

Colour mapping of traditional urban fabric material in the southeastern region of Turkey: havara stone

Anıl Süvari

Türkiye

Gamze Çoban

Türkiye

Anıl Süvari is an Associate Professor currently serving in the Department of Interior Architecture and Environmental Design at Alanya University, Turkey. He holds advanced degrees in Interior Architecture from Hacettepe University and Anadolu University (Turkey), as well as from ArtEZ University of the Arts (the Netherlands). Dr. Süvari has contributed to the academic discourse through various written works that explore pedagogical approaches and conservation practices within interior architectural contexts.

Gamze Çoban is an Assistant Professor currently serving in the Department of Interior Architecture and Environmental Design at Afyon Kocatepe University, Turkey. She holds advanced degrees in Architecture from Yaşar University and Gazi University (Turkey). Dr. Çoban has contributed to the academic discourse through various written works that explore conservation practices within architectural and interior architectural contexts.

Colour mapping of traditional urban fabric material in the southeastern region of Turkey: havara stone

● Anıl Süvari

Alanya University, Antalya, Türkiye

● Gamze Çoban

Afyon Kocatepe University, Afyon, Türkiye

ABSTRACT

Colour is one of the important elements that extends from the urban scale to the space scale. The use of colour is important in expressing the settlement's visual and psychological identity in the construction of place-specific architecture. Each settlement has unique colour cartels. The material is at the beginning of basic structural elements that make up these colour cartels. Havara stone is a cultural heritage item whose unique colour characterises the physical environment of the eastern region of Turkey, which was affected by an earthquake in 2023. The use of havara stone is important in the process of planning the restoration of historical environments in provinces located in the region. This study aims to determine the colours of the stone used, and their proportions. A centralised colour chart has been developed through computer-aided colour mapping techniques based on samples of apostle stone. This chart is intended to function as a referential framework for guiding colour selection in forthcoming restitution and adaptive reuse interventions

within the region. It is anticipated that the findings of this study will contribute to ensuring the quality and authenticity of restoration works, and that the colour mapping method will be adopted as a standard approach in the conservation of historical environments characterised by vernacular architecture and a preserved historical fabric. A colour chart is put in the middle with the computer-aided colour mapping method made from apostle stone samples. It is planned that this cartel will be the source of colour preferences in the restitution and re-functioning studies to be carried out in the region. It is hoped that the study's findings will assist in ensuring the quality of the restoration works and that the colour mapping method will be adopted for all historical environments having vernacular architecture with the historical fabric.

Keywords

Cultural Heritage, Traditional Urban Fabric, Colour Mapping, Havara Stone

Introduction

Factors related to the perception of the physical environment can be categorised into physical and design elements. Physical environmental factors include temperature, noise, odour, music and lighting, while design-related factors consist of architectural style, colour, material, interior organisation, texture and spatial layout. Among these factors, colour significantly influences

spatial experience as a fundamental component of human perception (Müezzinoğlu et al. 2021). The use of colour is crucial in constructing place-specific architecture, as it conveys a settlement's visual and psychological identity. Each settlement possesses a unique colour palette shaped by both natural and human-made elements. As a result of construction techniques developed after the Industrial Revolution, the chromatic design of today's urban

settlements has increasingly diverged from natural and cultural components. However, it has been observed that vernacular architecture has been less affected by these transformations, preserving its chromatic identity in terms of landscape, building facades and interior spaces (Birren 2016). The preservation of chromatic design in vernacular architecture, considered a form of cultural heritage, has become a prominent focus in contemporary restoration practices. In this context, identifying the colours specific to a region's natural and built environment is of great importance in restoration processes. The identification of these colours provides a basis for materials selection and colour preferences in the restoration of historical areas.

Traditional urban fabrics are spatial formations constructed by the needs of their time, using traditional materials, guided by prevailing aesthetic values, and developed with respect for the natural and built environment. In addition to their historical significance, they contribute meaningfully to the urban skyline. The buildings and the settlement patterns formed by their collective arrangement offer valuable insights into the social structure, urban planning approach, functional distribution and characteristics of commercial activities, and their interrelations during the period in which they were built. However, issues encountered in the planning

processes that guide urban development, along with natural disasters such as earthquakes and floods, affect the shaping of urban form and the integrity of the traditional urban fabric (Eriçok Keleş et al. 2021).

On 6 February 2023, a devastating earthquake with a magnitude of 7.7 on the Richter scale struck the southeastern Anatolia region of Turkey (Figure 1). Approximately nine hours later, a second earthquake with a magnitude of 7.6 occurred in the same region. According to official reports, nearly 32,000 people died and around 100,000 individuals were injured as a result of the earthquake. In addition, approximately 311,000 buildings were either destroyed or severely damaged to the extent that they became uninhabitable (AFAD 2023).

These earthquakes affected the traditional urban fabric of the provinces in the region, especially their historical environments (Figure 2). Restoration work has begun in the region affected by the earthquake. It is the aim of this study to present a colour chart of the historical texture of the region to contribute to restoration work carried out in Diyarbakır, Şanlıurfa and Gaziantep provinces, which were affected by the earthquake. In preparing the colour chart, we used the havara stone, a dominant architectural element in the city silhouette, as a reference. The study



Figure 1
Southeastern Anatolia region of Turkey and provinces affected by the 2023 earthquake¹



Figure 2
Historical environment damaged in the earthquake²

sought answers to the questions of which colours are found in havara stone, and in which proportions. Computer-aided applications were used to determine these colours and ratios. Samples taken from the stone were photographed in high resolution, and colour mapping was performed using the Adobe Photoshop photo processing application. The chart that we created provides a colour master plan, based on the colours and their proportions in havara stone, to assist with colour choices for street improvement works and interior design studies. In street improvement works, it is ensured that the colour character of the region is preserved in the colour choices for building facades, urban seating elements, urban equipment elements such as garbage bins and lighting that can affect the landscape, and in the selection of building materials, furniture fixtures and accessory colours in indoor living, sleeping, eating-drinking and wet areas.

Havara stone

Cities in the southeastern Anatolia region bear traces of both their past and present physical environments. Most of these traces are provided by the physical texture formed by havara stone, which is extracted from this region and has long been used in local construction. In Diyarbakır, Gaziantep and Şanlıurfa, havara stone is a dominant architectural element in the city silhouette. **Figure 3** shows the historical texture created by the use of havara stone in these cities.

The city of Şanlıurfa and its surroundings have rich sources of limestone, a natural building material. The stone, which is frequently used in traditional architecture, is known as Urfa stone because it is unique to this region. The scientific name of the stone is 'Marl Miocene'. It is also known as urfa stone or nahit stone, depending on



Figure 3
Gaziantep, Şanlıurfa and Diyarbakır street silhouette. Source: Authors' archive.

Table 1

Properties of havara stone

Scientific names	Common names	Type	Colour	Properties
Marnlı Miosen	Urfa stone Havara stone Nahit stone	Limestone	Initially white in colour, yellowing over time	Not very porous Absorbent Soft (i.e. easy and cheap to process) Hardens as it oxidises

the region in which it is used in architecture and building application areas. However, it is commonly referred to as havara stone in the literature (Schirmer 1998). Havara stone is a white-coloured limestone that turns yellow over time. It has small pores that are invisible to the eye; it is soft, making it easy to extract from the quarry and easy and inexpensive to process; it has low heat permeability, and it hardens as it oxidises. Havara stone is classified as a limestone mineral type formed by sedimentation. As it is not a hard stone, it can be easily shaped as a building material (Turgut et al. 2008; M.T.A 2010).

Havara stone has been used in religious buildings, traditional dwellings, military structures, water structures and temples in and around Şanlıurfa for 12,000 years. The use of stone in the architecture of the region dates to the early Neolithic period (pre-pottery). Starting from Göbeklitepe, it is seen that havara stone was used as a building and ornamentation material in Harran Castle, in the walls of Urfa Castle and in traditional Urfa houses. Göbeklitepe, which is on the World Heritage list, can be described as the most important example of the use of havara stone (Figure 4) (Ağan 2016). Due to the easy processing of the stone, various animal and plant reliefs could be carved on the columns. In Gaziantep Province,



Figure 4
Şanlıurfa Göbeklitepe³

Antep Castle (Figure 5), which dates to 6000 years ago, and the Theban settlement built around it were constructed from havara stone. Today, the castle is still in use. It is surrounded by the historical city centre for tourism and settlement purposes. In Diyarbakır, the city centre is surrounded by the city walls. Havara stone is used in the constructions within the city walls. In addition to these provinces, havara stone is used in the Hatay and Kahramanmaraş urban protected areas located in southeastern Anatolia (Çiççi, 2019; Kürkcüoğlu 2016; Yarış 2020).

Havara stone is one of the most frequently used building materials in the Turkish provinces of Şanlıurfa, Gaziantep, Hatay and Diyarbakır. There are both large and small quarries in these provinces. Havara stone is defined as the dominant building material in the formation of the traditional urban fabric of the region (Cansunar, Çobancaoğlu 2019).

Havara stone is preferred as a building material for the following reasons:

- It is compatible with the traditional architecture of the region.



Figure 5
Gaziantep Kalesi⁴



Figure 6
Street views. Source: Authors' archive.

- It is soft when it comes out of the quarry. It does not harden, and it gains durability after coming in contact with air.
- It is easily decorated. In the process of quarrying, the stone can be cut to the desired size using a disk saw.
- Since it is a local resource, it does not require high costs for transportation.
- It provides thermal insulation.
- It is a sustainable, low-cost material that does not harm the environment (Turgut et al. 2008).
- The use of havara stone is sustainable due to its being a local resource that can be transported economically, has a long life, and is reusable and recyclable.

The street texture where havara stone is used as a building material is shown in Figure 6. In addition to its use as a building material, the stone is used as an ornamental element. Stone ornaments are found in traditional

buildings such as mosques, inns and baths in Şanlıurfa and the surrounding provinces, and adorning traditional residential architecture in the form of geometric and floral motifs. Generally, floral ornaments are found on crown gates and ventilation ducts (Figure 7) (Öztürk Tel 2021).

Havara stone is used in interior partition walls, furniture and fittings, stairs, exterior walls on the upper levels of the building, building facades, courtyards, vault interiors, street and avenue floor material coatings, sidewalks and landscape reinforcement elements. Figure 8 shows examples of the use of havara stone in interiors.

Once large pieces of havara stone have been extracted from the quarry, it is processed as a building material. The stones are cut using a disk saw. If it is intended as a flooring building material, it is cut into blocks 27 cm in height, by 42–57 cm in width and to a thickness of 5 cm. Figure 9 shows a block of havara stone cut to be used as a building material. It is also possible to shape the havara stone to any desired dimensions to suit a particular purpose (Tel et al. 2021).

The concept of colour in the preservation of traditional urban fabric

Legal regulations have been made at the international and national levels to protect traditional urban textures and cultural assets. The first international document to establish universal principles on conservation was the Athens Charter, which entered into force in 1931 (Ahunbay 2021). The second important document was the Venice Charter, which entered into force in 1964. With the Venice Charter, the scope of the concept of conservation changed

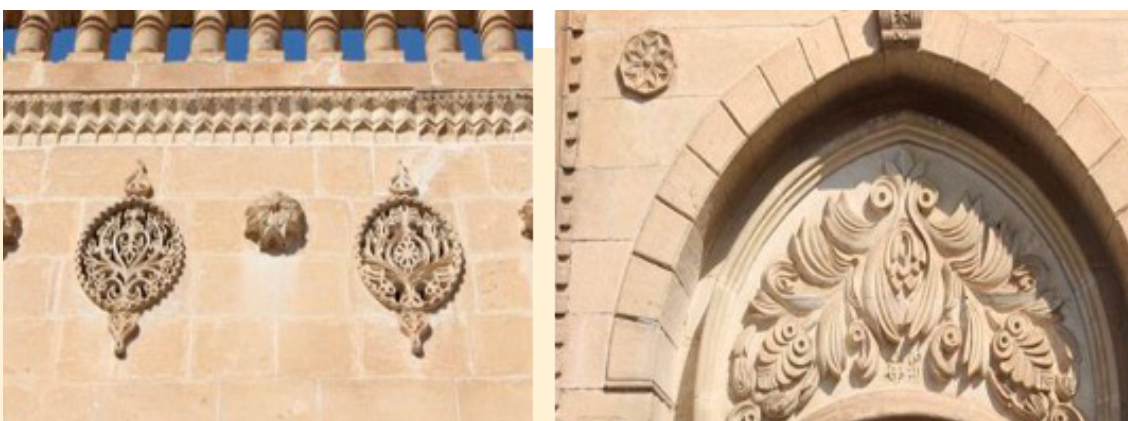


Figure 7
Ventilation ducts and door. Source: Authors' archive.



Figure 8
Use of havara stone in interiors⁵

from the building scale covered by the Athens Charter to cover both urban and rural settlements (Ahunbay 2021; Kuban 2010). One of the important decisions taken to protect the integrity of urban and rural settlements related to the general appearance of the historic environment. After the publication of the Venice Charter, experts working in the field of conservation came together and established the International Council on Monuments and Sites (ICOMOS) to support methods and techniques for

the protection of monuments and historical sites. Within ICOMOS, working groups were formed on conservation issues and bylaws guiding practitioners were prepared (Ahunbay 2021). According to the ICOMOS *Regulation on the Conservation of Historic Cities and Urban Areas*, the scale, size, style, construction technique, materials, colours, ornaments, forms, and interior and exterior appearances of buildings are all to be preserved within the scope of restoration works (ICOMOS 1987).



Figure 9
Block of havara stone. Source: Authors' archive.

One of the primary objectives of restoration work is to preserve all the elements that make up the character of the historical texture. The repair work must ensure that harmony is maintained between the restored texture and the traditional historical texture. Any loss of the historical texture will greatly damage the identity and texture of the city. In historical circles, the colour of the materials used is an important element in creating the traditional historical texture. In the historical environment, colours provide a holistic spatial understanding starting from the exterior and extending to the interior. First, a person begins to perceive space visually, so the original colour characters of historical environments are the first experience encountered in space. In any restoration work, the wrong use of colour will diminish the individual's holistic perception and understanding of space. However, in terms of colour properties, the use of incompatible colours will cause colour pollution. For this reason, colour choices in restoration works should not be left to

personal preferences or to fashion. It is necessary when selecting colours for structural elements such as walls, ceilings, floors, furniture/reinforcement and accessories to ensure they are appropriate to the historical texture of the environment (Ünver 2000).

Studies on historical environments and colour date back to the 17th century. The study that can be considered the first example of an official colour mapping study at the city level was carried out in the city of Turin, Italy. In subsequent years, colour designs were made in many cities, including Vienna, Prague, London, Warsaw and others (Lancaster 1996). In a research study conducted for the city centre of Zurich, colour samples were taken from the architectural features of all buildings dating from the 20th century. In this way, a colour master plan of the city was revealed (Sibillano 2021). Images from the study are shown in Figure 10. These studies were carried out using traditional colouring techniques, due to the inadequacy of computer technologies at the time they were carried out, and remained at a basic level. Today, environmental colour mapping methods using computer technologies provide accurate results about colours and combination ratios.

In a colour mapping study conducted in Sydney, Australia, colour studies for the buildings to be restored were carried out based on traditional and cultural heritage colour values instead of a colour palette obtained with physical and natural environmental data (O'Connor 2008).

It is suggested that the extraction of environmental colour maps in historical settlements may be a reference to restoration works that can be carried out. Gaiani and colleagues state in their work that in restoration,

colours are an important element in the protection of cultural heritage. It is emphasised that the identification and preservation of original colour palettes in historical buildings should be regarded as a critical component in restoration practices pertaining to both architectural and landscape interventions (Gaiani et al. 2020). However, Anwar states that the colour of materials used in the original buildings can be used as a reference when making new design decisions for historical buildings (Anwar 2019). In their study, Marinova and colleagues discussed the importance of preserving the original colour in the restoration of historical buildings and classified colours according to five criteria. These are:

- the colour's compatibility with the natural elements surrounding the structure (criterion of being informative about the environment)
- the colour's adaptation to the cultural elements of society (the aesthetic criterion)
- the colour's compliance with the characteristics of the period in which it was made (criterion of self-expression)
- the colour's compliance with sociological and economic values (criterion of symbolic meaning)
- the colour's compliance with the climatic characteristics of the region (criterion of light and heat) (Marinova, Ivanova 2019).

It is stated that a colour design that can be defined as successful should be considered on successive and integrating scales such as street, square, urban area, and then the entire city, and should be in harmony with the natural and artificial environment (Ünver 2000). Environmental colour mapping studies have been used in



Figure 10
Zurich city colour master plan study. Source: Sibillano, 2021.



several Japanese towns to address the issue of building facade decolouration and to help maintain a sense of colour harmony among local buildings (Iijima 1997). Porter's studies aimed to determine the environmental colour identity of existing urban settlements and to determine compatible colour alternatives for future adjacent settlements (Foote 1983; Porter 1997).

Methodology

The method of study used was environmental colour mapping. Environmental colour mapping is defined as the determination of colours belonging to a residential area. In this method, the colours belonging to the natural and artificial environment of the region are collected. This method enables an archive of the colours formed due to the location, natural light and cultural characteristics of the region to be extracted. Natural environmental elements such as the sky, vegetation and water, as well as the colours of man-made environmental elements such as building facades, roofs, floors and urban furniture, are also determined (Lenclos 1976; O'Connor 2008; Özcan Küçükkılıç, Ünver 2014). As a result of the environmental colour mapping method, the specified colours are classified. As a result of this classification, colour diagrams/cartels and similar visual data are prepared (Porter 1997).

In the environmental colour mapping method, the natural and artificial environments are analysed separately to determine the local colour identity of the region. Colours are detected by an on-site examination method and are then analysed by workshops (Lenclos 1989; Lenclos 1999; Lenclos et al 2024). Environmental colour mapping is carried out using photographic and digital mapping techniques. Photoshop and Illustrator programs stand out from the auxiliary tools in digital mapping techniques. The samples were pixelated using the 'Filter > Pixelate > Mosaic' steps in the Photoshop program. The colours in the pixels have been determined using the 'Eyedropped tool'. The determined colours were transferred to the palettes and weighted averages were then calculated on the colour palette.

The spectrophotometer device makes a colour determination based on the colour spectrum through the measurement of light. This method influences the intensity and polarisation of light. Since this study aims to determine the mixing ratios of colours, digital matching

methods provide more effective results compared to the spectrophotometer (James 2007). In this study, the Hex colour model was preferred over the RGB and Munsell models. The Munsell colour system classifies colours based on three attributes: hue, value (lightness), and chroma (saturation), and is primarily employed in scientific and educational contexts for its perceptual uniformity. The RGB model, commonly used in traditional photography and electronic display systems, defines colours through combinations of red, green, and blue light. The Hex model, which operates in conjunction with the RGB model, is widely used in HTML-based web design and digital media applications. Due to its practical compatibility with digital platforms and its relative alignment with human colour perception, the Hex model was deemed the most suitable for the purposes of this study (Robert 2004).

The physical properties of natural stone building materials are density, porosity, water absorption rate, compressive strength, resistance to wear, freeze-thaw rate, colour and texture, thermal conductivity, sound insulation and hardness (Smith et al 2008). This study deals with the property of colour and texture. Physico-chemical effects, mechanical effects, and effects related to living things are included as external factors in the deterioration of colour and texture properties in the use of natural stone materials in construction (Rives, Garcia Talegón 2006). It is not possible to evaluate the colour and texture properties of havara stone by exposing it to all of these factors in a laboratory environment. Qualitative studies that can reveal these distortions occurring in the natural process through experience can be identified. In this context, the samples of the havara stone were selected in accordance with the opinions of an expert team of ten people consisting of architects, mining engineers and stonemasons. The expert team consists of four architects who have done restoration work in the region, three mining engineers who have done scientific work on havara stone, and three stonemasons. According to the views of these experts, it was determined that havara stone has three states in terms of its colour and texture properties. The appearance of colour and roughness when first cut is shown in [Figure 11](#); the first stage when it begins to deteriorate is shown in [Figure 12](#); and the state in which it deteriorates the most without losing its functionality is shown in [Figure 13](#). Samples were selected according to these evaluations. The following reliability formula, developed by Miles and Hubermann, was used to measure the reliability of the samples selected by the experts: P (Percentage of consensus)

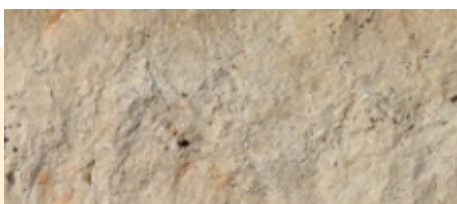


Figure 11
First stage. Source: Authors' archive.

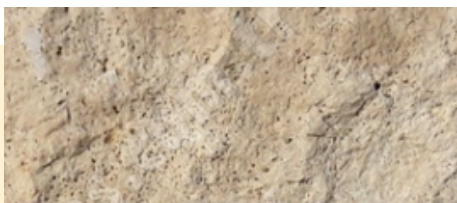


Figure 12
Second stage. Source: Authors' archive.



Figure 13
Third stage. Source: Authors' archive.

= Consensus / [Consensus + Disagreement] x 100. The reliability of this study was calculated as 87% according to that formula. According to Miles and Hubermann, studies with a reliability rate of more than 80% have been found to be reliable (Miles, Huberman 1994).

Findings

These findings present the content of the colours of the havara stone in the first, second and third stages. Visuals of the colours contained in each stage, colour names, colour codes, percentages of the colour and tone/saturation maps are given. The calculation of confidence intervals for colours represents a statistical method, typically conducted based on experimental data or datasets in which colour measurements have been recorded. The confidence interval is a statistical method used to estimate the unknown value of a parameter, such as the mean or average intensity of a colour. The calculation proceeds through the following steps.

1. *Data collection*: The data of the relevant colours is collected. This data is taken from the samples in which the colours are measured. Usually, RGB (red, green, blue) values or numerical values from another colour model are used.

2. *Average calculation*: The average value of the colours (e.g. the average of each RGB channel) is calculated.

$$\text{Mean} \quad \bar{x} = \frac{1}{n} \sum x_i$$

3. *Standard deviation calculation*: The standard deviation is calculated, which measures how far the colour data has spread.

$$\text{Standard Deviation} \quad s = \sqrt{\frac{1}{n-1} \sum (x_i - \bar{x})^2}$$

4. *Confidence interval*: The confidence interval is calculated by considering the sampling error and the distribution. For the 95% confidence interval, the following formula is used:

$$\text{Confidence Interval} \quad \bar{x} \pm \frac{ZS}{\sqrt{n}}$$








In this way, by calculating the confidence interval for a colour, the uncertainty and confidence level around the average of that colour can be determined.

The colours were determined by average weighted colour studies using the Adobe Photoshop program in a computer environment. The human eye can perceive that colour according to the saturation level of a colour. Accordingly, although colours with a density of less than 10% were given in the findings of the study, they were not considered in the interpretation of the findings (Triola 2018).

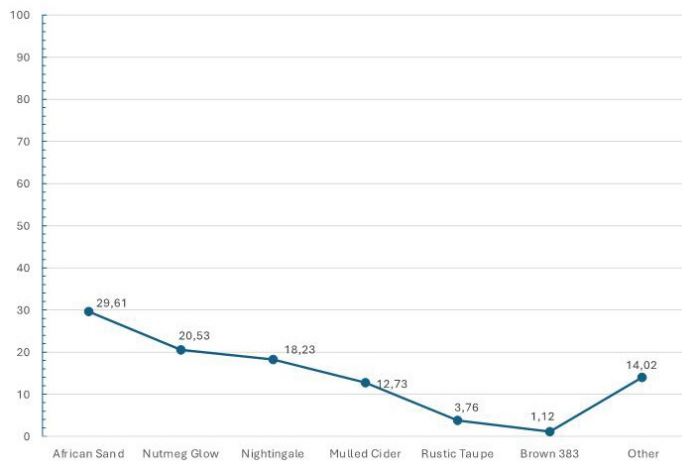
According to the environmental colour map findings of the first stage (included in Table 2), it is understood that African Sand has the highest intensity at 29.61%. The confidence interval of African Sand is at the level of 26.78 – 32.44%. It is observed that Nutmeg Glow, with a rate of 20.53% and a confidence interval of 18.03 – 23.03%, and Nightingale, with a rate of 18.23% and a confidence interval of 15.84 – 20.62%, have proportions close to that of African Sand. Colours such as Mulled Cider, with a ratio of 12.73%, and Rustic Taupe and Brown, which are less than 5% in total, are also available at this stage of the havara stone. At this stage, there are various different colours at a rate of 14.02%. According to the tonal/saturation mapping, it is understood that the colour tones are close to each other, and the saturation ratios are at a low level. In tone/saturation mapping, the saturation intensity is measured

Table 2

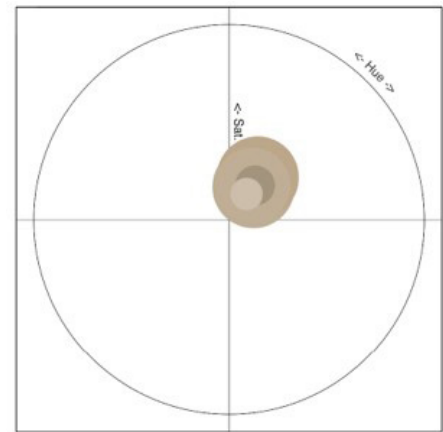
Environmental colour map findings of the first stage

	FIRST STAGE					
Values	Colour contents					
Color Visual						
Colour name	African sand	Nutmeg glow	Nightingale	Mulled cider	Rustic taupe	Brown 383
Colour code	#CCAC88	#D8B494	#5C4327	#A08262	#CCBCA2	#443424
Colour percentage (%)	29.61	20.53	18.23	12.73	3.76	1.12

Percentages of colours in first stage



Circle map



by the proximity of the colours to the midpoint of the circle, while the ratio of tones is measured by the colours standing apart from each other or standing on top of each other on the circle map. The percentages of the colours are given in [Table 3](#).

According to the environmental colour map findings of the second stage (included in [Table 4](#)), it is understood that the colour Foothill Drive has the highest intensity, at 33.51%, and a confidence interval ranging between 30.55% and 36.47%. Additionally, it is observed that Oatmeal Bath,







Table 3

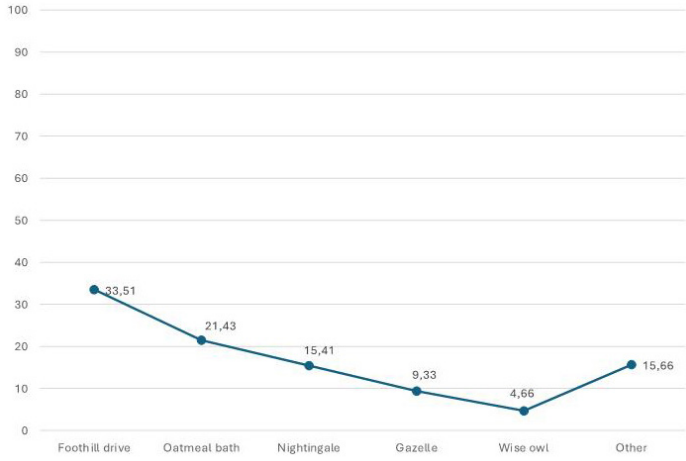
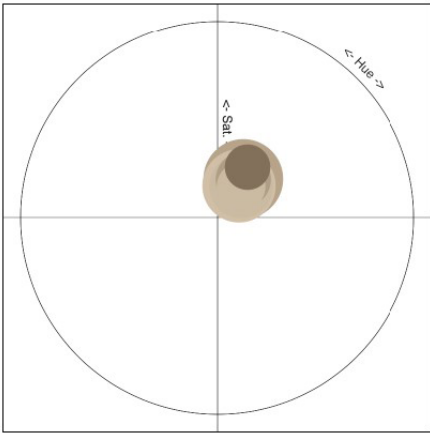
Percentages of colours in the first stage

Colour Name	Colour Percentage (%)	Confidence Interval (%)	Colour Code
African Sand	29.61	26.78 – 32.44	#Ccac88
Nutmeg Glow	20.53	18.03 – 23.03	#D8b494
Nightingale	18.23	15.84 – 20.62	#5c4327
Mulled Cider	12.73	10.66 – 14.80	#A08262
Rustic Taupe	3.76	2.58 – 4.94	#Ccbca2
Brown 383	1.12	0.47 – 1.77	#443424

Table 4

Environmental colour map findings of the second stage

	SECOND STAGE				
Values	Colour contents				
Color Visual					
Colour name	Foothill drive	Oatmeal bath	Nightingale	Gazelle	Wise owl
Colour code	#CCB48C	#DCC4A4	#5B4828	#948069	#CCBCA4
Colour percentage (%)	33.51	21.43	15.41	9.33	4.66

<p>Percentages of colours in second stage</p> 	<p>Circle map</p> 
---	--

with a proportion of 21.43% and a confidence interval of 18.95 – 23.91%, and Nightingale, with a proportion of 15.41% and a confidence interval of 13.21 – 17.61%, have values close to that of the African Sand colour. Colours such as Gazelle, with a ratio of 9.33%, and Wise Owl, which is less than 5% in total, are also found at this stage of the








havera stone. At this stage, there are various colours at a rate of 15.66%. According to the tonal/saturation mapping, it is seen that the colour tones are close to each other. When compared with the colour tone mapping of the first stage, it is understood that the tones of the second stage are closer to each other than the first stage. The proximity

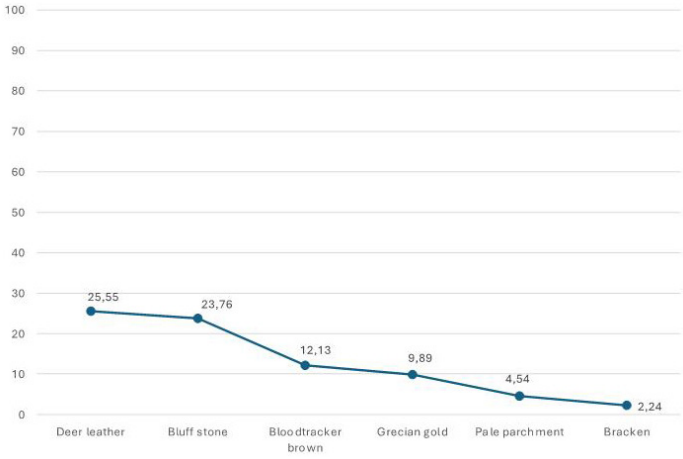
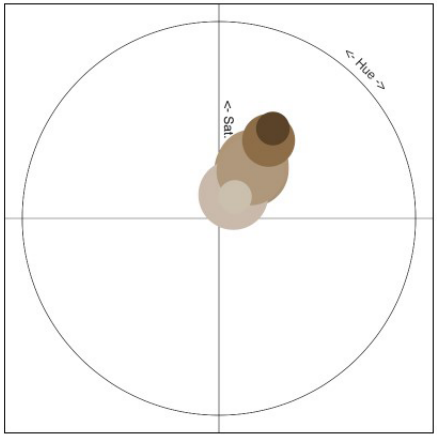
Table 5

Percentages of colours in the second stage

Colour Name	Colour Percentage (%)	Confidence Interval (%)	Colour Code
Foothill Drive	33.51	30.55 – 36.47	#CCB48C
Oatmeal Bath	21.43	18.95 – 23.91	#DCC4A4
Nightingale	15.41	13.21 – 17.61	#5B4828
Gazelle	9.33	7.48 – 11.18	#948069
Wise Owl	4.66	3.31 – 6.01	#CCBCA4

Table 6
Environmental colour map findings of the third stage

	THIRD STAGE					
Values	Colour contents					
Color Visual						
Colour name	Deer leather	Bluff stone	Bloodtracker brown	Grecian gold	Pale parchment	Bracken
Colour code	#AC7431	#D4BE9E	#743C04	#A07E56	#CFC1AC	#584029
Colour percentage (%)	24.55	23.76	12.13	9.89	4.54	2.24

<p>Percentages of colours in third stage</p> 	<p>Circle map</p> 
--	---

of the second stage to each other in terms of colour tone values ensures the creation of a homogeneous/balanced distributed visual perception in the designs. It is observed that the saturation rates are at a low level and are close to the values of the first stage. The percentages of the colours are given in [Table 5](#).

According to the environmental colour map findings of the third stage (included in [Table 6](#)), it is understood that Deer Leather is the colour with the highest intensity, at 24.55%, and a confidence interval ranging between 21.97% and 27.13%. Additionally, it is observed that Bluff Stone, with a proportion of 23.76% and a confidence interval of 21.23 – 26.29%, and Bloodtracker Brown, with a proportion of 12.13% and a confidence interval of 10.10 – 14.16%, have values close to that of Deer Leather. Grecian Gold, with a ratio of 9.89%, and colours such as Pale Parchment and Bracken, which are less than 5% in total, are also found

at this stage of the havara stone. At this stage, there are various colours at a rate of 22.89%. According to the hue/saturation mapping, the colours are moving away from each other on the circle map. This shows that the colour tones are not close to each other as in the first and second examples. Given the distance of the third stage from the first and second stages in terms of colour tone values, it can be seen that the compositions to be created with these colours in the designs are not homogeneous/balanced in distribution, unlike the second stage, and have features that can create an accent and contrast effect on each other. It is understood that the saturation ratios also differ. The saturation values of the Deer Leather, Bloodtracker Brown, Grecian Gold and Bracken colours are high, while Bluff Stone and Pale Parchment are at a low level. Accordingly, the havara stone of the third stage differs from the first and second stages. The percentages of the colours are given in [Table 7](#).

Table 7

Percentages of colours in the third stage

Colour Name	Colour Percentage (%)	Confidence Interval (%)	Colour Code
Deer Leather	24.55	21.97 – 27.13	#AC7431
Bluff Stone	23.76	21.23 – 26.29	#D4BE9E
Bloodtracker Brown	12.13	10.10 – 14.16	#743C04
Grecian Gold	9.89	8.01 – 11.77	#A07E56
Pale Parchment	4.54	3.21 – 5.87	#CFC1AC

Conclusion

In this study, an environmental colour mapping of the havara stone, which forms the basic building material of the provinces of Sanliurfa, Gaziantep and Diyarbakir in Turkey and gives its character to vernacular architecture, is performed to reveal the colour identity of the settlement. Colour mapping has become an important issue in terms of the restoration works started in these provinces following the 2023 earthquake disaster.

The environmental colour mapping results contain general results covering all the stages that the havara stone has undergone. Stone samples belonging to all these stages have been identified. There are no examples of structures made with a single havara stone stage. The reasons for this situation may include certain stones in the structure being more exposed to environmental effects and the surfaces of some stones being deformed during the cutting process. As a result, it is possible to find stone samples from all stages of the havara stone in a structure built with this stone. From this point of view, the colour chart created because of environmental colour mapping can be generalised for all structures built from havara stone.

According to the environmental colour mapping results given in Table 8, when the first-, second- and third-stage results of the havara stone included in the findings were evaluated, it was determined that the predominant colour across all the stages was Foothill Drive.

The results also revealed that the next most prominent colours were African Sand, Deer Leather, Bluff Stone, Oatmeal Bath and Nutmeg Glow, all with percentages of more than 20 in all stages. Nightingale is the only colour that takes place in both the first stage (with 18.23%) and the second stage (with 15.41%). Its percentage is higher

in the first stage than in the second stage, while it is not detected in the third stage.

Significant differences were found in the first and second stages compared to the third stage. The colour and tonal saturation levels of the first and second stages, and the presence in these stages of a common colour, distinguish them from the third stage. In the third stage, the colour saturations are excessive and distribution of the tones is far from homogeneous. Table 9 indicates that Deer Leather, Bloodtracker Brown, Bracken and Grecian Gold can be considered as appropriate colours for creating an accent principle for new designs to be made during the restoration phase.

As a result, the environmental colour map of the havara stone in shown in Figure 14 consists of 16 perceptible colours that can be used as a reference for selecting

Table 8

Environmental colour map findings of havara stone















Colour visual	Colour name	Colour code	Colour percentage (%)
	Foothill drive	#CCB48C	33.51
	African sand	#CCAC88	29.61
	Deer leather	#AC7431	24.55
	Bluff stone	#D4BE9E	23.76
	Oatmeal bath	#DCC4A4	21.43
	Nutmeg glow	#D8B494	20.53
	Nightingale	#5C4327	18.23
	Mulled cider	#A08262	12.73
	Bloodtracker brown	#743C04	12.13

Table 9

Colours with a high degree of saturation at all stages

Colour visual	Colour name	Colour code	Colour percentage (%)
	Deer leather	#AC7431	24.55
	Bloodtracker brown	#743C04	12.13
	Bracken	#584029	2.24
	Nightingale	#5C4327	18.23
	Grecian gold	#A07E56	9.89

colours for new designs in the restoration works carried out in Şanlıurfa, Gaziantep and Diyarbakır. Suggestions regarding possible areas of use range from landscape studies of the historical environment in which the havara stone is used to interior components.

In terms of landscape and architectural designs, the colour map can be used for:

- window joinery, doors and façade elements
- urban reinforcement elements such as sidewalk and floor materials, urban seating, lighting fixtures, information boards and rubbish bins in recreational area designs, garden designs and street designs.

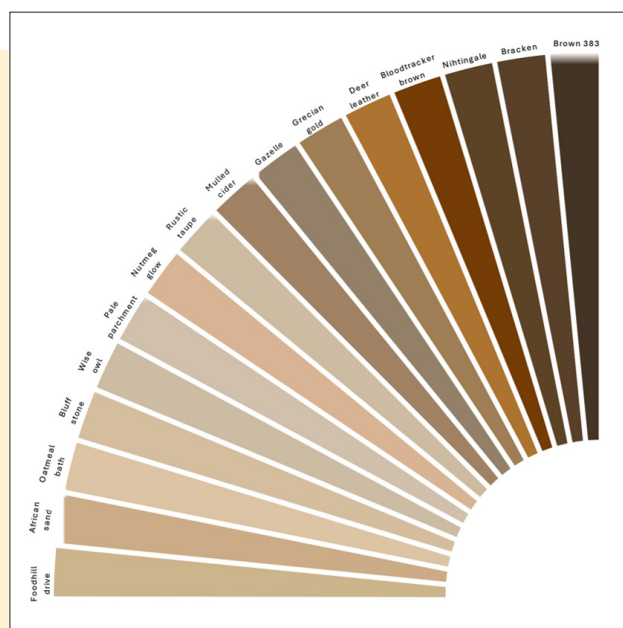


Figure 14
Havara stone environmental colour map. Source: Map by Authors.

In terms of interior design, it can be used in selecting colours for:

- internal walls
- floor and ceiling materials
- furniture and reinforcement elements
- indoor accessories (such as door handles, faucets, sinks).

In the study conducted by Serra et al. (2021), the analysis of colour tone, colour code, and colour percentages was framed within the context of the national system for selecting optimal colour combinations. The outcomes of their research have contributed new perspectives on the application of colour in architectural design. This approach is akin to that of Marinova et al. (2019), where a similar examination was carried out on the colours selected for building surfaces, with particular attention to their colour codes and the distribution of percentages. Another study, by Ulusoy and colleagues, analysed colour combinations and colour pairs, and the relationships between surface colours in the traditional urban texture, based on their tone and saturation (Ulusoy et al. 2021).

The colour mapping methods used in the literature studies examined were based on on-site examination of the study area and the obtaining of samples. When taking samples, the most suitable colour was determined experimentally, initially by a trial-and-error method. Since the weighted averages of the colours in the sample are unknown in this manual method, it is difficult to obtain the same colours repeatedly. This study started by taking samples from the natural environment, as was done in the literature studies. Then, unlike in the literature studies, the study was completed digitally. At this stage, the samples were transferred to digital media using an unfiltered photography method. The colours in the samples, and their percentages, were determined using photo analysis programs and clear data was obtained.

The havara stone can be evaluated not only as a physical building material, but also as a carrier of local information systems, aesthetic understandings and craftsmanship skills. In this context, analysing the colours that make up the stone and using them as a guide in the restoration processes contributes to the sustainability of cultural identity and social memory. Thus, the colours unique to the apostle stone, as an important component of the local building culture, also gain meaning from the

point of view of preserving the intangible cultural heritage.

It is thought that the results of this study can be evaluated as a planning criterion by designers and experts working in the field of restoration, as well as by the Regional Councils for the Conservation of Cultural Property. It was envisaged that the colour mapping method could be used to create a united approach in restoration work for all environments

having vernacular architecture and a historical fabric. The present study did not analyse perceptions by users of the colours chosen on the basis of environmental colour mapping. However, in future studies, it is proposed to improve the quality of the research by measuring users' psychological perceptions of the colours selected by colour matching. ❏

ENDNOTES

1. MAP. 2024. 'Türkiye Haritası'. <http://cografyaharita.com/turkiye-dilsiz-haritalari.html>.
2. '6 Şubat depremi'. 2024. <https://www.aa.com.tr/tr/asrin-felaketi/asrin-felaketi-tarihi-antep-evlerine-de-zarar-verdi/2813961>.
3. 'Havara Taşı'. 2024. <https://blog.oyuncakhobi.com/tas-tepeler-projesi-nedir-gobeklitepe-neden-onemli/>.
4. 'Antep Kalesi'. 2024. <https://www.gaziantep.bel.tr/tr/tarihi-ve-kulturel-eserler/gaziantep-kalesi>.
5. 'Gaziantep Evleri'. 2024. <https://www.cekulvakfi.org.tr/makale/tarihi-gaziantep-evleri>.

REFERENCES

- Müezzinoğlu, K. M., L. M. Hidayetoğlu and K. Yıldırım. 2021. 'The effects of light color temperatures on students' perceptual evaluations in design studios'. *Color Research and Application* 46: 1006–1018. <https://doi.org/10.1002/col.22654>.
- Birren, F. 2016. *Color psychology and color therapy: A factual study of the influence of color on human life*. Pickle Partners.
- Eriçok Keleş, A., E. Güler and Ö. F. Özdemir. 2021. 'Geleneksel Kent Dokularının Korunmasında, Koruma Amaçlı İmar Planlarının Öneminin Bitlis Örneğinde İrdelenmesi'. *İdealkent* 32: 208–241.
- T. C. İç İşleri Bakanlığı Afet ve Acil Durum Yönetimi Başkanlığı [AFAD]. 2023. '06 Şubat 2023 Pazarcık (Kahramanmaraş) MW 7.7 – Elbistan (Kahramanmaraş) MW 7.6 Depremlerine İlişkin Ön Değerlendirme Raporu'. https://deprem.afad.gov.tr/assets/pdf/Kahramanmaras%20%20Depremleri_%20On%20Degerlendirme%20Raporu.pdf.
- Schirmer, W. 1998. 'Havara on Cyprus – a surficial calcareous deposit'. *Eiszeitalter & Gegenwart Quaternary Science Journal* 48, no. 1: 110–117. doi:10.3285/eg.48.1.11. hdl:11858/00-1735-0000-0001-BA92-3.
- Turgut, P., M. I. Yesilnacar and H. Bulut. 2008. 'Physico-thermal and mechanical properties of Şanlıurfa limestone'. *Bulletin of Engineering Geology and Environment* 6: 485–490.
- MTA. 2010. 'Maden Tetkik ve Arama Genel Müdürlüğü. Güneydoğu Anadolu Bölgesi Maden Envanteri'. http://www.mta.gov.tr/v1.0/bolgeler/diyarbakir/index.php?id=gdab_maden_envanteri_maden&m=.
- Agan, A. 2016. 'Şanlıurfa kireçtaşlarının geleneksel bir yapı malzemesi olarak koruma ve parlatma performansı üzerine bir ön çalışma'. *Bulletin of Engineering Geology Environment* 7: 13–25.
- Kürkçüoğlu, A. C. 2016. *Göbeklitepe'den Günümüze Şanlıurfa Mimarisinde Taş Süsleme. Şanlıurfa Ticaret Odası*.
- Çitçi, A. E. 2019. *İlkçağdan Günümüze Gaziantep Tarihi*. Damla Matbaası.
- Yarış, S. 2020. 'Geleneksel Diyarbakir Evlerinde Taş Figürler'. *Bitlis Eren Üniversitesi Sosyal Bilimler Dergisi* 9, no. 2: 170–186. <https://doi.org/10.47130/bitlissos.724622>.
- Cansunar Yetki G. and T. Çobancaoğlu. 2019. 'Dünden Bugüne Gaziantep Geleneksel Mimarisinde Taşın Kullanımı'. *Art-Sanat Dergisi* 12: 129–162.
- Öztürk Tel, H. 2021. 'Sürdürülebilir Malzeme olan Urfa Taşının Tarihsel Süreçte ve Peyzaj Mimarlığında Kullanımları: Şanlıurfa Örneği'. *Bartın Orman Fakültesi Dergisi* 23, no. 3: 742–753. <https://doi.org/10.24011/barofd.954137>.
- Tel, H., G. Sariisik and Ş. Kuloglu Yüksel. 2021. 'Investigation of usability of Urfa stone in urban furniture design'. *Journal of the Faculty of Engineering and Architecture of Gazi University* 36: 2287–2299. 10.17341/gazimmfd.879849.
- Ahunbay, Z. 2021. *Kültür mirasını koruma ilke ve teknikleri*. YEM Yayınları.
- Kuban, D. 2010. *Türkiye'de kentsel koruma kent tarihleri ve koruma yöntemleri*. Tarih Vakfı Yurt Yayınları.
- ICOMOS. 1987. 'Tarihi Kentlerin Ve Kentsel Alanların Korunması Tüzüğü'. https://www.icomos.org.tr/Dosyalar/ICOMOSTR_tr0627604001536681570.pdf.
- Ünver, R. 2000. 'Renk Kirliliği'. *Gap Çevre Kongresi Bildiriler Kitabı*, 2.
- Lancaster, M. 1996. *Colourspace*. Academy Editions.
- Sibillano, L. 2021. 'The colour space of Zurich. An exemplary research on colour, texture and light in urban space'. Paper presented at: AIC 2011 – Interaction of Colour and Lighting in the Arts and Sciences Kongresi.
- O'Connor, Z. 2008. *Façade colour and aesthetic response: Examining patterns of response within the context of urban design and planning policy in Sydney* (PhD diss, University of Sydney).
- Gaiani, M., F. Apollonio and A. Ballabeni, A. 2020. 'Cultural and architectural heritage conservation and restoration: Which

colour?' *Color Technology* 137: 44–55.

- Anwar, M. 2019. 'Practical techniques for restoration of architectural formation elements in historical buildings'. *World Journal of Engineering Technology* 7:193–207. doi:10.4236/wjet.2019.71013.
- Marinova, I and A. Ivanova. 2019. 'Role of colors in historical buildings preservation'. *European Scientific Journal* 3: 107–116.
- Iijima, S. 1997. 'Cross-cultural color differences of commercial facility between Great Britain and Japan'. *Bulletin Okayama Market University* 33, no. 2: 39–51.
- Porter, T. 1997. 'Environmental colour mapping'. *Urban design International* 2: 23–31.
- Foote, K. E. 1983. 'Color in public spaces: Toward a communication-based theory of the urban built environment'. Research paper no. 205, Department of Geography, University of Chicago, 31.
- Lenclos, J. P. 1976. 'Living in colour'. In *Colour for architecture*, edited by T. Porter and B. Mikellides. Studio Vista.
- Özcan Küçükkılıç, E. and R. Ünver. 2014. 'Çevresel Renk Analizleri ve Gerçekleştirilen Çalışmalardan Örnekler'. *Mimarist* 51: 104–109.
- Özcan Küçükkılıç, E. and R. Ünver. 2014. 'Yerleşimlerde Yapı Yüzü Renk Tasarımına Yönelik Bir Yaklaşım Önerisi'. *Architecture* 379: 60–66.
- Lenclos, J. P. and D. Lenclos. 1989. *Couleurs de l'Europe*. Le Moniteur.
- Lenclos J. P. and D. Lenclos. 1999. *Couleurs de la France*. Le Moniteur.
- Lenclos, D., J. P. Lenclos and G. Bruhn. 2024. *Colors of the world: A geography of color*. W. W. Norton & Company.
- James, J. 2007. *Spectrograph design fundamentals*. Cambridge University Press.
- Robert, H. 2004. *Exploring color photography*. Laurence King Pub.
- Smith, B. J., M. Gomes Heras and S. McCabe. 2008. 'Understanding the decay of stone-built cultural heritage'. *Scholarly Journals: Progress in Physical Geography* 32, no. 4: 439–461. doi:10.1177/0309133308098119.
- Rives V. and J. Garcia Talegón. 2006. 'Decay and conservation of building stones on cultural heritage monuments'. *Materials Science Forum* 514–516: 1689–1694.
- Miles, M. and A. Huberman. 1994. *Qualitative data analysis: An expanded sourcebook*. Sage Pub.
- Triola, M. F. 2018. *Elementary statistics*. Pearson Education, 13th ed.
- Serra, J., Y. Gouaich and B. Manav. 2021. 'Preference for accent and background colors in interior architecture in terms of similarity/contrast of natural color system attributes'. *Color Research and Application* 47: 1–17. doi:10.1002/col.22698.
- Ulusoy, B., N. Olguntürk and R. Aslanoglu. 2021. 'Pairing colours in residential architecture for different interior types'. *Color Research and Application* 46: 1079–1090. doi:10.1002/col.22640.