RECOMMENDATIONS FOR HOUSING PLANNING AND DESIGN IN THE HOT-ARID REGION OF KHARTOUM

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ABSTRACT
This paper presents some recommendations on the measurements that should be taken in the planning and design of residential neighbourhoods and housing units from the thermal environment viewpoint, and the procedures to promote such an environment at the planning and design scales of housing.

The recommendations are based on a fieldwork conducted in the early nineteen nineties as a search in theoretical, professional and users' perceptions of passive thermal performance of the major residential trends in greater Khartoum. For this purpose, some residential regions were surveyed together with interviewing professionals from the public and private sectors in one hand and the inhabitants of the surveyed residential units in the other.

This study includes the main problems in planning and design of housing and their deviation from the theoretical knowledge in housing, planning and design in hot-arid regions (greater Khartoum and the neighbour-ing areas) and the non-conformity of both the professionals and inhabitants views in this respect. This paper presents general recommendations for residential planning and design especially from the thermal environmental aspects and for some typical samples in regions of greater Khartoum and for both professionals and inhabitants for upgrading the thermal environment in new and existing residential areas.

الملخص:
تقدم هذه الورقة بعض الاحتياطات الواجب اتخاذها في تخطيط وتصميم الأحياء السكنية والمساكن من الناحية البيئية الحرارية والإجراءات التي تمكن من ترقية البيئة الحرارية والأداء الحراري على المستوى التخطيطي للمستوطنات البشرية.

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وقد تم تأسيس هذه التوصيات بناء على دراسة ميدانية قام بها الكاتب في النصف الأول من التسعينيات

للبحث في المفاهيم النظرية والمهنية والشخصية للأداء الحراري السلمي لأبرز النزعات السكنية في الخرطوم الكبرى، حيث تم مسح بعض المناطق السكنية لهذا الغرض كما أجريت مقابلات مع المختصين في الجهات الرسمية والقطاع الخاص من جهة والسكان من جهة أخرى.

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وتحوي الورقة أهم المشاكل القائمة في التخطيط والتصميم السكني وانحرافاتها عن الأطرافات النظرية
tlttx/الระบบ لتقديم النصائح الممكنة في المناطق ذات المناخ الحار الجاف (منطقة الخرطوم الكبرى وما جاورها) والقصور في توجيهات المحترفين من المهندسين والمخططين في القطاعين العام والخاص وكذلك وجهة نظر السكان في هذا الشأن.
INTRODUCTION

This paper is based on a course of study executed during the early nineteen nineties, which was aimed at reviewing and evaluating local residential trends, in the Region of Khartoum, with respect to the thermal environment.

The study dealt with ‘passive thermal performance’, i.e. the modification of the indoor thermal conditions, without or with minimal use of mechanical means, as well as providing an outdoors environment, which is thermally suitable for users to carry out various activities. The term ‘perception’ was used to denote the study’s method of cognition as different from the conventional assessment methods of quantification.

Theoretical perception was referred to as the accepted knowledge and literature concerned with thermal planning and designs (Evans 1980). The study, in this respect, identified two major scales of passive thermal performance: the planning scale; and the architectural scale. For each scale, the study reviewed and discussed the objectives, considerations and requirements for the desired passive thermal performance in the specified locality—the region of Khartoum. From these, theoretical yardsticks drawn in order to be used in assessing the selected case – studies at their two scales, as well as testing corresponding professionals’, and user’s perception.

Professionals’ level of perception was defined as the perception by official town planners; at the planning scale, and architects; at the architectural scale – with respect to passive thermal performance – in the said locality. The inhabitants of the case – studies, referred to the user’s level of perception as the perception. This was concerned with the user’s response to passive thermal performance of house units indoors and outdoors, according to the activities performed and the use of these spaces at different seasons of the year and times of the day. The user’s level of perception included owners/user’s views on the passive thermal performance of the house units and the measures they took to upgrade this performance. Response to external spaces (roads, open spaces…etc.) was also included in this respect (B.R.S., 1975).

The region of Khartoum, where the case studies were chosen from its three main towns (Khartoum, Khartoum North and Omdurman), is characterized by a composite climate type (over six months hot and dry, about three month warm and humid, and a somewhat cold period the remaining months of the year). Thermal planning and design yardsticks of assessment and recommendations in this study were quoted for the critical season: the hot and dry.

It is worth noting that the study started off with the hypotheses that: major residential trends in Khartoum region are problematic from the view- point of passive thermal performance both at the planning scale and at the architectural scale; professionals’ and users’ perceptions of passive thermal performance of these residential trends do not always conform to theoretical knowledge, sometimes justifiably, sometimes
not; and the resolution of differences between theory and perception is thought to pave the way for ameliorating both existing and new residential trends in the region of Khartoum.

**METHODOLOGY OF THE STUDY**

The study adopted a methodology, which directly corresponded to the objectives stated. Literature on thermal theory and the present day major residential trends in the region of Khartoum were thoroughly reviewed (Doxiadis, 1991). A fieldwork involving collection of data was carried out through observations of the residential samples and recording of the corresponding professionals and user’s perceptions.

The proposed method was based on theoretical recommendations or yardsticks which were extracted from the literature reviewed. The method was dictated by the type of investigation and testing of samples, their features and scales, and the perceptions of the groups involved. Hence, quantitative and other methods involving instrumentation were deemed inapplicable (B.R.S., 1975). The testing and assessing of samples and perceptions of the groups was made through using these theoretical yardsticks to test the degree of conformation or deviation from them. The theoretical yardsticks were explained for each scale of the samples and for each level of perception by the groups involved.

The methodology also included devising criteria for selecting the localities for the case-studies and the samples at the two scales by focusing on the residential trends of the region of Khartoum, considering their origins, planning conditions, and type of housing (CEA, 1991). These criteria specified the samples for neighbourhoods, housing precincts and house-units selected as case-studies representing the major residential trends in the region of Khartoum (Hassan, 1995).

Six sample neighbourhoods were selected for the study; three from Khartoum town: Al Amarat (first and second class planning condition), Al Zuhur (3rd class) and Al Mogran (3rd class); one from Khartoum North town: Al Shaabiya (3rd class ‘Housing Project’); and two from Omdurman town: Al Morada (3rd class) and Al Gamayer (an illegal settlement at that time, now being replanned); (Elagraa, et. al., 1985 and Hassan, 1995).

A detailed plan of the investigation and fieldwork also explained the procedures and types of investigation tools used at each scale and at each level of perception.

**Fieldwork Results of the Study and Conclusions**

The study’s fieldwork results documented the physical aspects of the six selected samples, which represented various planning conditions. All samples are of the ‘site and services’ type of housing schemes, except Al Shaabiya and Al Gamayer as mentioned before. From these neighbourhoods, forty sample house-units were selected to represent various locations in the houses blocks, and various designs or spatial layouts, and types of construction.

Profiles of the sample housing precincts with special emphasis on thermal aspects were presented. The architectural character of the sample house – units was fully illustrated with comprehensive information on the thermal aspects of these samples. Owners and users of the surveyed house-units were interviewed for their responsive perceptions. Also, a number of planners and architects were interviewed for their respective perceptions (Hassan, 1995).
The analysis of the fieldwork results, at the two scales and for both professionals and users perceptions were based on the extracted theoretical yardsticks, indicating corresponding conformity or deviation. Reasons for deviation were also stated.

From a passive thermal performance point of view, problems were found to be in various aspects discussed. At the planning scale, deviations from the adopted theoretical yardsticks were found in such aspects as the nature of external surfaces (roads, open spaces, buildings, vertical surfaces), lack of water surfaces, and vegetation. Whereas at the architectural scale, the deviations were found to be in the form and spatial characteristics of sample house-units, and the thermal properties of materials and the performance construction elements (walls, roofs, windows, ..etc.). This was reflected in the user’s negative thermal responses at both the planning and the architectural scales.

Professionals and user’s perceptions of passive thermal performance of these trends showed some deviations from the accepted theoretical knowledge. This was shown by the irrelevance of planning and design of some main thermal aspects by professionals, and the rejection by users to the use of materials and types of construction that are supposed to suit the local climate.

It should be noted that conformity by samples to the yardsticks at the two scales was seen in such aspects as the correct orientation of buildings; the presence of courtyards which exemplified the best of thermal features in providing outdoor spaces for various domestic activities; the separation of heat-producing activities (cooking…etc) from other activities; The use of thick walls; and the placing of windows in North and South facades (Hassan, 1995).

**General Recommendations at the Planning Scale**

Generally, at the planning scale, blocks of plots in residential neighbour-hoods should be oriented East-West with a tilt, preferably to the East (Northern hemisphere). This would encourage night-time ventilation. Road networks should be planned in such a manner as to avoid long, unobstructed roads running north south. This would reduce the funnelling of hot, dust-laden wind. The general spatial layout should, by all means, be compact, by having optimum road widths, small, dispersed open spaces, and minimum plot areas. This will ensure mutual protection of buildings from intensive sun radiation, and the provision of better shading opportunities. Vertical surfaces should be of medium colours (between light and dark) to avoid glare, and they should provide shading to roads too. Artificial water surfaces are to be provided to increase humidity. Sprinkling water, at regular intervals, on unpaved roads and open spaces would stabilize the top, loose layer of soil, and prevents dust movement from these surfaces. Irrigated parks, trees and lawns should be an integral part of planning and urban design as plantation would improve the environmental quality, minimize glare and reduce the nuisance caused by dust. Trees also would provide shading when planted along road’s sides. Protective green belts should also be used to quench the effect of frequent dust storms.

For the studied residential trends, considerable deviations – with regard to accepted theoretical knowledge – are noticed in the absence of artificial water surfaces and the poor or non-existent vegetation. This was observed in all trends surveyed. Incompactness, resulting from increased plot areas of house-units, wide roads, and large open spaces also showed a considerable deviation, especially in the grid-iron pattern of layout prevailing in the neighbourhoods of Al Amarat, Al Zuhur and Al Shaabiya. North-South – orient-ed main roads in these grid iron patterns enhanced the funnelling of hot-dusty winds through
them. The roads themselves, together with the open spaces, were left without surface treatment, and they acted as sources of glare, heat and dust. Other deviations recorded were those such as some light-colored vertical surfaces were sources of glare and that shading of external spaces, for the convenience of the passers-by, was very limited.

Hence, the spatial layout, at this scale, would rather be a combination of configurations so as to enjoy the benefits of the grid-iron pattern, the non-grid-iron pattern, and the radial pattern, typical in the three towns of the region of Khartoum. This point must be taken into consideration so as to enhance better thermal conditions at this scale. Paving roads and open spaces is of a great economic challenge. If roads are difficult to be properly paved, it is recommended that cheaper finishes should be used wherever possible. Stabilized soils could be laid on roads and open spaces surfaces, and by watering, compacting and ramming a better finish would be obtained. In this sense, the type of soil used is recommended to be of a medium colour to avoid ground glare. Together with regular sprinkling of water, this can also solve the problem of dust generation from the plain, loose soil covering roads and open spaces typical in the studied trends. Shading to roads and open spaces could be provided by the use of trees or by means of building on plots’ boundaries facing the roads. The provision of artificial water surfaces might be economically not viable. Where these are difficult to provide, it is recommended that the available water resources in urban areas to be partially allocated for irrigating parks and trees.

To conclude, the orientation of the main roads axis in the grid-iron patterns of layout needs to be carefully studied. Consequences of the prevalent North-South orientation of these roads were seen in the problems they created. From a thermal viewpoint, road orientation is an important issue to be considered in this area (taking into account other planning and design factors). The conventional grid-iron pattern of layout should also be reconsidered, bearing in mind the thermal advantages of other patterns. In general, amendments and new trends should be recommended for orientation and spatial layout to upgrade the thermal environment at this scale. Horizontal and vertical surfaces (roads and open spaces; building facades and boundary walls) were problematic in various aspects. Remedies to these problems should be enhanced through economical solutions, as the main reasons for deviation in these aspects were economic. Such solutions could also be applied for the creation of an urban environment procuring positive thermal features, naturally, through the use of extensive vegetation and artificial water surfaces whenever feasible.

**General Recommendations at the Architectural Scale**

In general, buildings should be oriented East-West with a slight deviation to the east to encourage ventilation at night in Summer, both for the indoors and the outdoors. Building plans should be compact and inward-looking, surrounding one or more courtyards. Massive forms are recommended to provide a slow heat-up.

Patios or verandas are recommended to be used so as to provide shading for walls. Attached buildings on East and West sides in neighbouring plots are recommended, as this will minimize the surfaces, which are exposed to sun radiation. Courtyards must provide for shading during the day and ventilation at night. The use of plants in courtyards is recommended so as to provide shading and to improve the environmental quality. White colours should be avoided as these would act as a source of heat reflection and glare. The uses of hedges for plot boundaries provide shading and act as dust
barriers. Walls, external or internal should be of heavyweight construction. Windows should be located on North and South facades and be protected from sun radiation. Window sill heights should be such that as not to permit reflected radiation from the ground to enter the building. Window types that are tight closing are recommended for protection against heat and dust. Roofs should be of heavy-weight construction with high thermal capacities, by using dense materials with high thermal resistances. They should be finished with insulating materials with light colours. Roofs protection against sun radiation should also be considered.

For the studied sample house-units, the deviations from the adopted theoretical yardsticks were concerned with house form, plan and volume. Samples were mostly of incompact, exposed layouts. Their courtyards were not enclosed in the manner that provides shading. Lack of vegetation in many of the cases studied was typical. Considerable deviations were recorded for roofs, the majority of which had light construction. Windows also recorded considerable deviations concerning their sizes and shading.

To conclude, form and spatial characteristics that are recommended for hot-dry, areas, with prolonged hot-dry seasons should always be considered. The presence of one or more courtyards (which was prevalent in all trends) should always be encouraged. The spatial relation between buildings and courtyards should carefully be studied and designed aiming at ensuring better protection and shading, and enjoying summer breezes. All building elements and components that have direct relationship to the thermal performance should be carefully designed and detailed, as considerable deviations were seen in this respect. The solutions should aim at making users aware of the importance of the thermal properties of materials and thermal performance of building elements, as well as ensuring economical situations in implementation. In this respect, special attention should be paid to the form and the spatial characteristics of house-units in future planning and design. Window shading, which was considerably not provided in the majority of the samples, needs to be taken care of, both in the existing house-units and in future ones.

**Recommended Official Authorities Measures for Upgrading the Thermal Environment:** Planning authorities should make provisions for reconsidering their official goals and strategies in urban planning with respect to the environment. It is recommended that these goals and strategies (together with other local aspects’ economic, social, etc.) should be relevant to the local climatologically and thermal-environmental characteristics. Official plans for residential schemes should adopt the major principles for planning in hot-dry, areas. This should be reflected in the spatial layout, at the planning scale, and in the design and detailing of house-units, at the architectural scale. Moreover, the current planning and building regulations and bye-laws should also make provisions for tackling the thermal-environmental aspects in order to regulate and control the processes of planning, design and constructional detailing that would achieve the desired passive thermal performance at the two scales.

At the neighbourhood scale, official authorities (in the various govern-mental departments and agencies involved) should make all attempts and encouragements towards upgrading the prevalent thermal environment. The following measurements are recommended in this respect:

1. Municipal authorities should provide for regular water sprinkling services to unpaved roads and open spaces.
ii. Together with state authorities, municipalities should plan for and implement extensive vegetation programmes along roads’ sides and around open spaces.

iii. Authorities should also plan for developing new small parks to be dispersed within the residential neighbourhoods, and to ensure that these would be irrigated regularly.

iv. Old ‘earth-covered’ paved roads should be cleaned, maintained or repaved while unpaved roads are to be paved, when feasible.

At the house-unit scale, authorities should encourage users to plant trees and shrubs in front of their house-units and within their courtyards. This could be implemented by selling cheap tree and shrub shoots. In this respect, Neem trees proved to be advantageous in providing shade as well as they need minimum irrigation and care. Hence, it is recommended that such local species of plants to be sprouted.

Recommendations Concerning the Professionals Level: For most of the professionals interviewed, their perceptions did not conform to theoretical knowledge in relating thermal aspects to planning processes and in implementation. Considerable deviations were also recorded regarding perceptions on designing and detailing of building elements for good passive thermal performance.

Hence, official planning authorities should critically consider relating and adapting climatological and thermal environmental aspects to local planning goals and policies. In implementation, these aspects might arise when comparing the ‘site and services’ housing schemes, which had been adopted for the majority of housing plans, to the ‘completely built’ housing schemes. The latter is to be thermally recommended (although often beyond the capabilities of the authorities) in order to achieve the recommended thermal control and performance at the two scales. This might facilitate reducing plot areas – in future schemes – thus enhancing compact layouts and other recommended aspects for a mostly hot, dry locality. Furthermore, such issues should be tackled by planning and building regulations and by-laws. For example, architects and building technologists should look into those restrictions and problems they perceived and which were associated with the need for dense, massive and compact constructions. Professionals should think of the development of traditional building materials and techniques, to meet the challenge of both the thermal environment, and the desired architectural aesthetics and local character.

Architects and building technologists should consider and re-evaluate any restrictions they find concerning design and constructional detailing of house-units, with climatological and thermal – environmental aspects in mind. Users pattern of daily activities; a determinant factor dictating the spatial layout of a house-unit should be carefully studied at preliminary design stages to accommodate such activities indoors, and outdoors as well. These should be viewed as to avoid thermal discomfort conditions. Hence, the main objective in designing and detailing elements and components should be perceived in that they should act as thermal shields to the building from external solar radiation, high temperature and hot, dust-laden winds.

At this level, the following are recommended measures for upgrading the thermal environment:

i. Passive thermal performance of house-units should be upgraded through optimum designing and detailing as well as via research and experiment-ation.
ii. Research work should be relevant to local thermal – environmental aspects and local research capabilities.

iii. Experimental research work should complement theoretical and design research, where varieties of problems are to be solved in this respect.

iv. Publication of research results and recommendations should be considered as this would be of great benefit to the professionals and the public as well.

v. Teaching and directed research programmes should be initiated by professional and academic institutions. Such programmes are to be supported by design studios, laboratories and fieldwork, in the fields of planning, architecture and environmental technology.

Recommendations Concerning the User’s Level: The majority of the users who were interviewed during the fieldwork had perceptions which did not conform to the theoretical knowledge; as in their preference to use mechanical means of ventilation and cooling than the passive means of using appropriate building materials and constructional elements for their house-units. Also, users showed unacceptance to measures that might be proposed for upgrading their house-units’ thermal performance passively (for economic reasons).

According to this, owners should be made aware of the possibilities of using appropriate materials and elements in house construction (together with appropriate layouts that suit the local environment). Moreover, users should be made aware of upgrading their house-units’ thermal environment. There should be some channels through which any proposed measures might be communicated to the users. Officially, this could be through broadcast programmes or through press, while popularly it could be through environment societies and the like. The aim is to make users aware of these issues, but without adding a great financial burden to the households.

At this level the following are examples of recommended measures to be undertaken by users for upgrading their house-units’ thermal environment:

i. Regular (recommended daily) water sprinkling on courtyards. Bathing or washing water (without odours, grease…etc) could be used.

ii. The use of plantation whenever possible and feasible.

iii. The use of light-weight construction sheds annexed to kitchens or other parts where there are no verandas or patios. These would provide shade to walls and could be used for various domestic activities.

iv. For indoors, window shading, is recommended. Cheap, practical ways of shading windows, in existing buildings, should be used.

v. Reed matting may shade existing roofs - when it is feasible - as this is the most demanding issue for indoors thermal comfort.

REFERENCES


