



# CPEC NORTHERN ROUTE ROAD CONSTRUCTION ACTIVITIES IN KHYBER PAKHTUNKHWA **AN ENVIRONMENTAL REVIEW**

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CPEC Northern Route Road Construction Activities in Khyber Pakhtunkhwa

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# CPEC NORTHERN ROUTE ROAD CONSTRUCTION ACTIVITIES IN KHYBER PAKHTUNKHWA

## **AN ENVIRONMENTAL REVIEW**

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## Civil Society Coalition for Climate Change (CSCCC)

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# TABLE OF CONTENTS

<b>ACRONYMS</b>	<b>01</b>
<b>INTRODUCTION</b>	<b>02</b>
<b>METHODOLOGY</b>	<b>04</b>
<b>RESULT AND DISCUSSION</b>	<b>05</b>
3.1 Environmental impact due to road construction process, equipment and material use	<b>05</b>
3.2 CPEC northern road route in studied KP districts	<b>05</b>
3.3 Salient features of six studied districts along CPEC northern route in KP	<b>06</b>
3.4 Environmental Review: Assessment and findings	<b>07</b>
<b>CONCLUSION AND RECOMMENDATIONS</b>	<b>11</b>
<b>REFERENCES</b>	<b>13</b>
<b>ANNEXURES</b>	<b>15</b>

## ACRONYMS

<b>KKH</b>	Karakorum Highway
<b>OBOR</b>	One Belt, One Road
<b>CPEC</b>	China-Pakistan Economic Corridor
<b>EIA</b>	Environmental Impact Assessment
<b>FDI</b>	Foreign Direct Investments
<b>VOCs</b>	Volatile Organic Compounds
<b>PM</b>	Particulate Matter
<b>PAHs</b>	Polycyclic Aromatic Hydrocarbons
<b>KP</b>	Khyber Pakhtunkhwa
<b>NHA</b>	National Highway Authority
<b>KM</b>	Kilometers
<b>HA</b>	Hectare
<b>KM/HR</b>	Kilometer per hour
<b>FT</b>	Foot – unit of length
<b>SQ KM</b>	Square Kilometer
<b>M</b>	Meters
<b>&gt;</b>	Greater than
<b>&lt;</b>	Less than
<b>≈</b>	Approximately

# INTRODUCTION

Pakistan-China relations date back to the Silk Route, but formal ties began in 1950. Pakistan was the first Muslim country to recognize China as People's Republic and Pakistan International Airlines was the first airline in the world to operate a service to and from China. China has steadily appeared as Pakistan's largest trading partner (Holtom et al. 2013). The Pak-China relationship has grown steadily since 1960s and now the two countries privilege a deep friendship. The construction of Karakorum Highway (KKH) in 1972 further strengthened this bond. China-Pakistan Economic Corridor (CPEC) is a part of China's One Belt, One Road (OBOR) initiative. OBOR is a multifaceted framework of infrastructure, energy and other developmental projects designed to promote regional connectivity among Pakistan, China, and Eurasia. CPEC was inaugurated as a \$46 billion investment in April 2015 (Rifaat & Maini 2016); by 2017 the investment value increased to \$62 billion (Siddique 2017). Under CPEC, China will gain direct access to the Middle East, Africa and Europe through the warm Arabia Sea and Gwadar deep sea port, whereas Pakistan will gain modernization of infrastructure and overall economy through investments in energy, rail, roads, agriculture and industries (Irshad 2015).

Many projects have been started under CPEC, including: railways network construction, establishment of power plants, development of Gwadar Port and the development of economic zones and social sector projects, and the country-wide construction of roadway networks which can be divided into quadrants running North, West (unobstructed route from Kashgar, Xinjiang, China through Pakistan to Gwadar), East and Central (Annexure I). Development of 2,700 km network of roads include the reconstruction of KKH (254 km), Peshawar-Karachi Motorway (392 km) and N-30 (110 km), and up gradation of N-50 Phase-I (210 km) at an estimated investment of \$34 billion (Saeed 2017). CPEC will link seaports in Gwadar and Karachi with Northern Pakistan as well as points further North in Western China and Central Asia (Kugelman 2015). It will serve as an investment vehicle and corridor for cargo transport, minerals, energy production and commercial activities.

There are numerous benefits of CPEC roadway networks to Pakistan. Most of these benefits are social and economic in nature. However, avoidance of possible environmental costs associated with such infrastructure investments is crucial to Pakistan moving along a sustainable development pathway. Majorly, the benefits will include fulfilling Pakistan's energy demand, the establishment of international standard road and railway networks, capacity building, and increase in employment opportunities.

Environmental Impact Assessment (EIA) is the requirement under national environmental legislations of both Pakistan and China. It is also an international obligation, as ratified by both countries, under the Declaration on Environment and Development (Saeed 2017). Examining EIAs of Chinese Foreign Direct Investments (FDI), air quality and water consumption were the top two challenges identified. This is particularly important to note, given existing environmental problems in Pakistan, which include steep air quality deterioration and increasing water scarcity (Huang et al. 2017). Further, analysis from the Multi-Fuzzy Comprehensive Evaluation Model for environmental and social risks warns that the construction of investment projects have the most direct and obvious impacts on water, air and biodiversity and the resulting risks to these would be significantly greater than the same to soil and noise (Zhang et al. 2017). This presents a case for environmental and health concerns amid economic growth projections under CPEC.

## Environmental Review of CPEC Road Construction in KP

Huang et al. (2017) and Zhang et al. (2017) have conducted general environmental and social impact assessment of CPEC projects inventory. Their work has provided the framework for the present study, described ahead, which is an environmental review of only the road construction activities under CPEC (Figure 1) along the northern route in KP (Sazin - Sarai Gadai). The objectives of this study are to:

- 1) Conduct an environmental review and assessment of road construction activities

- in the six districts of KP along the CPEC northern route;
- 2) Identify the environmental segments and the districts that are at high risk of exposure and degradation from the road construction activities; and
  - 3) Recommend possible control measures for mitigation and protection of identified affected environmental segments in the six districts, in order to safeguard the health of population of the districts under study.



Figure 1: Districts in KP along northern CPEC road route.

## METHODOLOGY

Secondary data was collected through various means for the purposes of this study. Existing literature on the CPEC project and environmental and socio-economic profile of the studied districts was explored and consulted. Various online resources were also utilized. Further information was gathered through personal communication with the authorities concerned in Pakistan.

Road construction materials and processes (Section 3) and its associated equipment (Annexure II), route length, identified locations and main cities in each district along the KP CPEC road route and accessible route specific information (Table 1-2) were used to determine salient features of each of the studied districts in KP (Table 3, Annexures III, and Figures A–F) were used to determine.

As described and discussed in the foregoing pages, the impact of road construction activities

(3.1./3.4.1/Table 4) on environmental segments are graded by considering the extent of emission/releases from different phases/processes during road construction. Relative district exposure to these impacts are assessed (3.4.2./Table 5) by taking into consideration the district road length, population, forest and cultivated areas. As concluded in the last section (# 4), the overall districts categorization (in terms of most resistant to most vulnerable vis-a-vis CPEC road construction activities) is based on the collective exposure to the studied environmental segments (population, forest & cultivated areas) of each district. The study was conducted only on KP part of the CPEC route, which enters into Kohistan, passes through the districts of Shangla, Battagram, Mansehra, Abbottabad and makes an exit from Haripur (Figure 1 & Annexures III Figures A-F).

## 3. RESULT AND DISCUSSION

### 3.1 Environmental impact due to road construction process, equipment and material use

The road construction process will output a flexible pavement highway. The construction process involves:

- 1) Staking, to help keep soil disturbance to minimum possible;
- 2) Clearing & grubbing, which involves tree cutting/organic debris & stumps removal;
- 3) Sub-base formation construction through side casting;
- 4) Base course preparation (using stone, slag/gravel, cement, asphalt coarse & fine aggregates, soil, water & other material)
- 5) Compaction/grading and making of the final layer of hot asphalt mix (150-1770C) with further compacting, employing rolling at a speed of 5km/hr.

Additionally, construction of bridges and tunnels on the route will require iron and steel to make the structural support along with already described materials and the design of each bridge will depend on the topography of its location. Tunnel construction is done by drilling and blasting in the mountains (Adesiyun et al. 2008; Geyik 1986; Robinson & Thangesen 2004). Most of the road construction equipment is heavy machines and dozers whose engines run on diesel (Annexures 2) and thus requires a temporary workshop close to construction site for longer projects, like of CPEC, for their regular maintenance and repair in case of any technical or mechanical glitch.

### 3.2 CPEC northern road route in studied KP districts

The details of the CPEC KP route (334.2 kms), including route length in each district are given in Table 1.

**Table 1: Route of CPEC in studied KP districts**

Districts	Route Length	Route	Main Cities
<b>Kohistan</b>	≈ 134 km	Sazin, Barseen, Dasu, Komila, Leo, Pattan, Palas, Dhup, Dubair	Dasu, Pattan
<b>Shangla</b>	≈ 26.7 km	Besham, Shung, Dandai	Besham
<b>Battagram</b>	≈ 41.5 km	Thakot, Chanjal, Peshora, Battagram, Chappargram, Phagora	Thakot, Battagram
<b>Mansehra</b>	≈ 59 km	Sharkah, Icherrian, Shinkiari, Shinai bala, Dhodhiyal, Hathimera, Mansehra	Shinkiari, Mansehra
<b>Abbottabad</b>	≈ 42 km	Mast mera, Sajikot, Abbottabad, Khokar maira, Havelian, Irshad Nagar, Nowshera, Bhalder	Abbottabad, Havelian, Bhalder
<b>Haripur</b>	≈ 31 km	Mohri, Shah Maqsood, Chak Shah Muhammad, South of Haripur and then Kot Najibullah, Khattar Town	Haripur

Urooj 2017; Saeed 2017; National Highway Authority 2017

	Section I Havelian- Abbottabad	Section II Abbottabad- Mansehra	Section III Mansehra-Thakot	Total
Road Length (km)	27.3	9	78.7	115
No. of Lanes	6		2	12
Lane Width (ft)	98	66	33	197
Bridges (>100 m)	26	4	29	59
Bridges (<100 m)	10	4	25	39
Tunnels	2	4	0	6
Toll Plaza	3	2	2	7
Area covered by route (sq. km)	8.15	0.1810	0.791	9.122

Source: The data has been gathered by authors themselves after discussion with GM (Planning) National Highway Authority Mr Lohano in July, 2017

The study was conducted only on KP part of the CPEC route stretching 334.2 km. The route maximum and minimum length are in districts Kohistan and Shangla, respectively, whereas Battagram and Abbottabad have almost equal route lengths (~42 km). Complete road construction related information is not available. However, accessible for the three sections (total route length = 115km) Thakot-Mansehra, Mansehra-Abbottabad and Abbottabad-Havelian along KP CPEC is given in Table 2. Lane width, number of bridges and number of tunnels in three sections vary between 33-98 ft, 8-54 ft and 0-4ft, respectively.

### 3.3 Salient features of six studied districts along CPEC northern route in KP:

Located in northern of Pakistan, KP districts have immense natural beauty and aesthetic appeal, which requires additional measures to ensure environmental impact is reduced. Haripur has both plains and mountain whereas Abbottabad and Mansehra are mountainous and are situated at a higher altitude compared to Haripur. Table 4 enlists some salient features of the studied districts.

**Table 3: Salient features of districts**

Districts	Population	Total Area (sqkm)	Cultivated Area (Ha)	Forested Area (Ha)
Kohistan	472,570	7,492	14,871	87,695
Shangla	435,563	1,586	41,759	44,407
Battagram	307,000	1,301	24823	70,820
Mansehra	1,152,839	4,579	80,747	332,252
Abbottabad	881,000	722	25,645	15,558
Haripur	692,228	1,725	31,499	32,168
<b>Total</b>	<b>3,941,200</b>	<b>17,405</b>	<b>219,344</b>	<b>582,900</b>

Urooj, 2017; Saeed, 2017

Among the six select KP districts, **Kohistan** (Annexure III, Figure A) has the largest total area (7,492 sq.km.), the second largest forested area (88,000 Ha), and the smallest cultivated area (14,871 Ha). Its considered mountainous, with

valleys that are populated. The three highest mountainous ranges Himalayas, Karakoram and Hindukush co-join the Kohistan district. The Indus river cuts through the heart of the district. Forests consist of trees/shrub, oak and pure deodar.

Mountains are sub-tropical and temperate. Annual production of *Kharif* and *Rabi* crops are 56,154 tons and 2,441 tons respectively (Urooj 2017). Over 140 species of birds have so far been recorded in Palas sub-division along with some west Himalayan species. There are four pheasant species and some globally threatened species, including Markhor.

The Indus River is the major source of water, alongside the numerous rivulets that run through the district. A lot of other streams and waterfalls also emerge in the summer season, the result of snow melt (Urooj 2017).

**Shangla** district (Annexure III, Figure B) has the second largest cultivated area (41,759 Ha.) and the second lowest population (435,563). It is located between hillocks and is surrounded by high mountains, with the forests on the slopes. Forests are the main source of income for this district. It contains fertile land, with main crops produced there being maize, wheat and rice. The annual crop yield of *Kharif* crops is 41,044 tons and for *Rabi* crops it is 16,963 tons. A number of medicinal plants of economic importance are found in this area. Rains are usually of long durations, so plenty of streams and rivers flow through the district (Urooj 2017).

**Battagram** (Annexure III, Figure C) has the lowest population (307,000) among the six districts. Its flora contains many medicinal plants. It has two main streams – Nindhyar khwar and allai khawr (Urooj 2017).

**Mansehra** district (Annexure III, Figure D) has the highest population (1,152,839) and the largest cultivated (80,747 Ha.) and forest (332,252 Ha.) areas. Topographically the area is dominated by high mountains. There are a few level tracts and fertile valleys in the mountains. Indus, Siran, and Kunhar rivers flow through the district. Mansehra population also has access to piped water and about 21% population uses groundwater drawn from wells. Many herbs of medicinal value grow in Mansehra and it is a home to a variety of migratory birds (Saeed 2017).

**Abbottabad** (Annexure III, Figure E) is the second most populated (881,000) district after Mansehra with minimum cultivated (25,645 Ha.) and forest (15,558 Ha) areas. Siran and Kunhar rivers have innumerable tributaries in this area. Around

32.73% of the housing units have access to piped water within their houses and the rest of the population uses water from wells and ponds. Wheat and maize are the major crops. A wide variety of fruits are grown in the district (Saeed 2017).

**Haripur** (Annexure III Figure F) is the third most populated (692,228) district with the third largest (31,499 Ha.) cultivated areas, but it is also the second lowest (32,168 Ha.) forest areas among the studied KP districts. Having both mountains and plains, it is situated about 610 meters above sea level. Soils of Haripur is silty loam and silty clay loam texture. Haro, Siran, and Indus rivers flow through the district. Tarbela Dam was built on this portion of Indus River. *Dalbergia sisso* (Shisham), *Morusable* (Toot) and *Acasia Arabica* (Kiker) are most common. The area has a wide diversity of fauna, including Chukor. Main source of income for most population is agriculture. Wheat and maize are the major crops. Many fruits, including louqat, oranges, peaches, plums, pears and mangoes are grown in the area. Around 65% of the housing units in the district have access to piped water within their own houses and the rest of the population uses wells, ponds and hand pumps for their water needs (Saeed 2017). An earlier study carried out on the quality of potable drinking water samples from 13 localities in Haripur did not show any distinct impact due to pollution (Khan, Khwaja & Riaz 1999). However, the increased activities like the ones under CPEC, without appropriate safeguard to protect water sources may cause water pollution in the long run and affect public health.

### 3.4 Environmental Review: Assessment and findings

#### 3.4.1 Relative environmental impact due to construction material, equipment & process:

Studies by Huang et al. (2017) and Zhang et al. (2017) are very general in assessing environmental and social impacts of the overall CPEC projects, taken as whole. The present study on the KP road route indicates that the impacts of the road construction activities are different and vary with the process and component (Table 4; Annexure II). Most of these impacts have a detrimental effect on the environment & public health and require mitigation measures to minimize the damage.

**Table 4: Impacts of the road construction activities on various environmental segments/parameters**

	Selected environment segments/parameters										
	Air		Water		Land				Noise	Ecology	
	Emissions	Dust	Surface water	Ground water	Topography	Agriculture	Landscape	Soil	Noise level	Habitat	Biodiversity
<b>Construction Processes</b>											
Staking	NE	LA	NE	NE	LA	LA	LA	LA	NE	NE	NE
Grading	LA	<b>A</b>	<b>A</b>	LA	LA	NE	NE	<b>A</b>	<b>A</b>	LA	LA
Compacting	<b>A</b>	LA	NE	NE	NE	NE	NE	B	LA	NE	NE
Paving	<b>A</b>	NE	LA	NE	LA	NE	LA	LA	LA	<b>A</b>	<b>A</b>
Rolling	LA	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
<b>Equipment use</b>											
Dozers	LA	<b>A</b>	LA	NE	NE	NE	NE	<b>A</b>	<b>A</b>	NE	NE
Vehicles/ Trucks	<b>A</b>	<b>A</b>	LA	NE	NE	NE	NE	LA	<b>A</b>	NE	NE
Pavers	<b>A</b>	LA	LA	NE	NE	NE	NE	<b>A</b>	<b>A</b>	NE	LA
Rollers	LA	LA	NE	NE	LA	NE	NE	LA	LA	NE	NE
Generators	<b>A</b>	LA	NE	NE	NE	NE	NE	NE	<b>A</b>	NE	LA
<b>Materials use</b>											
Cement	<b>A</b>	LA	<b>A</b>	LA	NE	LA	NE	LA	NE	NE	LA
Water	B	B	LA	<b>A</b>	NE	<b>A</b>	NE	NE	B	NE	LA
Asphalt	<b>A</b>	NE	LA	LA	NE	NE	NE	LA	NE	NE	NE
Lime	NE	NE	<b>A</b>	LA	NE	NE	NE	NE	NE	NE	NE

**Legend:**

**A:** Adverse;      **B:** Beneficial      **NE:** No Effect      **LA:** Low Adverse

As evident from Table 4, all the segments of environment will suffer damage, varying from adverse to low, from CPEC road route construction in the studied districts. Air quality might be severely affected due to the increased material and frequent activity of vehicles/equipment use, resulting in higher emissions. Vehicles would be covering a lot of

distance from far/near point sources to transport raw and other materials for the road construction. For instance, trucks transporting cement will travel on a minimum average of 221 km to reach the construction site and for asphalt that distance is 110 km. Steel and Iron for the bridges will be transported on a minimum average of 157 km. These distances were calculated by determining

the average distance of the nearest industry/material collecting source to the construction sites from the major cities located along the CPEC route in KP. Running of machines, generators and vehicles functioning on fossil fuel (mostly diesel) will contribute to a high amount of emissions, being released to the atmosphere. Amount of gases such as Oxides of Nitrogen, Carbon, Sulfur, and Volatile Organic Compounds (VOCs) would likely to be enhanced to the air. Furthermore, most importantly, there will be substantial increased of dust and particulate matter (PM) due to excavation, blasting, filling and transportation activities in the studied district. VOCs may also arise from the hot-mix asphalt and paints used in the finishing phase of the roads construction (Kim et al. 2004). CPEC route passes through the highly populous areas of the districts, particularly Mansehra, Abbottabad and Haripur, therefore, those living close to the construction sites may suffer from airborne diseases.

From the environmental impact due to construction processes, equipment and material use in CPEC road route, as described in Table 4 and from the preceding discussion, the following conclusion can be inferred:

- Adverse environmental impact in the increasing order seem to be caused by Equipment use > Construction processes > Material use

### 3.4.2 Relative impact/exposure of environmental segments of the studied KP districts to CPEC route road construction activities:

Table 5 describes in decreasing order the level of exposure of the select environment segments (population, forest and cultivated areas) for the six studied district along the CPEC road route where construction activities are expected.

**Table 5: Relative impact/exposure of environmental segments of the studied KP districts to CPEC road route construction activities:**

<b>Environment Segments</b>	Maximum	2	3	4	5	Minimum
<b>Population</b>	M	A	H	K	S	B
<b>Forest Area (Ha)</b>	M	K	B	S	H	A
<b>Cultivated Area (Ha)</b>	M	S	H	A	B	K
<b>Total Area (sq. km.)</b>	K	M	H	S	B	A
<b>CPEC Road Length (km)</b>	K	M	A	B	H	S

Legend: K = Kohistan; S = Shangla; B = Battagram; M = Mansehra; A = Abbottabad; H = Haripur

The CPEC route road length in Mansehra district is about half that of Kohistan district (Table 1). However, among all six KP districts under study, it has the largest population, highest forest and cultivated areas (Tables 1 & 5); as such, Mansehra district population (particularly vulnerable children, women & elderly) and its environment would be *most adversely affected* from the CPEC route road construction emissions & releases. Although the road length in Battagram district is of about the same length, as that of Abbottabad (Table 1), among all the six districts it could be

*least adversely affected*, as it has the lowest population (about one third of Abbottabad/Table 3) and second lowest cultivated area (Table 5). Kohistan, Abbottabad & Shangla have the second largest forest area, population & cultivated area, and these would be more exposed/affected compared to the other districts (except Mansehra). In view of the CPEC road route length, the impact on these environmental segments of the districts seem to be in the order Kohistan (highest road length) > Abbottabad > Shangla (minimum road length). Similarly, Haripur forest

area (2nd lowest) would also be comparatively less affected due to shorter CPEC route road length which is only longer than that of Shangla (Tables 3 & 5).

The process of road construction involves a lot of water usage, resulting in possible stress on water availability to the local populations of the studied districts. Such stress could be maximum for Kohistan (longest route road) and minimum for Shangla (smallest route road). Mansehra and Abbottabad, despite shorter route road length, could also face water availability stress due to proportionately higher population in these districts that have an abundance of water supply and are rich in ground and surface water resources. Indus River flows in Haripur. Haro, Siran, and Dor rivers flow in Haripur and Abbottabad. Siran and Kunhar rivers pass through Mansehra. Many tributaries and smaller streams are also present in the study area. Construction of 98 bridges (Table 3) shows that the route will likely be crossing over these water bodies quite a few times. The CPEC route will cross over Dor river in Haripur district and travel parallel to it in southern Abbottabad. The route will cross over Siran thrice and will travel parallel to Burkas stream in Mansehra. Construction activities could affect water quality of the rivers and their tributaries due to the deposition of dust, disposal of debris, rock blasting for tunnels, use of explosives (usually chemicals based) tunnel-making/road construction, use of de-icing chemicals (such as chloride, acetate & formate salts, urea, glycol) and erosion of soil. Surface run off from the construction site may take along with it leaked/wasted diesel, motor oil, grease, welding wastes, heavy metals and Polycyclic Aromatic Hydrocarbons (PAHs) (Burton and Pitt 2002). Aforementioned rivers and their tributaries, especially Siran in Mansehra, are very likely at risk of water pollution because of being in close vicinity to the road construction site. Groundwater could be at risk of contamination if de-icing chemicals are used to melt snow during construction in winter season as they can percolate and reach down to surface water as well as sub-surface water table. Moreover, the extraction of water for construction process may cause reduction in groundwater levels in which case, Abbottabad will be particularly affected because of its mountainous topography and already low sub-surface groundwater resources. Agricultural productivity may also be affected due

to additional water usage/needs in CPEC road construction activities in the area.

Approximately 80% of the total erosion over the life of the road occurs within the first year after construction most of which is directly linked to the construction phase (Geyik 1986). Soil erosion might not only cause water pollution as mentioned earlier but could also lead to unstable land. Construction processes might change the landscape due to clearing of trees and cause changes in land use patterns, especially in Haripur where the construction site is close to the fertile agricultural plains. There could be loss of agricultural land and likely low production in areas located close to the construction site (Spellerberg and Toni 1998)

A total of six tunnels will be constructed in the study area that could make the surrounding ground unstable with increased risk of soil erosion. Use of explosives and the resulting releases may also affect the air quality.

Noise arising from the drilling and blasting of mountains in tunnel construction and from function of heavy machines working on site could be a nuisance for the locals and could also scare the wildlife in the area. Mansehra will have four tunnels constructed and thus will experience high levels of noise. Haripur and Abbottabad districts have parts of CPEC route passing through the highly dense populated areas and the population there could suffer the effects of substantially enhanced noise pollution. Furthermore, parts of CPEC road route, being constructed in mountainous areas, especially Mansehra and Abbottabad, the noise impact could be manifold resulting from the intense and prolonged echoes. Roads become a barrier to the movement of wildlife and cause habitat fragmentation (Forman and Alexander 1998). Animals are reluctant to cross the roads and this causes the populations to become isolated. Clearing out forests and trees to make room for the construction of road might also have the same effect. The famous Uchara forest in Haripur could specially be at risk as the route will pass from the south east of this forest. Roads and traffic have a negative effect on animal and bird's abundance (Van et al. 2011).

## CONCLUSION AND RECOMMENDATIONS:

In the present study, as described and discussed in the preceding pages, the following conclusions can be inferred:

- Adverse environmental impact in the decreasing order seem to be caused by:

### Equipment use > Construction processes > Material use

- Taking the six districts as a whole, the adversely affected in the decreasing order are:

### Mansehra > (Kohistan, Haripur, Shangla, Abbottabad) > Battagram

Further study and detailed information/data is needed to assess the comparative adverse impact on the environmental segments of Kohistan, Haripur, Shangla & Abbottabad.

- The environment segments of the above districts, adversely affected by the CPEC road route construction/activities are in the decreasing order:

### Air > Noise level > water bodies

- Priority remediation/control measure required are towards:
- Gaseous/vapour emissions to air > Noise > Surface water > Dust (settable particulates)
- Enhanced needs of:
- Energy > Water > Material (local production/imports)

The above findings of our study supports the earlier studies by Huang et al. (2017) and Zhang et al. (2017) in which air quality was found to be one of the top two challenges upon Chinese Foreign Direct Investment (FDI), particularly given the existing environmental problems in Pakistan. However, both water and noise seem to be the second biggest challenge specifically at the studied district level and for the CPEC KP road route construction activities.

It is obvious that to meet the additional energy, equipment and material needs for CPEC road route construction, the production of the same would have to be considerably enhanced which would result in further risks to environment and public health, also at their production site/s (close

or away from the road construction sites), especially in the absence of adequate environmental legislation or lack of its implementation in the country.

CPEC is considered a very beneficial project for countries as well as the region and the investment/resources put into it are huge but obviously that must not be done on the cost of the environment (KP six studied districts total forest area = 582,900 ha and total cultivated area = 2,109,344 ha) or putting at risk the health of the equally huge Chinese & Pakistani work force and of the local population (30,941,200) of the studied six district, along CPEC Northern route road (334.2 km.) in KP.

To mitigate the impact of CPEC road route construction, there is a dire need for active mitigation/control measures (pre-, during- & post-project completion) in place, if not already taken care of, to protect the environment and safeguarding health of the population in the six studied districts, especially and on priority in "Mansehra" district. (Population = 1,152,839; Forest area = 332,252 ha; Cultivated area = 80,747 ha; CPEC Northern route road length = 59 km). In this regard, the following control measures are recommended for consideration and adaptation:

- Densely populated, forest & cultivated land areas along the CPEC road route be preferably avoided as much as possible, even if somewhat higher construction cost is incurred.
- Drilling should be preferred over blasting in tunnel construction.
- Cuts and fills should be balanced and excavated materials be used as filler in construction.
- Debris should be disposed of at designated/approved locations.
- Trenches and windrows should be used to minimize surface polluted/contaminated runs off.
- Leaks and spills from construction equipment and vehicles should be prevented by daily inspection and repairing those operated in areas near

waterbodies.

- Water should be sprinkled to minimize dust and particulate matter (PM) emissions.
- Trees should be planted along the road immediately after the completion of construction at site/s.
- Noise barriers should be installed and wildlife corridors should be made.

All procurements be preferably made locally and from the nearby industries to minimize transportation/transporting distances, resulting in saving energy and decreasing emissions/releases to air. The CPEC route road/s should be preferably constructed far away from the forests, agricultural areas and water resources. The land clearance should be kept to minimum possible as well as the clearing of forests/trees, cultivated areas, highly erodible soils and steep slopes (which are prone to water and wind erosion) should be avoided. Re-vegetation should be done very progressively as each section of works is completed, keeping the interval between clearing and re-vegetation to a minimum possible.

Following steps are proposed for future studies/research work to assess the environmental impact due to CPEC activities, including infrastructure development in KP and other provinces:

- Detailed data, also taking into consideration other environmental segments, be collected and analyzed for Kohistan, Shangla, Abbottabad, and Haripur districts to find out the comparative adverse impact among these districts due to CPEC road route construction.
- District specific Environmental Impact Assessment (EIA) of CPEC western alignment (Saeed 2017), identified as M-1/N-55/N-50 (Peshawar-Dara Adamkhel-Muslimabad-Shahbazkhel-D.I. Khan-Akhmad-Darabund, entering Balochistan at Darazinda)
- District specific EIA should also be carried out for all CPEC projects (including transport infrastructure development) in all provinces to identify the likely affected areas/hotspots, with necessary and appropriate mitigation/control measures, for environmental protection and safeguarding public health and that of the huge work force (local and Chinese)
- Environmental standards for CPEC activities (including infrastructure development) to be agreed, adapted and implemented by the two countries.

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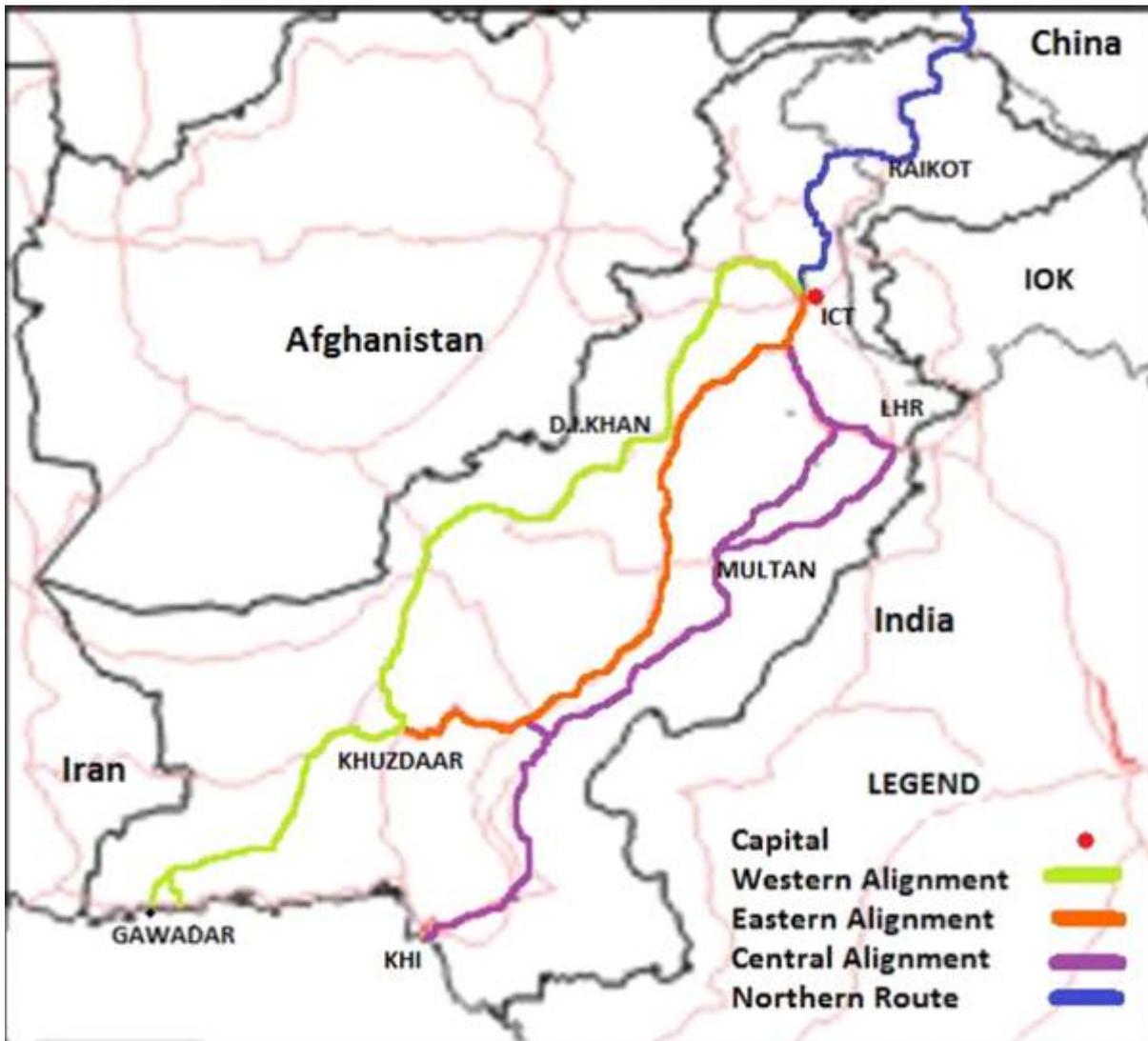
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# ANNEXURES

## Annexure I: CPEC Road Network

Road network of CPEC is spread throughout Pakistan. The Western Alignment (Yellow) is present in the provinces of Baluchistan and KP. Eastern Alignment (Orange) is present in

the provinces of Sindh and Punjab. The Central alignment (Purple) is present in Punjab and border of KP. The northern route is composed of E-35 Expressway and KKH and is common to all alignments.



Saeed 2017; Urooj, 2017

## Annexure II: Equipment used in road construction

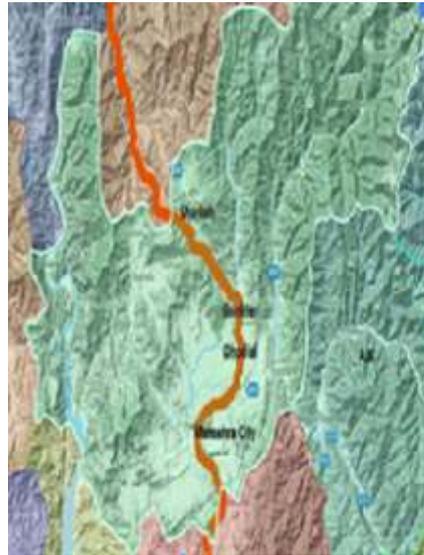
Equipment	Use	Construction Phase
Asphalt Distributors	Used to apply prime or tack coats on a surface in preparation for paving. Considered the most important piece of equipment on any asphalt surface treatment project.	Surface course construction
Asphalt Pavers	Piece of construction equipment used to lay asphalt on roads, bridges etc. Lays the asphalt flat and provides minor compaction before it is compacted by a roller.	Surface course construction
Dozers	Construction Equipment , equipped with a substantial metal plate, blade, used to push large quantities of soil, sand, rubble, or other such material during construction.	Staking Sub-base and base course construction
Dump Trucks	A truck used for transporting loose material such as sand, gravel, or demolition waste for construction.	Sub-base construction
Excavators	Heavy construction equipment used in digging of trenches, holes, foundations, material handling, forestry mulching, landscaping and drilling shafts for footings and rock blasting.	Sub-base construction
Generators	Converts motive power into electrical power for use in an external circuit.	All phases
Loaders	Used in construction to move aside or load materials such as asphalt, demolition debris, dirt, gravel, logs, raw minerals, recycled material, rock, sand, etc. into or onto another type of machinery.	All phases
Motor graders	Construction machine used to create a flat surface during the grading process. Used to prepare the base course to create a wide flat surface upon which to place the asphalt.	Base course construction Compaction
Road Rollers	Pad foot Drum Rollers compress high spots in soil prior to asphalt application. Smooth Single Drum Rollers compress the asphalt after its application.	Compaction Surface course construction Finishing
Stone Crusher	Used to reduce the size of rocks and stone.	Staking, Base course construction

Source: Robinson et al. 2008

Annexure III Figures A - F: Salient features of the studied KP districts.



Legend:  
 CPEC Route  
 Kohistan



Legend:  
 CPEC Route  
 Mansehra



Legend :  
 CPEC Route  
 Shangla  
 Water



Legend:  
 CPEC Route  
 Abbottabad



Legend:  
 CPEC Route  
 Battagram



Legend:  
 CPEC Route  
 Haripur



