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The Importance of Cartography in Covid-19 Pandemic Mapping

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Abstract:

Humanity has struggled with various epidemics throughout history. People has faced many epidemics from past to present such as Athenian plague in 430 BC, black death (plague) in Europe in the 14th century, cholera epidemic in London in 1850, SARS in 2002, tuberculosis in South Africa in 2006, MERS in 2012, West African Ebola virus epidemic in 2014. In order to improve the management of prediction and early warning, response, recovery and risk reduction processes of the epidemics and pandemics, it is important to manage spatial, thematic and temporal data of the epidemics and to share them accurately and reliably with decision makers and citizens. Nowadays, the ease of producing and sharing causes some problems called viral map (Robinson, 2018), infodemic (WHO, 2020) and cartofail (Field, 2020), so cartographers think about these issues with great concern.

Max Eckert (1908) expressed the characteristics that should be on a map as being correct, complete, convenient for the intended use, clear, understandable, legible and 'good'. The concept of accuracy mentioned here refers to the semantic (qualitative-quantitative) accuracy and geometric (geodetic measurements, topographic measurements, map projection, drawing-screen resolution) accuracy of the objects. As stated by Eckert, maps are the complete products that convey a message and information with their own signs and symbols with abstract text information. Legibility refers to be read and understood. For improving legibility, it is recommended that to be used a subtle bounding box around the title and legend (Slocum, et al., 2008). Maps are prepared according to a predetermined intended use, a certain user group and usage medium. “Good” map is to reach the earth reality in the harmony of all these concepts. According to these concepts, visual variables (color, shape, size, direction, hue, texture) proposed by Bertin (1967) for the abstraction of the earth reality are widely used in the design of map symbols.

Map design process consists of abstraction and constraints. The power of maps comes from cartographic abstraction. Abstraction includes generalization and symbolization operations, while constraints include conceptual (symbolization) and mechanical constraints (Buttenfield & Mark, 1990). Map design issues also include aesthetic concerns. Aesthetics expresses the realization of reality with art (Ziss, 1977).

User-specific features such as age, gender, education, expertise, cultural background that affect the use of maps are the primary elements to be considered in map design (Keskin et al., 2021). The design of a map that will contain optimum information on the small screen (navigation, mobile phone, tablet, watch) is a process that requires “special cartographic expertise”.

Cartographic model theory describes the processes of visualization of earth reality. It aims to create the primary and secondary models for earth reality. The primary model (digital landscape model) is created with the abstraction of earth reality by topographic and thematic measurements, and the secondary model (digital cartographic model) is created with the processes of symbolization and cartographic generalization. Model generalization refers to a set of database operations, while cartographic generalization refers to a set of visualization operations. In the model generalization phase, data sets with lower geometric, semantic and/or temporal resolutions are derived from the base data set. The number of attributes of the object is reduced by the semantic simplification process. The number of attributes of the object is reduced via semantic simplification process (Dogru, 2009; Mackaness & Chaudhry, 2008). Cartographic generalization operations include operations such as simplification, exaggeration, elimination, amalgamation, aggregation, displacement. Different generalization operations are applied at different scale/purpose levels.

Maps can get abstracted information that cannot be understood with words, numbers, tables or graphs at a glance. In this respect, it can be said that it is more powerful than numbers and words (Coltekin et al., 2021). Using the combination of visualization methods used for creating thematic maps (various graphic symbolizations) helps decision makers or users to make inferences quickly and easily. However, complexity and cognitive overload issues should be considered (Mocnik et al., 2020). Qualitative and quantitative researches should be done on whether the user perceives correct and sufficient information.

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Choropleth maps and proportional symbol maps have been extensively used throughout Covid-19 pandemic. The reason of this users can better understand the choropleth maps (Roth et al., 2020) and geographic information system and visual analytics tools can automatically produce these maps easily. However, in this case, the relationship between other attribute values related to the data cannot be examined. These values are usually obtained with "retrieve" feature of interactive maps. For example, with the number of cases and deaths, other values related to citizens such as income, age, disability status, chronic diseases, living alone or with someone and immigrants, travellers/tourists should be examined together. The relationship between the attributes can be examined by using various graphic symbols with the combination of spatial data. Nowadays, single subject maps (intermediate product) are produced instead of complex (interrelated/multi-purpose) maps. However, since the data is multi-purpose, interrelated, and multi-thematic by its nature, research on complex maps (end products) that are easy and fast to understand should be concentrated (Uluğtekin et al, 2003; Uluğtekin et al., 2011; Uluğtekin et al, 2013; Uluğtekin & Atalay, 2021).

Some problems are encountered when Covid-19 maps examined such as using incorrect proportional maps and heat maps, choropleth map generation without normalization, misclassification/grading on choropleth maps, incorrect and inconsistent use of scales and units, use of crowded and mixed point density maps (Mooney & Juhász, 2020). Mocnik et al. (2020) stated that visualizing space, time and numbers simultaneously is the key to understanding an epidemic. In addition to using maps as only a geometric base, it is also possible to create a comprehensive mental map for the user by making use of the power of visualization. Citizens and decision makers have benefited from maps during the pandemic in areas such as tracking case-death numbers, trace-tracking applications, tracking the number of vaccinations, learning the number of hospital-bed-personnel, learning about vaccine application points, mask distribution points and quarantine processes. However, they encounter different web pages and different data for each of this information. This situation creates doubts about the accuracy of the data. In this context, it can be said that the problems related to pandemic maps are not only related to visualization.

Even if the data comes from a common spatial data infrastructure, generalization of the incoming data for different scale levels, screen sizes and user characteristics etc. are issues to consider. Within the scope of this study, the cartographic tools and stages required for fighting against the pandemic for the case of Covid-19 will be emphasized. Although map design and production approach, which is described as “carto-democracy” today, should be replaced by tools that have been produced in a multi-disciplinary manner by discussing with experts (epidemiologists, economists, etc.) and giving more importance to map design, which is “cartographers’ area of expertise”.

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