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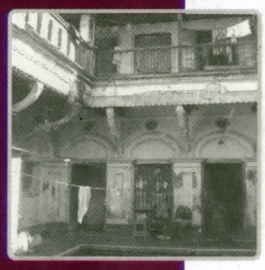

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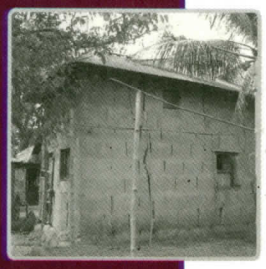
Landscape Urbanism



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Bangladesh University of Engineering and Technology, Dhaka

Protibesh
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Protibesh is a peer-reviewed research journal published by Department of Architecture, Bangladesh University of Engineering and Technology, in January and July every year. Protibesh, meaning environment, aims to provide a forum for publication of original research and scholarship, for better understanding of the different aspects of and intervention for environment in urban and rural settlements. Protibesh is committed to act as a catalyst to bridge theory, research and practice in the broad field of Architecture of Bangladesh.

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Contents

List of Reviewers

Editorial

Protibesh, the research journal of the Department of Architecture of BUET, is the leading publication in Bangladesh in the field of Architecture. It has been offering a platform for researchers in the region as well as from abroad who think of similar state of affairs. This issue of Protibesh consists of five papers, each one with diversified concerns. Among these, one paper focuses on climate and tradition; one on globalization and domestic space; one on the deltaic force and urban development; one on visibility and open space; and the last one on the indigenous building material and sustainability.

The first paper tilted "Transformation of Traditional Building Stocks in the Historic core of Kathmandu: looking through the prism of culture and climate", by Dr. Bijaya K. Shrestha and Sushmita Shrestha, discusses on cultural and climatic responsiveness of the traditional building stocks in the historic core of Kathmandu. Taking the challenge of considering scientific issues of climate and creative and collective issues of culture in the same platform, the authors show an excellent quality to reinstate the value attached to the historic buildings of Kathmandu. This paper seems to be an example of architectural research involving a multidisciplinary stance.

The second paper titled "Tracing Globalization: reflection of changes in lifestyle in domestic architecture" by Dr. Zebun Nasreen Ahmed takes the opportunity to reflect the engrossed social changes among the Bangladeshi families with the progressive influence of globalization of knowledge. This paper comes across chronologically how the infusing influences of globalization has been transforming the life style of Bangladeshi families and tries to reflect the corresponding changes in the house plan or in the domestic spaces. Although this paper does not imitate from any rigorous research background, the wealth lies in its uniqueness and in-depth observations made by individual academic. It is also important to note the attempt to relate the role of women in the layout of domestic architecture in a social-environment which is changing at the same time keeping it's traditional hooks strong to it's past.

The third paper published here is titled as "DELTA FORCE: New Cartographies of the Sundarbans- Alternative Design Concepts for Khulnâ & Environs" by Kelly Shannon and Ward Verbakel, two visiting scholars from Belgium. This paper is the result of a research work undertaken as part of Master's class of KULeuven in Khulna, Bangladesh. It seems a unique observation by the researchers into the local context of Bangladesh. It re-assesses the proposed master plan of Khulna and presents an alternative design approach for simultaneous operation at the larger regional scale, the city scale and the local scale.

The fourth paper in the list is "Integrating Open Space in Compact Layout: Study of a High-Density Residential Development in Hong Kong" by Afroza Parvin. The author here represents urban design character of a high density area in Hong Kong and analyses the situation with Space Syntax methodology. The rigorous investigation is explained here with systematic accounts and tried to develop a model for visibility analysis in tight urban context. It has been revealed that in spite of various limitations, the spatial configuration has significant effect on the patterns of open space use in high-density compact built environment.

The last and fifth paper titled as "Towards Sustainable Rural Development: an Investigation on Clay based Materials, their Appropriateness and Potential" by Fatema Meher Khan, Saimum Kabir and Shajjad Hossain presents the case of clay based indigenous building materials and assess their sustainability in the context of rural Bangladesh. The paper is rich with it's first hand observations, although limited in terms of variety. It reviews the traditional materials, the mud wall and clay roof tiles, their potential use and technical aspects with an attempt to reappraise the use of indigenous materials towards the goal of sustainability. This sort of observations is always welcome to reorient the society and the professionals with the progressively developing local techniques and locally made building materials.

Since last few years, Protibesh has been attempting to maintain a notable standard and offered a platform for the upcoming authors to express their ideas and be prepared for academic writing. Nevertheless, publication of Protibesh could be left in dream, if we could not get the lively response from our authors and reviewers. We are thankful to our eminent and diligent reviewers who spent their valuable hours in this painstaking process. For the late publication of this volume we take the responsibility and apologise for any inconveniences created to others. We, the present Editorial board and the Protibesh Committee, take leave from our readers and authors with the hope of more enthused progress of Protibesh in future. Thanks.

Editors: Dr. Farida Nilufar, Dr. Nasreen Hossain and Mahmudul Anwar Riyaad
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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 27°36' to 27°50' north latitude and 85°7' to 85°37' east longitude at an altitude of about 1340 m. from the sea level. It has mean monthly maximum temperature of 29.30°C and minimum temperature of 0.90°C with annual mean temperature of around 16.50°C. 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.

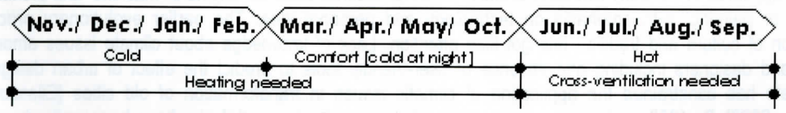


Fig. 1: Climatic analysis of Kathmandu from Bioclimatic Chart and Building Bioclimatic Chart

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.

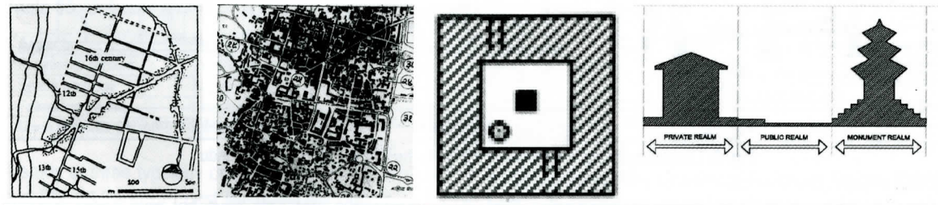
Table 01: Design recommendations for Kathmandu's climate

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

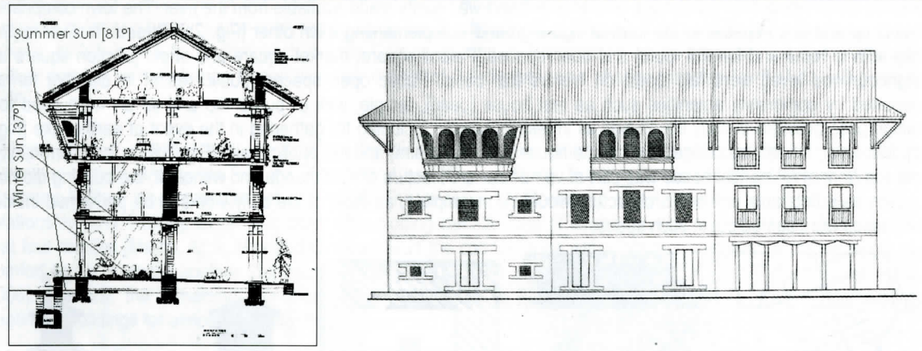
The traditional compact settlement shows significant response to temperate climate of Kathmandu [Table 02]. The orientation of urban fabric and street network had allowed maximum solar radiation both in the building as well as in street and community spaces. Moreover open spaces in the forms of squares [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] - Mixture of open and enclosure forms - Protected edges at winter windward side - Medium dispersed open space	- Compact settlement with clustering of houses around courtyard; - Distribution of open spaces in the form of courtyards and street squares
- High precipitation in summer	- Circumferential and intersecting tree strips - Uniform building heights, [Source: Golany, 1995]	- Little variation on building roof line except the 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] T ypical 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.

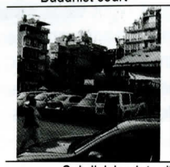
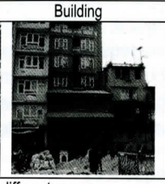
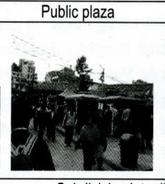
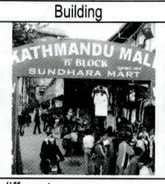
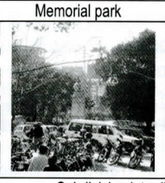
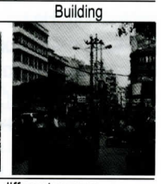
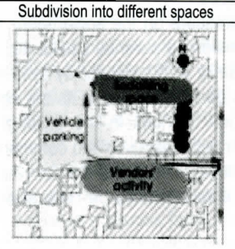
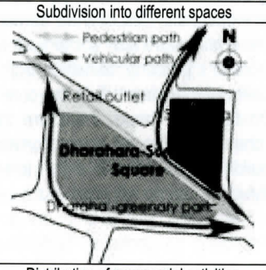
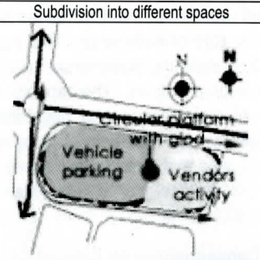
Table 03: Different aspects in cultural spaces of Kathmandu

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% Vendors occupation – 18% Socialisation space – 27% Remaining area – 30%		Greenary park/Dharahara – 47% Retail shop and food stalls – 20% Sundhara [water body] – 16% Remaining area – 17%		Greenary area – 55% Vehicle parking – 15% Socialisation area – 20% 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].

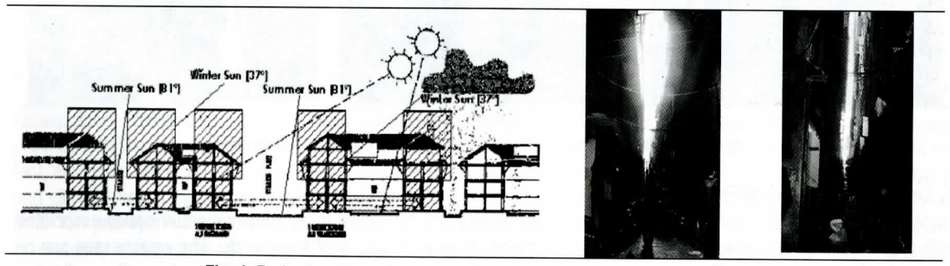


Fig. 4: Reduction of light & ventilation in public spaces and pedestrian lanes

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].

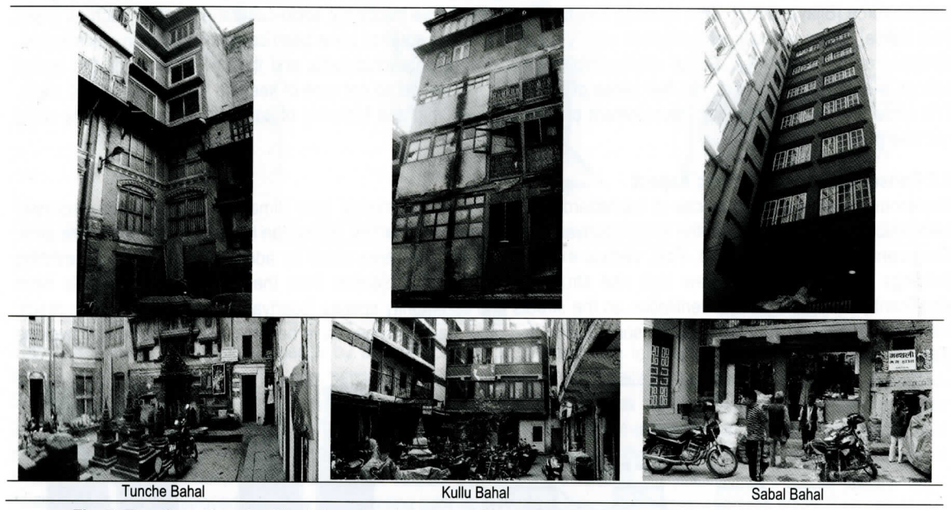


Fig. 5: Transformation of residential courtyards in three different phases and its implication on light and ventilation

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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Tracing Globalization: reflection of changes in lifestyle in domestic architecture

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Abstract
This paper reflects on how shifting lifestyles, through the influences of globalization have effected a change in the residential architecture of a region. The case of Dhaka has been put forth, focussing on influences from outside the region, distinguishing globalization from a more general process of modernisation, which could take place from regional influences. While globalization has existed in the distant past, its effects were gradual and almost imperceptible, lifestyle changes being ascribed, more as a result of cultural transformations than to foreign interventions. Presently however, the effects of globalization are making schismatic changes in social orders and lifestyles. The paper attempts to track the slow (and later rapid) changes brought about through globalization, beginning with rural beginnings, the slow transformations and subtle lifestyle changes in the adaptation to early urbanisation, and finally the rampant globalization of the immediate-past decade. Lifestyle changes are bound to affect the architecture of any society. This paper focuses on how changes have come about within the domain of the residence, discussing it in four broad phases: the urban beginnings, the mid-twentieth century, the post-independence years and the present developer housing phase. It is the contention of this paper that transformations in the role of women in the family, among many other influence of globalization, have been instrumental in bringing lifestyle changes, which in turn have necessitated changes in residential architecture.

Keywords: Globalization, Lifestyle, Residential Architecture, Women and Architecture, Urbanisation.

1. Introduction

Globalization is defined by experts as the intensification of worldwide social relations which link distant localities in such a way that local happenings are shaped by events occurring many miles away and vice versa (Giddens, 1996: 64). It is thus a comprehensive term for the emergence of a global society in which economic, political, environmental and cultural events in one part of the world quickly come to have significance for people in other parts of the world, a result of advances in communication, transportation, and information technologies (Tabb, W.K. 2006). Like all new paradigms globalization has the potential for enormous good, as well as if mishandled, equally significant bad.

The boundaries between globalization and modernisation are seen to fuse in many cases, and it is often difficult to differentiate between them. Globalization as implied in this paper is seen as a consequence of modernization that transcends the locality, or is effected by forces extraneous to the locale. Modernity on the other hand may be caused by completely regional effects and is summed up by experts as a condition of living imposed upon individuals due to a socioeconomic process involving a rupture with tradition and having a profound impact on ways of life and daily habits. Many experts believe that globalization cannot be a desirable thing in the arts or architecture as it is marked by the diffusion of commodities and ideas, and can foster a standardization of cultural expressions around the world (Watson, J.L. 2005). However, others argue that globalization has meant a decentring and a proliferation of differences, indeed the opposite of unification and standardization (Jameson, F. 1998).

But undoubtedly, one of the most important of the characteristics of globalization may be the collapse of time and space. And this impacts directly on the domain of architecture. It is through the architecture of a region that the lifestyle and culture of a place is persistently expressed (Rapoport, A. 1969). Mankind's dwellings stand as the concrete expressions of a complex interaction among cultural skills and norms. (Wagner, P.L. 1969). This paper, an outcome of the author's experience and observations in the practice and teaching of architecture in the region, examines the way globalization has brought about changes in the lifestyles and culture of Dhaka and how this has impacted on the architecture of residences in this region, particularly on the layout and space use of residential architecture.

2. Globalization: then and now

Globalization, though a buzz word in present day discourses is actually as old as time (Brahms, E, 2005). Whenever new people have arrived in any place, they have brought with them their cultures and as a result new ideas have been introduced. In the immediate region around Bangladesh, this happened when the Greeks came to India - and as a result not only ideas, but also their implementation as found in the arts, saw adaptation. The next phase was the spread of Islam, a peaceful infusion of new ideas by Saints or holy men (Chowdhury, A.M.1967), a new culture and a total change in the way of life was brought about. The effect was all pervasive because of the doctrine of Islam which encompasses the entirety of life - no division between secular and religious. But in the past, before the present advances in communication, the process of globalization was sluggish.

At present in the twentieth century, however, globalization has been very rapid - gradual changes have been replaced by abrupt schismatic changes. The reasons: increased travel, telephone (instantaneous communication), satellite TV, the growth of multinational corporations and the computer revolution. These successive influences have shaped life in general and influenced changes in the Architecture of Dhaka, both at the rural as well as urban levels (Ahmed, Z.N. 2001). The architecture education system in this region itself is a source of globalization. In 1961 Dhaka's first school of architecture was setup through collaboration with USA's Texas A & M architecture school - the international style entered the curriculum formally.

Many foreign architects also worked in this region in sixty's, which might have some passive influence on the local residential architecture. Whereas, each successive wave of globalization eats away at levels of sustainability, disturbing the balance of society initially, soon with acceptance and adaptation, equilibrium sets in. This results undoubtedly in a dilution of culture - effecting changes of lifestyle, which then permeates into the arts and other arenas of life. The influences are undeniable even from a cursory glance at men's wear, cinemas, architecture, etc, where styles are seen to juxtapose and influence each other. The process undeniably has positive aspects - it may generate more tolerance through the sharing of knowledge, technology, styles, increasing understanding of the others' viewpoints. But the key question from the point of view of arts is whether it wreaks havoc on aesthetics. Experts (like Tabb, W.K. 2006) fear a loss of cultural diversity. More worrying is whether threatened traditional groups in their attempt to preserve their particular cultures may become marginalised and breeds fanaticism as an extreme reaction.

3. Globalization as it makes inroads into society of the region

Urbanisation is only a recent phenomenon. Rural Bangladesh even now is very different from its urban counterpart. Open courts in rural houses are used for most of the daytime activities of the home, segregated for use by female members of the family. Individual huts are laid around the courtyard. The kitchen and toilets are well segregated from the living areas. The form of the rural house has seen very little change through history. In the first instances of globalization - when influences from the West in the form of Islam entered the lives of these peaceful agrarian villages, a change came about in the religious beliefs. But social customs and general culture of the area blended with new customs and merged with the new religion, modifying rather than totally displacing old values. Therefore the locals continued to lead similar lifestyles - greater equality between the different people as fostered by Islam ensured that certain places which had been out of bounds for the general public became more accessible - notably the places of worship. In the purely domestic arena, previously the supposedly sacred nature of the Brahmin female and the sanctity of her kitchen had made her domain necessarily segregated from possible intervention by males and females of lesser castes. Islam liberated society from these sorts of taboos, but on another platform, brought about increasing male-female segregation. Therefore though appearing due to different root causes, the effect of segregation and its manifestation in the layout of the house form remained very similar.

Socio-political changes with the advent of colonial British rule brought about changes in the region, which spurred on a spate of urbanisation. Dhaka, the city which had first been established by the Mughals, began to grow. People who migrated to the city from rural areas in search of work in general were adventurous young people in search of new experiences and wealth. Researchers find that most of those drawn to urban regions historically belonged to the Mughal Army and the artisan and service population retained by the rulers around them (Mohit, M.A. 1991). Due to social ties and economic uncertainties, it was unlikely that they came away with their families. Therefore it is conjectured that their abodes in the city were makeshift and had the air of impermanence. Male populations were therefore overwhelmingly larger than female population in the city during the early history of the cities, pulled in search of work and upward mobility. This custom is found time and again in the literature of the time, e.g. by Tagore

(Tagore, R. 1892) and numerous others writing about the Bengali middle class facing the duality of having homes in both the rural and urban domains and pulled by ties due to these. Research also supports the view that in long-distance moves men were the dominant players, rather than women, though in recent times this balance has shifted (Afsar, R. 2000). In the early years, exposure to conditions very different from their rural abode, and to new ideas inherent in the cultural mix of cities, i.e. to an indirect form of globalization, brought about a slow change in their lifestyles. Research further shows that Western ideas infiltrated into Dhaka specifically through three routes - education, in-service training and through the media (Imamuddin, A.H. 1982).

The increase in importance of the status of Dhaka, first as a provincial capital after the partition of India, and then as a national capital in 1971 with the formation of Bangladesh, brought about increasing urban migration, increasing the mix of cultures, modernisation and potential globalization. The jump of percentage of urbanised population of Dhaka according to statistics is from 14.79% in the 1961 census to 53.94% in the 1991 census, when the city had enormously grown in stature as the capital of independent Bangladesh (BBS. 2001: 39). Introduction of TV to the region in 1965 brought about instant exposure to cultures beyond the immediate horizon. English as the language of the rulers had always had a stronghold in the region, and the introduction of English programmes via the TV media ensured its continuity, while customs from afar became for the first time visually available to the general public.

The result has been felt through history in three separate breaks with tradition - the emergence of the nuclear family from the joint family of the past, spatial and temporal compartmentalisation of areas into residential, commercial, recreational, etc and this has infiltrated into the plan of residences, manifesting into spaces for different activities like sleeping, dining, studying, etc, instead of the single space accommodating most activities (Imamuddin, A.H. 1982).Moreover, with increased education came yet more exposure, as affluence and the possibility of travel grew. With affluence, international trade allowed the global market to enter even the most remote locality. The telephone increased the sense of closeness and simultaneity. Architecture reflects this slow influx of globalization. Replacing older values a slow transformation of new ideas and customs is seen in the residences due to necessity in some cases, and to choice in others. It is with globalization and the new incursion of ideas that choices entered the lives of these urbanites.

4. Evolution of the dwelling

In this section the evolution of the dwelling of the middle to high income group of urbanites is traced in terms of globalization influences. Discussed below is how the house-form seems to evolve as a shift in local customs, influenced directly from extraneous influences - an effect of globalization, rather than pure modernisation.

4.1 Dwellings during the urban beginnings

In early days of the seventeenth and eighteenth century, the urban house form was no different from its rural counterpart, except when forced upon by densification (Khan, I.M. 1982). From the idyllic sprawling low-density settlement of rural habitats, the urban house at the beginning had of necessity to be accommodated in more cramped surroundings. Initially houses tended to retain the court, which became increasingly closed as space constraints became acute.

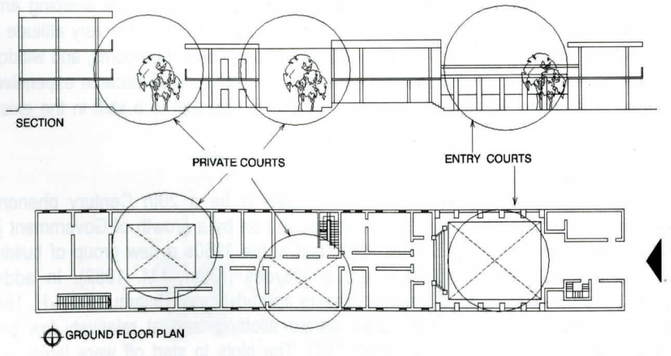

Fig 01: Three-court houses. Source: F.A.Haque, 1997

In early houses the kitchen and toilets were kept as far away as possible from the main living quarters, in a way similar to rural dwellings. A separate service court in three-court houses can still be found in these early residences (Figure 1). The first court served as a semi-public court, mainly the entry court to the ander mahal (inner sanctum) occupied by females members of the household. On the outer side of the first court was the male, to which zone male public access was limited. The second court was the most private area of the household, segregated from public access. Only family males were allowed there. Female guests were also entertained through this area. Greater access was allowed in the service court where privacy was less restricted as non-family males needed to enter this area for servicing toilets and for other general household activities involving domains outside the home. The servants' quarters, kitchens and toilets were housed around this court (Figure 2)

Fig 02: Interior Courts in early urban dwellings.

The introduction of new technology like flushing systems allowed toilets to be attached to living quarters. The introduction of cooking gas instead of fire wood allowed the kitchens to be brought closer also, as fumes/smoke diminished. This was a great departure from the idea of the 'sacred' kitchen - historically out-of-bounds for lower castes, a big shift in the context of the existing belief system. In general the concept of privacy (or separateness) of the individual members of the family from each other was not very prevalent in either rural or early urban living. This is not uncommon in many societies as shown by Broude in discussing husband-wife sleeping arrangements in a study of 116 monogamous societies around the world (G.J. Broude, 2003: 197-8). This very attitude saw reflection in urban Dhaka's living pattern. Thus bedrooms were often entered through other bedrooms, and windows to bedrooms opened freely onto the courts. The court disappeared generally as soon as land became expensive and density of residential areas began to increase. But it could only be implemented parallel to a shift in the existing custom and social expectation.

4.2 Mid twentieth century phase

The emergence of the urban middle-class in Dhaka is judged to be a 20th Century phenomenon, a direct consequence of Colonial rule (Imamuddin, A.H. 1982) and spurred on by a growth of Government jobs in the Civil, Military, Police, Railway and allied services. Studies show that in the 1950s a new group of buildings emerged to accommodate this group - 'colonies' for Government employees (Khan, I.M. 1982). In addition cities also experienced the growth of professionals like doctors, engineers and advocates (Imamuddin, A.H. 1982).To cope with increasing demand for housing, the Government also started allotting land at relatively low prices in planned residential areas, e.g. Dhanmondi R/A (Nilufar, F. 1997: 107). The plots to start off were large (approximately 1/3 acre each), and the economic and social background of the allottees had a semblance of homogeneity. During the

late fifties and early sixties these areas grew populated, with a family to each plot. Houses were relatively large, normally two storied with a number of bedrooms, each with an attached toilet. The living room (or drawing room as it was popularly referred to) was normally segregated from the rest of the more private areas of the house, having its separate entry. The entry to the rest of the house was separate and corridors were extensively used to connect the different spaces. Gardens all around the house served to provide outdoor space for aesthetics/recreation in the front, with vegetable patches at the back and sides. High boundary walls around the plots served to protect the plot-holders from inquisitive public gaze, imparting within the gardens the impression of enclosed courts. Servants quarters were normally provided at the back and the kitchen could be entered through backdoors.

4.3 Post-independence phase

A big change came by the end of the seventies, when the next generation needed expanded quarters. Discussed here is the case of Dhanmondi, as representing the pattern of urban land ownership. As many as a fifth of the original of these plots were at this point sub-divided among the inheritors into separate plots served by internal private access roads (Akbar, M.T. 2006). This trend saw the end of the joint family of the past, though the separate families tended to live in the same plot, but under different buildings. During this period many rentable walk-up apartments (usually restricted to four storeys) were constructed to supplement incomes through rent.

As soon as the one-unit house was sacrificed for economic gains, life style saw a new shift. With the grounds no longer under the sole control of one householder, people needed a different space for family gatherings, thus the family living space became firmly entrenched in these urban homes. No longer were corridors the main connecting paths to the individual rooms, as in previous eras. Now a largish family living space provided the counterpart to the open courts of the rural abode. This space opened to the individual rooms and provided a space where the family could spend much of the free time in the evenings, gossiping or watching TV. Privacy (a very individualistic concept) was gaining importance in family living as each family separated from the parent one. Therefore bedrooms became increasingly segregated from the adjacent spaces, with individual entrances, and windows were avoided onto these connecting spaces, often to the detriment of ventilation.

During this period, it was still common for the children's bedroom to be located adjacent to the master bedroom, allowing the mother to monitor growing children. This space would later be allocated to grown-up daughters, to instil a sense of security for the daughter. However a guest room nearer the entry and the less private drawing room would often be used by the son, freely accessible to his friends who could enter the house without infringing on privacy. As village roots weakened, the use of the guest room for guests diminished, but the name (guest room) persisted.

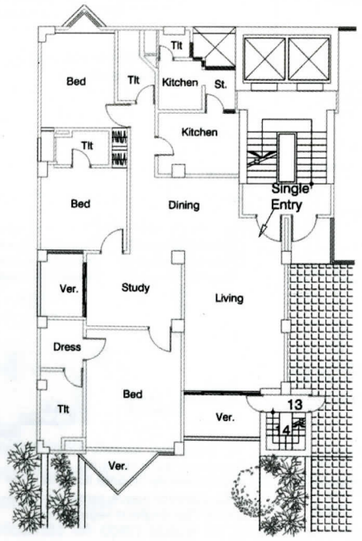

Fig 03: No segregation at entry, Prioprangan, U. K. Saha. Source: Sthapattya o nirman, 12

4.4 Developer-built housing phase

But with the ever-increasing population making yet more demands for housing, and the prices of land rising steeply, much of the early housing stock was demolished in favour of apartment complexes, a trend which seems here to stay. Commonly referred to as 'high-rise' apartments, these complexes are normally developer designed and built and in many of the residential areas restricted to just six storeys. They are equipped with lifts, and controlled by a management society that lays out the rules for each complex, particularly to do with the use of common facilities and spaces.

Community living has brought about yet another change in the lifestyle of the urban dweller. Open spaces are meagre due to dearth of land, and any that can be provided in such complexes are no longer private areas. The urbanite now shares these spaces with people they have only recently seen and may not yet have been acquainted with (Figure 4).

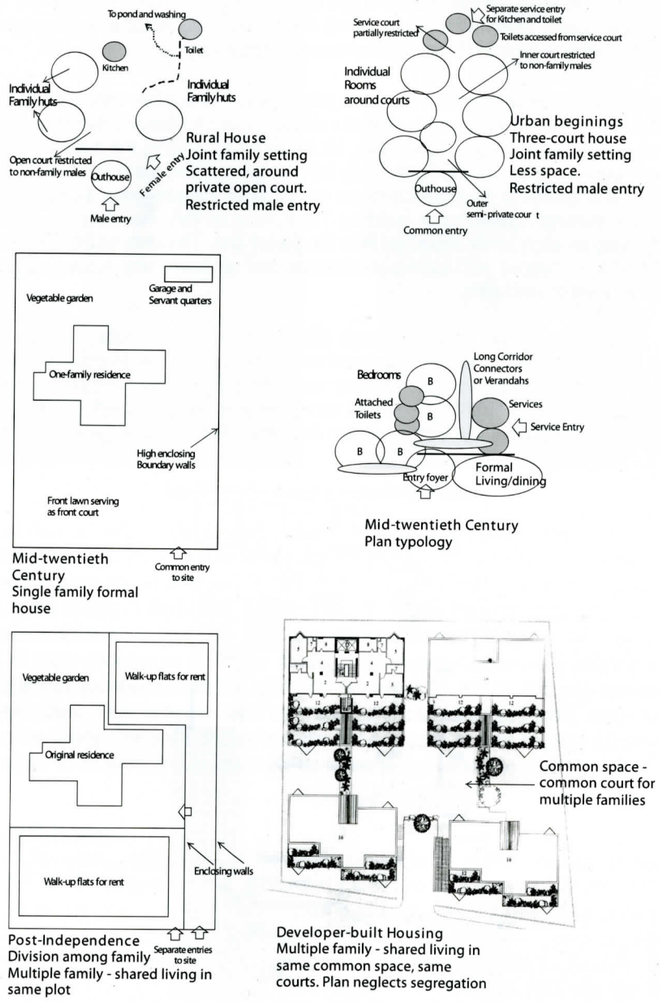

Fig 04: Evolution of the Dwelling: schematic phases

The greater exposure that women are subjected to in these new surroundings of necessity have reduced the convention of segregation in public life, which in turn impacts the private one. Thus the sacredness of the women's domain has diminished and with it the layout of the house is more open with greater freedom of access, less zonal segregation (Figure 6). Research (Khan, I.M. 1982: 6.20) indicates that, no amount of manipulation recreates the exclusiveness of the male and female domains of these houses, once the pattern is broken. In the house plan this effect is noticed through a growing tendency to provide a single main entry for all occupants (Figure 3). This is a departure from times when it was the norm to provide segregation at entry point (Figure 5) - allowing occupants to enter the home unobtrusively in order to preserve privacy from visitors in the living room. The salient features of the four phases are schematically depicted in Figure 4.

5. Effect of globalization

5.1 Changed life-style of twenty-first century

Many changes are seen in the way life is conducted in these apartments. Higher standards raise costs of living necessitating both husband and wife to seek employment. Higher education along with related greater exposure, make it possible for the wife to have increased employment opportunities (Elora, S.S. 2003). Statistics show that percentage of economically active females in urban areas of Bangladesh has risen from 4.7% in the 1981 Census to 35.7% in the 1995-1996 LFS (Labour Force Survey) count (BBS. 2001: 57). Of necessity many women now spend much of the day outside the home, while children also start schooling at younger ages. As much of the activities in residences have traditionally been directly under the domain of women, this alone has brought about major changes in the household (Table 1).

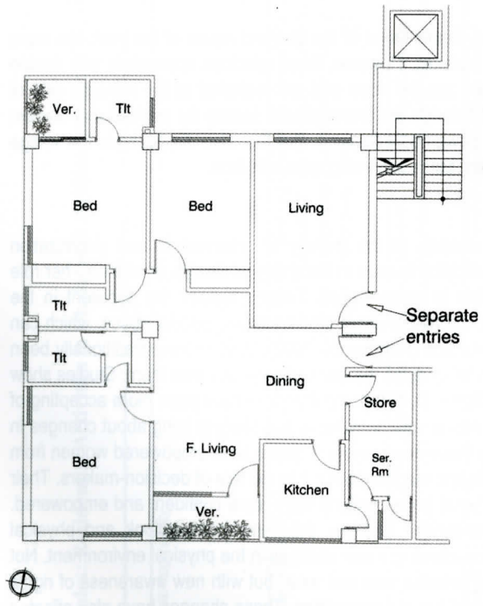

Fig 05: Plan with separate entries, Niraloy
Source: Z.N. Ahmed

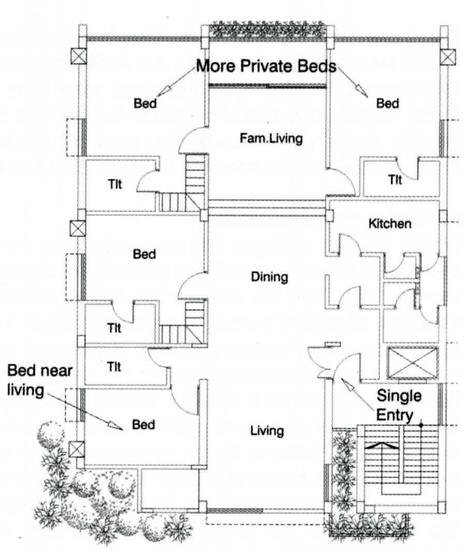

Fig 06: Bed, closer to living/entry areas
Source: Developer Housing Brochure

Lack of open ground areas has prompted more indoor activities for children. There is therefore less active play, more TV and computer, increasing opportunities for globalization both for adults as well as children. Health concerns related with sedentary lifestyles therefore increase, e.g. diabetes. Lack of open ground areas sometimes prompts a change in planning - the roof top becomes an open space for physical activities for the occupants. In residential areas, community open spaces like parks, which were not common in the history of urban Dhaka, are developing. Within the interiors, some indoor green spaces, terraces are also coming into fashion.

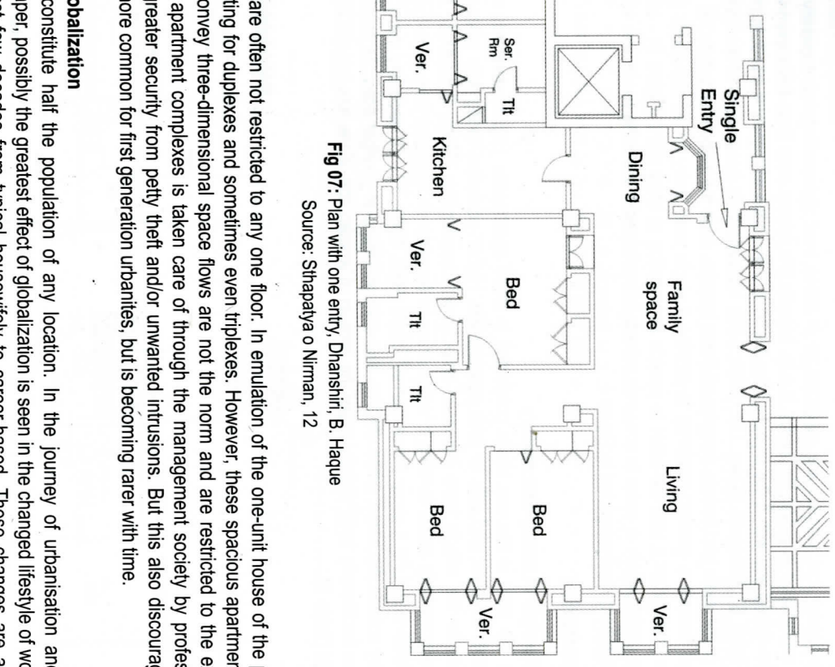

Fig 07: Plan with one entry, Dhanshiri, B. Haque
Source: Sthapatya o Nirman, 12

Luxury apartments are often not restricted to any one floor. In emulation of the one-unit house of the past, the more affluent are now opting for duplexes and sometimes even triplexes. However, these spacious apartments with double height areas that convey three-dimensional space flows are not the norm and are restricted to the extreme elite of Dhaka. Security in apartment complexes is taken care of through the management society by professional bodies; therefore there is greater security from petty theft and/or unwanted intrusions. But this also discourages the village visitor, which was more common for first generation urbanites, but is becoming rarer with time.

5.2 Women and globalization

Women generally constitute half the population of any location. In the journey of urbanisation and globalization discussed in this paper, possibly the greatest effect of globalization is seen in the changed lifestyle of women - her role changing in the past few decades from typical housewifely to career-based. These changes are apparent in the workplace, educational institutions, streets and also on TV, the all-pervasive new electronic cultural space, which can be referred to as a 'placeless' geography of image and simulation (Robbins, K. 1992). Women have traditionally been the passive marginalized members of society, allowing men to lay down the law and dominate over them. Studies show that women are different in emotional makeup from men (Morris, D. 1988) and therefore have been more accepting of their lot in life. The greater proliferation of women in public and private domains is thus likely to bring about changes in these environments due to different perspectives offered by these new players. Careers have empowered women from their passive roles, and serve to bring women into public life and put them often into the role of decision-makers. Their added status out of the house also impacts on their attitudes at home, making them more confident and empowered. The importance of this participation is all the more pronounced because their emotional outlook and physical parameters are significantly different from men, requiring and effecting major changes in the physical environment. Not only has globalization brought about a decrease in the gap between east and west, but with new awareness of rights and privileges of women, the entire family set-up has changed beyond recognition. These changes have also affected the architecture within dwellings, to provide for the changed role of woman in the family.

Table 1 below summarises the different activities involved in the day-to-day running of the average household and how the responsibilities of these have shifted from the past to the present. The note on the architectural implications of these shifts in the last column is hypothetical - qualifying much of the arguments for the impact on architecture due to these changing roles caused in part by globalization, and is based on the author's understanding, observations, experience and readings of the situation. Emphasis has been given in listing these changing roles as they are primarily responsible for changes in attitudes, leading to lifestyle change and the need for a more appropriate architectural response in contemporary dwelling design.

Table 01: Changing Roles: Residential Activities in Dhaka with Architectural implications

Activity	Past	Present	Architectural implication
Child rearing	Woman's sole responsibility	Man shares during absence of woman.	In past this space would be close to other domains of woman's activity, e.g. kitchen. For man's participation, should be closer to spaces where it can be performed along with other activities, like TV, study, etc.
Cooking	Woman's sole responsibility along with domestic help	Domestic help - becoming increasingly scarce with other employment options. Simpler cooking – no longer happy to cook in seclusion – seeks participation in other family activities. Men also cook – prefer electrical appliances – higher energy needs.	In past, isolated kitchens, as completely private woman's domain. At present, kitchen should be located closer to family living spaces so that the woman/man can participate more in other family activities, and is not isolated from the family life.
Housework	Woman's sole responsibility along with domestic help Outdoor work was arranged by the man.	More flexible boundaries. With dwindling domestic help – more on a self-help basis, mostly by woman but with increasing help from the man.	Rooms were large in the past involving extra work. Houses more compact now - easier maintenance, surfaces more amenable to cleaning.
Shopping	Man's responsibility	Increasing involvement of woman in outdoor activities.	In the past, shopping in bulk. Now less shopping – less storage space
Entertaining guests	Man's official and social guests waited, on by woman –segregation. Women visitors usually during the day when the man was at office or out. Resident visiting guests – as stronger village ties.	More mixed visitors, for both man and woman during all times. Segregation not as prevalent. Visiting resident guests less as new generations of city dwellers grow further from immediate village ties of older generations.	Previously separate entry + segregated sitting rooms with privacy from inner domains. Guest bedroom and toilet near entry – allowed guest entry without hampering privacy. Sitting room - kept sealed at non-visiting times to reduce cleaning. Presently less distinction between semi-private and private living spaces – often common entry.
Bedrooms for children	Son and daughter were treated differently, with more security for the daughter, greater freedom for the son.	Similar rights and treatment for both genders.	In the past one bedroom deliberately designed near entry for son or guests – access without hampering privacy. Daughter's room in interior – access to parent's room for security
Relaxation	For the man the house – a place to sleep – relaxation at 'Addas' either at home or friends'. Woman worked all day: in the morning- cooking and cleaning, rest of the day – catering to different domestic needs.	TV and other home entertainment systems provide relaxation scope at home with both man and woman participating. 'Addas' are getting rarer with decreasing time under present competitive job environment.	The family space is becoming more elaborate with time with provision for gadgets for home entertainment.

6. Conclusion

Globalization and its impact on the society and culture, and ultimately on the architecture of a region, have been identified through the different sections of this paper. While the borders defining globalization are often seen to merge with that of,modernization this paper confines the discussion to those aspects of society which are affected by forces extraneous to the region, thus focussing on globalization, as a specific manifestation of a more general process of modernization. Societies are formed through cultural continuity, and are through the ages exposed to different influencing factors. These mould existing practices and customs into newer models. The process is a continuous one, an inevitable reality of history. While traditionalists bemoan the corrosion of values as the mixing of cultures goes on, it is only pragmatic to recognise that it is impossible and possibly autocratic to attempt to stem the flow. However, individuality in different cultures need to be identified and their particularity needs nurturing so that cultures do not completely die or become subsumed by more commercial and dominant 'pop' cultures. In this flow of globalization there is the need to have some sense of continuity in order to eliminate rupture and an associated sense of alienation (Al-Hathloul, S. 1998).

Architecture registers culture, reflecting attitudes, life-styles and shifting viewpoints in works that have to last through changes, transcending eras for which they were first conceived. They therefore stand as testimony for bygone times and can be studied and analysed in retrospect to reveal original intentions - an exercise which can benefit the architect to understand society with its shifting foci. Such introspection regarding one's own roots can help increase awareness and sensitivity about the values and priorities of one's past, allowing more appropriate architectural responses for the future.

Along with the above focus, this paper also recognises the importance of women, who form a large section of society, in effecting changes in culture and life-styles, as a product of globalization. The areas in the household where globalization has given a changed attitude to women have been identified, as these are felt to directly affect the design of the relevant activity and spaces. It is conjectured here that this is one of the key features that have figured in the past, and will continue doing so in the future, in moulding the home.

The paper has focussed on the case of dwellings for the middle-class urban population of Dhaka representative of the urban majority, discussing how globalising influences have succeeded in moulding not only the life-style of the urbanites and their attitudes, but also their immediate abodes. It is important at this juncture, where globalization is threatening many cultures at the roots, for Architects to be aware of the inherent dangers of losing cultural identity. Therefore added efforts are needed to understand the underlying culture, how they are reflected in architecture and to be able to incorporate these values within the design of spaces.

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DELTA FORCE: New Cartographies of the Sundarbans Alternative Design Concepts for Khulna & Environs

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Abstract
The territory of southwest Bangladesh has recently been through trials and travails - from the process of de-industrialization to devastation in the wake of Cyclone Sidr. A state of uncertainty hovers over the region as jute mills close in Khulna, Mongla port has yet to take off and the frequency and severity of natural calamities appears to be on the rise. The resilience of the region is being tested as future scenarios are debated. Meanwhile, large-scale investment in infrastructure proceeds as the Southern Bypass and Rupsa Bridge have been completed and there is discussion of new airports and a second bypass in the vicinity of Khulna. A new master plan is being developed for the Jessore-Khulna-Mongla region while the Khulna Development Authority and Khulna City Corporation struggle for political buoyancy amidst the nation-wide corruption crackdown. Strategic intervention in the larger territory is compounded further by the contestations amongst a multitude of ministries and over-lapping jurisdictions. Traditional master-planning is incapable of reconciling the complex relationships at play in this territory. This article presents an alternative design approach - a new series of projective cartographies - for simultaneous operation at the larger regional scale, the city scale and the local scale.

1. The Agency of Mapping

The complexities of the region extend beyond the uncertainties and sectoral/political manoeuvring to the spatial qualities of the territory itself. The creation of maps and layered reading of the region at multiple scales makes clear the interplays between landscape, infrastructure and urbanization. The specificity of the context is embedded with inherent logics which are often in conflict with the impositions of sectoral-based master plans. In order to make design projections and new cartographies for the region, research began from the notion that interpretative mapping is a first step towards transformation of a territory. The reading of sites - from diachronic and synchronic perspectives - was necessary in order to create modifications that relate to the particularities of places and situations. Interpretative mapping allowed for multiple perspectives and methods of looking at history, contemporary reality and data. The interplay between paradigms, discourses - be they political, scientific or populist - forces, circumstances and hazards has resulted in a territory that is neither smooth nor understandable from a single perspective. The implicit and explicit translation of discourses to physical form is further modified by continuous practices of everyday life.

The notion of 'descriptive (landscape) urbanism' was used as a method and a critical discourse for analysis. The critical assessment and construction of mappings, overlays, narratives and urban biographies convey social realities on the ground. And since the paradigmatic and the descriptive can never be fully disassociated from one another, the urban analysis demands a back-and-forth method oscillating between the two - involving different scholarly and creative skills: scientific researcher, participating observer, stirring narrator. After all, urban design operates as much in the domain of design interventions as it does in the creation of a mindset or a shared vision.

The 'agency of mapping' is exploited as the initiation of 'design research.' As Corner writes, 'Mapping is a fantastic cultural project, creating and building the world as much as measuring and describing it. Analytical research through mapping enables the designer to construct an argument, to embed it within the dominant practices of a rational culture, and ultimately to turn those practices towards more productive and collective ends. In this sense, mapping is not the indiscriminate, blinkered accumulation and endless array of data, but rather an extremely shrewd and tactical enterprise, a practice of relational reasoning that intelligently unfolds new realities out of existing constraints, quantities, facts and conditions' [Corner 1999: 213,251].

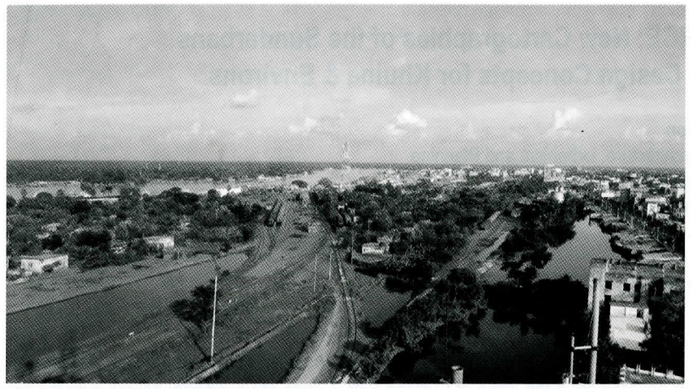

Fig. 01: The potentials of Khulna's under-utilised riverfront and railway networks

Maps - as projects in the making - unfold and uncover potentials through their inevitable abstraction, selection and omission of facts. Drawing is a tool to select, compare, combine, analyze and describe tendencies and the latent capacities of the landscape and its relation to urbanization. Mapping is operative in the sense that it reformulates the reading of existing territories and sets the stage for the inauguration of new worlds. The urbanist's gaze and descriptive map-making can be instrumental in clarifying the territories' essence, revealing hidden potential and disclosing conditions for the emergence of new realities. Working between multiple scales allowed for the discovery of potential sites for intervention and where the social needs of the inhabitants could be negotiated within the present process of unbalanced development. Understanding the shifting relationships (smooth and conflictual) between landscape, infrastructure and urbanization became a base for descriptive (landscape) urbanism. The link of various qualities and opportunities of the territory to their typo-morphological settlements were mapped in order to gain insights into the logics of development [Shannon 2008a].

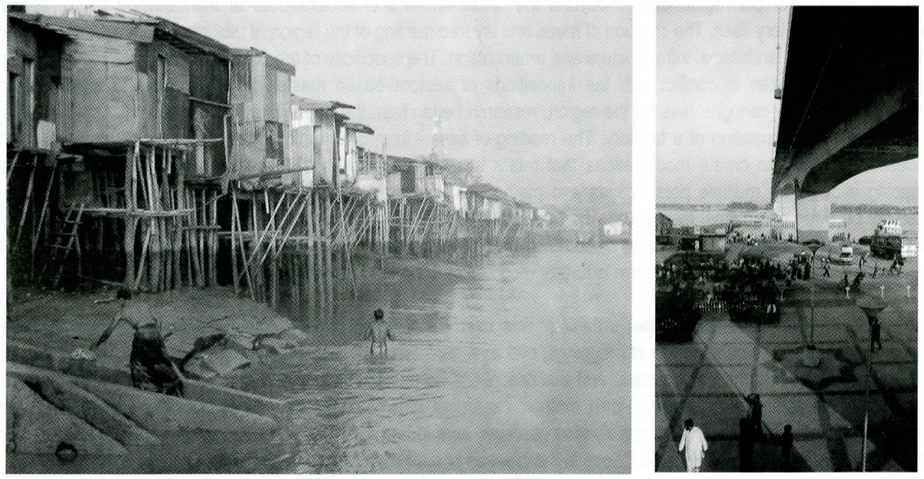

Fig. 02: Water-based urbanism is giving way to road-based urbanism as new infrastructure is realized.

1.1 Existing Spatial Logics of the JKM Region & Khulna

In the Jessore-Khulna-Mongla (JKM) region, urban analysis 'from above' included the layered mapping of the territory [1]. Linear dispersion, a settlement pattern along banks of waterways raised by silt deposits and linked to a long tradition of a productive economy, is the dominant form of (rural) settlement in the area north of the Sundarbans. While the organized dispersal is consistent with the structuring logics of hamlets linked to agricultural production, the contemporary economies of scale and shift from predominantly wet-rice cultivation towards more lucrative aquaculture

is changing the urban/rural concentrations, settlement hierarchies and sizes and structure of plots. As well, there are evident relations of settlement to soil types and the (increasing) extent of coastal saline intrusion, which also determines vegetation patterns and types of agro/aqua-culture production. Nevertheless, the whole of the territory is dramatically under-serviced in terms of infrastructure (basic sanitation, sewerage, drainage, clean water provision and public facilities ('social infrastructure' of education and healthcare facilities).

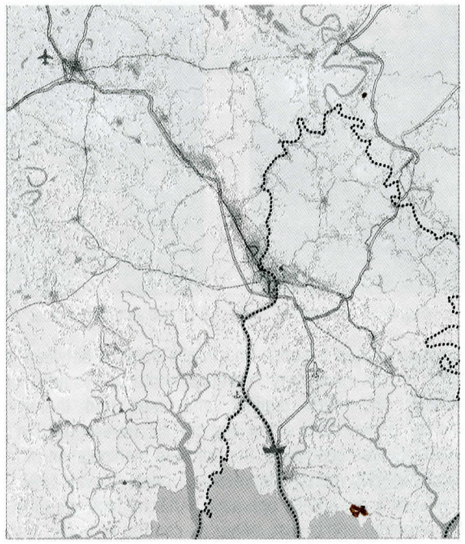

Fig. 03: The Jessore-Khulna-Mongla region and its urbanization pattern.

In the inter-lacing cross channels of the watery mosaic of the region, the slightest differences in topography revealed different settlement morphologies. The lower lands in the mazes of the riverine network serve as productive land. In the more urban agglomerations, the quintessential pattern is a densely vegetated natural or man-made levee on banks of rivers safeguarding habitation from regular flooding events. Khulna serves as an illustration of the region's denser areas. The spatial growth of the city itself is explained by its topography; it developed as a linear city. In pre-colonial times, the settlements occurred on the deposited sediment natural levee (2-4.2m above sea level) of west-side of the Rupsa and Bhairab riverbeds. During the British colonial era, Khulna grew due to its role as a river trading port city with administrative headquarters and market centre. The Jessore Road was an important transport link to the north and the corridor urbanized over time. In 1885, the road was paralleled by an important railway link with Calcutta (which has only recently been restored). Originally Khulna operated as a collection point for hinterland agricultural production (primarily jute, rice, tobacco, sugar cane and more recently shrimp) and natural resources (primarily fish and wood). It was established as a significant industrial base - specializing in jute mills with raw materials supplied from the nearby Sundarbans. The large and prosperous mills were linked to the riverfront and serviced by an extensive railway network. After Partition in 1947, the jute mills flourished under East Pakistani management and housing colonies, schools and social/cultural amenities augmented the progressive mill layouts. Once Bangladesh gained independence in 1971, the mills became state enterprises and slid into a vicious cycle of under-investment, an inability to properly compensate workers, dwindling orders from the world market (as plastic gained in popularity) and strikes. Mill after mill began closing their doors. The city lost its economic driver.

Meanwhile, new infrastructures and programs have located in Khulna. Its urbanized area is rapidly growing due to a rural-urban migration, with a large proportion of the population occupied in informal market activities. The demographic composition of the population is out of balance with a large dependant group of children and few adults, putting high demands on professionally active people. Spatially, the dense core of the city remains bundled along a stretch of 15km between the Rupsa/Bhairab River and the parallel Jessore Road; however, with development of the Bypass Road to the west, both planned and speculative urbanization has begun. The university campus promises to be a new core area and all the plots adjacent to the highway have been sold. At the same time, the water-based urbanism of the city is falling into disrepair and the massive industrial platforms, structures and infrastructural networks are abandoned. The

State remains the owner of a vast amount of property - significant holdings are in the under-utilised rail yards. The city, nonetheless, remains a centre for a largely productive hinterland, a relationship no longer based on the vast network of waterways, but one that is rapidly transforming into a road based system. The logic of the latter not necessarily follows the rules of the hydrology and topography that are inherent to the former.

Fig. 04: Ponds as result of cut & fill and as public space.

Urban and rural areas alike are the result of a subtle and fragile balance between water and land, permeable and impermeable surfaces, organized by the necessary hydraulic territorial systems for water management and soil stabilization. Levels of inundation determine distinct land uses and therefore the definition of wet/dry, productive/inhabited, safe/unsafe component parts of the land mosaic are essential. In a land where the difference of a few centimetres creates completely diverse conditions, the primitive manipulation of topography becomes a powerful tool. The village mound, dibi, and low-lying marshy depressions, beels [Novak 1993:24,27] and tanks, geometrically defined ponds, are often the result of a cut-and-fill operation. Artificial high grounds are created as 'safe' lands for habitation, while resultant water retention ponds also serve as centres of public life and daily domestic routines of drinking, bathing and washing. Beels and tanks are also used for irrigation and fishing. However, whereas beels are often dry in the winter and expand to fresh water lagoons in the monsoon season, tanks are explicitly designed to collect rain waters for use in the dry season. Pump wells are often located on their perimeter, accentuating their function as centres of social gathering.

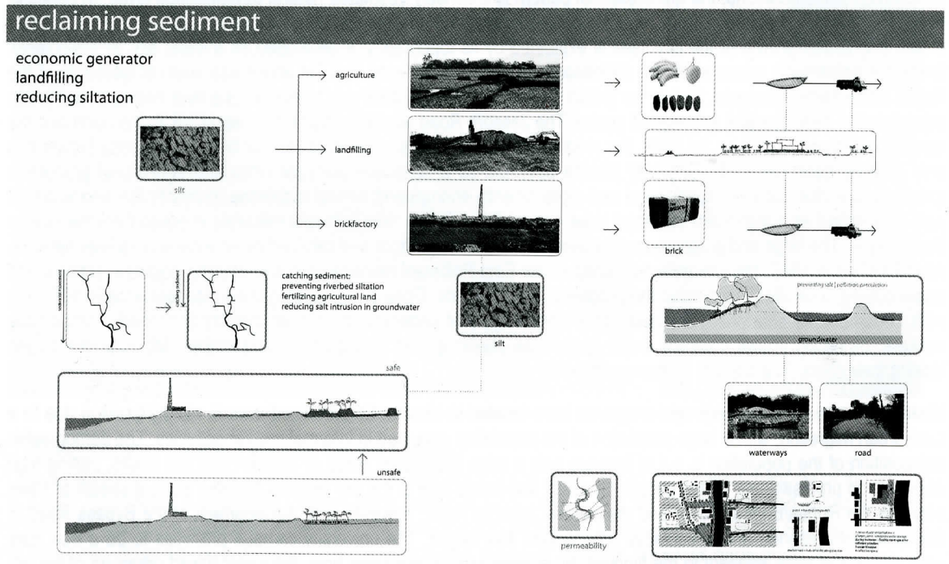

Fig. 05: Spatial Tools: Cut & Fill and Sedimentation.

Another tool that perhaps warrants reconsideration in the city-building process is that of sediment reclamation. As Ashraf has stated, there is a constant remoulding of the nation's territory as 'the land, formed primarily by silt deposits, is constantly shaped and reshaped by rivers, which themselves are constantly shifting and changing' [Ashraf 1997:9]. The harnessing of the dynamic natural process is employed by brick factories which are situated in the optimal flow of clay sediment. The irrigation system too profits from the over-flow of nutrient rich sedimentation for natural fertilization of agricultural fields. Well-placed spatial interventions could develop the logics of the natural process further - thus 'naturally' creating higher ground of a re-moulded topography.

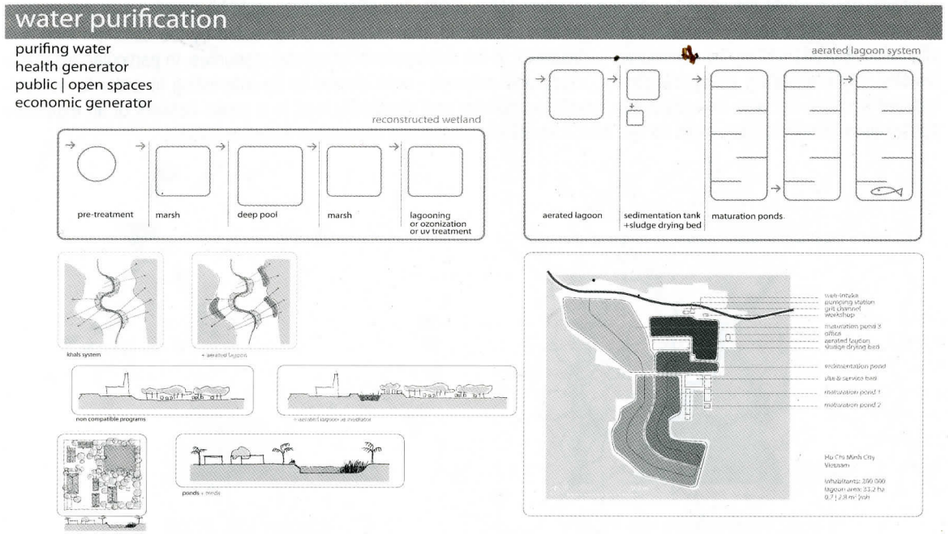

Fig. 06: Spatial Tools: Water Purification.

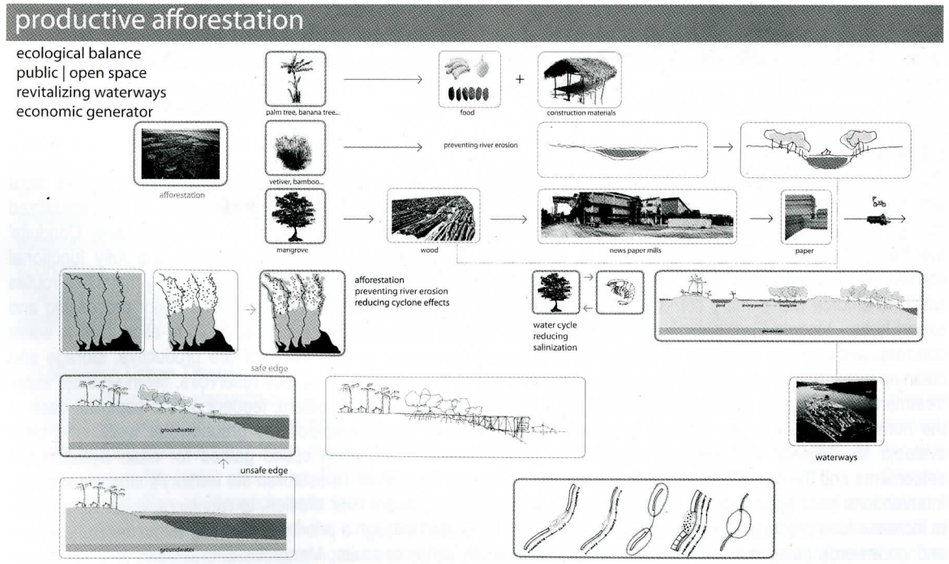

Fig. 07: Spatial Tools: Afforestation.

Two tools that were researched for their potential to work across scales, guide urbanization and address fundamental environmental problems were those of water purification and afforestation. It is paradoxical that the nation with perhaps more water in the world has severe shortcoming with regards to potable water. The constructed wetlands and aerated lagoons prove interesting not only for their low-cost, natural and maintenance-free, but also their capacity to act as land banks and open spaces that off-set urbanization and can be designed to be elements of an enlargened civic space. Afforestation was envisioned as an important strategic project for the environmental protection of the southern part of the country and was justified by the May 2008 announcement of a national programme of planting 100 million trees as a 'natural fence' along the coast to mitigate disasters [AFP 2008]. The afforestation could be coupled with the concept of 'social forestry' whereby unused and fallow land is planted, maintained and harvested by the common man with economic returns profiting the community participation in the management of natural resources. In particular 'extension forestry' - where plating alongside canals, roads and railways - was viewed to be interesting in order to not only improve ecology, but also beautify areas, create economies and eventually lead to a green network of an expanded public realm. Strategic sites could as well host a series of touristic and research-oriented programs.

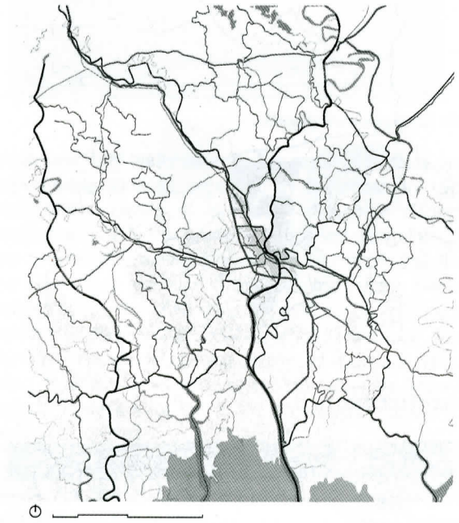

Fig. 08: JKM 'conduits'.

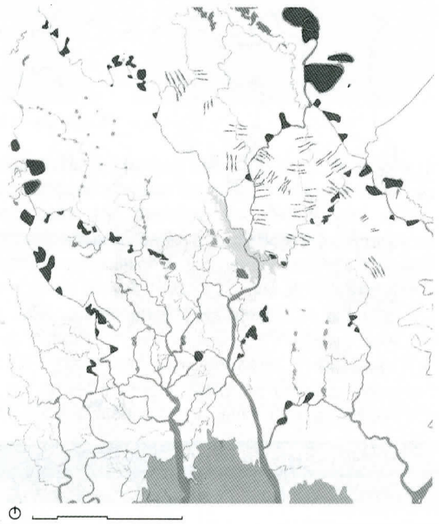

Fig. 09: JKM 'feeders'.

1.2 Territorial [Re] Structuring

The mapping of the territory and design tools research led to restructuring the JKM region and Khulna to work more with the inherent dynamics of a delta landscape. The deltaic region's envisioned transformation is conceptualized through four primary interventions: conduits, feeders, insulators and transformers. (use figs 8-11 near here) 'Conduits' are transport corridors. Interventions aim to re-assert water-based transport as a desirable and fully functional complement to road-based transport. The existing water hierarchy is rationalized and optimized to emphasize routes which re-enforce two primary corridors of interdependency between productive hinterland and major processing and export hubs - Mongla Port, Khulna and Jessore Airport. Shrimp production, for example, could re-align itself to water conduits, allowing live transport of fresh shrimp to export processing zones. 'Feeders' are productive, storage and cleaning water bodies. An underlying basis of interventions is the provision of various reservoirs, fishing ponds, water treatment and irrigation systems. Responding to a manifest drinking water problem, feeders aim to separate uses of the numerous ponds in the territory, providing an alternative to the arsenic-polluted groundwater wells, and clear systems for drainage and irrigation needs. The added benefit is the open space gained for often overcrowded settlements and the social life that comes along with the ponds. 'Insulators' re-establish the territory's inherent ecology. Interventions build upon existing programmes of afforestation to prevent river erosion, to rebalance water salinity and to increase food production. Insulator intervention would be guided through a priority of planning within the Sundarbans and northwards along the two strongly defined north-south water conduits. Mangrove afforestation is a necessary insulator for the delta landscape and could operate in a linear way along major waterways, leaving the more inland patches free for agricultural production. 'Transformers' are various types of public programmes (schools, clinics,

mosques) that the under-serviced territory requires. Based on a cut-and-fill principle, they are coupled with water treatment systems and located on new high-land. These public programmes vary in scale according to existing and desired inhabitation densities. With these interventions in place, urbanization (or de-urbanization) is guided by the conditions created by conduits, feeders, insulators and transformers. Over-time, larger areas for agriculture at a new economy of scales will evolve as the dispersed systems would be implicitly re-organized.

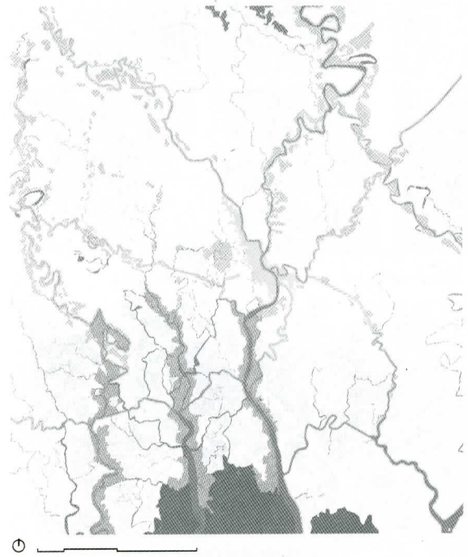

Fig. 10: JKM 'insulators'.

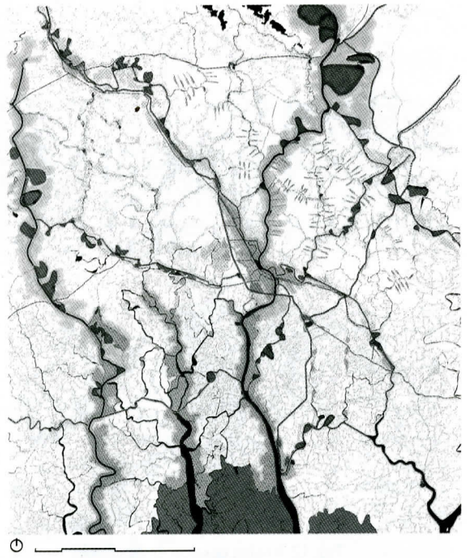

Fig. 11: JKM possible spatial future.

The same four layers from the JKM scale are developed at the Khulna city scale. Water 'conduits' are stressed near the western and eastern city edges - counterbalancing the new highway and providing connections from the productive hinterland. This allows farmers to transport efficiently and cheaply his goods to Khulna. As well, various water channels are re-instated, creating a logical drainage system for the city. In terms of roads, the network's missing links are completed - particularly connecting the city to the new highway by a series of east-west transversals. Special design attention is given to selected intersections where the transfer between road and water - in both directions - can be facilitated. 'Feeders' are strung along the new water conduits. Reservoirs and fishing areas are more peripherally located while water treatment is developed at both the city-wide and various neighbourhood scales. A large reconstructed wetland is created in the southern part of the city, working as a final cleaning mechanism before water is released back into the Rupsa-Bhairab River. Insulators are primarily located along the Rupsa-Bhairab River re-establishes the territory's inherent ecology. Within the city, social forestry creates micro-climates, provides new economies, creates transitions from water conduits to settlement areas and provides recreational spaces. 'Transformers' are strategically inserted into the fabric where most needed. They are also placed in water / road or water / water conduit intersections in order to induce urbanization, up-grading and densification.

1.3 Mapping Urban Tissues

The major structuring elements of the cities and landscapes are relatively easy to map and even project anew whereas understanding the urban fabric - the often uncelebrated (predominantly residential) infill - is more complex. However, it can be argued that the anonymous fabric is at least as significant in defining the character and culture of any given territory as are the larger structures. To further understand Khulna, a 1969 method of fabric analysis - by Caminos, Turner and Steffian of Massachusetts Institute of Technology [2] - was revisited. The systematic representation of 400x400m sample tissues revealed the correlation between various settlements, their topographic and socio-cultural contexts. The creation of the sample squares often literally included the putting on the map elements un-recognized, not officially mapped and documented. The compilation of an urban tissue atlas of sorts facilitates comparative analysis and remains a useful testament to the variety and richness of settlement morphologies. Admittedly, the danger

of such analysis lies in the ease to which it can become highly mechanistic. However, if well-balanced, it can reveal the inner-workings and provide a materiality to Khulna and its neighbourhoods.

Fig. 12: Khulna possible spatial future.

Fig. 13: Khulna's sample urban tissues.

In Khulna, five extremely contrasting fabrics were mapped. 'Bara Bazar' - the original area of settlement in Khulna - is the super-dense, primarily wholesale and storage area sandwiched between the main vehicular road (Jessore Road) and the Rupsa and Bhairab River. Narrow streets are appropriated by street vendors and the relation to the river is purely pragmatic - a backside for loading goods. The Rupsa slum, located in a lowland, is similar in terms of ground cover, but not nearly as dense - consisting of low-rise katcha (temporary structures) and timber industries perpendicular to the river; the sample fabric also hosts a gated housing community for Christians. Khalishpur, in the city's former economic heart, along the river, hosts a number of jute mills on government property (the analysed area includes one of the few working mills - Crescent Jute Mill). There is informal appropriation by slum dwellers on the non-gated areas of the neighbourhood. In Nirala/Bagmara there is an apparent spatial collision of very different grains and tissues. The southern fringe of the city was once low-lands and marshes; in the 1990s, part of the area has been reclaimed for planned, upper-middle class housing 'colonies' of 3-5 floors (Nirala) by the Khulna Development Authority. Surrounding the new development is Bagmara, an informal housing area of semi-permanent or temporary housing structures with predominately rural typologies. Clusters small grain housing are incrementally developed and nestled amongst dense vegetation and small water bodies. Finally, a tissue of the colonial fabric was analyzed. It represents the oldest planned residential area of the city and is typical of a British garden city colonial settlement. Today, the area is clearly a high-class neighbourhood; the streets are wide, tree-lined, in good condition, unoccupied by hawkers, have proper drainage (some of them even footpaths) and there are no retail shops at the roadside. The result is that they're only used for through-traffic and are rather empty in comparison with other streets in Khulna. In some parts of the area (mainly along the river side, with personal ghats), high-class officers reside (judges, district commissioners, etc.), but most of the buildings are used for administrative and governmental functions (court, jail, Sundarbans Forest info-centre, etc.). There was additional analysis completed which made more visible the invisible structuring logic of different settlement patterns. For instance, a highland/lowland comparison between the tissue of Rupsa and Nirala confirms that the low economic classes are often left to the most vulnerable and fragile ecologies. Land-filling is an expensive undertaking and larger-footprint, formal housing develops, while the marshy, unhygienic lowlands become illegally appropriated by the poor. As well, real and perceived, explicit and implicit boundaries of Rupsa and Colonial sample tissues revealed that the visual and physical fragmentation of the fabric by gates, fences and walls is complemented by unseen divisions of religion, social groups, etc.

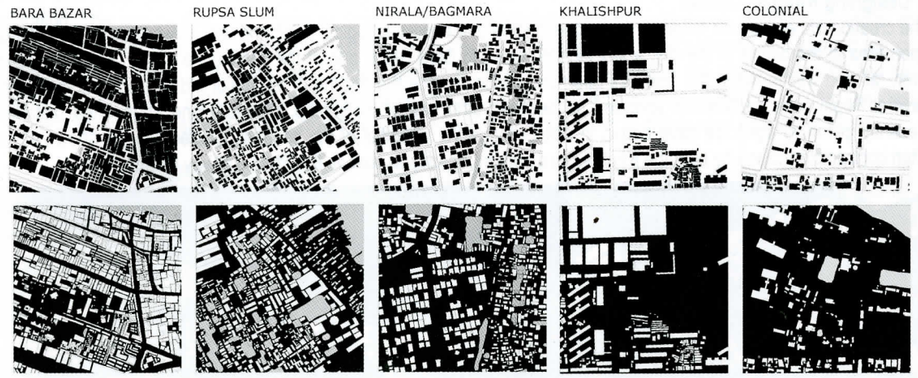

Fig. 14: Khulna's sample urban tissues: figure/ground and inverse figure/ground.

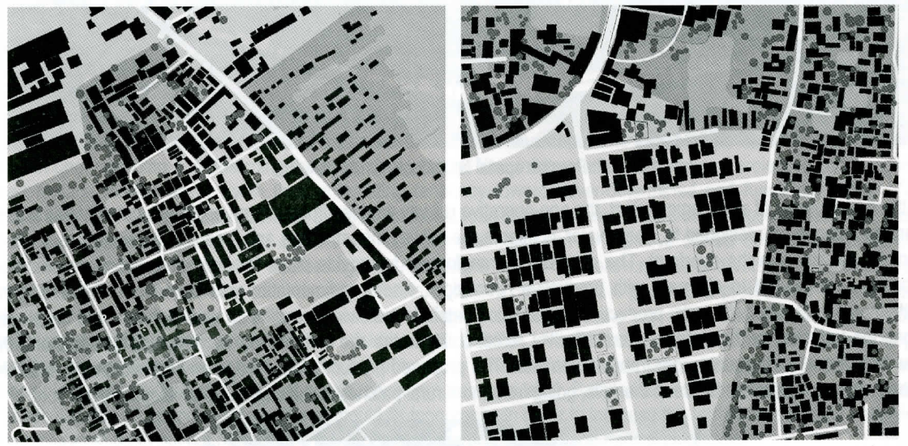

Fig. 15: Highland / lowland of Rupsa and Nirala. [Grey represents highland; blue is lowland and dark grey is water].

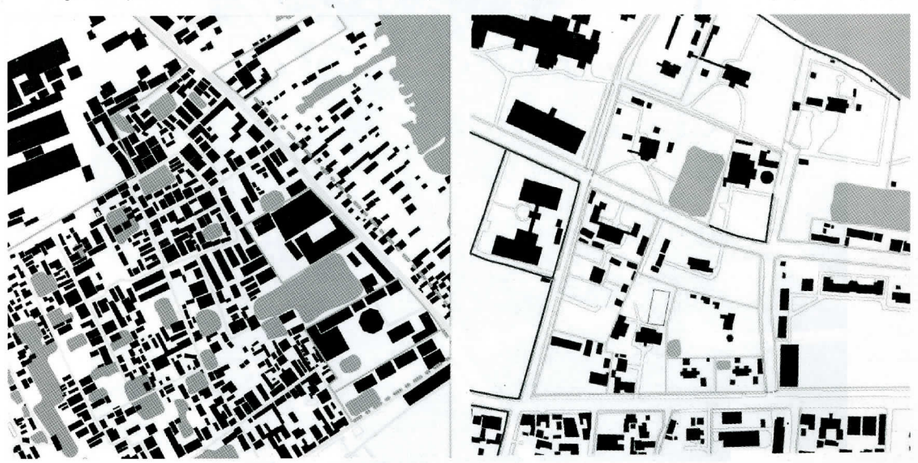

Fig. 16: Visible / invisible boundaries of Rupsa and Colonial. [Orange represents physical borders; blue is invisible boundaries]

2. Designing R-urban Tissues

The creation of new tissues followed the understanding of the existing logics. In Khulna, the railway yard is the biggest open area in the centre of the city, a key location close to Bara Bazar and at the confluence of four 'conduits': road, river, rail and waste. While the land has been underutilized since the decline of the major industries along the water, several illegal have settlements sprouted up between stretches of marshland, railtracks and abandoned factories. Recently, planning agencies have begun to acknowledge the potential of the centrally located site, as shown in the often contradictory plans by both the Khulna Development Agency as well as the State Railway Department.

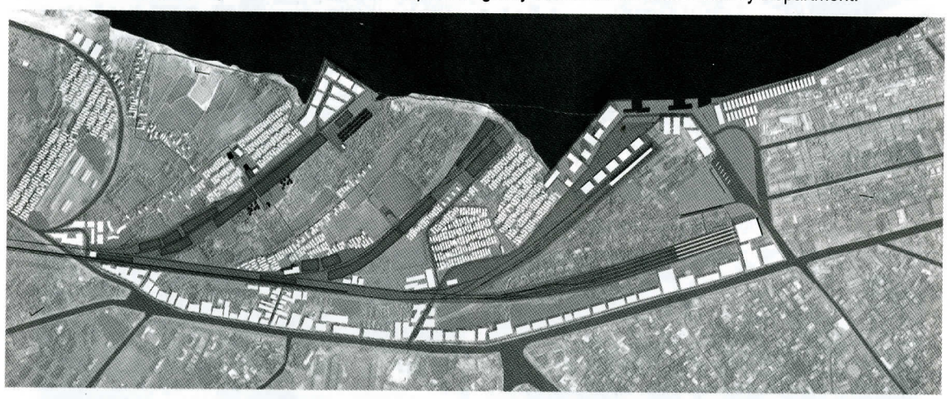

Fig. 17: Possible spatial future for Khulna's rail-yards.

In the development of a strategic project, the non-operative railway yard is turned into an operative water infrastructure. Aerated lagoons are designed to clean water, conserve the railway infrastructure and create open public areas which connect the city with the riverfront. The riverfront is transformed to provide place for new urban development. New urbanity is structured to alternate with productive river-edges where sedimentation can be caught. To service the settlements in-between the rails, productive afforestation patches and civic amenities on new high-land are developed along the trajectory of the water treatment facility. Accessibility to the site is improved via new road conduits and the new transformer of the passenger train/bus terminal. The proposed productive landscape and infrastructure guide the nature of the urbanization between the rails, going from more rural patches to the city's new development hot spot.

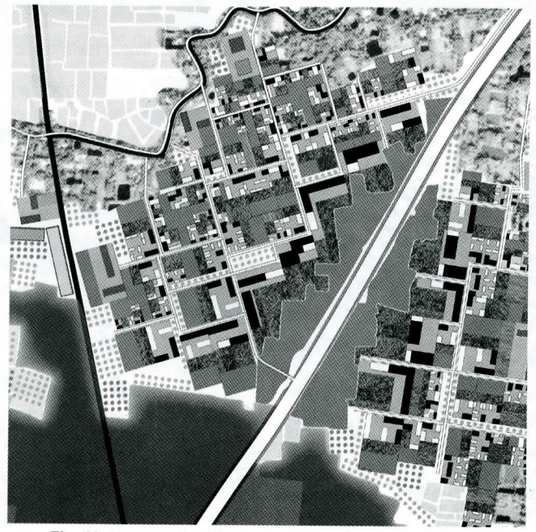

Fig. 18: Possible densification along urban periphery highway.

In the peri-urban periphery of Khulna, strategies of densification are developed in order to counter rural-urban migration. The new r-urban tissue aims to strengthen the sustainability of rural settlements along water and/or road infrastructure lines by providing social infrastructure , water purification (constructed wetlands and aerated lagoons) and public space which guides new urbanization. Water storage and irrigation systems are used to catch silt and sand, respectively to fertilize agricultural land and shape topography. By re-moulding topographic conditions, the design provides higher (safer) spaces: transformers equipped with civic amenities that re-define open spaces for water.

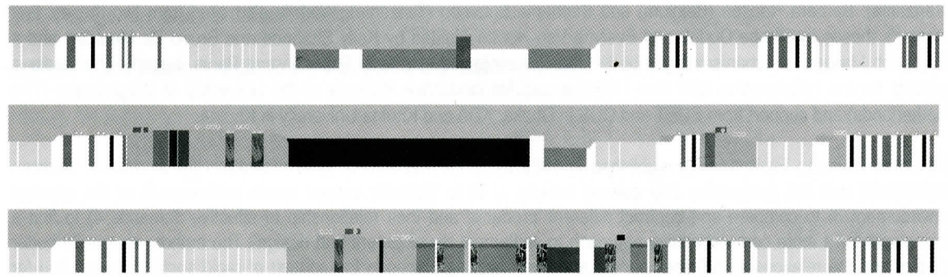

Fig. 19: Manipulation of topography as primary tool.

3. Bending, Not Breaking

The Jessore-Khulna-Mongla region's deep state of uncertainty is reflective of the larger notion of co-existence of permanence/impermanence, safe/unsafe in Bangladesh's deltaic landscape. The forces of the delta require innovative ways of understanding and designing the dynamic condition. New interpretative mapping and projective cartographies need replace master plans - with their unremitting tendency towards over-determined and functional zoning. The radical shift from a water-based towards a capital-intensive road-based urbanism need be seriously questioned. Basic sanitation remains a pressing need and the priorities of investments can be inclusive of new development sites and innovative economies, while also addressing more mundane concerns. Following an understanding of Southwest Bangladesh's interdependencies of landscape, infrastructure and urbanism, it is possible to project new relationships. Through a dynamic interplay of urban visions and strategic projects - designs can then make realistic, yet radical, amendments to the region's project mode - which in its orientation towards the liberal private market has seemingly forgotten to provide public services to the majority of its inhabitants. Design can overcome antitheses that are insolvable in non-spatial terms (political claims, social programmes, etc.). Bangladesh, in general, and the JKM region, in particular, has an opportunity to subtly re-mould its topography in order to increase the territory's resilience - allowing its structures to bend but not break in the wake of ever-more urbanization and natural calamities.

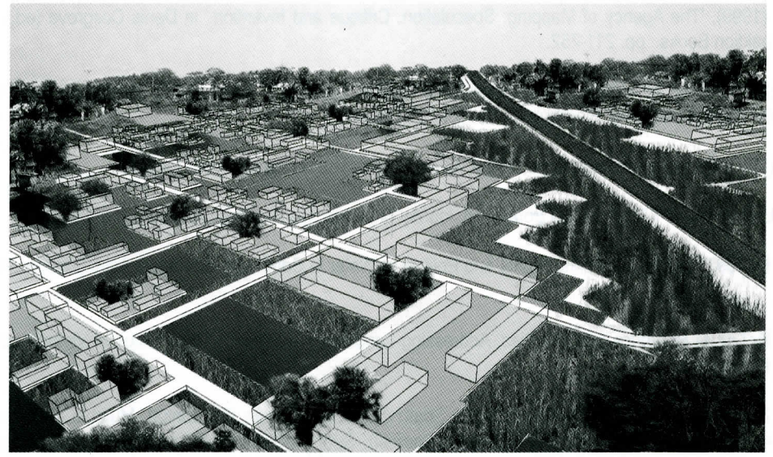

Fig. 20: A possible new (r)urbanity?

Notes

[1] All drawings / design proposals are from the KU Leuven Khulna Studio and Khulna theses projects. The studio was guided by Kelly Shannon and Ward Verbakel and with Bruno De Meulder, André Loeckx, Paola Viganò, Bernardo Secchi, Jörg Retkikke, Antje Stokman and Viviana D'Auria as jurors. Students in the course were: Sahdia Khan (Belgium), Makarand Salunke (India), Devangi Ramakrishnan (India), Tin Meylemans (Belgium), Wim Wambecq (Belgium), Karen Landuyt (Belgium) Sabina Favaro (Italy). Additional students who joined the fieldwork were: Piet Kiekens (Belgium), Anna Cornelis (Belgium), Elshima Mustafa Awad Elkarim (Sudan), Casmil Ntobangi Musobi (Tanzania), Barbara Roosen (Belgium) and Sephania Solomon (Tanzania). Work is also cited from two theses: first master's theses by Phebe Dudek and Evelyne Van Houtte (guided by Kelly Shannon and Bruno De Meulder) and a European Masters of Urbanism thesis by Sabina Favaro (guided by Kelly Shannon and Paola Viganò). The studio is grateful for the collaboration with Jörg Retkikke and his landscape students at the University of Wageningen (The Netherlands) and support from BUET and CUS in Dhaka, KDA and Khulna University in Khulna.

[2] Urban Dwelling Environments, published in 1969 by MIT Press aimed '1) to dramatize the correlation between settlements and the geographic and cultural context ... 2) to illustrate various levels and aspects of the physical environment 3) to compare and contract different 'products' and their relationship to effective demands 4) to find a framework for a more comprehensive approach to settlement development and design'. The authors sought 'to better understand the relationship between people and their dwelling places in the context of rapid social change.' And for them, 'analyses are no more than catalysts for leading questions about the relationships between socioeconomic contexts, housing demands and environmental products and no more than raw material for the formulation of hypotheses [Caminos et. Al 1969: v,vi].

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Integrating Open Space in Compact Layout: Study of a High-Density Residential Development in Hong Kong

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Abstract
In response to several urban problems such as demand of higher development density, traffic congestion, accessibility in urban core, design of compact urban layout has been adopted as a popular urban development option in many large cities. In the compact layout provision of local open space is crucial for the quality of life of the people living in extreme high-density built environment. The vertically distributed mixed land uses are accompanied with local open spaces at different levels to offer active and passive recreation, and social interaction spaces for the communities. In many instances the provision of multilevel open space-layout has been criticized for being too complex to access and to use. But whether the provision of open spaces in the overall spatial layout can itself be given some explicit description and be subjected to functional formulation is a problem which has been hardly tackled by architectural research. Using a computer-based technique known as "space syntax" this study investigates the spatial configuration of a high-density mixed use residential development to understand its relation to the patterns of open space use. Findings of the study suggest that, notwithstanding the effect of grade separated multilevel circulation spatial configuration has significant effect on the patterns of open space use in high-density compact built environment.

Keywords: Spatial Configuration, Open Space Use, Space Syntax, Hong Kong.

1.0 Introduction

Worldwide popular adoption of compact urban development has been compelled by the most pressing needs to create new urban spaces. This leads to the mixture of residential, commercial, and service facilities in the central urban areas. Such developments are generally incorporated with multilevel circulation system which is usually supported by mass transportation system like underground train. While there are many examples of successful compact development, there are examples that fail to function as predicted by the designers or the developers. In many instances, the spatial layouts are associated with some common problems such as, lack of intelligibility induced by the functional and spatial complexity of multilevel space network; and inconsistent relationship between the spatial configuration of the system and spatial distribution of multi-functional land uses.

High-density urban development of Hong Kong is most often referred to as good examples of compact development by the researchers advocating for such development pattern as the future urban design direction. In the extreme high density urban areas relatively unintelligible circulation systems characterized by mass-transit transportation system, level variation, mixed land use, and complex transition between levels make it difficult not only for the users to orient themselves to the overall spatial environment but also for the designers and planners to predict likely pattern of open space use. In many instances, the public realm is experiencing lack of communal space and over-use of public domain (Xue, et.al., 2001). Furthermore, in an extreme high-density context where most of the people are living in small flats with tight living environment, there are under-used spaces and left-over spaces evident in many areas. The local open spaces[i] appear at different levels in terms of various types of public spaces like parks, playground, neighborhood community space, children play area, seating out area, pedestrianized decks, and podium. This variety of spatial expressions induces various patterns of space use that eventually impacts upon the socio-spatial behavior of the people (Hillier, and Iida, 2005; Hiller et. al., 1989; Peponis, et al. 1989; Canter, et.al., 1975).

The compact spatial layout with communal open spaces in Hong Kong offers a fertile base for the development of an empirical knowledge-base that will help to better understand the relationship between the spatial configuration and patterns of open spaces use in compact layout. To this end, the study focuses on two important issues - firstly, how to describe the complex spatial configuration in a systematic way; and secondly, what is the impact of the configuration on the use of open spaces. It is hypothesized that in high density multilevel urban complexes the spatial configuration has significant impact on the pattern of open space use. However, previous researches suggest, efficiency of space use is also subject to several local urban design parameters like: location in relation to the transportation hub; surrounding land use; level variation; and so on (Chang and Penn, 1989; Parvin, et. al., 2006a; Parvin, et. al., 2006b). Furthermore, regarding the high density context where land uses are arranged vertically access to the spaces in upper

levels is confined to the transitional spaces. Thus this study proceeds with a sub-hypothesis that these local urban design parameters also have significant influences on the way people use the spaces. The study applies a computer-based technique known as "space syntax" for the spatial analysis of a case study area and conducts correlation analysis in order to test the research hypothesis. To analyze the effect of configuration on open space use the study involves study of both outdoor open spaces on the ground level and indoor public spaces at multilevel in a mixed-use compact residential development.

2.0 High-density Spatial Morphology and the Provision of Open Space

Hong Kong's current urban form supports the contemporary belief in the need to reduce the physical separation of activities. The basic provision of the local community with necessary commercial and GIC facilities, and open spaces favors the creation of pedestrian friendly spatial configuration. The larger development in podium-tower concept generally houses district level retail outlets i.e. large commercial-cum-residential complexes served by high speed mass transit railway (MTR) station in the podium while residential or office use in the tower. By connecting the mixed land uses at different floor plates, extending up to the surrounding areas, the space network with open spaces at different level not only becomes the vital element of the compact morphology but also a vital element in people's everyday life

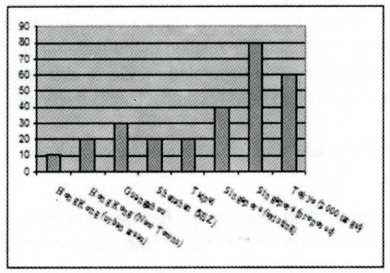

Fig. 01: Chart showing the comparison of open space provision (hectares per 100,000 people) in Hong Kong and other region in Asia. Source: Llewelyn-Davis in association with Hong Kong Productivity Council (1997).

However, the 'success' of providing housing for about half of the population in compact living environment has been achieved at tremendous costs in the form of high property price and congested living space[ii]. Compared to the other countries of the world, Hong Kong still ranks among the lowest in terms of open space provision (Figure 1). Nonetheless, researches show there are many instances of underused, deserted and leftover open spaces. Some researches found uneven distribution, inconvenient location, and poor accessibility hinder the optimum use of open space and results in surplus of open space in some areas while lack of it in others (Gilges, 1998; Coorey, and Lau, 2005; Li 1999; Law, 2000; Chang, 2000; Cheung, 2001; Liu, 2001). Gilges (1998) found, nearly three quarter of the total population are living in underserved neighborhood. Li (1999) in his study identified accessibility as an important factor contributing to the seldom (or no) use of open spaces in Wanchai. He also suggested that sometimes accessibility appears to be the only criteria for people to use open space. Law (2000) established user-friendly criteria to evaluate the open spaces in Hong Kong. Among them, accessibility is proposed as the most important one. In her study, accessibility of open space is evaluated according to users' response and perception. Chang (2000) indicated that in terms of accessibility, over 65% of the people prefer to go to the nearest green space. In terms of facilities and accessibility, the respondents' rated accessibility as more important than the provision of facilities. Liu (2001) indicated that small open spaces within urban areas should be accessible to all groups and should provide freedom for action. However, most of these studies stressed on the design qualities as major contributor to the effective use of open spaces in the context of Hong Kong, and ended up with design guidelines to be incorporated at design level. Even though accessibility has been identified as one of the key parameters, few of them investigated it in depth. Moreover, there is hardly any research that investigates the use of open space with regard to the urban layout or its spatial configuration where the open space is embedded in.

3.0 Methodology

To test the hypothesis, the study analyzes the Po Lam area, a high-density mixed use residential development that houses a multilevel commercial complex Metro City. The study applies the spatial modeling and observational techniques of the space syntax, developed by Hillier and Hanson (1984).

3.1 Space Syntax

Space syntax is a theory and a set of methods about space built on ideas which reflect both the objectivity of space and our intuitive engagement with it (Hillier, 2005). The space syntax methodology treats the built environment as a system of space analyzing them 'configurationally', and trying to bring to light their underlying patterns and structure (Hillier, 2004). The methodological key of space syntax is that it not only provides a way to describe the global structure of a built space without losing a view to its local structure, but also establishes a theoretical account that makes the social origin and consequence a part of the description (Hillier and Hanson, 1984). Central to the analysis is the concept of integration. It is a global measure that explains the relationship of each space to the space network as a whole represented by axial map. The axial map consists of the 'longest and fewest' straight lines that passes through at least one permeable threshold between two adjacent convex spaces (a convex space is one in which each point is directly visible and accessible from every other point, a piece of space always forms part of the fattest space it can)[iii]. This study also analyzes the configuration in terms of connectivity (it is the most obvious local property that represents the number of connections or intersecting lines a line has); accessibility (correlation between integration and axial depth from major surrounding routs); intelligibility (it is the degree of correlation between connectivity and integration values of each line. It depicts how connected each line is to others; i.e. how many neighbors it has intersecting it, and how integrated it is into the system as a whole); and local area effect (correlation between local (radius 3) and global integration (radius n). Local area effect represents the 'integration continuity' which means that local and global areas are spatially well embedded in a system without strong self-contained enclaves, thus the street pattern can tie different parts together in a system.

3.2 Field Observation

In Po Lam area twenty open spaces are observed to study the patterns of space use in terms of number of users and type of activities. Among the observed spaces Figure 2 shows 12 outdoor open spaces on the ground level (marked by dotted circles), rest are indoor spaces situated at different levels. The patterns of space use are recorded applying the 'static snapshot' technique. In this method both moving and stationary users are recorded in three categories of activity: sitting, standing, and playing. The data is collected by observer walking around in each space and taking mental snapshot of the activity in the afternoon between 4:00-6:00pm in three week days. To cross-check the data derived from the mental snapshot video recording (by handheld digital camera) at regular interval (5 minutes video at 20 minutes interval) is also carried out during the field observation. The data is recorded diagrammatically on large scale map of the spaces where people are represented by circles. Sitting people are noted as a circle with a line underneath; standing people are as a plain circle; and playing people are as circle with an arrow. In addition people who are talking are noted drawing circle around them. The data is expressed in terms of total number of people per space per day. During the field observation period an informal interview asking some narrowly defined questions is also conducted randomly to have an understanding on four relevant aspects - 1) the catchments of the users; 2) origin-destination pattern; 3) users status (resident or visitor); and 4) preferred spaces.

Descriptive qualitative analysis supplemented by simple correlation analysis is conducted to understand the interrelation between the configuration and the patterns of community space use. The effect of configuration is analyzed: 1) at ground level that includes spaces in Po Lam residential development on the ground level only; and 2) at multilevel that includes spaces at different levels in the Metro City commercial and residential complex situated at the middle of Po Lam. At ground level integration values are correlated with the number of users of the community spaces. In order to include the effect of the level variation different weighting is incorporated with axial integration value of the axial lines at different levels. The weighting of level variation (L) is discussed in the later part.

4.0 The Study Area

Figure 02 shows the survey map of the study area of Po Lam. The larger area marked by dotted line is the Po Lam area studied for space use at ground level and the small area marked by small dotted line is the Metro City complex studied for the public gathering spaces at multilevel. The case study area is a large residential development situated in the Po Lam district in Tsuen Kwan O New Town in Kowloon Bay. It includes public and private housing estates, open spaces, parks and GIC facilities while the Metro City (Figure 03) includes three commercial Plazas, residential towers above; and three adjacent housing estates. In terms of residential density, building density and population density the area is a High Density residential Zone (R1), with maximum domestic plot ratio of 8 and population density of around 2500 person per hectare. The land uses are systematically arranged at different levels (Figure 4) in terms of shopping complex that comprises four levels on the ground, apartment blocks start from the podium level above the shopping plazas, major government institution or community (GIC) facilities, commercial facilities. The Mass Transit Railway

(MTR) station is the focal point of the whole development with retail and public transport facilities and very high-density residential development around it.

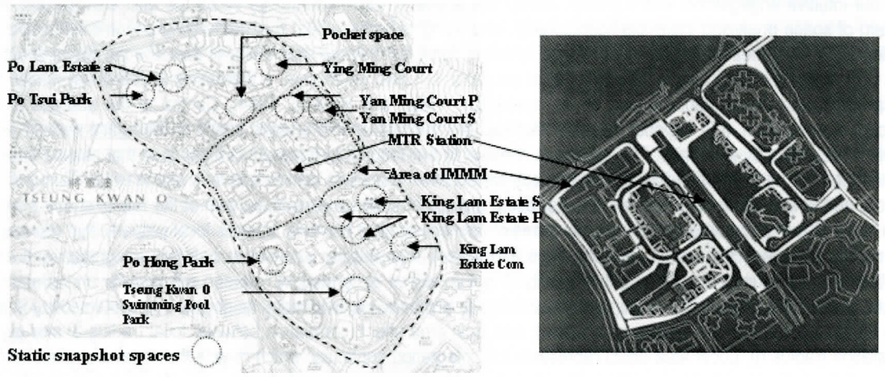

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Fig. 02: Survey map showing study area PoLam
Fig. 03: Detail plan showing public circulation spaces of the Metro City

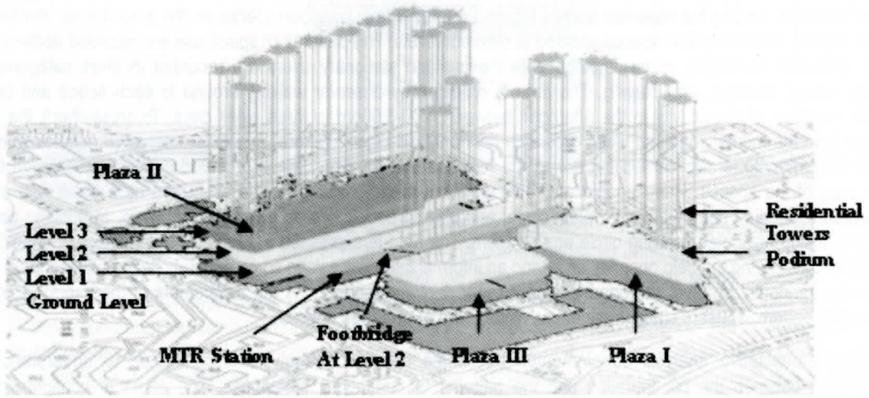


Fig. 04:. Diagrammatic representation of the Metro City multi-level complex showing land use.

4.1 Patterns of Open Space Use in Po Lam

The overall street network of the Po Lam area can be described as an irregular grid formed by main streets intersected with each other at a more or less orthogonal angle in the central part (around Metro City) with high concentration of commercial retail activities and transportation hub. Longer streets are leading from the central grid to upper (north) and lower (south) part of the grid with high concentration of mainly residential development. In the central part the open spaces are located at upper three levels connected through multilevel pedestrian circulation system, while in the residential areas open spaces are located on the ground level connected through horizontal pedestrian streets. The snapshots show that Po Hong Park is the most preferred open space (193 persons per day). In this park most of the users, mostly young adult and children, are found playing and talking. Young people are mostly playing and seem to know each other; children are found playing; and small kids are found with parents or baby sitter attending them. Second most preferred space is the small sitting out area between the government office building and the public dormitory on the Po Fung road (117 persons per day). Mostly elderly people are found here playing traditional Chinese Chess surrounded by other elderly people chatting and enjoying the game. Po Tsui Park is the third most preferred space (112 persons per day). In this park, unlike Po Hong Park, elderly people are mostly found sitting quiet and adults are found sitting and chatting; and young boys and girls are found gossiping or playing. The sitting out area in the Po

Lam estate (96 persons per day) and the King Lam estate are found to have similar users dominated mostly by the elderly and some adults. The small park adjacent to the Tseung Kwan O swimming pool (8 persons per day) and sitting out area in the Yan Ming Court (8 person per day) are found to have less users.

The multilevel spaces in the Metro City are found less preferred by the community people and found with few static users. Users in these spaces are mostly visitors. Among four levels Level Two is the most preferred one (112 persons per day) while Level One and Level Three are hardly used by the community people (average 17 persons per day). Findings from the informal interview suggest that the variation in density of users at multilevel spaces is mostly dependent on the proximity of the space to the MTR station; land-use; and location of vertical transitional spaces. However, the overall patterns suggest: 1) the outdoor open spaces are preferred to indoor commercial spaces; 2) the public parks and play grounds are used by young, adult and children coming from all the surrounding estates; 3) in the sitting out areas in the public housing estates the users are mostly elderly and women coming from the adjacent estate.

5. Configurational Analysis

Figure 5a shows the global integration pattern at radius n and Figure 5b shows the local integration pattern at radius 3 of Po Lam at ground level. The map shows values of integration in grayscale from black for the most integrated (and shallowest from all other lines on average) through to light grey for the least integrated (deepest on average). The global integration map shows the shallow integration core taking a form of incomplete grid. This grid-like core however does not extend deep into the surrounding areas, leaving most of the peripheral residential areas as rather segregated zones. It clearly shows the main structure of integration lines in which spaces along the MTR Station and commercial Plazas are picked up as the main focus of integration in the area.

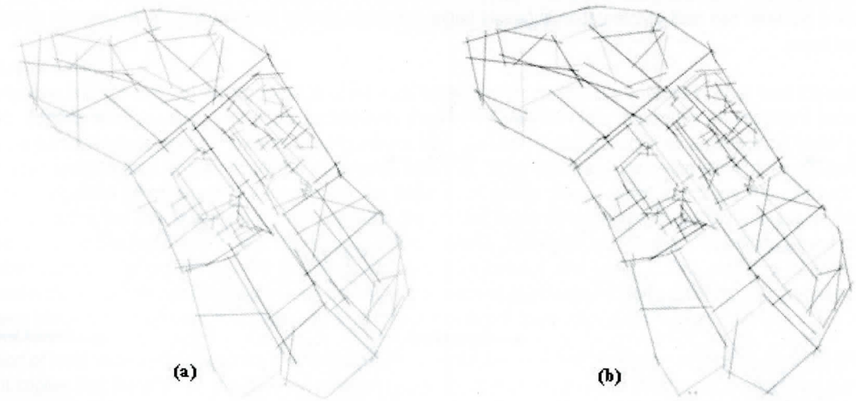
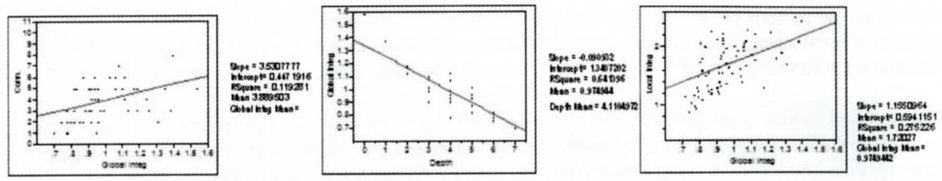


Fig. 05: Global integration map of Po Lam (a); and Local integration map of Po Lam (b) at ground level

The local integration map shows the whole system is better integrated compare to the global one where spaces in the public residential estates form the most integrated core. The integration core shifts from the space around MTR Station and commercial Plazas towards the spaces around the public housing estates. It forms a linear "tree" structure extends across the housing estates through number of secondary streets branched out from the "trunk" that passes through the main streets.

The scattergrams in Figure 6(a) plot integration against axial depth at global level in which lines within the study area are shown as small black points. The scatters (Figure 6a) show that Po Lam area has very good accessibility (r2=0.64). It implies, for the most part it has better visibility and takes only about 3 to 5 steps from the most integrated areas i.e. the MTR Station and the commercial areas. Only the peripheral spaces and some areas in the private housing estates occupy the deepest spaces with lower integration (in the lower part) indicating that at a given depth they are more segregated spaces.



6a

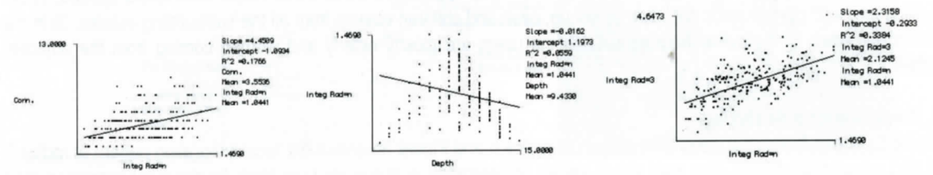
Fig. 6a: Accessibility of Po Lam.

6b

Fig. 6b: Intelligibility of Po Lam.

6c

Fig. 6c: Local Area Effect.



7a

Fig. 7a: Accessibility of Metro City.

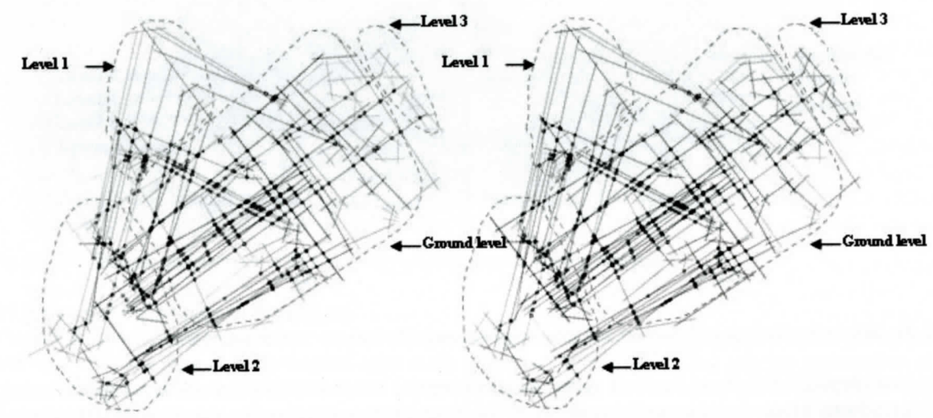
7b

Fig. 7b: Intelligibility of Metro City.

7c

Fig. 7c: Local Area Effect of Metro City.

But scatters in Figure 6(b) shows it is less intelligible (r2=0.12) due to lack of connectivity of the well integrated spaces. This is because of the concentration of the global integration core around the commercial area which has few direct connections to the cluster of streets embedded in the surrounding housing estates. However figure 6(c) shows a strong relationship between local and global integration (r2=0.59). Despite low intelligibility, the high degree of coincidence or overlapping between two radii of integration suggests better interfaces among the main streets and branch streets in functional terms.



8a 8b

Fig. 08: Global integration map of the Metro City (a); and Local integration map of Metro City (b).

Figure 8a and 8b show the global and local axial integration maps of the Metro City where different levels are presented side by side and connected by axial lines that represent the vertical transitional spaces. The global integration map (Figure 8a) clearly shows the main structure of integration in which Mau Yip road and part of Po Fung road at ground level; and at level 2 space connecting the MTR station to Plaza II and the major circulation spine including the atrium space of Plaza II are picked up as the main focus of integration in the area. Level 1 and 3 appear relatively segregated. The system shows a moderate local global correlation. In terms of connectivity, only the major circulation spine of Plaza II at Level Two becomes the most significant one. Regarding control, similar pattern follows.

Apparently it suggests that the composite system that includes all the levels is more integrated globally but a lack of connectivity suggests an unintelligible structure. At local level the integration core shifts to the Yan King road at ground level; and footbridge connecting the MTR Station to Plaza II; and major circulation spine of Plaza II. Locally Level One and Level Two appear to be better integrated. As a whole the complex is found to have better accessibility and intelligibility at local level. Scattergrams in Figure 7(a) plot integration against depth at radius n that shows a poor accessibility. The system also appears to be less intelligible in Figure 7(b). Figure 7(c) shows a weak relationship between the local and global integration. This poor relationship between two radii of integration suggests a broken relationship of interfaces with consequences for the movement economy that leads the movement to a pure origin destination movement pattern (Hillier, 1996, p. 178). Spatial modeling of the whole system that analyzes the multilevel spaces of Metro City together with its surrounding Po Lam area at ground level in one composite axial map shows similar trends as found while analyzed separately.

5.1 Impact of Configuration on Open Space Use

For Ground Level

In Po Lam, for the spaces on ground level, the correlation analysis between the global integration and the density of open space use (Figure 9a) reveals a moderate correlation coefficient (r^2=0.26). From the conventional statistical point of view the correlation (r^2=0.26) appears to be "insignificant", however, with regard to the sub-hypothesis about the key urban design parameters to have strong influence on the way people use the spaces, the apparent low statistical value (r^2=0.26) of correlation between the configurational property alone and density of open space use is considered to be significant. Furthermore, taking the configurational properties alone, findings of this study and other previous studies (Cheung and Penn, 1989; Parvin, et. al., 2006a; Parvin, et. al., 2006b) found statistical values of the correlation coefficients fall within the range of 0.18 to 0.30. Thus the effect of local integration is also found moderately significant with a correlation coefficient of r^2=0.25 (Figure 9b). Correlating with the depth (r^2=0.26) and connectivity (r^2=0.23) it is found that depth has greater effect on the density of users than connectivity. Based on these initial findings for ground level this study partially tested the sub-hypothesis for multiple levels in the following section.

For Multiple Level

The interview findings suggest the significance of the local urban design parameters such as in what level the space is located, i.e. the level variation; and direct accessibility from MTR and from their residence as important factors to choose a particular open space. However, among others, level variation was mentioned as an important factor to opt for an open space to use for their every day community activities. Since the spatial modeling alone does not consider the effects of other urban design parameters on the patterns of space use, in order to include the effect of level variation (most of the interviewees preferred space on the ground level) on open space use the integration value is approximated by dividing it with a value derived for different levels. The value is objectively quantified based on the field observation (1 for ground level; 2 for Level Two; and 4 for Level 1 and Level 3) and attributed to each axial segment in the multilevel complex. The values are set on the basis of knowledge of the occupancy; and preferences of the users (derived from informal interview) regarding the ease of direct connection to the MTR station.

Inclusion of level values with the spatial properties results in a highly significant correlation coefficient (r^2=0.69) (Figure 10a). It implies that the effect of configuration on open space use at multi-level layout becomes stronger when the level variation is taken into consideration. The local integration is found to have even higher effect (r^2=0.81) on the density of space use. Analyzing the correlating between density of users with depth (r^2=0.04) and connectivity (r^2=0.54) it is found that depth of multilevel spaces is not important at all to the users while connectivity is found to have significant impact.

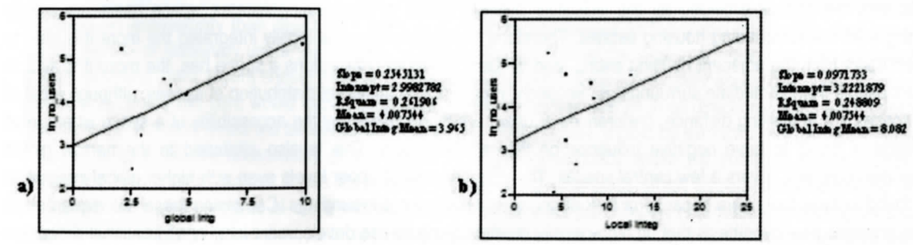


Fig. 09: Result of Space Syntax Analysis of Po Lam at Ground Level, global (a); and local (b).

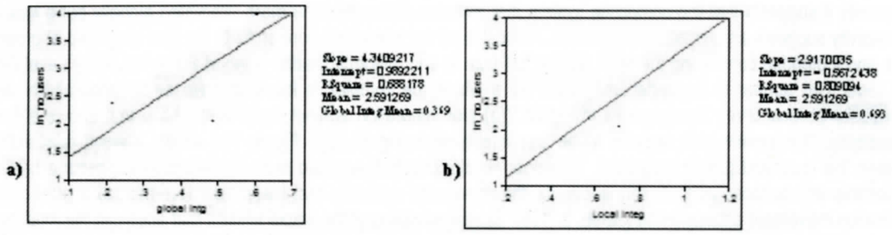


Fig. 10: Result of Space Syntax Analysis of Metro City at multilevel, global (a); and local (b).

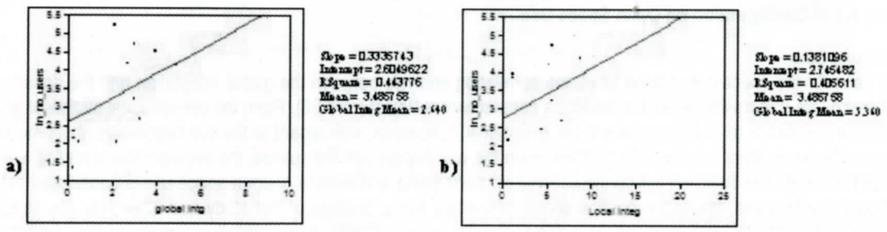


Fig. 11: Result of Space Syntax Analysis of Po Lam at multilevel, global (a); and local (b).

For the composite system of Po Lam residential development that includes both open spaces on the ground level and at multilevel, the correlation analysis shows the effects of both global integration (r^2=0.41) (Figure 11a) and local integration (r^2=0.44) are moderately significant. However, local integration is found to have stronger effects than that of global integration. Correlation analysis with depth (r^2=0.35) and connectivity (r^2=0.36) reveals similar trends where connectivity is found to have slightly higher effects on the density of users in the composite system.

From the above findings it is observed that, as a whole, in the composite system, (1) local spatial properties have greater effects on the density of open space use; and (2) spaces on the ground level have more users compare to the spaces on the upper levels. It is particularly evident when the multilevel complex of Metro City is observed. The findings imply two different but interrelated explanations. Firstly, from syntactic point of view, the global spatial properties represent spatial configuration with regard to all the spaces in the system and calculates integration regarding the most integrated global core (here around the MTR Station and commercial Plazas) while local spatial properties include individual constituent parts of the system and calculates integration regarding the immediate or neighboring spaces. Comparing the patterns of open space use and the local integration core it is found that from the most integrated local spaces the axial depth of the open spaces is between one to two steps. Similarly, regarding most obvious local property connectivity, the spaces with better connectivity are found to have higher number of users. Therefore, to explain space use at constituent parts i.e. the local open spaces, local configurational properties appear to be more effective. This proposition is substantiated by the field observation that reveals most of the open spaces, particularly the spaces provided for the individual housing estate or surrounding estates, space users are mostly coming from the surrounding housing estates. Therefore, the more a space is locally integrated the more it is able to attract users from the adjacent housing estate, and similarly the more connections a space has, the more it is able to attract people from immediate surroundings. Secondly, regarding the multilevel distribution of spaces, although most of the spaces are at walking distance, preferences of users are highly biased by the accessibility of a space where level variation is found to have negative influence on the resident users. This is also attributed to the narrow global integration core that covers a few central spaces. Therefore, spaces at upper levels even with higher global integration are found to have few users because of lack of connectivity with the surroundings. Combining these two explanations there emerges new hypothesis that, in high-density residential mixed use development local configurational properties can explain substantial amount of variation in the patterns of community space use.

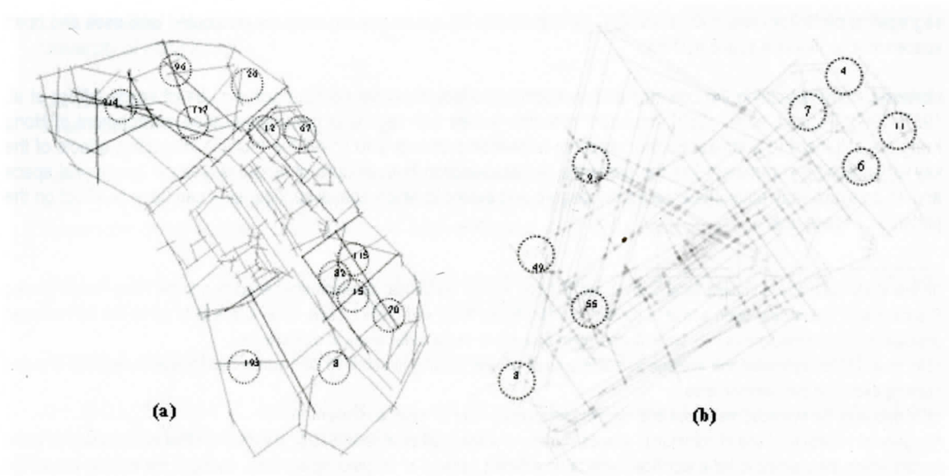


Fig. 12: Density of space use on 10% Local Integration core of Po Lam (a); and Density of space use on 10% Local Integration core of Metro City.

In light of this new hypothesis, distribution of user density is plotted against ten percent local integration core for Po Lam and Metro City shown in Figure 12(a) and 12(b) respectively. Figure 12 (a) reveals, out of four spaces with highest number of users three are concentrated on the street spaces covered by the local integration core, while the fourth one is just one step from the core. The most segregated spaces are mostly found with minimum number of users. Similar trend follows in the use patterns of multilevel spaces in Metro City 12 (b). As mentioned earlier, due to the poor connectivity the spaces at upper levels are found with less resident users and more visitors. This might be attributed to the higher concentration of commercial land use in the upper levels. However, notwithstanding the land use variable and level variation, distribution of user density reveals clear influence of spatial configuration particularly in terms of accessibility and intelligibility of the spaces.

6.0 Discussion and Conclusion

The study outcome is twofold; firstly, the case study reported here shows that the configurational analysis offers one possibility to research into dense urban environment whose spatial form would otherwise escape conventional representation. Regarding the use of open spaces on ground level, syntactic modeling alone is found to explain moderate amount of variability, while regarding the use of multilevel spaces, notwithstanding the effects of urban design variable like MTR, land-use or level variation, spatial configuration is found to have significant[iv] impacts on the pattern of open space use. Secondly, regarding the elements of spatial analysis themselves, the study outcome suggests, in analyzing high-density residential configuration local properties are more important. In light of the finding from this study some strategic design guidelines can be drawn towards the optimal use of open spaces in high-density compact built environment. First, the location of public open spaces should be on the ground level and connected by pedestrian circulation spaces characterized by well integrated local core, and continuity rather than fragmentation and discontinuity. Second, according to the activity patterns, spaces should be laid out in terms of hierarchy with greater emphasis on accessibility than depth. A larger open space well connected to the global integration core can render greater density of stationary users. By contrast, a smaller space linked to the local integration core can render smaller amount of users. Third, layout should have a syntactic core that represents more easily accessible open spaces within a system. A centralized core would allow individuals to traverse central spaces in all directions. Thus each constituent open space at different levels will be integrated in a system. Fourth, there should be syntactic shallowness in the whole layout to ensure relative accessibility of one space from any other space within the complex and to provide less segregated environment overall. It can be provided by designing continuous street layouts characterized by relative intelligibility throughout instead of disconnected enclosure or cul-de-sacs. Finally, and most importantly, continuity of integration should be preserved so as to achieve more vital urban environment by creating better interface between global and local areas. Continuous circulation would allow individual parts to aggregate into a whole without

segregating parts from one another even at various levels. Thus it can tie the vertically distributed land uses and open spaces in a continuous space system.

However, notwithstanding the powerful and independent effect of spatial configuration on use of space (Hillier et al, 1987; 1993; Peponis et al, 1989), important research issues with regard to the unique urban environment of Hong Kong are still there to address. Further research is needed particularly to unveil the multiple interacting effects of the key urban design parameters like the presence of transportation hub, mixture of land-use, vertical transitional space and so on which may have influence on the degree and extent to which spatial configuration can have its effect on the patterns of space use.

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[i] In this study open space implies 'local open space' in Hong Kong's residential developments. According to the Hong Kong Planning Standard and Guidelines, open space is divided into two types: local and district. Local open space is to serve the concentrated population in the immediate vicinity, while district open space is to serve wider areas at district level.

[ii] Liu, e. al. (1999) estimated the average saleable area of private housing is about 15.6m^2, which becomes even reduced in public housing excluding the common area.

[iii] For details of the syntactic measures and mapping techniques refer to Hillier & Hanson, 1984.

[iv] In general variability of use of community spaces in many of these studies is described by a variety of other non-spatial and social factors which are claimed to have significant effects on different patterns of neighboring activities. Owing to the existing knowledge on the higher significance of other social and non-spatial factors, although the correlation coefficients found in this study appear moderate statistically, with regards to the independent effect of spatial configuration on use of space (Hillier et al, 1987; 1993; Peponis et al, 1989) the correlations are considered to be highly significant.

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Towards Sustainable Rural Development: an Investigation on Clay based Materials, their Appropriateness and Potential.

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Abstract
Building material always plays an important role in the generation of form and character in architecture, which varies from region to region depending on locally available material. In this climatic domain, mud houses are typical and hold an important part of our traditional shelter. Being a delta, the land of Bangladesh is a renewable source for raw material of clay based products like mud wall and clay tiles. These materials are also linked to the roots to the culture and philosophy of the rural people. Due to the advent of the industrially produced and imported building materials, like CI sheet, these traditional building materials have almost disappeared in different areas of Bangladesh. Research and conservation are needed to ensure that the country does not loose the benefit of traditional construction, materials and systems in the course of enduring modernization. Some recent attempts of constructing buildings with clay in order to achieve a sustainable development by utilizing local technique and local resources gives us an opportunity to rethink the issue more seriously. This paper reviews the traditional materials - the mud wall and clay roof tiles, their potential use and technical aspects. The objective of the paper is basically a reappraisal of indigenous building material in architecture of Bangladesh in order to find a way to reestablish the traditional building materials, specially mud wall and clay roof tiles, in the context. Through the investigation, it is found out that like other materials these traditional building materials would prove as potential building materials in our contemporary vernacular architecture and thus once popular material - mud wall and clay roof tiles - could be revived in more innovative ways as a sustainable building material.

Key words: Indigenous Material, Sustainable Development, Mud Construction, Clay Roof Tiles, Local Technique, Low-cost.

1.0 Introduction

In the present context of climate change, energy crisis and global economic recession, planning for sustainable future is becoming a world-wide concern. In Bangladesh, where the severe impact of climate change is inevitable and energy crisis reaches at its peak during the last few years, it is necessary to develop appropriate strategies for sustainable future. According to the World Commission on Environment and Development the term 'Sustainability' refers to meet the needs of the present without compromising the ability of future generations to meet their own needs. The definition expresses a generalized concept of sustainability which has actually three different dimensions i.e. environmental, social and economical. In order to get a sustainable solution it is necessary to integrate these three different dimensions while creating a balance between the need and available resources. But the supply of non renewable resources (oil, gas, coal) is limited. So emphasis should be laid over renewable natural resources considering its availability and use. Since the rural areas are the major repository for our natural resources providing food and raw materials for shelter, the priority should be given to the sustainable use of these resources. In this regard, towards sustainable rural developments, local building materials like mud wall and clay roofing tiles can play a vital role.

Sustainable rural development is largely associated with the sustainability in rural architecture. The rural architecture of Bangladesh has distinct characteristics regarding planning, use of materials and location. For centuries, rural

architecture has been using locally available natural building materials. It is only from the late nineteenth century that rural architecture began to change both structurally and in the use of housing materials. (Banglapedia, 2003). The traditional and more natural building materials are now gradually being replaced by factory made, imported building materials like CI sheet, cement, steel, plastics etc. that are often liable for the degradation of the quality of built environment, limiting the use of local technology and manpower and thus influence the rural environment and economy. These universal materials are often insensitive to culture, customs and values of the rural society. Again the productions of these materials are more energy intensive and also responsible for the emission of green house gases. Here the paper delineates the pros and cons of local building material with special emphasis on mud and clay based products and their use in rural architecture. The paper also tries to outline the strategies and the traditional and technical means of improving the scenario with an aim to get a sustainable solution. However this sustainability is essentially context specific which encompasses environmental as well as socio economic sustainability.

The main objective of the study is the reappraisal of indigenous building materials. The paper tries to study traditional building materials specially mud and clay based products. It also tries to identify the reason behind its failure and to find out its potential use. In addition, it also aims to give a direction for the development of local building material industry by utilizing local resources and techniques. The scope of the paper is limited in exploring the present condition, technical problems and giving direction to solve the problem.

A reconnaissance survey with photographic and observational study was undertaken to know present condition and the use of mud and clay based materials. Field survey in different areas of Gazipur, Dinazpur and Shatkhira etc. regions of Bangladesh was conducted in 2006. Available relevant literature has also been reviewed. Unstructured interviews have been conducted on local experts and users for having a clear perception of character, maintenance and preservation of mud structures and clay tiles.

2.0 An overview on rural housing and building materials

About 76% people of Bangladesh live in rural settlements and 77% of dwelling units are located in rural areas (BBS, 2003). A large portion of rural housing is still dependent on locally - available building materials. For instance, in Bangladesh out of 14.8 million households, 3.7 million (or about 25%) used bricks (fired and unfired) as wall material, while 9.4 million (or about 63%) used bamboo and natural fibers such as straw, jute sticks, etc. (SDC/SKAT,1991). A survey conducted by World Bank (1998) shows that about 52% of roofs of rural houses are built of natural materials which include thatch, leaf etc.

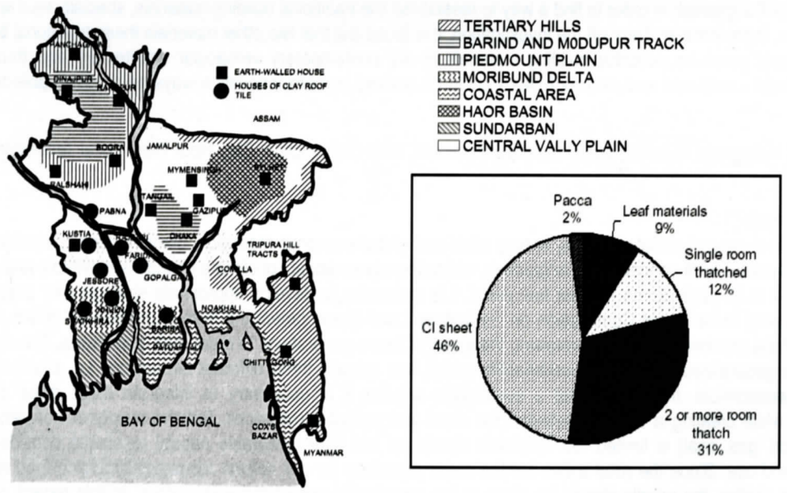

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Fig. 01: Map of Bangladesh showing different areas where mud construction and clay roof tiles are used as chief building material. (Source : Field work data adapted with the map of Banglapedia, 2003)

Fig. 02: Roofing material used in Bangladesh (World Bank-BCAS, 1998)

Unfortunately these traditional and more natural building materials are now gradually being replaced by the materials with high embodied energy like steel, plastic, concrete etc which are more dependent on high technology. Again in terms of environmental performance these materials often perform poorer than many other local building materials like mud and clay based materials. Besides the production of C.I sheet, brick, cement, plastic etc is more energy intensive and quite expensive. For example, the energy required for producing brick and CI sheet is much higher than mud block and clay roof tiles. The brick industries in Bangladesh consume high level of energy and are accountable for consuming 25.6% of Bangladesh's natural resources (Miah and Alam, 2002). The production process of brick and CI sheet is also often associated with air pollution (FAO, 1993). Again the thermal disadvantages of CI sheet is a serious problem especially in a hot humid climate like Bangladesh as CI sheet heat up very fast. (Ahmed, 1994).

On the other hand the traditional materials like mud wall and fired clay tiles have great potentiality in this regard. They are more environment friendly and energy efficient. The thermal performance of mud wall and clay roof tiles are quiet acceptable. The mud wall provides necessary balance between the exterior and interior temperature. (Ahmed,1994). Moreover the exploitation of the raw materials used for the production of clay roof tiles often requires very little energy as most of the processes are manual.

The use and choice of these materials largely influenced by the suitability and local availability of resources and may show regional variations due to climatic and geological conditions. For instance, most of the north western part of the country (Bogra, Rajshahi, Rangpur , Dinajpur) and the area at north of Dhaka (Mymensingh, Tangail, Modhupur, Gazipur) are located at a higher elevation and greater distance from the coastal area which is comparatively less flood prone, therefore dry and suitable for mud construction. So, the mud structures are prevalent in these regions. Again not all types of soil can be used successfully for mud construction. The best natural soil for mud construction is a mixture of Argillaceous and Silicious. The pure Argillaceous clay causes shrinking and cracking of the earth walls when dry. Mud walls constructed by pure Silicious clay might not be held up even during construction. Therefore the mixture of Argillaceous and sandy clay is suitable for making mud structures. (Wolfskill, 1963) Similarly clay tiles are used as roofing materials in the areas of dry climate (Part of Khulna- Shatkhira, Jessore, Pabna, Pirojpur, Borisal, Faridpur, Bagerhat) where soil with lateritic quality is available.

Mud house and clay roof tiles have some causes of failure in their continuous use. Use of natural building material is essentially context specific which largely depends on the suitability and availability of resources and limited to only low rise construction due to its low tensile property. There is no doubt that they are not as permanent as houses made of concrete or brick. Application of mud and clay based materials is also limited to address the growing demand of housing in urban areas. So in terms of land economy, use of these materials may not be feasible. Moreover in disaster prone region (against flood, cyclone, and earthquake) these materials are subject to rapid climatic decline. Criticism against its durability, frequency of maintenance can easily be overcome with innovation and intervention of these materials. In this connection Bangladesh House Building Research Institute (HBRI) and Bangladesh University of Engineering and Technology (BUET) have conducted useful research works for the improvement of these materials. Another reason of failure in the continuous use of mud is, unlike CI sheet, mud houses do not have resale value although clay roof tiles have trade benefits.

Although mud houses and clay roof tiles have some limitations, still reappraisal of these building materials is needed to maximize the social and environmental benefits, minimize the reliance of non renewable natural resources, safeguard the most valued natural and cultural assets and contribute positively to local economic development. Mud and clay based products are still one of the most viable building materials predominantly for the poor who remain on the side lines of money-economy. Moreover the most popular materials such as brick, CI sheet with high embodied energy have severe consequences on the global warming. Again the cost of building materials is increasing day by day. In order to get a sustainable rural development a reappraisal of the traditional building material i.e. mud wall and clay roof tiles is needed on various levels.

3.0 Use of mud wall and clay roofing tiles in vernacular architecture

Mud wall and clay roofing tiles are important building materials in vernacular architecture. They are readily available and low cost, and with these there are well developed vernacular building forms existing in rural Bangladesh. Mud houses have some specific characteristics in vernacular architecture. They are briefly described below. (Fig.3)

Plinth / Base : Raised plinth is a characteristic feature of the mud houses. It is used to provide protection against flood and to prevent the insect, animal population and it can take better advantages of wind flow as well. Generally the plinth varies from a height of 15 cm in higher areas to 120 cm in low-lying areas (Banglapedia, 2003).

Wall: Walls of the mud houses are usually made of mud blocks or combination of thatch and mud. One of the advantages of mud walls is that it keeps the interior space warm in winter and cool in summer (Koenigsberger, 1975). Openings of the mud houses are usually kept minimal and small to reduce glare as well as to prevent rainwater from entering the room (Banglapedia, 2003).

Roof: Broad overhang is used in order to provide shade to the verandah and give protection against rains. In vernacular architecture mainly straw, thatch, C.I. sheet etc are used as the roofing material. Besides clay roof tiles are also used as one of the chief roofing material because of its permanent nature compared to other traditional roofing materials.

Three case studies from different areas of Gazipur, Dinazpur and Shatkhira districts (see locations in Fig.1) are presented here to discuss the type and construction technique of mud houses and clay roof tiles. Present condition of the local industry and current uses were studied by field survey. Positive and negative sides of the material were investigated by interviewing the users and experts.

3.1 Mud-walled houses in Dinajpur and Gazipur

Like major part of the country the economy of this region is also agro-based and large part of its dwelling unit is still dependent on natural and organic material like mud, jute stick, and bamboo for wall construction. Majority of the mud houses are located in these regions. There are also some examples of multistoried mud houses. Even it has been observed that the more affluent section of local population is still using and up-grading mud structures.

In Dinajpur, mud walls are constructed by both layering and earth block technique but in Gazipur earth block technique is more popular. The soil required for the construction is usually collected by digging a pond or irrigation canal.

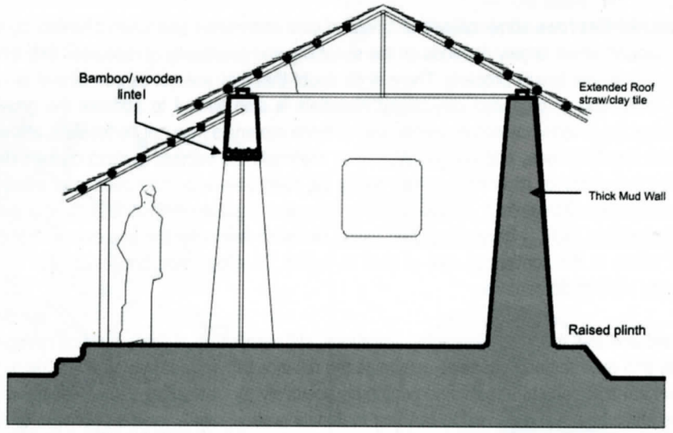

Fig. 03: Section of a traditional mud house showing its different parts

Construction in layering technique

In layering technique, a raised compacted earth plinth is prepared at first, and then mud walls built on plinth in strata of 40-50 cm. Mud walls are usually reinforced with straw or rice husk. The wet mud is mixed with straw with the help of cows and buffalo. After drying of each stratum next layer is added. At the time the earth walls are erected in layers, openings for doors and windows are retained. Traditionally wooden lintels are used in the openings but these days pre-cast concrete lintels are replacing them. Roof and verandah structures are added at the last phase. A layer of mud slurry with cow dung is then applied as a finish to fill the gaps in the mud wall. Usually it takes 50-60 days to complete

a single room dwelling unit under favorable site conditions and weather. Generally the major construction works in layering technique are carried out during dry seasons of a year.

Construction with earth blocks

Large earth blocks are made and lifted into the places; and are laid in successive layers. Block in successive layers are placed after sufficient drying of the previous layers. Vertically a gap is kept between two blocks. This gap prevents shrinkage and cracks. It also admits the wind to pass through its depth which results in fast and uniform drying of earth blocks. As the earth dries and shrinks, the gaps become larger which is finally filled with mud mortar for achieving a smooth and finished surface.

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Fig. 04: Mud house in Rudrapur, Dinajpur constructed with layering technique
Fig. 05: Mud wall construction in block technique.
Fig. 06: Mud house in Dokkhin Salna, Gazipur constructed with earth block technique.

3.2 Clay roofing tiles of Shatkhira

After the partition of India much of the art of clay tiles production have disappeared from major parts of Bangladesh. (Ahmed, 1994) Some examples of vernacular clay roofing tiles are still prevalent in the south and south western part of Bangladesh like Shatkhira, Jessore, Pabna, Pirojpur, Barisal, Faridpur etc. The information that is collected from Shatkhira on the types, construction process and installation of clay roofing tiles are presented here.

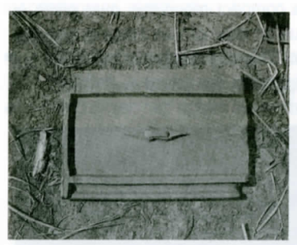

Fig. 07: Flat tile

Fig. 08: Ridge tile

Fig. 09: Barrel tiles

Roofing tiles produced in local industry of Shatkhira can be differentiated by its shape, use and chemical composition. These include flat tiles, barrel tiles, ridge tiles etc. The flat tile is the simplest type, which is laid in regular overlapping rows. The avalilable sizes are 25cm x 40cm, 20cm x 28cm, 28cm x 43cm. Each tile has a profile to allow interlocking and to protect sliding and a built-in channel to drain the water. Mission or barrel tile is a semi-cylindrical tile made by forming clay around a log and laid in alternating columns of convex and concave tiles. There are also roof tiles for special positions, particularly where the planes of the several pitches meet. They include ridge, hip and valley tiles .

In construction process at first manufacturers collect soil from nearby agricultural land. The soil is kept open to sky. Average sized industries employ one or two people to prepare the soil. A whole day is needed to compact the amount of soil to make 3000-4000 tiles. Water is mixed with the soil and compacted with 'leg-pressing'. Compacted soil is used to make slices of soil with the help of wooden frame. The slices are then laid in forma/dice and led into the pressing machine. It's a hand-operated machine that uses the mechanical advantages of a large threaded shaft which is rotated by a lever and creates a downward uniform pressure on the dice. Finally tile of desired shape comes out of the dice. It is then dried in the sun for a day or two. Before burning in 'skove kiln' a single coat of color (mixture of pitch khoir and powder of red soil) is applied. Inside the kiln, the tiles are arranged in rows and firewood is placed in between. It

ensures equal distribution of heat. Continuous burning at approximately average 900°C (initial temperature-800°C, maximum temperature-1300°C) temperature is necessary for two to three days for desired result. (Singh, 2004).

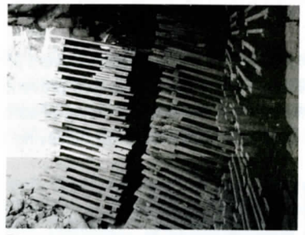
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Fig. 10: Wooden tray used to dry the soft tiles in sun before burning in kiln.
Fig. 11: Pressing machine to produce tiles from forma.
Fig. 12: Stacked tiles are ready to sale.

In the installation process roof tiles are arranged on the framework one by one, starting from the bottom end of sloped roof. Each upper row overlaps the immediate lower one. Every row is shifted horizontally 'half-tile' distance from adjacent rows. In most cases tiles are laid freely on the framework. In few areas holes are made in the tiles and tiles are attached to frame with nails. Sometimes little mortar is applied at overlapping portion and into the holes also. Generally an angle of 30° is maintained with the horizontal line. In Bangladesh, small-scale tile industries have limited production capability. The production is not possible all the year round due to un-favorable weather conditions during the rainy season (June to September). In rainy season they face problems to keep firewood dry and burning in the kiln.

4.0 Traditional and technical approach to solve the limitations

Several limitations of mud walled houses and clay roofing tiles are found from the above case studies which are discussed below:

- Dampness is one of the major problems for mud structure. The mud floor admits moisture rising from the ground making it wet and thus makes the mud plinth extremely vulnerable. Again compact monolithic mud plinth is sometimes not enough to withstand the intensity of flood. Addressing this issue an attempt was taken to stabilize the typical mud plinth by mixing of cement and using fired brick in foundation. This might improve the result but complete stabilized mud plinth is more expensive and harder to construct compared to the typical mud plinth.


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Fig. 13: The moisture rising from the ground make the earthen wall wet.
Fig. 14: Traditional mud houses erode as natural forces strike.
Fig. 15: Cracks develop as clay shrinks during its drying period.

- The intense, heavy rains are likely to erode the bases and surfaces of mud walls. In the regions with heavy rainfall and flood, the rural people build their mud houses with bamboo or wooden framework inside the earthen wall. So, even if the earth cover is washed away, the building remains stable and can be repaired. Some traditional solutions against the rain are construction of large overhanging roofs and use of verandahs around the house. Moreover, application of a coat of bitumen on the mud surface is also observed. Besides, a mixture of equal amount of kerosene and asphalt at a rate of 740 grams per sq.m onto the mud surface provides optimal stabilization. Again regular re-application of coats of mud slurry mixed with cow dung, painting with lime can protect surfaces and enable mud structures to last.


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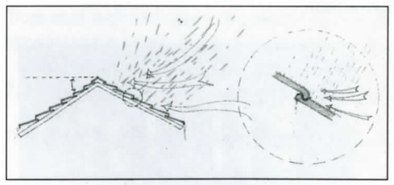
Fig. 16: Large overhang is used to protect the mud wall.
Fig. 17: Verandah around the house is provided to protect the wall from rain.
Fig. 18: Bitumen coat over mud surface.

- Cracks develop as clayey soil shrinks during its drying period. Fewer cracks may develop by using less amount of water in the preparation of mud and by adding rice husk or chopped straw - the fiber will reduce the cracks and strengthen the mud. (Siraj and Ahmed, 2004).

- Another problem in mud houses is lack of ventilation. Traditional mud houses usually have small sized and less number of openings which result poor lighting condition and ventilation inside the dwelling, The superstitious belief of the rural people to keep small openings is more responsible rather than structural limitation of mud wall. This situation can easily be solved by cutting out an opening in the rear wall which will ensure the cross-ventilation. (Siraj and Hodhson, 2004). Ventilation is much better for houses which are constructed partly with mud and partly with bamboo screen. In this type of house the plinth and lower part of the wall up to the door level are constructed with mud while the upper part is left to cover with bamboo mat. The porous screen of the bamboo mat allows adequate cross-ventilation for the interior of building in hot humid climate.

Compared to other traditional roofing materials in Bangladesh, clay roofing tile has a great potential with simple innovation and modification. Among all its advantages, it also has some limitations which are described bellow:

- The clay roofing tile is considered as heavy material compared to other roofing materials such as thatch, straw etc therefore, a strong and uniform roofing frame is needed.
- Wind driven rain enters inside the house if the gaps between the clay tiles are not properly sealed. (Fig-19). Water penetration due to wind driven rain can be stopped by (a) controlling slope (Fig-20), (b) perfect arrangement of tiles on frame and (c) applying little mortar at the joining/overlapping point of the tiles (Fig-20)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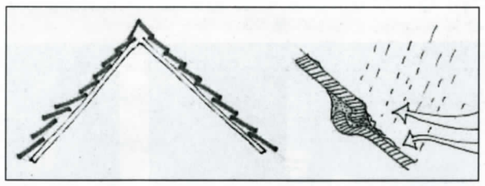
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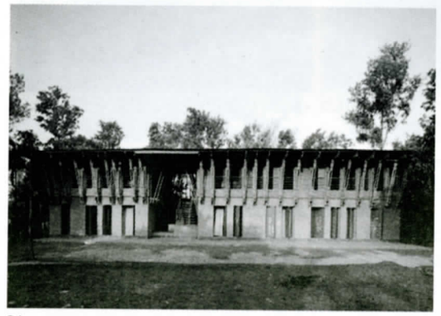
Fig. 19: Wind driven rain enters inside
Fig. 20: Shows the technical means to overcome the limitations of the house if the gaps between clay roof tiles. Clay tiles are not properly sealed.

- In rainy season, in case of continuous raining for 4 or 5 days, water penetnates underside the roof due to condensation. This problem can be lessened by changing (a) chemical properties of soil (using soil containing more iron) and (b) controlling porosity (with optimum pressure while producing in dice) of the material and (c) lessening the permeability (with salt/lead glazing at upper surface or mix lead with varnish) of the varnish.
- In case of heavy storms, the tiles may be thrown away by gusty wind .To stop flying away during storms; tiles should be attached/tied to frames with the help of built-in earthen hook.

Thus it has been identified that the mud wall and clay roofing tile has a strong power in terms of ingredients, shape, color, texture, using technique, functionality, durability and most importantly for cultural values of contextual architecture.

5.0 METI school at Dinajpur: an inspiration towards sustainable development



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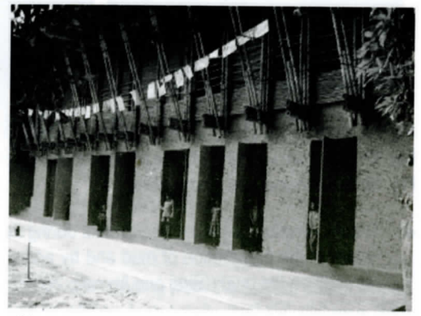

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Fig. 21: METI School: A modern approach but indigenous in spirit.
Fig. 22: Two storied METI School showing a innovative technique of mud and bamboo construction.

The METI (Modern Education and Training Institute) is an unique educational institute which was initiated by a local NGO, Dipshikha, in 1999 in Rudrapur, Dinajpur district in Bangladesh. The two storied school building constructed with mud and bamboo is a distinguished architectural example that encourages social development, restoration and environmental responsibility. German architect Anna Heringer and Eike Roswag used local knowledge, innovative methods of construction being inspired from local techniques, locally available renewable and cost effective materials with a hope "to set a trend in a fresh and regional architectural style that motivates people to bring their traditional construction methods- without the touch of being rustic - into a contemporary modern architecture." (Heringer, cited in web page: www.metischool.com, 2008). The project maintains a traditional identity while embracing modernity in both its form and purpose.

The school has a brick foundation with damp proof course and mud walls constructed in layering technique. The technique of reinforcement is completely traditional where the mixer of mud and straw are used in the wall to achieve long lasting results. The ground floor of the school is constructed with mud which acts as a base for the whole structure whereas the structure of the first floor is completely made of bamboo. It overcomes the limitations of mud structures of having small openings. Number of openings with variation in shape and size, rendered the interior of the school with ample light and ventilation. It has achieved the traditional look in architectural form.

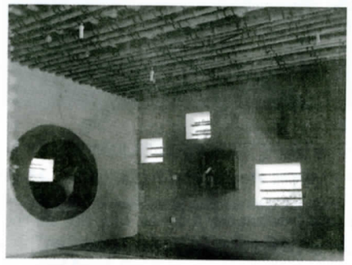

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Fig. 23: The mud surface rendered with charming color and texture of mud.
Fig. 24: The plastic nature of mud produced organic form of children play areas.
Fig. 25: Class room in the first floor.

The school is a manually constructed structure that shows the sustainable design practice in the local context. The METI School makes substantial use of locally available materials and resources which provides flexibility to adopt the

local habits and needs; and thus gives the protection of the cultural heritage. Again the local materials offer advantages from a socio-economic point of view. The method of construction involves local skills that can be realistically developed in the community and thus contribute to the local economy. The rational use of these readily available and renewable materials has less impact on our environment through energy and resource efficiency. Thus it contributes to get ecological sustainability by saving scarcity of resouces, reducing energy consumption and imrpoving environmental quality. Again mud can be easily recycled without any environmental impact.

Towards sustainable development how successful METI school is may be a question of debate. But the designer believes that *"architecture - if we use it wisely - has the potentials to contribute in a significant scale to the development of Bangladesh's ecological balance as well as its economic independence and thus can facilitate a process of self-discovery and identification in architecture and culture."* (Heringer, cited in web page: www.metischool.com, 2008).

6.0 Observations

Followings are the observations taken from the previous examples:

- Mud wall and clay roofing tiles are reliable, much more affordable, environment friendly as compared to many other popular building materials such as C.I. sheet, brick etc. As the construction of mud house with clay roofing tiles incorporates the use of raw materials collected from locally available natural resources and the use of local means of transport, they tends to be much more economical.
- Mud as a walling material and clay tile as a roofing material are less costly in comparison to CI sheet, brick and concrete etc. While C.I. sheet roofing may be a symbol of permanence for most of the rural poor, but to a large extent, it is an inaccessible building material in terms of cost (Ahmed, 1994). That's why the use of C.I. sheet is generally limited to the construction of roof. Again the lower quality C.I sheets, which are affordable to low income groups, corrode and develop rust quite rapidly. The better sheets are more durable and also more expensive. (Ahmed, 1994).
- With proper application and installation, mud and clay based materials can be proved to be durable as there are many evidences of mud walls and clay roof tiles which are more than 50 years old.
- Under normal conditions, clay roof tiles require minimal maintenance compared to its other counterparts. For example, to prevent rust developed in C.I. sheet or to clean it off, the surface requires expensive chemicals which are not available in most rural areas. (Ahmed, 1994). On the contrary, the clay roof tiles is rust free and its' affected modular units can be easily replaced in case of any damage.
- Roof tiles are energy efficient because of its superior thermal capacity.
- Clay roof tiles can resist fire more efficiently than any other indigenous roofing material such as straw, reed etc found in rural Bangladesh.
- Clay roof tile does not decompose in wet climates and are not susceptible to destruction by pests. It can be used in any climate or region and can withstand the severest weather conditions, including rain, wind, etc.

Thus-mud wall and clay roof tiles can appear as a key material in shaping the vernacular architecture because of its appearance in terms of color and texture as well as for its influence in determining the forms of architecture.

7.0 Strategies to overcome the constraints of mud and clay base building materials

The salient features of the strategies to overcome the constraints of mud structures are:

- Improvement of mud structures could be done through innovations and interventions of the construction technology to achieve the long lasting results as stated earlier.
- Greater emphasis needs to be laid to make mud and clay based products popular by solving their various limitations through traditional and technical means. Initiatives should be taken to overcome the limitations of mud structures through planning strategies i.e. constructing continuous verandah around the mud structure to protect it from the driving rain or by increasing the roof projection rather than the improvement of its chemical properties.
- Due attention should be given on construction and preservation of mud structures and clay roof tiles in order to achieve a sustainable rural development. Government should encourage for using local building materials, like mud and clay roof tiles, by giving incentive and taking initiative to build small scale public buildings with these materials with a hope to change the people's perception of the so called un-stability of mud as a building material.
- Care should be given to the preservation of cultural heritage and promotion of mud architecture in both private and public projects.

- The architects, engineers and manufacturers should be encouraged to come forward for the application and improvement of mud and clay based building materials. IAB (Institute of Architects Bangladesh) and IEB (Institute of Engineers Bangladesh) should work in coordination with House Building Research Institute (HBRI) for the development of these materials.

8.0 Conclusion

To get the sustainable solution for the development of an area, it is necessary to appreciate and use of its own potential regarding the materials and resources. In search for a context oriented sustainability, appropriate and contextual architectural expression for Bangladesh, mud wall and clay roofing tiles can play a vital role. Moreover, a cost effective solution in rural housing sector may be achieved by using mud and clay roofing tiles as a prime building material. But the major barrier for the innovation and use of these materials in architecture is attitude. From social point of view mud has always been considered as a primitive material and mud architecture is 'backward.' Because of continuous negligence of concerned authority on the use and improvement of these materials, the mud wall and clay roof tiles are still considered as temporary material which require continual repairs and maintenance and thus these are less appreciated in value. Replacing traditional building materials with modern ones (such as brick, concrete or CI sheet) does not necessarily lead to progress. A reappraisal of the indigenous building materials is needed on various levels to contribute for local economic development. The professionals should come forward to overcome some of the existing technical shortcomings of indigenous architecture to achieve a sustainable result.

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[i] Generally clay and mud are randomly used as synonyms. Both clay and mud come from the same earthy ground. Clay can be divided into 3 types - (i) Argillaceous clay, (ii) Silicious clay and (iii) Calcarious clay. Among these, the Argillaceous clay contain Alumina (Al2O3) and Kaolinite. The Kaolinite with the addition of more water gives a clay deposit known as Kaplin Kulkarni (1968), which is popularly termed as mud.

[ii] .Laterite means red tropical soil-a reddish mixture of clayey iron and aluminum oxides and hydroxides formed by the weathering of basalt under humid, tropical conditions. Alumina (Al2O3) and silica (SiO2) occupies major percentage of soil. Both of them along with iron control different properties of tiles like hardness, porosity, strength etc. Excess free silica reduces plasticity of soil and increases the required temperature of burning. Therefore soil, containing standard percentage of silica and alumina and more iron is suitable for tile making. Amount of pressure applied on soil determines the porosity in the tile. Extra pressure (compared to present technology in Bangladesh) would reduce porosity as well as evaporative cooling effect of the tile.

[iii] Evidence of such data has been collected from Salna, Gazipur during field survey.

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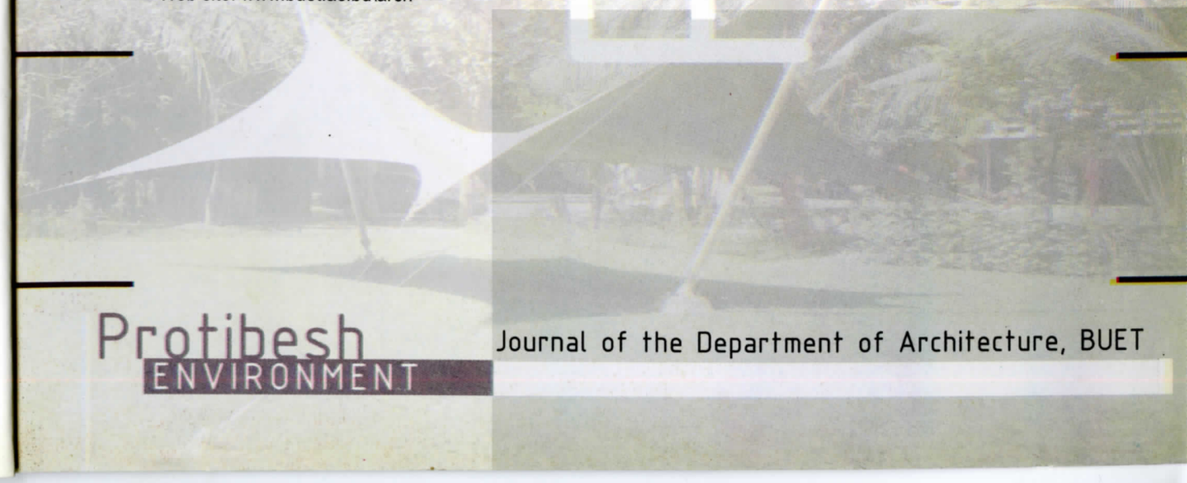

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