

# Coding of the Qualitative Maps in Geographic Information Systems GIS and Evaluated Cartographically

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## **Abstract:**

This article focuses on explaining the Geocoding in general and the cartographic symbolization in particular, which is a crucial factor in map representation, particularly qualitative map symbolization. This type of symbolization emphasizes the location and distribution of the phenomenon under study without considering quantitative differences. The article categorizes this symbolization into point, line, and area symbols, and discusses the appropriate contexts for each type. There are various symbols available within Geographic Information System (GIS) programs; however, the choice of symbol type, style, and size is not determined by the software itself but is governed by the principles and standards of cartographic design. It is imperative for the cartographer to be thoroughly knowledgeable about these principles and standards, both in general and in detail, given *the critical importance of symbols in map interpretation by the reader*.

**Keywords:** Map Coding, Qualitative Coding, Geographic Information Systems, Cartographic Design, Cartographic Evaluation.

## **Introduction:**

Geographers have traditionally been committed to transforming tabular data into maps over the years, which reveal the spatial distribution and analysis of various natural and human phenomena in the study area. This is achieved through the use of point, line, or areal symbols to represent the qualitative spatial distribution pattern. In the realm of this study, the nature of cartographic encoding in general and qualitative encoding in particular has been elucidated, along with the depiction patterns of point, line, or areal cartographic representation and the contexts of using each pattern. Additionally, the steps for implementing each type within Geographic Information Systems (GIS) software have been outlined. It has been highlighted that despite the availability of numerous qualitative cartographic symbols within the system, the skill and ingenuity in their utilization depend on the cartographic perception of the mapmaker.

The research problem can be formulated in the following question: What is the potential of GIS in qualitative cartographic coding? Can it be relied upon without resorting to cartographic design principles?

Geographic information systems have enormous potential in cartographic coding with the presence of a diverse package of symbols to meet the requirements of the map maker. However, one cannot rely on the random use of these symbols without subjecting them to the rules and principles of cartographic design. The extent of creativity in using that package depends on the extent of the maker's skill. the map.

The research included a definition of cartographic coding, an explanation of its types of qualitative coding, the steps for conducting it in its several types, and an examination of the extent of the negatives and positives in its application within the geographic information systems program.

The research aims to explain the nature of qualitative cartographic coding and the possibilities of its application within the ARC Map program and evaluate it graphically.

### **First - the concept of cartographic coding**

Cartographic encoding is a geographical method that enables the accurate recording of geographical phenomena. A map is a symbolic representation, differing in shape and size from the original it represents, depending on the scale of the drawing used. In order to be easily readable and interpretable, and to avoid overcrowding with information, specific methods must be used to clarify these features, and undoubtedly, the use of symbols is one of the most successful methods. Therefore, the success of a map depends on the language it employs, and the language of a map is its symbols, which should be clear and easily understandable when designing any map. These symbols are simply signs indicating the locations of various natural and human phenomena. In their significance, they provide a concise idea about the extensions, slopes, shapes, and orientations of these phenomena.

When well-designed, symbols accurately portray geographical data not only spatially but also quantitatively in most cases. Thus, map symbols fall into two categories: qualitative symbols and quantitative symbols. Maps are

categorized based on the type of symbol used in their depiction, either qualitative or quantitative. The language of maps relies on three types of symbols, each with its own meaning, and these symbols are attributed to their respective meanings (Al-Shari'i, 1997):

- Point symbols
- Line symbols
- Area symbols

### Second: Coding maps of qualitative distributions

Non-quantitative distribution maps focus on highlighting geographic facts without relying on statistical sources. Thus, they visualize these geographic phenomena regardless of their quantities or numbers, such as delineating political boundaries, transportation lines, or production regions. They are described as qualitative because they focus on a specific characteristic, such as regions of production of a certain crop like wheat, emphasizing differences in type rather than quantity. This is achieved through the selection of specific symbols to illustrate this geographic variation within the region. These symbols are divided into three main categories: point symbols, line symbols, and area symbols (Al-Ayissi, 2000). Based on these symbols, non-quantitative distribution maps can be divided into three main sections:

#### 1-Specific position symbol maps:

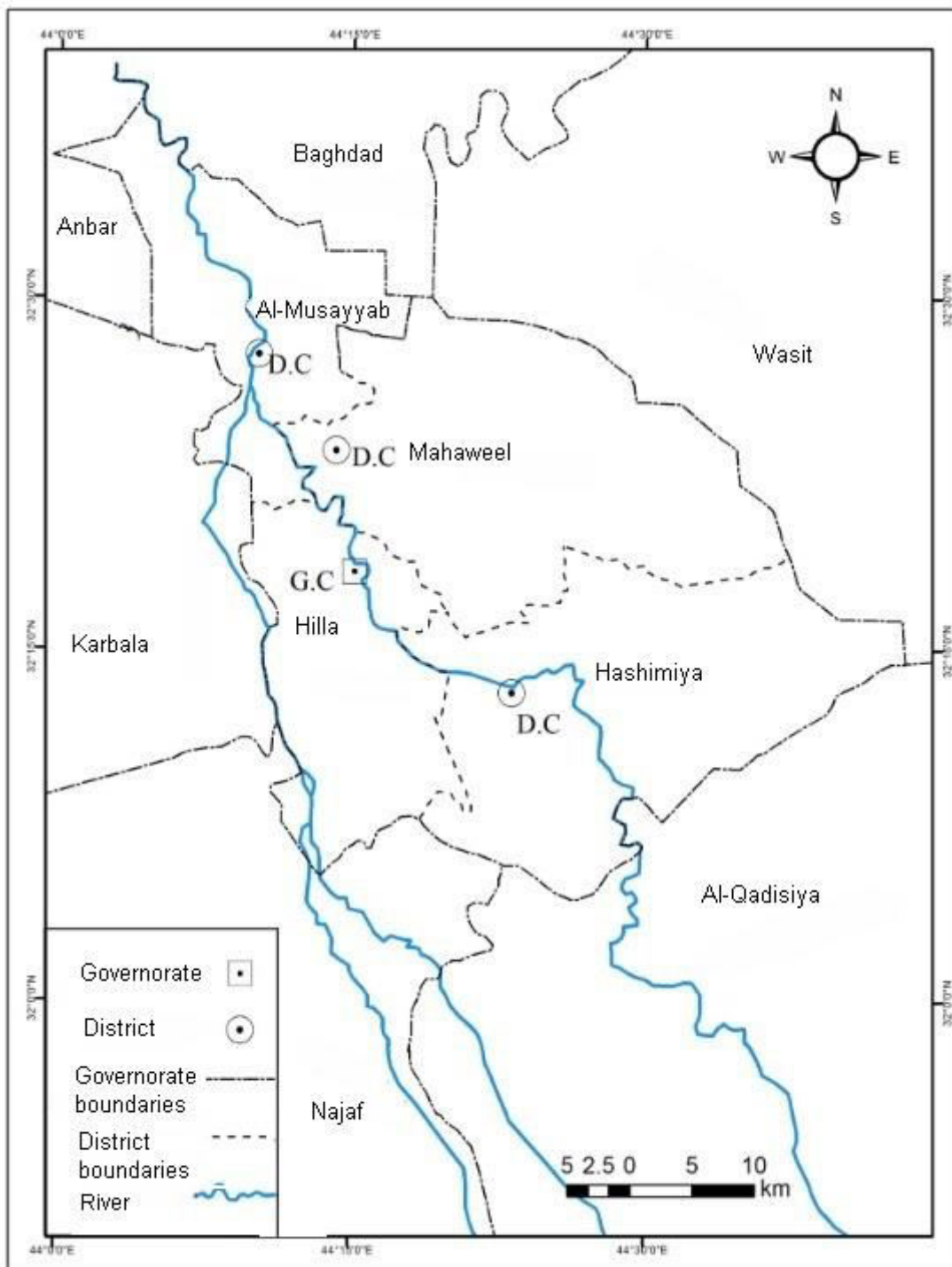
This refers to representation using geometric shapes such as points, circles, squares, triangles, or others. These geometric shapes may be replaced by pictorial representations depicting the phenomenon, or alphabetical letters may replace them. Maps drawn with these symbols do not indicate the relative importance of the phenomenon from one location to another. All symbols are symmetrical and do not differentiate between phenomena of varying importance. The map may show phenomena as equal in value, which is not consistent with reality, diminishing the value of these maps. However, they have their own importance in case of lacking quantitative data or when creating descriptive maps illustrating the geographic distribution of a phenomenon in the spatial extent shown on the map.

Despite not indicating the differences in importance and value of the studied phenomenon in all parts of the map, it is possible to distinguish between the same type within certain boundaries. For example, if the circle symbol is used to distribute urban centres on a map, it is possible to distinguish between the circles by drawing them solid, hollow, shaded, or coloured to differentiate between urban centres according to the established geographic criteria (Ziyadi, 1997).

**Map (1):** Spatial distribution of Iraqi governorates' centres using geometric symbols.



**Map (2):** Spatial distribution of district centres in Babylon Governorate using the literal symbol method.



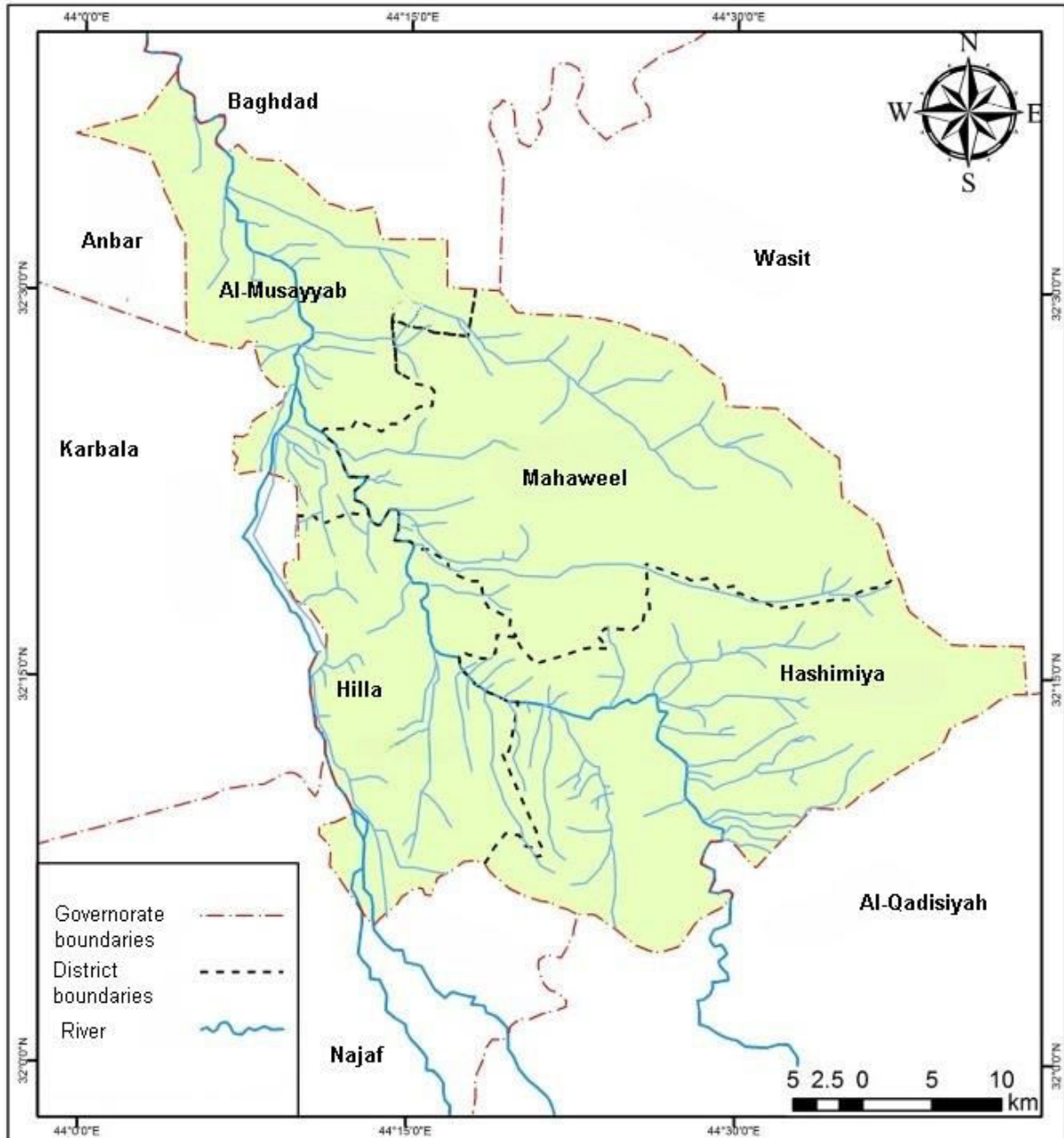
Source: Ministry of Water Resources, Directorate of Public Survey, *Administrative Map of Babil Governorate*, drawing scale 1:250000 for the year 2010.

Representation in the content of the map. This type of map can be of limited utility in most cases, as specifying the qualitative point location in the encoding of geographic phenomena on the map indicates only the location without demonstrating the actual or relative importance of this phenomenon. For example, when encoding industrial sites on the map, a similar symbol is given to them without distinguishing between large and small sites. The utility is limited to demonstrating the geographic concentration of the geographic phenomenon within the boundaries of a region or area, in addition to its usefulness when these symbols are overlaid with other distribution maps, whether with density maps or land use maps, which in turn display the characteristics of the represented place.

## 2 - Type-specific font symbol maps:

This is the method used to represent geographic phenomena with significant longitudinal extent while their latitudinal extent is limited to a few centimetres to a few meters, such as political boundaries, rivers, transportation routes, and communication lines. Maps using non-quantitative line symbols are among the most common types of distribution maps. It is rare to find a map devoid of political boundaries, rivers, or roads. A set of common symbols is used to illustrate these phenomena, which have become globally recognized due to their widespread use in geography. It is important to note that despite representing areas such as rivers and roads, this type of symbol, due to its small area, cannot be accurately depicted and translated on the map to scale and remains on the map as symbols.

**Map (3):** Water resources in Babil Governorate using type lines.



Source: The researcher, based on the Water Resources Directorate in Babil Governorate and the GIS10 program

## 3 - Qualitative cadastral shading symbol maps:

These maps are used to represent nominal and ordinal gradations of geographic phenomena by changing colour and pattern. Different colour shades or patterns with points or lines of varying density can be used to highlight land use patterns or soil patterns. As this type of map requires defining the distribution areas of species, it also indicates the areas occupied by each type. However, the focus of these maps is on depicting the types and distribution areas, but it does not negate their use in determining the areas occupied by each type.

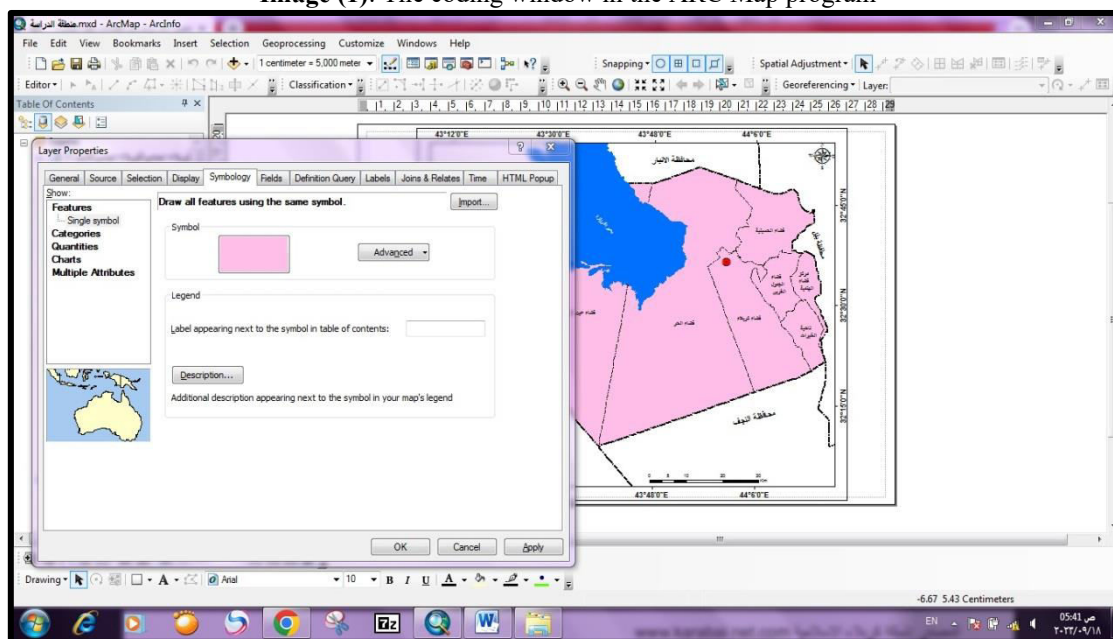
Several considerations must be considered when creating this type of map. Initially, the basic content of the map and its drawing scale must be determined. Then, information about the desired species to be represented is obtained, and a base map on which to represent the phenomena is prepared. The next step involves classifying the basic content of the map based on its primary content, where the main and secondary species to be represented on the map are classified. This classification is based on criteria established by the researcher, depending on the map's drawing scale, purpose, data accuracy, and diversity. For instance, if the drawing is at a large scale, more species can be represented, and vice versa. Furthermore, the map used for educational purposes differs in detail from the one used for research purposes.

Subsequently, information is obtained with precision, sourced either from satellite imagery, aerial photographs, larger-scale maps, or previous studies containing descriptions of the species to be represented. Fieldwork can also be utilized to determine the distribution of the species under study. Then, the boundaries of the species' distribution areas or phenomena on the base map are defined, and the colour code for each type of species is determined, or an appropriate colour gradient is specified for species sharing certain characteristics. The ultimate step involves creating the legend, which must include the same colours representing the species as those on the map. The symbol representing each type should be rectangular. The main purpose of these maps is to classify distributed phenomena on the earth's surface and determine the distribution areas of each classified species.

### Applying qualitative map coding within the GIS environment

Geographic information systems offer multiple forms of encoding, which are obtained by opening the ARC Map within the program and then opening a map that was prepared previously. Right-clicking on the name of the layer in the table of contents, and choosing from the Properties drop-down menu, the Layer Properties window appears. We choose the Symbology command, which is concerned with all symbols, both qualitative and quantitative, as all shapes appear and the first and second groups are used only for qualitative coding, and they are as follows: (look at image 1).

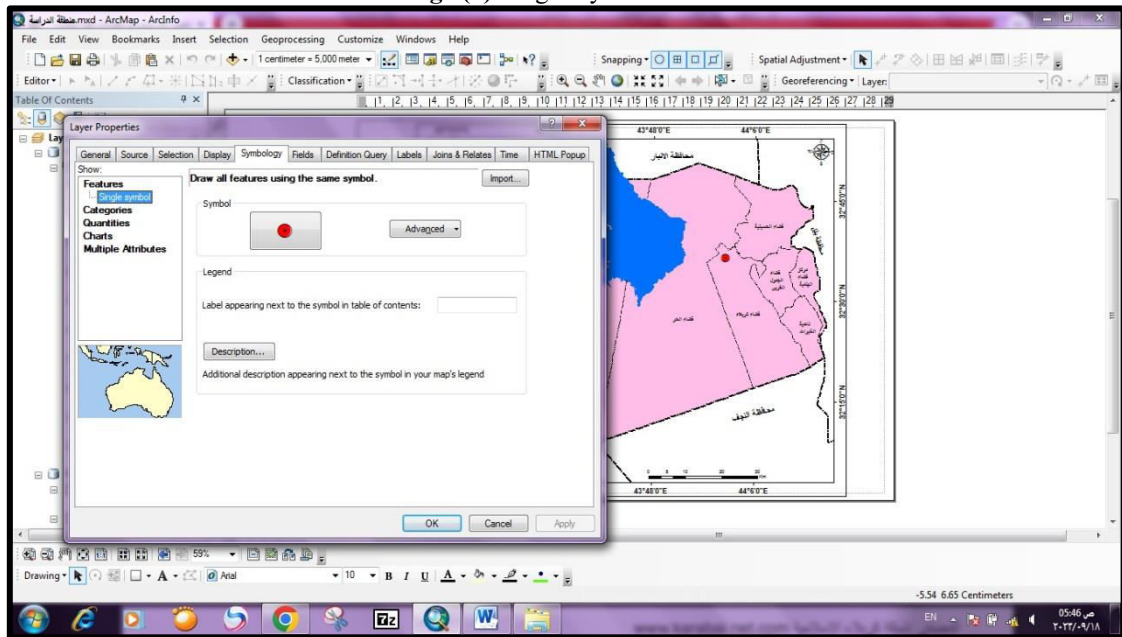
**Image (1):** The coding window in the ARC Map program



Features / which is the qualitative coding of features based on their names, types, or characteristics. It includes one type, see Figure (2), which is:

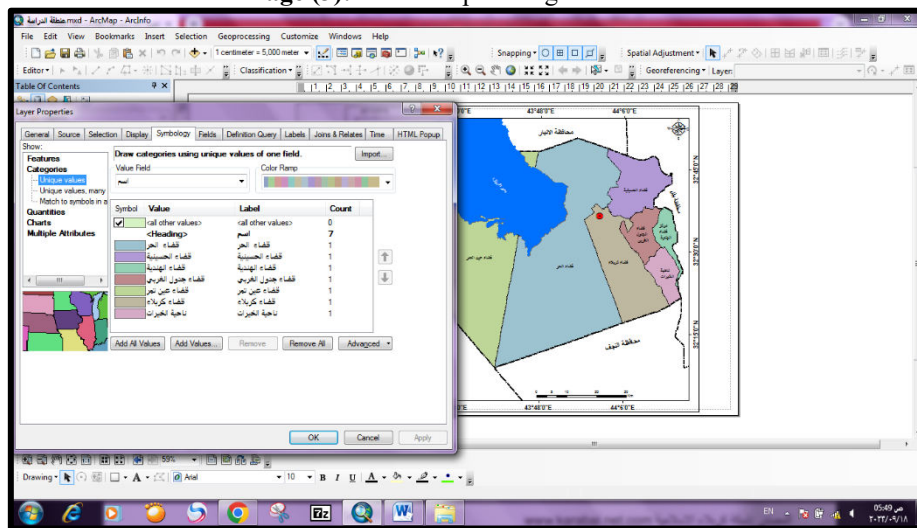
Single Symbol means a unified encoding of data. That is, all data within the layer is encoded with one unified code to represent a series of data within the map, whether that data is local such as schools, airports, or governorate centres, or linear such as borders, or railways, or is cadastral features such as bodies of water or desertification.

**Image (2):**Single Symbol window



Categories: It is a classification or categorical encoding of features based on the data entered in one or more fields within the class table. It includes three types (see image 3).

**Image (3):** The multiple categories window



Values / which is a categorical encoding of data. That is, giving a group of features a unified symbol based on the data entered in one of the layer fields.

Unique Values Many Fields, which is a categorical qualitative encoding based on encoding a number of qualitative characteristics of features based on a number of qualitative data from several fields in one batch, so that the first field is used to encode the feature while the other two fields are used to write an explanatory code next to the feature, such as writing the type of local airport. Or international and the date of its establishment, or the names of cities and their residents.

Match to symbol in a style Field Value to symbol in a style.Features in this type are encoded in a way that is consistent with the data recorded in the fields of the layer's table.

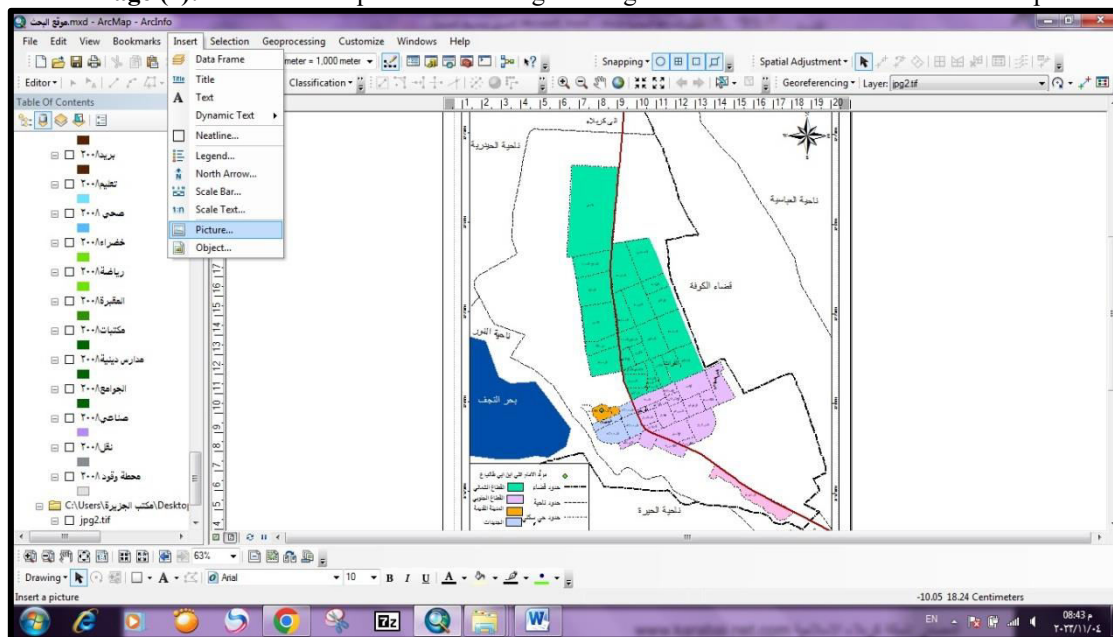
### **Cartographic Evaluation of the Efficiency of Geographic Information Systems in Coding Qualitative Maps**

The Geographic Information Systems (GIS) software provides users with the capability to choose various patterns of qualitative symbols to represent the type and extent of geographical phenomena, whether their extent is spatial, linear, or areal. Users can make various modifications to the symbols, such as changing their colour, size, position, or orientation, to align with the visual perception of the map reader.

Another significant feature is the ability to import symbols from outside the software and use them to represent the desired elements on the map. Users can add images from external sources by clicking "Insert" and selecting "Picture," then specifying the location of the element and selecting it.

However, a minor issue may arise regarding the selection of suitable symbols for the final map, considering their size, colour, and the phenomenon to be represented. This issue can be addressed using cartographic rules related to map design principles, including selecting appropriate symbols for their details. The purpose of design is to effectively convey information to the map user, considering all factors and conditions affecting it, such as the user's level of perception, the purpose of map usage, the complexity of its contents, available technical capabilities, costs, and other indicators.

**Image (4):** Illustrates the process of adding an image from outside the software to the map.



### Conclusions:

1. Geographic Information Systems (GIS) possess a significant capability in both qualitative and quantitative map symbolization.
2. The ArcMap interface within GIS allows the cartographer to control the style of qualitative map symbols, including their size, colour, and orientation, aligning with the map reader's perspective.
3. GIS capabilities extend beyond providing a suite of map symbols; a cartographer can import any other symbol from an external repository and modify its size and orientation as desired before pasting it into the map.
4. The availability of map symbol packages within GIS software does not eliminate the need for the cartographer to adhere to cartographic design principles. These principles remain fundamental for the scientific and accurate application of symbols, ensuring they suit the cognitive level of the map reader.

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