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Understanding socioeconomic, climatic, and physical factors on 311 flooding and raw sewage reports in Norfolk, VA

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Urban stormwater poses significant challenges related to flooding and water quality. Cities utilize 311 service request platforms for residents to report incidents, enabling governmental attention. Existing studies have explored socioeconomic and climatic factors' impact on the submission of requests, but a comprehensive understanding of how socioeconomic, climatic, and physical parameters collectively influence flooding and sanitation reporting remains unexplored. This study analyzes four years of 311 service requests for flooding stoppages and raw sewage concerns in Norfolk, VA, employing two Zero-Inflation Negative Binomial mixed effects models. These models identify statistically significant predictors for flooding stoppage and raw sewage concern request counts. The 311 service request data was geo-aggregated to the census tract level and temporally aggregated into weekly sums to account for possible lags in event occurrence and reporting of flooding stoppage or raw sewage. Duplicate service requests were also removed from the dataset. This study incorporates a wide range of explanatory variables, including socioeconomic factors (race, income, gender, education level), climatic factors (precipitation, tide level, groundwater level), and physical factors (topographic wetness index, impervious cover, distance from water bodies). All explanatory variables were aggregated to census tract level and weekly values where appropriate. Results reveal precipitation as a robust predictor in both flooding stoppages and raw sewage concerns. The conditional model for flooding stoppages identifies additional predictors such as educational attainment, race, and groundwater level. For raw sewage concerns, tide emerges as a significant predictor in the conditional and zero-inflation models, with the zero-inflation model identifying precipitation and groundwater level as well. Models were tested through nested cross-validation to validate their robustness. The study underscores the importance of climatic scenarios in predicting service requests, emphasizing their reliability in directing municipal funds for addressing community-identified flooding and sewage problems. Physical parameters like the topographic wetness index show weak predictability in low-relief coastal plains, such as Norfolk, VA. Moreover, the study sheds light on the limited relationship between flooding stoppages and raw sewage service requests, where the combined presence of these reports may indicate potential water quality and health concerns. This research contributes to a nuanced understanding of the multifaceted influences on urban stormwater reporting, facilitating targeted strategies for effective stormwater management.