ENVIRONMENTAL ASPECTS OF URBAN DESIGN IN HOT REGIONS

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ABSTRACT

Environmental urban design is an integral part of site planning process which determines the detailed layout of an urban area. Over the last years the international interest of the environment has increased. Climate is a major factor of the natural environment that affecting the comfort of the inhabitants. The present research paper discusses the climatic characteristics relevant to urban design in hot regions. The urban design elements that affects and can modify the urban microclimatic are discussed investigating what great role may urban design play in providing the comfortable conditions.

The urban design elements discussed in the paper are: location of urban areas, density of the built up areas, buildings configuration, orientation and width of streets, and the open areas design details which affecting the comfort of people outdoors. As a conclusion concerning urban design elements may help to provide a comfortable environment with the minimum need of mechanical energy.

INTRODUCTION

Environmental planning must form the basis for all site development decisions if the natural environment is to be conserved and people's environmental needs met. By site planning and urban design it is possible to create very local climates where people can be screened from the worst extremes of the hot regions climatic conditions. The possibility of manipulating local climate can be used to encourage people to use the outdoor areas associated with buildings.

In hot regions the problem is to locate the cool places. When no such places exist, people is driven indoors to expensively air-conditioned buildings. Air conditioning and cooling is not only expensive in terms of the capital required to

build the cooling systems and the power needed to run them, but also in terms of the air pollution created by the systems.

The physical design of the urban environment in hot regions could maximize the comfort of the inhabitants and minimize the need for cooling energy. The physical structures features of the urban area can affect the urban climate. As the structure of an urban context can be controlled by urban design. It is possible to modify the urban climate through appropriate design that can improve the comfort of the inhabitants, both indoors and outdoors and to reduce the required energy for cooling in summer, as well as for heating in winter.

URBAN DESIGN FOR HOT REGIONS

The first stage in site planning or urban design process is to gather all the information available about the local climate so that the limits within which the scheme must be developed are established. Climate is a major factor of the natural environment that affecting the comfort of the inhabitants. The urban design elements that affects and can modify the urban microclimatic should be considered as a basic factor has a great role in providing the comfortable conditions.

The hot regions are characterized mainly by their aridity, high summer daytime temperature, large diurnal temperature range and high solar radiation. Urban design should aim, in hot regions, from the climatic point of view, to achieve the following objectives:-

- Choosing locations with the most favorable climate.
- Minimizing urban temperature elevation above the surrounding level (the "heat island") by reflecting solar radiation from roofs, increasing the areas of green open spaces, etc.
- Enabling good ventilation potential for the buildings, especially in the evenings, and in the open spaces.
- Providing shade in summer in the streets, over sidewalks and in open spaces.
- Providing protection from winter winds.
- Minimizing the dust level.

The urban designer needs to understand how the natural environment can influence the site planning and urban design process. The urban design elements that affects and can modify the urban microclimatic should discussed investigating what great role may urban design play in providing the comfortable conditions. These elements are: location of urban areas, density of the built up areas, buildings configuration, orientation and width of streets, and the open areas design details which affecting the comfort of people outdoors.

LOCATION OF URBAN AREAS

In choosing a location for a new urban areas, both the problem of thermal comfort and of natural hazards should be considered. In hot regions it should be a place with lower summer temperature and good ventilation conditions, mainly in the evenings and at night. North and East facing slopes get less direct solar radiation than west and south slopes. So, it is better to choose such location to built-up an urban context (Figure 1).

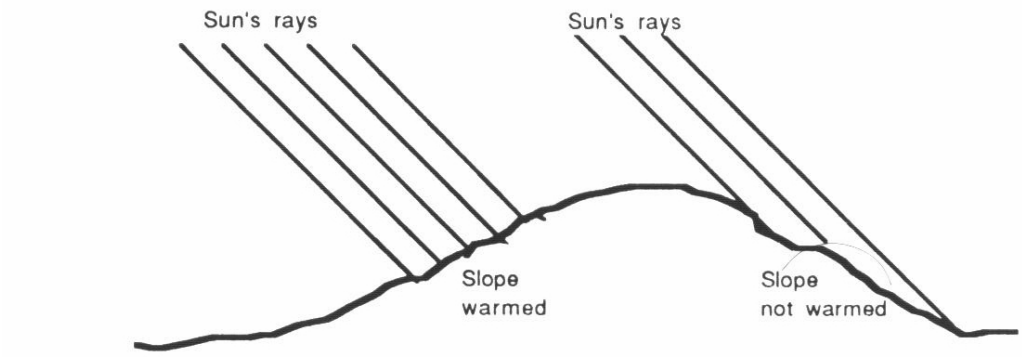

Figure1

A diagram indicating the influence of the angle and direction of slope on solar radiation at ground level.

Another factor influencing the amount of solar radiation reaching the ground is the amount of the air pollution: dirt, smoke and dust. Good ventilated urban environment, which depends on the availability of wind in the location, is essential in the evenings for indoor comfort and for enhancing the cooling rate of the building's interior. Water is on of the major determinants of the shape of the land. The planners and urban designers needs to understand the hydrological cycle (Figure 2). Water having a higher specific heat than land, and it is normally warmer in winter and cooler in summer, and usually cooler during the day and warmer at night, than the terrain.

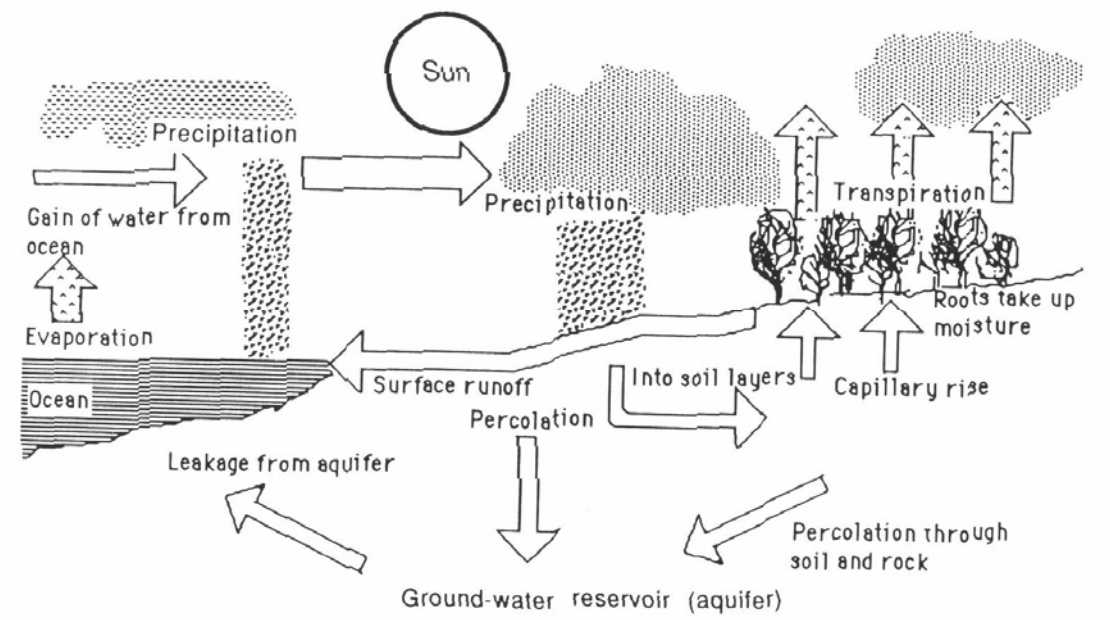

Figure 2

A simplified diagram of the hydrological cycle.

DENSITY OF BUILT UP AREAS

In hot climate, the density of the built-up areas may have both positive and negative effects on human comfort, depending on the details of the urban physical configuration. In the case of individual building units, the buildings can be cross-ventilated. Also, the distance between the buildings along the east/west axis can be minimized to minimize the exposure to direct solar radiation in summer.

In high density urban environment, where streets are narrow, small distance between buildings, and buildings are of about the same height, the wind speed reduced below roof level. So, it could provide protection from the dust effects while not provide good indoor ventilation, especially when the ambient wind speed is very low. (Figure 3).

Figure 3

A high density urban environment sample layout and partial plan.

BUILDINGS CONFIGRATION

In hot regions building with thick walls of brick or stone which, in addition to their insulating properties, function as heat reservoirs: during the hot day, the heat flow from exterior to interior is retarded and during the cooler hours a given part of the heat in the walls is released towards internal spaces. The consequence is a minimization of temperature change inside the building.

In courtyard buildings the internal patio environment is cooler private area suitable for many uses. It has proven most responsive to the rigorous conditions of hot regions by moderating the climatic extremes. (Figure 4)

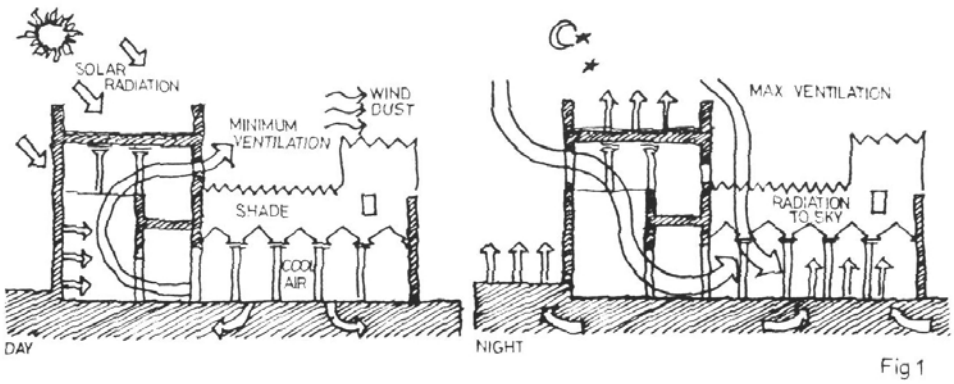

Figure 4

Cross sections of a courtyard house - Daytime & Nighttime

The reduction of the heat flux entering into the building through the roof by utilizing the evaporation of the water over the roof surfaces is a highly effective approach; this can be achieved by an open roof pond or thin film or flow of water or by a roof garden. A roof garden is essentially an evaporative cooling system except that it requires a layer of soil on the roof for grass and other vegetation to grow. Figure (5) shows cross sectional view of the roof with different treatment.

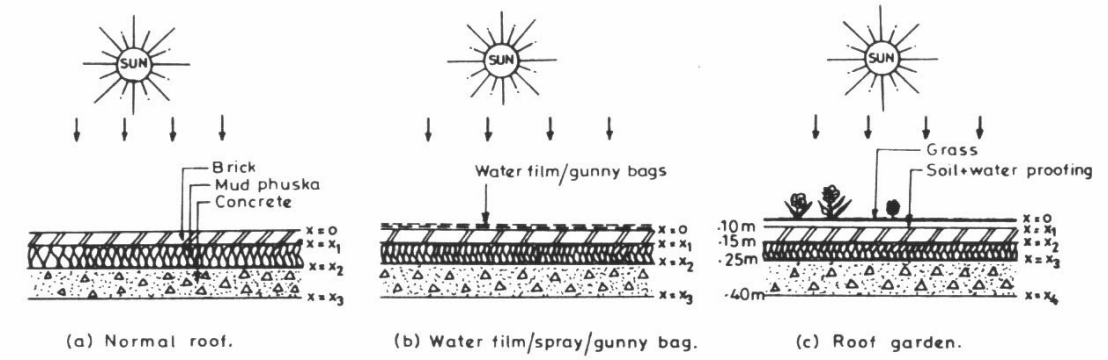

Figure 5

Cross section view of the roof with different treatment.

ORIENTATION AND WIDTH OF STREETS

The orientation of the streets in an urban areas affects both the urban ventilation and the solar exposure of the buildings. The main objectives related to the street layout in hot climate are to provide maximum shade in summer for inhabitants and minimum solar radiation exposure of the buildings. Narrow streets provide better shading than wide streets. From the solar radiation exposure viewpoint an east/west

street orientation is preferable to provide shading during the overheated period of the daytime.(Figure 6).

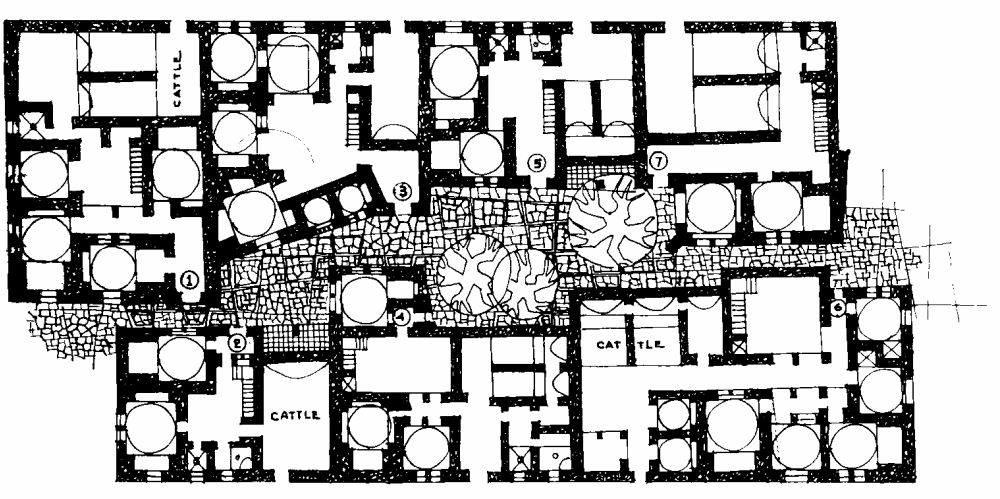

Figure 6
A narrow streets sample

OPEN AREAS DESIGN DETAILS

The climatic objectives in planning public urban open areas in hot regions should include, enhancing urban ventilation, providing shade for the users of these areas, and minimizing blockage of the wind within the open spaces and in the built up areas around the open spaces. Vegetation may be effectively used to act as a climatic moderator. It shelters from unpleasant winds, filters sand and dusts, regardless air temperature through evaporation, reduce glare, and minimizes the heat reflection from the ground surface. Above all, it shades and thereby cuts down solar heat gain. (Figure 7).

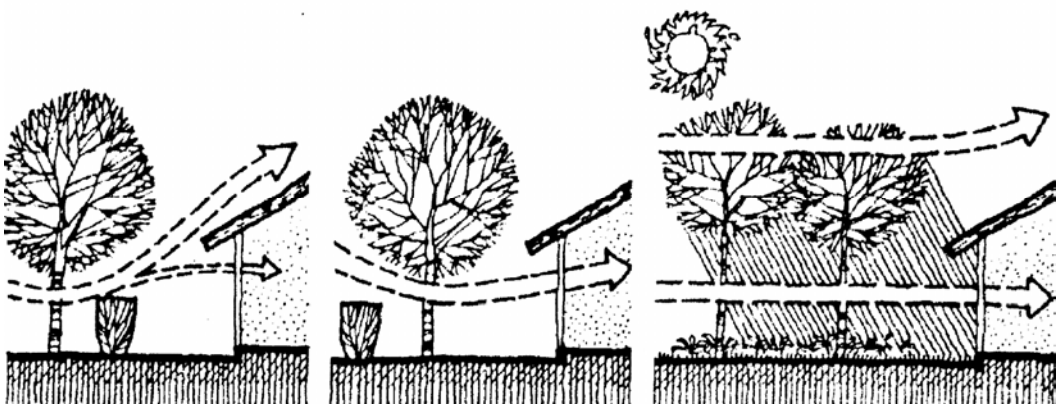

Figure 7
Air flow pattern and shading influenced by vegetation and landscaping.

The natural cover of the terrain tends to moderate extreme temperature and stabilize conditions through the reflective qualities of various surfaces. Plant and grassy covers reduce temperature by absorption and cool by evaporation. The local climatic patterns linked to local landforms can make the air movement mechanism less or more effective. The urban designer has to understand the landform factors that affect the air movement mechanism through an urban context and be able to predict where problems might occur to ensure the free flow of air through the urban context.

The layout of buildings should create the minimum obstruction to the free flow of natural ventilation and other natural elements such as flood waters and wind (Figure 8a is good, b is wrong). Open space should not be completely covered and has no dead end streets nor built-up street corners (Figure 8c-e are wrong, f-h are better). All buildings must be accessible to fire fighting equipment from at least two sides and courtyards should have emergency access.

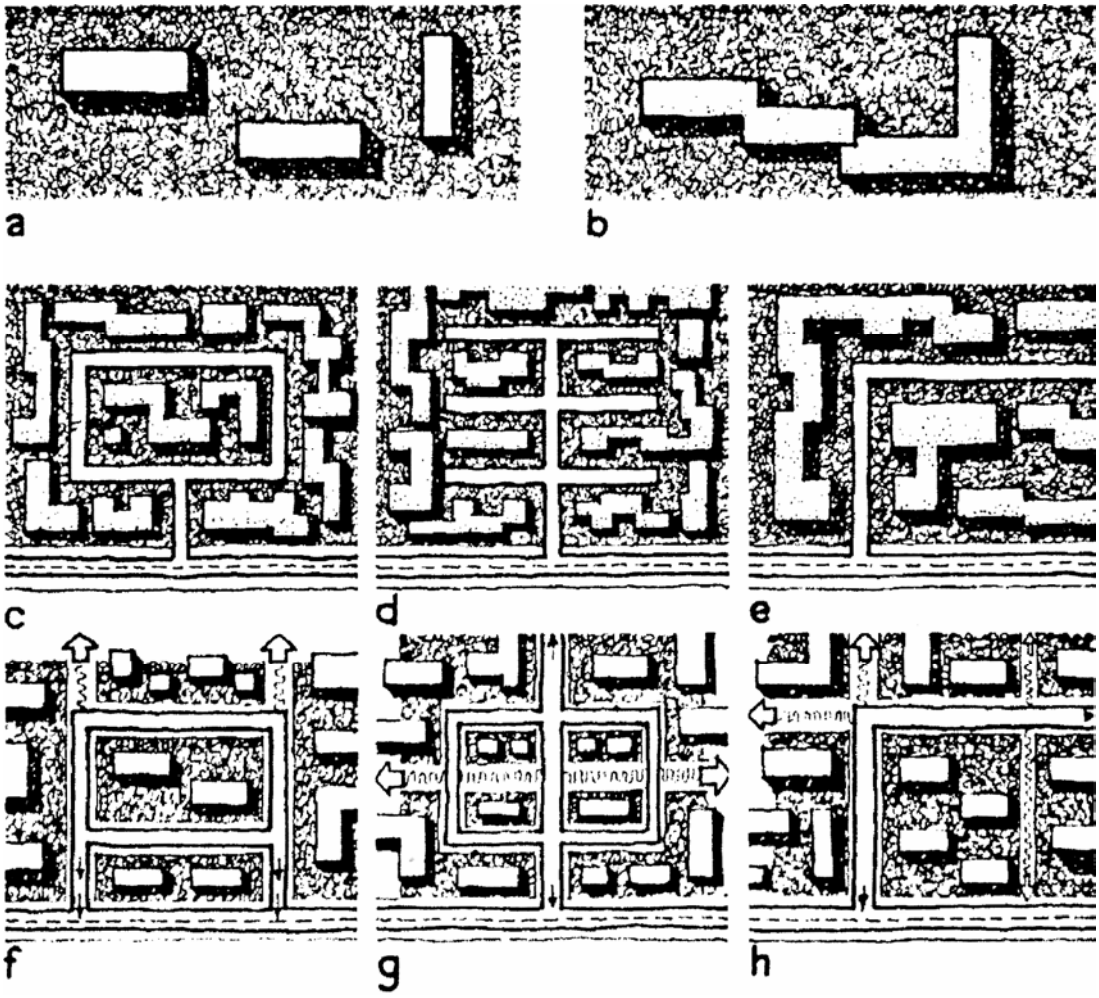

Figure 8
Illustration of different urban patterns.

CONCLUSION

The physical design of the urban environment in hot regions can be utilized to provide and create very local climates where people can be screened from the worst extremes of the hot regions climatic conditions. The urban designer has always had in hands a multitude of natural ways and means to offer the users acceptable climatic comfort regardless how severe hot climatic conditions are. The link between the site features and local climatic characteristics can be utilized to maximize human comfort outdoors. The site features and local climatic characteristics can be also exploited to minimize energy consumption in buildings during extremes of heat and cold. So, concerning urban design elements may help to provide a comfortable built environment with the minimum need of mechanical energy.

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