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Sustainable Architecture(s) – Humane Cities

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EDITOR:
Dr. Rama Subrahmanian

EXECUTIVE EDITOR:
Eric An

COPYEDITOR:
Amany Marey

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INTRODUCTION

Online Education: Teaching in a Time of Change

This special issue publication comes from the international symposium organized by AMPs with Dayananda Sagar Institutions, Bangalore in March 2022. The event was premised on the following call: In 2015, the year that the Indian government launched its 100 Smart Cities Mission, the United Nations published its 17 Sustainable Development Goals including the goal of "Making cities and human settlements inclusive, safe, resilient and sustainable". The Smart Cities Mission follows patterns of development undoubtedly spearheaded by the Global North. By contrast, sustainable development goals can be seen as predominately relevant to the Global South, which the UN projects suggests will be home to over 80% of the world's megacities by 2030. In the context of the Covid-19 pandemic, each of these agendas is in the process of revision.

The problems faced by these cities will be enormous: the health and wellbeing of inhabitants; the housing of rural migrants; balancing formal planning with incremental and informal design; dealing with environmental vulnerability; addressing social equity. They are all, already, issues that are both critical and subject to extensive debate. The World Health Organisation sees the notion of the 'healthy city' as already changed forever. Ananya Roy sees informality as a product of economic regulation, whether in Mexico, Egypt, India or Indonesia. Aromar Revi critiques the integration of the rural and the urban through the lens of sustainability and the notion of the rurban.

In bringing sustainability into the debate about healthy, equitable and humane urban development Revi opens a view onto questions of colonialism. Sustainability and public health have a conflicted history in the Global South where the march of economic development and agendas of public wellbeing and environmental protection often clash. Indeed, they have led to spatial practices such as uncontrolled density, 'public safety' zoning and gentrification that force the poor into cramped living conditions, unsanitary housing, flood plain areas and more.

The problem is complicated more when we consider those cites of the Global South that mimic architectural and developmental practices of the North. Yasser Elshehtawy has coined the term Dubaization. He suggests that the race to construct tall buildings in the Middle East threatens the identity of cities from Bangalore to Cairo. In the Middle East and North African region this push towards the fast-paced commercial development of 'global cities' is particularly challenging. The arid and semi-arid environments of these places make them vulnerable to climate change and drought and, in the long term, unhealthy, unsafe and totally uninhabitable.

Dr. Rama Subrahmanian

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URBAN WATERSHEDS – POLITICAL OWNERSHIP OF LAND AND CHANGING PERCEPTION OF WATER, A STUDY OF HYDERABAD'S LAKES

Author:
SAMYUKTA RAMAN

Affiliation:
JNAFA UNIVERSITY, INDIA

INTRODUCTION

The Deccan plateau in the southern part of India is endowed with a terrain of sheet rock that allows for little percolation of precipitation. This results in quick draining of rainwater into the closest river or stream due to the natural slopes. To practice agriculture in this region, inhabitants erected bunds to store surface water for irrigation and non-potable purposes. Such structures are called "tanks" and are common across the region. With the advent of urbanisation, these tanks have suffered maximum encroachment due to their man-made nature and irrigational purpose. This paper looks at three main water bodies of the city

1. The Musi river- the principal stream in the urban drainage of Hyderabad
2. The Hussain Sagar lake
3. The Himayat and Osman Sagar artificial reservoirs

To understand the changed relationship between the water body and the urbanized settlement around it and to establish the purposes the water body serves in the urban context in order to help frame guidelines for development around urban watersheds

Study structure

The study has been divided into 2 main parts-

- The image of the waterbody- environmental function, socio-cultural perception and economic value
- The political forces that control the land around the water body- local, market and even global forces

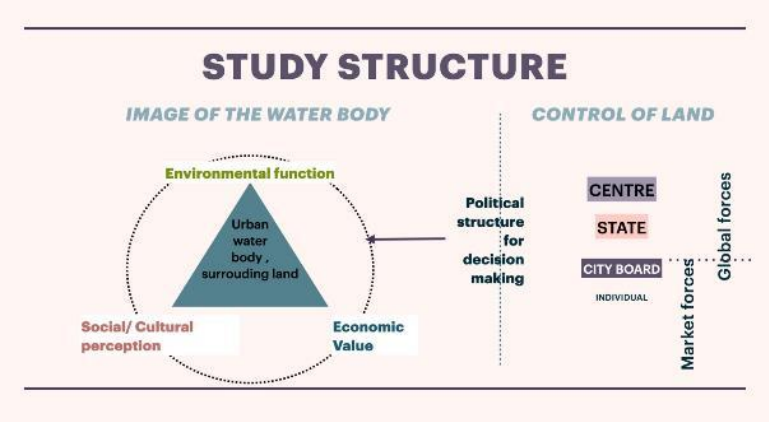

Figure 1. Study structure

HYDERABAD AND ITS WATER BODIES

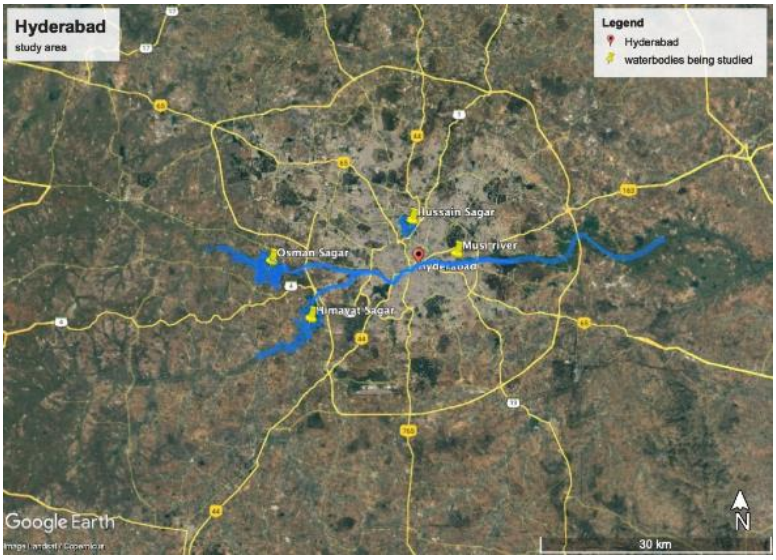

Figure 2. Water bodies in the study

The City of Hyderabad as per the latest Municipal development plan is spread over 7257 sqkm.[1] The Hyderabad Municipal development authority has notified 2446 water bodies[2] within this area as lakes. The city had its nucleus at the Golconda fort, North of the Musi River. When the city required expansion beyond the walls, the new city was laid out in the south banks of River Musi in 1591 with Charminar at its core.[3]

Thus, the Musi, with settlements both to the North and South of it became the first central water feature of Hyderabad city.

After the great Musi floods of 1908, when the river wreaked havoc on half the population, further development was shifted north towards the empty lands around Hussain sagar lake close to the railway lines in that area. Thus, the Hussain sagar watershed became the heart of development from the railway phase in 1890 till 1990 when the Cyberabad area was established.

Today, as Hyderabad continues to expand, the reservoirs Himayat Sagar and Osman Sagar and their protected catchment area is being considered for expansion. The International airport along with road connectivity to it existing in close proximity to the lakes is making the catchment area prime for

urbanisation. This paper shall examine the case for undertaking such a development and propose some approaches based on the lessons learnt from the Musi and Hussain sagar watersheds.
The aim of this paper is to detail out the scale of the economic and political forces at play while trying to understand the stakeholders in this development of land in watersheds.

WATER BODIES

Musi river- till 1908

Socio- cultural perception:

Musi, like most other Indian rivers carried a spiritual meaning. It was alive in the minds of the people through the ghats which were used by the Hindus for rituals and worship. The Muslims used it during the Muharrum procession for washing of their alams.[4]

Geographic character of the Musi watershed:

The watershed upstream of Hyderabad is characterized by rocky terrain and sparse forest cover resulting in rapid run off. [5]

Role of tanks:

Due to the rocky terrain, bunds were constructed across the surface to store water from the streams. These lake like water bodies were called Tanks to differentiate them from natural lakes. These tanks provided water for drinking, water and irrigation.They also served as preventive measures against flooding.[6]

The Watershed area of the Musi was populated by multiple tanks big and small which served to control the flow of the river and provide water for everyday use. The tanks and the river were an interconnected whole.

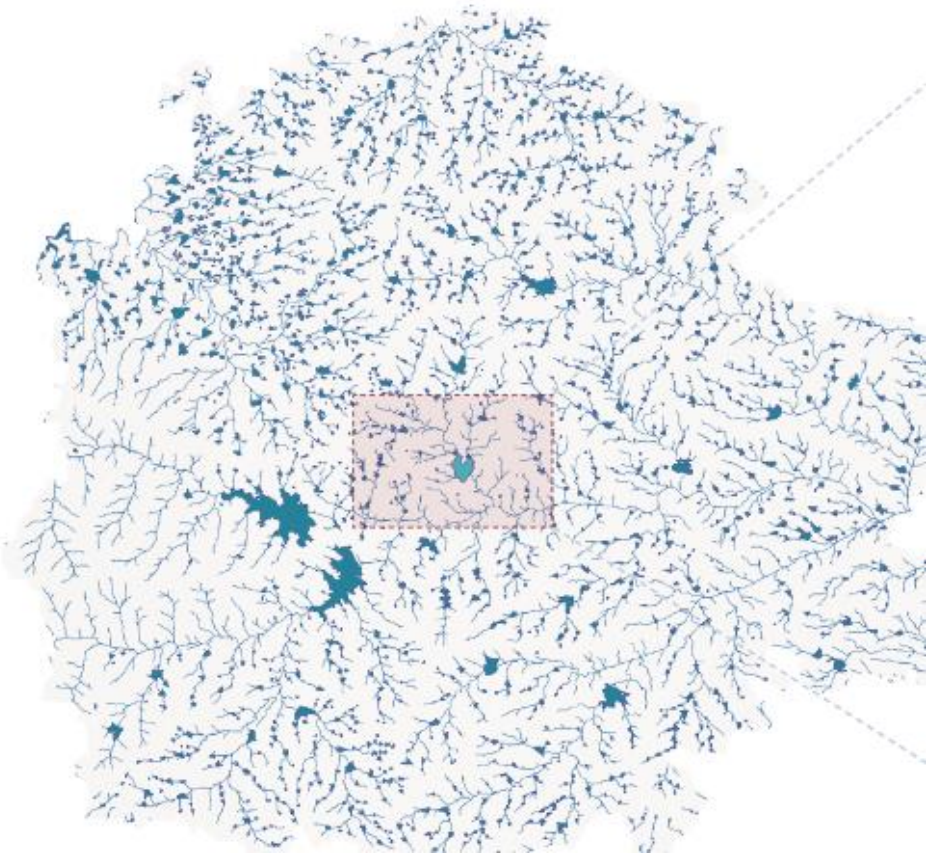

Figure 3. tanks in the watershed, pc WRI India

Floods of 1908:

The deluge of 28th September 1908 is a watershed moment in Hyderabad's modern history. In the 48 hours leading to the final flood, the Watershed of Musi received close to 1m of rainfall.[7]

The tanks on both Esa, a tributary of Musi and those on the Musi River breached. Esa River had 182 of 579 tanks breach and for the Musi the figure was 39 of 160.[8]

Political reactions and decisions:

Immediate reaction: As the Hindu majority perceived the river as a goddess, priests advised the king to offer a plate of offerings to the river goddess to calm her angry waters. It is said in popular folklore that half an hour after the Nizam waded into the floodwaters and placed the pooja plate in the waters, the waters receded[9]. Although the immediate reaction was determined by popular perception, the Nizam sought a more Scientific long-term solution in keeping with the spirit of the times

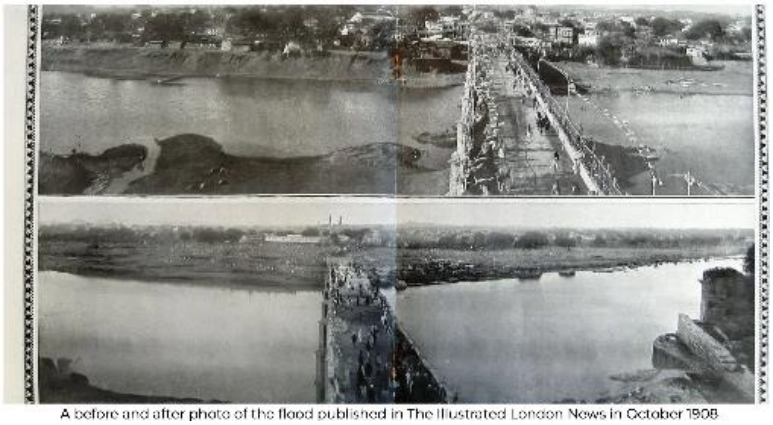

Figure 4. the Musi banks showing extent of damage after the floods

Long term relief: Sir Visvesaraya, a prominent member of the Indian Engineering Services and the then Dewan of Mysore was invited to study and provide solutions to prevent any future flooding of the city. He proposed two large flood balance reservoirs, Himayat and Osman Sagar which covered about 3561 Hectares of Land was proposed. These reservoirs situated above the height of the city could provide drinking water in the dry season, flood control during rains and water for irrigation through the year. Thus were born the first water bodies which personified scientific purpose and marked a distinct change in popular perception regarding water bodies.

Sir Visveraya's report also brought a new stakeholder in the development of the city, the Planner **[10].** The development of Land also took on a more Scientific spirit replacing the previous attitudes tempered by accepted Cultural norms between the rulers and the ruled.

Impact on the tanks + river system: The river that was regarded as a potent goddess became a water body tamed by the scientifically constructed reservoirs. Other minor tanks also lost their significance as a means of flood control. They were now significant only if they provided water for irrigation.

Hyderabad 1915-1996: Scientific spirit in developing land and water

Cities post industrialisation became engines of the economy and rational planning was a means to take care of two important factors of production

Land had to be judiciously used based on economic value, environmental feasibility and separating conflicting land uses

Well-being of labour is ensured by creating adequate housing, water supply and disposal of waste away from the city

The City Improvement Board was founded in 1912[11] with the mandate of creating a healthy habitat for the people. This period marks the early attempts at "creating land" by draining water bodies. "Large areas near the Hussain Sagar and Mir Alam tanks and swampy water-bodies like Mir Jumla, Afzal Sagar and Masaheba tanks were drained and converted to parks. The combined area of these new parks was roughly 3175 acres. Smaller parks, play- grounds and maidans (arenas) were included even within the closely built walled city" [12]

A new economic base was also required to catapult Hyderabad from a medieval provincial city to a Modern city on par with the colonial cities like Madras(Chennai) and Bombay(Mumbai). A 120 acre area to the east of the Hussain sagar lake was earmarked as The Azamgadh Industrial area.[13] in 1930. Interestingly, the Hussain Sagar lake had served as a source of water supply to the city up till this point.[14] Following the success of this Industrial area, a second cluster was set up to the north west of the Hussain Sagar lake along the railway line called the Sanath nagar Industrial area. The railway line, these two industrial areas and the attached workers housing resulted in intense development of land in the watershed of the Hussain sagar which continued to remain the central point of development till the 1990s.

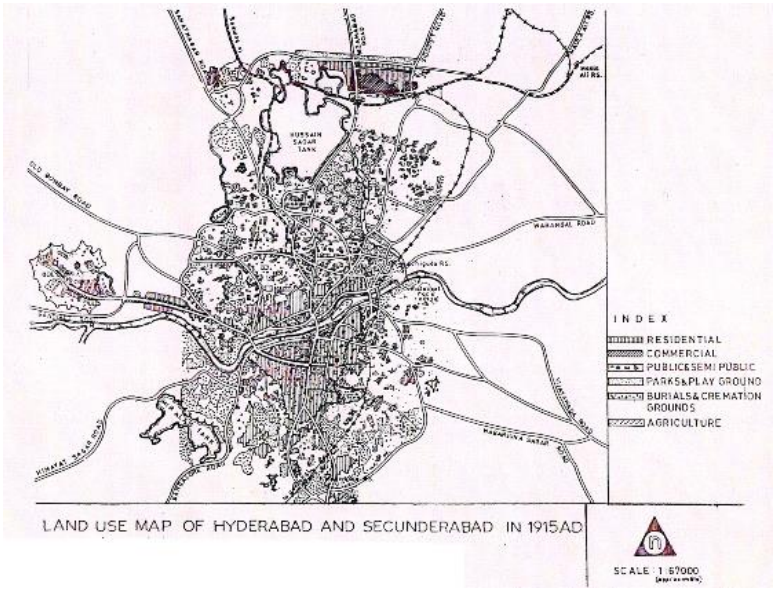

Figure 5. map indicating extent of the city by City Improvement Board

Hussain Sagar Lake

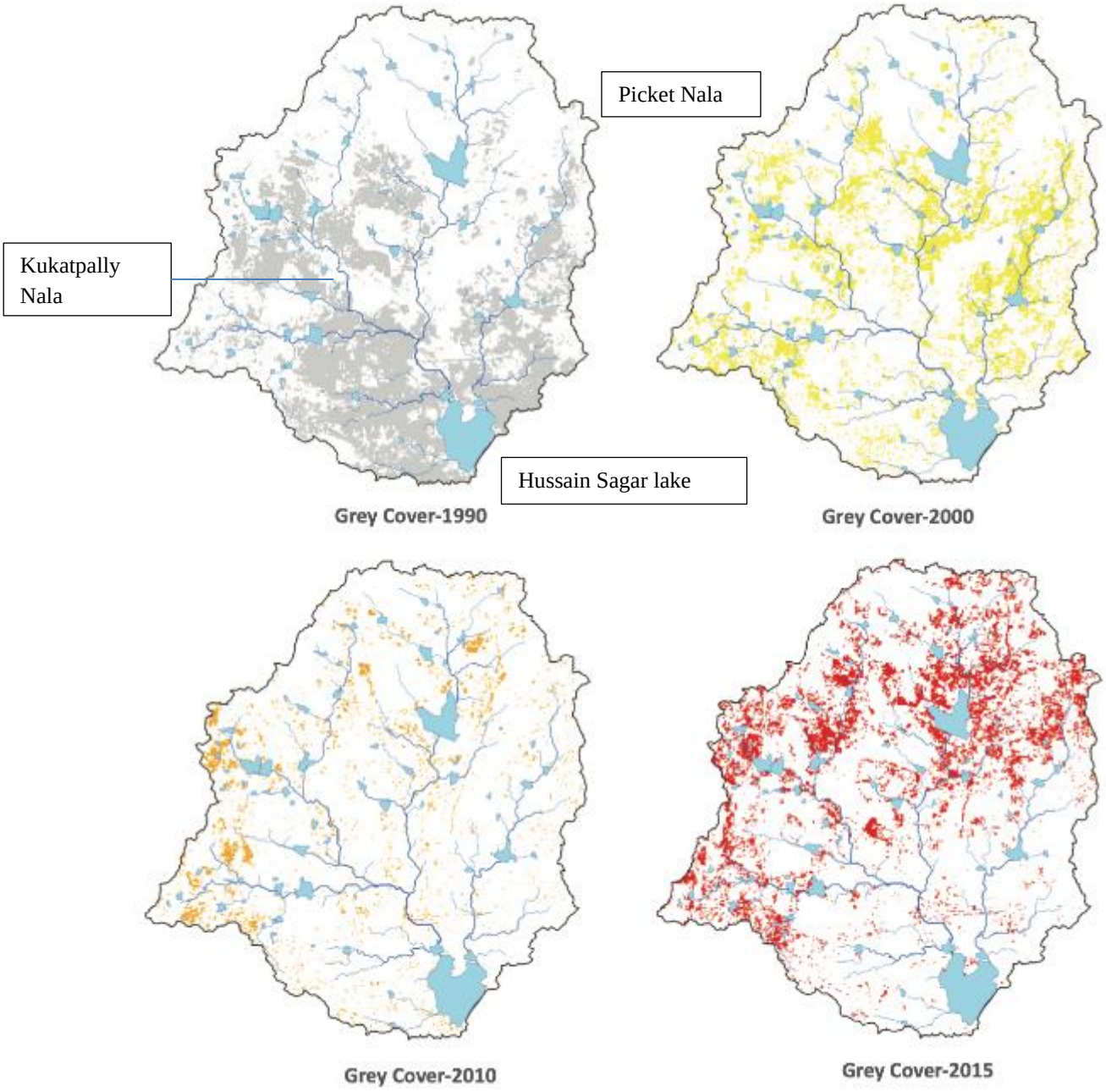

Figure 6. Watershed of Hussain Sagar lake courtesy WRI India

With the industrialization of the land around the lake, the water stopped being used for drinking water supply and the industries dumped their effluents into the streams upstream of the lake. However, as the city expanded, the Hussain Sagar watershed went from an Industrial Suburb to an Urban Area. In the Urban context, the lake area took on new meaning as a Public Space in the imagination of the people. In response to the 'Save the lake campaign', a civil society initiative in 1990 and subsequent judicial interventions, the State Government initiated a comprehensive programme for protection and

conservation of the lake. Further, the Japan Bank for International Cooperation (JBIC) funded Hussain Sagar lake and catchment area improvement project, steps were proposed to improve the environmental status of the lake ecosystem.[15] The state also set up the Buddha Purnima Project Authority in the Hussain Sagar watershed to implement programs for improving lake quality.
Stakeholders- Citizens, State government, Planning Authority
Issues raised by citizens- Environmental quality, Public Space quality
Criticism of initiatives- The Lake was treated as a standalone water body while ignoring residential development in its watershed area. The floods of 2000 which were a result of breaching of the Hussain Sagar Lake was a direct result of the uncontrolled concretization of the watershed area. Apart from being a valued public space, the report by the Geological Survey of India to the then government in 2000 highlights the importance of removal of encroachments to water bodies to prevent floods.
The floods of 2000 proved that the presence of the Himayat and Osman Sagar reservoirs could only control flooding from excess rainfall upstream of Musi. There was a new and emerging possibility of flooding due to failure of tanks in the various micro watersheds in Hyderabad city.

Hyderabad 1996-2020: Liberal Planning to suit the Markets

In 1991, India made fundamental changes to its economic policy to move from a relatively closed and state-controlled economy to a liberal market economy. The emergence of ITES services around the same time, brought new opportunities to emerging cities. In 1995, The Chief Minister of erstwhile Andhra Pradesh, Chandrababu Naidu used this opportunity to bring a new economic base to the state by facilitating the development of ITES sector in Hyderabad. For this purpose, he developed the CDA-Cyberabad Development Area[16] in 2001.

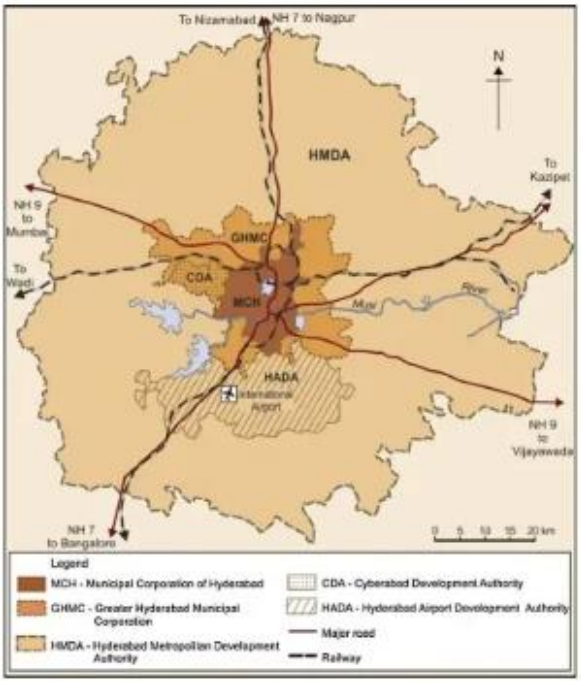

Figure 7. Location of CDA with respect to water bodies courtesy Diganta Das[17]

The CDA master plan emphasized a landuse zone with focus on software related industries. The development of Cyberabad marked the beginning of a new phase where the private developers played a major role in the development of built infrastructure making them a key player in dictating the direction of development. While the state government controlled overall land use and ensured

continuous supply of water and power, it heavily relied on the private infrastructure companies to provide world class infrastructure of international standards as per the aspirations of the IT industry and its employees[18]. This new hi-tech enclave was to be connected to a New International Airport. 5000 acres of land was identified to the south of the city for the development of the New International Airport and declared as a special development area HADA (Hyderabad Airport Development Authority). However, of these 5000 acres, 2000 fell within the Protected catchment area of Himayat and Osman Sagar lakes.[19]

Osman Sagar and Himayat Sagar: Protected greens vs urban utility

The Forum for Better Hyderabad, a citizens group filed a Public Interest litigation against locating the New Airport within the protected catchment area, but the case was dismissed as the proposed airport had cleared all the requirements put by the Andhra Pradesh Pollution control board and was accorded environmental clearance by the government of India on 6th March, 2003.[20]

The Airport terminal building opened to operations in 2008 being the first silver rated LEED Airport terminal building in Asia. Thus, setting an example of green conscious development[21] The HADA master plan was also notified in 2008 and carried the theme of eco- conscious development. Two notable features of the master plan were

- The 2000 acres of the catchment area was marked bio conservation zone where only Horticultural activities were permitted
- All forests and water bodies were protected under heritage regulations.

Figure 8. Land use map of the HADA area showing mostly "green" landuse

The planners used all the tools available to them such as allowing low FSI and permitting a minimum land parcel of 0.75 hectares (1.83 acres) for development, encouraging mostly agriculture and horticulture related land use to discourage encroachment of the catchment area.[22] However, two important developments led to speculation over these lands.

- Access to the Airport facilitated by the development of ORR also made the catchment area easily accessible and more valuable for development. The land prices have risen so high and the city has grown so close that it is now more profitable for the native farmers to sell their land to developers than continue farming.

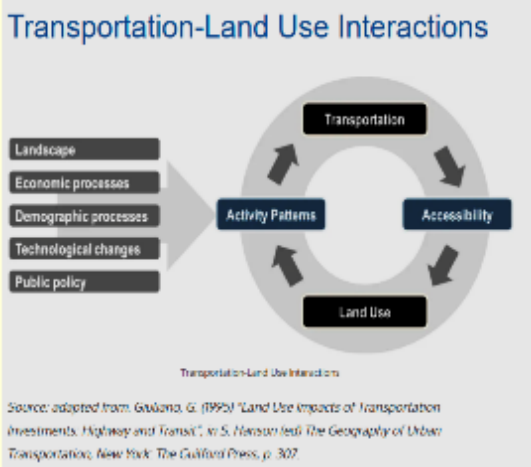

Figure 9. Land use transport interaction as per Giuliano

- City Municipal corporations are now encouraged to be more self-sustaining in terms of financial capacity and the auction of lands is an important revenue source for HMDA (Hyderabad municipal development authority). In its recent auction of the Kokapet land, the state government netted the equivalent of 258 million US dollars[23] (TNN 2021) This land, at the edge of the lake catchment area has given rise to fresh speculation on the value of this land to the city.

Figure 10. The catchment of area superimposed over the satellite image of the city, 2021

The extent of the catchment area is almost equal to the developed area of the city today, making a strong case for review of the development norms in this area. This paper shall now examine lessons learnt from development of the lands around Musi and Hussain Sagar to decipher tentative guidelines for development

Comparative analysis

	Musi river	Hussain Sagar	HS+OS
Extent	5km long (Visvesraya 1930)	4.7 sqkm (project 2018)	24.78+19.6 sq km (lake protection committe 2013)
Watershed		258 sqkm	1308+738.15 sqkm
Major flood	1908	2000	2020
Planning initiative	• Vishwesaraya 1908 • Musi riverfront development Authority 2017	• City Improvement Board 1930 • BPPA 1996 • Hussain sagar lake and catchment area initiative 2006	AP govt 1996
Economic purpose	Irrigation upstream and downstream of city Effluent discharge within the city	Flood control Recreational activity	Water supply- hasn't been feasible since 1996 due to less inflows Flood control- failed in 2020 due to failure of multiple tank systems
Environmental function	It is a dead river within the city and receives most inflow from sewage discharge	It is a dead lake. Also receives a lot of effluents from upstream	Diversion of water for irrigation and rainwater harvesting purpose has decreased inflows making water levels in the reservoir very low thereby rendering it an unfeasible source for water supply (Rao, et al. 2005)
Urban Value	After taming the river, Visvesvaraya advised planning of the riverfront as a "lake district" by planning public buildings close to the shoreline to discourage residential squatters from occupying the hazardous floodplain area However natural waterflows have decreased dramatically due to irrigation upstream. The river resembles an open cesspool and is a health hazard esp. for these public buildings including the government hospital and the High court	The watershed of the lake was heavily urbanised before realising the value of the lake as an urban public space. Effluents from upstream and encroached waterways makes it both an environmental hazard and a flood hazard. Tourism potential of the lake like sailing remain untapped due to the foul smell and poor water quality	These reservoirs which supply water almost entirely by gravity to the city are a sustainable model of water supply and efforts should be made to conserve them rather than call them obsolete in order to blindly open up land for development The city disregarded its tank and river system of flood control while developing because these two mega reservoirs promised flood control. Disregarding this aspect could have dangerous consequences to the entire city.
Money spent on beutification schemes	1665 crores (estimated budget) (Deccan Chronicle 2019)	754 crores (already spent) (Rafi and Acharya 2018)	-

Table 1. Comparative analysis

CONCLUSION

Water bodies are sources of water supply and irrigation outside the urban context. They often also serve ritual purposes to reinforce this importance. Once within the urban area, as observed in the case of Hussain sagar, they serve a more aesthetic purpose as a part of the larger public space. This value is endangered by environmental hazards like pollution and flooding as observed in the case of both Musi and Hussain Sagar. Post development efforts to rectify the quality of water bodies can be very expensive to the state exchequer as seen in the case of the Musi and Hussain sagar.

There is a chance to start right in the case of Himayat and Osman Sagar lakes. The watersheds of these reservoirs are already well mapped, and the micro watersheds should also be remembered in the development plan. It must be remembered that while water itself is better supplied as a commodity via taps to urban citizens, lakes are valuable urban spaces which can serve that purpose only if the environmental risks like flooding and pollution are abated at the planning level. The Urban watershed is mostly fed by manual drainage systems (sewage and storm water drains) these must be planned to imitate natural drainage systems as well as possible.

NOTES

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[16] Diganta Das. "Hyderabad: Visioning, restructuring and making of a high tech city." *Elsevier(2014).*
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[18] Diganta Das. "Ordinary lives in extraordinary Cyberabad." In *Transforming Asian Cities Intellectual Impasse, Asianizing Space, and Emerging Translocalities*, by Nihal Perera and Wing-Shing Tang, 112-20. Taylor and Francis (2012).
[19] The Himayat and Osman Sagar lakes were an important source of water to the city till 1996 and a catchment area of 10km radius around the lakes are protected under a special government order GO111. Refer judgement by supreme court of India dated 1.12.2000
[20] Refer case judgement of Govt of AP v/s Forum for better Hyderabad dated 24-03-2003
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MOHALLAS AS FIELDS OF IDENTITY FORMATION- UNDER THE AUSPICES OF CHANGING PATRONS

Author:
NADIA SHAH

Affiliation:
ILLINOIS INSTITUTE OF TECHNOLOGY, USA

INTRODUCTION

What are mohallas? 'Mohalla' in Urdu and Hindi, 'mahalla' in Bengali, 'mahala' in Marathi, is officially considered a 'division of a town, a quarter, a ward' of south Asian cities according to H.H. Wilson.[1] Schoenauer explaining the "mahalah" of Cairo in the 17th century describes it as a 'neighborhood block of oriental cities,' and also as a "closed precinct neighborhood"[2] of the Islamic city.[3] But he distinguishes the mohalla from an American neighborhood unit based on the fact that mohallas housed the rich and the poor nearby, suggesting that the ideology governing the lives of the residents often shaped the characteristics of the mohallas.[4]

Indian Mohallas have been discussed as fields of political identity formation against the backdrop of colonialism and postcolonial nation-state politics.[5] For instance, Masselos' study of Bombay provides a framework to study Muslim neighborhoods for the social organization of the different sects or identities within the bounds of the mohallas and the (almost 'claustrophobic') power dynamics of the mohallas on their residents.[6] Both Masselos and Legg also use the framework to suggest how the different identities came together to form a single identity of the 'other' to face the common colonial enemy, the British Raj, in the early 20th century. Focused on political geography, such a framework overlooks the intrinsic horizontal organization of the society that prevailed inside the mohallas and their social and economic connections with the outside world. Mohallas were primarily fields of the social and spatial organization since their inception in pre-colonial times, more specifically in the Moghul era. This research paper introduces a different framework to study the mohallas of the Indian subcontinent. It uses the changing patronage system and its impact on the cities. The study of mohallas spans over three-time periods to cover the three patronage systems: pre-colonial, colonial, and postcolonial. The pre-colonial era is marked by Moghul influence on cities, the colonial is British influence, and the post-colonial is also the post-Partition phase when the South Asian subcontinent was divided to form two major countries namely India and Pakistan. In this later epoch, the city form, including neighborhoods, was influenced by Western modernist ideas, industrial development, and free-market operations.

Horizontal Organization in Generic Islamic Cities:

Is there a generic Muslim mohalla? If so, then what are its intrinsic features in terms of spatial and social organization within and outside the mohalla? And what laws govern this organization?

The very early Islamic cities in the upper region of the Arabian Peninsula were resultant of the initial Muslim expansions in the first half-century after Prophet Mohammad's death in 632 CE. These garrison

cities were formed when the Muslim regiments chose to camp outside of the Sassanid cities even after their conquest. Since Islam encourages congregational prayer, the camps would essentially have a mosque or *masjid* (an Arabic term meaning place of prostration), for the residents to offer their five daily prayers with an adjoining '*madrassah*' (school). The soldiers could settle with their families and the members of their original tribes in these camp settlements. The settlements were organized spatially to accommodate the different tribes since in the early Islamic period tribal affiliations ran deep and strong. Both the mosque and madrassah, often connected, served to teach the Islamic doctrines and teachings to everyone. As the settlements grew, they became more permanent and took the form of dense cities. The initial apparent tribal differentiations withered away in these dense urban centers with time. In the early Islamic cities, a mosque was a central institution through which functions related to religion, law, education, and government could be run. The cases of Muslim adaptations of older Greco-Roman cities (in Schoenauer's account of early medieval Islamic cities) also show the mosque as a pivot for the organization of life in the city. Education was conceivably the most important secondary function of a mosque after congregational prayer, in the first four centuries of Islam.[7] The education involved the study of Quranic verses, their explanation (*tafseer*), sayings of the Prophet (*hadith*), Islamic law, other religious sciences, theology, and philosophy (*falsafa*). Later purpose-built madrassahs took over the functions of education, but they remained either physically connected or in close proximity to mosques. Some of the old standing madrassahs that we recognize today as famous universities of the Islamic world were actually mosques: al- Azhar in Egypt (970 CE) is known as the oldest functioning university in the world; the Qarawiyin mosque in Fez, and the Zaituna in Tunis.[8] The other functions that mosques catered to were in the realm of justice; The *Qadi* (Arabic term for judge) could hold his court in a part of a mosque-this act was rooted in the practice (*sunnah*) of the Prophet himself. The political dimension in which the mosque evolved and functioned is worth mentioning here. The chief Jami mosques were situated in the center and also oftentimes near the commander-in-chief's place of residence in an Arab camp settlement and later near the palace of the ruler in cities. Attending the Friday *Khutba* (sermon) and taking part in it was a mark of allegiance that legitimized the position of the ruler. The khutba and the *mimber* (raised platform like a pulpit in a mosque) could serve to make important administrative announcements and show affiliation to the commander or ruler.[9]

There was a hierarchy in the size and function of mosques, it will not be incorrect to say that in the medieval Islamic city, the Jami Mosque occupied the center position not only physically and functionally, but also for practical reasons. In most cities, it would be strategically located at the intersection of two main thoroughfares that would hold shops and workshops along them.[10] Besides the central Jami Mosque, there would be smaller mosques with their own bazaars, creating their own mohallas around them. Commerce and religion, the two aspects of the daily lives of the people were intrinsically connected. The city would house a number of mohallas with smaller mosques besides a Jami Mosque. As the cities grew the public functions were shifted to special buildings near the Jami Mosque. These public institutions of a medieval Islamic city were *suqs* (markets), *madrasahs* (schools), *hammams* (hospitals), *maristans* (hospitals), *khans*, or *karawansaraiy* (travelers' lodging). The Islamic city organized urban spaces and facilities in a horizontal hierarchical pattern escaping vertical or central power dynamics.

A defining aspect of the horizontality in the material and cultural life of an Islamic city was the law and practice of '*waqf*' or endowments. The public institutions so, central to the mohallas, were established and run through the acts of endowments called *awqaf* plural of waqf. The Arabic term waqf means to dedicate. The institution of waqf was intrinsically religious that required giving up one's property in the way of God, to seek God's pleasure by supporting the needy. The citizen did not view himself as a citizen of the city or any particular nation but as a part of a greater brotherhood or community *ummah*

formed by the Prophet himself. For this ideal *ummati* (member of the community), the affiliation to the larger community, the ummah, was more important than any geographical bounds.
This religious perspective was instrumental in creating a horizontal support system through endowments to take care of the poor and weaker strata of the society like the elderly, widows, orphans, and the disabled. It also supplied land and funds for the building and running of the major public institutions like "mosques, *Sufi Khanqahs* (abode of saints from where they preached their students or disciples in residence or just visiting), hospitals, public fountains, soup kitchens, travelers' lodges, and a variety of public works notably bridges".[11] Maintenance, daily operational cost, and renovation of these properties were also conducted through waqf money.

THE INDIAN MOHALLA DURING MUGHAL ERA

Earlier accounts of Indian cities are from Francois Bernier- a French traveler of the 17th century who traveled to Delhi between 1656-1668. His account of Shahjahanabad (Delhi), the capital of the Moghul empire, is mostly overshadowed by the comparison to European cities. The streets holding the arcaded bazaars met at the squares between the masjid and the fort. The multiuse buildings that composed these bazaars had storefronts and warehouses in the back with living quarters of the merchants and traders above them. Bernier's gravest comments are about the way commerce was conducted in the bazaars. How the shops did not display the goods as the European markets did. He seems to be astonished enough to point out in his account the way modest abodes made from mud and thatch sat in between highly crafted expensive-looking buildings. Because of this intermixing quality of social classes, he considers the Moghul capital city an amalgamation of "different villages" and not a city.
Blake's much recent study of Shahjahanabad (Delhi), drawing a lot from Bernier's accounts, claims Shahjahanabad to be a product and reflection of the 'patrimonial bureaucratic empire' of the Moghuls. His account describes the city as merely an extension of the imperial household system. Both these accounts place the royal family as the patrons of the city and responsible for all its functions, painting a picture of an incredibly centralized power that ran the city as the emperor ran the household and the Empire. However, Shama Mitra Chinoy argues that the Moghul city had horizontally laid out connections that survived even the most unpleasant times the Moghul family experienced and the horrific sieges the city endured. These connections were among the traders and their clients and among clans and casts. Chinoy draws her conclusions about the Moghul Indian city Shahjahanabad from the accounts of Dargah Quli Khan of Delhi, who penned the history of the city in 1737. Shahjahanabad was constructed by Moghul Emperor Shahjahan to replace his capital at Agra in 1639. The city had a heterogeneous population which was the soul of the city. The city had a number of distinct mohallas that followed the pattern of horizontal organization. Each *mohalla* in itself was a closely-knit homogenous community. The specific residential precincts housed solidarities such as ethnic groups, occupational groups, religious sectarian groups, and also multiethnic groups that identified themselves with a certain scholar or madrassah. In Islamic cities, the non-Muslim groups such as Jews, Christian, and Hindus (in South Asia) had their own mohallas. Mohallas were communities for both rich and poor and the newcomers were welcomed especially if they had an affinity with a particular mohalla as in figure 1.[12] The administrative responsibility of the mohallas was performed by the residents of the mohalla, including policing; for security, these were made as gated communities.
The Islamic trade guilds played a unique role in the occupational practices adding a layer to the horizontal organization of the cities. The guilds were open to non-Muslims as well.[13] In 17th CE Shahjahanabad (Delhi) Mosques, Temples, and Gardens were created and run through immovable (land) and moveable (money) endowments. A family member could preserve his or her property in a waqf (trust) for his children as well, instead of dividing it up into shares for each kin. The proceeds from such property were then distributed among the kins as per the conditions of the waqf, which could

also dedicate a share to the mosques, the poor, and the care for travelers in the lodges. The sense of responsibility to care for the members of one's own family and beyond family was related to one's religiosity and drove the society towards strong horizontal connections. The city had connections through commerce and trade guilds among the specialized craft mohallas and also with the suburban towns outside the city.

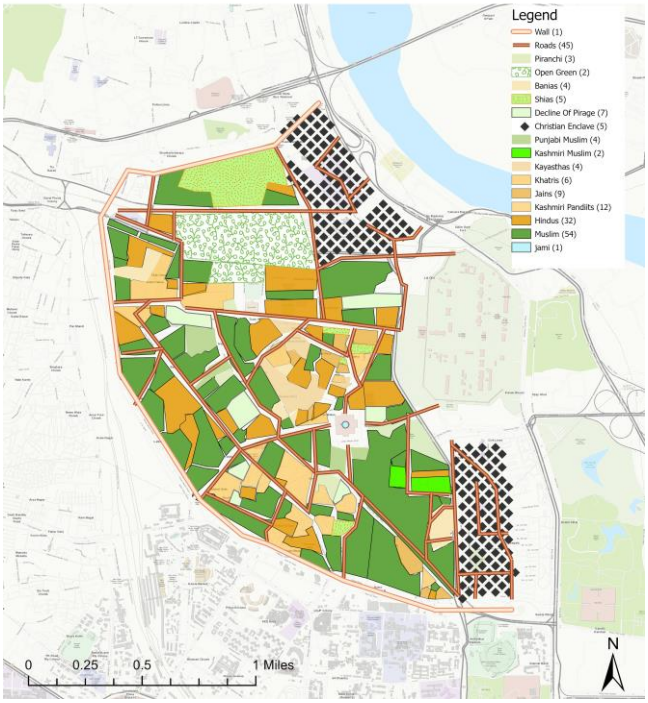

Figure 1. The division of the Pre-colonial Shahjahanabad city (18th-19thCE) into ethnic mohallas. (Source: Map created by the author based on historic data)

SOUTH ASIAN MOHALLA UNDER BRITISH COLONIALISM

However, the later colonial system found the horizontal systems of Waqf problematic for centralized governance. Under the waqf system, there was no clear owner of the land, and tax was collected on produce not land. Because of overlapping property rights, it was hard for the British government to collect taxes and govern centrally. The British, after colonizing India, introduced a new value system. They divided the land into lots or parcels.[14] They appointed legal owners of the property so that taxes could be collected. They also created a bureaucratic system and creditors, to assist those who were not able to maintain the ownership of the property and were lagging in taxes. Private waqfs were abolished to a great extent. In such a centralized system creditors became the ultimate beneficiary, and the commodified land and property became a part of the market economy.

POST-COLONIAL MOHALLA IN PAKISTAN

The post-colonial India created a new Muslim majority country called Pakistan and a smaller India in 1947. Pakistan faced the challenge of housing about 7 million refugees in the first ten years of independence. A new town was developed just to house the influx of 500,000 refugees in 1958. Korangi, a housing scheme was funded by the Ford Foundation and was planned and designed by the Greek architect Doxiadis, a few miles outside of Karachi. Doxiadis applied his so-called 'scientific method' of ekistics and created repeating sectors to manage and control the growth of the ever-expanding city

that he referred to as a living organism. Each sector was carefully designed to hold a specific number of mosques, schools, and markets in designated areas of the central commercial core. The number of amenities was decided on the number and economic status of the residents of the sector. Each sector held a particular economic class of residents based on their income level. The only planned segregation in the master plan of the town was based on economic standing and not on any ethnic groups, occupational groups, or religious sectarian groups. The Housing Types A 01 and Type B 01 with 1-2 rooms were designed for low and low-middle income groups. Housing Types C with more rooms was designed for more affluent classes in separate sectors. The proposed industrial area was to create jobs for the residents so that they could pay for the installments of their housing units (see figure 2).[15] Although a top-down modernist approach, the original master plan proposed by Doxiadis Associates included one big (Jami) mosque in the central core with shops and a market. 1 or 2 smaller mosques were planned a few blocks away from each other in the sector. The sectors were designed for pedestrian access only (see figure 3).

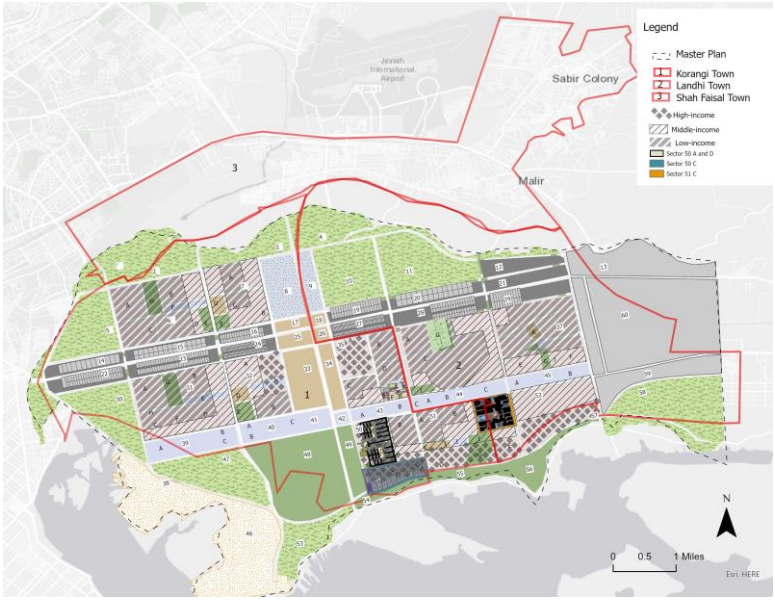

Figure 2. Postcolonial neighborhoods- Original Master Plan of Korangi Town by Doxiadis Associates in Karachi with planned sectors based on income levels with an overlay of current administrative boundaries (Source: Map produced by the author using the original master plan obtained from Constantinos A. Doxiadis Archives)

Figure 3. Overlay of Sector 51 C of Korangi Town's original plan by Doxiadis Associates over a current google image.

There was no accommodation for the endowment system to provide or run the public services. Continuing with the colonial policy the state took over the waqf institution and regulated its functions to maintain a state hegemony in Pakistan. Therefore, horizontal connections were severed and replaced with vertical hierarchical connections through bureaucratic state control. Public services in Pakistan through the government are very poorly provided as the state does not have enough funds. Public services such as transportation are left for the private for-profit sector.

A study of the religious institutions and markets of Korangi town reveals that they have multiplied significantly outside state control. But in the absence of any regulations, they fall under informal growth and territorialization of private interests.[16] The role of mosques has altered. They do not serve administrative purposes or as educational centers as before, but they still have a centralized position in the mohalla for congregational prayers. Most institutions run through for-profit private authorities, which is very different from the traditional (endowment) waqf system. A framework that looks at the horizontal connections across the cities and mohallas can highlight the strengths and weaknesses of this phenomenon.

CONCLUSION

Looking at the timeline of South Asian neighborhoods and more specifically the Indian neighborhoods since the Moghuls, it is evident that the value system that operated the cities shifted as the patrons of the cities changed. In the Moghul patronship, the system of waqf (endowments) was predominant and mosques played a foremost role in keeping the values intact of the society. Waqf took care of public infrastructure and the private needs of families. During the British colonial Raj, the system of private ownership of property became prevalent, which carried over into the postcolonial nation-state of Pakistan. Pakistani government policies upheld the commodification of landed and other property to support the market economy system. This system heavily depended upon vertical power structures constituting the capitalist industry, a bureaucratic structure, and creditors. A capitalist society is bound to produce inequalities per the Marxian line of thinking,[17] especially in the absence of government regulations and a cultural horizontal support network. As mentioned earlier, the historical waqf (endowment) system, helped the infrastructure and the disenfranchised in the society. To overcome the

drawbacks of the capitalist society a reconciliation of the priorities of the capitalist and precapitalist society is required. The institution of endowments has the potential to transform modern economies for the betterment of society at large regardless of religious and racial affiliations. By reintroducing the endowment system, acknowledging the human capital, and with supportive government policies, new private sector initiatives can be created that could generate horizontal support systems in cities, as in the pre-colonial age. There is a need for more research and supportive data for the reintroduction of the waqf (endowment) system to support the 21st-century city.

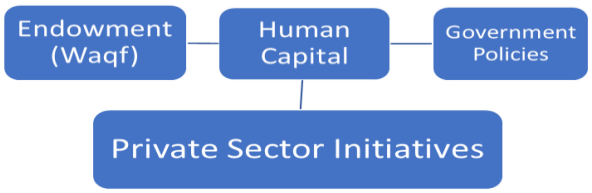

Figure 3. Reintroducing waqf to cities

NOTES

[1]Horace Hayman. Wilson, *A Glossary of Judicial and Revenue Terms and of Useful Words Occurring in Official Documents Relating to the Administration of the Government of British India &C*. (London: W.H. Allen & Co., 1855), 318. It is a reference taken from Jim Masselos' book, *The City in Action: Bombay Struggles for Power* (New Delhi: Oxford University Press, 2007), 18.

[2] Norbert Schoenauer, *6,000 years of housing* (New York: W.W. Norton, 2000)162.

[3] This paper uses the term, 'Islamic city' to define the cities that were a part of Muslim dynasties, during Muslim expansion that started from the Arabian Peninsula moved into Europe, and went all the way to Central and South Asia, (covering present-day Syria, Egypt, Spain, Turkey, Iraq, Iran, Afghanistan, Pakistan, and India) between 670 CE to 1800 CE. The term 'Islamic' is used to highlight the cultural similarities because of the common faith (Islam) shared by the populations of these vast regions.

[4] Stephen Blake, *Shahjahanabad* (Cambridge, GBR: Cambridge University Press, 1991).

Shama Mitra Chenoy, *Shahjahanabad, A city of Delhi, 1638-1857* (New Delhi: Munshiram Manoharlal Publishers, 1998).

[5] Stephen Legg, "A Pre-Partitioned City? Anti-Colonial and Communal Mohallas in Inter-War Delhi," South Asia: Journal of South Asian Studies 42, no. 1, (2019): 170-187, doi: 10.1080/00856401.2019.1554472.

[6] Jim Masselos, "Power in the Bombay "Moholla" 1904–15: An initial exploration into the world of the Indian Urban Muslim," South Asia: Journal of South Asian Studies 6, no.1, (1976): 75-95, doi: 10.1080/00856407608730711.

[7] Robert Hillenbrand, *Islamic Architecture Form, Function and Meaning* (New York: Columbia University Press, 1994) 59.

[8] Hillenbrand, 1994. Mosques maintained their close links with scholars, scholarship, and books all through the Middle Ages and up to modern times in some cases. Mosques provided the space for scholars to have intellectual debates, share their scholarship through discussion, and lectures, and read their works publicly for validation.

[9] Ira M. Lapidus, *A History of Islamic Societies* (Cambridge, England: Cambridge University Press, 1988), 326.

[10] Robert Hillenbrand, *Islamic Architecture Form, Function and Meaning* (New York: Columbia University Press, 1994) 44. Jami was a more enthusiastic project bigger than masjid meant for congregational prayer and other functions.

[11] Wael B Hallaq, *Sharia: Theory, Practice, and Transformation* (Cambridge, UK: New York: Cambridge University Press, 2009).

[12] The map in figure one was created by the author based on the maps and data that Shama Mitra Chinoy has presented in her book on Shahjahanabad. Reference: Shama Mitra Chenoy. *Shahjahanabad, a city of Delhi, 1638-1857*. New Delhi: Munshiram Manoharlal Publishers, 1998.

[13] Rooted in the tribal traditions of living in clusters for proximity and solidarity the closed precinct neighborhoods were favored in the Islamic city.

[14] Rekha Bandyopadhyay. "Land System in India: A Historical Review," Economic and Political Weekly 28, no. 52, (1993): A149-A155, URL: https://www.jstor.org/stable/4400592

[15] Korangi town's master plan by Doxiadis Associates. This Map was created by the author using data from Constantinos and Emma Doxiadis Foundation archives.

[16] Nadia Shah. "Radical Resistance or Active Agency- The Case of Korangi Town," Prometheus: Human, Behavior, Performance, and Built Environments 5 (2021).

[17] Richard Peet, "Inequality and poverty: A Marxist- Geographic Theory," Annals of the Association of American Geographers 65, no,4 (1975): 564-571, doi: 10.1111/j.1467-8306.1975.tb01063.

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SUSTAINABLE PROJECT FOR THE RUINS IN THE CONSOLIDATED CITY. THE CASE OF THE CONVENT OF SANT'ANTONIO DA PADOVA IN SCICLI, SICILY

Author:
FERNANDA CANTONE, FRANCESCA CASTAGNETO

Affiliation:
UNIVERSITY OF CATANIA, ITALY

INTRODUCTION

At the base of the cultural debate regarding Urban Recovery, which has been in discussion in Italy since the 80s of the twentieth century, there are some fundamental principles that today are counted in the concept of sustainability. The design of the existing dwellings deals with the construction of the past and draws on the heritage incorporating contemporary values; it refers to the concept of the building as a resource to be projected into the future through the preservation of identity, history and ancient knowledge. The passage of time widens the field of action of the conservation and its cultural, social and economic values to the anthropized territory. In this sense, in recent decades, the concept of landscape has become the key to the proposition of innovative strategies. The term historical urban landscape refers to a vast urban area characterized by historical stratifications of values, architectural, historical, cultural and natural characters that go beyond the notion of "historic center" but involve a wider urban context.[1] This broad context includes the natural features of the site, its built environment, both historical and contemporary, its infrastructure above and below ground, its open spaces and gardens, its land use patterns and spatial organization, perceptions and visual relationships and other elements of the urban structure. It also includes social and cultural practices and values, economic processes and intangible dimensions of heritage as well as related to diversity and identity.

Figure 1. Aerial view of the Complex in Scicli.

These characteristics provide a comprehensive and integrated approach to the identification, assessment, conservation and management of the historical urban landscape in the context of a general sustainable development.
The presence of a heritage, to be preserved, has made the general public and conscious about the inclusion of «their» favourite landscapes as part of a worldwide catalogue. A further step of this cultural policy was made in 2011, with the extension of the term landscape to urban areas of historical character, with the precise desire to denounce the now inadequate definition of the Historical Center, as a clearly restricted area, to which specific design strategies and behaviours could only be reserved. The city now needs management practices that, in the wake of sustainability, must take into account the many variables involved and highlight systems of systems, interconnected, that contain the needs of the community and can express the qualities that the urban environment should offer and enhance.
In 2021, the tenth anniversary of the "UNESCO Recommendation on the Historic Urban Landscape",[2] thematic meetings focused on various aspects of the themes of the project such as: public space, rehabilitation, tourism, cooperation between public and private, as well as the limitations caused by the pandemic on the management and use of the sites constituting the heritage of humanity.

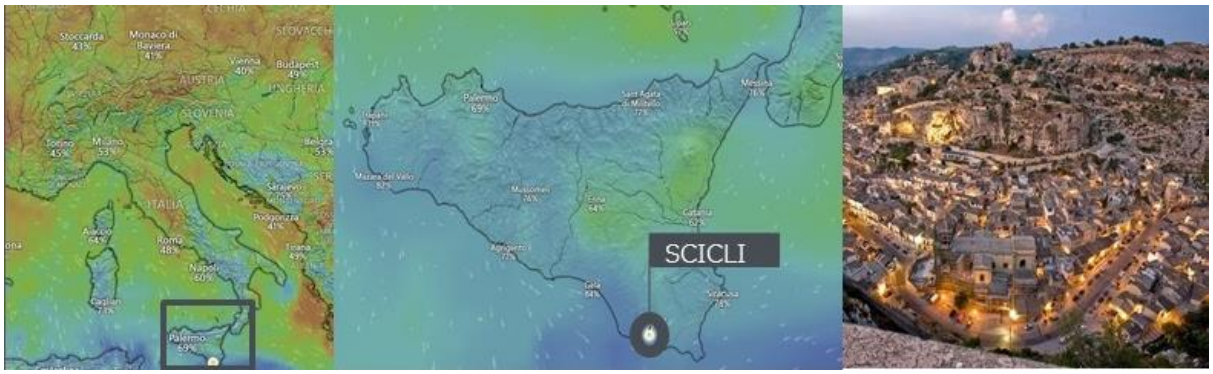

Figure 2. Italy, Siciliy and Scicli (RG) aerial view.

RUINS AND INTERVENTIONS

The meaning of place is often traced back to the physical environment and the objects that constitute it; from a phenomenological point of view, human experiences determine the meaning of the places themselves.[3]
The ruins of the past, the fragments of human works that have gradually given way to the "natural", are places where two realities confront each other: the work of man and the action of nature. In this imbalance, stacked in favor of nature, which invades and destroys the architectural work, man develops a feeling of melancholy and awareness of the separation "between the will of the spirit and the need of nature".[4] The imaginative potential produced by the ruins has enriched them with attractions and they have become passionate destinations for history-loving visitors. There are important studies on cultural tourism in these places and on the memorable tourist experience (MCTEs memorable cultural tourism experiences)[5] that highlight an increasing interest in the past.
Many popular books, films and series are set in historical realities. Castles, convents and productive buildings "offer a wealth of experience and intensity that illustrate well the affective nature of heritage. All this contributes to the great popularity of these type of buildings and therefore of their new functional needs.

However, the projects, in these cases, are also useful to confront the relationship between ruin and urban and territorial context of belonging, between architecture and nature, to such an extent that a fruitful union is formed between the urban project and the ruin itself.
In fact, some ruins, especially if within the historical urban landscape, can be recovered, maintaining the charm of the past. The contemporary architecture introduced inside the ruins can have a similar effect to the popularization of a tourist site, especially if it refers to the memory of the place.[6] From the marketing point of view, the contemporary project for the ruins acts through spatial metaphors and particular architectural symbols that characterize that place and that recall the past with the power of the present. Marketing activities, designed during the project phase, can influence and direct the recovery and reuse project.

THE CASE STUDY

The complex of the Convent of *Sant'Antonio da Padova* and the adjoining Church of *Santa Maria Immacolata*, is located in an area originally *extra-moenia*, away from the town of Scicli in the district of Ragusa and along the banks of a stream.[7] Since 2002, historic center of Scicli has become a UNESCO World Heritage Site.
The convent of Sant'Antonio has an uncertain date. It was founded between 1226 and 1363 but little remains of the building of that time. The 1693 marks the destruction of Scicli due to a strong earthquake that killed 2000 people and led to rebuild further downstream. The 1700s was the century of reconstruction and many churches and convents were built in the style of the purest Sicilian Baroque.

Figure 3. Vault of Chapel of 1500s in Santa Maria Immacolata Church and the ruins of the Church.

The convent today consists largely of the post-earthquake realizations of 1693, among them are the 1514 chapel, built by Master Pietro Rovetta[8], and part of the cloister of 1522[9]; some rooms were made for novices between 1560 and 1624.[10] The church was entirely rebuilt in the first half of the 1700s. The reconstruction work resulted in substantial changes to the plan, elevations and decorations but respected the formal rules of the period. In 1866 the complex passed to the State Property and was later sold to private individuals who placed a matchbook factory there. An explosion damaged the complex and the bombing of World War II completed the destruction. Since then, there has been a slow decline.

Today we can only perceive the ruins of the church inside, we can still distinguish the decorative stucco apparatuses, the perimeter walls of the complex and some internal divisions.

COMPARISON WITH SIMILAR CASES

The fascination of the ruins of the past and of a forgotten world offer increasingly important design cues. The approach can be varied but the goal remains common: integration between past and present.[11] In many projects there is also integration with civil society and a use not only contemplative of the ruins, but a social one for the community.

Figure 4. Urban Centre of Ruesta, Sebastián Arquitectos, 2018.

A perfect example is the project of the Urban Centre of Ruesta[12] in Urries, Spain, along the Pilgrim's Way to Santiago, conceived by Sebastián Arquitectos in 2018. It involved the consolidation of the ruins in the village of Ruesta, abandoned for several decades, to create areas for gathering and rest for pilgrims, with spaces for children, made in complete safety.

The ruins of the village, although perfectly distinguishable and consolidated, have become places of shelter for pilgrims, of rest, there is also a welcoming campsite and services designed for social aggregation. Another significant example concerns the recovery of the ruins of the Castle of Baena, again in Spain, designed by Josè Manuel López Osorio;[13] it integrates the historical and cultural heritage of the ruin with the ability to integrate it in the process of revitalization of the neighborhood. It can be implemented through a modular system to incorporate to the monument new uses that transcend the mere contemplation of historical ruins.

Figure 5. Recovery of monastery of Saint Frances in Sainte Lucie de Talleno in France, Amelia Tavella, 2021.

Equally interesting is the recovery of the ruins of the Monastery of Saint Frances[14] in Sainte Lucie de Talleno in France, in 2021.

A reconstruction was completed through the concept of camouflage. The architect Amelia Tavella wanted to recreate sensory settings linked to the silence of religious buildings. It is a formal reconstruction of the existing one, made of Corten steel that, according to the principle of mimesis, recreates rarefied and mystical settings.

Figure 6. Proposal project on the banks of the Mississippi river, in Minneapolis,USA, MSR Architecture

Another beautiful proposal project for the rehabilitation of the ruins is Water Work, located at the mills on the banks of the Mississippi, in Minneapolis, in the USA, carried out by MSR Architecture, [15] where these ruins are used for passive recreation areas, suitable also for children. The concept of public space is redesigned through the objectives of social and temporal integration that leads the user to a relaxing contact with water in all seasons.

The project of the Longrovia Rural Hotel, created by architect Luis Rebelo de Andrade in 2016, in Meda, Portugal,[16] involves the integration between old buildings and new spaces, created around the ruins of the functioning Roman Longrovia baths. Walkway systems connect the two functions by integrating the cultural and recreational components.

These projects propose a very evident system of social inclusion and integrated culture with the varied use of the ruins of buildings profoundly different in function, construction period, construction technologies, place and climate. In summary, these experiences inspire the imagination to create a project that finds in the ruins the turning point for an active integration between past and future and that sees the involvement of the settled communities.

These cases shall identify strategies for action relating to:

- Reconstruction and Integration with the neighborhood and community (Baena Castle);
- New uses for ruins (Ruins of Ruesta);
- Possibility of building inside the ruins through camouflage (Saint Francis Monastery);
- Social development of "sense of community " (Water Work, Minneapolis);
- Enhancement of culture and well-being (Longrovia Rural Hotel).

These are fundamental ideas for a sustainable project, in which the social component is stimulated by innovation and conservation, by new spaces for the community, by new economic and productive ideas. If used together and properly interpreted, they can give very positive results.

THE RESEARCH

Rural areas of Sicily are endowed with a remarkable historical-monumental and cultural heritage consisting of medieval and baroque villages that possess splendid examples of civil and religious architecture. The environmental natural heritage is strongly characterized by the presence of a historical memory, not always shared, on the peasant tradition.[17]

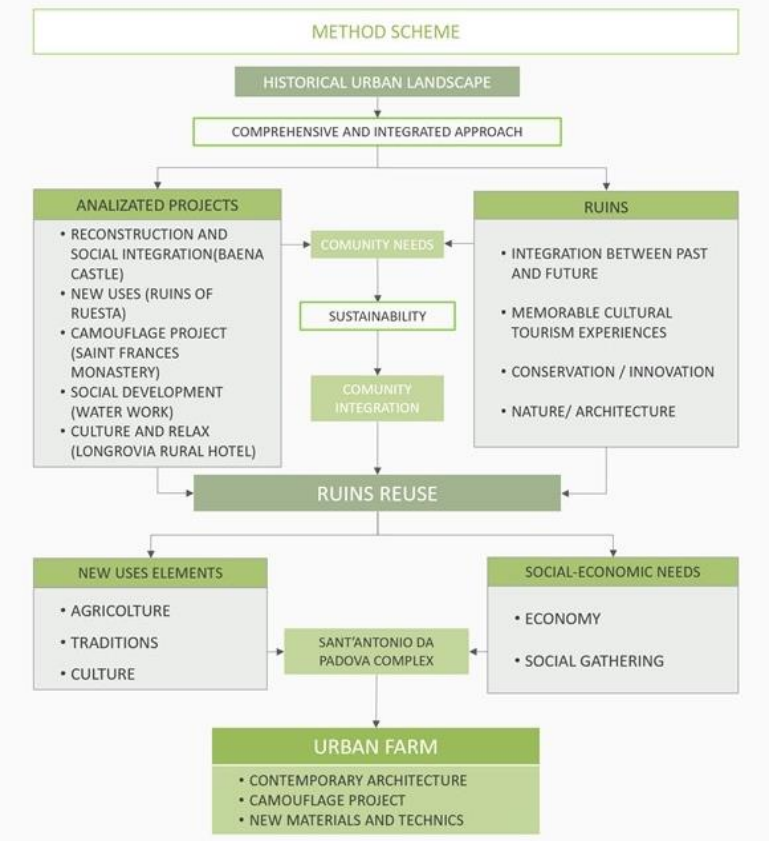

Figure 7. Methodological scheme.

The case study is located near the consolidated city. The public and private space of the Sant'Antonio da Padova Complex certainly represents the historical urban landscape, the place of memory and sociality with a decisive role in the image of the city[18] and therefore here it is necessary to start from this starting point.

The study began by researching and selecting projects on the ruins with marked characteristics of social sustainability and approaches the project in the Historical Urban Landscape with new energy. The characteristics of the ruins and the needs of the inhabitants are studied through the objectives deduced from the analyzed projects, identifying the needs of the local community, in terms of sustainability and social integration. The project involving the reuse of the ruins is therefore based on the characters of the context and community. Among them, the surrounding fertile soils become a fundamental element of the project of economic and social development. A sustainable approach, in this sense, leading to the rebirth of ancient agricultural traditions and also employing modern production, carried out respect for the land, genuine products, seeds and machinery to help man. This idea has been strengthened by studying the project of Agro Food Park (AFP), by William McDonough + Partners and other, conceived in 2015 in Denmark.[19] It is a virtuous example that confirms the ideas expressed earlier. It identifies as an Urban Farm, a container that responds to the demands of the community, enhances the values of the territory, stimulates the economy and boots the aggregate component. In this context, the project

rethinks the ruins in a contemporary key, proposing an idea that preserves, reuses, communicates and exploits the potential of the building and the space around it: an urban farm in the Sant'Antonio da Padova Complex. The creation of such an Urban Farm system in the recovered complex will host a "house of Sicilian crops" to reacquire and spread the ancient tradition of "cannavataro", a man familiar with the local agricultural tradition who cultivates the land as if it were the primordial mater and sells it directly to the consumer. Here you can buy or devour the products of the "cannavate", the biological archetype of the past that produces native varieties.

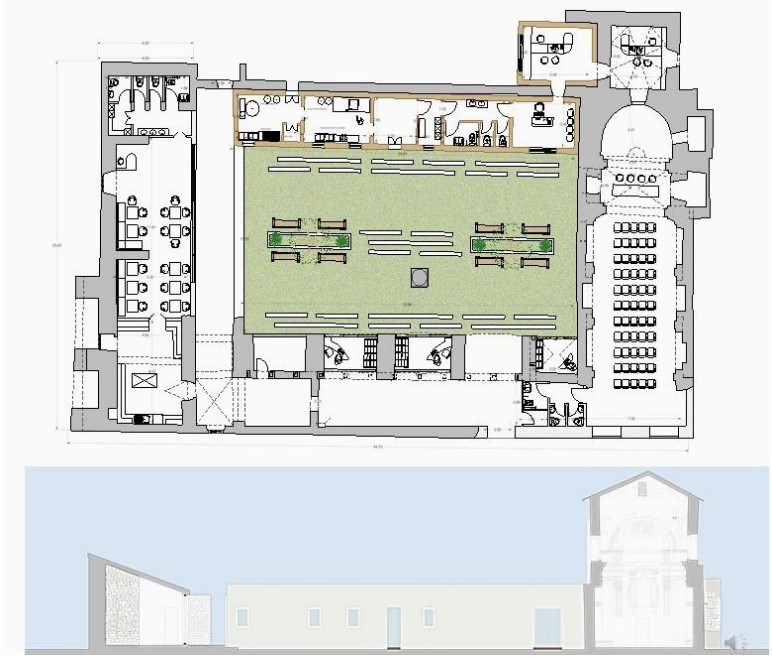

Figure 8. Plan and internal section of the project.

The cloister, the heart of the convent, will host a Garden of Sharing around which will develop the activities to start up:

- a Kitchen Garden with native crops, respecting the cycles of each crop and following the Slow Food principles;
- a Therapy Garden based on the desire to rediscover a slower rhythm of life, revaluating the beneficial properties of the fruits of the earth and regain possession of the territory, cultivating the land,
- an area of Research and Development with laboratories for the research into ancient grains and native seeds;
- a small meteorological station.

The complex will be completed by social and collective functions such as a restaurant with 50 seats in the refectory of the convent, and its kitchen, a common room for small conferences (55 seats) and for aggregation within the church, a temporary shop consisting of three small sales spaces positioned under the barrel vaults of the sixteenth-century loggia, to sell both processed products in laboratories and those produced in the Area of Cannavate and in the Kitchen Garden.

Outside the construction, instead, areas will be cultivated according to cycles that alternate the types of production according to the seasons.

The tradition of "cannavate" will be continued in the area that runs along the stream, forming small plots of land of 1000 or 2000 square meters at most, surrounded by citrus trees.

The project of technological reuse

The project involves the consolidation of the walls through a series of different interventions depending on the conditions of the supports. In areas with exposed masonry, the intervention involves the consolidation and preservation of the walls with the RETICOLA TWINS (*Reticolatus*) system[20] which occurs the reinforcement of the joints with the use of stainless-steel strands and lime mortar. This system improves the shear and flexural strength of the masonry allows to upgrade the resistance to cutting and bending of the masonry, while, at the same time, maintaining the original appearance. On the partially collapsed walls of the church indenting interventions will take place. For the restoration of the wall box, tie-rods and the creation of an upper curb that closes and connects the walls will be employed. Internally fixing and cleaning of the existing grouts will be undertaken.

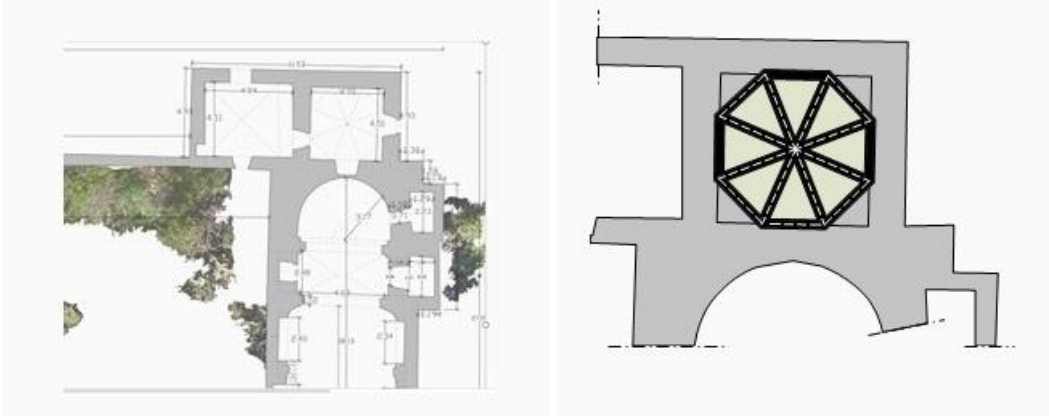

Figure 9. Consolidation of existing vaults.

The BETONTEX fibre-reinforced plating system,[21] will be used to consolidate the existing vaults. It is composed of fabrics, nets, flakes, sheets and preformed bars in carbon or glass fibres to be impregnated and/or glued on the turned surfaces by means of epoxy thermosetting resins. This type of intervention is used to prevent local and global collapse mechanisms and to achieve an increase in mechanical strength and ductility to the extrados of the vaults.

For the reuse of the most damaged spaces, the project involves the reconstruction of the spaces with X-lam panels, placed in adherence to the internal masonry. The choice of X-LAM (or CLT, Cross Laminated Timber) is linked to the excellent characteristics of resistance to seismic stress and thermal performance and air tightness.

Some completely collapsed walls will be replaced by large windows.

The project is therefore environmentally sustainable, respectful of the ruins and the technological culture of the past.

CONCLUSION

The research therefore proposes a new peri-urban model of reuse project that combines sustainability with the relationship architecture/ nature that the ruins impose.

Today, sustainability values in the design phase are well defined by technologies and materials that allow significant energy savings. The goal of this millennium is certainly a conscious and careful use of the building, based on the economic autonomy of the management of the dwelling.

The Urban Farm of Scicli will be a space for the production, processing and sale of seasonal agricultural products, typical of the area and the microclimate; it will be a commercial space with a 0-carbon impact, a cultural, educational, social and urban green space. Here it will be possible to combine agricultural experiments and social relationships through collaboration between academic and commercial

activities, leaving ample space for the aggregative capacity of the human being. The possibility of carrying out such a project leads to a reflection: the social role of cultural heritage. They become the perfect place for aggregative but also economic functions, places of meeting, relaxation, profit and commercial development, they also become a way to spread culture and respect for the past, a vital past, full of meaning and activity. The consolidated public space, and the historical buildings around, become a fundamental network for cultural, social and economic well-being.

Figure 10. View of the complex from the river.

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[7] Filadelfo Fichera, *Risanamento di Scicli: Relazioni ai progetti definitivi, compilati per incarico di s. E. Il Ministro dell'Interno* (Catania : Niccolò Giannotta Edit., 1889), cap. 1.
[8] Salvatore Cucinotta, *Popolo e Clero in Sicilia nella dialettica Socio-Religiosa fra cinque-seicento* (Messina : Edizioni storiche siciliane, 1986), 445.
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[13] https://www.archdaily.com.br/br/784946/restauro-castelo-de-baena-jose-manuel-lopez-osorio?ad_source=search&ad_medium=projects_tab&ad_source=search&ad_medium=search_result_projects(accessed 18/01/2022).
[14] https://www.archdaily.com.br/br/966259/convento-saint-francois-amelia-tavella-architectes?ad_source=search&ad_medium=projects_tab&ad_source=search&ad_medium=search_result_projects (accessed 18/01/2022).
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[20] https://www.fibrenet.it/system/sistema-reticola/ (accessed 19-12-2021).
[21] https://www.fibrenet.it/system/betontex-4/ (accessed 19-12-2021).

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ROLE OF BUILDING ENVELOPE IN FORMATION AND MITIGATION OF URBAN HEAT ISLAND

Author:
SEHGAL JAGRATI, KUMAR GIREENDRA

Affiliation:
MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY, INDIA

INTRODUCTION

Escalation in population with migration, economic development, social inclusiveness, and changes in land-use patterns had a remarkable effect on the process of urbanization in the world.[1] One of the significant scenarios is an expansion of a built-up environment[2] to cater to the growing population and migrants, which disturbs the natural process, modifies the urban thermal balance, increases overall heat emissions, and significantly changes the natural urban energy balance[3] and results in a phenomenon known as Urban Heat Island (UHI). UHI is a phenomenon where the temperature of urban areas is higher than neighboring rural areas.[4] Buildings in highly dense neighborhoods are one of the infrastructure trapping heat in street canyons through envelopes and if not treated properly, it directly results in a thermally uncomfortable space. Along with climate change and global warming, UHI can significantly impact the process of making urban settlements sustainable.[5]

This paper aims to understand the role of the building envelope in the formation and mitigation of UHI. The study produced a repository of research papers for building envelope and UHI to identify various possible approaches and technologies available as mitigation principles and solutions. The study outcomes reflect the potential of building envelope in mitigating UHI, understanding the existing scope and gap for future research in the considerable area to have a comfortable environment and healthy spaces around the city.

UHI AND BUILDING ENVELOPE

UHI has been a well-studied effect of environmental alterations because of manmade factors.[6] It majorly affects the health and comfort of residents[7] and has negative effects on thermal balance,[8] energy consumption and carbon emission. [9]

The mitigation strategies are designed to reverse the root causes of the phenomenon and are classified by various researchers.[10] They majorly follow three action plans, i.e., reduction in solar radiation, active cooling of elements in the built environment, and improvement of airflow.[11] The first two actions plans can be controlled by designing a building envelope, while the later one majorly can be executed with other mitigation measures.

Building envelope plays an essential role in the UHI process as it consists of various surfaces having different characteristics. Every surface emits radiations that add to the longwave spectrum, creating a change in energy balance and giving rise to the UHI.

For the sustainable development, defining the factors causing UHI and ways to mitigate them is gaining attention from the perspective of building and material design.[12] The study becomes significant in learning the present technological advancement in a similar domain to perform practical applications and discover potential research areas. These updates are explored through the systematic literature review of the available scientific work.

METHODOLOGY

The study adopts the standalone review method described in eight stages, further concise in the four significant steps.[13] The first stage is for planning the formulation of purpose, which is to identify the role of the building envelope in the formation and mitigation of UHI. The second stage is selecting relevant articles and eliminating the redundant ones. The articles are accessed through electronically available scientific databases: WOS and SCOPUS. A basic keyword, "Building Envelope and UHI" is used for querying both databases. The total articles generated are ninety-two. Among them, twenty-eight duplicate ones, nine reviews, two book chapters, four with restricted access, and nine less relevant articles are eliminated. In the third stage, 40 articles are extracted and tabulated for review. The last stage is to execute a systematic review done in the later part of the paper. The methodology adopted for the systematic review is shown in Figure 1.

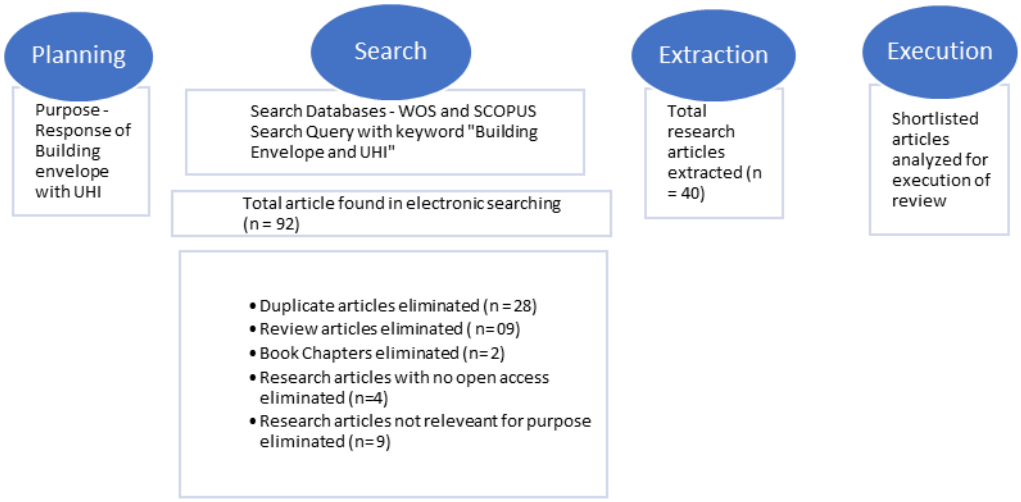

Figure 1. Methodology Flowchart

RESULTS

Focus Area

Among all the articles reviewed, two articles are based on the formation of UHI. The formation process of UHI[14] and the role of the building envelope has been explained extensively in the previous studies. In extracted articles, a single article simultaneously studied the formation and mitigation of UHI (n=1) through the building envelope and maximum articles deals with the mitigation of UHI (n = 37). There are endless number of records available in this area[15] here, the search is limited using the methodology mentioned above. Mitigation of UHI through the building envelope holds enough potential for discussion. Further, mitigation measures studies (n = 38) are categorized in two broad level records, i.e., design-based strategy (n= 4) and material-based strategy (n= 34) as shown in Figure 2.

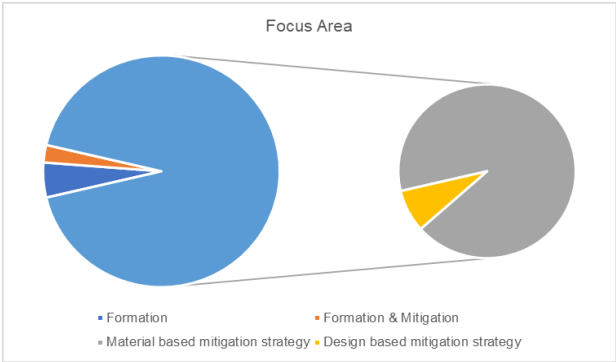

Figure 2. Number of articles based on focus area

Design and material-based mitigation strategies are proven beneficial for reducing heat transfer. It holds a lot of scope for future studies, which is discussed separately in the outcome and discussion section. At present, more research is focused on the application of materials in reducing UHI. Reviewed articles selected here are categorized according to mitigation strategies, as shown in Table 2. Figure 3 shows graphical information for the number of articles based on a mitigation strategy.

Material Based Strategy	**Design Based Strategy**
Cool/Diffusive/Highly Reflective	Facade WWR
Retroreflective	Shading Devices
Green	Solar Envelopes
Comparative	Orientation

Table 2. Classification of mitigation strategies on building envelope

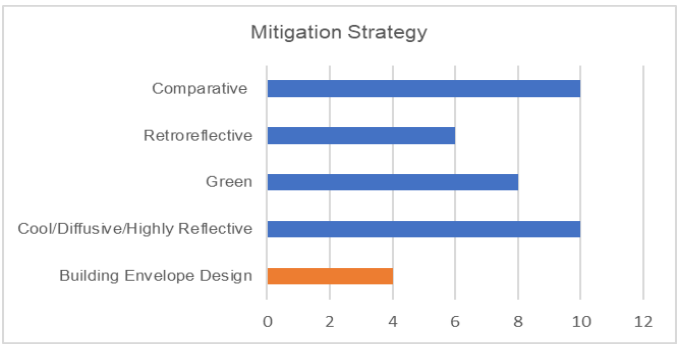

Figure 3. Number of articles based on mitigation strategy

Approach and Scale

Many articles reviewed have performed simulation analysis using Design Builder and EQuest at building scale and CFD Simulations, TRNSYS, and SOlEME for the campus, neighborhood, and canyon scale. Envi-met is one tool for performing simulation studies on buildings and neighborhood scales. WRF and ArcGIS modelling tools for the urban level study are more suitable. CFD Simulation using ANSYS Fluent is used for the material level study. For component scale study, Revit, Green Building Studio, and Grasshopper with other plugins are found to be more suitable. Some of these articles are based only on a simulation approach, while others are in combination with an experimental or statistical approach.

Besides simulation studies, another major approach explored is experimental analysis. The analysis is limited to the locations having the setup availability required to conduct these studies (mainly in Italy and Japan). The experimental approach is applied at all the scales, while the combination of simulation

and experimental is used at higher levels only. Only a few articles have approached statistical and analytical approaches combined with either simulation or experimental or both. Figures

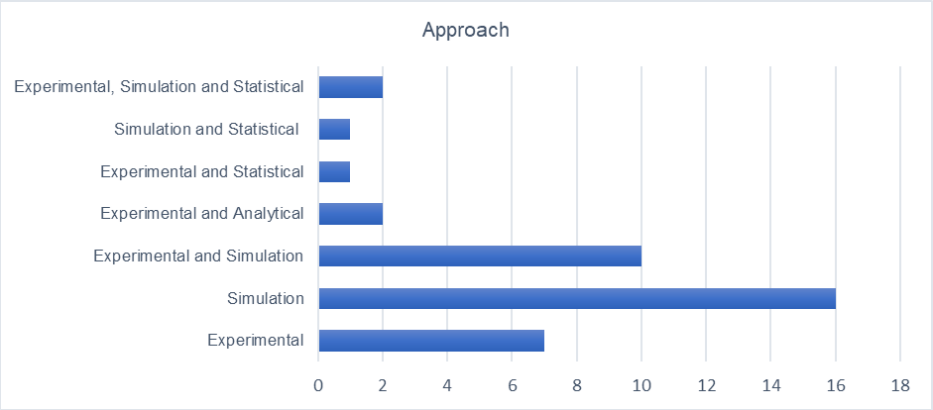

Figure 4. Number of articles based on approach of study

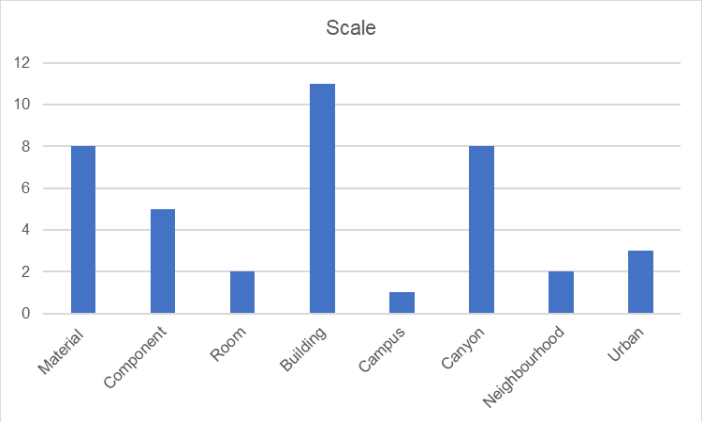

Figure 5. Number of articles based on scale of study

4 and 5 give graphical information about the number of articles reviewed for these approaches and scales.

UHI Mitigation impact with Thermal or Energy Performance

Articles studied the impact of mitigation measures through energy (n=5) or thermal (n=15) performance or both (n=13), including few articles related to other parameters also. The impact of thermal performance is measured majorly in terms of surface or air temperature reduction. At the same time, mean temperature reduction and sensible heat peak reduction are also considered. Only one article is found where thermal comfort is analyzed through people's thermal perception,[16] in terms of MOCI (an empirical index in the Mediterranean zone), including actual and thermal sensation vote. Similarly, the impact of energy performance is measured in terms of reduction of cooling, heating, or overall energy demand. Few studies also analyzed mitigation impact with other parameters like angular distribution of reflection intensity, solar reflectivity and surface solar load reduction. Figure 6 gives graphical information about the number of articles reviewed for the impact of mitigation measures on energy or thermal performance.

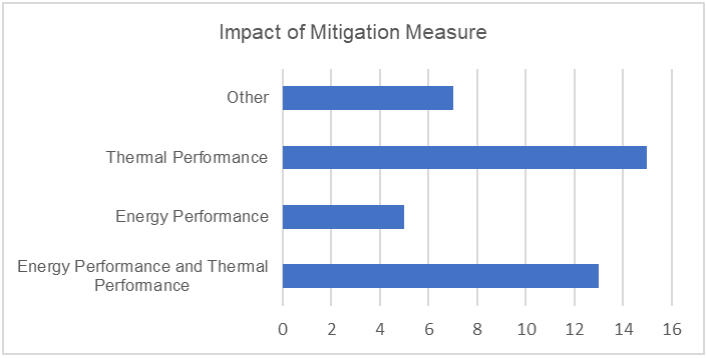

Figure 6. Number of articles based on quantitative impact of mitigation measure on energy or thermal performance

Geographic Domain

ASHRAE Climate Classification

ASHRAE is the 'American Society of Heating Refrigeration and Air-conditioning Engineers', which classified the climate zones in numeric terms (0 – 8). The classification is based on heating and cooling degree days. The numeric divisions further includes subclasses of A (Humid), B (Dry) & C (Marine) based on the moisture quality,[17] as shown in Table 3. It is found that the climate zone 3A followed by 4A are highly focused research areas. These zones are mostly found in cities of Italy, Spain, and Japan, with a warm and humid climate. Figure 7 gives graphical information about the percentage of articles belonging to the relevant climatic zone.

Zone Number	Zone Type	Zone Number	Zone Type
0A	Extremely Hot - Humid	4A	Mixed - Humid
0B	Extremely Hot - Dry	4B	Mixed - Dry
1A	Very Hot - Humid	4C	Mixed - Marine
1B	Very Hot - Dry	5A	Cool - Humid
2A	Hot - Humid	5B	Cool - Dry
2B	Hot - Dry	5C	Cool - Marine
3A	Warm - Humid	6A	Cold - Humid
3B	Warm - Dry	6B	Cold - Dry
3C	Warm - Marine	7	Very Cold
		8	Sub Arctic

Table 3. ASHRAE Climatic Zone Classification[18]

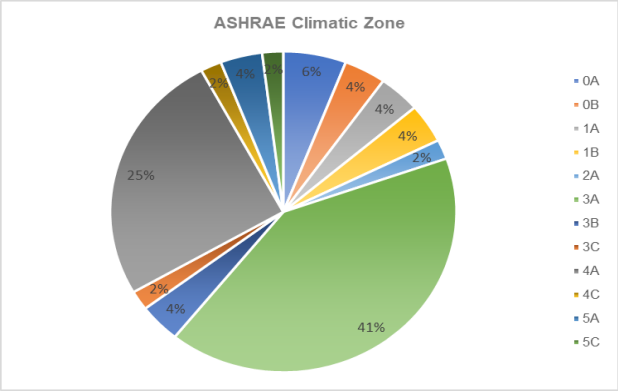

Figure 7. Number of articles based on ASHRAE Climatic Zone[18]

KOPPEN – GEIGER Climate Classification

Waldimir Koppen first proposed the quantitative climate classification in 1900 based on the world vegetation map. Rudolf Geiger updated the Koppen - Geiger classification map in 1936, 1954, and 1961. The first letter (A – E) is based on the five-vegetation group. The second letter specifies precipitation. The third letter indicates air temperature in a particular region.[18] Lastly, the polar regions are represented with the letters F and T as shown in Table 4. It is found that the climate zone Csa followed by Cfa, Cfb, and Dfa are highly focused areas. These areas majorly have a temperate climate and are primarily found in the cities of Italy, the USA, Japan, and Spain. Figure 8 gives graphical information about the percentage of articles belonging to the relevant climatic zones.

Main Climate	Precipitation	Temperature	Other
A - Equatorial	W - desert	h – hot arid	F – Polar Forest
B - Arid	S - steppe	c – cold arid	T – Polar Tundra
C – Warm Temperate	f - fully humid	a – hot summer	
D - Snow	s – summer dry	b – warm summer	
E - Polar	w - winter dry	c – cool summer	
	m - monsoonal	d – extremely continental	

Table 4. Letter indication for KOPPEN-GEIGER Climatic Zone Classification[19]

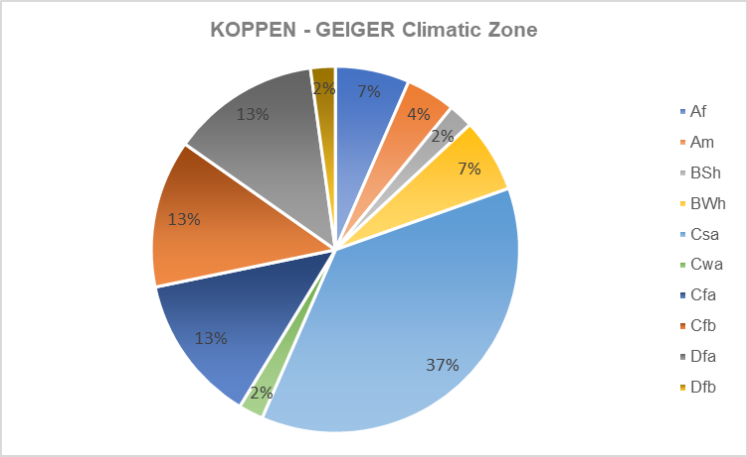

Figure 8. Number of articles based on KOPPEN - GEIGER Climatic Zone

OUTCOME AND DISCUSSION

Formation

Building envelopes are the major contributor to intensifying heat islands by adding an extra 3.7^{0}C to the environment.[19] One of the recent articles identifies that anthropogenic heat from HVAC is a major contributor, followed by envelope convection, zone infiltration, and exfiltration process.[20] Another article suggests that, especially in summer, the building surface's heat is more than the AC system.[21] Different scales, scenarios, and approaches of studies generate varied results. There is a need to analyze more situations simultaneously to create an appropriate ranking of contributing factors through the envelope, their comparison, and behavior in different climatic zones. All the studies significantly marked the contribution of the building envelope in the formation of UHI.

Mitigation

Outcomes of classified articles are discussed separately under each subheading.

Design Based Strategy

Design strategies are always there in research to maintain thermal balance by shading devices, cavity walls, insulating walls, double or triple skin façades, etc. The façade window-wall ratio is an effective strategy for reducing local air temperature in the canyon during winter, while in summer, the canyon aspect ratio (height of surrounding building/width of passage in between buildings) is an effective strategy.[22] Their diverse seasonal impact is essential to consider. Building roof orientation significantly impacts the reduction of external surface temperature. In contrast, the roof's typology (lightweight vs. heavyweight, insulated vs. non-insulated) shows a significant impact on internal surface temperature.[23] Using shape memory alloy with different geometry over façade leads to a reduction in absorbed solar radiation only in the case of an isolated standalone building. Considering results at the microclimate level is not significant as UHI includes multiple factors for its cause, and it's another matter of concern that should be discussed separately in future studies. Overall, a complex mix of parameters on the building envelope shows vast potential in maintaining thermal behavior and minimizing UHI.

Material Based Strategy

Cool/Highly reflective/Diffusive coatings

Cool coatings on building envelopes works on the action of decreasing albedo and shows highly reflective or diffusive behavior. In the case of mean external surface temperature, the cool roof (horizontal surface) reduces up to 10^0C. Still, it offers minimal impact on indoor surface temperature.[24] In contrast, in a different case, it shows a reduction of 2.6^0C in indoor operative temperature, and if coupled with a cool façade, it offers a reduction of up to 4.4^0C in indoor temperature.[25] Results vary because of different building typologies and surrounding microclimatic factors. The cool vertical surface shows a reduction of 1.3^0C in surface temperature and up to 0.4^0C in canyon air temperature.[26] Highly reflective material shows a 2.4% cooling load reduction with a 1% increase in heating load,[27] indicating better thermal performance in summer but not in winter. When translucent white marble is used as a cool material, total summer energy demand reduction is 10%.[28] Innovative cool materials are getting more consideration as they provide more detailed studies for particular wavelengths, either with the addition of infrared pigments or other combinations.[29]

With innovative materials, cool coatings on historical building envelopes also become possible as historical buildings have restrictions in altering their envelope as per conservation and preservation practices.[16] Considering thermal comfort and other parameters after applying cooling actions on building envelope in both outdoor and indoor environments should be explored more in future studies to analyze the cooling potential of new materials.

Green Cover

Increasing green cover is one of the effective strategies for reducing UHI.[30] Green roofs (horizontal surface) are proven valuable in maintaining thermal behavior, with other beneficial effects like, maintaining stormwater runoff.[31] A vertical greening system can reduce 10 - 14^0C in surface temperature, 0.7 – 0.9^0C in air temperature, 5 – 8% in cooling load, and most importantly, UHI intensity is reduced from 2.14^0C to 1.22^0C.[32] Applying green cover on a vertical surface (green wall or vertical façade) is catching attention with innovative measures. 100% green cover on wall protects solar radiation, and reduce space cooling load with better ventilation than 50% green cover, but increases space heating load. 50% green cover with 10 cm cavity is better in reducing cooling load as compared with 50 cm cavity space, as it helps in maintaining the thermal behavior.[33] In the case of glass façade,

100% green cover is more effective in reducing envelope thermal transfer value and decreasing mean radiant temperature compared to 50% green cover.[34]
One of the studies tried to develop a compact, lightweight smart bio façade, which reduced the exterior surface temperature by 3°C-3.5°C but did not significantly affect indoor temperature.[35] It is found that a green roof performs better than a green wall as green cover on the roof with dense vegetation and active irrigation resulted in the reduction of cooling load by 60%, while a green wall shows a reduction up to 40%.[36] Innovative green covers over different surfaces with variations in type, cavity, installation, and other parameters have potential for future studies. The cost-effectiveness, maintenance, and increase in winter heating loads raise the need to find out more efficient behavior of green walls.

Retroreflective

For building envelope coating, newly identified retroreflective materials are getting attention for mitigating UHI.[37] It improves the thermal behavior of façades by reflecting the solar radiation in the same direction, reducing the amount of trapped radiation[38] but only for a low angle of incidence. The application of retroreflective material on building façades can decrease the cooling demand from 8.1% to 16.1% but at the expense of a slight increase in heating demand.[39] The retroreflective performance of glass beads under high incident angles is inferior. The glass bead as retroreflective material with a refractive index of 1.9 and a white layer is one of the effective combinations.[40]
Bio-inspired retroreflective material is developed from the inspiration of the reflecting property of flower petals (Galanthus nivalis), reduces the total energy and cooling energy consumption of HVAC by 8.2% and 9.8%, respectively.[41] Practical application of these materials at different locations still needs to be tested in external weather actions.[42]

Comparative

Individually, mitigation strategies are proven beneficial in combating UHI, but in comparison, cool roofs are more effective than green roofs in minimizing the effect.[43] On a typical summer day, a cool roof can reduce heat gain by 37%, while a green roof reduces it by 31%.[44] The cool roof resulted in reduced external surface temperature by 15 - 25°C.[43] and have high mitigation potential than a green roof. Also, a green roof requires high maintenance.[44] Phase change material (PCM) based roof shows 54% lower heat flux to building interior and 40% lower sensible heat flux than the cool roof.[45] PCM stores thermal energy and helps in the reduction of heating, cooling, and energy demand.[46] 6" bamcrete (composite of bamboo and concrete) wall provided a cooling potential of 7.5 % compared to a regular 5" brick wall.[47] This study gave the idea that different compositions can be made with natural and local materials, and their behavior can be analyzed in comparison with passive strategies in different climatic zones.
Retroreflective material shows higher cooling potential than traditional diffusive coatings with a noticeable effect in decreasing circulating energy but only for the low angle of incidence.[48] It resulted in reduction of cooling demand but increase in heating demand by 8.1 % to 16.1 %[39] It behaves differently for different wavelengths received, while diffusive samples show the same property for every wavelength received.[49] The solar reflectance of retroreflective material is 62.8%, which is lower than the diffusive sample, which is 86.5%, and that is because the vertical surface temperature of retroreflective surface is found more.[50] Glass and Barium tiles shows robust retroreflective behavior for most of the incidence directions, showing the reduction in the UHI effect.[51] Retroreflective materials can target the effect by avoiding reflection getting trapped and is a more effective solution against the design[52] but seeks more research for varied scenarios, especially in case of high angle of incidence. Comparative studies for various measures can better understand the materials and their impact on

mitigating UHI in different situations, which are not explored as much as studies on single mitigation measures are done.[11]

CONCLUSION

Buildings are focused on mitigating heat islands as modifying temperature around them is difficult because of mixing a large proportion of the urban fabric. The building envelope is likely to reduce the effect and can foster both outdoor and indoor comfort. This is a review study in which the role of the building envelope has been discussed by classifying mitigation strategies in two domains (design-based and material-based), and articles are analyzed to understand the various approaches and scale of study. It can be seen how thermal and energy performance got affected by applying different measures to the building envelope. The most exciting area is how innovative actions and comparative studies produce significant results and show the future vision for application with varied techniques available in different scenarios. Various regions are identified for future studies and discussed with the outcome of the paper about the scope of the work based on available research in the specified domain. In conclusion, the building envelope holds immense potential in mitigating UHI with much research and technology. Much more innovation and comparison need to be explored.

Ref.	Mitigation Strategy	Approach	Result	Year
FORMATION				
20	NA	Simulation	UHI intensity is more in commercial as compared to residential building.	2022
19	NA	Experimental, Simulation and Statistical	Building envelopes are found major contributor for increasing heat island, max to 3.7°C, followed by AC systems that contribute up to 1.4°C.	2022
FORMATION & MITIGATION				
21	Cool Coatings and Insulation	Statistical and Simulation	Reduction in release of heat up to 63% is found with a cool roof, significantly higher than improving transmittance which makes the reduction of 1%.	2016
MITIGATION				
Design Based Strategy				
22	Façade WWR and Other Properties	Simulation	In summer the canyon aspect ratio was found to be an influential parameter and shows a reduction of 11^0C, while in winter the facade WWR was found to be an influential strategy and shows reduction of 40^0C.	2020
56	Overhang Devices (For Shading)	Experimental and Simulation	With the use of overhang, reduction in outdoor insolation with a significant difference of 2.8% is achieved, with a major effect on the south side of the building.	2014
23	lightweight and heavyweight roofs	Simulation	For the external surface temperature, North-facing heavyweight not insulated roof shows the best thermal behaviour and for the internal surface temperature, the North-facing heavyweight insulated roof shows the best summer thermal behaviour.	2020
52	Shape Memory Alloy	Simulation	The geometry of shape memory alloy shows the reduction in reflected solar radiation at street level.	2022
Material Based Strategy				
Cool/Diffusive/Highly Reflective				
24	Cool Roof	Experimental and Simulation	A reduction in mean outside surface temperature is found to be more than 10^0C in case of high temperatures.	2011
27	Highly Reflective Material	Experimental and Analytical	When solar reflectivity increased from 0.1 - 0.9, outdoor surface temperature got decreased by 0.5^0C.	2019
53	Cool-coloured concrete prototypes	Experimental and Statistical	Addition of infrared reflective pigment in sample increases reflectance in comparison with white and non-infrared and provides better thermal behaviour.	2017
54	Innovative Cool Material	Simulation	Envelopes with lower thermal transmittance and reflectance resulted in higher air temperature in range of 32.2°C to 35.8°C.	2017
57	Traditional clay tiles	Experimental and Simulation	Sheathing ventilation above clay tile is found to be an effective strategy in reducing roof temperature.	2019
26	Diffusive Cool Materials	Experimental and Simulation	A reduction of up to 1.3^0C in canyon surface temperature and up to 0.4^0C in air temperature has been found.	2018
16	Innovative Cool Material	Experimental and Simulation	A reduction in heat stress is found with combination of the cool red envelope and cool grey pavement.	2017
25	Cool Coating	Simulation	Cool painting shows maximum reduction of 4.4°C.	2017
28	Translucent Envelope	Experimental and Simulation	With the use of translucent envelope total yearly site energy demand reduced by 4%.	2017
Green				
32	Vertical Greening System	Experimental	A reduction in cooling load is found 5 - 8% with drop of 0.7 − 0.9^0C in air temperature, 10 - 14^0C in wall surface temperature and 43% in UHI intensity.	2017
31	Vegetated Roof	Simulation	Green roof along with maintaining thermal fluctuations and energy consumption, is also beneficial in mitigating stormwater runoff.	2018
34	Vertical Greening System	Simulation	For glass façade, 100% green coverage is effective in decreasing the mean radiant temperature.	2009
58	Vegetal Façade	Simulation	With vegetal facade, there is significant increase in the thermal delta of 11^0C. By modification of albedo range, surface temperature of pavement decreases by 10^0C.	2020
36	Green roof and green living wall	Experimental	A reduction in cooling load is found up to 60% with green roof while green wall shows a reduction up to 40 %.	2018
35	Bio-green wall system	Experimental	Bio façade shows reduction in exterior surface temperature by ±3°C-3.5°C but no major effect on indoor temperature.	2019

33	Vertical Garden	Simulation	With 100% green façade, protection against solar radiation is achieved and use of space heating increases.	2021
59	Living Wall with insulative layers	Experimental and Simulation	Best performance of living wall with insulation came on the south-facing wall, where cooling energy reaches 66%.	2012
Retroreflective				
60	Retroreflective Material	Experimental and Simulation	It is found that only 1% heat loss evaluated through sides of plate of 700 mm, with very little change in wind speed.	2015
61	Retroreflective Material	Experimental and Simulation	A retroreflective sample with a refractive index of 1.9 is most effective than the other retroreflective samples of different refractive indexes.	2016
62	Retroreflective Material	Experimental	It is found that the south surface is mostly influenced by the dependence of its reflectance on the angle of incidence of the solar direct radiation.	2018
55	Retroreflective Material	Experimental	Prism array retroreflective is found more effective than other glass bead retroreflective samples and glass bead retroreflective sample with white layer and refractive index 1.9 is the next most effective solution.	2016
42	Retroreflective Material	Experimental and Simulation	Capsule sheet and prism are found to have higher angular retro-reflectivity than other glass beads retroreflective samples.	2019
41	Bio Inspired retro reflective	Simulation	A reduction of 8.2% and 9.8% is found in the total energy consumption and cooling energy consumption of HVAC.	2015
Comparative				
63	Cool and Green with traditional	Experimental and Simulation	Cool roof or a combination of cool and green roof shows better performance as compared with the combination of green and traditional material.	2019
43	Green and Cool	Simulation	Cool roofs are more suitable for external surface temperature reductions ranging from 15 - 25 ^{0}C.	2016
44	Green and Cool	Simulation	Cool roofs have a higher mitigation potential compared to green roofs and reduced heat gain by 37% while green roof reduced heat gain by 31%.	2018
45	Cool Roof and PCM Based Roof	Simulation	PCM roof resulted in 54% lower TRHG flux (i.e., heat flux to building interior through the roof) and in 40% lower sensible heat flux than cool roof for several albedo value.	2016
47	Bamcrete (bamboo concrete)	Simulation	6" bamcrete wall shows maximum cooling potential of 7.5 % in comparison with regular 5" brick wall.	2018
50	Retroreflective and diffusive	Experimental	Retroreflective material has cooling potential in urban canyons but has higher vertical surface temperature in comparison with diffusive sample because of solar reflectance of RR material is 62.8%, which is lower than the diffusive sample, having 86.5%.	2015
49	Retroreflective and diffusive	Experimental	Retroreflective material behaves differently for different wavelength received while diffusive samples show diffusive properties same for every wavelength received.	2017
51	Retroreflective and Traditional clay tiles	Experimental and Analytical	It is found that the retroreflective behaviour of barium tiles is the best with the highest global reflectance, while its potential different latitudes and orientations changes.	2018
48	Retroreflective and diffusive	Experimental and Simulation	Retroreflective material shows higher cooling potential as compared with traditional diffusive coatings and a noticeable effect in decreasing circulating energy in the canyon but only for the low angle of incidence.	2015
39	Retroreflective and diffusive	Experimental and Simulation	It is found that cooling demand decreases from 8.1 % to 16.1 % with slight increase in heating demand with adoption of retroreflective material on building envelope.	2018

Table 1. Summary of Reviewed Articles

NOTES

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INVESTIGATING THE CREATIVE OPPORTUNITIES OF OUTDOOR PLAY SPACES FOR CHILDREN IN URBAN RESIDENTIAL AREAS- A CASE OF BAREILLY, INDIA

Author:
RICHA RAJE, TANYA KANSAL

Affiliation:
SCHOOL OF PLANNING AND ARCHITECTURE BHOPAL, INDIA

INTRODUCTION

'Play' is basically the means whereby children learn to be people who can live with themselves, learning and enriching themselves in their experiences, and also can learn to live with others.[1] It is an essential part of childhood as it is crucial for children's physical, cognitive, social and emotional development. Children can convert almost any activity into play. Whether it is a routine chore like sweeping, dusting, cooking, eating food, or even washing one's hands, children can transform the dull routine into pleasurable play. Children also have a remarkable ability to create their own play space, be it crowded hovels, community lanes, alleys, construction sites or even the traffic infested street, improvising play materials with whatever is accessible in their environments, be it sticks or stones, or tins and trash. [2]

Presently, there are 472 million children in India under the age of 18 years, representing 39% of the country's total population. By 2050, about 70% of the world's population will live in urban areas and children currently living in urban areas account for nearly half of the world population.[3] The urban play areas in India have become highly structured, monotonous, repetitive, and providing limited opportunities whereas the nature of children is of unstructured play which allows the scope of discovery, exploration, creativity and risk taking. Throughout history, children used to flee to the nearest natural features for playing- whether a water body or a big tree and a continuous connection with nature was observed. But today's urban child's life has become highly indoors and play has become a pastime rather than an inherent nature of the child. The interaction with natural environment enhances a child's empathy and compassion towards nature. To secure our future, we have to develop generations of compassionate individuals and therefore, provision and interaction with the natural elements is the need of the hour.

It is a child's fundamental right to play as enshrined in Article 31 of the UN Convention on the Rights of the Child (UNCRC, 1992) ratified by several countries including India.[4] Some other steps for children's play at national level are Child friendly city initiative under Smart City Mission, AMRUT reforms, URDPFI guidelines for open spaces and Infant, Toddler and Caregiver-Friendly Neighbourhoods (ITCN) guidelines. These schemes and their guidelines mainly focus on walkability, accessibility, provision of impermeable pathways, and provision of open green space with certain area requirements. Interaction with nature is given less concern and there is no study related to how children use spaces. Only quantitative aspects have been considered whereas children's physical and social environment requires to be understood qualitatively rather than just quantitative methods.

Being a child is a fluid and a constantly changing process. Whatever a child is capable of doing today, they might not have achieved yesterday; whatever they will be doing tomorrow, they might not do today. The conventional play spaces and the Indian play guidelines do not reflect on the need of the children. This is leading to one of the factors which is restricting the children to play indoors in urban areas, along with the other major factors of urban densification, digitalization, security concerns and the recent pandemic. There is a need to develop a better understanding of how the physical and social environment supports or hinders the different types of play which influences children's behaviour and development.

Creative Quotient

Based on an article in the Creativity Research Journal, "The Creativity Quotient: An Objective Scoring of Ideational Fluency" by Allan Snyder, John Mitchell, Terry Bossomaier and Gerry Pallier, a classical test for assessing the potential creativity of an individual is based on ideational fluency, where a person is asked to generate all possible uses for a familiar object like a piece of paper.[5]

Affordance

Another similar concept is the Theory of Affordance given by psychologist J.J. Gibson, which says the affordances of the environment are what it offers the animal, what it provides or furnishes, either for good or ill.[6] The theory says that all mediums, substances, surfaces, objects, places and even persons afford or provide some or the other opportunities for the user/observer.

Taxonomy of affordances

According to Harry Heft, the affordance of children's outdoor environments can be categorized into a taxonomy consisting of 10 categories: flat, relatively smooth surface; relatively smooth slope; graspable/detached object; attached object; non-rigid, attached object; climbable feature; aperture; shelter; moldable material; and water.[7] Another category of sociality was added by Marketta Kyttä to the taxonomy.[8]

Types of affordances

The affordances can also be evaluated in two ways: objective affordances and subjective affordances. Objective affordances are the potential possibilities created by the space components, which the designer brings to the environment for the activities designed for the users. Subjective affordances are the ones that are formed together with users' creativity and skills to use for the spatial components.[9]

Level of affordances

All environments have countless numbers of "potential affordances" that no agent has yet perceived. Once the potential affordances are encountered through the individual's independent mobility, action, and perception in the environment, they are known as "actualized affordances".[10] For example, a mound has uncountable number of potential affordances, but only some potential affordances are actualized by children at some point of time such as, climbing, sitting, standing, etc. Actualized affordances can further be divided into perceived, utilized and shaped affordances. Perceived affordances are what an individual recognizes when observing the environment, and they determine the usability and functionality of the environmental features. Utilized affordances are the opportunities that exist and can be occupied through direct physical interaction with the environment. Shaped affordances involve the manipulation of environmental features, which change the environment's properties – either functions or forms.[11]

With this study of creative quotient and affordances, the author is assuming that higher affordances ensures higher creative quotient.

AIM AND OBJECTIVES OF THE STUDY

The study aims to investigate the diversity of play affordances for children's creative development in outdoor play spaces of urban residential areas.

The objectives of the study are-

1. To assess the play potential offered by outdoor play spaces for children to play in the neighbourhood.
2. To investigate the affordances of natural landscape elements v/s man-made elements.
3. To compare children's preferences of the outdoor play spaces in comparison to the present situation.

By achieving these aims and objectives, this study will help designers to understand the qualitative requirements of children play environment.

Methodology

For the study, data collection was done by doing a traverse survey and photographic documentation of the neighbourhood. The methods included behavior mapping through observations which further led to the quantification of affordances and photographic survey. The data was then analyzed and some interpretations were done with the same which finally led to the results of the study.

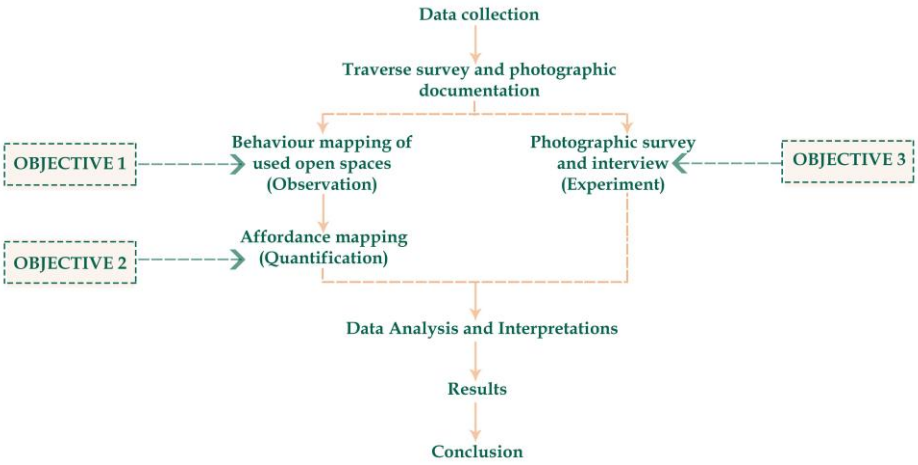


Figure 1. Methodology of the study

SITE AREA STUDY

The site selected for the study comprises of the colonies of Ekta Nagar and D.D. Puram located in the Bareilly district of Uttar Pradesh. The site was selected as it is comparatively a newer residential area of the city and therefore a prototype of all upcoming residential developments in the region.

The area has a flat terrain forming a part of the middle course of riverine landscape of central Indo-Gangetic plains causing silt deposition over large area. Soil type found here is Bhanger soil which is the older alluvial soil found in upland areas less prone to flooding. Bareilly has a composite climate with temperature ranging between 4º C in winter to 44º C in summer. The average rainfall recorded here is 1050 mm.

The site has a total area of 100.2acres (405390sqm.), accommodating a population of around twelve thousand. The building heights of the neighbourhood range between 9 to 12m.

The survey was done for a period of 5 days in the month of January, 2022. The time duration of the traverse survey and photographic documentation was from 4pm to 5:30pm in the evening. A total number of 31 middle-age children (6-12years old) were observed and interviewed.

Site Surroundings

The defined open spaces of the neighborhood consists of a linear neighbourhood level park(Park A-2.7 acres), three housing parks(Park B- 1.3acres, Park C- 1.1acres, and Park D- 1.5 acres), some small pocket parks and a district stadium which accommodates structured sports as shown in Figure 2. Other open spaces include some privately owned vacant lots left for future development and some parking spaces of school and banquet hall.

Figure 2. Open spaces and number of children on site

To study the usage pattern of the open spaces, the site survey was done by categorizing the users into different age-groups namely adults (above 18years old), teenagers (13-18 years old), middle age children (6-12 years old) and toddlers and pre-schoolers (0-5 years old). PARK B and PARK C were observed to be the most active zones, accommodating the largest number of children's activities as shown in Figure 2. The children's activities could also be seen on the some of the streets of neighbourhood. Middle age children were seen to be the most active and having a variety of activities, therefore the further study focused on a detailed behavior mapping of middle age group children present in Park B, C, and D.

Basic Observations

The total population of the neighbourhood is around twelve thousand, out of which around three thousand are children between the ages of 0-18years. The middle age children (6-12years old) are around one thousand-six hundred, and it was observed that only eighty to hundred i.e. 5.6% of middle age children are seen outdoors on a typical evening which is a really alarming situation. And the male-female ratio among them is even worse with 74.2% boys and 25.8% girls.

Behaviour mapping

The behaviour mapping of middle age children (6-12years old) was done in Park B, C and D. The time duration of the site observations was from 4pm to 5:30pm in the evening. The number of children observed in Park B, C and D were 15-20, 15-18, 8-10 respectively. The play activities of the children were assessed by categorizing them into physical, social, constructive, fantasy and games with rules as shown in the three maps of Figure 3. Certain major and minor pause points of children were also observed and recorded. The affordances of the various elements of the environment which were actualized by the children were also mapped based on the functional taxonomy by Harry Heft and Marketta Kytta as shown in Figure 4.

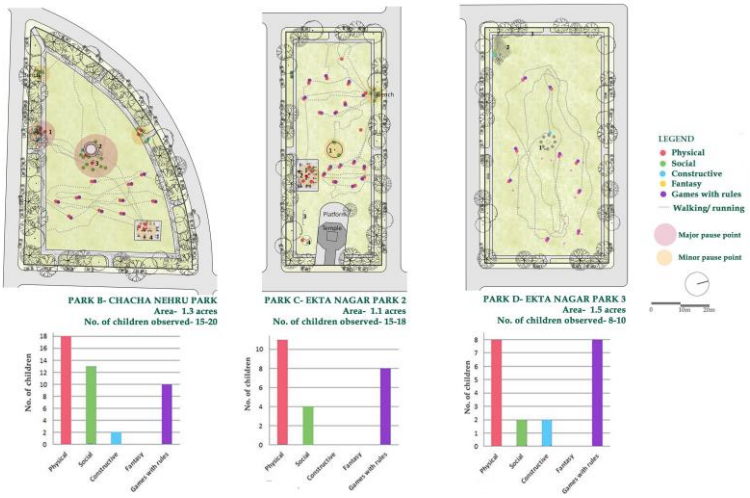


Figure 3. Behaviour mapping

Figure 4. Quantification of affordance

Photographic survey

An experiment using a photographic survey was done in the three parks- Park B, C and D. In the survey form two images (one natural and one man-made) of each of the eleven elements based on functional taxonomy of affordances (flat, relatively smooth surface; relatively smooth slope; graspable/detached object; attached object; non-rigid, attached object; climbable feature; aperture; shelter; moldable material; water; and sociality) given by Harry Heft and Marketta Kytta were included. The total number of images included were twenty two- 11 man-made elements and 11 natural elements. One form was provided to each child and they were asked to put a tick mark in front of any ten of their favourite items. The total number of participants in the survey was 31, between the age group of 06-12 years. The percentage of participants from Park B, C and D was 38.7%, 32.2% and 29% respectively. Among these 74.2% were males and 25.8% females as this was the general male-female ratio present in the outdoor spaces of the neighbourhood.

RESULTS

Types of Play Statistics

The results of the types of play observed in the three parks show that all the three parks mostly accommodated physical play and games with rules. There were no incidences of fantasy play observed in any of the parks. And even there were very few events of constructive and social play, which shows that there is lack of opportunities for social, constructive and fantasy play in the parks.

Actualized Affordance Quantification

On quantifying the number of actualized affordances by the children for different elements, it was observed that in Park B, the attached objects such as tree with aerial roots, shelter, railing and light pole platforms were providing the maximum number of actualized affordances and acting as pause points. Also, in Park C, the attached objects were providing the maximum number of actualized affordances and acting as minor pause points. In Park D, graspable/detached objects such as twigs, large stone, and garbage were providing the maximum number of actualized affordances.
Most of the attributes are not present in Park C and D showing less creative opportunities in the parks.

Results of Actualized Affordances of Natural v/s Man-made elements

On comparing the number of actualized affordances of natural elements and man-made elements following results were observed, also shown in Figure 5.

- Subjective affordances are higher than objective in both cases showing that the elements can provide various other opportunities along with the ones it is designed for. The results also show that subjective affordances of natural elements are much higher than man-made elements.

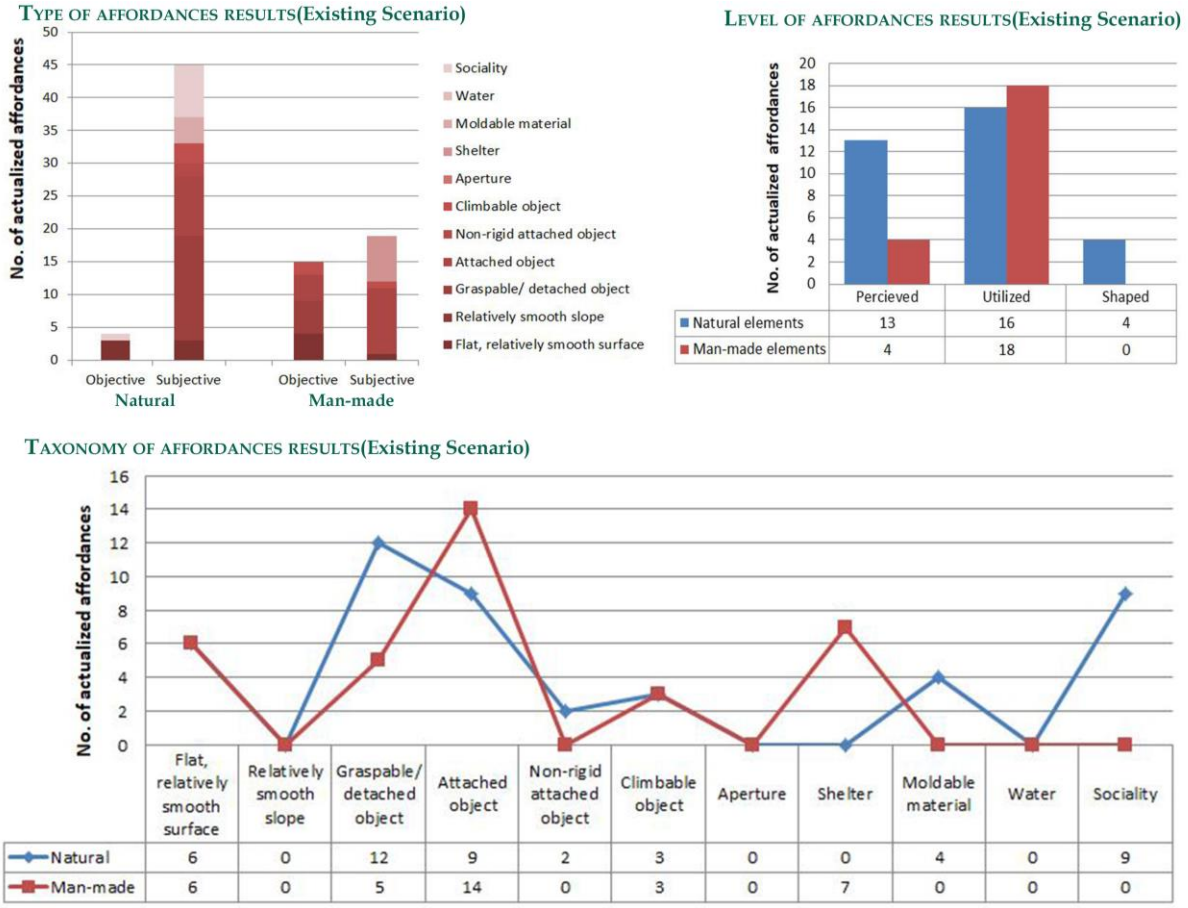


Figure 5. Actualized affordances results

- On comparing based on the taxonomy of affordances, the results show that most of the natural elements proved to be offering more affordances except attached objects, and shelter which shows the variety of opportunities the natural elements provide. The results also show that various attributes such as relatively smooth slope, aperture and water are not yet present on the site. And non-rigid attached object, shelter and moldable materials are present in very few places.

- Among perceived, utilized and shaped affordances, utilized affordances were the most observed whereas shaped were the least. There were more perceived and shaped affordances observed for natural elements, and more utilized for man-made. The results show that there is a need to incorporate moldable elements both natural and man-made to increase shaped affordances.

Results of Photographic survey

On comparing the number of children who were actually interacting with the elements of the taxonomy with the number of children who preferred interacting with those elements when asked in photographic survey, a wide gap was observed as shown in of Figure 6. This shows the placelessness and lesser creative opportunities in the outdoor spaces which might be one of the major factors of the huge number of children being indoors and there is an urgent need to fill this gap. And here comes our role that we as landscape architects and designers can and should create much more engaging and interactive outdoor play spaces for children.

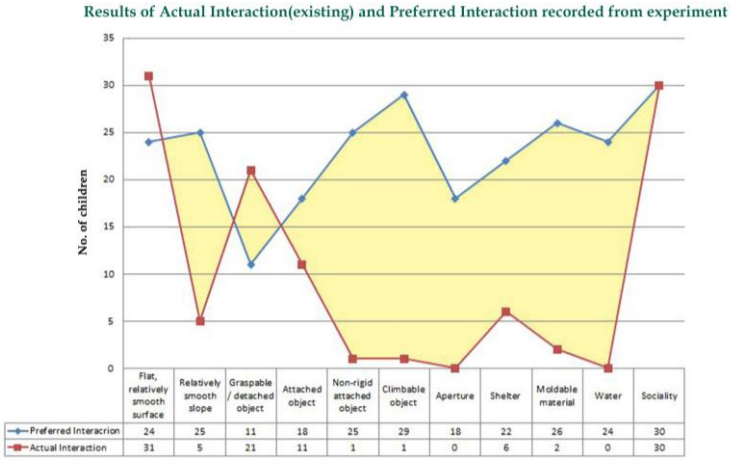
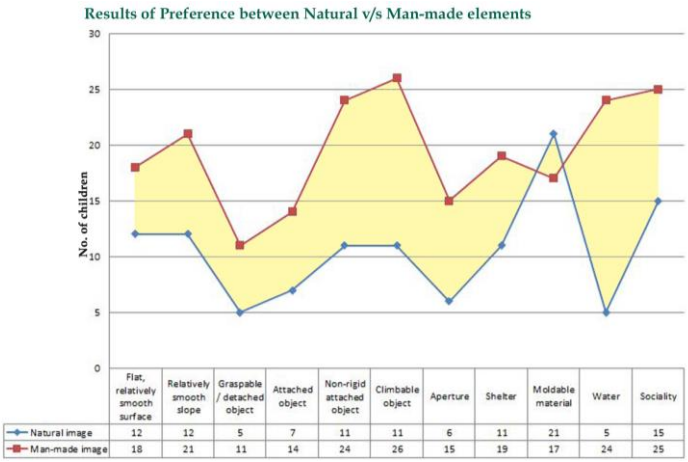


Figure 6. Photographic survey results showing comparison of actual and preferred interaction

The survey also showed a continuous gap between the preference of man-made and natural image as most of the children selected man-made images when asked for their preference as shown in Figure 7. This result was alarming and led a further enquiry. A round of informal interviews was done with following question- "Which of these activities have you performed?"

The answers conveyed that most of the children have never done the activities portrayed in natural images. Some of them, who had done those activities at some point of time, have chosen the natural images. This showed the unfamiliarity of the children with natural elements. Therefore, we can conclude that the children are facing Nature-deficit disorder (a term used by Richard Louv[12] to define the disconnection of children with nature) (Louv) and there is an urgent need to reconnect them with nature.



	Flat, relatively smooth surface	Relatively smooth slope	Graspable / detached object	Attached object	Non-rigid attached object	Climbable object	Aperture	Shelter	Moldable material	Water	Sociality
Natural image	12	12	5	7	11	11	6	11	21	5	15
Man-made image	18	21	11	14	24	26	15	19	17	24	25

Figure 7. Photographic survey results showing preference between natural v/s man-made elements

Further, the highest voted images of the children were sorted out and using them the attributes of the environment they preferred were interpreted. This showed that children preferred climbable, adventurous objects, social connectedness, graspable loose objects, sensory play elements like water, non-rigid attached object, manipulative and moldable materials and accessible level differences.

On analyzing the preferences of the female children separately, it was interpreted that they preferred more sensory, imaginative, manipulative, constructive and social play. They didn't want more physically intensive play. They want light physical activities such as climbing rocks. Such light physical opportunities, sensory elements and manipulative materials are not present on the site, which might be one of the reasons of resistance of girls to play outdoors.

CONCLUSION

The comparison between the actualized affordances of natural v/s man-made elements showed that the natural elements were offering more diversity of affordances and hence, more creative opportunities for children to play. These results indicate a positive correlation between creative opportunities and natural elements. However, the open spaces are present, the children are restricted indoors and the ones outdoor show a wide gap between actual and preferred interaction with the environment which indicates lack of creative play opportunities in the overall space design corresponding to lower creativity in children. Lack of free play opportunities, especially constructive, fantasy, imaginative and sensory play, which are light physically intensive is leading to one of the reasons for the large gap between male and female ratio of children found outdoors. The study also showed the unfamiliarity of children with nature leading to nature deficit disorder.

Therefore, through the study we can understand that there is a need of re-naturalizing the play environment by restoring the lost connection with nature and developing diverse urban residential landscape by increasing the creative play opportunities of outdoor spaces for children's holistic development. This study will further help the landscape architects, designers, planners and policy makers to develop outdoor play spaces which inspire the creative relationship of children and nature for a holistic development.

NOTES

[1] William D. Abernethy, *Concepts of Play* (Taylor & Francis Ltd., 1974), 311.
[2] Meera Oke, Archna Khattar, Prarthana Pant and T.S. Saraswati, *A Profile of Children's Play in Urban India* (Sage Publications,1999), 207.
[3] Kirti D. Bhonsle and Vinayak S. Adane, *Assessing the Play Provisions for Children in Urban Neighborhoods of India: Case Study Nagpur, Maharashtra* (Buildings, 2016), 2.
[4] *Article 31, Convention on the Rights of the Child* (United Nations Convention on the Rights of the Child-UNICEF, 1989), 9.
[5] Allan Snyder, John Mitchell, Terry Bossomaier and Gerry Pallier, *The Creativity Quotient: An Objective Scoring of Ideational Fluency* (Lawrence Erlbaum Associates Inc., 2004), 415.
[6] James J. Gibson*, The Theory of Affordances* (Taylor & Francis, 2015), 119.
[7] Harry Heft*, Affordances of Children's Environments: A Functional Approach to Environmental Description* (University of Cincinnati, 1988), 36.
[8] Marketta Kyttä, *Children In Outdoor Contexts Affordances and Independent Mobility in the Assessment of Environmental Child Friendliness* (Helsinki University of Technology Centre for Urban and Regional Studies, 2003), 63.
[9] Serap Yılmaz, Sema Mumcu, Abdullah Çiğdem, *Determining The Affordances Provided by Urban Open Spaces to Different Age Groups* (Gazi University-Journal of Science Part B: Art, Humanities, Design And Planning, 2017), 3.
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[12] Richard Louv*, Last Child in the Woods: Saving Our Children From Nature-Deficit Disorder* (Algonquin Books of Chapel Hill, 2005).

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UNDERSTANDING THE RAMIFICATIONS OF OVER-DEPENDENCE OF DAM AND PROPOSING ALTERNATE STRATEGIES TO DAM THROUGH CHANGE IN LANDSCAPE MEASURES

Author:
SHREYA SINGH, RICHA RAJE

Affiliation:
SCHOOL OF PLANNING AND ARCHITECTURE BHOPAL, INDIA

INTRODUCTION

Dams are the man-made structure which acts as a barrier for the natural flow of rivers, surface water or underground streams. These dams create reservoirs and not only help in flood management but also helps in managing the water resources for the communities in agriculture and farming, food production, water supply for drinking and household chores, sanitation and hygiene, etc. The dams have an average life expectancy of 100 years.

Many dams in India have crossed their life expectancy and many others are there with a lot of pressure on the dam due to siltation and increased water volume during monsoons. As sediments are being collected in the reservoir of dams, the reservoir cannot hold as much water. It obstructs the surge control dam's capacity to capture flood water effectively. So, it is felt much essential now to work out feasible arrangements and provide sustainable solutions for managing this volume and pressure discharge from dams.

Rivers are not flowing naturally as of the present condition due to construction of dams in the main course of river. Large rivers are usually dammed which causes the main disturbance in the flow regime of the river. These dams cause many ill-effects to the environment like Habitat fragmentation, negative impact on water body on which it is built, decrease of ground water table, downstream sediment erosion and prove to be a risk to the environment and overall biosphere.

This paper uses a detailed landscape assessment approach and identifies vulnerability of landscape of the dam. Potential opportunities have been identified to restore its strength. Alternate strategies to dams have been proposed for storing and ensuring the availability of water through change in landscape measures.

METHODOLOGY

The paper begins with the detailed study on dams and its impact. To substantiate the negative impacts, case examples of dam failures have been studied to understand the catastrophe they have caused and the impacts they have imposed. Then a case of Hirakud Dam was taken to understand the challenge and issue it is facing and the impacts it has on the environment. After understanding the ramifications of Hirakud dam, the need to replace the dam with alternative landscape strategies and techniques has been proposed.

IMPACTS OF DAM

Although dams have played crucial role in the development of civilizations yet their existence are contentious. The dams do not address the issues and threat they pose on to the environment like implications of water supply, flood risk, health, agriculture, energy generation and aquatic ecosystem health.[1] The dam's impact is not only about the technical designs, but the environmental and social impacts of it are the main driving factor for the existence of dams in this era.[2] Per capita water availability is also expected to reduce due to population growth[3]. Hence, dams need to be relooked upon now due to the threats which they pose.

Some of the major impacts of dams are:

- Habitat Fragmentation: The dams cause hindrance to the movement of fish population along the river. The aquatic food chain is disturbed and ultimately the entire aquatic ecosystem is disturbed.[4]
- **Impact on water body:** As these dammed rivers does not flow freely, it does not allow the river to carry the sediments downstream and as a result of which it gets deposited in the dam.
- Impact on ground water table: The river beds does not get enough water for recharge of ground water table. During monsoons, the speed of flow of river is so high that the recharge through river bed percolation is very less and hence the underground water table remains less and is negatively affected.
- Downstream sediment erosion: The decrease in sediment load leads to erosion in the downstream and ultimately leads to deepening and narrowing of river bed over time.
- High price and risk for disaster: Every dam also has a life span, after completion of life span of any dam, it starts becoming vulnerable.

Case examples on dam failure and conflicts

Name of Dam	Year of operation	Year Of Fail-Ure/conflicts	Capacity of dam	Reason of failure of dam/ Reason of conflicts of dam	What happened after failure? / How are conflicts addresses?
Machhu dam, Gujrat	1959	1979	101,020cubicdecameters	Because of incorrect structural design and unpredicted surge of monsoon storm.	Reconstruction of the dam was done with four times increase in spillway capacity
Tigra dam failure, Gwalior	1917	1917 & 1970	4.8M cubic meters	Infiltration. It also led to destruction of numerous lives and properties.	Reconstruction of the dam
Chang dam, Bhuj	1959	2001	370m L, 15.5m H	liquefaction of the soil underneath	No reconstruction
Fatehgarh dam, Gujrat	1979	2001	7.45M cubic metre	liquefaction of the soil underneath	No reconstruction
Sardar Sarovar dam	2017	2019-full capacity	9.460 km^3	The dam reached its maximum storage capacity of 138.7m in 2019.	Siltation in the reservoir, erosion in the catchment, Displacement of people, Submergence of forest

Table 1. Summary of case studies on dams which have undergone any kind of failure or conflict.

Conclusion from case studies:

Dams have many more negative impacts than the positive. In the long run, it can never prove to be a solution for the ecosystem and Dams are not the answer. It's not just a blanket statement, but after doing case assessment of the dams above, we have come to a conclusion that mostly all dams have outlived their purpose.

HOW DAMS HAVE BECOME A FACTOR OF RISK?

Dams have become a factor of risk: According to ICOLD (International Commission of Large Dams), India is ranked 3rd in the world for having the larger number of dams. According to ICOLD, India has 5701 large dams and 1000 more medium and small dams.

1. By 2025, 64 large dams will turn 125 years, 301 large dams will turn 75 years,237 large dams will turn 65 years and496 large dams will turn 50.[5]
2. So overall, about 3880 large dams of India will be between 50years and 100 years i.e., it means they would have crossed their life expectancy.

India's differently aged 5,000 large dams are located in different geomorphological and agro-climatic regions and have been exposed to changes in land use and land cover over many years. The sedimentation rates as well as storage capacity across dams varies both spatially as well as temporally within the lifespan of a dam.

CHALLENGES FACED BY DAMS

1. Space to build large dams is shrinking: The per capita storage capacity in India is very low with its existing large dams.Thus, any plan to tackle future crises with the assumption of higher per capita storage cannot be implemented realistically in India.

2. Many of India's dams are very old: Thus, about 619 large dams have already crossed the age of 50 years as of 2015. They are thus highly vulnerable to wear and tear and decrease in water storage capacity.
3. Design standards and construction practices vary widely among India's large dams: Aging dams are thus highly likely to not be remedied or fortified, raising serious concerns about their ability to withstand the impending water crisis.
4. Many large dams in India are structurally vulnerable: This differential ageing and deterioration of different parts of the dam can greatly affect the efficiency, water storage capacity and the safety of a dam in the long run.
5. Lack of information on dam ageing & Lack of information masks the real water situation in the country.

CASE EXAMPLE OF HIRAKUD DAM

The Mahanadi basin extends over an area of 141,589 km2 which is nearly 4.3% of the total geographical area of the country.Hirakud reservoir is built on 16th order stream of Mahanadi River and the upper and middle sub-basin of Mahanadi acts as catchment area for Hirakud dam which is 92Lakh Hectares.

Figure 11. Map showing the Mahanadi River basin (catchment of Hirakud dam)and the reservoir of the dam.
Source: Government of India, Ministry of water resources, Mahanadi basin, March 2014, NRSC, Hydrology and water resources Information System for India; Open street map. [6]

Oldest dam of India(1957) since post-independence period. Along with flood management, it was also built to fulfil other objectives of hydropower production and irrigation and navigation.

Major issue faced by Hirakud dam

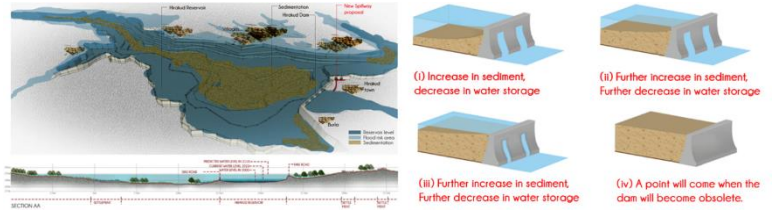

Figure 12. Issue faced by Hirakud dam: Sedimentation
Source: Author

Due to sedimentation, there is loss of storage capacity in the reservoir which is leading to shortage of the storage capacity of water. It is also causing the water to spill out from the reservoir area and cause flooding in the nearby area of the reservoir leading to the submergence of settlements and agricultural field.

At present, the water level of the reservoir stands at 629.52ft against the maximum storage capacity of 630 feet. The inflow capacity has increased by over 1 lakh cusec. This map shows the predictable future scenario if the sedimentation is not addressed. It will lead to flooding in the reservoir surrounding submerging various habitable and agricultural lands leading to its destruction.

Solution for addressing sedimentation

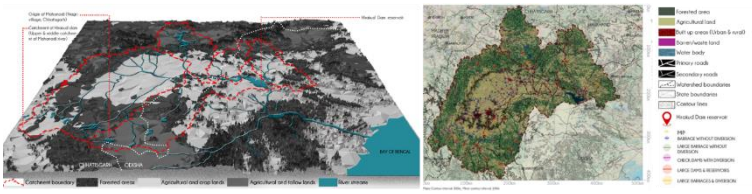

Figure 13. catchment of Hirakud Dam (3D and plan);
Source: Author

Solution: This can be done by incorporating better water management practices, along with sediment management techniques, to reduce the sedimentation rate into Hirakud Reservoir by Landscape management of the entire watershed of the Hirakud dam.

SYNTHESIS OF ISSUE IDENTIFICATION IN THE CATCHMENT OF HIRAKUD DAM

Issues considered after analysis of the entire catchment of Hirakud dam for synthesis are:

- Fragmentation of river: Dying of the river and also affects soil health, vegetation, fauna, risk of human life due to floods, ultimately leading to soil erosion and siltation in the reservoir bed.
- Encroachment on flood plain
- Vegetation degradation
- High Erosion susceptible areas
- Water quality risk and water scarcity risk areas

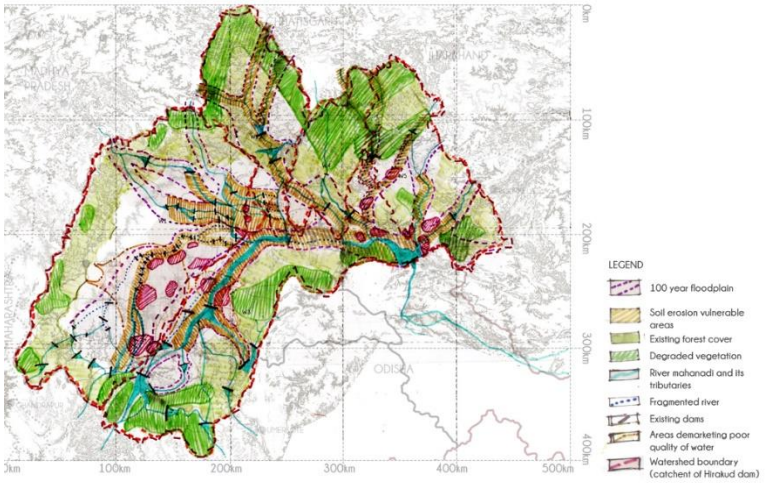

Figure 14. Synthesis map of Hirakud dam catchment showing the major issues faced by the dam
Source: Author
This map has been made to identify the major issues faced by the catchment of the dam.

REMEDIAL MEASURES THROUGH ALTERNATE SOLUTIONS: ENGINEERING SOLUTIONS OR NATURE-BASED SOLUTION?

Engineering solutions includes removal of sediments from the reservoir bed: Dredging, Drawdown flushing and addition of spillway, while Nature based solutions includes landscape management of entire watershed of dam: No construction should be done in the 100-year floodplain zone in order to ensure that the main existing river works; Proper buffer should be made along the streams of the main river and existing river; Discouraging channelization of water body; Implementation of nature based alternate solutions in the catchment for proper functioning of the dam.

Engineering solutions are temporary and cause environmental damage, while nature-based solutions are permanent sustainable solutions. These strategies need to be implemented at a larger scale and they help in minimizing the ill effects of dam on environment.

ALTERNATE STRATEGIES FOR DAMS: NATURE BASED SOLUTIONS

After making the synthesis map, critical areas were identified for which were in need of remedial measures. Then after this stage, Landscape management strategy plan is made to identify the solutions which needs to be implemented in these critical areas of the watershed of Hirakud dam.

The following map illustrates the Landscape Management Strategy Plan:

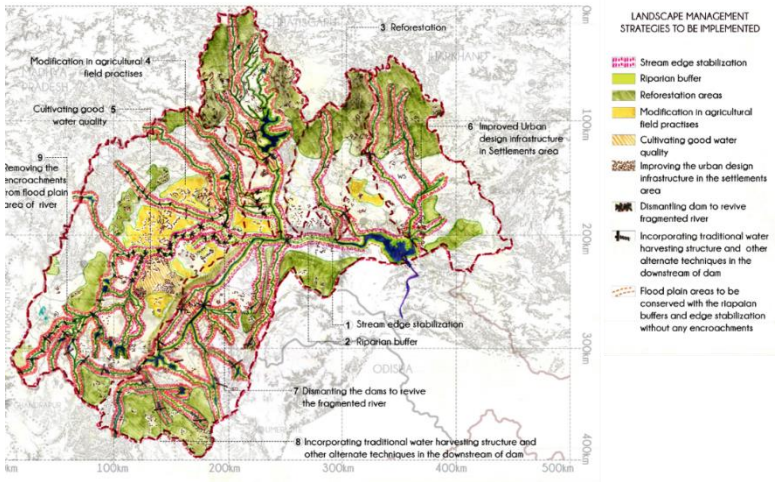

Figure 15. Landscape Management Plan of the watershed of Hirakud Dam; Source: Author

The following are the details of each strategy:

1. Stream edge stabilization

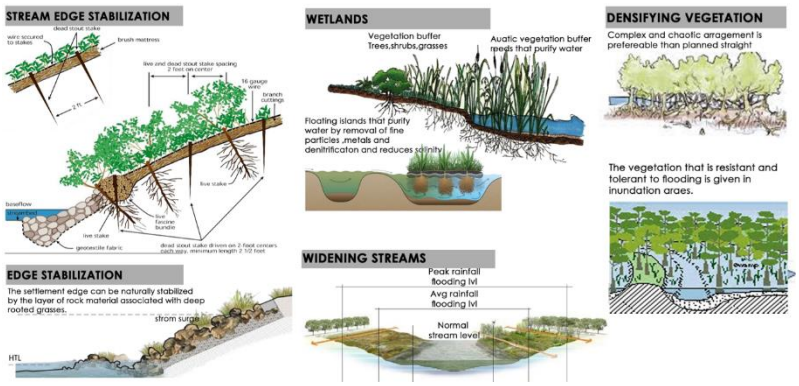

Figure 16. Nature based solution for early order streams in the catchment of dam. Source: Author

2. Riparian buffer
Riparian buffers along streams, lakes and wetlands can help to lessen the impacts of nearby development. We can categorise the streams as Upstream, Midstream and Downstream in the catchment. Mahanadi river is the 16th order of stream.

STREAM ORDER	STREAM ORDER NUMBER	WIDTH OF RIPARIAN BUFFER
Upstream	1st to 5th	100ft on both sides
Midstream	6th to 10th	100ft-200ft on both sides
Large stream	11th to 16th	300ft or more on both sides

Table 2. Required buffer width of riparian edges according to the stream order.

3. Addressing the issue of sedimentation: Sedimentation in the dam reservoir creates excessive pressure on the structure of the dam and thereby reducing the live storage capacity of the dam. Causes: Stages of Disintegration, erosion, transportation, and sedimentation leads to siltation of the reservoir bed;Effects: Loss of live storage of reservoir, Turbine's abrasion, downstream effects on river flow and decline in the life span of reservoir and ultimately the dam.[7]
Alternate techniques: So, instead of adopting engineering methods to remove the sediments, landscape architecture control measure or nature-based solutions will be a better alternative which would not allow sediments into the reservoir.
This can be made possible by applying the following solution in the catchment level of the dam.

Strategies	Area addressed	Time required	Reduction%	Reduction rate
Modified Agricultural practises	5171.4 sq.km	0-1 year	16%	436.8 Cum/Yr
Watershed conservation and restoration	3323.04 sq.km	5-10 years	26.5%	384.8Cum/Yr
Designating forest shelters	23187.01 sq.km	15-20 years	99.6%	5.2 Cum/yr

Table 3. Nature based strategies showing the time frame and reduction percentage after implementation

With these strategies, the sedimentation in the reservoir can be stopped within a time period of 20 years.
4.River flow management: Instead of damming a large river, alternative of it can be made by damming up a small river using natural materials like rocks, sticks, and mud. This practice does not harm the environmental flow in the river basin and the purpose of dam i.e., water storage is also fulfilled.
This practice of damming up upper order of river streams through traditional water harvesting structure was followed in ancient India and through community conservation efforts, many villages have been successful in harvesting, securing and managing the water resources.

Impacts of dam, when built on -	Erosion	Vegetation	Water quality	Water Availability	Animal habitat
Early order streams					
Mid order streams					
Large order of streams					

Very low negative impact Moderate negative impact Very high negative impact

Table 4. Table showing impact of dam on various parameters when built on different order of streams

From the matrix, it is concluded that when dams are built on early orders of streams, it does not have negative impact on the factors mentioned above, while it poses great threat and danger to the factors mentioned above when built on higher orders of streams or main river.

5. Sub-surface dams[8]

Underground dams can be very beneficial as water loss by evaporation will be far less when compared to the surface dams. The sub-surface dams capture ground waters flowing near the surface of the ground and it can be accessed via wells upstream from the dam which will gradually reduce the dependency from the existing dams

6. Partial removal[9]: Removal of an area of dam is a common adjustment here in an effort to allow the successful movement of aquatic species together with extended security for recreation waterway users.

7. Rock riffle[10]: It comprises of columns of boulders and rock slopes which are inclined and are introduced downstream of a dam to take up the rapids. Water slips slowly over the rock riffle and the dam still holds water to preserve upstream pools.

8. Rock arch rapids: A rock and boulder complex included upstream, from a dam makes a rock arch rapid. Caution and mindfulness are required whereas navigating the rapids, but the risk imposed by the dam no longer remains an issue.

9. Spillway modification and addition: As a close relative to dams, spillways can also be modified to promote fish passage and prevent the spread of invasive species.

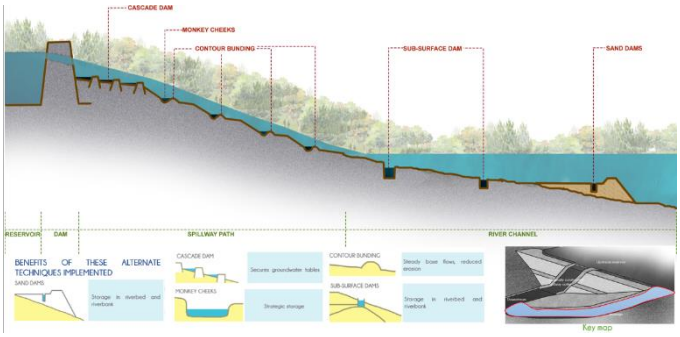

Figure 17. Techniques and benefits of the alternatives: Modification the spillway channel
Source: Author; Transforming Landscapes, Transforming Lives the Business of Sustainable Water Buffer Management

10. Alternative for the purpose of flood management [11]

This can be achieved by reducing the runoff i.e., by increasing the infiltration of storm water into the soil and decrease the runoff into the rivers. Vegetated buffer strips and Wetland restoration are excellent remedial measures for flood management. Natural flood management can also be done through river meanders and vegetation buffers.

SUMMARY OF THE STRATEGIES FOR THE ALTERNATIVE OF DAMS

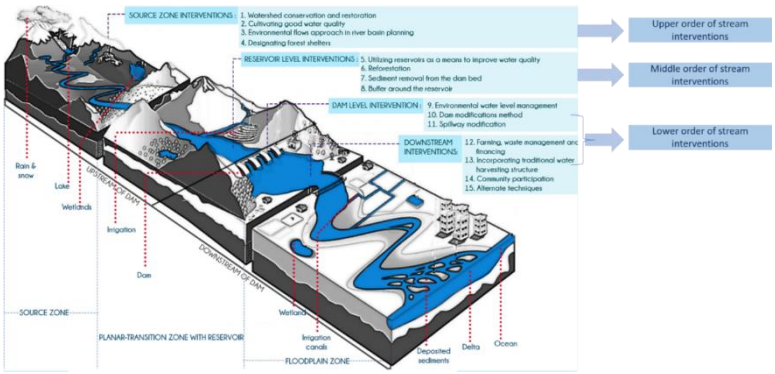

Figure 18. Strategies on various zones of interventions
Source: Author

- Watershed conservation and restoration:conserving lands and micro-watersheds and restoration of rural roads.
- Reforestation: the efforts can be made which would include planting millions of trees in the area around the dam.
- Buffer around the reservoir: it will be an erosion control method. Nature-based solutions, like using forests for regulating water flow & quality, will continue to provide their services until they are removed.
- Sediment removal from the dam bed: dredging the existing sediments from the reservoir or using any method willbe expensive anyhow, so preventing the sedimentation in the reservoir.
- Designating forest shelters: reforestation of the watershed and adding additional protected areas ofthe watershed. Also recovering degraded areas with native forest species in the buffer zone.
- Cultivating good water quality: it will be aimed at improving water quality and flows in the river watershed, while achieving a broader range of social and environmental goals. It will be a long tern goal in which phasal strategies will be implemented in different parts of the watershed of the river basin.
- Farming, waste management and financing:using it for economic benefits as well by environmental valuation of the forest preserves.
- Environmental flows approach in river basin planning: though there is no one correct approach to estimate the environmental flows, most of the environmental flow assessments in India seem to lack a holistic approach. They do not take into consideration the interconnections between river hydrology, morphology, ecology, livelihoods, and socio-cultural and religious practices which plays crucial role in managing the environmental flows of a river.
- Environmental water level management: through aquatic habitat management and water quality operations.
- Utilizing reservoirs as a means to improve water quality: instead of dismantling the old dam, using dam reservoirs as a tool for improving the quality of water.
- Incorporatingtraditional water harvesting structureand community participation: traditional water harvesting systems have a big solution to offer for the modern-day water crisis.

CONCLUSION

Choosing whether or not to remove a dam can be a very big decision on the strategy and policy makers. The complexity of choice is compounded when the dam still serves a few purposes and benefits to the growing population of India. Removing the dam completely might not be the right choice for every circumstance, but still many dams have been removed and replaced with alternative solution. These dams are not the answer in the current era of climate change. We need to start implementing the alternative measures to replace the dams and ultimately reduce the dependency from the dams. We need to protect our river and river ecosystem and therefore these dams need an immediate attention for its modification.

Replacing dams and implementing the nature-based alternatives can be the first step towards managing our river and other limited natural resources in a better way. Though it is a long-time taking process, yet it is the most effective sustainable practice which can be taken up as remedial measure for the existence of dam.

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INVESTIGATING OUTDOOR THERMAL COMFORT IN HIGH DENSITY URBAN FABRIC: A CASE OF CHHATRAPATI SHIVAJI PARK, MUMBAI

Author:
RICHA RAJE, OJASWINI SADHU

Affiliation:
SCHOOL OF PLANNING AND ARCHITECTURE BHOPAL, INDIA

INTRODUCTION

Population growth and rapid urbanization have exposed our cities to several environmental challenges. Replacing greenery with building construction materials like concrete, glass etc. have led to increased ambient temperatures causing urban heat island in many cities. Such problems are negatively affecting human outdoor thermal comfort especially in public open spaces. While the green cover is being compromised for accommodating larger population, the available green areas are unable to create comfortable environment for public use. This study aims to investigate urban thermal comfort of public parks in Mumbai city. The duration and intensity of the use of an outdoor space is greatly affected by the comfort or discomfort conditions of the area. To understand the micro climate and the thermal stress experienced in the park, meteorological readings like Air temperature, Humidity, wind speed, black globe temperature are recorded. Along with-it questionnaire surveys are performed to record user experience of the park, there preferred clothing and intensity of activities performed on site throughout the day. The qualitative and quantitative assessment will help map the heat stress vulnerability of these parks. The success of any public open space depends on the amount of time people spend at that open space. This understanding can be applied to re design our parks, using bio climatic landscape design strategies to create thermally comfortable outdoor experience for people and effectively improve the quality of urban living.

Outdoor Thermal comfort

Thermal comfort is defined as the 'condition of mind in which satisfaction is expressed with the environment and is assessed by subjective evaluation' as per ASHRAE-55.[1] The climatic parameters, e.g. sunlight, wind, temperature, and humidity, contribute to the Outdoor thermal environment. Factors influencing outdoor thermal environment are anthropological heat, evaporation and evapotranspiration of plants, shading by trees and man-made objects, and ground cover such as grass and paving, etc. The user behaviour depends on the outdoor thermal environment of public open spaces. Areas such as streets, Playgrounds, Plazas, Urban Parks provide different kind of thermal stress to people performing various kinds of outdoor activities.

The previous research literature indicates that the method of studying outdoor thermal comfort is mainly simulation analysis and on-site measurement. Field monitoring is the main method for evaluating outdoor thermal comfort. Field monitoring is the use of relevant measuring instruments for the site

study of outdoor meteorological parameters (such as air temperature-Ta, relative humidity-RH, black globe temperature -Tg, wind speed-v, global solar radiation-G, etc.), and subjective questionnaire surveys conducted near the monitoring sites. [2]

PET[3] is widely used as an outdoor thermal index as it has a thermo-physiological index, the background of which gives a real effect on the sensation of climate on human beings. [4] PET is one of the two-node steady-state models and is based on the Munich Energy balance Model for Individuals. It is defined as the air temperature at which, in a typical indoor setting, the human energy budget is maintained by the skin temperature, core temperature, and sweat rate equal to those under the conditions to be assessed.[5] The success of place making is a measure of popularity of the open space. Outdoor thermal comfort plays an important role in the design of Parks. Optimized thermal environment can attract more people to the parks and make their activities prolonged than usual.

Motivation

Urbanization has led to more built and lesser green areas in cities causing a negative impact on the microclimate of open spaces and urban parks. This has resulted in Uncomfortable outdoor environment for inhabitants. By improving outdoor thermal environment we can contribute to the livability of the city, quality of social and environmental life of people and tackle urban heat issue. Landscape design interventions of urban parks can help in creating cooler and comfortable environments. The study aims to investigate Outdoor thermal comfort in high density urban fabric - A case of Shivaji Park, Mumbai. The objectives are: Outdoor thermal comfort assessment of Shivaji Park; Understanding the impact of urbanization on bio meteorological parameters like temperature, humidity, wind speed; Role of Softscapes in improving outdoor thermal comfort of an urban Park.

METHODOLOGY

The methodology for this study included three steps i.e. data collection, data processing, data analysis and synthesis In this study, the field meteorological measurements and subjective questionnaires were conducted during the winters between 10th to 14th February. An average of data collected during these five days was taken forward for processing in order to derive the results.

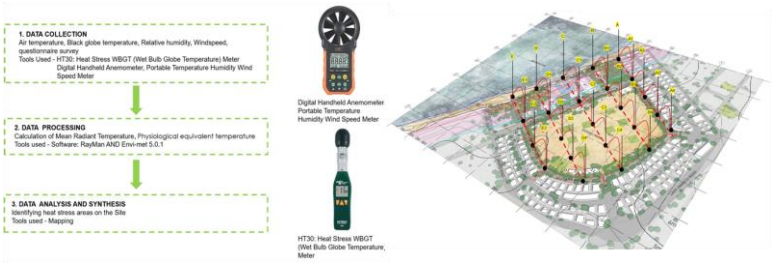


Figure 1. Methodology, Monitoring points on the Site

Site Area

The study was conducted in Chhatrapati Shivaji Park, Mumbai (19°1'36.42"N, 72°50'20.02"E)[6], and the largest metropolis in India with a core population of 12.5 million according to the 2011 Census of India. Mumbai is the most important city in the country due to its location, industry, and economy.[7]

This site was selected since it is one of the most important urban open spaces of the city. Shivaji Park is known as the cradle of game Cricket and also provides many other sports facilities.[8] The landscape of Shivaji Park was scattered settlements with background of coconut trees. The western boundary of the park was defined in 1920 by the Cadell road (present SVS road) other boundaries were defined by 1937. Shivaji Park ground is surrounded by many art-deco style buildings dating back in mid 1900's.

Buildings surrounding the park had a height restriction of ground plus three storeys.[9] The park has survived till date but the landscape surrounding the park has completely changed with the redevelopment of plots into high-rise buildings of concrete and glass facade. The site is located very near to the Arabian Sea. The major N-S thoroughfare of the city, SVS road passes through the study area. The road fragments two similar landuse which causes disconnect between the park and the sea and amenities on the either side of the road. The site is also in a close vicinity to the railway track and upcoming metro line.

Figure 2. Location and Landscape character of Chhatrapati Shivaji Park

Located close to the Arabian Sea, Mumbai has a warm humid climate classified under the Köppen climate category Aw signifying tropical wet and dry climate. The city receives significant monsoon wind and precipitation. Most of the precipitation occurs during summertime. The city has an annual mean temperature of 27.2 °C. Summers are hot-humid with an average temperature between 30 and 35 °C. Summertime high sometimes reaches 40 °C during April and May with humidity over 75%. Winters are mild and moderate.[10]

Data collection

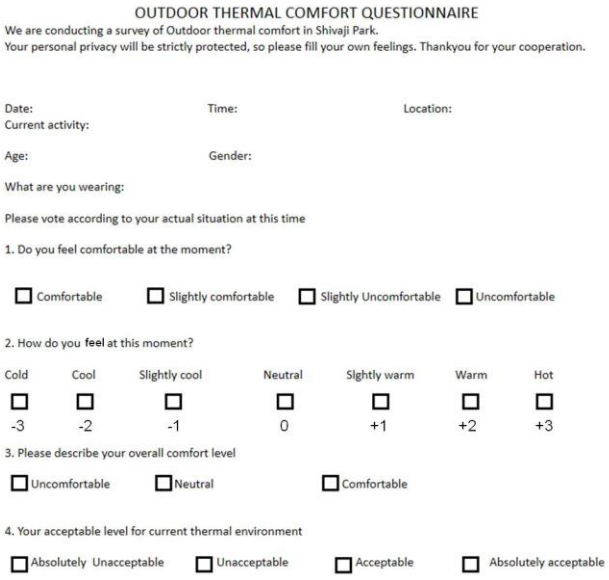
The observations and analysis was based on the primary data collected (air temperature, relative humidity, wind speed, black globe temperature) on the site between 10th to 14th February 2022 at morning 10am, afternoon 2pm and evening 6pm. The climatic data was recorded using Digital Handheld Anemometer, Portable Temperature Humidity Wind Speed Meter (air temperature, wind speed, Relative Humidity) and HT30: Heat Stress WBGT (black globe temperature) at height of 1.1m from the ground as per ASHRAE-55, 2010 protocol.[11] A traverse method of survey was adopted for recording the climatic data on the site.

Study was conducted during the time of February i.e. winter season, therefore it was very important to also note the climate experienced during the Summer Season when the air temperature and other climatic parameters are at its Peak. To find this extreme climate experienced during the Peak summer,

a simulation was run using ENVI MET[12] software which helped generating climatic data for summer season (Summer solstice - 21st June). Envi met was chosen since the software gave a result similar to the onsite observation when simulations were run for February month. Few values were assumed for the simulation such that the Air temperature in the range of 27 - 40°C, Humidity range of 60% - 80%, wind speed of 4m/s form west direction.

Questionnaire survey (Thermal sensation vote)

A questionnaire survey was also conducted on the site within the same dates to validate the results obtained through software. Random sampling was used to select pedestrians and street vendors for questionnaire survey. A gender ratio was considered to ensure number of men and women respondents were same. The survey was conducted in the morning, afternoon and evening and 20 respondents were surveyed each time. In order to study the thermal response and thermal stress at different hours of the day the respondents' thermal sensory vote data were collated and analyzed.



OUTDOOR THERMAL COMFORT QUESTIONNAIRE

We are conducting a survey of Outdoor thermal comfort in Shivaji Park.
Your personal privacy will be strictly protected, so please fill your own feelings. Thankyou for your cooperation.

Date: Time: Location:
Current activity:

Age: Gender:

What are you wearing:

Please vote according to your actual situation at this time

1. Do you feel comfortable at the moment?

☐ Comfortable ☐ Slightly comfortable ☐ Slightly Uncomfortable ☐ Uncomfortable

2. How do you **feel** at this moment?

Cold	Cool	Slightly cool	Neutral	Slghtly warm	Warm	Hot
☐	☐	☐	☐	☐	☐	☐
-3	-2	-1	0	+1	+2	+3

3. Please describe your overall comfort level

☐ Uncomfortable ☐ Neutral ☐ Comfortable

4. Your acceptable level for current thermal environment

☐ Absolutely Unacceptable ☐ Unacceptable ☐ Acceptable ☐ Absolutely acceptable

Figure 3. Thermal comfort Questionnaire

Data Processing

RayMan[13] software as tool was used to calculate the thermal index i.e. PET for the quantification of thermal heat or cold stress. RayMan software is a tool of applied climatology developed by Dr. Andreas Matsarakis and Dr. Frank Rutz of the University of Albert Ludwig Freiburg in Freiburg, Germany[14]. Calculation of PET in the RayMan software requires four climatic parameters as input - Air Temperature (Ta), Relative Humidity (RH), Wind speed (v) and Mean radiant temperature (T_{mrt}). T_{mrt} is a critical parameter determining the radiation a person experiences in the surrounding[15]. Using the RayMan model to calculate the thermal index PET requires the mean radiant temperature (T_{mrt}) as the input, and Calculation of T_{mrt} expressed as[16]

T_{mrt} =

$$\left\{(Tg+273)^4+\left[\frac{1.1\times10^8\times V_a^{0.4}}{\varepsilon_g\times D^{0.4}}\right]\times(Tg-Ta)\right\}^{\frac{1}{4}}-273$$

Where D is the spherical diameter (D = 150 mm in this study) and ε is the globe emissivity (ε = 0.95)

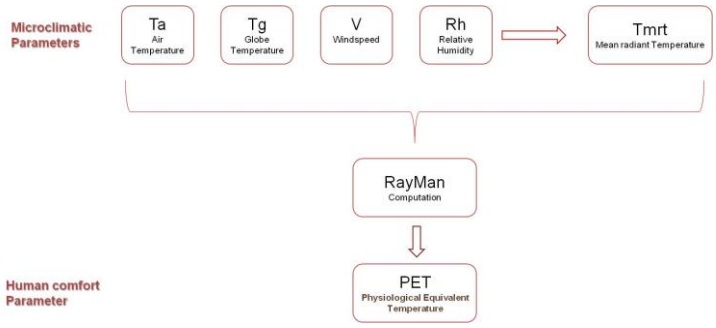


Figure 4. Deriving Human comfort parameter PET

RESULT

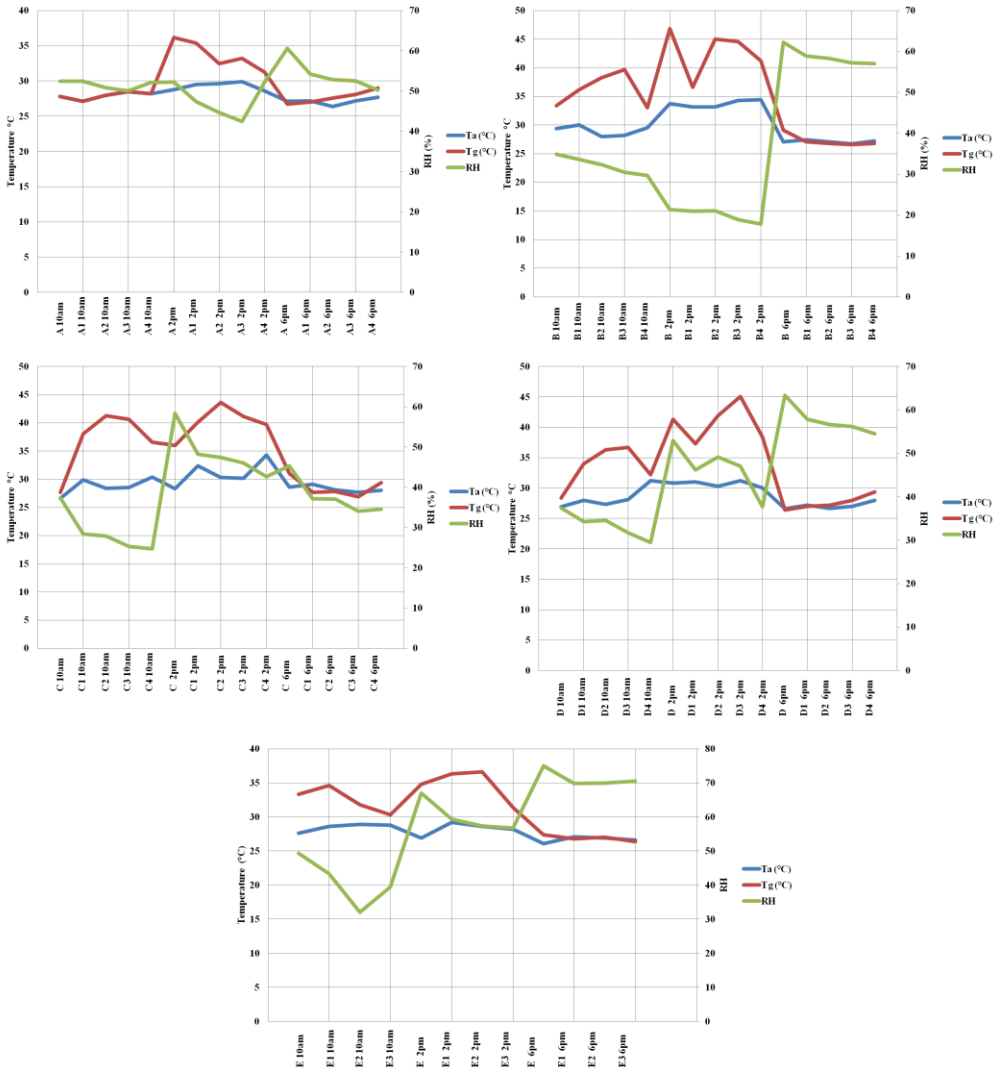


Figure 5. Field measurement of Air Temperature, Globe temperature and Relative Humidity

Figure 3 summarizes field measurements at Chhatrapati Shivaji Park during the winter seasons. There were some extremities that were observed in the climatic data recorded on the site. Along the points A - A_4, we find that the Black globe temperature (T_g) is found higher at point A_1 (SVS Road) compared to the other points during the afternoon at 2pm. The other monitoring points between A- A_4 have a fair

amount of canopy cover and therefore T_a and T_g are found to be lower. Higher Relative humidity, 50% - 60% was recorded along this section during the evening at 6pm. The climatic readings along the points B - B_4 records a high T_g (46.8°C) at the Beach side which could be an effect of concertized surfaces and absence of canopy cover. The difference between T_a and T_g is found to be 10-15°C during the afternoon at 2pm which indicates a high amount of heat stress experienced by the human body. Higher T_g among the points C -C_4 is found inside Shivaji Park ground followed by the SVS road. This is a result of absence of any canopy cover on the ground as well as the high amount of radiation from the tall glass facade buildings surrounding the Shivaji Park ground. A lower T_g was recorded at point C_1 near the Dadar beach is a result of high wind speed at that particular point of time. A drop in T_a and T_g during afternoon was recorded at point E due to the presence of Narali Garden having clusters coconut trees thus helping in lowering the temperature. The park records lowest T_a and T_g during the evening after 6pm.

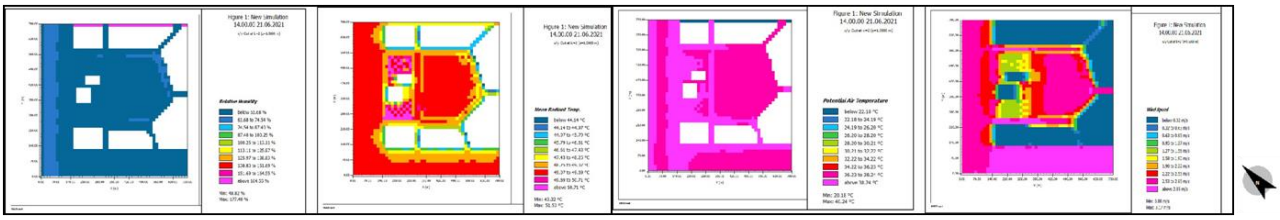


Figure 6. Climatic data simulated on Envi-met (21st June 2021)

Thermal index - Physiological Equivalent Temperature (PET)

PET was calculated using the RayMan software considering the clothing insulation and activities of the respondents on the site. The obtained PET values were then mapped to find out the heat stress areas of heat stress on site from 10th to 14th February. Fig. 7 summarizes all the PET and Land surface temperature values obtained from the RayMan software. It was observed that during the morning hours, the site experiences slightly warm to warm thermal perception which corresponds to a moderate to strong heat stress. The SVS road and parts of the Shivaji Park ground experiences the moderate heat stress as illustrated in Fig no. 7. During the afternoon hours, site experiences slightly warm to hot thermal perception which corresponds to a moderate to very strong heat stress. It can be noted that the SVS road and parts of Shivaji park ground are under strong to a very strong heat stress as illustrated in fig. no. 7.

PET (°C)	Thermal perception	Physical stress	Corresponding colour code
18–23 (°C)	Comfortable (Neutral)	No thermal stress	
23–29 (°C)	Slightly warm	Moderate heat stress	23°C 29°C
29–35 (°C)	Warm	Strong heat stress	29°C 35°C
35–41 (°C)	Hot	Very strong heat stress	35°C 41°C
> 41 (°C)	Very hot	Extreme heat stress	> 41°C

Table no. 1. Ranges of the PET for different grades of thermal perception
Source[17]

The land surface temperature is found to be as high as 50 -58°C on few areas on the site at 2pm during the winter month. The SVS road is found to be among the most heated surfaces on the site along with few monitoring points on the Shivaji park ground.

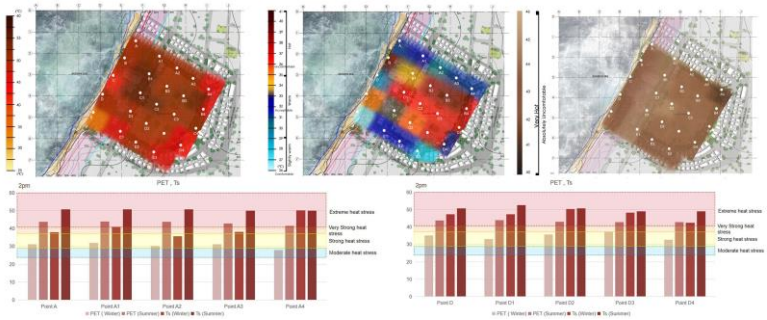


Figure 7. Comparison of Heat stress in Winter and Summer

The simulation of summer time climatic data was done for 2pm in the afternoon to generate a peak time scenario since it was observed in the previous studies that afternoon is the hottest time of the day. After the generation of PET values for summer afternoon it was found that all study points on the site are under extreme heat stress. A comparison for the same has been mapped in Figure no. 7. The PET range for a summer afternoon is 41°C - 44°C with a thermal perception of very hot corresponding to extreme heat stress. The highest land surface temperature for summer is recorded as 58°C on the road surface.

Thermal sensation vote

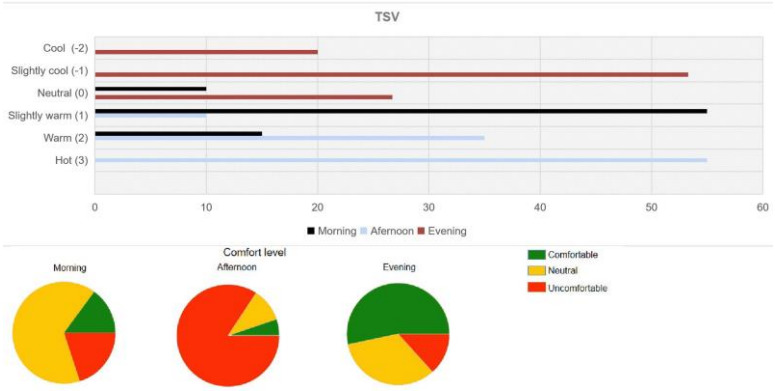


Figure 8. Thermal sensation vote

Time	PET (°C)	Physical stress	Observed Thermal perception	Observed Physical
Morning 8:00 - 8:30am	32 - 34	Strong heat stress	Slightly Warm	Moderate heat Stress
Afternoon2:00 - 2:30pm	36-38	Very strong heat stress	Hot	Very strong heat stress
Evening 6:00 - 6:30pm	24 - 27	Moderate heat stress	Slightly cool	Slight cold stress

Table 2. Thermal perception of respondents observed on the site

According to the results of the questionnaire survey which was conducted on the site between 10th - 14th February during the morning hours people were mostly engaged in the activities of walking, running, sitting or playing. Their clothing was cotton fabric or dry fit material. 60% of the respondent's experienced slightly comfortable environment, 55% respondents voted for a slightly warm thermal perception and 65% respondents overall thermal comfort vote was neutral. 65% voted neutral for acceptability towards current thermal environment. During the Afternoon people were engaged in activities of playing, walking wearing dry fit material cloths. 60% respondents experienced an uncomfortable environment. Thermal perception of 55% respondents was hot and Overall comfort level of 84.2% respondents was Uncomfortable. 50% voted complete unacceptability towards thermal environment. During the evening maximum respondents are experiencing a comfortable environment with neutral to slightly cool thermal perception and voted for acceptance to the thermal environment. A slight deviation in the thermal perception corresponding to the PET range and the observed thermal perception on the site recorded through the questionnaire survey (Table no.4) is a result of acclimatization of people to the climate.

CONCLUSION

In this study, the outdoor thermal comfort for Chhatrapati Shivaji Park, in hot and humid climate of Mumbai was in investigated. Through the field monitoring of various meteorological parameters and questionnaires, the data was collected and analyzed and following conclusions were obtained.

1. Results derived from various parameters like- Mean radiant temperature, Psychologically equivalent temperature, Thermal sensational vote and Visual Analysis indicate that : "Shivaji Park has an Uncomfortable Outdoor Thermal Environment"
2. The results indicate that Landscape design of urban parks can greatly influence outdoor thermal comfort. The areas of site covered with tree canopy cover are found more comfortable compared to the areas with none or lesser tree canopy cover.
3. The continuous flow of wind can also help to improve outdoor thermal comfort in a case of hot and humid climate. Few monitoring points on the site with ample amount of wind are found comfortable.
4. Studies indicate that outdoor cooling can be achieved by sensitive design of hardscapes and softscapes. In the case of a Hot and Humid climate there is a need to decrease surface temperature, air temperature, humidity and increase Wind speed.
5. The studies indicate that Outdoor Thermal comfort in dense scenarios is Inadequate. Therefore it is important to ensure the quality of Outdoor thermal comfort in urban parks. Present Study is conducted in a Warm and Humid Climate and Strategies in terms of "BIO CLIMATIC LANDSCAPE DESIGN"

can be modelled using Software to define the efficient use of softscapes in improving Outdoor thermal Comfort.

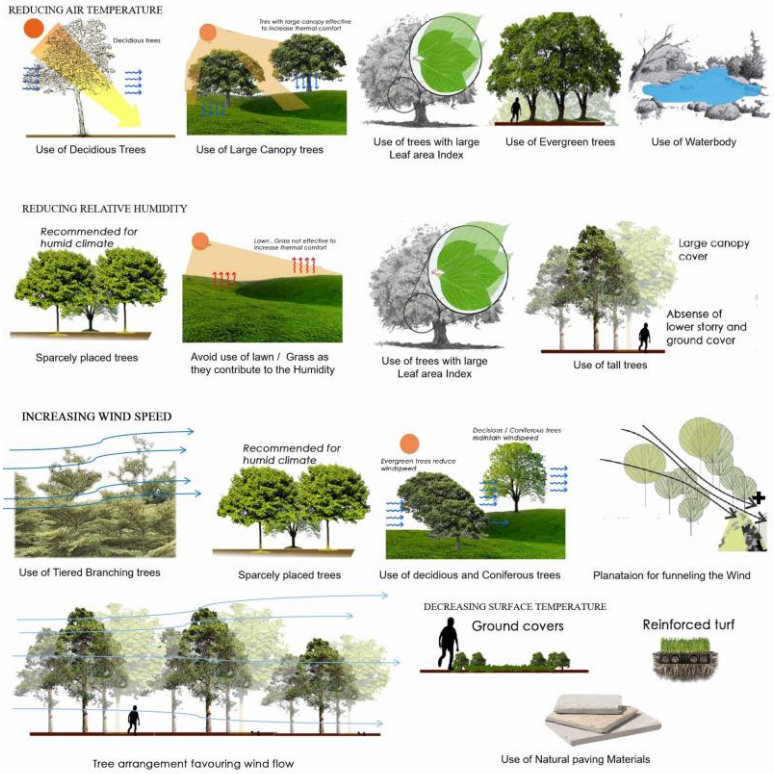


Figure 9. Nature based solution to improve outdoor thermal comfort

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COVID-19 RESPONSE ANALYSIS - BUILDING BACK BETTER IN THE BUILT ENVIRONMENT

Authors:
TIAGO DA COSTA VASCONCELOS, THOMAS CHEVALIER BØJSTRUP, NATALIE MOSSIN, PETER HINSBY, JULIE ZEPERNICK JENSEN

Affiliation:
ROYAL DANISH ACADEMY, DENMARK

INTRODUCTION

On the 31st of December 2019, an online media statement by the Wuhan Municipal Health Commission of a "viral pneumonia of unknown cause" marked the first incidence of what we are now all familiar with as the COVID-19 pandemic.[1] For many, COVID-19 has been the first time experiencing a pandemic, however, this is not the first time a disease has wreaked havoc on the world. More than 60% of emerging infectious diseases identified since 1940 originate from zoonosis[2] (infection or disease that is transmissible between animals and humans) with a majority of those linked to wildlife. While virologic mechanisms are not fully understood[3] – it is evident that our built environment together with social and cultural factors have a considerable influence on epidemics. This paper unpacks a recent study conducted by the Royal Danish Academy and Realdania in response to the COVID-19 pandemic. The study set out to map and document interventions in the built environment which successfully responded to the pandemic, whilst simultaneously demonstrating how ingenuity can turn mitigation into an inspiration for building smarter and better.

A BRIEF HISTORY OF EPIDEMICS

The 1665 Great Plague of London led to the death of almost a quarter of its population in just 18 months.[4] The heaviest impact felt by the poor; "who are either crowded up into corners and smothered for want of aire".[5] A common assumption at the time was that there was a causal link between the built environment and plague mortality rates. Later, throughout the nineteenth and early twentieth centuries, cities were afflicted with regular outbreaks of epidemics. Characterised by "residences in proximity to factories, animal yards, slaughterhouses and crowded tenement houses with little airflow or light"[6]; cholera, tuberculosis, and typhoid wiped out substantial portions of the population.[7]

The mid-nineteenth century then saw a wave of public health movements responding to epidemics.[8] Urban zoning laws, indoor plumbing, large windows, and healthy building materials are but a few examples of architectural responses to medical crises of their eras.[9] How our built environment and society and culture impacts their emergence and spread, however, is becoming increasingly important due to rapid globalisation.[10] *Figure 1* below depicts six of the last major zoonotic epidemics along with pathogen source as listed by the World Health Organisation.[11]

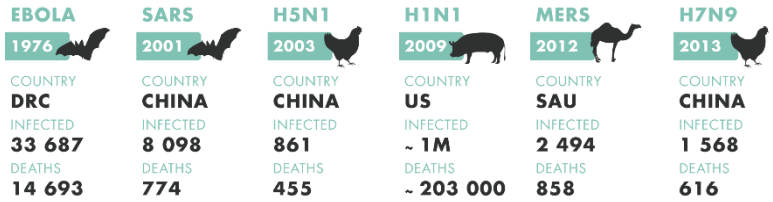

*Figure 19. Six of the last major zoonotic epidemics *exc. seasonal flu and 2019-nCov*

BUILDING BACK BETTER

Following the outbreak and spread of COVID-19, a greater momentum among building professionals, regulatory entities, and politicians toward identifying how our built environment influences epidemics has developed. The role our built environment plays in potentially 'flattening the curve' has led to questions regarding its impact on rates of infection[12], minimisation of the spread of infection[13], and the implication modern infrastructure has on the pervasion of epidemics.[14] Like natural disasters, epidemics leave much devastation in their wake – and in an increasingly globalised, densified world – the COVID-19 pandemic has been no exception. What is crucial now is to move forward stronger, more prepared than before. 'Building Back Better', adopted by the UN Sendai Framework for Disaster Risk Reduction 2015, is an approach aimed at decreasing the risk future disasters pose.[15] To build back better, is to learn from disaster, to better inform decision making going forward. With disaster acting as the trigger, building back better aims to create progressively resilient societies through the implementation of well-balanced disaster risk reduction measures; "including physical restoration of infrastructure, revitalization of livelihood and economy/industry, and the restoration of local culture and environment".[16] Building back better acts as the driving force behind this study.

INTRODUCTION TO THE STUDY

COVID-19 has had a variety of implications for our built environment, many of which provide an opportunity to identify ways in which we might build back better in its wake. This study positioned itself at this precipice; setting out to map and document interventions in the built environment which successfully responded to COVID-19.[17] These interventions serve as inspirational cases, demonstrating that ingenuity can turn mitigation into opportunity. Collected in a compendium, for each case the challenge which was met and how the solution confronted the problem was unpacked. To this end the compendium serves as a tool to inspire future developments and design considerations to the built environment, in the hope that we enable ourselves to Build Back Better.

Methods

The methodological approach for the study consisted predominantly of desk study; supplemented by observational fieldwork, mapping, and surveys. Conducted in three distinct phases.

Phase 1

Network Activation and Preliminary Case Search - Leveraging our professional network together with desk study to begin procuring potential cases.

Definition of Criteria and Taxonomy – Through roundtable discussion, review of local (Danish) building by-laws, and professional input - the definition of inclusionary criteria for cases and a taxonomy were generated. Cases must have (i) been of an architectural (building) scale; including (but is not limited to) everything which is part of or can be mapped onto a building. (ii) their need arisen as a direct result of the COVID-19 pandemic. (iii) and finally cases should have improved quality of life for their users. Additionally, the taxonomy described cases' building type/use, project timescale, the

physical nature of the case, and finally to which end-users and stakeholders it is aimed. This took the form of a gridded matrix. Literature Case Search - The literature case search was guided by aspects of the PRISMA guidelines, while the study did not include systematic review or meta-analysis, drawing from an established search protocol ensured the literature search was carried out to a recognised standard. This sought to identify potential cases which may have been described previously within academic literature, Given the recency of the pandemic, no suitable cases were found.

Phase 2

Case Collection – Eligible cases were collected through direct interviews with the team's active network and desk study (online searches, articles, and popular websites).
Case Analysis - Cases were then plotted within the taxonomy matrix. This determined whether the case met the inclusion criteria and delineated the qualities which we sought to describe.

Phase 3

Case Documentation - Once qualified, cases were documented by means of (i) a condensed write-up describing the case; the challenge it sought to meet, how it did so, who it was aimed at and its implications for design considerations in the built environment going forward (as it relates to the concept of building back better). (ii) Drawing representation; each case had a digital twin created utilising photo references and drawings where available. Thereafter, isometric vector drawing and diagrams were generated to describe the cases literally and conceptually. (iii) Finally, photographs highlighting the case and its impact/value were taken on site or collected from case contributors.

CASES

A sum of 35 cases were collected from around the globe, comprising of contributions from 14 different countries. Encompassing a range of scales, themes, and applications within the built environment. From medical facilities' design and construction to interior reconfiguration, playful markings, and signage, and rethinking spatial use– a wide range of interventions, documented as cases, now offer concrete examples to inspire a post-covid built environment.
In Denmark, the state-of-the-art children's hospital in Copenhagen 'Mary Elizabeth's Hospital – Rigshospitalet for Children, Adolescents and Expecting Families' considers the layout of the building such that individual wings of the hospital can be isolated to help prevent spread of disease. Additionally, careful attention has been paid to promote visual access throughout the buildings wards; while ensuring privacy is maintained. On the other side of the globe, the North Lantau infection control center provides an unprecedented look at what novel technologies and careful planning can achieve. By leveraging an integrated modular construction method and round-the-clock construction schedule, this world-class 44,000m^2, 800 bed facility was constructed in just four months. The adaption of novel building technologies and methods was also seen in Eldoret, Kenya; where at Oak Tree Center for Kidney and Chronic Diseases additional capacity for the sick was urgently needed. To accommodate, the clinic began construction of a new detached building on its grounds. The pre-fabricated component structure has several technologies that are not typical of construction in Kenya. However given the urgency of the situation, avenues for innovation opened, and were explored.
Back to Denmark and in Copenhagen at its municipal offices, rapid and tactical solutions to the pandemic sprang into action almost immediately. Standardized signage and symbols were designed and distributed to local businesses and buildings to increase public awareness. Smart occupancy sensors were implemented once workers returned to the office; and with careful consideration spatial changes were made to accommodate for the hybridization of the workplace. In Berlin at the newly designed head office for LOQI, careful attention has been placed on the form, colour, and layout of the office

space and furnishing –accommodating flexible workspaces, personal working pods, and coordinated gatherings. Across to Japan, and in Tokyo a new retail outlet called 'Playhouse' opened its doors recently welcoming shoppers to a novel consumer experience. COVID-19 drastically altered the way consumers behave, with an increasing focus on online shopping; the designers sought to explore the question of the future of physical stores. In doing so they created a space which is more theater than sales of goods; a multi-use space intended to allow consumers to build a relationship with the brand. It offers sales of goods and a host of demonstrations, live shows, activity, and action.

Public gatherings across the globe were heavily restricted or banned during much of the pandemic. This impacted many, the most vulnerable in our society, no doubt, were impacted the most. To resume regular schooling and operation, the Silkeborg Highschool in Denmark capitalized on its design typical of 1970's Danish school building. With a clear division between circulation, classrooms, and communal areas – the school reorganized its circulation, shutting its primary entrances and opting to direct students toward their individual classrooms via the exterior courtyards; thus, minimizing congregating of students. In Mexico City, a lush plot has been laid out and developed together with the community to provide a safe, open green space for locals. The gardens support social gatherings and food productions, offering young people education in health and cultivation. Set within its beautiful gardens, a self-sufficient wooden pavilion serves as an open to air meeting place for children during the day, whose day care centers are closed due to COVID-19.

In Bogota, Colombia, local businesses struggled immensely during the lockdowns; many shops, restaurants, and cultural institutions were prevented from opening. Colab-19 has designed a temporary building built from readily available and inexpensive materials that serves as a setting for various activities. "La Concordia" gave traders a way to stay open without breaking the restrictions, and cultural institutions a legal and safe framework for their events. Built from readily available and inexpensive materials, the construction provided businesses a way to continue to thrive during the difficult periods of restriction.

TRENDS

While each case has intrinsic value as a source of inspiration, four trends emerged through the process of documentation which offer insight into the nature and character of many of these interventions.

The first of these trends is the reconfiguring of interior. Cases presented us with ingenious ways to rethink the indoors, and no doubt this is something experienced by many throughout the pandemic. The possibilities for rethinking buildings at the interior design scale points to ongoing discussions about sustainability; the life of buildings, their renovation and re-use. Interior reconfiguration can, with limited material and resource consumption, change the functional possibilities of buildings, and if a function moves to a new building, the interior can move along with it.

The second trend identified is moving activities outdoors. Where possible, and applicable, making the most of sunshine and fresh air made all the difference for many during the tight restrictions and lockdowns. Cases have demonstrated that the division and definition of 'inside and out' is open to debate, with a blurring of the threshold taking place in many instances. Indoor spaces can be supplemented by zones and elements that expand the interior towards the exterior; balconies, covered areas, spaces that can be opened. There is potential for both reduced material and energy consumption and added value for users to pick up in these spaces, which through their totally open-to-air nature, reduce the spread of infection.

The third trend is consideration of space and its organization. Where careful planning of spaces made possible the safe, continued operation for many. In many areas of the built environment, openness and fewer barriers in spatial planning have characterised many environments we are now familiar with as 'open-plan'. Several cases, however, owe their success to just the opposite. How a building is formed -

that is how, its spaces are organized, and how it sits in its context - is a key question to address when speaking of resilience. Buildings that are built for flexibility, or have a robust circulation infrastructure, with generous exposure to their surroundings have been able to adapt to the new requirements without major changes to the structures.

The fourth and final trend is industrial innovation. The implementation of novel technology and solutions to streamline processes and improve results. In almost every case, time remained a central consideration in facing its challenge. Planning, design, construction, and organization must begin to consider, increasingly, time as a factor not just in delays or penalties, but in throughput for end-users. Additionally, integrating - from inception - technology and smart solutions which contribute to the overall health and wellbeing of users, while minimizing impact on the environment have played a central role in the success many of the cases.

DISCUSSION

This inquiry set out to investigate responses in the built environment to the COVID-19 pandemic, with a specific focus on the identification of realized, co-benefactory interventions. The scope of the inquiry reflects the specific context within which it was produced, constraints with respect to the reach of case mapping was limited to the network and knowledge of the editors. The trends we point to - as part of the outcome of this study - therefore cannot be seen as generalizable findings, but rather, a starting point for further inquiry and deliberation.

Nevertheless, we still believe that this compendium is a valid and relevant contribution to the discussion about how we can Build Back Better in the Built Environment after COVID-19. However, in acknowledging the limitations of this preliminary work, we encourage further, more systematic investigations into the responses to COVID-19 in the built environment; especially those which have provided co-benefits for their users. Furthermore, we believe that the ingenuity, on the part of the various stakeholders, which we have documented in this study and its subsequent publication[18], can serve as inspiration for processes of innovation. It could therefore be relevant for further studies to take a cross-disciplinary approach in exploring how human ingenuity in the form of ad-hoc interventions is applied to the built environment in times of health crises.

CONCLUSION

From hospitals to hospitality – to offices spaces, schools, entertainment, and even the home – these cases reinforce the idea that the built environment plays a vital role in not just our health and wellbeing, but mitigating risk and dealing with disaster, too. While vaccines have been an invaluable weapon in the fight again COVID-19, as with previous diseases, the built environment has also played a crucial role in the battle much as in the past.

With great ingenuity and under much pressure, cases have demonstrated an ability to challenge and expand upon the definitions of architecture as a mediator in our everyday lives. They provide us with tangible examples that the built environment has an immense potential for more than simply protecting against the spread of infection in the face of a pandemic.

This study with its 35 cases, sits within a discourse in public health practice and research, which focuses on the relationship between human health and the built environment. Simultaneously it focuses on the architectural scale and interventions made on the level of the individual building or space. It is our hope that the work will be of value for professionals and laypeople alike, who are engaged in forming the built environment which frames our lives – in times of stability, and of crisis.

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THE CITY AS SERVICE

Author:
IAN NAZARETH, DAVID SCHWARZMAN

Affiliation:
ROYAL MELBOURNE INSTITUTE OF TECHNOLOGY, AUSTRALIA

INTRODUCTION

Cities are straightforwardly a proposition – to exercise the benefits of dense settlement and adjacency. They thrive when the advantages of proximity between people and entities are greater than the cost. They are platforms for global activity, nodes for collective movements. Market-driven cities, industrialisation, globalisation, neoliberalism and so on, set in motion a cycle of distinctive, specialised and aspirational cities.[1] Cities also trade in imperialism, colonialism, tariffs and subsidies.

Buildings, infrastructures and their associated systems and apparatus are real, they are tangible, they exist. Cities (and urbanism) are almost decoupled from this legitimate, factual embodiment. They themselves are abstract constructs. The idea of the city and urbanism is an artifice. The city is staged, when its truths and mistruths are blurred. The city is imagined and believed.

Cities are also ideas.[2] Ideas entrenched in a vast mythology, a repository of representational images, concepts and narratives. This is their 'primum mobile', more so than any other single imperative. Cities are not a single truth, but perhaps many, often contradictory realities - A lucid public dream that represents an external reality that embody and empower their societies. They are fictions, held in general agreement.

Concepts, ideas and notions have shaped cities and became, arguably, a planning instrument. The city veers between non-hierarchical and hierarchical states – the realm of obscurity between flatness and multiple order of hierarchies simultaneously enacted. The tenets of modernity and the creeds of post-modernity are forsaken, but without succession.

Cities are empirical and even experimental. Seldom random, deterministic for most part. They reappear in our fantasies and nightmares. Cities are powered by myth, not the other way around. Its aspiration and progress are indistinguishable from hubris. City forms that have been virtually stable for centuries are undergoing a metamorphosis. Vaguely familiar on the surface but virtually unrecognisable when you peer into its cellular logic.[3]

The city is now, neither symbolic nor historical. The city has no reference point. Its polyvalency is self-perpetuating.

Incumbent City

The incumbent is 'the city as is' and a system to value and qualitatively understand the attributes of the city. It also encapsulates the necessary responsibility of the city. There is an acknowledgement that the city is an unfinished project and the interest here is the manner by which subsequent technologies occupy the incumbent city. Cities of the past one hundred years and more specifically the late 20th and early 21st century subscribe to Thomas Kuhn's thesis on 'paradigm shift' observed in 'The Structure

of Scientific Revolutions'[4] - where discontinuities become more apparent and perhaps a signature. These conditions are characterised as much by phases of normalcy as moments of revolutionary change. As particular development models mature a paradigm takes shape — they set in motion guiding concepts, theories and methods.

The City as a Service

Let's begin with a claim and assertion, that the dynamic progressions of the early 21st century city are distinct and atypical – unmappable when subjected to the dormant measures of 20th century metropolis (and preceding iterations), and perhaps, excessively contingent, and subservient when formulated against the virtual city. The hypothesis - that the City as a Service, is neither the post-industrial grouping of top-down, bottom-up hierarchies, (i.e. Incumbent City) nor the portentous open playable world of the Metaverse (an embodied Internet and universal and immersive virtual world).[5]

It embodies axiomatic presuppositions of the historical city and the incipient mythology, fantasy of what is to come. The City as a Service has relative location, geographical coordinates and exists as an irreversible succession of events. It is a mediatory hyperreality – arguably more real – as it's not only a physical domain, but also providing instructions guidelines about how to act across the abstract and generic and a broad range of situations.

The administrative and legal frameworks and governance more broadly is (yet) ambiguous allowing the Service City to operate within a meta-physical crosshatch, with loosely ordered space and time.

The 'City as A Service' sets in motion a web of recursions. Infinite loops and endless binaries - cities on the cusp of a singularity. It is a zeitgeist of runaway reactions, where the systems of the city are overcome by 'superintelligences' that surpass the capacity of citizens, public authorities and legal and regulatory frameworks to administer and govern. 'Disruption' – often the mantra for high technology corporations – the ideology of move fast and break things, has come to bear. Urban and statutory planning and our toolsets seem hopelessly retrospective.

Like any other service, the city is an end-to-end process, for transactions, end points, interfaces. An application interface (or API) for customers, consumers and citizens. An on-demand urbanism might be a virtue of this service – placeless and transitory. Its urbanism is a by-product of a field of open-source and proprietary variables, conglomerates meeting capacities and performance requirements independently and autonomously.

The city, is a scalar field condition, permeating physical and virtual space - a medium, a substrate that hosts probability. The arena of potentiality is not created by but mediated by the city. Its fundamental constituents and elementary particles are held within a 'weak' force. Proximity and immediacy might be beneficial or symbiotic, but their variables are temporal and transient. Densities waft and intensities flicker. The field is also a register and condensation of its immediate legacy.

There are physical implications to virtual agreements, these changes are already evident in the way cities operate and behave. Transactional exchanges perpetuate the idea of the city as an infrastructure and hosting environment. These services do not invent new forms or outlines but rather augments and interfere with the source code, the inputs and outputs and didacticism of the city. We are also familiar with its many mutants, variants and strains.

The terminal end is the threshold to the Smart City and all its paraphernalia. They compound all that is untold about technology with most that is un-apprehended within the systems of a city – an elaborate techno-bureaucratic smokescreen concealing responsibility. Its focus is data rather than space.

The aspiration of the city is no longer a product or an experience but scalable processes, services and ecosystems. How do we intercede in an arrangement in which agency is relinquished to things we do not completely understand?

'Platform Technologies' (in computing) describe a group of technologies that form the base infrastructure upon which other applications, technologies or processes are developed and delivered. The city too, is a representative platform technology. It provides a core set of underlying infrastructure services for investment and speculation. Buildings and developments typically are the modular structures that that plug-in to the platform to draw upon underlying services. The analogy of platform technologies is intensified and abstracted. Platform technologies are all about the algorithmic desire for incessant reciprocal rating and awarding of status.[6]

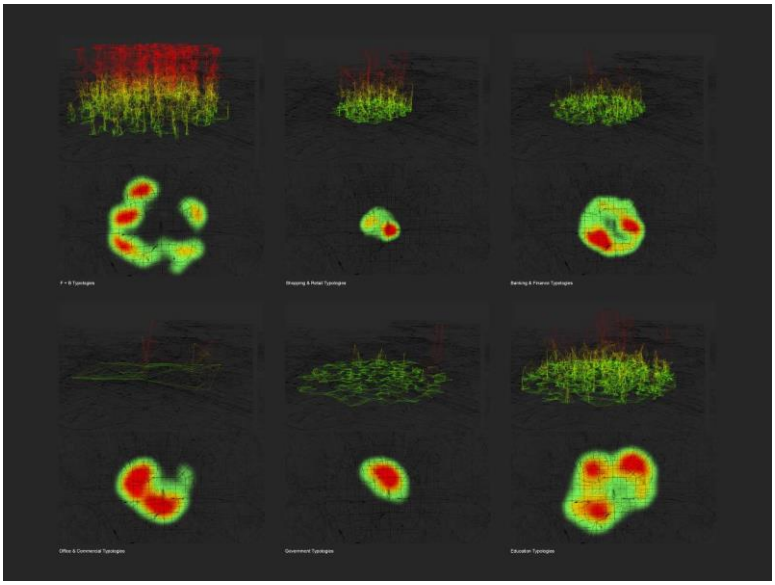

Figure 1. Spatializing User Comments and Reviews of Various Typologies in Beijing. Image: Sichuang Zuo Peihan Qian, Yuping Long, Xueli Li for Spatialising The Dematerialised City CDAC Tsinghua University Workshop 2022 with Ian Nazareth & David Schwarzman

The City as a Service is of an extreme present. While a citizen's immediate interactions are with broad urban systems and platforms appear to be 'personal' (mediated by technology), it simulates a city and continuum seemingly tuned to your preferences and benefit. Perhaps understood as the discovery of multiple futures where variants of you can exist concurrently – each prospect prescient, and uncannily well-judged. The city generates variance, inviting you to capitalise on chance and randomness.

Our experience of the intermingling of complex codependent systems and degree to which we determine the world is indeterminate. The temporal city is the city but also mechanism that make the city manifest itself to you. Did this city emerge as a logical extrapolation of the physical city or in response to the impending metaverse? A city where imagined futures are simulated and disposed with equal fervor. Technological change is a subconscious pretext for not changing at all.

The Service City is an ordering of self-contained entities of functional significance. Complexity emerges from the consequential interactions of finitely bounded individual preferences. The city reacts more precisely to patterns and behaviors. Even objects are now subsets of the patters of utility. Emergent solution to emergent problems that conserve historical layers. The service city is the capacity to of urban infrastructures to abstract - a conceptual scheme to reconcile and map geography onto utility and behavior, between the known and unknown.

The Service City is the element and dynamic of the city that remains intact across the multiple transitions and transformations. It is an urbanism substantiated by ubiquitous information flows and convergence of pervasive platform technologies on established and emergent built infrastructures and fabric. The realm of the real and possible blur.

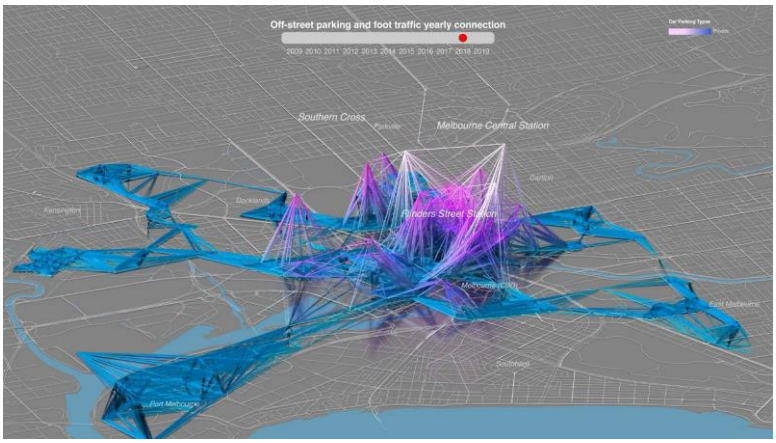

Figure 2. Visualizing public & private car parking densities within the city of Melbourne. Image: Yue Wu, Temporal City with Ian Nazareth & David Schwarzman

The following concepts are critical to the positioning the agenda on the city relative to technological change and perception – Law of Accelerating Returns, Antifragile and Bias Variance Tradeoff.

Law of Accelerating Returns

Technology is accelerating socio cultural behavior - and thereby individual. The city is rewired in space and time. Ray Kurzweil articulated the concept of the Law of Accelerating Returns 'as order exponentially increases, time exponentially speeds up (that is, the time interval between salient events grows shorter as time passes'.[7]

Linear thinking, (that accompanied stability) is rooted in the assumption that change would take decades, not months.[8] The growth and trajectories of cities are described as linear projections. Codified laws and unspoken social norms; legacy companies and NGOs; political systems and intergovernmental bodies – all have only ever known how to adapt incrementally.[9] In the Exponential Age this divergence is ongoing – and it is everywhere.[10] Changes, differentials are measured in months and days.

How might city - map against the rapid acceleration, how is volatility and exponential growth in its infrastructures, movements and usage patterns recorded in the physical fabric and virtual avatars? How does architecture absorb underestimation, overestimation and "mis-estimation"?

Antifragile

Robustness and resilience are insufficient. The research is concerned with in the notion of Antifragility that locates itself within a triad – fragile – robust – antifragile. "Antifragile"[11] is perhaps one step beyond robust, as it benefits from adversity, uncertainty and stressors. It is premised on an understanding that complex and co-dependent systems like economies and by extension cities are weakened, when deprived of stressors. Fragile and antifragile are relative — there is no absolute. Conversely or counterintuitively - can cities avoid optimization? Could they increase redundancies? The research is interested in extending this into a discussion of how cities and urban development behaves-and thrives-in conditions we don't entirely understand or are perpetually in flux.

High Variance Urbanism (Bias Variance Tradeoff)

The internet, technology has fast-tracked social, cultural, economic and political transition. We observe more fluctuations, changes, variation. More upside, more downside.

In statistics and machine learning, the bias–variance trade-off is the property of a model that the variance of the parameter estimated across samples can be reduced by increasing the bias in the estimated parameters.[12] The variance is an error from sensitivity to small fluctuations. There is a relationship

between the how the highs and lows are interpreted, extrapolated and hence manifested in the broader processes and mechanisms especially with the paradigms or real-time data, information and urbanism. Here, 'noise' in datasets could produce the intermittent highs and lows that assume a pattern and form in infrastructural responses, speculation, valuation and behavior of the city.

Spatialising the Dematerliased City

Projects in this space are empowered by a methodology of data scrapping – whereby geo-referenced information and data from web-based Application Programming Interfaces (APIs) can be extracted into design environments. Here raw information is co-referenced. The platform is thus a conduit between APIs and computer aided design application (Rhinoceros 3D) through an algorithmic visual programming language (Grasshopper). The focus is to hybridize disparate datasets from public services and private entities who have a vested interest in the city. This convergence offers architects, planners, and other disciplines an insight into behaviors of cities and networks all captured through decentralized systems. These can record and reveal patterns and offer new ways of engaging with the city.

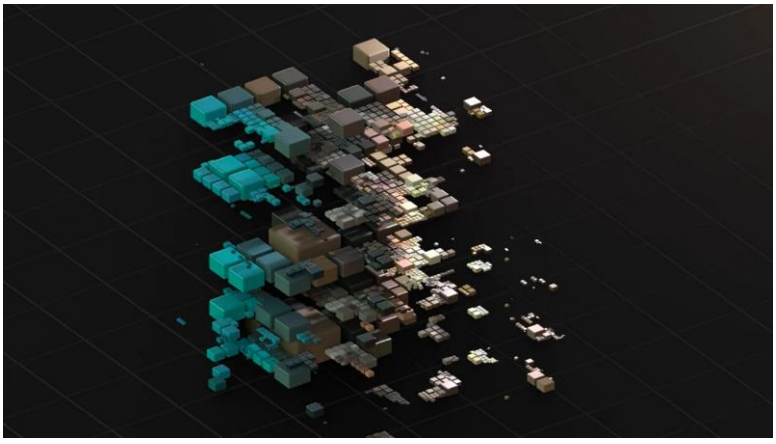

Figure 4. Visualizing digital and physical space. Image: Kevin Gao, Temporal City with Ian Nazareth & David Schwarzman

Through the introduction of time as a parameter (enabled by real-time or historic city data) the design project can begin to reveal the medium and invariants in behavior in which the city is suspended, how it can be manipulated and how we can steer change within our cities. In their very essence these approaches seek to better understand complexity in urban environments are bound by the feature of temporality. Their contribution is not static or restricted to a time and place context, but rather aims to deepen efficacy in productive intervention and influence the trajectory of complex urban environments with an extended temporal dimension.

Physical & Digital Space (a ripple, then a blur)

The architectural and urban design project is typically concerned with the design of static physical objects in a fixed time and place context. Contradictory to this the multiplying agency of digital infrastructures, apps to navigate the city, rate and review restaurants, deliver food and goods, move around the city in shared cars, stay in strangers' apartments, has remodeled patterns and behaviors of movement and occupation in the city. The nature of these digital infrastructures, i.e. peer to peer and sharing economy digital platforms, have mustered agency in their ability to respond rapidly to temporal user demand and popularity, they are immutable since they serve demand & purpose to perfection. Paradoxically the physical fabric of the city is fixed, programs and typologies are typically assigned & static - the architectural project in its traditional form can be hopelessly retrospective.

Projects undertaken under the aegis of 'City as Service' aim to further the core competency of the architect and designer to include an understanding of patterns, interdependencies, and relationships within a temporal urban environment. Speculative projects can blur the contrast between the city's static physical state and the dynamic social processes and human preferences which it orders - they suggest hybrid space between the digital and physical, dynamic and fixed. Programmatic and typological allocation is obscured to meet demand of users and subscribers (figure 3) space - which sits in both the physical and digital realms (figure 4) becomes an expression of user demand.

Figure 3. Visualizing Hybridized Programs. Image: Duy Hai Do, Temporal City with Ian Nazareth & David Schwarzman

Clayton – a refuge for an intermediate scale.

This is a design and research speculation and for Clayton[13] – a suburb in Melbourne's south east. An area defined as much by the density of exchange as by the relationships between the post-industrial fabric, the suburban intensification projects and technologies, infrastructures and platforms. Clayton sits within a field of intersections and entanglements - a growth corridor, a major train station, a university and medical precinct, a proposed national innovation employment cluster – high technology, high science and the suburban rail loop. Here the nodal will be further intensified by the distributed – Informational technologies could conversely hyper-centralise or hyperlocalise the city, either enabling detachment or supporting engagement with its developing context. Clayton is a testing ground for the emergent conditions in the city – sites and locations of scalable potential that accommodate transition. An intermediate scale, that is primed for disruption. The project advances an agenda that the city is not just a multiple of buildings – the city determines valency of a location which is crystallised into a building. The potential for what a building might be is determined by the city (valency might be equated value, cost, speculation, return on investment).

The project attempts to associate what might be understood as the fundamental interactions (like strategic, comprehensive and statutory urban planning, zones, regions) and elementary subdivisions (allotments, tenancies, binary, quantum states) between physical and simulated fields. The work seeks to gather agency in the 'territory' across the more established planning instruments and generative, emergent paradigms catalysed by decentralisation and distribution, with the aim to investigate a medium for exchange, or transactions, in fluctuating and volatile domains.

The project in Clayton was shadowed by a series of spatial and typological inquiries through speculation that each explore a physical, theoretical, technological, and cultural context. The shift in operation also represents relationships across scales, of fragments to the whole, and the analogy of peer-peer economies, subscriptions, recurrent patterns, and scalability. It reads the city both as an expansive entity but also as an active medium of gain. Between the ubiquity of the field and the fidelity of domains.

Figure 5. Visualizing a field condition of spatio-temporal digital and physical forces in Clayton. Image: Ian Nazareth & Wu Hao

CONCLUSION

Suspended within the animated variables of technological acceleration, economic viability, political will and contingent contextual forces, the urban architectural process is excruciatingly slow. Major urban projects are measured in 10, 20 even 30-year dockets, while decisions are made in the primary phases. Projects are obsolete before they are documented. Architecture in this instance can scarcely embody a zeitgeist. It is seemingly redundant, contemplative and perhaps even retrospective.

Usurped by technological nodes and entrenched in liminal overruns, the physical assets and infrastructures of the city have been appropriated by the innocuous internet-of-things, the semantic executing web, industry 4.0 and so on.

While the elastic behavior of urbanism predates the technological backbone especially in the realm of informality, it has certainly formalised and accelerated interaction between static and non-static entities, topological shifts, and differential characteristics globally.

We arrive at the epoch gamification of the urban experience where the mechanics of gaming are corralled into the coordinate geometries of the built environment to increase participation - they enhance, motivate, provide risk and reward. The city is external stimuli to the prowess of virtual interaction.

The city, now, suspends a concentrated, shifting view of human life. The city not only a physical map or virtual landscape of what people are thinking but how they form responses and arrive at perceived impulse. The city is stochastic, it's non-deterministic.

The City as a Service occupies a conceptually flexible domain, to abstractly represent the city, in order to fully comprehend its potential. A landscape of data and fact is reordered and transposed to landscape of relevance – choice architectures of separably manipulable entities - a city manifested at the highest possible resolution.

The City as a Service comprises a representative internal model of the operative city. It utilises these spatio-temporal models of the existing as a comparative to manifold, heterogenous models for potential action and speculation. It creates a functional representation that stands in for the collection of objects

and actions. It enables a city that senses far beyond normal limitations of the incumbent city. The city as a technology. Settlements and commerce that might be infinite in spatial and temporal dimensions.

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HERITAGE ROOTS, FUTURE GAZE. THE CASE OF AHMEDABAD

Authors:
ALISIA TOGNON, MARIANA PAISANA

Affiliations:
POLITECNICO DI MILANO, ITALY; CEPT UNIVERSITY, INDIA

INTRODUCTION

India is a country where the drive for modernization is becoming more urgent every day, and this topic is a central debate in the national political strategies. Moreover, the recent pandemic has highlighted the structural fragilities created by an inconsistent urbanization system in cities in India, as in many other countries.

This study reflects on considerations developed in ongoing research in the City of Ahmedabad. Ahmedabad is one of the first 20 Smart Cities in India and is inscribed on the UNESCO Heritage list (2017). The city has an intrinsic myriad of tangible heritage elements, historical built form, and monumental architecture, reflecting the succession of eras within its intricately layered past. These are strongly associated with the city's intangible memory comprising of identity, culture, traditions, and communities' everyday life. Recent decades have revealed the vulnerability of the historical core to the pressures of rapid urbanization. This status is substantiated by the phenomena of depopulation and abandonment of inner-city spaces resulting from migratory flows, overcrowding, lack of resources, and the need for economic growth and modernization.

This study aims to bring to the contemporary debate, on the one hand, the race for modernization in urban India and, on the other, the need to understand and safeguard cities' heritage.

We want to reflect on frameworks that can help define holistic interpretations and inclusive visions for a place like Ahmedabad, where contemporary cities and their cultural past can coexist in the future.

MODERN CALLING: THE INDIAN SMART CITY MISSION

Due to better job opportunities, the migration from rural areas to major Asian cities exacerbates the urban' growth and the decline of the ancient built environment.[1] In 2011, more than half of the world's population - 3.6 billion - lived in cities, which is expected to increase to 6.3 billion by 2050.[2] Similarly, 13 of 23 cities with a population of more than 10 million are Asian,[3] and, by 2025, 22 of the world's 37 megacities will be in the Asian continent[4]. As UNESCO reports, the urban areas of South Asia are among the largest and densest in the world, with about 1.77 billion people. India's urban population is expected to double by 2050, from 410 million urban citizens in 2014 to 857 million in 2050.[5]

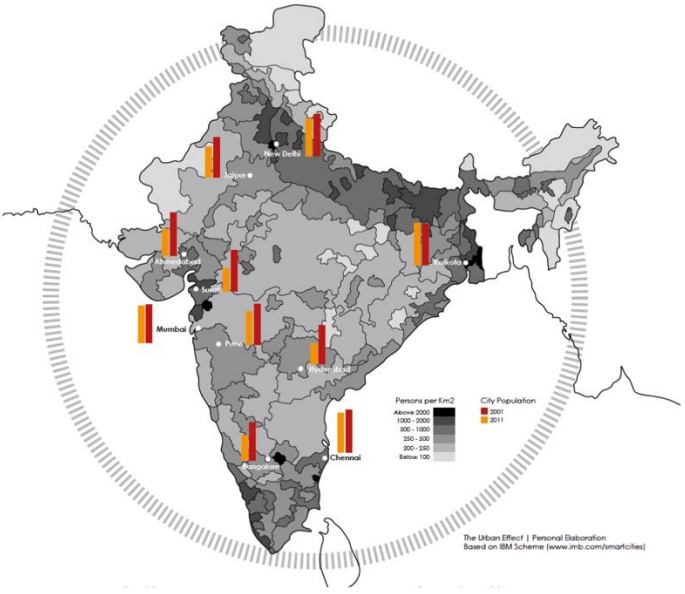

Figure 1. India urbanization ©Sara Rossi 2020

Facing the exponential urban growth, in 2015, the Central Government of India launched the Smart City Mission, an initiative to finance projects of retrofitting, renewal and greenfield approach in 100 selected Indian cities. The projects were co-financed by the central and state governments or urban local bodies and other initiatives such as the Swachh Bharat Mission [6] or the National Heritage City Development and Augmentation Yojana.[7]

In many cities in the west, a smart city is seen as integrating information and communication technology in projects that benefit the city's inhabitants and their businesses[8]. In the Indian context, however, the Smart City Mission funds a large variety of projects, some that involve technology, such as command and control centers or app base projects, and others that do not, such as the construction of affordable housing, waterfront, and garden redevelopments. The initiative delineates a loose framework by defining a *smart city* as: livable, sustainable and with a thriving economy offering multiple opportunities to its people to pursue their diverse interests.[9] It defines six guiding principles for the funded projects: community at the core; more from less; cooperative and competitive federalism; integration, innovation, sustainability; technology as means, not goal; and converge. [10] Furthermore, it enumerates comprehensive *smart city* development features such as mixed land used development, walkable localities, applying smart solutions to infrastructure and services, or giving an identity to the city.[11]

Some of the cities selected and funded by the India Smart City Mission initiated heritage-based development projects intending to address the pressures of urbanization, preservation and management of heritage. These projects aimed to solve conditions that are eroding the historical cities and their inner identity, such as deficient water and energy supply, as well as drainage infrastructure; demolition of ancient buildings and construction of new structures with an incongruent style and architectural language; encroachment of housing, retail, leisure, and tourism activities in relatively small areas of the historic center.[12]

Preservation of historical environments takes a secondary priority on the national urban agenda. Significant investments are largely allocated to building a "Global India"; therefore, public construction works, such as street widening, are often agents of demolition of entire complexes of historic buildings, irreversibly altering the traditional urban layout.[13]

However, as Minja Yang argues, there is a larger and relevant question about the consequences of urban growth on India's cities, considering the built environment, the multicultural aspects of citizens, and the

equity of access to resources.[14]

ROOTS FROM THE PAST: THE HERITAGE CONCEPT FOR MODERN INDIA

The heritage concept has its roots in 18th century Europe[15]. It is linked with the modernity project and the concept of national identity, which requires a national heritage designation through state policies.[16] Heritage, by definition, is a complex and multifaceted social construction based on the acknowledgement and assignment of a collective value to objects, buildings, and cities by the community. The geography of places establishes a network of remarkable points linked to a particular religious, civil or political value, affecting culture, society, and economy.[17] The idea of Heritage is, therefore, linked to cultural interests. However, its social and economic functions are now essential factors that cannot be underestimated,[18] creating different perspectives on Heritage and different economic values managed by particular social groups.[19]

The notion of 'Heritage Conservation' or 'Preservation' has long been a national government concern. Therefore, such principles are significant and controversial in nation-building policies, especially in ex-colonial contexts, where the concepts underlying the recognition of the 'meaning' of Heritage need a specific reframing.[20] In the British imperial setting, ideologies relating to national Heritage - both cultural and natural - were introduced and developed within a period of colonization and subsequently redefined and reassembled in a post-colonial era.

Indeed, the contemporary architectural conservation praxis in Asian territories finds its institutional and legal origins in the influences of the British Empire, which either directly ruled (as in India) or had a considerable geopolitical influence on the overall region from the late 18th Century until the independence years.[21]

In India's case, an ancient civilization whose cultural heritage spreads across thousands of years and displays an incomparable complexity due to an antique culture, the concept of Cultural Heritage assumes an ever-changing richness and diversity. India's immense collection of architectural and artistic works represents the collective achievements of various great civilizations and a distinctive local culture with deep vernacular and cultural traditions.[22]

Thus today, as one of the largest and most populous countries globally, India faces the difficult task of preserving a multifaceted cultural heritage in a dynamic and rapidly changing environment.[23]

It is worth underlining that the concept of "heritage conservation" is a recent phenomenon established under the British Raj in the second half of the 19th Century.[24]

In Asian countries subject to colonial rules, such as India, Vietnam, Cambodia, and Indonesia, the preservation of heritage at the state level was established directly by the colonizing governments.[25] These conservation institutions endured until the era of independence,[26] and after that, some existing systems were either abolished or evolved into institutions still operating today.[27] Early colonial conservation institutions reflected settlers' interests primarily in archaeological sites[28], excluding vernacular architectural typologies.[29] Indeed, conservation under the British rules was a direct political tool of the colonial system. However, its legacy has persisted in shaping sensibilities till today through institutions that persist in a revised form in the post-colonial era,[30] such as the *Archaeological Survey of India* (ASI),[31] established in 1861, which formed the basis for future legislation. The ASI became responsible for documenting and protecting India's antiquity by conducting geographical surveys of historical and archaeological sites.[32] The mission was further legitimized in 1904, when the agency adopted the *Ancient Monuments and Preservation Act*, the framework for conservation legislation in India, Pakistan, Sri Lanka, and Bangladesh.

The agency also published, in 1923, a prescriptive text on preservation best practices following a Western approach - the *Conservation Manual*[33] - which provided instructions on preservation techniques for the whole Empire.[34] During these years, meticulous work of annual reports monitored

the state of the monuments.[35]

In 1951, the foundation of the *Ancient and Historical Monuments and Archaeological Sites and Remains Act* (*Declaration of National Importance*), replaced in 1958 by the *Ancient Monuments and Archaeological Sites and Remains Act* (AMASR), [36] promulgated to preserve monuments, archaeological sites, and objects of national significance. In India, *The Ancient Monuments Archaeological Sites and Remains Act* of 1958 was recently amended in 2010 to include buffer zones of 100 and 200 meters around heritage monuments.

Moreover, it is still challenging to accurately recognize the value of the urban heritage, contained in the folds of historical urban fabrics, which still struggle to be preserved and suffer from neglect, fragility, and destruction. Urbanization is one of the critical factors increasing the vulnerability of Indian historic environments. They face an increase in real estate value and pressure of redevelopment, the structural and architectural deterioration of buildings and the lack of resources and incentives for restoration and maintenance of heritage.

Figure 2. Walled City of Ahmedabad: Buffer zone of ASI and Listed Monuments ©Authors 2021

AHMEDABAD IN-BETWEEN

Ahmedabad today is the seventh-largest metropolis in India and the largest in the state of Gujarat,[37] with a population of almost eight million.[38] It is a vibrant city animated by a multicultural spirit in a symbiotic relationship between historical fabrics, past monuments, remarkable architectural modernism masterpieces, and a robust globalized development and transformation trend.

Founded in 1411 by Sultan Ahmed Shah on the eastern bank of the Sabarmati River, Ahmedabad has a six hundred years long history and is second only to Delhi in terms of antiquity.[39] Ahmedabad is still distinguished by its extended story of glory and richness that has marked its prosperity and decline over the centuries. In this context, myth has overlapped history, dominations have become conflicts, and traditions have turned into innovations.[40]

Ahmedabad embodies all these aspects and reflects them in the architecture, mosques, temples, mills, and millions of people who live in the city today. A myriad of tangible heritage elements, demonstrated in their historical patterns and monumental architecture, is strongly associated with the intangible memory of the city, which includes its identity, culture, traditions, and the daily life of its dynamic local communities. It is a polyphonic city, with the cohabitation of diverse ethnic groups and religions, living together in the same place even if not without conflicts.

Ahmedabad's roots, consequently, are grounded in the history of the geographic area in which the city is embedded, where different religions such as Buddhism, Jainism, Zoroastrianism, [41] and Islam flourished at different times and where centuries of reign by kings, mostly Hindus, had preceded the

Islamic rule. Historically, Ahmedabad has always been the crossroads of one of western India's most important trade routes. The industrial era transformed, quoting Spodeck, into the so-called "Manchester of India",[42] due to its strong manufacturing growth and social and political history. The city also became famous for India's independence history, establishing itself as the headquarters of the freedom movement guided by Gandhi.[43]

Even today, the city depicts two dynamic souls in the same physical body. In the eastern part, the original Walled City, rooted in the tradition, with its suburbs dotted by textile factories (mills) and *chaal*, is characterized by the working and manufacturing class. On the west bank of the Sabarmati, new upper and middle-class districts - predominantly Hindu - coexist with cultural centers, universities, and masterpieces of modern architecture.[44]

Due to the association of traditional culture and intangible values and seeking to safeguard the city from the rapid and uncontrolled urban growth, the Walled City was designated in 2017 as one of two Indian cities listed as a UNESCO World Heritage Site, under criteria (ii) and (v).[45] The city structure reflects the common living rules, mutually accepted within the pol, clusters composed of self-sufficient dwelling units (*haveli*), with their own water supply, sanitation, natural climate control of the living spaces and an unique embroidery of inlaid woodwork on the façades.[46]

These characteristics are packed into 535.7 hectares,[47] a population of over 350,000, a density of over 700 people per hectare,[48] and a relative quota of conflicts. The result of these varied aspects is a unique settlement, universally noteworthy and intangible heritage expression of building traditions, religious beliefs, and craft skills.

Today, the city is an influential industrial and financial hub, with around 14% of India's stock market investments and 60% of the state's total productivity.[49] Several national, regional, and international scientific and educational institutions have been established.

In 2016, Ahmedabad was selected as one of the first 20 smart cities in India. In view of the open and abstract narrative of the initiative, Ahmedabad proposed projects that align with the current needs of the city: pedestrian friendly development, intelligent traffic management, wastewater recycling, development of green spaces, public transport-oriented zones, IT connectivity, water management, and energy efficient street lighting.[50]

Figure 3. Walled City of Ahmedabad (left) and western development areas (right) ©Authors 2019

The urban fabric of Ahmedabad changed drastically over the last years with extensive infrastructure projects like the BRTS, the metro or the riverfront redevelopment, but also with beautification projects, like Kankaria lake or Bhadra Square.[51] Like other Indian cities, Ahmedabad has seen an escalating pressure of globalized development, revealing the extreme fragility of the historical city core, overwhelmed by rapid urbanization. This situation creates a strong constraint on the city and the definition of public spaces, increasing urban complexity and chaos, exacerbating social inequalities, increasing land degradation, and reducing open spaces in future city planning. In the new public projects in the east side of the river, in the historical center (Bhadra square and riverfront redevelopment) the idea of innovation and the current notion of heritage created spaces of leisure and tourism, only recognizable to a few.[52] The idea of heritage, tangible, and intangible, was loosely associated with the existing livelihoods and the current uses, as they are seen as inconvenient and misleading for the clear understanding of the heritage forms. With these urban projects we can still read the confrontation between old and new,[53] with the two souls of the city being continuously set a part. We can witness a neglect of the urban heritage (even if there are many efforts of preservation of historical structures associated with the UNESCO listing) and a larger isolation of the historical core. A massive project that is an example of the efforts of modernization and globalization in Ahmedabad and that demanded a strategic approach to the historical center because of its location is the Sabarmati riverfront redevelopment. The project started in 1997, based on the narrative that identified the need to protect the city from the Sabarmati flooding.[54] The development narrowed down the riverbank, gaining land from the river and redistributing it to public parks and amenities, roads and private plots. The perineal river started receiving water from a canal, to maintain the same image throughout the year. The redevelopment of the riverfront completely changed the cultural and religious uses and meanings of the river that were still visible in the performed rituals on the religious structures55 and failed to connect with the urban fabric of the historical core. It was designed for modern and global use (leisure, boat riding, cycling). The proximity to the historical core presented an opportunity to reconnect the old and the new city on the two sides of the river, and to rethink the relation between heritage and innovation.

Figure 3. New City Develpments: Kankaria Lake, Sabarmati Riverfront ©Authors 2019

REFLECTIONS

It has been shown how the ideological roots of the prevalent heritage conservation in India are historically embedded in notions imported into the country mainly by British colonizers, borrowing deeply from notions of archaeology. Today, architectural, and urban conservation fields are

interdependent with antiquated legislation and ideologies, which struggle to achieve their goals in a recent effort to protect and manage heritage, and push for the development of globalized models, equally imported across borders. One of the problems is also related to the marginalization of conservation practice concerning integrating modern planning and policy. In recent decades, India's rapid urbanization and development, fuelled partly by globalization and facilitated by central government urban programs, threaten historical sites that remain unprotected. Many other significant challenges face the field today: these range from a rise in Hindu nationalism to natural hazards and climate change. Against this backdrop, India expresses concern about its position and recognition of value within the cultural debate on global preservation and history. Post-colonial subjugation continues to persist in the country concerning the era of colonialism and the subjugation of its great culture under British rule.[56] Recently, 'Look at East' (to South-East and East Asia) strategy has also begun in Indian politics, developing a realignment of interests in the world, in which the contribution to cultural heritage is defined as an integral part of this cross-border approach.[57]

The leading urban transformation mechanisms, such as the Smart City Mission focus on promoting and facilitating private investment, with the main objective of creating economic growth[58], turning the urban built environment into international legible forms. Many public urban projects in the last 20 years were infrastructures and “beautification” works that help preparing the urban fabric of Ahmedabad for private development and promote an image of a green, healthy, innovative city, “ready” for global investment,[59] but failed to recognize the potential and possible conciliation with its urban heritage.

Planning programs such as the Smart City Mission could collect and centralize data through information and communication technologies and find innovative ideas to reimagine the connection between urban development and heritage preservation. The use of technology can help solving some of the issues identified that persist in the historical context such as traffic, pollution or the lack and dense use of public space, and inform varied management systems to regulate traffic, street markets, festivals, etc. Learning from experiences across borders but basing solutions on a deep and live understanding of the place, can help redefining the notion of heritage and help develop a coherent plan to preserve and manage the historical core and structures through innovative projects, but preserving the value of historical identity.

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NOTES

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[3] “Population Division, World Urbanization Prospects, the 2011 Revision: Highlights,” United Nations, Department of Economic and Social Affairs (UN-DESA), accessed February 21, 2021, https://www.un.org/en/development/desa/population/publications/pdf/urbanization/WUP2011_Report.pdf.

[4] India has six megacities: Delhi, Mumbai, Calcutta, Bangalore, Chennai, and Hyderabad. Most of them also include protected areas on the UNESCO World Heritage list, thus creating protected urban areas of outstanding universal value.

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[8] In his book titled “Smart Cities”, Townsend defines smart city as “*places where information technology is combined with infrastructure, architecture, everyday objects, and even our bodies to address social, economic, and environmental problems*.” Anthony M. Townsend, *Smart Cities: Big Data, Civic Hackers and the Quest for a New Utopia* (W.W. Norton & Company, Inc., 2013).

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[10] "About smart cities mission", Ministry of Housing and Urban Affairs, Government of India, accessed February 10th, 2022. www.smartcities.gov.in/about-the-mission.

[11] "Mission objectives - Smart City Features", Ministry of Housing and Urban Affairs, Government of India, accessed February 10th, 2022. www.smartcities.gov.in/about-scm.

[12] Chika Udeaja et al. “Urban Heritage Conservation in India: Challenges of conserving Surat’s tangible and intangible heritage”, Sustainability 12, no. 6 (2020), doi.org/10.3390/su12062172.

[13] The Varanasi Kashi Vishwanath corridor, which opened in 2019, is an example of a heritage-based development, which cleared part of the dense historical core of the city, to open space for visits to the historical temple. The project includes a new precinct with a city museum, a multipurpose hall, and an exhibition gallery. The master plan designed a safer and more pleasant journey for pilgrims and tourists, but it is unclear what were the considerations and approach in terms of preservation, as it neglected the urban fabric, to detriment of a monument. It seems that the everyday rituals attached to the urban fabric, which constitute an intangible value of heritage, were also less considered. Divya A, "Sunday story: Project Varanasi", the Indian Express. December 19, 2021. https://indianexpress.com/article/india/kashi-vishwanath-dham-project-gyanvapi-mosque-varanasi-temple-7679567/.

[14] Minja Yang, “UNESCO Cultural Conventions for Sustainable Urban Development”, Context, Built Living and Natural, Journal of the Development and Research Organization for Nature, Arts and Heritage, Vol V, no. 1 (2008): 6-16.

[15] Françoise Choay, *L’Allégorie du patrimoine* (Paris: Editions du Seuil, 1996).

[16] David Lowenthal, *The Heritage Crusade and the Spoils of History* (Cambridge: Cambridge University Press, 1995).

[17] Giovanni Ferraro, *Il libro dei luoghi* (Milano: Jaca Book, 2001), 337-338.

[18] Laurajane Smith, *The Uses of Heritage* (London: Routledge, 2006).

[19] Salvatore Settis, ‘Il futuro del patrimonio culturale in Italia’, in *Battaglie senza eroi. I beni culturali tra istituzioni e profitto* (Milano: Mondadori Electa, 2005), 267-296.

[20] Few studies have been conducted on the idea of heritage in a colonial context. David Lowenthal, “Natural and Cultural Heritage,” International Journal of Heritage Studies 11, no. 1 (2005): 81-92.

[21] Not all these countries were directly annexed to the British Empire, as Nepal, Bhutan, and the Maldives. The influence of this period affected the geopolitical atmosphere of the whole region. Partially in response to the dynamics of the colonial era, each of these fiercely independent kingdoms and sultanates remained primarily locked to the rest of the world until the 1970s, creating interesting challenges for integration with the contemporary conservation practices. John Stubbs and Robert G. Thompson, *Architectural Conservation in Asia. National experiences and practice* (Abingdon: Routledge, 2017).

[22] The book by Kapila D. Silva and Neel Kamal Chapagain summarises well the issues of heritage values and practice on the Asian continent: «Pluralism is not just the acknowledgement of diversity but active and meaningful engagement with this diversity. There cannot be one universal approach based on a single, overarching value system; heritage management must be contextualized to the needs and beliefs of each Asian cultural context». Neel Kamal Chapagain "Introduction", in *Asian Heritage Management: Contexts, Concerns and Prospects,* eds. Kapila De Silva, Neel Kamal Chapagain (New York: Routledge, 2013), 9.

[23] Several monuments have the status of a UNESCO' world heritage site'; approximately ten thousand sites are recognized by national authorities [3,650 sites protected by the ASI], regional and local governments protect five thousand, and countless others remain unrecognized and thus unprotected. INTACH has estimated that the archaeological monuments receiving formal protection represent only 1-3% of the total nationwide and only 0.025% of non-monumental heritage resources (such as historic districts, landscapes, or locally significant resources) are nominated. "Charter for the Conservation of Unprotected Architectural Heritage and Sites in India" ,INTACH, accessed February 22, 2021, https://architexturez.net/doc/az-cf-21208. In India, 'heritage sites' are designated the buildings, artifacts, structures, areas, roads, and precincts of historical, aesthetic, architectural, cultural, or environmental significance and landscape natural features or panoramic beauty, including - but not limited to - sacred groves, scenic spots, walks, rides, paths, hills, hillocks, water bodies such as lakes, *kayals* (and areas adjacent to them), open areas, wooded areas, etc. Shyam Chainani, *Heritage Conservation: Legislative and Organizational Policies for India*, (Nuova Delhi: INTACH, 2009), 9.

[24] Manish Chalana, Ashima Krishna, "Introduction: Untangling heritage conservation in postcolonial India. From colonial to global times", in *Heritage Conservation in Postcolonial India*, eds. Manish Chalana, Ashima Krishna (London: Taylor and Francis, 2020), 29.

[25] John Stubbs and Robert G. Thompson, *Architectural Conservation in Asia. National experiences and practice* (Abingdon: Routledge, 2017)

[26] In almost all cases, British rule led to educational and cultural influences: e.g., the academic institutions established during the colonial period, such as the École française d'Extrême-Orient (EFEO) and the Royal Asiatic Society, which were prominent as research centers, repositories of knowledge and places of documentation, publication, and dissemination of the history of Asian countries and regions, at that time poorly known to the Western world. Scholarship during colonialism also provided a solid basis for the Western and local understanding of the history of various countries. The new Anglo-Saxon institutions, such as ASI, trained the first generation of non-European conservation practitioners, such as Rai Bahadur Daya Ram Sahni in India, A.H. Dani in Pakistan, and Senarath Paranavithana in Sri Lanka, who fostered the spread and progress of conservation principles in their countries in the post-independence era. John Stubbs and Robert G. Thompson, *Architectural Conservation in Asia. National experiences and practice* (Abingdon: Routledge, 2017)

[27] After the independence, it can be noted that there has been an effort in the Asian states to modernize the existing legislation, as well as training and deployment of national and technical administrative staff and merging the old colonial government within the new governmental departments (often under Ministries of Culture).

[28] A religious and political question must be emphasized in selecting heritage sites to be investigated by Western scholars. This situation explains the specific focus on Buddhist heritage and the relative exclusion of Hindu and Muslim sites from the study, following the former's official policy, which left the management of religious properties in the care of those who inhabited them. As a result, the places of worship of the 'living faiths' for Hinduism and Islam were safeguarded by their religious 'clerics', and wealthy patrons and Brahmins often financed their maintenance.

[29] The creation of the Bengal Asiatic Society in 1784 reflected the British focus on antiquarianism and Orientalism; the growth of archaeology in Europe would lead to the establishment of further institutions, such as the *Delhi Archaeological Society* in 1847 and the *Archaeological Survey of India* (ASI) in 1847. Refer to. Dhirendra K. Pant, *Care and Administration of Heritage Monuments in India, 1784- 1904* (New Delhi: Aryan Books International, 2012).

[30] Susan Johnson-Roehr, "The Archaeological Survey of India and Communal Violence in Post-Independence India", International Journal of Heritage Studies 14, no. 6 (2008): 506–523. doi:10.1080/13527250802503266.

[31] The ASI mission statements a wide definition of archaeology, which encompassed multiple forms of cultural heritage preservation in the built environment, and was so stated under the engineer Alexander Cunningham, first director-general of ASI. Refer to: John Keay, *To Cherish and Conserve: The Early Years of the Archaeological*

Survey of India (New Delhi: National Culture Fund, Archaeological Survey of India, 2011): 38 - 43. Alexander Cunningham, *Archaeological Report, 1862 - 65*, vol. I (New Delhi: Archaeological Survey of India, Government of India, 1865) Today, the ASI holds an invaluable collection of archaeology and heritage conservationdocuments under the Raj all over India. These reports first began in 1862 under the initiative of Sir Cunningham. Under James Burgess, the second Director-General of the ASI, started publishing an annual journal, The Indian Antiquary: A Journal of Oriental Research in Archaeology, History, Literature, Languages, Philosophy, Religion, Folklore, &c &c. in 1872, with a break from 1933-1937 (https://indianculture.gov.in/indian-antiquary-journal-oriental-research-archaeology-epigraphy-ethnology-geography-history) Then it turned into to New Indian Antiquary, in which information related to sites and discoveries in progress were reported in detail, until 1971. The journal aimed to share ideas and disseminate information on a wide range of subjects (including conservation) among scholars and professionals in India and abroad.

[32] Ashish Chadha, *Performing Science, Producing Nation: Archaeology and the State in Post-Colonial India* (Palo Alto: Stanford University, 2007).

[33] Indra Sengupta, "A Conservation Code for the Colony: John Marshall's Conservation Manual and Monument Preservation Between India and Europe", in *"Archaeologizing" Heritage*, eds. Michael Falser, Monica Juneja (Heidelberg: Springer, 2013): 21–38, doi:10. 1007/978-3-642-35870-8.

[34] The *Conservation Handbook* formed the framework for preservation practice in the colonial era and, subsequently, in the post-colonial era. Jahnwij Sharma "Conservation of Monuments in India: A 150-Year Perspective", in *Custodians of the Past: 150 Years of the Archaeological Survey of India*, eds. Gautam Sengupta and Narain Lambah (New Delhi: Archaeological Survey of India, Ministry of Culture, Government of India, 2012): 120–143.

[35] Archeological Survey of India, Royal Anthropological Institute of Great Britain and Ireland, *Indian antiquary* (Bombay: Popular Prakashan, 1872).

[36] "The ancient monuments and archeological sites and remains act", 1958. (Act No 24 of 1958), accessed May 10, 2022, http://asi.nic.in/wp-content/uploads/2018/06/new_6.pdf.

[37] Gujarat's state that is one of the most Urbanized State in India, and it is also one of the most prosperous, with an urban population of 25 million. Joel Kotkin "The World's Fastest-Growing Cities", *Forbes*, October 7, 2010, https://www.forbes.com/2010/10/07/cities-china-chicago-opinions-columnists-joel-kotkin.html?sh=1845b72654e2

[38] Data up to 2021, https://worldpopulationreview.com/world-cities/ahmedabad-population, accessed April 15th 2021.

[39] Major cities such as Mumbai, Kolkata, Chennai, Bengaloru, although larger and more populous, are more recent than Ahmedabad.

[40] Achyut Yagnik, Suchitra Sheth, *Ahmedabad: From Royal City to Megacity* (Gurgaon: Penguin Books 2016): xiii.

[41] The Indian Zoroastrians, known in India as Parsis, never became a dominant kingdom, but their influence was considerable in many ways. The Parsis left Persia in the 8th century, with the spread of Islam, and they went to India, to Gujarat, under the Hindu king Jadav Rana.

[42] Howard Spodek, *Ahmedabad: Shock City of Twentieth-Century India* (Bloomington USA: Indiana University Press, 2011)

[43] In 1915, when Gandhi went back to his homeland, he decided to establish his *ashram* in Ahmedabad until 1930.

[44] On the west bank of Sabarmati, there are new sprawls of residential quarters of middle class citizens, with a large numbers of cultural centres, universities and masterpieces of modern architecture, from architects as Le Corbusier, Louis Khan, Charles Correa or Balkrishna Doshi, who helped to establish a indian post independence language of architecture. Achyut Yagnik, Suchitra Sheth, *Ahmedabad: From Royal City to Megacity* (Gurgaon: Penguin Books 2016): 257-258.

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[53] This can be seen, for example, in Manek Bhurj, the bastion built in 1411 that was partially destroyed in 1999, with the addition of two new concrete bridges, added on the sides of the original steel platform of the historical Ellisbridge.
[54] Gloria Pessina, “The ‘Missing Conflict’ of the Sabarmati Riverfront. Authoritarian Governance, Neoliberalism and Water in Ahmedabad, India,” PArtecipazione e COnflitto, The Open Journal of Sociopolitical Studies 11, no.3 (2018): 692-716, doi:10.1285/i20356609v11i3p692.
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THE DEVELOPMENT OF DWELLING SOLUTIONS IN THE UNITED ARAB EMIRATES AND THE IMPACT OF COVID-19.

Author:
EMANUELA CORTI, IRENE PASINA

Affiliation:
AJMAN UNIVERSITY, UNITED ARAB EMIRATES

INTRODUCTION

In the early Seventies, after the union of the Arab Emirates, the government set welfare programs for its new citizens - at that time mostly Bedouins - to make the population sedentary and establish the new modern State. People's needs had to adapt to a new lifestyle and the result of the urbanization plan had various turns; among them the creation or idealization of a new national identity. The last fifty years have seen a rapid urban development: contemporary institutions for education, health and leisure coupled with the increase in automotive transport have led to the transformation of towns into cities. These changes have inevitably impacted the aesthetics of the urban environment and the social organization. [1] Dubai's government policies, cultural norms, and market forces have created neighbourhoods characterized by ethnic and socio-economic enclaves and segregation. [2] The city develops into neighbourhoods inhabited by some prevailing nationalities mainly linked to the commercial vocation of the different areas. Native-born citizens have their own subsidized areas separated from migrant groups. [3] The dwelling typologies developed in different ways, with large differences in the amount of space and in the quality of the interiors. In 2020, Covid-19 increased the discrepancy between people's needs and well-being and their actual available space. This text offers a reflection on sustainability and well-being of the Dubai dwelling system, based on data collected within a large group of people of diverse nationalities through a survey on the house's perception during pandemic.

The United Arab Emirates

The United Arab Emirates (UAE) consists of seven emirates of Dubai, Abu, Dhabi, Sharjah, Ajman, Ras Al-Khaimah, Umm Al-Quwain, and Fujairah, united as one federal state since December 2nd, 1971. Over the last fifty years, the Country has been progressing steadily driven by an oil-rich economy, scoring high developmental indices, with high per capita income and robust social development. Urban development has been a major concern and the Emirates had to face several changes and challenges. The largest portion of the population is made of expats, with overall 200 nationalities. 87.50% of the population in the UAE lives in urban areas while 12.50% live in rural areas. The estimated statistics of the population in 2022 is 10.08 million (the total Expat Population in 2022 is 8.92 million), and density is recorded as 102.20 individuals per square kilometer. However, the largest three emirates Abu Dhabi, Dubai, and Sharjah are carrying over 85% of the population. The Emirati population is only 11.69% of the total, while the largest percentage is represented by Indians (27.49%), followed by Pakistanis (12.69%), Filipinos (5,56%), and Egyptians (4,23%).[4] Traditional customs merge with a variety of

needs belonging to a wide range of cultures, and demographics characterize important communities and neighborhoods. One of the main goals of the authorities has been to provide UAE citizens with a house, able to combine different traditions and cultures, and project the newborn country towards modernity. While the average income is among the highest in the region, there is still a variability between wealthy and influential individuals who can afford luxurious living conditions and big families who, given the smaller budget for accommodation, need to live in smaller apartments. There is another consistent group of residents who lives in shared accommodations. The economic boom influenced a socio-cultural and economic transformation. The housing forms produced for the expatriate community are primarily medium- and high-rise apartment blocks for the low and middle-income workers, as opposed to luxury villas in exclusive areas or large expensive apartments in some of the trendiest areas in Dubai for the high-income expats.

BUILDING THE UNITED ARAB EMIRATES NATION AND ITS IDENTITY

In the past, the country was characterized by two main cultural trends: the nomadic desert-oriented Bedouins and the sea-oriented culture that revolved around pearling and sea trading. Before 1960, the only settlements were very small towns and villages; oil resources have enabled massive and rapid modernization through a construction boom, which transformed UAE's major cities into commercial capitals integrated with the global economy. The modernization process accelerated in the 1950s and 1960s when expectations of oil production attracted the sight of western companies to the region as a future source of energy and its potentiality for un-preceded opportunities and investments. These expectations were enhanced by the Emirati rulers' wide visions of the future and their persistence to be at the same modern levels that the neighboring countries in the Gulf region began to experience at that time.[5]

Figure 1. An aerial view of the abandoned town of Al Jazirat Al Hamra, in the south of Ras Al Khaimah. With the discovery of oil, its inhabitants were moved by the Government to Abu Dhabi (between 1968 and 1971). On the right side, a typical layout of the house

With wealth brought through the oil, the Emirati rulers realized that a more organized and sedentary lifestyle was essential to a modern state and started a first housing campaign to house locals in what was called the program of the *sha'bī* houses (*the people houses*). This program represented the first transition between the Bedouin life and the urbanized life. The development of the *sha'bī* houses involved experts and architects from abroad and was based on the use of modular pre-fabricated elements. The houses were organized in clusters, recalling the traditional villages' fabric made of narrow alleys (*sikka*). These houses usually consisted of two bedrooms, a kitchen, a bathroom, a shower, a *majilis* (living room) and a central courtyard around which all the rooms were directly opened. A tall

wall defined the perimeter and provided privacy. The courtyard was designed to be a space for interaction with family and friends, linked to the traditional lifestyle of living outdoor, and permeable to the public sphere of life, besides being a functional element that supported ventilation and cooling for the interior spaces. It was conceived based on the idea that the inhabitants would have been able to personalize their needs, but the design of these houses was not suitable for the inhabitants' cultural values and needs, especially Bedouins who were forced to settle in these projects.[6] Nonetheless, the *sha'bī* house marks a foundation moment in the future development of the dwelling typologies that will characterize some of the new Dubai neighborhoods.

Figure 2. The Sha'biya Al Safa Neighborhood and two typical plans

Dubai city's development

Dubai grew from a small fishing village led by a tribal ruling, and has developed so quickly that Bagaeen described it as having undergone "instant" *urban-ism*.[7]

Thanks to the diversification of the economy and its urban development, Dubai saw huge immigration of foreigner workers.[8] Trade and commerce have played a crucial role in molding the urban form of Dubai. Deira for example developed around the trade and flourished along the creek hosting temporary and permanent South Asian workforce from India and Pakistan. The fast-paced population growth in this region was followed by a need for change, led by imported western planners and technology required to achieve immediate and severe transformation of cities. The resulting change showed incompatibility between the transformations and traditions. Western planners gave more weight to speed, sufficiency, and quantity rather than allowing a transitional period, which could have been conducive to letting local traditions evolve, expand, and strengthen to accommodate the sudden changes in the urban fabric of these cities.[9]

Furthermore, the establishment of government-owned airways carrier Emirates Airlines in 1985 gave an exponential impulse to the expansion of the city, defining the touristic vocation and bringing in more workforce from all over the world. During these years, the fractionation and distribution of lands started to be influenced by the rental price of properties targeting the different segments of Dubai population. Only in 2002, Dubai's ruler Sheikh Mohammed Al Maktoum issued a land reform called Freehold Property, allowing foreigners to own real estate in Dubai which contributed to the establishment of gated communities tailored to expatriates of a certain income and origin.

Along with its urban development, the city kept defining its neighborhoods by some prevailing nationalities mainly linked to the commercial vocation of the different areas. Native-born citizens have their own subsidized neighborhoods segregated from migrant groups.[10] Isolated housing for low wage laborers evolved, as integrating these people into the existing community was considered indecorous. New housing patterns emerged to fulfil the demands, with a chaotic organization. The urbanscape has transformed rapidly with innumerous skyscrapers which stand tall adorning the city, and large luxurious projects like the Palm Islands have changed the map of Dubai completely.[11] For example, figure 2 shows Sha'biya Al Safa Neighborhood recently demolished to give space for new expansions. The historical areas of Deira and Burdubai with their vibrant population and their traditional vibes are contrasting with the new glass and steel development of Business Bay. Old and new live side by side in the urban fabric, Dubai speaks a multitude of languages as its numerous landmarks.

Figure 3. The contrasts in Dubai: the Al Safa neighborhood and the Bur Dubai port beside the contemporary skyline and the Burji Khalifa

Today the expansion of the city continues inland and while the ethnic groups' distribution appears to be more blended, some areas of the city still retain a particular feature, based on the prevalence of certain nationalities aggregated around the concept of solidarity among conational living abroad and the offer of affordable shared bachelor accommodations. In 2021, Sheikh Mohammed bin Rashid Al Maktoum launched the new Dubai 2040 Urban Master Plan, which revolves around five "Key Urban Centers": the historic area of Deira and Bur Dubai, that highlight the emirate's tradition and heritage; the business and financial heart of the city encompassing Downtown and Business Bay; the international tourism and leisure hub encompassing the Dubai Marina and JBR; the new Expo 2020 Centre, an economic and growth hotspot featuring affordable housing and a focal point for the exhibitions, tourism and logistics sectors; Dubai Silicon Oasis Centre, a science and technology and knowledge hub that drives innovation, digital economy.[12]

DUBAI AND THE COVID-19 PANDEMIC

Those five Urban Centers are currently characterized by different demographics, wealth, types and quality of dwellings. This research considers the impact that the Covid-19 pandemic had on Dubai city and its inhabitants, and how the lockdown and the sanitary restrictions affected the social and well-being perceptions of the interior spaces in these different areas.

We prepared a survey and spread it online between September 18th and December 20th, 2020. The English version has been translated into Arabic and Urdu to facilitate the collection of feedback.

The survey aimed at understanding demographics, the space they inhabit, its use and the modifications applied to the changes of needs during the pandemic; we explored challenges and interesting solutions to cope with new requirements and investigated future plans and new desires.

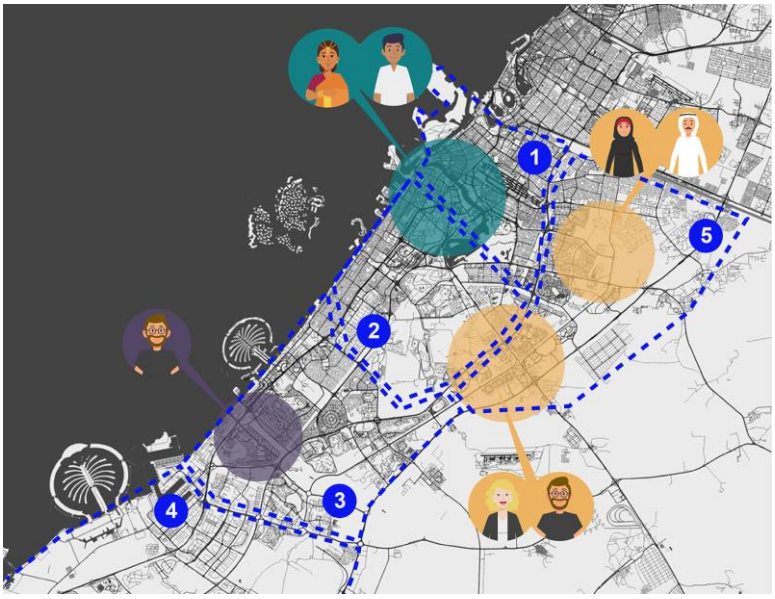

Figure 4. Key Urban Centers: Deira and Bur Dubai (1), Downtown and Business Bay (2); Dubai Marina and JBR (3); Expo 2020 Centre (4); Dubai Silicon Oasis Centre (5)

Survey results

Respondents are predominantly South Asian (25%) and African (22%), mainly Pakistani (18%) and Egyptians (20%) in their working age (between 25 and 39 years old), which reflects demographics residing in the Country. It is important to note that, most respondents are people with family and kids (77%) living in a house of 100 square meters or more. According to our questionnaire, only a few lost their jobs (6%), and most people were able to shift to remote work (72%) although their homes were not always adequate to host all family members with different needs. 54% of respondents declared that their house was ready to host people for a long period during the lockdown.

In general, the most used areas of the house have been the living room (34%) and the bedroom (33%), followed by the dining (16%) and the study room (9%). The most challenging part of the lockdown, according to our survey, has been remote work (39%), followed by supporting kids with home learning and playing time (12%). In addition, to cope with the stress 39% of the interviewees started training at home, either individually or through an online course. The family type that adopted most strategies to cope with the stress of the lockdown is the family with kids. 53% of the respondents reduced ordering food and started to cook more at home, and people stocked food at home, although after lockdown only a small percentage still keep stocks (23%). Respondents are now looking for outdoor space (32%) while extra space would be desired in the living room (33%) followed by the bedroom (23%). People now require contact with nature, natural light, and good air ventilation.

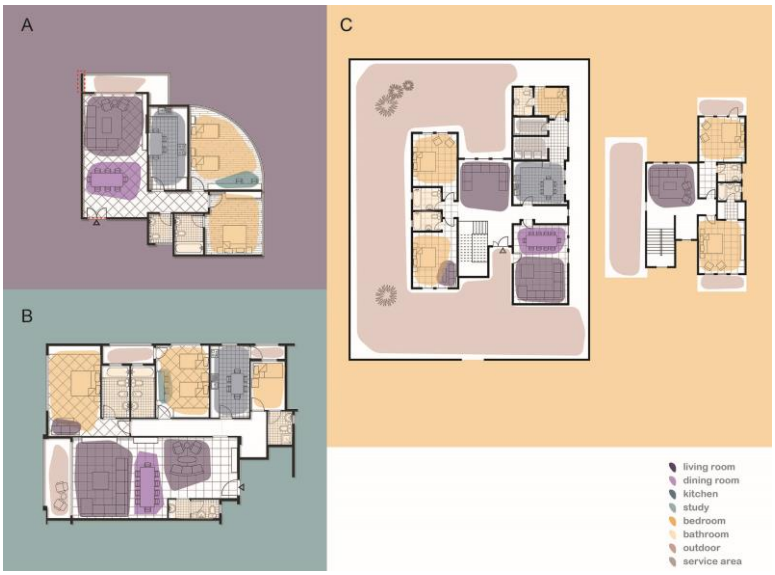

Figure 5. Three different plans considered: plan A in Deira and Bur Dubai (1), plan B in Dubai Marina and JBR (3); plan C in Dubai Silicon Oasis Centre (5)

Analysis

After we analyzed the data in general, we considered three floorplans taken from residential buildings representatives of the areas from which we got the majority of the answers, each belonging to a different "Key Urban Centers". The first one (Plan A) is an apartment of 99 sqm in a tower in Dubai Marina, with the entrance directly into the living area, a separate kitchen without a window, a master bedroom with an en-suite bathroom, and a double bedroom. Despite the large windows in the rooms providing beautiful panoramas, the apartment has only one external small balcony. The second plan (Plan B) is an apartment of 161 sqm in the historical area of Bur Dubai. Again, the entrance is directly into the living area, which is divided into three zones: two sitting areas and the dining. A long corridor distributes a separate kitchen, the master bedroom with an en-suite bathroom, a double bedroom, a bathroom and the maid room. Here, the living room opens toward a balcony, and the double bedroom has access to another small balcony. The third plan (Plan C) is a two-floor 4-bedrooms villa of 376 sqm in Oud al Muteena, one of the neighborhoods of the Silicon Oasis Centre. These new housing forms, built by national developers, are a combination of tradition and modernity. They have retained the original layout and segregation of spaces and uses. However, the architectural styles are borrowed from magazines and international villa type housing, a symbol of modernity.[13] This third plan shows the disappearance of the external detached *majilis* in contemporary villas, replaced by multiple sitting areas. The largest one is considered nowadays as the *majilis*, with separated access from the exterior and divided by the rest of the house to provide privacy to the female family members.

Figure 6. Advertising material for the Oud al Muteena development by Mohammed Bin Rashid Housing Est. The proposed floor plan is standard (Plan C) while the exterior is proposed in four different styles: Local Style, Islamic Style, Andalusian Style, and Modern Style

If we compare plans like in figure 7, it's easy to note that the single villa has a much more extensive social space. There is access to a private garden surrounded by tall walls, like in the traditional house, and there is a large terrace and two smaller balconies on the first floor. These spaces guaranteed the inhabitants had a healthy relationship with nature and good air ventilation, and at the end of the stricter restrictions period of the pandemic, allowed them to gather with friends and families maintaining a proper social distance. Besides, the community neighborhood also allowed a social interaction in the alleys and streets similar to the interaction that was possible in the traditional villages.

Figure 7. Social spaces in plans A, B, C

Meanwhile, people living in high rise buildings during the pandemic were totally disconnected from their neighbors; these apartments offer small balconies, generally divided by a wall to protect privacy, and there are no common areas outside the apartment's door. Even the communal spaces usually present in these tower buildings were not accessible for a long time. Social connections were limited to family members or co-habitants only. Therefore, this condition was very stressful, especially for families with kids. It is interesting to note how these typologies of dwellings were equally psychologically stressful for the inhabitants, even if the social and economic context of the neighborhoods were different. Some of the residents described the lockdown experience in these kind of apartment like being trapped in a glass cage.[14]

Figure 8. Photographs from the series 'At home' by Natalie Naccache, 2020 (courtesy of the Author)

CONCLUSION

The process of urbanization in the Emirates largely focuses on economic strategies and social subsidies for citizens; environmental and social concerns are either not prioritized or undeveloped. Dubai residents have been divided and sometimes hidden within the city; the wealthy part made up the image of the luxurious country, while the workforce have been segregated into residential areas with lack of facilities and services. Government housing programs for native citizens stimulated sub-urban growth and reflected a commitment to certain kinds of social sustainability, such as ensuring the stability of the family structure and the wellbeing of citizens. The larger group of expats with their varied nationalities, customs and needs have been excluded from the discussion, despite being the majority; this approach reinforced the separation of native-citizens from both a physical and social aspect. The Government recently introduced long term visas and it is trying to ease and prolong resident's stays, as part of a program that aims at supporting foreigner's investments. The fast pace city where people used to come and go, is becoming more attractive and people start planning more long-term. Therefore, different needs and priorities of the city's inhabitants should be considered. The Covid-19 pandemic has stressed some of the issues that are characterizing the city of Dubai and its growth since the early 2000's. The Government looks now at the future with Dubai 2040 Urban Master Plan which defines a comprehensive plan for a sustainable urban development with a focus on enhancing people's happiness and quality of life, through the development of urban centers with access to facilities and services. Some of the key priorities include improving the efficiency of resource utilization, developing healthy and inclusive communities preferred to the tall building residential typology, doubling green and leisure areas as well as public parks to provide a healthy environment for residents and visitors, develop communities and revitalize old central districts for national housing. Other objectives include enhancing environmental sustainability, safeguarding the emirate's cultural and urban heritage and developing a comprehensive legislation and planning governance model. Indeed, few recent projects in the hospitality sector focus on the Emirati culture and its heritage, and we do hope this is the sign that a more sustainable approach has initiated. Although, the plan refers to national housing projects and does not mention the private sector. The analysis raises several questions on a social and at a design level, that could be investigated further.

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SUSTAINABILITY IN SOCIAL INTEREST HOUSING: THE IMPLEMENTATION OF VEGETABLE GARDENS IN OPEN SPACES IN CONDOMINIUMS

Authors:
ELIANE SILVA BARBOSA; VIRGÍNIA MARIA NOGUEIRA DE VASCONCELLOS

Affiliation:
FEDERAL UNIVERSITY OF RIO DE JANEIRO, BRAZIL

INTRODUCTION

The accelerated occupation of cities, experienced in recent decades, led to a change in urban design. The Latin America is 80% urbanized, an extensive and heterogeneous territory, a place that encompasses extreme and diversified situations in terms of habitat[1]. Continent is a laboratory for the search for urban solutions.

All this growth calls into question the sustainability of cities, especially about climate change. The transformation experienced in cities stems from growth with a lack of urban planning, lacking spaces for green areas and where this absence leads to urban environmental discomfort.[2]

The importance of free spaces for building in the configuration of the landscape and for the health and well-being of the population is unquestionable. Unbuilt spaces contribute to the reduction of heat islands and environmental comfort, favoring the affective relationship of the place, in addition to contributing to healthier and more sustainable cities.

In Brazil, the Federal Government program known as **"**Program My House My Life**"** (PMCMV) launched in 2008, with the intention of providing access to housing for families with an income of up to 10 minimum wages, with a view to improving the population's quality of life**.**[3] The program proved to be more effective from the economic perspective than from the urban perspective.

This article aims to present a proposal for the implementation of vegetable gardens in open spaces in residential condominiums of social interest in cities with a hot and humid tropical climate, having as object of analysis the PMCMV sets. These condominiums are largely characterized by buildings with a height of up to five floors, located in areas far from urban centers and with little or no landscape treatment appropriate to the context. The study presents as a result a methodological guide for the introduction of vegetable gardens in the presented scenario.

The lack of green spaces, the application of mostly non-permeable floors and the spatial arrangement determined by the way in which the buildings are implanted, are determining factors in the environmental comfort of the place. In search of solutions that can mitigate discomfort, the vegetable garden project emerges as a possibility to favor the microclimate of the place and promote visual comfort, in addition to contributing to the food subsistence of the local community.

It is important to highlight the vegetable gardens initiative with the 2030 Agenda and how much the implementation of this proposal can contribute to the seventeen sustainable development goals (SDGs)[4].

The vegetable gardens project involves the three dimensions of sustainability: people, environment and economy and can directly benefit at least nine SDGs.
The implementation of vegetable gardens can favor nine SDGs, namely: SDG 1: end poverty; SDG 2: end hunger; SDG 3: well-being; SDG 8: decent work and economic growth; SDG 9: industry, innovation and infrastructure; SDG 10: reducing inequalities; SDG 11: make cities and human settlements inclusive, safe, resilient and sustainable; SDG 12; ensure sustainable production and consumption patterns; SDG 13: action against global climate change.
The study scenario for the implementation of vegetable gardens in residential condominiums was the City of Rio de Janeiro, located in Brazil, a country with a large deficit of housing and precarious settlements. The climate in the region is characterized as a hot and humid tropical climate, with very high temperatures in the summer and a period of lower rainfall in the winter. The issue of thermal comfort is one of the premises considered in architectural and urban projects, since in cities with a tropical climate, the individual's relationship with the environment can be unbearable if there is no effort to alleviate heat discomfort.

METHODOLOGY

The work is qualitative research that starts from bibliographic research and field visits, developing in six stages. Stage [1] is based on visits to PMCMV housing condominiums, located in the West Zone of the City of Rio de Janeiro, an area that concentrates most of these developments. The visits aimed to evaluate the quality of the built environment, highlighting the contribution of open spaces to environmental comfort. The technique of direct observation of the place was used and it led to the conclusion that the lack of treatment of the spaces contributes to the thermal and visual discomforts.
Stage [2] starts from the problems observed in the visits and leads to bibliographic research on the contribution of gardens to environmental comfort, in addition to food subsistence issues. The search for works already published with the theme: “vegetable gardens and environmental comfort” was carried out on the Mendeley Platform, in December 2021, and no studies were found in Brazil that directly relate these two subjects: vegetable gardens and environmental comfort.
In parallel with the search for publications on the subject, step [3] was developed, with a survey of plant species destined for vegetable gardens. The search in specialized books and reference sites on edible species contributed to the definition of categories and to the understanding of the guidelines of a vegetable garden for the hot and humid tropical climate.
In step [4] visits were made to vegetable gardens already consolidated in the City to observe their role and establish a parallel with the needs of the population, in addition to contributing to the understanding of the infrastructure necessary for the implementation of new gardens. The criteria for choosing the spaces visited were location in the West Zone of Rio de Janeiro (the same region as the condominiums visited) and the role they play with the community. Two visits were carried out, one of them in a public space, “Vinil Vegetable Gardens” and the other in an upper-middle class residential condominium, “Riviera Dei Fiori Vegetable Gardens”.
In step [5] analyzes of the information collected in the previous steps were carried out and from there, criteria were established that must be observed for the implantation of vegetable gardens in the condominiums of the PMCMV. The criteria were documented in step [6], which comprises the elaboration of the methodological guide for the implantation of gardens in the spaces of the condominiums in question.
Four basic criteria were listed for the choice of species, namely: [1] need for sun/shade (environmental analysis); [2] vegetation height (physical analysis); [3] soil type (physical and environmental analysis); [4] compatibility between the chosen species (physical and environmental analysis). The elaborate

script establishes the steps to arrive at the information that responds to the selection criteria, according to the summary presented in Table 1.

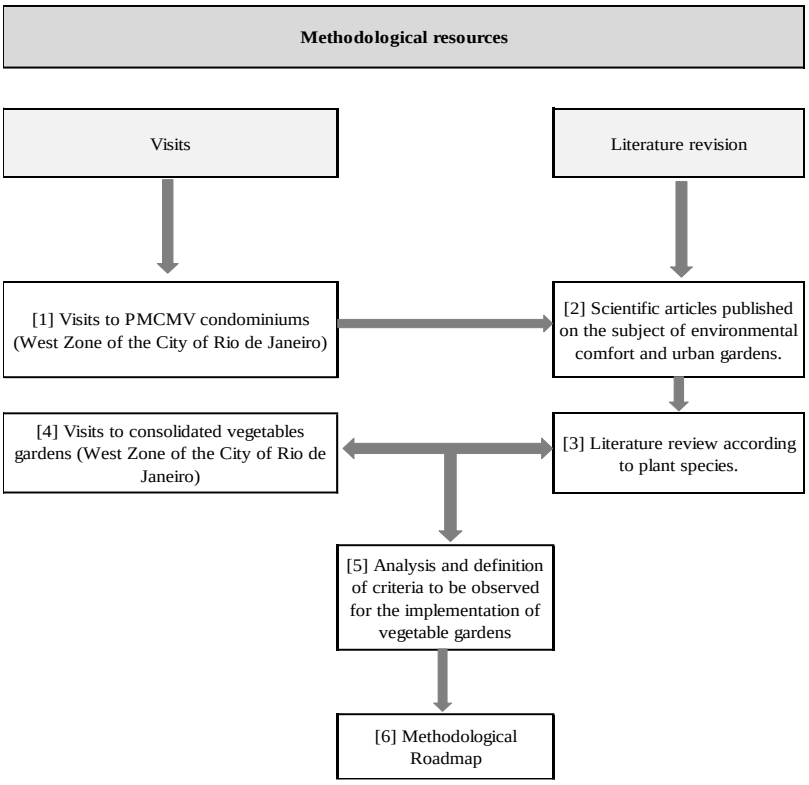

Table 1. Synthesis of the methodology by the authors.

FREE SPACES IN CONDOMINIUMS AND ENVIRONMENTAL COMFORT

The design and treatment given to open spaces are decisive factors in improving the comfort of the built environment. In the PMCMV condominiums, open spaces indicate a product in response to the rhetorical need to meet the program, without receiving due attention as a structuring element of the housing complex and demonstrating the absence of landscape structures. Figure 1 presents a schematic implantation plan highlighting the free spaces (in red) as leftovers from the built space.[5]

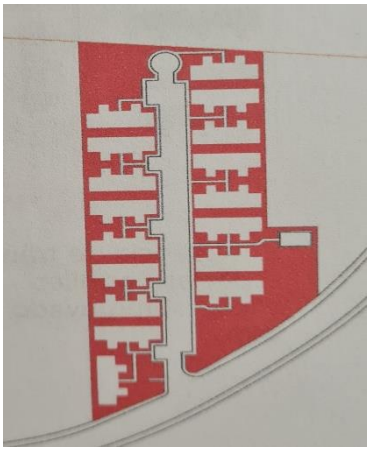

Figure 1. Example of implantation of by Benetti, Pecly, Andreoli.

We can define as free spaces all those not contained between the walls and ceilings of buildings built by society for their housing and work. In the urban context, open spaces are streets, squares, patios, backyards, parks, gardens, vacant lots, external corridors, villages, alleys and others where people circulate[6].

The open spaces of the PMCMV condominiums, exemplified in Figure 2, were chosen for the study of the implantation of vegetable gardens, since most of these open spaces have impermeable floors providing an increase in surface temperature and consequently in the ambient air temperature. Concrete and asphalt in cities absorb so much heat during the day, and that heat, when released at night, can raise the ambient temperature by up to 5.5°C, which can lead from unbearably hot days to lethal days[7].

The thermal and visual comfort of open spaces depends on the urban project and the decisions of the architect-urbanist can transform the microclimate, making it comfortable or unbearable[8]. For tropical areas, exposure to solar radiation should not be favored due to thermal discomfort, in addition to visual annoyance due to glare. The reduced distance between the built spaces provides a lack of privacy, visual discomfort, a decrease in the share of visible light from the sky and less capture of natural light.

Figure 2. PMCMV condominium free spaces by Eliane Barbosa

Vegetables gardens and the comfort of the built environment

Vegetation is a great ally for the visual and thermal comfort of the environment. The importance of vegetation in urban spaces goes beyond beautification, it can contribute to air quality[9]. Thermal comfort is one of the basic physical/biological needs and there are also four environmental factors that influence heat dissipation, namely: air temperature, air movement, humidity and thermal radiation[10]. Vegetation, when appropriate to the climate and conditions of the place, can reduce heat islands and increase soil permeability.

The implementation of vegetable gardens will reduce the proportion of impermeable soil, predominant in the types of condominiums visited. As solutions to favor the permeability of the soil, grass or interlocked floors are presented as options of low solar absorption. Vegetation should replace, whenever possible, any type of pavement, especially in tropical regions[11].

In the context of vegetated spaces, vegetable gardens appear as a possibility to bring together the positive attributes already described and to move beyond climate issues and contribute to the social and economic dimension of the community residing in these condominiums. The United Nations estimates

that the Planet will need approximately twice as much food by the year 2050. Climate change will also be responsible for a change in food production due to changes in the soil[12]. In this context, the vegetable garden contributes to reducing hunger, mitigating the rise in temperature and can also favor the local economy.

The vegetable gardens initiative is being discussed for implementation at different scales, mainly by the government in residual and public open spaces in cities, but little has been discussed the use in private open spaces of low-income communities. The visit to vegetable gardens in the City of Rio de Janeiro contributed to the perception of infrastructure challenges.

The first vegetable garden visited – "Vegetable Garden Vinil" is in a public open space, with the sense of urban agroforestry, it does not have defined beds, the fertilization is made from organic waste, protected by dry leaves that guarantee the lining of the floor. Figure 3 shows the composting site in the garden and exemplifies some species found there, such as: acerola, mint, pepper, banana, eucalyptus, in addition to brazilwood, a species native to the Atlantic Forest in Brazil.

Figure 3. Vegetable Garden Vinil by Ana Luisa Sumar

The second vegetable garden visited was that of the Riviera Dei Fiori condominium (Barra da Tijuca), an upper-middle class residential condominium, with a landscape design by Roberto Burle Marx, a landscaper of relevant contribution with projects recognized for transforming the landscape and respecting the local ecosystem. The vegetable garden was a more recent intervention in the condominium and without the intention of being a green space to beautify the place, but rather to generate fresh vegetables and available to the residents.

In the absence of references to gardens in popular condominiums, the visit to this garden contributed to the understanding of the implementation in private open spaces. As the site already has a good design, with a good proportion of permeable soils and vegetation, it was observed that the vegetable garden in this space is not intended to favor thermal or visual comfort. Some species found in the place are exemplified in Figure 4, such as: cabbage, lettuce, chicory, British.

Figure 4. Condominium Riviera Dei Fiori by Ana Luisa Sumar

The visits to the vegetable gardens added to the bibliographical research, allowed the understanding of the effects that the analyzed species can generate for the environmental comfort in the analyzed areas. As a result, combining different heights of vegetation to provide visual comfort and using species of bedding to improve the temperature of soil surfaces are two fundamental points for the use of the vegetable garden to promote the comfort of the built environment.

RESULTS

As a result, this work presents two Tables that help in choosing the species to be used in the gardens and the script containing all the steps for the implantation of new gardens in free spaces of social housing condominiums. As the suggestion to implement vegetable gardens in condominiums aims to go beyond subsistence and contribute to the environmental quality of the place, the criteria for defining the species relate physical and climatic aspects of the place with the compatibility of the type of vegetation.

The research related edible species, their climatic needs, and physical attributes of space. As a result, the work presents two species tables, one with species that need direct sunlight, Table 2 and another with those that develop better in the shade, Table 3.

The information highlighted in the Species Tables provides information needed to help define species when designing gardens. Soil type recommended spacing between species, maximum height to be reached, need for irrigation and indication of the ideal time of year for harvesting are data that, added to the scientific and popular names of the plants, contribute to the assimilation of the species. The two tables indicate six specimens of species each, grouped by category of food type (fruits, vegetables, and greens).

It should be noted that the two Tables can be made compatible, since a species that needs shade can approach a sunny species if it is higher and shades neighboring species. It is noteworthy that the implementation of vegetable gardens aims to contribute to the environmental quality of the place and, in this context, species that reduce heat discomfort, either by shading or floor covering, are welcome.

SPECIES WITH HIGH LIGHT NEED					
Scientific name (Popular name)	**Type of soil suitable for development**	**Recommended spacing between seedlings (m)**	**Maximum height (m)**	**Watering need classification**	**Best time of year for harvest**
Carica papaya (Papaya)	Medium texture, deep, well drained, not subject to waterlogging and rich in organic matter	3 m	8 m	A lot (3-5x/Week)	Whole year
Malpighia emarginata (Acerola)	Deep, loamy, well-drained sand	5 m	4 m	A lot (3-5x/Week)	8 months after planting
Capsicum annum (Pepper)	Fertile, rich in nitrogen, good drainage	0,5m	0,5-0,8 m	Moderate (2-3x/Week)	12 -16 weeks after planting
Phaseolus vulgaris (Pod)	Drained, fertile and rich in organic matter	0,5 m	-	A lot (3-5x/Week)	50-90 days after planting
Allium porrum (Leek)	Drained, rich in organic matter, pH 6 to 6.8	0,1 m	0,50 m	Little (1-2x/Week)	120-150 days after planting
Lactuca sativa (Lettuce)	Sandy clay, rich in organic matter	0,3 m	0,25 m	A lot (3-5x/Week)	Whole year
LEGEND: CATEGORIES:	**Fruits**	**Vegetables**	**Green**		

Table 2. Species with high light need

SPECIES WITH LOW LIGHT NEED					
Scientific name (Popular name)	**Type of soil suitable for development**	**Recommended spacing between seedlings (m)**	**Maximum height (m)**	**Watering need classification**	**Best time of year for harvest**
Ananas comosus (Pineapple)	Well drained, aerated and with a pH between 4.5 and 5.5	0,9 m	1 m	Little (1-2x/Week)	All year, with concentration between November and February
Musa spp. (Banana)	Deep alluvial, rich in organic matter, well drained and with good water holding capacity.	2 m	8 m	A lot (3-5x/Week)	Whole year
Canavalia ensiformis (Pork beans)	Undemanding, sandy or clayey	0,3 m	1,5 m	Little (1-2x/Week)	December. - January.
Mucuna aterrima (Mucuna-preta)	Undemanding, climbing	0,2	1 m	Moderate (2-3x/Week)	September. - November
Arctium lappa (Bardana)	Fertile, deep, drainable, organic matter	2 m	2 m	A lot (3-5x/Week)	4 months after planting
Thymus vulgaris (Thyme)	Sandy, well-drained soil	0,2 m	0,3 m	Little (1-2x/Week)	60 days after planting
LEGEND: CATEGORIES:	**Fruits**	**Vegetables**	**Green**		

Table 3. Species with low light need

The guide for the implementation of the vegetable gardens was elaborated in four stages, where physical and environmental aspects of the space to receive the project were related with the attributes of the vegetation previously researched and presented in Table 2 and in Table 3. It is observed that for the implementation of this roadmap a suitable professional is required to assist in surveys, simulations, and analyses. The definition of species can be described in a table and in drawings containing the location

of the vegetation. With this, the resident, when guided, will be able to proceed with the construction of the space. Table 4 is a summary of the results.

METHOD FOR IMPLEMENTING URBAN VEGETABLE PLANTS IN PMCMV CONDOMINIUMS		
Phases	**Methodological resources**	**Generated product**
[1] Physical identification of spaces for the implementation of vegetable gardens	Physical survey (areas, templates and form of implementation of buildings); soil type observation (correction).	Floor plans and cuts
[2] Environmental analysis of open space	Identification of climatic variables and simulation of the solar trajectory; Identification of the percentages of areas in the sun and in the shade in free space by drawings.(*)	Map with shadow and wind spots; map of areas available for planting
[3] Compatibility of species and climate	Analysis and grouping of species by their characteristics (insolation, size, soil and compatibility).	Tables by characteristics
[4] Systematization of the physical and environmental information of the place with the species	Crossing physical, climatic and vegetation characteristics data.	Definition of suitable species for the implementation of each vegetable garden. (Can be presented in a table or through a floor plan drawing with the specifications).
* Climatic data can be consulted on meteorology websites. Information such as: temperature, relative humidity and wind must be consulted. The solar trajectory must be simulated through the support of 3D modeling software. The simulation must take place at two different times of the year (summer and winter) and two times, morning and afternoon (9 am and 3 pm).		

Table 4. Summary table of the results.

CONCLUSION

This work highlights the importance of treating urban open spaces private open spaces in residential condominiums for social housing. Vegetation, when incorporated into the design of these spaces, can bring countless benefits already innumerable. The implementation of vegetable gardens is a viable option in terms of infrastructure, in addition to favoring gains through vegetation, it also contributes as a source of food.

The implementation of solutions for the open spaces of residential condominiums is a way, not only to improve the quality of the built environment, but to expand the relationship of belonging and dignity of the community with the place. About the pride of inhabiting, appropriating, and sharing spaces and that it is not a simple shelter, but a residence in the city that is inscribed in time[13].

The implementation of vegetables gardens based on the criteria defined in the script can contribute to the urban environmental quality and sustainability of the place, as it considers climatic variables and physical analysis. The definition of criteria and parameters allows for a more appropriate implementation to the place and generates greater chances of success. When a species that is inappropriate for a certain scenario is implanted, it can generate frustration and unwillingness on the part of residents to continue with the proposal.

The species tables presented do not total the universe of those compatible with the hot and humid tropical climate, they are just examples. If there is an option for an unlisted species, it is important to

observe the data in the table and seek this information so that the chosen vegetation is evaluated according to the same parameters.

The roadmap for the implementation of gardens can be implemented for different scenarios, as long as the physical and climatic analysis steps of the space and place are respected. The 2030 Agenda mentions the eradication of poverty and hunger as one of the goals and, if many countries adopt the gardening initiative as a possibility, local and global urban sustainability could be achieved.

From this work, we intend to continue with new studies including the implementation of the established roadmap for a concrete case study, defining the species to be used compatible with the climate and place.

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To the Federal University of Rio de Janeiro. To the Graduate Program in Architecture, Faculty of Architecture and Urbanism – PROARQ-FAU-UFRJ.

To the Energy, Space and Society Research Group.

NOTES

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TEMPORAL CHANGES IN NUMBER OF LAKES IN AHMEDABAD

Author:
ARCHANA BAGHEL

Affiliation:
ANANT NATIONAL UNIVERSITY, INDIA

INTRODUCTION

Historically, cities were built along waterways or lakes. The multi-faceted relationship between urban planning and water has influenced the development of metropolitan areas, cities, towns and even neighbourhoods throughout history and will continue to do so. Over time, human settlements water bodies and lakes have transformed the natural environment into the towns and cities we see today. Urban lakes are an important part of city ecosystems as they play a major role in providing environmental, social and economic services. Appropriate lake function can ease the impact of floods and droughts by storing large amounts of water and releasing it during shortages. Lakes also help in replenishing groundwater level as they are essential receptors for groundwater recharge, positively influencing water quality of downstream watercourses and preserving the biodiversity and habitat of the surrounding area. Lakes in urban areas provide us with prime opportunities for recreation, tourism and domestic purposes. They hold historical and traditional values and are important source of water.

The lakes, particularly the urban lakes, are in varying degrees of environmental degradation due to rapidly increasing population in the catchment areas of lakes and unplanned urbanisation. The major threats urban cities are facing are encroachment, land reclamation and resulting in lake shrinkage and decline in numbers, disposal of sewage, groundwater decline leading to fall in the level of water, unplanned tourism and absence of administrative framework. Their role of lake in urban context becomes more critical, when cities are facing the challenge of continuous decline in the groundwater table, frequent flooding and deterioration of existing water bodies.

Ahmedabad as a city is no exception to the present trend of urbanization all over the world leading to the migration of people from rural to urban areas. The unprecedented increase in population has an impact on the existing resources of the city. The lakes could not escape the fallout of rapid urbanization .Some lakes have vanished, and many others have shrunk in size.

This paper will explore the temporal change in the number of lakes in Ahmedabad city and investigate its relationship with increase in population and spatial growth of the city. The scope has been limited to studying the numbers of the lake in the Ahmedabad Municipal Corporation area incorporated before the recent addition in year 2020. All the water bodies mapped by Survey of India immaterial of size and presence of water are considered as lake due to its importance in urban ecosystem.

DEFINITION OF LAKE

In India, National Lake Conservation Programme under the Ministry of Environment and forests (MoEF) defines lakes as “standing water bodies which have a minimum water depth of 3m, generally

cover a water spread of more than ten hectares and have no or very little aquatic vegetation". The purpose of any definition is to provide an entity an identity which plays an important part in its survival. However, unfortunately, it is this very definition of lakes that pave ways for their exploitation. This is because as due to various environmental and climatic conditions often there are fluctuations in the given three parameters of a lake used in Ministry of Environment and Forests (MoEF) definition to define a lake. This is the loophole that is often used to exploit these water bodies to be used for other purposes.[1]

IMPORTANCE OF URBAN LAKE

Lakes traditionally been integral part of the community with sense of ownership amongst them and in urban areas provide a diversity of values and uses ranging from ecological goods and services to direct production values. The stored water may be used for consumptive purpose as well as non-consumptive use like irrigation, fishing, ecotourism, etc. The urban lakes are also sites of artistic, religious and spiritual pursuits. Lake plays an important role in urban ecosystem; it helps in replenishing and retaining groundwater and at same time acts like retention and detention basin for the rain water and provides protection from the flood. Therefore, the need to initiate efforts to restore, conserve, manage and maintain the lakes as an inseparable part of the whole eco system cannot be undermined.[2]

ISSUES RELATED TO URBAN LAKES

The Urban water bodies have been facing grim of unplanned urbanisation and increase in population in India. The major threats faced by urban lakes is landfilling, encroachment, decline in ground water table leading to fall in level of lake, disposal of sewage and solid waste, pollution due to tourism and absence of administrative framework.[3]

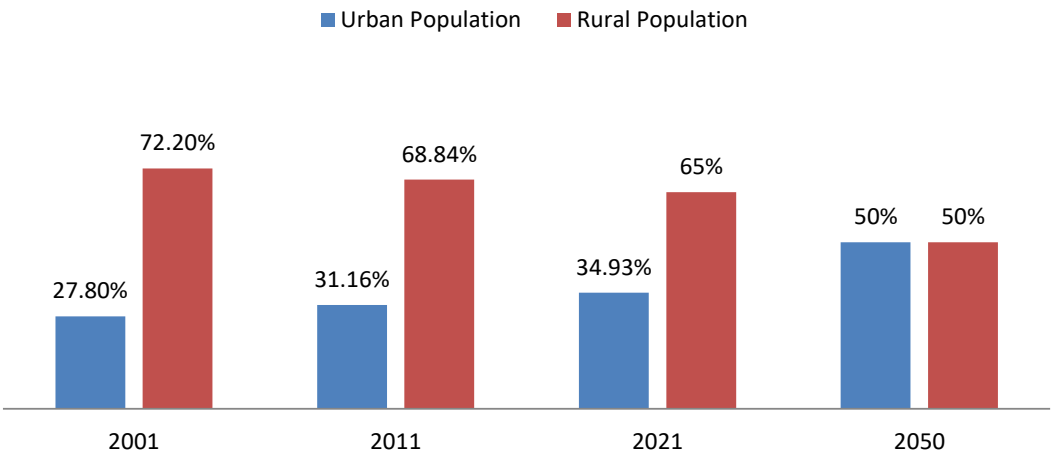


Figure 1. Decadal Change In Rural And Urban Population[4]

There has been an explosive increase in the urban population (*Ref Figure1*) and corresponding infrastructure is not developed to cope up with this population explosion leading to disposal of waste and turning of lake into landfills. Land scarcity is another major issue in urban area, even a small piece of land in urban areas has a very high economic value, leading to land reclamation of smaller water bodies in absence of any clear definition of lake to protect it. The local community also misuses the lake for their cultural or religious festivals such as the immersion of idols causing pollution to the lake. Illegal mining on the catchment and bed of the lake for building materials such as sand and quartzite

have extremely damaging impact on the water body. Unplanned tourism activities to attract tourists has become also become threat to urban lakes. The biggest challenge is the government apathy towards water bodies, which can be understood from the fact that it does not even have any data on the total number of urban water bodies in the country.

NEED FOR STUDY

In 1960, Ahmedabad had at least 204 lakes.[5] Today, almost all of these have been built upon, encroached or left to disuse. With rapid growth in population, the cities have spread out it in all directions, in a completely unplanned manner. The town planning schemes did not take into account the natural drainage patterns and topography of the area. This resulted in two things. Firstly, the rainwater that earlier flowed into the lakes and the low lying areas now got trapped near residential areas causing seasonal flooding and water logging. Secondly, the lakes dried up, making those prime targets of the real estate developers and other encroacher or they have been turned into garbage dump Moreover there is no clear data on number of lakes in Ahmedabad city speciazlly for the smaller water bodies and hence they are slowly and steadily disappearing in systematic manner. The water demand in the city is constantly increasing due to increase in population, in 1986 the demand was 400mld which increased to 760mld in 2011 and expected to increase to 1623mld in 2031(*Ref. Figure 2*),whereas in other hand the ground water table is depleting at faster rate (*Ref. Figure 3*). If the existing water bodies can be protected and the vanished water bodies can be revived it will help in ground water recharge, give entertainment opportunity to the people and help in reducing the flood in the city by providing retention and detention basin.

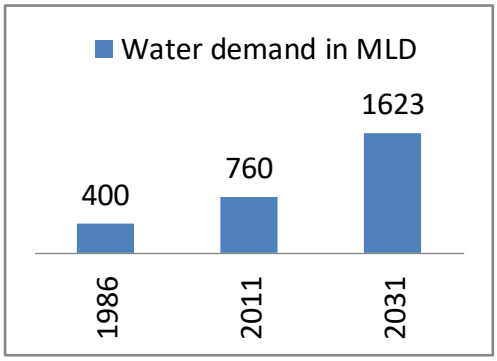


Figure 2. Increase in water demand[6]

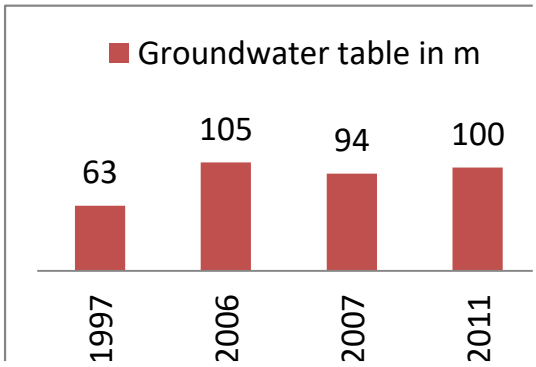


Figure 3. Depletion in Water Table[7]

STUDY AREA

The study area is in Ahmedabad city of Gujarat state which lies in the western part of the India (Ref. Figure 4). The study is restricted to only water bodies within the administrative area of Ahmedabad municipal corporation (AMC) limit having area of 450 sqm, which has witnessed the maximum urbanization and increase in population and hence its impact on the lake can be observed and analyzed. The periphery part of Ahmedabad is the Notified as Ahmedabad Urban Development Area (AUDA) admeasuring about 1866 sq. km, which regulates and monitors the development in it and in the center of AUDA Region lies the AMC zone having area of 450 sq. km governed by corporation. The study area is further divided in six zone i.e. north zone, south zone, east zone, west zone, central zone and new west zone respectively to study change of area and no. of lake(*Ref. Figure 7).*

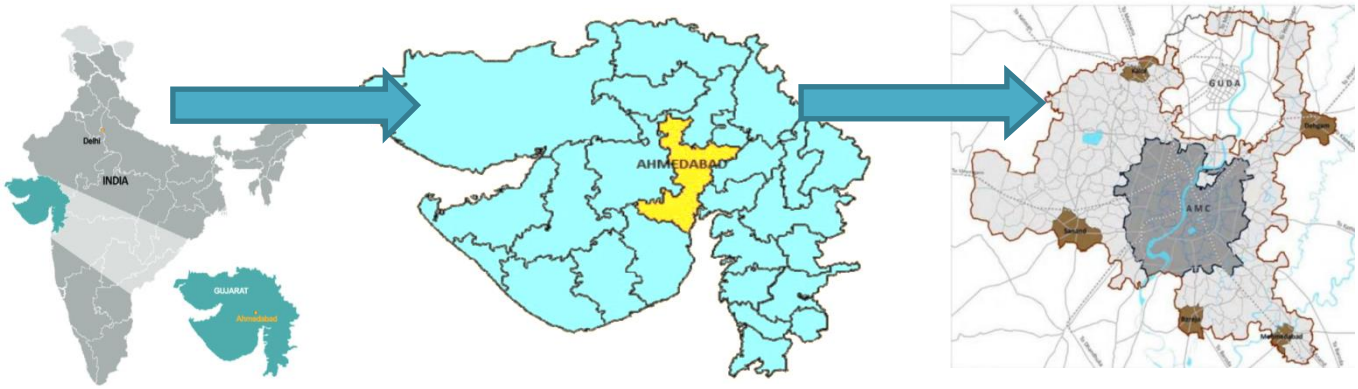


Figure 4. Location of Study Area

POPULATION GROWTH IN AHMEDABAD

The population of Ahmedabad city has increased from 15.8 Lakh in 1971 to 55 lakhs in 2011. During the 2001-11, the decadal population growth declined to 27.6%. This is partly due to the fact that the AMC area was increased from 190 sq. km to 455 sq. km. in 2008.

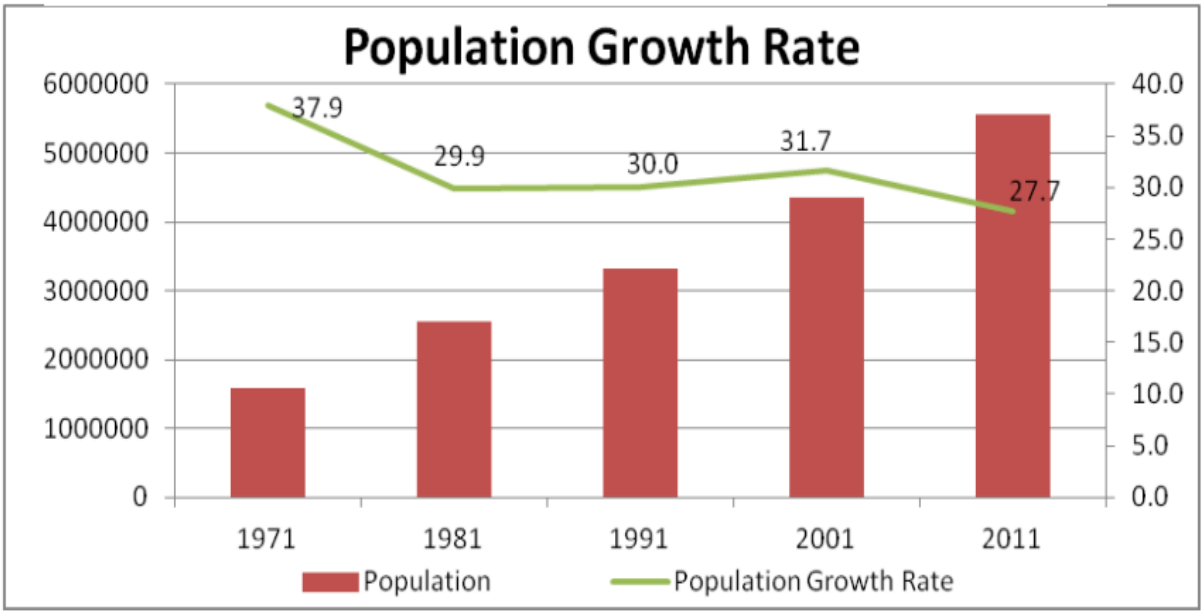


Figure 5. Growth of population Ahmedabad city[8]

ASSESSMENT OF THE TEMPORAL CHANGE IN THE NUMBER OF LAKES

To study the temporal change in the no. of the lake of Ahmedabad the toposheets of two different phase, at a gap of 32-40 years approximately, done by Survey of India, is used. To analyze the study area the four toposheets (46A/8,46A/12 &46B/5 AND 46B/9) of years 1999 -2006 are attached and overlaid with toposheets (46A/8,46A/12 &46B/5 AND 46B/9) of years 1963-72 and to get the AMC boundary, the Ahmedabad development plan 2021 is superimposed and analysis for change in number of lakes between is done. All the water bodies with or without water is called lake considering the important role it plays in urban ecosystem.

S.No.	Topo Sheet no.	The year of survey 1st Survey	The year of survey 2nd Survey	Difference in year
1	46A/8	1963-66	1998-99	35
2	46A/12	1967-68	1998-99	32
3	46B/5	1965-66	2005-06	40
4	46B/9	1971-72	2005-06	34

Table 1. Survey of India Toposheets Details

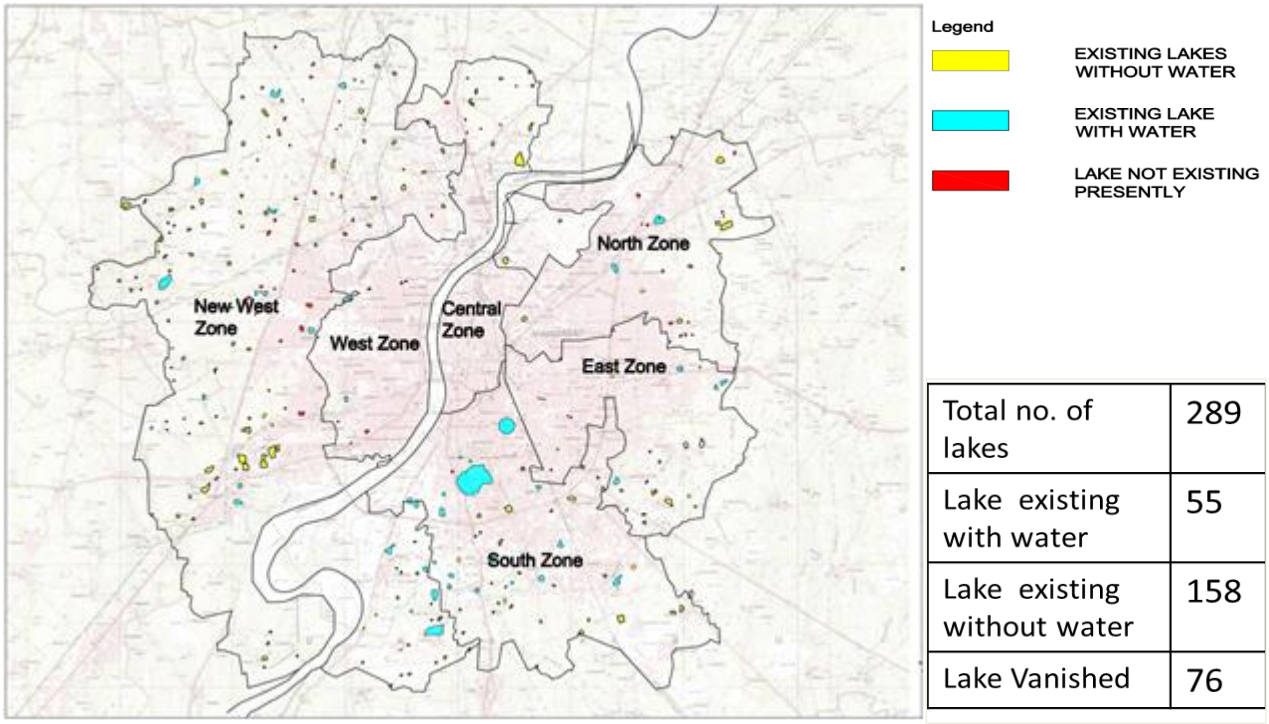


Figure 6. Change in Number of lakes in Ahmedabad City

The total number of lakes in AMC boundary lakes between year 1963-72 are 289 number. Which got reduced to 213 by year 1999-2006 and out of which the 55 lakes are with water and 158 lakes are without water. So it is clearly evident that 76 numbers (26.3%) of lakes vanished within span of 36 years approximately. The detailed study clearly indicates that it's the smaller lakes especially in peripheral area of the city where development pressure is higher is facing the brunt of development.

CHANGE IN THE NUMBER OF LAKES ZONE WISE

The zone wise analysis of changing number of lakes indicates that the percentage of number of lake vanished is highest in West zone and north zone of AMC, medium in New West zone and East zone and low in South zone(*Ref Table 2*) . But in contrary if analysis is done for the change in number of lakes vanished zone wise the scenario is different, it's the new west zone which had maximum no, of lakes, 166 number and around 40 numbers, 53% of lakes have vanished from this zone (Ref. Figure 7). The Central Zone did not have any lake in years 1967-72 and hence no change in the number of lake is observed.

S.No.	AMC Administrative Zone	Total no. of lake in year 1963-72	Total no. of lake in year 1998-2005	Total no. of lake vanished in year 1963-2006	Change in no. lake in %
1	South Zone	50	48	2	4%
2	East Zone	26	21	5	19%
3	Central Zone	00	00	00	00%
4	North Zone	24	9	15	61%
5	West Zone	23	9	14	61%
6	New West Zone	166	126	40	24%
	Total	289	213	76	

Table 2. Zone wise change in number of lakes

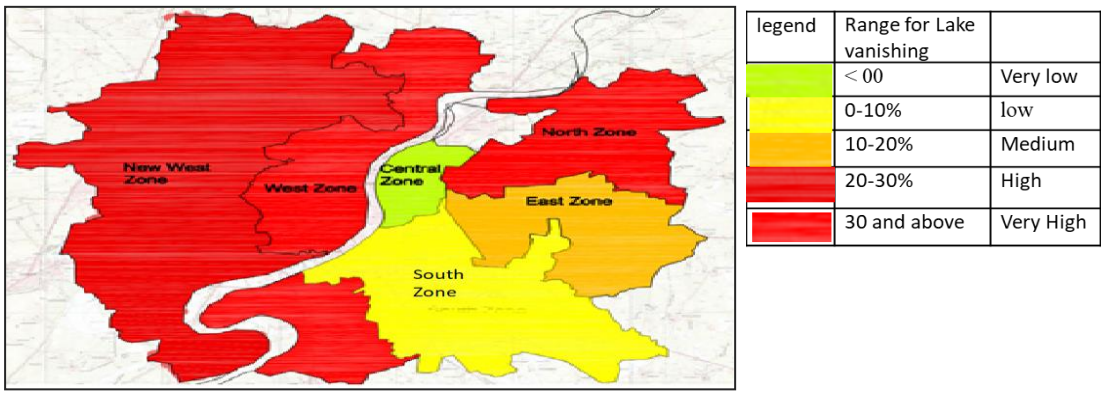


Figure 7. Zone wise change in number of lakes

RELATIONSHIP BETWEEN CHANGING NUMBER OF LAKES AND POPULATION

The decadal growth of population (*Ref. table.2*) between from 1991 to 2001 has been low in south zone, east and central zone and medium in north and west zone. The New west zone has witnessed the highest growth in the population of 69%. The new west zone has been added in AMC limits it year 2008

The comparison between decadal growth of the population in various zones and change in number of lakes (Ref Figure) clearly indicates the strong correlation between both the parameters in all the zones except central zone. The central one has witnessed the growth of population but had no lakes in year 1963-72 and hence there is no change in no. of lakes in this zone. In new west zone has witnessed maximum decadel population growth amongst all the zones and the change in number of lakes vanished (40 lakes) is also highest in this zone. The south zone has 16% decadal growth in population and only 2 lakes have vanished from this zone.

AMC ZONE WISE DECADAL POPULATION GROWTH

S.No.	Administrative zone	Total Population (1991)	Total Population (2001)	Growth rate
1	AMC-South Zone	656111	760452	16%
2	AMC-East Zone	710552	875177	23%
3	AMC-Central Zone	467609	577797	24%
4	AMC-North Zone	620448	846216	36%
5	AMC-West Zone	550094	752007	37%
6	AMC-New West Zone	410229	693980	69%

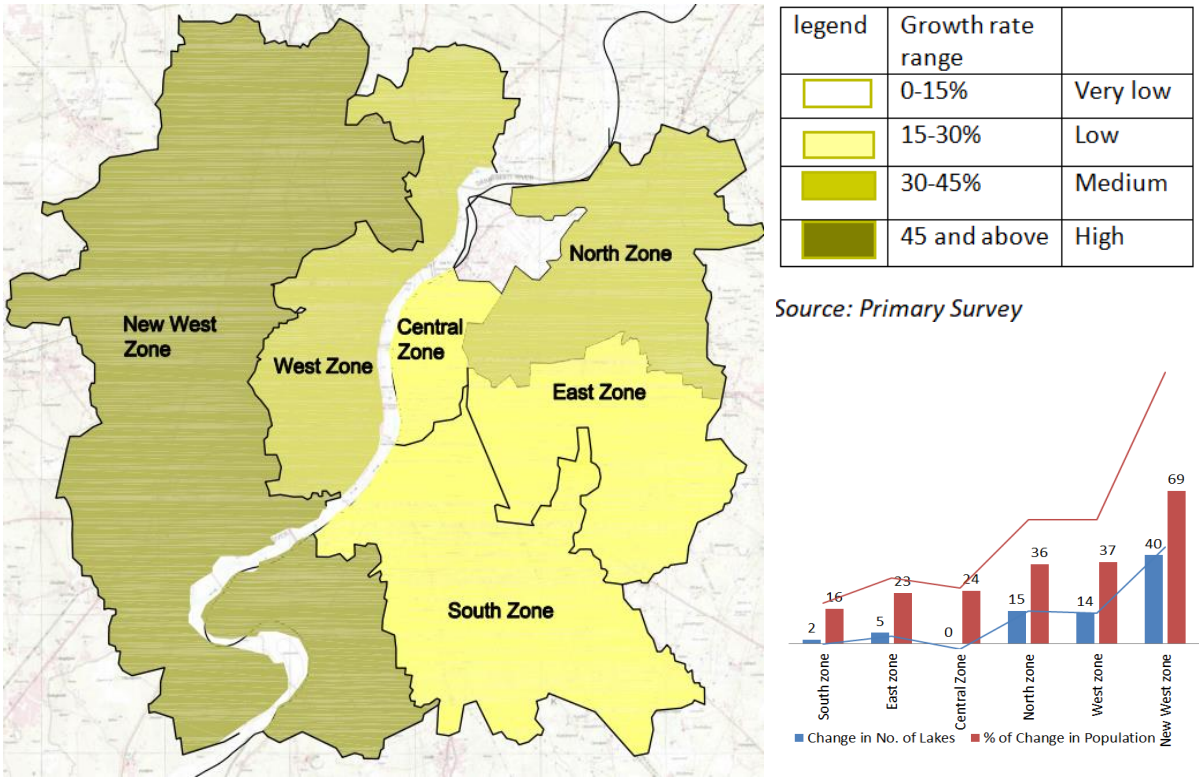


Figure 8. Relationship between change in population & change in number of lakes

SPATIAL GROWTH OF THE CITY & CHANGE IN THE NUMBER OF LAKES

To analyze the relationship between the change in no. with and spatial growth of the city the GIDB map, representing growth pattern of Ahmedabad is superimposed (*Ref. Figure 9*). In the earlier decades only eastern parts of the city registered faster growth rates, but since the 1980's the western periphery has grown rapidly. The analysis of relationship between growth patternsof the city reflects that the central zone was developed before 1972 and had caused pressure on the lake leading to complete vanishing of these lake from this area. The new west zone which was not developed during 1972 had maximum no. of lakes (166 lakes), and this zone started witnessing the spatial growth only after 1972 partly due to the saturation of population within the city area and the consequent large-scale housing development in the peripheral areas and hence it has seen the maximum number of lakes have vanished from the new west zone (40 lakes). The further study clearly indicates that out 289 lakes only 21 lakes

were there in developed area before 1972(*ref. figure* 9) and 267 lake were in periphery area. Out of 21 lakes existing in physically developed area, 10 lakes have already vanished.
The SOI map superimposed with AMC boundary (*ref figure. 10*), clearly indicates that all the lakes which have vanished are in the peripheral zone and fall in the recently developed area and most of the lakes which are existing, is in the area which is still not developed. Another important observation reflects that the lakes which have vanished are the smaller lakes which do not fall under definition of NLCP.

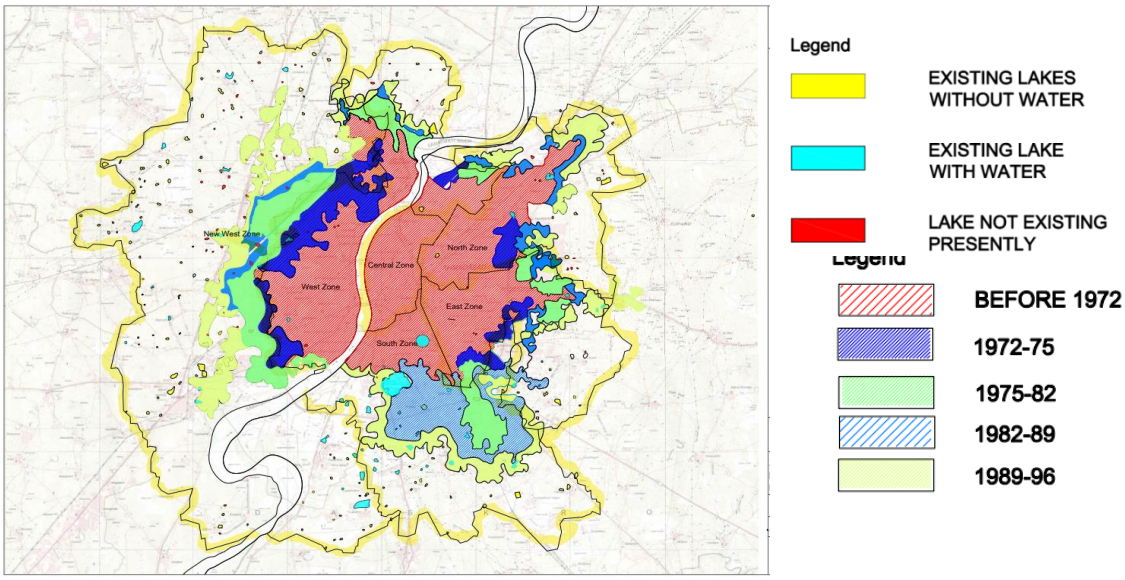
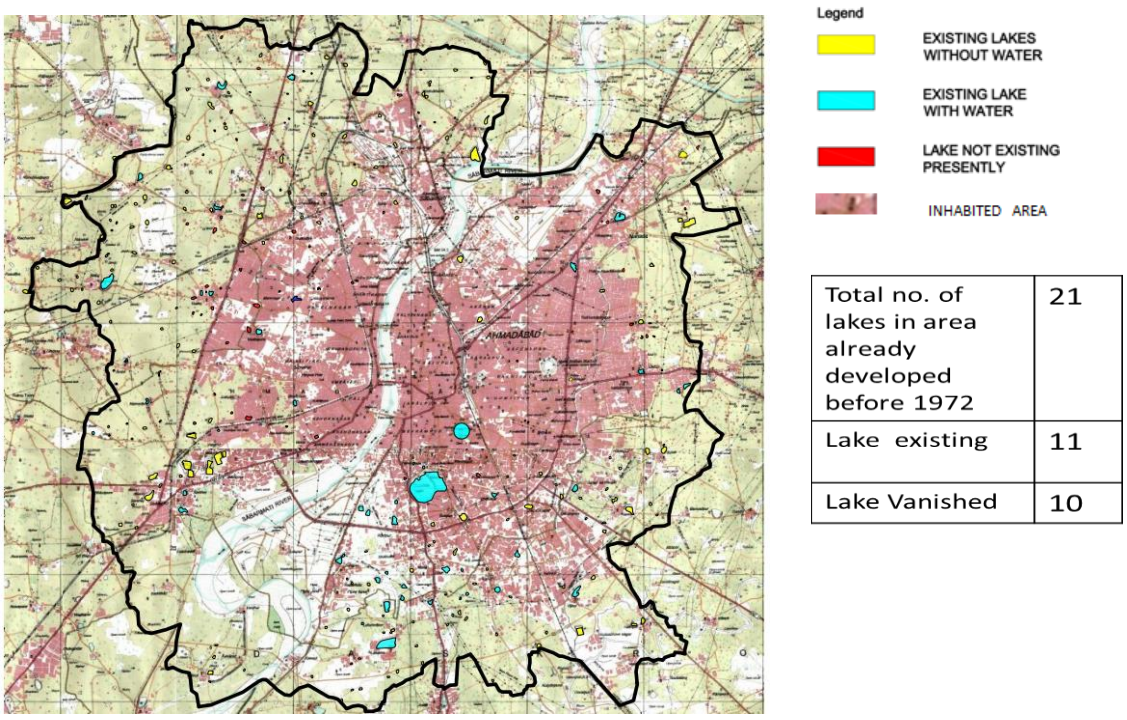


Figure 9: Growth pattern of Ahmedabad with existing and vanished lakes



Total no. of lakes in area already developed before 1972	21
Lake existing	11
Lake Vanished	10

Figure 10: Comparison of Vanished Lakes with inhabited area in city

CONCLUSION

The lakes are Sponges of cities and plays vital role in balancing the urban ecosystem hence it should be conserved immaterial of the size and depth. The vanished lakes visible in the Survey of India toposheets of 1970s, but missing in the survey of India toposheets 2000, should be to be traced in the village survey records, and reclaimed.

There is urgent need for sensitizing the urban community towards the importance of these water bodies and develop sense of ownership and responsibility, which will be play pivotel role in existence, sustenance and maintenance of this invaluable resource.

The research poses broader questions on the redefining the urban lakes and have accurate data of number of all the lakes existing in the region.

It is evident from the study that there is profound relationship between increase in population and decrease in the number of lakes and hence the civic bodies should focus on the proper development of infrastructure of the city and hence protecting the lakes from the grim of encroachment, pollution and land reclamation etc.. Most of the existing lakes are in area which is still not developed and there is urgent need for appropriate policies to be formulated and action to be taken to avoid the pressure on them, otherwise most of these lakes also will disappear and the cities will be without any lakes.

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