Weather Alerts Reduces Bikeshare Trips but Not Equally Across Communities

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The City of Philadelphia represents an urban context where social disparities, bikeshare investments, and climate-related challenges increasingly intersect. This study, assesses how and to what extent different types of National Weather Service (NWS) alerts (e.g., heat advisories, flood warnings) affect bikeshare demand by capturing variation in user responses and investigates whether disadvantaged and non-disadvantaged communities respond differently to the same alerts, highlighting disparities in behavioral flexibility, and environmental exposure. This framework carry direct implications for climate-adaptive transport planning and bikeshare system management, emphasizing the importance of integrating real-time alert responsiveness, flexible operational protocols, and targeted outreach within communities.

- Climate change is increasing the frequency and intensity of extreme weather, making such events a persistent challenge to urban mobility.
- Bikeshare use is expanding in U.S. cities, heightening the need to ensure operational reliability.
- Disadvantaged communities already experience compounded transport and infrastructure burdens, and weather-related disruptions further amplify their existing vulnerabilities.
- NWS alerts are increasingly used to communicate weather-related risks, shaping response to extreme conditions.

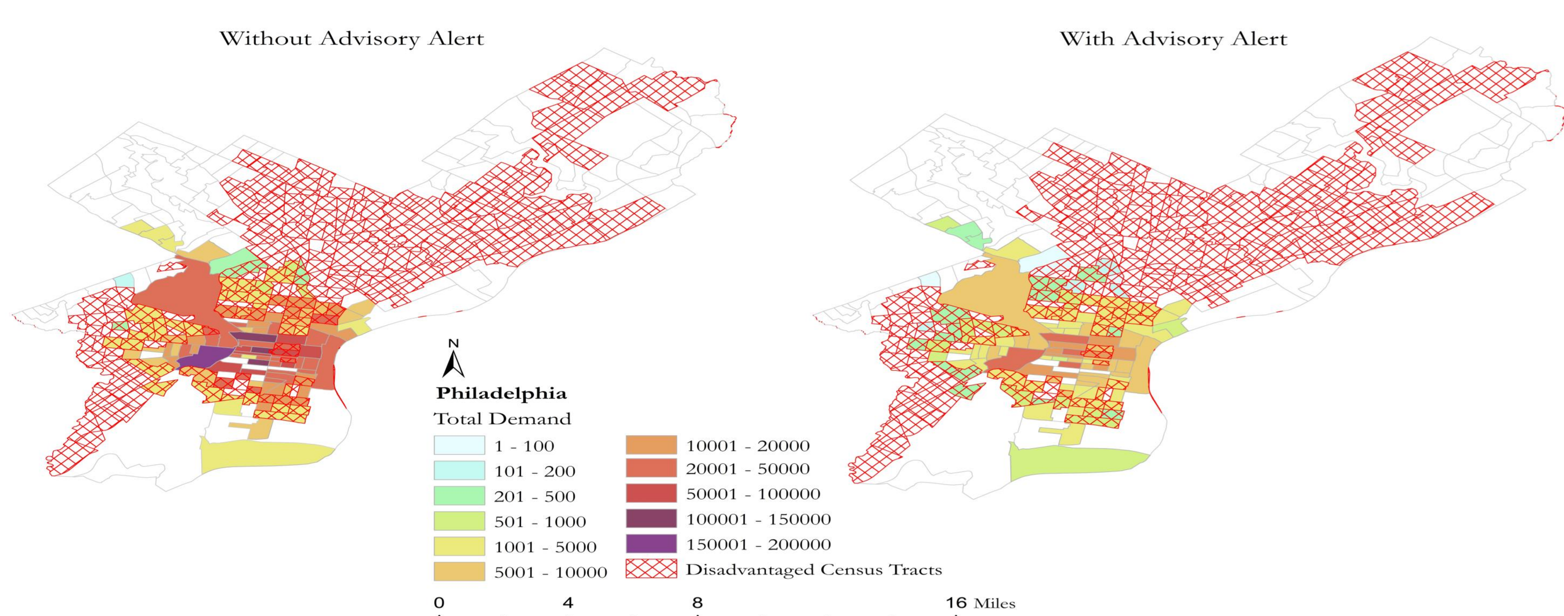
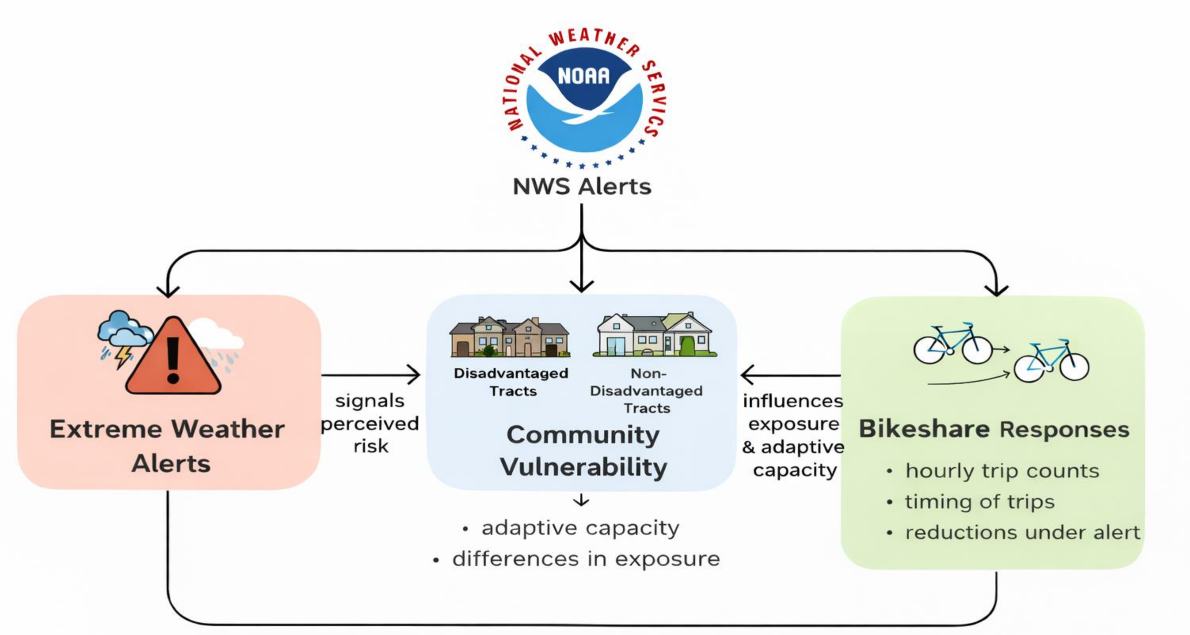


FIGURE 2 Total bikeshare demand on days without advisories (left) and days with advisories (right) across disadvantaged and non-disadvantaged communities in Philadelphia, PA. The color spectrum from baby blue to purple represents total bikeshare trip demand over all advisory and non-advisory days from 2022 to 2024, with lighter shades indicating lower demand and darker shades indicating higher demand. This figure illustrates how bikeshare usage varies by advisory status and community vulnerability.

- Winter storm warnings and flood-related alerts generate the largest reductions in hourly ridership, even after controlling for temperature, precipitation, temporal fixed effects, and spatial dependence, indicating that alerts signaling substantial physical disruption correspond with sharp contractions in cycling activity.
- The weekend ridership is generally more elastic than weekday ridership under precipitation and several alert categories, which is consistent with the greater flexibility of discretionary travel relative to commuting-oriented trips.
- Interaction estimates show that alert responsiveness varies by socioeconomic context. Flood and wind-related alerts produce larger proportional declines in non-disadvantaged communities, whereas heat advisories are associated with stronger reductions in disadvantaged communities after accounting for nonlinear temperature effects.

Conceptual Framework



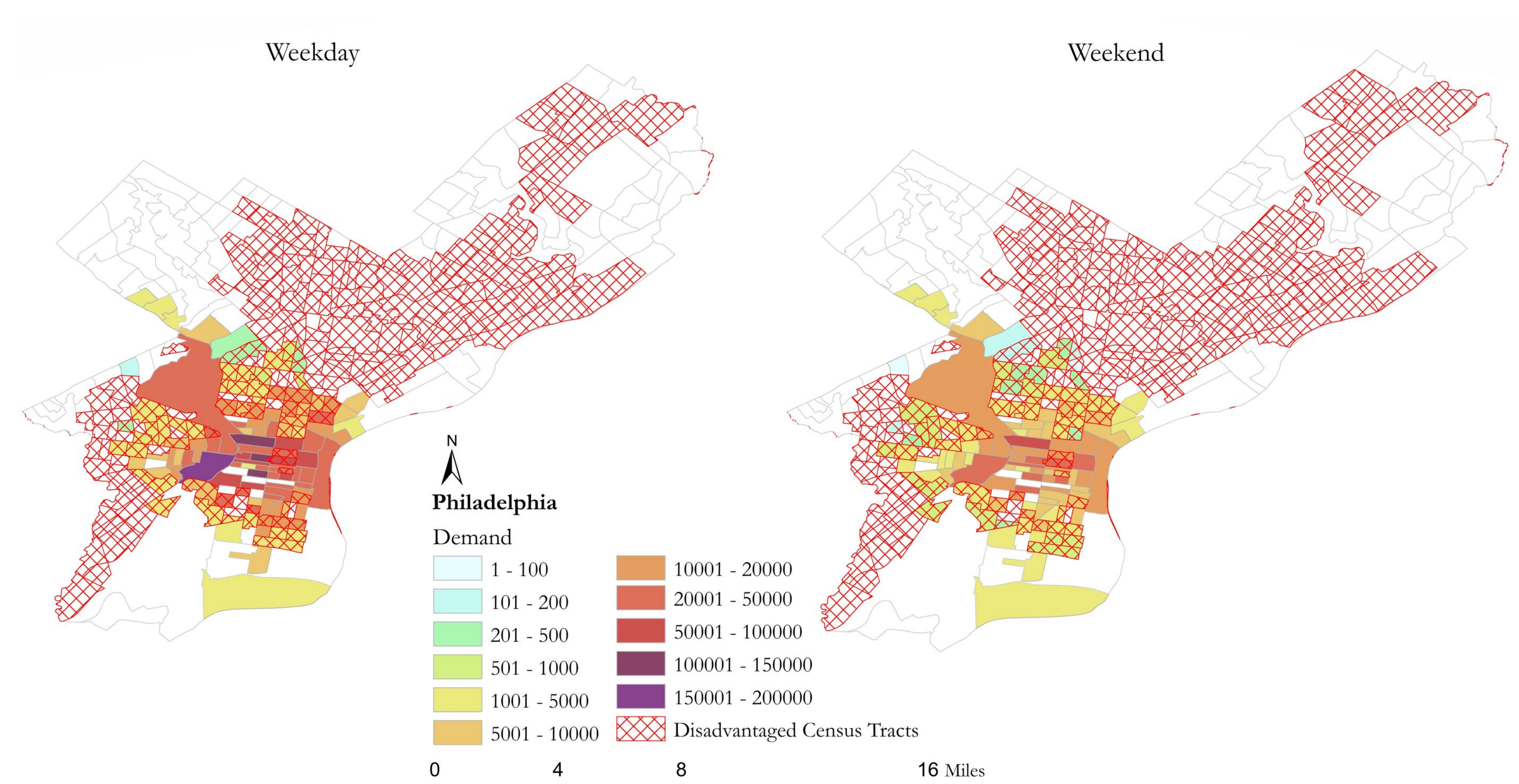


FIGURE 1 Total bikeshare demand on weekdays (left) and weekends (right) across disadvantaged and non-disadvantaged communities in Philadelphia, PA. The color spectrum from baby blue to purple represents the total bikeshare trip demand from 2022 to 2024, with lighter shades indicating lower demand and darker shades indicating higher demand. This visualization highlights spatial variations in usage across communities.

A Bayesian hierarchical negative binomial regression model with spatial dependence was estimated to analyze repeated hourly bikeshare trip counts observed within census tracts. Interaction terms between alert indicators and disadvantage status are included to assess whether the behavioral response to communicated risk differs systematically across community types.

$$Log\ (\mu_{it}) = \alpha + \beta A_{it} + \theta W_{it} + \gamma B_i + \delta(A_{it} \times D_i) + T_t + u_i + s_i$$

- Indicators for NWS alerts (A_{it}), distinguishing advisory, watch, and warning categories
- Hourly meteorological controls (W_{it})
- Tract-level built environment characteristics derived from the Smart Location Database (B_i)
- A binary indicator identifying disadvantaged tracts (D_i).

Policy Implications

ACKNOWLEDGMENT

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