

Vernacular architecture sustainability principles: A case study of Bosnian stone houses in Idbar village

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ABSTRACT

To ensure architecture built on sustainable principles and safeguard cultural heritage exposed to destruction are challenges Bosnia is facing in the modern age. The case study of this research, Bosnian village Idbar, with its important historical, traditional and architectural values, showcases the challenges mentioned above, and examines whether Bosnian vernacular rural architecture follows criteria of sustainability and was built on hypothesis that Bosnian vernacular rural architecture fulfills sustainability principles. It was addressed by analytical historical method with auxiliary method of case study which incorporated recordings of site conditions. Sustainability classification of cluster dwelling units in Idbar was examined in accordance to the conventionally accepted sustainability principles: minimal start up environmental impact, contextualization, adaptability, water usage sustainability, energy efficiency, self-conserving, and biodegradability. The research established set of evaluation principles and criteria concerning sustainability of vernacular architecture that can be universally applicable in Bosnia.

Keywords: Vernacular architecture, Cultural heritage, Architecture without architects, Sustainability, Local technology and materials

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1. Introduction

Vernacular architecture, by its nature, has been exposed to changes and adaptations that testify about the social, cultural and natural mutations. The isolated “islands” of remaining vernacular architecture ensembles in Bosnia have survived in the hardly approachable countryside areas that have remained out of the impact of the major development flows. Aside from tracing authentic Bosnian architectural expressions, this sort of isolated dwelling units is also convenient for exploration of the sustainability principles used by our ancestors. Bosnian vernacular architecture; houses, different kind of production buildings, such as mills, workshops, blacksmith’s shops, animal shelters, milk processing buildings, defensive systems, water supply, irrigation systems, et cetera, have been exposed to different types of pressures that result in oblivion and destruction of identity. This article explores sustainability principles of vernacular houses in the village Idbar, located close to town Konjic. Its architectural heritage is in poor condition, most of the houses are abandoned, and village is

exposed to degradation through destruction, building new structures, and especially through falsifying cultural memory by different forms of ethno-villages.

2. Village configuration

Idbar is a village located in southern Bosnia, 12 km away from town Konjic Figure 1. It was developed on the coasts of the river Baščica and first time mentioned in 1411 by Bosnian King Ostoja. During centuries, it had strategic importance due to its position and natural resources. Its tradition has been developing throughout centuries framing not only local customs, but building technology, religion, food, clothing, interpersonal relations, and legends. Thus, it provided important historical, cultural, traditional and architectural values. Nowadays, architectural heritage is in a poor condition, most of the vernacular houses are abandoned, and village is exposed to degradation.

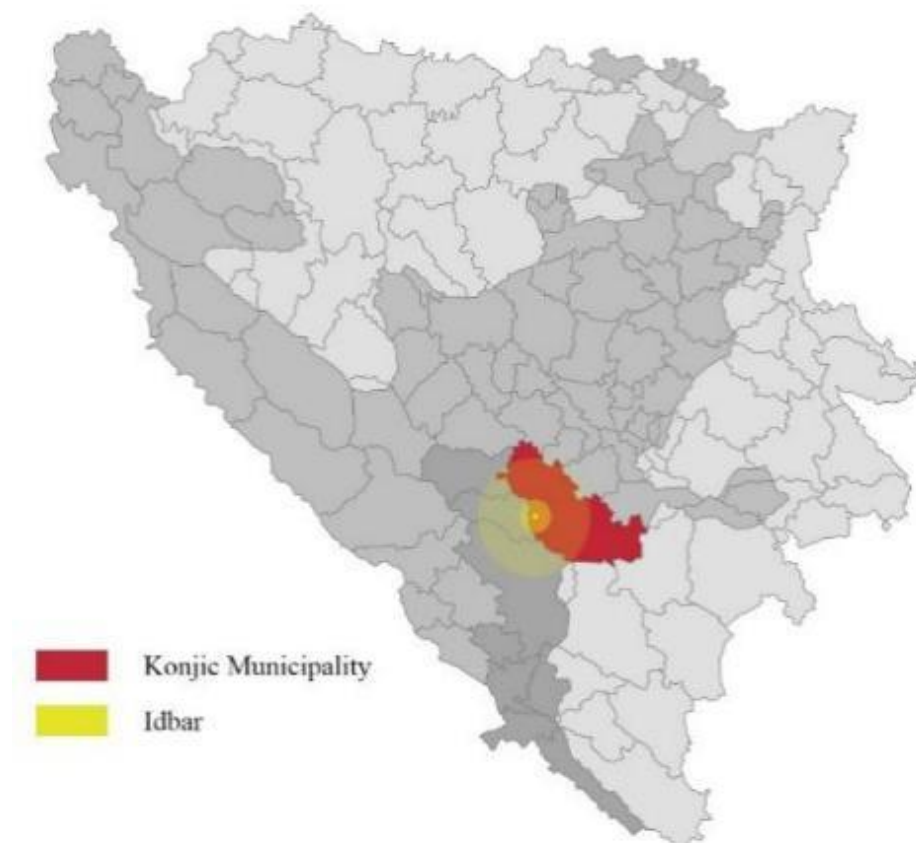


Figure 1. Location of Idbar. Map of Bosnia and Herzegovina. Photo: Google images (Location of Idbar in Municipality marked by author)

Idbar is longitudinally developed and consists of several smaller hamlets; Bukvići, Bajramovići, Ćosići, Kasali, Nuhići, and Raići, with the population of 238. The village starts with the dam built in 1954 to prevent accumulation of materials into the Jablaničko lake. The majority of residential houses in this village belong to northern Herzegovina style, as categorized by Astrida Bugarski [1]. Buildings are constructed from the local materials, stone and wood. During centuries, as a response to social conditions and level of development, several different styles of building structures emerged. Forest belts are longitudinally extended on the west and east sides of the village. Large areas of fertile agriculture land influenced centuries of residents' engagement in agriculture, beekeeping, and cattle breeding Figure 2. Although the hamlets in the village are scattered, residential buildings in every hamlet are closely connected to each other. Due to the comfortable climate conditions, configuration of the terrain and relations between families, houses were built in cluster formations, creating intimate courtyards Figure 2. Courtyards, unlike those in southern parts of Bosnia (*e.g.* Mostar, Stolac, Trebinje, Počitelj), were not cobbled, and were enclosed with characteristic wooden

fences locally called *lepirice*, while gardens were enclosed by fences locally called *plot*. Due to the terrain configuration, courtyards placed on the slope were designed like terraces, with dry stone supporting walls.

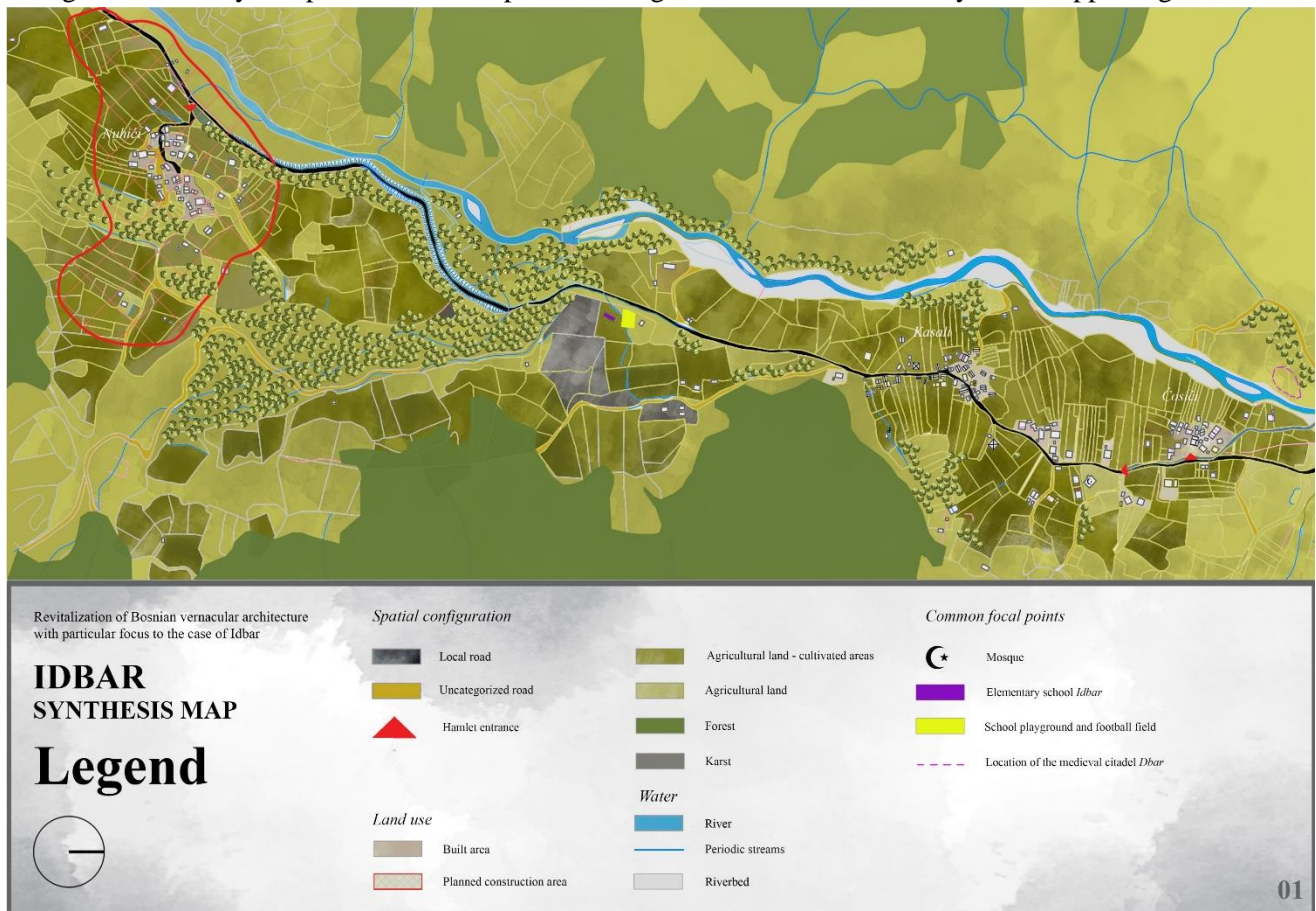


Figure 2. Synthesis map and configuration of the village

3. Vernacular architecture sustainability principles

Traditional building construction, materials and techniques applied through the history plainly lead to a conclusion that the building settlements were, out of necessity, sustainable. In the contemporary world with advanced technology and usually misunderstood concept of sustainability as a novelty, yearning for vernacular architecture principles may seem outdated. According to Kazimee [3], going back to vernacular architecture may be a method for solving nowadays challenges such as global warming. In defining lectures from vernacular architecture addressing usage of locally available materials, Paul Oliver even underlined that almost 90% of the world's housing shortages can be solved using local sources and traditional technologies instead of contemporary high-tech methods [4]. Vernacular architecture in the region of Konjic can be followed from XVIII century although the information from this period is sparse and most of the buildings remaining are severely damaged while others are destroyed by weathering or new construction. Sustainability principles that were out of necessity developed and integrated into building techniques of vernacular architecture in the Konjic region, particularly village Idbar, were examined and interpreted in the following chapters. Sustainability of vernacular houses was examined through test of sustainability following: 1) Start-up environmental impact; 2) Contextualization; 3) Adaptation to the circle of life; 4) Water supply sustainability; 5) Energy efficiency; 6) Self-conserving sustainability, and 7) Biodegradability.

3.1. Criteria one: Start-up environmental impact

Start-up environmental impact discusses sustainability principles that were integrated in the building design in Idbar. It is based on the examination of building materials and buildings technology.

Vernacular houses in Idbar were constructed out of several types of natural materials based on different constructive systems **Error! Reference source not found.** Houses were customized in accordance to residents' economic and financial situation, socio-political statuses, as well as ethnic and religious backgrounds. While basic residential and economic building units were constructed from the local materials based on the common knowledge of the rural area's residents and usually constructed by the hands of house tenants and their neighbors, houses with more complex forms were developed by the specialized rural masters [1]. Building construction in Idbar strongly defined ecological footprint that can be interpreted as a measure for the sustainability. Furthermore, following the measure of integration of the sustainability principles in the building construction leads to defining that the footprint was low. Examination of the start-up environmental impact suggest that materials used in construction, stone and wood, are found locally and further processed by local masters implementing eco-efficient technologies, and have decreased impact of the transport, and consequently decreased pollution.



Figure 3. The house in Idbar, showing commonly used building materials

3.2. Criteria two: Contextualization

Sustainability test for *Criteria two: Contextualization* integrates and discusses: 1) House and terrain; 2) Visual identity; 3) Symbiosis between man and nature; 4) Interior organization; 5) Interior furniture; 6) Courtyards, and 7) Materialization and the use of the fences.

Idbar is located in rugged terrain, and houses built there correspond to its natural configuration and typology. In order to perceive the best out of sunlight, houses were turned to the sun by their longer side. They were contextualized and integrated into slope **Error! Reference source not found.** In some cases, complete front end wall was sunken. As a result, basement, called *magaza*, was sunken in the ground and approachable from the agriculture fields which made storage of the harvest easier, while rooms were entered from the street level.



Figure 4. House contextualization and integration into slope, Idbar

Other than backing onto the natural configuration of the terrain, contextualization of the houses in the village is readable through its visual identity. In this region, limestone has played a great role in developing cultural heritage. Since most of the houses were made of stone, or combination of stone and wood, it creates certain unity of design Figure 5. Although stone houses of this region, particularly Idbar, had simple composition, purity of design style and simple design expression, varieties of building forms and different stages of development that enhanced regional characteristics of traditional house, suggest that this region offered richness of design expression.



Figure 5. Visual identity of houses in Idbar. Left: House in hamlet Kasali; Right: House in hamlet Nuhici

One of the most treasured values of Idbar's vernacular houses is symbiosis between nature and man, which has been developed centuries ago. Symbiosis is defined as an interaction between two different organisms living in close physical association, usually to the advantage of both. In two specific examples of contextualization, stone house was integrated into rock, forming perfect symbiosis of a man-made and natural environment Figure 6. Values of the common sense used in building technology and relation between man and nature, or traditional wisdom, can be used in future, which will initiate green and sustainable design without mechanized services. Symbiosis between man and nature is important for preserving identity of the regional culture, and it is one more proof that architecture is not just an enclosed and self-oriented entity, but rather, it represents an important part in contribution to a better environment.



Figure 6. Symbiosis between man and nature represented in built heritage

Bosnian stone houses had rectangular plans, usually 7 to 11 meters long, and 4 to 6 meters wide, following the custom of 3 meters difference between width and length. Since they were built on sloppy terrain, they were positioned on the slope by their length. Below one part of ground floor there was an underground space, storeroom. Ground floor consisted of two spaces – called *kuća* and *soba*. It was heated by a fire in a clay oven, typical for the Bosnian houses. First floor had one room called *odžaklija*, had a device for smoke collecting, *odžak* **Error! Reference source not found.** Second floor had a small space in which smoke was spread, and was used as food storage as well. Fruits and vegetables were stored in underground space, *magaza*, simple and uniformed spatial structure characteristic for this region. Storing food in this area during summer and winter would help creating optimal temperature for its preservation.



Figure 7. A device for the collection of smoke, *odžak*.

Interior of the stone houses in the village was organized in a similar way, but it was not uniformed [5]. Entrance was placed on the middle of the wall and it would lead into windshield, called *ganjak* that was sometimes used as a kitchen. Another form of kitchen formed in these houses was called *huđera* that contained *čivijaluk* or *čiviluk*, place for storing coats. Heart in Idbar's stone houses was mostly placed in the middle of the frontend wall, in the room called *majinska soba*. It was placed very low, built from stone and bordered with stone or wood, to keep material for heart, *vatrište*, from dropping off [6]. Heart was accompanied by two shelves in the wall, called *dolaf*. Sleeping room was called *halvat*, while beds were made from the wooden boards.

Houses of the Muslim population had small bathrooms integrated into interior space, usually placed in the corner of the rooms, called *đeriz*. *Đeriz* was built from a single-row stone, 15 cm high, coated with the combination of the lime and fine sand, *sitni kum*. Each *đeriz* had piping for leading water outside the house. Pipes were wooden, made from the *zova*. This type of tree had hollow laburnum, *srčika*, easy to turn into pipes. Floor in Idbar's houses was made out of the wooden boards, made from the oak, sometimes covered with woolen carpets. If house had attic, it was approached from *dihvana*, wooden gallery, by the stairs or sometimes ladders. As vernacular houses are conditioned by the configuration of the terrain, climate conditions, availability of natural materials in a given area, skills of the masters, et cetera, characteristics of vernacular stone houses in Konjic region are common for all people living in this area. Some discreet details included in house design which appeared on the houses served as an adaptation to the religious needs of tenants. Although their different economic, class or religious expressions did not play an important role, these were emphasized in some studies as a mean to express different identity.

Comfortable weather conditions contributed to creating courtyards. This resulted with a significant part of house functions transferred to these 'residential courtyards' [6]. Although the hamlets in the villages were scattered in configuration, houses inside of one hamlet were closely linked to each other, creating more intimate courtyards and private family atmosphere. Hilly terrain influenced more noticeable compaction of houses, and creation of courtyards Figure 8. As there was no water supply in the houses until 1970s, fountains, *česme*, were frequently built in the courtyards.



Figure 8. Houses in one hamlet creating intimate courtyards in hamlet Kasali

3.3. Criteria three: Adaptation to the family life circle

Stone houses provided a possibility for further adaptation in accordance to the needs of growing families. If the house was divided among two families, adaptation was done from the inside, by building a wall to divide interior space. This type of division secured continuation of habituated way of life. Due to the long-term durability, stone house itself provides a possibility of further longitudinal development when needed, where single space unit becomes a house with several rooms organized linearly. Due to the use of two roofs, stone houses were easily longitudinally developed by constructing new rooms next to the wall of *soba*, or *kuća*. Entrances to newly constructed rooms were added through existing rooms. If longitudinal developed was continued, then having the entrance from existing rooms was not possible anymore, but it was added from the outside. Sometimes, this new entrance was added from the new space, called *međuvrače*, built between existing and upgraded rooms, and served as a protection from the wind and snow [6]. Furthermore, this protection space was divided into *araluk* and *ćiler*. Development of the stone house was even regulated by construction of cross wings, built perpendicular to the main building Figure 9.



Figure 9. Adaptation of the house by addition of new cross wing on the house in hamlet Cosici

3.4. Criteria four: Water use sustainability

Water is one of the biggest natural resources in Idbar with more than hundred springs of fresh water [7]. Mills for grinding grains that were constructed on Idbar's springs were sometimes built and used by individual, but more frequently by a group. Every hamlet, or in some cases every household, had its own mill, which means that water was discharged to the courtyards, but they did not have direct water supply into the houses. The abundance of water and its natural recycling has enabled the use of water for drinking, cleaning, washing, feeding, irrigation systems, cooling, fishing, production of flour, which is closely related to the energy efficiency of the settlements. Water was used in the way that its natural recycling was maintained.

3.5. Criteria five: Energy efficiency

Vernacular architecture is bordered with ecological, economic, and social factors, where vernacular buildings are, as Lawrence [8] states, human constructs produced because of these factors. Since they are made of locally available materials, employing local people, using renewable sources of energy, vernacular buildings are based on sustainable design principles, and are climate-responsive in many ways [9]. Furthermore, vernacular architecture has been developing continuously and depends on experience, surrounding conditions and local materials [9]. Energy efficiency and renewable energy are said to be the twin pillars of sustainable energy policy [10]. Since vernacular architecture evolved through trial and error methods, buildings and site planning depend on substantially experience, surrounding conditions, and local materials such as adobe, stone and timber.

For thousands of years wood has been used as a building material. Although the chemical properties of wood are complex, human beings were capable to harness the unique characteristics of wood in order to build different varieties of structures. This versatile and adaptable material is used in building construction, shipbuilding, furniture and home décor industry. Being a natural resource is one of the strongest advantages of wood, making it available and economically feasible. It provides a good insulation from the cold, it is machinable and can be fabricated into different sizes and shapes. Furthermore, wood is a sustainable material, biodegradable and renewable with lowest carbon footprint of any other building material. Unlike many other materials, wood does not expand by the effect of heat. However, by the effect of heat, it dries out and gains strength. The coefficient of thermal conductivity of the wood is very low and for this reason wood is used for making matches, handles of hardware equipment, ceilings and wall coverings. In the case of fire, wood does not significantly change its mechanical properties, and this is a major advantage over competitive materials.

With more than 90% of calcium carbonate (CaCO_3), limestone represents a carbonate sedimentary rock [12], that forms from the accumulation of shell, coral, algal, and fecal debris. Limestone is a soft rock with a

surface that can be easily scratched and fine-grained. It is mostly white, but iron oxide can make limestone red, brown or yellow, while carbon can make it gray, black or blue. It is absorbent and can become quickly stained. Due to its durability, consistency in texture, easy resizing and reshaping, it is widely used in building construction. In the summer mode, when outdoor temperatures are very high, limestone enables fast diffusion of the heat to the inside, keeping interiors cooler. Together with low diffusivity, high thermal inertia contributes to energy efficiency of limestone which can be classified as a good absorbent of heat that will not rapidly change temperature, making it ideal building material for both summer and winter mode.

Interior organization of the houses was achieved in a manner to benefit the most from the heart. Sleeping rooms, placed one above the other, were heated by the heart. In the same time, this heat was used to drying fruits or meat. In this manner, stored harvest was protected from both high and low temperatures, as well as from other sorts of the harm. Storing harvest and other goods was in some cases extended from the basement to the hole in the ground, covered by wooden boards. Physical properties of the stone which was used as a building material prove that there was no need for placing additional insulation materials. Treatment of the wooden as well as the stone elements from their preparation and cutting in the special manner, to covering with lime plasters and limewash made a significant contribution to their safeguarding and conservation through the years.

3.6. Criteria six: Self-conserving sustainability

Self-conserving sustainability in the frame of sustainability test provides elaboration of the techniques applied in order to enhance self-conserving processes: 1) Limewashing stone; 2) Preparing roofing material; 3) Use of waste products generated by combustion of fuel wood for conservation; 4) Conservation through the benefits of the ecosystem and the natural food chain. Limewash is the finishing material applied to vernacular houses. It is made from limestone which has been crushed and slaked into water, forming lime putty. After maturing for several months, it was mixed with water to create limewash [19]. It is naturally white and has a chalky matt finish, applied to limestone or lime mortars. Since the limestone is porous paint and absorbed easily, it hardens the medium, helps to consolidate the building. In combination with breathable lime mortars and limestone, it reduces the effects of condensation and allows the moisture in the walls to evaporate to the outside [19]. Limewash is anti-bacterial and insecticidal and improves surface physically and visually. Duration of the roofing depends on the mode of cutting and quality of the wood [6]. Selection, that was done by the village masters who had experience and knowledge on this, included coniferous trees, primarily spruce and pine. Spruce and pine were easily found on the high mountains surrounding Idbar, and are referred as long lasting and durable. Due to respect for nature and out desire not to damage the forest, firstly chosen trees were the ones that were already hatched, called *izvala*. Trees used for roofing could not be chosen from the areas that are exposed to strong winds. Preparation of wooden boards, *šimla*, was a process that included cutting with a tendency of providing as much roofing material as possible. To prevent material from deformations, roofing could not be instantiated before the process of drying was finished. Apart from the quality of wood and type of cutting, the duration of wooden roofing was impacted by the smoke. Vernacular houses in Idbar and region had open fire places, hearts, that allowed smoke to move towards the attic. As the wood does not expand against heat but dries out, it becomes strengthened with prolonged lifetime. This system in building is considered as self-conserving sustainability. Since the smoke consists of solid particles, they were kept in a wooden construction and reduced the level of harmful emissions into the air. Carbon and nitrogen compounds formed by burning wood are known and often used in the chemical conservancy industry of wood. In addition, the attic was allowed to accommodate bats. Given that bats consume small insects that destroy wood, this natural food chain allows the protection of wooden structures from bio-degradation. At the same time, the batches of bats abound with nitrogenous compounds important for the conservation and longevity of wooden structures.

3.7. Criteria seven: Biodegradability

In building technology of Idbar's houses, all used materials were sustainable, and found in local area. During time, wood as an organic and biodegradable material decays, while stone have a recyclable characteristic and it can be re-used for other purposes. Furthermore, if used and properly maintained, stone houses can have long durability, but if abandoned and forgotten, these houses can 'disappear and die'. Decaying of these houses does not leave an impact on ecological footprint.

4. Conclusion

Gradually evolved vernacular architecture integrates the concept of sustainability and meets environmental, socioeconomic, and sociocultural characteristic of a society [20]. Test on the sustainability examined sustainability principles that were followed during construction of the vernacular houses in the village Idbar. This test was based on: 1) Start-up environmental impact; 2) Contextualization; 3) Adaptation to the circle of life; 4) Water supply sustainability; 5) Energy efficiency; 6) Self-conserving sustainability, and 7) Biodegradability. Sustainability test elaborated above proves that vernacular stone houses in the Idbar were built following the principles of sustainability and gaining harmonization with the site and settings. The results of the analyzes carried out in Idbar presented in this article confirm the theses of many contemporary authors, who claim that returning to the beginnings of vernacular architecture can be a method of solving the biggest problems of today, including global warming, and that traditional methods of building and using local sources and materials can settle almost 90% of the world's housing shortages. Furthermore, the evaluation principles developed to examine sustainability of Bosnian vernacular architecture in this research can be universally applicable in Bosnia. It is important to emphasize that the most important characteristics of the houses that were subject to research in the region of Konjic, including the names for the parts of the house, are common for all people, regardless of their different economic, class or religious expressions. In some cases, a discrete detail such as cross on the roofs of the Christian houses, gilded spike or crescent moon, *alem*, on the guest house, *musafirhana*, or a small overhang with the ablution area on the first floor of the Muslim houses, as well as the individual elements in the interior, served as an adaptation to the religious needs of tenants. But these never served for expressing different identity, although some studies tried to prove differently. These efforts, expressed in an unacademic way, can even be considered as a part of contemporary endeavor to stratification of the Bosnian identity.

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