbonation as a CO<sub>2</sub> capture solution for climate change mitigation in **Belt and Road initiative projects** is proposed in this study.

**Keywords:** BRI, mineral carbonation, climate change, carbon capture utilization and storage (CCUS)

## **Introduction**

Belt and road initiative (BRI) is a billion of dollars mega project, proposed by China in 2013 with an aim to connect Asia to Africa and Europe via sea and land (Schulhof et al., 2022). This project is described as the largest project in terms of infrastructure in the whole human history with an investment of more than US\$ 8000 billion with directly involvement of world's half population (Williams et al., 2020). This project is signed by about 130 countries and 30 international organizations received US\$ 90 billion in Chinese Foreign Direct Investment (FDI) with an exchange of US\$ 6 trillion in trade with China (CHINA, 2023).

This project aims to two new commercial corridors linking China to other parts of globe, reshaping economic geography in Central Asia and beyond (Bird et al., 2020). The BRI involves revitalizing ancient overland trading routes termed as the Silk Road Economic Belt and establishment of new sea corridors along the old Marco Polo road, spanning Africa, Southeast Asia, and Europe (Zhao, 2020). So, we can say that this project is an extension of the ancient corridor that once linked China with west, Ibn Battuta's and Marco Polo routes in the north as well as southern sea routes explored by Ming dynasty admiral Zheng He during his maritime expeditions. The BRI now refers to the whole geographical region of the well know "Silk Road" trade route (*Scholar*, n.d.). Key elements of this include promoting economic growth, stimulating economies in regions historically lagging behind, encouraging businesses to compete for BRI contracts, and fostering interdependent markets for China (Duarte et al., 2023). The initiative also focuses on developing high-technology industries globally and is aiming to promote the development of infrastructure like railways, ports, roads, airports etc., alongside energy projects like power stations and pipelines, and telecommunications networks (Mitrovic, 2016). Through the BRI, China seeks to secure its borders on the Asian mainland, facilitate trade and infrastructure development, and create partnerships with countries along the proposed routes (Liu & Dunford, 2016). The scale of the BRI is unprecedented in modern history, with investments anticipated to surpass several trillion dollars over the coming decades, aims to connect around 60% of the global

population through infrastructure development with "win-win partnerships"(Parks et al., 2023). It represents the largest infrastructure and investment project in history, dwarfing the Marshall Plan in its ambition and scope.

Table 1: Countries (excluding Palestine) participating in BRI

<b>Locations</b>	<b>Countries number</b>
Sub-Saharan Africa	44
Europe & Central Asia	34
East Asia & Pacific	25
Latin America & Caribbean	22
Middle East & North Africa	19
South East Asia	6
Total	150
EU	17
G20	8

In total, there are 150 countries (excluding Palestine) involved in BRI initiative. Among them, 17 are EU countries and 8 are G20 countries.

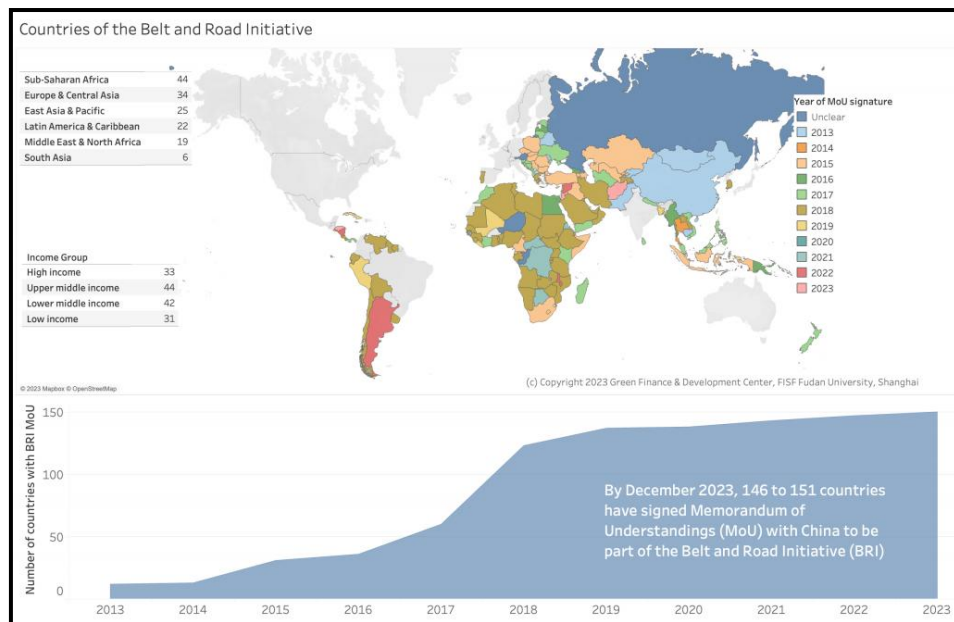


Figure 1: Nations for collaboration within BRI (WANG, 2023)

### Land Corridors of BRI (Teotia, 2023)

- 1) **New Eurasian Land Bridge:** This route runs through Kazakhstan, Russia, Belarus, Poland, and Germany, and China's Xinjiang Autonomous Region, links Western China and western Russia
- 2) **China–Central Asia–West Asia Corridor:** Extends via Western China to Turkey, facilitating economic connectivity across Central and West Asia.
- 3) **China-Indochina Peninsula Economic Corridor:** Connects Southern China to Singapore, enhancing economic ties and infrastructure development in the region.
- 4) **Trans-Himalayan Multi-Dimensional Connectivity Network:** Aims to transform Nepal a land-linked country from a landlocked, improving connectivity and trade opportunities.
- 5) **Northern China to Russian Far East Corridor:** This route extends from Northern China via Mongolia to Russia far East with the Russia-China Investment Fund
- 6) **China–Pakistan Economic Corridor (CPEC):** this is a significant component closely resemblance to the BRI, involving a \$62 billion investment in infrastructure projects in Pakistan. It focuses on

modernizing the economy, transportation and energy infrastructure. CPEC became partially operational in 2016 with Chinese cargo reaching Gwadar Port for further shipment to West Asia and Africa. The infrastructure at provides alternative routes that are not reliant on Malacca strait (S. M. Ali & Ali, 2020).

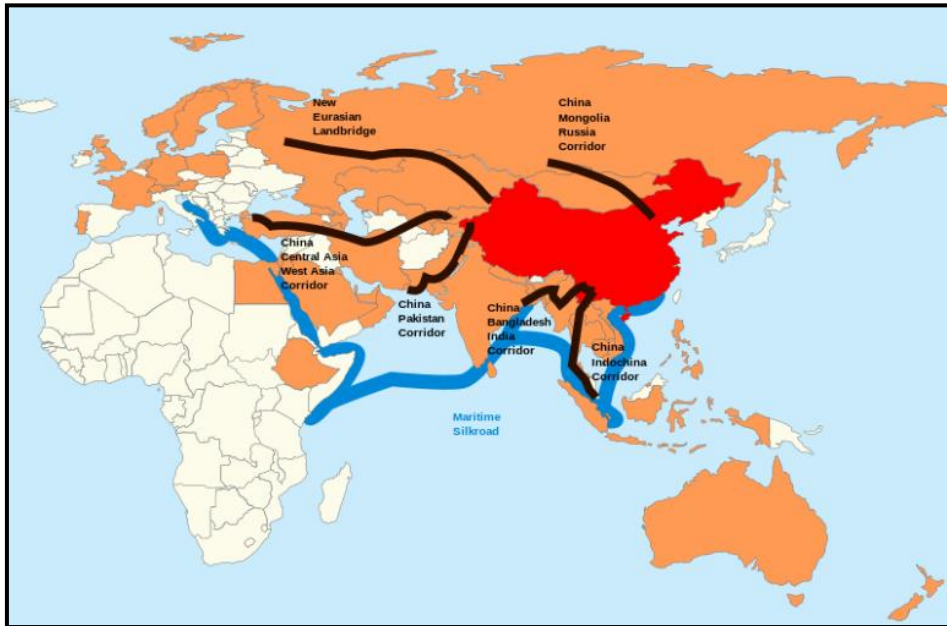


Figure 2: Routes connecting China and BRI member regions (Teotia, 2023)

### **Possible environmental challenges in China and BRI countries**

The BRI is a massive undertaking with the aim of promoting regional connectivity and economic growth across a population of 4.4 billion (Ge et al., 2018). This endeavor represents the largest infrastructure investment in recent history, totaling trillions of dollars for infrastructure development including transportation network, technical capacity building, telecommunications, energy, and industrial capacity (Liu & Dunford, 2016). On one hand BRI promises significant advantages, but in other hand it presents considerable environmental risks and challenges, ranging from immediate biophysical impacts to long-lasting negative consequences resulting from unsustainable infrastructure, technology, and resource extraction (Messerli et al., 2019). The BRI's vast scope and scale have significant environmental implications, including habitat destruction, pollution, increased carbon emissions, and systemic issues that may arise from locking countries into unsustainable development paths (Ahmad et al., 2020). It is crucial to consider that the first step of BRI framework involves constructions, including rail lines, roads, airports, industrial parks, seaports and similar more projects, which will be

responsible for environmental disturbance directly or indirectly (Losos et al., 2019). Such type of mega projects is full of uncertainties and risks, producing significant volumes of waste and harmful emissions that pose a threat to the ecosystem.

According to World Bank analysis on the environmental impact of BRI “such huge transportation infrastructure will expose local communities and regions to social and environmental threats as BRI routes crosses through them and this initiative can increase carbon dioxide (CO<sub>2</sub>) emission 7% in total” (Chin et al., 2024). Additionally the reports predicted that BRI transport infrastructure will raise CO<sub>2</sub> emission by 0.3 percent globally and more than 7% in some regions (Ruta et al., 2019)(Losos et al., 2019).

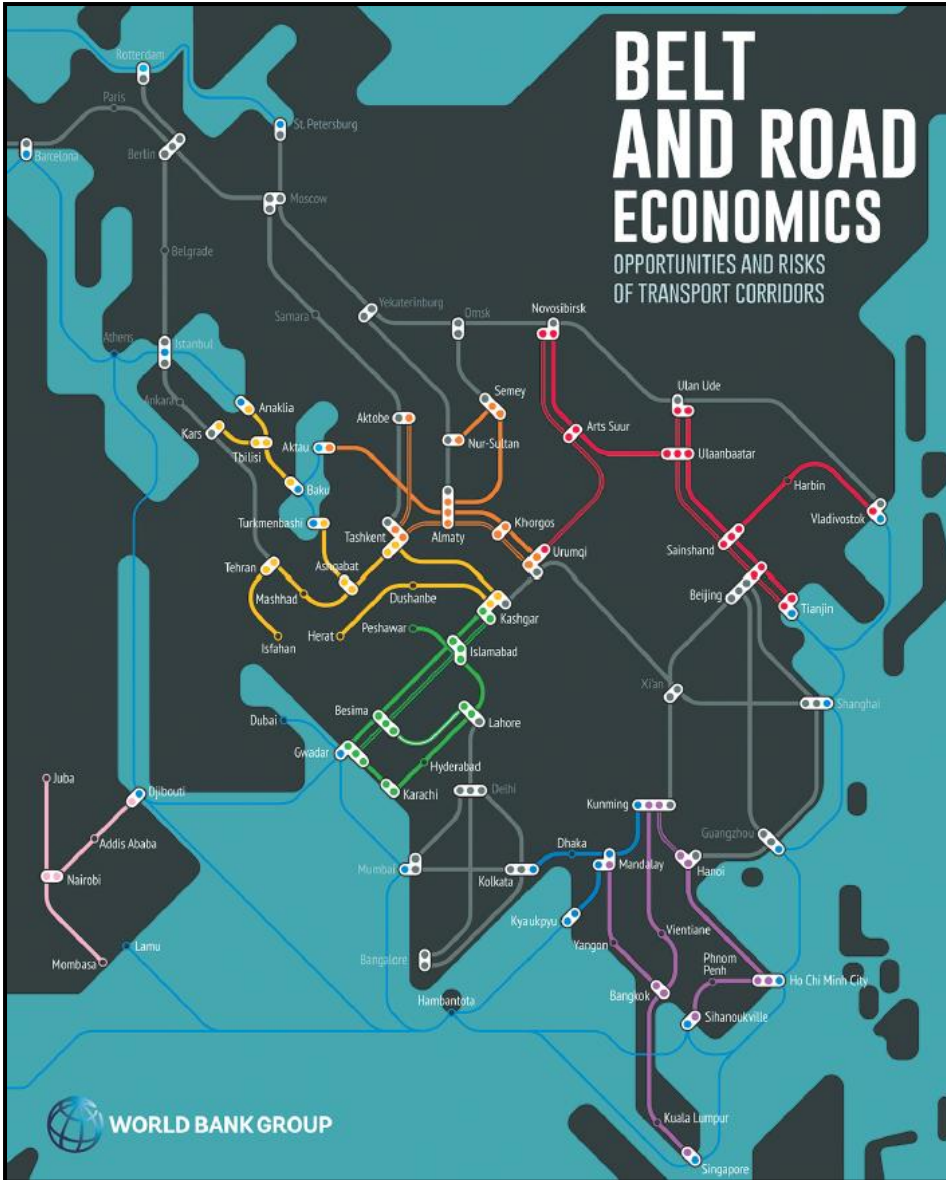


Figure 3; Six terrestrial routes of the Silk Road Economic Belt (Ruta et al., 2019)

Given the challenge of coal-fired electricity generation's dominance in China and 138 BRI countries, innovative approaches must be considered to achieve the goal of BRIGC or The Coalition. As climate change is a top priority of the ruling party in Chinese government so in 2020, China's president put forward "carbon peaking and neutrality before 2030" and "to achieve carbon neutrality up to 2060" (Cheshmehzangi & Chen, 2021). China is the largest CO<sub>2</sub> producer in the whole world, having half of the world's coal power plants located within its borders (Lindner et al., 2013). Moreover, China ranks as

fifth-largest producer of oil and the second-largest its consumer, along with serving as largest contributor to worldwide demand for gas (J. Zhang, 2015). In 2019, foreign direct investment (FDI) in China totaled \$138 billion, compared to \$135 billion in 2018. Of this, 1.6% was directed towards the mining sector, and 25.6% towards the manufacturing sector (ESCAP, 2021). In 2019, the mining and manufacturing sectors employed 3.7 million and 38.3 million people, respectively, which represented 2.1% and 22.3% of total employment in the country (LANKA, n.d.).

### **BRI International Green Development Coalition (BRIGC)**

President Xi Jinping announced the formation of the BRI International Green Development Coalition (BRIGC) during the first Belt and Road Forum for International Cooperation (BRF) in May 2017 (K. Chen, 2024). It was formally inaugurated during the Thematic Forum of the second BRF in April 2019. The main goals of BRIGC are to integrate environmentally sustainable practices into the BRI, promoting global agreement on the Green Belt and Road, and to help in achieving the 2030 Sustainable Development Goals (Cao et al., 2024). BRIGC presently boasts more than 130 partners, encompassing 25 environmental departments from various countries, international organizations, research institutions, and businesses (Geraci et al., 2020). It offers platforms for policy discussions, sharing of knowledge, transfer of green technology, and thematic activities that concentrate on global climate change governance and the promotion of environmentally-friendly practices (Geraci et al., 2020).

Many Sustainable Development Goals (SDGs), such as SDG2 (Zero Hunger), SDG3 (Good Health and Well-Being), SDG5 (Gender Equality), and SDG7 (Affordable and Clean Energy), are impacted by *BRIGC's* work (S. Ali et al., 2018). With an emphasis on participating nations in the BRI, the coalition consults with stakeholders on terms of reference and subject areas. Partners participate in core activities related to climate change governance and green transformation through policy dialogues, research projects, capacity building initiatives, and pilot projects (Baruah & Nath, 2019). The initiative aligns with the Climate Action Summit work stream by addressing thematic fields such as green finance, green energy, energy efficiency, environmental quality advancement, green cities, corporate social responsibility, and technology innovation. BRIGC collaborates with renowned institutions and experts on climate change, funding thematic activities through voluntary donations from partners. Stewardship is managed by Co-Chairs, a Consultation Committee, and a Secretariat. Communication strategies involve cooperation with existing bilateral and multilateral mechanisms.

## **Green Silk Road initiative**

BRI includes the Green Silk Road initiative, which focuses on promoting eco-friendly and sustainable practices in all BRI activities (L. Wang & Cheng, 2024). Advocating for recyclable, low-carbon, and sustainable lifestyle, this initiative, emphasized by Xi Jinping, aims to integrate sustainability into daily work and practices to achieve the UN SDGs by 2030 (Yang, 2021). The Green Silk Road initiative is recognized as a viable solution to improve the adoption of UN's 2030 Agenda for Sustainable Development, aligning global sustainability goals. Described as a sustainability-focused subtheme of the BRI, the "green silk road" aims to enhance Beijing's environmental credentials and promote sustainable practices within the initiative (Lewis et al., 2021). The Green Silk Road is acknowledged as a crucial tool to steer towards a new pathway of sustainable development, moving away from past environmental challenges (Thees, 2020). The Green Silk Road initiative is part of China's ambitious BRI, emphasizing sustainable practices and environmental considerations in infrastructure development. Sources collectively emphasize the significance of the Green Silk Road initiative in promoting environmental sustainability and eco-friendly practices within the broader BRI framework (*No Title*, n.d.).

## **Objectives of proposed roadmap**

The objective of this roadmap is to offer a sustainable road map solution for the ecological impact of the BRI on the world's climate by contributing to the ongoing literature and debates. The specific focus is to explore mineral carbonation, both in-situ and ex-situ, as well as geological carbonation, and imply possible green technologies and policies to BRI's collaborated countries to deal with the negative impact of the project on climate change and greenhouse gas emissions, which are associated with billions of dollars in investment. In short, while Belt and Road Initiative (BRI) projects have undeniably driven economic growth, the associated rise in CO<sub>2</sub> emissions necessitates robust and sustainable solutions. Among the promising approaches, mineral carbonation offers a unique opportunity to permanently store captured CO<sub>2</sub>, mitigating long-term climate change impacts. However, for the implementation and adoption of mineral carbonation strategy with BRI framework, many several knowledge gaps are needed to evaluate.

## **Carbon capture, utilization and storage, CCUS technology and Green BRI**

The use of CCUS technique to achieve large-scale and stable storage of CO<sub>2</sub> in a short period is the most effective way to solve the carbon emissions of key industries (Sanna et al., 2014). Among all the CO<sub>2</sub> sequestration techniques,

mineral carbonation is the most reliable as it provides safe and permanent disposal of CO<sub>2</sub> into stable minerals without any requirement for long-term monitoring (Qian et al., 2024). The idea of CO<sub>2</sub> mineralized storage was proposed in 1990s by Seifritz, a technique that mimics the natural weathering process of rocks; CO<sub>2</sub> then reacts with hydroxides, oxides, silicates, calcium and magnesium to form stable carbonates with permanent storage of CO<sub>2</sub> (Seifritz, 1990). Mineral carbonation and geological sequestration methods have the potential to overcome climate change challenges. Mineral trapping of CO<sub>2</sub> turns it into solid and stable carbonate minerals (Snæbjörnsdóttir et al., 2020). CO<sub>2</sub> interacts and reacts with the minerals present in mafic and ultramafic rock formations. CO<sub>2</sub> becomes part of the rock as a new and stable carbonate mineral through geochemical reactions at molecular level (Sturmer et al., 2020).

There is a huge variety and availability of geological sequestration options globally [15, 16]. A map of CO<sub>2</sub> sequestration pilot projects, facilities, and long-term carbon storage potential in geological formations within BRI partner countries is presented in Figure 1 (Zanoletti et al., 2018). Some of the global prospective locations and the corresponding rock types suitable for geological sequestration and mineral carbonation are,

- **Iceland:** Reactive Basalt (e.g., CarbFix project) has already capture 80,000 tons of CO<sub>2</sub> since 2012 of its commencement taking less than 2 years of mineral carbonation.
- **Washington State:** Wallula project (Continental Flood Basalt),
- **India:** Deccan traps (Continental Basaltic Lava),
- **Cyprus, Oman and Turkey:** Troodos, Kizildag, and Semail ophiolites (Reactive Peridotite Intrusions) and
- **Portugal:** Gabbros and Sines sub-volcanic massif (Peridotites).

Most of these projects are in the BRI partner countries so the CO<sub>2</sub> sequestration of these plants can be enhanced by more investment for their upgradation to mitigate the climate issues due to BRI project.

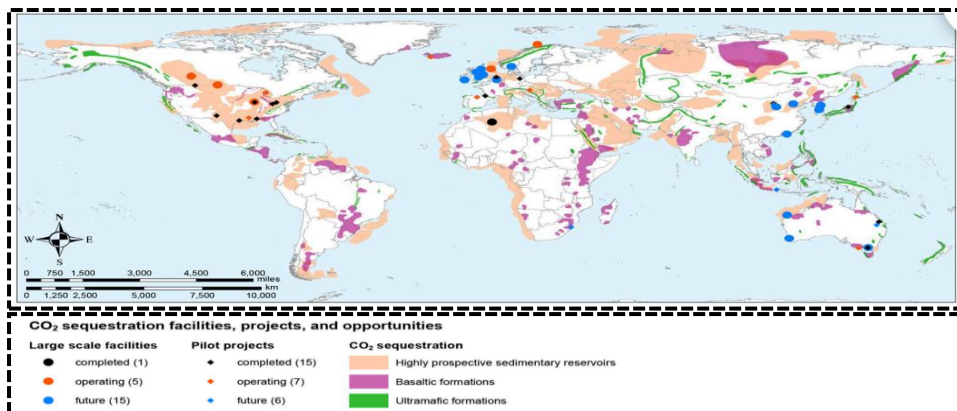


Figure 4; Map of pilot projects and CO<sub>2</sub> sequestration facilities, and long term storage potential in geological formations in different BRI regions of world (P. Kelemen et al., 2019) (P. B. Kelemen et al., 2011)

### Proposed In-situ CO<sub>2</sub> sequestration into underground rock deposits

CO<sub>2</sub> sequestration is a potential method in basalt or basaltic-andesite for mitigating climate change reducing emission of greenhouse, which involve the injection of dissolved CO<sub>2</sub> deep into the underground formations that are rich in magnesium and calcium (Schwartz, 2022). Since basalts are huge in quantity around the world (most seabed and continents are composed of about 5% of basaltic rocks) have high content of ferromagnetic silicate and pore structure favoring good condition for CO<sub>2</sub> sequestration. Basically basalt consist of minerals, plagioclase (anorthite-albite, CaAl<sub>2</sub>Si<sub>2</sub>O<sub>8</sub>-NaAlSi<sub>3</sub>O<sub>8</sub>) and pyroxene ([Ca,Mg,Fe]<sub>2</sub>Si<sub>2</sub>O<sub>6</sub>) as well as Olivine (Blondes et al., 2019). According to an estimate, about 3.5% or  $5.6 \times 10^6$  km<sup>2</sup> of land on earth surface is occupied by sub volcanic or Basalt volcanic rocks. About 0.3 Gt tons of CO<sub>2</sub> are sequestered each year by mineral carbonation. This process bypasses the slower stage of conventional CO<sub>2</sub> storage (Gill & Fitton, 2022),(Brady & Gíslason, 1997). The relative abundance of CO<sub>2</sub> is high as compared to other greenhouse gases, hence it is more responsible for 64% increase in greenhouse effect (Sandalow et al., 2021). The super-critical CO<sub>2</sub> at pressure of 7.38 MPa and 31.1°C reacts with the calcium and magnesium to form stable carbonate minerals. This process permanently locks away the CO<sub>2</sub> and prevents it from escaping into the atmosphere due to rapid mineralization, which is actually the mimic of natural weathering of rocks with atmospheric CO<sub>2</sub> for mineralization with the difference is that this process is faster than the natural process of mineralization (Li & Hitch, 2017),26]. Huge amounts of basalt formation are found around the world especially in the BRI partner countries as shown in figure 4 that provides good opportunity for sequestration of CO<sub>2</sub> thereby potential global carbon cycle as these minerals contain bulk amount of magnesium and calcium ions that chemically react with CO<sub>2</sub> and form

dolomites, calcite and magnesite. Lava is the main source of igneous rocks containing oxides, silicates, carbonates and sulphides. Igneous rocks that are formed during the cooling of lava are divided into plutonic or intrusive (solidification of lava inside earth surface) and volcanic or extrusive (solidification of lava above earth surface). Igneous rocks are divided into four categories based on the quantity of Silica ( $\text{SiO}_2$ ): mafic (Basalt), ultramafic, felsic and intermediate (Miandad et al., 2012).

McGrail et al. performed an experiment at  $50^\circ\text{C}$  and 103 bars of  $\text{PCO}_2$  in which they suspended hand sample basaltic rock into the supercritical  $\text{CO}_2$ . They noticed the formation of secondary carbonate on the basalt within 95 days (McGrail et al., 2017). However, solubility of  $\text{CO}_2$  in water can be substantial that is at 300 bars and  $100^\circ\text{C}$  water solubility is about 2 mol% (Schaefer & McGrail, 2009). Afterward Schaefer et al. reacted basalt at 103 bars and  $100^\circ\text{C}$  in a static autoclaves and noticed a change is occurring in weathering in one year time period that ranges from minor to severe (Saffar et al., 2020). During reaction of  $\text{CO}_2$  solution with Basalt nearly all the  $\text{CO}_2$  is absorbed at all temperatures ranging from 50 to  $200^\circ\text{C}$  and 300 bar but maximum extent as well as reaction rate occurs at 300 bar and  $100^\circ\text{C}$  (Bachu, 2000).. The recent famous basalt  $\text{CO}_2$  sequestration project is at Iceland's [Hellisheiði Geothermal Power Station](#) by CarbFix since 2012, where hot water is drawn from the ground into the geothermal power station to dissolve  $\text{CO}_2$  into the waste water and then injected hundreds of feet's deep into the basalt rocks (Cartier, n.d.). This project team found that about 90% of injected  $\text{CO}_2$  is converted into mineral within a period of 2 years after injection.

A similar mineralization project is also working in flood basalts of Columbia River, United State. The future version of project CarbFix has been sponsored by the European Union to reduce geothermal emission by carbon capturing and sequestration, CCS. Since then many other projects are under progress in Australia, India, South Africa and Canada for the sequestration of  $\text{CO}_2$  into the huge basaltic reserves in their countries (Balch et al., 2022). By including such  $\text{CO}_2$  sequestration plants and projects under BRI initiative the possible environmental crisis due to transport and infrastructure can be mitigated (Raza et al., 2022).

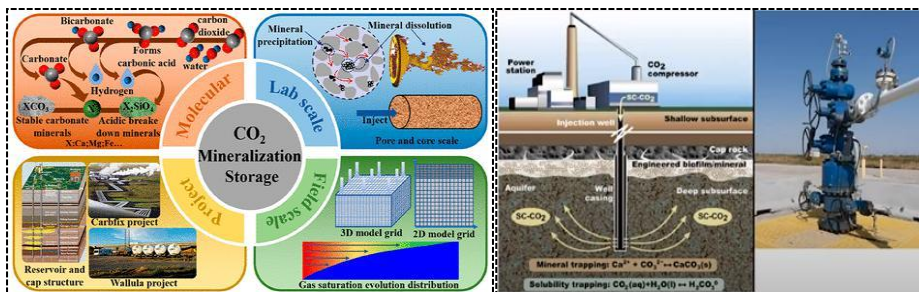


Figure 5: Overview of CO<sub>2</sub> injection into rock formation

### Proposed ex-situ CO<sub>2</sub> sequestration technology for BRI framework

Another proposed potential mineral carbonation technique is ex-situ carbon capture of utilization, and storage (CCUS) that is set to become the primary approach for addressing carbon emissions in key industries (Yadav & Mehra, 2021). Ex-situ mineral carbonation involves the chemical transformation of CO<sub>2</sub> into stable mineral carbonates outside of the natural geological setting, using industrial processes (Sanna et al., 2014). This method utilizes minerals rich in calcium and magnesium, such as those found in ultrabasic rocks, to form carbonates that permanently sequester CO<sub>2</sub>. Given the BRI's scale and its potential environmental impact, integrating ex-situ mineral carbonation into the initiative's framework could significantly contribute to reducing the carbon footprint of infrastructure projects. Moreover, this will also add value to industrial by-products, promoting sustainable development. Among the various CCUS methods, the ex-situ CO<sub>2</sub> mineralization storage approach has attracted much interest because of its benefits, such as abundant raw materials, wide distribution, environmentally friendly carbonate products, and the ability to achieve permanent storage without monitoring. However, the slow reaction speed of this CO<sub>2</sub> mineralization storage technology and the high cost of accelerated carbonation have affected its industrialization process (Sturmer et al., 2019). To reduce costs, measures include direct sequestration of CO<sub>2</sub> from flue gases, eliminating the CO<sub>2</sub> capture step; using calcium and magnesium-based waste as CO<sub>2</sub> mineralization raw materials to reduce raw material costs and detoxify waste; and increasing the application value of carbonation products to increase economic benefits (Sturmer et al., 2020). The authors' research on "mechanical activation of ultrabasic tailings-direct wet carbonation technology" reduced the net lifecycle cost of CCUS to 720 yuan/ton CO<sub>2</sub>, but the utilization issue of carbonation products remains unresolved. Calcium and magnesium-based minerals have ex-situ carbonation solidification characteristics, which can be pressed, formed, and cured to increase their strength and produce carbonation materials with carbonate as the binding phase. Carbonation curing technology offers features such as a

short process, simple operation, low cost, clean environment, and excellent material properties, enabling ex-situ CCUS technology to have broad application prospects in various fields (DiGiovanni et al., 2024).

Currently, there are several industrial applications of magnesium oxide cement, magnesium hydroxide stone, hydrated lime, low calcium cement, ordinary Portland cement, and solid waste containing cement clinker, such as steel slag, fly ash, blast furnace slag, and others (Aziz et al., 2020; T.-L. Chen et al., 2020; Du et al., 2022; Ho et al., 2017; Li, Zhao, et al., 2022; Luo & He, 2021; Mashifana & Sithole, 2021; Shu & Sasaki, 2022; X. Wang et al., 2019; YAN et al., 2016; Y. Zhang et al., 2019). However, these raw materials are typically available in small scales and may not meet the requirements for CO<sub>2</sub> mineralization storage for large-scale concentrated emission sources. Fortunately, ultrabasic mine tailings, including nickel, diamond, platinum group elements, and asbestos mines, contain a significant amount of magnesium silicate minerals needed for ex-situ CO<sub>2</sub> mineralization storage technology (Assima et al., 2014)(Mashifana & Sithole, 2021). The annual production of ultrabasic tailings worldwide is 1.5 times the global annual CO<sub>2</sub> emissions, and China's ultrabasic mines can store a total of  $13.02 \times 10^{12}$  t CO<sub>2</sub>, which is equivalent to 1887 times China's total emissions in 2008. Studies have shown that the carbonation solidification ability of serpentine in ultrabasic rocks is comparable to that of MgO cement, indicating the potential of serpentine to replace MgO cement as a carbonation cementitious material. However, there are limited reports on the carbonation solidification process using ultrabasic rocks as raw materials (Xu et al., 2023). The lack of understanding of the mechanism of carbonation solidification characteristics of ultrabasic tailings has hindered the design of ex-situ carbonation solidification processes for ultrabasic tailings, affecting the development and application of tailings carbonation materials, and limiting the research and development of new processes such as tailings carbonation solidification stacking and carbonation filling disposal. It is also essential to consider the solidification mechanisms of magnesium-based mineral carbonation. This process, which was initially proposed by Vandeperre and Al-Tabbaa in 2007, has since been the subject of extensive research (Vandeperre & Al-Tabbaa, 2007). The combined efforts of multinational research teams have improved our knowledge of the carbonation solidification properties of MgO cement and Mg(OH)<sub>2</sub>, as well as their activation processes.

This technique of ex situ mineral carbonation will not only support the green BRI development, but it will also open new avenues of circular economy by converting the CO<sub>2</sub> emission into useful commercial products. Thus, this technique is more in line with BRI goals. Furthermore, the ex situ mineral carbonation technique also have the potential to utilize industrial waste like

fly ash, steel slag, slag, desulphurized gypsum, waste concrete and other wastes from demolished building ensuring recycling and reuse phenomenon. This technique can valorize the waste materials from industry and rocks during the development of BRI infrastructure ensuring sustainable development.

For the successful adoption of these mineral carbonation techniques (in situ and ex situ) within the BRI framework this novel roadmap is proposed. However, there is a dire need of further investigation to find eligible BRI projects to acquire the necessary industrial wastes, agreements with business communities and development of scalable carbonation plants. This roadmap will further investigate the economic constraints and technological implications to ensure cost-effective mineral carbonation consistent with BRI objectives. For this we can seek the guidance of already functional mineral carbonation plants in different parts of the world (McGrail et al., 2017; Snæbjörnsdóttir et al., 2020). By implementing these novel techniques BRI can showcase its global commitment of sustainable development and combat climate change. This proactive technology not only solve urgent environmental issues but will also help in lowering global greenhouse gases. The creation of this roadmap will be a vital step toward achieving mineral carbonation's promise as a feasible CO<sub>2</sub> collection option throughout the BRI's vast network.

## **Scope**

The scope of this roadmap is broadly categorized into the following four domains:

***Domain # 1:*** Identification, 2D mapping, 3D modeling, quality and quantity estimation of rocks, minerals and tailing occurrences possessing a mineral carbonation potential.

***Domain # 2:*** Material characterization and investigation for accelerated mineral carbonation of mafic and ultramafic rocks and tailings.

***Domain # 3:*** Suitability studies of producing and utilizing stable carbonate compounds generated from mineral carbonation for industrial, commercial and household purposes. Some of the potential utilizations are;

- a) Construction materials (aggregates, binders to replace cement)
- b) Soil amendments for improving soil quality
- c) Industrial applications (e.g., fillers in paints and plastics)
- d) Potential for CO<sub>2</sub> sequestration through long-term carbon storage in landfills

- e) Mining application (Mine backfilling materials after mineral carbonation)

This area increases the economic value of the mineral carbonation process by developing beneficial uses for the produced carbonates, supporting their broader adoption within BRI.

**Domain # 4:** To devise and initiate an awareness and environmental governance plan for mineral carbonation to address the climate change challenges.

### **Methodology for BRI framework mineral carbonation R &D**

The following strategies will be adopted in this proposed R &D roadmap to achieve the suggested goals within BRI framework:

#### **1) Fieldwork and Investigations (Domain #1: Identification and Resource Assessment)**

##### **1.1 Identifying Potential Sites:**

Identifying the potential sites with outcrop exposures of Mafic and Ultramafic rocks using Multispectral and Hyper-spectral satellite and drone imagery and field observations and

##### **1.2 Geological and topographical survey**

Employ UAV (unmanned aerial vehicles) technology to conduct detailed Geological and topographic surveys of identified potential regions.

- This data will be crucial for creating accurate maps and models (Domain #2).

#### **2) Laboratory Work and Experimentation (Domains #2 & #3):**

##### **2.1 Data Processing and Modeling (Domain #1 & #2):**

- Utilize photogrammetry, remote sensing, and GIS software to process field survey data, satellite imagery, and drone data.
- Generate detailed topographic maps, geological maps, and digital elevation models (DEMs) and surface models (DSMs) for the identified regions. These will inform resource assessment and project planning (Domain #1).

##### **2.2 Material Characterization and Reaction Optimization (Domain #2):**

- Characterize the mineralogical composition, reactivity, and surface properties of collected mafic and ultramafic rock samples and potential waste streams.
- Investigate methods to accelerate ex-situ mineral carbonation reaction rates (Domain #2) through innovative pre-treatment techniques (e.g., mechanical activation, chemical modification) (Objective 2).

### **2.3 Valorization of Stable Carbonates (Domain #3):**

- Analyze the properties of the stable carbonate compounds produced from the mineral carbonation process (Objective 1).
- Conduct studies to assess their suitability for various applications, such as construction materials, soil amendments, or industrial fillers (Objective 1).
- Investigate the potential for utilizing mineral carbonation at household and industrial levels (Objective 1).

### **3) Desktop Studies (Domains #1, #3 & #4):**

#### **3.1 Mineral Resource Assessment (Domain #1, Supporting Objective 1):**

- Employ geostatistical and simulation techniques to estimate the quality and quantity of potential ultramafic mineral resources within the identified regions.
- This information is essential for evaluating resource feasibility and project scale within the BRI framework (Domain #1).

#### **3.2 Economic Modeling and Business Case (Domain #3):**

- Develop economic models for various mineral carbonation use cases relevant to BRI countries, considering factors like capital costs, operational expenses, and potential revenue streams.
- Conduct sensitivity analysis and simulations to assess the economic viability of different scenarios.

#### **3.3 Environmental Governance Framework and Policy Development (Domain #4):**

- Conduct a comprehensive literature review and survey of existing global and national environmental governance laws relevant to

mineral carbonation projects within China and Pakistan (BRI member states).

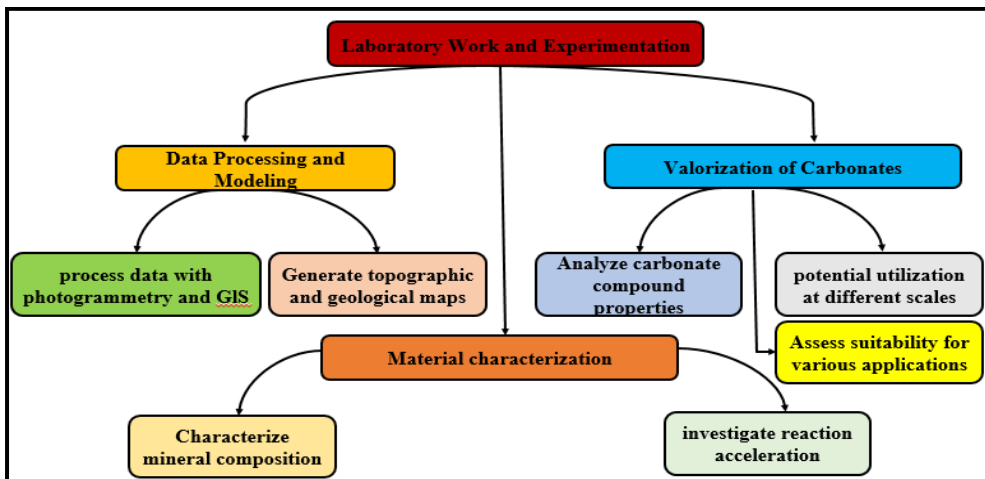
- Develop a framework that ensures responsible resource extraction, minimizes environmental impact, and fosters community engagement throughout the project lifecycle (Domain #4).

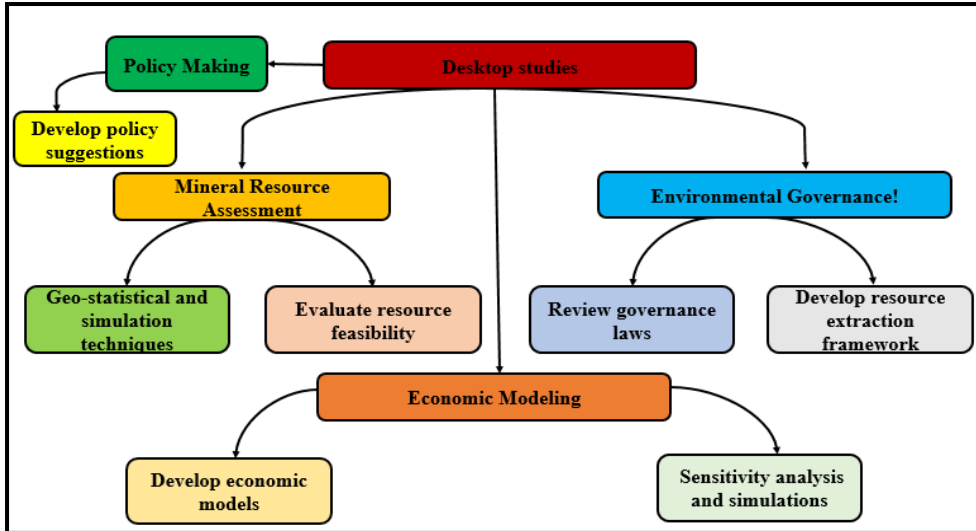
### 3.4 Policy Making (Domain #4):

- Based on the findings of the research, developing a suite of rules and recommendations for trade authorizations, offset credit verifications, and embedded emissions sequestration

### 4) Stakeholder Engagement:

- Throughout the project phases, engage key stakeholders, including industry representatives, research institutions, and national and international academics, to ensure successful knowledge sharing and implementation of the proposed roadmap.





This methodology aligns with research activity within the specific BRI domain it supports and addresses the objectives outlined in the proposal. By embracing a comprehensive approach integrating fieldwork, laboratory experiments, desktop studies, and stakeholder engagement, this R&D project has the potential to significantly advance the adoption of mineral carbonation as a climate change mitigation strategy within the BRI framework.

A flowchart of proposed methodology for topographic and geological mapping using satellite and drone is presented in figure 6.

Satellite image scenes will be acquired and analyzed by Geoinformatics software ENVI and SNAP to produce multiple useful image layers that can help in geological mapping in multiple mapping sheets on 1:50,000 scale. Geological mapping can be carried out by using multiple image layers created as color composites and band ratios as follow.

- a) Differentiation of different geologies/lithologies,
- b) Structural alignments and features,
- c) Alteration, surface characteristics, vegetation cover, land/water, and healthier greenery
- d) Shaded relief, outcrops and drainage networks.

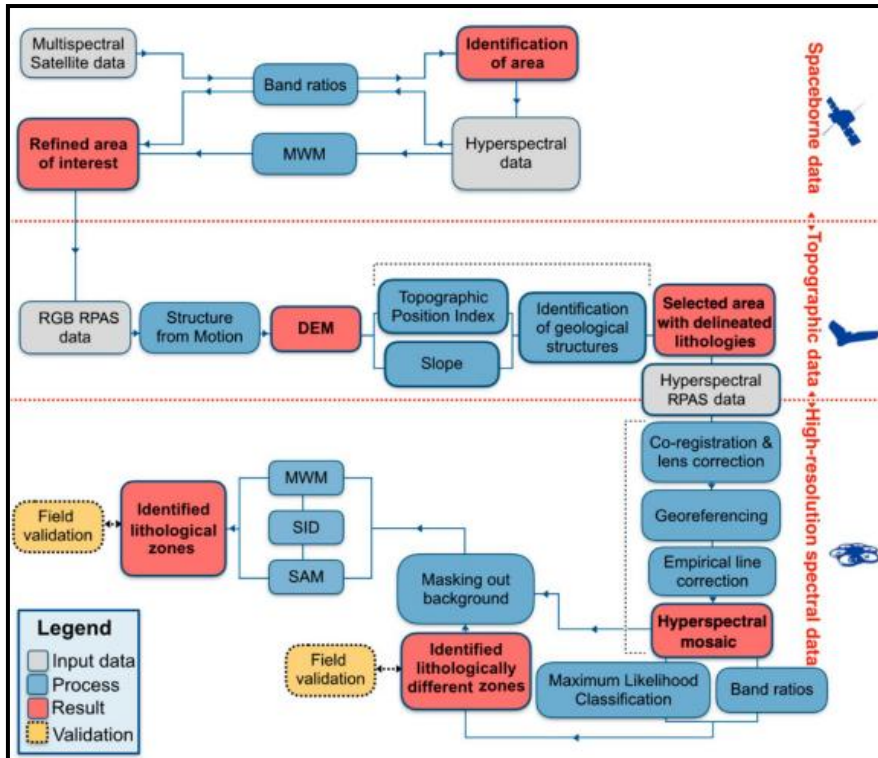


Figure 6; Flowchart of Using Satellite Multispectral, Hyperspectral Imaging and drones for geological and topographic mapping (Booyesen et al., 2019)

Sample geological maps generated using hyper-spectral satellite imagery is shown in Figure 6 and 7. Figure 6 shows a Sentinel-2 Principal Component Analyses (PCA) and hydrothermal altered basement outcrop covered by sand sheets on left side. The dyke swarm (black lines) crossing the basement (pink) buried in Ordovician sediments (green and dark brown) are also highlighted on the said map on right side. Figure 7 shows a lithological composite image. This type of imaging is useful for differentiating various types of surface cover types and general geology. It also displays alkalic granitoids in blue, granitic gneiss in yellow, and hydrothermally altered granite rich in muscovite clay in orange-red tones. The way of working of aerial topographic survey using drones already carried out by research is presented in Figure 8.

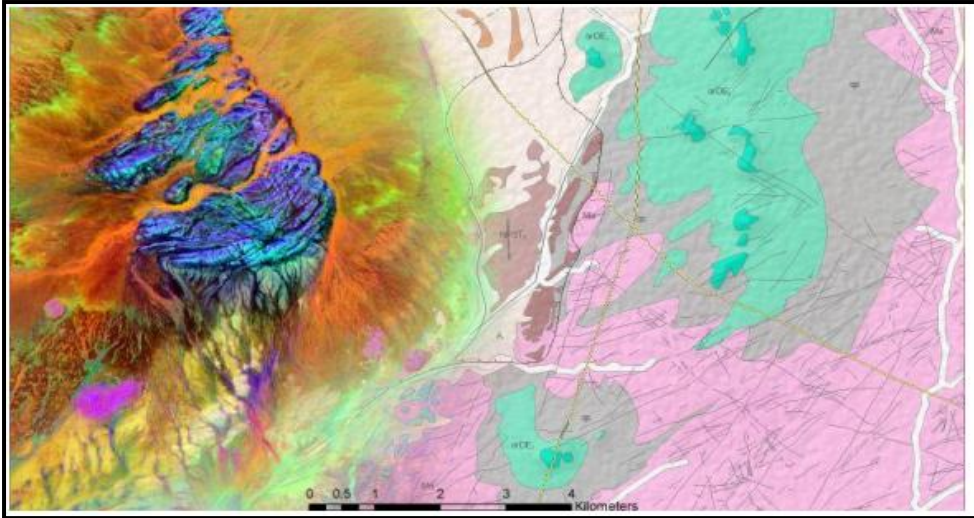


Figure 7: Geological map generated using Sentinel-2 satellite imagery (Courtesy: GAF AG)

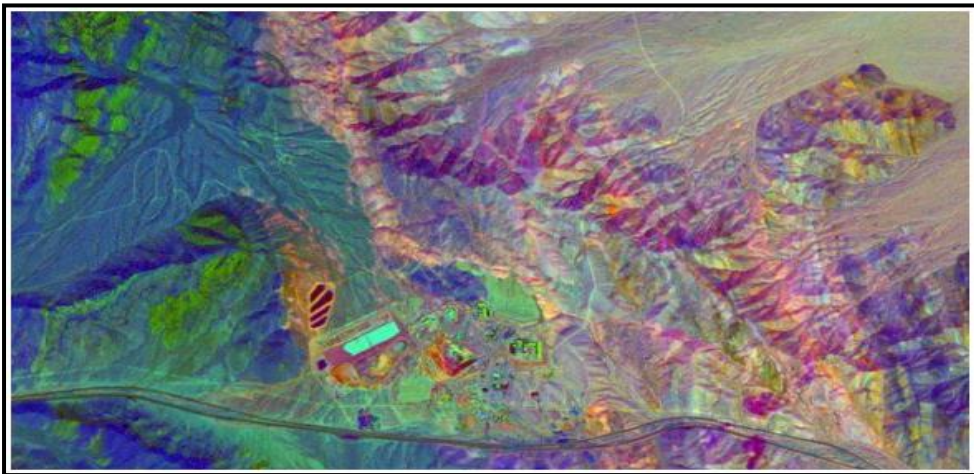


Figure 7; Lithological color composite image

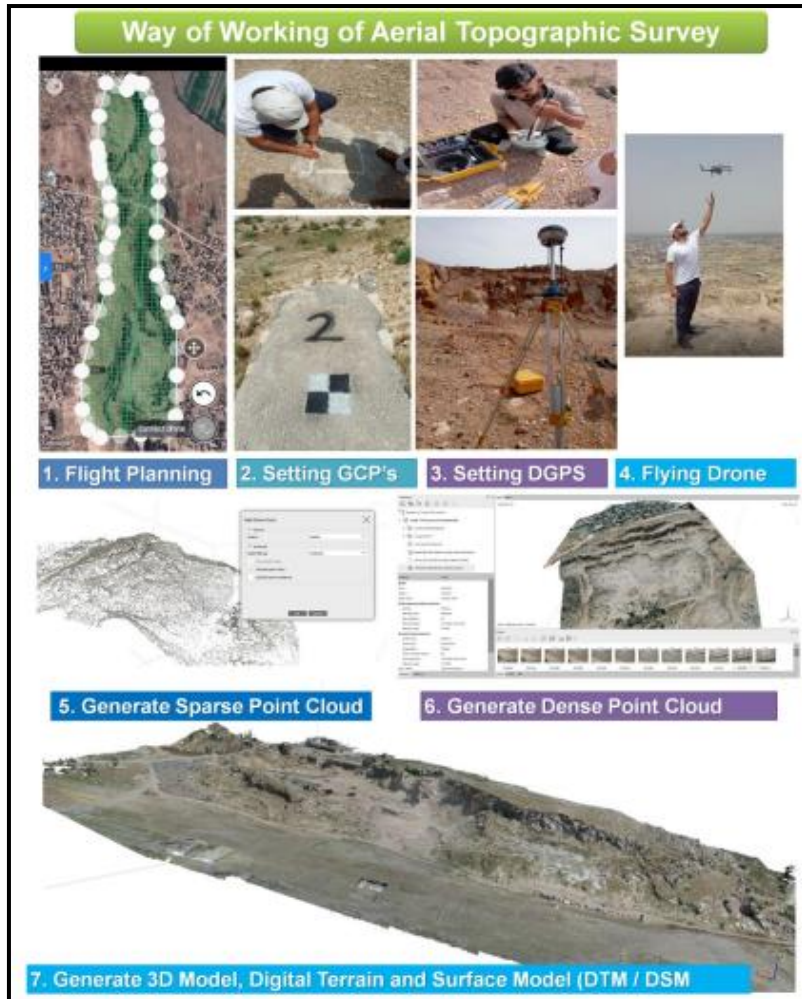


Figure 8; Ways of working of aerial topographic survey

## Conclusion

Key outcomes upon successful completion of this proposed R & D roadmap are:

- (1) Detailed topographic and geological maps, quality and quantity estimation of mineral resources suitable for ex-situ and in-situ mineral carbonation within identified regions of BRI countries as well as assessment of the CO<sub>2</sub> storage capacity of potential geological formations for geological sequestration.
- (2) Identification of optimal reaction parameters (e.g., temperature, pressure, pre-treatment methods) to accelerate and enhance the efficiency of ex-situ mineral carbonation processes.

- (3) Development of cost-effective ex-situ mineral carbonation technologies suitable for large-scale adoption within diverse BRI economies.
- (4) Comprehensive characterization of the physical and chemical properties of stable carbonate compounds produced from ex-situ mineral carbonation processes.
- (5) Utilization of stable compounds produced from mineral carbonation at an industrial and commercial level.
- (6) Establishment of a comprehensive environmental governance framework for responsible and sustainable implementation of mineral carbonation projects across BRI countries, addressing potential environmental and social impacts.
- (7) Development of policy recommendations for effective regulation and support of mineral carbonation technologies within the BRI framework
- (8) Public awareness and policy recommendations for environmental governance relating mineral carbonation geological sequestration.

#### **Suggested Citation**

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## Gold (Au) occurrences along CPEC route in Pakistan

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### Abstract

Pakistan is bestowed with abundant gold deposits in the form of placer and hydrothermal deposits found in the Kohistan Island Arc and the Karakoram Block of North Pakistan, the Peshawar Basin, Khyber Pakhtunkhwa, the Chaghi magmatic arc, and Baluchistan. The Au content in these deposits is high, as the pyrite from the placer gold deposits in the Gilgit-Baltistan area contains more than 500 ppm gold. Most quartz-bearing sulphide zones are reported to contain appreciable amounts of Au content in different parts of north Pakistan. Besides these, some high-grade hydrothermal deposits are also found in the Kohistan Island Arc in Gilgit-Baltistan Province. Placer gold deposits are reported from the Peshawar basin with high fineness. The Makaran Belt and Chagi magmatic arc contain world-class magmatic hydrothermal deposits, such as Saindak and Reko-Diq gold deposits. The gold deposits in Gilgit Kohistan Island Arc belong to porphyry and epithermal types. The research, prospecting, and exploration activities on gold deposits are very limited in the country and therefore have a low influence on the country's economy. Since the China Pakistan Economic Corridor (CPEC) projects are being constructed along the main mineralogical provinces of Pakistan. The CPEC projects include the prospecting and exploration of mineral deposits, especially gold deposits that, especially gold deposits, which have not been explored due to the lack of sophisticated technology. Under the CPEC umbrella, mineral processing and refining zones can be established,

which will effectively enhance bilateral trade in metallic and nonmetallic minerals and bring economic revolution in Pakistan. This book chapter briefly summarizes the gold deposits located along the CPEC route, and their exploration will play a critical role in raising the economy of both Pakistan and China.

## **Introduction**

Mineral deposits and their exploration using sophisticated technologies can be the backbone of a country's economy, and a developed mineral sector indicates a region's strong economy. Pakistan has a considerable amount of gold deposits and other base metals distributed in different areas. Porphyry ore deposits are the source of much of the copper, gold, and many other useful minerals. Pakistan is exceptionally rich with Cu-Au deposits in abundance. Pakistan can be divided into 4 metallogenic provinces which are: 1) Kohistan magmatic arc and adjoining areas, 2) Peshawar basin, 3) Chaggi magmatic Arc 4) Makran-Siahian ranges. All these regions fall along the route of CPEC, which will facilitate easy access to these metallogenic zones and enhance international trade in different types of metallic and non-metallic minerals. These metallogenic belts mainly contain porphyry-skarn, orogenic, and vein type deposits, among which the porphyry skarn type of deposits is dominant. Research on gold deposit is not extensive in Pakistan, many gold deposits are explored without carrying out detailed research of prospecting and ore genesis. Porphyry ore deposits are the source of much of the copper, gold, and many other useful minerals. Pakistan is exceptionally rich with Cu-Au deposits in abundance. The Copper- Gold reserves of Pakistan are divided into three regions:

\_\_ Reko Diq, Baluchistan, district Chagai, estimated worth is 1200 billion US Dollars.

\_\_ North areas of Pakistan, Gilgit and Baltistan, are estimated to be worth 1000 billion US dollars. Most of the area is unexplored in context of gold due to remote and rough topography.

\_\_ Northern Waziristan has reserves of gold, which are estimated to be worth 300 billion US dollars. Most of the area is unexplored and research activities are very limited.

Porphyry deposits are one of the world's main sources of Cu and Au and are a prominent focus for exploration (Sillitoe, 2010). Porphyry copper-gold deposits are mainly found along convergent tectonic boundaries, where oceanic plates subduct into the mantle. In order to create magmas that climb and form volcanoes and related porphyry copper-gold deposits, these

subducted plates dehydrate and release fluids that melt the mantle above (Sillitoe, 1972). Complex deformation and the production of porphyry copper deposits in a range of tectonic settings are possible in these magmatic arcs (Tosdal & Richards, 2001).

Numerous copper-gold porphyry-type systems are present in the Chagai metallogenic belt, which forms the northwest portion of Baluchistan. The most significant studied deposits are Durbanchah, Saindak, Koh-i-Dalil/Reko Diq, and Dnshte-Kain. These can be found scattered throughout the Chagai calc-alkaline magmatic belt, showing settings that are somewhat related to seduction and magmatic processes. The massive strato-volcano known as the Reko Diq complex was formed during the Miocene and spans an area of roughly 25 km x 20 km. It surrounds many closely spaced porphyry systems evident in the heavily eroded wide valley.

### **Gold mineralisation/deposits in Pakistan**

The known gold deposits and mineralisation and in different metallogenic belts of Pakistan are discussed below.

#### ***Kohistan Arc and Karakoram Block***

The three main geotectonic units that contribute to the extraordinarily diverse geology of North Pakistan are the Indian terrane, the Kohistan Island Arc, and the Karakoram terrane. The two primary suture zones that split these are the Indus Suture and the Shyok Suture, which are situated south and north of the Kohistan Arc. These tectonic regimes encompass components of island arcs, mélanges, back-arc basins, collisional zones, subduction zones, and Andean-type margins (Pettersen, 2010). A wide variety of mineral deposits are associated with these settings, including SEDEX Pb-Zn deposits, Ni-Co-Cu sulfides, arc-related Cu-(Mo)-(Au) porphyries, arc and back-arc epithermal precious metal deposits, polymetallic skarns and veins, Kuroko-type polymetallic massive sulfides, and PGE deposits (Sawkins, 2013). However, a lot of territory is still uncharted in North Pakistan because of its isolation and rugged, inaccessible geological terrain. Rocks in the Lhasa Block of south China, located further east, are known to contain a multitude of mineral deposits. These deposits include orogenic deposits, polymetallic skarns, vein-type polymetallic deposits, porphyry-associated skarns, magmatic Cu-Ni sulfide deposits, and Cu-Au-Mo porphyry systems (Zaw, Peters, Cromie, Burrett, & Hou, 2007).

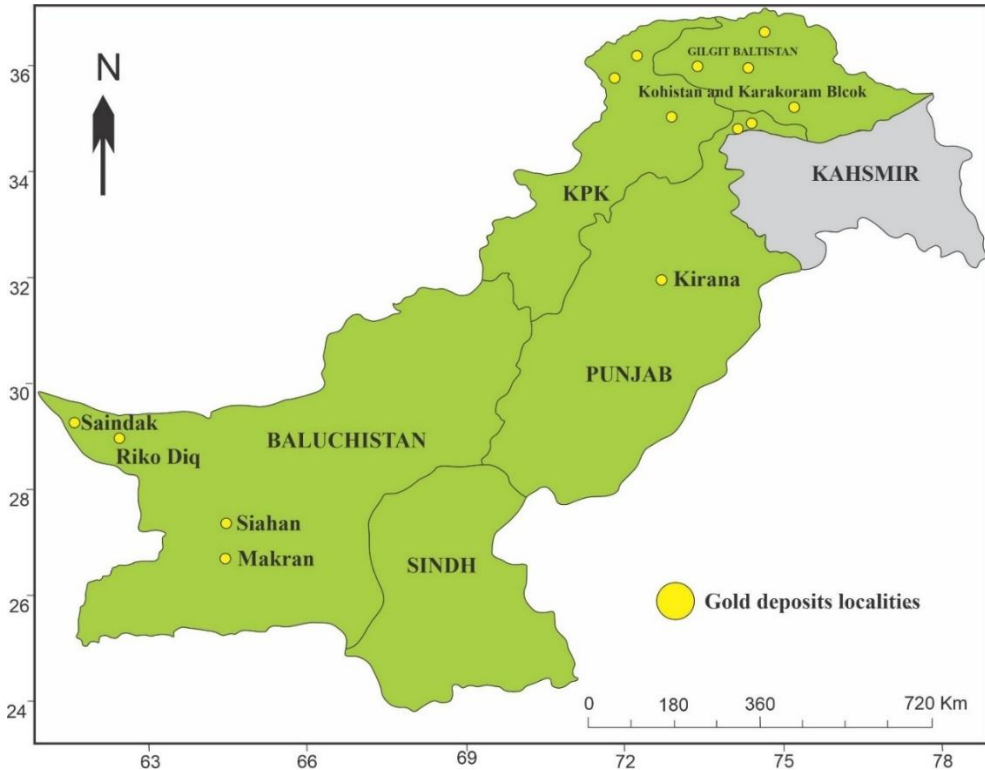


Fig. 1. Map showing gold deposits in different provinces in Pakistan, modified from Shah et al., (2020)

### ***Gold in Stream Sediments***

North Pakistan comprises a network of streams and rivers flowing from the catchments of valleys due to melting glaciers. Gold washing from the bed of the river is a primitive practice that carried out by local people to collect gold and sell it for earning; some families' livelihood solely depends on gold washing by manual and primitive techniques. Since the 18th century, people in northern Pakistan have been panning and washing river sediments and sands (Z. Ahmad, 1975; Alam, Li, Santosh, Shah, et al., 2019; Alam et al., 2023; Alam, Li, Santosh, & Yuan, 2019). Three Australian geologists named Ivanac, Traves, and King launched the first organized mineral prospecting efforts in 1951. Their research was released in a study that included information on Mastuj, Shandur Pass, Ghizar River, and the Hunza Valley, among other parts of the Gilgit Agency's geology and economic potential (Ivanac, 1956).

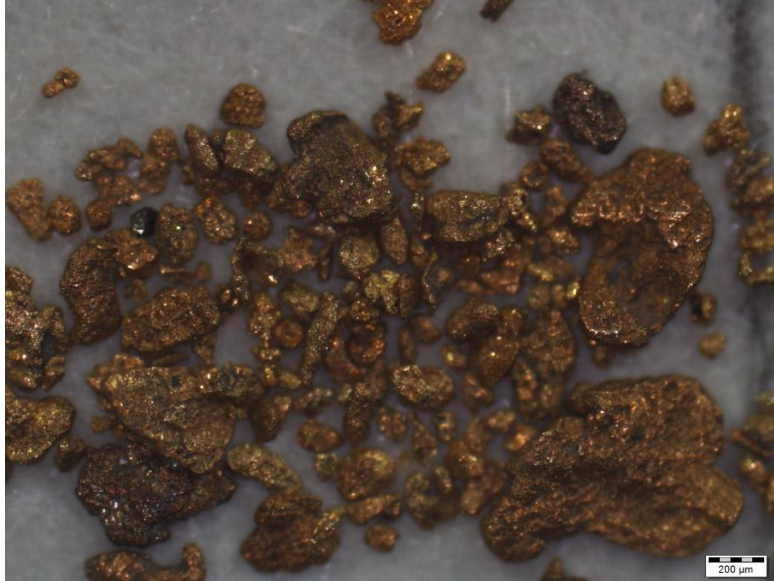


Fig. 2 Gold grains from placer deposits in Gilgit-Baltistan

(Tahirkheli, 1974) described the mineralogy of the stream sediments along these rivers. He claims that the concentrations of heavy minerals, including gold, in the stream sediments of these rivers exhibit erratic patterns. During the mid-1970s, the Austromineral of Vienna conducted exploration work in Chitral and Gilgit. They produced geological maps at 1:250,000 scale for the Gilgit-Hunza region, 1:100,000 for the Hunza-Rakaposhi-Gilgit area, and 1:50,000 scale for other regions like Chilas, Gilgit-Parri, Lower Hunza valley, Bagrote valley, and Bunji-Raikot bridge area. Local mapping of mineral possibilities and geochemical analysis were also included in the program; (Clavarino, Dawney, & Sweatman, 1994) identified 108 anomalous zones for Au. Higher order anomalies (28 zones) were determined to be connected to significant structures (Shyok Suture Zone). (Halfpenny & Mazzucchelli, 1999) demonstrated the significance of catchment control on the geochemical data of stream sediments and that the  $<75 \mu\text{m}$  fraction is especially helpful in detecting Au mineralization in North Pakistan. Excavations, trenching, aditing, and prospecting are also included in the program. Calkins et al. (1981) and Jankovic (1984) conducted reconnaissance work and described some of the mineralization in the Chitral region.

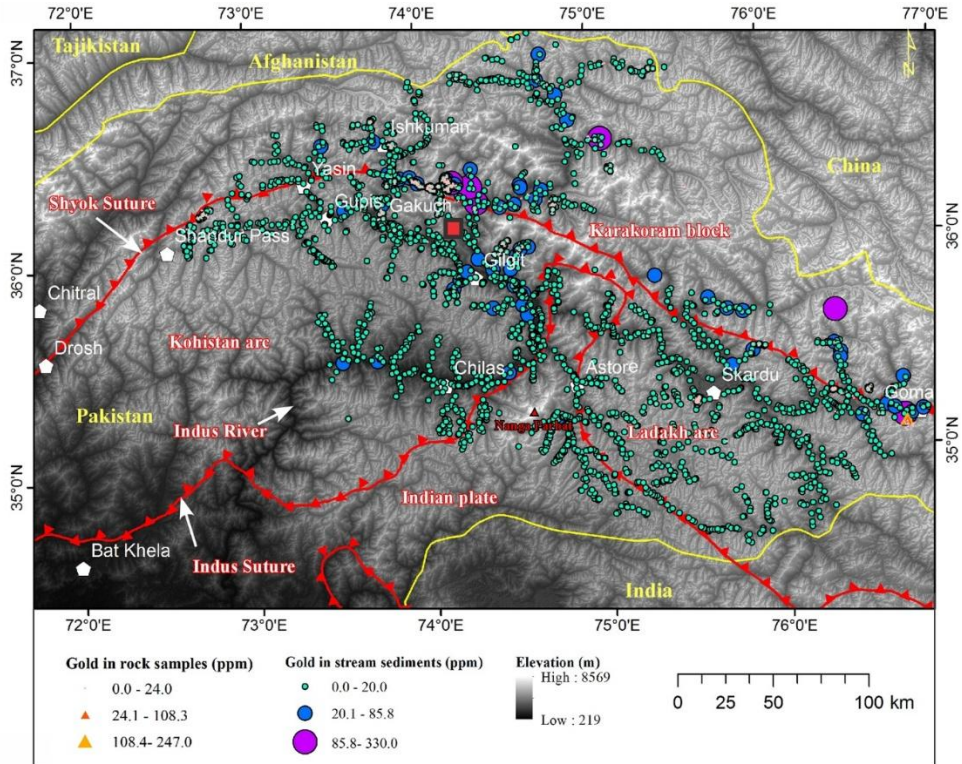


Fig. 3 Map showing concentration of placer gold in stream sediments (Khan et al., 2018)

Many multinational groups have conducted mineral exploration work in northern Pakistan throughout the past 20 years. The largest was the Australian Aid for International Development's Gold Exploration and Mineral Analysis Project (GEMAP) (1992 and 1995). With more than 1430 drainage samples spanning more than 50% of the land area in Chitral and 20% in the northern parts of Pakistan, GEMAP concentrated on Au and associated minerals over an area of 80,000 km<sup>2</sup> (Clavarino et al., 1994). With a primary focus on Au in the Chitral and northern regions, a sizable number of stream sediment and panned concentrate samples were gathered for this experiment from over 4260 sites in North Pakistan.

The Mineral Testing Laboratory (MTL) in Peshawar initially examined the samples for Au, Ag, Cu, Pb, Zn, Ni, Co, and Bi. To strengthen this, Minorco Services BV reanalyzed duplicate panned concentrate and stream sediment samples in 1997 at Perth, Western Australia's Ultra Trace Analytical Laboratories, utilizing techniques with lower detection limits (Halfpenny & Mazzucchelli, 1999). The resultant dataset is enormously expansive and open to both exploration and research endeavors. 108 abnormal zones for Au were identified by (Clavarino et al., 1994) in their initial study. Higher order

anomalies (28 zones) were determined to be connected to significant structures (Shyok Suture Zone). (Halfpenny & Mazzucchelli, 1999) analysis of the Minorco dataset demonstrated the significance of catchment control on the geochemical data of stream sediments and that the  $<75 \mu\text{m}$  fraction is beneficial in detecting Au mineralization in North Pakistan.

There are distinct variations in the size, shape, and form of the gold particles in both terraces—alluvial and fluvial. The fluvial terraces typically exhibit gold forms that range in size from 0.1 to 0.2 mm, sub-angular to rounded, and flaky. There are also a few 0.4–0.5 mm-sized gold particles that have an angular to subrounded shape. In the glacial-fluvial terraces, gold usually forms a solid to flaky substance that is angular to sub-angular in shape, and comparatively coarser in size (0.2–0.3 mm).

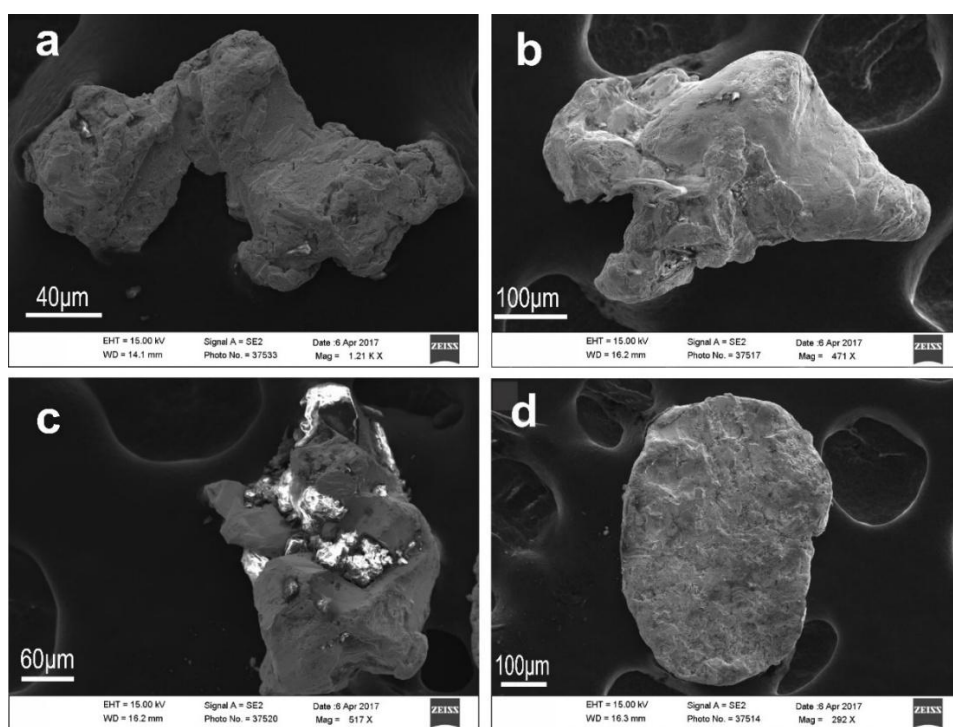


Fig. 4 Placer gold grains from Bagrote Valley (Alam et al., 2019a)

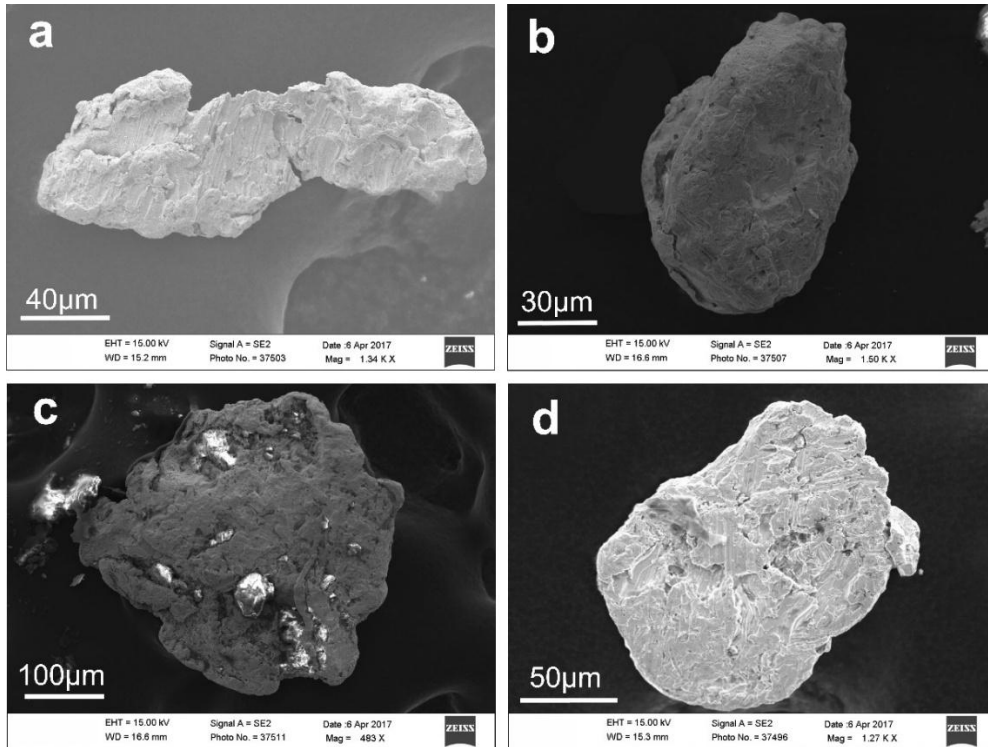


Fig. 5 Placer gold grains from Bar Dainter Valley (Alam et al., 2019a)

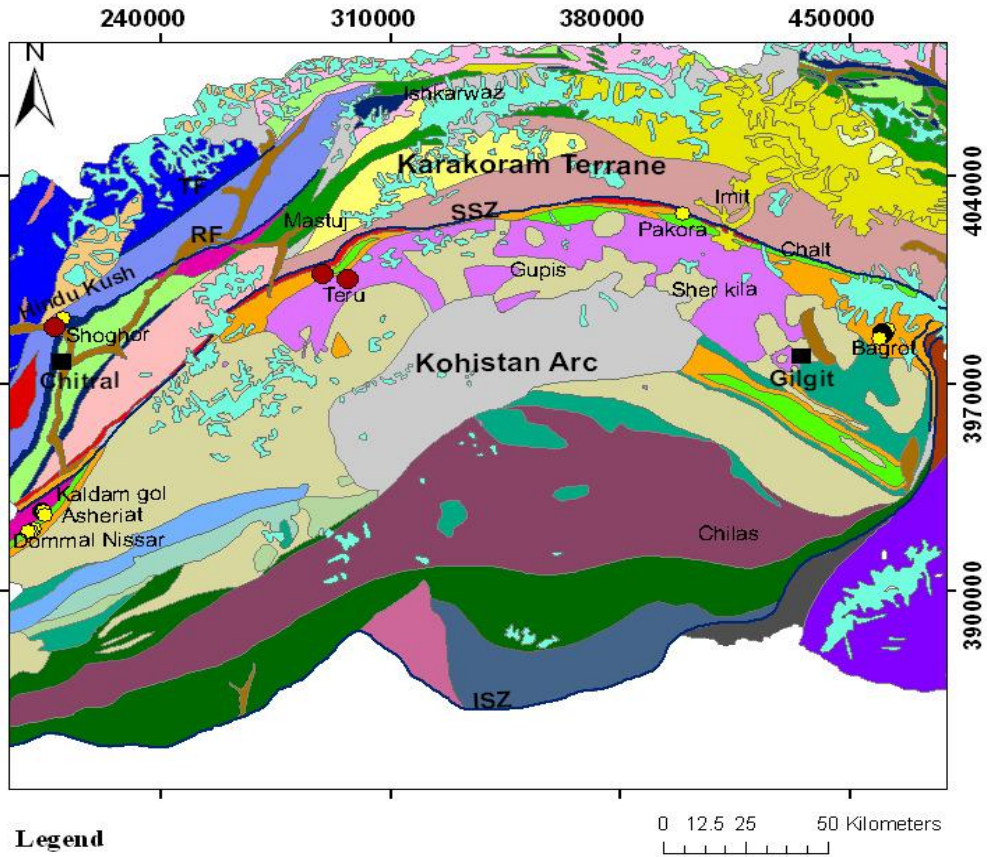
The gold found in the glaciofluvial and fluvial terraces in the Bagrote Valley is thought to have originated and been transported from a distal source at least a few tens of kilometres upstream, based on the size and shape of the gold particles found there. The rounded to sub-rounded and flakey look of the gold particles in the fluvial terraces indicates this. Less abrasion has been done to the gold particles in the glacial-fluvial sediments throughout their journey. Because no bits or indications of gold have been found, these particles are angular in shape and solid in form, indicating no possibility of gold-bearing bedrock beneath these terraces (Shah & Khan, 2004).

#### *Au in varying size fractions of the river sediments*

In North Pakistan, various sized percentages of stream sediments contain gold (Alam, Li, Santosh, & Yuan, 2019; Ali, Williamson, Moon, Shah, & Khattak, 2015). It is well established that determining the nature (mineralization type) of gold source rocks and the location of primary areas of gold mineralization may be accomplished by studying gold contents in various size fractions of stream sediments.

Table 1 Summary statistics for Au (ppb) in different size fractions of the stream sediment Samples in North Pakistan (Ali, 2011).

<b>Size fraction</b>	<b>1.68mm– 400µm</b>	<b>400-180µm</b>	<b>180– 75µm</b>	<b>&lt;75µm</b>
N	67	67	67	67
Mean Au (ppb)	73	51	69	108
Median Au (ppb)	11	9	17	15
Standard deviation	252	143	200	423
Min.	0.15	0.15	0.15	0.15
Max.	1549	818	1,326	3346
Percentiles	11	9	17	15



**Legend**

**Au <75 μm**

- 68 - 131 ppb (75<sup>th</sup>-90<sup>th</sup> percentile)
- 132 - 419 ppb (90<sup>th</sup>-95<sup>th</sup> percentile)
- 420 - 3346 ppb (95<sup>th</sup>-99<sup>th</sup> percentile)

— structure

- |  |                                  |
|--|----------------------------------|
| ● Galciers   | ● Shyok Suture Zone              |
| ● Kafirstan granite                                      | ● Purit formation                |
| ● Greenschist  | ● Shamran Volcanic Group         |
| ● Sandstone, shale and limestone                         | ● Yasin Group                    |
| ● Massive limestone and dolomite                         | ● Chalt Volcanic Group           |
| ● Permian massive limestone                              | ● Gilgit metasedimentary complex |
| ● Ghamu Bar plutonic unit                                | ● Kohistan batholith             |
| ● Hunza plutonic unit                                    | ● Chilas complex                 |
| ● Pelite, marble, amphibolite with lenses of ultramafics | ● Kamila amphibolite             |

Fig. 6 Relationship of significant factor scores to some of the known geological units and structure from Karakoram terrane, Shyok Suture and Kohistan arc (Searle and Khan, 1996). TF – Tirch Mir Fault, RF – Reshun Fault, SSZ – Shyok Suture Zone, ISZ – Indus Suture Zone (Ali et al., 2014).

Such research was carried out by Ali (2014). According to the study, Kaldam, a site in the Chitral area, has poor potential Au values even if Cu mineralization is known to exist there (Nichol, Hale, & Fletcher, 1994). The Awireth Gol region and an unidentified watershed near Teru contain 517–1549 ppb of Au (95th–99th percentile) in the coarse size fraction (1.68 mm–400  $\mu\text{m}$ ) of stream sediments. Similarly, the Shoghor and Bagrote catchments exhibit Au concentrations ranging from 85 to 516 ppb (90th–95th percentile) in this fraction. In contrast, samples from Dommal Nissar, Asheriat, Shoghor, Henzal, and Bagrote show relatively lower Au levels, ranging from 28 to 84 ppb (75th–90th percentile). In the medium-size fraction (400–180  $\mu\text{m}$ ), the unidentified Teru catchment and the recognized Shoghor prospect contain notable Au concentrations within the 95th–99th percentile. Additionally, samples from catchments with known Au prospects, including Shoghor, Henzal, and Bagrote, exhibit Au concentrations within the 90th–95th percentile. However, relatively low Au concentrations (31–80 ppb; 75th–90th percentile) were recorded in the Dommal Nissar, Asheriat, and Bagrote catchments.

For the fine-size fraction (180–75  $\mu\text{m}$ ), the Asheriat, Shoghor, and Teru catchments contain 528–1326 ppb of Au (95th–99th percentile), while the fine-size fraction from the Shoghor and Teru catchments holds 85–527 ppb of Au (90th–95th percentile). Lower concentrations (37–84 ppb; 75th–90th percentile) were found in the Dommal Nissar, Awireth, Henzal, Bagrote, and Bar catchments (Ali et al., 2014; Alam et al., 2019a). Notably, the Pakara basin exhibits a modest Au anomaly in the very fine-size fraction of stream sediments, which is not observed in other size fractions. This highlights the effectiveness of this extremely fine material in exploration (Fig. 5, Ali et al., 2014).

### ***Size and morphological characteristics***

Ali et al. (2014) reported that most gold grains from the Karakoram Terrain and Shyok Suture Zone have a long axis of less than 1 mm and are finely grained. In fluvial environments, the shape and surface texture of gold grains are crucial indicators for estimating transport distance from the source (Wierchowiec, 2002). Scanning electron microscopy (SEM) reveals clear evidence of hammering and abrasion on the surfaces of Au grains. Visual analysis of samples collected from various catchments indicates a range of grain morphologies, including irregular (18%), abraded (35%), and rounded to sub-rounded (47%) forms. Only a small number of Au grains from downstream samples have smooth surfaces; the majority of Au grains from Asheriat have irregular shapes. Some particles from upstream places exhibit

the hammering effect, which increases downstream due to transportation factors.

Additionally, these surface characteristics differ between sampling sites and among grains in the same samples. In contrast to the grains from Pakora and Teru, where most particle surfaces are worn down, indicating the influence of stream transport, Asheriat and Shoghor contain primarily irregularly textured particles that reflect close sources. Compared to Shoghor or Asheriat, Pakora and Teru have more gold with smooth, spongy textures and smooth contours (Ali, et al., 2014).

### ***Mineral inclusions***

Effective information on Au bedrock sources, such as possible ore minerals and gangue, can be obtained from the kinds of mineral inclusions found in Au grains (Chapman, Leake, & Styles, 2002). For instance, enargite inclusions can determine if a mineralization is classified as having low or high sulphidation (Mortensen et al., 2004). Apatite, pyrite, quartz, and other silicates are the most frequently occurring inclusions in Asheriat samples, with traces of molybdenite. Appropriate silicates such as pyrite, quartz, arsenopyrite (with modest peaks for Ni-Co), and rutile were most frequently found in Pakora samples. In contrast, CuS, CuO, CaO, apatite, pyrite, chalcopyrite, and other silicates were most commonly found in Teru samples. Qualitative SEM examination makes it unable to gather comprehensive information regarding silicate. Upon comparing the mineral inclusion data with the EPMA data of the Au grain, it becomes evident that inclusions of CuO and CuS are present in high Cu grains (up to 25 weight percent Cu, which typically have low Ag, <0.2 weight percent). On the other hand, Au grains with elevated Ag (~10 wt%) are linked to chalcopyrite inclusions. Grains with an Ag concentration ranging from 1 to 17 weight percent contain arsenopyrite. Whereas two Au grains from Shoghor contained bindheimite ( $\text{Pb}_2\text{Sb}_2\text{O}_6(\text{O}, \text{OH})$ ) and boulangerite ( $\text{Pb}_5\text{Sb}_4\text{S}_{11}$ ), which are likely to be an alteration product of boulangerite, which is known to occur in zones of mineralization in the area, no significant inclusions were found in the mineral inclusions of the Au grains from the Bagrote mining area (Ali, et al., 2014)

### ***Gold grain proximity to a source***

Assessing the distance from the bedrock source using morphological features for Au grains has been done extensively (Townley et al., 2003). According to (Grant, Lavin, & Nichol, 1991), grains with rounded and abraded shapes are typically thought to have been transported by streams and/or glaciers over distances greater than 1000 m. Grains with irregular shapes generally are

thought to have originated from distances between 1 and 1000 m.

Numerous researchers have reported finding Au grains in North Pakistan's rivers and streams (Sweatman, Clavarino, & Dawney, 1995); however, their morphologies as a distance measure from source have not been published. Therefore, these investigations were conducted for the Teru, Pakora, and Asheriat catchments, which were chosen based on the presence of anomalous Au in samples of stream silt and the catchments that had areas known to be mineralized (Bagrot and Shoghor). According to (Alam, Li, Santosh, & Yuan, 2019), only 6% of the Asheriat, 14% of Pakora, 14% of Teru, and more than 30% of the Bagrote area have rounded to sub-rounded morphologies. Glacier transit was thought to be the cause of the circular shape of the Au grains found in Bagrote (Shah & Khan, 2004). Many writers would have concluded that the irregularly shaped particles originated within 1000 meters of their source (Rasmussen et al., 2006). The morphological examination of Au grains from Shoghor and Bagrote, which displayed flatness indices ranging from three to twelve, confirmed this association. Shoghor samples were taken from a location within 1000 meters of their identified source of bed rock, while glaciers transported Bagrote sediments for less than 10 kilometers. According to the criteria outlined by (Townley et al., 2003), the bulk of Au grains from all the catchments exhibit proximal sources in the grain shape data, demonstrating a strong correlation with the flatness index.

### *Deposit type*

The geochemical composition of placer gold has been the subject of numerous investigations to determine the style of mineralization. For instance, techniques based on microchemical fingerprints were developed by (Chapman et al., 2002), to discriminate Au particles from different environments broadly. The minor elements, primarily Cu, of gold grains from porphyry-related mineralization types are used to differentiate them (Townley et al., 2003). At least in part, fineness has been used to distinguish gold grains from different geological settings (Morrison, Rose, & Jaireth, 1991).

All these methods, nevertheless, are not without flaws. The fundamental reason for this is that in order to obtain sufficient information on the types of mineral inclusions, at least 30-100 Au grains are required (Leake, Chapman, Bland, & Condliffe, 1997). (Morrison et al., 1991) noted that different types of gold deposits exhibit distinct ranges of Au grain fineness. For example, porphyry-type deposits typically range from 700 to 1000, volcanogenic deposits from 650 to 850, and epithermal deposits between 440 and 1000 (Alam et al., 2019a). Compared to gold grains from Pakora, Teru, Bagrote,

and Shoghor, those from Asheriat display a finer fineness range of 700 to 990, closely aligning with porphyry-type deposits. Gold grains from Bagrote, Pakora, and Teru exhibit a narrow compositional range, suggesting the presence of one or more types of bedrock mineralization. Additionally, these grains show a correlation between high Cu and low Ag content, indicating a possible origin from high-temperature mineralization processes. In contrast, gold grains from Asheriat display a broader range of Ag content and lower Cu levels, suggesting a different type of bedrock mineralization formed under lower-temperature conditions (Ali, 2013).

By integrating Au grain morphology and geochemistry with a GIS-based model that characterizes geochemical relationships for various deposit types—such as mafic-ultramafic, porphyry-type, and quartz vein deposits—valuable insights can be gained. The observed correlation between Au grain fineness and proximity to the source, along with the shared geotectonic settings of Teru, Pakora, and the well-known Bagrote area (Chalt volcanic and quartz vein mineralization), suggests that these catchments may host similar styles of mineralization. Across most of Gilgit-Baltistan’s Karakoram Block and the Kohistan Island Arc, the GIS-based model predicts porphyry-type Cu-Mo-Au mineralization (Ali, 2013).

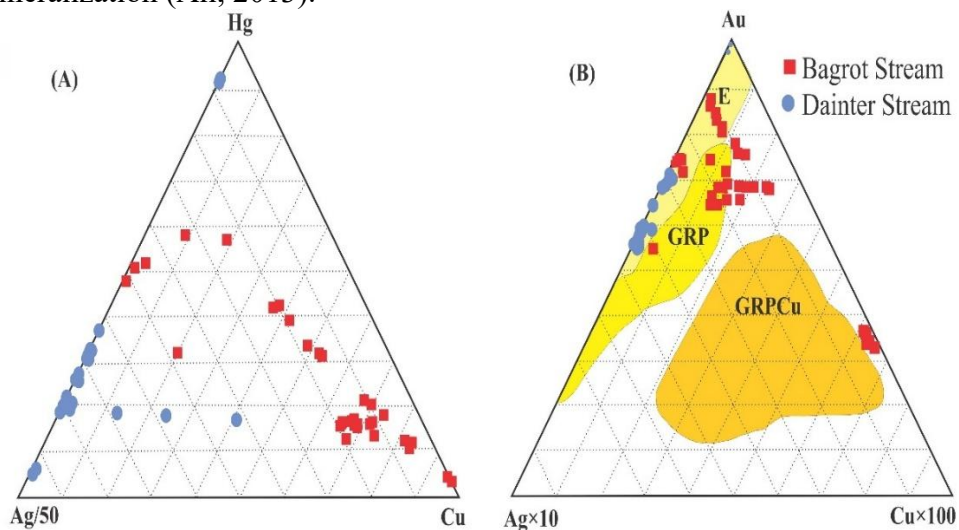


Fig. 7 Triangular plots showing the fields for different mineralisation styles (Alam et al., 2018) from Townley et al. (2003)

### ***Gold mineralization in sulfide-bearing altered shear zones***

There are several earlier research works on the sulfide shear zones in Pakistan's Kohistan Island arc (e.g., (Sheikh, Shah, Danishwar, & Ahmad, 2014). These studies from the sulfide shear zones of the Bagrote Valley show

that the concentrations of Cu, Pb, Zn, and Ni range from 5-96 ppm to 2-38 ppm to 9 ppm, 14 ppm, and 37 ppm, respectively, and 6-79 ppm to 37 ppm. Precious metals like Au, which have an average value of 0.083 ppm, vary from <0.05-0.161 ppm in these samples, and Ag, which has an average value of 0.64 ppm, from <0.05-11.30 ppm. Hydrothermal solutions are well known to be richer in sulfides, gold, and silver, which precipitate these metals at low temperature along fractures and other weak zones. This understanding stems from earlier investigations. It is possible that base metal sulfides, as well as gold and silver, precipitated along these altered/sheared zones due to the effects of hydrothermal solution inside the sulfide-bearing altered/sheared zones of the research area and the significant oxidation of sulfides in these zones. Nonetheless, surface weathering and the metals' erratic mobility are responsible for the enrichment of Au, Ag, and Pb and the depletion of Cu, Zn, Cr, and Ni in these zones (Shiekh, 2014; Miandad et al., 2014).

According to several studies, the altered/sheared zones containing sulfides are not economically significant regarding the amounts of gold found in surface samples. But, drilling into these zones and gathering samples at a depth could find interesting anomalies (Miandad et al., 2014).

There have been reports of several locations containing copper, cobalt, gold, and silver in the alteration zones caused by hydrothermal processes, although the concentrations are not high enough to be of commercial importance. These locality's rocks are similar to subduction-related calc-alkaline rocks of island arc type setting based on major and trace element chemistry and enrichment in large ion lithophile elements relative to high field strength elements with well-defined negative Nb anomaly. Hence, these rocks are considered a Cretaceous Kohistan Island arc component since they exhibit signatures associated with subduction (Sheikh, 2014; Miandad et al., 2014).

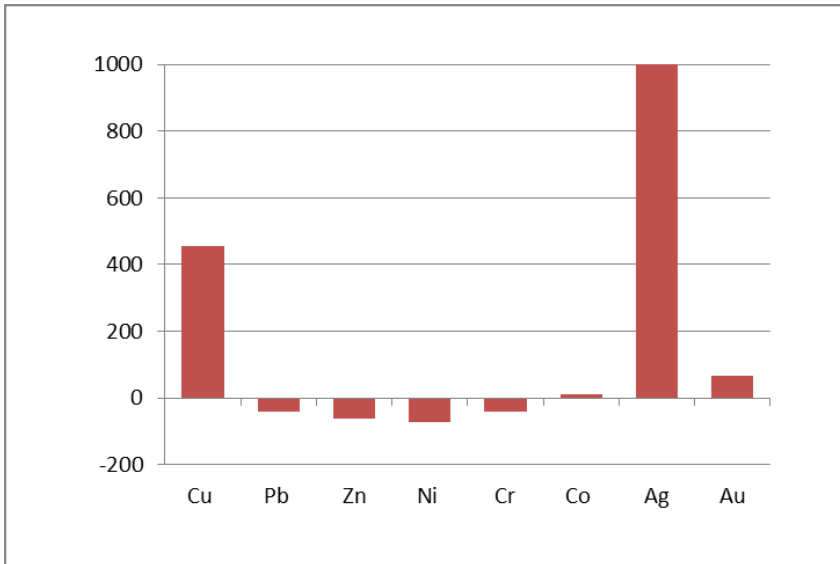


Fig. 8. Histogram displaying concentration of various metals in the altered sulfide zones and unaltered rocks of the Golo Dass Area ( Sheikh, et al., 2014)

### ***Gold in Peshawar Basin***

The southern edge of the Pakistani Himalayas is home to the intermountain basin known as the Peshawar Basin. Its south-eastern side is bounded by the Indus River, which is open for discharge, while its western and north-western mountain ranges are Khyber, Attock-Cherat, and Swat. (Fig. 8). Most of the Quaternary sediments in the Peshawar Basin date from the Pleistocene to the Recent era. These sediments are divided into piedmont deposits, lacustrine/loess sediments, and flood plain and stream channel sediments (Shah 2006).

The primary braided rivers in the basin are the Kabul, Swat, and Indus, which deposit sand, gravel, and clay carried over longer distances.

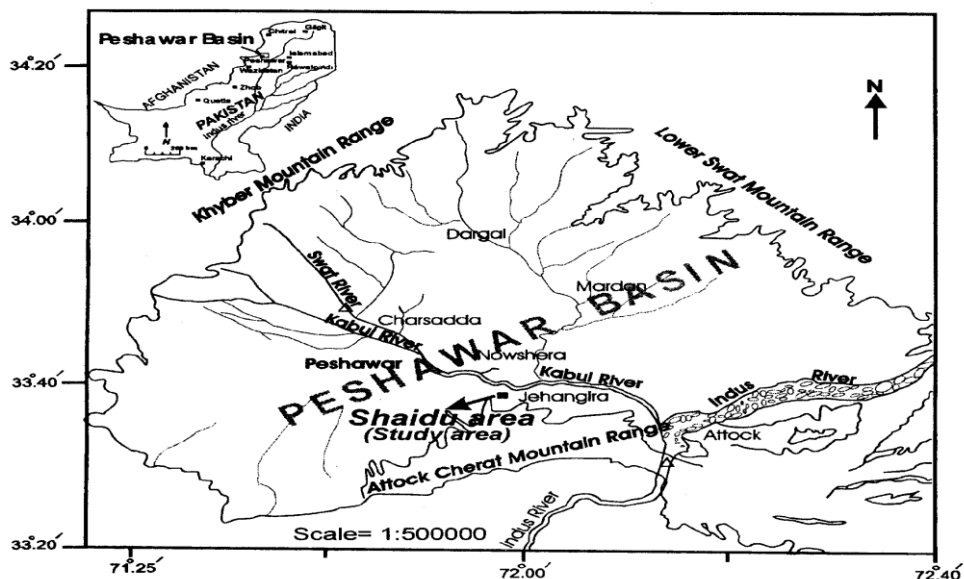


Fig: 9 Map of Peshawar basin (Shah, 2006)

By gathering representative samples of pan concentrates, the region has been examined for the first time for the presence of placer gold (Shah 2006). Studies in chemistry and mineralogy were conducted on these samples. These investigations indicate visible placer gold particles in the sediments under study, with varying sizes and morphologies, as well as significant concentrations of gold (up to 170 mg/kg). By building a mercury amalgamation facility on the site, it will be possible to extract the high recovery rate ( $> 30$  g/ton) of this economical-grade gold (Shah 2006).

Table 2: Au concentration in panned concentrates recalculated to total gold recovered in grams in Peshawar Basin (Shah, 2006).

Sample No.	Original sample's weight in Kg	Au in mg/kg	Au converted to g/kg	Wt. of gold in grams in original sample
SH-1	18.9	3.15	0.0032	0.06
SH-2	20.21	18.5	0.0185	0.374
SH-3	19.78	22.5	0.0023	0.045
SH-4	20.78	42.5	0.0425	0.883
SH-5	22.75	2.15	0.0022	0.049
SH-6	17.9	1.6	0.0016	0.029
SH-7	19.67	63	0.063	1.239
SH-8	20.23	2.85	0.0029	0.058
SH-9	20.65	39	0.039	0.805

<b>SH-10</b>	17.45	4.1	0.0041	0.072
<b>SH-11</b>	18.54	43.5	0.0435	1.152
<b>SH-12</b>	20.34	169.54	0.1695	3.448
<b>SH-13</b>	17.56	3.8	0.0038	0.067
<b>SH-14</b>	18.43	62.5	0.0625	1.152
<b>SH-15</b>	18.67	3.45	0.0025	0.064
<b>TOTAL</b>	291.86			9.15

The size and shape of the visible gold particles in the panned concentrates—which range from subangular to rounded and solid to flaky—indicate that the gold in this area originated and was transported by the Kabul River from a distant source that was at least a few hundred kilometres upstream, in either Afghanistan or the Chitral region of North Pakistan.

### ***Gold in Chagai magmatic arc (Baluchistan)***

The wealthiest mineral province in Pakistan is Baluchistan. The richest metallogenic zones in the Baluchistan province include the Indus Suture and the Chagai-Raskoh Magmatic Arc, but the Sulaiman and Kirthar are attempting to take the lead in sedimentary minerals. There are also small antimony deposits, asbestos, celestite, fluorite, magnesite, soapstone, Sulphur, and vermiculite.

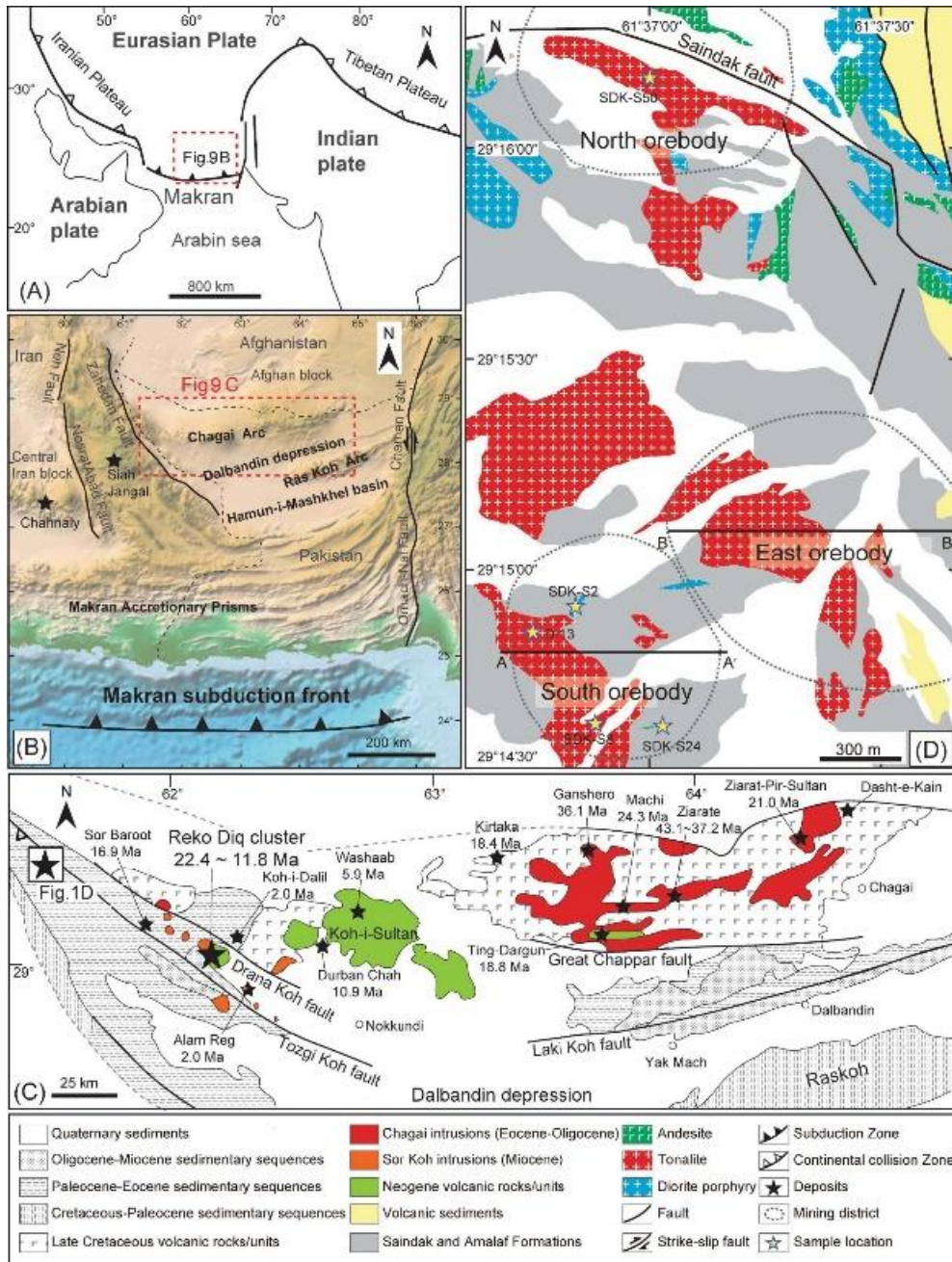


Figure 10. (A) Eastern Tethyan metallogenic domain's simplified tectonic framework (Wang et al., 2022). (B) the Chagai belt's regional geology (C) A simplified geological map of Pakistan's Chagai belt, based on geochronologic data from Perell'o et al. (2008) and Wang et al. (2022), and other sources. (D) Geological map (modified from Wang et al., 2022) of the Saindak porphyry Cu-Au deposit showing sample locations.

Pakistan's stratigraphy, fauna, and orogeny/tectonics demonstrate that Indo-

Pakistan was isolated as an island throughout the most likely Late Jurassic or Early Cretaceous to Middle Late Cretaceous.

The Chagai Arc is one of Pakistan's most significant mountain ranges in terms of economy. The magmatic rocks of this arc are closely linked to a variety of substantial minerals, such as porphyry (Cu-Mo-Au), and vein type copper, stratiform and skarn type iron, volcanogenic gold-silver and sulfur, and Kuroko-type lead-zinc-silver-copper (Siddiqui, 1996). Before (Siddiqui, 1996) findings, the oceanic island arc's calc-alkaline and tholiitic magmatism was thought to be a continental calc-alkaline magmatic belt of the Andean type.

Alkaline to calc-alkaline plutonic, volcanic, and sedimentary rocks make up the majority of the rocks that make up the Chagai belt (Razique, Tosdal, & Creaser, 2014; Wang et al., 2022). The Arabian Oceanic Slab's northward subduction beneath the Eurasian Continental Plate was the primary cause of the magmatism (Wang et al., 2022). This metallogenic belt is widely known for supporting many copper-gold porphyry type systems. It forms the northwest portion of Baluchistan. Durbanchah, Saindak, Koh-i-Dalil/Reko Diq, and Dnshte-Kain are the most significant and thoroughly researched deposits. These can be found scattered throughout the Chagai calc-alkaline magmatic belt, and they show settings that are somewhat related to seduction and magmatic processes. Developed during the Miocene, the Reko Diq complex is a sizable strato-volcano spanning an area of roughly 25 km x 20 km. It encircles several closely spaced porphyry systems that are revealed in the highly eroded wide valley (Wang et al., 2022).

Numerous porphyry copper deposits with gold and silver mineralization have been found by Geological Survey of Pakistan (GSP) (M. Ahmad, 1986). There are additional reports of skarn deposits and telethermal vein types. In partnership with Broken Hill Propriety (BHP) of Australia, GSP has found world-class gold reserves. Additionally, copper and related gold deposits, as well as their alteration zones, were investigated by Lake Resources (Australia) (Kazmi & Abbas, 2001).

### ***Rickodiq Porphyry System (Cu, gold)***

The Reko Diq copper ore deposits in Pakistan are the fourth largest in the world (about 87 million tons) and contain gold, silver, and molybdenum. It is situated on the Tethyan magmatic arc's Chagai volcanic belt, which stretches from Northern India to Pakistan, Iran, and Turkey. The region is 140 km wide and 400 km long. The Reko Diq Copper-Gold deposits are situated at an average elevation of around 1300 meters in the western portion of the Baluchistan province (Jones, 1960). It is mostly a sparsely populated low-

relief desert with summer temperatures between 40 and 45 degrees Celsius and winter temperatures between 10 and 5 degrees Celsius with fewer than 40 millimeters of precipitation. These desert conditions are the setting for the Reko Diq project. A treasure of about 12.3 million tons of copper and 20.9 million ounces of gold is hidden beneath the desert's dunes. According to (Siddiqui, 1996) and (Perelló, Raziq, & Schloderer, 2008), the Chagai Arc is one of Pakistan's most significant mountain belts regarding mineral resources. The arc's magmatic rocks are associated with various metal deposits, such as porphyry copper-gold, vein-type copper, stratiform and skarn type iron, volcanogenic gold silver, and kuroko-type silver-lead-zinc-copper. Within a 10-square-kilometer radius, a cluster of eighteen economically significant minerals and copper-gold deposits can be found in the Reko Diq.



Fig.11. Dry land of Chagai containing Copper-Gold deposits (source internet).

With an average copper grade of 0.53% and an average gold grade of 0.30 g/ton, the formation of Copper-Gold deposits at Copper-Gold Porphyry was greatly aided by the numerous crosscutting igneous intrusions that were followed by late-stage hydrothermal activity. A billion-ton economically mineable section of the deposit is anticipated to produce 200,000 tons of copper and 250,000 ounces of gold annually from 600,000 tons of concentrate. Reko Diq Baluchistan's gold and copper reserves are ranked fourth globally.

### ***Saindak Cu-Au deposit***

Situated in the west Asian metallogenetic zone of the Tethyan metallogenetic domain, and being the part of the Chagi-Raskoh Fe, Cu, Au metallogenetic zone, the Saindak Cu-Au deposit is one of Pakistan's major porphyry deposits. This regional ore deposit represents a concentration area for Cu, Fe polymetallic metallogenesis and is concentrated along a certain structure position. This metallogenetic zone comprised of Saindak porphyry Cu-Au, Dasht-ekain Pb, Zn and Dasht-ekain Pb, Zn, etc, which are the known principal multi-metallic deposits (JIAN et al., 2014). According to estimates (JIAN et al., 2014; Wang et al., 2022) the total reserves in Saindak are 237,024 tons of Cu with an average grade of 0.40% and 9777 kilograms of Au with an average grade of 2.1 g/t.

### ***Alteration Type***

According to Runtang (2014), the primary types of alteration include gasification, potassium feldspar alteration, silicification, sericitization, clay grouting, chlorination, saussuritization (epidotization), albitization, and biotitization. Cu (Au, Mo)→Cu(Au)→Pb-Zn is the sequence in which the metallogenesis element zonates from inner to outer and from lower to upper (JIAN et al., 2014; Wang et al., 2022).

### ***Geology of Ore Body***

A huge lenticle ore body made of fine vein disseminated ore is created in the middle of the rock body, whilst the veined ore body is near the margin. The ore body is in the "biotite quartz diorite porphyry" body described in the Saindak model. The metallogenesis occurs in tandem with the alteration. Cu is the primary metallogenetic element; other components include Au, Ag, Mo, S, Pb, Zn, and many more. The primary strata are the Oligocene Amalaf Formation and the Tertiary Eocene Saindak Formation. Andesite porphyry, diorite vein, and dike, as well as biotite quartz diorite porphyry body (stock), are intruded upon by these formations. The key strata that the ore-bearing porphyry body has invaded among them is the Saindak Formation (JIAN et al., 2014).

### ***Siahan and Makran ranges***

This zone has enriched mineralization of gold, silver, and sulfur. Gold and silver mineralization related to stibnite has been identified through chemical investigations. The antimony mineral is scattered throughout the finely-grained gold that was discovered. Gold, silver, and sulfur mineralisation is enriched in the Kuchaki North locality. The antimony mineral is scattered

throughout the finely-grained gold that was discovered. Additional locations (Fig.11c) of stibnite linked to gold and silver and hosted by quartz-carbonate veins (M. S. Malkani, 2015) include Ahmadab Kaur, Sor Jor Jauder, Mahmoodi Kaur, Kasig Kaur, Musa Kaur, Panir body east, Nagindap Damagi, Hashani Damagi, Hashani, and Panir Body west. However, no more research has been done in this area regarding the sorts of deposits or gold reserves.

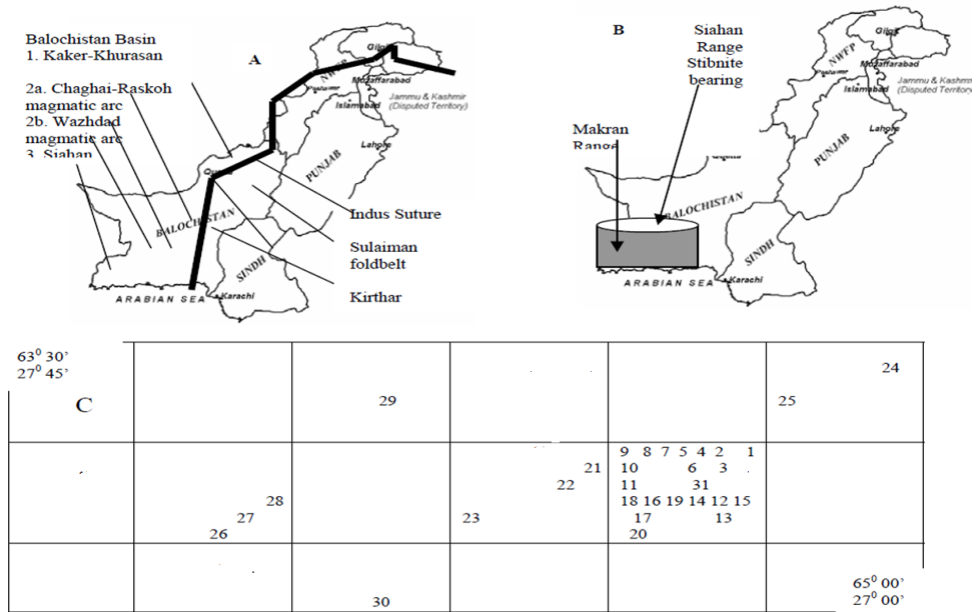


Figure 12. (a) The majority of Balochistan Province is depicted in the southwest of Pakistan; (b) the black and grey rectangles represent the Makran Range of the Balochistan basin; (c) the major mineral localities in the Makran (and Siah) basin are represented by the white oval in the north, which represents the Siah Range, which is home to the antimony mineral. The locations of stibnite-gold are: 1-Jauder, 2-Mahmoodi, 3. Jor Jauder, So Jor 4-Hashani, 5-Damagi Nagindap, 6-Damagi Hashani, Ahmadap, 7 Body East: 8 Panir, Body West: 9 10-Northern Slope, Kasig 11-Musa Kaur Kuchi North (12) and Kuchi South (13). Gokumb (number 14), Siagari (15), Surmagi North (16), and Surmagi South (17) 19-Hurain, 20-Kulo, 21-Gazin, 18-Huspi, 22-Aj Geiji, 24-Lidi, 25-Miani, 23-Siminj, 26-(M. Sadiq Malkani, 2011) Machi Koh, 27-Mir Baig Raidgi, 28-Safed Gilanchi, 29. Palantak, and 30-Saghar. Modified after (Malkani 2011).

First-hand reports of certain fresh discoveries in the Makran and Siah mountains were made by (M. Malkani, 2004). The arc basin containing stibnite in Qila Abdullah is located in the back arc basin of northern Balochistan, whereas the remaining arc basin containing very tiny quantities of stibnite are found in the southern Baluchistan forearc basin (Fig.11c). The strike slip fault exposes antimony, gold, quartz carbonate vein, and related

minerals south of Bibi Jan Ziarat. It is located at the base of Koh Sabz Ridge Extension and on the northern slope of the ridge continuation (M. S. Malkani, 2015).

## **Conclusion**

This report briefly reviews the gold occurrences/deposits in different metallogenic belts i.e., Kohistan and Karakoram Block, Peshawar Basin, Chagi magmatic arc and Makran and Siahn ranges in Pakistan. The studies on gold deposits in Pakistan are very limited, hence the limited prospecting and exploration activities. The Kohistan and Karakoram Block contains numerous occurrences of Au where high contents of gold has been reported in stream sediments and bed rocks such as in Bagrote, Bar, Shagor, Ashrait, Pakora, Shimshal areas. The sources for these placer gold deposits are not known. Also, there are gold-bearing sulphide shear zones across north Pakistan, where appreciable Au contents were reported. But the detail studies have not yet been done on these deposits. Also, the prospecting and exploration activities are negligible in other metallogenic belts of the country. The Chagi magmatic arc in the Baluchistan basin contains world deposits of gold such as Rikodik and Saindak copper and gold deposits. The Peshawar basin also contains placer gold but the sources are not known. There are many Au occurrences in Makran Siahn orogenic belt, and a detailed study on these deposits has not been done till date.

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