ANWAR 2

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The color scheme of the riverfront elevation of the old city in Mosul

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Abstract

Abstract

Color is an important architectural element that expresses the culture of nations, their traditions, and their special social behaviors. Color in historical architecture is based on a set of influences linked to the geography of the place, the nature of the land, the prevailing climatic conditions in the region and continuous use of available local materials and the way they were employed. All of which contributed to building color schemes linked to certain areas rather than others. Many architects have studied the color scheme of many cities in order to provide a logical tool to be used in the field of restoration and reconstruction, in a way that creates a natural local environment that approaches and mimics the original colors. The successive events of the war that occurred recently had a great impact on the city of Mosul in general and the old city in particular. Its effects go beyond demolition and destruction to greatly harmed its urban structures.Therefore, the aim of the research was to study and analyze the color scheme of the river facade of the old Mosul city, to benefit from it in the process of reconstruction and restoration of this destroyed city. The researcher analyzing digital images of the selected samples using computer techniques to give high-accuracy results. The methodology of the practical study was based on several steps that began by drawing the river facade using AutoCAD, then analyzing the digital images using MATLAB to reach the color scheme characteristics and the color relationships of the facade that diversity in hue, color intensity, light value and contributed to forming dark and bright areas and generating a scene consisting of the overlay of color blocks on each other at different levels that were unified through the use of the relationship of color harmony and contrast, which contributed to maintaining the unity and continuity of vision in the far and near distances of the river facade. The research found that there are color attraction points within the river facade, the most important of which are the deep shadow foci with their achromatic color, which were concentrated in the central area of the river facade more than the rest of the areas, due to accumulation, mass overlap, and high building density.The study showed the closeness of the percentages forming the color space of the sky and water within the image of the river facade, which contributed to giving a color theme consisting of a field and a frame that formed the prevailing mental image among most of the residents of Mosul. While the rest of the color ratios of the architectural elements ranged from the highest percentage of building blocks in orange (O) to the lowest percentage represented by glass spaces in blue (B) since Mosul architecture is part of Islamic architecture, which is characterized by closure from the outside and openness towards the inside.

Keywords: color in architecture, ancient architecture of Mosul, color scheme, local materials.

Theoretical framework of the research:

Definition of color: Color is a physical phenomenon whose main source is light and visuals in nature, and the medium of vision is the eye. Colors are classified into primary colors and neutral colors, each color has characteristics: the color hue, color value, and color intensity.

Introduction to color in architecture:

Color is one of the effective factors in architecture through which individuals express their feelings. It is an element of design that helps give the building its privacy and distinctive function. It can be used to enhance the space, give it uniqueness, and add calm or vitality to it. Color adds meaning, context and identity to architecture in general. It can support architectural form, enhance or blur the spatial boundaries of the form, and sometimes define and highlight surfaces and volumes within the formal structure. The effects of colors on humans are influenced by cultural and subjective factors such as memory, vision, age, gender, etc. Color works with shape, appearance, texture, and scale as one of the important factors in designing the interior or exterior facades of a building. (Akshara Jain, 2017, p. 93, 94). For most people in the world, color expresses their civilization and helps in understanding the spatial culture of the region. Color is one of the most important inputs that contribute to establishing the mental image of the urban scene. (Galen, Minah.,2008)

Factors related to color in architecture:

The geography of the place, the local climate, the shape of the land, the nature of the site, the construction technology, the local culture, the nature of the systems and legislation in the region are among the most important factors influencing the determination of the prevailing colors in that region. Some of these factors may be fixed and others may change, so it is necessary to clarify the most important of these factors and their effect on forming the color scheme for a specific urban environment, which are as follows:

1- Geography of place:

Color in architecture represents a cognitive system stemming from a set of influences linked to the geography of the place, the nature of the land, social and cultural behaviors, the nature of local materials, and the methods of employing them (Al-Hankawi). Color in traditional cities was linked to local materials and became part of their urban landscape (2019, Niaz, p. 29). For example, areas with a clay nature work to create towns built of clay bricks, and areas with a stone nature produce towns built from them. Thus, color schemes were linked to certain areas and not others (Lanclose, 2009). Architectural styles developed within the limits of these materials, and their continuous use produced an urban environment with color and visual harmony despite the diversity and complexity of shapes. The craftsmen in traditional cities relied on their own experiences and the experiences of their teachers in using colors, which were influenced by the nature of the geographical and environmental location, local materials, and possible construction methods (Qasim, 2017). The local climate and the nature of the location are fixed influences that we do not expect to change. Swirnoff has shown that the geographical location in relation to the lines of longitude and latitude and the extent of its influence on the perception of the bright and dark areas determined by the angle of incidence of light is an important factor in shaping color in the urban environment and how colors are seen on its surfaces. He also considered the direction of the building mass in relation to the sun's rays to be another important factor, as color is affected by changes in sunlight during the day and during the four seasons, as light conditions can be an important controller of the fluctuating color qualities as a result of a specific context (Lanclose, 2009)

2- The culture of the region and the prevailing legislation:

Color has played a distinctive role in architecture throughout history, as color is a clear expression of their culture for most of the world's population and an important means of visual communication. Both cultural and environmental factors have a significant impact on the choice or preference of one color over another, and colors differ in terms of their connotations, symbolism, and psychological effects according to civilizations, peoples, traditions, and ideas (Akshara Jain, 2017). Culture is often formed from a fixed essence that is difficult to change, while legislation and regulations are characterized by a temporary stability that leaves an impact on the architectural form in the stage in which it prevailed. Building legislation and laws play a major role in establishing all details related to urban identity, including color, as it is preferable to delegate this responsibility to local authorities and municipal administration. These color choices, over time, become the colloquial language of the built environment and affect its urban landscape. Failure to comply with building regulations results in the overlapping of different types of colors and building materials on the outer shell of buildings, which leads to the loss of the urban identity of the area (Niaz 2019, pp. 29-30). In New York City, we find brightly colored facades on the streets of Manhattan that appear to be Mexican or Central American, as many immigrants brought their color preferences stemming from their cultures to the host city and used the abundance of saturated colors known in that area, which reflected the culture of its residents (Lanclose, 2009).

3-The nature of materials and construction techniques:

The color we see depends entirely on the material of the structure and the texture of the surface under a certain light. Color and texture are inseparable twins. The texture of the material represents the external image of the surfaces, structures and different things that we look at, and every natural or artificial material has its own texture and color property that is closely linked to this texture (Alessandro, 2017). Smooth surfaces differ from rough surfaces, although they have the same color characteristics, as the value of light reflection on the color surface changes with the change in its texture, and the texture varies depending on the material. The natural materials that were used in traditional architecture, in which humans do not interfere in their manufacture, but rather in their refinement and treatment, transfer their properties to the outer shell, including their color properties (Qasim, 2017). For example, wood, stone and even clay are of great importance in determining the nature of the prevailing color in traditional architecture, as color is associated with the techniques related to these materials. Stones are among the oldest materials used in architecture in different shapes, forms and colors such as basalt, marble and granite. Wood is one of the most common materials in the construction industry and has a yellow color that quickly turns gray due to rapid decay as a result of exposure to the weather even after treatment, while the clay material used in construction ranges in color from red to gray and is susceptible to erosion over time. (2017, Qasim) (Gorzaldini, 2016). Finishing materials greatly affect the visual and physical aspects of the urban landscape, and this effect can be either positive by achieving the concepts of (visual unity, visual attraction, and visual suitability) within the general context of the landscape or negative through visual pollution resulting from the lack of organization and coordination of the nature and colors of these materials within the landscape (Niyaz, 2019, p. 29).

Previous studies on color in architecture:

1-Sustainable color design in architecture: materials, technologies and products 2016

The study showed that the sustainability of color in architecture lies in the integration of the color of building surfaces with the local environment and climate, as well as its integration with the materials, techniques and products used in construction. The research focused on studying the nature of the color characteristics of the materials used at the level of facades and roofs in traditional architecture. A large sample was collected to reveal the color system using the (NCS) tool, which is the Swedish standard for notating colors. The study showed the association of color with the local culture and the traditional use of building stones available in the region, such as stone, clay, wood, etc. The study confirmed that every surface exposed to the weather during different periods of time is subject to changes in the intrinsic properties of the materials and techniques used, so color stability becomes very important, so color stability has been linked to the sustainability of the material or product. When we deal with color, it cannot be separated from the health condition of the material, as it is an indicator of the stability and sustainability of the color.

2- The concept of light and color as a key element of experiencing 'feeling architecture' 2019

The study views color as a distinctive feature of the city, as it creates space, buildings, and the entire architecture. The architectural space and the elements that make it up cannot be perceived without color. In the past, architecture used materials with natural colors that were an integral part of the natural environment. Due to the rapid development, man discovered a way to produce colors and the possibility of obtaining a variety of them, and multiple architectural trends emerged. Architects invested in colors to obtain multiple psychological effects and unique appearances (p. 18). The study showed that color works to highlight important architectural elements or hide defects, and sometimes works to visually enlarge or reduce the space. A unique architectural composition can be created through an inexplicable relationship between materials, light, and color, which generates different effects and achieves eye satisfaction (10-19)

3- Use of Color in Architecture– Industrial Architecture Perspective, 2020

The study showed that color over the past decades has been fully integrated into the construction process with a wide range of color techniques that appear through materials, surfaces, and light and end at an early stage of the design process, while colors are diversified with modern technology to become the most important and most obvious feature of the building during the twentieth century. The study confirmed that the presence of a color plan contributes to achieving an integrated relationship between shapes and masses (pp. 51-52). Harmony and consistency are among the most important design relationships that can be called upon to design successful color groups that are linked to the compositional aspects of color properties, including color gradation, value, and saturation, which together contribute to achieving harmonious color effects. Color harmony may be achieved when using a single pigment in a variety of values or saturations to work as monochromatic schemes or similar groups. The study explained that complex compositions that include different levels of saturation require a thoughtful balance between bright and dull elements.

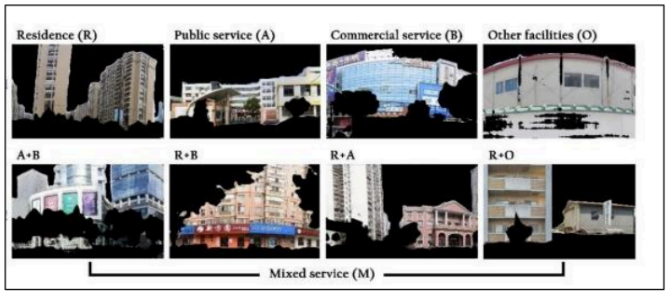
4- Color and light in the requalification, regeneration and valorisation of residential buildings

The study showed that a large number of European countries have a large architectural heritage that has been rehabilitated and its outer envelope renewed through color and light. The rehabilitation and renewal process that takes place on the building envelope through color solutions affects socially, economically and environmentally, mainly in residential buildings, and is closely linked to local materials, construction techniques and the history of the surrounding context. The

study analyzed buildings built after World War II in both Italy and Europe that were rehabilitated, where data was collected and the type of materials used in the outer envelope was analyzed and these materials were classified into: traditional, innovative and smart. The study focused on an in-depth analysis of the color plan and techniques used in the facades to discover "color techniques". An example is the ATER residential buildings in Verona, made up of three typical buildings. The facades still have the original colours, often damaged and showing signs of deterioration. In the new design, traditional solutions were abandoned and innovative intelligent colour techniques were used, resulting in a group of buildings that belong entirely to traditional architecture. The material itself determined the color of the facade, in other cases thin films or paints and pigments were applied to obtain different gradations.

5- Development of a City-Scale Approach for Façade Color Measurement with Building Functional Classification Using Deep Learning and Street View Images 2021

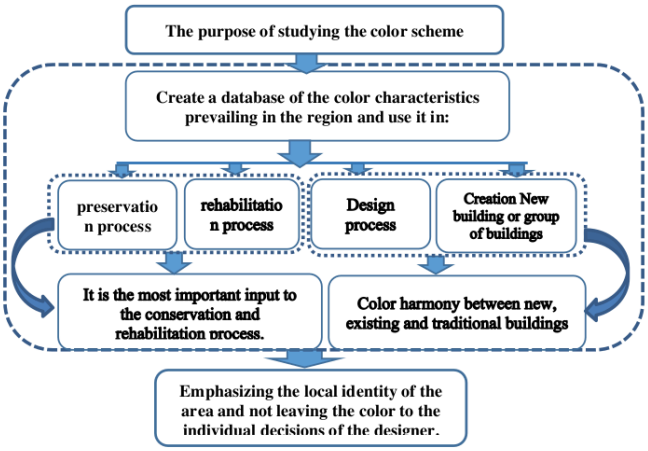
The study confirmed that accurate color measurement in the urban facade is very necessary in the urban planning process of the city. Manual methods for measuring the color of building facades are limited and ineffective at the city level, so the study moved towards using the latest methods for measuring color using virtual tour image technology and techniques, image segmentation and processing, color calibration, and reaching a color chart to create color distribution maps for the facades of three major cities in China, which gave an overall perception of color in the urban facade. The colors of the facades are measured from images to collect digital data for the color system, and the colors in the images often contain impurities, so it is necessary to segment the building facades and clean the data to improve the accuracy of detecting the color plan of the facade, saturation, and value (HSV). Decision makers attach great importance to color in the urban environment, determining the nature of the dominant color of facades, describing its characteristics, and issuing a series of determinants and rules for the color plan for the urban environment, which contribute to achieving colour harmony at the level of the whole and can be invested in developing old buildings or renovating existing buildings to preserve the color identity of the area.



The most important conclusions drawn from previous studies:

Previous studies confirmed the association of color with the nature and sustainability of the material itself, especially in traditional architecture, as it was characterized by the continuous use of local building materials available in the region, and thus determined the prevailing color character in it, which helped in building the architectural identity of the community. The studies also showed that

accurate measurement of the color scheme of facades and architectural surfaces is very necessary before carrying out any design, preservation, or rehabilitation process for a building or the creation of new buildings in the region. Manual methods for measuring color are limited and ineffective, and it is necessary to move towards using the latest methods for measuring color and collecting its digital data and reaching all its characteristics such as hue, value and intensity using computer programs and high-resolution imaging techniques.



Definition of color scheme:

Creating a color scheme is a process in which a database of the color characteristics of natural and artificial elements within a specific urban image is identified and documented, and then coordinated and presented with color relationships and used in construction processes and future projects to achieve color harmony between buildings (Swirnoff, L., 2009)).

Methods used to find the color scheme in architecture:

Many designers and architects have relied on different methods in developing the color scheme for buildings. Lenclos developed a method to identify the prevailing color characteristics of the architecture of a certain area that express a certain color system, and then coordinate and present them in diverse and harmonious color formations and relationships that can be used in future projects for the same area. This is done by taking a sample of all the materials used in the building. In the event that it is impossible to obtain samples, their colors can be represented using the (Color palettes) model or using (Color notation systems) such as (NCS) Natural Color System). Then all selected samples are translated using the color palettes model and classified into groups of color families. The study showed that the colors of materials such as bricks, stones, or a thin layer of paint will acquire a color difference over time so that it is difficult to find their original hue again. In this case, it is possible to: determine the color hue of the surface by choosing the most dominant

color hue that we see from a certain distance. The end result is harmonious color combinations that can be used in future projects.

Byron worked on the methodology developed by Lenclos to create a color scheme for the traditional city of Savannah, Georgia. A color scheme was also prepared by Roger for the new city of New Hall, an extension of Harlow, in order to provide a color scheme that is consistent with the original by matching the color of hand-drawn or documented samples using digital camera technology to collect color data of the urban environment to obtain the required accuracy and then entering it into Photoshop and determining the color ranges using color systems (Lenclos p. , 2009).

O'Connor stated that the most important steps followed in drawing color schemes for a group of buildings is to rely on computer techniques to reach a classification of the colors of photographs taken with high accuracy, where the color hue of the building's facade is reached through the color picker in the Photoshop program by finding the color of a single pixel, thus forming a database for a group of colors that represent the prevailing color characteristics in that facade, and then the colors are classified into color groups such as the color of water, trees, sky, and building. He assumed that the similar colors in the digital image are identical and emphasized the necessity of determining the prevailing color ranges and knowing the percentages of each color (O, Connor, Z., 2009).

Color in old Mosul architecture

The association of color with local materials in old Mosul architecture

The external appearance characteristics of the material such as color and texture are an important factor in the production of Mosul architecture, as we notice the heavy reliance on the traditional local material as a basis for the construction of this architecture. This stems from its economic nature as it is the material available in the region, in addition to the presence of professional labor in its construction. The old city of Mosul has a group of distinctive landmarks and buildings with architectural and historical value that represent an important part of the city's identity and culture (Al-Alaf, 2014). They were built with local materials (such as stone, clay, brick, plaster and marble) at different stages of time. This gave it a distinctive color feature among historical cities with its colors, characteristics and relationships, and greatly affected the sensory and visual aspects of the riverfront and reflected its environmental and spatial affiliation, historical developments, and religious and social influences (Dhanun, Majeed. Al-Sayegh, 1982, p. 5). The ancient Mosul architecture dates back to the second half of the eighteenth century and the nineteenth century. The city of Mosul was exposed to a terrorist war that destroyed the most important landmarks of the city and its ancient cultural heritage in an attempt to erase its historical identity. The residential area of Al-Qala'at was the most destroyed, as this area contains historical structures of high heritage value, especially the parts overlooking the river, which was reflected in the river image of the old city as a whole. In order to preserve the authenticity of these historical buildings and the sustainability of their urban image, it is necessary to document a color scheme that represents a database of the color characteristics of the architectural and natural elements of the river facade of the old city of Mosul, which can be coordinated and presented with color relationships and used in future reconstruction processes and projects.

Nature of the practical study:

Due to the demolition and destruction of most parts of the riverfront of the old city, it was not possible to carry out the photography process at the present time and with high accuracy, so the available images of the riverfront before the destruction were collected and the color differences due to different natural lighting conditions, reflections and other environmental factors were overcome. Since most of the images were fragmented and did not actually and accurately reveal the surfaces and colors of the buildings, the practical study came in six stages as follows:

The first stage: The cropped riverfront images were processed and linked together (Table No. 1) and redrawn using AutoCAD to obtain the building blocks and surfaces accurately. Since the human visual ability to deal with the built environment depends on his ability to classify the compositional structure of the image within levels based on distance and the viewer's relationship with his distance from the image, the riverfront image was drawn and classified into three levels: the (detailed) level, which is the level close to the river, to which the architectural elements and their details were introduced. The intermediate level: which was represented by the building blocks without entering into the elements and details. The distant level: which was represented by the borders of the river panorama linked to the skyline.

The second stage: Due to the inaccuracy of the images obtained for the river facade, the main colors of the local materials were highlighted, which were discovered from the most accurate images of a sample of the interior facades of the old city houses, where samples of accurate photographs were used, which were entered into the (MATLAB) program to extract the color scheme of the local materials used in these samples and extract the dominant colors. (Table No. 2)

The third stage: The dominant color characteristics extracted from the second stage were invested and their colors were introduced to the river facade that was drawn in the first stage using the AutoCAD program. The light was shed on the level close to the river, and the colors were introduced to its architectural elements and details. As for the intermediate level: it was represented by the dominant color in the images of the buildings without going into the elements and their details. The distant level: which was represented by the dominant color in the borders of the river panorama linked to the skyline. (Table No. 3).

Stage Four: Determine the color space for each color composition in the riverfront relative to the color space of the facade as a whole (Table No. 4).

Stage Five: Find the color relationships in the facade by sorting the relationship (harmony and contrast) according to the basic dimensions of color (which were found in the second stage of the analysis) to know the types of color relationships that contributed to achieving the color contrast and harmony of the riverfront (Table No. 5)

Stage Six: Indicate the points of color attraction and polarization in areas (1,2,3) in the riverfront. (Table No. 6)

The method adopted in analyzing digital images in the MATLAB program:

The human eye has limited ability to distinguish similar and adjacent colors in their hue, value and color intensity. Hence, we decided to analyze digital images of selected samples using computer techniques to give high-accuracy results. The methodology for analyzing digital images using computers in the MATLAB program is based on the following aspects:

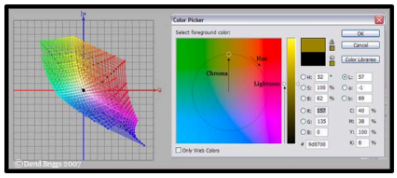
1- Using MATLAB: This system is considered, from a scientific point of view, the best computer program for processing digital images, in terms of the ability to deal with a large number of images in a record period of time and automatically, in addition to MATLAB's handling of the image as a matrix of numbers, which facilitates access to any pixel image unit easily through its coordinates. The programming was done in MATLAB language as it is an interactive language with the user, as it contains a library of functions designed for special purposes in processing digital images.

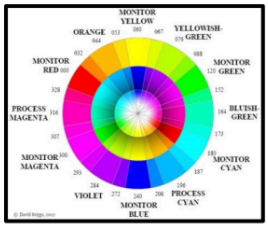
2- Using RGB (Red, Green, Blue) and HSV (Hue, Saturation, Value) systems in the analysis: These systems are considered, from a scientific point of view, the best color systems used in analyzing digital images by finding the hue, value, and intensity of each pixel in the image. The application included the process of analyzing digital images of selected samples through three steps, including:

   1- Finding the basic dimensions of color through:

   First: Determining the hue for each pixel in the image: The image is scanned pixel by pixel and the RGB color compounds are found for each pixel. The study will depend on determining the hue of the color on the RGB system arrangement of the color families, which are: red (R), orange (O), yellow (Y), yellow-green (YG), green (G), blue-green (BG), turquoise (C), sky blue (BC), blue (B), violet (V), crimson (M), and red-crimson (MR). (Table No. 2)

   Second: Determining the value and intensity for each pixel in the image: The ranges of values and intensity were classified into three ranges: low values and intensities (L) (33-1), medium values and intensities (M) (66-34), and high values and intensities (L) (100-67). (Table No. 2)





HSV color model RGB color model

Figure (1-4) Color models used in analysis using computer techniques
http://www.huevaluechroma.com/index.php

   2- Finding the shape of the color space: The image is displayed in layers according to the number of colors present in it. Each color is considered a layer and is known as an image (i.e. each layer is formed from a group of shapes that carry the same color). (Table No. 4)

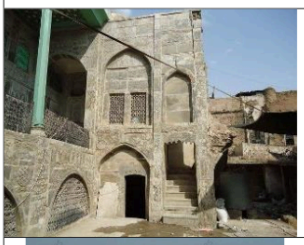
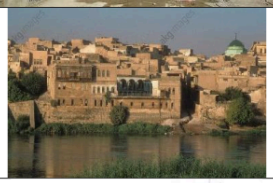
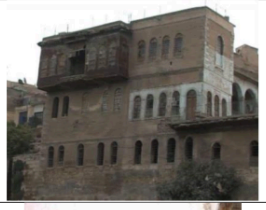
   3- Finding color relationships through: sorting the relationship (harmony and contrast) according to the basic dimensions of color (which were found in the first step of the analysis). (Table No. 5)

Practical study:

Table (1) First stage: Processing the cropped riverfront images in the appendix and linking them together to draw the riverfront lines using AutoCAD.

Table (2) The second stage: Extracting the color scheme of local materials for images within the interior facades of old Mosul houses

The nature of the color characteristics of the riverfront	Color

Samples	Dominant colour	Elements associated with color	Color chart Color pigment/color intensity/photometric value	Materials associated with color	qualities of interface elements
	Hue:60 Sat.:2 Val:74	gallery Ewan Window and door frames column wall surface arc	Hue:60 Sat.:2 Val:77 Hue:60 Sat.:2 Val:65 Hue:70 Sat.:3 Val:83 Hue:75 Sat.:2 Val:71 Hue:72 Sat.:3 Val:68 Hue:69 Sat.:4 Val:76 Hue:48 Sat.:3 Val:61 Hue:69 Sat.:4 Val:73 Hue:69 Sat.:4 Val:67 Hue:70 Sat.:3 Val:80 Hue:60 Sat.:4 Val:64 Hue:60 Sat.:2 Val:74 Hue:69 Sat.:4 Val:70 Hue:80 Sat.:2 Val:58	Marble	Color characteristics of architectural elements
	Hue:33 Sat.:42 Val:78	Continuous solid walls	Hue:33 Sat.:42 Val:78 Hue:36 Sat.:44 Val:76 Hue:33 Sat.:45 Val:69 Hue:33 Sat.:39 Val:78 Hue:33 Sat.:48 Val:66 Hue:34 Sat.:43 Val:74 Hue:34 Sat.:44 Val:71 Hue:34 Sat.:42 Val:77 Hue:32 Sat.:35 Val:81 Hue:33 Sat.:44 Val:76 Hue:34 Sat.:47 Val:68 Hue:33 Sat.:42 Val:76 Hue:33 Sat.:45 Val:73 Hue:33 Sat.:51 Val:63 Hue:33 Sat.:28 Val:61	Clay (Ficus)	
	Hue:27 Sat.:59 Val:31	Window frame door Mashrabiya	Hue:29 Sat.:58 Val:33 Hue:15 Sat.:42 Val:31 Hue:19 Sat.:37 Val:36 Hue:26 Sat.:52 Val:35 Hue:29 Sat.:58 Val:35 Hue:26 Sat.:55 Val:30 Hue:23 Sat.:45 Val:39 Hue:18 Sat.:40 Val:33 Hue:24 Sat.:43 Val:35 Hue:27 Sat.:59 Val:31 Hue:22 Sat.:48 Val:33 Hue:29 Sat.:52 Val:35 Hue:29 Sat.:61 Val:29 Hue:9 Sat.:40 Val:27	Wood	
	Hue:40 Sat.:4 Val:65	Staircase Screen door Sheds	Hue:40 Sat.:4 Val:65	iron	
	Hue:226 Sat.:46 Val:27	Windows	Hue:226 Sat.:46 Val:27	Glass	

Color characteristics of natural elements	Stone				
	sky	Hue:206 Sat.:21 Val:73 Hue:206 Sat.:25 Val:73 Hue:202 Sat.:25 Val:73 Hue:198 Sat.:19 Val:70 Hue:207 Sat.:22 Val:72 Hue:204 Sat.:18 Val:70 Hue:198 Sat.:22 Val:71 Hue:203 Sat.:23 Val:71 Hue:202 Sat.:27 Val:72 Hue:201 Sat.:17 Val:69 Hue:203 Sat.:26 Val:71	SKY	Hue:206 Sat.:25 Val:73	
	river	Hue:201 Sat.:15 Val:45 Hue:201 Sat.:21 Val:53 Hue:200 Sat.:25 Val:43 Hue:200 Sat.:20 Val:48 Hue:203 Sat.:18 Val:51 Hue:201 Sat.:22 Val:50 Hue:201 Sat.:22 Val:51 Hue:201 Sat.:14 Val:48 Hue:203 Sat.:12 Val:51 Hue:200 Sat.:23 Val:46 Hue:199 Sat.:16 Val:54 Hue:193 Sat.:14 Val:49 Hue:200 Sat.:22 Val:47 Hue:200 Sat.:27 Val:39	river	Hue:200 Sat.:22 Val:47	
	Plants	Hue:87 Sat.:30 Val:24 Hue:82 Sat.:27 Val:33 Hue:87 Sat.:42 Val:29 Hue:87 Sat.:38 Val:32 Hue:83 Sat.:31 Val:37 Hue:84 Sat.:47 Val:17 Hue:79 Sat.:33 Val:26 Hue:74 Sat.:36 Val:32 Hue:81 Sat.:28 Val:40 Hue:85 Sat.:42 Val:20 Hue:87 Sat.:34 Val:35 Hue:79 Sat.:42 Val:23 Hue:78 Sat.:31 Val:29	Trees and plants	Hue:79 Sat.:42 Val:23	
	Soil topography	Hue:33 Sat.:42 Val:78 Hue:36 Sat.:44 Val:76 Hue:33 Sat.:45 Val:69 Hue:33 Sat.:39 Val:78 Hue:33 Sat.:48 Val:66 Hue:34 Sat.:43 Val:74 Hue:34 Sat.:44 Val:71 Hue:34 Sat.:42 Val:77 Hue:32 Sat.:35 Val:81 Hue:33 Sat.:44 Val:76 Hue:34 Sat.:47 Val:68 Hue:33 Sat.:42 Val:76 Hue:33 Sat.:45 Val:73 Hue:33 Sat.:51 Val:63 Hue:33 Sat.:28 Val:61	soil	Hue:33 Sat.:28 Val:61	

The results showed the use of two types of colors represented firstly - chromatic colors and divided into three groups of colors: primary colors, secondary colors and tertiary colors that result from mixing primary and secondary colors together. The number of hues used in the river facade was five hues represented by red, orange, yellow-green, sky blue, blue. Secondly - neutral chromatic colors (such as white, black and gray) and they appeared in the materials of brushes and iron.

Table (3) The third stage: Entering the color characteristics extracted from the second stage onto the river facade that was drawn in the first stage using the AutoCAD program.

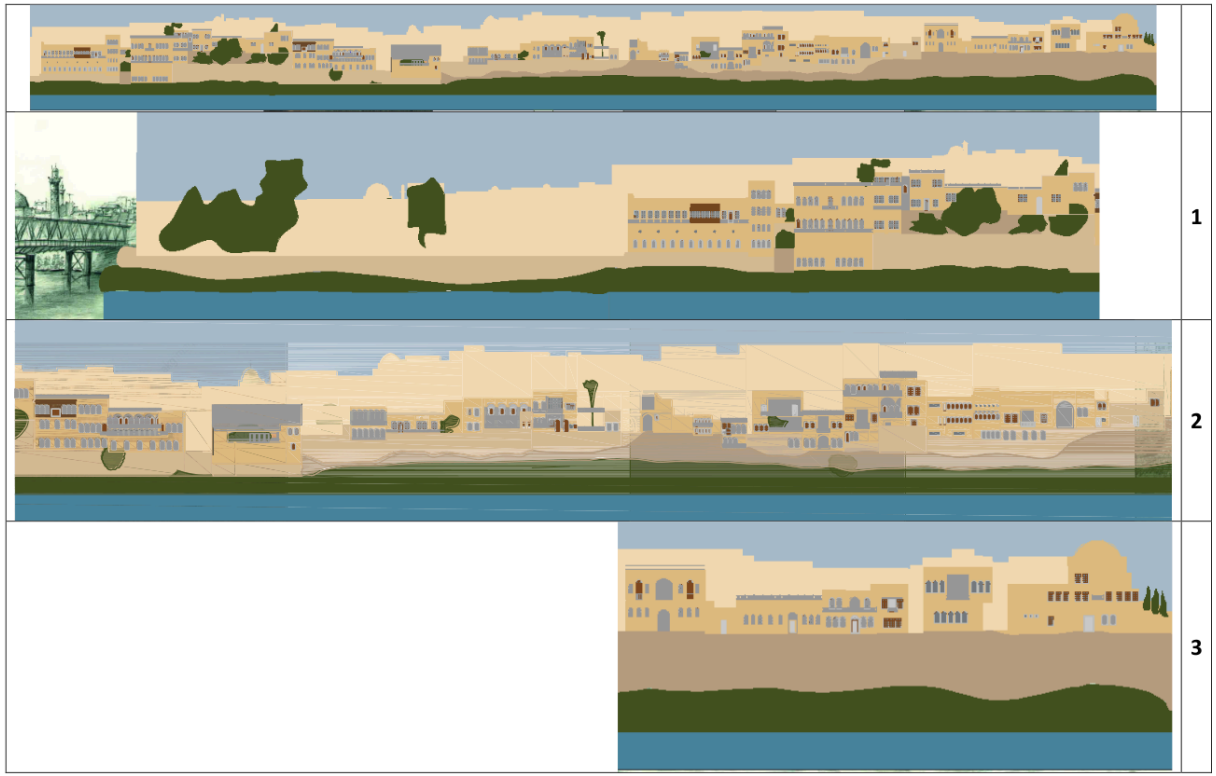
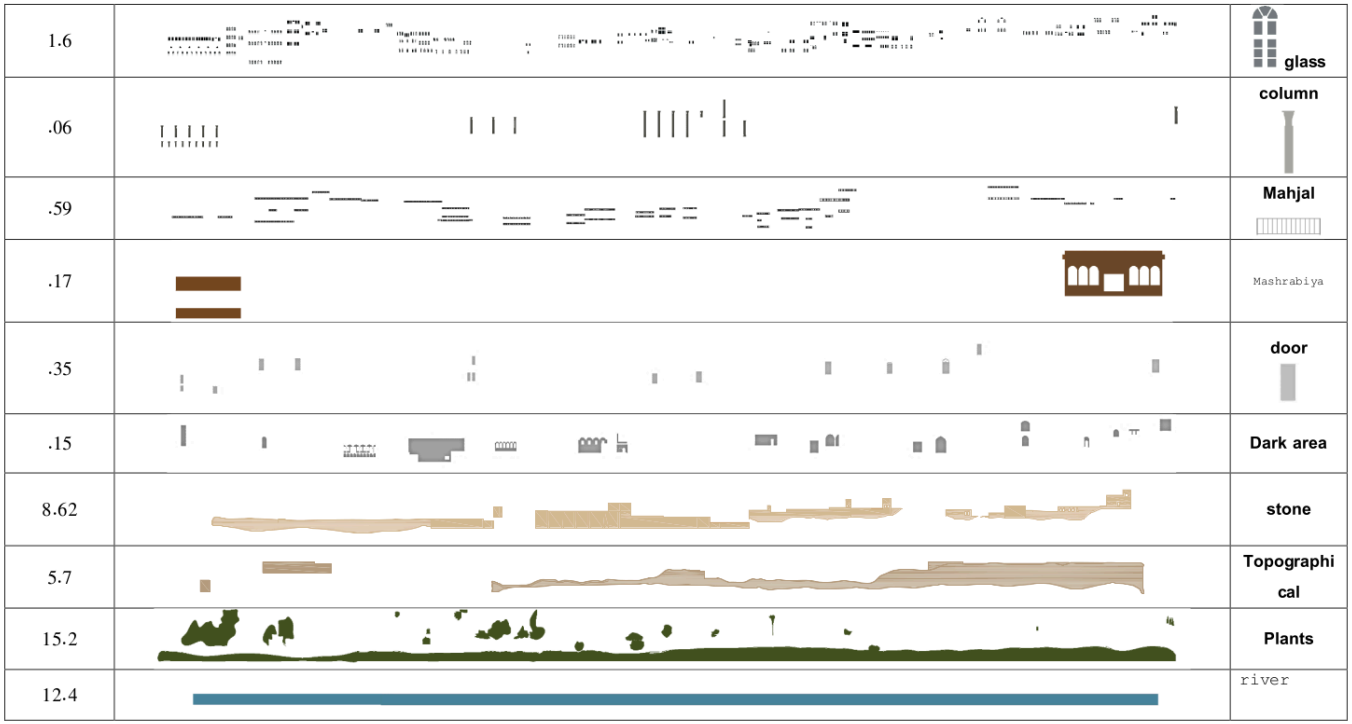


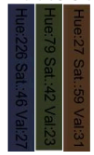
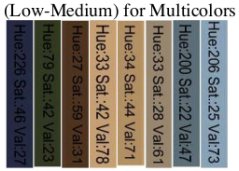
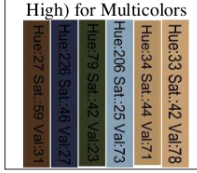
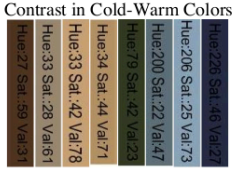
Table (4) Fourth stage: Determining the color space for each color composition in the river facade in relation to the color space of the facade as a whole.

The color space of the element	Levels of color composition of the riverfront	Natural and architectural elements
12		SKY
18		Walls (Level Two)
18.7		Walls (first level)
2.7		window
.14		framework
.7		Window frames
1		protection


1.6
glass
.06
column
.59
Mahjal
.17
Mashrabiya
.35
door
.15
Dark area
8.62
stone
5.7
Topographical
15.2
Plants
12.4
river

The results showed a clear concentration in the use of the orange color (O) with different values and intensities for the first and second detailed levels, while the use of other dyes varied. The yellow-green color of plants occupied second place, followed by the sky-blue color of the sky and water in close proportions.

Table (5) The fifth stage: finding the color relationships (contrast and harmony) that were achieved in the river facade.

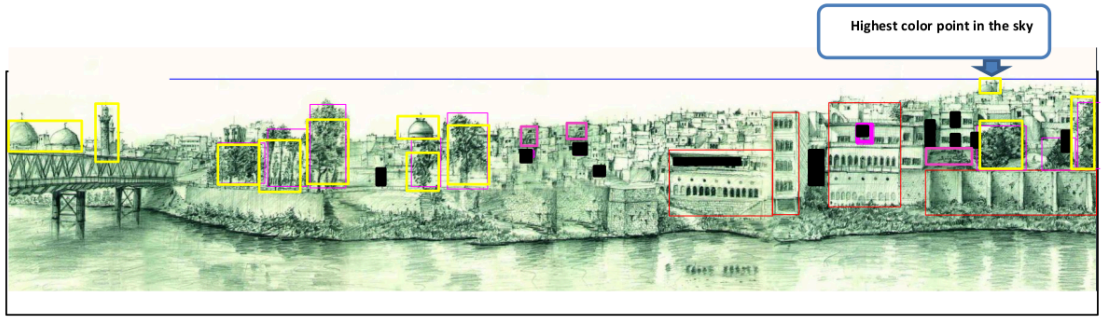
Harmony in Value ((Low -(Low) for Multicolors 	Harmony in Value (Medium-Medium) for Multicolors 	Harmony in Value (High-High) for Multicolors 	Harmony in Value (Low-Medium) for Multicolors 	Harmony in Value (Medium-High) for Multicolors 	Harony in Value (High- Medium) for One Color
Harmony in Saturation ((Low -(Low) for Multicolors 	Harmony in Saturation (Medium-Medium) for Multicolors 	Harmony in Saturation (Low-Medium) for Multicolors 	Harmony in Saturation (Low -Low) for One Color 	Harmony in Hue 	Harmony in Hue
Contrast in Value (Low-High) for Multicolors 	Contrast in Cold-Warm Colors 	Contrast in Complementary Color 	Contrast in**(Chromatic–Achromatic)** Color 	

The results showed the use of the color harmony relationship between one color and another in the chromatic or achromatic family, which is generated as a result of the proximity in light value or intensity in a single color family or between several color families. There is also the harmony in hue generated between two or three colors that differ in hue and are adjacent in the color wheel. The use of the color contrast relationship in light value, and complementary contrast (we can perceive it between every two opposite colors and on both sides of the color wheel diameter where they form a complete color scheme) and contrast in warm and cold colors (the colors of the visible spectrum between red and yellow are called warm colors, while cold colors are located between the range of blue and green). The contrast in chromatic and achromatic colors is produced when chromatic and achromatic colors come together.

Table (6) Sixth stage: The points of attraction and color polarization will be indicated in areas (1, 2, 3) on the riverfront according to the following table:

	Color attraction points	key
	dark spots	
	deep shadow spots	
Minarets	Vertical elements in the interface	
Domes		
Trees		
	Large blocks and areas of color	
	Highest color point in the sky	

Area 1



Area 2

Area 3

The results showed the presence of points of attraction and color polarization within the riverfront and distributed within the three regions (1, 2, 3) in varying degrees. The dark color spots represented by the color of the trees were clear in region 1, while the deep shadow spots were concentrated in region 2. As for the vertical color elements that penetrate the blue sky line, they were distributed in a different way in the three regions, and the most important of these elements are the trees, domes, and minarets, while the large color spaces and blocks appeared clearly in region 1, 3.

Conclusions:

The results obtained from the analysis of the selected samples of the river facade of the old city of Mosul showed that there is a color scheme that represents the basis on which the color formation of the facade was relied upon, and gave a clear picture of the definition of the prevailing color characteristics in the architecture of old Mosul, which can be used in future projects for the same area. The most important conclusions drawn from this color scheme are as follows:

1- Color is one of the mechanisms that contribute to distinguishing the different architectural elements, which gave privacy to each element individually. Color contributed as a formative element that determined the arrangement of surfaces on the river facade, and the presence of diversity in the light values and color intensities used contributed to forming dark and bright areas and generating a scene composed of the overlay of wall blocks on each other at different levels.

2- Despite the diversity of hues used (5 hues with different values and intensities), they were unified through the use of the color harmony relationship (generated as a result of the proximity in light value or intensity in one color family or between several color families or harmony in dye through the use of two adjacent colors in the color wheel).

3 - The achievement of the relationship of color contrast with light value, integrated contrast, contrast with warm and cold colors, contrast with chromatic and achromatic colors is due to the color composition of the river facade as a whole, represented by the presence of the sky, building blocks, plants, and the river, as the presence of color contrast enhanced the clarity of the difference between the colors of these components, which sought to create a beautiful scene that the eye can read.

4- The use of the orange color (O) with different light values and intensities for each of the clay material (labkh), the clay bricks, and the color of the topography of the land, at the first and second detailed levels, contributed to achieving a relationship of color harmony with the hue due to the large color space formed by this dye, which in turn gave unity and visual continuity along the riverfront, and formed a scene rooted in the viewer's memory.

5- Using the two relationships of harmony and contrast together contributed to maintaining unity and continuity of vision at long and short distances, which require a series of recurring elements ranging in size from large to small and with different colour qualities.

6- The presence of the orange color (O) for the continuous and topographical walls has a major role in achieving a relationship of integrated color contrast with the sky blue (BC) of the sky and water, which contributed to enhancing the clarity of the architectural elements represented by the blocks with wide spaces.

7- The use of neutral achromatic colors in the shutters, window protectors, iron doors and furniture gave a kind of balance in the colors so they were not used as points of attraction that affected the general view of the facade. While the presence of the red color (R) with a low value and medium intensity for the mashrabiyas contributed to them being points of attraction on the river facade and were concentrated in areas 1 near the bridge and the middle area 2. It was also evident that there were dark color attraction areas represented by the yellow-green color of the trees (YG) with a low value and distributed harmoniously within the three areas of the facade, but they were concentrated near the iron bridge in area (1) as they are open areas that were previously recreational areas.

8- One of the attractions of the riverfront is the deep shaded areas with their achromatic colour (of low value) which were concentrated in the middle zone 2 of the riverfront more than the rest of the areas, where the peak was in the accumulation and mass overlap and building density and parts of the inner courtyards of the Mosul houses were exposed and the courtyards, arcades and deep roofed balconies formed clear shaded spots in addition to the presence of shaded areas formed as a result of the alleys surrounded by building blocks in a dense manner.

9- The most important vertical elements that clearly cut the blue sky line in the river front are the trees with their yellow-green color (YG) of low value in region 1 and region 2, as well as the domes with their orange color (O) of high value and medium intensity as in the dome of the Shatt Mosque in region 3 and the domes and minarets near the old iron bridge in region 1. They were the highest vertical color attraction points that cut through the azure blue sky line (BC).

10- There are some large blocks and color spaces that represented points of attraction in the riverfront, including continuous surfaces at the level of two floors or prominent blocks at the level of the second floor. These large blocks and surfaces appear in their orange colour (O) with high value and medium intensity among the small block details that characterise the riverfront and were clear in areas 1 and 3, due to the low density of blocks and details.

11- The research reached the convergence of the percentages forming the color space of the sky blue (BC) of the sky and water within the image of the river facade, which contributed to giving a color theme consisting of a field and a frame. Thus, the color composition of the river facade was determined by a frame (represented by the sky and water), and the field represented by the architectural elements and nature forming the river facade, which in turn formed the prevailing mental image among most of the residents of Mosul. While the rest of the color percentages of the architectural elements ranged from the highest percentages of the building blocks in orange (O) with high value and medium intensity to the lowest percentages represented by the glass spaces in blue (B) with low value and medium intensity, since Mosul architecture is part of Islamic architecture, which is characterized by closure from the outside and openness towards the inside, so the dominance was for the solid walls whose color is largely related to the nature of the materials and climatic factors.

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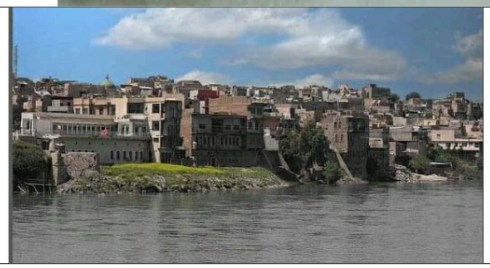
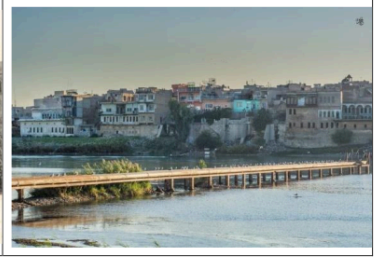
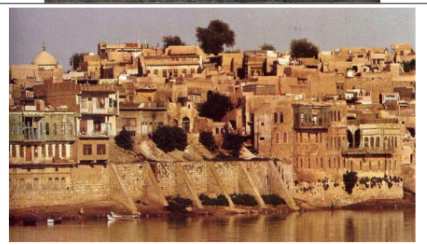
Table Appendix (1) First stage: Images of the cropped riverfront that were collected and linked together to draw the riverfront lines

Area 1







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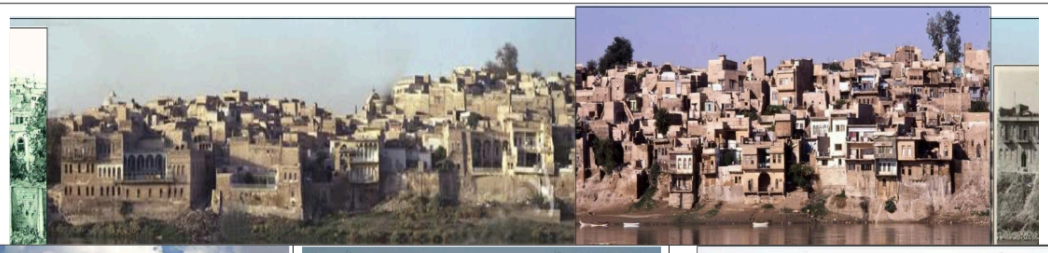
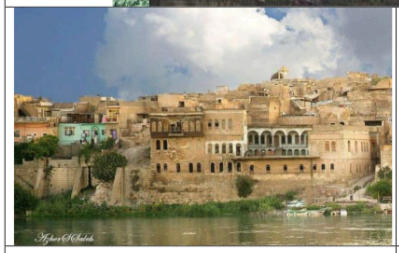
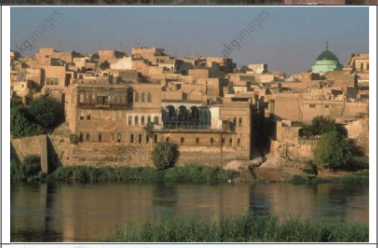
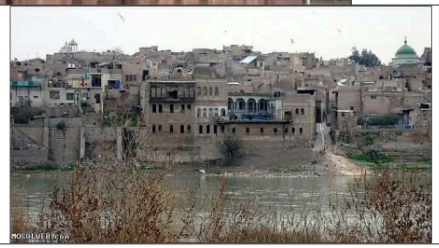
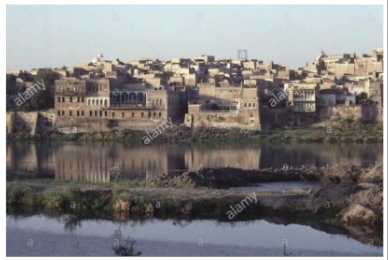
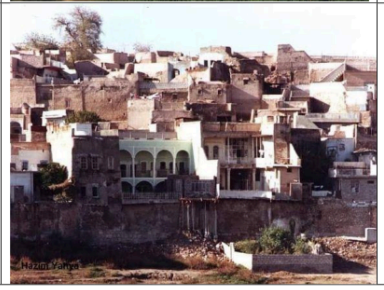


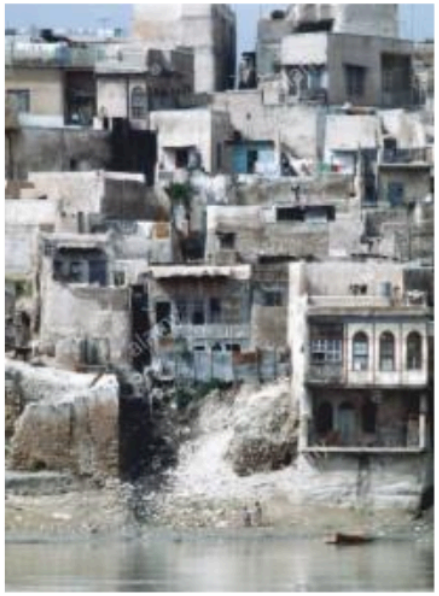


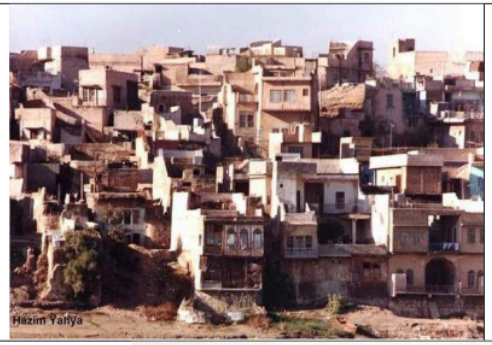


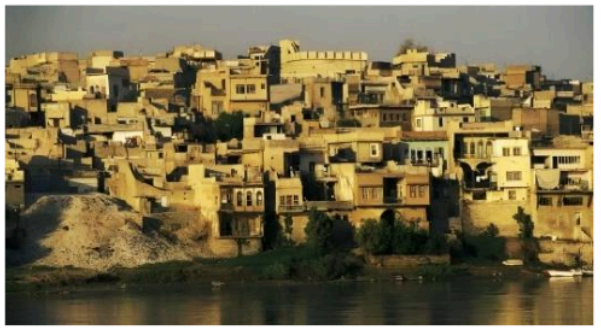


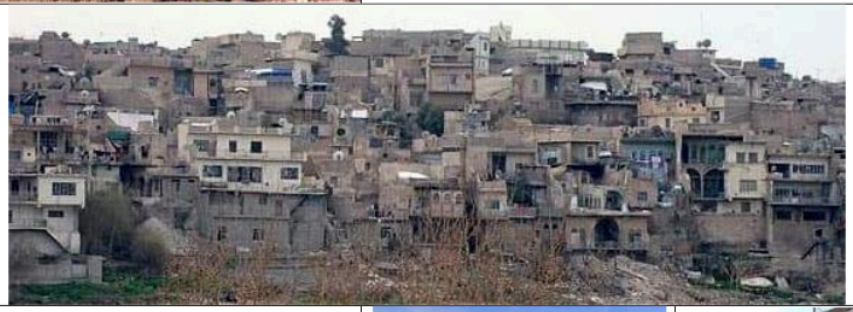


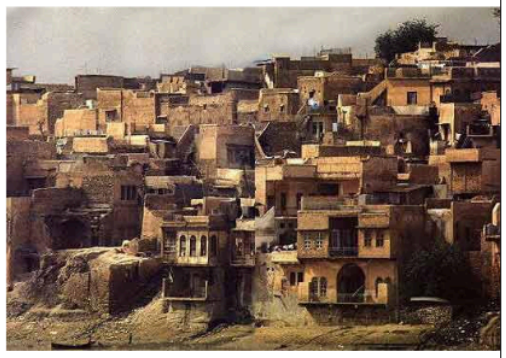


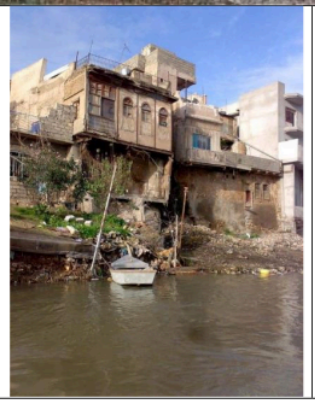


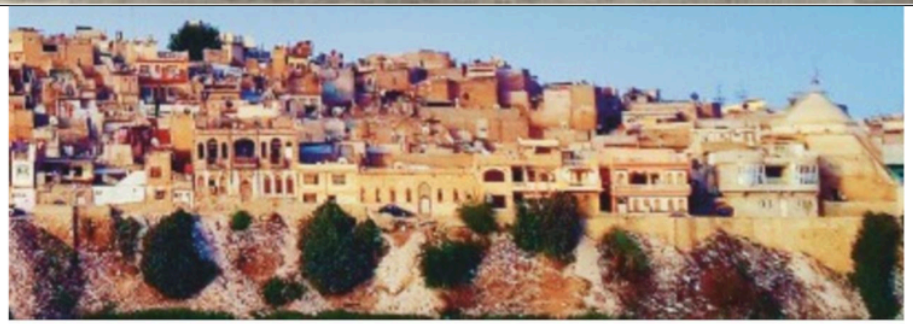
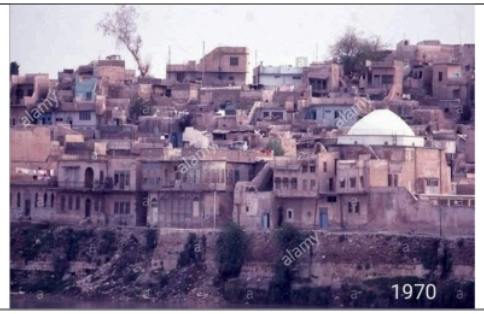

Hazim Yafiya









Area 3



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