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The Perceptual problems of colors in geographical maps

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Abstract: A map is a symbolic representation differing in its shape and area from the origin it typifies, according to the scale used. Therefore, it requires briefing many geographical features, whether nature or human, so as not to clutter the map with information, and it can be read and interpreted clearly and easily. Hence, it needs to use specific methods to clarify these features. Color is a positive force that affects the nervous system, which is a reason for drawing joy that cannot be underestimated when looking at it. Cartographically, color has a great factor in estimating the shape of geographical phenomena on maps and determining their sizes, development and dimensions, in addition to explaining distances, densities, movements and directions. Perhaps the question around which this topic and its content are about is: Will the effect of colors remain in the mind for a longer period of time than the effect of black and white which is also more attractive and impactful.? Hence, we say that color is an important and basic means of expression and understanding, but it has become a necessity, such as its use in some maps of modern distributions that clarify at the same time more than one dimension of a single geographical phenomenon, and also that depend on the installation of more than one cartographic design in one panel to express the geographic phenomenon entrusted by studying.

Keywords: **perception, color, hue, color gamut, color contrast.**

I. INTRODUCTION:

The geographical map that we create becomes more realistic by using the agreed upon colors, especially wall and topographic maps, in the representation of different natural appearances. Color in maps has a positive power and a great role in estimating the shape of a geographical phenomenon on maps. These colors have been adopted within high-level geographical and cartographic conventions and conferences for the purpose of the unity of these colors in order to unify the connotations and concepts so that the maps are truly a universal language that transcends international barriers. The goal is to choose the colors in a way that ensures the speed of discrimination, customization and identification of the geographical phenomenon on all maps. The colors used in the maps have the ability to clarify the main theme of the map, especially that color, with its different characteristics, facilitates the deduction of a large amount of visual differences in any map.

For example, the colors on the topographic map, among the most important colors used in the topographic maps and are internationally recognized are:

* **Red color**: It is usually used to represent main roads and residential complexes.

* **Black color**: It is used for appearances created by humans, including bridges and dwelling compounds.

* **Blue color**: It is used to represent water bodies such as oceans, seas, lakes, swamps, rivers and valleys.

* **Brown color**: used to represent terrain phenomena with leveling curves and represent cliffs and rocks.

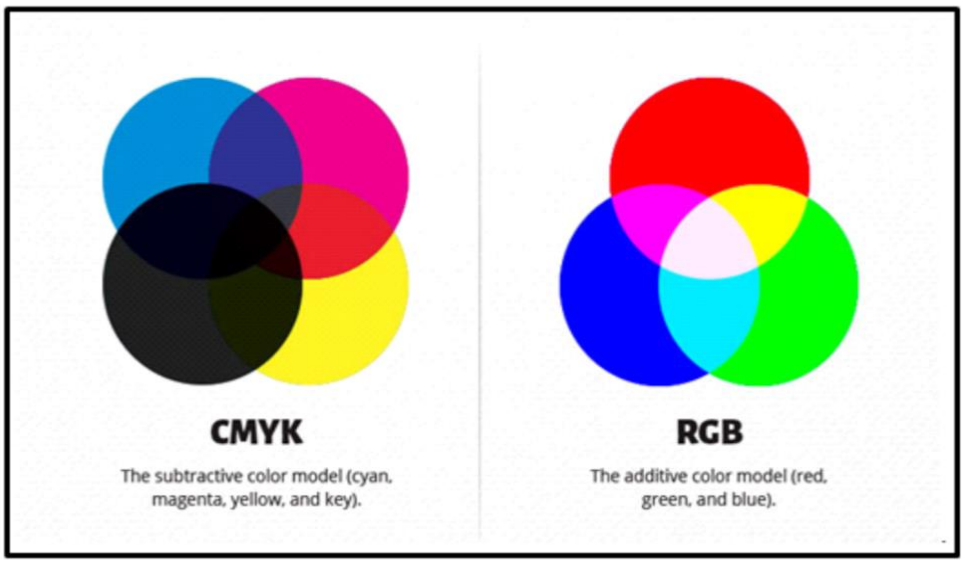
* **Green color**: It is used to represent vegetation such as forests, high grasses and isolated trees.

In spite of that, we face many problems about establishing the correct interpretation of geographical phenomena, both natural and human, because they interfere with the interpretation process after the maturity of a correct vision of the map reader, which includes the personal interpreter capabilities and the circumstances that are related to the interpretation process. Furthermore, it includes the difference in viewpoints between people, their speed of perception, and the difference in their ages and sex, and above all, it is the correct method adopted by the mapmaker in choosing the appropriate colors with all their physical and chemical characteristics and using the appropriate color for the proven phenomenon.

The color

It is the body characteristic such as blackness, white, redness, etc., and the color of everything: what separated it from others. This is what we see when the colorants modify the light physically so that the human eye sees it (called the response process) and is translated in the brain (called the sensation process that psychology studies).The rays of light in the strict sense of the word are not colored. There is only a specific energy in the rays and the ability to induce a feeling of this or that color. Color is a physiological effect produced in the retina of the eye, where cone cells can perform a three-color analysis of scenes, whether the color is caused by The pigment or colored light. The association of color with things in our language, which appears in phrases such as "this thing is red in color", is a misleading association because it cannot be denied that color is a feeling that only exists in the brain, or the nervous system of living organisms. (Ahrens. et al. 2005). See Figure (1)

Figure (1) the chromatography system



Elliot Andrew et al. (2007). Color and Psychological.

The color sensation is affected by a long-term historical concept according to the nature and culture of the viewer, and also a short-term concept, which is the neighboring colors. Cynthia. (2005)

Color science is sometimes called chromatography which includes the ability to perceive color in the human eye, the origin of colors in materials, color theory in art and also color physics in the electromagnetic spectrum. Color has the power to change the human psyche because each of the colors is associated with specific concepts and has special connotations. By means of "color tests", the emotional and intellectual states of a person can be shown, for example, white represents chastity, black represents sadness, and so on. (Green. 2011)

Factors of visual perception of colors

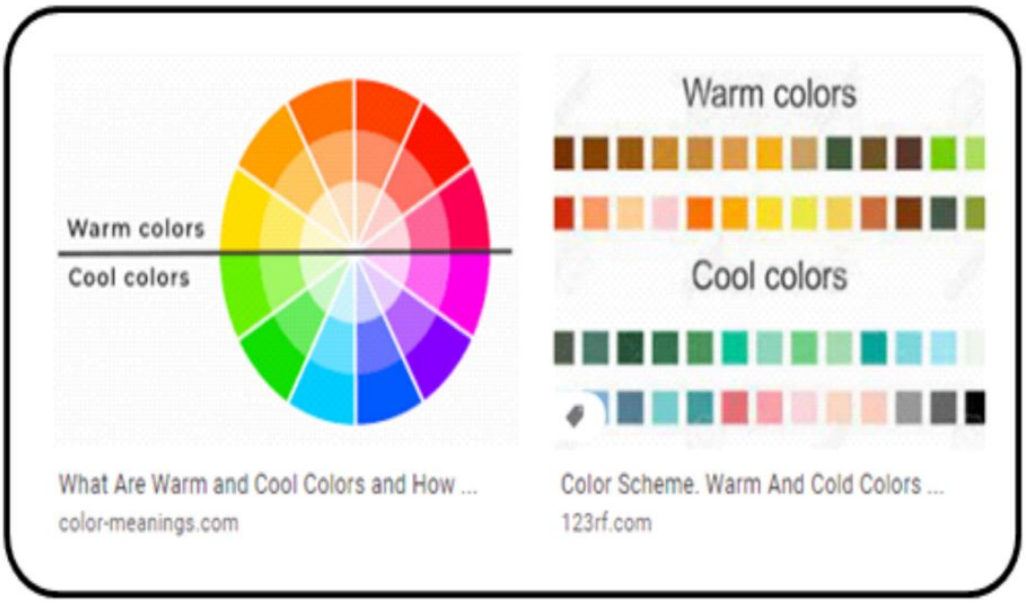
The human eye has the ability to accurately sense colors and what they can be according to the color value and type and depending on the represented phenomenon, whether natural or human, which can be sensed through the spectral series of colors that can be used in the representation process. Hence, it became necessary to point out the most important factors that human eye is sensitive to. The human sense of color is related to the following things: (Al-Qassab. 1984)

Color gamut, color intensity and chromatic value

Colors acquire characteristics and features that differ among themselves, and as is well known, the basic colors are three, but if mixed with each other, they produce different colors, such as mixing blue and red, resulting in black. Thus, the color value of the resulting color changes in terms of being light or darker, and it follows the actual ratio of the intensity of the color that the human eye senses. Colors have an

indication of the sense of the third dimension in color pictures, although they are only flat and are distinguished by only two dimensions. The sense of colors near and far is one of the psychological phenomena that have a profound effect in drawing maps and drawings. The reason for this phenomenon is that the light rays entering the eye are refracted in an inverse relationship with the length of the wave. This theoretically means that the blue is concentrated and clustered in the front of the retina, while the red is concentrated behind or behind the retina. As a result, the red thing appears to the eye a little closer to the blue thing, as well as the colors close to red, yellow and orange, while the distant colors, including blue and green, are used, and colors close to the shape or image are usually used. As for the distant colors, they are used for the background or the ground, and the close colors form the warm colors with high values and deep saturation, while the far colors include cold colors with low values and little saturation. (Frank and Krogh. 2013). See Figure (2)

Figure (2) warm and cold colors.



https://www.color-meanings.com/warm-cool-colors

Using colors in maps

Some geographical maps, especially topographic and wall maps, adhere to specific colors in representing their various phenomena, as the high geographical and cartographic conventions and conferences stipulated that for the purpose of the unity of these colors to unify the connotations and concepts so that the map is truly a universal language that transcends international barriers. However, the thematic maps remain of a special nature as they are subject to the choice of their colors by their designer, and perhaps one of the objectives of this study is to present some proposals through the findings of this study that benefit in the field of color selection in a way that ensures the speed of distinction, allocation and identification of the geographical phenomenon on the maps.(Norton and Clyne. 2013)

The use of colors in representing the natural phenomenon differs from that of the human phenomena. The first used in its representation of colors from an early period, that is, around the year 120 AD, where the world map of "Marinos" was one of the first accurate maps that depended on colors; Therefore, there is near agreement on the colors of natural phenomena, as for human phenomena, the choice of their colors is still being studied, and perhaps the best evidence for this is evident in the clear difference between the colors of some maps such as: population, urbanization, economic activity, languages, religions, diseases, cultures, and urbanization in Global and national geographic atlases. (Al-Issawi.1978)

From another standpoint, it became clear from the study that many of the thematic maps in the seventeenth and eighteenth centuries were focused on clarifying the geographical phenomenon on maps as a spatial distribution pattern only, but recently the geographical phenomenon represented on the maps

has become seen through its value (quantity) in addition to this. The pattern of its distribution. This had an impact on the intensive use of color in maps to fully clarify the dimensions of the geographical phenomenon represented on the maps. Thematic Quantitative Maps supported using colors in maps extensively. One of the objectives of this study is to emphasize the idea that the colors used in the maps have the ability to create the desired effect to clarify the main subject of the map, based on the fact that color has different characteristics (saturation, luminosity). (Agreement, contrast) to easily derive maximum visual differences from maps. (Stiha. 1971)

Using colors in the design

The cartographic design process depends on a set of criteria that must be met for the purpose of completing and producing the final model. The lack of proficiency in the implementation and presence of these foundations means that there is a major defect in the application and output and these principles are (principles of map design, the content of the map, scientific accuracy, clarity, levels Visual, perceptual). In order for colors to be used in the design, a set of conditions must be met, which are: (Dawood. 1434)

* "The colors should be consistent and harmonious with each other.

* The color is appropriate and expresses "the element to be represented, and this is one of the most important conditions for the color signature. The color of any element in the map should not be adopted without this condition being met, and must be changed if there is inconsistency or disparity between it and the other colors included in the design of the map.

* " Avoidance of dark and bright colors, that is, high frankness, except for necessity, because they achieve a visual distraction that distracts attention from the primary purpose of choosing a color.

* The function of the auxiliary colors should be to highlight the similarity or difference between the areas of distribution of the elements in order to achieve a more easy decision for the cartography work.

* The small size of the cartographic areas on the map should be allocated dark or bright colors to compensate for the small size of their area.

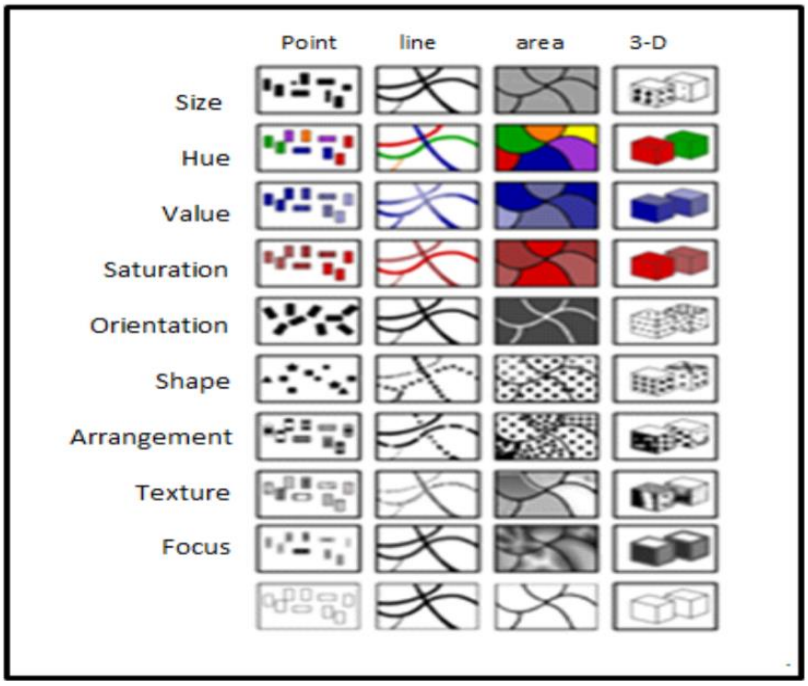
* Different colors are used in the map to work on clarifying opposite phenomena, for example, dry areas and rainy areas, or areas with high population density, and areas with low population density.

In the case of using a single color gamut, the color categories should not be so many that it is difficult for the user or reader of the map to distinguish between these categories and affect the level of perception of the map. (Sabry. 2001)

The goal behind using colors

Color is considered one of the important selective visual variables because the reader can understand it easily and because it is one of the variables that are firmly rooted in his memory. Therefore, colors are used in most objective maps, the main goal of which is to identify, select and distinguish the phenomenon represented on the map and to match it with other phenomena. Colors are one of the most important elements in map design, but this selective variable is characterized by a number of difficulties in representation, as well as in the perception resulting from the hue, intensity and value. There are many variables that are explained by using colors in the map, including physical and chemical physiological, psychological and technical, as there are basic colors such as (yellow, red, and blue) or the so-called (printing colors), and secondary colors, which are derived from the basic color models with varying proportions. (Najeeb Al-Zaidi, et al. 2005) See Figure (3).

Figure (3) color and visual variables



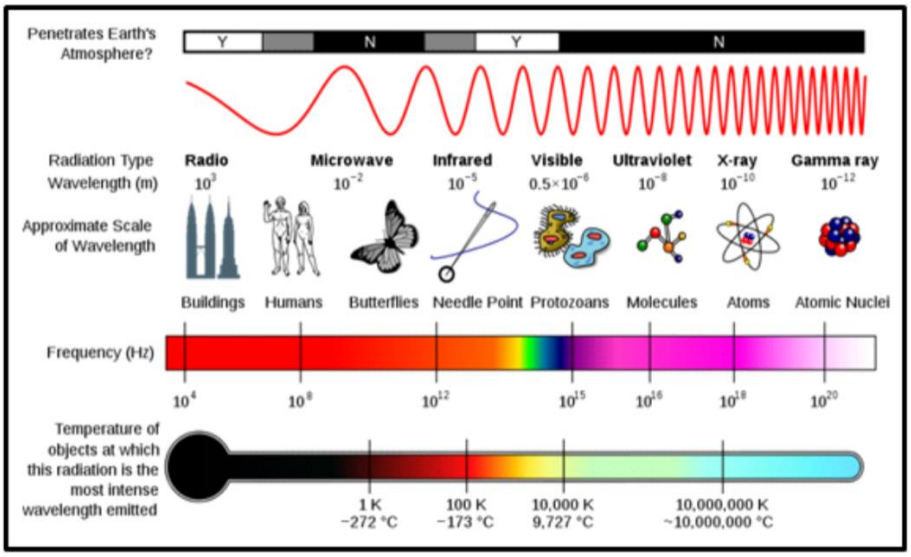
http://www.kennethmoreland.com/color-maps

The problem of colors appears clearly in the maps of distributions by contrasting the color value and the gradation from dark to light in the representation of a certain gradual phenomenon. This discrepancy in the value of the color indicates the contrast of lightening or even the difference in the tone or color value or the nuance of color (which is the pigment that distinguishes color In addition to other colors). In addition to the intensity of color, it is through these dimensions that the perception of color can be achieved, and the feeling and color increase from these mentioned properties. (Al-Masraf,1980)

Problems choosing colors in the map

The cartographer faces some problems in the process of choosing the color to draw the map, so he must understand it, understand it and its states in order not to make a mistake while he is practicing the cartographic work. The color problems are determined in the thematic map according to: **1.Classification problem**: This is based on the degree of color sense, as there are colors with longitudinal waves that give a sense of warmth and heat, and there are colors with short waves that give a sense of coolness, while blue or close to blue colors are called cold colors (see Figure 4) and sometimes they differ. Perspectives on the interpretation of the so-called cold color on one side and hot and warm color on the other side. (Olson. 1976) The red, orange, and yellow colors and their gradations are colors that express hot or warm areas, while the blue and its hues represent the cold regions. As for men of natural trends or photographers, the red color for them is a cold color, while the blue color represents the highest temperature temperatures of the color. (Balogun. 1982)

Fig. (4) Classification of colors according to wavelength



https://earthsky.org/space/what-is-the-electromagnetic-spectrum

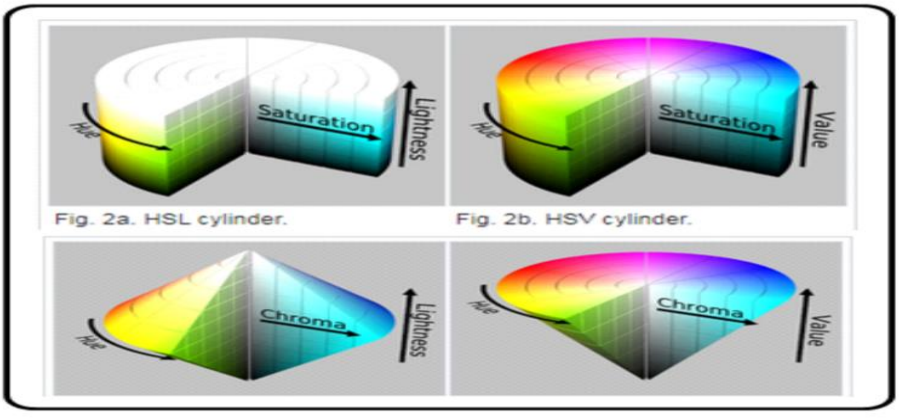
2.The problem of color contrast: color contrast is meant the difference in color in terms of many problems that can be explained as follows (Loyelk. 1975). See Figure (5)

3.Contrast in the niche of color: This can be determined by the niche of color in relation to another color next to it in the event that the tonal tone of both is equal. So, if two complementary colors are adjacent, one cold and the other hot. This juxtaposition will result in the emergence of the characteristics of each color, which results in a clear difference and contrast in intensity, the coldness of the first and the hotness of the second.

4.Discrepancy in tonal tone: and is also determined by the phenomenon that changes the degree of a certain color to the degree of another adjacent color. The degrees of adjacent colors appear light colors lighter than they are, and dark colors are darker than they are.

5.Contrast in tonal degree and nacelle: and this type of contrast combines the contrast in the degree of color and the nuance of color together, because the human eye cannot see the contiguous and different colors in degree and nacelle at its origin, due to the effect of juxtaposition, gradation and nacelle on the value of color.(Graham. 1998)

Figure (5) Saturation, Contrast, and Hue

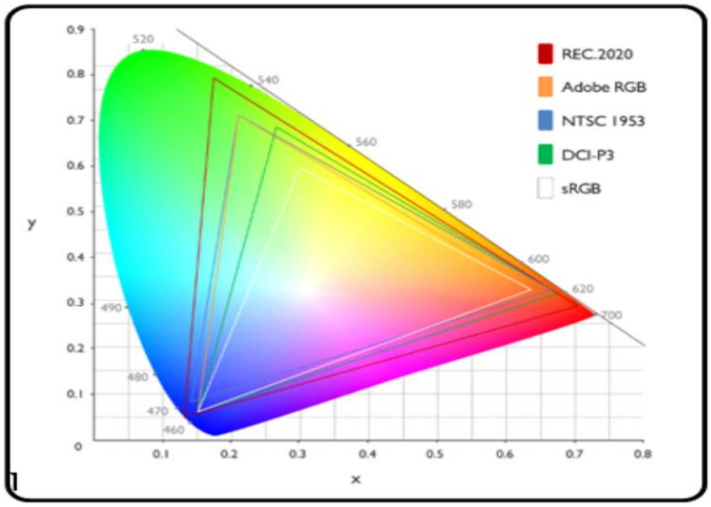


Ray Osbrne (1980) Lights and Pigments ,London.

6.The problem of choosing a color: when schetching a map and choosing colors, different reactions must be taken into account, whether from the psychological side of the person, or the physiological aspect that depends on the mechanism of the human eye, or from the objective aspect that is viewed from the academic or scientific point of view. In the process of selecting colors for the map, two important elements emerge, namely the choice of color, and the method used in order to reach the desired or desired object for the final drawing of the map. (Graham. 2005)

The best typical use of colors is through gradations such as (reddish orange or yellowish orange and red) or (greenish-blue, then scarlet, then purple, then black), see Figure (6). Also, computer technologies and their programs have presented the issue of mixing colors, giving us wide options of shades and color models within the principles of color options. (Harry.1973)

Figure (6) the color scheme for different colors according to the CIE 1931 system

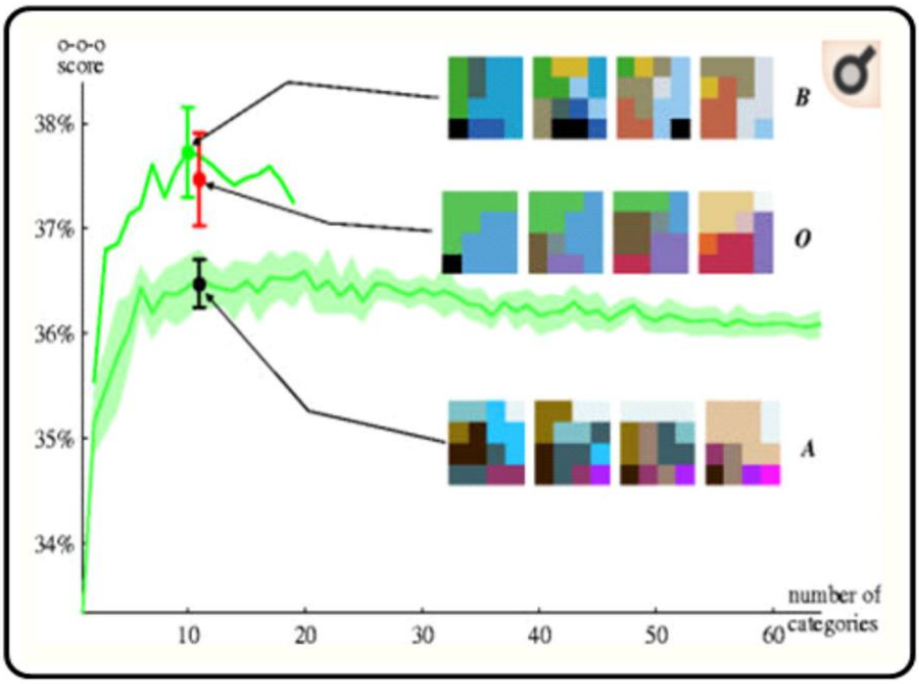


Raj Pant and Farup) .2012) Riemannian formulation and comparison of color :difference formulas. Color Research &Application.

4. The problem of mixing symbols: The choice of symbols is a ruling matter in drawing the map, and it is usual for the symbols to be chosen with the prescribed color scheme at the same time. Choosing a color with a specific symbol helps to bring out the map correctly (Raj Pant and Farup. 2012)

5. The problem of the number of categories that are represented by color: The researchers believe that the greater the number of categories used, the greater the benefit from the colors. When the categories are fewer in number, then the steps of the value must be more, assuming that the hierarchy of value is used. (Sanders, et al. (1996). See Figure (7)

Figure (7): Regular and random examples of colors to represent groups



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II. CONCLUSION:

Color is considered one of the most important visual variables used in the mapping expression, and color has three characteristics which are hints, saturation and value. The researchers emphasized that tone and saturation are used to distinguish between phenomena and value. The fact that color is an important visual variable that has a great impact on the map reader when interpreting and reading, as it is considered one of the best visual variables for the strength of its effect, the extent of its understanding and the speed of perception by the reader. If we look at several maps in which the visual variables are used in each map, we find that the map in which color is used attracts the view more than others, so that non-specialists can understand and comprehend the maps in which color is used more than others. In the using colors in drawing natural and human phenomena, several problems arise based on several elements, including the physiological composition of the eye, the structure and the structural properties of color. But, these problems can be overcome by adopting methods and tools that help to choose the colors that have less influence on the reader's eye and the interpreter of the map in addition to experience the process available to the reader and interpreter of the geographical map.

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