

# Making vivid maps: expressive geovisualization for representing spatial vulnerability

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## Abstract:

Our world has been deeply disrupted by public health crises, including the COVID-19 pandemic and the spread of other significant infectious diseases like Ebola and SARS. Epidemic outbreaks around the world present a major challenge that requires collective effort to monitor, respond, and recover. A major focus in the science of disease dynamics is on the development and deployment of effective visualization, as it can help communicate specialized knowledge to key audiences through visually accessible information (Carroll et al., 2014). As a result, map dashboards and other means of visual communication are commonly used to highlight and explain spatial patterns of areas vulnerable to an outbreak.

In cartography, maps are commonly regarded as rhetorical devices that can be used to produce, persuade, and communicate narratives and emotions through the visual design of spatial data (Caquard & Griffin, 2018; Roth, 2021). While the existing literature on spatial vulnerability has increasingly recognized cartographic visualization as a desirable tool for disaster planning, decision-making, and mitigation (De Sherbinin et al. 2019), few articles have centred on designing vivid cartographic symbols to amplify spatial vulnerability. Vividness in cartography offers mapmakers and researchers a new mean to describe and evaluate compelling and persuasive map designs (Fish, 2021). We also need to know more about how such representation choices influence the quality and efficacy of visual communication, to understand their impact beyond regarding them as merely an end state of vulnerability analysis.

In response to this research gap, we propose new methods to amplify the vividness of spatial vulnerability, using an approach we call Expressive Geovisualization (EG). The leading principle of EG is to make data representations intentionally persuasive based on amplified realism. This approach answers the call to design spatial representations that implement cartographic vividness (Fish, 2021). Our approach for EG in the context of infectious diseases modifies geospatial thematic layers visual effects, and colour blending modes (Figure 1) to make spatial data about the spread of disease look like an actual infection. We also demonstrate how point symbology can be made expressive in this context through the use of pictographic icons that look like virions (Figure 2). The goal here is to see to what extent we can amplify aspects of realism with the goal of thereby increasing vividness in maps. In theory, amplifying vividness can improve the visual impact and memorability of what people see in our maps. We draw upon earlier work here that focuses on style development in cartography (Christophe et al., 2016), visual effects in game design (Corredor et al., 2014), embellishment in visualization (Bateman et al., 2010), and the use of skeuomorphism in user interfaces (Shen et al., 2024).

We propose reproducible specifications for our method based on the assumption that we will have aggregated point data that can be represented using hexagonal tessellations with a Discrete Global Grid System (DGGS).

To evaluate this new approach, in future work we will examine whether EG designs influence 1) map reading and 2) affective responses to synthesized vulnerability maps. We will develop synthetic stimuli and gather results from a controlled user experiment with a series of map reading tasks and survey questions. Our analysis will help us explain the potential opportunities and pitfalls associated with the use of EG vulnerability representations versus more traditional cartographic design approaches. Finally, we will conclude with suggestions for the next steps to implement and extend EGs in other contexts.

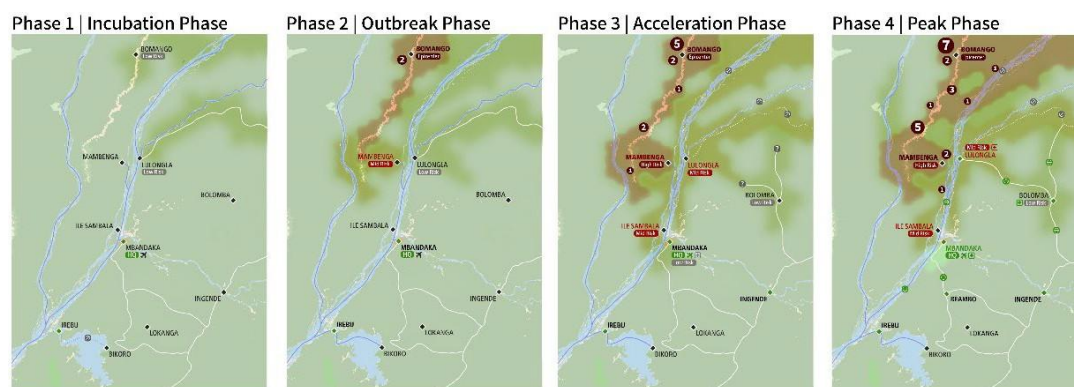


Figure 1. A set of images that mimic the dynamic phases of a disease outbreak with color blended thematic layers.



Figure 2. Examples of proposed skeuomorphic proportional symbols for an active disease situation.

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