Learning from the Past:
Environmental aspects of the traditional settlements of Mt Verno, Greece

AINEIAS OIKONOMOU[1, 2], FLORA BOUGIATIOTI[1]

[1]School of Architecture, National Technical University of Athens, Athens, Greece
[2]Department of Architecture, University of Patras, Patras, Greece

ABSTRACT: The main goal of this paper is to explore the environmental aspects that characterise the architecture (typology, morphology, materials and building techniques) of the various traditional settlements that are situated in the wider area of Verno mountain, in north-western Greece. These settlements were mainly constructed during the 19th century, at a period when this area formed part of the Ottoman Empire, and are mostly rural situated in the planes and in the mountains. The analysis involves the presentation of the open and closed spaces of the buildings (typology), their form (morphology), their building materials and techniques (construction), as well as the analysis of their bioclimatic behaviour in terms of thermal and daylighting conditions.
Keywords: traditional architecture, north-western Greece, environmental performance

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.

Various researchers have examined traditional and vernacular buildings with respect to bioclimatic and environmental architecture. For the wider area of the Balkan Peninsula, previous studies concern areas of Former Yugoslavia [1, 2, 3], Bulgaria [4], Romania [5, 6] and Turkey [7, 8, 9]. For Greece, earlier studies dealt with vernacular architecture in general [10] and in northern Greece in particular [11]. Finally, for north-western Greece, previous studies analyse the bioclimatic aspects of the traditional buildings, which are found in Florina [12] and other towns [13].

The aim of the present study is to document and analyse the different architectural and environmental aspects of the traditional, rural settlements of an area, which includes the massif of Mt Verno and the plains situated on its north-eastern and south-western sides. First, the typology, the form, the building materials and the construction techniques are analysed. After that, the bioclimatic behaviour of a typical house based on the analysis of its thermal behaviour and daylighting conditions issues throughout the year is presented. Finally, general conclusions outline the environmental aspects of this architecture.

METHODOLOGY

The study is mainly based on a large-scale in-situ research, which included various field trips, and involved the detailed photographic recording of the remaining traditional building stock in 50 settlements. Furthermore, the research included the survey-documentation of representative buildings in some of the settlements. From the collected data, conclusions concerning the typology, the form, the construction techniques and the materials of the buildings are drawn. Bibliographic research is also used for the presentation of the general data of the study area (geographic location, climate, topography, ground composition, historical data), which, due to the restricted size of the paper, are briefly presented. Finally, Ecotect v5.5 [14] and Radiance [15] are used in order to analyse the thermal and daylighting conditions of a typical house and its variations.

GENERAL DATA

Geographic Data Mt Verno is situated in north-western Greece, between the prefectures of Florina (Lat. 40.8N, Long. 21.4E) and Kastoria (Lat. 40.5N, Long. 21.3E), constituting their natural boundary. It has a mean altitude of 1500 m, while its highest peak, Vitsi, is 2128 m above sea level. The planes of Florina and Kastoria, which are situated on its sides, have a mean altitude of 650 m.

The massif is densely vegetated, mainly with beech and oak forests. In the different areas, the ground composition differs and includes limestone, slate and granite.

The traditional settlements of the wider Verno area are situated both on the slopes of the mountain's volume

and in the plains of Florina and Kastoria that surround it. (Fig. 1) In this way, while latitude and longitude values are similar, altitudes vary significantly.

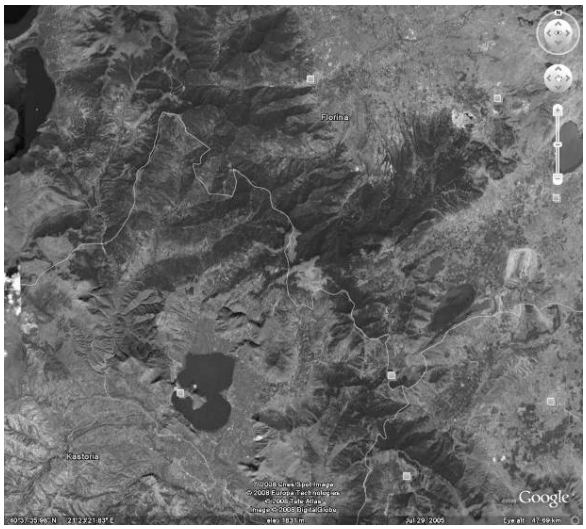
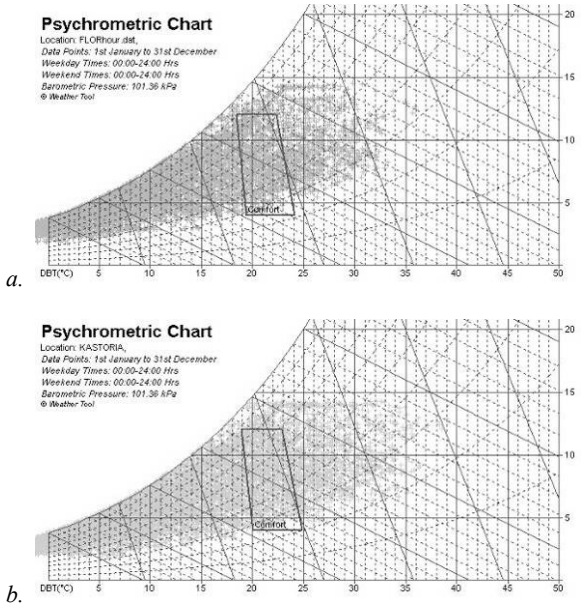


Figure 1: Aerial view of the study area. Source: Google Earth

Climatic Data Mt Verno has a continental climate, which is characterised by long, harsh winters and short, warm summers. The large mountainous volume also affects the mesoclimate of the wider area, which is also characterised by significant inter-seasonal and diurnal differences. The towns of Florina and Kastoria also have a cold continental climate, with long, cold, humid winters and short, warm, and dry summers. (Fig. 2)



a.

b.

Figure 2: Psychrometric charts for: a. Florina and b. Kastoria. [16]

ARCHITECTURAL AND DESIGN ELEMENTS

Architectural Typology The typological analysis involves the design of the plan and its different spaces. [13] In the settlements of the area around Mt Verno, the buildings have two (2) storeys and the most predominant house type has two living spaces and a common, central, semi-open (inner *hayat*) (Fig. 3) or closed space (*sofa*) (Fig. 4). On the ground floor, the central, common space serves for circulation -it includes the staircase to the upper storey-, for storage and/or for stabling. The spaces on its sides constitute the winter living spaces.

Other building types include the closed house with an inner sofa and four living spaces (Fig. 5), and the rural, open hayat house, which has an outer semi-open space in front of two living spaces. In many cases, the hayat is partially or totally converted into closed space (Figs. 6, 7). The type with the hayat was used mainly during the 19th century, whereas the types with the inner sofa were very common at the end of the 19th and during the first decades of the 20th century in the Verno area.

Figure 3: House with an inner hayat in Antartiko.

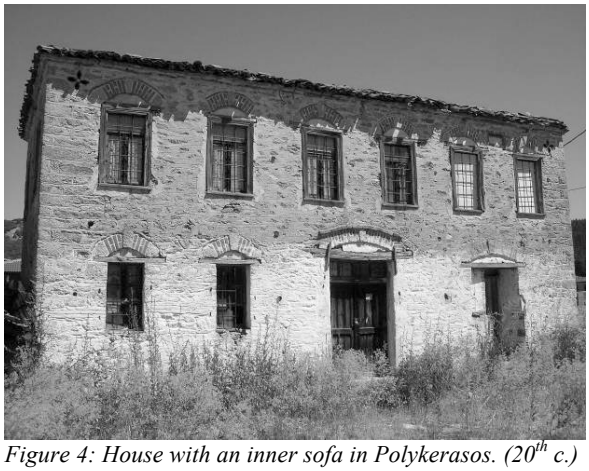


Figure 4: House with an inner sofa in Polykerasos. (20th c.)

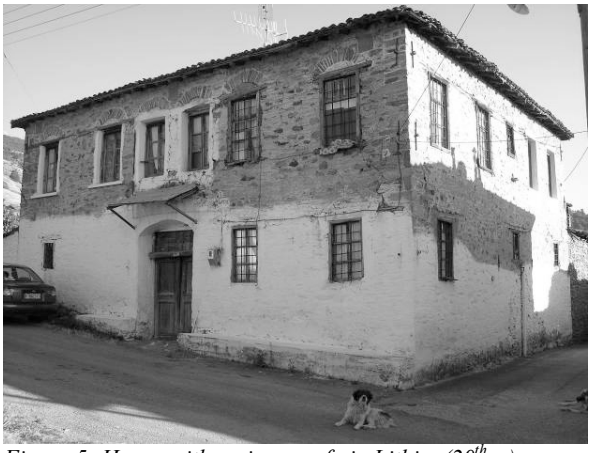


Figure 5: House with an inner sofa in Lithia. (20th c.)

Figure 6: House with an open hayat in Halara. (20th c.)

Figure 7: House with a closed hayat in Melas. (19th c.)

Architectural Form The analysis of the form of the buildings focuses on elements such as the *hayat*, the projections (*sahnisi*) of the summer closed living spaces (odas) and and/or the circulation space (sofa), as well as on the number and geometrical characteristics of the windows.

In most settlements, the house form is very simple and comprises two openings per elevation, in every living space. There are settlements, where the openings are specially formed with stone or fired-clay brick arches. (see Fig. 4, 5, 8) In some cases, specific morphological elements such a central projection of the inner sofa (Fig. 8, 9) or a central, wooden balcony are seen, along with a central, small pediment. Finally, a characteristic morphological element, which is often noticed, is the use of building guild symbols (crosses) made of ceramic tiles in the upper corner of stone walls. (see Fig. 8)

Figure 8: House with a projection of the central space and pediment in Aetos. (20th c.)

Figure 9: House with a projection of the central space and pediment in Sklithro. (20th c.)

Materials and Construction Techniques In the different settlements, the materials vary depending mainly on their location. (Fig. 10) In this way, rural buildings are constructed with adobe bricks in the plains (Figs. 3, 6), and with local stone in the mountainous areas (Figs. 4,5,8,9,11,12), whereas examples of mixed construction (stone or adobe walls in the ground floor and timbre frame walls filled with adobe bricks or covered by lath and plaster in the upper story) can also be found (Fig. 7).

The construction technique is similar in all the settlements: it is simple and includes horizontal wooden framework in normal increments. Depending on the time of construction, the wooden elements are visible, in the

case of older buildings (19th century), or hidden, in the case of recent ones (beginning of 20th century).

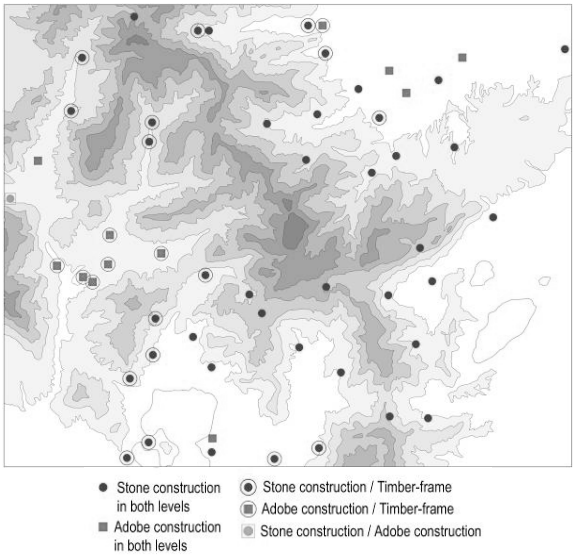


Figure 10: Map of the area representing the different building materials and construction systems.

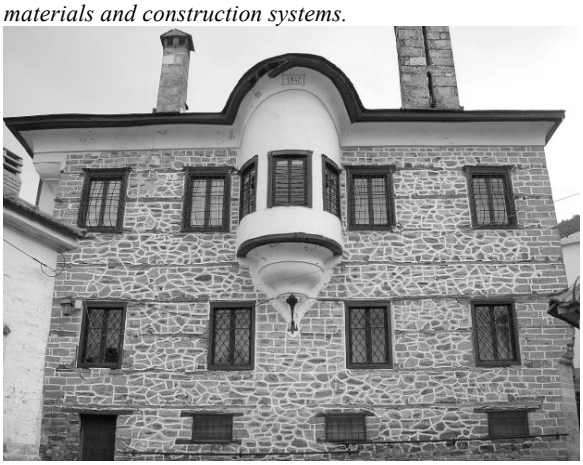


Figure 11: House with stone walls and visible, horizontal wooden framework in Kleisoura. (1842)

Figure 12: House with stone walls and hidden, horizontal wooden framework in Variko. (20th c.)

It should be noted that the buildings of the same period in the towns of Florina and Kastoria are constructed with thick stone or adobe walls in the ground floor, while light timber frame walls filled with adobe or covered with lath and plaster, are used in the upper storeys. [13] Even though these towns not included in the study, this type of construction is also found in the rural settlements that are situated at a close distance from them. (Fig. 13)

Figure 13: House with stone walls and timber-frame structure covered with lath and plaster in Korissos. (19th c.)

BIOCLIMATIC ANALYSIS

Presentation of the study The study includes a preliminary bioclimatic analysis of the thermal behaviour and the daylighting conditions of a typical house with the use of the Ecotect v5.5 software [14]. A two-storied house with three spaces on each level is chosen, as it is the type of house that is most commonly found in the settlements of the area. (Fig. 14)

The aim of the thermal analysis is to obtain a representative picture of the passive thermal behaviour the house, namely its behaviour without active heating systems (fireplaces, braziers, etc.), during the period that the house is on a free-running regime. The aim of the daylighting analysis is to investigate the effect of design (number and size of windows, space dimensions) and orientation on daylighting levels and distribution.

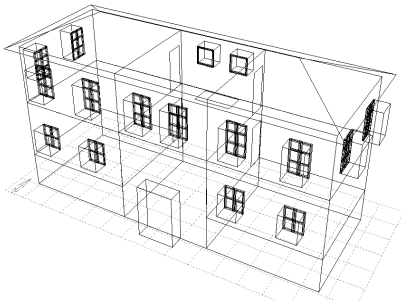


Figure 14: 3D model constructed with Ecotect. [15]

For the thermal analysis, three variations are constructed and analysed, in order to represent the different building materials, which are used in the

various settlements. In the first variation, all the external walls are constructed with stone (thickness: 60 cm, U-value: 1.76 W/m^2.K), in the second one with adobe bricks (thickness: 60 cm, U-value: 1.02 W/m^2.K), while for the third variation a mixed construction is assumed with stone walls on the ground floor and timber-frame walls on the upper storey. In all three variations, the model had southern orientation.

For the daylighting analysis, the same model is tested for the two most commonly found orientations: southern and eastern. The basic model is further developed in order to account for the effects of wall thickness and window construction. For reasons of comparison, a model with an open central space (*hayat*) was also analysed.

Thermal analysis The results of the thermal analysis [14] indicate that the effect of different external wall construction on the thermal behaviour of the house is not as important as it was presumed to be. This maybe due to the fact that both basic wall configurations (stone and adobe) have an important thickness (60 cm) resulting to similar U-values, and a limited number of windows.

For a cold winter day, the analysis of environmental temperatures shows that both at the ground floor and on the upper storey the diurnal range is very small (2 ^{o}C, from -4 to -2 ^{o}C), with the stone construction being slightly colder (by 0.5 ^{o}C) than the adobe one. It is interesting to note that the diurnal range of the exterior temperatures is 5 ^{o}C (from -9 to -4 ^{o}C). For a hot summer day, with exterior environmental temperatures fluctuating between 20 and 39 ^{o}C, the respective interior temperatures also present a small diurnal range of 2 ^{o}C (from 27.5 to 29. ^{o}C).

Daylighting analysis The daylighting analysis is performed with Ecotect v5.5 [14] and Radiance [15]. Ecotect is used to export the daylighting analysis grid to Radiance. The results of the Radiance simulation are then reinserted into Ecotect and the daylighting analysis figures are obtained from there. The isolux contours have a range from 0 lux to 1000 lux, with a step of 100 lux.

During the winter (Fig. 15), with overcast sky conditions (external illuminance of 5000 lux –C.I.E. overcast), daylighting levels are very low (up to 200 lux, average value 90 lux), with the windows acting as individual lighting sources. Furthermore, in the case of overcast sky, there is no difference in the daylighting levels resulting from the orientation. In the case of the open hayat, the space has very elevated daylighting levels, as was expected.

During the summer (Fig. 16), with clear sky conditions (external illuminance of 81000 lux, calculated by [15]), the daylighting analysis shows higher levels and better distribution. In this case, the effect of orientation is more pronounced: the highest levels (average value 358 lux) are observed in the south-facing model, while the results for the eastern orientation are lower (average value 268 lux).

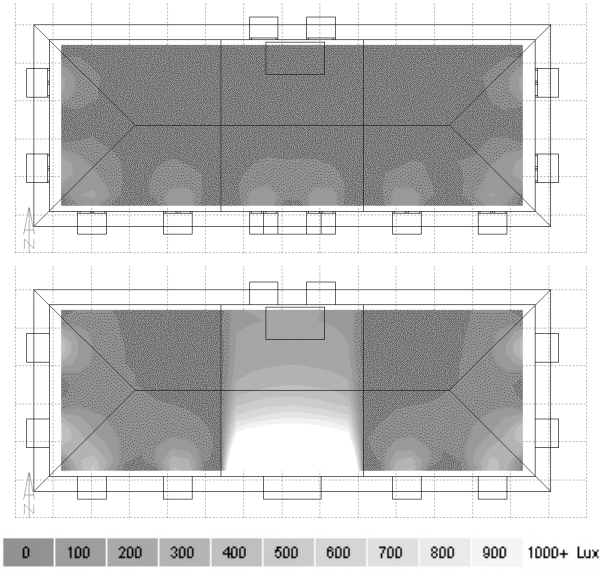


Figure 15: Daylighting analysis at December 21st, 12:00 TST (external illuminance value: 5000 Lux)
a. Upper storey of south-facing model with closed hayat.
b. Upper storey of south-facing model with open hayat. [14, 15]

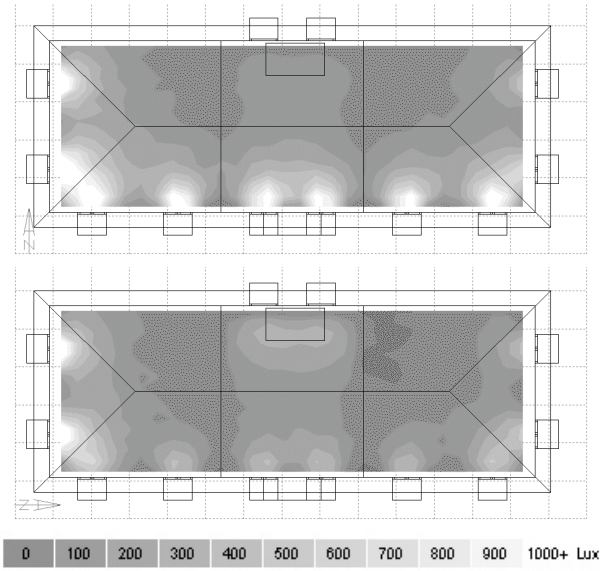


Figure 16: Daylighting analysis at June 21st, 12:00 TST (external illuminance value: 81000 Lux)
a. Upper storey of south-facing model.
b. Upper storey of east-facing model. [14, 15]

CONCLUSION

The main conclusions of the study point out issues of place and locality, but also issues of the people's habits

and adaptability to the local environmental and climatic conditions. The rural way of living during the 19th century lead to the prevalence of building types with open hayats on the upper storey and storage rooms on the ground floor, which served for agricultural and cattle-breeding activities. At the end of the 19th and the beginning of the 20th century, the building types became more introvert, which lead to the construction of more compact, closed buildings or to the modification of the existing ones.

The settlements under investigation present, more or less, uniform architectural and design elements in terms of typology, morphology and construction techniques. The differences between them are mainly due to their period of development and growth (19th or 20th century). Further differences include the use of construction materials, which depends on where the settlement is situated. As most of the villages are located on the massif of Mt Verno, the prevalent building material is locally available stone. Adobe construction is common in the few villages of the plains (Korestia area).

The local materials and construction techniques (predominantly thick walls made of stone and/or adobe) directly affect the form of the house. The windows are less in numbers and smaller in size compared to the houses that are constructed during the same period in the urban centres of Florina and Kastoria, as well as in their nearby settlements. This fact directly influences daylighting levels, which were calculated to be very low, especially during the winter. At the same time, though, the use of thick walls and few openings results in remarkably steady interior thermal conditions, with a very small diurnal temperature range throughout the year.

The majority of the buildings in the settlements under investigation is characterised by proper southern or south-eastern orientation of the buildings and by the exploitation of the prevailing winds. Furthermore, the buildings are placed in their plots in such a way as to minimise overshadowing.

The group of the fifty settlements of the Verno Mountain, which was analysed in this paper, forms a significant cultural heritage. The present research constitutes a first attempt to document, analyse and evaluate the many aspects of their traditional architecture. Further research should include a more detailed survey-documentation of all existing building types, in-situ environmental measurements and more detailed computer-based analysis. This will lead to the formulation of a series of design principles, which characterised the traditional architecture of the past and can be applied as guidelines for the restoration / rehabilitation of existing buildings, as well as for the construction of new ones.

ACKNOWLEDGEMENTS. The authors would like to thank Arch. Eng. Axilleas Stoios for his help and valuable information throughout the field study. Aineias Oikonomou would also like to thank the Greek State Scholarships Foundation (I.K.Y.) for supporting the on going post-doctoral research, of which this study forms part, and is conducted in the Laboratory of Architectural Form and Orders, N.T.U.A. School of Architecture.

REFERENCES

1. Krainer, A., (1986). Equality in Variety. A Review of Bioclimatic Growth of Buildings on Yugoslav Territory. In *PLEA '86 Conference.* Pecs, Hungary, p. S168-219.
2. Vuksanovic, D., (1991). Bioclimatic Characteristics of Some Traditional Urban and Architectural Forms in Montenegro. In *PLEA'91. Architecture and Urban Space.* p. 245-250.
3. Pucar, M., et al., (1994). Bioclimatic Features of Some Historical Settlements in Serbia and Montenegro. In *Architecture of the Extremes. 11th PLEA Conference.* Israel, p. 463-470
4. Dimov, D. and Donchev, T., (1992). Energy Saving of Ancient Bulgarian Houses. In *3rd Int. Conference. Energy and Building in Mediterranean Area.* Thessaloniki, Greece, p. 33-40.
5. Dabija, A.-M., (2006). Tradition and Innovation in Contemporary Romanian Architecture. In *PLEA 2006 Conference.* Geneva, Switzerland, p. 79-83.
6. Petrasincu, N. and Laurentiu, F., (2006). Bioclimatic Elements for Traditional Romanian Houses. In *PLEA 2006 Conference.* Geneva, Switzerland, p. 85-88.
7. Karaman, A., (1983). The Ecology of the Vernacular Housing in Turkey toward Designing for 'Locus'. In *Second International PLEA Conference*. p. 273-280.
8. Güleç, S., et al., (2006). Analysis of the Units contributing Climate Comfort Conditions in Outdoor Spaces in Turkish Traditional Architecture. In *PLEA 2006 Conference.* Geneva, Switzerland, p. 103-110.
9. Korumaz, M., et al., (2006). Evaluation of the Energy Efficiency of Gaziantep Traditional Buildings. In *PLEA 2006 Conference.* Geneva, Switzerland, p. 95-101.
10. Pelekanos, N., et al., (1986). Vernacular Architecture in Greece. A Survey from the Bioclimatic Point of View. In *PLEA '86 International Conference.* Pecs, Hungary, p. D1-9.
11. Andreadaki, E. and Nomikos, M., (1988). Regional Architecture of Makedonia: The Case of Vernacular Settlements as an Example of Passive Low Energy Design. In *6th Int. PLEA Conference.* Pergamon Press , p. 193-198.
12. Oikonomou, A., (2006). Summer Thermal and Daylighting Conditions in 19th Century Traditional Buildings of Florina in North-Western Greece. In *PLEA 2006 Conference.* Geneva, Switzerland, p. 61-66.
13. Oikonomou, A., (2008). Bioclimatic elements and design principles of the traditional architecture in northern Greece. In *PLEA 2008 Conference.* Dublin, Ireland.
14. Ecotect Tool software, v5.5, Square One Research PTY Ltd., Dr. A. Marsh, http://www.squ1.com
15. Radiance software, v1.02, Lawrence Berkeley National Laboratory, http://radsite.lbl.gov/deskrad
16. Weather Tool software, v2.0, Square One Research PTY Ltd., Dr. A. Marsh, http://www.squ1.com