The Environmental Impact of The China–Pakistan Economic Corridor (CPEC): A Case Study

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Abstract
Pakistan is embarking on its mega project CPEC, in partnership with China, which is a part of the larger One Belt One Road project and it brings with it great promise for both China and Pakistan. Due to the enormous planned development and energy-generation activities, primarily through coal, the danger of damage to the environment is equally enormous. Whereas China is moving away from coal-based energy and is implementing stricter pollution-control laws, Pakistan is initiating such projects now, despite its international commitments, and that too without strictly undertaking environmental assessments or without having a very good history of implementing its environmental protection laws. If Pakistan does not take timely action to ensure the prevention of environmental degradation, its people could suffer greatly due to the resulting adverse effects to the environment; the fallout of which could also impact the rest of the world.
Keywords: Environment, pollution, environmental cost, CPEC, China, Pakistan.

China-Pakistan Economic Corridor (CPEC), termed as a game changer for the region, is a mega project between two neighboring nuclear powers, that is, China and Pakistan, whose people enjoy time tested brotherly relationships. The project is part of China's One Belt One Road initiative that is expected to open new routes for China to the rest of the world. It is bound to generate economic activity across the globe and as a result is of interest to many nations who want to become part of this venture. Pakistan's geographical location places it right at the center of this global project as it will become a hub connecting the Middle East, Europe and Africa with China and will generate a lot of economic activity for Pakistan boosting its economy. There are great expectations in Pakistan from this project, but only a few stakeholders are concerned with the devastating impact the project might have on the environment in Pakistan. Of particular concern are the side-effects of construction of the new road, railway networks as well as the increased traffic on the routes. The new energy power plants, grids, use of fossil fuel, additional infrastructure and the huge industrial zones along these routes will have additional environmental fallouts. It may be safely assumed that all these developments will have a major impact on the ecology, biodiversity, air quality, water quality, habitat of flora and fauna, wildlife and agriculture all across Pakistan. The exact extent of this impact is not known, and merits a thorough study.

This paper, therefore, begins with the observation that impact assessments of mega projects required by our law in accordance with assessment tools like EIA, IEE, SEA, CIA or SIA have not been

undertaken as expected. An assessment carried out with these tools usually leads to the adoption of mitigating measures for the reduction of harmful impacts on the environment. In addition to this, the measures that the country needs to adopt with respect to our international commitments pertaining to carbon emissions, as detailed in the relevant conventions and protocols ratified by Pakistan, have also not been undertaken.

The paper will attempt to estimate the possible damage caused as a result of the omission of undertaking impact assessment with the use of the necessary tools, the absence of the resulting preventive and mitigating measures, and the harmful environmental damage that may be caused in the future. The findings of the paper may then be used as suggestions for immediate preventive action and as future warnings.

Magnitude of the Project

The China-Pakistan Economic Corridor (CPEC), officially launched in 2015 and to complete in 2030, connects the Kashgar Province of China to the Gwadar Port in Pakistan through a road network spanning 3,218 kilometers (Deloitte Pakistan | CCG, 2016) and comprises railways, highways, pipelines, economic zones with industrial parks and various energy projects. This project is expected to further strengthen the ties, in the economic sphere, between two regional partners who have already been cooperating at the military and diplomatic level for the last few decades. Given below is a breakdown of the salient features of CPEC for understanding the magnitude of the associated projects and economic activity: (Ministry of Planning, Development & Reform, Islamabad, Pakistan, n.d.)

- **CPEC Routes:** CPEC will be spread over three major routes or corridors, that is, the Western, Central, and Eastern Routes. The Western Route will connect Gwadar Port to the under-developed and under-populated provinces of Balochistan and Khyber Pakhtunkhwa, The Eastern Route will connect Pakistan's two megacities, Karachi and Lahore, and the Central Route will link Khyber Pakhtunkhwa and Balochistan to Punjab, as shown in the following figure: (Ministry of Planning, Development & Reform, Islamabad, Pakistan, n.d.)

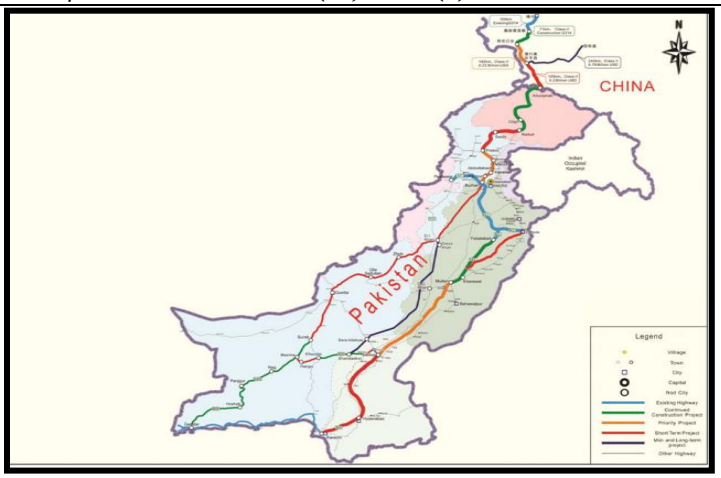

Figure 1. CPEC Roadway Network
Source: Pakistan Economic Survey

- **Roads:** The following major road projects, covering a total length of 968 km with a cost of roughly US$ 5.5 billion, are currently underway: (Ministry of Planning, Development & Reform, Islamabad, Pakistan, n.d.)
    - The Karakoram Highway (KKH) Phase II covering the Thakot-Havelian section;
    - The Peshawar-Karachi Motorway from Multan to Sukkur;
    - The Khuzdar to Basima Road (N-30);
    - An upgrade of the D.I. Khan (Yarik) to Zhob highway (N-50 Phase-I); and
    - The remaining portion of the KKH covering Thakot to Raikot (N35).
- **Railway:** The 1,872 km long Karachi to Peshawar railway line (ML-1) will be upgraded by 2022 at an estimated cost of around US$8 billion, which will enable speeds of up to 140 km/h. The Pakistan Railway Network will ultimately be expanded and connected to the Kashgar Province in China. (Ministry of Planning, Development & Reform, Islamabad, Pakistan, n.d.)
- **Pipelines:** An initial network of pipelines will be laid to transport liquefied gas and oil from the Middle East to China cutting the present 2,400 km journey down to 12,000 km. Eventually, CPEC will become an energy corridor that will connect the Middle East, China, Iran, Afghanistan, Central Asia and possibly even India. (Ministry of Planning, Development & Reform, Islamabad, Pakistan, n.d.)
- **Economic Zones:** Special economic zones will be established at various locations, including Nowshera in Khyber Pakhtunkhwa, Port Qasim and Dhabeji in Sindh, Bostan in Balochistan,

Faisalabad in Punjab, Mirpur in Azad Jammu and Kashmir (AJK), Mohmand Agency in the Federally Administered Tribal Area (FATA), Moqpondass in Gilgit Baltistan, and Islamabad. (Ministry of Planning, Development & Reform, Islamabad, Pakistan, n.d.)

- **Energy Projects:** A total of 22 energy projects for generating nearly 14,000 MW are currently planned, at a cost of roughly US$ 27 billion. The projects will comprise Hydel, Wind, Solar, Coal, Imported Fuel as well as Transmission Lines. From these, under the Early Harvest Program, projects with a generating capacity of 10,400 MW are to be completed by March 2018. (Ministry of Planning, Development & Reform, Islamabad, Pakistan, n.d.)

Socio- Economic Uplift by CPEC projects

CPEC brings with it the promise of economic growth of mammoth proportions for both China and Pakistan. These economic benefits will also be felt by the rest of the world through lowered costs of energy and raw materials being received by China, and the lowered transportation cost of finished goods becoming available to the rest of the world. For Pakistan, which could use this long-term economic uplift, CPEC is being highlighted as a "game changer" that will not only improve the economic conditions of the people, but will also serve as a catalyst for vital infrastructure development that will put Pakistan on the right path towards genuine economic progress.

Some of the major benefits for Pakistan that will be realized between 2015 and 2030 include the creation of an "estimated 700,000 jobs resulting in an increase in economic growth by about 2% annually." (Analysts, 2016) An increase in roads and traffic flow will result in the requirement of an "estimated 800,000 autos over the next 15 years" (Hashemy, 2016.) This will galvanize the transportation businesses. Local banks with a "current deposit base of $90 billion and outstanding loans of $46 billion is estimated to have a loan growth of 2-3% annually," (Hashemy, 2016.) and around "US$30 billion worth of projects will be insured locally and internationally with an increase of Rupees 2 billion annually in premiums locally." Due to the increased connectivity through new rail and road projects tourism is expected to increase phenomenally and as a result the hospitality industry will experience a boom as well. Trade & Commerce is bound to increase as well especially if free trade agreements are negotiated on better terms with our neighboring countries. Many business sectors will experience a boost especially the "energy, gas & electricity distribution, cement, steel, construction and allied industries sectors" (Pakistan-China Institute, n.d.).

CPEC: Potential Constraints & Threats

With all the benefits associated with CPEC, it is impossible to image a scenario where this high volume of projects as well as the extensive and intricate road and railway networks will not adversely affect the environment. It can be said with a surety that they will and it is necessary to point out the major potential pitfalls, especially with respect to the environment. The highways and railway lines will pass through the valleys of the Northern Areas which will have an immense impact on the ecology and the natural habitat of a vast number of species of wildlife as well as the flora and fauna. Due to the relative close proximity of these sources of pollution and residential areas in the Northern Areas, coupled with the high altitude environment, the negative impact on the human environment will be intensified. Air contamination and noise pollution will be a natural byproduct of the surge in transport density which will create several problems in the area for humans and wildlife as well as the overall ecology. Careful planning and mitigation are vital at this juncture before the projects are implemented. The adverse effects of environmental degradation in hilly areas have more widespread impact as compared to plane areas, particularly due to the impact they can have on the tourism industry. Gilgit-Baltistan (GB) relies heavily on its natural resources and serene beauty for the purpose of tourism. There is great potential to attract more tourists in the future by developing the tourism industry of Pakistan, but this will only be possible if we make a concerted effort to maintain, conserve, and even improve access to the beauty of the area. Without considerable thought and effort for the preservation of these natural resources, the rivers, lakes, mountains, game reserves, and sanctuaries will get polluted by the tremendous infrastructure development projects and anthropogenic actions related to CPEC.

In addition to the environment and resources, the impact of the round-the-clock traffic, emissions of poisonous gases from other projects, dust particles, and suspended solid particles will result in air-borne diseases and respiratory problems for the people of Pakistan. Deforestation due to the infrastructure projects in the area and large-scale construction activities will contribute to accumulation of greenhouse gases.

Pakistan is already affected by climate change and global warming issues as its glaciers, about 5,000 of them, are melting and the country is facing extreme weather patterns and seasonal shifts which is impacting the Agro-economy of the country in a great deal. Unchecked pollution can worsen the situation and impact water quality as well as quantity, which can lead to devastating consequences for the future and quality of life in Pakistan.

Other studies have also highlighted the potential risk to the environment due to CPEC projects. Some of the findings are shared below.

The Daily Times highlights the threat to Pakistan's glaciers by stating that, "the silk road of Pakistan is already quite risky to travel on because of the traffic moving from the China to Pakistan and also from the other parts of Pakistan. Currently a handful of trucks commute between

Pakistan and China, however, once CPEC projects will be fully initiated hundreds of trucks a day are expected to travel that route and which will emit a lot of fumes and these fumes would eventually settle on glaciers causing them to melt along with other factors" (Ahmed, Z., 2016).

According to a study undertaken by Zhang et al. (2017), "The CPEC developmental projects will have consequences on the aquatic life and will also impact the aquatic biodiversity, as in Pakistan there is no proper waste disposal system. Incinerators are installed to dispose waste and a large community dumps their waste in the water bodies. Under the CPEC construction projects there is no plan or alternative introduced for waste dumping, so once the toxic waste of CPEC projects will be dumped in the water bodies it would ultimately pollute the quality of the ground and surface water bodies and consequently it will have harmful impacts on the health of the surrounding communities. These people will suffer from different water borne diseases as well as the water scarcity as a lot of stress would be on the water bodies as the process of road construction will utilize a lot of water." This is advice that should not be ignored.

Deforestation due to a lot of infrastructure development and construction work under the CPEC projects will lead to the loss of biodiversity and will erode and deteriorate soil, which would increase the chances of floods in the area. Pakistan already has an unfortunate history with flooding, which has a devastating impact on the economy as well as the loss of life. Once the forest cover is reduced because of anthropogenic activities and development, it will have a negative impact on air quality too. A decreased forest cover will not be sufficient enough to absorb carbon dioxide and other GHG gases polluting the air in high quantities. The Government of Pakistan will not be able to handle the smog created by the suspended particles in the air due to heavy traffic and the construction work. The province of Punjab is already facing issues due to heavy smog. Ultimately, the local communities and the people of Pakistan will suffer a lot.

Beyond this, as per the WWF-Pakistan, Chitral in Khyber Pakhtunkhwa, "is on the migratory route or flyway of several globally important bird species. About 20% of approximately one million migratory birds passing through Chitral fall prey to hunting and now because of the developmental projects they would lose the habitats and will ultimately leave the area or would get extinct. WWF-Pakistan initiated efforts to reduce the hunting pressure in 1992 (WWF-Pakistan).

Pollution from CPEC and its effects will not stay limited to Pakistan only and can become a global concern. Emissions of Greenhouse gases will consequently accumulate in the atmosphere and will contribute to global warming, ozone depletion, and carbon dioxide accumulation, primarily contributed by fossil fuel use due to the coal-based power generation projects, will ultimately make this a global issue. Presently, Pakistan is one of the lowest contributors towards global warming in the

region, but this can drastically change if careful planning is not undertaken to limit pollution as a result of CPEC projects.

Environmental Impact Assessment (EIA): A Legal Requirement

"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, S., 2017). It is important to address and to mitigate the likely impact of any developmental project to safeguard the Environment. EIA recommends and proposes the possible control measure to protect the identified affected environmental segments the study is covering under the CPEC.

EIA in Pakistan was initiated under the Pakistan Environmental Protection Ordinance 1983, and the Ordinance required that every proponent shall file a detailed environmental impact statement under section 12 of the Pakistan Environmental Protection Act (PEPA), at the time of planning the project, which was likely to cause adverse effects on the environment. However, being an ordinance, it was later on withdrawn and the Pakistan Environmental Protection Act (PEPA) 1997 was declared (Environmental Protection Department, Government of Punjab, n.d.).

An EIA is required to be submitted to the concerned environmental protection agency (EPA) prior to start of construction work. However, there is no legal requirement for SEA of policies, plans and programs in the country till now. The Act also contains provisions for imposing a fine in case of non-compliance with section 12 and other specified clauses of the Act and any of the subsequent rules and regulations. The fine may extend up to one million rupees, with an additional fine extendable up to one hundred thousand rupees per day during which contravention continues. These amounts of fine are much higher as compared to the fines on violating other laws in the country.

As per the Express Tribune, the Country representative IUCN, Mehmood Akhter Cheema, made a telling observation when he said "Since the environment became a provincial matter, I have doubts about the technical capacity of environmental protection agencies to carry out sound EIAs." He adds, "that the ecological footprint of this project is unclear" from the various reports he has seen. "So far, the government has not revealed whether any measures have been taken to ensure sustainable development, or if there is an enhanced environmental monitoring and reporting plan. It is important that the government engages with organisations like IUCN to provide technical oversight on a continuous basis. While all EIAs should have been done before a project begins, it's not too late" (Ebrahim, Z.T., 2017).

The article in the Express Tribune goes on to state that, "Adil Najam, dean of the Fredrick S. Pardee School of Global Studies at Boston University emphasized the need for the key regulators including federal and provincial environmental protection agencies, and the climate

ministry to carry out independent EIAs, and for the government to then act on them at the design phase so that the best possible technology and standards are used for each project." Najam said, "If we do that, I think the overall impact can be economically and environmentally beneficial. If not, we will lament the mistakes of omission in ten and twenty years" (Ebrahim, Z.T., 2017).

This project will have considerable impact on natural habitats, resettlement, migration and dislocation of the people and social and cultural issues which is a priority requirement to be addressed before the implementation of the project and that is why impact assessments are a prerequisite for any developmental project in the country which is also a legal requirement to achieve the sustainable development goal for which Pakistan is a signatory to the United nation's Convention for Climate change (UNFCCC).

Coal Based Projects and International Commitments of Pakistan

There are many expected negative environmental impacts related to the coal-based power-generation projects in the CPEC plans. A few notable ones have been given below.

According to Amin Ahmed, "The Asian Development Bank says that the upcoming 10 gigawatts generation capacity under the China-Pakistan Economic Corridor which is expected to be commissioned before 2019, will increase greenhouse gas emissions substantially that will worsen the climate change mitigation concerns. Moreover, ash handling and disposal problems will also exacerbate negative impacts on the environment, says an evaluation report of the power sector of Pakistan released by ADB. The report says that future increase in fossil-fuel power generation will contribute to climate change and environmental degradation. The bank itself is funding 600MW coal plant in Jamshoro Currently, more than 60 per cent of the utility electricity generated in Pakistan comes from fossil fuel-based generation, including gas, coal and furnace oil. This level of dependence on fossil fuels, plus the sector's operational inefficiencies with high technical losses and low generation efficiency impact the environment, is contributing to climate change due to high greenhouse gas emissions. The ADB is itself helping fund a 600MW super critical coal-fired power plant in Jamshoro, Sindh. The agreement for the $900 million project was signed in March last year." (Ahmed, A., 2018).

"The implementation of CPEC projects lacks legal cover and is against international agreements, as set by the United Nations. Estimated 34 US $ Billions have been allocated for the energy projects in Pakistan under the CPEC project inclusive of the coal based power plants. Burning coal is of great apprehension and it is the matter of the social and Environmental concern. Pakistan is one of the 7 countries in the world who are getting effected by the climate change and global warming effects the

most and it most vulnerable and though the contribution of the emission is very meager i.e. 0.46%" (Naureen et al., 2017).

As per Muhammad Salman Khan, "increasing carbon emissions are contributing to a significant rise in global temperatures which are further responsible for contributing to widespread melting of glaciers, rise in sea levels, rampant droughts, catastrophic floods and heat waves that has not only killed thousands of people but displaced millions around the world, including in countries like Pakistan which remains worst affected from this climate crisis. Pakistan happens to be one of the most affected countries from the present climate crisis. It has already suffered from extreme and deadly climate events such as the massive floods of 2010 and 2012, the catastrophic Gayari avalanches of 2012 and the heat wave of 2015 which have led to widespread loss of human life, undermining economic development and national security of the country." (Khan, M.S., 2016)

This does not bode well for Pakistan as the planned massive coal-based power generation projects to drastically add to an already perilous environmental condition.

As per a study by Kim et al. (2004), "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) will likely be enhanced in the air." The add that, "there will be a substantial increase 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 road construction."

All this points to the fact that Pakistan is facing a serious challenge to address the potential adverse impact on environment which would likely to be produced by CPEC especially by the energy sector using the coal to produce the energy, particularly on agriculture, water and climate change.

Coal based projects being the dirtiest are discouraged in the world whereas CPEC focuses on them. Credible and reliable environmental impact assessments of these projects are of considerable significance and need. It is important to note that 60% of these projects under CPEC have been completed yet EIAs or SEAs of the projects have not been conducted, nor has any of the project documentation been shared with the public or other stakeholders. This should be a matter of grave concern not only for the Government of Pakistan but the citizens as well. Realization of the fact that Pakistan is ranked as the 7th highest country in the world that is getting affected by the consequences of climate change, impact assessments of this mega project and its subprojects is of the utmost importance to safeguard the environment of the Country. The social and economic development of the region should conform to the principle of environmental stability and sustainable development.

A study conducted by Naureen et. al. (2017) related to the carbon emissions of existing coal-based power generation plants has revealed some startling results that are worthy of mention here. They have been listed in the table below:

Table 1. *Coal Power Projects under CPEC*

Sr. No.	Power Plant	Power Capacity (MW)	CO_2 Equivalents Released (tons)
1.	Sahiwal 2X660 MW Coal-Fired Power Plant, Punjab	1,320	17,284.38
2.	Engro Thar 4X 330 MW Coal-Fired, Thar- Sindh	1,320	9,613,772
3.	Port Qasim Electric Company Coal Fired, 2X660, Sindh	1,320	16,160,895.30
4.	Gawadar Coal Power Project	300	3,672,930.75
5.	HUBCO Coal Power Plant, Hub Balochistan	1,320	16,160,895.30
6.	Rahimyar khan Coal Power Project, Punjab	1,320	16,160,895.30
7.	SSRL Thar Coal Block 1-6.5 mpta Thar, Sindh	1,320	14,192,963.40

*Total Carbon emission released is 75,979,636.4 Tons out of 5,580 MW of Coal based Power Plants generation. (Naureen et al., 2017).

According to Fahad Saeed, in an article in the South Asia Journal, Pakistan is struggling "with many environmental issues, including receding glaciers, floods, heatwaves, droughts, shifting weather patterns and declining ground water levels etc. Agriculture, which comprises 21% of Pakistan's GDP, 60% of exports and employs 45% of the national labour force, is particularly vulnerable to climate change" (Saeed, F., 2017). We are a signatory to the landmark agreement of Paris in 2015 along with 194 other countries who have decided to curtail the use of coal to bring down the global warming impacts. China – the "world's second biggest economy and largest coal consumer, which also has the world's highest coal-fired power plant capacity – is considered a crucial player in the success of the Paris Agreement. Domestically, China has realized that its over-dependence on coal causes severe air pollution and other environmental impacts. The most recent data shows reductions in coal use for the third year in a row" (Saeed, F., 2017).

"Yet China also invested US$25 billion in coal projects worldwide between 2007 and 2015, according to a recent report by the Natural Resources Defense Council. The report criticizes China and other G20 countries for such investments, which are in conflict with their climate commitments under the Paris Agreement. It shows how some of the world's leading polluters have, on the one hand, pledged to control

climate-changing carbon emissions within their borders and, on the other, continued to finance fossil fuel projects elsewhere. That's precisely what happened with Pakistan. After most international financial institutions turned away from coal, China established itself as Pakistan's partner in developing the new coal power plants. Under the 2015 China Pakistan Economic Corridor (CPEC) initiative, the Chinese government and banks have planned to finance companies to invest US$27.6 billion in energy and infrastructure projects in Pakistan over the next six years, of which Pakistan is contributing US$18.1 billion. According to Pakistan's Ministry of Planning, Development and Reform, coal-fired plants with a combined capacity of 7,560 MW will be established as CPEC-energy priority projects" (Saeed, F., 2017).

Research Methodology

To carry out this research, data from the Ministry of Planning and Reform's CPEC Wing was used as extensive secondary material along with information from other important websites and academic research articles. A mixed methodology approach has been adopted, both qualitative and quantitative, to investigate the harmful impacts of the CPEC projects of infrastructure development, and the use of coal for power generation.

Selden and Song evaluated airborne discharges in 1994 (SO_x, NO_x, SPM, and CO). Their model has been used for evaluating environmental degradation due to CPEC. The discharges are measured as far as kilograms per capita on a general premise. The fixed conditions were of frame:

$$s_t = \alpha_o + \alpha_1 x_t + v_t$$

Where dependent variable is emissions of carbon dioxide gas (CO_2), x is the time period. We have divided time into two parts which are before the development of CPEC and the present stage of CPEC. We will use dummy variable 0 before CPEC and 1 after completion of CPEC. The value "v" is the error terms. The author recommends that in countries with small inhabitant density there will be fewer pressures to take up strict environmental values and emission due to transport will be high.

Techniques for Extenuating Road-Related Impacts

This segment will elude some alleviation procedures to comprehend the viability of administration activities amid development. Table 2, gives an outline of a normal impact of CPEC roadway organize and clarify some related preparatory estimations.

Table 2: Environmental Effects and Management Plan for Pre-Construction CPEC Phase

Externality	Environmental Effect	Mitigation Measure	Responsibility	
			Implementation	Supervision

Degradation of air excellence from construction activity	Air quality will be affected by escapee dust emissions from manufacture machinery. Emission may be accepted long-distance due to wind.	Sprinkle water to clear up dust. Use of wet scrubbers to reduce dust in a road construction area.	Project drawing consultants NHA	China State Construction Engineering Company China Civil Engineering Construction Corporation NHA
Flora and Fauna	Native plant and animal variety will be gone due to wide-range cutting of trees	Seedling of trees to be planted on both sides of the road along the length. Usual monitoring of farm.	Project drawing consultants	China State Construction Engineering Company China Civil Engineering Construction Corporation NHA
Hydrological system changes	Negligible impacts are expected through possible changes in CPEC highway network	Drain through embankments Planning a subsurface drainage system to take expected flow even for upcoming needs.	Project Design Consultants	China State Construction Engineering Company China Civil Engineering Construction Corporation NHA
Land attainment Resettlement	Loss of farming land Resettlement of Affected People	Help affected people where relocation is essential.	Government of Pakistan	
Noise	Noise turbulence may be reported to neighboring community	Tree cultivated area	Project Design Consultants	

Public utilities	Inconvenience caused by disruption of public utilities.	Relocation or reconstruction of new community utility lines (water supply, sewerage, electricity, lighting, gas and telecommunication) before building starts.	Project Design Consultants	
Controlled access link	Barrier across the motorway because of being fenced	Building of flyover and underpass at the open roads and passages.	Project Design Consultants	China State Construction Engineering Company China Civil Engineering Construction Corporation NHA
Soil Erosion	Silting up of water bodies by particulate global clastic material. Increased food danger. Reduction in land productivity. The dangers of deforestation. Biodiversity thrashing.	Tree cultivated area Stone plunging Rock riprap design for security of stream channels near road structures etc.	Project Drawing Consultants	
Soil salinity and water logging impacts	Would be small and short-term in nature	Consume through embankments	Project Drawing Consultants	

Topography	Road building practices that may cause changes in geography such as bridges, embankments, etc. Illustrate changes to topography due to new road construction.	Stipulation for roadside arboriculture with screen plantations for caring.	Project Drawing Consultants

Source: Khan (2014) Environmental Impact Assessment of Motorway (M-3 & 4)

Data Collection

Unstructured data has been used which is not organized in a definite manner. The data set ranges from 2005 to 2017. The data set is attached in appendix A. Emissions of carbon dioxide gas (CO_2) have been used as dependent variable and x represent time. Time has been divided into two halves. One half consist of the time period that is before the development of CPEC and the other half is also time but it is after the development of CPEC.

Dummy Variables

Dummy variables are also known as indicators, design, Boolean, binary or qualitative variables. Time dummy is a variable which equals 1 for a given year and 0 for all other years. Normally we should include T-1 time dummies (for T being time dimension of a dataset) but it can be restricted if you have some strong prior as to where the time-fixed effects should occur. Time has been divided into two portions. We are going to check the impact on the environment before the development of CPEC and its impact on the environment and pollution after the development of CPEC. Therefore, we have two dummy variables for time.

Dt0= before the development of CPEC.

Dt1= after development of CPEC

Hypothesis Testing:

Null hypothesis=Alternative hypothesis

CPEC has no impact on environment= CPEC has an impact on environment

H0=H1

The dataset used for estimation must fulfill all the assumptions of BLUE data. Two issues were found with the data:

1. Heteroscedasticity and

2. Serial co-relation.

Different econometric tests have been used to transform the data set.

Table 3. *Coefficients*

Coefficients					
Model	Unstandardized Coefficients	Standardized Coefficients			
	B	Std. Error	Beta	t	Significance
Constant	.924	.031	-.479	29.435	.000
Before CPEC	-.041	.020		-2.115	.052

a. Dependent Variable: pollution

The negative relationship shows that we have a significant model and the variable will have a significant effect and these variables are significant to work on.

Table 4. *Model Summary*

Model Summary 2				
Model	R	R Square	Adjusted R Square	Std. Error
1	.479	.230	.178	.07693

a. Predictors: (Constant), before CPEC
b. Dependent Variable: pollution

The value of a correlation is correlation coefficient (or "r"). Its limit is from -1.0 to +1.0. The nearer r is to +1 or -1, the closer the relation between the two variables. If the value of r is close to 0, that shows there is no relationship among variables. It is understood that CPEC is under development, therefore, we do not have too many observations, however, we still get an acceptable value for r. This shows the variables used in this study are closely linked and their impact will be even greater in the coming years.

Data Analysis and Results

The construction work under the CPEC project will involve a lot of digging, excavation, grubbing, heavy machinery, etc., which will degrade the environment in many ways. The pollutants in the air have an immense effect on the environment, which will lead to huge health impacts on the economy and the ecology as well. Running of machines, generators and vehicles functioning on fossil fuel (mostly diesel) will contribute to a high amount of emissions, being released into the atmosphere. The amount of gases such as Oxides of Nitrogen, Carbon, Sulfur, and Volatile Organic Compounds (VOCs) will likely be enhanced in the air. Furthermore, there will be a substantial increase of dust and particulate matter (PM) due to

excavation, blasting, filling and transportation activities in the region. Bonn-based Climate change watch dog, Germen Watch revealed the air-quality index, measuring the quality of air in different cities, and found that it was highest in Lahore, which the people of region have witnessed in the form of smog. The long-term effects of climate change are also visible in Balochistan; the province goes through the long droughts every year. Despite the fact that the major projects of CPEC are yet to commence, there are still some effects that can be noted, that means the variables used in this study are significant. It is expected that CPEC will generate substantial adverse effects for environmental sustainability in Pakistan, which is a very serious matter.

Recommendations

Recycling, Resuming and Reducing

There should be a check and balance on the food items or the products that are being produced in the region. All the products delivered to the market should be reusable and recyclable. This act can help reduce the pollution in the targeted area. There should be proper waste dumping sites and the latest technology should be used to dispose of the toxic waste from hospitals rather than dumping them in water bodies and in soil which would ultimately create disastrous impacts on the health of people of Pakistan as well as the aquatic and terrestrial life of the plants and animals.

Afforestation

It must be kept in mind that the future of our earth can be secure if we plant more trees. As we know that most of the development of CPEC is in the northern areas, therefore, the government must formulate a policy that is specifically linked to the growth and protection of plants and trees. With the removal of each tree for the development of the project, more trees must be planted. This will help to filter the air and also save the land. It would also be useful to conserve the environment as well as to avoid the loss of biodiversity and to control the floods in the area. The greater the forest area, the higher the chances of avoiding landslides and soil erosion.

Environmental Protection Regulatory Framework (EPRF)

Guidelines are available for environmental regulations for the people, environment and for the factories working in the area, which should be adopted and enforced. The government and the policy makers should be implementing the rules to avoid carbon dioxide gas emissions greater than the prescribed maximum amount. Every industry should implement the National Environmental Quality Standards (NEQs) prescribed by the environmental legislators. Waste from factories should be dumped with proper treatment, as per the guidelines, so that they do not harm the aquatic life or air and the overall ecology. Handling and proper disposal of industrial waste including hazardous gases, wastes and liquids needs to be strictly overseen and regulated, to keep them within

manageable levels. Violators should be strictly punished. Clear cut guidelines and standard operating procedures (SOPs) should be established and implemented for waste disposal and maximum emission levels that need to be adhered to by all industrial/power generation facilities. The reproduction units that violate the rules must be heavily penalized.

Use of Latest Technology

The latest technologies should be used to control the all kinds of pollution. The chimneys of the factories should be lined with specialized sheets. By using these sheets, the harmful pollutants will cling to them, thereby reducing the toxic emissions into the atmosphere. It would be preferable to use the process of incineration with the chimneys to control the pollution even further. Latest waste disposal mechanisms and technologies should be adopted for the waste treatment and disposals. China is using the ultra-supercritical technology at their coal plants to generate energy as a part of their strategy to attain clean energy. The high-efficiency coal-fired power plant sharply reduces the emission impact of energy generated from coal, however, that technology has unfortunately not been shared with Pakistan as some projects are under construction, while some are in planning phase. This aspect of Environmental Impact Assessment (EIA) has been fully set aside.

Conclusion

CPEC will have social, economic and environmental impacts on Pakistan's ecology unless effective steps are taken proactively to ensure that the negative fallout of such development is curtailed. China, on the one hand, is already phasing out the use of coal power plants and are using advanced technology to adopt clean energy in compliance with the Paris accord. They are taking measures to control their greenhouse gas emissions and are implementing their local laws to control air pollution by imposing heavy fines on violators. Pakistan, on the other hand, in a bid to expedite the CPEC projects without creating too many hurdles, is not respecting its local laws available for impact assessment of the developmental projects. In addition to bypassing or ignoring local laws, Pakistan is also not abiding by the international agreements and commitments we have made. Pakistan is already suffering due to ineffective, or half-hearted, implementation of environmental conservation policies and laws over the last few decades, and as a result is facing the consequences of unsustainable ways of energy production through pollution, smog, and other health related issues. As the magnitude of CPEC projects is greater than any development Pakistan has undertaken till date, it is absolutely essential to understand, at the initial stages, that the negative consequences to the environment of this development will also be equally great. As Pakistan is already in the top seven nations facing environmental challenges going into the future, it is crucial that we behave

in a prudent manner for the sake of our own future. The Government of Pakistan must ensure the immediate undertaking of all relevant impact assessments, make the results and resulting reports public, and ensure that all required mitigation procedures are put into place at this early stage. It will result in greater economic loss if Pakistan is required to address the negative consequences after the fact. Not only will it end up costing Pakistan more financially, but the Pakistan will have to pay the price in terms of the environment, which has a cost that goes beyond financial terms. Pakistan has a great future ahead and with CPEC it seems to be positioning itself to leap into that promise of economic prosperity that it has always held. For the sake of its own people and the rest of the world, it would be great if Pakistan ensures responsible behavior towards the environment so that the people of Pakistan can enjoy the benefits rather than regret them.

Future Research Directions

This exploration suggests that more research is required about the CPEC infrastructure development projects and their effects on communities and ecology. Scientists require more data to identify the impact in various districts of Pakistan. In light of new data, scientists will have the capacity to suggest better alleviation systems that can be utilized at specific destinations. Along these lines, this examination suggests another investigation, which will investigate the social and economic and environmental impacts of the infrastructure developmental projects.

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Appendix-A

No#	Pollution (CO2 Emission)	Time
1.	0.738456	2000
2.	0.741359	2001
3.	0.768458	2002

4.	0.764702	2003
5.	0.788668	2004
6.	0.804959	2005
7.	0.872802	2006
8.	0.887768	2007
9.	0.929857	2008
10.	0.99103	2009
11.	0.97205	2010
12.	0.950832	2011
13.	0.946268	2012
14.	0.929801	2013
15.	0.918978	2014
16.	0.904316	2015
17.	0.896264	2016

Residuals Statistics

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	.8418	.9244	.8710	.04068	17
Residual	-.10337	.14920	.00000	.07448	17
Std. Predicted Value	-.716	1.314	.000	1.000	17
Std. Residual	-1.344	1.940	.000	.968	17

a. Dependent Variable: pollution

Statistical results

```
RECODE time (2000 thru 2010=0) INTO first.
VARIABLE LABELS first 'before CPEC'.
EXECUTE.
RECODE time (2000 thru 2010=0) (2011 thru 2017=1) INTO second.
VARIABLE LABELS second 'after CPEC'.
EXECUTE.
REGRESSION
  /MISSING LISTWISE
  /STATISTICS COEFF OUTS R ANOVA
  /CRITERIA=PIN (.05) POUT (.10)
  /NOORIGIN
  /DEPENDENT pollution
  /METHOD=ENTER before
  /SCATTERPLOT= (pollution, *ZPRED)
  /RESIDUALS HISTOGRAM (ZRESID) NORMPROB (ZRESID).
```

Regression Notes

Output Created		19-Oct-2017 23:25:05
Comments		
Input	Active Dataset	DataSet0
	Filter	<none>
	Weight	<none>
	Split File	<none>
	No. of Rows in Working Data File	17

Missing Value Handling	Definition of Missing	User-defined missing values are treated as missing.
	Cases Used	Statistics are based on cases with no missing values for any variable used.
Syntax		REGRESSION /MISSING LISTWISE /STATISTICS COEFF OUTS R ANOVA /CRITERIA=PIN(.05) POUT(.10) /NOORIGIN /DEPENDENT pollution /METHOD=ENTER before /SCATTERPLOT=(pollution ,*ZPRED) /RESIDUALS HISTOGRAM (ZRESID) NORMPROB (ZRESID).
Resources	Processor Time	00:00:01.435
	Elapsed Time	00:00:01.400
	Memory Required	1396 bytes
	Additional Memory Required for Residual Plots	912 bytes

Variables Entered/Removed

Model	Variables Entered	Variables Removed	Method
1	before CPEC		Enter

a. All requested variables entered.

b. Dependent Variable: pollution

ANOVA 3

Model	Sum of Squares	ds	Mean Square	F	Sig.
Regression	.026	1	.026	4.474	.052a
Residual	.089	15	.006		
Total	.115	16			

a. Predictors: (Constant), before CPEC

b. Dependent Variable: pollution