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**“Sustainable Urban Design and Climate
With Reference to Palestine”**

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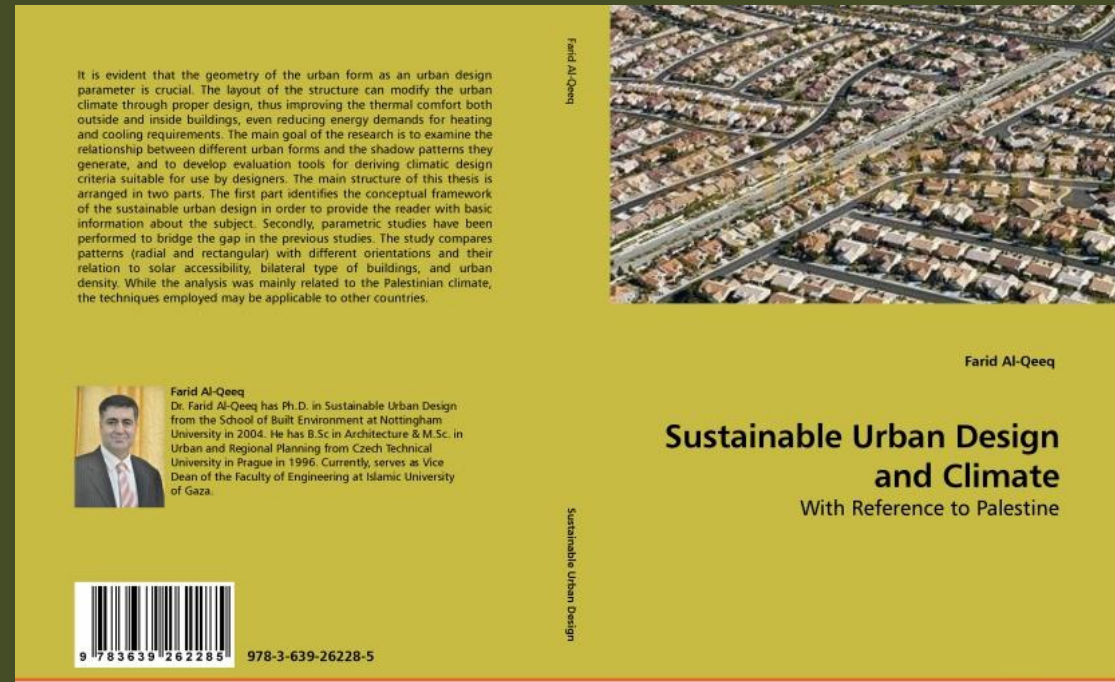
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Editorial Reviews

It is evident that the geometry of the urban form as an urban design parameter is crucial. The layout of the structure can modify the urban climate through proper design, thus improving the thermal comfort both outside and inside buildings, even reducing energy demands for heating and cooling requirements. The main goal of the research is to examine the relationship between different urban forms and the shadow patterns they generate, and to develop evaluation tools for deriving climatic design criteria suitable for use by designers. The main structure of this thesis is arranged in two parts. The first part identifies the conceptual framework of the sustainable urban design in order to provide the reader with basic information about the subject. Secondly, parametric studies have been performed to bridge the gap in the previous studies. The study compares patterns (radial and rectangular) with different orientations and their relation to solar accessibility, bilateral type of buildings, and urban density. While the analysis was mainly related to the Palestinian climate, the techniques employed may be applicable to other countries.





BASIC URBAN DESIGN PRINCIPLES

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November,2010

2.1 INTRODUCTION

“We shape our dwellings and afterwards our dwellings shape our lives”.

Winston Churchill



2.1 INTRODUCTION

Buildings provide shelter and safe places for human beings, also helping to determine our quality of life, The same is true of streets, villages, towns and cities where we live.



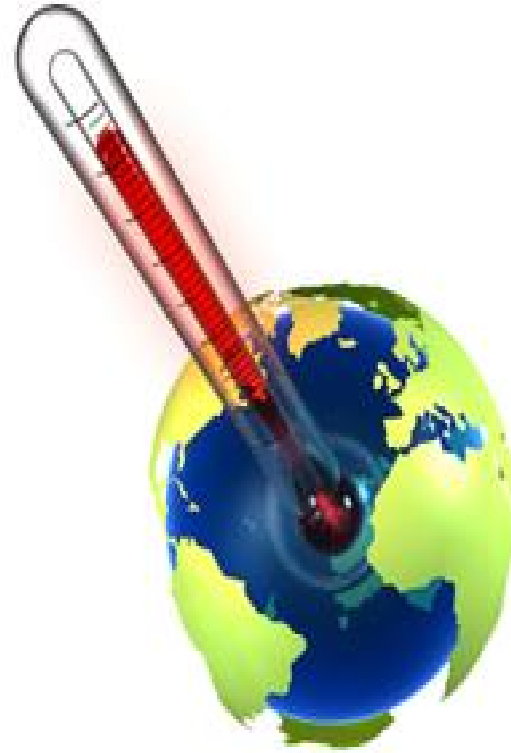
2.1 INTRODUCTION

The built environment is not just a group of buildings; it is also the physical result of various economic, social and environmental processes, which are associated with the needs of society.



2.1 INTRODUCTION

Development of the urban environment has serious effects on the quality of the global environment. Major concerns are the quality of air, increase in temperature, acoustic quality and traffic congestion.



2.1 INTRODUCTION

Buildings are related to global changes in the increase of urban temperature, the rate of energy consumption, pollution and the production of waste, conversion of agricultural to developed land, loss of biodiversity, water shortages, etc.



2.2 CLIMATIC ASPECTS OF HUMAN SETTLEMENT



It is a recognized fact that only species which are in harmony with their environment and adapted to all internal and external forces to which they are exposed are fit to survive.



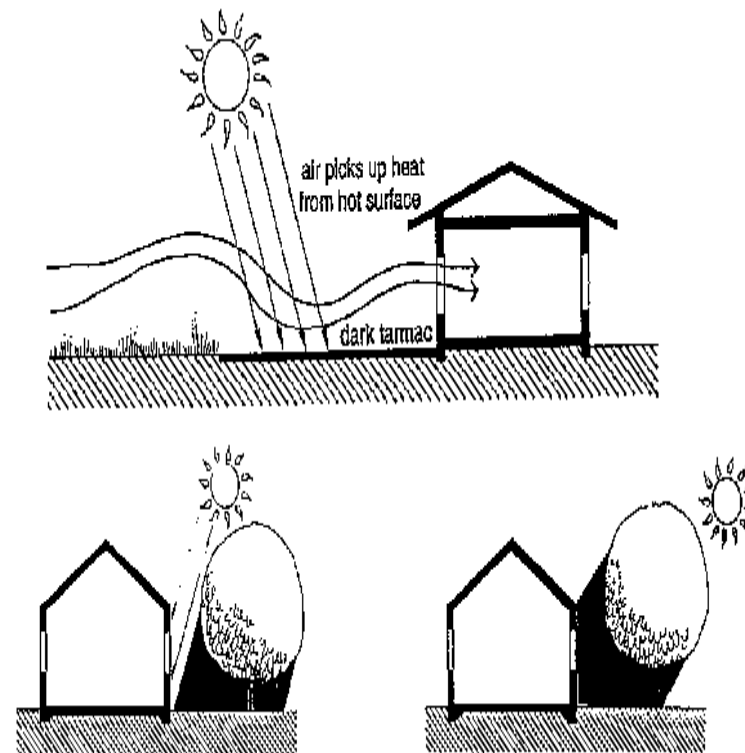
2.2 CLIMATIC ASPECTS OF HUMAN SETTLEMENT

- The structure, which reduces unpleasant stresses, and at the same time utilizes all natural resources favourable to human comfort, is “climate balanced’ The approach to such structures should be comprehensive, based on local experience, technologically advanced and adapted to the local ecosystem without disturbing its balance.



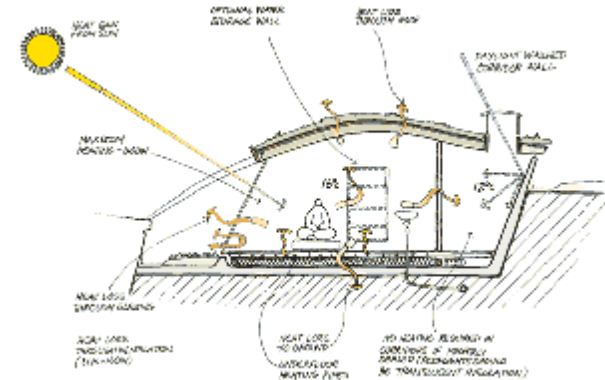
2.2 CLIMATIC ASPECTS OF HUMAN SETTLEMENT

It is clear that - climate consideration stands in the forefront. There are mainly three techniques for promoting the liability and comfort of human settlements. They are the use of shadow and breeze, water elements, and the minimization of the impact of solar radiation. In traditional desert settlements, all the above techniques are use.



2.3 HUMAN COMFORT

- ☉ Comfort within buildings is mainly controlled by four factors: air temperature, mean radiant temperature, humidity and airflow.
- ☉ These are mainly the parameters which affect the heat transfer processes from the body to the environment. In addition, there are other factors which affect comfort, such as clothing, activity level, etc.
- ☉ Comfort is mainly influenced by temperature and humidity.



2.4 THE INFLUENCE OF URBAN FORMS ON CLIMATE

- ⊕ It is an established fact that the process of urbanization produces radical changes in the environment of the region, involving radiative, thermal, moisture and aeodynamic characteristics.
- ⊕ Different layouts result in differing microclimates ,with greater or lesser comfort.



2.4 THE INFLUENCE OF URBAN FORMS ON CLIMATE

- ☞ Urban buildings forms might be modelled for solar access or shade for shelter, exposure to winds depending.
- ☞ To succeed in integrating renewable energies in established urban structure, the actual behavior and the microclimate performance of the urban forms have to be precisely identified.
- ☞ Geometry is a variable that may be controlled for the preservation of bioclimatic conditions, besides others functional, socioeconomic and symbolic aspects of the urban form.



2.6 THE BUILT ENVIRONMENT AND LANDSCAPE



- ☉ The liveability of open spaces is significantly affected by environmental factors, including solar radiation, ambient temperature, humidity, velocity and radiant energy from the sun.
- ☉ All these factors directly affect the potential for thermal comfort in open spaces.



2.6 THE BUILT ENVIRONMENT AND LANDSCAPE

- ☉ Open space design in the arid zone is more essential to human comfort than in non-arid zones.
- ☉ Adjacent buildings, pavements and dry ground heat up quickly, causing painful glare and reflecting radiation towards the building; at night they will reradiate the heat stored during the day.



2.6 THE BUILT ENVIRONMENT AND LANDSCAPE

- Enclosure of out-door areas by walls which are themselves shaded will help to avoid such undesirable effects and at the same time will support effective protection from the dust and hot winds outside.



2.4 THE INFLUENCE OF URBAN FORMS ON CLIMATE

- ☉ The urban layout affects the climate of the area and can even modify it to improve the thermal comfort conditions both outside and inside building, even reducing their energy demands for heating and cooling.



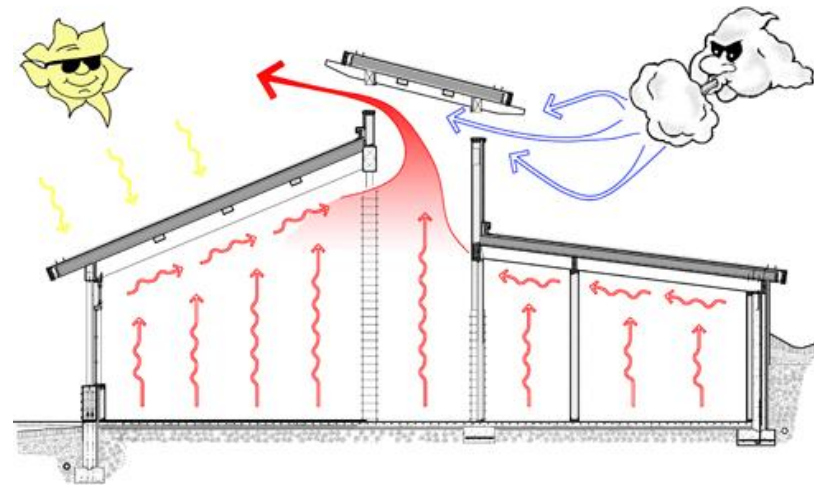
2.4 THE INFLUENCE OF URBAN FORMS ON CLIMATE

- ☛ It seems clear that street geometry as an urban design tool is more important in improving urban climate than other factors: at least in the small to medium scale.
- ☛ Solar radiation, temperature and wind conditions can vary significantly according to urban form and layout density.



2.4 THE INFLUENCE OF URBAN FORMS ON CLIMATE

- ☉ Usually winds in towns are moderate because of the number and range of obstacles they face.
- ☉ However, some types of urban configurations such as long straight avenues or multi-storey buildings can cause significant air circulation.



2.4 THE INFLUENCE OF URBAN FORMS ON CLIMATE

- High buildings rising above low-rise building can create strong turbulent wind conditions on the ground as the air is brought down from high levels.



2.4 THE INFLUENCE OF URBAN FORMS ON CLIMATE

- ☪ 2.4.2 Urban Heat Island
- ☪ It becomes very clear that urban geometry and thermal properties of built-up surfaces have more influence on the magnitude and configuration of the urban heat island than wind behaviour or population density.

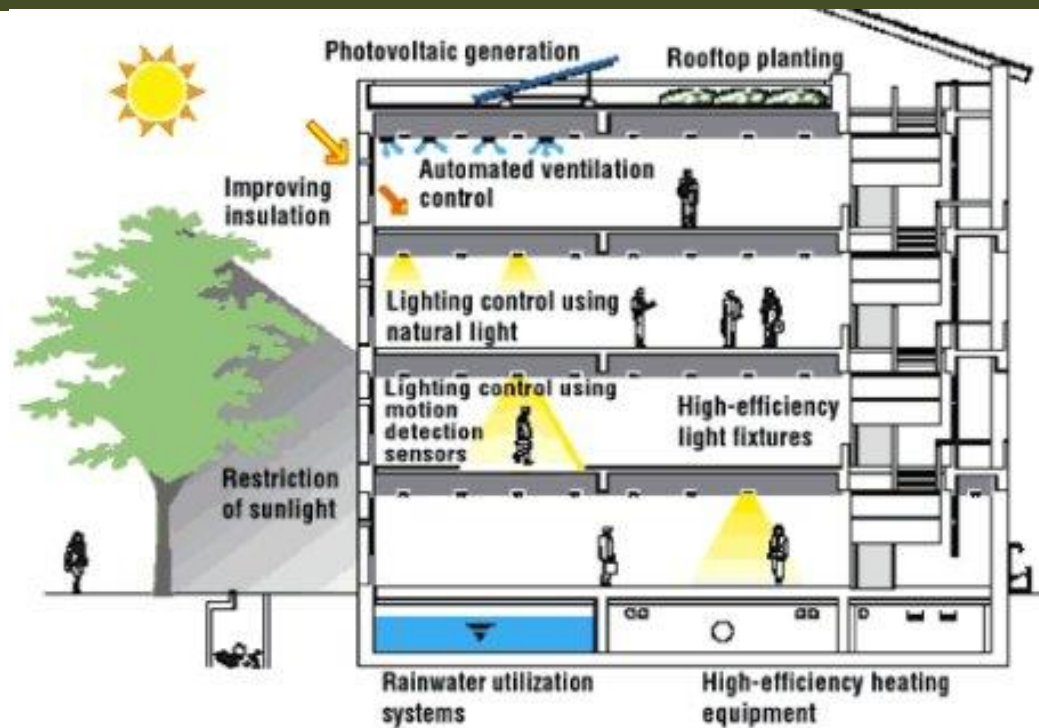


2.4 THE INFLUENCE OF URBAN FORMS ON CLIMATE

- ☉ The climate of cities shows considerable difference from that of the surrounding countryside, as large urban areas are warmer than the surrounding suburban and rural areas.



2.4 THE INFLUENCE OF URBAN FORMS ON CLIMATE



- ⌚ This temperature difference between the city and its surroundings is known as the “urban heat island”.
- ⌚ The phenomenon of the urban heat island is due to many factors.

2.4 THE INFLUENCE OF URBAN FORMS ON CLIMATE

- ☉ One of the most important factors is the geometry of the city streets, which means long-wave radiation is exchanged between buildings rather than being reradiated to the sky.
- ☉ Additionally, air pollution in cities creates a layer that blocks the night heat radiation to the sky dome, contributing to the enhancement of the “heat island” phenomenon.



2.4 THE INFLUENCE OF URBAN FORMS ON CLIMATE



- ☪ As a result, the urban heat island will increase the cooling requirements of building in summer and modify heating demand in winter.
- ☪ Also, the thermal properties of materials increase the storage of sensible heat in the fabric in cities.



2.4 THE INFLUENCE OF URBAN FORMS ON CLIMATE



- Studies of the urban heat island refer usually to the “urban heat-island intensity”, which is the maximum temperature difference between the city and the surrounding area.
- The difference in climate between urban areas and countryside is greatly affected by the way through which the received solar radiation is treated.



2.4 THE INFLUENCE OF URBAN FORMS ON CLIMATE



☞ On the other hand, cities are characterised by reduced green areas and an accumulation of artificial materials which have high absorptive properties.



2.4 THE INFLUENCE OF URBAN FORMS ON CLIMATE



- ⌚ The two most important factors are density and district integration.
- ⌚ Density is the use of units per acre for overall development instead of using rigid lot size requirements to control density; this permits flexible clustering of housing units.



2.5 THE INFLUENCE OF THE SOCIO-ECONOMIC CONDITIONS ON URBAN FORM



☐ 2.5.1 Compactness

- ☐ Compactness is the technique of minimising the amount of building surface exposed to the direct radiation of the sun.
- ☐ Compact cities were developed throughout history for many reasons: social cohesiveness, defence, economic efficiency , or adapting to a stressed climate.



2.5 THE INFLUENCE OF THE SOCIO-ECONOMIC CONDITIONS ON URBAN FORM



- ⌚ The compact form alleviates the strong, hot day or cold night winds, reduces the harsh effect of dusty storms, reduces direct radiation, and minimises heat gain during the day and heat loss at night.
- ⌚ Therefore, the compact city consumes less energy for cooling or heating.
- ⌚ Density is one of the main criteria for keeping the overall energy consumption of buildings and traffic at the lowest level possible.



2.5 THE INFLUENCE OF THE SOCIO-ECONOMIC CONDITIONS ON URBAN FORM



- ⌘ The compact city allows a noticeable shortening of the entire infrastructure network and transportation system and therefore reduces energy consumption and construction cost.
- ⌘ Also, there is quick and easy access to facilities within the compact neighborhood.



2.5 THE INFLUENCE OF THE SOCIO-ECONOMIC CONDITIONS ON URBAN FORM

- ☉ Urban density is one of the main factors that affects the microclimate of an area and determines the urban ventilation conditions and urban air temperature.
- ☉ The heat island is more intense in the city centre, where there is a dense urban structure and concentrated activities.
- ☉ Studies have shown that the phenomenon of the "heat island" is mainly affected by urban density rather than by the size of the urban area.



2.6 THE BUILT ENVIRONMENT AND LANDSCAPE

- ☉ 2.5.2 Land Use
- ☉ The concept of land use proximity is linked directly to the concept of compactness; both are desirable ways of achieving the same goal.
- ☉ Land use can be proposed as an integrated pattern for the residential area where shopping, offices, clean manufacturing, educational and cultural activities, social services and restaurants can be joined within residential areas.



2.6 THE BUILT ENVIRONMENT AND LANDSCAPE



☐ 2.5.3 The City Network

- ☐ Canyon street morphology plays an important role in affecting the urban climate.



2.6 THE BUILT ENVIRONMENT AND LANDSCAPE



- ☉ The road and alley networks within a city is channels for air movement and heat exchange, and play a significance role in establishing the city climate.
- ☉ The city's network should be designed in relation with the daily and seasonal sun cycle.
- ☉ In the arid city, shadowing is a desirable design concept to protect pedestrian paths from the stressed climate.



2.6 THE BUILT ENVIRONMENT AND LANDSCAPE



- ☉ Alleys should be shadowed and cool throughout the day.
- ☉ This is achieved by considering their orientation and direction, by landscape elements, and by adjusting the building heights.
- ☉ Narrow alleys will keep their space cool in the day and warm at night.



2.6 THE BUILT ENVIRONMENT AND LANDSCAPE

- The most efficient urban form (that is the lowest total travel time) would couple dispersed employment and commercial opportunities with residential density declining with distance from the centre.



2.6 THE BUILT ENVIRONMENT AND LANDSCAPE



- **2.6 The Built Environment and Landscape**
- **The main benefits resulting from appropriate modifications of climatic conditions are: air cooling, sheltering from wind to reduce convective heat losses in winter, the filtration of air pollution, reduction in noise levels and channelling of cooling summer breezes.**



2.6 THE BUILT ENVIRONMENT AND LANDSCAPE

- Measures are taken in the space surrounding buildings (private gardens, courtyards, atria), in the design (orientation, shape, openings, internal layout, functional elements) and in the construction (material, colour) of each individual building.



2.6 THE BUILT ENVIRONMENT AND LANDSCAPE

- Successful design for the environment surrounding the building can result in minimising the operating hours of the air conditioning in mechanically ventilated buildings, or reducing the hours of thermal discomfort in naturally ventilated buildings.



2.6 THE BUILT ENVIRONMENT AND LANDSCAPE



☞ 2.6.1 Open Space Design

☞ Landscaping could be applied to public spaces in the form of large public parks, small neighborhood parks, playgrounds, trees along streets, or by providing space for landscaping around buildings

2.6 THE BUILT ENVIRONMENT AND LANDSCAPE

- The consideration of the location of open space, its pattern of distribution within the city, its size and its positioning in relation with the neighbouring land uses is very important, in terms of the type of microclimate which it can generate.



2.6 THE BUILT ENVIRONMENT AND LANDSCAPE

- The liveability of open spaces is significantly affected by environmental factors, including solar radiation, ambient temperature, humidity, velocity and radiant energy from the sun.



2.6 THE BUILT ENVIRONMENT AND LANDSCAPE



- ☺ All these factors directly affect the potential for thermal comfort in open spaces.
- ☺ Open space design in the arid zone is more essential to human comfort than in non-arid zones.
- ☺ Adjacent buildings, pavements and dry ground heat up quickly, causing painful glare and reflecting radiation towards the building; at night they will reradiate the heat stored during the day.

2.6 THE BUILT ENVIRONMENT AND LANDSCAPE

- Enclosure of out-door areas by walls which are themselves shaded will help to avoid such undesirable effects and at the same time will support effective protection from the dust and hot winds outside.



2.6 THE BUILT ENVIRONMENT AND LANDSCAPE



- ⌚ As the area adjoining the building becomes an extension of the indoor space, it has to be treated by the designer with equal care.
- ⌚ While natural conditioning is preferable to mechanical control for indoor spaces, this is the only method of control possible for the out-door space.



2.6.2 VEGETATION

- **vegetation plays an important role in the improvement of man's immediate physical environment.**



2.6.2 VEGETATION



- Landscaping through vegetation is a very effective strategy for modifying the microclimate .



2.6.2 VEGETATION

It modifies the microclimate and energy use of buildings by lowering air temperature increasing the relative humidity of the air, functioning as a shading device and channelling wind flow.

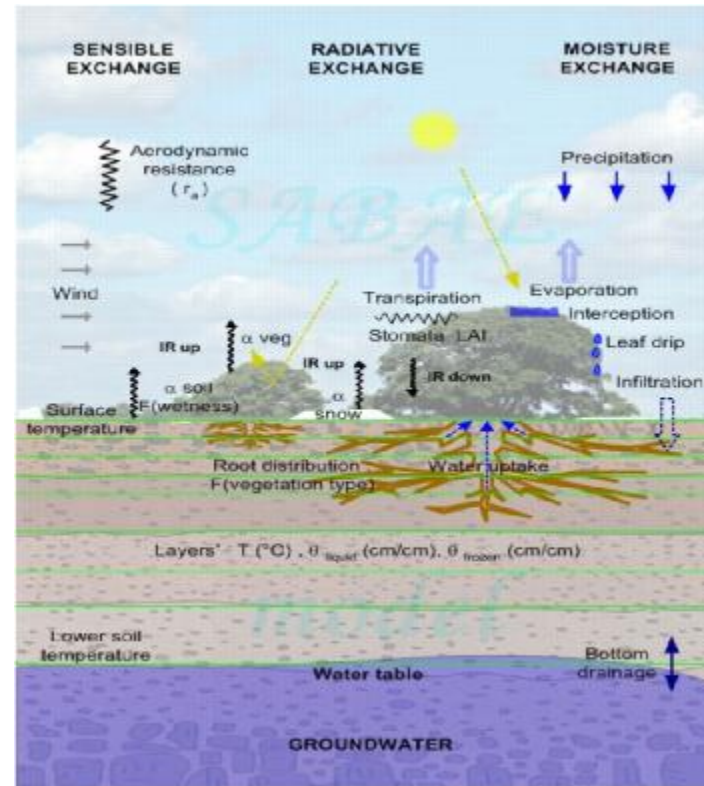


Planting Trees is a Good Strategy for Improving the Quality of Life in Urban Areas.

2.6.2 VEGETATION

○Vegetation contributes to the control of solar radiation, temperature and humidity.

○Evapotranspiration and tree shading are an important control measure in heat-island mitigation.



2.6.2 VEGETATION

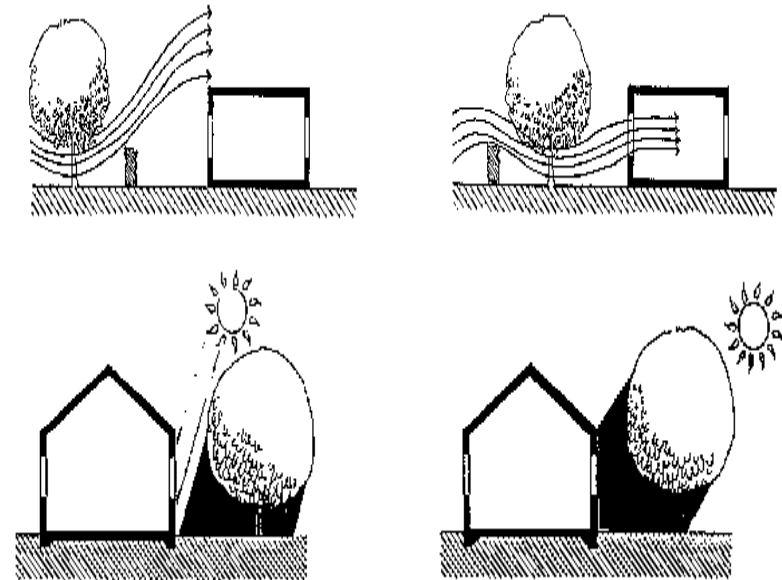
- ☉ One of the simplest and cheapest strategies for countering the urban heat island effect is to increase the number of trees and other plants.



2.6.2 VEGETATION

○ Properly selected and sited vegetation can provide shade for both buildings and people and can offer protection from the convective cooling of the wind .

○ The recommended energy-conserving landscape designs are those that provide shade from the summer sun, channel cooling breezes toward windows, allow winter sun to reach the structure and, particularly, to penetrate southerly windows and provide protection from winter winds.



2.6.2 VEGETATION

- vegetation can improve the quality of daylight entering the building by softening and diffusing it and reducing the glare from the bright sky.
- In addition, plants can control air pollution, filter dust and reduce the level of nuisance. It can extend the living area outdoors under more pleasant thermal conditions.



2.6.2 VEGETATION

- ☪ Vegetation enhances human thermal comfort and adds to the psychological well-being of urban dwellers.
- ☪ In addition, urban vegetation improves the surface water flow by quantitative and qualitative regulation of runoff and enriches the urban bio-diversity.

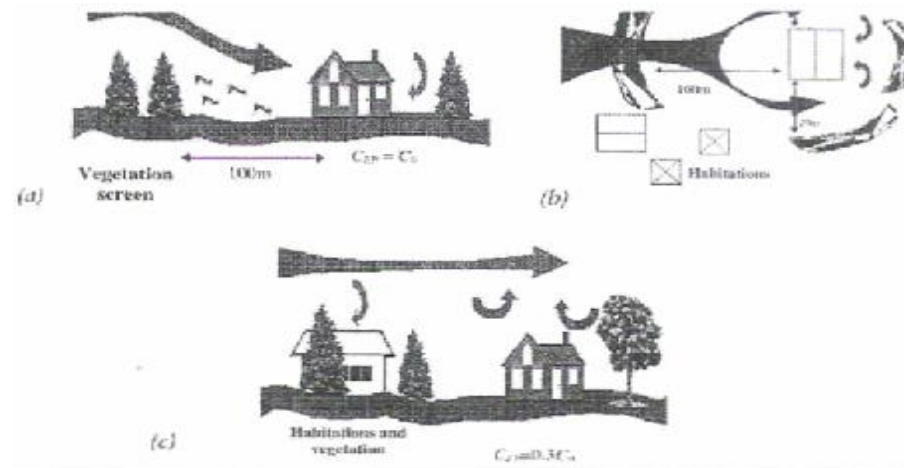


2.6.2 VEGETATION

- In hot dry climates, trees with dense canopy that provide thick shade are desirable as they reduce direct and diffuse radiance.
- In humid climates, the beneficial cooling effect may be reduced by the undesirable, increased relative humidity of air.
- The vegetation in this case should be arranged to encourage air movement.



2.6.2 VEGETATION



The Influence of Vegetation on the Surrounding Environment

- Trees and bushes can be also located in such a way to improve ventilation conditions inside the building by directing more of the cooling breezes into the building .

2.6.2 VEGETATION

- ☞ Trees absorb most of the solar radiation falling on their leaves (up to 90 %).
- ☞ The absorbed solar radiation is mainly consumed for evaporating water from the leaves.
- ☞ The remaining small portion of the absorbed solar radiation is used for photosynthesis.
- ☞ Leaves with open pores release about 50 to 70% of the amount of vapour that would be released from the same water area under the same climatic conditions.
- ☞ In heavily landscaped areas, in an ambient temperature drop in the immediate surroundings of 5.5 to 8.5 ° C in hot dry climates.



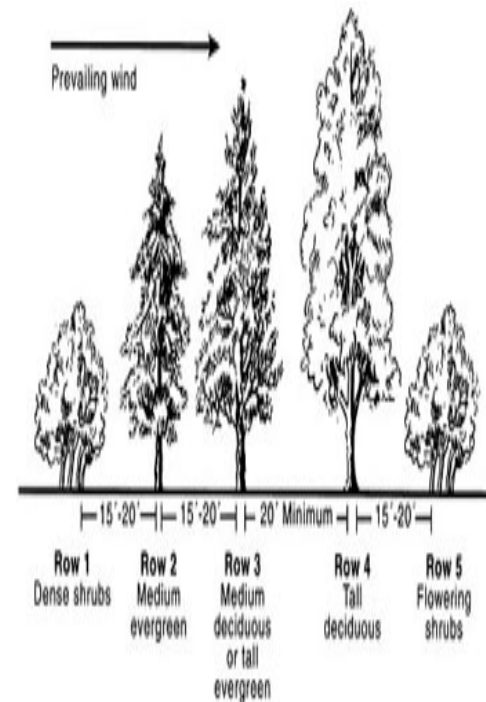
2.6.2 VEGETATION

- ☉ Evapotranspiring surfaces in urban areas, like water, parks, trees, lawns, etc., have the effect of lowering the temperatures of the surrounding, much drier non-vegetated areas. This so called “oasis effect” results from the movement of hot, dry air sinking over the cooling vegetation and advecting into the neighborhood along the streets from the downwind park/urban boundary.
- ☉ 20-30% of cities’ area should be vegetated to benefit from the oasis effect and to offset the development of the urban heat island.



2.6.2 VEGETATION

- Plants, particularly if in full foliage, are obstructions to wind. Hence, there is a major reduction in wind velocity up to five times the height of the obstruction.
- Dense rows of trees are even more effective in providing shelter. For example, Wind velocity may be reduced by 50 percent for a distance downwind from 10 to 20 times the height of such dense shelterbelts.



2.6.2 VEGETATION

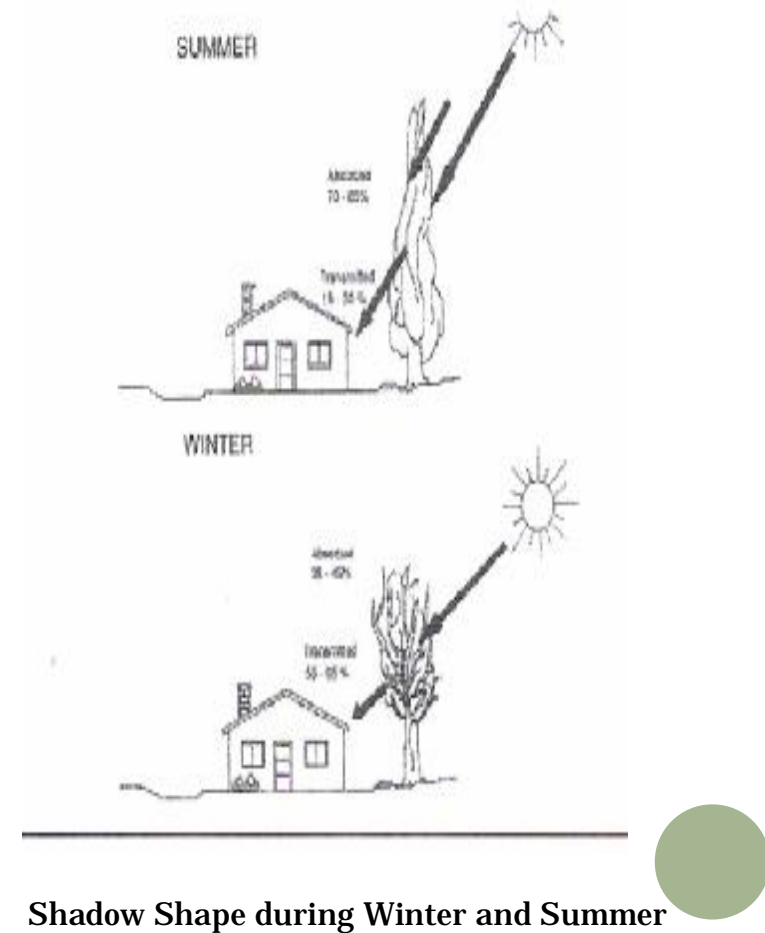
- ☞ Windbreaks or shelterbelts can be used for the reduction of domestic heating requirements.
- ☞ more belts with greater density and thickness will produce larger effects in wind protection.

The choice of trees should be very carefully based on the shape and character of the plant (tree or Bush), both during the winter and summer periods, and on the shadow shape they provide.



2.6.2 VEGETATION

- ☞ Deciduous trees are very useful as they drop their foliage during autumn and permit solar access during winter.
- ☞ Therefore, they are leafless when solar gains are most valuable, while they can provide some shade in summer.



2.6.2 VEGETATION

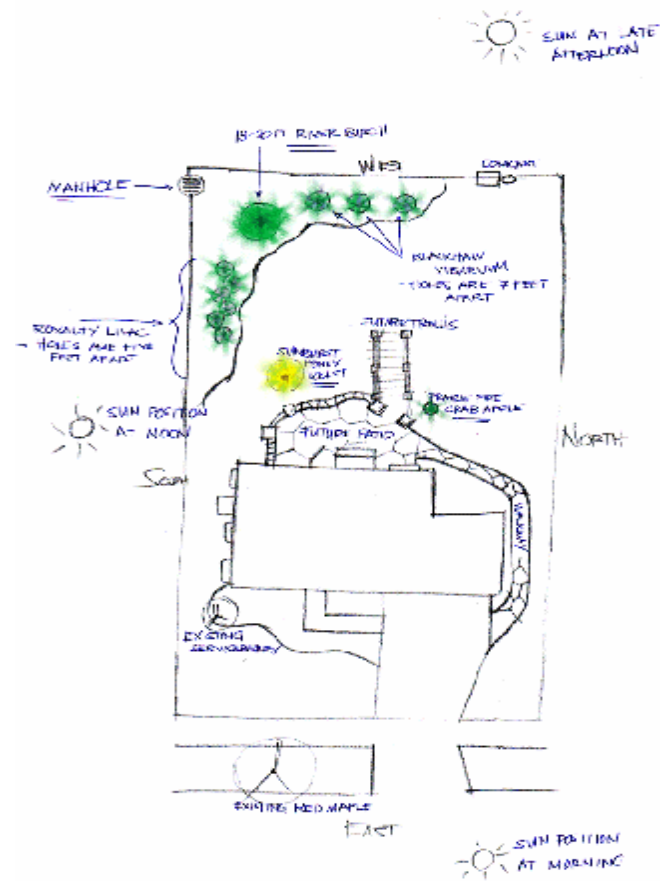


The most appropriate plants for effective landscape are native plants as they are accustomed to the local climatic conditions.



2.6.2 VEGETATION

Tree locations are important; the position of plants around the building should be carefully chosen in order to provide shade at the most critical hours of the day.



2.6.2 VEGETATION

○Shading of windows is the most beneficial .Horizontal overhangs like pergolas, are preferable at the south side, as the sun is in its high position at this orientation. Trees on east-south-east and west-south-west sides offer the best performance as the sun is at low altitudes in the morning and late in the afternoon, and low sunrays cast long shadows.

○Vertical trellises, covered by vines or other creeping plants, are effective on east and west facades.



2.6.2 VEGETATION



- ☞ the roof is a part of the building that absorbs the highest amount of solar radiation during summer, grass planting provides a remarkable reduction in the roof's surface temperature and consequently in air temperature of the space below it.



2.6.2 VEGETATION

○In addition, the roof garden provides an amenity space by extending activities at a higher level, where air speed is higher than at the ground.

○Grass and other plants covering the ground around a building are also effective in controlling its air temperature and in ensuring that its load will be smaller than a building surrounded by asphalt or concrete surfaces.



2.6.2 VEGETATION

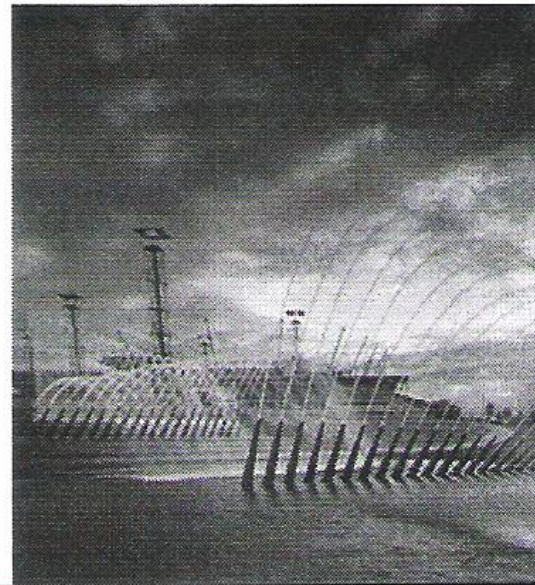


In the case of buildings with solar collectors on the roof, precautions should be taken to control trees height positioned at the south side in order not to obstruct solar access to the collector.



2.6.3 WATER SURFACES

Water surfaces modify the microclimate of the surrounding area by reducing the ambient air temperature either through evaporation (latent heat) or by the contact of the hot air with the water surface.



Water Surfaces Can Increase Human Comfort



2.6.3 WATER SURFACES

- ⌘ Fountains, ponds, streams and waterfalls may be used as cooling sources in order to lower the temperature of outdoor spaces and of the air entering into buildings.
- ⌘ The psychological cooling effect offered to people is also significant.
- ⌘ Although water surfaces are very useful in dry climates, their existence may be limited by the scarcity of water.
- ⌘ As water surfaces increase air humidity, they can be problematic in very humid climates.



2.7 CONCLUSION

- The intrusion of the form of the urban pattern will influence the microclimate of the site and, to certain extent, the immediate macroclimate of the region.
- Heat gain and loss within a settlement result from the overall form and configuration, street patterns and orientation, building material and its color, overall exposure to radiation, and density of vegetation.
- Urban areas are increasing in size rapidly and it is estimated that in the future most of the world's population will be living in urban areas.
- Increasing urbanization and industrialization has caused the urban environment to deteriorate.



2.7 CONCLUSION

- The concentrated activities of the population in urban areas and the rapid increase of motor traffic are the main contributors to air pollution and the deteriorating environmental and climatic quality.
- The relationship between urban areas and nature should be developed to achieve a symbiosis between the two.
- Alterations and other measures carried out in public spaces or existing buildings, or caused by new construction must consider the climatic aspects of the development.



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