Dashboards – new tools of cartographic communication

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1. Introduction

Dashboards are single-screen visualization systems, where various critical pieces of information are placed in the form of panels. They allow the user to take a shared view on a given dataset. Although dashboards can include not just text, charts and graphs, but also webmaps, their potential in terms of highly interactive, explorable visualizations for cartographic concerns in a narrower sense has not been investigated yet. In this article, we discuss the applicability of dashboards for representing large volumes of sensitive point data. Our aim is to demonstrate how cartographic dashboards facilitate spatial insights and visual analysis. We also touch upon the challenges faced by cartographers when creating complex dashboards. Although there are many open-source and commercial platforms available to create dashboards, we will take most examples here from ESRI's ArcGIS Operation Dashboards web application. However, our findings should be general enough to apply also for other spatial dashboard applications independently of the concrete frontend chosen.
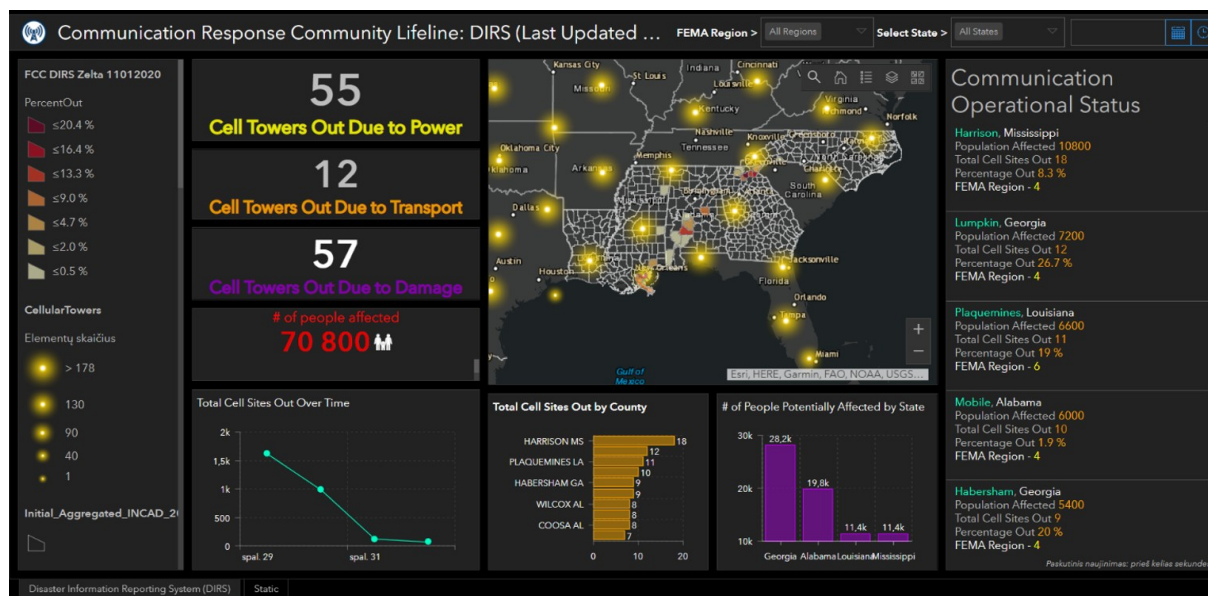

Fig. 1. Sample map dashboard with typical elements (URL 1: Federal Emergency Management Agency, 2021)

2. Dashboards – types and examples

Dashboards are configurable web apps that allows to use charts, gauges, maps, and other visual elements to reflect the status and performance of assets, personnel, services, and events in real time, thus facilitating status monitoring, trend visualization and decision making.

Dashboards are composed of synchronized configurable elements, such as maps, lists, charts, gauges, and indicators, and occupy 100 percent of the application browser window. These components can be stacked or grouped together in various ways to provide intuitive and easy access to geodata for a wide range of purposes:

- *strategic* – dashboards help executives track key performance indicators (KPIs) and make strategic decisions by evaluating performance based on their organization's goals. An example of use is the „Arkansas Crash Analytics Tool" (URL 2), which helps to improve the possibilities of real-time data submission, their accuracy, accessibility and integration into the solution of road traffic problems. It allows to exchange data between different institutions and perform analysis in order to identify the main accident sites, problem areas, noticeable trends;

- *tactical* – dashboards help analysts and line-of-business managers analyze historical data and visualize trends to gain deeper understanding. An example of use: „West Virginia Controlled Substance Monitoring Program 2014 to 2019" (URL 3). The West Virginia Board of Pharmacy (BOP), in collaboration with the West Virginia Department of Health and Human Resources (WV DHHR), Office of Maternal, Child and Family Health (OMCFH), Violence and Injury Prevention Program (WV VIPP), has conducted surveillance using data generated by the Controlled Substance Monitoring Program (CSMP). One of the main purpose is to present data in visually and simple way, with possibilities of analyse. In case, this will provide opportunities to conduct further research/analysis on certain topics of interest, determine high-risk areas in the state, and provide appropriate prescriber education and intervention;

- *operational* – dashboards help operations staff understand events, projects, or assets by monitoring their status in real time. An example of use – „Communication Response Community Lifeline: DIRS" (URL 1). DIRS is a voluntary, web-based system through which the Commission collects operational status and restoration information from communications providers during major disasters and subsequent recovery efforts. DIRS provides communications providers with a single, coordinated, consistent process to report their communications infrastructure status information during disasters. Dashboard represent real-time information and helps make quick decisions to solve the problems;

- *informational* – dashboards help organizations inform and engage their audiences through community outreach. An example of use – „NFL Super Bowl LV – 2021" (URL 4). NFL Super Bowl LV is the championship game of the National Football League (NFL), the highest professional level of American football. The dashboard shows matches that have taken places, provides statistical information about the winners and losers of the cup, and currently provides information about COVID-19 cases among the players.

3. Dashboards in crime geography

Crime geography is the study of the territorial differentiation of crime and the connections between geographical conditions and the level of crime in territorial systems of different taxonomic rank" (Бадов/Badov, 2009). The history of crime geography begins in the early 19th century in France (Balbi & Guerry, 1829) and Belgium (Quetelet, 1835), while geographers get involved into crime geography only in the second half of the 20th century (Harries, 1971, 1974; Pyle et al., 1974). For a long time crime analysis includes intelligence crime analysis, forensic

crime analysis, strategic crime analysis. However, crime mapping and spatial analysis supplement all of them thus allowing for a better understanding not only of the phenomenon itself, but also to solve a crime. Dashboards support all of these goals and are therefore increasingly applied to crime investigation and the visualization of crime data:

- The Jacksonville Sheriff's Office uses dashboards for crime analysis (URL 5). Firstly, a map provides a spatial overview of all Incidents, Arrests and Field Interviews of the last 12 month; data shown in this map is updated on a daily bases. Secondly, the map filters "shotspotter calls" and crimes occurring near any police camera. Filters can be applied for various distances around each camera and analysts can review video feeds for potential security issues. Additional dashboards, like the "Calls for Service Dashboard" map current/active calls in Jacksonville while the "Violent Crimes Dashboard" shows violent and firearm-related crimes regarding the spatial distribution.

- Houston Police Department is another agency relying on dashboards for crime visualization and analysis. There are overview dashboards displaying all events in real time, including statistical information. It also provides tools to filter crimes by type, specific area, and so on. The online map and the graphs are interactive and interconnected (URL 6).

The increasing application of dashboards for crime visualization and analysis is driven by several advantages:

- dashboards are easy to understand – dashboards are visual displays that present data in an easy-to-read format. All relevant information can be seen on a single screen, facilitating understanding quickly and easily;

- interactive – help each person answer questions and solve problems by giving users a tool they can interact with. Dashboard elements are linked, providing dynamic results as users explore any data;

- integration – integrate with other ArcGIS Online tools and applications, also there is the ability to add links to other desired web sites;

- simplicity – dashboards can be realized at a low cost of time and labor

- various devices – dashboards can be viewed on a computer, a mobile device, and so on. This allows you to reach a wider audience;

- real-time information – it is possible to update data in real time thus providing the most recent information.

4. Crime event data registered by the police of Lithuania

The Register of Events Recorded by the Police (RERP) collects, accumulates, processes, systematizes, stores data and provides natural persons and legal entities with information and documents submitted. It is important to note that the events recorded in the RERP are, in legal terms, not crimes, but only events with the characteristics of a criminal offense. RERP general provisions state that data are provided to the register not only by police officers, but also by victims, health care workers or other persons who have seen incidents. „The objects of the register are criminal offenses, other violations and events of law, which investigation is entrusted to the police, also persons brought to police detention and closed". This definition at the same

time helps to understand what events are recorded by the police. These are criminal offenses, other violations of the law and incidents whose investigation is assigned to the police by law.
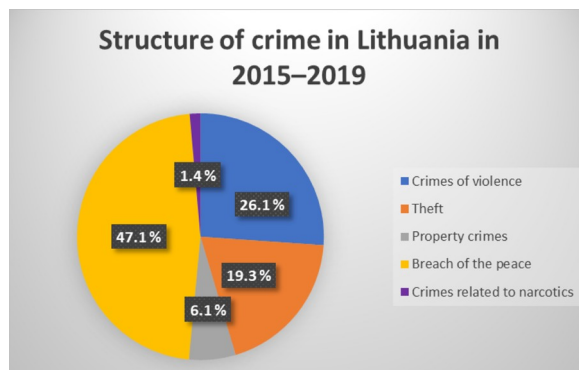

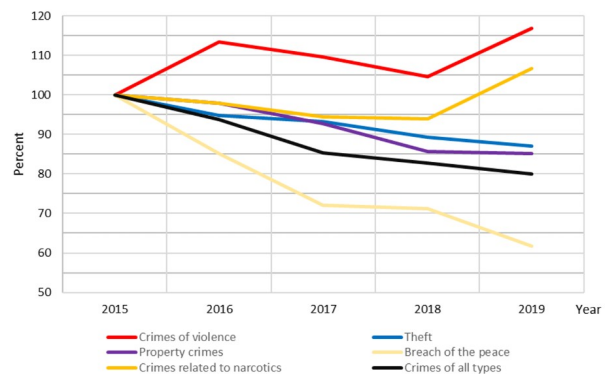**Fig. 2.** Structure of crime in Lithuania in 2015–2019

Fig. 3. Crime in Lithuania between 2015– 2019

In Lithuania, crime geography often used spatial data based on the RERP, which presents information in a raster (grid) and vector (point objects) format. This database is simplified and provides only the most important information for spatial research: address of the event location, geographical coordinates, event type, time, etc. A total number of 3,45 million events has been recorded for the period of 2015–2019.

5. Case study – spatial dashboard for crime data

Currently, an application is being created for the cartographic presentation of crime in open spaces on the internet maps of the Vilnius City Municipality. Five tasks are set to achieve the goal of investigating ways and possibilities of mapping crime:

1. Get acquainted with the concept of crime and crime in open space.
2. Analyze the data of events registered in the open space by the police.
3. Review research on open space crime in other countries.
4. Apply methods of spatial data analysis and generalization; prepare data for cartographic web presentation to Vilnius City Municipality.
5. Create online maps and make their primary estimation.

Various methods will be used to perform the work: analysis of literature, linguistic (verbal) analysis, quantitative analysis, statistic analysis, cartographic analysis. Our main goal is to propagate use of different cartographic methods for representation of crime. The following possibilities for the user will be presented:

1. Filter data by specific area, event types and date.
2. View aggregated data on supplementary charts and graphs.
3. Integrating dashboard into additional cartographic products.

We expect these dashboards to facilitate insights into particular trends of spatial distribution and dynamics of crime. Not only the application with several dashboards can be used as an analysis tool for specialists with advanced knowledge in GIS and cartography, but also as a free and highly accessible tool for the society to explore the data. In both cases, similar answers

are sought for: What is the level of crime near the place where I live? Where is the rate of crimes particularly high or low? How differ patterns of crime over different territories? Having even tentative answers will contribute both to increased safety and a higher sense of security.

6. Discussion and further research

Maps are a great tool to communicate spatial information. Combing maps with additional methods of data visualization can take this communicational power even a step further. Dashboards allow to combine several ways of presenting information into a single application, which makes it a top-candidate of dynamic data representation. Together with other webmapping formats like story maps or atlas-like narratives we can integrate the obtained results with descriptive information, which makes it easier for the user to understand the information and allows us to reach a broad public. Web maps are easily accessible and their interactivity is engaging, so that users can feel like map makers or analysts, changing visualization parameters by clicking only one button. The ability to select display methods, relevant data or the desired area expands the use of the application.

Dashboards are composed of configurable elements, such as maps, lists, charts, gauges, and indicators, and occupy 100 percent of the application browser window. Elements can be stacked or grouped together in various ways. Dashboards are created to be intuitive and easy to understand by different types of users, and not only by GIS professionals. Like every tool, also dashboards come along with advantages and disadvantages, where future research is necessary, e.g. on use and usability of the different components and methods that define a given dashboard, or on the integration of dashboards with other communication formats. Also the use of dashboards in an offline environment is an open question of research.

In a nutshell, I wanted to point to the potential of dashboards for cartographic purposes. Using the example of crime mapping, I tried to show how specialists of different disciplines can use this visualization method to display, analyze and communicate spatial data.

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