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**Research article**

# DESIGN STRATEGIES OF THE RESIDENTIAL BUILDING IN WARM and HUMID CLIMATIC ZONES - TURKEY

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## ABSTRACT

In the passive design of buildings, evaluation of many parameters such as orientation, building shape, materials and climate data are present. This study was based on the factual analysis of climatic issues of Adana located "hot and humid" climatic zone and southern of Turkey and looked into the role of climate in shaping the residential buildings. More environmentally ways of achieving residential thermal comfort in this climate need to be investigated.
This study was undertaken;
-to determine the potential improvement in the thermal comfort of typical Adana houses to with way an analysis of passive design improvements instead of the use of mechanical devices and thus,
-to reduce the negative environmental impacts of hot-humid climate.
It proposes some design strategies about climate-balanced building design based on some climatic factors, specifically the effect of natural ventilation on thermal comfort, in Adana, Turkey.

**Keywords:** Passive Design, Residential In Hot And Humid Climate, Thermal Comfort, Turkey, Adana

## 1. INTRODUCTION

Climatic aspects have greatly influenced the design of the ancient and traditional architecture. Although most researchers (Asatekin, 2005, Hall, 1988, Taylor, 2004, Mumford, 1989) in the fields of urbanism and history claim that the formation of historical urban settlements is not primarily shaped by climatic conditions of a location, the importance of thermal comfort conditions in the buildings of such settlements cannot be disclaimed. Traditional built environment is unique with its intuitive repetitive character and often considered by users as adaptive to climate. However, in most of the design suggestions of today, the sensitivity towards climate is missing or replaced by a technological interest with more and more high-tech solution for issues related to thermal comfort. Passive cooling and heating alternatives are widely abandoned in temperate climates.

Natural ventilation by openings is one of the most primitive methods of passive cooling. The effectiveness of openings for ventilation is known, yet has not been discussed analytically before 1950s. It's effect on thermal comfort has been a more recent issue of discussion. In the last 10 years, it is shown that the effect of natural ventilation on comfort level under hot conditions is positive for people of hot climatic zones. Airflow up to certain levels can cause toleration of extra 3-4 ˚C temperature above limits. When we examine traditional settlement examples in Anatolia (the part of the Asian continent in Turkey) we see that climate considerations have striking effects in their formation (Terim, 2011, 1-4).

This study looks into the role of climate in shaping the residential buildings. It proposes some design strategies about climate-balanced building design based on some climatic factors, specifically the effect of natural ventilation on thermal comfort, in Adana, Turkey.

### The Aim And Method of The Study

Due to hot-humid climate in Adana, most buildings are equipped with air conditioning devices. To minimize these problems, the influence of climatic effects on building design is analyzed. So a range of design techniques are defined againist climate impacts and solar radiation in Adana. The passive design in buildings would provide significant benefits in environmental and monetary terms (Yuceer and Çerçi, 2002, 74). More environmentally ways of achieving residential thermal comfort in this climate need to be investigated. So, the aim of this research is to increase the thermal comfort of typical Adana homes to with way the passive design instead of the use of mechanical devices.

### The Method of the Research

-Precedent for passive climate and bioclimatic design were studied,
-Literature study of Adana were carried out to understand application of passive strategies,
-Afterwards the analysis of the thermal comfort conditions of Adana city was evaluated,
-After alternative design schemes for spatial organization configurations were studied with further simulation studies.
The proposed strategies used for the study are ecpected as a guiding instrument for other similar studies and further steps of this study.

## 2. THE CASE STUDY

Adana, 4. capital city of Turkey is chosen as the case study area. It is one of the fastest growing urban sites in the south of Turkey, which has famous for its historical building (dated over 150 years) placed an old tumulus (**Figure 1).** Buildings surrounding the old city, the city has expanded towards to the north. Due to unconscious design approaches, they put enormous pressure on city dwellers' life comfort. So, the city's resident areas are need to mitigate the climatic issues with incorporation of ecologic principles during the design of residential buildings. Given that city dwellers' thermal comfort level are gradually deteriorating, ensuring the quality of the building and it's environment is of paramount importance.

For these reasons, the principal goal of the research was to mitigate the climate issues ; to develop guidelines for environmentally bioclimatic residential building based on passive design principles in Adana. The strategies thus, developed were applied to designing a residential building that is environmentally bioclimatic.


**Figure 1.** The location of Adana/Turkey (Source:http://gelistir.somee.com ; adana-bld.gov.tr (15.03.2015)

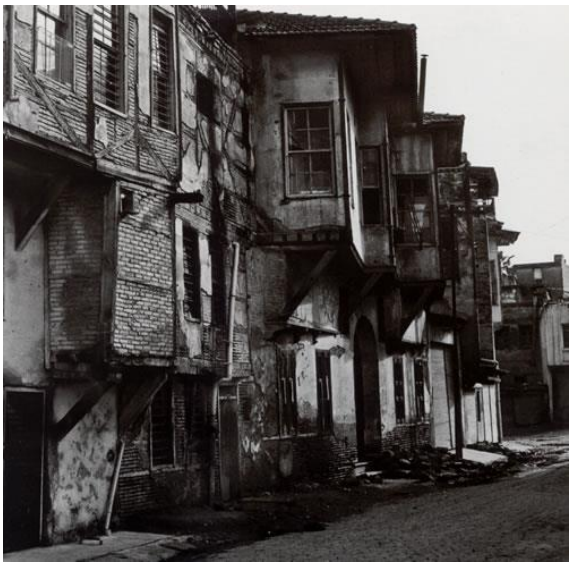

**Figure 2.** Typical houses in old Adana (turizmtrend.com)


**Figure 3**.Typical apartment blocs in Adana (Photo: Çerçi, 2014)

## 2.1 Residential Status in Adana

When comparing the existing situation of the historical and new areas in Adana, situated in central southern Anatolia ; Adana was a sustainable place from environmental, sociological and ecological point of view until the 30-40 year.

Traditionally, the residences of the city were vernacular that used local resources for the construction to achieve maximum climate comfort.
The residences of the old city were in a harmonious relationship with nature, and used properly of local building materials and the orientation of the individual dwellings as a response to variation in climatic factors (**Figure 2**). In this respect, these buildings present excellent models for energy efficient design, even today.

Current buildings with the improper material usage and orientation has negative climatic comfort on the users. Conflicting land use and inadequate urban design of the city are creating severe climatic conditions and offering non-sustainable living in the city (**Figure 3)**. So, the residential buildings in the housing sector are vulnerable from

environment and its construction point of view. There is need to bring about change in building design and in direction of natural/environmental sensitivity principles at large. This study attempts to determine the necessary strategies in order to mitigate the problems.

## 2.2 Evaluation of Climatic Effect on Building Design : Adana Example

Adana's Climate Chart. Geographical location: Adana / Turkey, Latitude: 37.00. North, Longitude: 35.00, Elevation: 50.00 m., Climate: Mediterranean climate (cooler mid-latitude / CSA, CSB, a; Köppen system) (Source; Yüceer, 2010, 3). Adana climate is mild temperatures in winter and very sunny and hot - humid during the long summer months.

The hottest and coldest days for the climate of the Adana;

-summer is 21 July,

-winter is 2 January

On average from June to

November are the high humidity and temperature. So, direct sun light might cause unpleasant heat, reflection and other serious problem such as solar radiation in buildings and dwellings.

### 2.2.1 The Climatic Data of Adana

Due to the hot and humid climate of Adana, the cooling of the interior, much more important is the heating. Adana in climate data, in the 6th, 7th and 8th months, sunshine duration is quite high. In these months are "wind needed" zone and shadings in the openings during daytime.

Psychrometric Chart analysis made for Adana, showed months that fall within "comfort zone" are April, May and October during daytime. All other months during daytime required heating or cooling depending upon season. Similarly, winter months required internal heat gain and conventional heating during night. Hovewer, it is possible to extend the comfort environment with applying passive design strategies.

### 2.2.2 The Strategies For Passive Design

The paper describes an approach to simplify and clarify passive design strategies for the Adana climate data ; and proposes some design strategies to be applicable (any built area for the region) about climate-balanced building design based on some climatic factors, specifically the effect of natural ventilation on thermal comfort. These are as follows;

- **Orientation of the building and settlement layout ;**

First of all, with the good orientation of the building can be saved energy. In the residential building design, the main factors affecting the orientation of the building ;

- optimum utilization of solar and wind,
- topographical features,
- views.

The most important questions are the quantity, orientation and proportion of the glazed surface. The huge glass surface used on the southern side of the building increases the heat absorbing capacity of the building during the winter seasons. The best orientation for buildings to harness solar gain during winter is to tilt the building 30° East or West of South. With the long axis facing south is provided more solar radiation and thus, benefit from it.

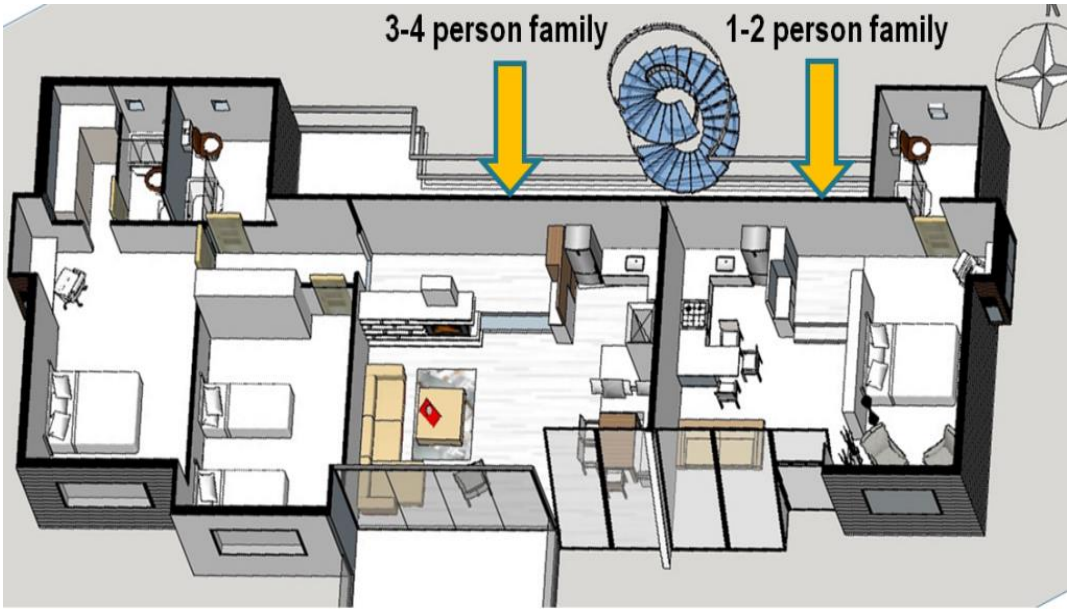


**Figure. 4** South-facing building with solar gain and good for air circulation buildings designed by authors

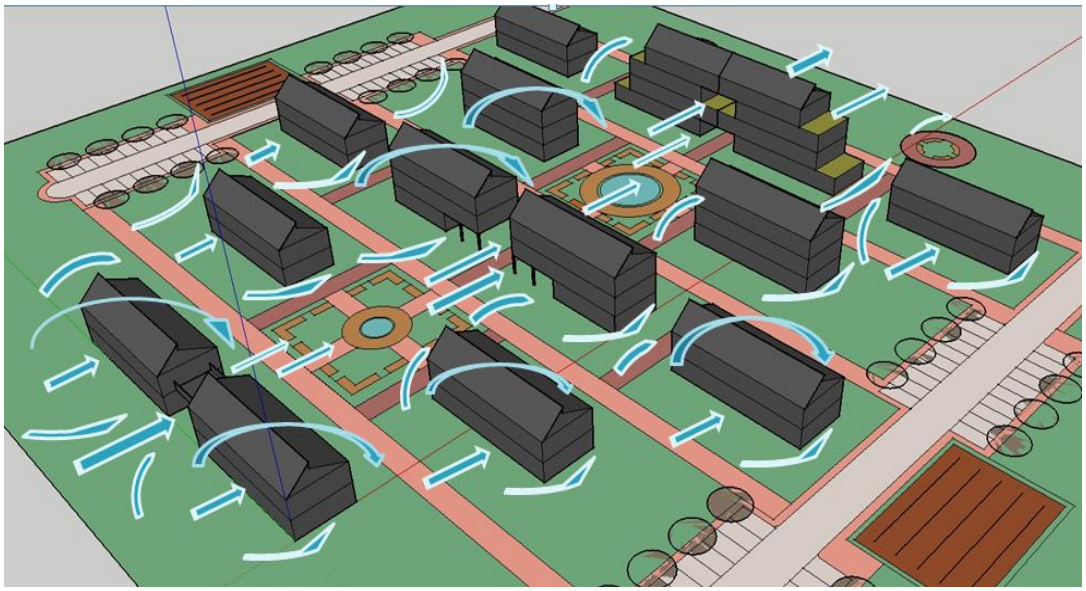

**Figure. 5** Open space for air circulation of the residential settlement shaped according to climatic consideration designed by authors

- **The shape of the building and spatial organization;**

It is important to think about the shape of the building during the planning period. It is better to have a compact shape. Most occupied spaces such as living room; bedroom should be oriented to South, South East and South West. **Figure 6, 7** shows the settlement of South-facing building with solar gain and open space between buildings good for air circulation. Bedroom oriented towards west are haven't large volume of space with adequate ventilation and are opened little window (**Figure 4, 8**).

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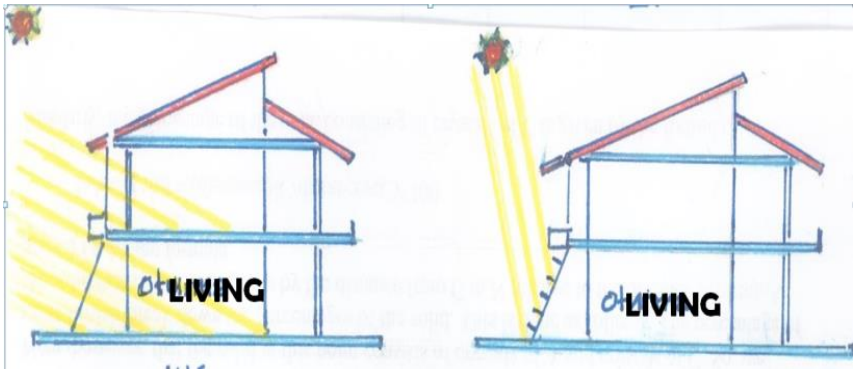
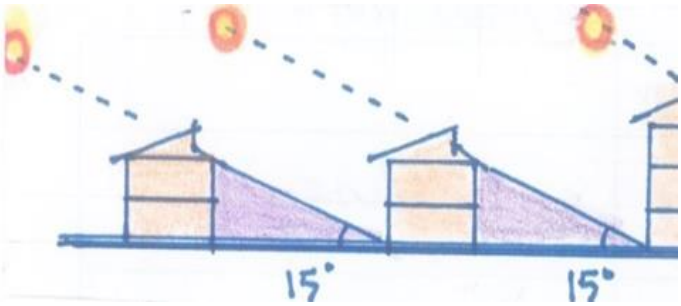



**Figure 6.** Access to the living area of the sun in summer and winter




r **Figure 7.** The distances of the buildings for access the sun

**Figure. 8** Air ccirculation of the indoor and outdoor house

- **Protection from direct sunlight and rain ;**

Sites that face south direction are beneficial for avoiding overshadowing. (**Figure 4, 5)**. Windows and walls are provided according to the floor to floor height and surface facing sun. Vegetative elements over the shading device are reduced solar heat gain during summer.

A study on shading device design was made with the case of Adana by Yüceer in 2004. In this study, the phases and priorities of shading device criteria were classified for the Adana climate data, after which the Solar Tool computerized program analyzed the obtained data design criteria. It was found that, the application of horizontal shading device to prevent undesirable solar heat gain in Adana of latitude 37 works successfully. North is effective in all directions which the sun scans. As seen **Figure 11,** with the application of horizontal shading to a "P" type window in Adana of Latitude 37, horizontal dimension alternatives of shading devices and shading efficiencies were

determined. The design strategies of shading devices that were developed in this study were found to be applicable any built area for the region (Yuceer, 2010, 6-13).

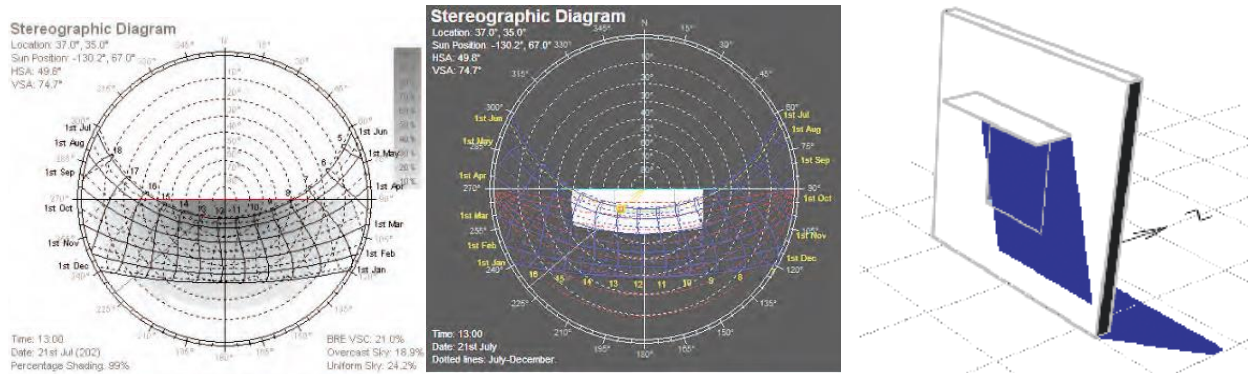



**Figure 9.** Areas shaded area into the horizontal element on the stereographic diagram
**Figure 10.** The dates to be done shading in Adana
**Figure 11.** Shadow element for P 100/120 window

- **Natural ventilation and air conditioning;**

Natural ventilation is the movement of air in and out of a space through openings such as windows and doors intentionally provided for this purpose. This enables the maintenance of both fresh air ventilation an a cooling effect by replacing hot interior air with cool outside air. If the temperature is too warm i.e.as in dry-hot desert settlements, this hypothesis cannot be stated (Santamouris, 2001). From a sustainability point of view using natural ventilation and avoiding air conditioning is the best option as this does not require electricity use.

In hot climate zones like Adana, ventilation has particular importance as a remedy against high temperatures and humidity. An important feature of traditional architecture in Adana is to use natural ventilation; that is allowing air to flow during the summer. This air flow, which can be assisted by a fan.

**Figure 12.** A Residential building shaped according to climatic consideration

In model residential design, the simplest natural circulation technique, which is to ventilate a space through window and door openings is used. Besides, locations of residential buildings, which rely on prevailing breezes for cooling, are mainly selected according to local wind direction: south-north and northwest-southeast. So, the dwelling plan is designed depending upon orientation and position and size of windows. With opening windows on opposite sides

(with air corridor) from south to north of rooms are induced natural ventilation and with the opening windows on opposite sides (with air corridor) from south to north of rooms are induced natural ventilation.

- **Shading, trees around the house;**

The usage of shading could be important mainly on warmer climate and in summer seasons. Suitable shading can provide good indoor climate control thereby avoiding air conditioning system during the summer whilst heating / let the sunshine in during the winter;
The most common options preferred in model building as follow,
- shutters which are preferably mounted outside the window,
- bay window (cumba) elements in west and east facades covered with solar control elements as shutters.
- external horizontal surface - mounted above the window to cut off direct solar rays,
- solar panels used to shade facades or terraces,
- the roof - when exceeding the building with 60 cm or more to give shadow on the walls and windows (**Figure 12).**
- deciduous trees - leaves provide shade during the summer but fall down in the autumn.

- **Main material of the walls;**

It is important to take into account the heat absorbing and storing capacity of the materials. For example bricks absorb the solar heat better and store it for a longer time than wood (Szuppinger,2011). The materials of the walls determine the heat absorbing and storing capacity of the walls. From this point of view modern, energy efficient bricks seem to be the best option.

- **Photovoltaic panels ;**

As an alternative to electricity for running appliances in the building, photovoltaic (PV) panels and solar collector for water heating are implemented in southern direction.

## 3. CONCLUSION

This study, with Adana facing problems in relation to thermal comfort demands to modify design standards that meet bioclimatic environment conscious building has been pointed out.
The contemporary residential buildings in Adana shows that buildings built after 1980 have lack a climate-balanced design according to the various literature study and passive strategies. Therefore, to mitigate the problem, the concepts of passive designs were used for mainly cooling, ventilating and daylighting. The analysis from Psychrometric chart provide useful design techniques such as building orientation, wall materials with low thermal properties, protection to walls and windows during rainy period, ventilation requirement during summer, radiation needs during winter period to be applied. The recommended design strategies were used for a bioclimatic residential model in Adana in order to improve city's livability.

Achieving the city's livability and making urban investments in Turkey are mainly at the responsibility of municipalities. In this context, it is expected that the architects undertake the important mission of forming creative products with contemporary designs reflecting traditions and history which have an important role in the urban design.

In this respect, some suggestions to create areas with a better climatic comfort can be listed as follows.
. to prepare urban improvement and growth master plans to regional improvements.
. to benefit from historical settlements models in forming the criteria of an environmental design with passive elements.
. to select natural recyling and regional materials for new building constructions which contribute to the ecological identity as well as providing financial solution.

As a result, the awareness training on government energy efficiency polices needs to be further enhanced given.

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