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Investigating the Geoenvironmental and Climatic Impacts on the Facades of Historical Houses in Killit (Dereiçi) Village, Mardin

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Abstract

Killit (Dereici), which is largely abandoned today, is an Assyrian village thought to have a population of more than 20,000 spread around the world. The Kilit (Dereiçi) village of Savur stands out as a rare example in the world with its multi-identity structure. The street façades of this Assyrian village, which has such cultural importance, can be clearly seen today, due to various factors. The aim of the study is to investigate the damage patterns and the factors affecting the durability of Kilit (Dereici) street facades (Old Bazaar). For this purpose, observational detection method was used and the findings were presented based on the dictionary of stone deterioration patterns prepared by ICOMOS-ISCS,2008. As a result of the study, the most intense deteriorations observed on the street facades; cement-induced faulty repairs made between the joints of the stone blocks on the facades and 'crack, disintegration, erosion, 'missing part, discolouration' on the stone surfaces exposed to climate impact for a long time.

Keywords: *Geoenvironmental and climatic impacts, stone deterioration, disintegration, restoration, Killit (Dereiçi) Village.*

Mardin Killit (Dereiçi) Köyü'ndeki Tarihi Konutların Cephelerinde Jeoçevresel ve İklimsel Etkilerin Araştırılması

Öz

Killit (Dereiçi), bugün büyük ölçüde terk edilmiş bir köy olup, dünya çapında yayılmış 20.000'den fazla nüfusa sahip olduğu düşünülen Süryanilerin bir köyüdür. Savur'daki Kilit (Dereiçi) köyü, çok kimlikli yapısıyla dünyada nadir bir örnek olarak öne çıkar. Kültürel öneme sahip bu Süryani köyünün sokak cephe tasarımları, çeşitli faktörlere bağlı olarak bugün net bir şekilde görülebilir. Çalışmanın amacı, Kilit (Dereiçi) sokak cephelerinin (Eski Çarşı) hasar desenlerini tespit etmek ve bozulma süreçlerine etki eden faktörleri araştırmaktır. Bu amaçla, gözlemsel tespit yöntemi kullanılmış ve bulgular, ICOMOS-ISCS, 2008 tarafından hazırlanan taş bozulma desenleri sözlüğüne dayanılarak sunulmuştur. Çalışmanın sonucunda, sokak cephelerinde en yoğun bozulmaların gözlendiği noktalar; cephe taş blokları arasındaki derzlerde yapılan çimento kaynaklı hatalı tamirler ve uzun süre iklim etkisine maruz kalan taş yüzeylerde 'çatlama, ayrışma, erozyon, parça kaybı, renk değişimi' gibi durumlardır.

Anahtar kelimeler: *Geoçevresel ve iklimsel etkiler, taş bozulması, ayrışma, restorasyon, Killit (Dereiçi) Köyü.*

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1. Introduction

The facades of historical buildings are open-air museums that exhibit the building materials and construction techniques of the region in which they are located (Türkeri, 2021). Investigation of how environmental conditions and external factors affect the facades of historical buildings and what kind of deterioration patterns they cause is particularly important in ensuring the sustainability of historical buildings (Karkaş & Acun Özgünler, 2022; Karataş et al., 2022).

Studies have been conducted in different parts of the world to examine the damages on the facades of historical buildings and the factors that cause these damages. In the studies, it has been determined that the most important cause of the damages on the facades is the effect of water (Umaroğulları & Kartal, 2021). These studies emphasize that the effect of water causes erosion on the surface of the stone, mıssıng parts and mortar melting between the joints. In addition, the liquid entering the stone; It can make the stone a suitable environment for the transport and deterioration effects of agents such as salts, biological agents and various water-soluble substances (Alves et al., 2021). According to Iucolano et al. (2019) the limestones change color as a result of exposure to sunlight and condensation cycles. Ergüler & Shakoor (2009) reported in their experiments on different stone types that there were intense weathering on stones with wetting-drying cycles. Beck & Al-Mukhtar (2014) observed that there is a significant erosion in the limestone with wetting-drying cycles. Bustamante et al., (2020) found a mass loss of more than 14% on stone surfaces that are heavily exposed to water. Winkler (1997) observed that the side exposed to rain shows significant erosion in stone structures, while the material is preserved on the protected side. Bonazza et al., (2017) and Gulotta et al., (2018) showed that rain has an abrasive effect especially on low porous carbonate rocks in their study on marble, one of the stone material types, and they emphasized that erosion occurs on the stone surface.

Another cause of damage to facades is faulty repairs. Duffy et al., (1993) and Arroyo et al., (2013) determined in their studies that the composition of the mortars used in the previous repairs in the buildings was rich in sulfate and this material caused the stones to deteriorate. Specifically, in the studies conducted in Mardin Province in Turkey, it is reported that the damages on the facades are mostly caused by faulty repairs caused by water and cement acting heavily on the stone (Dal & Öcal, 2017).

Earthquake is another factor that causes damage to façades (Caglar et al.,2023; Erberik et al., 2008). According to Khalil et al. (2016) the effects of strong ground shaking on the stability of the Step pyramid. Ahmed (2021) showed the earthquake-induced effects for all faces of the pyramid structure. According to Karatas et al., (2023) the damage caused by the earthquake on the facades of the historical Antep Castle and its walls in Gaziantep, Turkey, and finally explained which parts on the facades of the historical Antep castle and its walls were damaged by the earthquake.

As described above with examples from the literature, many studies emphasize that the deterioration factors in sedimentary rocks are not solely dependent on environmental factors, but also largely influenced by their physical and chemical properties. It is emphasized that among the chemical and physical destructive agents, the factors leading to the dissolution or alteration of the rock's nature must be identified (Patil et al.,2021). Based on this requirement highlighted in the literature, this study differs from similar studies conducted in Mardin and its surrounding geography by proposing a systematic approach that not only identifies the types of rock deterioration occurring in the structures but also reveals the types of factors that contribute to the deterioration or influence its intensity.

The Kilit (Dereiçi) village of Savur stands out as a rare example in the world with its multi-identity structure. It is seen that there are still places of worship belonging to three Christian denominations in the village, namely Orthodox, Catholic and Protestant. The street façades of this Assyrian village, which has such cultural importance, can be clearly seen today, due to various factors. The aim of the study is (1) to discuss the damage models of Qillit Village Street Facades (Old Bazaar) and the factors affecting their durability with on-site observations and (2) to present a scientific conservation proposal for use in the restoration phase of the structures. In order to achieve all these goals, damage detection and durability problems factors were investigated by using observational analysis techniques in the study. The conducted study will contribute to the literature by proposing a method that will assist researchers in systematically identifying the types of factors that contribute to the deterioration of stone cultural heritage structures, in addition to the types of deterioration. This method will also help determine the factors that can influence the intensity of the deterioration or damage.

1.1. Description of Killit (Dereiçi) Village

When we look at the history of Mardin, it is noteworthy that it has a district that is very similar to it with its city structure. Savur district, which has a settlement and history approximately 1000 years older than the city of Mardin to which it is affiliated, is an area that lies at the intersection of two valleys. Located 7 kilometers east of Savur town centre, the village of Killit, with its new name Dereici, is an interesting residential area hidden in the interior of the mountains. It is called by this name today because a stream flows through it (Kudeb, 2023). The valley between Savur and Mardin also forms the Mardin-Midyat highway. The city, which preserved its population thanks to this road, lost its importance after the change of the Mardin-Midyat road route and started to emigrate (Alp, 2015).

Savur, which used to be the largest vegetable, fruit and timber producer in the region, even hires seasonal workers, but today, with the change of road, perhaps it is experiencing one of the quietest periods in its history. The village is currently abandoned. Today, it attracts attention with its stone structures and worship structures that offer cultural diversity. The village, which was a large and important Assyrian settlement before emigration; It has three churches and three monasteries belonging to orthodox, protestant and catholic communities. At this point, Killit Village of Savur stands out as a rare example in the world. Grapes are still produced near the village, which is also famous for its wines, and the tradition of vintage is continued. Many TV series, movies and documentaries have been shot with the village in the recent past (KVTB, 2023). Although the multi-identity structure of the village is important, not only different peoples such as Assyrians, Muslims, Turks, Arabs, Kurds and Armenians, but also different sects of the same religion have lived in this small geography in an undisturbed harmony for centuries. The harmonious lifestyle and the unity of identities have made Kıllıt Village a rare place in the world.

The original main building material of the historical houses in Dereiçi (Kıllit) village is stone. Smooth limestone was used in the arch stones, around the window and door openings, and at the junction corners of the facades. Except for the south facade, the other facade stone masonry follows this principle. Some facades made of smooth limestone exhibit protruding profiled stone ledges. In the rubble stone courtyard walls, there is a circular rubble stone masonry entrance gate that provides access to the courtyard(Figure 1).

Figure 1. Killit (Dereiçi) Village silhouette

2.Material and Method

Considering the size of the area, specific parcels were selected to systematically examine the facade issues. In the findings section of the study, material deteriorations on these parcels were explained through facade photos. The selected areas within the scope of the study are parcels 1-2-3-4-5-6 of plot 179(a), parcels 1-2 of plot 182(b), and parcel 1 on plot 186(c) observed (Figure 2). Under the findings section, material deteriorations identified on the facades during the research are illustrated and explained with photos.

Figure 2. The locations of the parcels being worked on in the Killit (Dereiçi) Village (KVTB, 2023)

To investigate the deterioration patterns on the facades and the processes influencing the deterioration, a research strategy was adopted, which involved literature review, field studies, on-site observations, and analysis of climate data specific to the Savur region. The following steps were followed in the research:

2.1. The Types of Stone Deterioration

Firstly, in the study, a table was prepared based on the stone deterioration pattern dictionary prepared by ICOMOS-ISCS (2008) to characterize and classify the deterioration patterns that occurred on the facades of the old bazaar section of the Dereiçi District. The stone deterioration patterns in the table were directly taken from the dictionary to present the types of deterioration in universal terms to the literature. Additionally, library studies were utilized to categorize the types of damage and factors influencing stone deterioration, and the factors that can affect the severity of damage were categorized within each deterioration type. The prepared table serves as a reference for the detection and documentation of stone material deterioration (Table 1). On-site observations were conducted to characterize and classify the deterioration patterns on the facades of the buildings. The buildings were observed in situ, and the types of deterioration detected on the facades were marked on the deterioration assessment tables prepared specifically for limestone.

The stone deterioration types defined in the ICOMOS-ISCS (2008) dictionary is arranged into 5 families: Crack and deformation, Detachment, Features induced by material loss, Discoloration and deposit, Biological colonization. The descriptions of the stone damage types defined in the stone deterioration pattern dictionary prepared by ICOMOS-ISCS (2008) are provided below.

I. Crack and deformation:
- Crack: A linear fissure or break in the stone surface.
- Deformation: The alteration or distortion of the stone's original shape or form.

II. Detachment:
- Blistering: The formation of blister-like elevations or bubbles on the surface of the stone, often caused by trapped moisture or gas.

- Bursting: The sudden rupture or breaking open of the stone surface, typically due to internal pressure or expansion.
- Delamination: The separation or splitting of layers within the stone, resulting in a loss of cohesion between them.
- Disintegration: The gradual breaking down or crumbling of the stone material, often resulting in the loss of structural integrity.
- Fragmentation: The breaking or fragmentation of the stone into smaller pieces or fragments, often due to external forces or weathering.
- Peeling: The separation or detachment of thin layers or flakes from the surface of the stone.
- Scaling: The detachment or removal of larger sections or scales from the surface of the stone, often due to weathering or impact.

III. Features induced by material loss:

- Alveolization: The formation of small cavities or pits on the surface of the stone, resembling honeycomb-like structures.
- Erosion: The gradual wearing away or removal of the stone surface by natural processes such as wind, water, or chemical reactions.
- Mechanical Damage: Physical harm or injury to the stone caused by external forces, such as impact, cutting, scratching, or abrasion.
- Microkarst: Small-scale dissolution or erosion of the stone surface due to the action of acidic water or other chemical processes.
- Missing Part: The absence or loss of a portion or fragment of the stone, resulting in an incomplete or damaged structure.
- Perforation: The presence of small holes, perforations, or penetrations on the surface of the stone, often caused by decay, corrosion, or mechanical damage.
- Pitting: The formation of small depressions or pits on the stone surface, typically due to chemical reactions, weathering, or biological activity.

IV. Discoloration and deposit:

- Crust: A hard, brittle, and usually thin layer that forms on the surface of the stone, often as a result of chemical reactions, mineral deposits, or weathering processes.
- Deposit: The accumulation or buildup of foreign substances, such as minerals, salts, pollutants, or biological matter, on the surface of the stone, which can alter its appearance and contribute to its deterioration.
- Discolouration: The change in color or hue of the stone's surface, often caused by various factors such as oxidation, biological activity, pollution, or exposure to environmental elements.
- Efflorescence: The white, powdery or crystalline deposit that forms on the surface of stone or masonry due to the migration of salts and their subsequent crystallization.
- Encrustation: The formation of a hard, crust-like layer on the surface of the stone, often caused by the accumulation of minerals, organic matter, or other substances over time.
- Film: A thin layer or coating that covers the surface of the stone, which can be caused by various substances such as dust, pollutants, or organic matter.

- Glossy Aspect: The shiny or reflective appearance of the stone's surface, often resulting from polishing or the presence of a protective coating.
- Graffiti: Unauthorized markings, inscriptions, or drawings that are intentionally applied to the surface of the stone, typically using spray paint, markers, or other materials.
- Patina: The natural or acquired thin layer that forms on the surface of stone over time due to weathering, oxidation, or other chemical reactions, which can impart a characteristic color or texture.
- Soiling: The accumulation of dirt, dust, pollutants, or other substances on the surface of the stone, resulting in a dirty or discolored appearance.
- Subefflorescence: A secondary deposit that forms below the surface of the stone due to the migration and crystallization of soluble salts, which can lead to internal deterioration and surface damage.

V. Biological colonization:

- Biological colonization: The process by which living organisms, such as algae, lichens, mosses, molds, or plants, establish and grow on surfaces, including stone. It involves the colonization and growth of these organisms, which can have an impact on the appearance and deterioration of the substrate.
- Alga (Algae): Simple, photosynthetic organisms that can be found in aquatic environments or on moist surfaces. Algae come in various forms and colors and can contribute to the biological colonization of stone surfaces.
- Lichen: A composite organism resulting from a symbiotic relationship between a fungus and algae or cyanobacteria. Lichens can grow on various substrates, including stone, and can have a crust-like or leafy appearance. They play a role in the biological colonization and can contribute to the deterioration of stone surfaces.
- Moss: Small, non-vascular plants that thrive in damp and shady environments. Mosses have leafy structures and can grow on stone surfaces, particularly in areas with moisture and suitable conditions. They can contribute to the biological colonization and can impact the appearance and deterioration of the substrate.
- Mould (Mold): Fungi that can grow on organic materials, including stone surfaces, under conditions of high humidity or moisture. Mold growth on stone can occur in the presence of organic matter or in damp environments. Mold colonization can lead to discoloration and degradation of the substrate.
- Plant: A multicellular organism belonging to the kingdom Plantae. Plants can include various types such as grasses, shrubs, or trees. In the context of biological colonization, plants refer to the growth of higher plants, such as weeds or other vegetation, on stone surfaces. The presence of plants can contribute to the deterioration of the substrate and alter its appearance.

2.2. Geoenvironmental Data Analysis

In the second phase of the study, climatological information and environmental data specific to the Savur region were obtained. The climatological information was derived from climate data obtained from the database of the Meteorological Institution. Environmental data, on the other hand, was collected through on-site observations. The following details describe the climatological information and environmental data pertaining to the Savur region:

Mardin's geological texture I.-IV. the interior of the masses dated to the Geological Time forms the erupted material and the rocks formed as a result of their change. II. In the Geological Time, calcareous lands were formed in the northeast. Looking at the general view of the Qillit Village Street Facades, it is almost impossible to distinguish the structures, mostly of local stone, from each other. Straw-yellow cut stone material attracts attention in almost all of the buildings. The same practice can be observed on all its walls (Alioğlu, 1996).

In Savur, the summers are hot, arid, and clear and the winters are very cold, snowy, and partly cloudy. Over the course of the year, the temperature typically varies from 27°F to 98°F and is rarely below 18°F or above 103°F. The hot season lasts for 3.3 months, from June 9 to September 17, with an average daily high temperature above 86°F. The hottest month of the year in Savur is July, with an average high of 97°F and low of 66°F. The cold season lasts for 3.6 months, from November 24 to March 13, with an average daily high temperature below 53°F. The coldest month of the year in Savur is January, with an average low of 27°F and high of 42°F (Figure 3).

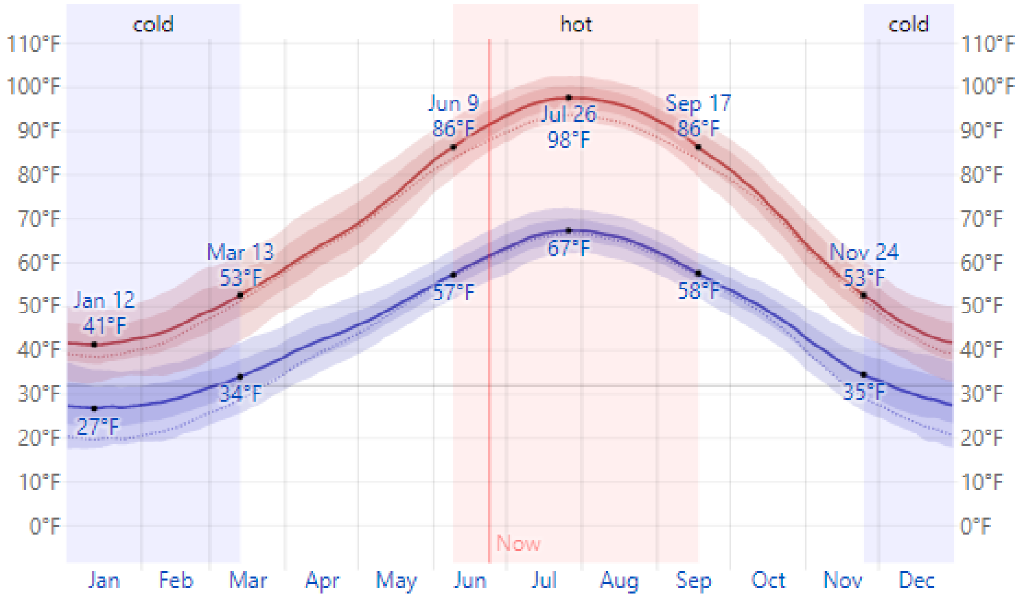

Figure 3. Average high and low temperature in Savur (T.C. Çevre, Şehircilik ve İklim Değişikliği Bakanlığı Meteoroloji Genel Müdürlüğü, 2023)

A wet day is one with at least 0.04 inches of liquid or liquid-equivalent precipitation. The chance of wet days in Savur varies throughout the year. The wetter season lasts 6.8 months, from October 23 to May 16, with a greater than 14% chance of a given day being a wet day. The month with the most wet days in Savur is February, with an average of 7.2 days with at least 0.04 inches of precipitation. The drier season lasts 5.2 months, from May 16 to October 23. The month with the fewest wet days in Savur is August, with an average of 0.1 days with at least 0.04 inches of precipitation. Among wet days, we distinguish between those that experience rain alone, snow alone, or a mixture of the two. The month with the most days of rain alone in Savur is March, with an average of 6.6 days. Based on this categorization, the most common form of precipitation throughout the year is rain alone, with a peak probability of 23% on April 2 (Figure 4).

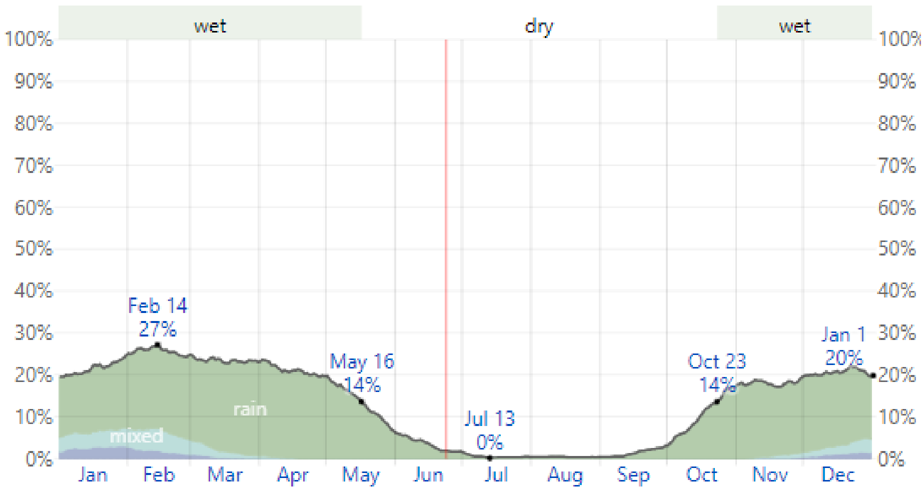

Figure 4. Daily chance of precipitation in Savur (T.C. Çevre, Şehircilik ve İklim Değişikliği Bakanlığı Meteoroloji Genel Müdürlüğü, 2023).

The length of the day in Savur varies significantly over the course of the year. In 2023, the shortest day is December 22, with 9 hours, 34 minutes of daylight; the longest day is June 21, with 14 hours, 46 minutes of daylight (Figure 5).

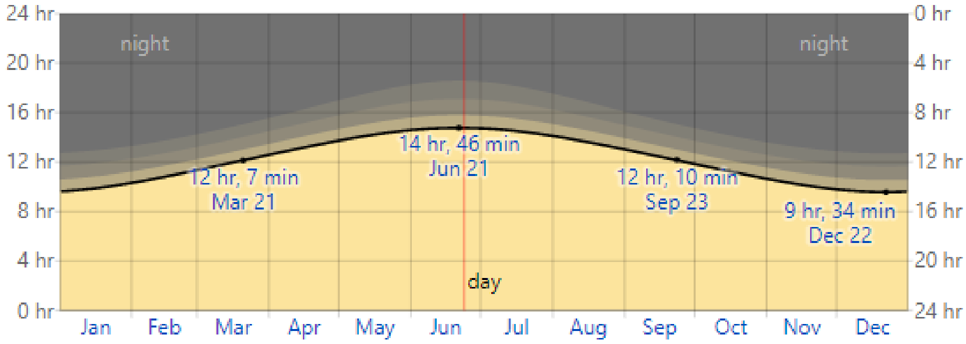

Figure 5. Hours of daylight and twilight in Savur (T.C. Çevre, Şehircilik ve İklim Değişikliği Bakanlığı Meteoroloji Genel Müdürlüğü, 2023).

The perceived humidity level in Savur, as measured by the percentage of time in which the humidity comfort level is muggy, oppressive, or miserable, does not vary significantly over the course of the year, remaining a virtually constant 0% throughout (Figure 6).

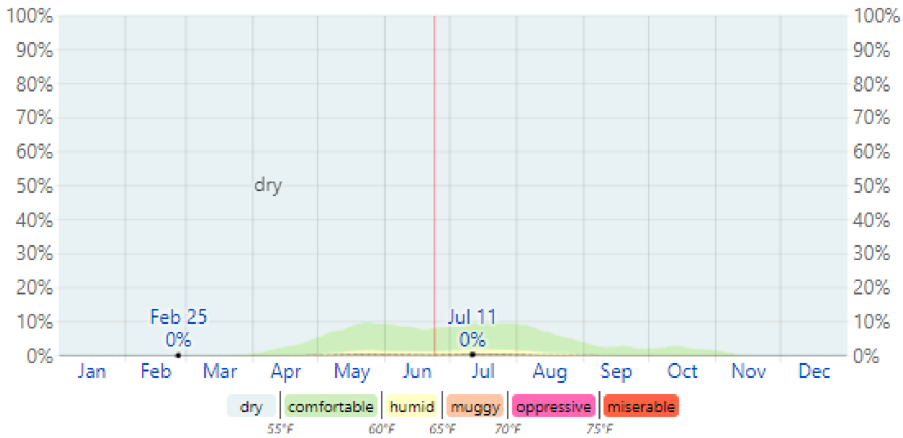

Figure 6. Humidity comfort levels in Savur (T.C. Çevre, Şehircilik ve İklim Değişikliği Bakanlığı Meteoroloji Genel Müdürlüğü, 2023).

2.3. Stone Deterioration Types and The Factors Influencing The Deterioration Process Detection Table

Lastly, in the study, the deterioration types of the structures identified during the on-site visits were interpreted in comparison with the climatological and environmental data obtained for the area. The obtained results, which include the types of factors that can cause material deterioration processes on the building facades, are marked on the table. The table below presents the chart indicating the deterioration types and factors related to the structures (Table 1).

Table 1. Stone material damage types and causal factors of damage types ıdentified on the facades of historical houses in Killit (Dereiçi) Village

		Damage Type Causal Factors							
Stone Material Damage Type		**water penetration**	**relative humidity**	**cement mortar**	**salt**	**temperature fluctuations**			**climate of the region**
						thaw-freezing cycles	**the wet and dry cycles**	**daily and seasonally changes of the moisture**	
CRACK & DEFORMATION	**CRACK**	x		x			x	x	x
	DEFORMATION								
DETACHMENT	**BLISTERING**								
	BURSTING								
	DELAMINATION								
	DISINTEGRATION	x		x			x	x	x
	FRAGMENTATION								
	PEELING								
	SCALING								
FEATURES INDUCED BY MATERIAL LOSS	**ALVEOLIZATION**								
	EROSION	x					x	x	x
	MECHANICAL DAMAGE								
	MICROKARST								
	MISSING PART								
	PERFORATION								
	PITTING	x		x			x	x	x
DISCOLORATION & DEPOSIT	**CRUST**								
	DEPOSIT								
	DISCOLOURATION								x
	EFFLORESCENCE								
	ENCRUSTATION								
	FILM								
	GLOSSY ASPECT								
	GRAFFITI								
	PATINA								
	SOILING								
	SUBFLORESCENCE								
BIOLOGICAL COLONIZATION	**BIOLOGICAL COLONIZATION**								
	ALGA								
	LICHEN								
	MOSS								
	MOULD								
	PLANT								

3. Findings and Discussion

In this section, the obtained results are presented based on the comparative interpretation of deterioration types observed on the structures identified during on-site visits, along with the climatological and environmental data obtained for the area. These results are documented on the damage assessment chart. In the study results, it has been determined that the most commonly observed types of deterioration on the facades of historical structures are 'crack, disintegration, erosion, missing part, and discoloration'. Significant cracks running along the facades can be observed.

3.1. Deteriorations Observed on Parcel 1-2-3-4-5-6 of Plot 179

The main building material of structures, which is stone, features smooth limestone used in the arch stones, window and door openings, and facade corner joints. Four of the upper-level window openings on the south facade of the parcels have wrought iron railings, and the surroundings of the window openings are adorned with material made of smooth limestone. The upper right part of the south facade is enriched with facade ornamentation and decorative elements using smooth limestone. Additionally, this part of the facade is terminated with a profiled sill and parapet stone made of smooth limestone. Iron railings that deviate from the original texture are used on the windows of the south facade of the parcel. A garden gate made of wood that deviates from the original texture is seen in the garden wall. On the ground floor of the parcel, on the left side, there is a wooden door with an ornate stone arch. Next to it, passing through a pointed-arched eyvan, there is a low-arched wooden door. On the upper floor, there are four circular-arched windows with smooth limestone. The upper floor is terminated with a row of sill and parapet stone. There are three decorative elements on the facade surface. On the protruding rubble stone wall between the entrance floor and the first floor, plant formations can be observed. The stone surfaces exposed to atmospheric conditions for an extended period show darkening. Cement-based material has been used in the joints on the facades (Figure 7). Corrosion is visible on the iron railings that have reached the present day. Large-scale disintegration is observed on the facades of the structures. Advanced levels of erosion issues are observed on the stone surfaces (Figure 8).

Figure 7. Deteriorations observed on parcel 1-2 of plot 179

Figure 8. Deteriorations observed on parcel 3-4-5-6 of plot 179

3.2. Deteriorations Observed on Parcel 1-2 of Plot 182

The arch stones, window and door openings, and facade corner joints of the structure are made of smooth limestone. There is one door opening on the ground floor of the south facade of the parcel. On the upper floor, there are four circular and six rectangular window openings. The joinery and railings of the first two windows on the left side have disappeared over time. Concrete-based lintel applications have been applied to the structure. The courtyard on the right side of the building is covered with sheet metal and surrounded by iron railings. Access to the upper floor is through this balcony.

In the Savur region on the facades of the structures, there is a significant occurrence of mortar voids between the joints and the problem of 'missing parts' on the facades. The walls of the structures exhibit a significant issue of "discoloration." Additionally, the street facades on the northern side, which do not receive direct sunlight, show a lesser extent of deterioration. Another observed form of deterioration is the use of cement mortar to connect and fill the large cracks and missing parts in many of the stone blocks used in some facade walls (Figure 9).

Figure 9. Deteriorations observed on parcel 3-4-5-6 of plot 179

3.3. Deteriorations Observed on The Facade of Parcel 1 on Plot 186

The original main building material of the structure is stone, with smooth limestone used in the arch stones, window and door openings, and facade corner joints. Two circular-arched wooden veneer doors with double wings are observed on the facade surface. The upper-level window openings on the south facade of the plot have wrought iron railings, and a smooth limestone frame has been built around the window opening. The right side of the south facade is covered with smooth limestone, featuring decorative elements at the facade and window edges, as well as between two windows. Additionally, this part of the facade is terminated with a profiled sill and parapet stone made of smooth limestone. On the left side of the facade, there is a window that deviates from the original texture, opened at various times. On the east facade of the structure, there is a circular-arched window opening with a straight lintel. Furthermore, there are three window openings that deviate from the original texture, opened at various times on this facade. On the right side of this facade, there is a pointed-arched eyvan with rubble stone masonry. Passing through this section leads to the staircase section ascending to the upper floor. In the lower right corner of this facade, a rubble stone masonry wall is observed.

The examined parcel is currently not in use. Discolorations are observed on the stone surfaces exposed to atmospheric conditions for an extended period on the facade. Cement-based material has been used in the joints on the facades. Collapses are observed in the staircase leading to the upper floor. Corrosion is visible on the iron railings that have reached the present day. Damage and deteriorations are observed in the wooden veneer doors. Unqualified fillings are observed inside and around the structure. Poorly executed window openings have been added later to the east facade of the structure. Two iron doors that deviate from the original texture have been installed. Window railings that do not conform to the original texture have been applied on the facade surfaces. Large-scale disintegration is observed on the facades of the structures (Figure 10a). Particularly, these damages are more prominently observed at the junction points of the walls and at the highest points (Figure 10b).

(a) (b)

Figure 10. Deteriorations observed on the facade of parcel 1 on plot 186

4. Discussion

The aim of the study is to identify the stone material deterioration patterns and the factors causing deterioration processes on the facades of Qillit Village Street Walls (Old Bazaar). The study results have revealed that the most commonly observed types of deterioration on the facades of historical structures are 'crack, disintegration, erosion, missing part, and discoloration'.

The obtained results suggest that the main cause of stone deterioration on the facades of historical houses in Killit (Dereiçi) village is the region's climatic conditions. Based on the climatic and environmental analyses conducted in the region, Mardin's Savur area exhibits distinctive climatic characteristics with annual and daily temperature variations. Throughout the year, there is a significant temperature difference between seasons. While the summer months can be extremely hot, the winter months are dominated by cold weather. Daily temperature fluctuations are also significant, as there can be noticeable changes in temperature throughout the day. Additionally, the annual precipitation amount in the Savur region is an important factor. The area generally has a dry climate with low annual rainfall. Rainfall is concentrated mostly in the winter months, while it decreases during the summer months. The historical structures in the region are located in an environment characterized by hot and dry summers, and the effects of rain during the cold seasons and high temperature fluctuations lead to significant physical deterioration. The maximum and minimum temperature differences (averaged throughout the year) in the region are approximately 35 °C, and the temperature variations in the Savur region are relatively significant. These variables, along with the heterogeneous structure that enhances the weathering process and its speed, have contributed to the formation of climate-induced issues such as 'crack, disintegration, erosion, and discoloration' on the facades, affecting the physical deterioration of the stone blocks (Sandrolini et al., 2011; Khanlari et al., 2014; Derluyn et al., 2018).

Due to the significant temperature variations, cracks initially form in the stones of the structures, which are further exacerbated by the absorption of water and the penetration of water into the cracks, leading to dissolution-freezing cycles and contributing to the physical weathering process. In later stages, these developing cracks transform into the problem of 'disintegration'. The crack type provides suitable conditions for water to penetrate into the stone structure, eventually leading to disintegration and detachment after several cycles of dissolution-freezing (Odom, 1984). This is the main reason for the high density of deterioration observed, especially in the eastern and western facades of the monument, in the stone blocks used in the construction of the walls.

The stone material used in the buildings in the region is limestone. Limestone is a material that easily dissolves in water. This characteristic is a significant factor in the rapid deterioration of the limestone-based stone used on the facades, especially during the winter season when rainfall is prevalent, and its destructive effects manifest as 'erosion' on the surface. The impact of water on the stone has led to mass losses on the stone surface and mortar voids between the joints in the Savur region, resulting in the problem of 'missing part'. Several studies have highlighted the detrimental effects of water on limestone-based materials, including surface erosion, mortar voids, and missing parts (Alves et al., 2021; Ergüler & Shakoor, 2009; Bustamante et al., 2020; Iucolano et al., 2019; Beck & Al-Mukhtar, 2014; Bonazza et al., 2017; Gulotta et al., 2018).

Another form of deterioration is the "discolouration" observed on the surfaces of certain blocks in the walls of the structures, resulting from the intense exposure to sunlight. Furthermore, due to variations in the intensity of sunlight on different sides of the façade, less deterioration of this type is found on the north-facing street façades that do not receive direct sunlight. This phenomenon is related to temperature fluctuations on the facades and supports the formation of condensation on the shaded side due to lower average temperatures on the façade. On the other hand, on the southern side of the building, where the destructive effects of temperature differences are more pronounced, a higher incidence of "discolouration" issues is observed. This finding aligns with the results of the study by According to Fahmy et al. (2022), demonstrating that surfaces exposed to greater sunlight tend to exhibit more "discolouration" compared to sheltered areas.

Another type of deterioration identified is the use of cement mortar to fill and repair large cracks that have formed in many of the stone blocks used in some wall facades due to temperature differences. However, the repair mortar used in restoration should exhibit high compatibility with historical materials in terms of physical, chemical, and mechanical properties to ensure the long-term durability of the brick structure. Compatibility criteria are determined by the characteristics of the original mortar, but the quality and performance of the repair mortar are often not evaluated after its application to the wall. At this point, the repair mortars specific to historical mortars and brick structures should be examined chemically, mineralogically, and physically to ensure compatibility (Karataş et al., 2022). Additionally, aesthetic, mineralogical, physical, and mechanical characterization should be considered to assess overall performance. Material compatibility and workability should also be taken into account (Duffy et al., 1993; Arroyo et al., 2013; Türkeri, 2022; Dal et al., 2016).

Restoration and conservation interventions require planning and documentation. Restoration experts and conservation scientists emphasize that more than half of the interventions carried out today result in damage due to inappropriate conservation measures. In this context, integrating HBIM (Historic Building Information Modeling) tools into the obtained data is recommended in our study, enabling continuous monitoring of material damage in the structures for future work. Our study suggests expanding the field damage assessment with 3D documentation studies to create a database in the HBIM environment. Today, material deterioration and damage assessments can be easily documented in 3D using laser scanning methods. The importance of having such a database lies in determining the condition of historic buildings and assisting in decision-making regarding management, reuse, and maintenance.

5. Conclusion and Suggestions

Determining the damage on the facades is necessary in order to carry out the restoration work on the street facade of the building. For this reason, in this article, the damage assessments of the Killit Village Street Fronts (Old Bazaar) and the factors causing the damage were investigated. In the results, it was determined that the most intense deteriorations on the street facades were ‘crack, disintegration, erosion, missing part, discolouration’ on the facades. In addition, it has been observed that the joinery and balustrades of most windows on the facade surfaces have disappeared today, and PVC-based window joinery and non-original iron doors, which are contrary to the original texture, have replaced them. On some facades, unqualified window and door openings can be seen, and unqualified fillings can be seen inside and around the building. Within the scope of these problems, intervention suggestions for the repair of the structure are presented below.

During the cleaning phase, the dirt and darkening on the stone surfaces will be cleaned with low pressure water and air. If it is not sufficient, mechanical cleaning methods will be recommended. Dirt and darkening on soft limestone surfaces should be mechanically cleaned by dry cleaning method. The application will be made using soft hard plastic brushes. The cleaning of the developed and developing palnt formations on the building elements should be done as a priority. For the herbaceous and woody structures of these plant formations, mechanical methods (herbicides) should be intervened (Lazarini & Tabasso, 1986). All stone surfaces will be cleaned of cement-based joints, exposed surfaces will be repaired with joint mixture ratios determined according to the analysis results or with hydraulic lime. Repairs made with unqualified materials on the wall surface will be scraped away from the building. Concrete-based repairs and attachments seen on the facade surface will be carefully dismantled. The original iron railings will be cleaned using mechanical methods (soft wire brushes). It will be protected by applying two coats of anticorrosion and using metal paints with galvanic and cathodic protection in black color (Asthurst & Dimes,1998).

Cracks formed in the wall during the consolidation phase, cracks up to 0.5 cm will be repaired with binder mortar injection. Cracks larger than 0.5 cm will be repaired by sewing method. During the reconstruction phase, all the doors and windows seen on the façades will be dismantled and renewed according to the detail project. Electrical installation will be drawn on the facade surface in accordance with the electrical project. These productions must be in a quality and workmanship that will not disturb the original structure of the structures under the supervision of the supervision. Square and road arrangement will be made in accordance with the restoration project (Eskici, 1997; Dal & Öcal, 2017). During the completion phase, the stones spilled from the façade surface and the stones that have lost their stability will be completed based on the original stone dimensions, type, construction technique and knitting style. Original stone will be used primarily in the restoration. Deformations up to 5 cm will not be touched, and distortions of more than 5 cm will not be imitated. If the deteriorated stones create a static problem, they will be removed from the surface by the decay method and completed based on the original stone dimensions, type, construction technique and knitting style. Concrete-based repairs and annexes seen on the façade surface will be carefully dismantled during the add-ons to be removed. All iron-based repairs against the original texture will be dismantled (railing, door, etc.). Unqualified fillings in and around the project area will be removed from the project area (Capponi & Vedovello, 2000).

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Author Contribution and Conflict of Interest Declaration Information

1st Author % 50, 2nd Author %50 contributed. There is no conflict of interest.

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