Policy Brief # **59**

Preliminary Environmental Impact Assessment (EIA) Study of China-Pakistan Economic Corridor (CPEC) Northern Route Road Construction Activities in Khyber Pakhtunkhwa (KPK), Pakistan

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1. Introduction

Pakistan-China relations date back to the Silk Route, but the 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. It 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) but as of 2017 its worth has increased to $62 billion (Siddique 2017). Because of CPEC, China will discover a relaxed access to the Middle East, Africa and Europe, whereas Pakistan's infrastructure and overall economy will be modernized (Irshad 2015).

Many projects have been started under CPEC, including railways network construction, establishment of power plants, and development of Gwadar Port, economic zones and social sector projects, but most prominent is across the country construction of roadway networks which can be divided into northern section and three other alignments, like western (the limelight among the roadway projects, providing unobstructed route from Kashgar, Xinjiang, China through Pakistan to Gwadar), eastern and central (Annexure I). Development of 2700 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 be used for cargo transport, minerals, energy production and commercial activities. There are numerous benefits of CPEC roadway networks in Pakistan. Most of these benefits are social and economic but need to avoid all possible environmental loss/es. These benefits will include fulfilling of country's energy demands, international standard roads and railway network, capacity building, and increase in employment rate.

Environmental Impact Assessment (EIA) is the requirement of national environmental legislations of both Pakistan and China as well as of Declaration on Environment and Development, ratified by both countries (Saeed 2017). According to a study, air quality and water consumption were found to be the top two challenges upon Chinese Foreign Direct Investment (FDI), particularly given existing environmental problems in Pakistan (Huang et al. 2017). Using a Multi-fuzzy comprehensive evaluation model for environmental and social risks, another study warns that the construction of investment projects shall 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).

1.1. EIA of CPEC Road Construction in KPK

Studies by Huang et al. (2017) and Zhang et al. (2017) have been recently reported which are very general in assessing environmental and social impacts of the overall CPEC projects. The present study, as has been described in the foregoing pages, is a preliminary Environmental Impact Assessment of only the road construction activities under CPEC (Figure 1) along northern route in KPK , which enters KPK at Sazin in Kohistan district, passes through Battagram, Shangla,

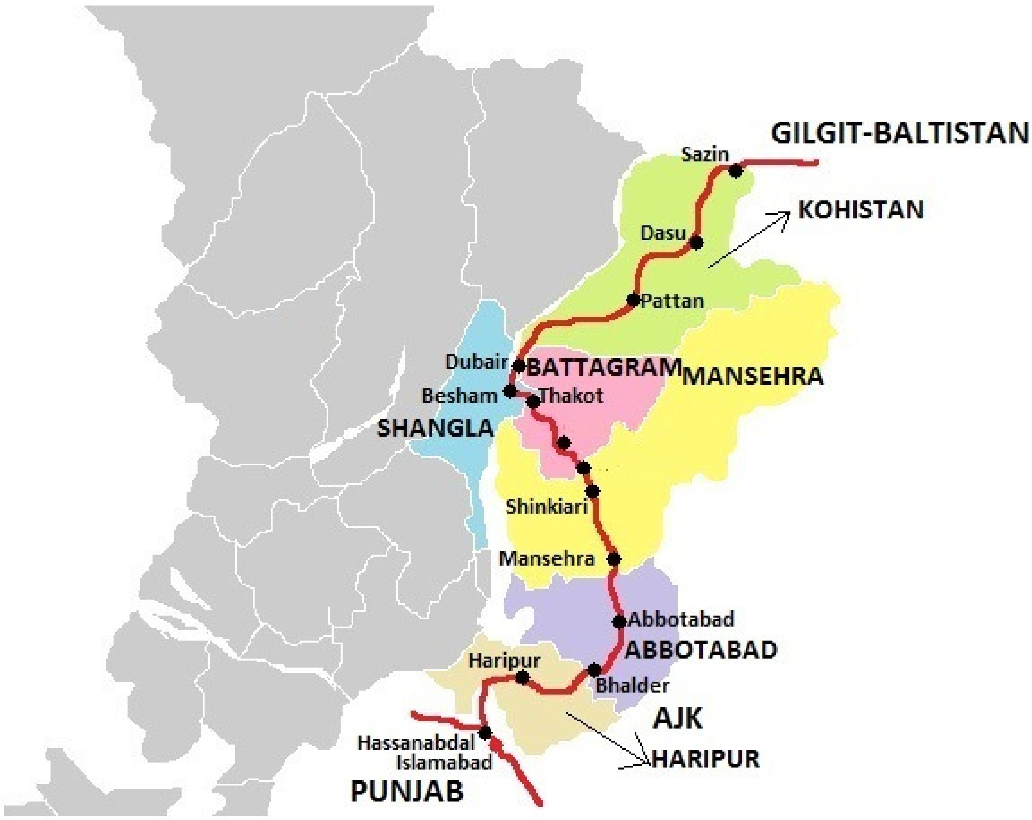

Figure 1: Districts in KPK along northern CPEC road route.

Mansehra, Abbottabad & Haripur districts and the exiting KPK at Sarai Gadai (Figure 1). The objectives of this study are to examine the environmental impact of road construction activities in the six districts of KPK along the CPEC northern route, identify the environmental segments and the districts that are at high risk of exposure & degradation from the road construction activities and recommend some possible control measures towards direly needed mitigation to protect the identified affected environmental segments in the six districts to safeguard the health of population of the districts under study.

2. Methodology

To carry out this study the secondary data was collected through various means. 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 material and processes are briefly described in section 3 and the equipment used, given as annexure II. Route length, the identified locations and main cities in each district along the KPK CPEC road route and accessible route specific information are given in Table 1 and 2 respectively. Some salient features of each of the studied districts in KPK are described in Table 3 and Annexures III (Figures A–F)

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.

3. Results, and discussion

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

The road will be constructed as a flexible pavement highway. The construction process involves staking (which helps keep soil disturbance to minimum possible), clearing & grubbing (tree cutting/organic debris & stumps removal), sub-base formation construction (through side casting), base course preparation (using stone, slag/gravel, cement, asphalt coarse & fine aggregates, soil, water & other material) & 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. 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. Tunnels will be constructed 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 KPK districts

The study was conducted only on KPK 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). The details of the CPEC KPK route (334.2 kms), including route length in each district are given in Table 2. The route maximum and minimum length

Table 1: Route of CPEC in studied KPK districts

Districts	Route Length	Route	Main Cities
Kohistan	≈ 134 km	Sazin, Barseen, Dasu, Komila, Leo, Pattan, Palas, Dhup, Dubair	Dasu, Pattan
Shangla	≈ 26.7 km	Besham, Shung, Dandai	Besham
Battagram	≈ 41.5 km	Thakot, Chanjal, Peshora, Battagram, Chappargram, Phagora	Thakot, Battagram
Mansehra	≈ 59 km	Sharkah, Icherrian, Shinkiari, Shinai bala, Dhodhiyal, Hathimera, Mansehra	Shinkiari, Mansehra
Abbottabad	≈ 42 km	Mast mera, Sajikot, Abbottabad, Khokar maira, Havelian, Irshad Nagar, Nowshera, Bhalder	Abbottabad, Havelian, Bhalder
Haripur	≈ 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

Table 2: Route Specific Information

	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	4	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

are in districts Kohistan and Shangla, respectively whereas Battagram and Abbottabad have almost equal route lengths (42 km) about 1/3rd of that in Kohistan (Table 1). Complete road construction related information does not seem to be available, however, accessible for the three sections (total route length = 115km) Thakot-Mansehra, Mansehra-Abbottabad and Abbottabad-Havelian along KPK CPEC is given in Table 3. 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 KPK:

Located in the Northern Areas of Pakistan, all these districts are blessed with immense natural beauty and aesthetic appeal. 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 (sq km)**	**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
Total	3,941,200	17,405	219,344	582,900

Urooj, 2017; Saeed, 2017

Among the six select KPK districts, ***Kohistan*** (Annexure III, Figure A) has the largest total area (7,492 sq.km.), the 2nd largest forested area (88,000 Ha) but the smallest cultivated area (14,871 Ha.). It's mountainous with valleys which 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, among other, include trees/shrub oak forests 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. Indus river is the major source of water. Along with that numerous amount of rivulets runs through the district. A lot of other streams and water falls also emerge in summer season as the snow melts (Urooj 2017). ***Shangla*** district (Annexure III, Figure B) has the 2nd largest cultivated area (41,759 Ha.) and the 2nd lowest population (435,563). It is situated between hillocks and surrounded by high mountains, with the forests on the slopes. Forests are the main source of income. The areas in Shangla are fertile, main crops being maize, wheat and rice. The annual crop yield of Kharif crops, is 41044 tons and Rabi crops, 16963 tons. A number of medicinal plants of economic importance are found in the 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 studied six districts. The flora includes many medicinal plants. Nindhyar khwar and allai khawr are the two main streams of Battagram district (Urooj 2017).

Mansehra district (Annexure III, Figure D) has the highest population (1,152,839) and the largest cultivated area (80,747 Ha.) and forest (332,252 Ha.) areas. Topography of 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 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 2nd 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 both permanent and scanty. 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 3rd most populated (692,228) district with the 3rd largest (31,499 Ha.) cultivated but the 2nd lowest (32,168 Ha.) forest areas among the studied KPK 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. Dalbrgia 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 the public health.

3.4. Environmental Impact: 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 KPK 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***
Construction Processes											
Staking	NE	LA	NE	NE	LA	LA	LA	LA	NE	NE	NE
Grading	LA	***A***	***A***	LA	LA	NE	NE	***A***	***A***	LA	LA
Compacting	***A***	LA	NE	NE	NE	NE	NE	B	LA	NE	NE
Paving	***A***	NE	LA	NE	LA	NE	LA	LA	LA	***A***	***A***
Rolling	LA	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Equipment use											
Dozers	LA	***A***	LA	NE	NE	NE	NE	***A***	***A***	NE	NE

Vehicles/Truck s	***A***	***A***	LA	NE	NE	NE	NE	LA	***A***	NE	NE
Pavers	***A***	LA	LA	NE	NE	NE	NE	***A***	***A***	NE	LA
Rollers	LA	LA	NE	NE	LA	NE	NE	LA	LA	NE	NE
Generators	***A***	LA	NE	NE	NE	NE	NE	NE	***A***	NE	LA
Materials use											
Cement	***A***	LA	***A***	LA	NE	LA	NE	LA	NE	NE	LA
Water	B	B	LA	***A***	NE	***A***	NE	NE	B	NE	LA
Asphalt	***A***	NE	LA	LA	NE	NE	NE	LA	NE	NE	NE
Lime	NE	NE	***A***	LA	NE	NE	NE	NE	NE	NE	NE
Paints	LA	NE	LA	NE	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 KPK. 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 impac/exposure of environmental segments of the studied KPK 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) of the six studied district to CPEC road route construction activities in KPK.

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

Environment Segments	Maximum	2	3	4	5	Minimum
Population	**M**	A	H	K	S	B
Forest Area (Ha)	**M**	K	B	S	H	A
Cultivated Area (Ha)	**M**	S	H	A	B	K
Total Area (sq. km.)	K	**M**	H	S	B	A
CPEC Road Length (km)	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 KPK districts under study, it has the largest population, highest forest and cultivated areas (Tables 1 & 5) and as such, Mansehra district population (including vulnerable children, women & elderly) and 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 2nd lowest cultivated area (Table 5). Kohistan, Abbottabad & Shangla have the 2nd 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 (2^{nd} 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 of 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 activates 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).

4. 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 KPK 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 (KPK 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 KPK.

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 xix 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 water bodies.
- 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 KPK 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 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 be also 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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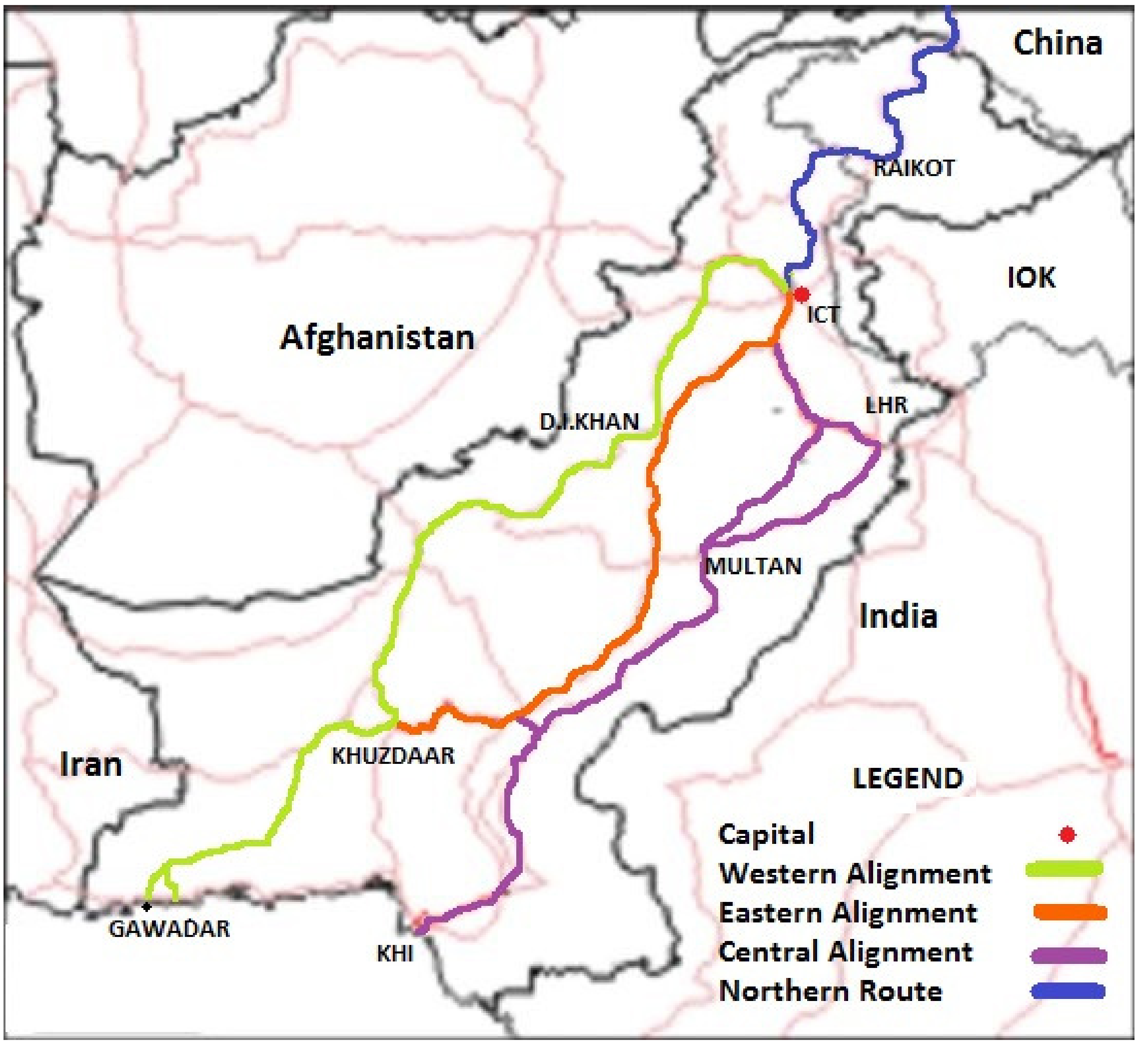
6. ANNEXURES

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



Saeed 2017; Urooj, 2017

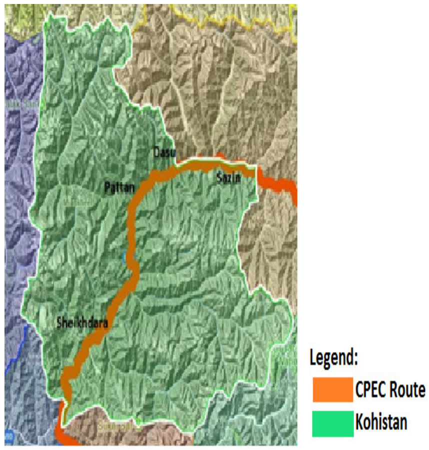
Annexure II: Equipment used in road construction

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

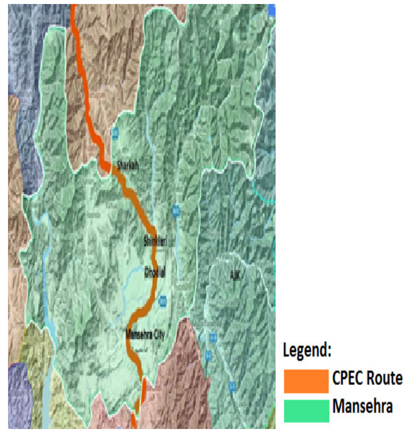
Road Rollers	Pad foot Drum Rollers compress high spots in soil prior to asphalt application. Smooth Single Drum Rollers compress the asphalt after its application.	Compaction Surface course construction Finishing
Stone Crusher	Used to reduce the size of rocks and stone.	Staking, Base course construction

Robinson, R. et al 2008

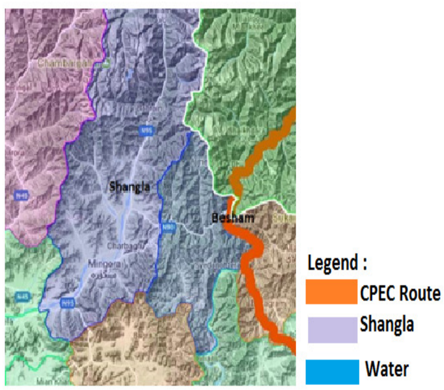
Annexure III Figures A – F: Salient features of the studied KPK districts



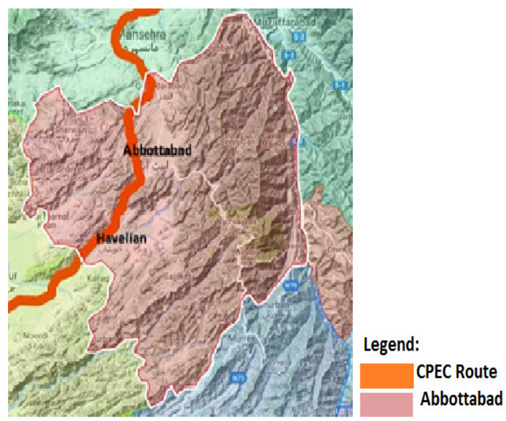
A: Kohistan



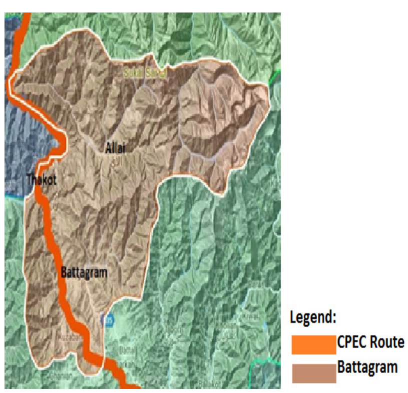
D: Mansehra



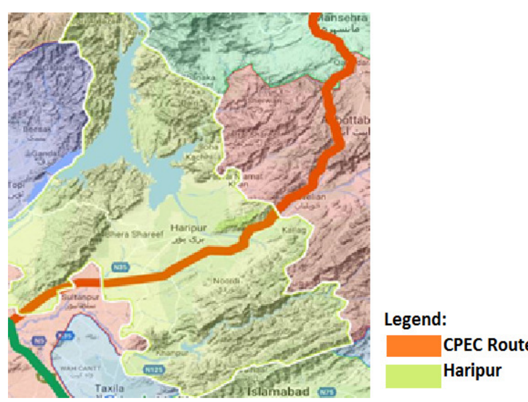
B: Shangla



E: Abbottabad



C: Battagram



F: Haripur