

# SOCIO-ECOLOGICAL ASSESSMENT OF URBANIZATION THROUGH GEOINFORMATICS: A CASE STUDY OF BAHRIA TOWN HOUSING SCHEME-KARACHI-PAKISTAN

Hiba Arif<sup>1</sup>, Lubna Ghazal<sup>1</sup> and Naila Jabeen<sup>2</sup>

<sup>1</sup>Department of Geography, University of Karachi, Karachi-75270, Pakistan

<sup>2</sup>Institute of Environmental Studies, University of Karachi, Karachi-75270, Pakistan

Corresponding author email: [hibaarif.geo@gmail.com](mailto:hibaarif.geo@gmail.com), [lubnag@uok.edu.pk](mailto:lubnag@uok.edu.pk)

---

## ABSTRACT

Urbanization is a worldwide phenomenon that is accelerating in developing countries of South Asia. Karachi, the mega city of Pakistan is confronted with issues related to ill-planned construction and poor infrastructure for municipal services causing various problems. The growing need of the locals for a better standard of living led to the emergence of gated communities in the outskirts of the city; Bahria Town Karachi (BTK), located 30km away from the city center, is the biggest and perfect example of such a newly emerged gated housing societies, launched in 2014. This research paper aimed to assess the Socioeconomic and environmental impacts of BTK on landscape, drainage, agriculture, etc. For this purpose, an environmental index was generated to assess the impacts numerically. The incorporation of remotely sensed data and geo-informatics helped to identify the changes in the landscape in the past decade.

The outcome of the index reveals that Bahria Town Karachi has had detrimental effects on both ecological systems and human interests. The index assigned a total score of -17.544, indicating the severity of these impacts. Ecological parameters were uniformly negatively affected, accumulating a total score of -14.416 out of the overall -17.544. On the other hand, the impacts on human interests were multifaceted, with certain variables showing significant improvement, particularly for high-income groups, while others, especially low-income native people, experienced adverse effects. This exacerbates existing socio-economic disparities within the region. In total, social parameters received a score of -3.128 out of -17.544, reflecting the varied nature of these impacts.

**Keywords:** Urbanization, Gated-communities, Socio-Environmental Impact, Indices, Remote Sensing, Geoinformatics, Bahria Town

---

## INTRODUCTION

The overall population of Pakistan is projected to increase significantly and reach 380 million by 2050 due to the escalating urbanization rate of 3% annually (Malik et al., 2020). Karachi is Pakistan's most densely populated and fastest-growing megacity (Liet et al., 2023), with more than 20 million inhabitants (Census Report, 2023). Urbanization and rapid development frequently adversely affect the environment and local communities, including habitat loss and socio-economic disturbance (Malik and Wahid, 2014). The Pakistan Economic Survey (2021) highlights the country's rapid urbanization, leading to inefficient fossil fuel consumption, traffic congestion, and irregular land use (Raza and Dongsheng, 2023).

Karachi is facing several environmental issues due to urban sprawl. Unplanned congested infrastructure, causing pressure on resources and residential schemes, compelled high-income groups of people to explore new residential areas that are peaceful and comfortable for living. This has led to the emergence of gated communities in the suburbs of all big cities. Compared to the rest of the city, the planning and development in these new high-end communities is highly structured and regulated (Azam, 2020). In these peri-urban areas a quarter of the population already live in squatter settlements, facing mistreatment and forced eviction by commercial organizations for profit. Land acquisition is a common problem, especially at Super-Highway, due to the involvement of various land mafias.

Bahria Town, along with the Malir Development Authority (MDA) and Board of Revenues, are influential agencies in land ownership distribution in Karachi, with Bahria Town being the most dominant beneficiary. Established in the 1990s, Bahria Town has developed several gated communities in different cities such as Rawalpindi, Islamabad, Lahore, and Karachi, among them, Bahria Town Karachi being the largest, covering an area of 16,000 hectares. Despite promises to prioritize local communities, Bahria Town forcefully acquired land from them at low prices. This study aims to examine the challenges faced by affected locals and the impacts of development projects on the environment.

Bahria Town Karachi (BTK) is an example of a major development project facing scrutiny for its environmental and social consequences. As cities expand into natural areas, evaluating and comprehending the impacts to guide

sustainable development strategies is crucial. MDA and board revenue work behind the scenes to facilitate Bahria town development. Through political influence, the land owned by villagers for a century was purchased. Bahria Town Karachi projects began after the government bought land at a nominal price. Consequently, forests, rich farmland, and drainage systems are occupied, which can lead to substantial ecological disasters (Nazir and Yousuf, 2021).

Bahria Town Karachi is one of many new housing societies emerging on the fringes of Karachi. This research underscores the significant impacts these developments can have on the surrounding environment and the potential to exacerbate socio-economic disparities. It highlights the key parameters that must be considered when initiating any new project and demonstrates how geo-informatics can be effectively employed to evaluate these impacts. Additionally, the research offers a practical set of criteria that researchers can utilize and adapt for assessing various parameters.

## LITERATURE REVIEW

Over the past 20 years, Pakistan's energy consumption has increased due to population increase and urbanization, across several industries, resulting in increased ecological danger due to carbon dioxide (CO<sub>2</sub>) emissions (Raza *et al.*, 2021a). Climate change is caused by increased concentrations of atmospheric greenhouse gases (GHGs) (Raza *et al.*, 2021b)

In the '8th International Conference on Karachi' at the Institute of Business Administration (IBA), Hassan discussed Karachi's unplanned growth, highlighting the loss of 15,000 mangroves and 2,800 villages and the destruction of agriculture due to the extraction of 60 billion cubic feet of sand and gravel for construction (Hasan, 2020a; Hasan, 2020b.)

Karachi has been experiencing growth in the core areas and the city's outskirts (Kugelman, 2014). Urban planning failure has led to extensive conversion of rural lands to urban areas, causing agricultural loss and intensifying flooding (Kleemann *et al.*, 2017).

Urban expansion in the Central, South, East, and newly emerging Malir districts was notable from 1990 to 2020, with Malir, West, and Keamari experiencing the fastest growth. Predictions indicate the urban built-up area will grow from 584.78 km<sup>2</sup> in 2020 to 652.59 km<sup>2</sup> by 2030, marking a significant suburban expansion of 111.6% compared to 2020 (Baqa *et al.*, 2021).

The economic divide in Pakistan has increased so much that in the current economy, the middle class has shrunk to only a small fragment (Ibrahim, 2018). As of 2016, 35% of the population lived below the critical poverty line. The Constitution of Pakistan dictates basic rights (such as free healthcare and primary education) for all "The Constitution of the Islamic Republic of Pakistan", 1973; Mahmood and Shaukat, 2006). However, "Private" hospitals and schools have increased the perception of separate standardization for basic needs (Talpur and Hussain, 2023).

The expansion of gated communities, which started in the 1990s, has now become a common feature in most cities (Wang and Pojani, 2020). According to the literature, the five main causes of the development of gated communities are increased crime rates, a desire for a better lifestyle, a sense of community, social homogeneity, and higher social status (Roitman, 2010). However,

Gated developments have emerged in Lebanon, South Africa, Saudi Arabia, Southeast Asia, and Phoenix, Arizona, providing privacy, identity, and a professional-class lifestyle. In major metropolitan areas, 50% of new residential development is associated with the community, highlighting its prevalence (Nagle, 2017; Jurgens and Gnad, 2002; Glasze and Alkhayyal, 2002; Chris Webster and Klaus Frantz, 2002; Franzese and Siegel, 2007)

In Pakistan, gated communities are associated with an 'ideal' standard of living. Bahria Town Karachi has exaggerated the perception of public and private amenities. Bahria town has its own identity, being secluded from Karachi, which is only accessible via the Super-Highway. Gated community initiation can leave thousands homeless and disrupt income, while the land remains uninhabited for years before being used for a living (Imtiaz, 2019).

Bahria Town is grappling with land acquisition controversies, with locals being illegally seized with political backing, often facing ill-priced land and police harassment (Zaman and Ali, 2016). Most indigenous communities were farmers by occupation, and most of the land destroyed was fertile and legally sanctioned as agricultural land in 1953 and 1958 (Imtiaz, 2018; Hassan, 2016).

In 2018, the Supreme Court declared land acquired by BTK illegal (Riaz, 2018; Kamran, 2018), citing political influence in rural areas like Gadap. BTK's registration forms became more valuable than indigenous farmers' legitimate land papers (Hasan and Arif, 2018a).

In 2013, the Sindh court banned the government from allocating government land to private developers. However, the board of revenue transferred 43 dehs authority to the Malir Development Authority, claiming to have paid 25% of the market price. The Supreme Court observed in 2018 that the Malir Development Authority illegally

transferred 9,140 acres to Bahria Town, leading to a verdict. However, in 2019, the court accepted compensation of 460 billion Pakistani rupees over seven years. The All-Parties Conference (APC) accuses the Supreme Court of wrongdoing in Bahria Town, demanding compensation according to the market value and withdrawal of 500 FIRs against villagers (Ali and Syed, 2016)

A 2021 survey by Humaira Nazir found that villagers were being forced out of their homes due to illegal land acquisition, while residents of Bahria town Karachi were less concerned. Real estate developers found the development legal and paid landowners a large amount (Humaira Nazir, 2021).

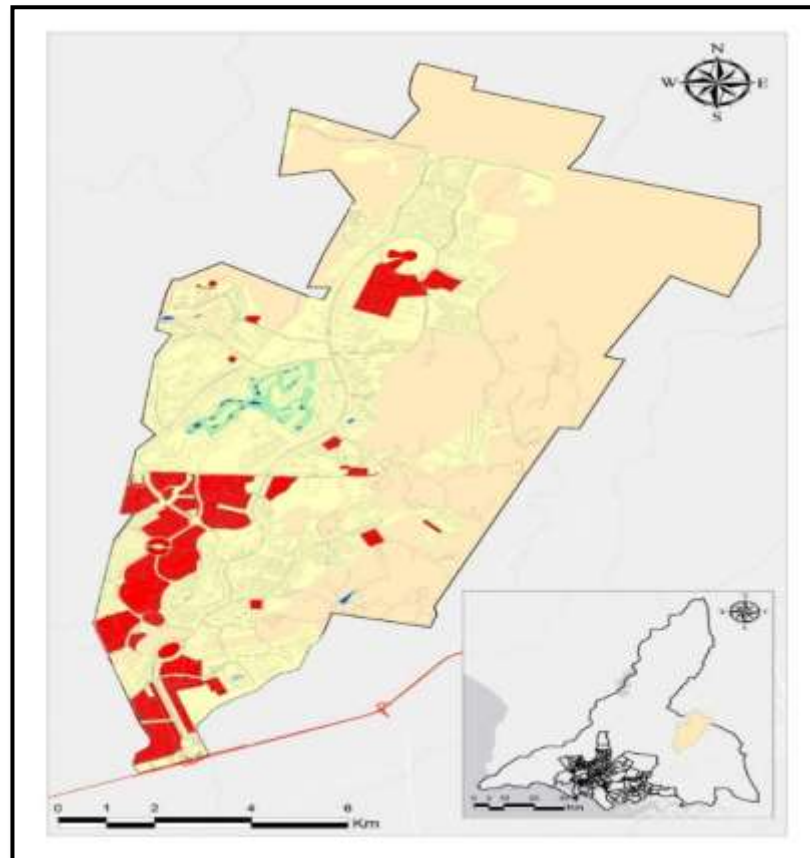
The development of Bahria Town Karachi has impacted 40 villages, leading to resistance and retaliation since its launch in 2014 (Memon and Fatima, 2022).

The Sindh Indigenous Rights Alliance was started with the alleged illegal occupation of villagers' land in 2015. The Sindh Indigenous Rights Alliance reports that only 10% of villagers have sold their land in the affected area, with Bahria Town Karachi occupying over 40,000 acres, accusing BTK of crackdowns against indigenous communities (Anwar, 2018).

Urban sprawl in Karachi has led to ecosystem degradation and hydrology destruction, with agricultural land covering 14% of the streambed and urban area increasing from 1993 to 2015. The once-fertile landscapes, rocky and dotted with perennial streams, have been leveled to meet the demands of commercialization (Somaiyah Hafeez, 2021). Urban expansion in Karachi is increasing flash floods, causing land buildup, and disrupting groundwater recharge. Bahria Town's encroachment on riverbeds exacerbates these issues, posing a significant environmental crisis (Zafar, 2018).

### STUDY AREA

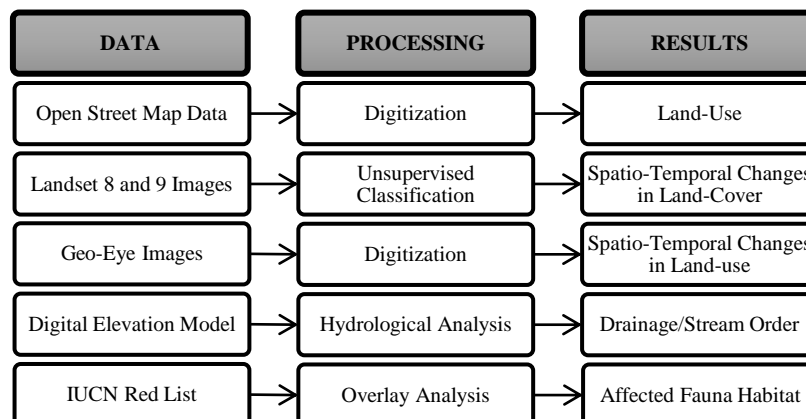
Bahria Town Karachi, a privately owned gated community, is in the suburbs of Karachi (**Figure1**). The project launched in 2014 and is currently in its construction stage. All the basic amenities, such as residential, commercial, and health care, have facilitated it. The project, costing around \$1 billion and covering 45,000 acres, is expected to house around one million people. However, controversies have arisen from villagers in Gadap and Kathore who fear land takeover (Deol, 2021).



**Fig.1. Study Area Bahria Town Karachi**

## METHODOLOGY

Fig 2. Methodological framework.



Our research aimed to assess the environmental and socio-economic impacts of Bahria Town Karachi. To achieve this, we created a simple environmental index to monitor the spatial-temporal changes of various parameters affecting the area. This index assigns numeric values to these changes. This approach allows for the comparison of multi-faceted impacts and the calculation of a cumulative value representing the overall effect of all parameters.

Primary and secondary data were utilized in this project. Primary data, including resident interviews and photographs, were gathered during the field survey. The secondary data encompassed a wide range, from satellite images to published reports. This data underwent further processing and analysis using ArcMap and Google Earth Pro (Figure 2).

### Land-Use

The data obtained from the OSM website was imported and converted into a feature dataset using the OpenStreetMap toolbox in ArcMap. After conversion, the dataset was meticulously edited using high-resolution imagery to rectify any inaccuracies. Subsequently, this data was incorporated into the map layouts.

### Spatio-Temporal Changes in Land-Use

GeoEye satellite images, accessed through Google Earth Pro, with high spatial resolution, facilitated the identification of spatio-temporal changes in land-use, such as alterations in agricultural land, increases in impervious surfaces, and changes in topography.

### Spatio-Temporal Changes in Land Cover

Landsat 8 and 9 imageries, obtained from the United States Geological Survey (USGS) and NASA Goddard Space Flight Center, underwent unsupervised classification to ascertain spatio-temporal changes in bare land, vegetation, and built-up land.

### Adversely Affected Fauna Habitat

To assess the impact on fauna habitats, the International Union for Conservation of Nature (IUCN) Red List was employed to identify concerned species habitat that overlapping the area occupied by Bahria town Karachi. The IUCN categorizes species into six classifications based on their conservation status: Least Concern, Vulnerable, Endangered, Critically Endangered, Nearly Extinct, and Extinct. Our study excluded habitats of species classified as Least Concern from the analysis.

### Stream Order

High-resolution elevation data from Google Earth Pro was utilized after conducting interpolation to generate a surface. Subsequently, various hydrological analyses were performed in ArcMap to determine stream order.

### Final Index

All findings were compiled into an index to evaluate the impact of Bahria Town Karachi. Using various criteria, points were assigned to different parameters based on their degree of impact.

The final index was assessed by following formula:

$$EIV = \sum_{i=1}^n (Vi)Wi$$

Where

EIV = Environmental Impact Value

$V_i$  = Relative change of the environmental quality of parameters

$W_i$  = Relative importance or weight of parameter

N = Total number of environmental parameters

Detailed parameters and their criteria are provided in **Table 1**.

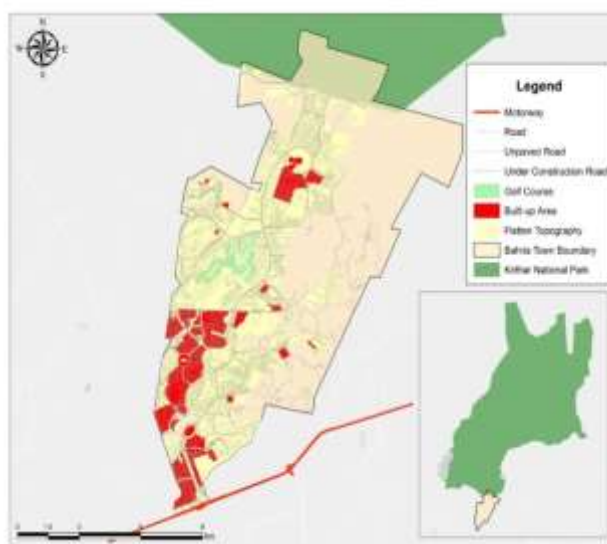
**Table 1.** Detailed parameters and their criteria

Parameters	EIV Criterion
1. National Park, 2. Natural Topography 3. Regional Hydrology, 4. Bare Land 5. Agricultural Land 6. Primed Residential and Commercial Land	Adversely impacted each 10% = -1 Improved 10% = +1
1. Concerned Fauna Habitat 2. Indigenous settlement 3. Under Construction Facilities	10 adversely impacted = -1 Improved 10 = +1
1. Historical Sites 2. Developed Facilities	5 sites adversely impacted = -1 Improved 5 = +1
1. Developed Residential and Commercial Infrastructure	Improved 5% = +1

## RESULTS AND DISCUSSION

### Kirthar National Park

Certain sections of Bahria Town Karachi are situated within the globally acknowledged conservation areas of Hub National Park and Kirthar National Park (Humaira Nazir, 2021). Map **Figure 3** illustrates that 0.21% of the Kirthar National Park area, equivalent to 8.66 km<sup>2</sup>, now lies within the jurisdiction of Bahria Town which is 0.64% of the total area of Bahria Town. According to the index method, a deduction of -1 point is given for each 10% of the negatively impacted region, causing a deduction of -0.064 points in the final index.



**Fig.3.** Encroachment of Kirthar National Park

### Concerned Fauna Habitat

The establishment of Bahria Town has reduced available habitats for wildlife species, primarily due to the conversion of previously vacant lands. Our study excluded habitats of species classified as Least Concern from the analysis. A minimum score of -1 mark is assigned in our index for every 10 adversely affected habitats. Our research identified the overlap of Bahria Town with the habitats of 14 fauna species, which used to be previously found in this area, resulting in a cumulative deduction of -2.8 marks (**Table 2**).

**Table 2.** Affected Status of Fauna Species due to BTK

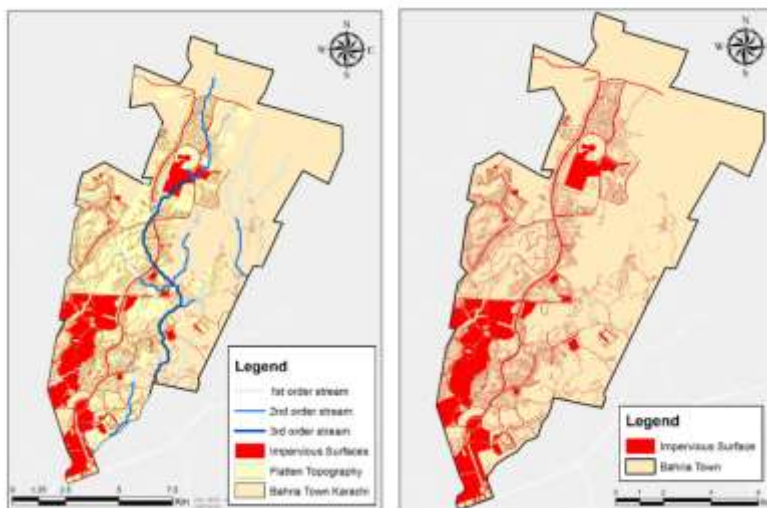
S no	Common Name	Bionomial Name	Status	Point
1	Common pochard	Aythya ferina	Vulnerable	-0.1
2	Eastern imperial eagle	Aquila heliaca	Vulnerable	-0.1
3	Egyptian vulture	Neophron percnopterus	Endangered	-0.1
4	Greater spotted eagle	Clanga clanga	Vulnerable	-0.1
5	Indian pangolin	Manis crassicaudata	Endangered	-0.1
6	Indian pangolin	Bagarius yarrelli	Endangered	-0.1
7	Indian soft-shell turtle	Nilssoniana gangetica	Endangered	-0.1
8	Leopard	Panthera pardus	Vulnerable	-0.1
9	Lesser florican	Sypheotides indicus	Critical	-0.1
10	Marbled duck	Marmarometta angustirostris	Vulnerable	-0.1
11	Red-headed vulture	Sarcogyps calvus	Critical	-0.1
12	Saker falcon	Falco cherrug	Endangered	-0.1
13	Sociable lapwing	Vanellus gregarius	Critical	-0.1
14	White-rumped vulture	Gyps bengalensis files	Critical	-0.1
<b>Cumulative points assigned to adversely impacted fauna habitat</b>				<b>-1.4</b>

### Aesthetic Features

The Bahria development in Karachi has improved the area's aesthetic appeal by incorporating diverse plant species, enhancing the visual appeal, and implementing green parks and roundabouts to augment the overall scenic quality, earning it a +2 rating in the index.

### Terrain

Bahria Town Karachi has been implicated in the alteration and degradation of the natural terrain and stream beds within its vicinity, as illustrated in **Figures 4 and 5** which depict that a substantial area of 69 km<sup>2</sup>, constituting more than fifty percent (50.8%) of the entire land area, has been flattened for obtaining the plain terrain for ease in the construction process at low cost. This deliberate reshaping of the topography has multifaceted detrimental consequences. In order to quantify the extent of topographic alteration, our index allocates a negative one -1 point for each 10% of flattened terrain. As a result, the cumulative score in the computed index amounts to -5.08 points.



**Fig. 4.** Flatten topography in BTK (a), Impermeable surfaces in BTK (b)

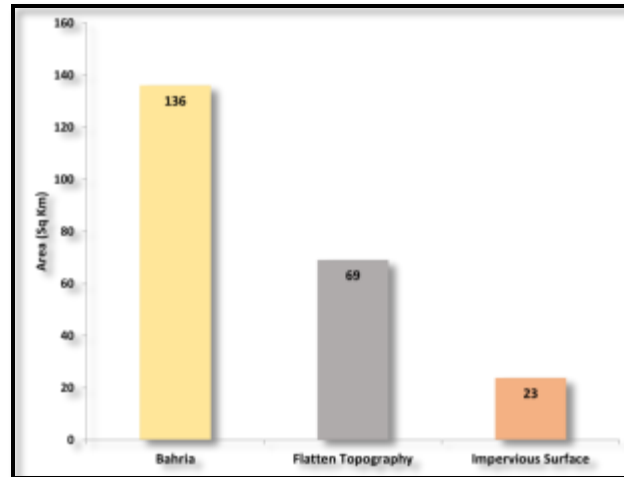


Fig.5.Alteration in BTK terrain

### Hydrology

The rapid urbanization of Karachi is expected to increase the frequency and severity of flash floods within the region. Alterations in the natural drainage patterns adversely affect the ecology and the well-being of local communities. Bahria town is also involved in extracting gravel and sandstone from riverbeds for construction purposes, as well as extensive topographic leveling coupled with blocking rainwater channels, leading to groundwater depletion. Additionally, Bahria Town's implementation of deeper tube wells than those in surrounding villages to cater to the project's water demands exacerbates groundwater depletion, leading to water scarcity and potential drought in the rural peripheries of Karachi, having a detrimental impact on agriculture (Humaira Nazir, 2021).

The hydrological landscape of the area has been severely compromised by Bahria Town's interventions, indicating that 23 km<sup>2</sup>, constituting 17.5% of the total area, has been transformed into impervious surfaces. This transformation intensifies groundwater depletion and contributes to Karachi's urban core flash floods. Recognizing the two major adverse effects of increased impervious surfaces leading to 1) Groundwater Depletion and 2) Flash Floods, a weighted approach was employed to account for their significance (Figures 4a, 6, and 7). Consequently, a 17.5% change in impervious surfaces would typically warrant a -1.75 point deduction in the index, with the applied weight of 2, a total of -3.5 points are assigned in the final index.

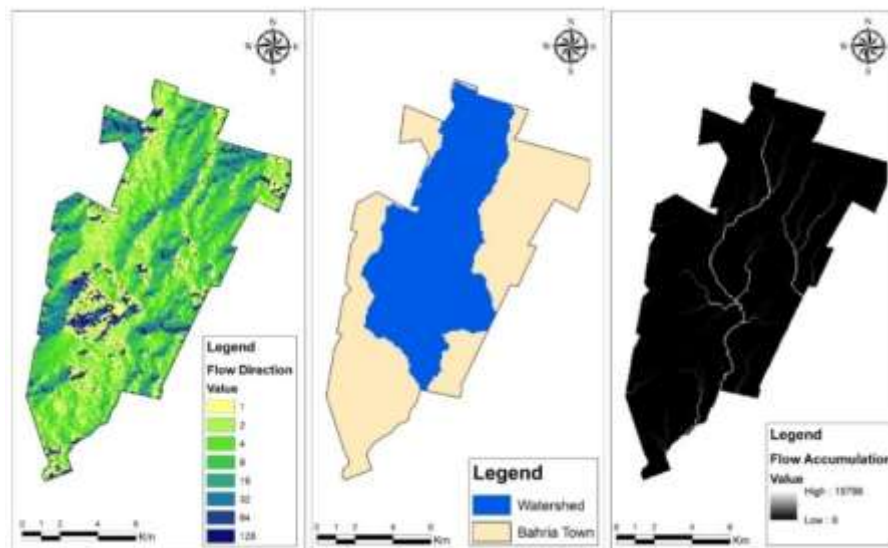


Fig.6.Hydrological Analysis of BT

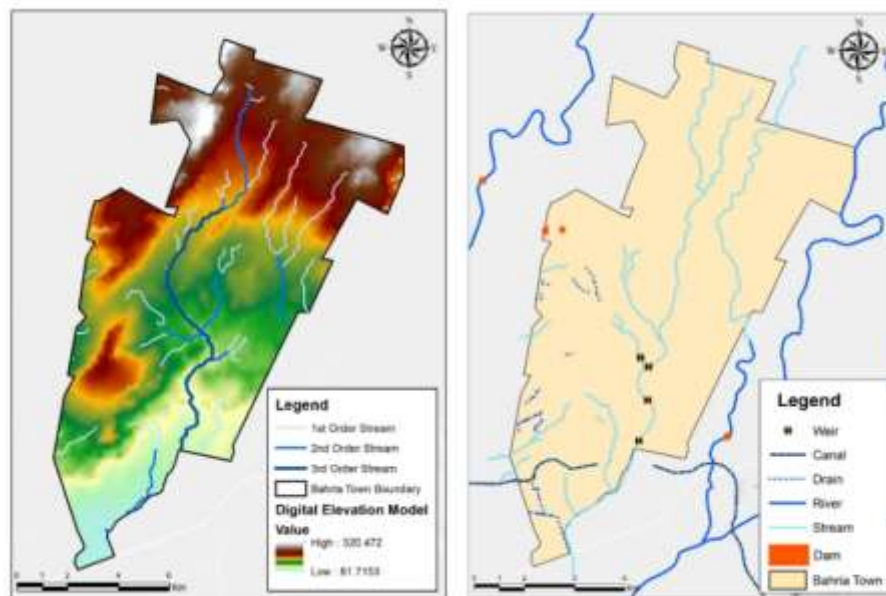


Fig.7. Surface and drainage of the Study Area

### OpenBare Land

The development of Bahria Town has led to a decrease in the extent of bare land inside the vicinity, which has been largely replaced by built-up land. Bare soil plays a crucial role in recharging groundwater levels through percolation. **Figure 8** indicates that after the construction of Bahria Town Karachi, a decline in bare land area has been observed from 93.79 km<sup>2</sup> to 62.16 km<sup>2</sup>, a 33.72 % decrease. Consequently, the index assigned a -3.372 point to denote this reduction in bare soil, reflecting its impact on groundwater recharge dynamics.

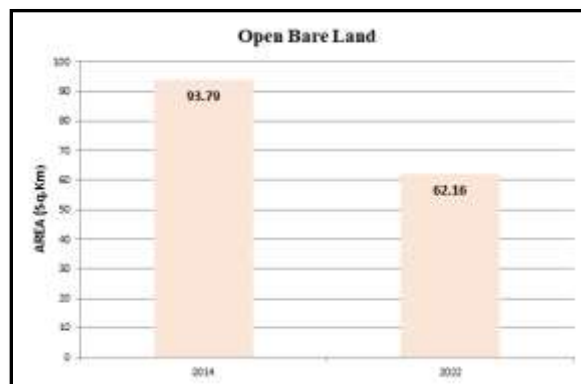


Fig.8. Decline in bare open land

### Pollution

The 30-kilometer distance between Bahria Town and Karachi is expected to increase vehicular dependency and fuel consumption, leading to increased air and noise pollution (Humaira Nazir, 2021). To account for the pollution emanating from vehicles, a deduction of -1 mark is assigned. Additionally, Bahria Town proposed two electricity generation power plants (Mirza, 2015), which would have exacerbated environmental degradation and raised health concerns. The negative ramifications of these proposed power plants would have justified a deduction of -2 marks in the index. However, due to the market crash, construction is halted. Therefore, no deduction is allocated in the index for this aspect.



**Agricultural Land**

The construction of Bahria Town in Karachi has negatively impacted agricultural land and ecosystems, significantly reducing the production of vegetables and fruits. Historically, Karachi’s peri-urban land was reserved for agriculture. It was famous for its variety in fruit production since the 70s. In the valley of Malir fruits like (Guava, Mango, Mulberry, Papaya and Bananas) and vegetables such as (Brinjal, Tomatoes, Spinach, Pumpkin, Okra etc) were significantly produced (Ghazal *et al.*, 2013 and 2015).

Disrupted local hydrology, depleted groundwater, and affected neighboring villages. An immense decline in these fruits and vegetable production is evident due to scarcity of lowering in the groundwater table, thus negatively affecting the income of the native population. The agricultural land has also been severely reduced, from 17.10 km<sup>2</sup> in 2014 prior to the Bahria Town’s construction to 5.51 km<sup>2</sup> in 2022, with a tremendous decline of 67.78% (Figures 9 and 10). Consequently, -6.778 points are assigned to highlight the severe impact on agricultural areas due to the construction of Bahria Town.

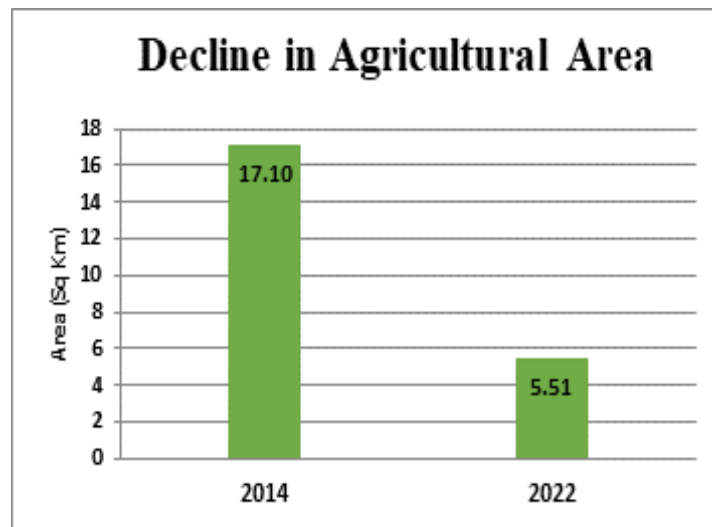


Fig.9. Temporal changes in agricultural land

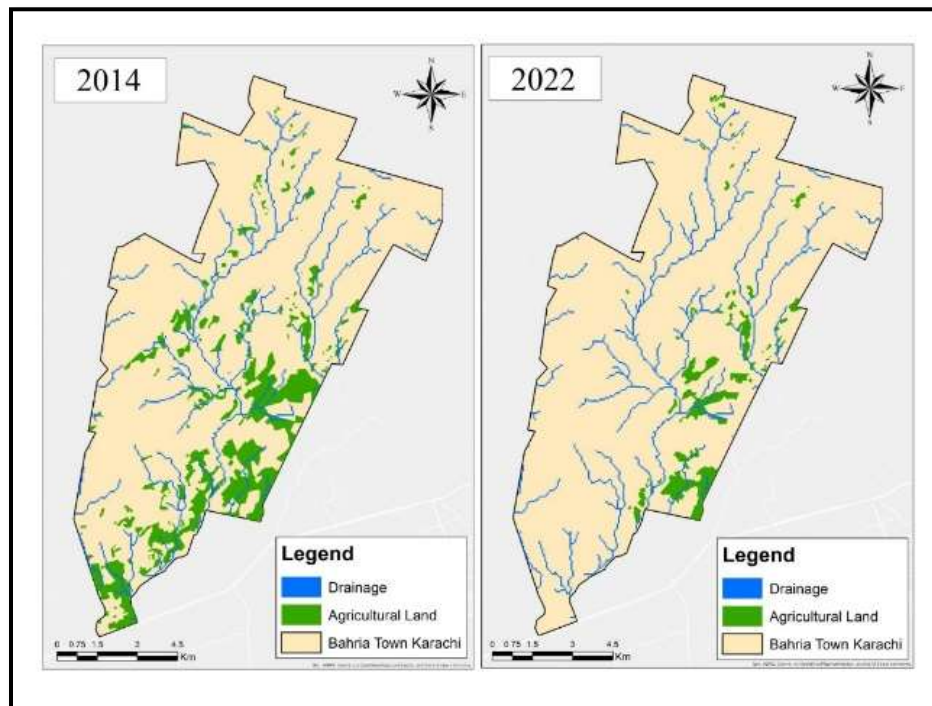


Fig.10. Spatio-temporal changes in agricultural land

### Impact on Indigenous Former Settlement

Bahria Town Karachi bears responsibility for the displacement of villages that existed in the area prior to the initiation of the project. These forced displacements have provoked numerous conflicts and social tensions, fostering distrust among the indigenous communities towards the authorities. Numerous prior studies have shed light on this contentious issue. Existing research, including data from previous studies, was incorporated into our research index.

According to Ali (2016), eight to nine villages have been completely demolished to make way for the project. Hasan and Arif (2018b) reported that residents from 45 villages are being compelled to abandon their properties. Additionally, Humaira Nazir (2021) estimated that approximately 45 villages in the vicinity of Bahria Town Karachi will eventually be directly or indirectly impacted by the project's expansion.

In the index, a deduction of -1 point is allocated for every 10 villages adversely affected by Bahria Town's construction. Consequently, for the displacement of communities, a total of -4.5 points are assigned in the index.

### Historical Sites

The area designated for constructing Bahria Town Karachi has a rich archaeological history, spanning over 500–600 years of continuous habitation. Regrettably, the development of Bahria Town has led to the bulldozing of several heritage sites, with each tomb callously uprooted by heavy machinery and disregarded like discarded debris. The destruction of these sites symbolizes the clash between cultural heritage and modern development, raising questions about preserving historical sanctity in the face of urban expansion (Zaman and Nazisha, 2016).

The extent of the destruction of archaeological sites was estimated using the data from previous reports. In the final index, a deduction of -1 mark is attributed to every five historical sites destroyed due to the construction of Bahria Town Karachi. While official records are lacking, historians concurrently identify four types of demolished historical sites: Buddhist stupas, ancient graveyards, temples, and shrines (Somaiyah Hafeez, 2021; Humaira Nazir, 2021). Conservatively estimated, a minimum of six sites have been lost to the relentless development, warranting a deduction of -1.2 points in the final index.

### Residential Infrastructure

Bahria Town Karachi is anticipated to accommodate over 1 million residents (Qureshi *et al.*, 2021); the National Accountability Bureau reported that as of March 2016, Bahria Town had already sold at least 104,000 plots. Bahria Town's master plan allocates 36% of its land for residential purposes (Qureshi *et al.*, 2023).

Utilizing Google Earth imagery, the developed and leveled areas were delineated, identifying 10.66 km<sup>2</sup> of land has undergone construction, while 58.54 km<sup>2</sup> has been leveled and outfitted with roads, potentially earmarked for plot development. In our index, 1 point is assigned for every 5% of developed land designated for residential purposes. Similarly, 1 point is assigned for every 10% of leveled land intended for residential use, as represented in **Table 1**.

**Table 3.** The score assigned to residential infrastructure

	Total Area (sq.km)	Residential Area sq.km (36 % of Total Area)	% of Residential Area (sq.km)	Point
Developed Area	10.66	3.84	2.82	0.56
Sites Primed for Development	58.54	21.07	15.50	1.55
<b>The cumulative score assigned to a residential area</b>				<b>2.11</b>

It was determined that only 3.84 km<sup>2</sup> of land had been developed for residential purposes, constituting a mere 2.82% of the total area of Bahria Town. Consequently, 0.56 points are assigned for this category. Meanwhile, 21.07 km<sup>2</sup> of land has been leveled and equipped with roads (**Table 3**).

### Commercial Infrastructure

Bahria Town Karachi has significantly expanded commercial opportunities within the region. The master plan of Bahria Town designates 16% of its land for commercial purposes (Qureshi *et al.*, 2023). High-resolution 51cm Geoeye Google Earth imagery was utilized to demarcate the built-up and leveled areas. This analysis identified that 10.66 km<sup>2</sup> land has undergone construction, while 58.54 km<sup>2</sup> has been leveled for the construction of roads (**Figure 11**).

In our indexing approach, 1 point is allotted for every 5% of developed land designated for commercial purposes, and likewise, 1 point is assigned for every 10% of leveled land intended for commercial use. Considering that commercial usage accounts for 16% of the area according to Bahria Town's master plan (Qureshi *et al.*, 2023), our analysis focused exclusively on this portion.

**Table 4. The score assigned to commercial infrastructure**

	Total Area (sq.km)	Commercial Area sq.km (16 % of Total Area)	% of Commercial Area (sq.km)	Allotted Score for Index
Developed Area	10.66	1.71	1.25	0.25
Sites Primed for Development	58.54	9.37	6.89	0.69
<b>The cumulative score assigned to the commercial aspect</b>				<b>0.94</b>

The findings revealed that only 1.71 km<sup>2</sup> of land has been developed commercially, constituting a mere 1.25% of the Bahria Town area. Consequently, 0.25 points were allocated for this category. Meanwhile, 9.37 km<sup>2</sup> of land has been leveled and prepared with roads, representing 6.89% of the total area, and was assigned 0.69 points for this aspect. Cumulatively, commercial development garners a total of 0.94 points in the final index, reflecting the progress in this domain within Bahria Town Karachi (**Table 4**).

**Service Facilities**

Bahria Town Karachi introduced essential services like hospitals and universities, transforming the region. However, the full potential of these facilities is not enjoyed/obtained, due to several factors. Much of Bahria Town remains uninhabited, and the elevated costs deter many indigenous villagers living outside Bahria Town. Moreover, individuals residing in the main urban area of Karachi find these services less accessible due to the considerable distance (Bahria Town, 2024).

In our indexing methodology, 5 completed facilities are allocated 1 point, while 10 under-construction facilities are also assigned 1 point. **Table 5** provides a comprehensive list of all the facilities considered in this study and their corresponding score. The results reveal a cumulative of 3.3 points assigned to facilities in the final index.

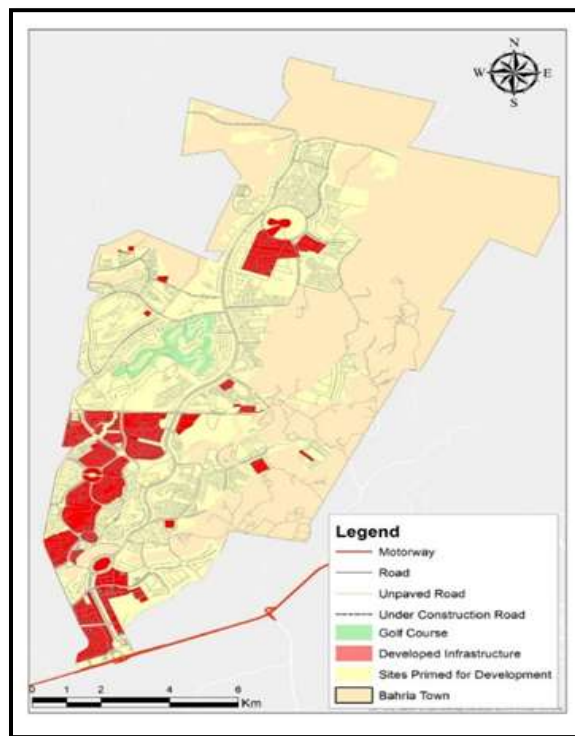


Fig. 11. Bahria town Karachi land use

**Table5.**The score assigned to facilities

Types of Facilities	Facilities	Status	AllottedScore
Educational	Schools	Completed	0.2
	Colleges	Completed	0.2
	Universities	Completed	0.2
Health Care	Hospital	Completed	0.2
Sports	Swimming Pool	Under Construction	0.1
	Badmintoncourts	Under Construction	0.1
	Squashcomplex	Under Construction	0.1
	Tennis courts	Under Construction	0.1
	Gymnasiums	Under Construction	0.1
	Cricket Academy	Under Construction	0.1
	Rafi Cricket Stadium	Under Construction	0.1
Leisure	Amusement Park	Completed	0.2
	Safari Parks	Completed	0.2
	Golf Course	Completed	0.2
	Zoo	Completed	0.2
	F1 Mini Racecourse	Completed	0.2
	Carnival area	Completed	0.2
Hospitality	Restaurants	Completed	0.2
	Cafe	Completed	0.2
Religious	Grand Jamia Mosque	Completed	0.2
<b>Cumulative score assigned to facilities</b>			<b>3.3</b>

### Overall Environmental Impacts

The Ecological Assessment of BT revealed a significant negative impact on various ecological parameters. The impact has caused ecological degradation, lowered groundwater levels, and soil depletion. Physico-chemical factors such as hydrology, flooding, and pollution compound the negative impact. The damage has adversely affected agricultural lands, indigenous settlements, historical sites, and conflicts. Despite some positive indicators, the overall Environmental Impact Value is -17.544 , as shown in **Table 6**. The environmental analysis of the current study emphasizing the need for immediate action and comprehensive mitigation measures for future residential schemes.

**Table6. Cumulative environmental score index.**

Parameters	Degree of Impact	Criterion	Allotted Score
National Park	0.64% adversely impacted	10% = -1	-0.064
Concerned Fauna Habitat	14 adversely impacted	10 = -1	-1.4
Natural Topography	50.8% adversely impacted	10% = -1	-5.08
Regional Hydrology	17.5% adversely impacted	10% = -1 (2 weighted)	-3.5
Bare Land	33.72% adversely impacted	10% = -1	-3.372
Pollution	Adversely impacted	--	-1
Agricultural Land	67.78% adversely impacted	10% = -1	-6.778
Indigenous settlement	45 adversely impacted	10 = -1	-4.5
Historical Sites	Minimum 6 adversely impacted	5 = -1	-1.2
Developed Residential Infrastructure	Increased 2.82%	5% = -1	1.56
Primed Residential Land	Increased 15.5%	10% = -1	1.55
Developed Commercial Infrastructure	Increased 1.25%	5% = -1	0.25
Primed Commercial Land	Increased 6.89%	10% = -1	0.69
Developed Facilities	Introduce 13 new facilities	5 = 1	2.6
Under Construction Facilities	Introduce 7 new facilities	10 = 1	0.7
Landscape Beautification	Notable Improvement	--	2
<b>Cumulative Environmental ScoreMatrix</b>			<b>-17.544</b>

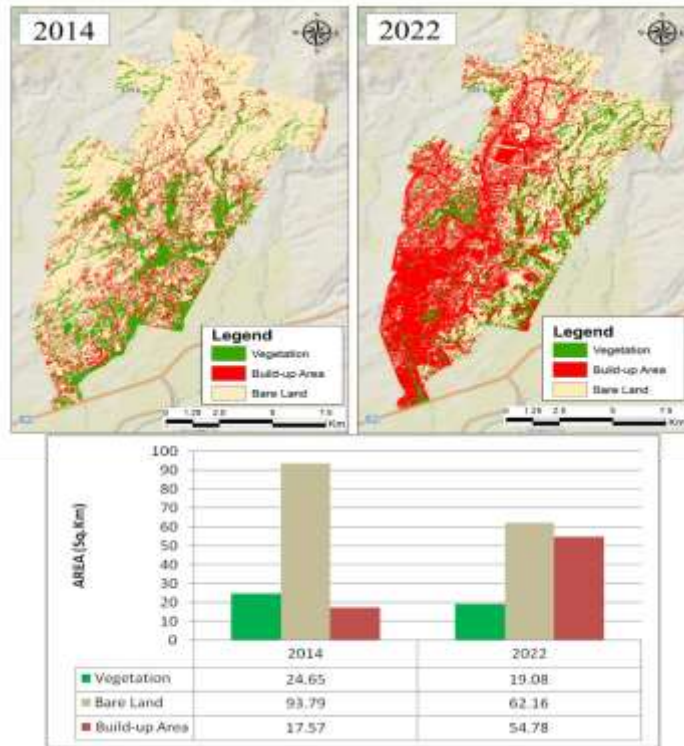


Fig. 12. Transformation of Land Cover and Land Use (2014-2022)

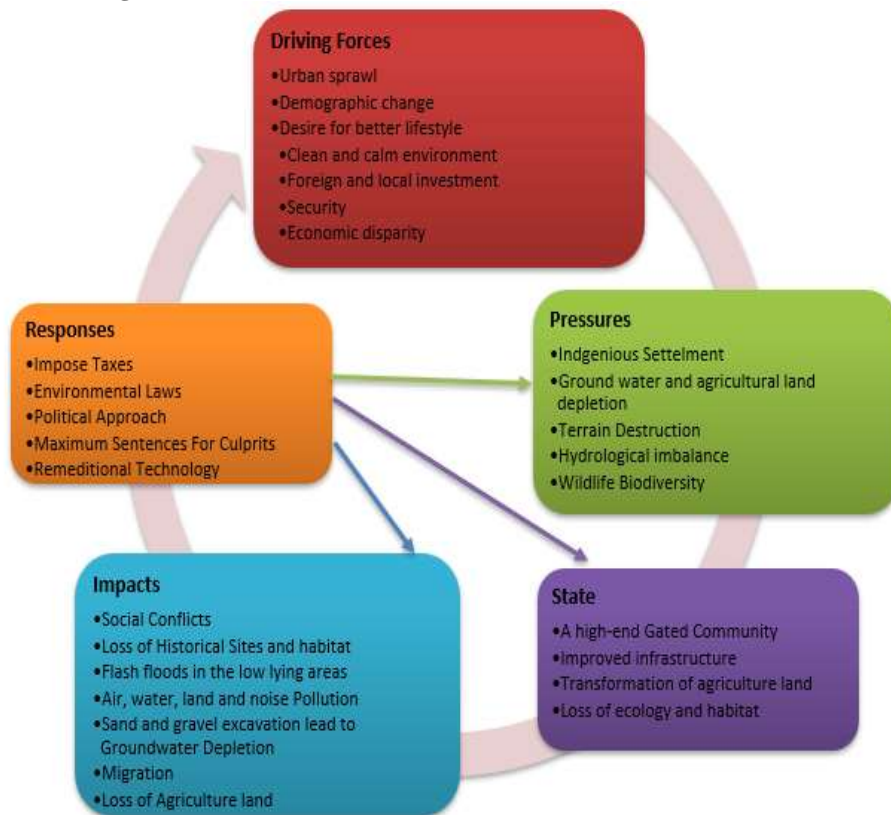


Fig.13. DPSIR Model

### **Transformation of Arable Land and change in Land use and land cover**

Between 2014 and 2022, the BT region saw significant changes in land cover. The vegetation area shrank from 24.65 km<sup>2</sup> to 19.08 km<sup>2</sup>, while built-up areas grew from 17.57 km<sup>2</sup> to 54.78 km<sup>2</sup> (Figure 12). The decline in vegetation may be due to urbanization, land use changes, or deforestation, while urban expansion could be driven by population growth or infrastructure projects. Sustainable land management is crucial to balance development and environmental conservation amidst these changes.

### **DPSIR Model**

The study also aimed to identify the drivers, pressures, states, impacts, and responses (DPSIR) to improve sustainability, reduce negative effects, and highlight the most important areas for revising land-use and built regulations. To achieve this, the author developed the DPSIR model by analyzing the project's relevant impacts and reviewing key literature patterns.

### **Conclusion**

The emergence of Bahria Town Karachi has colossal and adverse effects on ecology and human interests. The most severe consequence of ecology is the massive scaleflattening of natural topography, accounting for over 50% of the total area. Contrary to its purported focus on human interests, the evidence suggests a different narrative. The adverse impact on agriculture is significant, with a staggering 67.78% of farmland destroyed as a result of development, leading to a net negative score of -6.778 out of a total of -17.544. This decimation strikes at the livelihoods of indigenous communities and exacerbates socio-economic disparities.

Human interest indicators further accentuate disparities among socioeconomic classes, with positive scores predominantly favoring high-income individuals enjoying the perks of new residential and commercial areas replete with various amenities. Conversely, indigenous communities, already marginalized, bear the greatest burden of this project. Bahria Town Karachi's actions, stripping indigenous groups of basic rights, have escalated conflicts, fostering animosity not only towards development itself but also towards politicians, law enforcement, and the judicial system, perceived as complicit in their betrayal, exacerbating social tensions.

The aftermath is visible in the displacement of villagers and loss of homes and livelihoods, prompting migration towards the main Karachi urban area. This unintended consequence directly contradicts Bahria Town Karachi's purported objectives, amplifying population pressures. In the face of such egregious violations, decisive action is imperative in light of these dire circumstances, a resolute response from the judiciary is imperative. The authorities must hold the perpetrators accountable, with stringent legal action and enforcing existing laws without leniency. Concurrently, systemic flaws that facilitated the construction of Bahria Town Karachi must be identified and rectified to prevent future transgressions.

Crucially, the plight of displaced villagers demands immediate attention; they must be justly compensated for their losses and provided with resettlement options. Additionally, any further expansion of Bahria Town Karachi should be halted to prevent further ecological devastation and socio-economic upheaval. Implementing robust mitigation measures for ecological destruction is equally vital, marking a comprehensive approach to rectify the multifaceted issues stemming from this project. Only through concerted and decisive action can the adverse impacts of Bahria Town Karachi be mitigated, ensuring the preservation of both ecology and human welfare.

### **Limitations:**

1. Socio-Economic Parameters: For certain socio-economic impacts, such as those on indigenous settlements, historical sites, and facilities, geo-informatics technologies could not be utilized. Consequently, the research relied on previous studies and news articles, which may provided limited and outdated indformation
2. Residential and Commercial Utilization: Evaluating the residential and commercial aspects of Bahria Town Karachi (BTK) would have been more accurate if based on the number of residents and employees, rather than merely assessing the increase in infrastructure. This approach would have provided a more precise reflection of the socio-economic dynamics within the area. However, due to the unavailability of relevant data, the research had to rely solely on the increase in residential and commercial infrastructure as a proxy measure.
3. Environmental Parameters: In assessing spatio-temporal changes in environmental parameters, digitization was primarily employed to identify changes in the area. However, for changes involving bare soil, digitization was not feasible. Instead, unsupervised classification was performed, which may yield results that differ from those obtained using other parameters. This methodological discrepancy could introduce variability in the findings.

**Future Recommendations:**

The development of Bahria Town Karachi commenced without a proper Environmental Impact Assessment (EIA), with the EIA being conducted only during the construction stages. As a result, many adverse impacts could not be effectively mitigated. The research findings indicate that Bahria Town Karachi has had numerous negative effects on the ecology and has exacerbated socio-economic disparities. To avoid such issues in the future, it is crucial that EIAs are performed prior to the initiation of any project, especially of big magnitude.

Additionally, this research provides a comprehensive framework for assessing multifaceted parameters that may impact any project. This framework can be adopted to evaluate other new housing societies rapidly emerging on the outskirts of Karachi.

**REFERENCES**

- Ahmad, J. Q. and S. M. Zafar (1973). *The constitution of the Islamic Republic of Pakistan*.
- AID.Slaev, I. N. (2013). Factors of Urban Sprawl In: Bulgaria. *Spatium International Reviews*, 22-
- Aleksandar, D. and I. N.Slaev (2013). Factors of Urban Sprawl in Bulgaria. *Spatium International Reviews*, 22-29.
- Ali, F. Z. and N. Syed (2016). Bahria Town Karachi: Greed Unlimited. *DAWN. COM, April*, p. 18.
- Anwar, N. (2018). Receding rurality, booming periphery. *Economic and Political Weekly*, 53(12): 46–54.
- Azam, O. (2020). Karachi has been sprawling in total absence of urban planning: Arif Hasan, *The News International*.
- Bahria Town Karachi. (2022).Bahria Town.2024 accessed on 8, March 2024 Retrieved from <https://bahriatown.com/bahria-town-karachi/>
- Baqa, M. F., F. Chen, L. Lu, S. Qureshi, A. Tariq, S. Wang and Q. Li (2021). Monitoring and modeling the patterns and trends of urban growth using urban sprawl matrix and CA Markov model: A case study of Karachi, Pakistan. *Land*, 10(7):, 700..
- Chris Webster, G. G. and Klaus Frantz (2002). The global spread of gated communities. *Environment and Planning*, 29: 315 - 320.
- Deol, T. (2021). Why Pakistan’s opposition is calling this Karachi housing project ‘modern form of colonialism’. *The Print*.
- Franzese, P. A. and S. Siegel (2007). Trust and community: The common interest community as metaphor and paradox. *Mo. L. Rev.*, 72: 1111.
- Ghazal, L., J. H. Kazmi and S. Zubair (2015). Monitoring and Mapping Spatio-Periodic Dynamics of Vegetation Cover in Karachi Using Geoinformatics. *International Journal of Biology and Biotechnology*, 12(4): 621-627.
- Ghazal, L., S. J. H. Kazmi and S. Afsar (2013). Spatial appraisal of the impacts of drought on agricultural patterns in Karachi. *Journal of Basic and Applied Sciences*, 9: 352-360.
- Glasze, G., and A. Alkhayyal (2002). Gated housing estates in the Arab world: case studies in Lebanon and Riyadh, Saudi Arabia. *Environment and Planning B: Planning and Design*, 29(3): 321-336.
- Hasan, A. (2020a). *What I have learnt in 45 years about urban planning of Karachi through participation, voyeurism, disillusionment, love, hope and affection*. Paper presented at the 8th International Conference on Karachi, IBA University, Karachi.
- Hasan, A. (2020b). The changing nature of informal settlements in the megapolis in South Asia: the case of Karachi, Pakistan. *Communities, land and social innovation*, 91-108.
- Hasan, A. and H. Arif (2018). Pakistan: Urban Housing Issues. Available from: <https://arifhasan.org/wp-content/uploads/2018/08/PakistanUrbanHousingIssues180905.pdf> [Last accessed: May5, 2024].
- Hasan, A. and H. Arif (2018). Pakistan: the causes and repercussions of the housing crisis. IIED Working Paper, IIED, London. <https://www.iied.org/10864iied>
- Hasan, S. (2016). Projects like Bahria Town are ‘atom bombs’ for the poor. Retrieved from <https://www.dawn.com/news/1258793>
- Humaira Nazir, M. S. Y. (2021). Bahria town Karachi: A case study in urban development. *Journal of research in architecture and planning*, 30(1), 51-61.
- Imtiaz, S. (2018). Suburbanisation and Class Disparity: Deciphering How the Economic Gap Narrates Lifestyle.
- Imtiaz, S. (2019). Suburbanisation and Class Disparity: Deciphering How the Economic Gap Narrates Lifestyle.
- Jurgens, U. and M. Gnad (2002). Gated communities in South Africa experiences from Johannesburg. *Environment and Planning B: Planning and Design*, 29(3): 337-353.
- Kamran, R. (2018). Significant Portion of Bahria Town Karachi Declared Illegal, Banks Stop Accepting Instalments. Retrieved from <https://propakistani.pk/2018/12/12/bahria-town-karachideclared-illegal-banks-stop-accepting-installments/>

- Kleemann, J., J. N. Inkoom, M. Thiel, S. Shankar, S. Lautenbach and C. Fürst (2017). Peri-urban land use pattern and its relation to land use planning in Ghana, West Africa. *Landscape and Urban Planning*, 165:, 280-294.
- Kugelman, M. (2014). Understanding Pakistan's unstoppable urbanization. *Pakistan's runaway urbanization: What can be done, 1*.
- Li, Cai, Sania Khan, Noman Sahito, Muhammad Yousif Mangi, and Wadi B. Alonazi (2023). Examining the informal urban growth trends in a Port city. *Heliyon* 9 (12).
- Mahmood, S. and N. Shaukat (2006). *The Constitution of the Islamic Republic of Pakistan, 1973*. Legal Research Centre.
- Malik, S. and J. Wahid (2014). Rapid urbanization: Problems and challenges for adequate housing in Pakistan.
- Malik, S., Roosli, R., Tariq, F., and Yusof, N. A. (2020). Policy framework and institutional arrangements: Case of affordable housing delivery for low-income groups in Punjab, Pakistan. *Housing Policy Debate*, 30(2), 243-268.
- Mallick, U. (2022). Residents oppose Malir Expressway project at Environmental Impact Assessment hearing, *Dawn*.
- Memon, A., and Fatima, U. A Review Analysis of Impacts on Local Communities by the Development of Bahria Town Karachi.
- Mirza, J. (2015). "K-Electric, Bahria Town to develop LNG, coal-fired power plants" Retrieved from The News International <https://www.thenews.com.pk/print/28228-k-electric-bahria-town-to-develop-lng-coal-fired-power-plants>
- Nagle, J. (2017). Ghosts, memory, and the right to the divided city: Resisting amnesia in Beirut city centre. *Antipode*, 49(1), 149-168.
- Nazir, H., and Yousuf, M. S. (2021). Bahria Town Karachi: A Case Study in Urban Development. *Journal of Research in Architecture and Planning*, 30(1), 51-61.
- Qureshi, Nadia, and Yue Li. 2021. "Bahria Towns: A Case Study of Private Cities in Pakistan." Background paper, Private Cities: Outstanding Examples from Developing Countries and Their Implications for Urban Policy, World Bank, Washington, DC.
- Qureshi, Nadia, and Yue Li. 2023 "Pakistan: Bahria Town Karachi". Private Cities: Outstanding Examples from Developing Countries and Their Implications for Urban Policy.
- Raza, M. Y., & Dongsheng, L. I. (2023). Analysis of energy-related CO2 emissions in Pakistan: carbon source and carbon damage decomposition analysis. *Environmental Science and Pollution Research*, 30(49), 107598-107610.
- Raza, M. Y., Khan, A. N., Khan, N. A., & Kakar, A. (2021). The role of food crop production, agriculture value added, electricity consumption, forest covered area, and forest production on CO 2 emissions: Insights from a developing economy. *Environmental Monitoring and Assessment*, 193, 1-16.
- Raza, M. Y., Wang, X., & Lin, B. (2021). Economic progress with better technology, energy security, and ecological sustainability in Pakistan. *Sustainable Energy Technologies and Assessments*, 44, 100966.
- Riaz, M. (2018). The "Untouchable" Malik Riaz. Retrieved from
- Roitman, S. (2010). Gated communities: definitions, causes and consequences. *Urban Design and Planning*, 163, 31-38.
- Somaiyah Hafeez, Z. M. (2021, 8 July 2021). The battle over Bahria town Karachi, *The Diplomat*.
- Talpur, M. A. H. and G. Hussain (2023). Analysis of the Gap Between Existing and Required Facilities of Health and Education in District Tharparker. *GUMAN*, 6(4), 319-327.
- Wang, H. and D. Pojani (2020). The challenge of opening up gated communities in Shanghai. *Journal of Urban Design*, 25(4), 505-522.
- Zafar, S. (2018). Impact of New Urban Schemes on Natural streams of Karachi.
- Zaman, F. and N. Ali (2016). Bahria Town Karachi: Greed unlimited. [online] dawn. com.
- Zaman, F. and S.A. Nazisha (2016). Bahria Town Karachi: Greed unlimited. Retrieved from Dawn <https://www.dawn.com/news/1252809>

(Accepted for publication June 2024)