P-ISSN 2664-0422	Pakistan Social Sciences Review	Oct-Dec 2023, Vol. 7, No. 4
O-ISSN 2664-0430	https://doi.org/10.35484/pssr.2023(7-IV)58	[653-663]

Pakistan Social Sciences Review
www.pssr.org.pk

RESEARCH PAPER

Impacts of the China-Pakistan Economic Corridor on the Natural Environment of Pakistan

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Abstract

This study aims to explore environmental risks imposed by the developmental projects of the China-Pakistan Economic Corridor (pinyin: Zhōng bā jīngjì zǒuláng). CPEC is helping Pakistan with energy, economic, and infrastructural development and it is also highly addressing the damage to the natural environment. The natural environment has immense importance for the growth and stability of a country. It is further attached to fundamental elements such as biodiversity, acid rain, glaciers, thunderstorms, agriculture, ecosystems, water resources, and tourism. Although climate change is a global phenomenon, and China-Pakistan Economic Corridor works as a catalyst to address climatic concerns in Pakistan. Through the energy projects of CPEC tons of CO2 are emitted daily which is considered a major cause of ozone depletion according to the global index. Pakistan has witnessed heavy flooding, heat waves, increasing temperature, a decline in biodiversity, and glacier melting for a decade. Economic development at the cost of environmental loss is not suitable for it. Securing the natural environment and natural resources should be the major concern of Pakistan.

Key Words CPEC Climate Change Natural Environment Environmental Sustainability

Introduction

Climate change is a global phenomenon that rapidly occurs in the world. Pakistan has been at a high risk of climate change for the past decades. Pakistan is experiencing extreme weather and increasing temperatures that cause melting of Himalayan glaciers. It is alarming for the whole region. Pakistan ranks in the top 10 countries vulnerable to climate change. As compared to the vulnerabilities, mitigations, and adaptation are very low in Pakistan. It is a long-term shift in the temperature and weather patterns. In very few cases, climate change occurs naturally but it is the result of human activities. A major cause of climate change is greenhouse gas emissions. Increasing heat levels up greenhouse gas levels (carbon dioxide and methane), these gases trap the sun's rays and increase the temperature which is the main contributor to Climate Change. Burning of oil, coal, and gasses in huge amount also cause climate change. (Anjum, et al., 2021)

CPEC continuously promotes potential threats to the natural environment. Infrastructural development is a major threat to biodiversity and environmental sustainability. Glacier melting, heavy flooding, and deforestation, all are the result of environmental degradation. Pakistan has big reservoirs of glaciers. The mountain range of northern Pakistan is known as the house of glaciers. It hosts almost 5000 glaciers. The newly emerged projects of CPEC cause climate change which further creates an alarming situation for glaciers melting. Glaciers are the main source of river water. Heavy floods are direct results of melting glaciers. (Ali, Sajjad, & Haleem, 2021)

Some of the CPEC projects impose environmental risks and effects which further enhance climate change Some of the energy projects of CPEC are coal-based that are considered harmful to the environment and public health. There is a need for time to explore environmental risks that are directly or indirectly connected with CPEC and its coal projects. The destruction of the environment causes natural disasters like flooding, earthquakes, blizzards, and tsunamis. Several studies have shown that CPEC power and coal projects are the cause of damage to the water, air, and biodiversity of Pakistan because due to CPEC deforestation is happening rapidly. (kakar, Shabbir, & Mustafa, 2021)

Literature Review

Climate change harshly impacts the natural environment of the local region. First, it causes temperature and weather changes. When surface temperature is rising extreme weather events take place. These changes disturb the environment and human lives badly. A severe heat wave was recorded in Pakistan and India in 2022 that raised the temperature to 51. These heat waves are supposed to occur after every 312 years but now it is said that these waves will come after every three years which is very alarming for nature. These heat waves would be more severe and recorded frequently. Pakistan experiences heavy monsoons and annual rains which cause damage and loss. Climate change is a global catastrophe but Pakistan experiencing rising temperatures more than the global average. Rising temperature is more experiencing in the northern sides of Pakistan as compared to the south. The frequency of hot days and hot nights also increased. (Iqbal, 2020)

To some extent, CPEC is a proven beneficiary from a socioeconomic perspective. It works effectively to meet the energy crises of Pakistan both at the industrial and domestic levels. To some extent, it boosts the agriculture of Pakistan with the help of new technologies, instruments, and tools. FPCCI being an optimist inserts the agriculture department in CPEC. Agriculture development is directly proportional to infrastructure and technological development. There is a strong relationship between infrastructure, agriculture, and technological development. Infrastructure development plays a vital role in the uplift of agriculture in Pakistan.

Due to rapid climate change and developmental projects of CPEC especially Coal-based projects Pakistan is in a worse environmental crisis. Due to the substantial use of fossil fuels to produce energy, a remarkable increase occurs in greenhouse gas (Co2 & NH4) emissions. These are the main contributors to water and air pollution. GHS emissions increase the local surface temperature of Pakistan more than the average global rise. Due to these irregular environmental changes, Pakistan experiencing polar ice melting, glacier melting, water pollution, air pollution, natural environmental challenges, and a decline in biodiversity. It also affects the economic health and GDP of Pakistan. CPEC is a core contributor to the degradation of the natural environment. (Kanwal, et al., 2022)

Pakistan is situated in semi aired to the hyper-aired region which is why its vulnerability to climate change is higher than other third-world countries. Pakistan has to face 3.8 billion dollars economic loss due to climate change and China is the driver of climate change, due to its BRI and CPEC. Many studies have shown that the region near CPEC is highly susceptible and vulnerable to climate change, erosion, and water shortage. Flooding is also the result of climate change which highly affects human beings as well as animals. Due to climate change, our, forests are not safe. The destruction of forests happens rapidly. The assessment shows that due to coal projects of CPEC ecological vulnerability increases day by day. Based on past studies of ecological vulnerability, a new ecological vulnerability index model is introduced to elaborate the

geographic component data and temporal features of ecological vulnerability. According to the climate index, Pakistan ranks 8th number in the top ten states and CPEC further upgrades its ranks in the global climate index. Environmental degradation mostly occurs in the host regions of CPEC. These regions are experiencing high temperatures and high potential evaporation that surpasses precipitation. The region faces extensive deforestation. In southern parts of Pakistan, salinization is also affected due to high evaporation and specific topographic features. Furthermore, soil erosion is also a dominant ecological problem and human activities. (Wu, et al., 2021)

The China-Pakistan Economic Corridor (CPEC) is a large-scale infrastructure project that aims to enhance connectivity and promote economic cooperation between China and Pakistan. Primarily the focus of CPEC is to improve transportation networks, energy infrastructure, and industrial development.

The construction of new roads, power plants, and industrial zones under CPEC has the potential to increase greenhouse gas emissions. Industrial activities, especially in the energy and manufacturing sectors contribute to higher levels of carbon dioxide (CO2) emissions. CPEC involves the development of several coal-fired power plants in Pakistan to address the country's energy needs. Coal is a significant contributor to CO2 emissions and air pollution, which adversely impact climate change and public health. Infrastructure projects, including roads, power lines, and industrial zones, often require clearing land, which can lead to deforestation and habitat loss. Deforestation contributes to climate change as forests serve as carbon sinks, absorbing CO2 from the atmosphere. The loss of habitats can also disrupt ecosystems and affect biodiversity, further exacerbating environmental challenges. (Ali, Khayyyam, & Nazar, 2021)

Coal, Carbon Emission, & CPEC

Coal reservoirs in Thar have a huge capacity for power production. More than half of the CPEC projects are coal-based. Coal combustion is a direct contributor to increased temperature and climate change Infrastructural projects of CPEC release 36.5 million tons of CO2 which is a severe contributor to air pollution and environmental degradation of host communities. The combustion of coal for energy generation has significant environmental impacts. (Ali S. , 2020)

Burning coal releases carbon dioxide (CO2) and greenhouse gas contributing to climate change and global warming. The combustion of coal is a major source of CO2 emissions, which can lead to the intensification of the greenhouse effect and contribute to a rise in temperature. Coal combustion releases various pollutants into the air, including sulfur dioxide (SO2), nitrogen oxides (NOx), particulate matter (PM), and mercury. These pollutants have detrimental effects on air quality and human health. SO2 and NOx can cause respiratory issues, smog formation, and acid rain. Particulate matter leads to respiratory, and cardiovascular problems, and mercury emissions can bioaccumulate in ecosystems posing risks to wildlife. Coal combustion produces ash as a byproduct, known as coal ash or fly ash. Proper disposal of coal ash is crucial to prevent contamination of water bodies and soil. If it is not managed effectively, coal ash will leach toxic substances such as heavy metals, including arsenic, lead, and mercury, into the environment, posing risks to aquatic ecosystems and human health. (Iqbal, 2020)

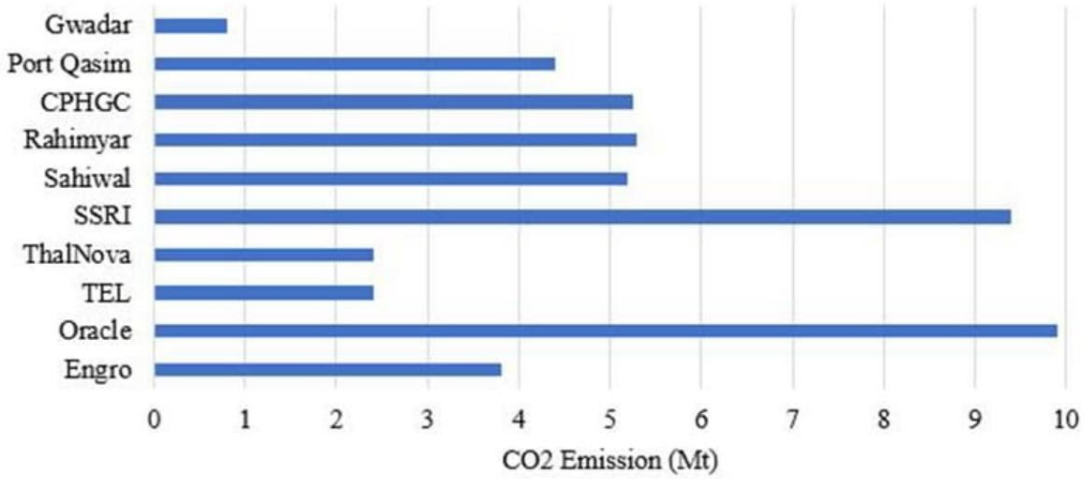

Figure 1 level of CO2 emission

Coal-fired power plants require significant amounts of water for cooling purposes. The withdrawal of large volumes of water from rivers or other water sources also has negative impacts on aquatic ecosystems, particularly during periods of low flow. Additionally, the discharge of heated water back into water bodies affects water temperature and alters aquatic habitats. Furthermore, inadequate management of coal ash disposal contaminates water bodies, leading to water pollution. Coal mining leads to deforestation, habitat destruction, and soil erosion. It also contributes to water pollution through the discharge of mine wastewater, which may contain heavy metals and other contaminants. (Ullah, 2022)

Coal projects often require substantial amounts of water for their operations, which strains local water resources, particularly in water-scarce regions. The extraction and consumption of water for cooling purposes reduced water availability for agriculture, domestic use, and ecosystem maintenance. The discharge of untreated wastewater from coal plants contaminates water sources, further jeopardizing the health and livelihoods of host communities. Coal-based power plants are notorious for their contribution to air pollution. The combustion of coal releases harmful pollutants, including sulfur dioxide, nitrogen oxide, and particulate matter. Host communities living in proximity to coal plants are at increased risk of respiratory problems, cardiovascular diseases, and other health issues. The emission of pollutants affects agricultural productivity and livestock. The extraction, transportation, and burning of coal contribute to global warming, which adversely affects the environment and host communities' livelihoods. Climate change impacts, such as erratic weather patterns, glacial melting, and water scarcity, can further exacerbate the vulnerability of these communities, which rely heavily on natural resources for their survival. (Afaqi & Askari, 2022)

This GHG emission directly or indirectly causes the following environmental curse in Pakistan.

- Heavy Precipitation
- Heat Waves
- Tropical Cyclones
- Droughts
- Heavy Floods
- Typhoons
- Extreme Weather Events
- Heavy Rainfall

- Polar Ice Melting
- Glacier Melting
- Rise in Sea Level
- Decrease in Water Resources
- Agriculture damages
- Stress to the Ecosystem
- Decline in Biodiversity
- Record Breaking Warmth
- Catastrophic Storms
- Severe Fires

Environmental Attributes

Pakistan is a country with diverse natural environmental attributes that encompass various landscapes and ecosystems. Here are some notable features:

Mountains Pakistan is home to the Mountain ranges of Himalaya, Karakoram, and Hindu Khush. K2 the world's second largest mountain is located in Pakistan. These mountains have breathtaking scenery, glacial rivers, and huge freshwater resources.

Glaciers Pakistan has some of the world's largest glaciers. Glaciers such as Siachen, Biafo, and Baltoro are major sources of freshwater, rivers that sustain agriculture and human settlements downstream.

Rivers The country is traversed by several major rivers, including the Indus, Jhelum, Chenab, Ravi, and Sutlej. These rivers support irrigation for agriculture, and hydropower generation, and serve as important habitats for aquatic life.

Coastal Areas Pakistan has a coastline along the Arabian Sea, stretching over 1,000 kilometers. The coastal areas, such as the Mkran Coastal Range, provide diverse marine ecosystems, mangrove forests, and nesting grounds for various marine species.

Deserts The Thar Desert, located in the southeastern part of the country, spans across both Pakistan and India. It is the world's seventeenth-largest desert and is characterized by arid landscapes, dunes, and unique flora and fauna adapted to desert conditions.

Forests Pakistan has various forests, including the coniferous forests of the northern areas and the mangrove forests along the coast. These forests support biodiversity, provide habitats for wildlife, and contribute to carbon sequestration.

Wetlands Pakistan has several wetlands of international importance, such as the Indus Delta, Hangul Wetlands, and Kartar National Park. These wetlands serve as crucial habitats for migratory birds, provide breeding grounds for fish, and support local ecosystems. (Shabbir, Omer, & Jurgen, 2022)

CPEC and Biodiversity

Infrastructural projects fragment landscapes and disrupt ecological connectivity. It hinders the movement and dispersal of wildlife, affecting their ability to access resources, find mates, and maintain genetic diversity. Fragmentation also increased the risk of local extinctions and reduced the resilience of ecosystems. Industrial activities and increased human settlements associated with CPEC contribute to pollution and degradation of water bodies. The discharge of industrial effluents, improper waste management, and sedimentation harms aquatic ecosystems and impacts fish populations

and other aquatic organisms. The development of infrastructure and increased transportation networks facilitate the introduction and spread of invasive species. Invasive species outcompete native species for resources, disrupt natural ecosystems, and pose a threat to biodiversity. (Lashari, et al.,2020)

Air Pollution

CPEC involves the establishment of power plants, manufacturing units, and industrial zones. These industrial activities release pollutants into the air, including sulfur dioxide (SO2), nitrogen oxides (NOx), particulate matter (PM), and volatile organic compounds (VOCs). Emissions from coal-fired power plants are a significant source of air pollution. It includes the construction of new roads, highways, and transportation infrastructure. This leads to increased vehicular traffic, especially from heavy-duty trucks and machinery associated with the project. Vehicle emissions, such as carbon monoxide (CO), nitrogen dioxide (NO2), and PM, contribute to air pollution. Dust and Construction Activities, Excavation, demolition, and earth-moving activities can result in the release of fine particles into the air, leading to localized air pollution. Dust can also be generated during the transportation of construction materials and from unpaved roads. Energy Generation from Fossil Fuels: CPEC includes the development of coal-fired power plants to meet Pakistan's energy demands. Coal combustion releases pollutants such as sulfur dioxide, nitrogen oxides, and fine particulate matter, which contribute to air pollution and have adverse health effects. (Anjum, et al., 2021)

The ambitious infrastructure initiative has raised concerns about its environmental impact, particularly in the picturesque region of Gilgit-Baltistan. This study aims to explore how CPEC poses significant threats to the natural environment of specific areas of Pakistan that hosted CPEC like Gilgit-Baltistan and how to protect hosted areas from environmental hazards. Gilgit-Baltistan is home to diverse ecosystems and ancient forests, which are being indiscriminately cleared for the development of infrastructure projects. Deforestation leads to the loss of wildlife habitats, erosion, soil degradation, and a decline in biodiversity. (Ullah H. Q., 2022)

CPEC involves the construction of numerous dams and hydropower projects along the Indus River and its tributaries. These projects often require diverting river courses and flooding large areas, resulting in the destruction of critical wildlife habitats. The damming of rivers disrupts fish migration patterns, impacting the local fish populations and the communities that rely on them. Additionally, the alteration of river flows affects the aquatic ecosystems and their delicate balance. CPEC's massive construction projects, including roads, tunnels, and pipelines, disrupt the delicate ecological balance of Gilgit-Baltistan. The fragmentation of natural habitats isolates wildlife populations, restricts their movement, and disrupts ecological processes such as pollination and seed dispersal. (Asif & Ling, 2019)

Sahiwal

Energy and Infrastructural projects of the China-Pakistan Economic Corridor work in different areas of Pakistan. In the construction of the Sahiwal Coal Power Plant, the Chinese experts said Super Critical Technology is being used in it. Despite this, the environmentalists didn't agree with this power plant construction on fertile land. About 90% of the local people are assumed to make use of agricultural resources. Half of the fertile land is lost due to construction and the other half lost its fertility due to the emission of toxic elements by this powerplant. A very low quality of coal is used in this power plant as 1 kg coal combustion produces only one unit of electricity and discharges almost 20 different toxic elements. The environmental impacts of the Sahiwal coal power plant address the cases of raging temperature, heavy flooding, agricultural losses,

disturbed land fertility, contributed pollution in canal water, and air pollution. Coal combustion discharges many toxic elements, including fly ash and land ash. This plant carries out almost 20 harmful toxic elements, which are released into soil and water. Public health is badly affected and the rate of lung issues has been highly addressed in the last few years in host communities. A local person from Sahiwal said in an interview that he doesn't know about the scientific properties of coal used in this power plant but if the white cloth is hung on a rope, it becomes black after 8-9 hours so how they can commit that a supercritical coal is being used in this powerplant. The government is witness to all these hazards & harms of agriculture, the environment, and public health but it is ignored just because of economic development. (Niazi, 2018).

Figure 2 Coal power plant pollution

Thar

Coal mining and power projects in Thar are the major projects under the umbrella of the China-Pakistan Economic Corridor. Centre of Research on Energy and Clean Air conducted studies regarding the impacts and outputs of the Thar power plant. Forceful displacements are the major concern of local people but it is a socio-economic problem. Regarding the environment, coal energy is very toxic and harmful, leading to health issues, loss of livelihood, loss of lives, and a massive increase in poverty. Local people are compromised with clean drinking water resources, and a meaningful rise in air pollution leads to breathing issues due to coal mining. Thar is the major contributor to air pollution including mercury and corban die oxide emissions in the whole region. Almost 29000 air pollution-related deaths, 40 thousand Asthma cases, and 32,000 premature births are reported. These nine coal power plants in Thar address Pakistan's worst public health index. These power plants should also move toward renewable energy resources for the betterment of the local people and Pakistan. (Hasan, 2020)

Gilgit Baltistan

China-Pakistan Economic Corridor initiated landmark infrastructural projects in Gilgit Baltistan to uplift the living standards of the local people. This is due to the key

geographical location of this region. It is present in the heart of South Asia and is a full-fledged reservoir of natural resources for Pakistan. Mega infrastructural developments, road networking, Dam constructions, and oil & gas pipelines are projected under the umbrella of the China-Pakistan Economic Corridor. ALL the developments come at the possible cost of local livelihood degradation, environmental instability, and exploitation of natural resources. Gilgit Baltistan provides almost half of Pakistan's drinking water and irrigation water. CPEC makes it worse and forms an unreversible depletion of water and the ecosystem of Gilgit Baltistan. Due to the use of technologies and heavy traffic, a huge amount of CO2 emission is happening in the region leading toward glacier melting, air pollution, water pollution, loss of natural habitats, and decline in biodiversity. Pakistan is considered a rich habitat of glaciers and Gilgit Baltistan hosts almost 80% of glaciers. Heavy glacier melting has created an alarming scenario in Pakistan for the last few years. Heavy flooding is the result of glacier melting and almost half of Pakistan confronted the flood in the last monsoon. Other than flooding, ice melting releases a dangerous virus that leads to incurable diseases. Land sliding, deforestation, and loss of forests are the other major concerns resulting from the infrastructural projects of the China-Pakistan Economic Corridor. Due to land sliding many road accidents are reported daily.

Gwadar

Gwadar is the central point of the China-Pakistan Economic Corridor. It is the hub of trade and regional connectivity. It enhances the economic and infrastructural development but at the same time, it harms the environment of the region. One of the factors that are affecting the natural environment of Gwadar in CPEC is the emission of gases by the vehicles that are being used in the completion of this project. Almost 36.5 million CO2 is released by these vehicles daily, eventually creating air pollution. The people who breathe in this polluted air are at high risk of respiratory problems. Moreover, this change in the climate is melting the glaciers and recent studies have shown that increased CO2 in the air has resulted in floods that occurred in Baluchistan in 2019. Pakistan had some energy crisis, so for CPEC some coal power plants were planted to fulfill energy requirements. Through the production of energy, some gases are also released in the environment that consequently cause global warming and it also makes the rain acidic when these gases react with each other. Acid rain burns the skin of people and causes severe eye infections. As Pakistan has only 5.1% of forest area that is reduced by the cutting of trees for the Karakorum Highway for CPEC, the increased amount of CO2 is not being absorbed by the trees and the air is becoming more polluted day by day and the number of asthma, bronchitis, and cardiac patients are increasing. (Ali S. , 2020)

Findings

- CPEC aims to mitigate the energy crisis in Pakistan. It has started many coal-based energy projects in different areas of Pakistan. These projects are not able to fulfill the energy needs of Pakistan but it badly affects the natural environment.
- A massive tree cutting due to new constructions and road networking of CPEC is another major environmental concern. Road networking increases vehicle trafficking. All these phenomena are interlinked and lead to huge CO2 emissions.
- Coal combustion is the major cause of CO2 emissions that harm the environment and level up different kinds of negative impacts regarding public health, biodiversity, water pollution air pollution.

- Although climate change is a global phenomenon, not only occur in Pakistan. However, CPEC has the potential to address climate change and environmental harm in Pakistan. Over the past few years, we all have been witness to a rapid increase in environmental damages and changes in our country like floods, droughts, increased temperature, heat waves, and viral diseases.

- Smog is the major result of CPEC coal-based power projects in Punjab and Sindh provinces. We are witnessing smog that appears for the last 4 to 5 years. Before that, we weren't aware of it. Smog is a combination of fog, smoke, and severe air pollution. It has a major contribution to environmental degradation and climate change by releasing greenhouse gasses into the air. Smog reduces air quality by reducing atmospheric pollutants such as nitrogen, sulfur, and volatile organic compounds. These pollutants can have determinable effects on both human health and the natural environment. It creates lung diseases and leads to fatal road accidents due to zero visibility on roads. It also has adverse effects on agriculture. The deposition of pollutants on crops can interfere with their metabolic process, reduce crop yield, and lower the nutritional quality of harvested crops. It also affects the water bodies, plant life, and wildlife as well.

- Coal-based processing has adverse effects on the natural environment in the form of Greenhouse gas emissions and global warming. Coal holds a large number of Sulphur compounds that are released during coal combustion and pollute air, water, and land. Other agricultural activities such as livestock, grains, and vegetables are also affected.

- After suffering from a huge burden of health problems China also switched off these energy resources and ran its projects on renewable energy resources but in Pakistan CPEC still works on coal-based energy. If we do a comparative analysis of China and Pakistan, China is the world's first country that rapidly converts non-reusable energy into reusable energy. Despite this, Chinese projects in Pakistan are still coal-based.

Conclusion

CPEC has historically not prioritized environmental sustainability. However, it is too risky for Pakistan to achieve economic development at the cost of environmental loss. CPEC is a game changer for Pakistan's economy, but despite this, the natural environment and public health cannot be bulldozed. However, unfortunately, the natural environment has been bulldozed. While CPEC coal projects address Pakistan's energy needs, they can inflict significant damage on the host communities. Displacement, land acquisition, air pollution, water scarcity, health hazards, social and cultural disruptions, and climate change impacts are some of the challenges faced by these communities. Policymakers, project developers, and stakeholders must ensure that the negative impacts are mitigated through the implementation of robust environmental and social safeguards. Prioritizing sustainable practices, community engagement, and alternative energy sources can help protect the well-being and livelihoods of host communities and contribute to more environmentally responsible and socially inclusive development under the CPEC initiative.

Recommendations

- Sustainable land management practices must be adopted to control land degradation caused by mining activities to enhance the productivity of other ecosystems and services such as crop production.
- Climate adaptation and mitigation strategies must be part of mining projects' planning and development initiatives. This includes the use of green technologies,

exploring development projects that make little use of natural resources, disaster risk reduction programs, and supporting technological innovations and best practices implemented in other regions.

- Pakistani policymakers must use alternative ways of energy production other than coal. We have to plant wind power plants on motorways same as in Germany.
- Norway produces 99% of renewable energy sources by installing hydropower stations, and dams. Pakistan has to follow the same strategy as Norway and convert energy resources from coal to renewable energy sources. Pakistan has to build Dams to store water from summer to winter. It can also prevent heavy flooding and helps to make a whiter climate & healthy environment.

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