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Commentary

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Mapping COVID-19: How web-based maps contribute to the infodemic

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Abstract
A proliferation of web-based maps have appeared depicting many different aspects of the spread of the novel coronavirus (SARS-CoV-2). In this commentary, we consider the usage of web-based mapping during the COVID-19 pandemic and argue that web maps have been widely misused for delivering public information on this fast moving, epidemiologically complex, and geographically unbounded process.

Keywords
COVID-19, infodemic, misinformation, pandemic, web mapping

Introduction

In this commentary, we examine the use of web-based mapping during the first few months of the global coronavirus pandemic (SARS-CoV-2/COVID-19). Our specific conceptual contribution arises from our view that web-based mapping and related cartography have been widely misused. The flexibility, dynamism, and ease of creation inherent in today's web-based mapping architectures have seen these digital maps become part of the 'infodemic' during the COVID-19 pandemic. The World Health Organization (WHO) warned that the COVID-19 pandemic 'has been accompanied by a massive "infodemic"—an overabundance of information—some accurate and some not', making it very difficult for people to access trustworthy data sources and reliable information as required (WHO, 2020). We argue that web-based maps are not bad tools but become cumbersome instruments when used incorrectly, widely, and without consideration for the underlying data, models, processes, and basic cartographic principles. Ash et al. (2018) challenge thinking about ways in which digital technologies, such as web-based maps and associated platforms, reshape geographies and mediate the production of geographical knowledge.

The complex epidemiology of SARS-CoV-2/COVID-19 varies widely and is still not fully

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understood, making provision of information challenging. This originates from many factors: geography, socio-demographics, cultural aspects, political decisions, and non-pharmaceutical interventions such as 'lockdowns' based on public health and economic constraints. Widely available software to create web-based maps is very user-friendly and has no prerequisites of cartographic or Geographic Information Systems (GIS) skills. This can exacerbate the spread of maps of questionable quality on the Internet. Mapping health and epidemiological data is not straightforward (Carroll et al., 2014). Even simple health data can be collected, analyzed, and visualized in different ways; however, geography has evolved into a data-driven field over recent years (Miller and Goodchild, 2015), which is able to deal with understanding and visualizing such complex issues.

Web-based maps: An emerging tool for information dissemination and storytelling in the digital age

Web-based maps are online mapping platforms allowing geographical data to be overlayed onto digital maps. These maps are embedded into webpages or applications and are interactive (offering zoom, pan, selection, etc). The last two decades have seen the emergence of a new era in mapping (McQuire, 2019). Online maps are now capable of offering multiple features and services by bringing many traditional GIS functionalities to the web-browser.

Increasingly, web-based maps are being used by online news media. Usher (2020: 250) introduces 'digital news cartography' where 'maps are visual representations of complicated databases turned into geographically distributed, clickable, and even customizable, knowledge'. Design choice facilitating clear and effective communication of the underlying data is a principal challenge in web-based map design. As Monmonier (2018: 205) emphasizes: 'if not harnessed by someone who is knowledgeable and with honest intent, the power of maps can get out of control'. The advent of web-based mapping can also be seen as the democratization of cartography, putting maps and mapping capabilities into more people's hands. According to Crampton and Krygier (2005), the shift from traditional cartography to the decentralized Internet makes maps an even more powerful tool since using maps to support claims is no longer the privilege of professional cartographers and academics alone anymore. The power of maps originates from people's trust and the tendency to naively accept them as truth (Monmonier, 2018), which is dangerous in an era of fake news.

Illustrating web-map usage during the COVID-19 pandemic

Spatial epidemiology widely regards web-based maps as an excellent tool for analyzing the spread of infectious diseases as well as public information. However, the complexity of disease data has the potential for misinterpretation and cognitive overload (Carroll et al., 2014). Even well-intended maps can suffer from the 'data rich but information poor' (DRIP) syndrome if map-makers try to carelessly crowd too many resources into one interface. Maps sometimes corresponding to different spatial units and referring to different aspects of the pandemic—infection rates, testing sites, population dynamics—can easily overwhelm casual users.

We are not designating web maps as the tool of choice for those circulating 'alternative facts'. Rather, poor design and deployment of web maps often inadvertently create misinformation and opportunities for misinterpretation. Below we list some of the most common issues associated with web maps used in COVID-19 information dissemination, such as:

- Incorrect and inconsistent scales and units of aggregation being used.
- Incorrect use of bubble charts and heat maps.
- Overly crowded dot/pin maps indicating COVID-19 cases or medical facility locations.
- Poorly graduated or classified choropleth maps.
- Predominant usage of choropleth mapping over other suitable forms.
- Maps without normalization.

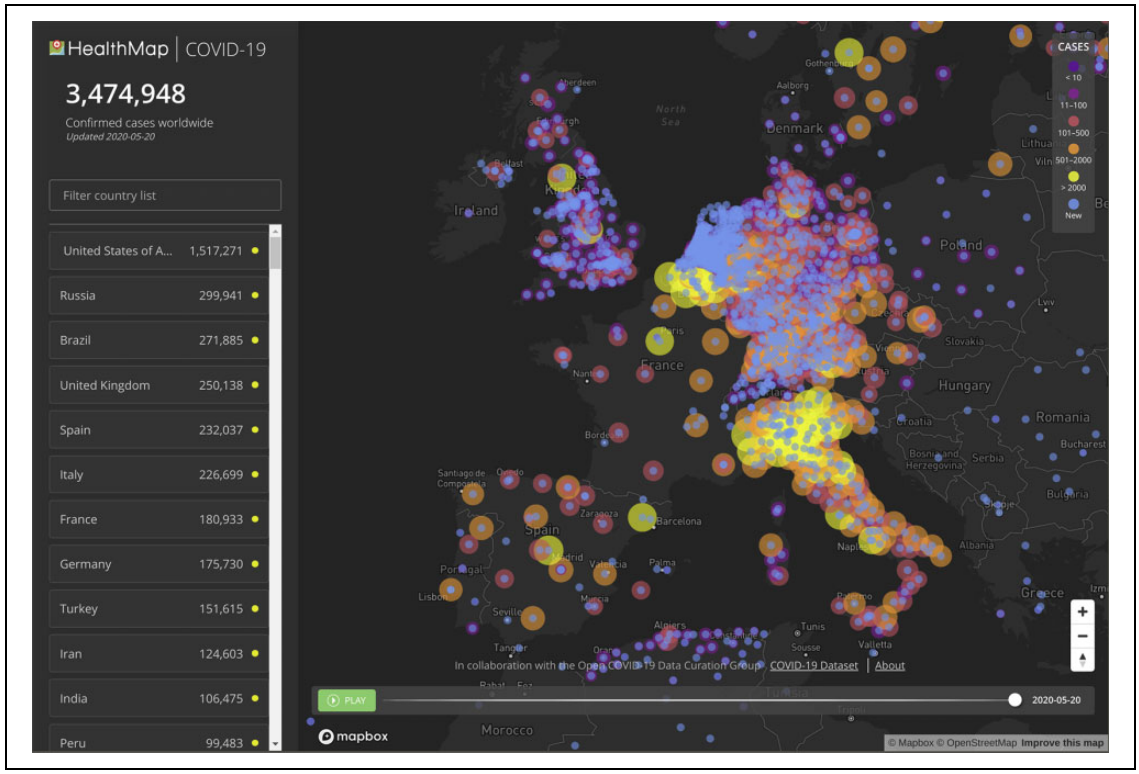

Figure 1. COVID-19 cases as seen on HealthMap. Inconsistent use of spatial aggregation across countries gives a false impression of the virus' spread.
Source: HealthMap (https://www.healthmap.org/covid-19/).

- Maps lacking the representation of uncertainty.
- Ineffective representations of the temporal dynamics of the spread of COVID-19 due to the complexity of epidemiological models.
- Maps designed for global audiences should use global data. However, this diminishes the impact for local audiences.
- Overall poor map design, in general.

Most maps we currently see are affected by one or more of these issues. As an example, Figure 1 plots inconsistently aggregated data on the same map, rendering visual comparison of different areas misleading: Italy and Spain are similarly affected (both have around 230,000 confirmed cases at the time of writing) but appear differently on the map. Also, methodological uncertainty is not represented in this map, as in the case of Hungary and Slovakia that do not appear to have COVID-19 cases on the map. Figure 2 features a choropleth map presenting absolute numbers without normalization; it therefore ignores both the modifiable areal unit problem and population structure/dynamics. Additionally, the color choice (red–blue) is questionable since people respond to certain colors emotionally (Monmonier, 2018), which may affect the dissemination of factual information about the COVID-19 pandemic.

The issues outlined above are not specific to web-based maps since traditional maps displayed online as static images can suffer similar problems. As far back as 2000, Dodge and Kitchin (2000) cautioned both unwary map designers and map users to actively and reflectively consider maps found online. Drawing meaningful conclusions

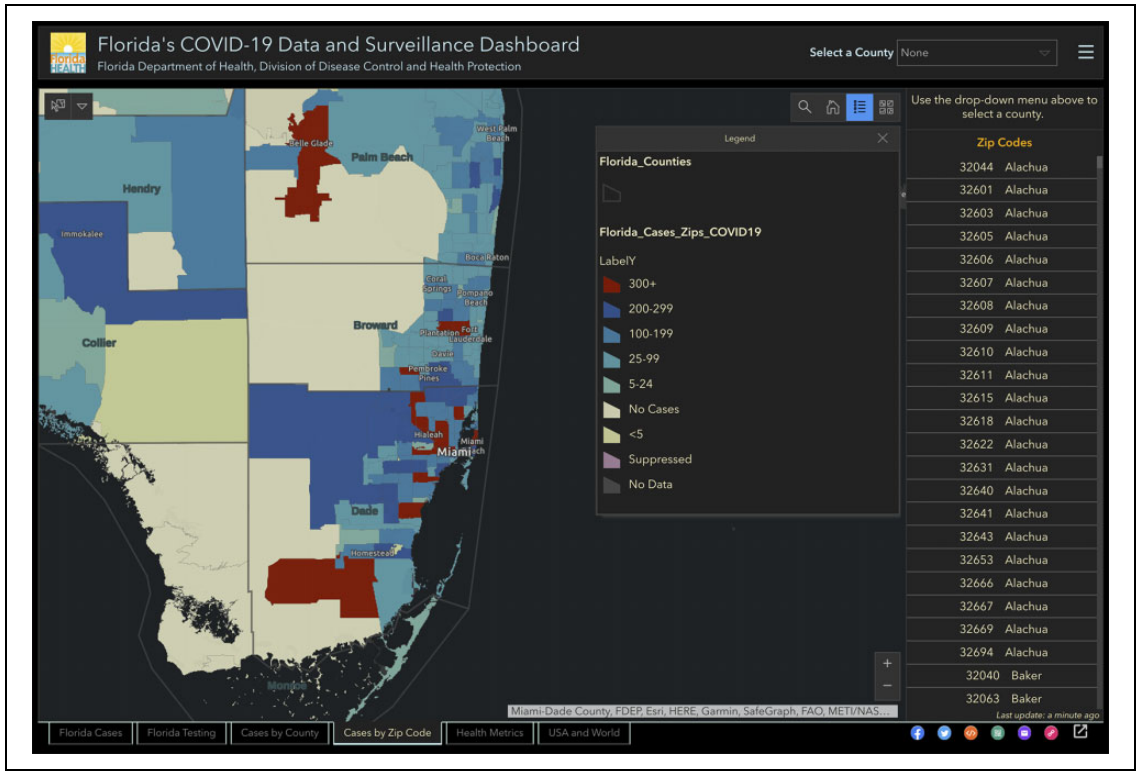

Figure 2. A choropleth map by the Florida Department of Health plots absolute case numbers per ZIP code without normalization and uses 'emotional colors'.
Source: Florida Department of Health on their COVID-19 site (https://floridahealthcovid19.gov/)

from today's coronavirus-related maps depends on how effectively a map presents its intended information in simple visual ways. The ability to do so is greatly diminished in most web-based maps and applications aimed toward disseminating knowledge about the pandemic. Maps also have the potential to 'go viral' on the Internet, subsequently aiding misinformation and 'alternative facts' as has already happened with a map illustrating global air traffic. After being taken out of its original context, headlines appeared such as 'New map reveals no country safe from coronavirus tentacles' and 'Terrifying map reveals how thousands of Wuhan travelers could have spread coronavirus to 400 cities worldwide' in various news outlets (BBC, 2020). While these statements proved to be correct as the pandemic unfolded, this incident illustrates how attracting attention and promoting an idea with an unrelated (or even intentionally misleading) map is not far-fetched.

The future of web-based mapping in the infodemic-pandemic

Most people consulting coronavirus-related maps do so in a search for understanding, reassurance, and maybe even some good news. Since the expectations of users are always evolving, there is a 'constant need for map designers to effectively test and assess the usability of their products and services' (Li et al., 2017: 820). Humprecht and Esser (2018: 516) conclude that online news media 'are not tapping their digital potential to increase understandability of their news content'. This void includes

web mapping and visualizations, driven by commercial pressures and resource issues.

Perhaps now is a good time to revisit guidelines for the use of maps in journalistic contexts (e.g. Monmonier, 1989, 2018). As for the coronavirus pandemic, more interaction between health and government officials, geographers, the geospatial community, and data visualization experts/data journalists to develop guidelines for communication with web-based maps might be the way forward to ensure that web-based maps realize their potential. This aligns with Kitchin et al.'s (2013) public geography which has established itself as a legitimate and valuable form of geographical practice encouraging direct and sustained social engagement with the community.

Are web-based maps the right tool for the task at hand—informing the public in near real time of the global, national, and localized pandemic spread of the coronavirus? There are numerous mathematical models predicting COVID-19 cases and mortality, and generating estimates of R_o, the reproductive rate of the disease. These models often involve differential equations or stochastic frameworks, meaning they are beyond the expert comprehension of most people. How to deliver this information effectively within the constraints of the web-based map is a very difficult question requiring urgent attention. Many of the maps produced during the COVID-19 pandemic appear different or even contradictory. While there are multiple ways of geographic storytelling, we feel that this multiplicity may well fuel the WHO's infodemic concerns. Depoux et al. (2020) suggest that the social media panic created by COVID-19 travels faster than the virus itself and operational tools (e.g. dashboards, real-time web-based maps) are needed to combat this. We believe that careful geographical work combined with well-designed, web-based maps can become a targeted response to the COVID-19 'infodemic' into the future.

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