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Comparison between the Problems of Urbanization in Quetta City and Hub City: An Urban Geographical Perspective

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ABSTRACT

Urbanization is a pressing global phenomenon, particularly in developing countries, where it poses complex challenges to urban populations. It continues to shape cities leading to complex issues of environmental degradation, impacting public health and socio-economic inequalities. The main objective of the present study is to assess the urbanization problems of Quetta City and Hub City in Balochistan, Pakistan. The research methodology of this study consists of a combination of both qualitative and quantitative approaches. The methods used for the comparative study of urbanization problems include literature review, comparative analysis, interviews with stakeholders, and spatial analysis using ArcGIS 10.8.2, Google Earth Pro, and Google Earth Engine (GEE). The findings of the study revealed that both cities have experienced rapid urban growth, leading to significant problems. Both cities are experiencing urban sprawl (1985-2025) which has resulted in the urban heat island (UHI), air and water pollution, insufficient healthcare facilities, water scarcity, and loss of green spaces. The study results also highlighted that, along with these factors, urbanization is aggravating socio-economic inequalities for at-risk groups, which is not specific to any one city. Insufficient access to basic services, such as sanitation and healthcare, complexes public health challenges, mostly in slum areas. Both cities have experienced rapid urban growth, leading to significant problems in both cities. The study suggests that both cities are experiencing urban sprawl which has resulted in the urban heat island (UHI) phenomenon, air and water pollution, insufficient healthcare facilities, water scarcity, solid waste management issues, urban planning and sustainability issues, and water quality issues. Additionally, the comparison highlights the unique urban problems in each city, calling for policy-level interventions to advance urban sustainability and mitigate urban socioeconomic inequalities. This in-depth study adds to the sparse literature on urban issues in Balochistan and calls for urgency in solving urban issues rigorously through intelligent urban planning and management.

Keywords: *Urbanization, Quetta city, Hub city, Urban geography, Problems of urbanization, GIS, RS*

1. INTRODUCTION

Urbanization is a global phenomenon that presents significant challenges, particularly in developing countries (Abdul & Yu, 2020; Özden & Enwere, 2012). It is a complex phenomenon that creates numerous challenges for cities across the globe. These include environmental, social, and governance challenges (Festus et al., 2020; Ibimilua & Ibimilua, 2024; Liu, 2022; Syaodih, 2019; Tanrıkul & Hoşkara, 2019; Zhang et al, 2022). Urbanization in Asia is worsening environmental problems like air and water pollution, contributing to the urban heat island effect and loss of green spaces due to urban sprawl (Handayani et al., 2018; Kanga et al., 2022). Urbanization critically affects public health, especially in developing countries where sanitation and healthcare access are inadequate, and a significant percentage of the population lacks access to basic services (Lakshman, 2023; Subasinghe et al., 2021). Socio-economic inequalities are aggravated by urbanization, mainly in South Asia, where rapid urban growth repeatedly overtakes infrastructure development in cities. This often led to the spread of informal settlements and slums, where overcrowding, inadequate housing, and limited access to essential services are major concerns (Devkota, 2018; Gupta & Hall, 2020).

The rapid growth of the urban population in Pakistan has made cities unable to deal with rural-to-urban migrants. Due to urbanization, the pressure on the prevailing set-up of urban areas increases which results in different urban problems (Anwar et al., 2022). The urban population in Pakistan faces several social, economic, and environmental problems. These include issues such as haphazard expansion, inadequate housing, lack of basic services, and climate change (Abdul & Yu, 2020). Rapid urbanization has created significant land cover changes, resulting in the loss of green spaces and increased pollution levels in cities (Bokhari et al., 2022). This degradation has aggravated the reduction of vegetation and the increase in impermeable surfaces in cities like Karachi and Lahore (Arshad et al., 2022; Baqa et al., 2022). Karachi and Lahore are the biggest concentrations of urban population in Pakistan. The biggest city in Pakistan is Karachi which faces problems of power failures, frequent traffic jams, shortages of water, poor solid waste management, and heat island effect. Likewise, Lahore has witnessed the worst smog (Abdul & Yu, 2020). Further, inadequate sanitation worsens public health challenges, especially in slums (Habib, 2022; Waseem & Talpur, 2021). Balochistan, the largest province of Pakistan by area is facing rapid urbanization in its fewer urban centers. This led to challenges in providing basic services such as water supply, transportation, and sanitation with health hazards and environmental degradation.

Quetta is the capital city of Balochistan province. There has been a rapid migration from rural areas of Balochistan towards Quetta city which has resulted in unplanned development and growth of squatter settlements (Sajjad & Blond, 2020). This has led to a housing shortage, inadequate infrastructure, and a lack of access to basic services (Sajjad & Blond, 2020). Likewise, due to the development of industrial zones and its proximity to Karachi, Hub City has experienced rapid urbanization which has caused problems such as encroachment on agricultural land, uncontrolled urban sprawl, and squatter settlements.

Urbanization is a worldwide trend and it transforms not only the urban landscape but also the economy and society as a whole in cities. Both Quetta City and Hub City which are located in Balochistan province, Pakistan, are urban centers that have experienced rapid urbanization in the recent few decades raising different concerns (Mengal, 2018; Shahzad et al, 2021). Understanding the specific urban problems, they face is essential for developing targeted policies and interventions. However, there is a lack of literature on problems of urbanization in Balochistan particularly literature on comparative analysis. More studies are required to emphasize an analysis of urban issues and problems in Balochistan (Anwar et al., 2022). This paper seeks to analyze the urbanization challenges these cities face from an urban geographical perspective.

2. MATERIAL AND METHODS

2.1 Study area

Balochistan is the biggest province in terms of area with an extent of 347,190 km^2, which is 43.6% of Pakistan's total land area (**Figure 1**) (Ullah et al. 2025). Quetta is the capital and also the largest and most populous city of Balochistan province (Ullah et al. 2024). Quetta is situated in a geographically important location characterized by its unique topography, climate, and socio-economic dynamics. Its geographical location is 30.17° North latitude and 66.97° East longitude. The average elevation of Quetta Valley is about 5,500 feet with an area of 3,447 km^2 (Ullah et al. 2024; Bazai & Panezai, 2020). It is surrounded by the mountains of Murdar, Chiltan, Takatu, and Zarghoon (Dawood et al., 2021). According to the 2023 census, the Quetta sub-division city has an urban population of 1,241,375 (Pakistan Bureau of Statistics, 2023). The Hub district was established in the year 2022 and is located adjacent to Karachi. It is Balochistan's most productive district, contributing meaningfully to the province's economy through its agricultural, fisheries, livestock, and industrial sectors and produces around 90% of Balochistan's industrial output (Khan & Liaqat, 2023; Shaikh et al, 2020). Hub City is located near the Hub River, which plays an important role in the local ecosystem and agriculture, providing crucial water resources for irrigation in an otherwise arid region. As per the census report of 2023, Hub City has a population of 195,661, of which 99,983 are males and 95,672 are females (Pakistan Bureau of Statistics, 2023).

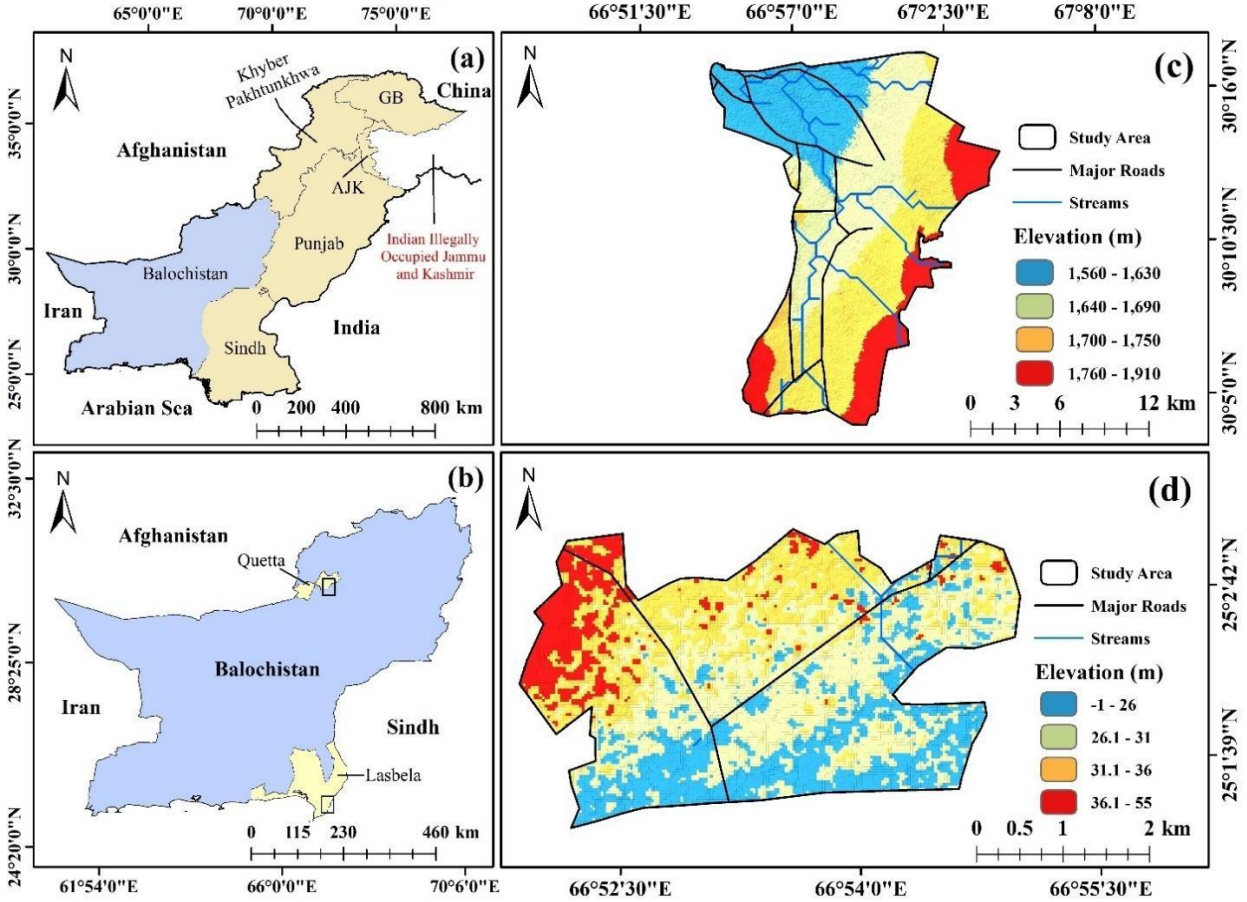

Figure 1. (a) Pakistan association with neighboring countries, (b) Balochistan map along with selected districts i.e. Quetta and Lasbela maps, (c) study area map of Quetta city, and d study area map of the Hub city.

2.2 Methods

The research methodology of this study consists of a combination of both qualitative and quantitative approaches. The following methods were used for the comparative study of urbanization problems between the city of Quetta and Hub.

2.3 Literature Review

An inclusive review of the current literature on the problems of urbanization in Quetta and Hub cities was conducted including academic journal articles, government reports, newspapers, and other relevant publications.

2.4 Spatial Analysis

Various forms of geospatial data like satellite imagery, land use strategies, and census data were integrated to explain the spatial dynamics of urbanization in two cities. The tools of geographic information systems (GIS) i.e. ArcGIS 10.8.2, Google Earth Pro, and Google Earth Engine (GEE) platforms were applied for obtaining and processing data associated with the urban growth, land surface temperature (LST) analysis, land use land cover of these two cities, infrastructure, and environmental characteristics. The LST of the study area was calculated from Landsat-8 satellite data using GEE through the following steps;

1. Top of Atmosphere (TOA) Spectral Radiance

The conversion of DN to TOA is performed using the radiance rescaling factors through the following equation;

$$L_\lambda = M_L \times Q_{cal} + A_L$$

Where:

L_λ is TOA spectral radiance, ML represents band-specific multiplicative rescaling factor from the metadata, Q_{cal} is the Landsat band 10 image and A_L is the correction/rescaling for band 10.

2. Calculating Brightness Temperature (BT)

$$TB = \frac{K2}{In\left(\frac{K1}{K\lambda} + 1\right)} - 273.15$$

Where:

TB = Top of the atmosphere (TOA) brightness temperature, K1 and K2 are thermal conversion constants, and Lλ is Top of the atmosphere (TOA) spectral radiance.

3. Calculating Land Surface Emissivity (ε)

Land surface emissivity was calculated from the normalized difference vegetation index (NDVI).

$$NDVI = \frac{NIR\ (B5) - Red\ (B4)}{NIR\ (B5) + Red\ (B4)}$$

Calculating emissivity (ε) from NDVI;

$$\varepsilon=0.004 \times NDVI+0.986$$

4. Calculating Land Surface Temperature (LST)

$$LST = \frac{BT}{1 + (\mathrm{W} \times \mathrm{BT})/14380 \times \mathrm{In}\ (\varepsilon)}$$

Where;

LST is Land surface temperature (°C), W is the wavelength of emitted radiance, BT is the top of atmosphere (TOA) brightness temperature and ε is land surface emissivity.

2.5 Stakeholder Interviews

In-depth interviews were conducted with local government officials, community leaders, and key stakeholders to gain a deeper understanding of urban development problems and their views on possible solutions.

2.6 Comparative Analysis

The data from a review of literature, geospatial analysis, and stakeholder interviews were used to do a comparative analysis regarding the problems of urbanization between the cities of Quetta and Hub. The analysis was focused on identifying the similarities and differences in the urbanization patterns and the specific challenges faced by these cities.

3. RESULTS

3.1 Problems in Quetta City and Hub City

3.1.1 Urban Heat Island

The Urban Heat Island (UHI) effect is a noteworthy phenomenon in speedily urbanizing areas, categorized by high temperatures in urban regions compared to their rural surroundings. Rapid urbanization in Quetta has intensified the UHI effect, which has led to increased land surface temperatures (LST) caused by the replacement of natural vegetation with impervious surfaces such as concrete and asphalt (Sajjad & Blond, 2020). This not only affects the local climate but also has consequences for energy consumption and public health (Peng et al., 2012). The results show that in the last twenty years, the urban population increased by 80% and the urban area grew by 194%. Additionally, the annual and seasonal temperature trends indicate that both the minimum (Tn) and maximum (Tx) temperatures in Quetta City are rising faster than those in nearby regions (Sajjad & Blond, 2020). The UHI effect in Hub City poses challenges that are similar to those in Quetta, which include increased energy demand for cooling, exacerbated air pollution, and heightened health risks for residents. The land surface temperature (LST) of Quetta and Hub cities is shown in Figure 2.

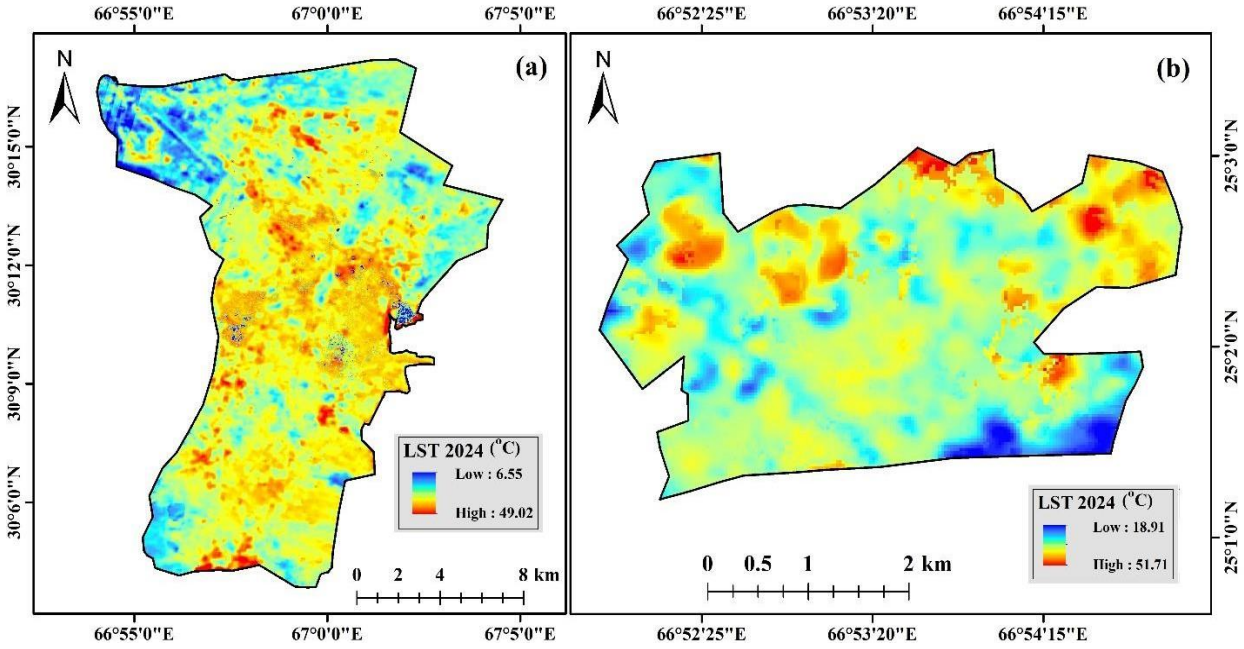

Figure 2. (a) The LST of Quetta City and (b) the LST of Hub City.

3.1.2 Air Pollution and Health Impacts

Pollutants of various kinds are affecting Quetta city badly (Ilyas et al., 2008). High air pollution, especially particulate matter (PM) is one of the prevalent issues Quetta City is facing (Shahzad et al., 2021). According to (Fatima et al., 2023) the $PM_{2.5}$ in Quetta is66.94-72.59 micrograms per cubic meter (µg/m³), while in Hub, it is 39.04-56.03 micrograms per cubic meter (µg/m³) as shown in Figure 3. (Ilyas et al., (2008) in their study concluded that lead exposure is strongly linked to high blood pressure, problems with the eyes, nose, and throat, fatigue, digestive issues, and cancer. They also report that motor vehicles are now the main source of air pollution, while burning coal, running kilns in furnaces, and burning natural gas are other contributors. Air pollution has significant effects on the exacerbation of asthma, allergies, and other respiratory diseases in the city (Ilyas et al., 2010). In contrast, Hub City, being an industrial hub, also faces significant air pollution challenges, but the specific impacts on human health have not been extensively studied. A constant dust haze in the air is causing serious respiratory issues and other health problems in the city (Ahmed, 2019).

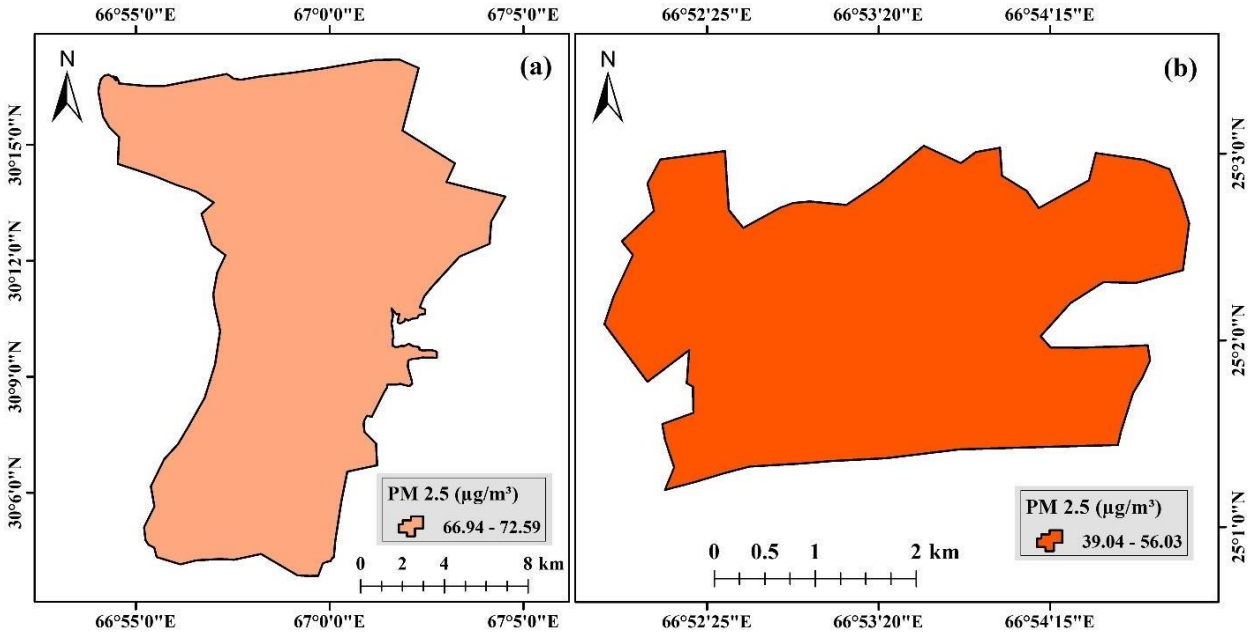

Figure 3. Air pollution PM (µg/m³) in Quetta City (a) and Air pollution PM (µg/m³) in Hub City (b).

3.1.3 Health Facilities

Quetta being the capital city of Balochistan, has a more wide-ranging network of health facilities than Hub City, which is relatively smaller and less developed. There are significant differences between infrastructure, accessibility, and service delivery between the two cities. There is a mix of public and private hospitals in Quetta city. Public sector health network ranges from basic health units (BHUs) to tertiary referral centers (ul Haq et al., 2012). However, despite this, the infrastructure for healthcare facilities is extremely insufficient for the population in Quetta City (Anwar et al., 2022). Many patients visit Karachi due to a lack of medical facilities. Service delivery of Bolan Medical Complex (BMC) **(**Figure 4 a), and Civil hospital (Figure 4 b**)** is below national health standards (Anwar et al., 2022). On the other hand, Hub City has fewer health facilities which lack basic resources. Residents of Hub City often travel to Karachi city for medical care.

Figure 4. Conditions of hospitals in Quetta (a) BMC and (b) Civil hospital.

3.1.4 Water Quality and Urbanization

The quality of groundwater is rapidly deteriorating in many urban areas of Pakistan (Iqbal et al., 2023). Overexploitation of groundwater caused by rapid urbanization in Quetta is deteriorating the quantity and quality of groundwater at an alarming rate (Ahmed et al., 2019) and made drinking water challenging in many areas (Dawood et al., 2021). (Khan et al., 2022) in their study found that drinking water from different sites in Quetta city is microbiologically contaminated and therefore presents significant health risks to the population of the city. Factory waste chemicals in Hub City go directly into water resources, polluting the water and causing various health problems (Iqbal, 2020).

Urbanization, agriculture, and deforestation in Quetta and the Hub have changed land use, resulting in groundwater quality degradation (Iqbal et al., 2023). Increased runoff from sewage and industrial wastes, flooding, and pollution have caused water quality degradation in these cities (Iqbal et al., 2023). However, the extent of these issues and the specific effects may differ between the two cities, and further research is needed to understand the differences.

3.1.5 Water Scarcity

Due to climatic and anthropogenic factors, Quetta city faces severe water scarcity and it is a pressing issue in Quetta. The primary source of water for inhabitants of Quetta is groundwater. Uncontrolled extraction of groundwater has caused a substantial decline in water level, with research demonstrating a decline of 1 to 1.5 meters per year in certain parts of the city (Kakar et al., 2020). This has been further intensified by prolonged droughts in Balochistan (Rehman et al., 2019). The scarcity of water in Quetta has serious consequences for the people of Quetta City as accessing clean and sufficient water for daily needs is challenging for them (Figure 5a) (Barrech et al., 2020).

In contrast, Hub City has no severe shortfall of water as compared to Quetta. Its major source is Hub Dam which is a reservoir on the Hub River and provides water to Hub in Balochistan and Karachi in Sindh (Figure 5b). Yet, it is not sufficient for domestic, agricultural, and industrial usage, especially in dry periods. The prolonged droughts are a major concern just like for the rest of Balochistan (Rehman & Alamgir, 2018).

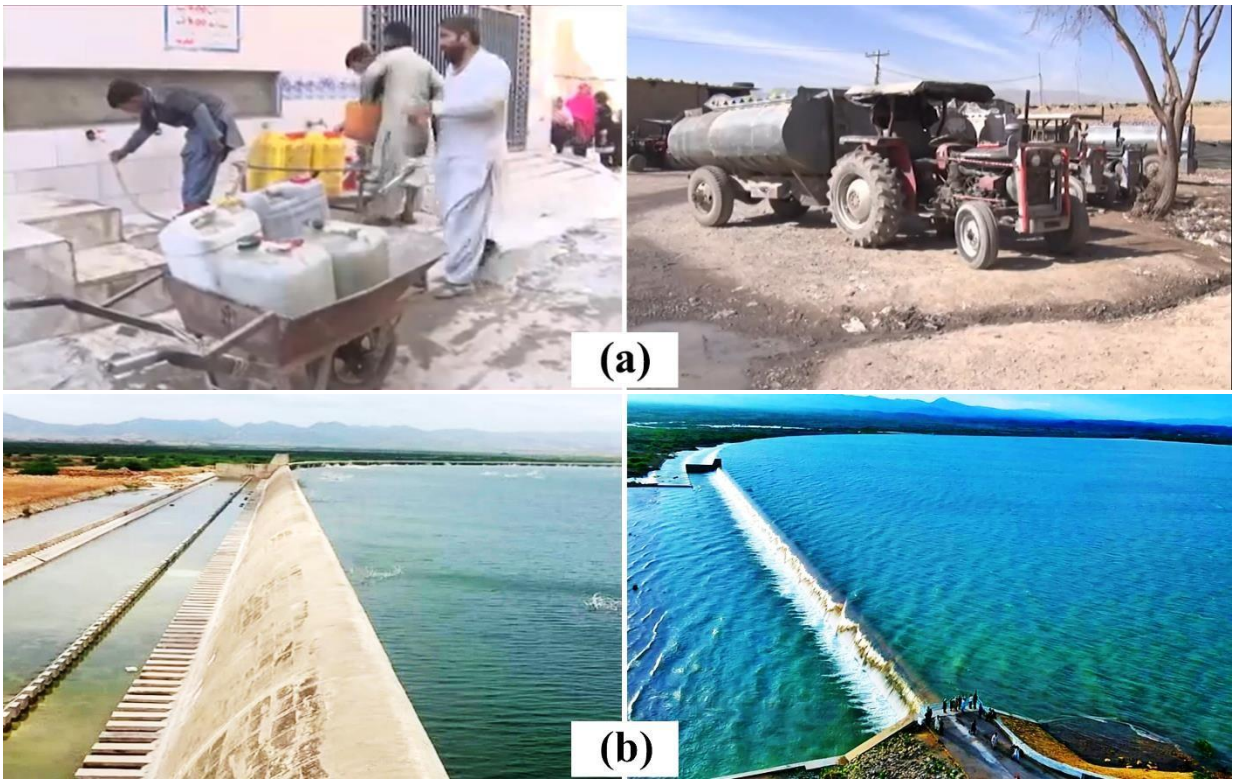

Figure 5. Water situation in Quetta City (a) and Hub dame in Hub (b).

3.1.6 Urban Planning and Sustainability

The lack of plan implementation in Quetta City has created many issues for the urban population of Quetta (Mengal, 2018). These are accompanied by a plethora of human-induced disasters such as civil unrest, refugees, terrorism, and health epidemics (Mengal, 2018). Over the past few decades, Quetta City has witnessed a significant urban sprawl which has affected its resources and land use management (Anwar et al., 2022). (Bazai and Panezai, 2020) report a massive loss in vegetation cover and a decrease in open areas during 1999-2019 in Quetta City. They further report that the increase in the built-up area in Quetta city has put enormous pressure on already resource-scarce cities.

The task of urban planning and sustainability is a requirement of both Quetta City and Hub City. In particular, the challenges identified for Quetta City include uncontrolled expansion of the city, transport issues, and the delivery of urban services (Shah, 2023). The inadequate infrastructure of the urban road network in Quetta cannot meet the rapid increase of traffic influx (Anwar et al., 2022) (Figure 6 a). As in the case of an industrial city, Hub City also faces challenges with the need to ensure economic growth and environmental protection. The development of factories and many other industries is occurring and the infrastructure is shaping up very fast (Figure 6 b).

During interviews, it was revealed that traffic jam is a major concern for inhabitants of Hub. The main Karachi-Quetta Highway passes through the Hub City causing major implications for people. A bypass has been built to minimize the traffic rush but it is not enough. Also due to its proximity to Karachi, it is becoming a commuter town of the Karachi metropolitan area. Stakeholders were in view that the worsening state of roads and streets in the area has made everyday life difficult. Integration of urban and rural infrastructure as well as planning sustainable transport systems is important for the two cities.

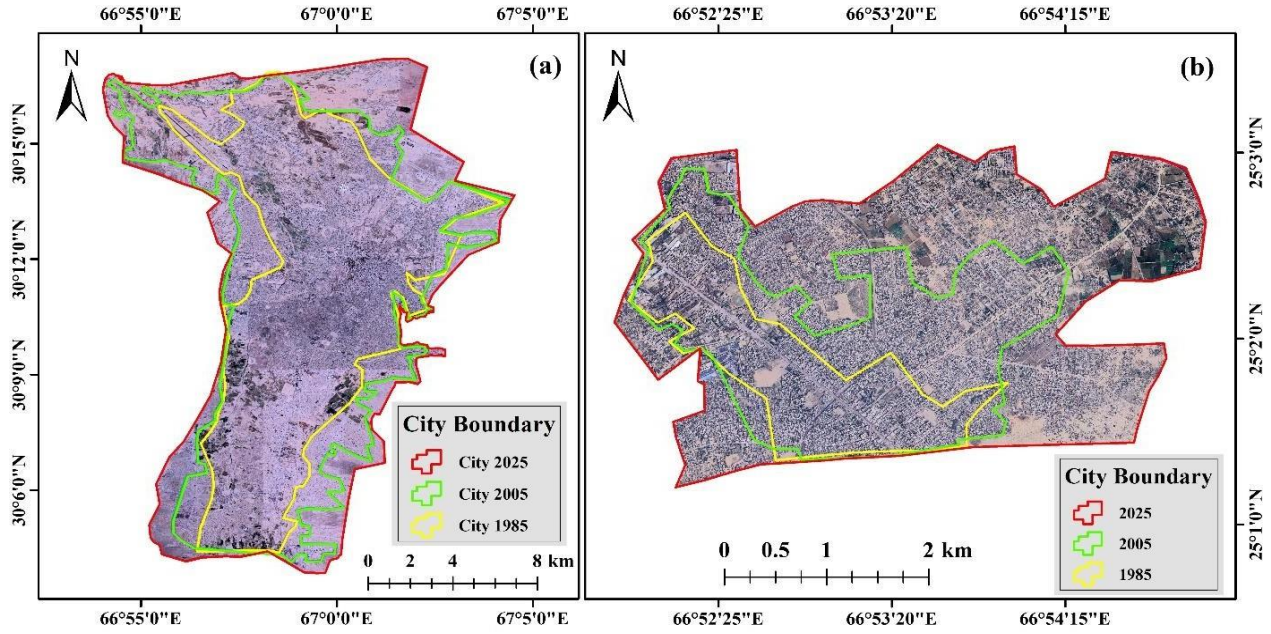

Figure 6. (a) city boundary in Quetta and (b) city boundary of the Hub.

3.1.7 Socioeconomic Impacts and Vulnerable Populations

As the provincial capital, Quetta has a rapidly growing population and a severe imbalance in dietary intake, which has resulted in issues such as iron deficiency anemia among women of reproductive age (Qadir et al., 2022). Moreover, 85% of the people in Quetta had no direct access to recreational facilities (Anwar et al., 2022). Water shortages throughout the year and gas shortages in winter are persistent phenomena witnessed by the residents of Quetta City (Anwar et al., 2022). While, Hub City, being an industrial hub and near the major city of Karachi, possibly will face different socioeconomic challenges, such as the amalgamation of migrant workers and the provision of sufficient housing and services. Community leaders revealed during interviews that increased commercialization in Hub City has led to many social, political, and hygienic problems. The effects of urbanization on vulnerable populations such as the urban poor may also differ between the two cities, thus requiring further research. Residents of Hub City face widespread poverty and deprivation despite its economic potential with many residents lacking access to basic services (Khan & Liaqat, 2023). There is a need for additional expansion in housing, education, and healthcare services to improve the quality of life in Hub City (Khan & Liaqat, 2023).

3.1.8 Solid Waste Management

A major concern for the people of Quetta City is untreated waste as shown in Figure 7 a. A growing population and a lack of solid waste management are leading to an environmental hazard and adverse health effects (Anwar et al., 2022). Despite being the province's capital city and having a formal waste management system, Quetta faces several challenges. Zahra (2021) reports that according to Metropolitan Corporation Quetta, daily waste production in Quetta city is 1000 MT out of which only 350 MT is collected by QMC and the rest is left behind.

Meanwhile, Hub City faces obvious challenges in solid waste management due to limited resources. The waste management system in Hub City is often informal, with many residents engaging in self-disposal practices, which can lead to improper waste handling (Figure 7 b).

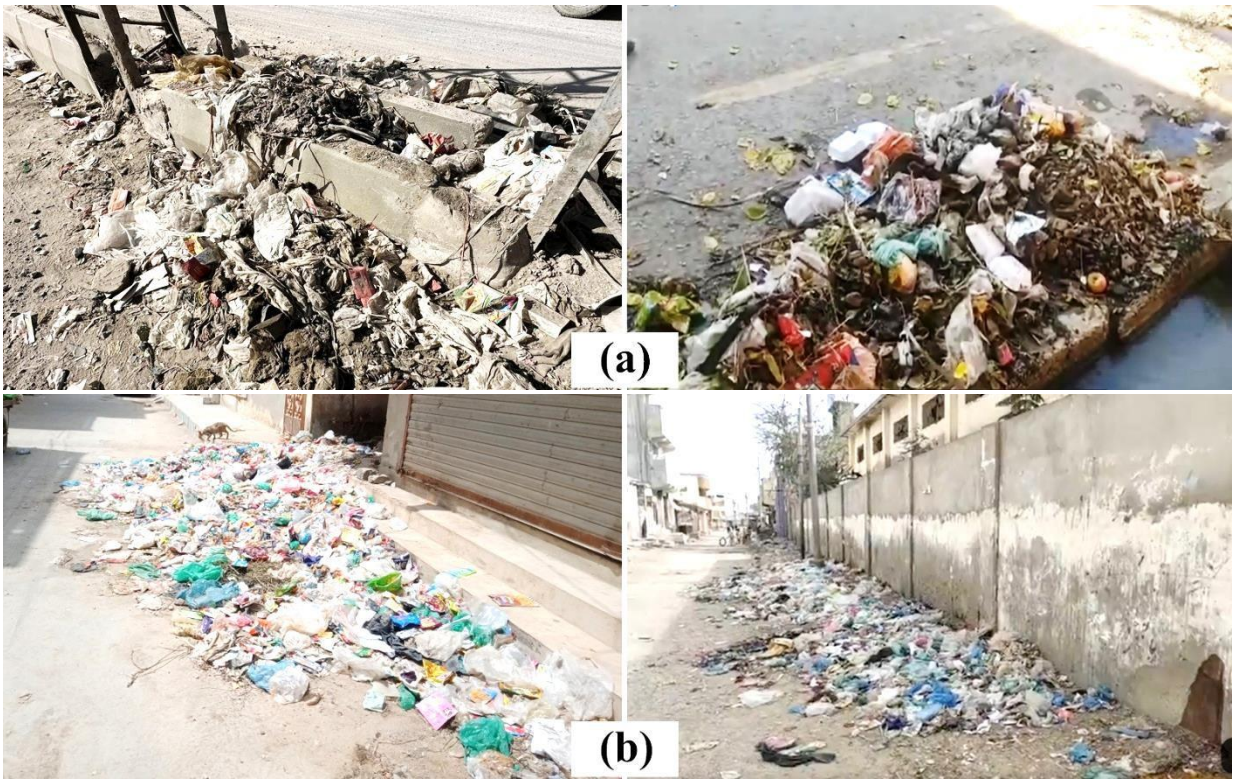

Figure 7. Solid waste management situation in Quetta City (a) and Hub City (b).

4. DISCUSSION

Both Quetta and Hub City display a plethora of urbanization problems that are associated with rapid development, such as the Urban Heat Island (UHI) phenomenon, air pollution, poor healthcare facilities, water quality and shortages, poor solid waste management, and socio-economic inequalities affecting vulnerable groups. The specific problem noted within Quetta City is the augmentation of the UHI effect from urban sprawl with increased impervious cover, as evident in earlier literature (Arshad et al., 2022; Ma & Peng, 2021). Evidence demonstrates that there is a significant land surface temperature increase (LST) associated with urban expansion. The effects of exacerbated UHI in these cities depict a negative feedback loop where higher temperatures exacerbate public health hazards, raise energy requirements for cooling purposes, and add to environmental degradation (Nolan, 2015). Research has pointed out that increasing land surface temperatures directly affects urban climates and emphasizes the importance of sustainable urban planning to counteract these (Abd-Elmabod et al., 2022).

Air quality is another issue of concern affecting health outcomes both in Quetta and Hub City. The high $PM_{2.5}$ levels of up to 72.59 µg/m³ in Quetta pose severe respiratory health risks that are further worsened by car emissions and industrial processes (Manisalidis et al, 2020). Hub City, which is an industrial area, also suffers from air pollution though less documented health effects. The air quality statistics indicate an alarming trend, whereby both cities are witnessing rising respiratory diseases caused by poor air quality. The dismal situation warrants holistic pollution management approaches that encompass public health strategies to emphasize air quality enhancement measures (Al-Thani & Isaifan, 2024; Ogwu & Izah, 2024).

Health facility quality and access to healthcare are a stark contrast between Hub City and Quetta City. Quetta, being the capital, has comparatively more comprehensive healthcare services, but the facilities

provided are not sufficient to cater to the increasing demands of its population (Ullah et al., 2025). Emphasizing healthcare equity, several studies illustrate that urban centers generally display disparities in service access among various socio-economic segments, exacerbating pre-existing health inequalities (Gelormino et al., 2015). On the other hand, Hub City's limited healthcare infrastructure restricts residents' access to basic medical services, prompting many to turn to Karachi for treatment. This disparity points to an acutely imperative requirement for policies that facilitate more equitable distribution and improvement of health services in both urban areas

Water quality and scarcity are issues common to both cities but of different magnitudes. Groundwater over-extraction in Quetta has resulted in serious depletion and contamination issues compromising drinking water security (Nasrullah et al., 2024). In contrast, Hub City is served by water sourced from Hub Dam, even though such supply is not enough during periods of drought, a piece of evidence of regional exposure to climate variability (Shah et al., 2025).

In addition, solid waste management has become a significant issue in both urban areas. Quetta experiences high challenges in waste collection, where a minimal amount of waste generated is subjected to proper treatment, resulting in environmental degradation and health risks (Muhammad et al., 2024). Similarly, in Hub City, unofficial waste management activities point to resource shortcomings that make it difficult to dispose of and treat waste, having adverse effects on public health. These findings are in line with (Iqbal et al., 2022; Sohoo et al., 2022) who claim solid waste management is a gigantic issue in urban areas of Pakistan.

Finally, the socioeconomic inequalities exposed in this research highlight how both Quetta and Hub urbanization continue inequalities, especially within marginalized communities. Similar findings are reported in the literature which shows urbanization spreads inequalities (Haque & Sharifi, 2024; Hussain, 2023).

4.1 Recommendations and Policy Implications

The urbanization problems faced by the cities of Quetta and Hub demand targeted recommendations and policy implications to deal with major urbanization problems. To address these issues, there is a need for measures such as affordable housing, public transport improvement, and implementation of urban greening initiatives in Quetta City. Likewise, strategies such as agricultural land preservation and the development of sustainable industrial zones in Hub City mitigate urban problems (Sajjad & Blond, 2020, Ashraf et al., 2022, Anwar et al., 2023). The government should assign enough financial and technical resources for improved solid waste management (Muhammad et al., 2024).

Overall, this comparison of problems due to urbanization in the cities of Quetta and Hub necessitates a more comprehensive study of specific problems for urban development in Balochistan. By addressing the challenges of these cities urban planners and policymakers can work for a more sustainable and livable urban environment.

5. CONCLUSION

The urbanization problems confronted by the cities of Quetta and Hub reveal the need for more comprehensive and wide-ranging solutions to the multifaceted issues due to urbanization. The replacement of natural landscapes with impervious surfaces accentuates the Urban Heat Island (UHI) effect. Quetta, with more healthcare facilities, still lacks enough resources for its growing population, while Hub City struggles even more with access to health services. Water problems, such as declining groundwater in Quetta and reliance on a single reservoir in Hub City, add to the difficulties. The immediate concerns of deteriorating air quality, heat island effect-induced rising temperatures, and water shortage have serious implications for the health and well-being of people who live in the city, especially

for marginalized populations. In addition, socio-economic problems driven by urbanization constitute a significant impediment to enhancing the welfare of inhabitants. As the gap between access to vital services is increasingly widened, the poor population who live in informal settlements face multiple challenges to combating poverty and destitution. Other issues include poor urban planning, socioeconomic gaps that leave vulnerable groups underserved, and major waste management problems. To tackle these challenges, a coordinated effort between government, communities, and other stakeholders is needed to improve public health, infrastructure, and overall quality of life. Future studies should continue to explore these urban issues to guide policymakers toward sustainable urban development.

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