

269: Bioclimatic elements and design principles of the traditional architecture in northern Greece

Aineias Oikonomou

*School of Architecture, National Technical University of Athens, Athens, Greece
aineias4@yahoo.com*

Abstract

The main goal of this paper is to explore the design principles and analyse the bioclimatic elements of the traditional buildings in rural areas and urban settlements of northern Greece. These are buildings, which were mainly constructed during the 18th and the 19th century, at a period when this area formed part of the Ottoman Empire. The analysis involves the presentation of the open and closed spaces of the buildings (typology), their form (morphology) and their building materials and techniques (construction). These elements are combined in different ways in the various towns and villages, and depending on their orientation, influence insolation, shading, natural ventilation, as well as thermal and visual comfort conditions in the different spaces of the buildings.

Keywords: traditional architecture, northern Greece, environmental performance

1. Introduction

The traditional architecture of every area is based on the accumulated experience and practice of many centuries and can constitute a continuous source of knowledge. The use of local materials and the harmonisation with the local environment and climate are some of the factors, which contribute to the distinct architectural identity of every area.

This study aims at detecting, documenting and analysing the bioclimatic elements and the design principles of the traditional architecture of the 18th and 19th century, in northern Greece. First, the different aspects of the traditional architecture, namely the typology, the form and the building materials and techniques, are analysed. After that, the bioclimatic function of the different elements based on issues of thermal and visual comfort throughout the year, is presented. Finally, general conclusions are drawn in order to outline the design principles of this architecture.

2. Presentation of the study

2.1 Climatic data

Northern Greece is an area with relatively uniform climatic characteristics and a climate, which is characterised as continental and is affected by the presence of large mountainous areas. In most parts, the climate is characterised by cold to very cold winters and warm summers. Relative humidity varies according to the presence of large water bodies. The prevailing winds during the winter are mainly northern, whereas during the summer have different directions. [1]

2.2 Analysis procedure

The traditional houses in northern Greece are divided in two general categories: rural and

urban, the former of which is further divided into houses in mountainous areas and houses in the plains. This categorisation is mainly based on the different design of rural and urban houses, as well as on the different available local materials. Furthermore, rural and urban settlements are characterised by completely different socio-cultural conditions, which in, turn shape and affect the design and the construction of the house.

For the different settlements, the analysis involves the presentation of the open and closed spaces of the buildings (typology), their form (morphology) and their building materials and techniques (construction). It should be noted that apart from local particularities, the traditional buildings in question are characterised by remarkably uniform typological characteristics. This fact, along with the similar climatic conditions, renders possible the formulation of generalised observations and facilitates the drawing of conclusions.

2.3 Methodology

The data, which is used for this study, is based on a series of field trips both in rural settlements and in urban centres of northern Greece, where a substantial number of traditional buildings of the 18th and 19th century still exists. The urban centres, which are included in the study, are the towns of Trikala, Siatista, Eratryra, Kozani, Kastoria, Florina, Edessa, Veroia, Thessaloniki, Kavala and Xanthi, whereas the rural settlements include a number of small villages situated in the wider area of north-western Greece, namely Florina and Kastoria.

The field trips involved a detailed photographic record of the remaining building stock, as well as an informal analysis of the typology and the morphology of the buildings. Furthermore, materials and construction techniques were

identified and analysed. All the above-mentioned observations are combined with a bibliographical study of the traditional architecture of the wider area of the south-eastern Mediterranean during the 18th and the 19th century. Furthermore, for the buildings in the town of Florina, which was the object of a PhD thesis [1], extensive bioclimatic analysis was performed, based on both in-situ measurements and the use of software.

3. Bioclimatic elements and design principles

3.1 Typology

The typology of the traditional houses of northern Greece is based on three basic elements: the private room (*oda*), the open space (*hayat*) and the closed, common space (*sofa*). [2,3] The private room (*oda*) is a closed living space with a square plan, which houses all the basic functions of the family life, such as eating, sleeping, and receiving guests. [2] The *hayat* is a semi-open, transitional space, with a rectangular or square shape, which, sometimes extends between the rooms of the house in the form of an *eyvan* taking a T-shape. [2] Its bioclimatic function concerns the insolation during the cold, winter period, the shading during the summer and the natural ventilation. In this way, the *hayat* is used throughout the year for circulation, for every-day activities, such as cooking and drying of agricultural products, and for resting during the hot, summer period. Finally, the *sofa* is a closed, common space with rectangular shape used for circulation and/or social gatherings and events, similar to the hall of the Anglo-Saxon traditional house. [2]

The three, afore-mentioned elements are combined in the plan and form three basic building types: the type with a *hayat* (outer sofa), the one with an inner sofa and the one with the central or cross-shaped sofa. [2,3]

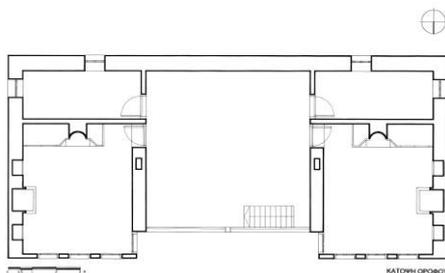


Fig 1. Plan of a house with an inner hayat in Florina

The *hayat* is the most common and important element in rural buildings in a wide geographical area, which includes Turkey, Northern Greece and the southern parts of the Balkan countries. In northern Greece, the type with the *hayat* is mainly found in the rural settlements, which are situated in the plains, and, sometimes, in mountainous, cattle-breeding settlements. (Fig. 2) These houses have two or three rooms with a linear *hayat* in front of them.



Fig 2. Hayat house in Psarades

This type is also found in some urban centres (Kastoria, Veroia, Edessa and Xanthi), where, during the 18th century, large mansions with open rectangular or T-shaped *hayats*, were constructed. Later, these *hayats* were closed with windows and were transformed to closed, solar spaces. (Fig. 3)



Fig 3. Mansion with a closed hayat in Kastoria

During the 18th century in other urban centres, such as Siatista, Eratyra and Kozani, and during the 19th century in Kastoria, Florina, Veroia and Thessaloniki the prevailing building type is the one with the inner sofa. (Fig. 4,5) These houses are symmetrical with one or two rooms on both sides of the hall. This is also the most common building type in the mountainous areas, as well. (Fig. 6)

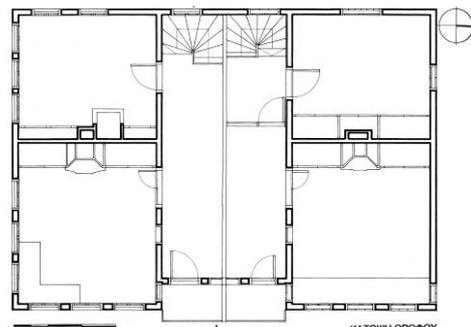


Fig 4. Plan of a house with an inner sofa in Florina



Fig 5. House with an inner sofa in Florina



Fig 6. House with an inner sofa in Pisoderi

The third building type, with the central, cross-shaped sofa is not as common as the other two and can be found only in some large mansions of the most important urban centres (e.g. Kastoria, Veroia and Xanthi) (Fig. 7) and of wealthy mountainous settlements (e.g. Nymfaio).



Fig 7. Mansion with a central sofa in Kastoria

3.2 Form

The basic morphological elements of traditional buildings are the projections (*sahnisi*) of the summer closed living spaces (*odas*) and the projections (*divanhane*) of the circulation space (*sofa*). These element are found in both rural (Fig. 8) and urban buildings. (Fig. 9)



Fig 8. House with projections in Kranionas



Fig 9. House with projections in Thessaloniki

Apart from that, the form of traditional house is defined by the shape and the number of windows on the main and secondary facades. During the 18th century, the styles of the Tulip period and the Turkish Baroque are characterised by many small windows with shutters and separate upper course windows. [4] Typical 18th century houses are found in Siatista (Fig. 10), Eratyra, Kozani, Kastoria and Veroia.



Fig 10. 18th century mansion in Siatista

During the 19th century, the Imperial Style dictates larger openings (proportion 1:2) with neoclassical decorative elements, without separate upper course windows. [4] Typical specimens of this period can be seen in Trikala, Eratyra, Kastoria (Fig. 11), Florina (Fig. 12), Veroia, Thessaloniki, Kavala and Xanthi.



Fig 11. 19th century house in Kastoria



Fig 12. 19th century house in Florina

3.3 Building materials and construction techniques

In rural settlements, the choice of building materials depends solely on the geomorphologic characteristics of the ground. In the mountainous settlements, the main construction material is local stone. There are two-storied buildings constructed with granite or lime stone depending on local availability. (Fig. 13) On the contrary, the main construction material in the plains is adobe. (Fig. 14) In both cases, construction is simple and includes horizontal wooden framework in normal increments.



Fig 13. Large mansion in Nymfaio built with stone



Fig 16. Restoration of a mansion in Kastoria



Fig 14. House in Ano Kranionas built with adobe

In Florina, exists a local structural system. The thick ground floor walls are built with local river stone or adobe bricks and comprise a wooden infrastructure of post and tie beams. (Fig. 17) In the old towns of Edessa (Varosi) and Veroia (Barbouta), the houses are constructed with local porous stone on the ground floor and timber-frame with adobe bricks or lath and plaster on the upper storey. (Fig. 18)

In urban settlements, the construction of the houses includes all the above building materials. The structural elements of the ground floor are usually walls made of local stone or adobe bricks. These walls are 60 to 65 cm thick, and have an average height of 240 to 300 cm. The construction includes horizontal structural wooden elements. On the other hand, the structural elements of the upper floor are usually lightweight walls, which are called *tsatmas*. These walls are 20 cm thick, and are formed by a wooden frame structure, which is filled up with adobe bricks, or, in some cases, small stones and mud. The wooden frame structure comprises of horizontal, vertical and diagonal beams, with dimensions 8 x 8 cm or 10 x 10 cm.



Fig 17. House in Florina built with the local structural system

For instance, in Siatista and Eratyra, the main construction material is local limestone, but the upper storey is usually constructed with fired clay bricks. (Fig. 15) In Kastoria, there are three-story buildings, where the first levels have thick stone walls, while the upper storeys are constructed with timber framed structure with lath and plaster finishing (*bagdati*). (Fig. 16)



Fig 15. House in Eratyra built with stone and lightweight timber frame walls filled with fired clay bricks



Fig 18. Houses in Veroia built with local porous stone and lightweight timber frame walls

3.4 Orientation

The orientation of the buildings mainly depends on the place. In rural, mountainous settlements, it depends on the slope of the mountain. In most cases, villages are built in south-facing slopes, unless security issues prevail. In rural settlements in the plains, the houses are usually situated towards the south. In this way, the orientation of the hayats is mainly southern, even though there are also cases of north-facing hayats.



Fig 19. Northern main façade of a house in Florina

On the contrary, in urban centres, the orientation is often “overshadowed” by socio-cultural issues. Houses are situated parallel to the street fronts and the main (street) façade is designed accordingly. (Fig. 19) Nevertheless, even in this case, the need to exploit the favourable orientation affects the design, leading, for instance, to the creation of many windows in the back, hidden southern façade. [1]

3.5 Thermal comfort conditions

Thermal comfort in the traditional house largely depends on the construction materials and on the number of windows, as well as on the strongly adaptive behaviour of the users. Winter rooms, which are usually situated on the ground floor, have thick stone or adobe walls (see Table 1) with few and small windows in order to minimise thermal losses during the winter (see Fig. 20). Summer rooms are placed on the upper storey, where the design, the light-weight, timber-frame construction along with the creation of many windows and openings helped achieve efficient natural ventilation and night cooling (see Fig. 21). This explains why the upper storey was a preferred location during the summer nights.

Table 1: Thermophysical properties of typical wall construction in northern Greece. [1]

	Thickness (cm)	U-value (W/m ² K)	Time lag (h)
Limestone	60	1.76	14.9
Adobe	60	1.02	17.6
Tsatmas	20	2.24	5.7

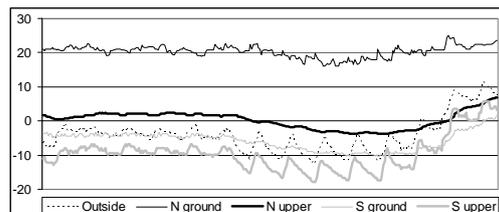


Fig 20. Winter temperature measurements in a typical house with inner sofa in Florina

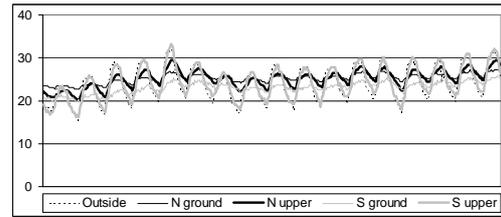


Fig 21. Summer temperature measurements in a typical house with inner sofa in Florina

3.6 Visual comfort conditions

Visual comfort conditions in the open and semi-open spaces of traditional houses largely depend on the dimensions and the number of windows. The winter rooms, which are usually situated on the ground floor, have thick walls and few openings in order to minimise the thermal losses during the cold period. As a result, the amount of daylight, which reaches the winter spaces, is significantly reduced. On the contrary, the need for a proper social image, along with the need for daylighting and natural ventilation resulted in the creation of many, large windows in the upper storey, where the summer rooms were situated (see Fig. 22).

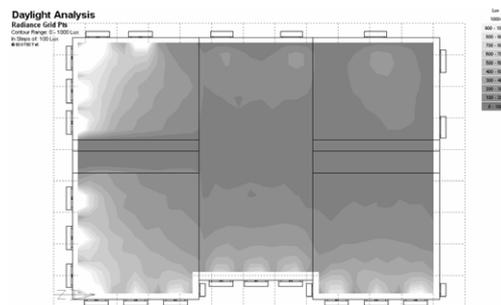


Fig 22. Summer daylighting analysis in a house with an inner sofa in Florina

In the hayats, the daylighting levels are very high throughout the year regardless of the orientation and the sky conditions (clear or overcast). This is due to the absence of opaque elements in the façade. (see. Fig. 23) Nevertheless, it should be noted that the conversion of the hayat into a closed solar space drastically affects daylighting conditions. [1]

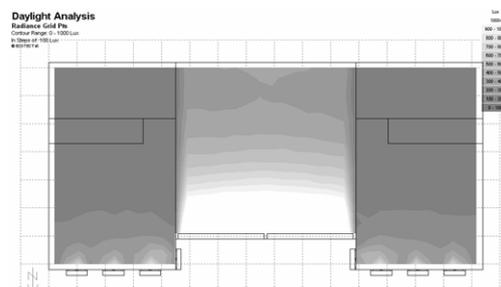


Fig 23. Summer daylighting analysis in a house with an inner hayat in Florina

In the main rooms (oda), daylighting levels and distribution depend on the presence of windows on one or more external walls. When windows are created in two perpendicular external walls,

as in the case of corner projections (*sahnisi*), the area of adequate daylighting levels is extended and the distribution is improved.(Fig. 22) Finally, the projection (*divanhane*) of the circulation space (*sofa*) can have windows on its three sides resulting in even better daylighting conditions. [1]

4. Conclusion

It would not be right to argue that climate and materials are the parameters, which define the design of the plan and the facades of the traditional house.

As Rapoport stresses, the form of the house is defined by a series of socio-cultural factors and is shaped by climatic conditions, the available materials and the construction techniques. Materials and techniques do not affect the building type or the basic form, but facilitate or rule out certain construction decisions. Similar sites can lead to different architectural forms, (Fig. 24, 26) while similar forms can be found on different sites. (Fig. 24,25 and 26,27) [5]



Fig 24. Hayat house in Psarades built with stone



Fig 25. Hayat house in Gavros built with adobe

Nevertheless, it is clear that the traditional architecture of northern Greece is characterised by proper southern or south-eastern orientation of the buildings and by the exploitation of the prevailing winds. At a large extent, these buildings are oriented in such a way that the best possible exploitation of solar radiation for passive solar heating, as well as for daylighting of the living spaces is achieved. Furthermore, even though only local building materials are used, these are integrated in construction elements with thermal characteristics (density, heat capacity, time-lag) that improve the inter-seasonal thermal behaviour of the various spaces.

Finally, due to restricted means (economical, constructional, etc.), compromises are made in many cases. The small number of windows on

the winter (ground floor) rooms is a direct effect of the compromise between thermal and visual comfort. The diurnal and inter-seasonal use of the different spaces is a direct effect of the limited energy resources.



Fig 26. House with sofa in Psarades built with stone



Fig 27. House with a sofa in Miliona built with adobe

Today, with the reserves of conventional energy sources drastically depleted, it is imperative to look into the past for guidelines and solutions. In no way is it suggested to copy-paste traditional building types, forms and materials into the present. What is apparent, though, is the need to integrate the elements and principles, which were outlined in this paper, into the contemporary architecture.

5. Acknowledgements

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