

Impact of Air Quality on Ecological Sustainability of Old Commercial Hub at Faisalabad

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Received May 09, 2022; Revised January 03, 2023; Accepted January 17, 2023

Abstract

The air quality of Faisalabad city has reached hazardous levels in the past few years. Smoke from industrial chimneys, the use of coal, and transport emissions are the major causes to pollute the city's air. The old commercial hub, Faisalabad, is one of the areas producing air pollutants that are impacting ecological sustainability in a negative manner. Hence, this research focused to investigate particulate matters which are polluting the area and adversely impacting the ecological sustainability of the old commercial hub. Experimental observations were made to examine the air quality. Earlier works to investigate the air quality of old commercial hubs were done while taking single readings from a central point. 8 readings i.e., one from each road of the hub and 1 from the center were taken to conduct this research, so that, the whole hub can be observed while having the proper description. Both air quality and growth of the old commercial hub are being linked to observe the adversely impacted ecological sustainability. It was viewed that physical elements and living beings are both being affected in a negative way. The absence of green areas to filter the air is also a reason for the deterioration of ecological sustainability. Appropriate steps are required to be taken to manage the area's growth and betterment of air quality. By considering the investigations and recommendations, of this research, the administration can plan the required policies for area betterment and can minimize the negative impacts of air quality in the area with the provision of healthy environmental conditions.

Index Terms: Air Quality, Ecological Sustainability, Faisalabad, Inappropriate Planning, Old Commercial Hub.

I. INTRODUCTION

The ecological sustainability of Faisalabad city is getting worsen with the passage of time due to increased population, vehicular emissions, and industrial units. The environment of the city is being deteriorated with a number of pollutants causing air pollution, water pollution, and noise pollution. Air pollution, being one of the major types of environmental pollution found in the city, is giving rise to many diseases like the weakening of the lungs, liver damage, birth defects, thyroid system disorders, pink eyes, etc. [1].

Research on air pollution is being carried out at international levels for many decades. More research, considering the local context of the city, on air pollution is required to further understand the diseases generated by it. These research investigations can support the preparation of environmental quality standards and can also contribute to the public health improvement of the overall city or any particularly identified area [2].

This research, for air pollution investigations, was conducted in a primary commercial hub of Faisalabad city. This city is an old and the third largest city in Pakistan. It was established in 1892, as a town, by the British Government to make the area an agricultural market. It was developed at a rapid rate i.e., in 1898 its status was upgraded as a city and in 1904 as a district. The railways,

hospitals, courts, educational institutes, religious buildings, monumental structures, and a commercial hub were planned and built to enhance the functions and administration. The whole city was planned as emerging from that commercial hub, in the form of Union Jack, which made it the commercial hub of primary importance [3], and [4].

In 1911, most of the infrastructure of the district was built. At that time, Lyallpur's total population was 19,578 inhabitants, which was facilitated by the commercial hub. With the passage of time, the district grew, and in 1985 it was upgraded to a divisional headquarter. The population of the city is around 3.5 million at present [4-6].

The massive increase in population overburdened the old commercial hub. The area of the commercial hub is still the same, but users and visitors increased in number. This increase in usage, gave rise to pollutants, generally emitted through transport and surrounding industry, which are negatively impacting the ecological sustainability of the area [3].

Consequently, air quality is found to be among the highest impacting factors which are deteriorating the ecological sustainability of the area. Hence, the air quality has been investigated in the further readings of this research paper at the old commercial hub is the central and primary point of the city [1], and [7].



II. SIGNIFICANCE OF STUDY

The overall situation of Panjab, especially Faisalabad city is not good regarding air pollution. The city has been included in the list of the most polluted cities in the country. Due to the massive load shedding of gas, people are forced to burn wood to cook their food, which further escalates air pollution [8].

The selected area, to investigate the air pollution, was found appropriately planned at the time of its establishment. Previously, there were large roads, green elements, and healthy buildings which were producing a pleasant atmosphere for workers, residents, visitors, birds, trees, etc., but currently, the ecological sustainability is unpleasant due to various current issues. Polluted air quality is one of the primary current challenges. Physical elements and living beings are getting uncomfortable and unhealthy. The impact of the polluted air is affecting the buildings due to which their life is becoming short, more maintenance is required, and the buildings are getting sick which in turn is not good for living beings.

This study identified the diminished and declining physical elements of the mentioned built area, examined air quality parameters, and established various recommendations based on the findings for the appropriate ecological sustainability of the commercial hub, better for both living and non-living elements.

These findings and recommendations can support the local administration to maintain the area in a much better way with the provision of an adequate environment.

This adequate environment can in turn further enhance the area's activities, shopping as the primary activity of the area can generate more economy because shopping is not just a need-based activity. It is now considered a social activity for the local community and all other users [9].

The users of the area can also get benefit from this study. They can have an overview of the situation and can take necessary actions to conserve their belongings.

III. METHODOLOGY

The research was started with data collection from literature as well as from different departments involved, to further elaborate the existing situation of the study area. The offices visited were the Metropolitan Corporation Faisalabad, the Department of Environment and Parks, and the Horticulture Authority Faisalabad. After compiling the data collected from mentioned offices, air recordings were taken by using an instrument called an 'Air Quality Monitoring Device'. This device gave readings of particulate matters i.e., PM_{2.5} and PM₁₀ in $\mu\text{g}/\text{m}^3$. After having the PM readings Air Quality Index (AQI) was calculated. The compiled data and results were analyzed while considering National Environmental Quality Standards (NEQS) for ambient air, Punjab Government AQI standards, and United States AQI standards to form the conclusions and recommendations, hence considering the local and international level.

This research is having both qualitative and quantitative parts. The data collection that was started with qualitative aspects, was transferred to quantitative with instrumentation for further enhancement of results that were needed to resolve the stated issues. Initially, the

subject area of interest i.e., built environment and architecture were studied to know the related problems.

The problem identified is:

"Growth of old commercial hub at Faisalabad was not planned by considering ecological sustainability of the area".

To resolve the problem identified, an objective was formulated i.e.:

"To investigate the air quality parameters of inappropriate ecological sustainability in the old commercial hub of Faisalabad city".

IV. ECOLOGICAL SUSTAINABILITY OF THE OLD COMMERCIAL HUB

Faisalabad is a city which is developing at a rapid rate. The old commercial hub (see figure I) being the central business district, since the time of its establishment, is now accommodating the increasing demands of the city. As it is a planned establishment and has no room available for current or future development, therefore, the hub is growing inwards, instead of outwards, in terms of vertical development and horizontal development by finishing the green areas and parking places. There are eight bazaars with the clock tower being the central point which is located in the old commercial hub. One bazar also known as the ninth bazar was planned to be a parking space for future use as this bazar connects all eight bazaars as can be seen in the following image:

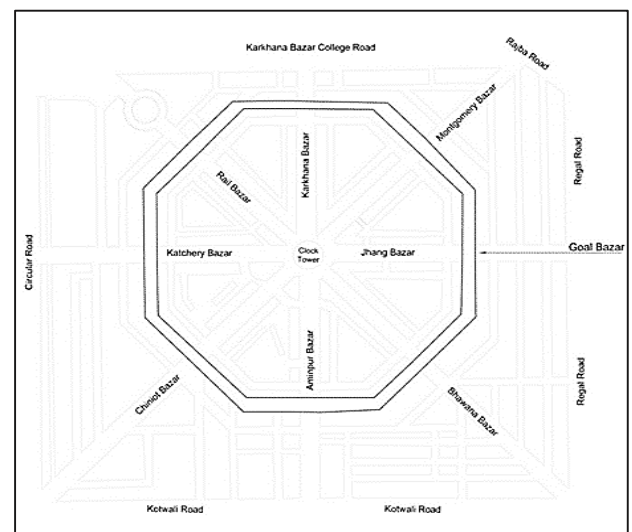
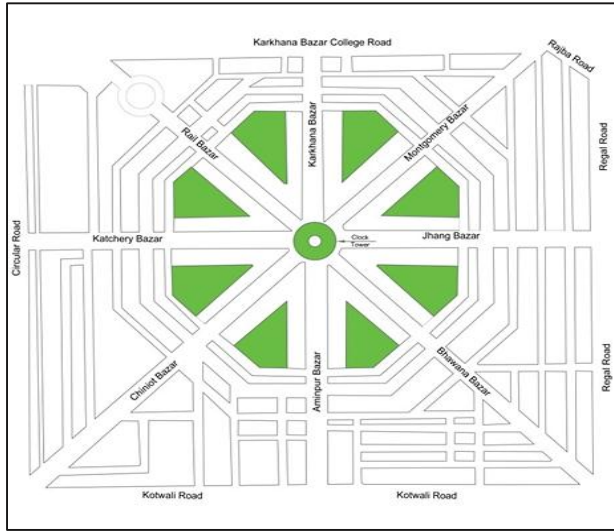
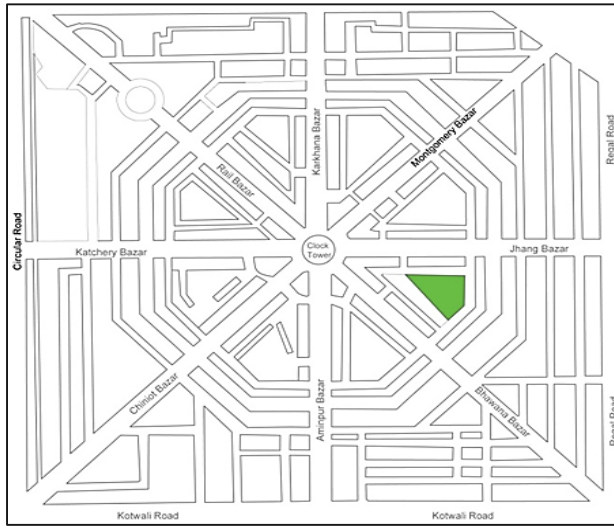


Figure I: Map of Old Commercial Hub of Faisalabad City Highlighting Goal Bazar [10]

To fulfill the increased commercial demands this whole area had been converted into a ninth bazaar. Similarly, green areas previously planned as breathing space for the old commercial hub were also converted into markets. Only one green area is still in existence because the space was allotted to a government school soon after the partition in 1947 and the school is still functioning. This green area is serving as a park/ground for school activities. The previous plan and the current plan showing the 'Gol Bazar' and earlier green spaces are as follows (see figure II).



(a)



(b)

Figure II: (a) Earlier Plan Showing Green Areas at Top; (b) Current Plan Showing Green Areas at Bottom

V. PHASES OF OLD COMMERCIAL HUB WITH RESPECT TO AIR QUALITY

The old commercial hub has undergone several important phases. Every phase explains the change in the area. This change has been justified by the users and administration as a requirement for development i.e., revenue generation and to facilitate the increased public users. These changes as was expected generated revenue and also facilitated the users according to their needs as demanded.

But at the current time when everyone at the global level knows ecological sustainability of the world is being disturbed because of human activities as in the past developments were made without respecting the environment.

The administration and people of the selected area are also aware of the fact and are now trying to make the hub ecologically sustainable by creating various interventions like systematic parking of vehicles, check and balance of new construction i.e., according to Bye-Laws, anti-encroachment operations, etc. In spite of all the interventions, the current status does not fall within the comfort zone.

The overall air quality of Faisalabad is unhealthy as can be seen in table I as follows:

Table I: Air Pollution Levels. [11-16]

S. No.	City	AQI	Air Pollution Level
1	Faisalabad	153	Unhealthy
2	Lahore	268	Very Unhealthy
3	Multan	139	Unhealthy for Sensitive Groups
4	Islamabad	169	Unhealthy
5	Peshawar	312	Hazardous
6	Karachi	84	Moderate

Air pollution levels according to United States Standards, of some other major cities of the country can also be seen in table I and it can be deduced that the overall quality of air in the country is not satisfactory while Faisalabad does not fall in very bad condition relatively. Thus, things are reasonably easy to manage in Faisalabad as compared to the other major cities.

The following table (table II), is showing some approximate facts about the old commercial hub derived by the authors from their personal observations, discussions with the users, and interviews with concerned officers:

Table II: Phases of Old Commercial Hub

S. No.	Approximate Built Area	Approximate Open Area	Total Area	The ratio of Open and Built Areas	Time-Period
1.	60 Acres (Space allocation only- considering single-story buildings on average)	65 Acres (Space allocation only)	125 Acres (Space allocation only)	52:48 (Space allocation only)	1892-when it was established/planned (Open area includes both green and circulation areas)
2.	40 Acres	85 Acres	125 Acres	68:32	1904-when the city was upgraded to district level
3.	100 Acres (Many buildings were having 2 stories)	55 Acres	125 Acres	44:80	1976-when city master plan was revised
4.	180 Acres (on average, each building is having 3 stories)	55 Acres	125 Acres	44:144	2021-when investigated by the author

As can be observed from table II, the open and built area ratios are continuously changing with the passage of time i.e., the open area is decreasing and the built area is increasing.

In phase one, when the area was planned and established in 1892, 52 % area was planned as open space. The open space included green areas and circulation spaces i.e., roads and streets. The built area was allocated as 48 % and it was considered that each building will have a single story. The common building design, as observed by the author, in Faisalabad city is that each building is having single story except monumental structures like the clock tower. The buildings erected in the vicinity of the old

commercial hub area were the district council, courts of justice, coronation library, women's hospital, and many governments officers/official residences. All these buildings are still standing and are comprised of a single story.

VI. AIR QUALITY MONITORING

To observe and investigate the air quality parameters in the old commercial hub air quality was checked through Air Quality Monitoring Device. The device was locally made. It was having a small pipe through which air was sucked and released. The readings of particulate matter were seen on the display board. A memory card was inserted in the device which recorded the digital data i.e., readings. The air quality was checked on an hourly basis. The device can be seen in the following figure:



(a)



(b)

Figure III: (a) Air Quality Monitoring Device at Top; (b) Device Setting at Bottom

The above-shown device required a flat area to be placed for air monitoring. An electricity connection was also required to make the device functional. The size of the device is around 18 inches on each side (having four sides in total). There was no special procedure to carry the device on-site. It just required appropriate handling.

VII. RESULTS

The results found after monitoring the air at identified sites can be seen in the following table:

Table III: Air Quality Monitoring Report

Sampling Point	PM _{2.5} µg/m ³	PM ₁₀ µg/m ³	AQI
Goal Kachehri Bazar	101	196	176
Goal Rail Bazar	104	194	178
Goal Karkhana Bazar	88	164	170
Goal Montgomery Bazar	69	117	160
Goal Jhang Bazar	89	167	170
Goal Bhowana Bazar	91	106	171
Goal Aminpur Bazar	80	117	160
Goal Chiniot Bazar	90	165	162
Clock Tower	109	178	180

The above-shown data was recorded by identifying 9 points i.e., 8 recordings were taken from one central point of each bazaar and 1 recording was taken at the clock tower being the central point of all bazaars as can be seen from figure I and figure II respectively.

The above table (table III) is showing PM_{2.5} and PM₁₀ readings. The first one i.e., PM_{2.5} is a particulate matter having fine particle that pollutes the air and is a concern for human health. Visibility of the area is reduced due to these small particles and the area seems hazy when a safe threshold is exceeded. People usually need health advice from the administration when these small particles are elevated outdoors. These particles/droplets are up to two and a half microns in width. Micron is a distance measuring unit like inches, meters, etc. An inch is comprised of 25,000 microns [17].

The second one is PM₁₀. These are the particles, polluting air, and can be inhaled. They have a diameter of up to 10 microns. It is found in dust and smoke as floating solid or liquid particles. They can stay in the air for weeks. PM₁₀ can penetrate deep into the lungs but cannot get into the bloodstream being larger particles [18].

VIII. ANALYSIS

The air quality index, found during the air monitoring of the identified site, can be seen in table II. The Air Quality Index or AQI is above 150 at each site. On average, it can be deduced, that the AQI of the area is near about to the value of 200. PM_{2.5} is near about 100 or above at each site and PM₁₀ is above 100 at three sites and above 150 at the remaining four sites.

The standard values of PM_{2.5} and PM₁₀ can be seen in the following table (table IV):

Table IV: National Environmental Quality Standards for Ambient Air-NEQS, Pakistan. [19]

Pollutants	Time-Weighted Average	Concentration in Ambient Air	
		Effective from 1 st January 2009	Effective from 1 st January 2012
Respirable Particulate Matter. PM ₁₀	Annual Average*	200 µg/m ³	120 µg/m ³
	24 hours**	250 µg/m ³	150 µg/m ³
Respirable Particulate Matter. PM _{2.5}	Annual Average*	25 µg/m ³	15 µg/m ³
	24 hours**	40 µg/m ³	35 µg/m ³
	1 hour	25 µg/m ³	15 µg/m ³

It can be seen from table II and table III that values of PM_{2.5} are extremely high and the values of PM₁₀ also fall in the high-value category on average.

The standards for the air quality index are shown in the following table (table V):

Table V: Province of Punjab-Pakistan, AQI [standards] [20]

Air Quality Index	Color Indicator/Status	Overall Description
0-100	Good	Good-Minimal Impact.
101-200	Satisfactory	Satisfactory – May cause minor breathing discomfort to sensitive people.
201-300	Moderately Polluted	Moderately Polluted - May cause breathing discomfort to people with lung diseases such as asthma, and discomfort to people with heart disease, children, and older adults.
301-400	Poor	Poor - May cause breathing discomfort to people on prolonged exposure, and discomfort to people with heart disease.
401-500	Very Poor	Very Poor - May cause respiratory illness to people on prolonged exposure. The effect may be more pronounced in people with lung and heart disease.
500+	Severe	Severe - This may cause respiratory impact even on healthy people, and serious health impacts on people with lung/heart disease. The health impacts may be experienced even during light physical activity.

From table II and table IV, it can be deduced that the air quality of the monitored sites falls in a satisfactory zone but near about moderately polluted zone.

The AQI standards of the United States are shown in the following table as a comparison with international standards:

Table VI: US Standards of AQI [21]

Daily AQI Color	Levels of Concern	Values of Index	Description of Air Quality
Green	Good	0 to 50	Air quality is satisfactory, and air pollution poses little or no risk.
Yellow	Moderate	51 to 100	Air quality is acceptable. However, there may be a risk for some people, particularly those who are unusually sensitive to air pollution.
Orange	Unhealthy for Sensitive Groups	101 to 150	Members of sensitive groups may experience health effects. The general public is less likely to be affected.

Red	Unhealthy	151 to 200	Some members of the general public may experience health effects; members of sensitive groups may experience more serious health effects.
Purple	Very Unhealthy	201 to 300	Health alert; The risk of health effects is increased for everyone.
Maroon	Hazardous	301 and higher	Health warning of emergency conditions; everyone is more likely to be affected.

It can be observed that the AQI of the monitored sites falls in an unhealthy zone which means that this area can create health problems not only for sensitive people but also for healthy or normal people.

According to The Urban Unit, Planning, and Development Department-Punjab Report 2014, levels of particulate matter in the air of Faisalabad are high to very high while considering World Health Organization and International Standards [22].

Thus, it can be deduced that the AQI of Faisalabad was between high and very high levels in 2014 and this deterioration in air quality still continues as the current US AQI level in Faisalabad is falling into the unhealthy to very unhealthy category [23].

The old commercial hub is expanding vertically at present because there is no space that can be associated with the area for horizontal expansion. This expansion is needed at the time to fulfill the demand and supply of goods in the whole city. Buildings built to accommodate 10 users are accommodating 30+ users with the same infrastructure and space. The overall situation is putting a burden on the area and making the area congested and degrading the air quality levels in the red zone.

Law implementation is observed to be on the weaker side. Buildings approved for 3 stories are built up to 4 or 5 stories. Land use is also not according to the approved plans as identified during the surveys. Most of the areas are encroached and illegal constructions. Some areas are encroached with permanent structures i.e., shops, and most of the areas are temporarily encroached with temporary structures i.e., fruit stalls, etc. Consequently, blocking the roads and making less than half of the road width available for vehicles and pedestrians to move was noted during the surveys. These all are the contributing factors to the deterioration of the environment.

IX. CONCLUSIONS AND RECOMMENDATIONS

The air quality monitoring concluded the rapidly deteriorating environmental condition which is one of the major contributors to airborne diseases as well. The old commercial hub designed based on the principles of ecological sustainability with the provision of green spaces is presently disrupted physically and chemically. Green areas initially planned are being encroached due to which deterioration of air quality is being expedited as no trees and plants are present to clean or filter the air wherever possible. These green and open spaces also act as buffer

zones that are continuously recycling the surroundings and acting as a catalyst in natural processes required for the stability of the ecosystem. The acquiring of these spaces and overburdening the infrastructure with illegal constructions are damaging the overall quality of life in the area. There is a need for a comprehensive zonal plan with the removal of illegally occupied areas to regenerate the ecological sustainability of the area and for the future. Here are a few recommendations based on the study to immediately reduce the impacts on the ecological cycle of the selected area.

The pedestrianization of old commercial hubs is a primary thing that is required to be done for the improvement of ecological sustainability. It will also minimize the traffic load, increase the road width, and will be beneficial in minimizing the air pollution generated by vehicles. Pedestrianization will also be feasible to create small green zones in the area which cannot be created while having vehicular movement because large road width is required everywhere for vehicles.

Anti-encroachment operations can be done to vacate the illegally occupied land. These operations can also vacate originally planned green areas for a better environment. Trees and plantations which attract birds can be done in vacant plots after anti-encroachment operations to enhance the living environment. Ornamental horticultural works can also be a preference to make the area aesthetically pleasing.

Identification of pollution-generating activities and their minimization can help to upgrade the air quality of the area. Cooking on coal, chemical usage for jewelry making, cloth dyeing process, etc., are some of the pollutions generating activities observed by the author. To permanently or completely remove these activities might not be possible. The solution is to perform these activities while following standard operating procedures or environmental quality standards to minimize the generation of pollution.

Hence, every work in the area is required to be done by adopting measures explained in National Environmental Quality Standards as it is also observed from the air monitoring results that the area requires to enhance the air quality.

Awareness campaigns, in particular, at the community and administrative level can generate self-motivation among the users to make the old commercial hub areas ecologically a better place.

Acknowledgment

The authors would like to thank almighty Allah first and then the management of University of Management and Technology, Lahore, Pakistan, for their support and their assistance throughout this study.

Authors Contributions

Both the authors; Bazla Manzoor, and Saima Gulzar equally contributed to this study.

Conflict of Interest

The authors declare no conflict of interest and confirm that this work is original and not plagiarized from any other

source, i.e., electronic or print media. The information obtained from all of the sources is properly recognized and cited below.

Data Availability Statement

The testing data is available in this paper.

Funding

This research received no external funding.

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