Social Survey Based Planning for Improved Ambient Air Quality of Grand Trunk Road Peshawar, Khyber Pakhtunkhwa, Pakistan

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Abstract

Peshawar city is a typical example of ribbon development growing along the East and West mobility corridor known as Grand Trunk Road. The City is a provincial capital and attracts peoples from rest of the province for education, commercial and business activities. This attraction is directly proportional to population growth in Peshawar. This scenario resulted in traffic increase and caused air pollution and traffic jam. Objective of this research is to know the community's perception and to analyze different parameters (CO, NOx, PM_{10}, O_3, and Noise) in the ambient air of the Grand Trunk Road in Peshawar. It also to recommends a mitigation policy guideline for an environment friendlier urban transport corridor. Available data regarding air quality of the study area was analyzed and a Social Survey was carried out for collecting information. The study analyzes the records of transport-induced air pollutants over the past decade. The social survey results are annexed with the present available ambient air quality data for a comprehensive outlook of the problem. The assessment of the results shows that COx, SOx and O_3 are within the permissible limits of National Environmental Quality Standards (NEQS), while PM_{10} and Noise level is violating the NEQS. The expected increased volume of traffic to be induced from the new land development projects will also increase the pollution level of the parameters which are within the permissible limits of NEQS. For the mitigation and control of the above parameters and expected increase to be occurred, a comprehensive recommendations based on the findings of this study have been suggested.

Keywords: Ambient Air Quality, vehicular emission, air pollutants, social impacts, NEQS, SO_2, CO, O_3, PM_{10}

Introduction

This study aims to address the existing gaps in urban air quality management by analyzing the specific contributors to the air pollution in Peshawar and proposing effective planning strategies for sustainable urban development. Despite the concerted efforts to document air pollution in Peshawar, a comprehensive synthesis reveals critical concerns related to vehicular emissions, fuel quality, and their impact on air quality standards. This study aims to address these concerns and contribute to the existing body of knowledge.

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Uncontrolled urbanization, characterized by unchecked expansion and increased motorization, significantly contributes to the deterioration of air quality. This has pronounced consequences on both the environment and societal well-being (Qureshi & Huapu, 2007). Urban air quality management is based on achievement of air quality standards, generally in the areas that are thought to be representing the most exposed population during specific time. Inadequate system for traffic results in environmental problems, particularly in urban areas of Pakistan (Mansha *et al.*, 2012; Shah, 2006). Some of the air pollutants are SOx, NOx, COx, Ozone, PM, Noise etc. This situation is made serious due to the absence of proper planning for controlling air pollution for future perspective (Malik and Tahir, 2014; Li and Michel, 2009). Air pollutants have a long-range transport mechanism which leads to regional and global pollution. Air pollution can be controlled mainly through controlling various emission sources (Zhao *et al.*, 2007). These pollutants are discharged directly into the air or transformed in the troposphere by photochemical reactions (Jenkin, 2004; Real and Sartelet, 2011). Exposure to ambient air pollution for long time may leads to serious health issues including deaths from cardiopulmonary diseases (Brunekreef *et al.*, 2009). In the following section a comprehensive literature review is carried out to know the background and status of the ambient air quality in the study area.

Background and Previous Literature

In the Urban areas of Pakistan, the Air pollution is quickly becoming an environmental problem. The major factors are the increase in number of vehicles, inefficient energy use, unchecks expansion of urban areas. The old vehicles, diesel trucks and low level of fuel quality made provoked the problem. Two-stroke engines automobile are adding more pollutants to air due to inefficiency of burning fuel. The surge in two-stroke vehicles, increasing by 117% in the last decade, poses a substantial threat to air quality due to their inefficient fuel combustion. These vehicles significantly contribute to pollutants in the urban air (DETR, 2000). As till 2010 ambient air quality guidelines were not established. The main reason was, as the permanent check system in the country was absent. So there were no foundations for forming strategies for monitoring of various air pollutants (World Bank, 2006; GOP, 2012; Aziz, 2006).

According to a report by the Greater London Authority (2014), both Quetta and Peshawar rank at No. 5 and No. 7, respectively, among the top 10 most polluted cities. This ranking is attributed to elevated levels of air pollutants such as PM10, SO2, and NOx (Greater London Authority, 2014).

The organic fuel combustion is directly proportional to the release of air contaminants. The growth rate of oil and petroleum usage in the transport vehicles is about, 6% per year (Khan and Tabassum, 2014).

In Peshawar city the major gaseous air pollutants i.e. CO, NOx, SOx and hydrocarbon levels were average in nine out of ten locations. The carbon monoxide and nitrogen oxides levels were above the permissible limit of National Environmental Quality Standards for ambient air quality, NEQS, 2000 (Khan, 2008). The growing population in Peshawar resulted in traffic increase which causing extra fuel consumption, air pollution and traffic jam. A study shows that in Peshawar, the increasing ratio of the number of vehicles was 126.4 from the year 1998 to the year 2009. Addition of private cars in the already present vehicles volume is increasing the problem. The part of the private car in the total volume is 75.35 %. It increased 228.98 % during the period of 1998-2009 (Ali *et al*., 2012). Using of diesel fuel in transport sector adding more PM to the air. Diesel with high sulfur content (0.5-1%) causes high emission of SO_2 and PM. According to a report in Pakistan NO (2) is appeared the next high-risk air contaminant. The SO (2), NO (2) and CO levels were recorded several times above than the air quality strategies/guidelines set by the WHO (Colbeck et al., 2010; ADB, 2006).

The air discharged in the result of organic fuel combustion has the PM, CO, CO_2, Hydrocarbons and NOx. CO reduces the hemoglobin in the blood. The oxidation of (Non-Methane Hydro Carbons) NMHCs is responsible for 30 - 60% of CO in the atmosphere. CO is an important variable as it can be used as an indicator of mobile source emissions. The car and other light vehicle running on petrol, they emitted more pollutants, which are a potential health hazard than diesel engine. Petrol engines emission contains much more CO and HC than diesel engine (Zuckerman, 1991; Warneck, 1988).

To address the multifaceted challenges of urban pollution, standards such as the National Environmental Quality Standards for Noise have been established. Table No. 1 outlines these standards, providing a framework for managing noise pollution in different zones.

Table No. 1 National Environmental Quality Standards for Noise

S. No *Zone/ Area*	With Effect from 1st July, 2010		With Effect from 1st July, 2012	
	Limit in dB			
	Day time	Night Time	Day Time	Night Time
1. Residential areas (A)	*65*	*50*	*55*	*45*

2.	Commercial areas (B)	*70*	*60*		*65*	*55*
3.	Industrial area (C)	*80*	*75*		*75*	*65*
4.	Silence zone (D)	*55*	*45*		*50*	*45*

(*Source: GOP, The Gazette of Pakistan, 2010).*

Study Objectives

Objective of the research is to analyze specific parameters in the ambient air of the Grand Trunk Road in Peshawar and to recommend a mitigation policy guideline to plan for an environment friendlier urban transport corridor. The specific objectives of the study are;

1. To study the level of atmospheric pollution and evaluating its impacts on the local population along the major transport corridor of Peshawar City.
2. To quantify the concentrations of key air pollutants such as CO, NOx, PM10, O_3, and Noise along the Grand Trunk Road in Peshawar.
3. To recommend specific urban planning guidelines, including traffic management strategies and green infrastructure initiatives, aimed at mitigating the identified environmental problems along the Grand Trunk Road in Peshawar.

These objectives collectively aim to provide a comprehensive understanding of the ambient air quality along the Grand Trunk Road in Peshawar and develop targeted mitigation strategies for creating an environmentally sustainable urban transport corridor.

Research Methodology

The main sources used for this study were

a. Secondary data
b. Primary data

Secondary Data

Secondary data, including information on the specific air pollutants in the air over the past decade (since 2004), was collected from reputable sources such as PCSIR, 2008; GOP, 2010; Pak-EPA, 2006; Ghauri *et al.*, 2007; Colbeck et al., 2007 and Ernesto *et al.*, 2014; GOP., 2012 Majid H, 2012; 3(3); Rooh Ullah, 2019; SGS, 2017.

Primary Data

The questionnaire survey was conducted at the six specific points along G. T. Road, Peshawar (CCPH, ICUT, TBS, SP, HC,

GBS), chosen based on high traffic density and diverse demographic representation to ensure a representative sample of the study area.

1. Custom Check Post Hayatabad (CCPH)
2. Iqra Chowk, University Town (ICUT)
3. Tehkal Bus Stop (TBS)
4. Suree Pull (Mufti Mehmud Fly over) (SP)
5. Hashtanagri Chowk (HC)
6. General Bus Stand (Haji Camp Adda) (GBS)

The questionnaire, designed to gauge public perception of automobile-induced pollution, included questions related to awareness of air quality issues, health concerns, and suggested mitigation strategies. The questionnaire was filled at the selected six points from the 120 number of respondents, associated to the area for at least last ten (10) years. The reliability co-efficient of the questionnaire was found as 0.522, using Cronbach Alpha technique. The purpose of the questionnaire survey was to know the public perception about the pollution created by the automobile/ motor vehicles.

Data Analysis and Discussions

The growing population in Peshawar has resulted in the increase of number of vehicles, causing extra fuel consumption, air pollution and traffic jam. A number of townships have either already established or planned to be established in the next few years. Regi Lalma is one of major townships among these townships. According to Government of Pakistan, 1998 District Census Report (DCR, 1998), total population of Peshawar district was 2019118 and in 2017 this population was raised to 4,269,079 (GOP, 2018). At this growth rate it is estimated that this figure will rise approximately to 50, 23,435 tell 2024. As per Bureau of Statistics report, 2013, the registered vehicles in district Peshawar are 5, 21,150 (and 5, 77,232 in 2016 as per report of Daily News Paper Dawn, December 4, 2016). In Peshawar district, road network is 420.500 Km in length (GOKP, 2014-b).

Ambient Air Quality of the Study Area in Comparison with NEQs

The situation of ambient air quality level is presented and discussed in the light of the secondary data.

Table – 2 Average level of ambient air parameter in the study area

Parameter (Unit)	CCPH	ICUT	TBS	SP	HC	GBS	NEQs

CO (mg/m3)	2.0	1.3	2.3	3.5	2.1	3.2	5.0
SOx (µg/m3	28.5	29.4	37.4	41.3	39.43	46.4	120
PM_{10} (µg/m^3)	205.4	211	271	389	290	369	150
O_3 (µg/ m^3)	18.35	21.6	27.4	34.3	31.43	41.4	130
Noise (dB)	88	81	80	91	86	82	65

The Table- 2 presents the average values of parameters at different points in the study area. It can also be observed that different parameters level, in high traffic areas was relatively higher, as compared to those of less traffic area. The level of the parameter at SP point is higher than other sampling points. Among the petroleum fuels the combustion of petrol is the major producer of CO. In recent years most of the vehicles of the petrol engines are using CNG as fuel; therefore, it may be the cause of CO and Sox levels within the permissible limit of NEQs. The monitored data regarding respire-able particulate matter (PM_{10}) at data collection points in the study area is between 205.4 µg/m^3 and 369 µg/ m^3 for 24 hours (Table – 2). It also shows that the parameter is in violation of NEQs-Pakistan at all the points of the study area. Dust sources are also a factor. The O_3 concentration is within the permissible limit of NEQs. The other parameter that is Noise Pollution monitored at different data collection points in the study area is exceeding the NEQs permissible limits.

Previous Ambient Air level of the Study Area

In order to evaluate the change in the ambient air quality of recent measured situation (average data of study area) and of the data available since 2004 was compiled from the available/published literature and is presented in Table -3.

Parameter (Unit)	2004	2007	2010	2013	2016	NEQs
CO (mg/m3)	3.0	3.5	1.5	2.5	1.72	5
SOx (µg/m3	58	57	41	27	37	120
PM_{10} (µg/m^3)	219	530	540	571	290	150
O_3 (µg/ m^3)	48	47	36	49	53	130
Noise (dB)	111	116	119	63	76.50	65

Table – 3 The ambient air (PM_{10}, CO, O_3, Sox and Noise) level for different parameters in study area in 2004, 2007, 2010, 2013 and 2016 in comparison to NEQs (Source: PCSIR, 2008; GOP, 2010;

Pak-EPA, 2006; Ghauri *et al.*, 2007; Colbeck et al., 2007 and Ernesto *et al.*, 2014; GOP., 2012 Majid H, 2012; 3(3); Rooh Ullah, 2019; SGS, 2017).

Ambient Air Pollution level in Peshawar

The Table - 3 shows the ambient air quality levels recorded since 2004 in the study area. The graph shows the recorded parameters levels and the NEQs level. The PM_{10} level is exceeding the NEQs permissible limit. This indicates the increasing dust in the air. The other pollutants CO, O_3, and SOx, were found within the permissible limits. The Noise was another parameter exceeding the permissible limits. Similarly, the same graph shows the ambient air quality recorded in 2007 on G.T road Peshawar. The graph shows the recorded parameter level and the NEQs. As compared to 2004 the 2007 situation is much worst. Especially the particulate matter situation is more serious. Similarly, the noise level is exceeding the NEQs permissible limits as in the case of 2004 data. The situation of 2010 is much worse than that of 2007. The particulate matter exceeds the average level of 2007. If we compare these readings thoroughly then we found that the particulate matter and the noise level is the most uncontrolled and burning issue among the air pollutants. The entire ambient air quality picture is made unpleasant by the particulate matter and noise level. The level of particulate matter and noise is much greater than the NEQs permissible limits.

Social Survey

The social survey revealed that awareness about the importance of atmosphere as well as the idea about air pollution was well known to the local residents, workers, stakeholders as well as general public of the study area. Air pollution was found a cause of several diseases common among general public. The common concept of air pollution among general public was the dust and smokes from the vehicles. In fact, these dust particles, smokes and gases combined to make hazardous matter in the air. Inhaling this matter causes different acute as well as chronic diseases. It was also noticed that 100% respondents say that noise pollution is increased, dust and particulate in air of the study area is also increased.

According to Bureau of Statistics data (GoKP, 2014-b) the total number of registered vehicles in Peshawar in 2013 were 5, 21,150. It is estimated that this number will increase up to 19, 74,807 in 2023. The increase in number of vehicles causes air pollution. The questionnaire survey in the study area shows that most people are suffering by dust, smoke and noise pollution.

The public opinion was measured for the change occurred in the ambient air situation in previous 10 years on the selected data collection points. Maximum numbers of respondent have indicated

that the pollution level in the ambient air of the study area has increased as compared to the past 10 years (Fig. 1). The figure shows that 60 % in CCPH, ICT 70%, TBS 80%, SP 100%, HC 90% and in GBS 100% respondent, respectively pointed that, there is increase occurred in the ambient air quality of the study area.

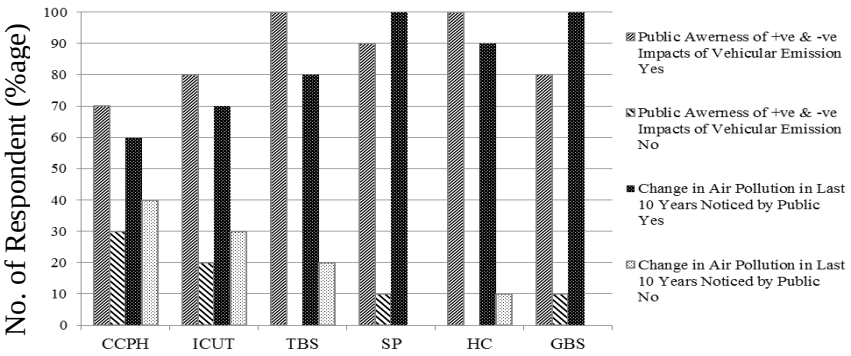

Fig. 1 Graph showing the social survey results

Change Occurred in Ambient Air Quality of the Study Area

The comparative study of the present available data and previous data (Table -2 and Table - 3) shows that, there is a definite change occurred. The change occurred is either positive or negative. The Fig – 2 shows the intensity of change related to the permissible limits of NEQs. The measuring units of the parameters are given with each parameter name.

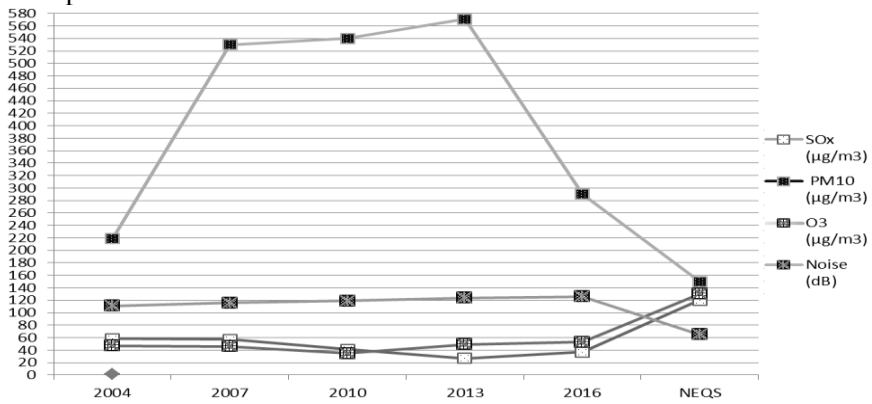

Fig.- 2. Ambient air quality levels for different parameters in 2004, 2007, 2010, 2013 and 2016 in comparison to NEQs.

Conclusion

The ambient air quality level on G.T. Road Peshawar was evaluated by the interpretation and analysis of the primary data and secondary data. The data was evaluated and concluded that, the increasing population in the Peshawar city is leading to increase in

road vehicles. In 2013 it was 521150, which may increase up to 1987104 in next 10 years. The reports show that the level of SO_2, CO and $O_{3\ are}$ within the NEQs permissible limits. But, it is expected that the designed future developments in the study area will attract more transport activities, ultimately these parameters will also cross the NEQS permissible limits. Comparison of the present ambient air level and previous air quality level (since 2004) shows a significant variation in parameters. The parameters found in violation with NEQs in this study are PM_{10} and Noise level. On the basis of present air quality situation as well as of previous decade, suggestions are recommended for improvement of air quality of the future 10 years. This study also concluded that the adoption of pollution control policies, measures, traffic management as well as the use of environment friendly fuel can reduced the level of air pollutants in the ambient air of the study area.

Suggestions to reduce motor vehicle' emission in the study area

This study is a planning oriented study. As discussed the ambient air quality situation is already in serious condition. With the development of mega townships, the population number of the Peshawar city will also raise. Similarly, on the basis of proposed and expected development (townships, and road network) in district Peshawar, the estimated number of registered vehicles will rise to 1974807 in next ten (10) years. The accumulative length of roads will also increase with the development of new townships and expansion of the city in the forthcoming decade. The above estimation will increase the pressure on ambient air and will minimize the carrying capacity. The following recommendations for improvement of ambient air quality of study area, based on the findings of this research study are given below;

1. The enforcement of funneled mounted on vehicles, Plantation and green areas establishing along the road sides as well as in congested areas of the city, sprinkling of water in morning and evening along roads, Incentive to transporters for adopting environmental friendly practices and low pollutants production, Awareness and education programs for awareness among transporters as well as general public may be helpful in controlling the Particulate Matters. It is also recommended that the Pakistan Environmental Protection Agency (EPA) proposed maxi-mum 24-hour particulate matter concentration limits should be implemented.
2. Vehicles responsible for noise pollution should be fined. Plantation along road side and in open areas may decrease the intensity of noise. Banning the use of pressure horn, encouraging the public transport system and monitoring of the silencers of the

vehicles by the concerned institutions may be helpful in reducing the noise generated by the vehicles on road in the study area.

3. To control the CO level in study area, there should be imposition of ban on 2-stroke motor cab/cycle rickshaws and induction of 4-stroke CNG, solar power and electric power engine rickshaws and taxies, induction of CNG Buses, should be ban on the importation of old second hand motor vehicles. Plantation and green areas construction should be made along the road sides as well as in congested areas of the city. This will reduce COx level.
4. The increasing SOx level can be controlled by the reducing sulfur content in fuel, inspection of engines and maintenance system. Alternative and efficient means of transportation e.g. metro bus service and bus services should be introduced, Improvement of fuel quality and efficiency of the road transport vehicles in the Peshawar city. The vehicle fitness for environmental health as well as for direct human health in the study area should be checked regularly. There is a need to make the VETS, Peshawar more effective.
5. A strategic planning guideline to air pollutant control in Study Area can be applied, if the recommendations are conventional to all stakeholders. Therefore, there is a need to convey these recommendations to government, environmental protection agency, academia, media, aid agencies, and non-governmental organizations. Air quality management plans are means of improving air quality. There is a need for implementing such policies and review their effectiveness.

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