Visualization of Spatial and Temporal Pollution Exposure through a Temporal Ordered Spacial Matrix

D. R. Wootton[1] , P. Goffin[1] , and M. Meyer[1]

[1]University of Utah Salt Lake City UT, United States

Abstract

Poor air quality impacts public health due to increased incidences of serious health conditions; yet the data obtained about pollution is recorded at coarse resolution. Such resolution fails to capture known microclimates of air pollution and can pose a health hazard to individuals of sensitive groups when outdoors. AQ Route Explorer is a tool that visualizes spatial and temporal pollution trends for a given path of interest, helping people to make more informed personal health decisions.

CCS Concepts

• ***Computing methodologies*** → *Visualization;*

1. Introduction

High concentrations of fine particulate pollution (PM 2.5) is hazardous to human health. Continued exposure to pollution can lead to a variety of health effects: stroke, heart disease, cancer, and respiratory diseases [XXSL16] . These health effects can be particularly problematic for sensitive groups who are recommended to reduce the duration of their exposure to the outdoors [EPA, EPA16]. These recommendations are often made for large areas and do not account for known microclimates in pollution [BEP10] — possibly providing unsafe or inaccurate information to sensitive individuals.

In order to increase accessibility of air pollution data to the public, we present AQ Route Explorer, a tool used to visualize the spatial and temporal distribution of pollution along a route and compare it with other routes. This tool allows users to interact with their pollution exposure and understand how different routes would change their personal exposure. Such information can enable sensitive groups to circumnavigate polluted areas and make better informed health decisions.

2. Related Work

The creation of AQ Route Explorer extends previous work on visualizing multivariate geographic data. Our tool implements a similar design to Oceanpaths [NL15], a tool for analysis of multivariate oceanography data. Oceanpaths uses a map and an analysis interface. Its map interface allows a user to draw a path on a map. Along the path, points are interpolated and data is then visualized on an analysis view in the form of a scatterplot network, conveying attribute information such as ocean depth. AQ Route Explorer's map interface uses a similar map interface (Figure 2B); however, the Analysis View is extended through the use of an Overview Pane (Figure 2C) and a Drill-Down View (Figure 2D).

The Overview Pane is differentiated through the use of a Temporal Ordered Spatial Matrix (TOSM) as presented by Kraak and Vlag [KV07]. Through reducing spatial dimensions into a single dimension ('distance along the path' rather than Latitude and Longitude), TOSM allows for the encoding of time using position and an attribute of interest (e.g. pollution concentration) using color. This forms a sheet of rows and columns as seen in Figure 1. We employ linked highlighting and a scented widgets slider [WHA07] to improve the accessibility of this technique.

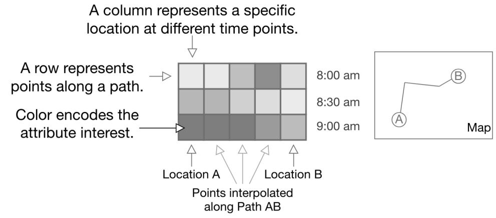

Figure 1: *Diagram of the TOSM Visualization.*

Our work builds upon the contributions of these works by use of unique highlighting mechanism for TOSM as well as demonstrating interaction techniques that allows for the use of TOSM to compare paths.

DOI: 10.2312/eurp.20191156

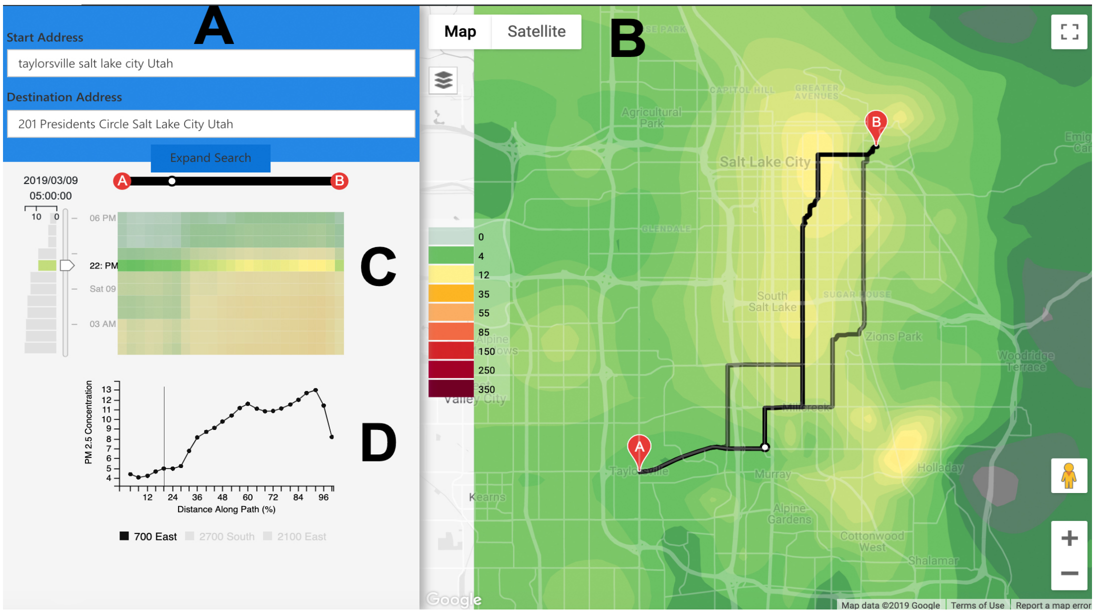

Figure 2: *Overview of tool components. A. The Route settings. B. The Map Component. C. The Overview Pane. D. The Drill-Down Pane.*

3. Visualization Approach

AQ Route Explorer is composed of a Settings Panel and two primary interfaces: a Map Component and an Analysis Interface. These interfaces allow a user to edit suggested routes and observe the corresponding pollution data for the routes that are visualized on the map. Its primary purpose is to support users in identifying paths that would minimize their pollution exposure while allowing for user control of the route.

3.1. Map View

The Map Component visualizes 3 suggested routes and allows interactive route planning adjustments using the Google Maps API. Additionally, a contour map of pollution at the selected time is visualized on the map. Such information would enable the user to alter their route, minimizing the amount of pollution that they are exposed to. The Analysis View actively updates as users drag their route, visualizing pollution exposure along that path.

3.2. Analysis View

The Analysis Interface is comprised of both an Overview Pane and a Drill-Down Pane. The Overview Pane provides a general look at the TOSM of the currently selected path. This pane also allows for a user select a specific time (using the vertical time slider) and visualize data from all three paths on the Drill-Down Pane. Through selecting an alternative time with the slider, the map renders a new contour map which displays pollution data at the selected time point. The Drill-Down Pane is a time chart that enables quick comparisons of how pollution varies across a path and can assist a user in identifying which paths could minimize their exposure to air pollution.

3.3. View Interactions

The Map and Analysis views are strongly linked through two interactions: a map highlight and a contour map update. These interactions are demonstrated through the demo video in supplementary material. The map highlight is linked to hover events on the TOSM. When a TOSM cell is hovered over, it's corresponding location on the map is highlighted by a white circle. The map update is triggered by a click event on a TOSM row, where the map data is updated to the clicked time.

From informal discussions with users, these interactions allow for them to better understand the relationship between the path and the TOSM. The interactions also enable the user to quickly see how columns on the TOSM correlate with their respective spatial point along the route.

4. Conclusion and Future Work

In this poster sketch, we have presented AQ Route Explorer, a tool used to explore spatial and temporal trends to make informed personal health decisions. This tool contributes an extension to the TOSM through adding interactions and a new drill down pane that allows a user to quickly compare an attribute of interest across multiple paths. Through the use of this tool, users can make informed changes to their typical route that could reduce their exposure to air pollution.

In our future work, we would like to perform a user study with selected members of the public to gain insight into how the TOSM visualization is understood and how the interactions and drill-down view enhance TOSM's usefulness.

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