ICONARP
International Journal of Architecture and Planning
Received: 17.03.2022 Accepted: 05.12.2022
Volume 10, Issue 2/ Published: 20.12.2022
Research Article *DOI: 10.15320/ICONARP.2022.218 E- ISSN:2147-9380*
ICONARP

Qualitative/Quantitative Comparison of Changes in Alanya Rural Architecture in terms of CO2 Emissions and Energy Conservation within the Scope of Sustainability

Ercan Aksoy*
Özlem Sağıroğlu Demirci ****

Abstract

Due to the rapid growth and development caused mainly by tourism of Alanya, rural areas are affected, losing their original texture and authentic structures and being exposed to unqualified interventions. The aim of this study is to determine the original features and reveal the value of Alanya rural architecture within the framework of the sustainability principles, and to determine how these values have changed with the unqualified interventions, by detailing qualitatively and quantitatively on the basis of each intervention. Within the scope of the study, the rural architectural heritage in Alanya has been documented in terms of settlement texture, space organization, architectural elements, material, construction and energy efficiency. For the analysis, a rural house that preserves its original values was used. A comparison was made between the values of this house and the values obtained as a result of the changes in the other buildings in the area. In cases where these interventions are applied in various variations, the changes in the heating and cooling load of the house are compared with the CO_2 emission. It has been determined that the rural houses of Alanya provide energy conservation in a way that is perfected by tradition, both in terms of settlement features and space and materials on the basis of structure. It has been determined that the heating/cooling energy requirement can decrease but the CO_2 emission increases in the individual changes made by evaluating different types of deterioration. When the most common application variations detected in the field are evaluated, it has been determined that both the heating/cooling energy requirement and the CO_2 emission have increased. Rural settlements and residences define an architecture that has reached the highest level in terms of convenience, functionality and economy. Since any intervention to these structures means the loss of their energy conservation properties as well as their originality, a very careful decision should be made. The study reveals the first data in which the rural architecture of Alanya is evaluated within the scope of sustainability and energy and CO_2 emissions are compared depending on deterioration/changes.

Keywords:
Rural architecture, rural conservation, rural sustainability, vernacular architecture, design builder

* Eha Construction & Architecture, Ankara, Turkey. (*Corresponding author)*
E-mail: ercanaaksoy@hotmail.com

**Faculty of Architecture, Gazi University, Ankara, Turkey.
E-mail: osagiroglu@gazi.edu.tr

To cite this article: Aksoy, E., & Sağıroğlu Demirci, Ö. (2022). Qualitative/Quantitative Comparison of Changes in Alanya Rural Architecture in Terms of CO2 Emissions and Energy Conservation within the Scope of Sustainability. *ICONARP International Journal of Architecture and Planning,* 10(2), 614-639. DOI: 10.15320/ICONARP.2022.218

INTRODUCTION

Rural structures are formed entirely within the framework of livelihoods such as agriculture and animal husbandry, and needs for life. These structures, which are designed as fully functional, have been shaped on the basis of social rules and needs for sharing since the existence of humanity; designed with material obtained from the immediate environment. Over time, they have formed a certain understanding and style with environmental conditions, the limitations of climate and topography, and traditional construction technique and craftsmanship tradition. They have come to encompass the most suitable, economical and easy solutions within the framework of material, atmospheric and environmental conditions, needs and traditions. For this reason, they have been accepted as the structures with the highest value, the lowest carbon footprint and the highest resource conservation within sustainability all over the world. However, steps have been taken recently to protect these values. For this reason, undesirable textural changes have occurred within the scope of rural settlements. Similarly, changes and transformations have occurred in the organization of space and architectural elements in original buildings. For this reason, these settlements and structures of superior value have lost their original qualities. Among the regions where these changes and transformations take place the fastest and unplanned, rural areas close to the city centres and rural areas subject to tourism supply have a great place in the context of migration. However, in the recent past, with the realization of the importance of the quality and quantity of these deteriorations, steps have been taken to protect rural areas. For this reason, rural areas have been registered under the name of 'urban protected area' and protection and construction conditions have been brought, or rural design guides have been created and criteria for new buildings to be built have been started to be determined. For the new buildings to be built in the area, similar criteria such as gauge, colour, window/door gap ratios, roof shape were determined and applied within the scope of quality and quantity. On the other hand, in the buildings to be protected, criteria in terms of quantity have been determined and applied, on the condition that the original features are adhered to. However, in all these steps, what is considered and designed in general is the structural and visual preservation of the texture and structures. For this reason, modifications and transformations of materials and architectural elements are generally allowed. In this context, architectural elements made of cement-based materials, plastic, aluminium, metal or polycarbon-based materials that do not require mastery or can be easily found in their cheap and processed form; it was preferred as long as it remained within the criteria determined within the scope of elevation-colour-texture-benefit/harmful. Similarly, in rural areas that are not under protection and do not have a rural design guide, since there were no zoning-construction criteria until recently; modern materials that can be easily found and applied; texture etc. applied without complying with such

DOI: 10.15320/ICONARP.2022.218

criteria. Thus, the unique characteristics of rural areas have been deteriorated.

SUSTAINABILITY AND EFFICIENT USE OF ENERGY

The energy need increases depending on the population with the development of technology and industry. However, energy resources are decreasing day by day due to excessive use, unconscious/unplanned consumption and the use of faulty production techniques. This situation also causes environmental pollution, climate change and degradation of natural areas. Especially the use of heavy fuels is a triggering factor for this cycle. The efforts to break this cycle over time have revealed the necessity of using renewable energy sources. However, studies have revealed that using only renewable resources is not enough, it is necessary to reduce the energy need and to obtain the highest efficiency with the least energy.

Construction sector and unplanned development plays an important role in environmental pollution, ecological deterioration, reduction of natural resources and deterioration of human-environment relationship (Ergöz Karahan, 2017; Dikmen, 2011; Amasyalı & El-Gohary, 2018). The construction industry uses 39% of the global energy and 42% of the water stand-alone (Sayın, 2016; Nejat et al., 2015). In addition, construction is effective in the deterioration of clean water, 40% of stone-gravel and sand consumption, and 25% of forests (Lippiatt & Norris, 1995). In addition, 38% of the world's CO_2 emissions are also generated by buildings (Zhong et al., 2019). Particles and gases generated by the products used in the construction industry are also a source of pollution (Vural & Balanlı, 2005; Marzouk et al., 2017).

Architecture before the industry and industrial revolution has been created with clean energy within the scope of materials, techniques and technology. This phenomenon is accepted in the direction of traditional architecture to create a clean energy solution for today's cities and architecture. This has enabled a detailed examination of traditional architecture in terms of sustainability and energy conservation. Within the scope of the investigations; The sustainability of the cultural heritage has been determined in terms of environment, energy and tourism (Butler, 2009; Barthel-Bouchier, 2016), the design criteria and sustainability of an ecological neighborhood settlement have been examined within the scope of sustainability at the city scale (Gebel et al., 2021). Thermal comfort conditions were analyzed in a traditional palace (Al-Sakkaf et al., 2021), traditional Turkish house in Safranbolu (Harputlugil & Çetintürk, 2005) and on churches that were severely damaged and restored (De Rubeis at al., 2020). Sustainability of rural architecture has been researched through a traditional settlement in Cyprus; As a result, it is emphasized that it has many of the criteria, but it needs to be developed to meet contemporary needs (Philokyprou & Michael, 2021). In studies examining sustainability in terms of traditional buildings in different countries, courtyard houses in Iran and China

ICONARP – Volume 10, Issue 2 / Published: 20.12.2022

(Soflaei et al., 2017) and local houses in Southern Italy and Lithuania were evaluated (Samalavičius & Traškinaitė, 2021). The environmental effects of materials and their recycling costs were examined in the context of masonry walls, and their data were presented under 15 parameters (Erduran et al., 2020). Green building and energy certification systems in new buildings were compared and their pros and cons were determined, and a study was conducted to determine which one would be suitable for Turkey (Said & Harputlugil, 2019). Utkutug, on the other hand, examined examples of high-performance green buildings around the world and stated their characteristics (Utkutuğ, 2011). In addition to these studies, there are studies in which sustainability should be included in the architectural education process and applied. In this context, sustainable architectural designs were desired from students in the 3rd year studio course (Mohamed & Elias Özkan, 2019), sustainability was evaluated within the scope of the architectural project competition (Yurtsever et al., 2013) and the integration of sustainability with the architecture master's program was compared with domestic and international examples (Gökşen et al., 2020). In addition, there are studies in which traditional houses are evaluated in terms of thermal analysis (Temur, 2011) and it is determined that they save thermal comfort better by consuming less energy (Vissilia, 2009). In the studies, it is understood that the housing structures are built in accordance with the climate, topography and atmospheric conditions. It has been determined that due to the use of local materials, they are highly energy efficient and healthy buildings, and therefore they can set an example for sustainable new constructions (Yüksek & Esin, 2013; Sanchez & Medrano, 2015).

Sustainability is defined as "meeting the needs of the present without compromising the ability of future generations to meet their own needs"; (WCED, 1987) is discussed under three headings as economic, environmental and social (Akdiri et al., 2012; Li, 2011; Sev, 2009; Williams & Dair, 2007; Juan et al., 2019). These criteria are examined within the scope of environmental protection with low resource use, minimum pollution and natural life in environmentally. In terms of economy, the main topics are the minimum use of energy and water resources, the preference of local materials, and the construction of suitable functional-reliable structures. On the other hand, social sustainability is addressed within the framework of a safe and healthy environment, providing social opportunities such as education and health for the public, improving access opportunities, giving importance to urban design and evaluating the traditional housing stock. Good project management is required for sustainable buildings. For this reason, energy, water, land and cost should be used at the minimum rate during the construction and use of the building (Hill & Bowen, 1997; Cole & Larsson, 1999). If possible, renewable energy sources and recyclable materials should be used (Miyatake, 1996). Decisions should be made in line with the needs and requirements, and it should be ensured that employees and the environment are not exposed to pollutants and waste

DOI: 10.15320/ICONARP.2022.218

materials (no chemical products are used) during construction. A healthy built environment should be created, natural habitats should be improved or not damaged at worst (Halliday, 2008; Kibert, 2008). When considered in this context, it can easily be said that traditional settlements and houses are very good examples within the scope of sustainability principles, and that they are a serious instructor by creating a document value from the past to the future.

SUSTAINABILITY IN ALANYA RURAL ARCHITECTURE

Alanya is a district of Antalya Province, with a length of 73 kilometers along the Mediterranean coast. There is the Mediterranean sea in the south and the Taurus Mountains which has altitude of 2500 – 3000 meters in the north. There are settlements in the district between 0-1500 meters altitude. For this reason, rural settlements have different characteristics depending on the topography. In the district where the Mediterranean climate is observed; the summers are hot and the winters are mild. Although it is a very fertile region due to its climate and soil quality, forests with cedar, oak and juniper trees cover a large area (Özgür, 2018). Many vegetables and fruits are grown Due to the fertile agricultural areas; In addition to its natural habitats (Sapadere Canyon, Dimçayı National Park, İncekum Nature Park), it also shows diversity in terms of flora and fauna.

Topography and Settlement

The climatic structure of the region is an important factor in the settlement of the houses on the land. The southern slopes of the hills are warmer, while the northern slopes are colder and shady in the northern hemisphere. The eastern and western slopes are hot and sunny, especially in summer. For this reason, it is recommended that the settlements should be established on the south slope of the hills in hot and dry summer months, cold winter months, on the south slope in cold climates, on the hilltop in hot and humid climates, on the north slope in hot and dry summer months and warm winter months (Lechner, 2015). Positioning the houses in harmony with the land and the environment, preserving the slope with minimal interference to the topography, and not blocking the sun and wind by not blocking each other while the buildings are being built are also important criteria in terms of energy conservation.

ICONARP – Volume 10, Issue 2 / Published: 20.12.2022

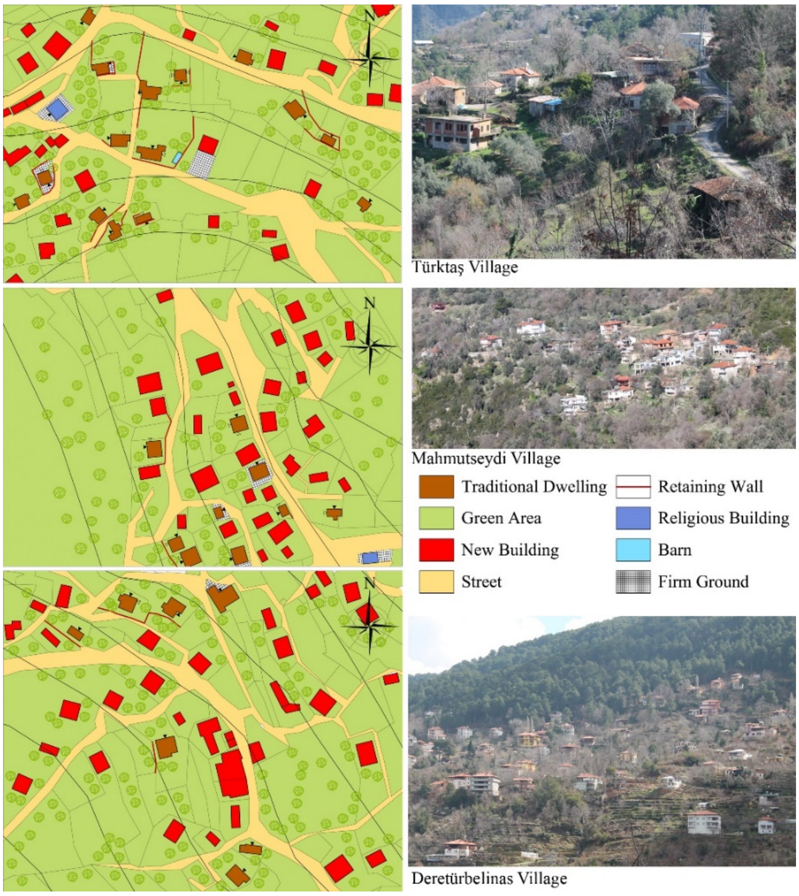

Figure 1. Topographic maps and settlement views of the villages.

It has been determined that the villages in the higher parts of Alanya district are mostly located on the southern or northern slopes of the hills (Figure 1, Türktaş Village) and rarely in the southwest direction (Figure 1, Mahmutseydi & Deretürbelinas Village). Traditional dwellings are positioned in accordance with the topography in an energy efficient manner. For this reason, it is understood that organic texture is preserved in all villages. The buildings are positioned in such a way that they do not block each other's sun and wind, if there is a landscape they are directed towards the landscape. In coastal villages, traditional residences were built on the southern slopes but located at higher elevations.

Solar Control

The first design principle in solar control, which can be provided naturally, is reforestation. Trees that allow shadow control, especially in temperate and warm climatic regions, also maximize solar use. Trees that will be used to reduce the effect of the sun in summer should allow sunlight in winter. For this reason, deciduous trees with low light permeability in summer and trees with high light permeability in winter should be used. However, considering the position of the sun, evergreen trees can be planted in the northern parts of the buildings as there will be no direct sunlight from the north. In the east-west direction, in particular, trees with high trunk sizes should be selected that do not prevent airflow while providing solar control (Figure 2).

DOI: 10.15320/ICONARP.2022.218

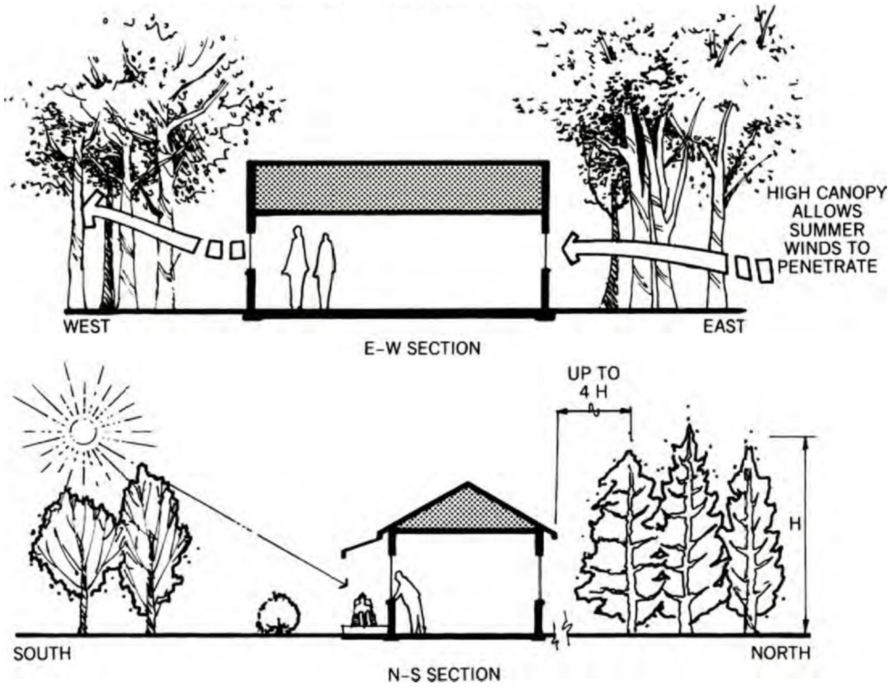

Figure 2. Afforestation scheme in temperate climate zones (Lechner, 2015).

However, reforestation, which is one of the alternative methods of solar control, also has a great visual and environmental impact (Gürsel Dino, 2017). Another parameter that has an important place in solar control, along with trees, is the architectural elements used in the building design. Roofs, fringe widths, cantilevers, and window elements, which will be designed depending on the direction and angle of the sunlight, directly affect energy use. Designs that cut off the summer sun but do not block the winter sun are evaluated for their sustainability. In addition, it is important to add auxiliary architectural elements in order to use not only indoor spaces but also open spaces.

Alanya rural housings are mostly located in the northern parts of the parcels. For this reason, there are more deciduous trees, especially in the southern and western parts of the buildings, and sparse deciduous trees (figs, walnuts, apples, olives, etc.) in the eastern part. In the houses located to the south of the parcel, on the other hand, there are trees in the adjacent parcel that cover the southern facades of the buildings (Figure 3).

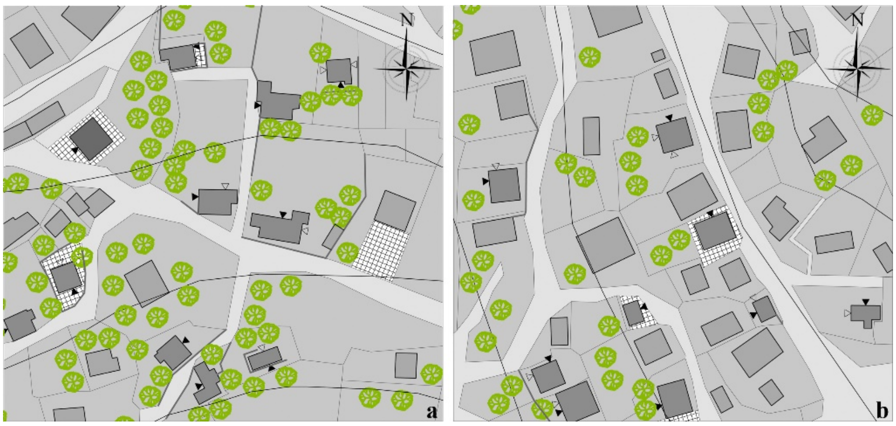

Figure 3. Topographic maps and settlement views of the villages; Türktaş (a), Mahmutseydi (b).

The district is located between the "36°30'07" and "36°36'31" northern latitudes. The sun angle was determined as 36.33° on average at the midpoint of the district boundaries (it was found by adding the latitude degrees at the northernmost (36°36' N) and the southernmost (36°30' N) of the district and dividing them by 2 (36.36+36.30)/2). For this reason, the incidence angle of the sunlight in Alanya district was calculated by subtracting the degree between the latitude of the district and the tropic of Cancer from 90° by using the 76.94° (23°27' N to the tropic of Cancer on June 21) of sunlight in summer (based on June 21) (90-(36.33-23.27), while it is calculated as 30.40° in winter (based on December 21), (23°27' S to the tropic of Capricorn on December 21), calculated by subtracting the degree between the latitude of the district and the tropic of Capricorn from 90° (90-(36,33+23,27)). Ground floors are not used as housing in Alanya rural residences. For this reason, there are no windows under the cantilevers, and the cantilevers are not used for solar control. There are small ventilation spaces on the ground floors used for storage purposes such as animal shelters or haystacks. However, when the few houses with large ground floor windows were examined, it was found that the sunlight does not enter directly in summer depending on the wall thickness, but in winter the sunlight can enter depending on the angle (Figure 4a). In addition, shutters are available in buildings where ground floor windows are large (Figure 4b). On the first floors, which are used as living spaces, both the eaves distance and the canopies on the windows blocks prevent unwanted sunlight. The use of wooden meshworks (Figure 4c) and shutter (Figure 4d) is also frequently seen in the windows in order to get controlled light. Especially when the meshworks have air permeability, they have a positive effect in the summer months thanks to their low sunlight permeability. The shutters are designed to have 4 equal-sized parts in some of the houses. With these shutters, sunlight can be blocked from entering the upper or lower sections, ventilation is provided, and this approach makes solar control easier.

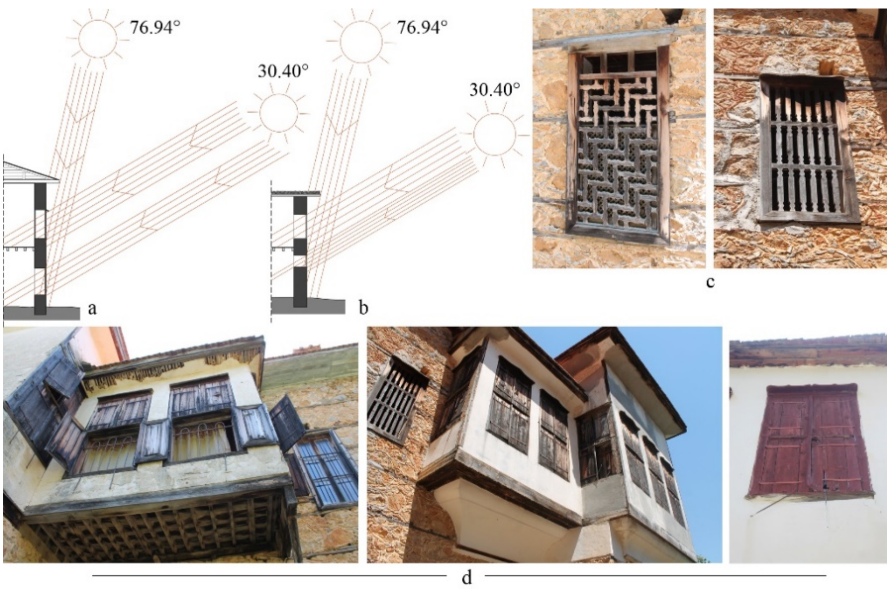

Figure 4. Building-sun relationship and window designs; angle of incidence of sun (a, b), meshwork (c), shutter (d).

DOI: 10.15320/ICONARP.2022.218

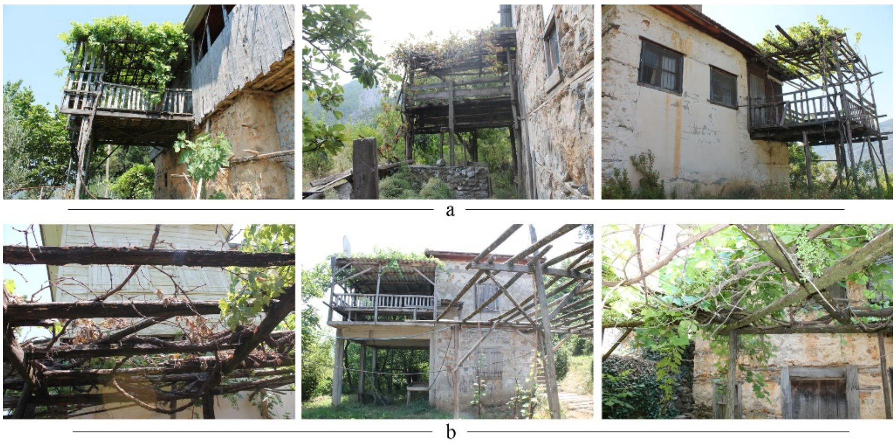

Figure 5. "İskenet" designs in rural dwellings in Alanya

In order to provide wind and solar control in semi-open or open spaces, the vast majority of housings in the area have wooden suspended gazebos called "iskenet". These gazebos are used to create canopies and semi-enclosed spaces in the garden or to provide solar control by covering the gazebos, which are the open cantilevers of the buildings (Figure 5a, b). The 'iskenet' gazebos, which provide the highest level of use of open spaces in summer, are designed in the south and west directions of the houses. In this way, shading and solar control can be achieved. Vines can be found on the tops of the gazebos and on all facades of the buildings and provide shading in summer, while in winter they allow sunlight due to falling leaves.

Wind Control

The positive or negative factors of the wind differ according to the climate data of the settlements. It is expected to avoid the wind effect in cold climatic zones and to benefit from wind in hot climatic zones. One of the best-known methods for wind control and therefore reducing cooling costs is controlled planting of trees to block wind in cold climatic zones and allow wind in hot climate zones. The prevailing wind direction throughout Alanya is between northeast and east (N 69.9° E) (Sabancı, 2012). The trees in the gardens of the rural houses are largely not located in the direction of prevailing wind (Figure 6a). Thus, they do not block the wind of places such as the gazebo and the main room (known as 'çağnışır'), which are frequently used in the summer.

Another element that allows cooling by allowing the wind is that the railings of the gazebos are made with gaps. This pattern, which causes increased comfort conditions even at the sitting level of the users, is seen in the entire authentic gazebo architecture (Figure 6b).

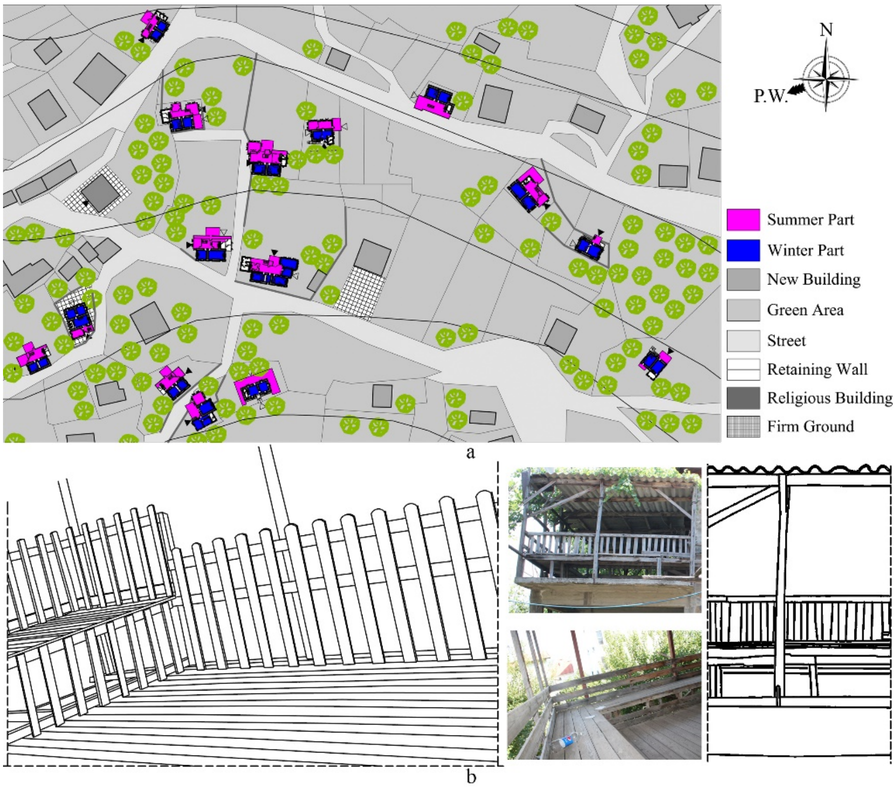

Figure 6. Planting trees so as not to cut the wind (a) and wind permeable elements (b).

Another control method is to direct the building based on the wind direction and design a building geometry for ventilation and cooling. Buildings with a squarish shape are less affected by the wind when placed perpendicular to the wind direction (Figure 7a). Buildings with the same form allow more wind when placed diagonally in the wind direction (Figure 7b). Rectangular buildings get less wind when their narrow edges are in the wind direction, while the wide edge gets more wind when it is in the wind direction (Figure 7c) (Watson & Labs, 1983).

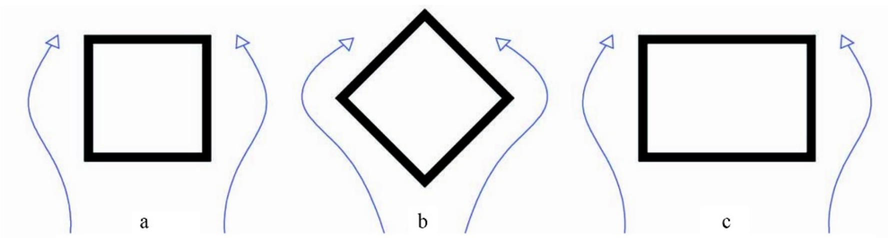

Figure 7. Orientation of structures against the wind (Watson & Labs, 1983).

The buildings in the Alanya countryside are largely made in square or rectangular form. In addition, the orientation of the buildings varies according to the locations of the villages, with the principle of taking advantage of the wind or protecting against it. Therefore, in villages with warmer and milder weather conditions, the buildings are positioned diagonally according to the prevailing wind direction (Figure 8a). In villages with colder conditions, however, they are designed perpendicular to the prevailing wind direction (Figure 8b). Thus, it was possible to benefit more from the wind in hot regions, and the effect of wind was alleviated in cold regions, adhering to sustainability principles.

DOI: 10.15320/ICONARP.2022.218

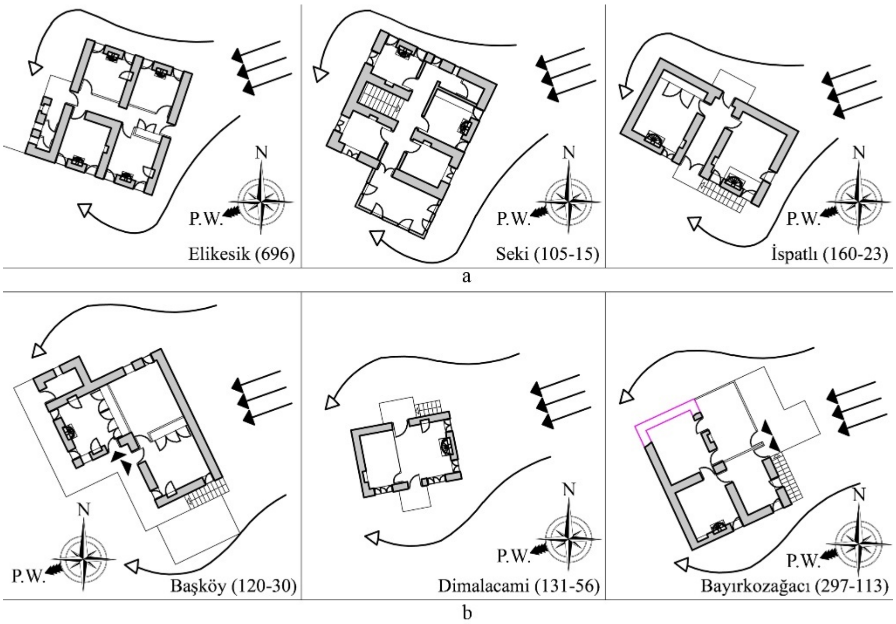

Figure 8. Orientation of Alanya rural dwellings against the wind.

Ventilation and Cooling

It is important to use natural factors to provide ventilation and cooling in regions with hot and temperate climates. For this reason, the places of the spaces (windows, doors) in the building and the positions/arrangements of the spaces can be used for natural ventilation. Windows or ventilation gaps are designed in the direction of the wind and in other places accordingly. When the windows are installed in the opposite part of the air flow direction, they cause the air flow to be fast while providing air flow indoors (Figure 9a). However, in this case, the air flow is fast and the ventilation of the spaces is insufficient. For this reason, it is suggested that windows and spaces should be installed on the side facades and diagonally according to the wind direction (Figure 9b) (Aktuna, 2007). The gaps in the structures are made in accordance with the passage of the air flow in Alanya villages. Windows and spaces are positioned diagonally on different façades. Thus, maximum ventilation is provided and climatic effect is created. Natural cooling is provided and the dwellings are designed to consume low energy (Figure 10).

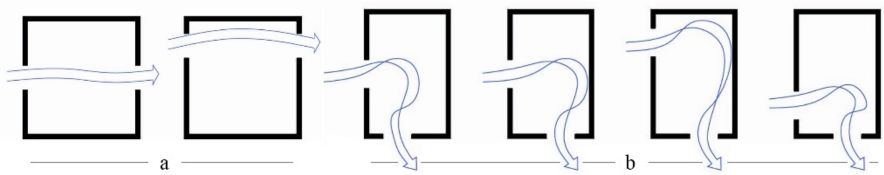

Figure 9. Air movements according to space directions (Aktuna, 2007).

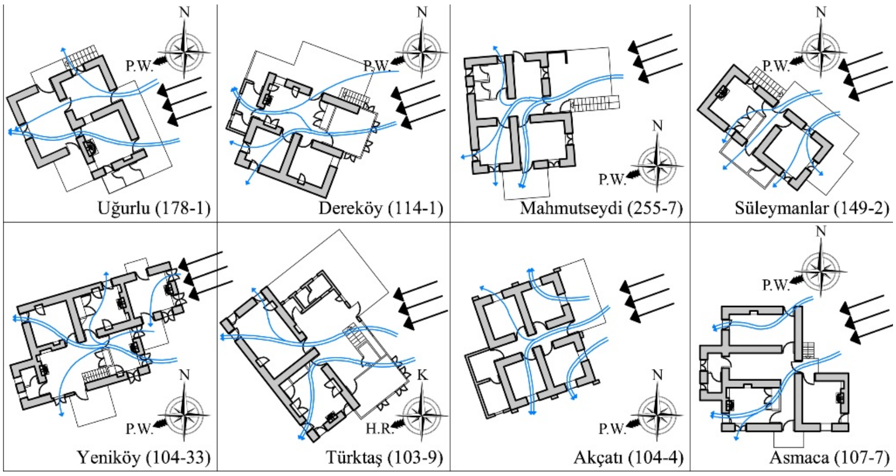

Figure 10. Air flow paths in rural dwellings in Alanya.

While it is important for the building form to be sheltered like square and rectangular in terms of heat loss, turning the spaces used in summer to the prevailing wind direction and increasing the surface areas in these spaces are the elements that provide cooling. The surface area is increased by removing the walls of the summer spaces by disrupting the compact form and cooling can be more effective.

The places used in the summer months of the qualified houses in the region are positioned in the direction of the wind (Figure 11). In addition, the wall surface areas of these spaces are increased in order to receive the wind better, allowing for better cooling (Figure 12). Most of the time, the pergola sections, which are limited only by railings without being limited by walls, are also constructed in the direction of the prevailing wind.

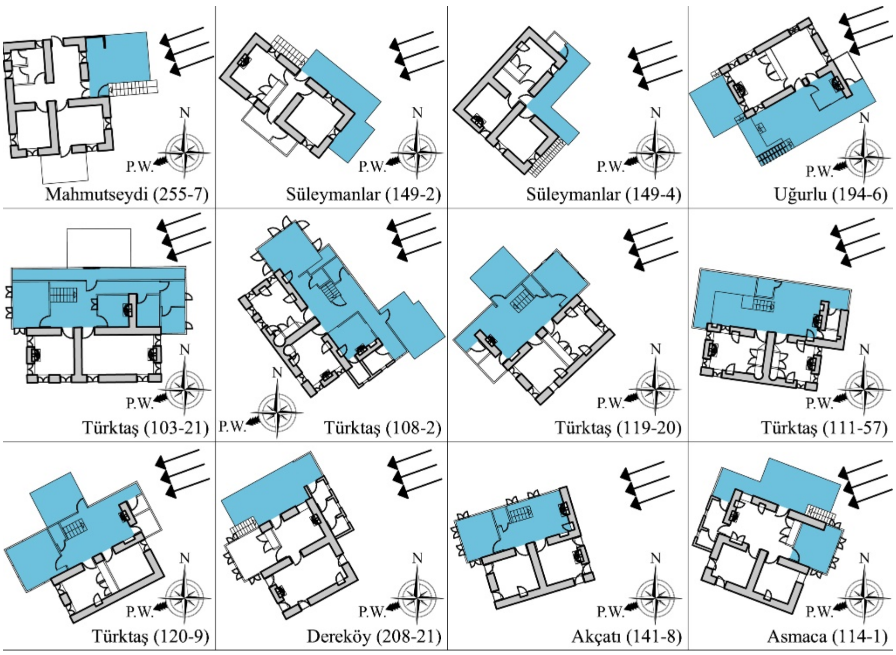

Figure 11. Summer space locations in rural dwellings in Alanya.

DOI: 10.15320/ICONARP.2022.218

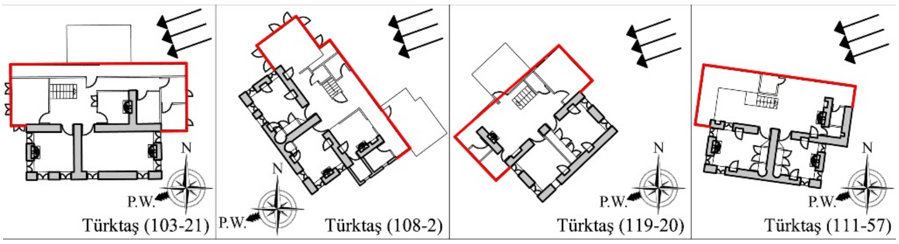

Figure 12. Increased summer space surfaces in Alanya rural dwellings.

Heating

The kitchen spaces of traditional houses that produce heat should be designed in a way to ensure that the heat is transferred to other spaces at least in hot climatic regions. These spaces should have good ventilation or should be set up outside the building if possible. On the contrary, these spaces should be designed in the center of the building to allow the heat to spread in cold climate regions (Aktuna, 2007). In buildings where different spaces are used in summer and winter months, even in hot regions, the presence of a fireplace in at least one of the winter spaces is beneficial in meeting the need for cooking and heating at the same time.

In buildings with barns or sheepfold on the lower floors, positioning the rooms on the upper floors and the barns on the same axis creates a positive situation for the need for heating. This allows to use of the animals body heat and makes it easier to heat the upper floors.

Figure 13. Kitchen and fireplace settlements in rural dwellings in Alanya.

It is seen that in the rural houses of Alanya, the kitchen space of which is designed separately, all of the kitchens are located in the summer section, that is, in well-ventilated sections (Figure 13a). The fireplaces, which are not limited by any divider and used directly in the sofa, are also the sections where the kitchen function is performed, causing the heat dissipation to be at the minimum level. In addition, the fireplaces in the summer section allow to be heated of these spaces and make it possible to use them in the winter (Figure 13b). In addition, fences which known as "daraba" were used to limit the kitchen spaces and the ventilation was ensured to be at a high level.

A fireplace is designed in at least one room in houses without a separate kitchen and sofa. The fireplace was used to provide both cooking and heating functions. In the houses with a single fireplace, heat loss is reduced by using a square or rectangular plan scheme and care is taken to distribute the heat within the spaces. In buildings with more than one fireplace, it is possible to heat the desired spaces at different times (Figure 13c).

98% of Alanya rural houses were built with two floors and the lower floors were used as barns. The upper floor plan setup can be followed in the same way on the lower floor due to the carrier system. For this reason, there are rooms on the upper floors of the barns on the lower floor (Figure 14). This made it possible to use the warmth of the animals to heat the rooms.

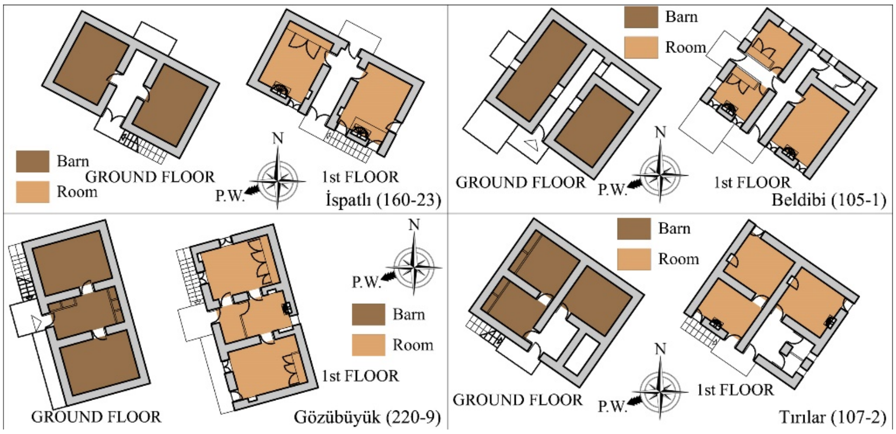

Figure 14. Barn-room settlements in rural dwellings in Alanya.

Building Envelope and Transparency Rate

The elements that form the outer boundaries of the building and limit the interior spaces are called the building envelope. In order to reduce the energy consumed for buildings and to provide comfort conditions with the least energy consumption, keeping the hot air out in the summer and the cold air in the winter is a priority. For this reason, especially the window sizes and numbers should be designed according to the usage purposes of the spaces.

Looking at the building envelopes of the rural dwellings in Alanya, it is understood that the windows of the spaces used in winter are smaller in size, but their number is also less (Figure 15a). The windows of the spaces used in the summer are both larger and more numerous (Figure 15b). Due to the fact that the ground floors of the rural dwellings are used as service floors (barn, hayloft, warehouse (depot)), the windows are kept small in order to prevent unwanted heat loss/gain and at the same time to provide ventilation at the optimum level. In the design of these windows, joinery was generally not used (Figure 15c), and in very few examples, shutters (Figure 15d) or railings were used (Figure 15e). In

DOI: 10.15320/ICONARP.2022.218

addition to the windows, it is seen that small spaces are designed in the building envelope for ventilation purposes (Figure 15f).

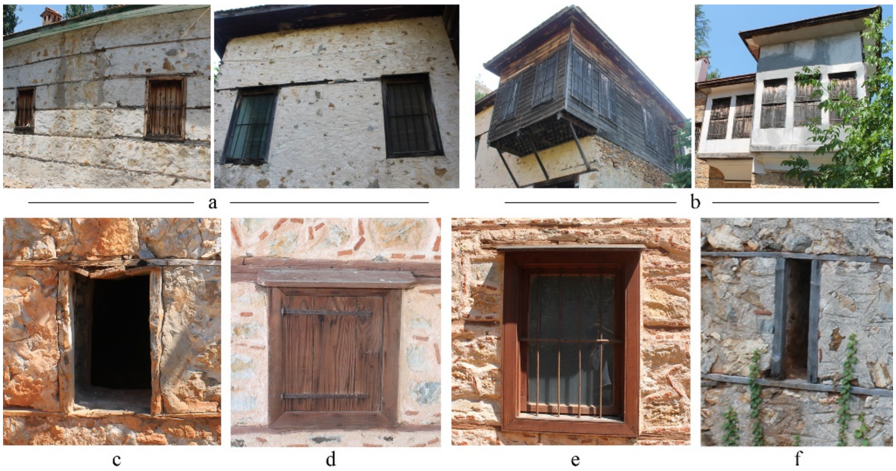

Figure 15. Summer-winter spaces and service floor windows in Alanya rural dwellings.

The ratio of the window and door openings on the building facades to the whole facade is called the transparency ratio. This ratio determines the comfort conditions and energy use by directly affecting the heat losses or gains depending on the values on different facades. Especially window designs provide gain for heating, ventilation and lighting, but also cause heat loss due to low heat permeability resistance. For this reason, the opaque-transparent ratio in structures is important. In order to prevent excessive heat loss and gain, it is recommended that the transparent-opaque ratio should not exceed 10-15% (Soysal, 2008), and that the space-occupancy ratio should be limited to a maximum of 40%, taking into account adequate ventilation and lighting in sustainable design (Aktuna, 2007; Çakır, 2011; Kuşçu, 2006).

When the houses are evaluated in terms of transparent-opaque ratio, it is determined that they have a ratio of at least 10,36% and at most 23,20%. The average value of these ratios was determined as 17.56% in 9 housing samples (Figure 16). It is understood that the transparent-opaque ratio, which should be around 15% in terms of optimum thermal insulation, is provided in Alanya rural residences. In addition, the ratio, which should be max. 40% in terms of ventilation and lighting, has not been exceeded in any residence. For this reason, it is seen that the houses provide optimum energy use in terms of the building envelope.

ICONARP – Volume 10, Issue 2 / Published: 20.12.2022

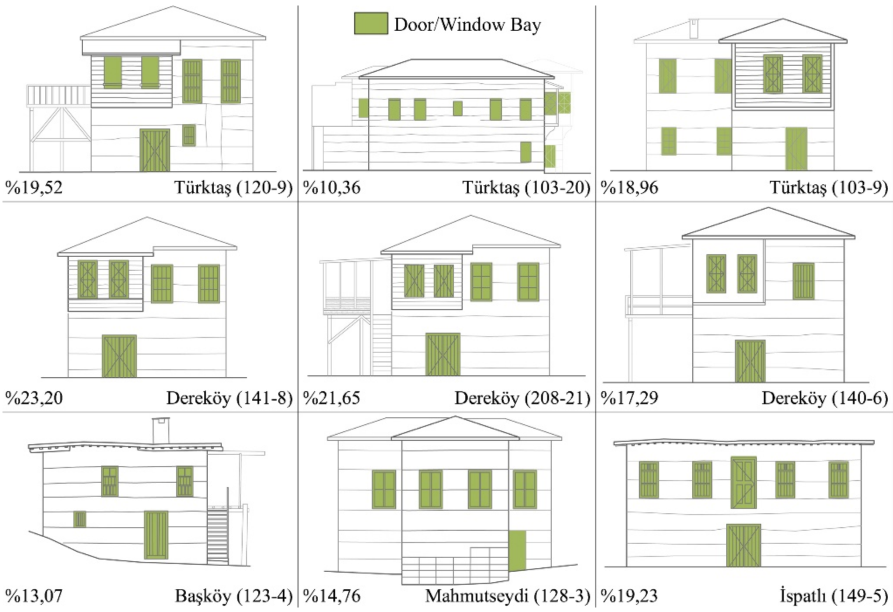

Figure 16. Transparent-opaque ratios in Alanya rural dwellings.

Construction Materials

Construction materials have important effects in terms of sustainability on the basis of production, use and after-use effects. The amount of energy consumed during the production of materials varies according to the type of material. The materials most commonly used in buildings are wood (5 kWh/m^3), concrete (45 kWh/m^3), glass (60 kWh/m^3), brick (140 kWh/m^3) and steel (550 kWh/m^3). There are great differences between the values in the production of these materials (İnanç, 2010). For this reason, it is important to choose materials that can be produced with low energy in terms of efficiency principles. In addition, materials that can be obtained from the environment close to the building and produced without creating waste material have a great value for the environment.

The low repair and maintenance costs of the materials to be used and the fact that they do not emit harmful gases to the environment are important in terms of their impact on the environment when used. When the building has completed its life, the materials should be reusable, recyclable and should not harm the ecosystem by leaving excavation residues. Based on these values, sustainable, durable, easily repairable/available, long-lasting and renewable materials should be used, which consume less energy, are not harmful to the environment and humans, or are least harmful for their production, use and after use.

Stone (Figure 17a), wood (Figure 17b) and soil (Figure 17c, d) were used as building materials in Alanya qualified rural dwellings. Quartzite, barite, limestone, travertine and marble are mined throughout the district. The most commonly used stones in buildings are limestone and travertine, which can be obtained from the nearest area. Wood is obtained from pine, cedar, fir, juniper and oak trees found in the region. The plaster/mortar content is the soil in which quartz mineral is predominantly seen. Soil was used on the top cover of the structures (Aksoy and Sağıroğlu Demirci, 2022). When the materials are examined,

DOI: 10.15320/ICONARP.2022.218

it is seen that the amount of energy needed in the production of all of them is at the lowest level, the maintenance / repair costs are low, they can be easily obtained from the region, harmless to the environment, durable, long-lasting and renewable materials.

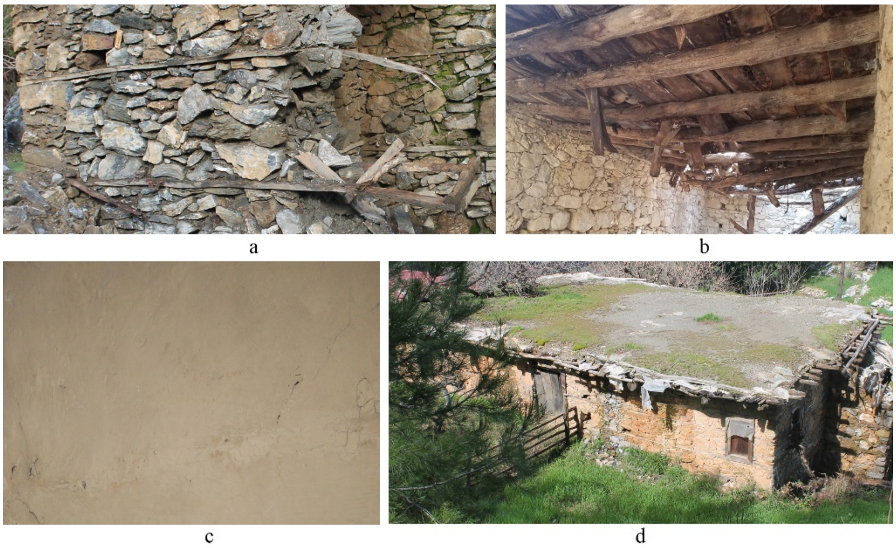

Figure 17. Transparent-opaque ratios in Alanya rural dwellings.

CHANGES MADE IN ALANYA RURAL HOUSES

The characteristics of the original examples of Alanya rural architecture show that they contain the most effective solutions in many respects. However, over time, the structures have changed due to changes and developments in comfort conditions, difficulties in finding craftsmen and materials, and functional or spatial transformations within the scope of tourism. For these reasons, changes and transformations were made in the original spaces and architectural elements, with additions, changes or transformations in the infrastructure and superstructure.

The changes and transformations in which the calculations will be made were identified among the most common examples within the scope of the study (Aksoy, 2021) carried out in 68 villages in the area between 2018-2021. In addition to unique situation (Figure 18a), the most intense changes detected in the area are; adding a concrete flat roof (Figure 18b), adding a hipped roof (Figure 18c), plastering the walls with cementitious plaster (Figure 18d), replacing the exterior door with a metal door (Figure 18e), replacing the windows with metal or PVC windows (Figure 18f, g), increasing the size of the window (Figure 18h) and making the walls concrete instead of stone.

Figure 18. Building materials used in rural dwellings in Alanya.

CHANGES IN ENERGY REQUIREMENTS RESULTING FROM ORIGINAL ATTRIBUTES BY ADDITIONS, REMOVALS AND REPLACEMENTS

In order to determine the effect of changes, additions and removals in the buildings in the area, a 4-room residence in Başköy, which is one of the original examples, was determined. The house was modeled in the "DesignBuilder" software and compared with the original space and its elements in terms of energy conservation through the changing space and elements.

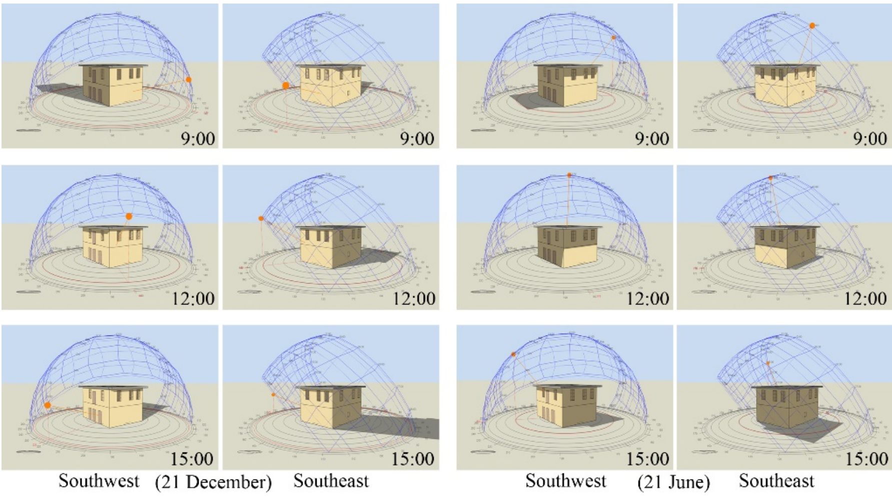

Figure 19. Sun angles depending on the location of the qualified dwelling in Başköy.

The shadow formations that occur with the sun angles on different dates were determined regarding the extent to which the 4-room house in Başköy can benefit from the sun. For this, the dates of June 21st and December 21st, when the sun's rays are the most vertical and horizontal, were used; In order to see the angle of incidence of the sun's rays during the day, 3 different time zones were determined as 09:00, 12:00 and 15:00. In line with the building location, material and window designs, it is understood that while it is protected from sunlight during the summer months, it is utilized efficiently in the winter months (Figure 19). This is achieved especially by turning the winter spaces to the southeast-southwest direction and keeping the window sizes smaller, and by turning the summer spaces to the prevailing wind direction and positioning the windows at different angles.

In order to determine the energy loads in the modelling, values for both heating and cooling were determined; the maximum energy

DOI: 10.15320/ICONARP.2022.218

consumption for the use of the house in its original state has been determined. The total area of the building is 70.08 m^2, and the heated and cooled building area is 35.04 m^2. The ground floor and upper floor walls of the building are made of 60 cm masonry stone, and the roof is 25 cm thick as an earthen roof. The floor of the building is covered with 3 cm of wood on the beams, and the floor of the ground floor is soil, and it is modelled in the same way. In addition, the doors are 4 cm thick, wooden knock-out doors and windows are available as 3 mm single-layer glass in 4 cm thick joinery and have been chosen in the same way.

Considering the months, the most energy is spent in January (72.53 kWh/year) for heating the building, and the most energy is spent in August (688.15 kWh/year) for cooling the building. The total amount of energy needed annually is 220.15 kWh for heating and 2048.71 kWh for cooling. The amount of energy spent for heating per square meter is 1034.89 Wh/m^2 in January, and the amount of energy spent for cooling is 9819.49 Wh/m^2 in August. The annual total amount of energy needed according to the characteristics and location of the building is 3141.41 kWh/m^2 for heating and 29233.84 kWh/m^2 for cooling (Table 1).

Table 1. The heating and cooling energy needs of the building according to the months, in its original form

Months	**Cooling (kWh)**	**Heating (kWh)**	**Cooling (Wh/m^2)**	**Heating (Wh/m^2)**	**CO_2 emission (kg)**	**CO_2 emission (gr/m^2)**
January	0	72,52528	0	1034,893	439,6887	6274,096
February	0	56,90601	0	812,015	393,8193	5619,568
March	0	38,43453	0	548,4379	426,5338	6086,383
April	-1,567337	0,587215	-22,365	8,37921	399,0284	5693,899
May	-30,21868	0	-431,203	0	419,0276	5979,275
June	-268,111	0	-3825,79	0	463,4120	6612,613
July	-632,844	0	-9030,31	0	565,1039	8063,697
August	-688,1501	0	-9819,49	0	578,5101	8254,995
September	-373,0504	0	-5323,21	0	488,8492	6975,588
October	-49,80738	0	-710,722	0	423,7759	6047,031
November	-4,958916	2,847986	-70,7608	40,63907	400,7229	5718,078
December	0	48,84897	0	697,0458	430,5525	6143,728
TOTAL	**-2048,708**	**220,15**	**29233,84**	**3141,41**	**5429,024**	**77468,95**

A high level of energy is consumed in the production of building materials. In addition, buildings emit carbon (CO_2 emissions) to the environment according to the materials they are built from. The higher the emission, the higher the damage to the environment, while the lower level causes it to decrease. The CO_2 emissions of the materials vary throughout the year depending on the temperature and climatic conditions. The highest CO_2 emission of the selected residence in the Alanya countryside is 578.51 kg in August; the lowest CO_2 emission is in April with 399.03 kg; the annual total CO_2 emission is 5429.02 kg. The CO_2 emission per square meter is 8255.00 gr/m^2 in August, 5693.90 gr/m^2 in April, and the annual total is 77468.95 gr/m^2 (Table 1).

In line with the changes in Alanya rural buildings, energy needs and CO_2 emissions have been determined depending on different factors. In addition, the total energy need and carbon emissions that occur when all the changes are made together were calculated and the differences between the original situation and the new situation were determined.

Heating, cooling and CO2 emission values were determined by considering each of the changes detected in the area as a different parameter. However, in many of the examples encountered in the field, it was determined that more than one of these parameters were changed at the same time; these samples were also evaluated (Table 2).

In the calculations of the parameters, the most frequently encountered and documented values in the field investigations were used. In this context, the most common applications are: removing the earthen roof and making a 12 cm reinforced concrete roof cover or a wooden hipped roof without insulation and tile; It is the use of cement-based interior and exterior plaster instead of soil and lime plaster, replacing the original doors and windows, and using 4 cm thick iron joinery doors and 130 cm wide modern windows (double glazed PVC joinery with a glass thickness of 3 mm and a gap of 13 mm). In the analysis, it was determined that the positions of the buildings did not change. In addition to the changes applied individually, the variations in which more than one change was applied together were also determined and analysed (Table 2).

Table 2. The heating and cooling energy needs of the building according to the months, in its original and different forms

	Changes	Cooling (kWh)	Heating (kWh)	Cooling (Wh/m²)	Heating (Wh/m²)	CO_2 emission (kg)	CO_2 emission (gr/m²)	CO_2 emission (kg)-Including Material Production
1	Unique Situation	2048,708	220,15	29233,84	3141,41	5429,024	77468,95	9036,5
2	Concrete Roof (12cm)	2896,932↑	238,7109↑	41337,50↑	3406,263↑	5641,796↑	80505,08↑	9768,2↑
3	Hipped Roof	1893,485↓	158,2521↓	13116,93↓	1096,276↓	5367,513↓	37182,91↓	13402,8↑
4	Cement plaster (interior-exterior)	1929,463↓	207,3402↓	29520,9↑	3172,318↑	5068,636↓	77550,46↑	14441,8↑
5	İron door	2111,137↑	220,5824↑	30124,67↑	3147,58↑	5444,324↑	77687,27↑	14194,0↑
6	İron window	2050,342↑	220,9029↑	29257,16↑	3152,153↑	5429,711↑	77478,75↑	9036,5←→
7	PVC Window (Double glazed)	1978,241↓	215,764↓	28228,32↓	3078,824↓	5410,25↓	77201,06↓	9537,5↑
8	Windows are enlarged	2549,531↑	198,2949↓	36380,29↑	2829,55↓	5541,99↑	79080,91↑	8938,7↓
	MOST COMMON APPLICATION VARIATIONS IN EXAMPLES WHICH DETECTED IN THE FIELD							
9	2-4-5-6-8*	3351,194↑	207,2296↓	51273,49↑	3170,626↑	5413,221↓	82822,63↑	19963,1↑
10	3-4-5-6-8*	2487,937↑	121,1832↓	17831,81↓	867,8659↓	5170,635↓	37030,04↓	23597,7↑
11	2-4-5-7-8*	3256,073↑	198,8544↓	49818,13↑	3042,485↓	5386,932↓	82420,41↑	20113,8↑
12	3-4-5-7-8*	2317,899↑	100,8142↓	16599,88↓	721,9917↓	5121,687↓	36679,5↓	23748,3↑
13	Reinforces Concrete-3-4-5-7-8*	2397,239↑	96,44875↓	14123,28↓	568,2259↓	7588,948↑	44710,13↓	39696,2↑

* It indicates the equivalents of the applied changes in the first 8 items.

EVALUATION AND CONCLUSION

Sustainability is an important parameter that should be considered long-term and also in new constructions. The importance of efficient use of energy resources and energy, reducing environmental pollution and building in accordance with nature is increasing day by day. For this reason, it is important to consider the environmental impact in both the

DOI: 10.15320/ICONARP.2022.218

interventions to the existing structures and the newly designed structures.

While traditional buildings in rural areas, which were built within the framework of limited opportunities in the past, are mostly compatible with topography, climate and nature, these features are put into the background in today's buildings. This leads to overuse of resources, depletion of resources, pollution of the environment and air, and more energy consumption. For this reason, it is necessary to benefit from the design data of traditional buildings in the new construction and to be developed by taking them as an example.

Alanya is located in a region with hot summers and mild winters. For this reason, it is seen that qualified houses are positioned on the slopes of the hills and in this way they benefit more from the wind. In addition, the structures built by adhering to the organic texture of the residential areas are designed in a way that does not cut each other's sun/wind and in accordance with the slope.

Although it is seen that solar control is also considered in qualified buildings, trees, structural and architectural elements are used for this. Since the houses are located close to the northern part of the parcels, trees have been planted in the south and west parts. Thus, while the unwanted sun rays are prevented in the summer months, cooling is not hindered since the northeastern parts, which are the dominant wind direction, are not closed. In addition, keeping the south facade windows smaller, the use of grids and shutters on the windows and the orientation of the building show that solar control is considered. The frameworks created to provide shade over the arbor sections also provide open space solar control.

Wind control can be achieved by positioning the buildings according to the prevailing wind direction, depending on their mass characteristics. In addition, the hollow design of the wooden partition elements used in the building allows the wind to pass through and provides cooling in open and summer spaces. In order to ensure adequate indoor ventilation, positioning to the wind direction has been realized and the windows have been designed on the side facades, not opposite, to prevent linear/fast flow.

There are stoves in the winter spaces to heat the houses during the winter months. The furnaces are made in different numbers according to the size of the building. It is also seen that the furnaces are built in a single room due to the sufficient heat dissipation depending on the building form. In the houses with kitchens, these spaces are designed inside the summer sections in order to provide heating in the winter and to disperse the heat in the summer. Benefiting from the body heat of animals in buildings whose lower floors are used as barns is also seen throughout the region. The gaps designed in the building envelopes for thermal insulation were found to be 17.56% on average. This provides about 15%, which is necessary for optimum insulation.

ICONARP – Volume 10, Issue 2 / Published: 20.12.2022

Since the materials used in the original buildings are completely natural materials, they have low maintenance costs, are easily obtainable, consume less energy in both production and use, and are recyclable. In addition, materials that are harmless to the environment and nature are used.

Changes in original buildings and new buildings built in rural areas were analyzed and the amount of heating and cooling energy needed, CO_2 emissions in use and CO_2 emissions, including the production of materials, were determined. In the analyzes made depending on a single parameter change in the houses whose qualities are deteriorated due to different factors, it has been determined that although the heating and cooling energy can decrease, CO_2 emissions do not decrease, except for one situation, considering the production processes of the materials. However, the total effect ratio was found by evaluating the data of all parameters proportionally (Table 3).

Table 3. Total rate of change due to changes in quality housing

	Changes	Total Energy Cooling-Heating (kWh)	CO_2 emission(kg) -Material Production Inc.	Energy Exchange (%)	CO_2 emission Exchange (%)	Total Effect (%)
1	Unique Situation	2268,858	9036,5	-	-	-
2	Concrete roof (12cm)	3108,6429↑	9768,2↑	%37,01	%8,10	%45,11↑
3	Hipped roof	2051,7371↓	13402,8↑	-%9,57	%48,32	%38,75↑
4	Cement plaster (interior-exterior)	2136,8032↓	14441,8↑	-%5,82	%59,82	%54,00↑
5	İron Door	2331,7194↑	14194,0↑	%2,77	%57,07	%59↑
6	İron window	2271,2449↑	9036,5←→	%0,11	-	%0,11↑
7	PVC Window (Double glazed)	2194,0050↓	9537,5↑	-%3,30	%5,54	%2,24↑
8	Windows are enlarged	2747,8259↑	8938,7↓	%21,11	-%1,08	%20,03↑
	MOST COMMON APPLICATION VARIATIONS IN EXAMPLES WHICH DETECTED IN THE FIELD					
9	2-4-5-6-8	3558,4236↑	19963,1↑	%56,84	%120,92	%177,76 ↑
10	3-4-5-6-8	2609,1202↑	23597,7↑	%14,10	%161,14	%175,24 ↑
11	2-4-5-7-8	3454,9274↑	20113,8↑	%52,28	%122,58	%174,86 ↑
12	3-4-5-7-8	2418,7132↑	23748,3↑	%6,60	%162,80	%169,40 ↑
13	Reinforces Concrete-3-4-5-7-8	2496,6878↑	39696,2↑	%10,04	%339,29	%349,33 ↑

Depending on the change of individual building elements, the energy need increased mostly as a result of enlarging the windows (21.11%) and decreased (-9.57%) as a result of the hipped roof construction. The amount of CO_2 emission increased mostly due to the plastering of the walls with cement-based plaster (59.82%), and decreased due to the enlargement of the windows (-1.08%). On the other hand, in the

DOI: 10.15320/ICONARP.2022.218

integrated deteriorations in the buildings, the increase in energy demand is seen mostly due to the concrete roof, cement-based plaster, metal doors and windows and window enlargement (55.84%), while the increase in CO_2 emission is seen in the new buildings made with reinforced concrete system and added spaces (hipped roof, cement plaster, metal door, PVC and large-sized windows are used) (339.29%). Depending on the application of combined variations, there is no reduction in energy demand and CO_2 emissions. Considering the sum of the proportional values of the energy change and the CO_2 emission change, no reduction was detected in any case. While the least increase is seen in the use of metal windows in the replacement of individual structural elements (0.11 %), the highest increase is seen in the construction of new reinforced concrete system buildings (349.33%) (Table 3).

The data obtained within the scope of this study show that all kinds of non-specific interventions to the buildings, with the exception of the roof addition, increase the heating and cooling load and increase the CO2 emission. In this context, the necessity of applying original materials and details in interventions to qualified buildings has been determined. The buildings that make up the rural architectural heritage have a superior experience in terms of harmony with the topography, orientation to the sun/shade, protection of the built and natural environment, and the use of materials with energy efficiency and environmental sensitivity in terms of structural and architectural elements. In the problems that depend on atmospheric conditions, environmental data and the user, the protection of the structure requires intervention. However, making these interventions using easily available but non-original shapes and materials causes a decrease in energy efficiency and an increase in environmental pollution due to both the alteration/deterioration of traditional buildings and the materials and production techniques selected in new buildings.

REFERENCES

Al-Sakkaf, A., Mohammed Abdelkader, E., Mahmoud, S., & Bagchi, A. (2021). Studying Energy Performance and Thermal Comfort Conditions in Heritage Buildings: A Case Study of Murabba Palace. *Sustainability*, 13(21), 12250.

Akadiri, P.O., Chinyio, E.A. & Olomolaiye, P.O. (2012). Design of A Sustainable Building: A Conceptual Framework for Implementing Sustainability in the Building Sector, *Buildings*, *2(2)*, 126-152.

Aksoy, E. (2021). Determination of Protection Possibilities in Rural Areas Which Transformed Under the Influence of Tourism and Changing Production Dynamics: The Case of Alanya. Ankara: Gazi University, Graduate School of Natural and Applied Science (Unpublished PhD Thesis).

Aksoy, E. & Sağıroğlu Demirci, Ö. (2022). *Alanya Kırsal Mimarisi*. Gece Yayınları.

Aktuna, M. (2007). The Analysis of Buildings in Vernacular Architecture Regarding to Sustainable Design Principles with Example of Antalya Kaleiçi Houses. İstanbul: Yıldız Technical University, Graduate School of Natural and Applied Science (Unpublished MSc Thesis).

Amasyali, K. & El-Gohary, N.M. (2018). A Review of Data-Driven Building Energy Consumption Prediction Studies, *Renewable and Sustainable Energy Reviews*, *(81),* 1192-1205.

Barthel-Bouchier, D. (2016). *Cultural Heritage and the Challenge of Sustainability*. Routledge.

Butler, R. (1991). Tourism, Environment, and Sustainable Development. Environmental Conservation, 18(3), 201-209.

Cole, R.J. & Larsson, N.K. (1999). GBC'98 and GBTool: background, *Building Research & Information*, *27(4-5)*, 221-229.

Çakır, G. (2011). In The Context of Sustainable Architecture Examining of High-Rise Buildings. İstanbul: Mimar Sinan Fine Arts University Graduate School of Natural and Applied Science (Unpublished MSc Thesis).

Darwin, C. (2009). *The Expression of the Emotions in Man and Animals (Digitally)*. Cambridge University Press.

De Rubeis, T., Nardi, I., Muttillo, M., & Paoletti, D. (2020). The restoration of severely damaged churches–Implications and opportunities on cultural heritage conservation, thermal comfort and energy efficiency. *Journal of Cultural Heritage,* 43, 186-203.

Dikmen, Ç.B. (2011). Enerji Etkin Yapı Tasarım Ölçütlerinin Örneklenmesi, *Politeknik Dergisi*, *14(2)*, 121-134.

Erduran, D.U., Demirel, İ.O. & Elias-Özkan, S.T. (2021). Analysis of Brick Wall Debris for Reusing, *Journal of the Faculty of Engineering and Architecture of Gazi University*, *36(4),* 1923-1938.

Ergöz Karahan, E. (2017). Geleneksel ve Günümüz Konutunda Sürdürülebilirlik ve Yaşam Alışkanlıkları: Osmaneli Örneği, *MEGARON-Yıldız Technical University Faculty of Architecture E-Journal*, *12(3),* 497-510.

Gebel, Ş., Ayçam, İ. & Kalfaoğlu Hatipoğlu, H. (2021). "Eko mahalle" yerleşimi ve örneklemeleri. In H.B. Henden Şolt (Eds.). *Mimarlık Planlama ve Tasarım Alanında Araştırma ve Değerlendirmeler* (pp. 223-260). Gece Kitaplığı.

Gökşen, F., Ayçam, İ. & Güner, C. (2020). Sürdürülebilirliğin Mimarlık Yüksek Lisans Programı ile Bütünleştirilmesi: Yurt Dışı ve Türkiye Örneklerinin Karşılaştırmalı Analizi, *Uluslararası Doğu Anadolu Fen Mühendislik ve Tasarım Dergisi*, *2(2),* 401-433.

Gürsel Dino, İ. (2017). Binalarda Güneş Kontrol Yöntemlerinin Optimizasyon Temelli Performans Değerlendirilmesi, *Gazi Üniversitesi Fen Bilimleri Dergisi Part C: Tasarım ve Teknoloji*, *5(3)*, 71-87.

Halliday, S. (2008). *Sustainable Construction*. Butterworth Heinemann.

Hill, R.C. & Bowen, P.A. (1997). Sustainable Construction: Principles and A Framework for Attainment, *Construction Management & Economics*, *15(3),* 223-239.

Juan, Y.K., Hsing, N.P. & Hsu, Y.H. (2019). Applying the Kano Two-Dimensional Model and Quality Function Deployment to Develop Sustainable Planning Strategies for Public Housing in Taiwan, *Journal of Housing and the Built Environment*, *34(1)*, 265-282.

Kibert, C.J. (2008). *Sustainable Construction: Green Building Design and Delivery, 2nd edition*. Wiley and Sons, Inc.

Kuşçu, A.C. (2006). Research of Traditional Konya House in Sustainabile Architecture Context. İstanbul: Yıldız Technical University, Graduate School of Natural and Applied Science (Unpublished MSc Thesis).

Lechner, N. (2015). *Heating, Cooling, Lighting Sustainable Methods for Architects*. John Wiley and Sons Inc.

DOI: 10.15320/ICONARP.2022.218

Li, W. (2011). Sustainable Design for Low Carbon Architecture, *Procedia Environmental Sciences*, *(5)*, 173-177.

Lippiatt, B.C. & Norris, G.A. (1995). *Sustainable Building Technical Manual, Selecting Environmentally and Economically Balanced Building Materials*. Public Technology Inc.

Marzouk, M., Abdelkader, E. M., & Al-Gahtani, K. (2017). Building information modeling-based model for calculating direct and indirect emissions in construction projects, *Journal of cleaner production,* 152, 351-363.

Miyatake, Y. (1996). Technology Development and Sustainable Construction, *Journal of Management in Engineering*, *12(4),* 23-27.

Mohamed, K.E. & Elias Özkan, S.T. (2019). Sustainable Architectural Design Education: A Pilot Study in A 3rd Year Studio, *The Academic Research Community Publication*, *2(3),* 126-135.

Nejat, P., Jomehzadeh, F., Taheri, M. M., Gohari, M., & Majid, M. Z. A. (2015). A global review of energy consumption, CO2 emissions and policy in the residential sector (with an overview of the top ten CO2 emitting countries). *Renewable and sustainable energy reviews*, 43, 843-862.

Özgür, F. (2018). Determination of Botanical Composition and Hay Yield On Different Altitudes Rangeland in Alanya. Düzce: Düzce University, Graduate School of Natural and Applied Science (Unpublished MSc Thesis).

Philokyprou, M. & Michael, A. (2021). Environmental Sustainability in The Conservation of Vernacular Architecture. The Case of Rural and Urban Traditional Settlements in Cyprus, *International Journal of Architectural Heritage*, *15(11)*, 1741-1763.

Sabancı, S. (2012). Climate Properties of Alanya and Manavgat. İstanbul: İstanbul University, Graduate School of Social Sciences (Unpublished MSc Thesis).

Said, F.S. & Harputlugil, T. (2019). A Research On Selecting the Green Building Certification System Suitable for Turkey, *GRID-Architecture Planning and Design Journal*, *2(1)*, 25-53.

Samalavičius, A. & Traškinaitė, D. (2021). Traditional Vernacular Buildings, Architectural Heritage and Sustainability, *Journal of Architectural Design and Urbanism*, *3(2),* 49-58.

Sánchez, P.A.L. & Medrano, F.J.S. (2015). Sustainable Architecture in the Traditional Rural Environment: Moratalla. In C. Mileto, F. Vegas, L. Garcia, V. Cristini (Eds.). *Vernacular Architecture: Towards a Sustainable Future* (pp. 449-454). Taylor and Francis Group.

Sayın, S. (2006). The Significance of the Use of Renewable Energy in Our Countrie's Building Sector and The Opportunities of Utilizing of Solar Energy in Buildings. Konya: Selçuk University, Graduate School of Natural and Applied Science (Unpublished MSc Thesis).

Sev, A. (2009). How Can the Construction Industry Contribute to Sustainable Development? A Conceptual Framework, *Sustainable Development*, *17(3),* 161-173.

Soflaei, F., Shokouhian, M. & Zhu, W. (2017). Socio-Environmental Sustainability in Traditional Courtyard Houses of Iran and China, *Renewable and Sustainable Energy Reviews*, *(69),* 1147-1169.

Soysal, S. (2008). The Relationship of Design Parametrics with Energy Consumption in Residences. Ankara: Gazi University, Graduate School of Natural and Applied Science (Unpublished MSc Thesis).

Temur, H. (2011). The Evaluation of Traditional Edirne Housing Architecture in Terms of Energy Efficiency and Thermal Analysis in The Context of

Sustainability. Edirne: Trakya University, Graduate School of Natural and Applied Science (Unpublished MSc Thesis).

Ulukavak Harputlugil, G. & Çetintürk, N. (2005). Geleneksel Türk Evi'nde Isıl Konfor Koşullarının Analizi: Safranbolu Hacı Hüseyinler Evi, *Gazi Üniversitesi Mühendislik Mimarlık Fakültesi Dergisi*, *20(1),* 77-84.

Utkutuğ, G. (2011). Sürdürülebilir Bir Geleceğe Doğru Mimarlik ve Yüksek Performanslı Yeşil Bina Örnekleri, X. Ulusal Tesisat Mühendisliği Kongresi, 13-16 April 2011, pp. 1517-1538, İzmir.

Vissilia, A.M. (2009). Evaluation of A Sustainable Greek Vernacular Settlement and Its Landscape: Architectural Typology and Building Physics, *Building and Environment*, *44(6),* 1095-1106.

Watson, D. & Kenneth Labs. (1993). *Climatic Design: Energy-Efficient Building Principles and Pracrise*. McGraw-Hill Book Company.

WCED (World Commission on Environment and Development). (1987). *Our Common Future*. Oxford University Press.

Williams, K. & Dair, C. (2007). What Is Stopping Sustainable Building in England? Barriers Experienced by Stakeholders in Delivering Sustainable Developments, *Sustainable Development*, *15(3)*, 135-147.

Yurtsever, B., Ulukavak Harputlugil, G. & Harputlugil, T. (2013). Sürdürülebilir Bina Tasarımının Mimarlık Eğitim Süreci Içerisinde Değerlendirilmesine Yönelik Bir Çalışma, 11. Ulusal Tesisat Mühendisliği Kongresi, 17-20 April 2013, pp. 1437-1443, İzmir.

Yüksek, İ. & Esin, T. (2013). Analysis of Traditional Rural Houses in Turkey in Terms of Energy Efficiency, *International Journal of Sustainable Energy*, *32(6)*, 643-658.

Zhong, H., Wang, J. & Jia, H. (2019) Vector Field-Based Support Vector Regression for Building Energy Consumption Prediction, *Applied Energy*, *(242),* 403-414.

Resume

Dr. Ercan AKSOY received his B.Arch and M.Arch from Selçuk University, Faculty of Architecture, and Ph.D. from Gazi University, Faculty of Architecture. He currently works as General Director in Eha Cons. & Architecture in Ankara. His research focuses on the preservation of built heritage, rural architecture, restoration and conservation.

Assoc. Prof. Dr. Özlem Sağıroğlu Demirci received her B.Arch from Karadeniz Technical University, Faculty of Architecture, and M.Arch and Ph.D. from Gazi University, Faculty of Architecture. She has been working in Gazi University, Department of Architecture. Her research focuses on vernacular architecture, digital works at conservation of heritage and architectural design in historical environment.

DOI: 10.15320/ICONARP.2022.218