

Assessing the Environmental Sustainability of Islamabad's Rapid Metropolization: Analyzing the Ecological Costs of Urban Expansion

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Abstract

Rapid urbanization is a global phenomenon driven by population growth and rural to urban migration. While urban expansion contributes to economic development, it's also exerts significant pressure on natural resources, leading to environment degradation. This research examines the environmental implications of rapid urbanization in Islamabad, drawing on existing literature and is grounded in primary data collected through qualitative interviews with key government urban planners, environmental experts, academicians and civil society representatives from Pakistan. Based on the analysis of the data, this study argues that unregulated urban growth in Islamabad has disrupted the ecological balance, lost substantial green cover, experienced a sharp decline in groundwater levels and witnessed deteriorating air quality due to increased carbon emissions. Despite Pakistan's commitment sustainable development, governance challenges, weak policy enforcement and political interference have exacerbated these environmental concerns. The unchecked urban sprawl threatens Islamabad's ecological balance, public health and long term sustainability of Islamabad. The study recommends urgent sustainable urban planning, green infrastructure initiatives and public-private partnerships to mitigate the adverse effects of urbanization and promote environmental sustainability in Islamabad.

"Keywords: Urbanization, Climate Change, Carbon emssion, Urban Planning, Water Scarcity, Sustainability, Ecological Balance."

1. Introduction

Rapid urbanization is the speedy expansion of urban centers due rural to urban migration or the natural growth of the inhabitants. It has been the trend throughout the world in past few decades, but in near future it is predicted to be more frequent, for instance, it is estimated that by 2050 about two third of the world population will live in the cities and it will be challenging for them to cope up with their needs (United National, 2022). It is important to promote and ensure building of the sustainable cities; it will be a measure towards keeping sustainable natural environment (Jabeen et al., 2010). The concept of sustainable environment refers to keep the ecological balance by conserving natural resources for the present and future through sustainable practices (Said et al., 2024).

ISLAMABAD is located at the foot of Margalla Hills, on Potahar Plateau and surrounded by Himalayan forests, which is serving as capital of Pakistan since 1963; it was planned in 1960 to offer sustainable urban design. However, the rapid urbanization driven by population growth, rural to urban migration and

infrastructure development has led to environmental challenges (Ali et al., 2023). This study aimed at assessing the ever-expanding population's impacts on ecological balance of Islamabad.

Seto et al. (2014) claimed that cities across the world significantly contribute to the global carbon emissions and resource depletion. Ahmed et al., (2019), argued that similar trends have been observed in Islamabad, with issues such as Water scarcity, air pollution and deforestation/loss in green land. Over last three decades the population of this city has rapidly expanded from 0.117 million in 1961 to 2.4 million in 2023, this triggered rapid urbanization and has made ever increasing demand on natural resources (Ahmed et al., 2023). According to Global Forest Watch from 2001 to 2023, Islamabad lost 13 hectares of tree cover. Moreover, the WWF-Pak reported that the built-up areas has increased from 2,693 hectares in 1990 to 18,469 hectares in 2020 at the expense of agriculture and grassland, key ecosystem, that provide carbon sink, barrier to pollution, and biodiversity growth (WWF-Pakistan, 2020).

Beside this, UN Habitat called rapid urban growth and its derivative loss in green cover as the major reason behind the rise in Islamabad's temperature for instance it has been predicted that Islamabad will experience rise in temperature at the pace of 0.7°C until 2039 and 2.2 °C until 2069. This is higher than the 2°C limit that the Intergovernmental Panel on Climate Change has recognized as the point beyond which ecological systems (and human systems by extension) may become severely disrupted (UN Habitat, 2023).

Moreover, Pakistan is signatory of various national and international legislations regarding urban planning such as Islamabad master plan (2020-2040), National Environmental policy (2005), UN's 2030 agenda-Sustainable Development Goals Particularly SDG-11; which call to ensure "sustainable cities and communities" and many more. Beside commitment to all these legislation Islamabad is struggling to manage natural resources and sustainable urban planning because in Pakistan, there is lack of effective implementation of existing legislation or have loopholes, aimed at curbing uncontrolled and uninformed influx of population and environmental exploitations.

It is evident that the unplanned & uncontrolled urbanization is proved to be curse for nations by impacting its economics, social Integration, and particularly the environment.

2. Problem Statement

Rapid urbanization in Islamabad hinders city's ability to ensure the sustainable management of natural resources and environmental protection. The rapid urbanization phenomena in Islamabad, with current population of 2.4 million (2023) has led to deforestation (from 2001 to 2023, Islamabad lost 13 hectares of tree cover), water pollution/ scarcity (Groundwater in the federal capital has lowered by five times over the last five years, Ministry of State for Interior.), carbon emission and lower air quality "air quality has been recorded as very unhealthy in month of November, 2024" (Khalid et al., 2023), threatening the city's environmental sustainability which is an existential threat to the lives of inhabitants.

3. Literature Review

Urban expansion is a process experienced throughout the globe and across the cities of the world but its impacts largely varies from country to country based on the way they are planning it. An addition of a prefix 'Rapid' to this process changes its meaning and the extend of its impacts, as the Rapid Urbanization is the process through which cities grow rapidly and even causes the surrounding peri-urban areas to grow faster (Jamal et al., 2021). Thus has a far reaching impact on Environment, economic and social sustainability of urban centers. But the major focus of this paper is its far-reaching impacts on the Environmental sustainability.

Anwar (2024), Demonstrates that, the rapid urban growth increases the demands of natural resources to meet the human needs which leads to the depletion of the natural environment hence hampers their sustainable usage. The Rapid City sprawl causes unplanned settlement and the overuse of nature and the ecosystem; the population increase and migration towards the city are also driving forces of city expansion in terms of area and size. The conversion of natural land and forests into housing colonies and urban networking are the major causes of this alternation, which leads to negative impacts on the environment and biodiversity loss in the area (Aziz et al., 2024).

Azka et al., (2024), identified the relationship among the land use, land cover and the land surface temperature, according to this study there is an inverse relation among land use and land cover for instance Normalized difference vegetation index (NDVI) maps showed a dramatic decline in dense vegetation, from 6.01% in 2019 to just 0.17% in 2022. While there is direct relation among the land use and land surface temperature i.e. the densely populated area poses the extreme temperatures. Due to accelerated urbanization trend across the globe, unsustainable planning and management has consequently led to tremendous deterioration of ecosystem especially vegetation cover and water resources (Rahman et al., 2019).

Sohail et al., (2019) argued that in present time the Rural to Urban migration is very complex phenomena which dramatically increases the urban population that deteriorated the natural composition of environment such as loss in land cover, extreme weather patterns and poor water quality, For instance they did a water quality assessment of 32 sites in Islamabad, they got a pathetic result, only one out of 32 sites "Pak secretariat P-Block", was having suitable drinking water.

Aslam et al., (2021) stated that the rapid urbanization is result of weak urban governance, which converted the green land into built infrastructure; residential, commercial, roads, railways, airport and other. Moreover the rapid urbanization is termed as a driving factor exacerbating the impacts of climate change (Haque et al. 2020). It has been claimed that if it is not planned and managed properly, the urban expansion would increase the frequency of extreme weather patterns such as heat waves, flood, storms, extreme rainfall and drought. Urban sprawl in metropolitans of Pakistan, has significantly contributed to increase carbon emission through various ways including heightened energy consumption, transportation demands and changes in land use (Faqrooq et al., 2019).

Rapid urbanization often leads to increase energy consumption due to the ever-increasing demands for transportation, residential areas and industrial activities. A study analyzing house hold energy consumption across Pakistan recognized Islamabad as having the highest per capita carbon emission, estimated at one ton per year (Hasan et al., 2020). The rapid expansion of urban areas results in development of infrastructures to accommodate the growing population, this leads to increased vehicle usage, contributing to higher carbon

emissions. The reliance on the fossil fuel powered mode of transportation in Islamabad further exacerbated this issue, as city's infrastructure development has not kept pace with the rapid population growth as it was initially designed based on the limited elite population, which now result in traffic congestion and increased emissions.

Moreover, the rapid urban expansion typically involves converting natural landscape into built up areas in cost of green land, reducing area's carbon sequestration capacity (Murtaza et al., 2016). This has happened in major metropolitans of Pakistan including twin city Rawalpindi. Mannan et al., (2021), have examined the urban growth patterns of Islamabad and its twin city Rawalpindi between 1990 and 2020. It has revealed substantial urban expansion with built-up area increasing annually by 26.72 percent in Islamabad, which led to decrease in agriculture land by 1.04 percent per year. This study states that despite of this higher pace of urban growth Islamabad has reserved carbon sequestration capacity of its forests. Its forests experienced an increase in total stored forest carbon from 2779.64 Gg C to 3548.16 Gg C during the given period, which suggests the effective forest management practice Bokhari, et.al (2022), assessed the magnitude and speed of urbanization from 1976 to 2016 and claimed that it has caused environmental degradation in urban areas as during this time span Islamabad has witnessed the exponential population growth causing the peri-urban areas to grow fast than usual. Unicef report (2020), revealed that the unplanned urban expansion has increased the number of slum and underserved settlements in Islamabad, according to the report there are 63 slum areas (Kachi Abadis) which constitute 38 percent of capital's population. The clearing of land for housing and infrastructure in informal settlements can disrupt ecosystem, reduce biodiversity and causes soil erosion and pollution.

Furthermore, rapid urban expansion alters the microclimate of any regions which indirectly contributes to the carbon emissions (Tahir, et al., 2015), study demonstrates that, replacement of natural landscape with built-up environments can lead to increased temperatures and altered rainfall patterns, hence can influence the energy consumption patterns such as increasing demands for air conditioning, thereby contributing to higher carbon emission. Wang, et al., (2020), argued that due the rapid use of land, public spaces and green covers and availability of required resources is limited in cities, and air pollution, poor hygiene, solid waste management and related issues will persist if not planned and managed properly and urgently.

The Government and other international and local organizations have been working on various strategies and efforts to make Islamabad as a sustainable city through certain legislation, but due to over reliance on the already scarce natural resources to meet the demands of ever-growing population, it is difficult for relevant actors/agents to manage it accordingly.

4. Theoretical Framework

To explore the relationship between rapid urbanization and environmental sustainability, the study draws on Urban Ecology theory. Many scholars have made their contributions over the period including Robert E. Park, Ernest W. Burgess, and George E. Hawley. This theory examines the nexus of the human population and the environment. In urban settings, cities are like ecosystems in which infrastructure, environment, roads, buildings, humans, and animals interact with one another, disrupting the green spaces, environmental degradation, and loss of biodiversity.

5. Methodology

This research is conducted using a qualitative methodology. The data was collected from vital informants, including Government Urban planners, environmental experts, academicians, and civil society representatives. The authors collected data through an in-depth interview of 40 critical respondents comprised of Government Urban planners (n=06), environmental experts (n=12), academicians (n=14), and civil society representatives (n=08). The sample size of this research paper is n=15. Purposive sampling techniques are used for this research paper. The interview was conducted through an exploratory questionnaire. The in-depth interview was conducted in Urdu and English. Afterward, the data collected in Urdu was translated into English through Otter. Clarke & Braun (2017) used six thematic analysis phases for this research study. After the translation and transcription, the data was read and reviewed in breadth and depth for familiarization. In the next phase, Coding was accomplished through Delve, and themes were developed as an outcome of the coding. After naming and interpreting the theme, the final analysis is usually regarded as follows.

6. Findings/Data Analysis

Urbanization is the increasing concentration of population in urban areas, is a transformative process shaping economies and societies worldwide, but it often comes at significant environmental cost "(United Nations, 2022). According UN unplanned urbanization can lead to resource depletion, environmental degradation and socio economic inequalities, necessitating a balanced approach to sustainable development. Population growth and unplanned urban expansion have turned Islamabad from planned city to one of the most unplanned cities despite its original blueprint. Degradation of natural resources in Islamabad has emerged as a critical issue, with loss of green space, ground water depletion and extensive deforestation being the most prominent concerns. Deforestation has occurred to accommodate the ever expanding population and major influx that has drastically affected air quality and biodiversity loss. During the interview a respondent expressed concern over environmental degradation, stating:

“Areas declared as national parks are now being used for construction purposes. This shift has resulted in the destruction of critical habitats, causing a significant decline in biodiversity. The encroachment disrupts ecosystems and threatens the survival of various species (Personal communication, Nov 2024).”

Similarly another Participant highlighted concerns over urban expansion in this regard, she stated:

“The green belts are increasingly covered with concrete as rapid construction projects, including roads and flyovers, continued to expand. This urban development driven by the need to accommodate a growing population, has led to a noticeable decrease in Islamabad green cover affecting the city natural environment (personal communication, Nov 2024).”

The loss of green spaces has disrupted the rain cycle, increase urban heat, and affected weather patterns, with deforestation in Margilla Hills reaching alarming rates (Trees that once helped in carbon capture have been removed, contributing to rising pollution levels). The built-up area has increased by 113% in the last six months while illegal settlements are expanding into protected green zones, further exacerbating the issue (personal communication, Dec 2024). An Environmental expert sharing her view on loss of green space disclosed that:

“Green areas have decreased by around 33% in the last six month, highlighting the ongoing tradeoff between environmental preservation and urban expansion. This rapid decline suggests that infrastructure and economic development are taking priority over sustainability, leading to deforestation, habitat loss and environmental degradation (personal communication, Jan 2024).”

Groundwater depletion is another major issue; the city heavily dependence on groundwater has further exacerbated environmental challenges. Rapid depletion of groundwater is being observed, particularly due to horizontal expansion of sectors and societies which leads to over- extraction of groundwater and contamination of natural streams. During an interview session a respondent highlighted the critical issues of groundwater depletion, stating:

“Islamabad is heavily reliant on groundwater for its water supply, but the rapid expansion of sectors and unplanned urbanization has significantly depleted this vital resource. The table is declining at a concerning rate of 1.2 meters per year, threatening the city long term water security and sustainability (personal communication, Dec 2024).”

Similarly a climate justice activist during an interview session emphasized the growing water crisis, stating:

“The contamination of water bodies has become a major concern due to industrial waste disposal, the dumping of untreated waste into open drains and lack of sewage treatment. Additionally, reduced groundwater recharge has further strained water resource, exacerbating water scarcity and deteriorating water quality. These factors pose serious environmental and public health risks, making clean water less accessible and increasing dependency on already depleting groundwater reserves (personal communication, Dec 2024).”

While the deforestation/loss of green spaces, depletion and contamination of water resources pose significant challenges to Islamabad’s environmental sustainability, the city air we breathe tells an equally troubling story. Air pollution and carbon emission have also worsened due to rising traffic and industrial smog. The air pollution is increasing day by day, with reduction of green spaces exacerbating the situation especially during winters. Respiratory issues among residents of twin cities have increased due to smog, which has become a major health hazards during winter. During an interview session, s respondent from local health department emphasized the alarming air quality, stating:

“Factories in I-9, I-10 and Tarnol contribute significantly to carbon emission and the air quality index has reached unbreathable levels and further emphasized that factories burn low-quality fuels, releasing of CO₂, in high amounts, along with other harmful pollutants like SO₂ and NO_x which exacerbate respiratory and cardiovascular health issues among residents (personal communication, Dec 2024).”

The ecological imbalance caused by urbanization has disrupted weather patterns, leading to increased temperatures, urban heat islands effects and extreme weathers events. During an interview a session, a respondent explained the severe weather challenges faced by Islamabad, citing:

“Islamabad is experiencing extreme summers and freezing winters. One such example of unpredictable weather was the cloudburst in sector E-11, Islamabad on July 28, 2021. This unexpected

and intense rainfall caused severe flooding in the area, causing significant damage to infrastructure and resulting in both economic losses and the loss of lives. These extreme weather events are becoming more frequent, raising concerns about climate change and the city's vulnerability to such disasters (personal communication, Oct 2024)."

Such weathers shifts and increased frequency of heat waves are clear indicators of climate change. Due to such conditions, biodiversity loss is becoming another major concern, with habitat destruction and declining species population in Islamabad capital territory. An Environmental expert shared his opinion on growing environmental concerns, stating:

"Islamabad population has doubled since 2004, putting immense pressure on local wildlife populations. He further disclosed that, illegal settlements, industrial growth and rapid expansion of housing societies have worsened habitat destruction, particularly in Margilla Hills. This unchecked urbanization is not only threatening biodiversity but also compromising the natural balance of the region, making it increasingly difficult for wildlife to thrive (Personal communication, Oct 2024)."

The roots of above all issues lies in the urban planning and governance, which have struggled to keep pace with Islamabad's rapid urbanization and development. Urban planning and governance challenges, such as lack of policy enforcement, overlapping of institutional responsibilities, and political interference, have further complicated the situation. An academician, during an interview, stressed the disconnect between policy and action, stating:

"The government has failed to address the environmental challenges because the policies remain on paper with minimal implementation; she noted further that, there is lack of coordination among institutions like CDA, PWD and local government which creates major hurdles in urban planning and governance. This disconnect approach prevents efficient management of resources and hinders progress in addressing environmental issues, leaving the city vulnerable to further deterioration (Personal communication, Nov 2024)."

Similarly, a participant highlighted the negative impact of political interference on policy enforcement, stating:

"Political interference and corruption have also hindered the enforcement of sustainable environmental policies. The respondent explained that political pressures have led to the legalization of illegal settlements, which would otherwise have been demolished. This lack of accountability has worsened the city urbanization issues, making it harder to implement lasting solutions for environmental and land management problems (Personal communication, Jan 2024)."

7. Conclusion and Recommendations

Urbanization is often viewed as a sign of progress; its unchecked acceleration becomes a double edged sword, placing an unsustainable burden on a nation's already scarce resources and its administrative frameworks. Rapid urban expansion disrupts the delicate ecological balance, leading to long term environmental degradation and escalating governance challenges. Over last few decades it has been a pressing challenge faced across the world. Capital of Pakistan is one among the most rapidly growing metropolitans in

the world with 5% growth rate. It results in the deterioration of natural ecosystem of the city such as loss in green cover, biodiversity loss, depletion of groundwater and contamination, deforestation, carbon emission and air pollution with abrupt fluctuating weather patterns. This highlights how critical the situation has become. But it can be handled through taking certain steps at national, local and individual level.

The study reveals several recommendations, to address these challenges, sustainable urban development strategies such as green infrastructure initiatives, Green public transport, and community involvement have been proposed. Investing in more green spaces to absorb carbon emission and improve air quality while emphasizing the need for public private partnership to develop eco-friendly urban spaces. Additionally expanding public transport and promoting electric vehicles were also recommended to reduced traffic congestion and carbon emission.

Community involvement plays a key role in addressing environmental related challenges. Community involvement in decision making process was highlight in the study as essential for sustainable urban development, with focus on awareness campaigns and workshops proposed to educate citizens about environmental challenges and sustainable urban development. In nutshell; without immediate action, the environmental and social consequences of rapid urbanization will continue to worsen, posing long term risks to the Islamabad environmental sustainability.

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