The Influence of Climate and Culture in the Formation of Vernacular Settlements in Počitelj, Bosnia and Herzegovina and Safranbolu, Turkey

Adna BERKOVİĆ* and Fatih CANAN**

** Konya Technical University*
Konya, Turkey
ORCID: 0000-0002-0548-0811
adnaberkovic@gmail.com (Corresponding author)

*** Konya Technical University*
Konya, Turkey
ORCID: 0000-0003-4469-1993
fcanan@ktun.edu.tr

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Abstract

Vernacular architecture is acknowledged as an architecture created on the basis of a tradition that indicates one geographically or rather culturally differentiated area. It has features of traditional architecture, yet vernacular structures have been built in various architectural styles depending on the location. The significance of climate in formation of vernacular settlements is widely acknowledged. Vernacular settlements were designed to be climate-responsive achieving comfort by passive means. Climate comfort is one of the uttermost crucial components of present-day architectural design. It is not to be expected that vernacular dwellings respond to today's requirements in terms of comfort, yet their sustainable strategies could be used as a model for modern building design. Vernacular building strategies were developed by appreciating environment, climate, and culture. Regardless of the distance between Počitelj and Safranbolu, resembling vernacular design approaches were noticed under the impact of the same climate conditions and the similar culture considering both settlements were under the rule of the Ottoman Empire at a certain point in time. Therefore, the climatic factor along with cultural factor are relevant to the study as both climate and cultural factor modelled vernacular architecture with common characteristics in both settlements. These resembling vernacular design patterns provide a sufficient level of comfort for its inhabitants in both regions considering that they have been developed to adapt to a specific climate and geographical territory. This paper compares two distant vernacular settlements, Počitelj and Safranbolu, in terms of climate comfort and cultural impact by using qualitative data analysis, comparative synthesis, and field observation methods. The outcomes of the study provide points of similarity between climate responsive vernacular design patterns used in the two settlements located in the same type of climate, as well as understanding how sustainable building strategies can contribute in achieving suitable climate comfort conditions in modern building design.

Keywords: Climate responsive design, vernacular architecture, Ottoman architectural heritage, comparative analysis, sustainability

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1. INTRODUCTION

Traditional architecture is studied mainly for its original architectural aspects that have developed over time. It is one of the main subjects for the conservation of the immovable cultural heritage. It has also been studied for several decades, by its aspects which reflect the sensitivity towards the environment. Forgotten for a long time in western countries, especially in the modern period, the environmental qualities of traditional architecture spread all around different geographic regions of the world were rediscovered (Aalen, 1987; Heath, 2009; Mileto et al., 2015; Tawayha et al., 2016). The exhibition appointed as 'Architecture without architects' was performed in 1964 in New York under the direction of Bernard Rudofsky, and drew the attention of researchers in the architectural field (Rudofsky, 1987). It was Rudofsky who first mentioned the term vernacular in an architectural context. The type of architecture known as 'vernacular architecture' offers a great diversity in the creation of forms, spatial organizations, and the uses of techniques and materials. This type of local architecture responded optimally to the 'cultural' and 'climatic' requirements of the population (Güleç, Canan and Korumaz, 2006; Korumaz, Canan and Güleç, 2006).

In recent years, the scientific community in the domain of the built environment is progressively interested in the sustainable features of vernacular architecture. This is particularly as a result of demands to respond to a climate change, global pollution, and to find solutions on the decrease non-renewable energy consumption in the buildings. The annual number of studies on vernacular architecture has increased since 2007 (Nguyen et al., 2019). This indicates a greater interest in the sustainable characteristics of vernacular architecture.

Vernacular architecture is a unique creative interpretation that primarily takes into account the culture and the geography of the place. Vernacular architecture has been formed with natural links to the place. It can be described as a genuine climate-responsive and environmentally-friendly architecture (Philokyprou et al., 2017; Mirehei and Hajilou, 2018). Systematic research carried out on vernacular architecture in different regions of the world with the same type of climate but distant from each other, demonstrated similar spatial or technical resolutions (Zhai and Previtali, 2010; Fernandes et al., 2014; Bülüç, Canan and Yanar, 2018). For example, the use of Juniperus thurifera timber structures in traditional architecture is visible throughout the Mediterranean (Ruiz-Checa and Cristini, 2013). On the other hand, on the Mediterranean islands, the presence of Cubic architecture is very common in Sicily, Lipari, and Ibiza (Bianco, 2016). It is also possible to see types of construction built with similar techniques in climatic zones that are similar or different from one another. The existence of the corbelled dome constructions in the different climatic zones of the world is an impressive example of these statements (Martynenko, 2017). Due to cultural aspects, differentiations are also visible in the creation of the architectural space and its use (Ebrahimi, Pour Rahimian and Sahraei, 2013).

Research conducted on vernacular architecture can lead architects and urban planners to find solutions to environmental constraints (Vellinga and Asquith, 2005; Weber and Simos, 2014; Desogus, Felıce Cannas and Sanna, 2016). Construction techniques, design approaches obtained by trial and error during a long period can still be useful today (Hadjrı, 1993). In recent times, architects who have adopted a regionalist philosophy to contribute to sustainable architecture have been inspired by vernacular architecture (Tewari, 2015; Tewari, Prabhakar and Popli, 2017). Learning from the past is an approach that can be practiced with

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various methods to project a contemporary living environment (Mazhar et al., 2015; Ozorhon and Ozorhon, 2019).

The Regions of Počitelj and Safranbolu are located in the same climate zone where climate is certainly one of the factors with dominant multidimensional influence on buildings. In this extent, vernacular architectural building strategies are a model for overcoming climatic force. In vernacular settlements, where dwellings are related to local conditions, it is common that building forms and climate responsive strategies are different from one area to another. Despite the contrary, it is also likely to find similar vernacular settlements from distant regions. For the most part those settlements are positioned within the same type of climate which is shown in several studies (Fernandes et al., 2014). In this present research besides being located in the same climate zones, the two selected historical cities were both formerly in the Ottoman territory. Ottoman Empire with a presence of different cultures ensured a diversity of vernacular settlements and cultural heritage. Počitelj (situated in the southern part of Bosnia and Herzegovina) and Safranbolu's (situated in the northern part of Turkey) vernacular settlements are one of the most outstanding models, which reflect the history, culture, and lifestyle of the Ottoman Empire between the 16-19 centuries. Therefore, similar urban patterns and traditional dwellings that are a fusion of oriental (Ottoman) and local (regional) architectural elements were created. This gave rise to the formation of two distant vernacular settlements which represent a synthesis of the climatic and cultural conditions. All of these factors led to sustainable dwellings that responded to a variety of functions and provided high life quality of their inhabitants.

What began in ancient times as settlements in harmony with environment had from the Renaissance onward developed into an entity that dominated, exploited, and sprawled uncontrollably, producing broken communities that were out of touch with their natural surrounddings (Vellinga, 2019). Lately, as a consequence of uniformity of building industry, vernacular strategies were put aside and mechanical systems like HVAC started to be a part of every building even if it is not imperative. While being dependent on mechanical systems, a huge number of modern buildings does not have any relation with the surrounding environment which leads us to more energy consumption and constant environmental impact along with modern buildings not having any social or cultural context. Paul Oliver emphasised that relationship between architecture and culture is fundamental in order to meet the future housing needs in the world (Oliver, 2003). The solution to the world's housing demands will only be met through the support, enhancement, and adequate servicing of vernacular architecture (Oliver, 1998). For that reason, it is essential to research the field of vernacular architecture and implement cultural and climate-responsive skills from vernacular sustainable techniques into modern building design.

The aim of the study is to attempt to demonstrate the effectiveness of vernacular climate adaptive solutions in two settlements that are miles apart and share similar cultural background as well as to challenge the utilization of alike solutions in contemporary architecture in terms of comfort conditions and sustainability.

2. METHODOLOGY

This study analyzed sustainable design principles in vernacular dwellings in two settlements based in two different countries that were under the rule of the Ottoman Empire at a certain point in the past: Počitelj in Bosnia and Herzegovina and Safranbolu in Turkey. In this paper, qualitative data analysis, comparative synthesis, and field observation methods were

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used to demonstrate sustainable strategies and points of similarity and / or difference between building techniques used in vernacular architecture in settlements that share same climatic features and similar topography. The analysis was based on an examination of sustainable and climate-responsive building strategies in both settlements to understand similarities and differences which were later to be compared. To get more accurate results, the field observation method was applied as well. The comparative synthesis was used for an evaluation of such sustainable strategies which can later be used as a direction for the implementation of alike building solutions in contemporary architecture.

3. DESCRIPTION OF THE CLIMATE IN POČITELJ AND SAFRANBOLU

The Köppen climate classification is one of the most widespread climate classification systems. As stated in the Köppen climate classification Počitelj and Safranbolu reside in the Cfa climatic sub-type (the minor type of C-temperate major climatic type) where winters are mild and precipitation is evenly distributed throughout the year. In this climate type, the temperature of the warmest month is 22 ºC or above and no dry months in the summer. The coldest month averaging above 0 ºC (Climate-Cfa, 2020).

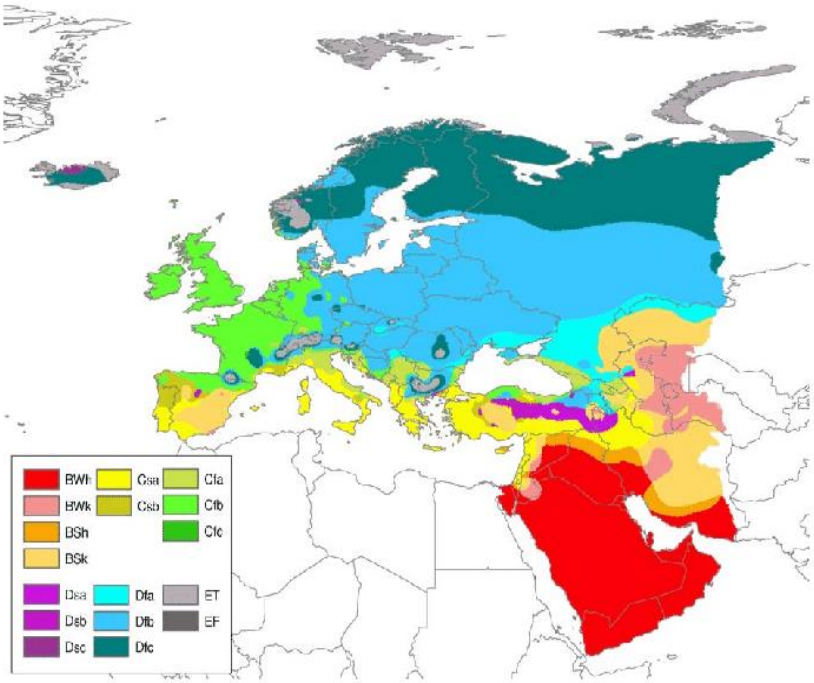

Figure 1. Köppen climate classification, map of Europe (Peel, Finlayson and Mcmahon, 2007: 1641)

Počitelj is situated in Bosnia and Herzegovina, on a dominant cliff above the left bank of the river Neretva with geographical coordinates of 43º 8’ 2’’ North, 17º 43’ 57’’ East and lies on 12 m above sea level (the elevation above sea level is 45 m in the center part of the settlement). In Počitelj, the climate is warm and temperate. There is a great deal of rainfall in Počitelj, even in the driest month. The average temperature is 15.8 °C. Precipitation averages 1349 mm. The driest and warmest month, with a temperature average of 25°C and precipitation average of 41 mm, is July. The greatest amount of precipitation occurs in December, with an average of 188 mm (Počitelj Climate Summary, 2020).

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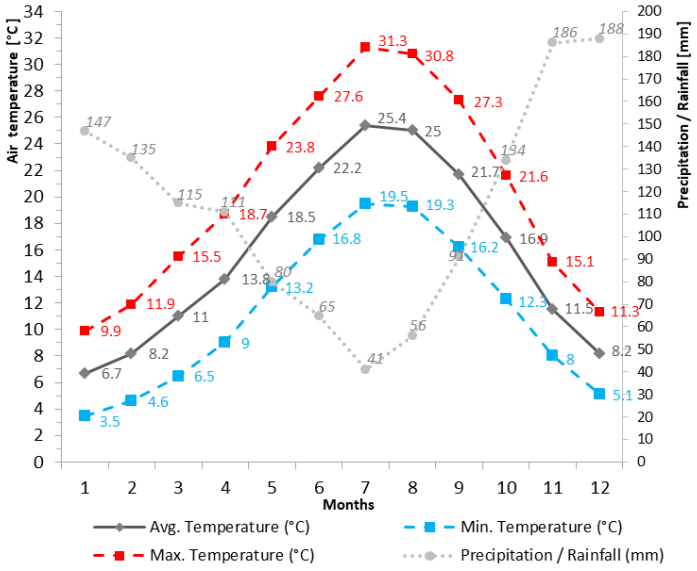

Figure 2. Weather data of Počitelj, Bosnia and Herzegovina (Počitelj Climate Summary, 2020; reproduced by the authors)

The city of Safranbolu is located at the north-western Black Sea region, at the cross-section of the 41º 16' 02'' northern latitude and 32º 41' 39'' eastern longitude and lies on 478 m above sea level. In Safranbolu, as well, the climate is warm and temperate. There is significant rainfall throughout the year in Safranbolu. Even the driest month still has a lot of rainfall. The average annual temperature is 12.8 °C. The average annual rainfall is 597 mm (Safranbolu Climate Summary, 2020).

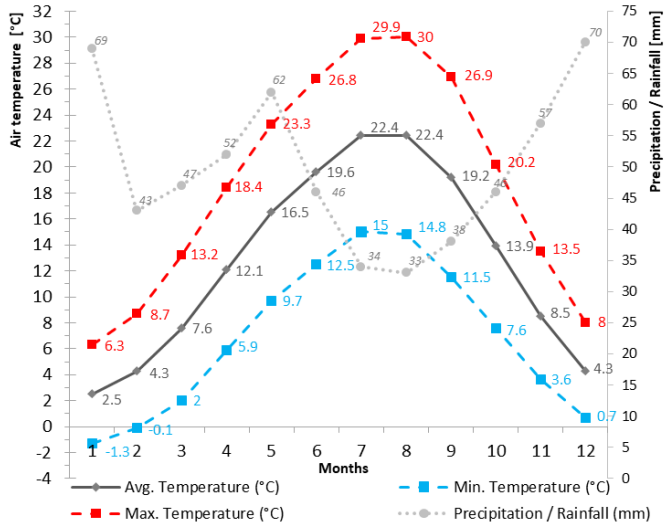

Figure 3. Weather data of Safranbolu, Turkey (Safranbolu Climate Summary, 2020; reproduced by the authors)

4. CLIMATE RESPONSIVE AND CULTURAL APPROACHES APPLIED IN POČITELJ AND SAFRANBOLU

The formation of vernacular settlements reveals strategies in terms of sustainability. There is no better confirmation of sustainability than these settlements that have lasted for hundreds of years at a time due to their ability to adjust to local terms. In the traditional world, either man-made or natural things are in unique harmony with each other toward the destined perfection (Adeli and Abbasi, 2015). Comprehending nature implies establishing nature-compatible architecture by exploiting local renewable materials, adaptation to climate, and

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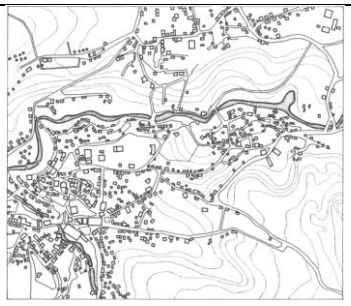
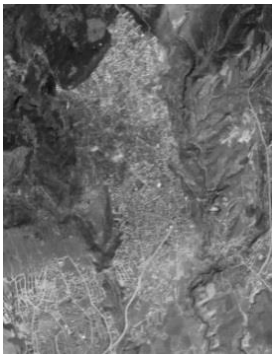
developing convenient micro-climate. This section attempts to highlight features associated with climate-responsive building techniques and cultural impact in Počitelj and Safranbolu vernacular settlements.

Figure 4. Map of Europe showing position of Počitelj and Safranbolu (Figure is from Google Maps (2019), colorized and reproduced by the authors)

Chart 1 demonstrates similar climate-responsive vernacular approaches and cultural impact by comparing two different sustainable solutions in the Cfa climate sub-type in both settlements (Počitelj and Safranbolu).

Chart 1. Similar climate-responsive vernacular approaches in Počitelj and Safranbolu[1]
(City of Safranbolu, 1994; Čelić, 1959; Cerasi, 1998; Sankovic, 2007; Pasic, Zgonic and Kudumovic, 2012; Bayazit, 2014a)

Strategy&Description	Počitelj	Safranbolu
Urban Layout -urban layout is compact in both settlements in means of reducing the number of surfaces that are exposed to the sun and wind power -both settlements are located on steep hills and river banks, shaped in a form of triangle which protects them from wind power -the urban solution with settlements in harmony with topography provides enough sunlight in winter months -residential area is located out of the central area which is common for Ottoman settlements and culture	 (Čelić, 1959: 16)	 (Cerasi, 1998: 117)
	 (Google Eath, 2019a)	 (Google Eath, 2019b)

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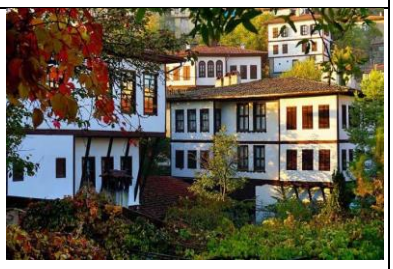
Street pattern -the street pattern is like a branching tree designed to drain excess rains -high garden walls form organic streets and ease air circulation -streets are closed to vehicle traffic and are narrow and steep -pedestrian-oriented approach is followed in urban planning -relationship between streets and courtyards has a cultural character	 (2019)	 (2003)
Dimensions and building forms -dwellings are creating a human scale environment -houses are generally three-story, building forms are characteristic to the Ottoman architecture and provide privacy to the inhabitants -houses are built in harmony with topography, are compact and oriented to the south and west to maximize sunlight during winter -pitched roof ease indoor air circulation and cast longer shadows	 (2019)  (2019)	 (2003)  (2003)
Vegetation -lower temperatures and increased air moisture, as well as shading, were achieved with planting greenery -vegetation is useful to cool the air streams before they reach the dwellings	 (2019)	 (2018)
Materials -local materials were used in both settlements -using local materials was climate-responsive sustainable solution that developed desirable micro-climates	 (2019)	 (2018)

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Openings and building envelope -using light colors minimized heat gains during summer and heat loss during winter -big openings are used on the insolated elevations, while the number and size of openings on the north side was minimized to reduce heat loss -ground floor openings were minimized to respect privacy of inhabitants	 (2019)	 (2018)

Chart 2 demonstrates different climate-responsive vernacular approaches and cultural impact based on differences in climate conditions in the Cfa climate sub-type in both settlements.

Chart 2. Different climate-responsive vernacular approaches in Počitelj and Safranbolu

Shading -in addition to vegetation as a method of lowering heat gains, in Safranbolu window shading was present while that is not the case in Počitelj	 (2019)	 (2018)
Roofing -roof construction in both settlements is wooden, however, roofing material is different in Safranbolu – ceramic tiles, while in Počitelj the roof covering is in the form of stone slates	 (2019)	 (2018)

Chart 3 demonstrates similar climate-responsive vernacular approaches as well as cultural impact by comparing selected case studies – Gavrankapetanovic House in Počitelj and Hacıhüseyinler House in Safranbolu.

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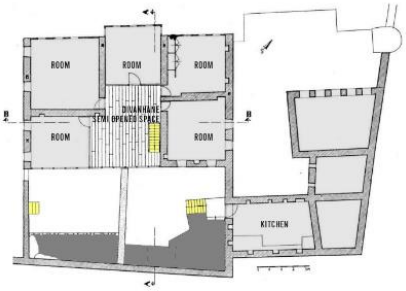
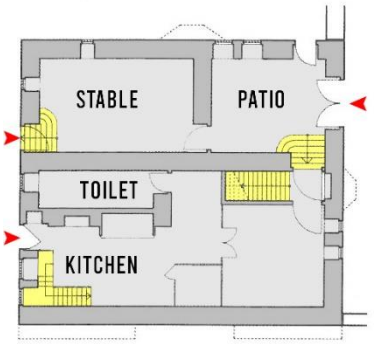
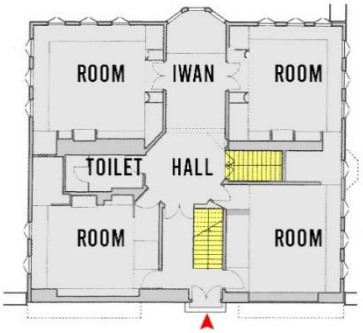
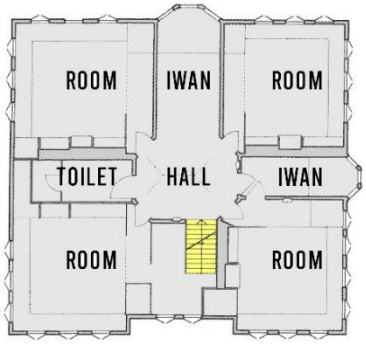
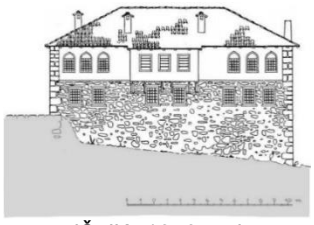
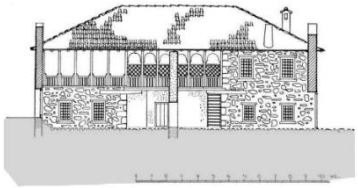
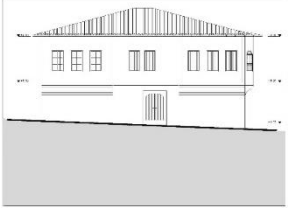
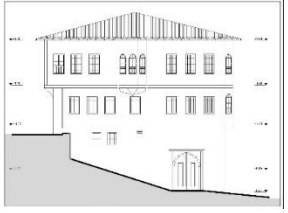
Chart 3. Selected case studies: comparison of the Gavrankapetanovic house in Počitelj and Hacıhüseyinler house in Safranbolu. (Čelić, 1959; City of Safranbolu, 1994; Pasic, Idrizbegovic Zgonic and Kudumovic, 2012; Bayazit, 2014b)

Descriptions	Gavrankapetanovic House, Počitelj	Hacıhüseyinler House, Safranbolu
House plans -Safranbolu house spatial organization reflects in 'iç sofalı' plan type where hall and stairs are located in the interior part of the dwelling, while Pocitelj houses have outdoor stairs that lead to semi-opened space called divanhane -the basement is built to decrease thermal exchange and exploit moisture of the ground considering excessive rainfalls in both settlements -high courtyard walls provide privacy as well as air circulation and reduce heat since they are covered in vegetation, the only difference is the physical division of the courtyard to male and female part in Gavrankapetanovic House, which is not noticed in Hacihuseyinler House, nor any house in Safranbolu or Pocitelj region -there is periodical movement from winter section (first floor) to summer section (second floor) and vice versa, winter section floor height is lower in order to lower heat loss and keep the temperature high during the cold months -Gavrankapetanovic House has differentiated spaces for men, women, and guests which is not the case in Hacihuseyinler house	 (Čelić, 1959: 44)  (Čelić, 1959: 45)	 (Bayazit, 2014b: 27)  (Bayazit, 2014b: 27)  (Bayazit, 2014b: 27)
Facades -facades are plastered and colored white to reduce heat gains in the summer period -the first floor is lower than the second floor in order to keep heat in the winter period -pitched roofs provide shadow long enough in the summer period -reduced openings reduce heat loss in the winter, and vice versa, they reduce heat gain in summertime	 (Čelić, 1959: 43)  (Čelić, 1959: 42)	 (Bayazit, 2014b: 32)  (Bayazit, 2014b: 33)

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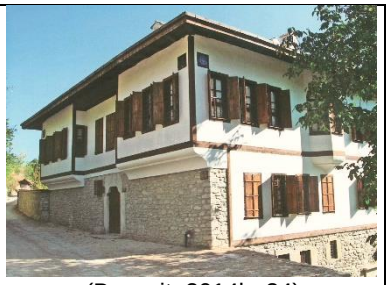
Materials		
-local materials were used to build both houses -the ground floor was made of stone while upper floors were made with 'hımış system' -doors and windows were made of local wood -roof covering is different – in Počitelj stone slates while 'alaturka' tiles were used as covering in Safranbolu	 (2019)	 (Bayazit, 2014b: 34)

5. DISCUSSION

Despite the distance between Počitelj and Safranbolu and their position on two different continents, corresponding sustainable vernacular approaches were determined in both settlements. The same approaches are the outcome of climate impact along with common Ottoman culture impact. As presented in Chart 1, Chart 2 and Chart 3, the approaches used in the two settlements are very much alike. Some of these approaches are debated below.

5.1. Similarities

5.1.1. Urban Layout

On the urban design scheme, dwellings built on a human scale and compact layout with street patterns like branching trees are both in harmony with topography as well as climate conditions. Compact urban layout is frequent in areas with hot summer periods and windy areas. Developing a convenient micro-climate with narrow streets, courtyards, providing enough shading, and using vegetation resulted in reducing heat losses in winter, reducing heat gains in summer, and protecting the settlements from wind influence.

5.1.2. Street Pattern

At street level, high courtyard walls formed narrow streets closed to vehicle traffic and eased air circulation in the settlements. Street pattern in both settlements is in a form of branching tree designed to drain excess rains that are present all over the year in Pocitelj (average precipitation is 1349 mm) and Safranbolu (average precipitation is 597 mm). Relationship between streets and courtyards has also a cultural character which comes from the Ottomans. In Ottoman culture houses are 'protected' from the outer world with garden walls and garden gates.

5.1.3. Dimensions and Building Forms

Dwellings are designed to handle a variety of functions, but one of the most crucial is to establish living conditions that are satisfactory to their inhabitants, specifically concerning the predominating climates. Buildings do not control climate, which, apart from the wind or sun shadow that they throw aside, remains to a great extent unchanged. But the dwelling can modify the internal climate, even though it is affected by the outside conditions. The materials that are used, the shapes they take, the volumes they enclose, and the services that are installed may all contribute to the 'micro-climate' that the dwelling generates (Oliver, 2003; Meir and Roaf, 2018).

In settlements like Počitelj and Safranbolu where topography determined building orientation, dwellings were integrated into their natural context making minimum impacts to the

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environment. When possible, dwellings were oriented towards the south where the south facade was the one with the most openings because sun radiation is stronger, particularly in winter. Dwellings are creating a human scale environment and are positioned so that neighbour dwelling has its own privacy which is related with cultural influence dating back to the Ottomans. Residential houses are utmost three-story with building forms characteristic to the Ottoman architecture, covered with pitched roof to ease indoor air circulation and cast longer shadows during the summer. Facades orientated towards main wind flows were the ones with the least and smallest openings.

5.1.4. Vegetation

One of the passive climate-responsive sustainable strategies is undoubtedly the vegetation. Lower temperatures and increased air moisture, as well as shading, were achieved with planting greenery. Vegetation is useful to cool the air streams before they reach the dwellings. In addition to vegetation being climate-responsive strategy, it is also related with Ottoman culture. Ottoman houses, even the smallest ones, have gardens that provide privacy to the residents in addition to having affirmative influence on the microclimate around the dwellings.

5.1.5. Materials

The predominantly used material in Pocitelj and Safranbolu vernacular settlements was stone. It was used to build the foundation of dwellings, walls, up to roof coverings. The stone used in the settlements was local, mainly white limestone and black stone. Wood as a material was also very important, different types of wood were used for different building elements. In the roof and floor structure, pinewood was the main building material. The wood type of architectural elements such as doors, windows, and stairs were selected depending on their exposure to atmospheric agents. Timber ties were generally not left unprotected, so they had to be plastered. As for masonry, there were two types of masonry, dry masonry and one where the mortar was used. The mortar was used only in external layers of the walls, ground floor walls were not plastered so they could keep humidity from coming up the walls. Lime was used as the main bonding material. Clay mixed with lime was used as leveling layer for stone floors. All of these are natural materials with a low carbon footprint and can be recycled. All of building materials used have hygroscopic features which allows them to regulate air humidity and provide desired comfort.

In Chart 4 advantages of traditional building materials used in Pocitelj and Safranbolu over the conventional building materials are presented. Local building materials have less embodied energy, lower global warming potential, as well as less environmental impact than conventional building materials.

Chart 4. Properties of traditional and conventional building materials (Fernandes, Mateus and Bragança, 2013: 625)

Material	Density (kg/m^3)	Thermal storage capacity (Wh/kg^oC)	Embodied energy ($MJ\ eq/m^3$)	Global warming potential ($kg\ CO_2\ eq/m^3$)
Adobe	1770-2000	0,23-0,30	943	38
Stone	2600-2800	0,22-0,24	1300	26
Timber	650	0,14	1058.88	57.7
Straw	110-150	0,055-0,065	65	0,65
Concrete	2400	1,10	1450	264
Hollow bricks	1200	0,26	4245	357

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5.1.6. Openings and Building Envelope

The building envelope of vernacular dwellings is directly influenced by climate conditions since it is in the direct contact with the environment. Therefore, as the climate in both settlements is the same, the climate was determining factor in designing building envelopes. Since both regions are rainy with average percipitation in Pocitelj of 1349 mm and in Safranbolu of 597 mm, the pitched roof was used as a roof solution. Courtyards ensured control of the sunlight and provided natural ventilation. Compact forms reduced heat losses through the building envelope during winter, along with blocking winds. Respecting vernacular principles, building envelope materials used were local, natural, and renewable, therefore it affected dwellings' energy efficiency performance. Size and number of openings were minimized to reduce heat gains / losses. Using light colors for the building envelope was also one of the climate-responsive approaches that reduced heat gains.

5.2. Differences

5.2.1. Shading

Climate with hot summers such is in Safranbolu and Pocitelj (Cfa climatic subtype) requires from building envelopes to deal with intensified solar power throughout the year. In Pocitelj it is accomplished by reducing the size of openings and moving them inside to provide shade, while in Safranbolu it is accomplished by wooden shutters that worked as both ventilation grids and shadings. The possible reason for not using wooden shutters in Pocitelj is that precipitation averages 1349 mm, while in Safranbolu it is 597 mm, besides that Safranbolu area is more plentiful with timber.

5.2.2. Roofing

As presented in Chart 2, the difference between roofs in two settlements is in the roof covering. It is related to the climate conditions, where wind power is excessive in Počitelj and it was only logical to use stone slates. Besides, Počitelj area is rich in stone excavation sites where it was possible to excavate stone as main building material not just for roofing but the whole building.

5.3. Comparison on Micro-scale

Selected case studies of Gavrankapetanovic house and HacıHüseyinler house besides confirming common climate-responsive building strategies in both settlements on micro-scale level (Chart 3.), furthermore represent a common influence of Ottoman culture in two different parts of the globe. As vernacular architecture is characterized by its reliance on needs, building materials, and traditions specific to its particular locality, similar vernacular settlements from distant regions are product of climate-responsive approaches and culture impacts which can be seen in the example of Pocitelj and Safranbolu.

The houses in Safranbolu and Počitelj show similarities in the terms of materials and building form and climate-responsive building strategies, yet there are differences in plan layouts of the homes. However, plan layouts didn't affect building forms nor the urban layout in general since that distinction is related with cultural impact. Besides case studies, additional examples of houses from Safranbolu and Pocitelj are presented to establish the fact that differences in plan layouts did not result in anything different than passive climate-responsive building strategies in both settlements.

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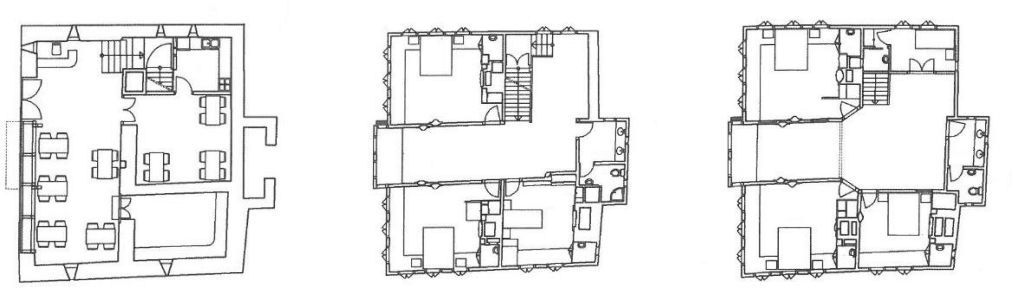

Figure 5. Ground, first and second floor plans of Arap Hacılar House in Safranbolu (Bayazit, 2014b: 40)

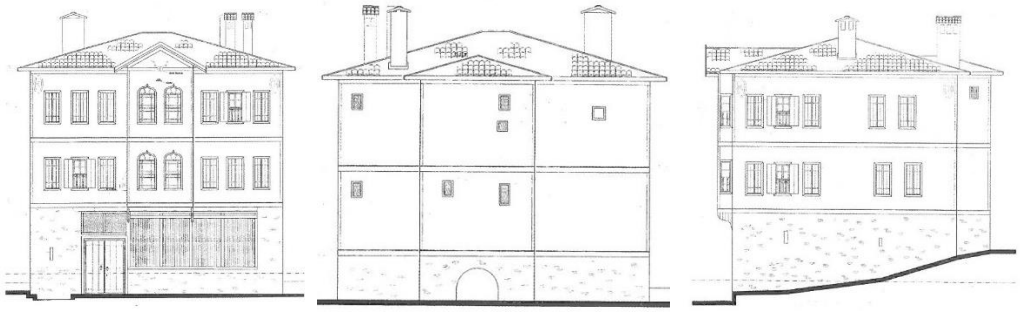

Figure 6. Main, back and lateral facades of Arap Hacılar House in Safranbolu (Bayazit, 2014b: 42)

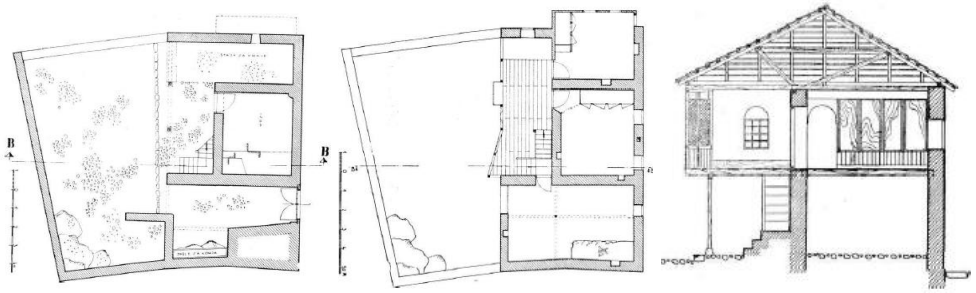

Figure 7. Ground, first floor plan, and section of a residential building in Pocitelj (Celic, 1959: 38-39)

Observing other examples than Gavrankapetanovic and Hacıhüseyinler Houses it is noticeable that similar climate-responsive strategies are present in both settlements, while culture impact originated differences in plan layouts. Dwellings in Pocitelj were not just influenced by the Ottoman culture but have elements of traditional bosnian architecture and that is where differences in plan layouts originate. Nevertheless, local materials, sustainable building techniques, indoor comfort conditions remain the same in all buildings.

6. CONCLUSION

Nature is believed to be a part of architecture; therefore, the architecture makes an intimate connection with nature. Exploiting local materials, as a matter of fact, natural materials is one of the important features of these settlements regarding sustainability and affirmative relation with nature itself. This study points out that it is desirable to use these principles in modern building techniques as well. These two settlements located in two different parts of the world, yet using the same building logic and principles, endured over centuries and responded to the needs of its inhabitants. Instead of relying completely on technology, modern dwellings ought to point out the relationship with the surroundings. Examining traditional methods and building techniques can lead to less energy consumption and reducing waste (Chart 4).

By limiting attention to the technological and environmental performance of buildings, the importance of the cultural embodiment of vernacular architecture is neglected, making our understanding of how it relates to its environment partial and distorted. A holistic and integrated

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perspective that looks at all aspects of a building tradition (social, economic, political and environmental) and the way they interrelate is essential. Only then will it be possible to understand, for example, why traditions that appear sustainable from an environmental perspective may often be abandoned, while those that are economically unviable may sometimes be maintained.

Despite the distance between Pocitelj and Safranbolu it was possible to find similar climate-responsive approaches in both settlements, as well as culture influenced building elements. Pocitelj and Safranbolu dwellings represent unique forms of vernacular architecture which are part of the culture that produced them, and above all they represent sustainable passive settlements where similarities in vernacular building design are mainly response to climate conditions.

From the examples presented in the research vernacular design strategies are oriented towards sustainability and achieving indoor comfort conditions. Taking the best from the past combined with using modern technologies can improve modern people's life quality. Present comfort standards are far ahead of the traditional dwellings comfort standards but respecting and improving traditional building principles in modern means fossil fuel emission can be reduced. The paper proved that climate-responsive sustainable building approaches are the same in both settlements and that vernacular settlements are in unique harmony with nature and climate-responsive overall. Paper set up a way towards using sustainable building principles to create modern settlements in a close relationship with nature and draws proposal for further research on more detailed data on vernacular building techniques that would be useful to develop guidelines on modern sustainable building design that would use local materials with lower carbon footprint instead of relying on HVAC systems and prefabricated elements.

In order to meet today's housing needs relationships between vernacular architecture and environment is essential to be understood. In future, reference archive of vernacular passive performance of buildings in Turkey and Bosnia and Herzegovina, as well as in other countries around the globe could be a strong opening for utilization in modern building techniques relying on climate and cultural impacts. Vernacular architecture, with more scientific researches and using modern computer programmes to simulate passive performance of vernacular buildings can be used as design guide for modern building strategies in different climate typologies.

Information / Acknowledgments

All figures and charts in the article are produced by the authors in declared year, unless stated otherwise.

Conflict of Interest Statement

This article complies with research and publication ethics and there is no potential conflict of interest.

Notes

[1] The plans and the elevations of the Hacıhüseyinler House were obtained and reorganized by using the architectural drawings of Şükran Arslan, Nesibe Günalp and Elif Köse cited in the book of Prof. Dr. Nigan Bayazıt (Safranbolu Geleneksel Konutları ve Toplumsal Değişme) as reference.

The plans and the elevations of Gavrankapetanovic's House were obtained and reorganized by using the architectural drawings of architect Džemal Čelić as reference. The drawings were made as a part of an architectural study and published by the Republic Institute for the Protection of Monuments in 1959 in the book "Naše Starine VII" (Čelić, 1959: 5).

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Authors' Biographies

Adna BERKOVIĆ

Adna Berković was born in Sarajevo, Bosnia and Herzegovina in 1992. In 2014 she graduated from the University of Sarajevo, Faculty of Architecture and Urban Planning. She obtained her master's degree in architecture from the same university in 2016. She has been working as an architect in private sector since 2014. She has been a PhD student at Konya Technical University since September 2019.

Fatih CANAN

Fatih Canan was born in Paris, France in 1973. He is Associate Professor at Konya Technical University, Faculty of Architecture and Design. He graduated from Selçuk University, Faculty of Engineering and Architecture in 1997. In 2001, he was awarded the "European Master in Architecture and Sustainable Development" by the associate institutions EPFL (Ecole Polytechnique Fédérale de Lausanne, Switzerland), UCL (Université Catholique de Louvain, Belgium) and EAT (Ecole d'Architecture de Toulouse, France). He received his Ph.D. degree from Selçuk University in 2008. His research field is microclimatic and ecological design.

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