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Transformation of Traditional Building Stocks in the historic core of Kathmandu: looking through the prism of culture and climate

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Abstract
The social fabrics and traditional building stocks in the historic core of Kathmandu in the past were not only cultural and climatic responsive but also balanced the building stocks with infrastructure capacity. However, haphazard transformation of old houses at two fronts – replacement of 3-4 storey residential houses by 6-7 commercial use [or mixed use] with modern reinforced cement concrete structures - has not only destroyed the community bonds and cultural spaces in the neighbourhoods [and the town] but also reduced the thermal comfort inside the buildings. Moreover, such changes without improving the infrastructural capacity have also generated a new set of urban problems of environmental degradation, traffic congestion and exposition of higher percentage of people under seismic risk including destruction of unique townscape. The existing legislation is inadequate and ineffective whereas the concerned agencies are little concern with culture and climatic issues in building transformation. To reverse this trend, vertical division of the traditional houses should be discouraged whereas culture and climatic responsive renovation and new construction works in the historic core area should be promoted through formulation of urban design guidelines and provision of numerous incentives. Such practice should be disseminated to architectural colleges, private practitioners and those working in real estate and building industry. Last but not the least, public education and community awareness on culture and climate responsive planning, design and construction is recommended.

Key Words: Traditional Building, Culture, Climate, Transformation, Urban Design, Legal and Institutional Framework.

1. Overview and Study Objectives

Since the earliest days of human settlements, people have learned the art and technique to build their shelters and arrange them in a best way based on their own personal experiences, available natural resources including learning from the nature [Burke, 1971]. Both the settlement and buildings slowly evolved on incremental basis with each phase having strong roots in the previous era. Human settlements modify the materials, the structure and the energy balance of the earth surface and the composition of the atmosphere compared with the surrounding 'natural' terrains. These artificial factors determine a distinct local climate in the cities [Oke, 1978; Landsberg, 1981]. Though traditional built form and architectural vocabulary are the result of multiple factors, culture and climate are the two most important determinants [Rapport, 1969]. However, after the industrial revolution with the development of advanced technology and with the changing economy, a new way of building designing and city planning – modern architecture and town planning – appeared in the early twentieth century, which considered cities as 'engine of machine' and architecture as 'sculpture or painting' with emphasis on technology and personal idea. The earlier evolutionary process and continuation of culture and tradition has got little attention. Lack of knowledge about climate issues among urban planners and designers including and absence of user-friendly tools to predict the effect of urban design on the microclimate has constrained the application of climatic issues in transformation of old cities [Eliasson, 2000; Johansson, 2006]. By 1980s numerous consequences of modern planning and design have been well acknowledged. As a result, new way of managing the built environment through urban design strategy considering culture and human behaviour and new dimension in building design through bioclimatic design approach incorporating climatic factors such as energy renewable [solar and wind] have emerged not only to regain the lost community spaces but also to achieve thermal comfort and human convenience inside the buildings.

The traditional urban form of Kathmandu in the 'Malla Period' [13th - 18th century] was characterised by three to four storied building blocks which were built in a row along narrow non-axial streets, paved with bricks or stone slabs and by the houses which were clustered around the courtyards and Buddhist monasteries [Bahal and Bahil] based on the

social status and profession [Jaata] of the people. Those extraordinarily skilful 'Newar' builders used limited resources [available local materials and indigenous technology] to achieve human comfort in buildings. After 'Rana' autocracy [1846-1951] huge population influx to Kathmandu destroyed the traditional building stocks and degraded the earlier socio-cultural setting associated with the old built form. Against such backdrop, this paper aims to analyse the transformation of traditional building stocks in the historic core of Kathmandu from the perspective of culture and climate with fourfold objectives. First, it plots the climatic parameters of Kathmandu in the Bioclimatic charts and Mahoney table to find out the thermal comfort and climate responsive design guidelines. Second, it analyses the cultural significance and climatic response of traditional built form and vernacular architecture in the historic core area of Kathmandu. Third, it identifies numerous consequences of haphazard changes of buildings both on the interior spaces of private individual buildings as well as on the exterior community places and then relates those impacts with the existing legal and institutional framework to check their efficiency. Fourth and last, it draws a conclusion and proposes some key strategies to mitigate those problems.

2. Climatic Parameters of Kathmandu, Thermal Comfort and Design Guidelines

Kathmandu, the socio-cultural, economic, tourist, political and administrative centre of Nepal lies between 27º36' to 27º50' north latitude and 85º7' to 85º37' east longitude at an altitude of about 1340 m. from the sea level. It has mean monthly maximum temperature of 29.30ºC and minimum temperature of 0.90ºC with annual mean temperature of around 16.50ºC. Relative humidity varies between 36% and 100% depending on ambient temperature, with the highest humidity normally occurring around dawn [Showa Shell Seiku, 1998]. Annual rainfall is of 1,400 mm, mostly occurring from March to September due to Indian monsoon. Wind is ordinarily light throughout the year but strong in and around the hot months. The average hours of sunshine is 6.3 hours, and varies between 3.3 hours to 8.4 hours [HMG, no date] whereas the annual global solar radiation is at around 1510 kWh/sq. m., i.e., the daily average of 4.13 kWh/sq. m. [Showa Shell Seiku, 1998]. Fog is common in the morning during the months of October to February [Pandey, 1987; Yogacharya, 1998].

Physical environmental parameters such as air temperature, relative humidity, acoustics, air quality, lighting, ventilation and air distribution are all interrelated. These factors together with building services system and individual physiological conditions such as health, social relation, and financial state determines the state of mind. Thus the feeling of thermal comfort is a composite state of an occupant's mind responding to the senses of numerous factors. However, climatic response to human being can be analysed by using the Bioclimatic chart [Olgyay, 1962] and Building Bioclimatic chart [Givoni, 1976]. It was found that each degree Celsius change in temperature would associate the same effect on human comfort with a change in perceived air quality of 2.4 decipol, or a change in noise level of 3.9 dB [Fanger, 1988].

Thermal comfort condition and specifications for climatic responsive planning and design can be found by plotting numerous climatic parameters into the Bioclimatic Chart [Olgyay, 1962], Building Bioclimatic Chart [Givoni, 1976] and Mahoney Tables [Koenigsberger, et al., 1973]. The analysis of Bioclimatic Chart [daytime temperature -humidity relationship] and Building bioclimatic chart after plotting climatic data of all the months of Kathmandu Valley reveals that four months [March, April, May and October] lie in the comfort zone with night time temperature falling below the comfort range whereas another four months [June, July, August and September] are hot [Fig. 1] [Upadhayah et. al, 2006]. Similarly, the remaining four months from November to February is cold. Therefore, Kathmandu requires heating in buildings for almost eight months in a year and cross ventilation for the remaining four months in summer.

Fig. 1: Climatic analysis of Kathmandu from Bioclimatic Chart and Building Bioclimatic Chart

Similarly, temperature and humidity data of Kathmandu are used in Mahoney Table to identify the pre-design guidelines for thermal comfort design in buildings [Upadhayay et. al, 2006]. It is grouped into eight headings: layout, spacing, air movement, openings, walls, roofs, outdoor sleeping and rain protection requirements [Table 01], which are used here as a basis for analysing the transformation of traditional buildings stocks in the historic core area of Kathmandu. North-south orientation with long axis on East-West direction is preferable whereas open spaces for breeze penetration with protection from hot and cold winds are recommended. Similarly, light walls with short time lag with medium openings [20% -40%] and protection of walls and windows from rain is needed for the individual buildings.

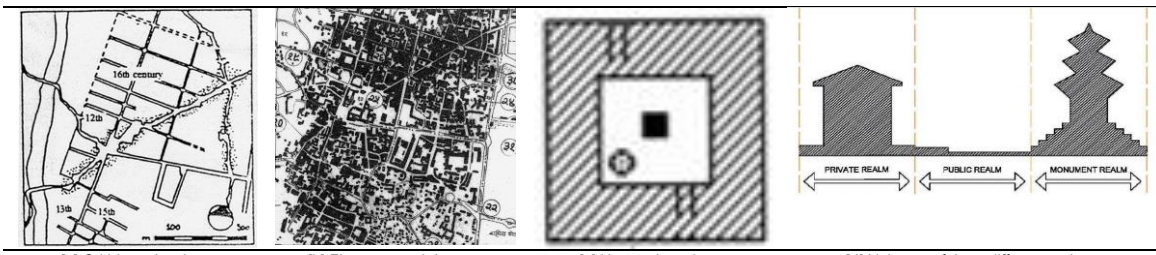
Table 01: Design recommendations for Kathmandu's climate

Aspect	Recommendation	Aspect	Recommendation
Layout	North-south orientation with long axis on E-W	*Walls & floors*	Light walls, short time lag, low thermal capacity
Spacing	Open space for breeze penetration but protection from hot and cold winds	*Roofs*	Light, insulated roof, reflecting surface
Air movement	Rooms with single banked with provision of air movement	*Protection of opening*	In north and south walls at body height on windward side
Openings	Medium openings [20-40%]	*Protection of wall & opening*	Protection from rain

3. Cultural Significance and Climatic Response of Traditional Built Form and Architectural Vocabulary in Kathmandu

The urban morphology, together with its street patterns and layout, and the building typology in Kathmandu not only reflects the socio-cultural behaviour pattern of inhabitants but also influences the thermal performance of the settlement. Built-up areas influence the absorption and reflection of solar radiation, the ability to store heat, the absorption and emittance of long wave radiation, winds and evapotranspiration. The geometric form of the urban canopy layer greatly influences the urban climate [Arnfield, 2003]. Human socio-economic activities create pockets of urban microclimate within the city [Golany, 1995]. Architectural built forms have evolved in response to the climate, lifestyle and availability of building materials.

Though Kathmandu was formally established in 1143 A.D. during 'Licchhavi' period with development of many satellite towns such as Chapagaon, Shaku, Kirtipur, Thimi, the earlier human settlement of 'Kirata' period [prehistoric] located at high ground was further expanded through grid iron planning with street orienting about 17° of north [towards east] during 'Malla' period [Fig. 2a]. The location of the town was significant from cultural and climatic perspectives in many ways. First, the compact settlement was developed along the trade route between Tibet and India not only to promote trade and business but also to preserve the agricultural lands. Integration of land use supported proximity, climatic comfort, and social interaction. Second, maximum solar radiation particularly for the cold winters and safety from the regular river flooding was achieved by developing the settlement at high ground. As the riverfronts and the low land areas often covered by early morning fog with formation of cold air basin, these areas were better suitable for agriculture rather than human habitat. Third, the drainage problem was automatically solved due to high ground whereas water needed for agricultural land at river basin was easily made available from the river. The town comprised of built up and open spaces in the form of 'figure-ground' complementing each other [Fig. 2b]. Streets [festival route, daily activity route and funeral route] and open spaces [Palace square, market square and street junction square at neighbourhood level] were laid down on hierarchical basis. Public open spaces [public realm] in different forms supported by community amenities such as rest house [paati], temple, well or public tap and so on were used for multipurpose activities in daily life as well as in festival season including for gathering in the event of earthquake [Fig. 2c]. Moreover, it had also bridged the private houses [private realm] and the public realm [Fig. 2d]. In fact, community space in front of residential house was part of vernacular architecture of Kathmandu and without it, the building did not function as a habitable unit and architecture would be incomplete, as most of the daily works to be performed inside the houses were carried out in such spaces.



[a] Grid-iron planning [b] Figure-ground theory [c] House clustering [d] Linkages of three different realms

Fig. 2: Traditional planning & built form with linkages of individual building, community space and monuments

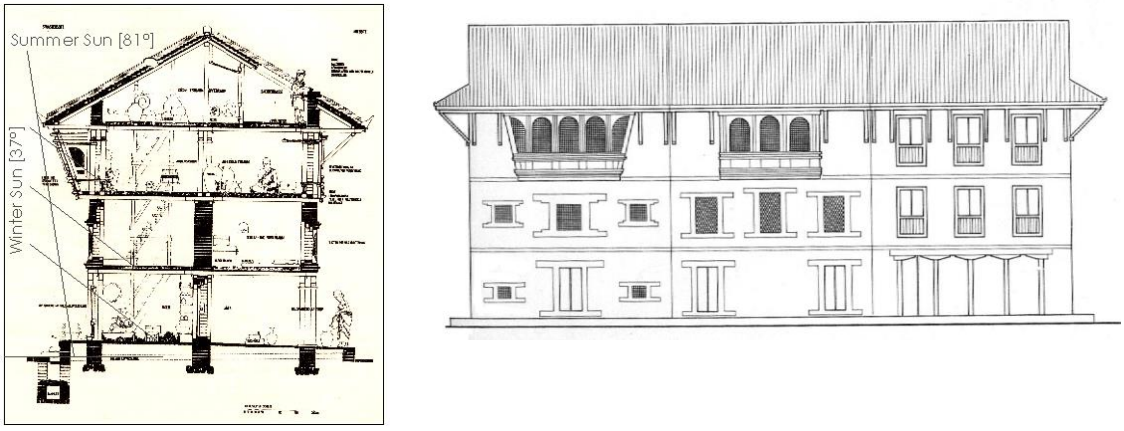
The traditional compact settlement shows significant response to temperate climate of Kathmandu [Table 02]. The orientation of urban fabric and street network had allowed maximum solar radiation both in the building as well as in street and community spaces. Moreover open spaces in the forms of squares [durbar, market and residential] and their spatial distribution on the hierarchical basis in the whole town had improved thermal performance. Residential neighbourhoods having community spaces around 10-12% in the form of interconnected courtyards [length and width

varies from 20 -24m] encircled by 3-4 houses with little variation in building height but unifying architectural elements [exposed brick, decorated wooden windows, tiled sloped roof] have not only allowed maximum sunlight and wind protection in the public spaces, but such community spaces have also acted as the venue of socialisation and symbol of community identity. As the streets were generally 4-6m wide with buildings of 3-4 storeys lining continuously on both sides, the ratio of height of building with street width was about 1.5, which is suitable for the climate of Kathmandu to ensure penetration of sunlight in the streets and buildings.

Table 02: Urban thermal performance and response of built form of traditional settlement of Kathmandu

Major issues	Basic urban design response	Built form of Kathmandu
- *Low temperature in winter*	- Heating [passive and active]	- Compact settlement with clustering of houses
	- Mixture of open and enclosure forms	around courtyard;
	- Protected edges at winter windward side	- Distribution of open spaces in the form of
	- Medium dispersed open space	courtyards and street squares
- *High precipitation in summer*	- Circumferential and intersecting tree strips	- Little variation on building roof line except the
	- Uniform building heights, [Source: Golany, 1995]	public and monumental structures

A typical newari house of 'Malla' period in Kathmandu is characterised by a simple rectangular shape (generally six m by 4 -8 m]. These houses has vertical room arrangement based on the functional requirement such as ground floor for storage of farm products, cattle, poultry; first floor for sleeping; second floor as living and working area and attic space for kitchen and prayer room [Fig. 3a]. Like the layout of the town, the residential units too manifest the spiritual beliefs and hierarchical organisation of the complex symbolic system – the house taking its roots below the ground, rising above the earth [where people live] and pointing towards the celestial regions; each part of house has also symbolic values such as the foundations representing the King of Snakes, the windows indicating the eyes, the bricks as ninety million stars, and so on together with the religious meaning of domestic objects [Barani, 1994]. Common life style, use of locally available materials [brick, mud, wood, etc.] and similar construction methodology have led to the formation of singular composition on building facades with little variations on building bulk, architectural style, roof-lines, etc. Exposed brick façade with cornice lines defining the floor height with symmetrical position of windows [different in each floor] are the characteristics of Newari vernacular architecture. Though there is a change in fenestration with time, no changes have been observed in the roof treatment, which has been dominating since ancient time [Fig. 3b].



[a] Typical cross section [b] Transformation of fenestration in buildings of the core [Source: Wolfgang, 1976]

Fig. 3: Characteristics of traditional buildings in the historic core of Kathmandu

Moreover, their response to climate is noteworthy. First, these indigenous materials have not only better thermal properties and are completely biodegradable but they are also more appropriate and affordable. Second, the thick composite walls are of adobe and sun dried brick in outer face acting as a good absorbent with mud plaster inside acting as good insulator. Such walls store heat from the sun during the day time and radiate it into the room at night when outside temperature is below thermal comfort level. Mud brick structure maintains a higher internal temperature, since it reradiates the absorbed heat back into the room. Mud brick with its mud plaster is conducive to balancing humidity levels within the interior space and helps to maintain stable humidity level [Elias-Ozkan et. al 2006]. On the other hand, humidity levels within the other building materials rise and fluctuate with changes in external humidity levels. With equal wall thickness, the behaviours of a mud brick wall is same as an insulated brick wall [Soofia et al,

2006].Third, sloped roof of tiles with mud layer on the wooden battens receives the maximum solar radiation throughout the year. Since the U value of the roof is higher [i.e. low insulating property], it absorbs more heat during the day and disseminates the same at night when the outdoor temperature is low. Therefore, the attic space in traditional houses remains always warm. Moreover, roof overhang, which is about 60cm, in the south façade is sufficient to protect rain and summer sun but easily allows winter solar heat. Nonetheless, traditional buildings have some weaknesses too. Firstly, most of the traditional buildings have double bays and backside either with small setback or without it. In some cases, cluster of buildings around the courtyard has created problem in orientation. On top of that, small window openings on one side of the room have limited the scope of cross ventilation and natural light penetration. Heavy wooden panels in the windows by absorbing heat on daytime and emitting at night block solar penetration and obstruct air circulation. Secondly, traditional building materials require higher maintenance and also degrade upon exposing to nature over a long period. Thirdly, the traditional houses lack Damp Proofing Course [DPC] on the ground floor making them cold, damp and inhabitable. Lastly, traditional structure is vulnerable to seismic risk not only due to heavy roofing material, but also because of lack of tie beam connecting all four sides at different levels.

4. Transformation of Traditional Building Stocks and Its Numerous Consequences

Rapid urbanisation and increased socio-economic activities exerted tremendous pressure on the social fabric of the historic core of Kathmandu. This aspects were reinforced with social system of transferring parental assets equally to children including sentimental value on ancestor's property, transition from joint family to nuclear family system and poor economic level.. The capacity and quality of infrastructure in the core area is decreasing due to its old age and lack of maintenance and upgradation. On the other hand, there are tremendous changes in the building units irrespective of infrastructural capacity. The changes are at two levels: conversion of residential uses into commercial or mixed used and three to four storey high buildings into seven to eight storeys. The overall impact is the conversion of the historic core into 'high rise high density' urban fabric with numerous negative consequences on cultural aspects and microclimate.

4.1. Consequences on Cultural Aspect

Negative consequences of haphazard urban transformation in the historic core of Kathmandu is discussed here, which lie on three different aspects. First, though the street and open spaces are still intact, the transformation of buildings together with haphazard infill and encroachment of public spaces [courtyards and streets] in many ways have destroyed the earlier urban form and the balance between built up and open spaces. The earlier street [and open space] width – building height ratio, the singular composition of continuous street walls, volumetric definition and unity in street scene have been degraded or lost for ever. Penetration of business activities inside the courtyards has invited more people and vehicles thereby creating traffic congestion and conversion of the public areas (squares, residential courtyards and Buddhist monasteries) into parking lots, garbage dumping sites and stranger's gathering places. Encroachment of public spaces by shop owners by different ways, such as, displaying selling items, loading and unloading goods, using shop front spaces for works, has been significantly increased. Traditional land use compatibility by keeping the same professional people in the same locality for work efficiency and social harmony has been disintegrated with the incoming of new inhabitants and changing of ground floor use.

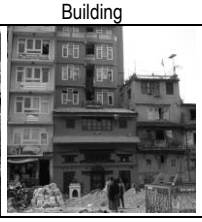
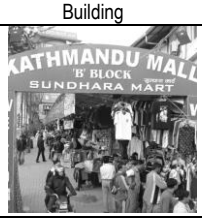
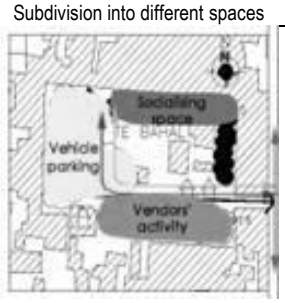
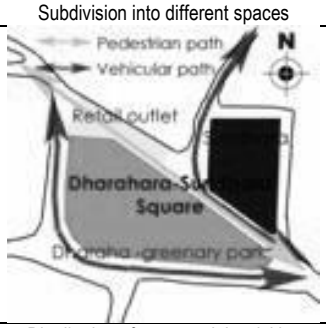
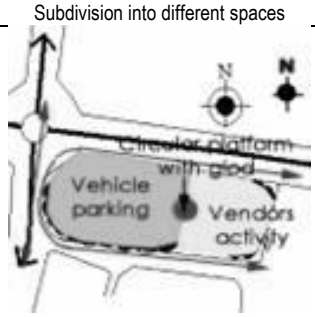
Table 03: Different aspects in cultural spaces of Kathmandu

Aspects	TB	DSS	BP
Locational context	Residential quarter	Office-commercial complex	Residential– commercial complex
Space typology	Buddhist Monastery	Public plaza	Earthquake memorial park
Formation period	Licchhavi and Malla	Rana	Rana
Mode of development	KMC and local clubs	Public-private partnership	Local club

A study of three typology of cultural spaces of Kathmandu namely Te-Bahal [TB], Dharahara-Sundhara Square [DSS] and Bhugol Park [BP] best illustrates the numerous consequences of haphazard urban transformation of Kathmandu [Table 03] [Shrestha and Shrestha, 2007]. In fact, instead of integrating the public spaces into the surrounding areas, the present ongoing activities in all cases have reshaped the earlier form and size of the open spaces and modified their spatial linkages with the surrounding areas in different ways. The earlier singular public open space has been divided into different subspaces with incompatible usages and without clear linkages [Table 04]. For instance, the metallic street leading to Shankata at Te-Bahal has divided the square into two parts: the raised platform often occupied by vendors (vegetables and flowers) on the left side and the lower part used for paid vehicular parking whereas the diagonal pedestrian path and the curved vehicular street at DSS has physically divided the square into three independent and isolated units: one is the raised platform comprising Dharahara and greenery park encircled by

boundary wall; second is the recently opened retail outlets and food stalls on the north-west corner, and the last part is the neglected Sundhara with small open space in the south side. Similarly, the central circular platform with sitting arrangement at BP has divided the area into two parts with vehicular parking on the east side and vendor's occupation on the west side.

Table 04: Commercialisation of public space and surrounding buildings in all the cases

Te Bahal		**Dharaha-Sundhara Square**		**Bhugol Park**	
Buddhist court	Building	Public plaza	Building	Memorial park	Building
					
Subdivision into different spaces		Subdivision into different spaces		Subdivision into different spaces	
					
Distribution of commercial activities		Distribution of commercial activities		Distribution of commercial activities	
Vehicle parking – 25%		Greenary park/Dharahara – 47%		Greenary area – 55%	
Vendors occupation – 18%		Retail shop and food stalls – 20%		Vehicle parking – 15%	
Socialisation space – 27%		Sundhara [water body] – 16%		Socialisation area – 20%	
Remaining area – 30%		Remaining area – 17%		Remaining area – 10%	

The earlier use of public open spaces by different people at different time for multiple activities has been illegally encroached upon by incompatible commercial activities focusing on the potential customers only. In the case of Te-Bahal, the traditional use of the courtyard space for social activities such as children playing, conversation, people gazing, etc. has been encroached in different ways [Table 4]. The construction of structures together with allowing paid vehicular parking on the courts have destroyed the cultural significance of the Bahal, whereas these courts should strictly house only shrines, chaityas and other related artefacts. The case is not different at DSS, where the open spaces have been destroyed either by constructing park or building a new retail outlets and food stalls. The earlier use of public space to pause from busy urban life as well as to read the local newspaper at Bhugol Park has also been commercialized into single use of vehicular parking or vendor's business [Shrestha and Shrestha, 2006]. Moreover, at Te Bahal, a 'dabali' with an old *pati* along with many idols located to the south of the 'Sankata' shrine was replaced by a new concrete structure, which also houses the local ward office at present. The remaining *pati* on the ground floor of the Bhadrakali shrine was also partly converted into a shop and the remaining space closed off from public access through vertical iron bars. Other urban artefacts such as wells and culturally significant places like 'Chhwasa' (a place protected by a demon) and 'lachhi' (private space in front of the house allocated for public use) have either disappeared or been encroached upon. In the case of DSS, the opening of Sundhara Mart fronting towards the east side of square with huge commercial signage including the dominating entry gate at the entrance has added business flavour in the square whereas the isolated buildings in the north and south without public oriented activities on the ground floor but with a high boundary wall has hardly anything to do with square users. Similarly, the buildings in the south and west sides of Bhugol Park is hardly responsive. Significant reduction of cultural space and negligence of social artefacts have not only adversely affected the people's relaxation, socialization, communication and celebration of events at regular intervals but has also helped in the obliteration of memories of place. This has impact on weakening the social ties and public life, hampering the scope of bringing people from different walks of society together at city level and community developing a habit of not taking care of cultural properties. The cultural practices in the past were tied to the religious beliefs and faiths through the means of local festivals and celebration of rituals, commercialization of the open courts and the enclosing buildings. It also resulted into community's little interest in

'Sangha' together with lack of information to the general public at present which have not only converted the religious activities into mere rituals but it has also gradually faded the historical stories, beliefs, legends from people's mental maps.

In terms of individual building transformation, the vertical division of traditional building stocks and haphazard renovation and reconstruction of them, often different from the adjacent buildings in terms of scale, material and architectural style including variations in building setback and plinth has not only destroyed the local streetscape but also reduced the habitable rooms [spaces] inside the houses. In the subdivided units, the new door and window openings are created on the load bearing front façade whereas new toilet, staircase, etc. is added by destroying the part of the existing structures. In other cases, new habitable rooms are added simply by adding new floor of different materials, height and construction technology on the existing old structures. Penetration of new economic activities resulting from the commercialisation of space has not only caused the conversion of ground floors of buildings, even located inside courtyards without vehicular access, into shops but has also accelerated the replacement of small open spaces available in the form of building setbacks, kitchen gardens or storage shed by new high-rise structures. This whole process of rebuilding - formation of soft storeys, discontinuity in load transferring system, lateral stiffness and strengths resulting in torsional effect, creation of 'pounding effect' due to differences in floor and building heights, material and construction technique in adjacent buildings – has further weakened those old buildings against the seismic force [Bijaya, 2002]. This situation has further worsened as traditional socio-cultural amenities such as 'paati' [rest house], water conduits, etc. attached with 'Viharas' and street squares have been ceased to function, encroached, disappeared or demolished. Social relationship between the original inhabitants and the new comers on the rented spaces is poor as the latter do not feel sense of belonging and hence do not care of keeping the area neat and clean. The social needs of community, development of intimate friendship and fostering of community and civic pride could not take place.

4.2. Consequences on Climatic Aspect

Numerous negative consequences of haphazard urbanisation of Kathmandu from climatic perspective are discussed here which are more evident in the small courtyards and streets and narrow pedestrian lanes of the historic core area. The overall impacts are twofold. First, vertical expansion of the core area either by addition of floors on the existing buildings or construction of new high rise structures often with projection from the second floor onwards have significantly reduced light and ventilation on the streets and community spaces [courtyards and squares]. As a result, the earlier street and squares used for socialisation and other daily activities have become less habitable and hygiene [Fig. 4].

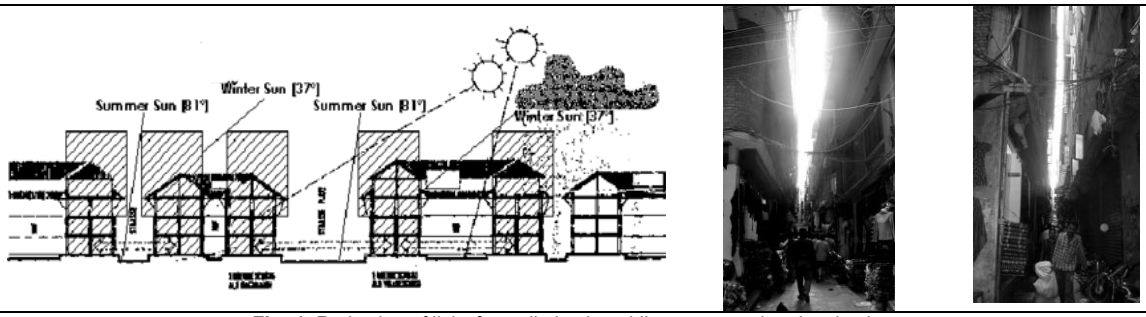


Fig. 4: Reduction of light & ventilation in public spaces and pedestrian lanes

Study of three different residential courtyards [bahal] namely Tunche Bahal, Kullu Bahal and Sabal Bahal best demonstrates the transformation of the area in three different stages [Fig. 5]. There is addition of many floors on the existing old structures without conversion of ground floor for commercial uses at Tunche Bahal – first stage of transformation – has also made the courtyards less usable for daily life activities. For instance, the original five storied buildings has been increased into ten through vertical division and the earlier 3-4 storey height has been changed into 5-6 storey in almost all the buildings through addition of extra 2-3 storey in the existing old structures. Lack of sunlight reaching to the ground, low level of privacy and loss of sense of enclosures are the main reasons for not using the community spaces. The second stage of transformation is marked by conversion of the balcony into rooms, addition of storey on the existing floor including new high rise construction together with conversion of ground floors into shops. Moreover, the business persons have also invaded the community spaces either by extending their business activities [displaying goods, loading and unloading, etc.] as well as by using for motorbike parking. Absence of sunlight and poor

ventilation combined with little privacy has forced many residents to leave the buildings, at least the lower few floors. As a result, the commercial activities have started to move upwards in first and second storeys too. In the last stage of destruction, all the old buildings have been replaced by modern RCC high rise structures with conversion of ground floor either for shops or offices, as the case of Sabal bahal.

Second, material change in building façade and in the pavement has also impact on the thermal comfort on the streets as well as inside the buildings. Vertical division of old structures has reduced the habitable space and their haphazard renovation has hampered the smooth circulation and placement of other essential functions [such as toilet, staircase and door and window openings], thereby reducing the thermal comfort inside the house. Formation of damp spaces with insufficient light and air has negative implication on health and physical growth of residents. The 'sense of enclosure' of earlier period has been converted into 'sense of suffocation', public space into commercial activity, and community bond and self-help practice into habit of confrontation. Also, the new modern reinforced cement concrete buildings with brick walls [4.5" and 9" thick] and cement plaster are not preferable from thermal comfort point of view, as it makes the interior spaces of buildings hot in summer and cold in winter. Comparison of modern RCC buildings with cement plaster and old structures of brick in mud mortar and timber construction has already revealed the superiority of traditional construction both in winter and summer [Givoni, 1976].

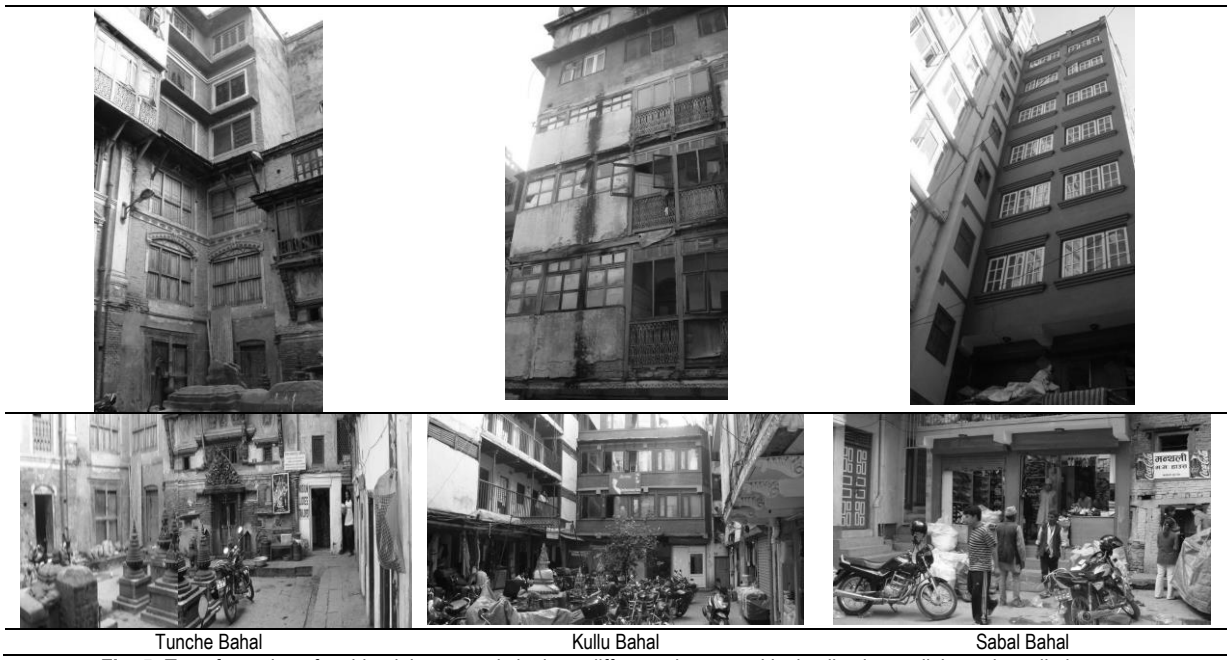


Fig. 5: Transformation of residential courtyards in three different phases and its implication on light and ventilation

5. Legal and Institutional Framework

Existing legal and institutional framework is simply inadequate and ineffective to address numerous issues associated with climate and culture as a result of rapid transformation of the historic core of Kathmandu. The weaknesses can be categorised into three parts. First, no master plan exists for the planned development of Kathmandu, as the earlier five plans were never implemented. Absence of planning standards and urban design guidelines means the existing building bylaws is the only legal tool to regulate the urban growth of Kathmandu. The newly revised bylaws focus on individual building and are applicable only for new construction. Therefore, activities such as vertical division of old houses, addition of floor on the existing old house including conversion of ground floor into commercial uses and so on remain unchecked, as the bylaws have no clauses to regulate such changes. Except the requirement of 'light plane' in the street section, no other clauses requiring incorporation of energy conservation, passive solar design and thermal comfort of occupants are included in the recently revised building bylaws. High maintenance cost of traditional houses, difficulties in getting building materials and their short life span all have encouraged ordinary people to shift into modern RCC construction. Second, the concerned agencies namely Kathmandu Valley Town Development Committee, Kathmandu Metropolitan City and its ward and village offices including Department of Archaeology have poor technical and managerial capabilities. For instance, though the Town Development Act 1988 provides legal basis for preparation of Planning Standards and Urban Design Guidelines for [re]development and urban growth of the city.

The Kathmandu Valley Town Development Committee is yet to prepare such specifications. Third, the existing institution is weak in implementing the bylaws. Three different institutions are responsible for regulating the building transformations in the historic core areas. Kathmandu Metropolitan City issues permit to build whereas the Kathmandu Valley Town Development Committee inspects the site construction. For punishment to defaulters, these institutions need to rely on Chief District Officer under the Ministry of Home. As they can not take any action without any complaints from the public, the task of violating bylaws has become unabated. There are failure even to enforce simple clauses of the bylaws such as building height restriction, floor area ration and other building detailing through building permit system and monitoring the construction sites. In fact, the intention of issuing building permit is more to collect revenue rather than regulate the growth and building construction.

For instance, the bylaws categorize 'Dharahara – Sundhara' square into two zones: Dharahara and Sundhara including enclosing buildings of east and south as 'Open greenery sub-zone [Tundikhel]' and the reaming enclosing buildings of the north and west sides as 'Preservation Sub-zone' both under the 'Old Urban Area' [KVTDC, 2050 BS]. Similarly, 'Te Bahal' of Kathmandu lies under the 'Monument sub zone' category. According to it, new construction is allowed to a maximum height of 13.7 m. maximum floor height of 8 ft.; brick façades without cement plaster; traditional style wooden windows and doors [and covering of the rolling shutter of the ground floor with wooden doors]; no balconies, cantilever or other projections above the court area except wooden balconies from the third floor onwards within the building property line; and sloped roofs allowing, at maximum, one-third of roof area for flat terraces. Incompatible land uses that disturb the *bahal* environment are not permitted. However, violations of these clauses are numerous [Table 05]. At least one third of the buildings facing the court are more than five storeys high, and many buildings including the one which houses the local ward office are cement plastered. Others have exposed rolling shutters on the ground floor. None of the newly constructed buildings or those with floor additions have sloped roofs. Moreover, construction of two structures on the open court and renting part of them by the local club for the use of metal work, and allowing parking on the court – are all against the spirit of the present bylaws. It is believed that more than 90% of building construction in Kathmandu and Lalitpur are non-engineered and unmonitored, and illegal home construction is as high as 27% [CBS 1997]. In many cases, the byelaws are conflicting with the existing other legislations such as 'Ancient Monument Protection Act 1976 [2013 BS],' and recently enacted 'Local Self-Governance Act 1999' particularly in punishing defaulters [MOLJ, 1999].

Table 05: Violation of building bylaws by many ways in all the three cases

No. of storeys	No. of buildings (TB)	No. of buildings (DSS)	No. of buildings (BP)
0 – 3	6 (10%)	13 (68.4%)	6 (22.2%)
4 and 5	35 (56%)	5 (26.3%)	11 (40.7%)
> 5	21 (34%)	1 (5.26%)	10 (37.0%)
Total	**62 (100%)**	**19 (100%)**	**27 (100%)**

Finally, those involved indirectly in the building transformation process namely local architectural schools, private practitioners and those involved in real estate and building industry are less concern on culture and climatic issues. In fact, architects are more concerned on the physical form [and dealing with nonliving objects] rather than socio-cultural and climatic issues [human components] whereas the engineering colleges producing architects and engineers have given low priority in heritage and energy conservation subjects. The opportunity to design climatic responsive structure in relation to occupant health safety and offering 'Energy Certification of Building' as practised in other nations is hardly realised.

6. Conclusions and Recommendations

Rapid transformation of traditional building stocks of the historic core area of Kathmandu - vertical division and haphazard renovation of the divided parts, addition of floors on the existing old structure and replacement of the old houses by new reinforced cement concrete structures - has numerous negative consequences. It has not only destructed the traditional social fabric and vernacular architectural character but has also produced new set of urban problems of environmental degradation, traffic congestion and intensification of earthquake vulnerability. The root cause of all these problems is the changes in building units at two levels – from residential use to commercial [or mixed used] and from vertical extension of buildings without improving the quality and quantity of infrastructures which serves those buildings. As the existing legal and institutional framework is simply inadequate and ineffective to address these issues, the process of destruction in the historic core area has unabated. It is essential to regulate the building transformation based on the local context and infrastructural capacity through provisions of land use allocation and

density. Moreover, the following recommendations are suggested to mitigate the numerous weaknesses mentioned above.

[a] Analyse the historic core area of Kathmandu – social fabrics and vernacular architecture - from cultural and climatic perspectives and identify the numerous salient features in order to formulate urban design guidelines and building detailing for renovation work as well as new construction activities;

[b] Discourage the vertical division of old houses and their haphazard renovations such as creation of door and window openings, addition of new concrete floor on the old mud flooring and so on through legal means;

[c] Intervene on the root causes of problems – regulating individual building transformation through controlling building use and its density based on local context, infrastructural capacity and so on;

[d] Promote various types of incentives such as technical and financial support, floor area ratio bonus, tax subsidise and so on for those who are willing to follow the urban design guidelines and climatic parameters set by the public agencies;

[e] Enhance the technical and managerial capacity of the public agencies namely Kathmandu Metropolitan City by hiring urban designer and energy conservation experts and also build partnership with non-government organisations, professional bodies and local architectural and urban design schools for research, information dissemination and public education.

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