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THE DOUBLE-EDGED SWORD OF MOTORWAY DEVELOPMENT: BALANCING ECONOMIC GROWTH WITH ENVIRONMENTAL AND SOCIAL SUSTAINABILITY

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ABSTRACT

This research paper offers a comprehensive analysis on the relationship between motorway infrastructure and environment in Pakistan. Multiple impacts of motorway on various environmental aspects are examined making the motorway as an important part of national infrastructure. It addresses the questions like (a) how a motorway infrastructure changes the local and regional temperature, affects air quality index, produce noise pollution that impact social life (b) what are the effects of a motorway on water resources, geology and agriculture (c) how land acquisition and soil modification for motorway infrastructure and its contribution to the advancement of commercial units affect the local environment. The building and maintenance of a motorway infrastructure leads to the local and regional environmental challenges. Data is collected through primary and secondary sources. Interviews are conducted to collect first-hand insight into the impact of the motorways on the local and regional environment. The research contributes to academic literature by offering an in-depth analysis. It offers research-based recommendations for policymakers and stakeholders in Pakistan.

Keywords: *Motorway, Infrastructure, Environment, Social Life, Pakistan.*

INTRODUCTION

Motorway and environmental conservation as strong social, political, and economic policies are working now throughout the World of nation-states. A motorway is a road which is mostly used by cars. It passes over or beneath the other ordinary roads. It stays away from restricted areas. It can only be reached from these ordinary routes at specific places. It is composed of large radius curves that are joining straight lines. A motorway has all the elements that are required for optimal visibility and maximum stability. It manages the flow of traffic efficiently. It is totally different from other ordinary road for all kinds of traffic (Flonneau, 2022).

The world of nature or natural environment is the surroundings of all kinds of lives that are the most significant context for social health and well-being. Environment consists of regional temperature, air quality index, noise pollution, water resources, geology, agriculture, and soil modification. In this present era, it is being affected by development, pollution, human activities, and climate change. It is crucial for sustainability. Natural environment refers to the physical and biological components of the earth. It includes the ecosystem of earth (Kidd & Kidd, 2017). Natural environment is the physical and biological world around us (Miller & Spoolman, 2019). Natural environment includes all living and non-living things that naturally exists on earth like air, water, and plants (Cunningham & Cunningham, 2018). Natural environment is the sum of all external conditions that affects the survival of lives on earth (Meffe & Carroll, 1997).

Environmental conservation is a process in which the natural world, environment or climate is protected and preserved by individuals, groups, and organization from collapsing by understanding the implications of human activities like development, soil modification, pollution, deforestation, burning fossil fuels and unsustainable agriculture. It refers to the practices and policies that aimed to protect and preserve the natural environment (Bryant, 2015). It involves the protection and preservation of natural resources including water, air, soil, ecosystem and biodiversity (Cunningham & Cunningham, 2018). It involves the protection and preservation of natural ecosystems and services they provide like air and water (Daily, 1997).

Environmental impact assessment (EIA), examines the possible consequences of a development project on the environment. Every country needs to work on development projects, and these projects will unavoidably have an impact on the environment. Consequently, businesses are viewed as unfriendly to the environment, despite their incorporation into it. When starting a project, two considerations must be made: i) it must be financially practical. ii) It must be technically practical. But now, an EIA has allowed us to make the proposal socially and environmentally acceptable that is no longer the case. These days, this is an important consideration for any development project plan. Nowadays any large-scale development project can never be preceded without EIA. Planners and decision-makers are better able to understand the environmental effects of a proposed project by using the Environmental Impact Assessment (EIA) method. When decisions are being made about a project's development, the EIA mandates that the environment and public participation must be taken into account. It seeks to lessen a project's influence on the local environment by taking into account all potential advantages. One of the objectives of development is to lessen or completely eradicate environmental harm.

Environmental Impact Assessment is a systematic process for predicting and evaluating the potential environmental impacts of a proposed project (Morgan, 2012). It is a systematic process for identifying the impacts of environment due that proposed project and development (Lee & George, 2000). It is a process to identify measures to avoid the harmful impacts of environment (Therivel, 2004).

Hypothesis:

The growth of motorway networks challenges the local and regional environment. Gains in the availability of high regional temperature, bad air quality index, noise pollution, polluted water resources, unsustainable agriculture, and soil modification are indicators of the effects as motorway networks make on social life in a country.

Statement of Problem:

The relationship of motorways with local environment creates many challenges and opportunities. In Pakistan, if government takes initiatives of a motorway understanding its impact on local and regional environment, their efforts become paramount.

Objectives:

This research paper offers a comprehensive analysis on the relationship between motorway infrastructure and environment in Pakistan. Multiple impacts of motorway on various environmental aspects are examined making the motorway as an important part of national infrastructure. It addresses the questions like (a) How a motorway infrastructure changes the local and regional temperature, affects air quality index, produce noise pollution that impact social life? (b) What are the effects of a motorway on water resources, geology and agriculture? (c) How land acquisition and soil modification for motorway infrastructure and its contribution to the advancement of commercial units affect the local environment? The building and maintenance of a motorway infrastructure leads to the local and regional environmental challenges. Data is collected through primary and secondary sources. Interviews are conducted to collect first-hand insight into the impact of the motorways on the local and regional environment. The research contributes to academic literature by offering an in-depth analysis. It offers research-based recommendations for policymakers and stakeholders in Pakistan.

Significance:

This research is very significant because it offers a comprehensive analysis on the relationship between motorways and environment in Pakistan. The

transformative impact of motorways is closely examined making them an essential part of the national infrastructure. The growth of motorway networks creates many environmental challenges that need to be solved for better social life. The analysis also demonstrates how motorways facilitate commercial units that harm local environment. It also contributes in academic literature, offers recommendations, and raises public awareness about the impact of motorway on local and regional environment.

Research Methodology:

The project is based on quantitative approach, social impact type of secondary nature, examine objectively, deductive reasoning, a case-study, context, historical as well as thematic review of literature, curiosity-based topic, simple hypothesis, primary as well as secondary source of data and Turabian style of citations.

Chapterization:

There are total ten chapters that are briefly discussed in the paper. Total ten chapters are named as following: i) Introduction ii) M-4 Motorway: A Main Development Project iii) Temperature iv) Air Quality v) Noise vi) Water vii) Geology viii) Agriculture ix) Recommendations x) Conclusion

Literature Review:

A History of British Motorways by George Charlesworth offers a thorough examination of the growth and development of the motorway system in the United Kingdom. This book, which was published in 1984, offers a comprehensive historical analysis of the policy decisions, the building of motorways, and the socioeconomic effects that these initiatives had on the people of Britain. The book traces the development of British motorways from their theoretical beginnings in the early 1900s to their remarkable expansion in the years following World War II. A few of the significant turning points in the history of the motorway system that Charlesworth emphasizes are the passage of the Road Traffic Act of 1956, which prompted the construction of motorways, and the ensuing stages of design and implementation.

The perspective of the local populace on road and transportation infrastructure of the China-Pakistan Economic Corridor (CPEC) is examined by Ali et al. (2018). The study sheds light on how infrastructure initiatives, such as the China-Pakistan Economic Corridor (CPEC), affect Pakistan's rural populations. The Journal of Chinese Economic and Foreign Trade Studies published it. In an effort to fortify relations between China and Pakistan, transportation infrastructure is being created as part of the CPEC. This study examines how the community views this development. Ali et al. look at a number of variables, such as social effects, environmental worries, and financial gains, that affect locals' opinions. Written by Ahmad, Khan, and Rehman in 2022, the case study titled "Impact of Transport Infrastructure Development under BRI on Trade: A Case Study of CPEC in the Context of Pakistan, In this paper, they examine the Belt and Road Initiative (BRI) and its influence on the development of transportation infrastructure, with a particular focus on the China-Pakistan Economic Corridor (CPEC) and its implications for trade in Pakistan. In the context of a sizable multinational development project, this article provides a thorough analysis of the ways that infrastructure projects impact trade dynamics and economic performance. It was published in the International Journal of Business and Economic Affairs. The study looks at the connection between trade in Pakistan and the expansion of the nation's transportation network made possible by the CPEC. It aims to comprehend the ways that trade efficiency, economic expansion, and regional ties are impacted by infrastructure upgrades. The paper evaluates the direct and indirect advantages of various infrastructural advancements using case studies and economic data.

Andrew Badenoch's 2007 paper in the Journal of Transport History, "Touring Between War and Peace: Imagining the 'Transcontinental Motorway', 1930–1950," explores how the Transcontinental Motorway was conceptualized and discussed during the interwar and early postwar years. Badenoch looks at how the idea of a transcontinental road network was changed by the political and economic turmoil of the time. The idea of the Transcontinental Motorway, a planned network of roadways meant to cross continents and improve worldwide communication, is the primary subject of Badenoch's paper. Examining this vision's goals, beginnings, and obstacles from an infrastructure standpoint, the paper

highlights how historical events like the Great Depression and World War II influenced the development of this infrastructure concept.
The impact of urban highway building on city settings and planning is examined in the 1972 article "Urban Motorway Impact" by W. Bor and J. Roberts in the Town Planning Review. The study looks into how highway development affects social dynamics, land use, traffic patterns, and other facets of urban life. An investigation of the effects of urban freeways on city development and the urban environment is provided by Bor and Roberts. Their work examines the potential advantages and unintended repercussions of building high-speed roadways in densely populated urban areas.
A detailed examination of the factors and management strategies for off-highway plant and equipment may be found in the 2003 book Management of Off-Highway Plant and Equipment by D. J. Edwards, F. C. Harris, and R. McCaffer. Spon Press's book is a useful resource for professionals involved in the design, procurement, and administration of heavy machinery used in mining, construction, and other industrial applications. The book covers a wide range of management-related subjects, including off-highway plant and equipment selection, operation, maintenance, and disposal. It covers both theoretical concepts and practical applications, providing insights into practical management strategies to ensure the long-term uptime and optimal operation of heavy machinery.
The impact of living next to an urban motorway on the wellbeing of local residents in impoverished areas is examined in the 2017 PLOS ONE publication "Effects of Living near an Urban Motorway on the Wellbeing of Local Residents in Deprived Areas" by Foley, Crawford, and Humphreys. Using a natural experimental approach, the study looks at how living next to a major road affects several aspects of the welfare of its population. The well-being of people residing in underprivileged areas is examined in relation to living next to an urban expressway. The scientists hope to separate the impacts of being close to a freeway on quality of life and health by taking use of the natural variance in exposure to surroundings around roads.
The impact of the Multan-Sukkur Motorway investment on the local people of Pano Aqil, a town in Sukkur, Pakistan, is examined in the 2019 Paradigm article "The Socio-Economic Impacts of Multan-Sukkur Motorway Investment on the People of Pano Aqil, Sukkur, Pakistan" by Khan and Mari. With an emphasis on the socioeconomic changes it has brought about, the study looks at how the road project has affected every facet of local life. Khan and Mari look into how Pakistan's largest infrastructure project, the Multan-Sukkur Motorway, affects the people living in Pano Aqil. The impact of the expressway on the local economy, social institutions, and general level of living is examined in detail in this study.

M-4 Motorway

According to the National Highway Authority (NHA) (2020), the M4 motorway is a 184-kilometer long, 4-lane controlled access highway connecting Pindi Bhattian and Multan (National Highway Authority;, 2024). Pakistan Today (2019) reports that the M4 motorway is expected to boost economic activities in the region by improving connectivity and reducing travel time (Pakistan Today;, 2019). On August 19, 2009, the construction of M4 motorway was officially launched with a groundbreaking ceremony presided over by Pakistani Prime Minister Syed Yousaf Raza Gillani. It was the projected that the construction was to be completed in three years. At the Sargodha Road Interchange in the northern suburbs of Faisalabad, the M4 motorway started where the M3 ended. It continued to connect the cities of Multan, Jhang, Gojra, Toba Tek Singh, Shorkot, Khanewal, and Faisalabad in a southwesterly direction. When it got to Khanewal, it joined the N5 to finish the M5. Along with two substantial bridges that cross the Shadhnai Channel and the River Ravi, four sections of the M4 were built. The 58-kilometer Faisalabad-Gojra, the 61-kilometer Gojra-Shorkot, the 64-kilometer Shorkot-Khanewal, and the 45-kilometer Khanewal-Multan were the four sections.
From the government of PTI in 2019, the Federal Minister for Communications Murad Saeed officially opened the Gojra-Shorkot section of the Faisalabad-Multan Motorway. The Pakistan Muslim League-Nawaz administration first suggested the Gojra-Shorkot stretch in 2016. At a ceremony held at the Shorkot interchange in this regard, the federal

minister as well as top representatives from the Ministry of Communications and the National Highway Authority (NHA) were present. The part was accessible to the public after the event. The NHA set January 2019 as the timeframe for finishing the component that was previously mentioned. But the Shorkot-Khanewal segment was still unfinished, and field sources said it would take several more months to finish. On the other hand, the Gojra-Shorkot section was nearly finished and had to be opened to the public the next week.

The 61-kilometer segment that was originally discussed was further separated into the packages; i) Gojra-Jamani (31km) and ii) Jamani-Shorkot (30km). China Railway First Group and Xinjiang Beixin received the aforementioned packages, which had an estimated total cost of Rs10.615 billion and Rs10.99 billion, respectively. With the hope that the projects would be completed in two years, the PML-N administration awarded the contracts in April 2016. However, a new deadline of January 2019 was set, and the project's completion date was rescheduled for April 2018.

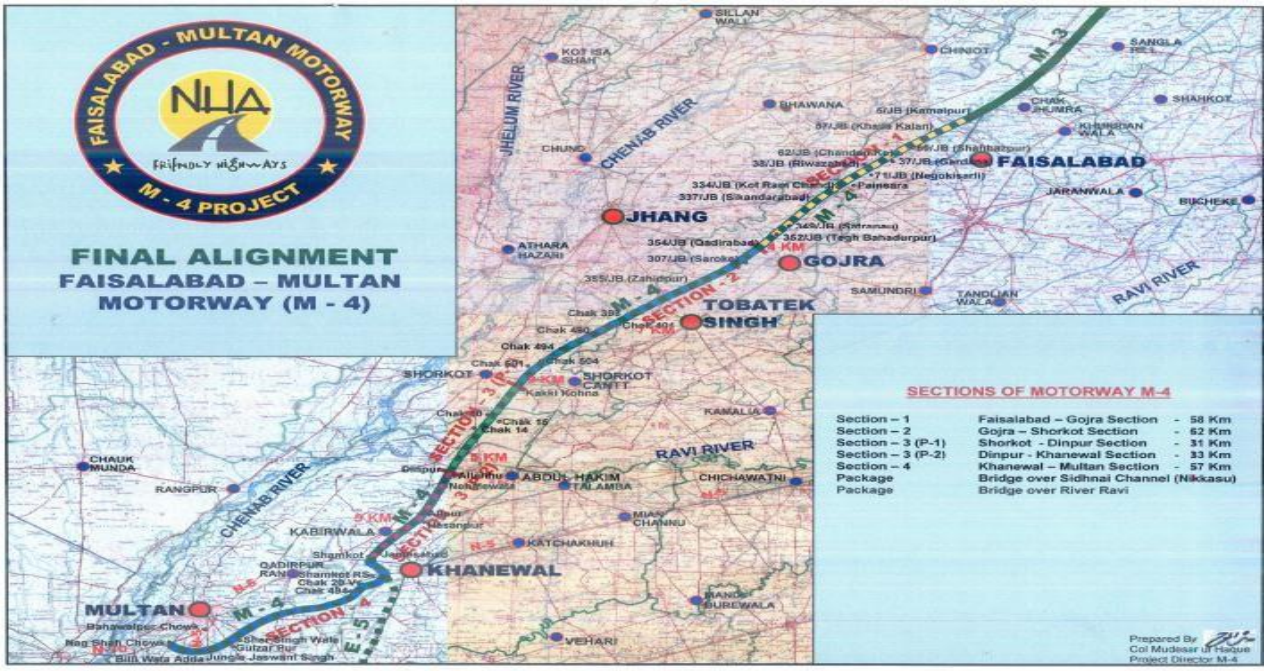
The timely completion of the Faisalabad-Multan Motorway (M-4) project was imperative to ensure regional connectivity, stimulate economic growth, and augment Pakistan's indispensable north-south transportation network. When the Gojra-Shorkot segment opened, the 64 km long Shorkot-Khanewal section which still had to be complete, the freeway connection between Multan and Faisalabad, was the only segment missing. In response to a message, NHA General Manager Shoaib Khattak stated that the remaining construction on the Shorkot-Khanewal stretch was proceeding at full pace and would be finished in the coming months. Punjab's northern and southern regions would be connected by the current motorway networks once M-4 was completed. The M-4 Motorway was designed to reduce the distance between Islamabad and Multan. The motorways M-1, M-2, and M-3 were constructed recently. It would connect the cities of Bahawalpur, Rahim Yar Khan, Sukkur, Ghotki, and Lodhran (where the M-5 Motorway was being built) in a southwesterly direction. On the other hand, National Highway and Motorway Police (NH&MP) sources claimed that the NH&MP had already begun deploying its logistics and would shortly assume control of this section upon its inauguration. Infrastructure development was given top priority by the previous PML-N government (The Express Tribune, 2015).

The M-4 Motorway, which connected Multan and Faisalabad, was planned to be built by the National Highway Authority (NHA). Initial Environmental Examination (IEE), commonly referred to EIA, was required for every project of this type in accordance with Section 12 of the Pakistan Environment Protection Act of 1997.

The "Pakistan Environment Protection Agency (Review of IEE/EIA) Regulations 2000" stated that EIA was necessary for the project. The goal of this motorway was to facilitate the easy transportation of goods for farmers and traders. It was a segment of the National Trade Corridor (NTC). It was the National Trade Corridor Highway Investment Program (NTCHIP) of the Asian Development Bank (ADB). This project was important not just for the local economy but also for access to China and the Central Asian states, as it was situated close to the ports of Karachi and Gawadar. The current Pindi Bhattian – Faisalabad motorway (M3) was extended by this new motorway. It began near Sargodha Road, at the end of the M3 (Pakistan Environment Protection Agency , 2000).

M4 was a dual motorway with four lanes. On the borders of each carriageway, space was set aside in case a lane was added later. The freeway was originally supposed to be 184 kilometers long, but in July 2014, an extra 57 kilometers were built to reach Multan. However, the first 184 kilometers of the EIA was only to be covered by this investigation. The M4 final-alignment is displayed in Figures 1.

Figures 1: **The M4 final-alignment**



(National Highway Authority, 2010)

Temperature

The M-4 motorway travels through a region with significant temperature variations, including warm summers and mild winters. The season typically lasts from April to October, with the hottest months being June and July. These months bring the highest temperatures to the area, reaching as high as 41°C. As summer ends, the temperature drops a little, especially at night. The coldest months of the year are December, January, and February. Winter lasts from November to March. The average high temperature and low temperature for this time of year are 19°C and 4°C, respectively. The seasonal fluctuations in the region are aptly demonstrated by these temperature ranges. The summer and winter temperature extremes in the area are depicted in depth by the data provided by the Pakistan Meteorological Department (PMD). Table 1 provides information on temperature, precipitation, and relative humidity for the districts of Jhang, Toba Tek Singh, and Faisalabad to aid with comprehension. These districts have similar climatic characteristics due to their proximity to one another. At 115.0 mm and 89.8 mm, respectively, the two monsoon months of July and August have the highest average monthly rainfall. There is extremely little precipitation in the area. On the other hand, November usually receives an average of just 3.0 mm of precipitation. The M-4 corridor's overall climate profile is impacted by the seasonal fluctuations in precipitation seen by these figures.

Table 1: Mean values of monthly data over 30 years (Faisalabad, Toba Tek Singh and Jhang)

Month	Mean Temperature (°C)		Precipitation (millimeters)	Relative Humidity (%)
	Maximum	Minimum		
January	19.4	4.1	11.5	66.0
February	21.9	7.1	20.1	61.2
March	26.7	12.3	25.7	58.2
April	33.5	18.0	16.9	46.5
May	38.4	22.7	16.1	37.5
June	41.5	31.8	27.9	41.7
July	40.1	32.4	115.0	61.5
August	38.1	26.6	89.8	65.9
September	35.7	23.7	28.6	59.9
October	33.0	17.1	3.8	54.7
November	27.2	10.3	3.0	62.7
December	21.4	5.1	8.6	66.5
Annual (Average)	31.2	17.6	372.3	56.6

(Pakistan Meteorological Department , 2020)

Air Quality

Huge agricultural fields encircle the project region, and this has a big impact on the ecosystem there. Thus, the primary contributor to air pollution in this area is dust. The primary sources of this dust are the region's varied agricultural techniques and dry, arid environment. Significant volumes of airborne particulate matter are produced by the combination of these factors. The condition of the roads, high traffic, and the limited space for cars to pass are some of the factors that make the dust problem worse. These components work together to produce an atmosphere where dust can spread quickly and have an impact on air quality. The initiative intends to put in place a number of strategies targeted at lowering dust output in order to address these problems. An essential part of this plan is building smooth, well-maintained asphalt roads and concrete shoulders alongside the roads. The project is to improve the general quality of the air in the area and reduce the amount of dust created by fortifying the road conditions and infrastructure.

The Environmental Protection Agency (EPA) is responsible for enforcing ambient air quality regulations in the United States. The EPA establishes and enforces air pollution standards. However, there are currently no formal comparison points because Pakistan lacks comparable air quality legislation. A troubling finding is displayed in Table 2: on occasion, the project region's PM10 (particulate matter smaller than 10 micrometers) concentration can surpass the USEPA's regulation limits. There's a possibility that this occurrence will cause the local air quality to fall short of the strict standards set by the US. There are various explanations for the higher PM10 levels. This concentration of small particle matter is mostly caused by emissions from traffic. The dust that has accumulated on the roads and is propelled into the air by passing cars is a contributing factor to the issue. PM10 levels regularly above permissible limits in the atmosphere created by the mix of these dust particles and vehicle emissions, underscoring the need for better air quality management and mitigation efforts in the area.

Table 2: Ambient Air Quality

Parameters	Average Test Results at Various Locations					USEPA (standards)
	L1	L2	L3	L4	L5	
CO (ppm)	1.20	0.33	0.70	0.48	1.40	35
NO2 (ppm)	0.02	<0.01	0.02	0.01	0.02	0.053
SO2 (ppm)	0.02	<0.01	0.01	0.01	0.01	0.14
PM10 (μg g/m^3)	266.3	142.6	228.5	135.2	287.2.8	150
Location L1: Faisalabad-Sargodha road, Location L2: Painsara-Bhawana road, Location L3: Gojra-Jhang road. Location L4: Shorkot Cantt road, Location L5: Khanewal Multan road						

(Societe Generale de Surveillance, 2021)

Noise

Because the project region is primarily rural with few traffic crossings, it has significant issues with noise pollution. The neighborhood and its environs suffer greatly from the exceptionally high noise levels that are known to be present at intersections and other locations where traffic congestion occurs. An SGS research revealed that the noise levels reported in the vicinity of these crossings frequently lie between the National Environmental Quality Standards (NEQS) and World Health Organization (WHO) standards. These limitations are frequently exceeded, nevertheless, particularly at busy crossings or during rush hour. It is expected that the problem would worsen as the project is being constructed. Due to the increased activity associated with construction activities, such as heavy machinery operations and construction traffic, noise levels beyond current regulations are likely to occur. Even during the project's active phase, noise levels may modestly increase due to ongoing traffic and usage patterns. Because of this, it is anticipated that noise pollution will remain an issue, requiring the application of effective mitigation techniques to decrease its detrimental effects on the community. A thorough summary of the noise levels obtained at different points throughout the project area is given in Table 3. The numbers show a considerable range in the average noise level measurements across numerous locations. A significant percentage of these statistics are above the 70 dB (A) cutoff points set by the National Environmental Quality Standards (NEQS), which indicates high levels of noise pollution in the area. The results show that peak noise levels are relatively high, almost exceeding the 70 dB(A) threshold set by the World Health Organization (WHO) and the NEQS, although average noise levels are rather variable. This implies that noise levels are occasionally approaching or exceeding permissible thresholds, which may have an impact on the general public's health as well as the quality of the environment. Elevated noise levels emphasize the need for effective noise management strategies to mitigate impacts on neighboring communities and ensure legal observance, especially when they approach predetermined thresholds.

Table 3: Noise Levels at Various Locations

Time	Faisalabad-Sargodha Road dB(A)			Painsera-Bhawana Road dB(A)			Gojra-Jhang Road dB(A)			Toba-Warriam Road dB(A)		
	Avg.	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	MaX	Min.
07:00	63.9	72.1	59.2	67.9	71.1	53.2	69.2	78.8	52.6	79	85	61
09:00	77.5	94.1	63.6	66.6	70.3	55.9	76.3	85.4	54.3	71	82	62

11:00	78.3	90.3	67.9	65.2	72.7	58.3	75.4	89.6	59.5	73	86	63
13:00	65.5	72.4	58.6	65.8	72.9	58.1	75.1	94.2	63.3	76	91	56
15:00	79.7	95.4	59.8	60.4	73.6	55.7	78.6	92.1	67.7	74	91	66
17:00	78.1	96.4	60.1	62.3	71.4	49.6	74.7	86.9	62.1	71	93	68
19:00	76.3	96.8	61.6	60.1	68.8	51.4	69.8	74.2	56.9	75	92	67
21:00	79.0	98.0	63.4	59.7	69.2	48.9	70.1	84.3	59.8	78	86	61

(Societe Generale de Surveillance, 2021)

Water

The main water sources in the project area are the Chenab and Ravi rivers, which are essential to the area's irrigation and farming systems. These rivers drain into an extensive system of canals and water courses that supply vital irrigation to the nearby farmlands. The Burala, Guggera, and Jhang branches are among the most crucial parts of this irrigation system; they are also essential to the water distribution system in the area. The primary irrigation canals of Toba Tek Singh, Jhang, and Faisalabad districts, which fall under the project region, supply the districts with water. This method ensures that these districts' agricultural activities are supported by a consistent supply of water. Extra irrigation infrastructure also helps the Khanewal district, which is a component of the larger project area. The Irrigation Department is specifically in charge of the Sadhnai Canal and the Abdul Hakeem Distributary, which supply water to this area. These additional sources increase the productivity of the local agricultural sector by supplying vital water for nearby farming operations. The Sadhnai Canal and the River Ravi are two major rivers in the project region that are essential to the irrigation and water management systems there. Two notable features that require bridge construction to offer transit and communication over these bodies of water are the Sadhnai Canal and the River Ravi. The distance between them is 145+900 kilometers. Two crucial bridges, one over each of these significant waterways, are to be built, according to the project's scope of work, which is detailed in Package-IV. Building up the region's infrastructure is crucial to guaranteeing improved access and the smooth movement of people and products. The project region depends on tube wells to sustain agricultural activity in addition to the bridge building. These tubewells are essential for supplying an additional irrigation water supply in places where canal and river water may not be adequately available. The field receives sufficient year-round watering thanks to the addition of tubewells to the current irrigation system, which also increases agricultural productivity. There have been intermittent reports of waterlogging issues and salt harming the environment and agriculture in the Khanewal district. These issues are not widespread, although they have been seen in a few places in the region. These problems are most noticeable in areas where normal farming operations have been disturbed by waterlogging and salt. Notwithstanding these worries, it's crucial to remember that the impacted areas are more than a kilometer from the M-4 freeway. This segment shows that although the issues are serious where they exist, they do not directly affect or encroach upon the road infrastructure. To make sure that these problems don't get worse, get in the way of future land use and development in the area, or get closer to the highway, monitoring and action are still essential. In several places around the project area, a thorough process of collecting data on the quality of surface and groundwater was conducted. The bulk of samples did not meet the drinking water quality standards set by the World Health Organization (WHO), according to the results of the groundwater research. In particular, the examination found higher-than-acceptable amounts of salt and chloride in addition to excessive levels of total dissolved solids (TDS). These elements have a

part in problems with water quality that have serious repercussions for human health and safety. Furthermore, alarming claims have emerged concerning the existence of fecal coliforms in groundwater samples, specifically Escherichia coli (E. coli). These bacteria's existence raises concern about water safety and sanitation as well as possible pollution. However, it has been established that the project area's surface water is suitable for agricultural usage. Because it complies with the restrictions set forth by the National Environmental Quality Standards (NEQS), it meets the requirements for agricultural use. Both surface and groundwater are essential to the local community's ability to provide basic needs like drinking water and irrigation. The information presented in Tables 4 provides a thorough understanding of groundwater quality, highlighting areas of concern and assessing the general suitability of these water sources for various uses.

Table 4: Ground Water Quality at Various Locations

Parameters	Faisalabad-Sargodha Road	Gojra-Jhang Road	Shorkot-Cantt Road	Khanewal-Multan Road	WHO Limits
Chemical Parameters					
pH (mg/L)	7.95	8.52	7.88	8.13	6.5-8.5
Total Dissolved Solids (TDS)	2023	3915	1495	947	1000
Chloride (Cl) mg/L	524.7	825	489	159	250
Nitrates (NO3) mg/L	6.7	14	5.7	18	50
Sodium (mg/L)	541	1040	286	187	200
Fluoride (Fl) mg/L	0.91	1.04	0.6	0.89	1.5
Arsenic (As) mg/L	<0.01	<0.01	<0.01	<0.01	0.01

(Societe Generale de Surveillance, 2021)

Geology

The Pakistan Geological Survey characterizes the topography of the project area as being flat with a moderate slope that extends from the northern to the southern areas of the region. The region is characterized by a steady gradient, which adds to its general flatness. The project location is located at a very moderate and consistent height for the region—roughly 500 meters above sea level. Agricultural operations benefit from the exceptionally fertile soil found in each of the project area's four selected areas. Rich alluvial loam soil makes up most of the project area, according to the Punjab Agriculture Department. Because it is rich and perfect for growing crops, this kind of soil is widely prized for offering the best basis for agricultural activity. In addition, the riverbeds of the Chenab and Ravi rivers, which run through the region, are notably sandy. Because it may be used for a range of construction and infrastructure development projects, this sand is a vital resource for the building sector. The availability of this material from the riverbeds further supports the region's demands for development and construction.

Agriculture

Irrigation is the main technique utilized along the M-4 corridor to sustain agricultural activity. The region's agricultural operations depend on the steady water supply that the perennial canals at Sagir Head Works and Abdul Hakeem Head Works offer. These irrigation systems are necessary for crops to flourish all year round. However, there are drawbacks to this reliance on irrigation. In particular, significant water shortages during the winter may affect the growth and seeding of Kharif crops, which are normally grown in the warmer months. The planting timetable is thrown off, and crop productivity is impacted by these shortages, highlighting the significance of efficient water management techniques. Moreover, there are significant differences in the farming practices throughout the four regions that the M-4 route passes through. Every district follows its own distinct agricultural methods and chooses its own crops according to the local climate, soil type, and

water availability. The diversity of agricultural landscapes and practices along the M-4 road is reflected in the variations in cropping patterns, which highlights the difficulty in controlling irrigation and agricultural productivity in the area.
A thorough summary of the principal crops grown in each Tehsil within the project region is given in Table 5. The variety of crops grown in the region is shown in this table, which groups the main agricultural goods for each Tehsil. Apart from the basic crops previously stated, many kinds of vegetables are grown in different areas of Toba Tek Singh and Faisalabad. This enhanced vegetable output supports various farming methods in these areas and adds to the local food supply. Furthermore, the Toba Tek Singh district is also known for its abundance of fruit crops, especially mangoes and citrus. Numerous orchards in the district are devoted to these fruits, which are important from an economic and cultural standpoint. Mango and citrus orchards contribute to the region's agricultural diversity and local economy by selling fruit and hosting associated activities. Toba Tek Singh's general agricultural character is elevated by this fruit development, setting it apart from other districts in the project zone.

Table 5: Major Crops Pattern in the Project Area

	Tehsil	Rabbi	Kharif
1	Faisalabad	Wheat, Fodder	Sugarcane, Fodder, Rice, Potato
2	Gojra	Wheat, Vegetables	Sugarcane, Potato, Cotton, Fodder
3	Toba Tek Singh	Wheat, Fodder	Sugarcane, Cotton, Fodder
4	Shorkot	Wheat, Fodder	Sugarcane, Cotton, Rice
5	Kabirwala	Wheat, Gram	Rice, Cotton, Fodder, Vegetables
6	Khanewal	Wheat, Gram	Cotton, Rice, Sugarcane, Maize

(Punjab Agriculture Department, 2021)

Recommendations

The following important recommendations should be considered in order to improve the Environmental Impact Assessment (EIA) procedure for the highway project that connects Faisalabad and Khanewal, as well as to improve EIA methods generally:
1. Establish a Clearly Defined and clear Planning Process: The EIA depends on the establishment of a clear and well-defined planning process. This means that each stage of the review process must have clear objectives, deadlines, and roles defined. A systematic planning approach ensures that all relevant social and environmental issues are considered in an organized way, enabling effective management of any repercussions. The planning framework needs to be reviewed and revised frequently during the course of the project to account for any changes or new information.
2. Create and Maintain Baseline Data: To precisely evaluate the project's environmental effects, comprehensive baseline data must be gathered and preserved. Numerous factors should be covered by this data, such as biodiversity, soil conditions, socioeconomic status, and the quality of the air and water. Maintaining this baseline data provides a point of comparison for assessing the efficacy of mitigation efforts, as well as enhanced tracking of changes and consequences over time.
3. Evaluate Long-Term and Indirect Environmental Issues and Put Mitigation Plans into Practice Suggestion: Identifying and recommending management solutions for long-term and indirect repercussions are crucial, in addition to addressing immediate and direct environmental problems. This entails determining possible long-term effects and creating mitigating or preventative strategies. To guarantee that environmental sustainability is preserved for the duration of the project, long-term

mitigation techniques should be incorporated into the project design.

4. Conduct a Methodical Analysis of the Environmental and Socioeconomic Domains' Benefits, Issues, Risks, and Trade-offs: Understanding the project's numerous socio-economic and environmental benefits and challenges is made simple by a comprehensive study. It is necessary to assess any risks and trade-offs in order to make sure that the advantages outweigh the disadvantages. A thorough analysis ought to take into account both qualitative and quantitative aspects in order to facilitate well-informed decision-making and offer a fair evaluation of the project's overall impact.

5. Engage and Communicate with Local Communities: To ensure that their views and concerns are taken into account, local communities must be involved in the development and implementation of the EIA. Asking the community for their opinions, incorporating their suggestions into the assessment, and maintaining communication are all examples of active involvement. Apart from enhancing the accuracy and relevance of the EIA, this approach fosters respect and collaboration between the project developers and the affected communities.

These suggestions can be put into practice to improve the EIA process, which will improve the management of environmental effects and guarantee that the project's long-term advantages are maximized while minimizing its negatives.

Conclusion

It is projected that the proposed highway connecting Faisalabad and Khanewal would have a significant beneficial social and economic impact by meeting local demands and improving the effectiveness of trade routes on a regional and worldwide level. This infrastructure project has the ability to create jobs, quicken economic growth, and increase local firms' access to markets by making mobility and communication easier. But a project this scale has environmental consequences that must be carefully thought out and handled. Environmental Impact Assessments (EIAs) are essential to this process since they offer recommendations to lessen adverse effects in addition to a full study of potential environmental issues. There will likely be a number of noteworthy environmental repercussions from the highway project. Among these, the uprooting of an additional 12,900 fruit trees and the removal of around 18,300 trees from the project's right-of-way are noteworthy. 4,715 acres of productive agricultural land will be lost as a result of this deforestation, which would have an effect on nearby farming and wildlife. A significant number of people will also be displaced as a result of the removal of 207 residential buildings, which serve a variety of purposes during the construction phase, including temporary shelters and longer-term housing. Disruptions to basic services like phone lines, gas supplies, and electrical transmission networks can also have an impact on residents' day-to-day lives. Furthermore, restricting access to the new expressway may make traveling more difficult for local commuters. Other crucial infrastructure, such farmhouses and tube wells, which are essential to the region's agricultural economy, could also sustain damage. The road provides significant advantages for connectivity and economic growth, but in order to guarantee that the project is carried out successfully and sustainably, these environmental issues must be addressed and managed.

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