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Building and Environment 37 (2002) 1003–1012

BUILDING AND ENVIRONMENT

www.elsevier.com/locate/buildenv

Design with the climate in housing environments: an analysis in Northern Cyprus

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Received 6 March 2001; received in revised form 30 August 2001; accepted 13 September 2001

Abstract

Today, we need one sector to show the way towards sustainable development. Housing, because of its ability as a total entity to satisfy all the levels of need, is in a unique position to set this example, of a more holistic policy which proactively considers the broader issue of the global environment together with local tradition (Oktay D. Planning Housing Environments for Sustainability: Evaluations in Cypriot Settlements, YEM Publications, Istanbul, 2001; WV Vliet (Ed.), The Encyclopedia of Housing, Sage Publications, London, 1999).

So far as housing is concerned, local sustainable development deals with improving the quality of life of the local community through the prudent use of local resources. The aim, therefore, is for a high degree of local self-efficiency, which is related to the ecological site design as a determinant of urban ecology. In this context, certain design issues need to be addressed in new developments to meet requirements for sustainability. Design with climate is one of the most important criteria to be considered.

Each region has its own climatic conditions and cultural patterns, which must be the basis for the solutions in each individual case. In fact, each country or region has a traditional settlement and building form or 'vernacular architecture'. Since these cases embody a great deal of experience, wisdom, and cleverness, the layout, basic design, and orientation of older buildings are worth studying in some detail for valuable clues and ideas. In particular, vernacular architecture is almost always climatically appropriate. Protection from sun and heat plays an important role in the areas with a hot climate during the summer months, while the problems of areas with a cold climate are quite different.

To this end, this paper attempts to evaluate the housing settlements in Northern Cyprus where the vernacular urban and architectural patterns provide useful hints for designing more sustainable environments. In this context, the courtyard, the element providing the most significant climatic utility in a hot climatic region, will be introduced as a design tool for the new developments. © 2002 Elsevier Science Ltd. All rights reserved.

Keywords: Design; Climate; Housing; Vernacular; Northern Cyprus

1. Introduction

If we wish to exist in harmony with our environment, we must do by choice what our ancestors did out of necessity, 'design with the climate and with a sense of place'. If we ignore this, we miss out on many sustaining qualities of the natural context of site and surroundings [11].

In general, when climate expertise is part of the planners' skills: the full potential for using solar energy is realized, air drainage patterns carry pollutants away from residential areas, city-dwellers enjoy improved levels of climatic comfort, and the site of a new town is chosen to lessen danger from natural hazards.

When deciding how to make an environmentally responsible intervention with a new building within the site, two major site factors must be addressed [1, p. 63]:

- the local climate.
- the environmental impact of the building on the site.

2. The local climate

The use of characteristics of local climate in housing is not a new innovation. Historically, it dates back to the fourth century BC in Greece and probably much earlier than that. As Vitruvius (110 BC) pointed out, "we must at the outset take note of the countries and climates in which buildings are built".

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PII: S0360-1323(01)00086-5

Fig. 1. Typical residential street in a Roman town [4, p. 79].

Ancient builders learned to design houses to take advantage of the sun's energy during the moderately cool winters and to avoid the sun's heat during the hot summers. Thus, solar housing came into being — designing buildings to make optimal use of the sun by responding to its changing positions during different seasons. The Greeks knew that in winter, the sun's path was in a low arc across the southern sky and, therefore, openings could capture much needed heat. In summer, the sun's path was much higher overhead so roof overhang provided shading. The fact that most early buildings were made of stone supported the storage of solar energy.

Early evidence also shows that solar principles and other local climatic qualities were used not only for single, isolated villas but for groups of houses within an urban context as well. Hippocrates, for instance, suggested that facing east would be the healthiest quality; facing south is acceptable too. Vitruvius, on the other hand, concerned with prevailing wind, suggested that broad streets would be open to the winds, but the narrower ones would be protected [2,3]. As in Greek towns, most streets in Roman towns had walls of stuccoed brick with few openings. Shadows kept them cool despite the bright sun (Fig. 1). They were usually 12–20 f wide. The side walks were usually 12–18 in above a paved street surface, and at the intersections of streets there were stepping stones at sidewalk level, with enough space left between them to let pack animals and the wheels of carts pass. For safety along residential streets, windows customarily were restricted to upper floors, which often projected over the street. In late Roman times many cities built colonnades along both sides of their principal streets [4]. This principle has been the norm for many urban settlements in the Mediterranean region as a perfect solution to prevent pedestrians from the climatic elements and enrich the street space. Villages and small towns were planned to receive benefits of the sun with optimal community and building plan shapes, east/west street orientations, and good solar access to most buildings and outdoor public places.

Many problems can be avoided if careful work is done at the city and site planning level to reduce the effects of the most annoying climatic factors. Types of undesirable weather conditions vary considerably from area to area and country to country. Each region has its own climatic conditions and cultural patterns, which must be the basis for the solutions in each individual case. Protection from sun and heat plays an important role in the areas with a hot climate during the summer months, while the problems of areas with a cold climate are quite different.

3. The environmental impact of the buildings on the site

Ecological site planning allows appropriate levels of natural daylight and solar radiation into each dwelling unit. Each dwelling unit will require a relatively unobstructed southern exposure, and the building design itself will need to ensure that winter sun can enter to warm the interior while higher-angle summer sun is excluded to keep the unit cool. The buildings should be considered in relation to the site and their relationship with other buildings on the site. Aspects such as aesthetics, over-shading, self-shading, climatic variations, vegetation and pollution should also be examined to avoid negative effects on existing and new buildings. An overall site strategy for energy use and the potential for an integrated energy policy for the site should be evaluated at an early stage — e.g. the use of waste heat, the potential to generate electricity on site using a combined heat and power scheme, renewable energy, etc. In other words, the site should be considered holistically and not each building in isolation [1, p. 64].

In this context, the designer may start work before a large building is constructed on or near a particular site, or the site may not yet have been cleared of buildings. Even when conditions on and around the site offer no such problems, it is seldom possible to obtain even one year's measurements. It is necessary, therefore, to use those methods which allow the extrapolation of predicted conditions based on established principles regarding the behavior of the microclimate, and superimposed on the general climatic conditions of the location. [1]

[1] A standard reference on microclimatic conditions is Rudolf Geiger, *The Climate Near The Ground* (Cambridge, MA: Harvard University Press).

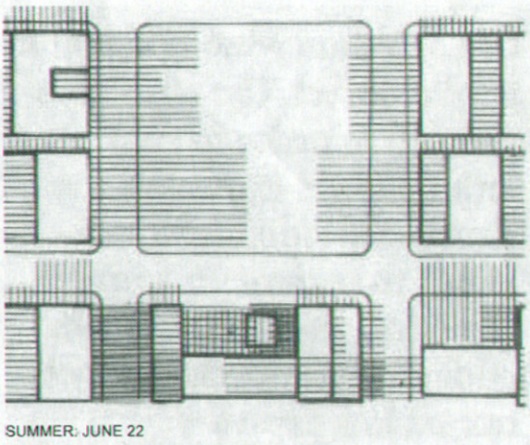

Fig. 2. Site analysis of a hypothetical site showing how adjoining buildings cast shadows, as shown for the extremes of winter, summer, and the equinoxes at the latitude of Indianapolis [4, p. 219].

By simple geometrical principles, the shadows of existing or proposed buildings which fall on the site, can be determined and charted for different times of the year (Fig. 2).

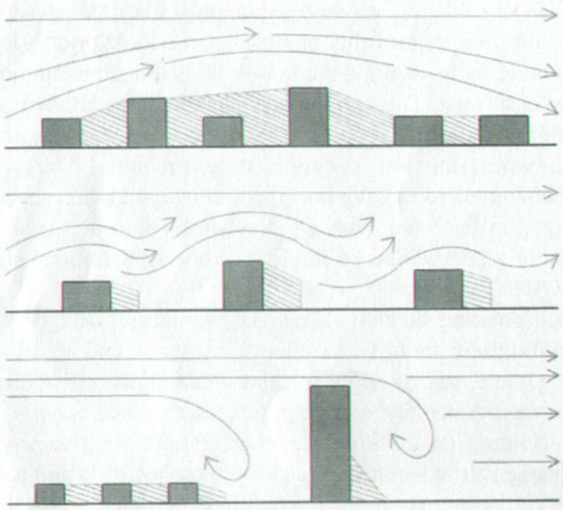

Fig. 3. Movement of wind in low, densely built areas and areas with tall freestanding buildings.

Sites that open to the south or north may have equivalent conditions throughout the year, with the west portion sunny in the morning and shaded in the afternoon. Differences in the amount of sunlight falling on part of a site may well be the deciding factor in determining that area's function. It is often found that a critical role is played by a tall building that is not even adjacent to the site but casts a very long shadow. The direction of sunshine is the only element of microclimate that can be determined with accuracy [4, p. 218].

Estimating the microclimatic influences of wind is more difficult and uncertain. In places where the wind and the accompanying cooling are the main problem, the density and the heights of the buildings are significant in reducing the effects of the most annoying weather conditions. Wind tends to bypass low, densely built areas, but it is caught, directed downward, and intensified by tall freestanding buildings (Fig. 3).

On the other hand, each region of the country has a traditional building form or 'vernacular architecture'. The vernacular has traditionally been described as those forms which grow out of the practical needs of the inhabitants of a place and the constraints of site and climate. We can learn a great deal about the relationship between buildings and sites from the vernacular examples.

The traditional dwelling in countries with colder climates is often sited just below the brow of the hill on a southward slope, protected by the hill, which is often supplemented with a shelter-belt of trees. The northern face of the building usually has only a few openings, whereas the southern façade contains the main openings, thus maximizing the benefit of the limited sunshine. This common-sense approach to the sitting of a building and its internal organization mitigates the worst effects of a cold winter climate,

and has valuable lessons for the greening of building design. It would appear from this model that the ideal orientation for a building in such a climate is with its long axis running along east–west. The northern facade should be fronted by accommodation not requiring good views or lighting and rooms where only low level of heating is required. The type of accommodation facing north would be circulation space, storage, toilets[2] and, possibly, kitchens. The rooms with a southern aspect would be the living rooms, bedrooms, and study/work spaces.

Incorporating suitable elements of vernacular design into a building will improve its energy efficiency and comfort. For example, adding adobe or other thermal mass to houses in the deserts can make them much easier to keep cool.

Depending on the climate, other features such as wide overhangs, airlock entries, arcades or porches, atria and natural ventilation may boost the building's efficiency.

One aspect of vernacular architecture that is frequently overlooked is building color. Roof color, especially, may substantially affect a building's energy use. In a hot climate, a white or light-colored roof, in combination with well-placed shade trees, can lower the building's cooling load by 30%.

4. Climatic considerations in Cypriot settlements

The climatic characteristics of Northern Cyprus can be examined in four main regions: Lefkoa (Nicosia) inland, Gazimagusa (Famagusta), on the eastern coast, Girne (Kyrenia), on the northern coast, and Güzelyurt on the western coast. Although these regions are in the same climatic zone (semi-arid Mediterranean climatic zone) and not too far from each other, they demonstrate different climatic conditions; hot–arid, hot–humid and composite climates. This is due to the geographical qualities such as topographical values and proximity to the sea.

In the case of vernacular Cypriot settlements, the response to heat has resulted in similar regional solutions to the problems of living in climatically difficult environments. Houses in towns and villages were grouped close together to shade each other from the midday sun (Fig. 4). The ratio of building height to street width created a protected space (especially in the hot summer months), making walking comfortable and allowing the residents, especially the women, to sit in the street (Fig. 5).

In vernacular Cypriot houses, there are a rich variety of open and semi-open spaces, such as open-to-sky courtyards, *verandas* at the front and *sundurmas* at the back, all with access to greenery. In a courtyard, *avlu* in Turkish, and *havli*

[2] However, when locating toilets, the dominant wind direction needs to be considered as well. Toilets should preferably be placed on the 'negative wind pressure' side to prevent odor coming into the rest of the dwelling. If an appropriate location is not possible to arrange, certain design mechanisms should be applied to avoid negative consequences.

Fig. 4. The map of a traditional quarter in Gazimagusa (Famagusta).

in local Cypriot Turkish, compared to other kinds of open terrain, the sense of enclosure and small scale is easily manipulated, and given a mixture of hard and soft treatments. Greenery is especially desirable for the shade it provides, the heat gains that it prevents and the relief it gives to the eye. Dixon [16] described that in the past, every family in Lefkosa (Nicosia) had a courtyard with a date palm, a pomegranate, a lemon tree and water.

The well-defined, open-to-sky courtyards of the houses formed climatically comfortable spaces for the dwellers, and included diverse functions such as social gathering and entertainment for the afternoons and evenings, food preparation and domestic works during spring and summer days, drying laundry, etc. (Fig. 6). During the hot summer months, the courtyard traps the dense, cool air in the center of the house, helping air circulation and bringing down the general temperature inside. With its trees, flowers and small vegetable plot, the *avlu* is the closest relation the house has to nature; and thus it also provides the inhabitant with direct access to nature [5]. Trees, as Nature's own evaporative coolers, are the important components of the courtyard; they also filter blowing dust from the air. Date-palms are successfully integrated into the space as their forms, with branches far from the ground, do not impede air movement. The function of shade is also performed by the walls enclosing the open space, while maintaining the courtyard's status as a 'light-well' for the building [5,6].

However, a centrally located courtyard may not be appropriate for the houses in a hot–humid climate, due to the need for stronger cross-ventilation.

Thus, satisfying the climatic needs, these spaces were efficiently used as 'outdoor rooms' for varied purposes. As the climate is appropriate, the upper terraces of the houses were used for drying food and airing clothes as well. The semi-open spaces of the typical Cypriot house such as *sofa*, the open hall as the core of the house, and *sundurma*, a semi-open space at the back of the rich people's house, were

Fig. 5. The street in the traditional quarter of Gazimagusa (Famagusta).

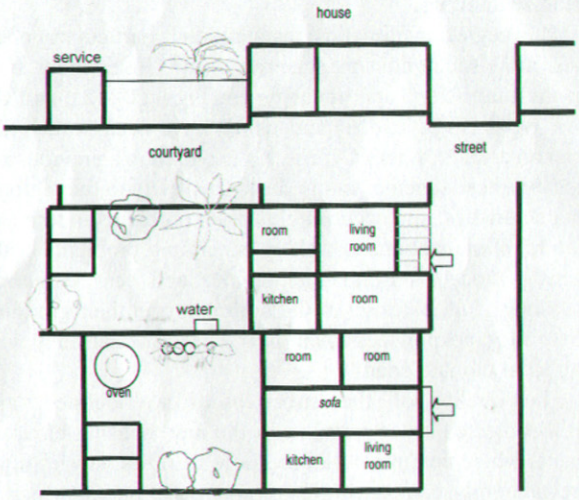

Fig. 6. Typical plan of a courtyard house.

Fig. 7. Courtyard of a rich family house: view to the *sundurma* [7].

perfectly appropriate for the climate and extensively used by their residents too [5,6] (Fig. 7).

One particular example of settlement pertaining to the local traditional values is Akdogan (Lysi) situated in the flat land of the Mesoria Plain.[3] The climatic aspects of this village, as in the whole region, reveal the characteristics of a hot–arid climate [8], such as:

- hot summers and moderately cold winters,
- intense heat in the day-time,
- often intense cold at night,
- minimal annual rainfall with very high summer aridity,
- sparse or non-existent vegetation except along water-courses,
- limited water supply.

In line with these characteristics, site planning, orientation and formation of buildings, vegetation, interior ventilation, and building material were carefully selected in the village.

Pure geometrical forms are used in the design of houses, as convenient in hot climates, due to the quality of air insulation. Living spaces of the dwellings are generally oriented

[3] Design with climate was one of the issues discussed in the graduate course 'Sustainable Developments' at the Faculty of Architecture of EMU (Spring Semester, 1998–99) supervised by the author. The related case study was carried out by Nazife Özay and Saziye Hafizoglu.

Fig. 8. Vernacular houses in Akdogan, Mesoria, Northern Cyprus (Photo: N. Özay & S. Hafizoglu).

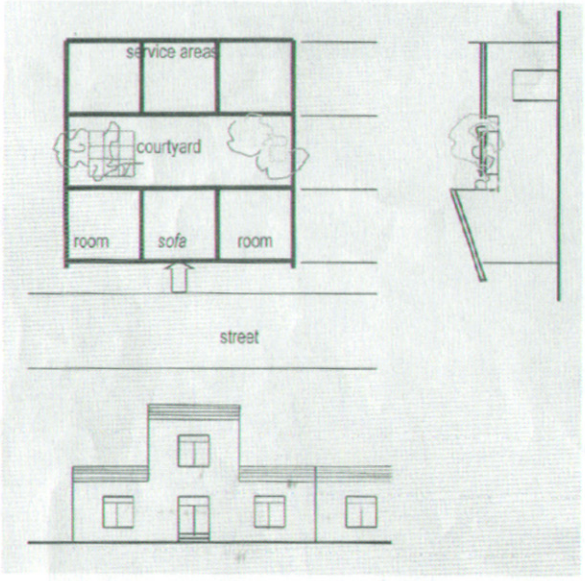

Fig. 9. Typical plan and elevation of an Akdoan (Lysi) in house.

towards the south direction. Courtyards of the dwellings provide a variety of vegetation such as wine grapes, lemon, fig, pomegranate and pine trees. Vegetables are grown for the use of the residents. All this vegetation provides evaporative cooling, and shading in hot days. Traditional building material 'adobe' is widely used in the village, as it is locally available in the Mesoria Region. It provides energy efficiency, re-cycling and flexibility (Fig. 8).

External building color is also consciously used on the houses, like in all Cypriot houses, as another important characteristic of vernacular architecture. Due to its effect on the building's energy use, a white roof is preferred; the outer walls are light in color as well, in order to reflect sunshine.

The typical layout of the house consists of three parts: the main building (living spaces), the secondary building (service areas), and the inner courtyard (Fig. 9).

Main building comprises three equal size rooms: a living room which has a direct connection to the street and a room at each side, which are used as bedrooms. In the two-story house, a staircase from the living room leads to the bedroom on the second floor. Owing to the narrow plan, each room has an opportunity of cross-ventilation by means of windows placed in the 'outer' and 'inner' (between house and courtyard) walls.

The inner courtyard which is screened from the street by high walls (about 1.5 m.) seems to be the heart of the house around which the main building and the service rooms are located. However, there still is an opportunity of cross-ventilation through the opening to the street above the walls. The service part includes kitchen, storage and WC-bathroom. Animal barns are also placed in this area, and an earth oven is also included.

However, when we look at the new housing developments, climatic conditions of the island do not seem to be considered at all, not only in the orientation of the dwelling units, but also in the formation and arrangement of residential buildings. The thermal appropriation of the buildings which is determined by the building envelope, the material and the design of the outer walls, has not been consciously dealt with either.

This neglect in climatic consideration is particularly obvious in the social housing schemes of the Government, both in the multi-story apartment types (Figs. 10–12), and the row-types (Figs. 13–16) and which have been built in the four areas of Northern Cyprus. As explored in a previous paper [9], these schemes firstly, lack sensitivity to the regional characteristics, and accordingly create problems in terms of natural climatization, as well as generating problems in the sense of 'local/environmental identity' and 'sense of place'. Secondly, in the design of the buildings and their grouping there is no acknowledgement of the need for harmony with the local climate conditions.

The quality of the street as a well-defined, and well-protected space was lost in the new housing environments where apartment blocks, more than four stories high, are randomly composed. The new type of street, which is merely a vehicular channel, rather than a space defined by walls of buildings, cannot provide any shading opportunities, and makes walking arduous in the hot period, lacking three-dimensional qualities, neither does it provide a sense of place. [4]

Considering the dwelling units and their relationships with the exterior spaces, the orientation is a great problem in

[4] The results of a survey (1999) comprising 100 students of Architecture at EMU revealed that only 15 percent of the students mentioned the street in which they live, when they were asked to evaluate their home environment within a one-page essay. It is also pervasively observed that, the design of the built environment itself does not easily promote the interest of the residents of the newer settlements in terms of care and improvement in their locality, such as tree-planting, rubbish collecting, etc., due to the lack of sense of belonging to their environment.

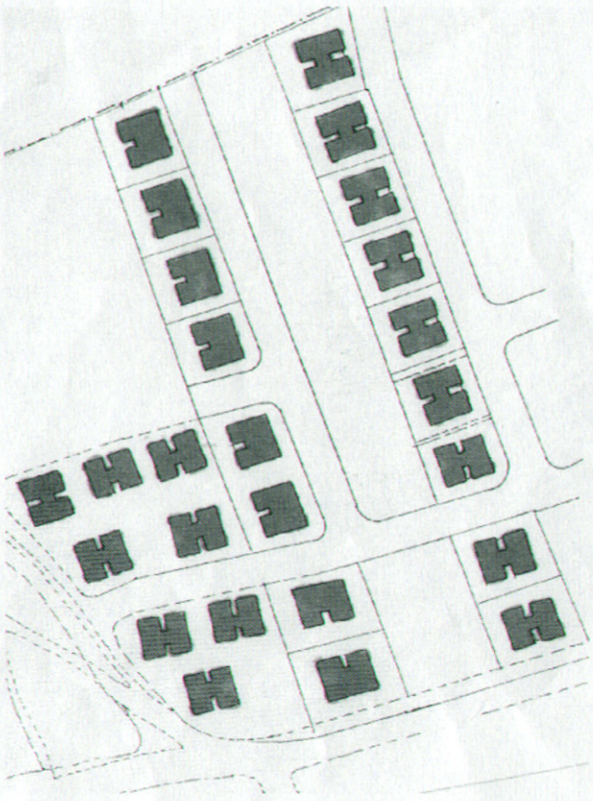

Fig. 10. The layout plan of the apartment-type social housing complex in Gazimagusa (Famagusta).

Fig. 11. The view of a typical street in apartment-type social housing complex.

newer housing schemes. For example, in the row-type housing, the living rooms and patios of the rows on one side of the street face the West, which is the worst direction in terms of sun orientation in Northern Cyprus. The residents of such units cannot use their indoor and outdoor spaces in the afternoons in the hot period.

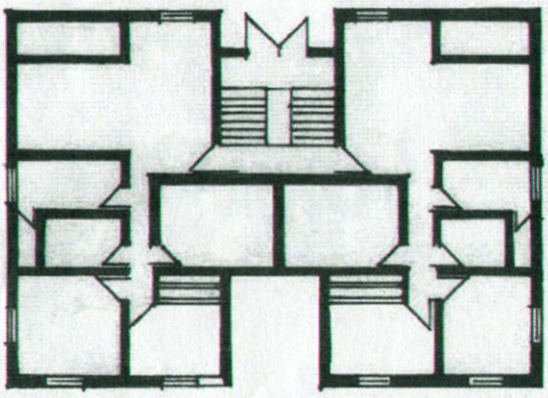

Fig. 12. Typical flat plan of apartment-type social housing complex.

5. Conclusion

It is acknowledged that housing not only satisfies the basic need for shelter, but also satisfies other needs required for sustainability. For a long-term sustainable solution to the housing problem facing most developing countries today, environment and tradition are not only mutually supportive, but also pre-requisite aspects. These aspects should be taken into consideration in both site design and building design.

The evolution of housing as directed by public policy in Northern Cyprus is a good example of the gradual move towards 'non-sustainable' development, which results from 'excluding' the environment and tradition. When designing new housing environments in Northern Cyprus, we need to move towards 'sustainable' development and 'include' environment and tradition [12–15]. Vernacular settlements have much to teach the professionals in terms of evaluating global environment and local tradition, is in respect of ecological site design.

Design with the climate and with a sense of place is a valuable asset for ecological site design, as perfectly achieved in vernacular examples. In this context, the settlement plan and the block designs must form a cohesive and harmonious whole, in which the dwellers will feel at home in the literal sense of the world.

Local climate consideration should address positive and negative aspects of the site. The building orientation should take advantage of free energy from the sun in terms of both heat and light if appropriate. Local wind conditions, direction and strength should be established and accounted for.

In the case of Cypriot settlements, the hot climate of the island brings the possibility for open and semi-open spaces to be used for 9 months of the year. These spaces, therefore, should be carefully designed within a hierarchy of public, semi-public, semi-private and private spaces. The multi-purpose street as a protected space, and the multi-functional open-to-sky courtyard, provided that it is open to cross-ventilation, together with the other forms

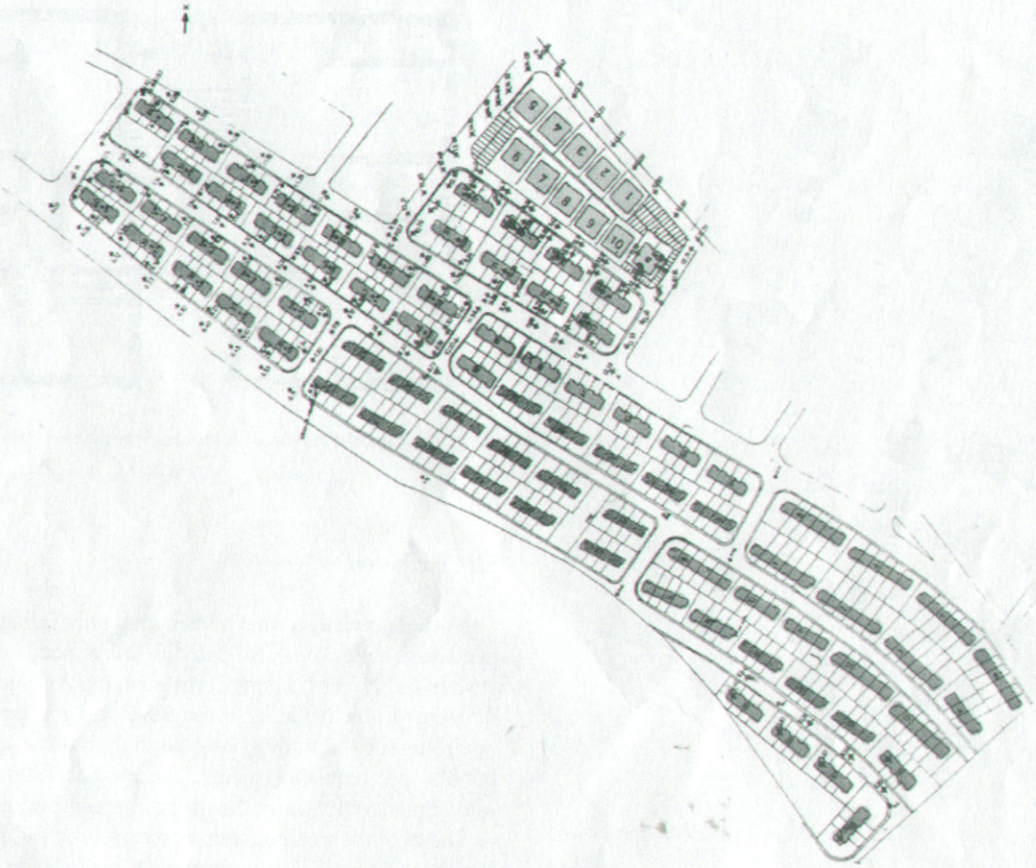

Fig. 13. The layout plan of the row-type social housing complex in Gazimagusa (Famagusta).

Fig. 14. The view of the row-type social housing complex in Gazimagusa (Famagusta).

Fig. 15. The view of a typical street in the row-type social housing complex.

of exterior spaces, like the *veranda* and *sundurma*, of the vernacular settlements, provide useful clues for today's environments. When a more flexible design is possible, these traditional outdoor spaces should be interpreted and modified in the new housing developments. Considering the increase in land prices and in density compared to the past, the solution of multi-story residential blocks seems to be essential in new areas of expansion. However, such

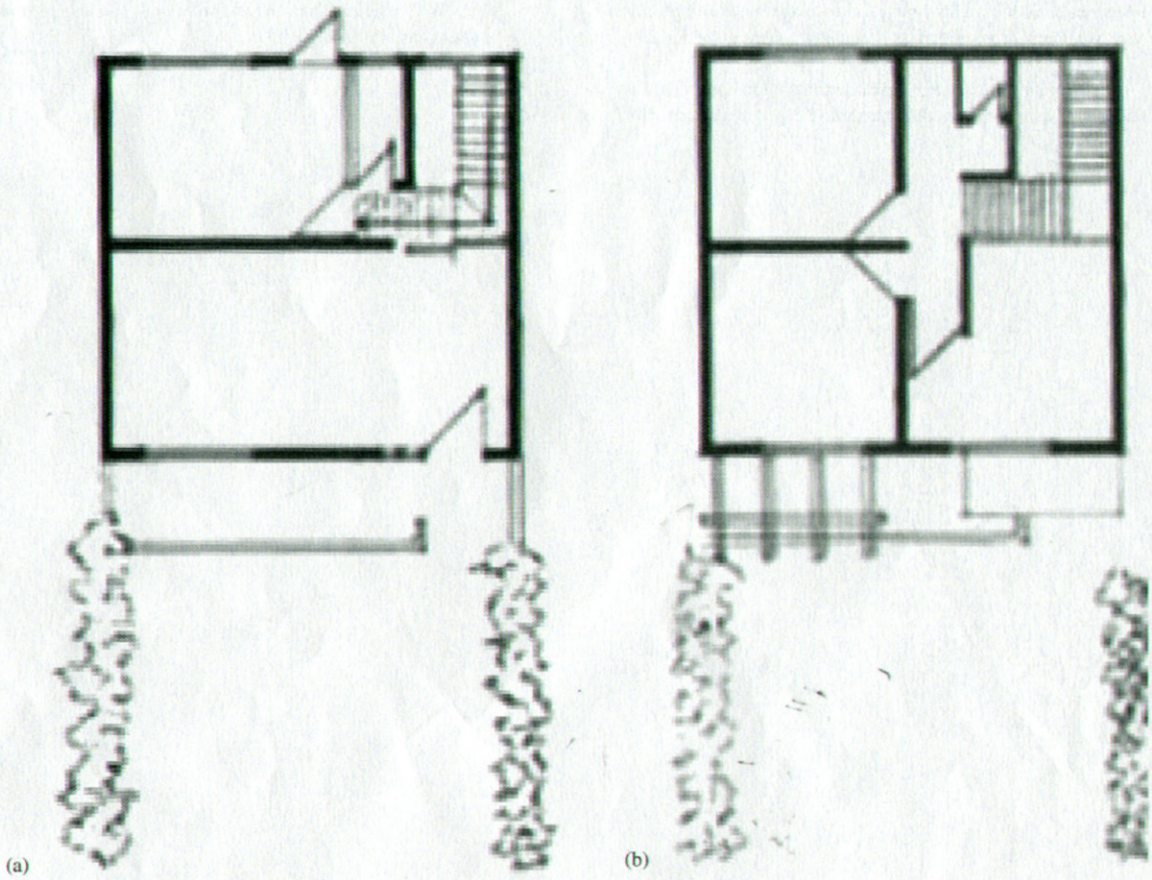

Fig. 16. Typical house plan of row-type social housing complexes.

blocks may still be climatically appropriate and on a human scale. They can be arranged as buildings of different heights around a multi-purpose courtyard, which is visually well-defined but open to the summer breeze; this will act as a private or semi-private space for the dwellers and bring a sense of place. In this context, the use of appropriate vegetation should not be neglected. Trees with branches far from the ground, such as date-palms, would be ideal, as they contribute to the identity of Cypriot settlements and do not impede air movement.

These conclusions are also in agreement with the findings of the author's survey-based study [10] identifying the major likes and dislikes of the dwellers concerning the open spaces in their home environment. In line with this and the above discussion, the paper is expected to provide a useful design guide for planners, urban designers and architects in areas with similar environmental character.

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