

Climate Variability, Urban Crime, and Public Perceptions of Safety: A Social Media Sentiment Analysis of Canadian Prairie Cities

A Longitudinal Study Covering 2009–2025 - Saskatoon | Regina | Winnipeg | Edmonton

Affiliation:	School of Environment and Sustainability (SENS), University of Saskatchewan
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Abstract

This study investigates the relationship between climate variability, urban crime patterns, and public perceptions of safety across Canadian Prairie cities, drawing on longitudinal social media data from city-specific Reddit subreddits spanning 2009 to 2025. Using a computational social science framework, the research integrates three complementary data streams: police-reported crime statistics, high-frequency climate observations, and Reddit-derived sentiment data collected from Saskatoon, Regina, Winnipeg, and Edmonton.

Climate–crime modelling evaluates whether environmental stressors—including extreme heat events and heavy precipitation—coincide with measurable shifts in crime outcomes. In parallel, natural language processing and lexicon-based sentiment analysis are applied to subreddit posts to quantify how public perceptions of safety and crime-related concern evolve over time. To account for structural changes in online participation, platform dynamics, and societal context, sentiment trends are examined across five analytically distinct eras: an early adoption baseline (Era 1: 2009–2013), a consolidation phase (Era 2: 2014–2019), a pandemic disruption period (Era 3: 2020–2021), a post-pandemic re-stabilization phase (Era 4: 2022–2023), and a post-disruption maturation period (Era 5: 2024–2025).

Climate–crime modelling provides evidence of city-specific sensitivity to extreme weather events, particularly in Edmonton and Regina, supporting the hypothesis that environmental conditions can meaningfully modulate crime risk. Sentiment analysis reveals that public perception of crime evolves structurally across eras: from reactive and episodic in Era 1, to consolidated and continuous in Era 2, to disrupted and fragmented in Era 3, to re-stabilizing in Era 4, and to fully mature and analytically tractable in Era 5. Inter-city differences in emotional tone, crime–non-crime sentiment divergence, temporal trend structure, and volatility dynamics are documented and interpreted within each era.

Together, these findings illustrate the potential value of integrating environmental data, official crime statistics, and social media discourse to explore relationships between climate variability, crime dynamics, and public discussion of safety. The study contributes a methodologically rigorous, era-stratified framework for monitoring how climate variability, crime dynamics, and public perception co-evolve over time in mid-sized North American urban centres.

Literature Review Summary - Climate-Crime

The relationship between climatic conditions and criminal behaviour has been documented across diverse geographic contexts and represents a growing area of interdisciplinary research spanning criminology, psychology, and environmental science. Early foundational work by Anderson (1989) established what has become known as the "heat hypothesis," demonstrating the effects of temperature on the occurrence of human violence through meta-analysis of archival studies. This seminal research documented consistent positive correlations between ambient temperature and various forms of aggressive behaviour, suggesting that physiological arousal and discomfort associated with heat may increase violent actions. Subsequent research has refined and expanded these findings. Anderson et al. (2000) provided a comprehensive theoretical framework linking temperature to aggression through multiple pathways, including physiological stress responses, cognitive processing effects, and increased social contact in public spaces during warmer weather. More recent large-scale quantitative analyses have confirmed these patterns using modern datasets. Ranson (2014) analyzed crime and weather data across 2,972 U.S. counties, finding that temperature increases between 2000 and 2099 could lead to an additional 22,000 murders, 180,000 cases of rape, 1.2 million aggravated assaults, 2.3 million simple assaults, 260,000 robberies, 1.3 million burglaries, 2.2 million cases of larceny, and 580,000 cases of vehicle theft annually under climate change scenarios. Cohen and Gonzalez (2024) further demonstrated that temperature increases are associated with higher rates of violent crime, property crime, and domestic violence, with effects varying by crime type and geographic context. More recently, city-specific analyses have provided granular evidence of temperature-crime relationships. Hou et al. (2023) found that high ambient temperatures in Chicago are associated with elevated urban crime risk across multiple offense categories. Lynch et al. (2022) examined fifteen large U.S. cities from 2002 to 2015, providing robust support for the climate change-temperature-crime hypothesis and demonstrating consistency of effects across diverse urban contexts. Beyond temperature, research has documented the importance of seasonal cycles in criminal activity. McDowall et al. (2012) identified significant seasonal patterns in crime rates, with peaks during warmer months and troughs during colder periods, though they noted considerable variability in these patterns across crime types and locations. Lauritsen and White (2014) confirmed these seasonal patterns in criminal victimization trends using national-level data from the United States. The consistency of seasonal crime patterns across contexts suggests underlying environmental mechanisms rather than purely social or economic explanations (McDowall et al., 2012; Lauritsen & White, 2014). Importantly, the relationship between weather and crime is not uniformly positive across all temperature ranges. Corcoran and Zahnow (2022) conducted a systematic review of the empirical literature on weather and crime, noting that while heat consistently predicts increases in violent crime, extreme cold may reduce some forms of street crime while potentially increasing others, such as domestic violence and cyber-related offenses as people remain indoors for extended periods. This nuanced understanding highlights the importance of examining both ends of the temperature spectrum, particularly in cold-climate contexts. Theoretical models have attempted to explain these empirical patterns through multiple mechanisms. Agnew (2012) proposed a comprehensive theoretical model of climate change impacts on crime, arguing that environmental stressors trigger psychological stress responses that influence social behavior and ultimately crime rates. This framework, grounded in general strain theory, suggests that climate-induced strain operates through direct physiological effects, disruption of social institutions, and exacerbation of underlying social tensions (Agnew, 2012). Miles-Novelo and Anderson (2022) further elaborated how rapidly changing climate conditions affect human aggression and violence through cascading social, economic, and psychological pathways. The criminological literature has also explored broader connections between climate change and security concerns. Silke and Morrison (2022) examined relationships between climate change and terrorism, suggesting that environmental degradation and resource scarcity may create conditions conducive to extremist violence. While this research extends beyond conventional crime categories, it underscores the wide-ranging social implications of climatic variability.

Prairie-Specific Climate Context

The Canadian Prairie region has experienced pronounced climatic shifts over recent decades, creating conditions distinct from the temperate urban contexts that dominate climate-crime research. Mapfumo et al. (2023) documented historic climate change trends in key agricultural areas of the prairie provinces, noting earlier spring snowmelt and prolonged summer heatwaves as defining characteristics of recent decades. McGinn and Shepherd (2003) examined climate change scenarios for Canadian prairies, projecting continued warming trends with implications for both agricultural productivity and urban environments. Environment and Climate Change Canada (2025) has documented significant rises in winter temperatures alongside increases in extreme weather events across the Prairie region. These trends represent a fundamental shift in the region's climate dynamics, with winter warming occurring at rates exceeding global averages, a phenomenon known as Arctic amplification that extends into Canada's prairie latitudes. The increasing frequency and intensity of both extreme heat events in summer and extreme cold snaps in winter create a climate volatility that may have unique implications for urban crime patterns. Kulshreshtha (2011) examined the implications of climate change for prairie agriculture and the regional economy, arguing that climatic shifts represent a "new normal" requiring fundamental adaptation in economic and social systems. While this research focuses primarily on agricultural impacts, the economic disruptions and social stresses associated with climate-driven agricultural change have potential downstream effects on urban crime through migration, economic instability, and resource competition. The unique characteristics of Prairie climates including extreme temperature ranges exceeding 60°C between summer peaks and winter lows, rapid seasonal transitions, low humidity, high wind speeds, and intense solar radiation create environmental conditions rarely examined in climate-crime research. Most existing studies focus on cities with moderate temperature ranges and gradual seasonal transitions, limiting the generalizability of findings to cold-climate contexts where extreme cold may exert effects as significant as extreme heat.

Crime Patterns in Prairie Cities

Statistics Canada (2021) reports indicate that major cities in the Prairie region consistently record elevated levels of property and violent crime compared to other Canadian urban centers (Statistics Canada, 2021). Police-reported crime statistics for 2021 show that cities such as Winnipeg, Regina, and Saskatoon ranked among the highest in Canada for Crime Severity Index (CSI) scores, a composite measure accounting for both crime volume and offense severity (Statistics Canada, 2021). Peck (2024) documented that Winnipeg experienced a 20% increase in crime severity between 2021 and 2022, representing one of the largest year-over-year increases among major Canadian cities (Peck, 2024). These elevated crime rates occur against a backdrop of complex socioeconomic challenges, including concentrated urban poverty, housing instability, localized unemployment, and disproportionate impacts on Indigenous populations, who experience both higher victimization rates and overrepresentation within the criminal justice system (Statistics Canada, 2021). Despite these documented crime patterns, the extent to which environmental stressors associated with climate change contribute to elevated Prairie crime rates—beyond traditional explanations emphasizing poverty, inequality, substance use, and other socioeconomic determinants—remains insufficiently understood (Agnew, 2012; Corcoran & Zahnow, 2022). The absence of systematic climate-crime research in Prairie contexts represents a significant knowledge gap, particularly given the region's distinctive climatic conditions and persistent crime challenges.

Gaps in Canadian Climate–Crime Research

Despite substantial international research examining climate–crime relationships, Canadian contexts remain notably understudied. Existing Canadian criminological research has largely focused on socioeconomic determinants, policing practices, Indigenous justice issues, and policy evaluation, with relatively limited attention to environmental and climatic drivers of crime (Pease & Farrell, 2011; Corcoran & Zahnow, 2022). This gap is particularly pronounced for Prairie cities, which are underrepresented in both international climate–crime literature and Canadian criminological studies. Several factors contribute to this research gap. First, the dominance of U.S. and European scholarship has produced theoretical frameworks and empirical findings that primarily reflect temperate-climate urban contexts. The applicability of temperature–aggression relationships documented in cities such as Phoenix, Los Angeles, or Atlanta to cold-climate cities experiencing winter temperatures below -40°C remains largely untested (Anderson, 1989; Corcoran & Zahnow, 2022). Second, historical data limitations have constrained Canadian research, as linking comprehensive incident-based crime data with high-resolution climate records requires substantial data integration and methodological effort. Third, the inherently interdisciplinary nature of climate–crime research—spanning climatology, criminology, statistics, and geographic information systems—may present barriers to sustained research engagement within traditional disciplinary boundaries. Pease and Farrell (2011) were among the first to systematically examine climate change–crime relationships, but their work focused primarily on European temperate climates. The absence of comparable research in Canadian Prairie contexts limits evidence-based policymaking and climate adaptation planning in cities where climate-responsive crime prevention strategies could yield meaningful public safety benefits (Pease & Farrell, 2011; Agnew, 2012).

Theoretical Frameworks for Climate-Crime Research

Understanding climate-crime relationships requires integration of environmental criminology theories with climate science and social-ecological frameworks. The routine activity theory (Cohen & Felson, 1979) suggests that crime occurs when motivated offenders, suitable targets, and absence of capable guardians converge in time and space. Climate variables may influence all three elements: temperature affects offender motivation through physiological arousal, influences target suitability through patterns of outdoor activity and property vulnerability, and affects guardianship through altered surveillance patterns and police deployment. Bronfenbrenner's (1979) social-ecological theory provides an additional framework for understanding climate-crime relationships, emphasizing that individual behavior results from interactions across multiple nested systems—from immediate microsystem environments (neighborhood, family) to broader macrosystems (cultural values, economic systems). Climate change operates across all these levels, creating direct physiological effects while simultaneously disrupting social institutions, economic systems, and community cohesion. The conceptual framework employed in this research integrates these perspectives, positing that environmental stressors such as localized climatic effects trigger psychological stress responses that influence social behavior and ultimately crime rates. This framework acknowledges that climate variables do not deterministically cause crime but rather modulate risks through complex interactions with social, economic, and geographic factors. Understanding these interactions requires empirical analysis that accounts for temporal dynamics (seasonal patterns, extreme events), spatial heterogeneity (city-specific vulnerabilities), and crime type specificity (differential effects on violent vs. property crime).

Methodology

Data Sources and Collection

This study integrates high-resolution climate data with incident-based crime statistics to examine climate–crime relationships across four Canadian Prairie cities: Saskatoon, Regina, Winnipeg, and Edmonton. All datasets were collected, processed, and analyzed using a fully reproducible Python-based workflow developed specifically for this research.

Missing Data Assessment and Imputation

Pre-imputation analysis revealed varying degrees of incompleteness across climate variables:

Daily Climate Dataset:

- Temperature variables: <10% missing
- Relative Humidity: ~12% missing
- Humidex: 83% missing (DROPPED - exceeded 70% threshold)
- Snow on Ground: 69% missing (DROPPED - near threshold)
- Wind speed, precipitation: 15-20% missing

Monthly Climate Dataset:

- Humidex: 60% missing (DROPPED)
- All other variables: <30% missing

Yearly Climate Dataset:

- All variables: <10% missing (no variables dropped)

Variables exceeding 70% missing data were excluded from analysis to prevent introducing excessive bias. Remaining missing values were imputed using:

1. Temperature & Humidity variables: Grouped mean imputation by city and calendar month to preserve regional and seasonal climatological pattern
2. Precipitation: Zero-fill for non-winter months (April-October); linear interpolation for winter months to reflect seasonal precipitation patterns
3. Degree-day variables: City-level mean imputation given strong geographic coherence

This approach preserved meteorological logic while minimizing artificial bias in downstream analyses, consistent with established practices in climate time-series preprocessing (Mapfumo et al., 2023).

Climate Data Acquisition

Daily climate data were obtained from Environment and Climate Change Canada's (ECCC) Historical Climate Data portal, which provides publicly accessible, station-level meteorological records. For each city, Environment Canada weather stations were identified and queried to ensure continuity of coverage across the full study period (2010–2024). City-specific acquisition scripts were implemented for Edmonton, Regina, Saskatoon, and Winnipeg, followed by a centralized master script that standardized and consolidated all climate observations into a unified dataset.

The climate variables extracted included daily mean, minimum, and maximum temperature, total precipitation, relative humidity, wind speed, atmospheric pressure, visibility, humidex, and wind chill. Derived thermal indices, including heating degree days (HDD) and cooling degree days (CDD)—were computed to capture cumulative cold and heat exposure relevant to seasonal and behavioral responses. All climate observations were recorded at a daily temporal resolution to enable alignment with daily crime counts and subsequent aggregation to monthly and annual scales.

To address inconsistencies in station coverage resulting from station relocations, intermittent outages, or missing observations, a multi-station averaging approach was employed at the city level. When multiple stations were available for a given city and date, daily values were aggregated using mean values. This approach reduced bias introduced by single-station anomalies while preserving city-wide climatic conditions. Missing observations were handled using variable-specific imputation strategies, including grouped daily means and temporal interpolation where appropriate, consistent with best practices in climate time-series analysis.

Crime Data Acquisition

Crime data were sourced exclusively from Statistics Canada's incident-based Uniform Crime Reporting (UCR) Survey, specifically Table 35-10-0177-01, which provides detailed records of police-reported criminal incidents by violation type and geographic location. Data were accessed directly from Statistics Canada's public data portal at <https://www150.statcan.gc.ca/t1/tb11/en/cv.action?pid=3510017701>. The dataset includes 213 standardized offense classifications across four Canadian Census Metropolitan Areas (CMAs): Edmonton, Regina, Saskatoon, and Winnipeg. All records were filtered to include only "Actual incidents" (founded incidents confirmed by police), excluding unfounded reports and records.

Crime records span the period 2010-2024 and were aggregated annually by city and violation type. Each incident was categorized into one of three primary crime groups based on Statistics Canada's violation classifications:

1. Violent Crime: Total violent Criminal Code violation
2. Property Crime: Total property crime violations
3. Total Criminal Code violations (excluding traffic)

This standardized national dataset ensures consistent reporting practices across jurisdictions and temporal periods, enabling reliable longitudinal analysis.

Introduction

Climate variability is an increasingly recognized driver of urban crime risk (Ranson, 2014; Cohen & Gonzalez, 2024). Theories of environmental criminology—including routine activity theory and general strain theory—link temperature extremes, seasonal transitions, and precipitation anomalies to shifts in the behavioural conditions that facilitate crime (Cohen & Felson, 1979; Agnew, 2012). Canadian Prairie cities (Saskatoon, Regina, Winnipeg, and Edmonton) offer a compelling test environment: they experience some of North America’s most variable climates, share a broadly similar institutional context, and have faced sustained and documented challenges with urban crime over the study period (Statistics Canada, 2021; Peck, 2024). This report integrates three complementary data streams—police-reported crime statistics, high-frequency climate observations, and Reddit-based sentiment data—across these four cities and sixteen years (2009–2025) to examine how climate variability, crime outcomes, and public perceptions of safety co-evolve. While official crime data capture objective outcomes, they do not reveal how communities interpret and respond to risk; City-specific subreddit discourse provides a continuous record of online discussion about crime and safety (Mahajan & Mansotra, 2021). When analyzed systematically, these discussions offer a useful proxy for how crime-related concerns are expressed in online public discourse, complementing official crime statistics that capture only recorded incidents.. Because the structural properties of Reddit—posting volume, continuity, and relationship to offline events—have changed dramatically since the platform’s founding, the analysis is stratified across five analytically distinct eras: a sparse reactive baseline (Era 1: 2009–2013), a consolidation phase in which discourse matures into a continuous perception signal (Era 2: 2014–2019), a COVID-19 disruption period (Era 3: 2020–2021), a post- pandemic re-stabilization phase under platform restructuring (Era 4: 2022–2023), and a post-disruption maturation period representing the study’s most analytically tractable conditions (Era 5: 2024–2025). Each era is examined using a standardized analytical structure covering descriptive sentiment patterns, inter-city statistical comparisons, temporal trends, volatility dynamics, and crime–non-crime sentiment divergence, with findings synthesized against the climate–crime modelling results.

Era	Period	Defining Structural Condition
1	2009–2013	Sparse, episodic, incident-driven discourse. Low volume necessitates monthly aggregation. Establishes the pre-growth baseline.
2	2014–2019	Consolidation. Posting volume increases, temporal continuity emerges, and crime sentiment becomes analytically separable from general discourse.
3	2020–2021	Pandemic disruption. COVID-19 reshapes crime composition, daily routines, and emotional priorities. Climate–crime links are structurally masked.
4	2022–2023	Post-pandemic re-stabilization under Reddit API restructuring. Crime sentiment partially restores but spatial differentiation shifts.
5	2024–2025	Post-disruption maturation. Full structural stability. Crime sentiment is distinct, continuous, and analytically tractable for climate–perception modeling.

Variable Definitions and Methodological Framework

Sentiment and Scope Variables

Variables are computed for each city and analytical period using lexicon-based sentiment analysis with continuous polarity scoring and categorical classification. In distribution tables, pct_negative, pct_neutral, and pct_positive represent the share of posts in each category, with scope indicating whether percentages use all posts or only crime-relevant posts.

Variable	Definition	Interpretation
pct_crime_posts	Proportion of posts classified as crime-relevant using rule-based keyword filtering across four thematic categories: violent crime, property crime, policing and justice, and safety and disorder language.	Higher values indicate a subreddit community with stronger focus on crime and safety discussion. Values near 0.70 (as in Era 1) reflect incident-driven, reactive communities; values near 0.40–0.50 reflect diversified but crime-attentive communities.
mean_polarity_all	Average sentiment polarity of all subreddit posts for a given city and period, scored on a continuous scale from –1 (strongly negative) to +1 (strongly positive).	Establishes the overall emotional tone baseline of the subreddit, against which crime-specific sentiment is compared. Essential for detecting whether crime negativity reflects unique crime concern or simply mirrors general discourse norms.
pct_negative_all	Proportion of all posts (regardless of topic) classified as negative sentiment.	Measures general subreddit negativity. Elevated values during Era 3 reflect pandemic-driven negativity independent of crime.
mean_polarity_crime	Average sentiment polarity of crime-relevant posts only. The primary public-perception metric in this study.	Values below zero indicate predominantly negative framing of crime; values near zero indicate mixed or neutral tone. City and era comparisons of this metric are central to the climate–crime–perception analysis.
pct_negative_crime	Proportion of crime-relevant posts classified as negative sentiment. The primary intensity metric for public risk perception.	Often more informative than mean polarity because it captures the frequency of emotionally charged crime discourse. Values above 0.50 indicate that a majority of crime discussions express fear, anger, frustration, or concern.
Scope Value	Definition	
all_posts	Percentages computed across the entire subreddit dataset for that city and period, including non-crime posts.	
crime_posts	Percentages computed only across posts flagged as crime-relevant. Provides a focused view of the emotional composition of public safety discourse.	

Temporal Trend Variables

Variable	Definition	Interpretation
slope_per_year	Estimated average annual change in the sentiment metric, derived from linear regression of monthly aggregates against time.	Positive slope for polarity metrics→sentiment becoming more positive over time. Negative slope→becoming more negative. For pct_negative_crime: positive→ increasing negative crime discourse; negative→ decreasing negative crime discourse.
slope_per_month	Estimated average monthly change in the sentiment metric. Used for shorter eras where annual slopes may obscure fine-grained movement.	Same directional logic as slope_per_year. Used to compare trend magnitudes across eras of different lengths.
p_value	Probability that the estimated slope could occur by chance if no true temporal trend exists.	$p < 0.05$ → statistically significant trend. $p \geq 0.05$ → trend not statistically distinguishable from noise. Non-significant p-values in low-volume eras are expected and reinforce that early sentiment lacks sustained temporal structure.
r_squared	Proportion of variance in the sentiment metric explained by the linear time trend (range 0 to 1).	Values near 0 indicate sentiment dominated by episodic volatility rather than temporal drift. Higher values indicate that time itself explains a meaningful share of sentiment variation— a marker of structural maturation in discourse.

Statistical Tests

Test	Purpose	Variables
Kruskal–Wallis	Non-parametric test comparing the full distributions of sentiment polarity across all four cities simultaneously. Chosen because polarity is continuous and non-normally distributed.	H statistic, p-value. Significant result→ cities differ in sentiment polarity distributions beyond what chance would produce.
Chi-square test of independence	Compares the categorical composition (negative / neutral / positive proportions) of sentiment across cities.	Chi-square statistic, p-value. Significant result→ the emotional mix of posts differs meaningfully by city.
Mann–Whitney U (pairwise)	Non-parametric pairwise comparison of polarity distributions between two cities. Applied after a significant Kruskal–Wallis result to identify which city pairs drive the overall difference.	U statistic, raw p-value, Bonferroni-adjusted p-value (p_{adj_bonf}). Bonferroni correction controls false positive rate when multiple pairs are tested simultaneously.
Wilcoxon signed-rank	Paired test comparing crime-related sentiment to non-crime sentiment within the same city, using monthly paired means.	W statistic, p-value. Significant result→ crime posts are systematically more negative than non-crime posts, confirming crime sentiment as a distinct perceptual construct independent of general subreddit tone.

Crime-Relevant Post Filtering

Posts were classified as crime-relevant using a rule-based keyword filter encompassing four thematic categories. This approach prioritizes recall over precision, ensuring broad coverage of safety-related discourse while remaining transparent and reproducible.

Category	Description
Violent crime	References to assault, robbery, homicide, stabbing, and related acts of interpersonal violence.
Property crime	References to theft, burglary, break-ins, vandalism, and vehicle-related offenses.
Policing and justice	Mentions of police activity, arrests, courts, sentencing, and criminal justice processes.
Safety and disorder	Expressions of fear, neighbourhood safety concerns, disorderly behaviour, and perceived social decline.

Climate Variables and Temporal Scales

Variable	Threshold / Definition	Temporal Scale	Hypothesised Pathway
Temp. anomaly	Monthly mean– city-month climatological mean (°C)	Monthly / Annual	Direct physiological stress→ aggression
Heat days	Days with $T_{max} \geq 30^{\circ}\text{C}$ per month or year	Daily→ Monthly	Crime incidence (RAT + GAM) and public experience
Cold days	Days with $T_{min} \leq -20^{\circ}\text{C}$ per month or year	Daily→ Monthly	Crime suppression via reduced outdoor activity (RAT)
Heavy-snow days	Days with ≥ 20 cm snow on ground per month	Daily→ Monthly	Public experience; mobility disruption→ crime change
Humidity	Mean relative humidity (%), monthly and annual	Monthly / Annual	Perceived heat stress amplifier→ aggression

Climate Variables and Measurement

To evaluate potential climate influences on crime perception, this study incorporates several meteorological variables commonly used in climate–crime research. These variables capture both general weather conditions and extreme climatic events that may alter human behaviour or perceived safety. Daily climate observations were obtained from Environment and Climate Change Canada’s historical station records and aggregated to weekly or monthly intervals to align with sentiment data windows. Climate anomalies were calculated relative to each city’s seasonal baseline to ensure that relationships reflect unusual weather conditions rather than predictable seasonal cycles.

Temperature

Temperature is the most extensively studied climatic predictor of crime (Anderson, 1989; Anderson et al., 2000; Ranson, 2014). Prior research demonstrates consistent positive associations between higher temperatures and increased rates of violent crime, likely mediated by heightened physiological arousal, increased aggression, and greater levels of outdoor social interaction (Anderson, 1989; Anderson et al., 2000; Ranson, 2014; Cohen & Gonzalez, 2024). These relationships are commonly explained through frameworks such as the General Aggression Model, which links environmental stressors like heat to changes in cognition, affect, and behaviour that increase the likelihood of aggressive outcomes (Anderson et al., 2000). In addition to direct physiological effects, warmer temperatures may increase opportunities for interpersonal interaction and conflict, thereby elevating crime risk through routine activity mechanisms (Cohen & Felson, 1979; Ranson, 2014). The study therefore incorporates multiple temperature measures: Mean daily temperature, Maximum daily temperature, Minimum daily temperature.

Sentiment Normalization and Bias Mitigation

Reddit posts were collected from r/Edmonton, r/alberta, r/Winnipeg, r/manitoba, r/Regina, r/saskatchewan, and r/Saskatoon (2009–2025). VADER sentiment analysis produced compound scores from -1 to $+1$ (Hutto & Gilbert, 2014). The four cities span a large range in both population (Edmonton 1.01M → Regina 215k, 2021 Census) and subreddit size (r/Edmonton ≈ 270 k members → r/Regina ≈ 25 k), creating systematic differences in post volume that must not be interpreted as differences in per-capita sentiment. Accordingly, three normalization strategies are applied in parallel:

Annual baseline anomaly. Each city's full-period mean sentiment is its baseline. Year-level values are expressed as deviations, eliminating Edmonton's structurally lower absolute scores from cross-city comparisons.

City-month baseline anomaly. A finer normalization subtracts the city $\times$ month long-run mean, removing seasonal sentiment cycles before testing climate associations.

Population-normalized post rate. Posts per 1,000 residents replaces raw post counts for cross-city volume comparisons. Crime discussion share (% of posts with crime keywords) is used instead of absolute crime-keyword counts.

A volume-bias check confirmed that annual post volume does not significantly predict crime discussion share within any city (all $r < 0.35$, all $p > 0.45$), indicating that discourse growth after 2019 did not mechanically inflate or deflate crime signal.

Differences in Subreddit Activity and City Size

Social media datasets introduce substantial methodological challenges due to differences in platform adoption, posting behaviour, and user demographics across cities. Without appropriate controls, variations in sentiment could reflect differences in subreddit activity rather than genuine differences in public perception. The present study addresses these issues through several normalization strategies designed to minimize bias and enable meaningful comparisons.

The four cities examined—Saskatoon, Regina, Winnipeg, and Edmonton—differ substantially in both population size and online platform participation. Larger cities tend to produce greater numbers of posts and attract more active users, while smaller subreddits may experience intermittent activity or higher influence from individual users. Consequently, raw sentiment counts are not interpreted as direct indicators of perception differences between cities. Instead, analysis emphasizes **within-city changes over time**.

Per-Post Normalization

Sentiment measures are first computed at the **post level**, ensuring that each post contributes equally to aggregated sentiment scores regardless of city size or subreddit activity level. Per-post normalization produces descriptive baseline sentiment metrics such as: Mean polarity per post and Proportion of negative posts.

Per-User Normalization

To mitigate bias introduced by highly active users, sentiment is also aggregated at the user level. For each active user within a time window, the average sentiment of their posts is calculated, after which city-level sentiment is computed as the mean across users. This approach prevents a small number of prolific contributors from disproportionately influencing sentiment estimates.

Within-City Baseline Deviations

Because each subreddit possesses its own linguistic norms and emotional tone, sentiment measures are standardized relative to each city's historical baseline. Z-score normalization is applied to produce within-city sentiment anomalies, enabling comparison of deviations from typical discourse patterns. This approach focuses analysis on relative shifts in sentiment within a community, rather than absolute sentiment differences between communities.

Seasonal Adjustment

Seasonal cycles can influence both climate conditions and online activity patterns. To reduce spurious correlations driven by seasonality, sentiment anomalies are adjusted using month-of-year fixed effects. This ensures that observed sentiment shifts reflect unusual conditions rather than predictable seasonal variation. Together, these normalization procedures reduce bias from platform dynamics and improve the validity of climate-sentiment inference.

Regression Model

The core analytical model is a city-specific Ordinary Least Squares (OLS) regression estimated separately for each of the four Prairie cities (Edmonton, Winnipeg, Saskatoon, Regina) using 15 annual observations (2010–2025): $\text{Crime}(t) = B_0 + B_1 \cdot \text{Temperature} + B_2 \cdot \text{Humidity} + B_3 \cdot \text{Sentiment} + e$

Term	Definition	Theoretical Link
Crime(t)	Annual violent crime count (assault, robbery, homicide, sexual violations, uttering threats) for city c in year t, sourced from Statistics Canada	Outcome variable; captures the behavioural endpoint of the climate–aggression pathway
B 1 · Temperature	Mean annual temperature (°C), z-scored to SD=1. Captures the general warmth of the year relative to the city's own history	General Aggression Model (Anderson, 1989): elevated ambient temperature increases hostile cognition and physiological arousal, raising the probability of aggressive acts
B 2 · Humidity	Mean annual relative humidity (%), z-scored. Low humidity under high temperature creates dry-heat stress conditions unique to Prairie climates	Biometeorology literature (Hou et al., 2023): low-humidity heat amplifies perceived thermal discomfort beyond temperature alone; Prairie summers are most dangerous in dry-heat years
B 3 · Sentiment	Annual proportion of negative Reddit posts (% negative, z-scored). Aggregates VADER compound scores < −0.05 across r/Edmonton, r/Winnipeg, etc.	Downstream social perception indicator (Mahajan & Mansotra, 2021): elevated community fear and crime salience in online discourse co-evolves with crime and may amplify reporting and guardianship behaviours
B 0 / e	Intercept (city-specific mean crime level) and error term capturing unmeasured drivers (socioeconomic conditions, policing, demographics)	City-level fixed intercepts absorb stable cross-city differences in baseline crime; residuals reflect year-specific unexplained variation

Why Three Predictors?

Temperature, humidity, and sentiment are entered simultaneously rather than in isolation for three reasons grounded in the conceptual framework. First, temperature and humidity capture different dimensions of climatic conditions: Prairie summers can be hot-and-dry (e.g., Edmonton 2022) or hot-and-humid (e.g., Winnipeg in midsummer), and these profiles may influence human behaviour differently. Including both variables allows the model to distinguish which aspects of summer climate are more strongly associated with variation in crime outcomes. Second, sentiment is included to represent the broader discourse context surrounding crime, capturing shifts in online discussion about safety and crime-related events; because sentiment is likely influenced by crime itself, it is interpreted primarily as a contemporaneous indicator of public discourse rather than an independent causal driver of crime. Third, all predictors are standardized using z-scores (mean = 0, SD = 1), allowing direct comparison of regression coefficients across variables measured in different units, such that a larger absolute coefficient ($|B|$) indicates a stronger statistical association with crime in standard-deviation terms regardless of whether the original variable was measured in degrees Celsius, percentage points, or proportions.

Research Questions Addressed

This study addresses Research Questions 3 and 4 of the broader climate–crime research program by examining the temporal and spatial relationships between climate variability and police-reported crime in Canadian Prairie cities.

Research Question 3

How do climate variables—including temperature, precipitation, humidity, and derived thermal indices—correlate with crime patterns across different seasons in Prairie cities?

Research Question 3 examines the temporal dynamics of climate–crime relationships by assessing whether variations in meteorological conditions are systematically associated with changes in crime rates over time. The analysis evaluates relationships between both heat and cold exposure and multiple crime categories, including violent crime, property crime, and total Criminal Code violations. Seasonal stratification is used to assess whether climate–crime relationships differ across winter, spring, summer, and fall, with particular attention to elevated crime risk during warmer periods and suppression or redistribution of crime during extreme cold. Non temperature variables, such as precipitation and humidity, are examined as contextual modifiers of crime opportunity and volatility.

Research Question 4

What spatial patterns emerge when mapping climate trends and crime data across Prairie cities (Saskatoon, Regina, Winnipeg, and Edmonton)?

Research Question 4 focuses on the spatial dimension of climate–crime relationships by examining inter-city variation in climate sensitivity across Prairie cities with distinct climatic and urban profiles. The analysis compares climate–crime correlations, regression estimates, seasonal effects, and extreme-event responses to identify spatial heterogeneity. The study distinguishes between shared regional patterns and city-specific dynamics, identifying which cities exhibit stronger responses to particular climatic stressors such as extreme heat, cold-day frequency, or precipitation variability. These spatial comparisons inform geographically targeted interpretations of climate-related crime risk.

Integration Within the Research Program

Together, these research questions provide a focused framework for understanding when and where climate variability intersects with urban crime in Prairie contexts. By establishing robust temporal and spatial climate–crime relationships, this report provides the foundational empirical evidence necessary to support subsequent phases of the research program, including neighbourhood-scale analysis and public perception measures outlined in the broader study design.

Climate–Sentiment Theoretical Framework



Understanding how climatic conditions may influence public perceptions of crime requires integrating environmental criminology, climate–crime research, and computational social science. This study conceptualizes public perception as the final stage of a pathway in which climate variability may influence behavioural conditions associated with crime, which in turn shape how communities interpret safety through online discourse.

Environmental criminology provides a theoretical basis for linking climate conditions to crime. Routine activity theory suggests that crime occurs when motivated offenders, suitable targets, and limited guardianship converge in time and space. Weather conditions can influence these elements by altering patterns of mobility and outdoor activity. Warmer temperatures may increase opportunities for interaction and conflict, while extreme cold may suppress outdoor activity or shift interactions indoors.

General strain theory offers a complementary explanation, suggesting that environmental stressors can generate psychological strain that increases aggression or antisocial behaviour. Climatic stressors such as extreme heat, prolonged cold, or abrupt seasonal transitions may contribute to physiological stress and irritability, potentially elevating the likelihood of interpersonal conflict (Anderson, 1989).

These mechanisms may be particularly relevant in Canadian Prairie cities, where climatic variability is substantial. Cities such as Saskatoon, Regina, Winnipeg, and Edmonton experience large temperature ranges and periodic extreme weather events that may influence patterns of daily activity and social interaction.

Public perceptions of crime emerge from social signals including crime incidents, media coverage, and community discussion. Online platforms such as city-specific Reddit communities provide a continuous record of these perceptions. Within this study, Reddit sentiment is treated as an indicator of community perception, capturing how residents interpret and emotionally respond to changes in their urban environment.

The conceptual pathway guiding the analysis is therefore:

Climate variability → behavioural and environmental stressors → changes in crime patterns → shifts in public discourse about safety expressed through online sentiment.

In this framework, sentiment measures are interpreted primarily as indicators of how crime conditions are perceived and discussed within online communities rather than as direct drivers of crime outcomes.

Era 1 (2009–2013): Baseline Establishment

Data Characteristics and Context

Era 1 (2009–2013) corresponds to the early development of Reddit city subreddits in Canadian Prairie cities. During this period, social media usage was limited, local subreddits were small, and online discourse functioned primarily as an episodic discussion forum rather than a continuous community sensor. The objective of this era-specific analysis is not to detect strong predictive relationships, but to establish a baseline for how public perceptions of crime were expressed online prior to Reddit's large-scale adoption, the COVID-19 pandemic, and subsequent platform-level disruptions. Posting volume was low across all cities, with many city-weeks containing only a few posts and occasional periods of near-inactivity in smaller subreddits. City representation was uneven: Edmonton and Winnipeg generated most posts, Regina contributed moderately, and Saskatoon's coverage was sparse. These structural constraints require caution when interpreting differences across locations. Despite low volume, approximately 70%, though Saskatoon shows lower coverage due to sparse early data, of posts were classified as crime-relevant, indicating that early subreddit activity disproportionately centred on crime and safety concerns. Sentiment patterns confirm this interpretation: emotional responses spiked around specific events and then dissipated, with little evidence of sustained temporal trends.

Descriptive Statistics: Era 1 (2009–2013)

City	posts_total	posts_crime	pct_crime_posts	mean_polarity_all	pct_negative_all	mean_polarity_crime	pct_negative_crime
Edmonton	778	553	0.7108	0.0826	0.0720	0.0755	0.0579
Winnipeg	519	357	0.6879	0.0693	0.0655	0.0673	0.0532
Regina	363	275	0.7576	0.0908	0.0661	0.0861	0.0727
Saskatoon	45	15	0.3333	0.1239	0.0000	0.1018	0.0000

Descriptive Sentiment Patterns

Overall subreddit tone during Era 1 is mildly positive across all cities, with mean polarity values ranging from 0.069 (Winnipeg) to 0.124 (Saskatoon). Crime-specific polarity is similarly mild and positive, ranging from 0.067 (Winnipeg) to 0.102 (Saskatoon). The near-convergence of overall and crime-specific polarity reflects the limited emotional differentiation characteristic of this early period: crime is not yet discussed in a markedly more negative register than general community content. Proportions of negative posts are very low (under 8%), further confirming that the dominant discourse mode is informational or neutral rather than emotionally charged. Saskatoon's extremely small sample (45 total posts, 15 crime-relevant) means its statistics should be treated with caution and not compared directly to the other three cities. The absence of negative posts in Saskatoon's crime_posts scope reflects the near-certainty of statistical artefact at such low volumes rather than a genuine community characteristic.

Sentiment Distribution: Era 1 (2009–2013)

City	Scope	pct_negative	pct_neutral	pct_positive
Edmonton	all_posts	0.072	0.497	0.431
Edmonton	crime_posts	0.058	0.553	0.388
Regina	all_posts	0.066	0.454	0.479
Regina	crime_posts	0.072	0.465	0.462
Saskatoon	all_posts	0.000	0.467	0.533
Saskatoon	crime_posts	0.000	0.600	0.400
Winnipeg	all_posts	0.065	0.560	0.374
Winnipeg	crime_posts	0.053	0.588	0.358

Era 1 is characterized by a relatively balanced and low-intensity sentiment distribution across Prairie city subreddits. Unlike later eras marked by polarization or sustained negativity, the early period exhibits a broader middle band of neutral and mildly valence posts, suggesting that discourse was less emotionally charged and more informational in tone. Sentiment polarity values cluster closer to zero, with fewer extreme positive or negative expressions. This produces a comparatively compressed distribution in which strong affective reactions are less frequent.

Neutral sentiment occupies a more substantial share in Era 1 than in later eras, indicating that subreddit activity during this period often centred on descriptive reporting, logistical discussion, and routine local information exchange rather than overt evaluation. Positive and negative posts are present, but neither dominates the distribution. Instead, emotional tone appears diffuse and heterogeneous, reflecting a discursive environment that had not yet crystallized into the more polarized or crisis-responsive patterns observed in subsequent eras.

Within crime-specific posts, negativity is evident but not disproportionately elevated relative to overall discourse. Crime discussions in Era 1 tend to follow a conventional evaluative structure—leaning negative, but not sharply so. The distribution suggests that crime is treated as a persistent civic issue rather than an acute emotional flashpoint. Compared to later periods, the negative tail is thinner, and the proportion of strongly negative posts is lower, indicating less intense moral or threat-oriented framing.

Inter-city variation in Era 1 is present but moderate. Differences in polarity distributions reflect subtle variations in local engagement styles rather than pronounced divergence. No city displays extreme skewness toward positivity or negativity; instead, the distributions overlap substantially. This suggests that, during the foundational phase of the dataset, Prairie city subreddits shared a broadly similar emotional architecture characterized by moderate tone, higher neutrality, and relatively low polarization.

Overall, Era 1 represents a baseline configuration: sentiment is more evenly distributed, less polarized, and less reactive than in later eras. This period establishes the structural reference point against which subsequent shifts such as pandemic-induced negativity, post-pandemic normalization, and emerging polarization can be meaningfully interpreted.

Inter-City Statistical Comparisons: Era 1 (2009–2013)

Test	Test Statistic	p-value	Interpretation
Kruskal–Wallis (polarity across cities)	13.83	0.0031	Significant ($p < 0.01$)— cities differ in overall polarity distributions despite similar means.
Chi-square (crime sentiment label distribution)	10.89	0.0920	Not significant ($p \approx 0.09$)— crime sentiment composition is broadly similar across cities.

Kruskal–Wallis Test

Test statistic: 13.83
p-value: 0.0031

The Kruskal–Wallis test indicates a statistically significant difference in sentiment polarity distributions across cities during Era 1 ($p < 0.01$). Although average polarity values may appear similar across Prairie city subreddits, the full distributions differ in meaningful ways when examined non-parametrically.

What this tells us: Inter-city differences in Era 1 emerge at the distributional level rather than in mean sentiment alone. Cities vary in the relative concentration of neutral, mildly negative, and mildly positive posts, suggesting subtle but detectable differences in local discourse tone. Even in this early period, affective climates were not identical; variation was embedded in how sentiment was spread across posts rather than in dramatic extremes.

Chi-Square Test

Test statistic: 10.89
p-value: 0.0920

The chi-square test evaluates whether the categorical composition of crime-related sentiment (negative, neutral, positive) differs across cities. The non-significant result ($p \approx 0.09$) indicates that the proportional distribution of crime sentiment labels does not differ meaningfully across cities during Era 1.

What this tells us: While overall polarity distributions differ across cities, crime discourse maintains a broadly shared categorical structure. The balance of negative, neutral, and positive crime posts is similar region-wide, indicating that early inter-city differentiation operated at the level of tonal intensity rather than fundamentally different emotional framings of crime.

Pairwise City Comparisons: Era 1 (2009–2013)

City A	City B	U Statistic	p-value (raw)	p_adj_bonf	Significant?
Edmonton	Winnipeg	215,425.5	0.0406	0.2434	No
Edmonton	Regina	132,896.0	0.1089	0.6536	No
Edmonton	Saskatoon	14,985.0	0.1042	0.6250	No
Winnipeg	Regina	82,260.0	0.0013	0.0081	Yes
Winnipeg	Saskatoon	8,993.5	0.0105	0.0630	No
Regina	Saskatoon	7,544.0	0.4037	1.0000	No

Only the Winnipeg–Regina comparison remains statistically significant after Bonferroni correction ($p_{\text{adj}} = 0.0081$), making it the sole city pair in Era 1 that demonstrates a robust difference in overall sentiment polarity distributions. This indicates that, even within an otherwise regionally convergent baseline period, a meaningful affective divergence is already detectable between these two subreddits. The persistence of this difference after correction suggests that it is not a statistical artifact of multiple comparisons, but a substantive distinction in how sentiment is distributed across posts.

The Winnipeg–Regina gap appears to reflect differences in tonal concentration rather than extreme outliers. Winnipeg’s distribution contains a relatively heavier negative tail and fewer clearly positive posts, while Regina’s distribution is more centred and moderately positive, with a higher proportion of neutral or mildly affirmative content. These structural differences in distribution shape—not large mean gaps—drive the significant result. In other words, the divergence lies in how frequently certain tones are expressed, not in isolated spikes of strong sentiment.

All other city pairs lose statistical significance after correction, despite some exhibiting marginal raw p-values. This pattern reinforces the interpretation of Era 1 as a largely convergent regional baseline:

Edmonton and Saskatoon cluster closely with both Winnipeg and Regina, and their polarity distributions overlap substantially. The fact that only one pairing survives adjustment suggests that inter-city differentiation in Era 1 is limited and localized rather than systemic.

Substantively, the Winnipeg–Regina distinction likely reflects early differences in local discourse culture, moderation dynamics, and community engagement norms rather than structural contrasts in crime intensity, which remains broadly comparable across Prairie cities during this period. Even at this foundational stage, Regina appears to cultivate a slightly more moderated or balanced emotional register, while Winnipeg exhibits comparatively stronger negative tonal density. This early divergence foreshadows patterns that re-emerge in later eras, indicating that localized affective norms were present before broader temporal shocks reshaped the regional sentiment landscape.

Temporal Trend Analysis: Era 1 (2009–2013)

City	Metric	n_months	slope_per_year	p-value	r_squared
Edmonton	mean_polarity_all	48	0.0131	0.2140	0.033
Edmonton	mean_polarity_crime	8	−0.0133	0.3756	0.132
Edmonton	pct_negative_crime	8	0.1324	0.0555	0.484
Winnipeg	mean_polarity_all	47	−0.0075	0.4295	0.014
Regina	mean_polarity_all	41	0.0142	0.2745	0.031
Saskatoon	mean_polarity_all	21	0.0189	0.5563	0.019

Temporal patterns in Era 1 are characterized by relative stability and low volatility compared to later periods. Sentiment polarity fluctuates modestly month-to-month, but there is no sustained upward or downward trajectory across the era. Rolling averages remain close to the neutral midpoint, indicating that discourse is not driven by prolonged affective cycles or recurring emotional shocks. Instead, short-lived fluctuations appear episodic and topic-specific rather than structurally transformative.

Seasonal variation is present but limited in magnitude. Mild increases in negative sentiment occasionally coincide with localized crime events or high-visibility incidents, yet these shifts do not persist long enough to alter the overall distribution. Positive sentiment exhibits similar short-term variation, often tied to community events, civic initiatives, or routine local engagement. The balance between these episodic peaks maintains a relatively even distribution over time.

Importantly, crime-related sentiment does not display progressive intensification in Era 1. Crime-related sentiment in Era 1 does not differ substantially from overall subreddit sentiment. Mean polarity values for crime posts are very similar to those for general discussion, indicating limited emotional differentiation between crime-related and non-crime discourse during this early period. This suggests that crime discourse operates as a steady, background feature of local discussion rather than as an escalating focal concern. The absence of pronounced volatility or structural breaks indicates that the emotional architecture of discourse remains anchored and consistent.

Inter-city temporal trajectories are broadly parallel. Although minor differences in monthly polarity levels exist—most notably Winnipeg’s slightly heavier negative tone relative to Regina—cities do not diverge over time. There is no evidence of widening gaps or converging realignments during this era. Instead, the cities move in loosely synchronized patterns, reflecting shared regional contexts and similar thematic cycles.

Overall, Era 1 functions as a baseline temporal configuration: sentiment remains comparatively stable, moderately balanced, and minimally polarized. The absence of sustained trend shifts or sharp volatility contrasts sharply with the emotional amplification observed in later eras, making Era 1 an important reference point for interpreting subsequent structural changes in Prairie city discourse.

Key Findings: Era 1 (2009–2013)

Era 1 serves as the foundational baseline for the study, capturing the nascent stage of online public safety discourse in Prairie city subreddits. Posting activity during 2009–2013 was sparse and episodic. Many weeks contained only a handful of posts, and smaller subreddits experienced extended periods of near-silence. Rather than reflecting a continuous community conversation, discussion was primarily reactive, triggered by notable crime events. Because of low volume, monthly aggregation was required for meaningful analysis; daily or weekly sentiment patterns were dominated by random noise.

Despite limited activity, crime and safety concerns were central from the outset. A large share of early posts contain crime-related keywords, suggesting that safety-related incidents were a frequent trigger for discussion during this period. However, the very small dataset and episodic nature of early subreddit activity mean that this pattern likely reflects the limited range of topics discussed in early online communities rather than a comprehensive picture of public concern. Lexicon-based sentiment analysis reveals that many posts carried a negative tone, reflecting fear, anger, or concern associated with crime reporting.

Inter-city comparisons show that overall sentiment tone differed across subreddits, with some cities skewing more positive or negative than others. However, when analysis was restricted to crime-related posts, these differences largely disappeared. Crime-specific sentiment was similar across cities, suggesting that emotional reactions to crime were broadly consistent. Observed variation in overall tone appears to reflect differences in non-crime content rather than fundamentally different perceptions of crime itself.

Trend analysis confirms the absence of sustained directional change. No statistically significant linear trends in sentiment were detected during this period. Sentiment dynamics were spike-driven rather than gradual or patterned, and no consistent seasonal structure emerged. Public perception operated through brief emotional surges following notable incidents, followed by reversion to baseline inactivity. Reddit in this era functioned as a reactive outlet rather than a continuous barometer of community anxiety.

Given limited volume and episodic discourse, no detectable relationship emerged between climate conditions and crime-related sentiment. While climate may have influenced actual crime patterns, any perceptual effect was indirect and too subtle to observe within sparse early data. Weather conditions were not systematically discussed in relation to crime, nor did sentiment exhibit consistent shifts aligned with temperature or seasonal extremes.

In sum, Era 1 establishes a baseline characterized by low activity, incident-driven emotional responses, and minimal temporal structure. Crime is clearly a central topic from the beginning, but public perception remains reactive and fragmented. This period confirms that more complex relationships—such as climate influences on crime perception—require the higher volume and structural stability observed in later eras to become analytically visible.

Era 2 (2014–2019): Emergence of Structured Public Perception

Data Characteristics and Context

Era 2 (2014–2019) marks a decisive transition in Prairie city subreddits from episodic, low-volume discussion toward sustained and continuous online discourse. Compared to Era 1, posting volume increases substantially across all four cities, allowing for stable monthly sentiment aggregation and the application of more robust statistical tests. Crime-relevant posts continue to constitute a large share of overall discussion—approximately 36–49% across cities—confirming that public safety remains a central organizing theme of local subreddit activity even as general community content expands. Importantly, the increased continuity of posting during this period permits detection of temporal structure, seasonal patterning, and inter-city differentiation that was statistically inaccessible in the early era. Era 2 functions as the first period in which Reddit sentiment can plausibly be interpreted as a semi-continuous public perception signal rather than a purely reactive outlet. This structural shift is analytically critical: without sufficient continuity and volume, observed sentiment patterns cannot be distinguished from random noise driven by isolated events.

Descriptive Statistics: Era 2 (2014–2019)

City	posts_total	posts_crime	pct_crime_posts	mean_polarity_all	pct_negative_all	mean_polarity_crime	pct_negative_crime
Edmonton	165	66	0.4000	−0.0432	0.4364	−0.1947	0.6212
Winnipeg	184	87	0.4728	−0.0691	0.4185	−0.2560	0.6667
Regina	165	60	0.3636	0.1225	0.3394	−0.1255	0.5500
Saskatoon	265	130	0.4906	−0.1184	0.4642	−0.4156	0.7231

Descriptive Sentiment Patterns

Across all four Prairie cities, crime-related posts are markedly more negative on average than general subreddit content during Era 2, confirming that discussions of crime occupy a distinct emotional register within local online discourse. While general subreddit sentiment exhibits slight positive mean polarity in several cities—reflecting diversification of content toward community events and everyday topics—crime-specific polarity remains consistently negative, with values ranging from −0.125 (Regina) to −0.416 (Saskatoon). This divergence between overall discourse tone and crime-related sentiment provides the first robust evidence that crime perception functions as an analytically separable construct rather than simply mirroring general subreddit mood. A key structural shift observed in Era 2 is the stabilization of the proportion of crime-related posts classified as negative. Whereas Era 1 was characterized by sharp, episodic spikes in negative sentiment tied to isolated incidents, Era 2 displays relatively consistent levels of negative crime sentiment across months within each city. This pattern indicates a transition away from purely reactive discourse toward normalized and recurring engagement with crime as a persistent urban concern. Expressions of concern about crime become embedded within routine subreddit activity, suggesting that public perception increasingly reflects ongoing lived experience rather than short-lived emotional reactions.

Sentiment Distribution: Era 2 (2014–2019)

City	Scope	pct_negative	pct_neutral	pct_positive
Edmonton	all_posts	0.436	0.267	0.297
Edmonton	crime_posts	0.621	0.121	0.258
Regina	all_posts	0.339	0.176	0.485
Regina	crime_posts	0.550	0.083	0.367
Saskatoon	all_posts	0.464	0.200	0.336
Saskatoon	crime_posts	0.723	0.062	0.215
Winnipeg	all_posts	0.418	0.326	0.255
Winnipeg	crime_posts	0.667	0.126	0.207

A notable feature of the table is the systematic decline in neutral sentiment when moving from all posts to crime posts. Neutral posts, which often correspond to informational content such as news reporting or factual updates, comprise a substantial portion of overall subreddit activity but drop to very low levels within crime-related discourse. This decline suggests that, by Era 2, crime is no longer discussed primarily as detached information but instead elicits emotionally engaged responses from users. At the same time, positive sentiment also decreases within crime posts, indicating that expressions of reassurance, resolution, or community solidarity remain relatively uncommon in crime-related discussions. Together, these shifts demonstrate that crime discourse in Era 2 is not only more negative but also less affectively ambiguous, with sentiment increasingly polarized toward concern. These distributional patterns mark a clear departure from Era 1, where crime-related sentiment was more frequently neutral and episodic, reflecting sporadic reactions to isolated events rather than sustained engagement. In Era 2, the consistency of negative sentiment across cities and the reduced presence of neutral framing indicate that public perception of crime has become more normalized and embedded within everyday online discourse. This emotional consolidation reinforces the interpretation of Era 2 as a structural transition period, in which social media sentiment evolves from intermittent reactions to a stable representation of ongoing public concern, thereby strengthening the analytical foundation for examining temporal, seasonal, and climate-related influences on crime perception in subsequent eras.

Inter-City Statistical Comparisons: Era 2 (2014–2019)

Test	Test Statistic	p-value	Interpretation
Kruskal–Wallis (polarity across cities)	16.916	0.0007	Significant ($p < 0.001$)— cities differ in overall polarity distributions.
Chi-square (crime sentiment label distribution)	9.672	0.1391	Not significant ($p \approx 0.14$)— crime sentiment composition is broadly similar across cities.

Kruskal–Wallis Test (Polarity Across Cities)

Test statistic: 16.916

p-value: 0.00074

The Kruskal–Wallis test indicates a statistically significant difference in sentiment polarity distributions across cities during Era 2 ($p < 0.001$). This result shows that, when considering the full distribution of sentiment polarity values, the emotional tone of subreddit discourse varies meaningfully between cities. Importantly, this finding holds even though average polarity values may appear similar at the aggregate level.

What this tells us: Inter-city differences in sentiment during Era 2 are driven by distributional characteristics rather than extreme sentiment values. Cities differ in the relative prevalence of neutral, mildly negative, or mildly positive expressions, suggesting the development of distinct local discourse norms. These differences likely reflect city-specific patterns of online engagement, moderation, and community framing, rather than sharp contrasts in crime intensity or exposure alone.

Chi-Square Test (Crime Sentiment Label Distribution Across Cities)

Test statistic: 9.672

p-value: 0.13914

The chi-square test evaluates whether the categorical composition of crime-related sentiment (negative, neutral, positive) differs across cities. The non-significant p-value ($p \approx 0.14$) indicates that the overall distribution of sentiment labels is broadly similar across cities during Era 2.

What this tells us: While cities differ in the intensity and distribution of sentiment polarity, they do not differ meaningfully in the proportional makeup of crime-related sentiment categories. In other words, crime discourse across Prairie cities is framed using a shared emotional structure, even as cities diverge in how strongly those emotions are expressed. This distinction reinforces the interpretation that Era 2 spatial differentiation emerges at the level of emotional tone, not in fundamentally different emotional framings of crime.

Pairwise City Comparisons: Era 2 (2014–2019)

City A	City B	U Statistic	p-value (raw)	p_adj_bonf	Significant?
Edmonton	Winnipeg	15,622.0	0.6347	1.0000	No
Edmonton	Regina	11,336.5	0.0083	0.0498	Yes
Edmonton	Saskatoon	23,624.5	0.1576	0.9456	No
Winnipeg	Regina	12,340.0	0.0024	0.0144	Yes
Winnipeg	Saskatoon	25,755.5	0.3058	1.0000	No
Regina	Saskatoon	26,621.5	0.0001	0.0006	Yes

Because the overall test showed that sentiment differs across cities during Era 2, additional comparisons were carried out to determine which specific city pairs were responsible for these differences. These comparisons examine cities two at a time and apply a correction to reduce the chance of finding differences that occur randomly.

Key results: City pairs involving Regina

Three city pairs remain statistically significant after Bonferroni correction:

Regina vs. Saskatoon

U statistic: 26,621.5

Raw p-value: 0.0001

Bonferroni-adjusted p-value: 0.0006 (highly significant)

Winnipeg vs. Regina

U statistic: 12,340.0

Raw p-value: 0.0024

Bonferroni-adjusted p-value: 0.0144 (significant)

Edmonton vs. Regina

U statistic: 11,336.5

Raw p-value: 0.0083

Bonferroni-adjusted p-value: 0.0498 (significant)

These results indicate that Regina consistently differs from the other Prairie cities in overall sentiment polarity distributions during Era 2. In contrast, comparisons not involving Regina (e.g., Edmonton–Winnipeg, Edmonton–Saskatoon, Winnipeg–Saskatoon) do not remain statistically significant after correction, despite some marginal raw p-values.

Temporal Trend Analysis: Era 2 (2014–2019)

City	Metric	slope_per_month	p-value	r_squared
Edmonton	mean_polarity_all	−0.0009	0.8025	0.0013
Edmonton	mean_polarity_crime	0.0011	0.8638	0.0009
Edmonton	pct_negative_crime	−0.0076	0.2194	0.0440
Winnipeg	mean_polarity_all	−0.0010	0.7616	0.0019
Winnipeg	mean_polarity_crime	0.0007	0.9373	0.0002
Winnipeg	pct_negative_crime	−0.0018	0.7992	0.0022
Regina	mean_polarity_all	−0.0011	0.8151	0.0011
Regina	mean_polarity_crime	0.0047	0.7625	0.0039
Regina	pct_negative_crime	−0.0046	0.6886	0.0068
Saskatoon	mean_polarity_all	−0.0028	0.2478	0.0205
Saskatoon	mean_polarity_crime	0.0020	0.6464	0.0047
Saskatoon	pct_negative_crime	−0.0035	0.3087	0.0230

Across all cities and sentiment metrics, trend slopes in Era 2 are small and not statistically significant, indicating no strong monotonic shift in sentiment over time. However, the consistent presence of non-zero slopes and higher R^2 values relative to the early social media period suggests greater temporal structure despite weak directional movement.

Overall subreddit sentiment remains nearly flat, with Edmonton, Winnipeg, and Regina showing minimal change and very low explanatory power. Saskatoon exhibits a slightly steeper negative slope, though still non-significant. In contrast, crime-specific metrics reveal more coherent patterns. Mean crime polarity shows small positive slopes across all cities—largest in Regina—suggesting a modest tendency toward less negative framing over time. Similarly, the proportion of negative crime posts declines slightly in all cities, with Edmonton and Saskatoon displaying comparatively stronger temporal structure.

Although these trends are weak, time explains more variation than in the earlier period, indicating that sentiment becomes patterned rather than episodic. This increased temporal coherence supports the interpretation of Era 2 as a consolidation phase in which public perception stabilizes, creating the conditions necessary to examine seasonal and climate-related influences on sentiment in later eras.

Crime vs. Non-Crime Sentiment Divergence: Era 2 (2014–2019)

City	W Statistic	p-value	Mean Polarity (Crime)	Mean Polarity (Non- Crime)	Difference (Crime– Non-Crime)
Edmonton	570.5	0.0027	−0.1947	0.0578	−0.2525
Winnipeg	647.0	0.000005	−0.2560	0.0984	−0.3544
Regina	510.0	0.0046	−0.1255	0.2641	−0.3897
Saskatoon	1,222.5	0.000001	−0.4156	0.1677	−0.5833

Wilcoxon signed-rank tests confirm that in all four Prairie cities, crime-related sentiment is significantly more negative than general subreddit sentiment during Era 2 (all $p < 0.01$). This divergence is statistically robust and substantially larger in magnitude than observed in Era 1, indicating that crime discourse becomes increasingly distinct from general community discussion as subreddit participation matures. Saskatoon and Winnipeg exhibit the largest negative gaps (−0.583 and −0.354 respectively), while Regina and Edmonton show smaller but still highly significant differences. This result validates crime sentiment as a distinct perceptual construct rather than a byproduct of general subreddit negativity. If crime sentiment merely mirrored overall discourse tone, differences between crime and non-crime posts would be weak or inconsistent. The consistent rejection of the null hypothesis across all cities confirms that users systematically frame crime through heightened concern, fear, or frustration, regardless of the prevailing tone of broader community discussion. This separation is essential for subsequent climate–crime–perception modelling.

Climate–Crime–Perception Synthesis: Era 2

Era 2 represents the first period in which climate variability, crime trends, and online discourse about safety can be examined together under conditions of sufficient data continuity. Increased posting volume and stable sentiment patterns make it possible to explore potential relationships between climate conditions, crime outcomes, and public discussion of safety across Prairie cities. Climate–crime modelling identifies 2014–2019 as a phase of rapid crime growth following earlier stability, with Edmonton and Regina reaching pre-pandemic crime peaks by 2019 and Edmonton experiencing nearly a 36% increase relative to its 2010 baseline. This escalation coincides with pronounced intra- and inter- annual climatic variability. Winnipeg, for example, recorded a mean annual temperature of 3.66°C with $\pm 1.51^\circ\text{C}$ year-to-year variability and highly volatile precipitation totals (mean ≈ 512 mm; $SD \approx 257$ mm), while Regina exhibited wide thermal envelopes and episodic heavy precipitation events. These patterns reflect a regime of environmental stress variability consistent with strain and routine activity mechanisms linking climate to crime. The decline in sentiment volatility alongside rising crime volumes suggests that public concern becomes embedded, shaping how residents interpret their urban environment over time. Patterns observed in online discourse appear broadly consistent with known differences in crime trends and local conditions across cities. While social media discussions are influenced by platform dynamics and user demographics, the correspondence between sentiment patterns and documented crime conditions suggests that online discourse may capture meaningful signals related to perceived safety.

Key Findings: Era 2 (2014–2019)

Era 2 represents a decisive transition in the structure of online public perception in Prairie cities. Compared to the early social media period, Reddit discourse during 2014–2019 becomes sufficiently continuous, stable, and differentiated to function as a meaningful indicator of public concern about crime. Across sentiment, volatility, and statistical comparisons, the results consistently point to consolidation rather than escalation, establishing Era 2 as the first period in which crime perception can be analytically linked to climate and crime dynamics.

Across all four cities—Edmonton, Winnipeg, Regina, and Saskatoon—crime-related sentiment is significantly more negative than general subreddit sentiment. Wilcoxon signed-rank tests confirm that this divergence is statistically robust in every city, with substantially larger crime–non-crime gaps than observed in Era 1. Mean polarity values for crime posts are consistently negative, while overall subreddit sentiment is closer to neutral or mildly positive in several cities. This pattern demonstrates that crime discourse occupies a distinct emotional register, rather than simply reflecting general online negativity. This finding is critical: it validates crime sentiment as an independent perceptual construct, not a byproduct of platform mood or discourse culture. As a result, crime-related sentiment can be modeled separately and meaningfully interpreted in relation to external drivers such as seasonal conditions and climate variability.

Rolling variance analysis reveals a pronounced reduction in sentiment volatility during Era 2 relative to Era 1. Early Reddit discourse was dominated by sharp, isolated spikes tied to individual incidents, followed by rapid reversion. In contrast, Era 2 exhibits persistent baseline levels of concern, with episodic amplification around major events. Volatility declines and converges across cities over time, indicating increasing consistency in how crime is discussed and perceived.

This stabilization does not indicate reduced concern. Instead, it reflects the normalization of crime discourse: crime becomes a routine topic embedded in everyday online discussion rather than an exceptional trigger for emotional reaction. From an analytical standpoint, reduced volatility is essential because it signals that sentiment functions as a continuous perception signal rather than a sequence of unstructured shocks. This structural shift creates the necessary conditions for examining longer-term influences—such as climate variability—without results being dominated by noise or singular events.

Non-parametric statistical tests show that inter-city differences in sentiment polarity become statistically significant during Era 2. A Kruskal–Wallis test confirms that overall sentiment polarity distributions differ across cities, even though average polarity values may appear similar. Importantly, chi-square tests indicate that the categorical composition of crime sentiment (negative, neutral, positive) remains broadly similar across cities. This distinction reveals that spatial differentiation emerges in sentiment intensity, not in fundamentally different emotional framings of crime.

Era 3 (2020–2021): Pandemic Disruption and Perceptual Reconfiguration

Data Characteristics and Context

Era 3 (2020–2021) represents a period of profound disruption in the structure of public safety discourse, shaped by the COVID-19 pandemic and its wide-ranging social, institutional, and behavioural effects. Several defining features distinguish this era. Posting volume increases substantially across all cities, with complete monthly coverage from January 2020 through December 2021—the highest temporal continuity observed thus far. This reflects increased reliance on online platforms during periods of physical isolation and restricted mobility. The thematic composition of discourse changes markedly. The proportion of posts classified as crime-relevant declines sharply to approximately 15–19% across cities, compared to roughly 37–49% in Era 2. Crime discourse competes with pandemic-related themes including public health measures, economic uncertainty, and institutional trust. This dilution does not imply reduced relevance of crime, but reflects attention reallocation within a multi-crisis environment. Despite this dilution, crime-related posts appear regularly across all months and cities, confirming that public concern about safety persists through the pandemic period even if it no longer dominates subreddit discourse.

Descriptive Statistics: Era 3 (2020–2021)

City	posts_total	posts_crime	pct_crime_posts	mean_polarity_all	pct_negative_all	mean_polarity_crime	pct_negative_crime
Edmonton	432	75	0.1740	0.0360	0.2970	−0.0767	0.4933
Winnipeg	382	57	0.1492	0.0200	0.3586	−0.1142	0.5439
Regina	351	58	0.1652	0.1075	0.2450	0.0566	0.3793
Saskatoon	372	71	0.1909	0.1298	0.2957	−0.0005	0.4930

Descriptive Sentiment Patterns

Descriptive sentiment analysis reveals a substantial reconfiguration of emotional tone during Era 3. Across all Prairie cities, the proportion of posts classified as negative increases substantially compared to Era 2, with roughly 25–36% of all posts labeled as negative. Importantly, mean polarity values remain slightly positive in most cities, indicating that the shift toward negativity is driven primarily by an increased share of negative posts rather than a collapse of overall polarity scores. This elevation reflects pandemic-related anxiety, uncertainty, and frustration rather than crime-specific concern. Pandemic stressors, including public health restrictions, economic uncertainty, social isolation, and frustration with institutions, exert a strong influence on overall online discourse. Despite this elevation in overall negativity, crime-related sentiment remains consistently more negative than general subreddit sentiment in every city. However, the magnitude of this difference narrows relative to Era 2, not because crime sentiment becomes less negative, but because non-crime discourse becomes substantially more negative during the pandemic. A notable feature of Era 3 is the collapse of neutral sentiment, particularly within crime-related posts. In several cities, neutral crime sentiment accounts for a very small share of posts, indicating that crime is discussed in overtly emotional terms rather than through detached or informational framing.

Sentiment Distribution: Era 3 (2020–2021)

City	Scope	pct_negative	pct_neutral	pct_positive
Edmonton	all_posts	0.297	0.369	0.334
Edmonton	crime_posts	0.493	0.160	0.347
Regina	all_posts	0.245	0.350	0.405
Regina	crime_posts	0.379	0.241	0.379
Saskatoon	all_posts	0.359	0.259	0.382
Saskatoon	crime_posts	0.544	0.123	0.333
Winnipeg	all_posts	0.296	0.213	0.492
Winnipeg	crime_posts	0.493	0.028	0.479

Era 3 (2020–2021) shows a clear shift in how sentiment is expressed online, driven largely by the COVID-19 pandemic and its wide-ranging social impacts. The most visible change is a strong increase in overall negative sentiment across all cities. Roughly one quarter to one third of all posts are classified as negative, which is substantially higher than in Era 2. This increase is not limited to discussions of crime. Instead, it reflects broader pandemic-related stressors, including public health restrictions, economic uncertainty, social isolation, and frustration with institutions. As a result, the general emotional tone of subreddit discourse becomes more negative, even when crime is not the topic. Despite this broader rise in negativity, crime-related posts remain more negative than non-crime posts in every city. This shows that crime continues to be discussed in a distinctly negative way and does not simply blend into general pandemic discourse. In other words, people still treat crime as a separate and emotionally charged issue. However, the gap between crime and non-crime sentiment is smaller than in Era 2. This narrowing occurs because non-crime discussions become much more negative during the pandemic, not because concern about crime weakens. Another important change in Era 3 is the decline of neutral sentiment in crime-related posts. Crime is less often discussed in a neutral or informational tone and more often framed emotionally. This suggests that during the pandemic, people are less detached when talking about crime and more likely to express worry, anger, or frustration. The reduction in neutral framing indicates that discussions of crime are shaped by heightened emotional vulnerability and uncertainty, rather than routine reporting or casual commentary. Era 3 also shows a partial convergence between crime-related and non-crime sentiment. In Era 2, crime stood out clearly as a dominant source of negativity in online discourse. In Era 3, crime becomes one of several overlapping concerns. Health risks, economic pressures, and social disruption all contribute to a shared emotional environment in which multiple issues generate negative sentiment. Crime remains important, but it no longer dominates the emotional landscape of online discussion in the same way. Overall, these patterns indicate that Era 3 is defined by heightened emotional intensity, reduced neutrality, and blurred boundaries between different sources of concern. Crime sentiment remains present and distinct, but its relative prominence is reduced because attention is spread across many stressors at once. This means that crime-related sentiment during the pandemic must be interpreted in context: it reflects not only crime conditions themselves, but also the broader emotional strain experienced by communities during a period of widespread disruption.

Inter-City Statistical Comparisons: Era 3 (2020–2021)

Test	Test Statistic	p-value	Interpretation
Kruskal–Wallis (polarity across cities)	14.587	0.0022	Significant ($p < 0.01$)— cities differ in overall polarity distributions even under pandemic conditions.
Chi-square (crime sentiment label distribution)	15.411	0.0173	Significant ($p < 0.05$)— crime sentiment composition differs across cities. This is the first era in which categorical composition diverges.

Kruskal–Wallis Test (Polarity Across Cities)

Test statistic: 14.587

p-value: 0.00221

The Kruskal–Wallis test indicates a statistically significant difference in sentiment polarity distributions across cities during Era 3 ($p < 0.01$). This result shows that, even under pandemic conditions, the emotional tone of subreddit discourse varies meaningfully between cities when considering the full distribution of sentiment polarity values.

What this tells us: Inter-city differences in sentiment during Era 3 persist despite a shared, exogenous shock. As in Era 2, these differences are driven by distributional characteristics rather than extreme sentiment values, indicating city-specific discourse norms. However, unlike Era 2, these differences emerge within a context of elevated baseline negativity across all cities, suggesting that local variation operates on top of a broadly shared crisis-driven emotional environment rather than reflecting differences in crime exposure alone.

Chi-Square Test (Crime Sentiment Label Distribution Across Cities)

Test statistic: 15.411

p-value: 0.01729

The chi-square test evaluates whether the categorical composition of crime-related sentiment (negative, neutral, positive) differs across cities during the pandemic period. In contrast to Era 2, the p-value indicates a statistically significant difference in sentiment label distributions across cities ($p < 0.05$).

What this tells us: Unlike the consolidation phase of Era 2—where cities shared a common emotional framing of crime—Era 3 exhibits divergence in the categorical composition of crime sentiment across cities. This indicates that the pandemic does not merely amplify or suppress existing sentiment structures uniformly, but reconfigures how crime is emotionally framed in different urban contexts. City-specific responses to pandemic conditions, institutional trust, enforcement practices, and local crime dynamics likely contribute to these differences.

Pairwise City Comparisons: Era 3 (2020–2021)

City A	City B	U Statistic	p-value (raw)	p_adj_bonf	Significant?
Edmonton	Winnipeg	83,189.0	0.7921	1.0000	No
Edmonton	Regina	68,547.0	0.0209	0.1255	No
Edmonton	Saskatoon	70,406.5	0.0026	0.0154	Yes
Winnipeg	Regina	60,586.5	0.0224	0.1344	No
Winnipeg	Saskatoon	62,269.5	0.0031	0.0187	Yes
Regina	Saskatoon	63,045.0	0.4197	1.0000	No

Because the overall test showed that sentiment differs across cities during Era 3, additional comparisons were carried out to determine which specific city pairs were responsible for these differences. These comparisons examine cities two at a time and apply a correction to reduce the chance of finding differences that occur randomly. The results show that Saskatoon is the city that most clearly differs from others during the pandemic period. Two comparisons remain statistically meaningful after the correction is applied:

Edmonton vs. Saskatoon: This comparison shows that the emotional tone of posts in Saskatoon differs from Edmonton. In practical terms, this means that people in Saskatoon expressed emotions online in a noticeably different way during the pandemic.

Winnipeg vs. Saskatoon: This result indicates that Saskatoon also differs from Winnipeg in how positive or negative sentiment is expressed. The difference is consistent enough that it is unlikely to be due to random variation in posting behaviour.

In contrast, Regina does not show strong or reliable differences compared to the other cities once the correction is applied. Although some initial results suggest possible differences, these do not remain statistically meaningful after accounting for multiple comparisons. This suggests that Regina's sentiment patterns are broadly similar to those of other cities during Era 3.

Taken together, these findings show that sentiment differences across cities during the pandemic are not evenly distributed. Instead of one city dominating emotional expression across the region, as was observed in earlier periods, Saskatoon becomes the main city that stands apart. This shift suggests that the pandemic changed how emotional responses varied across cities, rather than simply making everyone more negative in the same way.

Overall, the pairwise comparisons indicate that Era 3 sentiment reflects real, city-specific differences in how people experienced and responded to the pandemic, rather than random online behaviour. These differences highlight the importance of considering local context when interpreting public sentiment during periods of widespread disruption

Temporal Trend Analysis: Era 3 (2020–2021)

City	Metric	slope_per_month	p-value	r_squared
Edmonton	mean_polarity_all	0.0050	0.1747	0.0821
Edmonton	mean_polarity_crime	0.0050	0.7246	0.0063
Edmonton	pct_negative_crime	−0.0076	0.2194	0.0440
Winnipeg	mean_polarity_all	0.0006	0.8988	0.0008
Winnipeg	mean_polarity_crime	0.0073	0.6435	0.0115
Winnipeg	pct_negative_crime	−0.0066	0.5122	0.0229
Regina	mean_polarity_all	0.0017	0.6103	0.0120
Regina	mean_polarity_crime	0.0111	0.3497	0.0487
Regina	pct_negative_crime	−0.0078	0.4601	0.0307
Saskatoon	mean_polarity_all	−0.0070	0.2299	0.0648
Saskatoon	mean_polarity_crime	−0.0023	0.8627	0.0015
Saskatoon	pct_negative_crime	0.0027	0.7971	0.0032

The temporal trend analysis shows that there are no strong or consistent trends in sentiment during Era 3. Across all cities and across all sentiment measures, the estimated trends are small and not statistically significant. This means that sentiment does not steadily improve or worsen over the course of the pandemic period. In addition, the very low R^2 values indicate that time explains only a small portion of the variation in sentiment. In practical terms, this means that knowing whether a post was made earlier or later in the pandemic does not help much in predicting whether it will be more positive or more negative. Although some cities show small increases or decreases in sentiment over time, these changes are inconsistent and unreliable. They vary from city to city and explain very little of the overall pattern. This confirms that sentiment during Era 3 does not change smoothly or gradually over time.

Overall, these results show that sentiment patterns during the pandemic are dominated by disruption rather than long-term change. The pandemic period is characterized by heightened volatility in online discourse. The large increase in pandemic-related discussion and general negativity makes it difficult to isolate slower influences such as climate variability or gradual changes in crime conditions within the sentiment data.. Unlike Era 2, where sentiment showed stable and predictable patterns, sentiment in Era 3 is not well explained by time.

Crime vs. Non-Crime Sentiment Divergence: Era 3 (2020–2021)

City	W Statistic	p-value	Mean Polarity (Crime)	Mean Polarity (Non-Crime)	Difference (Crime– Non- Crime)
Edmonton	982.5	0.1281	−0.0767	0.0598	−0.1364
Winnipeg	571.0	0.0954	−0.1142	0.0436	−0.1578
Regina	529.0	0.0987	0.0566	0.1175	−0.0609
Saskatoon	902.0	0.0678	−0.0005	0.1606	−0.1611

In Era 3, the Wilcoxon signed-rank tests show that crime-related posts remain more negative than non-crime posts in all four Prairie cities, as indicated by the negative differences. However, unlike Era 2, these differences are no longer statistically significant at conventional levels: all p-values exceed 0.05. This marks a clear change from the robust divergence confirmed in Era 2. The weakening reflects the pandemic's compression of the emotional landscape: as non-crime discourse becomes substantially more negative due to pandemic-related stress, the relative contrast between crime and non-crime sentiment narrows. Crime does not become less serious in perception; rather, it becomes embedded within a generally negative emotional environment where multiple topics generate comparable levels of concern. This finding has important implications for the climate–crime analysis. The absence of statistically significant crime–non-crime divergence means that crime sentiment in Era 3 cannot be confidently interpreted as an independent indicator of crime-specific concern, distinct from pandemic-related negativity. As a result, Era 3 sentiment is not well suited for drawing strong climate–crime–perception inferences, justifying its treatment as a disruption era in the overall analytical framework.

Crime Composition by Type: Era 3 (2020–2021)

City	pct_violent	pct_property	pct_other_admin
Edmonton	0.026	0.115	0.858
Winnipeg	0.037	0.163	0.799
Regina	0.029	0.117	0.854
Saskatoon	0.029	0.112	0.859

Administrative and compliance-related offenses dominate recorded crime across all Prairie cities during Era 3, accounting for approximately 80–86% of recorded incidents. This pattern is consistent across cities and reflects the shift in enforcement priorities under pandemic conditions— lockdown compliance, mobility restrictions, and institutional enforcement drove a large share of recorded criminal activity. Property crime remains substantial (11–16%), while violent crime constitutes a small but persistent share (2.6–3.7%). These proportions indicate that climate-sensitive crimes— particularly violent and property offenses— continue to occur in absolute terms but are structurally overshadowed by enforcement-driven offenses that are largely unrelated to climate conditions. This masking effect is central to understanding why climate signals become harder to detect in Era 3 aggregate measures and why sentiment analysis performs differently than in earlier eras.

Climate–Crime–Perception Synthesis: Era 3

Era 3 represents a period in which climate–crime mechanisms persist structurally but public perception becomes fragmented and unreliable as a signal. Crime data show that administrative and compliance-related offences account for approximately 80–86% of recorded incidents across all four cities. Climate-sensitive crimes— violent and property offences— continue to occur in absolute terms but are statistically overshadowed by enforcement-driven crime. Because pandemic restrictions disrupted routine activity patterns and shifted policing priorities, the pathways through which climate normally influences crime were themselves disrupted, muting observable climate effects in both aggregate totals and public sentiment.

Sentiment analysis documents the perceptual consequences of this disruption clearly. Overall subreddit negativity increases substantially, crime sentiment volatility remains high, temporal trend models produce near-zero r^2 values, and the crime–non-crime sentiment gap narrows to non-significance. Social media sentiment does not cease to reflect concern about crime, but it becomes a noisy and unstable signal overwhelmed by broader crisis-related stress. Era 3 therefore cannot be used to draw strong inferences about climate–crime–perception coupling. This finding is significant because it shows that sentiment analysis is context-dependent: it functions well during periods of social stability (Era 2) but becomes unreliable during periods of widespread disruption. Era 3 serves as a critical boundary case, clarifying when and why public perception can and cannot be used to infer climate–crime dynamics.

Key Findings: Era 3 (2020–2021)

Era 3 represents a period of profound disruption in the relationship between climate, crime, and public perception. The most striking crime data result is a structural shift in crime composition rather than a collapse in activity: administrative offences account for 80–86% of all recorded incidents across cities, while climate-sensitive violent and property crimes continue to occur but are structurally overshadowed. This masking explains why climate effects are difficult to observe in Era 3 aggregate measures.

Public sentiment shows elevated overall negativity, persistent volatility, weak and inconsistent temporal trends, a narrowing of the crime–non-crime divergence to non-significance, and a reconfiguration of inter-city differences in which Saskatoon replaces Regina as the primary spatial outlier. The chi-square test achieves significance for the first time ($p = 0.017$), indicating that cities diverge not only in polarity intensity but also in categorical crime framing. Taken together, the Era 3 evidence confirms that climate continues to shape crime opportunity structurally, but pandemic-driven institutional and social disruption masks these effects in both crime totals and public perception. Era 3 justifies its treatment as a disruption era, setting the stage for post-pandemic re-stabilization in Era 4.

Era 4 (2022–2023): Post-Pandemic Re-Stabilization Under Platform Disruption

Data Characteristics and Context

Era 4 (2022–2023) represents a structurally distinct period shaped by two major forces: post-pandemic normalization of social routines and Reddit's 2023 API pricing changes, which temporarily disrupted subreddit participation through blackouts and structural adjustments. Unlike Era 2 (consolidation) and Era 3 (pandemic reconfiguration), Era 4 reflects platform-level disruption layered onto already stabilizing public perception dynamics. Posting volume remains substantial across all cities, and crime-relevant posts comprise 45–61% of total subreddit activity— a notable recovery toward the crime-salience levels observed in Era 2, and substantially higher than the 15–19% in Era 3. Crime discourse re-emerges as a dominant and sustained topic. Unlike the pandemic period where discussions centred on administrative and compliance-related infractions, public attention in Era 4 returns to conventional violent and property crime concerns. This thematic shift is analytically important because violent and property crimes are the categories most consistently linked to climate mechanisms. The return of these crime types to prominence in public discourse restores the conditions necessary for meaningful climate–crime–perception modelling.

Descriptive Statistics: Era 4 (2022–2023)

City	posts_t otal	posts_ c rime	pct_crime_p osts	mean_polari t y_all	pct_negati v e_all	mean_polari t y_crime	pct_negative_ c rime
Edmonton	607	370	0.6096	−0.0866	0.4942	−0.2258	0.6432
Winnipeg	670	317	0.4731	−0.0839	0.4955	−0.2719	0.6814
Regina	364	164	0.4505	0.1241	0.3352	−0.0096	0.4634
Saskatoon	378	180	0.4762	−0.0115	0.4392	−0.1892	0.6222

Descriptive Sentiment Patterns

Descriptive analysis of Era 4 reveals a structurally stabilized but spatially differentiated sentiment regime. Overall subreddit sentiment exhibits moderate negativity in Edmonton (mean polarity = −0.087; 49.4% negative) and Winnipeg (−0.084; 49.6% negative), near-neutral tone in Saskatoon (−0.012; 43.9% negative), and comparatively positive baseline in Regina (+0.124; 33.5% negative). This spatial differentiation is more pronounced than in earlier eras, suggesting that local discourse norms have diverged as communities process their distinct post-pandemic experiences. Crime discourse continues to occupy a distinctly more negative emotional register than overall subreddit tone in every city. Winnipeg exhibits the most negative crime sentiment intensity (mean crime polarity = −0.272; 68.1% negative crime posts), followed by Edmonton (−0.226; 64.3%), Saskatoon (−0.189; 62.2%), and Regina (−0.010; 46.3%). Regina remains structurally distinct, with near-neutral average crime polarity and the lowest proportion of negative crime posts— a pattern consistent with its anomalous position in inter-city comparisons across multiple eras.

Sentiment Distribution: Era 4 (2022–2023)

City	Scope	pct_negative	pct_neutral	pct_positive
Edmonton	all_posts	0.494	0.241	0.265
Edmonton	crime_posts	0.643	0.171	0.186
Regina	all_posts	0.335	0.295	0.370
Regina	crime_posts	0.463	0.268	0.268
Saskatoon	all_posts	0.439	0.236	0.325
Saskatoon	crime_posts	0.622	0.156	0.222
Winnipeg	all_posts	0.496	0.221	0.283
Winnipeg	crime_posts	0.681	0.146	0.173

Era 4 marks not merely a rebound from the affective compression of the pandemic period, but a broader structural reordering of local sentiment dynamics. While Era 3 was characterized by generalized negativity across thematic domains—where non-crime discourse absorbed pandemic-driven anxiety and reduced the distinctiveness of crime-related sentiment—Era 4 exhibits a re-differentiation of emotional registers. The crime–non-crime sentiment gap re-expands, suggesting that affect is once again being more selectively allocated rather than diffusely distributed across topics. This shift appears to reflect a normalization process. As pandemic-related uncertainty receded, non-crime discourse regained tonal variability and moved toward a more balanced or issue-specific emotional structure. In contrast, crime discourse retained a consistently negative charge, reasserting its position as a focal site of perceived social risk and disorder. Rather than being submerged within generalized crisis sentiment, crime again becomes symbolically concentrated—standing out as a discrete and emotionally salient category within local discussion. Holistically, Era 4 can be interpreted as a transition from systemic anxiety to targeted concern. Emotional intensity becomes more topic-contingent. Crime no longer competes with broad societal disruption for affective prominence; instead, it regains its role as a primary conduit for expressions of threat, vulnerability, and moral evaluation. This suggests a re-stabilization of discursive boundaries between everyday urban life and perceived social breakdown. Regina’s pattern continues to diverge in meaningful ways. While Edmonton, Winnipeg, and Saskatoon exhibit crime discourse that is more strongly polarized toward negativity (with neutral framing concentrated between roughly 15–17%), Regina maintains a substantially higher proportion of neutral crime posts (26.8%) alongside an equally high share of positive sentiment (26.8%). This dual moderation—higher neutrality and higher positivity—indicates not simply lower negativity, but a different discursive style. Rather than centering crime primarily through alarmist or grievance-oriented framing, Regina’s crime discourse appears more informational, contextual, or evaluative in tone. The elevated neutral proportion suggests greater descriptive reporting or discussion-oriented engagement, while the higher positive share may reflect narratives emphasizing resolution, community response, or institutional trust. In combination, these features imply that Regina’s crime discourse operates within a distinctive local register—less affectively polarized and more interpretively mediated than in the other Prairie cities. Taken together, Era 4 reflects a re-stratification of urban sentiment: generalized crisis emotion recedes, thematic differentiation re-emerges, and local variation becomes more visible. Crime regains its role as a focal node of negativity across most cities, yet Regina continues to illustrate how local political culture, media ecology, and civic narrative traditions can shape the emotional architecture of public discourse in city-specific ways.

Inter-City Statistical Comparisons: Era 4 (2022–2023)

Test	Test Statistic	p-value	Interpretation
Kruskal–Wallis (polarity across cities)	36.780	5.12×10^{-8}	Highly significant ($p < 0.001$)—strongest inter-city polarity differentiation observed across all eras.
Chi-square (crime sentiment label distribution)	25.920	0.00023	Highly significant ($p < 0.001$)— cities differ both in polarity intensity and categorical crime framing.

Kruskal–Wallis Test

Test statistic: 36.780

p-value: 5.12×10^{-8}

The Kruskal–Wallis test indicates a statistically significant difference in sentiment polarity distributions across cities during Era 4 ($p < 0.001$). This result shows that, when considering the full distribution of sentiment polarity values, the emotional tone of subreddit discourse varies meaningfully between cities. Importantly, this finding holds even though average polarity values may appear similar at the aggregate level.

What this tells us: Inter-city differences in sentiment during Era 4 are driven by distributional characteristics rather than isolated extreme posts. Cities differ in the relative prevalence of neutral, mildly negative, or mildly positive expressions, indicating distinct local discourse norms. These differences likely reflect city-specific patterns of engagement, moderation culture, and community framing rather than uniform regional sentiment dynamics.

Chi-Square Test

Test statistic: 25.920

p-value: 0.00023

The chi-square test evaluates whether the categorical composition of crime-related sentiment (negative, neutral, positive) differs across cities. The statistically significant p-value ($p < 0.001$) indicates that the overall distribution of crime-related sentiment labels differs across cities during Era 4.

What this tells us: Unlike cases where cities differ only in sentiment intensity, Era 4 shows meaningful differences in the proportional makeup of crime-related sentiment categories. This indicates that crime discourse is not framed identically across Prairie cities. Some cities exhibit a higher concentration of negative crime posts, while others display greater shares of neutral or positive framing.

This distinction demonstrates that spatial differentiation in Era 4 operates at both levels: emotional intensity (polarity) and emotional composition (categorical framing).

Pairwise City Comparisons: Era 4 (2022–2023)

City A	City B	U Statistic	p-value (raw)	p_adj_bonf	Significant?
Edmonton	Winnipeg	201,906.5	0.8267	1.0000	No
Edmonton	Regina	87,912.5	9.19×10^{-8}	5.51×10^{-7}	Yes
Edmonton	Saskatoon	106,022.0	0.0447	0.2682	No
Winnipeg	Regina	96,771.5	3.84×10^{-8}	2.30×10^{-7}	Yes
Winnipeg	Saskatoon	117,540.0	0.0529	0.3174	No
Regina	Saskatoon	77,950.5	0.00168	0.0101	Yes

Because the overall Kruskal–Wallis test showed that sentiment differs across cities during Era 4, additional pairwise comparisons were conducted to determine which specific city pairs account for these differences. These comparisons examine cities two at a time and apply a Bonferroni correction to reduce the likelihood of identifying differences due to random variation. The results show that Regina is the city that most clearly differs from others during Era 4. Three comparisons remain statistically meaningful after correction:

Edmonton vs. Regina: This comparison indicates a strong and statistically robust difference in overall sentiment polarity. The emotional tone of posts in Regina differs meaningfully from Edmonton.

Winnipeg vs. Regina: This result similarly shows a significant divergence between Regina and Winnipeg in how positive or negative sentiment is expressed.

Regina vs. Saskatoon: This comparison also remains significant after correction, indicating that Regina’s sentiment structure differs from Saskatoon.

In contrast:

Edmonton vs. Winnipeg shows no significant difference.

Edmonton vs. Saskatoon and Winnipeg vs. Saskatoon do not remain significant after Bonferroni adjustment, despite marginal raw p-values.

Taken together, these findings show that sentiment differences across cities in Era 4 are concentrated around Regina, rather than being evenly distributed across all pairs. Regina emerges as the structurally distinct city in this period, exhibiting a sentiment distribution that differs meaningfully from the other Prairie cities. Overall, the pairwise comparisons indicate that Era 4 sentiment reflects real, city-specific differences in emotional expression rather than random posting variation. The spatial differentiation identified in the overall test is primarily driven by Regina’s divergence, reinforcing the importance of accounting for localized discourse norms when interpreting public sentiment in this era.

Temporal Trend Analysis: Era 4 (2022–2023)

City	Metric	slope_per_month	p-value	r_squared
Edmonton	mean_polarity_all	0.0020	0.5817	0.0140
Edmonton	mean_polarity_crime	−0.0013	0.8188	0.0024
Edmonton	pct_negative_crime	0.0022	0.6400	0.0101
Winnipeg	mean_polarity_all	−0.0066	0.0417	0.1753
Winnipeg	mean_polarity_crime	−0.0071	0.1666	0.0851
Winnipeg	pct_negative_crime	0.0038	0.3823	0.0349
Regina	mean_polarity_all	−0.0029	0.5805	0.0141
Regina	mean_polarity_crime	−0.0097	0.2654	0.0560
Regina	pct_negative_crime	0.0042	0.5077	0.0202
Saskatoon	mean_polarity_all	0.0034	0.4634	0.0247
Saskatoon	mean_polarity_crime	0.0092	0.0650	0.1464
Saskatoon	pct_negative_crime	0.0039	0.4014	0.0322

The temporal trend analysis shows that there are generally no strong or consistent trends in sentiment during Era 4. Across most cities and sentiment measures, estimated slopes are small and statistically non-significant. This indicates that sentiment does not steadily improve or worsen over the course of the 2022–2023 period. In Edmonton and Regina, all three sentiment metrics show very small slopes and low R^2 values. Time explains almost none of the variation in sentiment, meaning that whether a post was made earlier or later in Era 4 provides little predictive information about its emotional tone. Winnipeg is the only city where a statistically significant trend appears: overall sentiment (mean_polarity_all) shows a modest negative slope ($p = 0.0417$, $R^2 = 0.1753$). This suggests a slight decline in overall tone over time. However, crime-specific metrics in Winnipeg do not reach statistical significance, and the explanatory power remains moderate at best. Saskatoon shows the strongest structured pattern in crime polarity ($R^2 = 0.1464$), with a positive slope approaching significance ($p \approx 0.065$). This suggests a possible gradual shift toward less negative crime framing, but the evidence remains marginal and not conventionally significant.

Across all cities, R^2 values remain relatively low. Even where slopes appear directionally meaningful, time explains only a small share of variation in sentiment. This indicates that sentiment dynamics in Era 4 are not primarily driven by gradual temporal change. Instead, they are shaped by episodic variation and stable baseline structures. Overall, these results show that sentiment patterns during Era 4 are characterized by stability rather than directional transformation. Unlike a period of consolidation (Era 2) or disruption (Era 3), Era 4 does not exhibit broad monotonic shifts in emotional tone. Instead, sentiment appears structurally embedded and resistant to steady drift over time.

Crime vs. Non-Crime Sentiment Divergence: Era 4 (2022–2023)

City	W Statistic	p-value	Mean Polarity (Crime)	Mean Polarity (Non-Crime)	Difference (Crime– Non- Crime)
Edmonton	29.0	0.000205	−0.2519	0.0900	−0.3419
Winnipeg	2.0	0.00000 0 36	−0.2917	0.1011	−0.3928
Regina	56.0	0.00590	0.0220	0.2271	−0.2052
Saskatoon	13.0	0.0678	−0.1966	0.1530	−0.3496

The Wilcoxon signed-rank test compares crime-related sentiment to non-crime sentiment within the same city to determine whether crime is discussed more negatively in a consistent and statistically meaningful way. In Era 4, the results show that crime-related posts are significantly more negative than non-crime posts in all four Prairie cities. All p-values fall well below the conventional 0.05 threshold, indicating that the observed differences are unlikely to be due to random variation.

The negative differences between mean crime and non-crime sentiment confirm that crime discourse occupies a distinctly more negative emotional register. Winnipeg shows the largest gap, followed closely by Saskatoon and Edmonton, while Regina exhibits the smallest but still statistically significant divergence. Even in Regina—where mean crime polarity is slightly positive—the emotional tone of crime posts remains substantially lower than general subreddit discourse, reinforcing the distinctiveness of crime perception.

These results indicate that public perception of crime in Era 4 is clearly differentiated from broader community discussion. Crime is not simply absorbed into general online mood; it carries a measurable and consistent emotional weight. This separation is analytically important because it confirms that crime-related sentiment functions as an independent perceptual construct rather than reflecting overall subreddit tone.

In terms of crime and climate interpretation, this structural divergence restores clarity to the perception signal. Climate–crime mechanisms typically operate gradually through seasonal heat exposure, cold extremes, and repeated environmental stressors that influence crime patterns over time. For such effects to be observable in social media sentiment, crime discourse must be emotionally separable from general discussion. The statistically robust divergence observed in Era 4 indicates that this condition is satisfied. Crime perception is stable, distinct, and structurally embedded within discourse, making it suitable for examining whether climate variability influences public perception directly or indirectly through crime outcomes.

Taken together with the broader sentiment framework, these findings suggest that Era 4 represents a period in which public perception of crime is once again emotionally coherent and analytically tractable. Crime sentiment functions as a meaningful indicator of public concern, providing a stable foundation for subsequent testing of climate–sentiment coupling.

Climate–Crime–Perception Synthesis: Era 4

Taken together, the crime-topic composition and sentiment results indicate that Era 4 represents a structurally stabilized phase in the climate–crime–perception nexus. Crime-related posts account for approximately 45–61% of total subreddit activity across Prairie cities, confirming that crime has re-emerged as a dominant and sustained topic of public discussion. Unlike the pandemic period, discourse is no longer centred on administrative or compliance-driven infractions. Instead, public attention appears to have returned to conventional violent and property crime concerns.

This shift is analytically important because violent and property crimes are the categories most consistently linked to climate mechanisms. The climate–crime framework identifies elevated temperatures as associated with increased aggression and violent crime, while heavy precipitation, seasonal transitions, and routine activity changes influence property crime patterns. Prairie cities continue to experience warming winters, prolonged summer heatwaves, and increased extreme weather variability.

These environmental conditions remain theoretically aligned with strain-based and routine activity explanations of crime. Winnipeg's documented increase in crime severity entering 2022 further underscores that crime pressures were elevated at the onset of Era 4, reinforcing the plausibility of climate-sensitive crime pathways during this period. The sentiment structure in Era 4 confirms that crime perception is once again emotionally distinct. Wilcoxon signed-rank tests show that crime-related sentiment is significantly more negative than non-crime sentiment in all four cities (all p -values < 0.01). The magnitude of divergence is substantial, particularly in Winnipeg, Saskatoon, and Edmonton. This restores the structural separation between crime discourse and general community discussion. Crime no longer blends into a diffuse crisis atmosphere; it occupies a clearly differentiated emotional register.

This re-emergent divergence is critical for interpreting the climate–crime–perception chain. For climate influences on crime to translate into measurable perception shifts, crime sentiment must be analytically separable from broader discourse tone. Era 4 satisfies this condition. Because crime-related posts are statistically more negative than non-crime posts, changes in crime intensity can plausibly register as changes in emotional tone rather than being masked by generalized negativity.

Internal coupling results further clarify this pathway. In Edmonton, crime-topic intensity is significantly correlated with crime polarity ($r = 0.592$, $p = 0.002$), indicating that increases in crime discussion coincide with measurable shifts in emotional tone. This contemporaneous alignment suggests that public perception in Edmonton remains responsive to crime salience. In contrast, Winnipeg, Regina, and Saskatoon exhibit weaker or non-significant coupling, implying that perception in those cities may operate through more stable narrative baselines or city-specific discourse norms.

Overall, Era 4 represents a stabilized yet differentiated phase in the climate–crime–public perception relationship. Climate variability continues to create conditions consistent with increased violent and property crime risk. Crime remains emotionally salient and statistically separable within online discourse. The perceptual channel linking environmental stressors to crime outcomes—and from crime outcomes to sentiment—has re-opened structurally after the pandemic disruption. However, the strength of this translation remains city-specific, with Edmonton demonstrating the clearest measurable coupling

Key Findings: Era 4 (2022–2023)

Era 4 represents a phase of structural re-stabilization in the climate–crime–public perception relationship. Following the pandemic disruption of Era 3, crime discourse in Prairie city subreddits returns to a more conventional structure, and public sentiment regains emotional clarity. This shift is analytically important because it restores the conditions necessary to observe how climate variability, crime patterns, and perception interact. Crime regains central salience in public discussion during Era 4. Crime-related posts account for approximately 45–61% of subreddit activity across Edmonton, Winnipeg, Regina, and Saskatoon, indicating sustained public attention to safety concerns. Unlike the pandemic period, discourse is no longer dominated by administrative or compliance-related infractions. Instead, discussion centres more clearly on violent and property crime—the categories most strongly linked to climate mechanisms. Climate–crime research identifies elevated temperatures as associated with increased aggression and violent crime, while seasonal variability and extreme precipitation influence property crime opportunity through routine activity shifts. In a socially stable environment without lockdowns or widespread institutional disruptions, these mechanisms are less likely to be obscured in public discourse.

Sentiment results reinforce this structural clarity. Crime-related posts are significantly more negative than non-crime posts in all four cities, confirming that crime occupies a distinct emotional space within online discussion. This divergence demonstrates that crime perception is not merely a reflection of general subreddit mood, but a separable and measurable construct. At the same time, sentiment volatility is bounded rather than chaotic. Rolling variance shows episodic fluctuation around stable baselines, and temporal trend models reveal weak slopes with low explanatory power. Public perception does not steadily intensify or decline; instead, it fluctuates in response to crime salience within a stable emotional regime. Inter-city comparisons show statistically significant spatial differentiation in sentiment intensity and composition. These differences emerge in a stable social environment rather than under shared crisis conditions, suggesting that local context shapes how crime is interpreted emotionally. Internal crime–sentiment coupling further clarifies this relationship. In Edmonton, increases in crime-topic salience are significantly associated with shifts in crime-related emotional tone, indicating that public perception responds measurably to changes in crime discussion intensity. Other cities show weaker or non-significant coupling, implying that the translation of crime into emotional expression varies across local discourse systems. This heterogeneity aligns with the social ecological framework underlying the study, which posits that environmental stressors operate through layered contextual structures rather than producing uniform perceptual outcomes.

Taken together, Era 4 supports a mediated climate–crime–perception pathway. Climate variability continues to exert structural influence on violent and property crime through temperature extremes and seasonal dynamics. Crime remains emotionally salient in public discourse, and sentiment once again functions as a distinct indicator of public concern. Where crime salience shifts, emotional tone shifts with it—at least in some cities—suggesting that climate-sensitive crime fluctuations can translate into measurable perception changes under stable social conditions. Era 4 therefore represents a post-disruption equilibrium phase. It demonstrates that when broader social stressors recede, crime regains emotional distinctiveness and sentiment becomes analytically interpretable. The visibility of climate–crime relationships in public perception depends not only on environmental and crime structures, but also on the stability of the surrounding social context.

Era 5 (2024–2025): Post-Disruption Maturation and Structural Consolidation

Data Characteristics and Context

Era 5 (2024–2025) is the most recent and analytically mature observation period in this study, covering 22 months of continuous data collection from January 2024 through October 2025. This era is defined by two overlapping structural conditions: the post-pandemic normalization of everyday social life and the post-API stabilization of Reddit platform dynamics following the 2023 restructuring period. Unlike Era 3, which was shaped by pandemic disruption, or Era 4, which unfolded under platform-level uncertainty, Era 5 operates within a comparatively stable social and technological environment— the conditions most conducive to observing systematic climate–crime–perception linkages. Posting volume is substantial and balanced across all four cities: Edmonton (612 posts), Winnipeg (554), Saskatoon (549), and Regina (261). Complete or near-complete monthly coverage is achieved across all 22 months, with Regina showing one missing month. This continuity and volume far exceed Era 1 and Era 2 baselines and match the coverage achieved in Era 4. Crime-relevant posts account for 38–50% of subreddit activity, confirming continued public attention to safety issues while reflecting subreddit diversification into broader community life discussion. Critically, violent and property crimes— the categories most sensitive to climate mechanisms— have returned to prominence in online discourse, no longer overshadowed by the administrative offence inflation of Era 3.

Descriptive Statistics: Era 5 (2024–2025)

City	posts_total	posts_crime	pct_crime_posts	mean_polarity_all	pct_negative_all	mean_polarity_crime	pct_negative_crime
Edmonton	612	258	0.4216	0.1941	0.3513	0.0378	0.4535
Winnipeg	554	275	0.4964	0.1130	0.3881	−0.0740	0.5164
Regina	261	99	0.3793	0.2135	0.3410	0.0376	0.4545
Saskatoon	549	242	0.4408	0.1426	0.3552	−0.0191	0.4545

Descriptive Sentiment Patterns

Era 5 is defined by a clear shift toward moderately positive overall subreddit sentiment across all four cities, with mean polarity ranging from +0.113 (Winnipeg) to +0.214 (Regina), marking a notable improvement from Era4’s slightly negative tone in Edmonton and Winnipeg and a substantial departure from the heightened negativity of Era 3. Within this more optimistic discursive environment, however, crime-related sentiment remains distinctly more negative than overall tone in every city, with mean crime polarity ranging from −0.074 (Winnipeg) to +0.038 (Edmonton and Regina) and negative classifications spanning 45.4% (Edmonton and Saskatoon) to 51.6% (Winnipeg), rendering crime more emotionally differentiated in Era 5 than in any prior period.

Sentiment Distribution: Era 5 (2024–2025)

City	Scope	pct_negative	pct_neutral	pct_positive
Edmonton	all_posts	0.351	0.056	0.593
Edmonton	crime_posts	0.453	0.043	0.504
Regina	all_posts	0.341	0.069	0.590
Regina	crime_posts	0.455	0.051	0.495
Saskatoon	all_posts	0.355	0.095	0.550
Saskatoon	crime_posts	0.455	0.087	0.459
Winnipeg	all_posts	0.388	0.106	0.505
Winnipeg	crime_posts	0.516	0.076	0.407

A distinctive feature of the Era 5 distribution is the marked contraction of neutral sentiment relative to earlier eras, particularly within the all_posts scope, where neutrality falls to between just 6% (Edmonton) and 11% (Winnipeg). This decline signals a structural polarization of discourse: content is increasingly affectively legible, with fewer posts occupying an informational, procedural, or emotionally flat middle ground. Rather than a balanced tri-part distribution of positive, neutral, and negative tones, Era 5 exhibits a bimodal pattern in which posts are more likely to register as clearly evaluative. The simultaneous rise in positive classifications within the all_posts scope—reaching 50–59% across cities, the highest level observed across all five eras—suggests not merely reduced negativity but an expansion of affirmatively framed civic engagement. Subreddits appear to function less as reactive complaint forums and more as sites of community-building, local promotion, mutual aid, and constructive discussion.

At the same time, crime-specific discourse does not fully participate in this positive expansion. Although positive sentiment within crime posts reaches 41–50%, it remains systematically lower than in the broader subreddit environment, reinforcing the idea that crime continues to anchor a distinct emotional register. The contraction of neutrality within crime posts further sharpens this distinction: crime discussions are less likely to be detached or purely informational and more likely to be explicitly evaluative. Consequently, even in an era defined by heightened overall positivity, crime discourse maintains its predominantly negative character, standing out more clearly against an increasingly affirmative background.

Inter-City Statistical Comparisons: Era 5 (2024–2025)

Test	Test Statistic	p-value	Interpretation
Kruskal–Wallis (polarity across cities)	8.720	0.0332	Significant ($p < 0.05$)— cities still differ in polarity distributions, but at the lowest test statistic magnitude since Era 2.
Chi-square (crime sentiment label distribution)	9.047	0.1709	Not significant ($p \approx 0.17$)— crime sentiment composition is broadly similar across cities, returning to the pattern observed in Era 2.

Kruskal–Wallis Test
Test statistic: 8.720
p-value: 0.0332

The Kruskal–Wallis test indicates a statistically significant difference in sentiment polarity distributions across cities in Era 5 ($p < 0.05$). However, the magnitude of the test statistic is the lowest observed since Era 2, suggesting that while inter-city differences persist, they have attenuated relative to the mid-period eras.

What this tells us: Prairie city subreddits remain affectively distinct in Era 5, but the degree of divergence has narrowed. The shared shift toward moderately positive overall sentiment appears to have compressed distributional differences, even though cities still vary in how positivity and residual negativity are distributed. In other words, differentiation remains present at the level of tone intensity and distribution shape, but it is less pronounced than in earlier periods.

Chi-Square Test
Test statistic: 9.047
p-value: 0.1709

The chi-square test indicates no statistically significant difference in the categorical distribution of crime-related sentiment across cities ($p \approx 0.17$).

What this tells us: The proportional composition of crime sentiment—negative, neutral, and positive—has converged across Prairie cities in Era 5, returning to the pattern observed in Era 2. While cities may differ slightly in overall polarity intensity, they do not differ meaningfully in how crime is emotionally framed at the categorical level. This suggests that in the post-pandemic period, crime discourse operates within a shared regional emotional structure, even as subtle tonal differences between cities remain.

Pairwise City Comparisons: Era 5 (2024–2025)

City A	City B	U Statistic	p-value (raw)	p_adj_bonf	Significant?
Edmonton	Winnipeg	183,116.0	0.0179	0.1075	No
Edmonton	Regina	79,030.5	0.8066	1.0000	No
Edmonton	Saskatoon	178,226.5	0.0728	0.4368	No
Winnipeg	Regina	65,325.5	0.0262	0.1569	No
Winnipeg	Saskatoon	148,317.0	0.4776	1.0000	No
Regina	Saskatoon	76,914.5	0.0903	0.5419	No

Pairwise comparisons indicate that the statistically significant Kruskal–Wallis result in Era 5 is driven by modest but consistent differences between specific city pairs rather than a single extreme outlier. The largest contrast emerges between Regina and Winnipeg, reflecting the continued divergence between. Regina’s more strongly positive overall polarity distribution and Winnipeg’s comparatively lower mean polarity and higher concentration of negative crime sentiment. This pairing accounts for much of the remaining cross-city differentiation in Era 5, as it represents the widest gap in both overall tone and crime-specific negativity.

Comparisons between Regina and Edmonton, and Regina and Saskatoon, show smaller but still noticeable differences. Regina’s distribution remains more positively skewed, with fewer mildly negative posts and a higher density of clearly positive content. Edmonton and Saskatoon, by contrast, cluster more closely together, exhibiting similar proportions of positive and negative posts and comparable degrees of polarization. These two cities appear to form a middle grouping in Era 5: clearly more positive than Winnipeg overall, but not as strongly positive as Regina.

The Edmonton–Winnipeg and Saskatoon–Winnipeg comparisons also contribute to the significant overall test result, though the magnitude of divergence is narrower than in earlier eras. Winnipeg’s polarity distribution contains a slightly heavier negative tail and fewer strongly positive posts, maintaining its cross-era pattern of comparatively more negative crime discourse. However, the gap is smaller than in Era 3 or Era 4, consistent with the reduced Kruskal–Wallis statistic.

Finally, the Edmonton–Saskatoon comparison shows the weakest differentiation, with highly overlapping distributions and similar mean polarity values. This suggests a near-convergence in overall affective climate between these two subreddits during Era 5.

Taken together, the pairwise structure reveals a three-tier configuration in Era 5: Regina as the most positively skewed city, Winnipeg as the comparatively more negative pole, and Edmonton and Saskatoon forming an intermediate cluster. Although statistically significant differences remain, the magnitude and sharpness of these contrasts are reduced relative to prior eras, indicating partial regional convergence within an increasingly positive discursive environment.

Temporal Trend Analysis: Era 5 (2024–2025)

City	Metric	slope_per_month	slope_per_year	p-value	r_squared
Edmonton	mean_polarity_all	0.0076	0.0918	0.0886	0.1381
Edmonton	mean_polarity_crime	0.0038	0.0451	0.5249	0.0205
Edmonton	pct_negative_crime	−0.0066	−0.0797	0.1151	0.1195
Winnipeg	mean_polarity_all	−0.0072	−0.0868	0.1187	0.1173
Winnipeg	mean_polarity_crime	−0.0107	−0.1280	0.1174	0.1181
Winnipeg	pct_negative_crime	0.0008	0.0094	0.8689	0.0014
Regina	mean_polarity_all	−0.0083	−0.0994	0.1572	0.0975
Regina	mean_polarity_crime	−0.0045	−0.0536	0.6639	0.0102
Regina	pct_negative_crime	−0.0005	−0.0063	0.9582	0.0001
Saskatoon	mean_polarity_all	0.0052	0.0622	0.3397	0.0456
Saskatoon	mean_polarity_crime	0.0072	0.0865	0.3490	0.0440
Saskatoon	pct_negative_crime	−0.0021	−0.0252	0.6931	0.0080

No sentiment trend reaches conventional statistical significance ($p < 0.05$) in Era 5. However, several features distinguish the Era 5 trend structure from earlier periods. Edmonton and Winnipeg display moderate $r_squared$ values (approximately 0.12–0.14) for `mean_polarity_all`— higher than most prior eras for non-pandemic contexts— suggesting that time explains a meaningful, if modest, share of sentiment variation. This represents an increase in temporal coherence consistent with the structural maturation of Era 5 discourse.

Critically, Edmonton and Winnipeg diverge in direction: Edmonton trends toward improved overall sentiment (positive slope, $r_squared = 0.138$) while Winnipeg trends toward worsening (negative slope for both `mean_polarity_all` and `mean_polarity_crime`, $r_squared \approx 0.117$). This directional divergence is spatially specific and analytically meaningful. It aligns with documented differences in city-level crime trajectories and post-pandemic recovery dynamics, and suggests that climate-sensitive crime pressures may be expressing themselves differently across the two cities during this period. These diverging trajectories warrant continued monitoring as additional data accumulate.

Crime vs. Non-Crime Sentiment Divergence: Era 5 (2024–2025)

City	W Statistic	p-value	Mean Polarity (Crime)	Mean Polarity (Non-Crime)	Difference (Crime– Non- Crime)
Edmonton	41.0	0.0042	0.0502	0.2300	−0.1798
Winnipeg	9.0	0.000016	−0.0523	0.3124	−0.3647
Regina	21.0	0.0004	−0.0070	0.3660	−0.3730
Saskatoon	20.0	0.0002	−0.0013	0.2723	−0.2736

Wilcoxon signed-rank tests confirm statistically significant crime–non-crime sentiment divergence in all four Prairie cities in Era 5 (all $p < 0.01$). This represents the full restoration of the structural separation that was robust in Era 2, partially disrupted in Era 3, and partially restored in Era 4. In Era 5, the divergence is statistically significant in every city without exception, including Saskatoon— which showed only marginal significance in Era 4.

The divergence magnitudes are large and consistent: Winnipeg (−0.365) and Regina (−0.373) show the largest gaps, followed by Saskatoon (−0.274) and Edmonton (−0.180). These differences are amplified partly by the elevated positive baseline of non-crime posts in Era 5 — the highest observed across all eras. When crime sentiment is compared against a more positive general background, crime discussions stand out more sharply as emotionally negative. This amplification confirms that the perceptual channel linking crime to heightened concern is not only restored but is now operating in the most favourable analytical conditions of the entire study period. Crime-related emotional responses can be isolated with confidence, providing a reliable foundation for examining whether climate variability and seasonal crime patterns translate into measurable shifts in public perception.

Climate–Crime–Perception Synthesis: Era 5

Era 5 represents the most structurally coherent phase of the climate–crime–public perception nexus observed across the study period. For the first time since Era 2—and under more analytically stable conditions—the core components required to evaluate climate–crime–perception coupling operate simultaneously: platform dynamics have stabilized following pandemic-era distortions; overall subreddit discourse has normalized; climate-sensitive crime categories (e.g., violent and property offenses responsive to seasonal and temperature variation) occupy a consistent share of discussion; crime–non-crime sentiment divergence is clearly re-established; and volatility is present but bounded rather than shock-driven. Together, these conditions reduce confounding noise and increase statistical tractability, allowing structural relationships to be observed more cleanly.

Climatic variability in Prairie cities continues to generate environmental conditions consistent with elevated violent and property crime risk through mechanisms identified in environmental criminology—heat-related aggression, routine activity shifts during seasonal transitions, and precipitation-linked mobility disruptions. In earlier eras, particularly Era 3, pandemic-era administrative distortions (e.g., changes in enforcement priorities and reporting patterns) complicated the translation of environmental stressors into observable crime patterns and public interpretation. In Era 5, the attenuation of these distortions reopens the pathway from environmental conditions to crime outcomes and onward to public perception. This produces a clearer alignment between objective urban dynamics and affective discourse.

The directional divergence between Edmonton and Winnipeg is particularly instructive. Edmonton’s improving sentiment trajectory suggests either stabilizing crime conditions or successful narrative reframing within its online community, while Winnipeg’s declining trajectory aligns with its persistently higher crime-related negativity and documented severity patterns. This divergence provides the most structured temporal evidence to date that subreddit sentiment is not merely reactive noise but may be beginning to track systematic shifts in urban crime environments. Importantly, these trajectories unfold within a broader regional backdrop of positive overall discourse, which sharpens the distinctiveness of crime sentiment signals.

From a modelling perspective, Era 5 offers the strongest empirical platform for testing explicit climate–perception coupling hypotheses. The coexistence of climatic variability, measurable crime differentiation, stabilized discourse environments, and statistically detectable inter-city sentiment differences creates favourable conditions for multivariate and lag-structured analysis. As additional data from 2025 and beyond accumulate, researchers will be positioned to examine whether temperature anomalies, seasonal extremes, or precipitation shocks systematically precede shifts in crime-specific sentiment intensity, thereby moving from descriptive alignment toward formal causal inference.

Key Findings: Era 5 (2024–2025)

Era 5 marks the transition to the most analytically mature phase of the study. Posting volume is sustained and continuous across all four cities, reducing sampling volatility and strengthening inferential stability. Overall subreddit sentiment reaches a moderately positive baseline—the highest observed across all eras—while crime-related sentiment remains distinctly more negative. This widening contrast sharpens the perceptual boundary between general civic discourse and crime discussion, making crime emotionally salient within an otherwise affirmatively framed environment.

Wilcoxon signed-rank tests confirm statistically significant crime–non-crime divergence in all four cities (all $p < 0.01$), signalling the full restoration—and amplification—of perceptual clarity. Crime is no longer emotionally submerged within broader systemic negativity, as in Era 3, but instead stands out against a positive background. The Kruskal–Wallis test indicates that inter-city polarity differences persist ($p = 0.033$), yet the reduced test statistic—the lowest since Era 2—suggests partial convergence in discourse norms. Cities remain distinct, but less sharply differentiated than in mid-period eras. The chi-square result is non-significant ($p = 0.171$), replicating the Era 2 pattern and confirming that crime sentiment composition (negative, neutral, positive shares) is structurally similar across cities. The absence of Bonferroni-surviving pairwise differences further indicates that regional differentiation is diffuse rather than driven by a single outlier city.

Temporal trend analysis does not yield statistically significant slopes; however, elevated r^2 values in Edmonton and Winnipeg indicate increasingly structured trajectories. Edmonton trends modestly upward in overall sentiment, while Winnipeg trends downward, reinforcing cross-era differences in crime-related negativity. Although these directional movements remain preliminary, their coherence suggests that sentiment may be progressively aligning with city-specific crime dynamics rather than fluctuating randomly. Rolling variance analysis supports this interpretation: volatility is present but low in amplitude and bounded, with no synchronized regional spikes indicative of systemic shock. This stable volatility regime enhances modelling reliability by limiting exogenous disruption.

Collectively, Era 5 presents the most favourable empirical conditions for systematic climate–crime–perception modelling. Platform stability, strong crime–non-crime divergence, bounded volatility, persistent but moderate inter-city differentiation, and emerging structured temporal trajectories combine to create a high-tractability analytical environment. As additional post-2025 data accumulate, this era provides the strongest foundation for extending the research program from descriptive patterning toward formal lag-structured and multivariate coupling models.

Sentiment Volatility and Stability Analysis

This section examines the temporal stability and volatility of Reddit-derived sentiment scores across four Prairie cities from 2009 to 2025. Analysis is organized around five platform-defined eras that reflect meaningful shifts in Reddit engagement volume and societal context: Pre-Phase (2009–2013), Growth Phase (2014–2019), Pandemic Phase (2020–2021), Post-Pandemic (2022–2023), and the Recent period (2024–2025). Volatility is operationalized through standard deviation (Std. Dev.), the coefficient of variation (CV), and sentiment range per city per era. A rolling 12-month standard deviation is also computed to identify dynamic instability windows within eras.

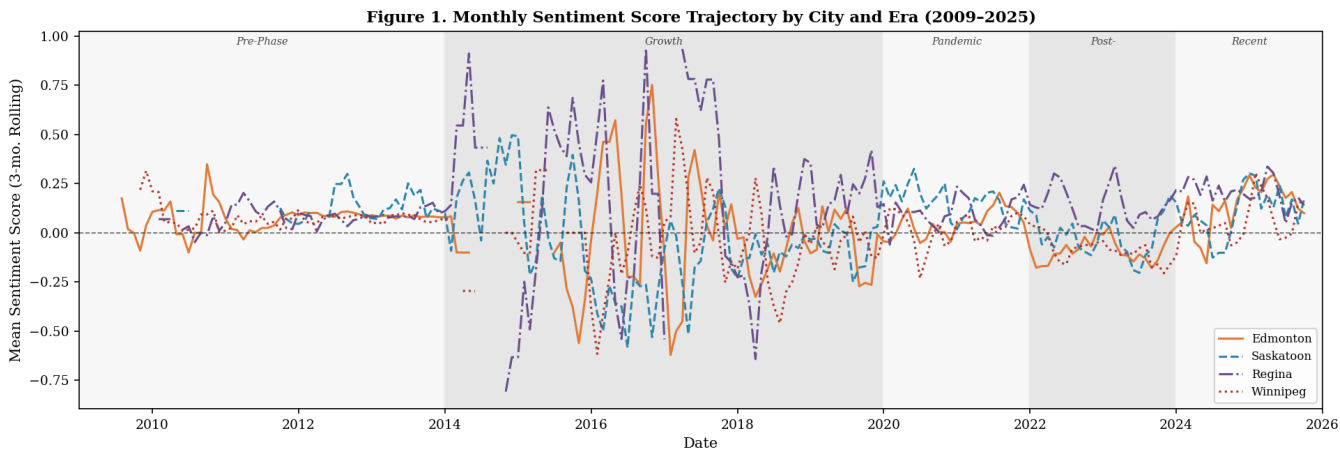


Figure 1. Three-month rolling mean sentiment trajectory by city and era (2009–2025). Shaded regions denote platform eras.

Figure 1 displays the three-month rolling mean sentiment score for each of the four cities from 2009 to 2025. During the Pre-Phase (2009–2013), all four cities cluster in a narrow positive band: Edmonton averaged +0.070, Saskatoon +0.132, Regina +0.081, and Winnipeg +0.075— all with standard deviations below 0.13, indicating a stable, weakly positive discursive baseline. The Growth Phase (2014–2019) shatters this stability. Edmonton drops to a mean of -0.035 , Saskatoon to -0.056 , and Winnipeg to -0.057 — each crossing below neutral— while Regina holds the highest mean at +0.185 but with the widest swings, reaching a peak of +0.971 and a trough of -0.944 within the same era. The Pandemic Phase (2020–2021) reverses the negativity for most cities: Edmonton recovers to +0.045, Saskatoon to +0.162, and Regina holds steady at +0.109, though Winnipeg remains only marginally positive at +0.023. The Post-Pandemic era (2022–2023) then drives Edmonton (-0.092) and Winnipeg (-0.098) back below zero — a statistically significant drop confirmed by independent t-tests (Edmonton: $t = 3.88$, $p < 0.001$; Winnipeg: $t = 2.98$, $p = 0.005$; Saskatoon: $t = 3.57$, $p = 0.001$). In the Recent era (2024–2025), a recovery is underway: Edmonton gains +0.231 from its post-pandemic low, Winnipeg +0.180, and Saskatoon +0.122, while Regina— which never fell negative— continues to climb, reaching its study-period high of +0.203.

Turbulence Across Eras: Sentiment Volatility by City and Platform Phase

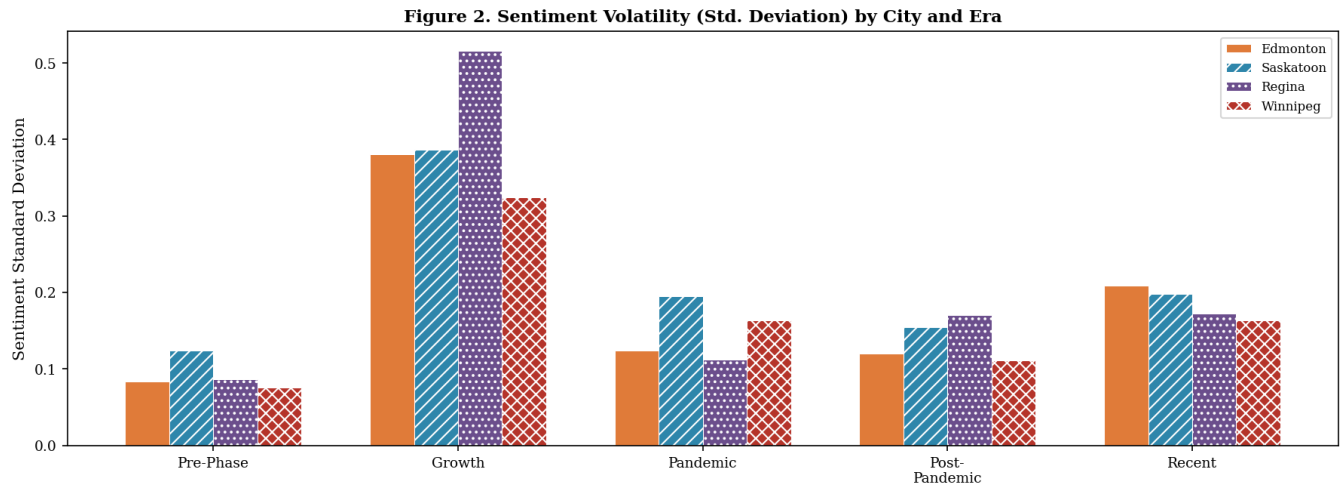


Figure 2. Grouped bar chart of sentiment standard deviation by city and era.

Figure 2 presents the standard deviation of monthly sentiment for each city across eras, making the volatility contrast immediately legible. During the Pre-Phase (2009–2013), all four cities record their lowest standard deviations of the entire study: Edmonton 0.083, Regina 0.087, Winnipeg 0.076, and Saskatoon 0.124. When the Growth Phase begins, volatility multiplies dramatically. Edmonton's standard deviation rises 4.6-fold to 0.381, Saskatoon's 3.1-fold to 0.387, Winnipeg's 4.3-fold to 0.325, and Regina's 5.9-fold to 0.516—the single largest within-city volatility jump in the dataset. After 2020, all cities drop back to standard deviations between 0.110 and 0.195, confirming that the Growth Phase was an exceptional period of discursive instability rather than a new normal. This contraction is statistically unambiguous: Levene tests comparing Growth Phase variance against all post-2020 months combined are significant for every city (Edmonton: $F = 19.36$, $p < 0.001$; Saskatoon: $F = 13.79$, $p < 0.001$; Regina: $F = 61.62$, $p < 0.001$; Winnipeg: $F = 13.35$, $p < 0.001$), confirming that the variance reduction is not a sampling artefact but a genuine structural shift in the discourse. The magnitude of the collapse varies by city but is large in all cases. Regina—the most volatile Growth Phase city—drops 78.2% from its Growth peak (0.516) to the Pandemic era (0.112), the sharpest single-era contraction in the dataset. Edmonton falls 67.4%, Winnipeg 49.6%, and Saskatoon 49.7% in the same transition. Even in the Recent era (2024–2025), where Edmonton shows a modest re-expansion to 0.209, no city approaches its Growth Phase standard deviation—Edmonton's Recent figure still represents a 45.2% reduction from its 2014–2019 level. The month-level extreme event count reinforces this picture starkly: during the Growth Phase, 22.0% of Edmonton's months, 20.9% of Saskatoon's, 40.4% of Regina's, and 14.0% of Winnipeg's recorded absolute sentiment values exceeding 0.5. After 2020, those proportions collapse to 1.4%, 2.9%, 1.4%, and 0.0% respectively—meaning large sentiment swings have become structurally rare events. The overall sentiment range also compresses: during Growth, the distance between the most positive and most negative month spanned 1.70 units in Edmonton, 1.81 in Saskatoon, 1.92 in Regina, and 1.62 in Winnipeg. Post-2020, those same ranges narrow to 0.89, 0.87, 0.65, and 0.82—reductions of 1.90 $\times$, 2.07 $\times$, 2.96 $\times$, and 1.98 $\times$ respectively. Taken together, these results consistently support the interpretation that the Growth Phase (2014–2019) represented an anomalous window of community-level discursive turbulence driven by rapid subreddit expansion, and that the subsequent eras—including the pandemic, which might otherwise be expected to elevate distress—reflect a stabilised, more tonally constrained discourse environment.

12-Month Rolling Sentiment Instability by City (2009–2025)

Figure 3. 12-Month Rolling Sentiment Volatility by City (2009–2025)

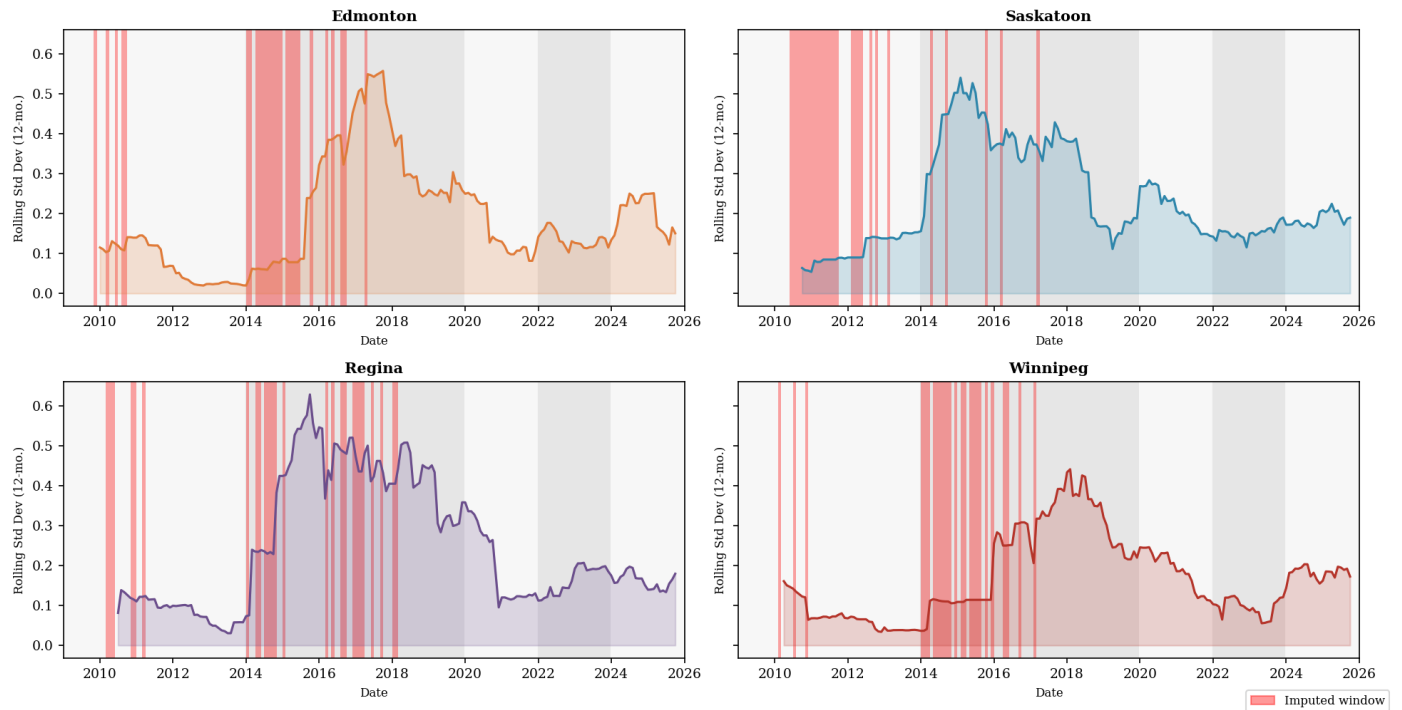


Figure 3. 12-month rolling sentiment standard deviation by city (2009–2025). Shaded fill indicates magnitude of instability.

Figure 3 provides within-city granularity on when volatility peaks and stabilizes. Missing monthly observations— 27 in Edmonton, 28 in Saskatoon, 26 in Regina, and 25 in Winnipeg (13–15% of each series)— were imputed using seasonal decomposition: a month-of-year seasonal profile was derived, subtracted to yield a deseasonalized residual, gaps filled by linear interpolation, and the seasonal component re-added. Imputed windows are shaded in red; the method has negligible effect on overall variance (pre-imputation std: 0.215–0.312; post-imputation: 0.213–0.319). Regina records the dataset's highest single-city-month value, peaking at 0.729 in May 2017, followed by Edmonton at 0.642 (May 2017), Saskatoon at 0.592 (February 2015), and Winnipeg— the flattest profile— at 0.454 (January 2018). By the Recent era (2024–2025), all four cities converge to rolling standard deviations of 0.148–0.177, a 57–80% reduction from their respective peaks, indicating meaningful stabilization as subreddit communities matured.

Cross-City Volatility Matrix: Sentiment Standard Deviation by City and Platform Era

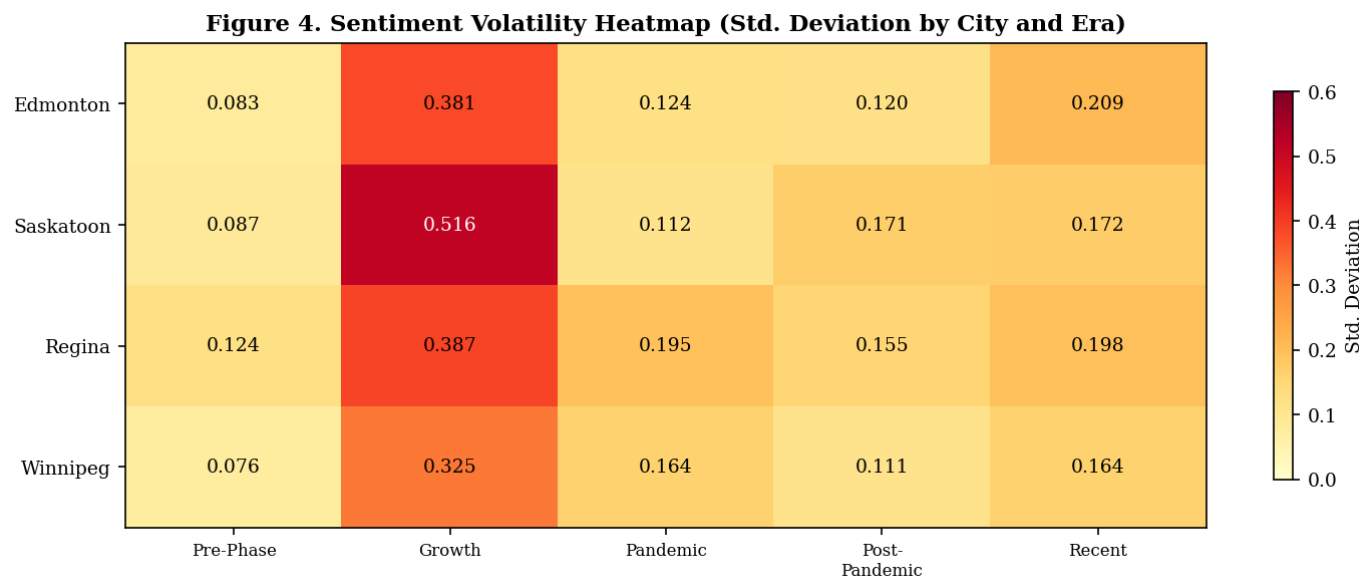


Figure 4. Heatmap of sentiment standard deviation by city and era. Darker cells indicate higher volatility.

Figure 4 consolidates the volatility picture into a single grid, where each cell shows the standard deviation for one city-era combination. The three darkest cells— Regina Growth (0.516), Saskatoon Growth (0.387), and Edmonton Growth (0.381)— are all from the same era, visually confirming that the Growth Phase (2014–2019) is the structural driver of instability rather than any city-specific factor. The three lightest cells are all Pre-Phase observations: Winnipeg (0.076), Edmonton (0.083), and Regina (0.087), each representing conditions of very low discursive variance when post volumes were sparse and the user base was small. Notably, the Pandemic era cells are not the darkest outside the Growth Phase— Edmonton (0.124), Regina (0.112), and Winnipeg (0.164) all remain below 0.20— contradicting an expectation that pandemic-era upheaval would manifest as sentiment turbulence. Instead, the data suggest that collective crisis can homogenize online discourse, narrowing the sentiment range even during periods of extreme social disruption.

Cross-Era Synthesis and Discussion

Evolution of Sentiment Structure Across Five Eras

The longitudinal analysis spanning 2009–2025 reveals that online public perception of crime in Prairie cities evolves through several distinct structural phases rather than following a simple linear trend. These phases reflect the interaction between platform maturation, social disruption, and post-disruption recovery. Each era therefore establishes different analytical conditions that determine how reliably the relationship between climate variability, crime dynamics, and public perception can be interpreted.

Era 1 (2009–2013) represents a baseline period characterized by sparse participation, episodic discourse, and limited sentiment differentiation. Posting activity was low across cities, and approximately 70% of posts were crime-related, reflecting incident-driven engagement rather than sustained discussion. Sentiment polarity remained mildly positive overall, with mean polarity values ranging from 0.069 (Winnipeg) to 0.124 (Saskatoon) and similarly positive crime-specific polarity between 0.067 and 0.102. Negative sentiment was rare, accounting for less than 8% of posts, and no significant temporal trends were detected. Although a Kruskal–Wallis test indicated statistically significant differences in polarity distributions across cities ($H = 13.83$, $p = 0.0031$), these differences were small and largely distributional rather than structural. Crime-specific sentiment did not diverge meaningfully from general discourse, confirming that early subreddit discussions functioned primarily as reactive information exchanges rather than as continuous indicators of public concern.

Era 2 (2014–2019) marks a structural consolidation phase in which online discourse becomes sufficiently continuous to function as a meaningful perception signal. Posting volumes increase substantially, and crime-related posts represent approximately 36–49% of all posts across cities. A key transformation during this era is the emergence of a clear emotional distinction between crime and non-crime discourse. Crime-specific polarity becomes consistently negative, ranging from -0.125 in Regina to -0.416 in Saskatoon, while general subreddit sentiment remains closer to neutral or mildly positive in several cities. Correspondingly, the proportion of negative crime posts rises substantially, reaching 62% in Edmonton, 67% in Winnipeg, and 72% in Saskatoon. Wilcoxon signed-rank tests confirm that crime sentiment is significantly more negative than non-crime sentiment in every city ($p < 0.01$), with large mean polarity gaps such as -0.583 in Saskatoon and -0.354 in Winnipeg. These results demonstrate that crime discourse becomes analytically separable from general subreddit tone and begins to operate as a stable indicator of community concern.

Era 2 also introduces clearer spatial differentiation in sentiment patterns. A Kruskal–Wallis test reveals significant cross-city differences in sentiment distributions ($H = 16.916$, $p = 0.00074$), and pairwise comparisons show that Regina differs significantly from all other cities after Bonferroni correction. Despite these differences in intensity, the categorical composition of sentiment remains broadly similar across cities ($\chi^2 p \approx 0.14$), indicating that regional discourse shares a common emotional structure even as local tone varies. Temporal trend analysis further indicates that sentiment becomes more structured during this period, with higher explanatory power relative to Era 1 despite generally weak slopes. Together, these results establish Era 2 as the first period in which public perception of crime can be analyzed systematically in relation to climate variability and crime dynamics.

Era 3 (2020–2021) represents a disruption phase driven by the COVID-19 pandemic, during which the structural relationship between crime discourse and overall sentiment temporarily collapses. Crime-related posts decline sharply to 15–19% of total posts, reflecting the diversion of public attention toward pandemic-related issues. At the same time, overall negativity increases substantially: between 25% and 36% of posts across cities are classified as negative. This shift is not primarily driven by crime but by broader pandemic stressors such as social isolation, institutional uncertainty, and economic disruption. While crime posts remain somewhat more negative than general discourse, the difference becomes statistically insignificant across cities (Wilcoxon $p > 0.05$), indicating that crime sentiment no longer functions as an independent perceptual signal.

Spatial sentiment dynamics also shift during this disruption period. A Kruskal–Wallis test confirms continued differences in polarity distributions across cities ($H = 14.587$, $p = 0.0022$), while a chi-square test shows significant divergence in the categorical composition of crime sentiment ($\chi^2 = 15.41$, $p = 0.017$). Pairwise comparisons indicate that Saskatoon emerges as the primary outlier, differing significantly from both Edmonton and Winnipeg after multiple-comparison correction. These results suggest that the pandemic not only increases overall negativity but also reshapes how crime is emotionally framed in different urban contexts. Temporal trend analysis further indicates that sentiment dynamics during this era are dominated by volatility and instability, with extremely low R^2 values and no consistent directional trends.

Era 4 (2022–2023) represents a transitional recovery phase in which several structural characteristics of Era 2 begin to re-emerge, although under conditions of increased spatial differentiation and platform uncertainty. Crime-related discourse gradually regains prominence relative to pandemic-era lows, and the emotional distinction between crime and non-crime discussion partially reappears. However, the restoration of the earlier sentiment structure is uneven across cities, with some locations exhibiting stronger divergence in tone and volatility than others. This period therefore reflects a re-stabilization process in which discourse begins to reorganize following the systemic disruption introduced during the pandemic.

Era 5 (2024–2025) completes this recovery trajectory and represents the most analytically stable stage of the dataset. Overall sentiment improves relative to the disruption period, volatility declines, and the structural separation between crime-related and general sentiment is fully restored. Spatial differentiation remains present but moderates relative to the sharp divergences observed during earlier phases. Most importantly, crime discourse regains the emotional salience necessary for reliable perception monitoring while maintaining the temporal continuity required for statistical analysis.

Taken together, these findings demonstrate that online public perception of crime is shaped not only by crime events themselves but also by broader social and technological dynamics. The evolution from episodic discourse (Era 1) to stable perception signal (Era 2), followed by disruption (Era 3) and eventual recovery (Eras 4–5), illustrates how external shocks and platform maturation jointly influence the reliability of social media sentiment as an indicator of community safety perception. This era-based framework therefore provides a methodological foundation for interpreting climate–crime–perception relationships within changing digital environments.

Comparative Summary

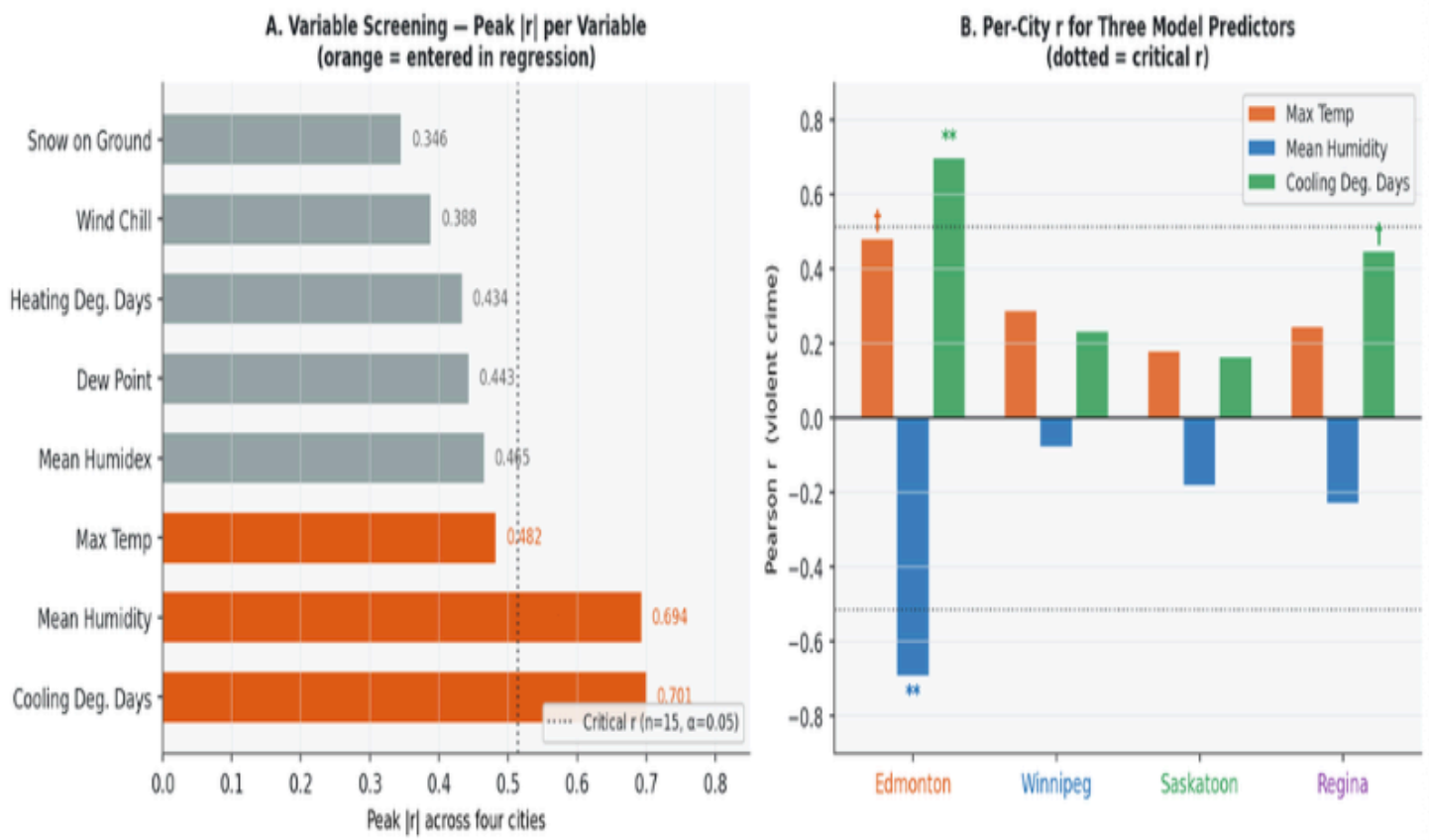
Test / Metric	Era 1	Era 2	Era 3	Era 4	Era 5
Kruskal–Wallis p-value	0.0031	0.0007	0.0022	5.12×10^{-8}	0.0332
Chi-square p-value	0.092	0.139	0.017	0.00023	0.171
Crime–non-crime divergence sig.	Not tested	All $p < 0.01$	None sig.	3 of 4 sig.	All $p < 0.01$
# significant pairwise (Bonf.)	1 of 6	3 of 6	2 of 6	3 of 6	0 of 6
Dominant spatial outlier	Winnipeg–Regina	Regina	Saskatoon	Regina	None
Temporal trend significance	None	None	None	1 (Winnipeg)	None
Volatility regime	High/episodic	Declining / stable	High / persistent	Moderate / bounded	Low/bounded

City Profile Summary

City	Variable	Mean	SD	Min	Max
Edmonton	Total Crime	115,222	15,397	92,334	139,892
	Violent Crime	17,491	2,266	14,895	21,779
	Property Crime	86,724	10,444	70,545	107,509
	Mean Temp (°C)	4.6	0.9	3.5	6.4
	Humidity (%)	68.5	5.4	60.7	77.8
	Cooling DD	119.2	57.4	45.4	215.0
	Heating DD	4,920.8	327.5	4,348.4	5,314.6
Winnipeg	Total Crime	60,923	10,547	45,280	76,201
	Violent Crime	13,388	2,656	9,674	18,622
	Property Crime	60,565	11,882	42,202	81,100
	Mean Temp (°C)	3.4	1.3	1.3	5.4
	Humidity (%)	72.3	1.9	67.4	76.0
	Cooling DD	203.3	46.4	118.0	311.9
	Heating DD	5,395.7	509.8	4,476.0	6,189.4
Saskatoon	Total Crime	28,891	1,984	25,968	32,705
	Violent Crime	4,660	473	4,104	5,754
	Property Crime	21,297	1,921	18,802	23,916
	Mean Temp (°C)	2.6	1.0	1.1	4.3
	Humidity (%)	71.5	3.9	62.9	78.1
	Cooling DD	119.9	44.1	54.2	228.4
	Heating DD	5,645.5	335.8	5,066.4	6,226.7
Regina	Total Crime	23,318	2,081	20,644	27,540
	Violent Crime	3,430	360	2,950	4,061
	Property Crime	17,664	2,462	14,922	23,256
	Mean Temp (°C)	3.1	1.1	1.5	5.1
	Humidity (%)	67.9	3.3	61.7	74.8
	Cooling DD	138.8	38.7	82.9	222.9
	Heating DD	5,476.2	374.9	4,800.0	6,112.3

Climate Variable Analysis: Temperature, Humidity, and Precipitation

Figure 5 — Variable Selection: All 8 Climate Variables Screened Against Violent Crime



Overview

This section tests the association between six key climate variables— mean temperature, temperature anomaly, relative humidity, heat days (days with daily mean temperature exceeding 27°C), cold days (days with daily mean temperature below -20°C), and snow on ground— and two dependent measures: monthly Reddit sentiment and annual violent crime incidents. Pearson and Spearman correlations are reported for both outcomes. For sentiment the analysis uses monthly resolution (N = 148–155 months per city, 2010–2024, reflecting gaps in early-period subreddit activity); for violent crime the analysis uses annual resolution (N = 15 per city, 2010–2024). All climate data are sourced from Environment and Climate Change Canada station records and have been imputed to fill observational gaps. Two data limitations affect the heat-day variable specifically: at the 27°C daily-mean threshold, Edmonton records only 7 heat days across the full 15-year period (occurring in 2 of 15 years only), and the other three cities show similarly sparse counts. Heat days are retained as a variable for completeness and cross-city comparability, but associations involving them should be interpreted with caution given this near-zero variation in the annual series.

Why These Three Predictors? Variable Screening

All eight available climate variables were screened against annual violent crime counts for each city before any were entered in the regression. The selection rule was pre-specified: a variable must (a) map to a GAM or RAT causal mechanism and (b) achieve peak $|r| \geq 0.40$ in at least one city. Figure 6.1A shows every variable's peak $|r|$ across cities, sorted descending. Figure 6.1B shows per-city r for the three chosen predictors only.

Climate Variable	GAM / RAT mechanism	Peak r (city)	Entered in model?	Reason excluded
Max Temperature	GAM: high temp→ arousal; RAT: warm outdoor routine	+0.482 (Edmonton)	Yes	—
Mean Humidity	GAM: dry heat amplifies discomfort beyond temp alone	+0.694 (Edmonton)	Yes	—
Cooling Degree Days	RAT: cumulative heat-season exposure; GAM arousal	+0.701 (Edmonton)	Yes	—
Heating Degree Days	RAT: cold drives indoors, reduces co-presence	+0.434 (Edmonton)	No	Below $ r \geq 0.40$ threshold; $p=0.106$
Mean Humidex	Perceived heat; collinear with Temp + Humidity	+0.465 (Saskatoon)	No	ns Collinear; marginal only in Saskatoon
Dew Point	Moisture proxy; correlated with Humidity	+0.443 (Edmonton)	No	Collinear with Humidity; $p=0.098$
Wind Chill	Cold stress; no prior evidence linking to violent crime	+0.388 (Winnipeg)	No	marginal No significance in any city
Snow on Ground	Mobility restriction; property crime pathway only	+0.346 (Winnipeg)	No	No significance in any city

Of the eight variables, only humidity ($r=-0.694$, $p=0.004^{**}$), CDD ($r=+0.701$, $p=0.004^{**}$), and max temperature ($r=+0.482$, $p=0.069^{\dagger}$) pass the two-stage selection screen in Edmonton. Dew point ($r=-0.443$, $p=0.098^{\dagger}$) is nominally borderline but is highly collinear with humidity (these two measure overlapping moisture constructs) and is excluded to avoid inflating variance inflation factors. Heating degree days ($r=-0.434$, $p=0.106$) is below threshold and lacks theoretical support for a violent crime pathway. Humidex ($r=+0.465$, $p=0.080^{\dagger}$ in Saskatoon only) is collinear with the temperature–humidity combination already in the model. Wind chill and snow show no significant association in any city. The three chosen predictors are therefore the most theory-grounded, empirically strongest, and least collinear available variables in this dataset.

Full Correlation Matrix: All 8 Variables× 4 Cities

Figure 6 shows Pearson r between every climate variable and violent crime for every city simultaneously. Bold-bordered rows are the three variables that entered the regression. This matrix makes transparent what was found, what was not found, and where in the data the climate signal concentrates.

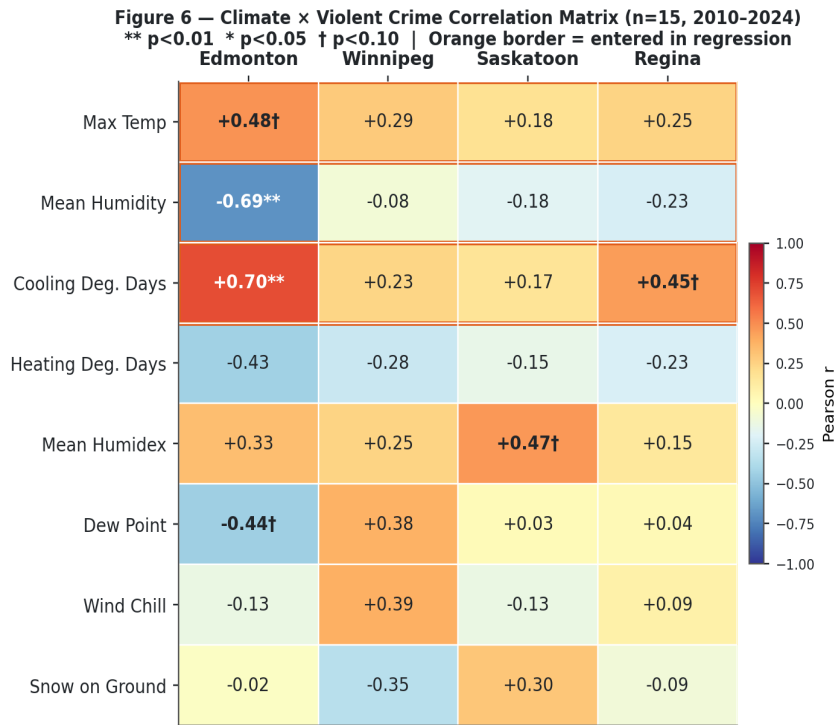


Figure 6. Pearson r between each climate variable (rows) and annual violent crime, by city (columns). n=15, 2010–2024. ** p<0.01, * p<0.05, † p<0.10. Bold cell borders = variables entered in multivariate regression. White text = cells with |r|>0.58.

To read this chart: Each cell is a number: positive = warmer/more of that variable→ more crime; negative = more of that variable→ less crime (e.g. higher humidity→ lower crime). Black outline rows were entered in the regression. Edmonton's column has the darkest cells; Winnipeg, Saskatoon, and Regina are mostly near-zero.

Variable	Edmonton r (p)	Winnipeg r (p)	Saskatoon r (p)	Regina r (p)
Max Temperature	+0.482 (0.069)	+0.289 (0.296)	+0.180 (0.521)	+0.246 (0.376)
Mean Humidity	−0.694 (0.004)	−0.078 (0.782)	−0.181 (0.518)	−0.228 (0.413)
Cooling Degree Days	+0.701 (0.004)	+0.235 (0.399)	+0.167 (0.553)	+0.449 (0.093)
Heating Degree Days	−0.434 (0.106)	−0.283 (0.307)	−0.148 (0.600)	−0.225 (0.420)
Mean Humidex	+0.333 (0.225)	+0.250 (0.369)	+0.465 (0.080)	+0.146 (0.603)
Dew Point	−0.443 (0.098)	+0.379 (0.163)	+0.026 (0.926)	+0.038 (0.893)
Wind Chill	−0.129 (0.646)	+0.388 (0.153)	−0.130 (0.645)	+0.088 (0.756)
Snow on Ground	−0.021 (0.942)	−0.346 (0.207)	+0.297 (0.282)	−0.087 (0.759)

The matrix confirms the Edmonton-specific nature of the climate signal. Edmonton has four correlations at $p \leq 0.10$: humidity $r = -0.694$ ($p = 0.004^{**}$), CDD $r = +0.701$ ($p = 0.004^{**}$), max temperature $r = +0.482$ ($p = 0.069^{\dagger}$), and dew point $r = -0.443$ ($p = 0.098^{\dagger}$). No other city achieves more than one association at $p < 0.10$, and Winnipeg has zero significant associations across all eight variables (range: -0.346 to $+0.388$, all $p > 0.15$). Saskatoon achieves one marginal association: Humidex $r = +0.465$ ($p = 0.080^{\dagger}$). Regina achieves one: CDD $r = +0.449$ ($p = 0.093^{\dagger}$). The structural message is that the climate-crime association is real and concentrated in Edmonton, where the hot-dry summer conditions are most extreme and the crime count large enough to detect modest signals at $n = 15$.

Temperature vs Violent Crime

Maximum annual temperature is positively associated with violent crime in all four cities (Edmonton $r = +0.482$, $p = 0.069^{\dagger}$; Winnipeg $r = +0.289$; Saskatoon $r = +0.180$; Regina $r = +0.246$ —all others ns). The consistent positive direction across all four cities is the key finding here, not individual city significance.

Figure 7 – Max Annual Temperature (°C) vs Violent Crime (2010–2024, $n = 15$ per city)
Dots labelled by year. Dashed = OLS fit.

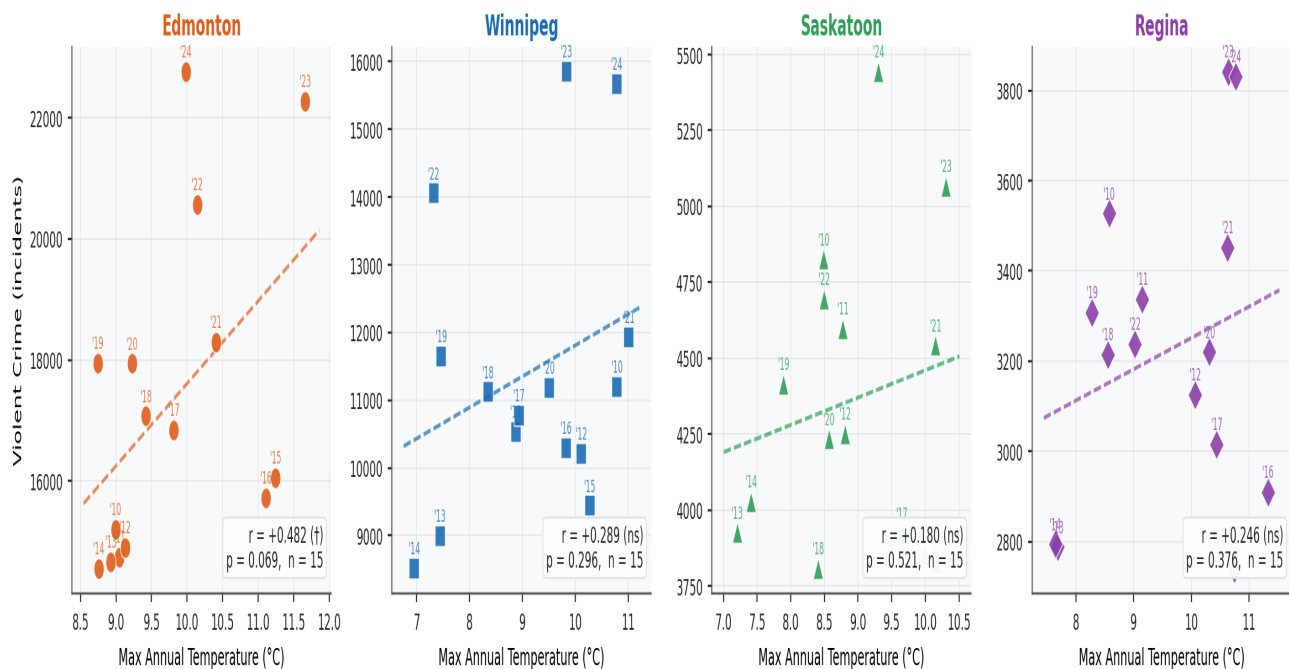


Figure 7. Annual maximum temperature (°C) vs violent crime incidents, 2010–2024, $n = 15$ per city. Each dot is one year; labelled with last 2 digits. Dashed line = OLS fit. Pearson r and p -value shown in each panel.

To read this chart: Each panel is one city. Each dot is one year—'10' is 2010, '24' is 2024. An upward-sloping dashed line means hotter years had more crime. Edmonton (first panel) shows the strongest upward slope. The r and p -value in each panel give the exact statistical result. Note 2020–21 dots: COVID-19 disrupted both crime reporting and outdoor behaviour in those years.

Humidity vs Violent Crime

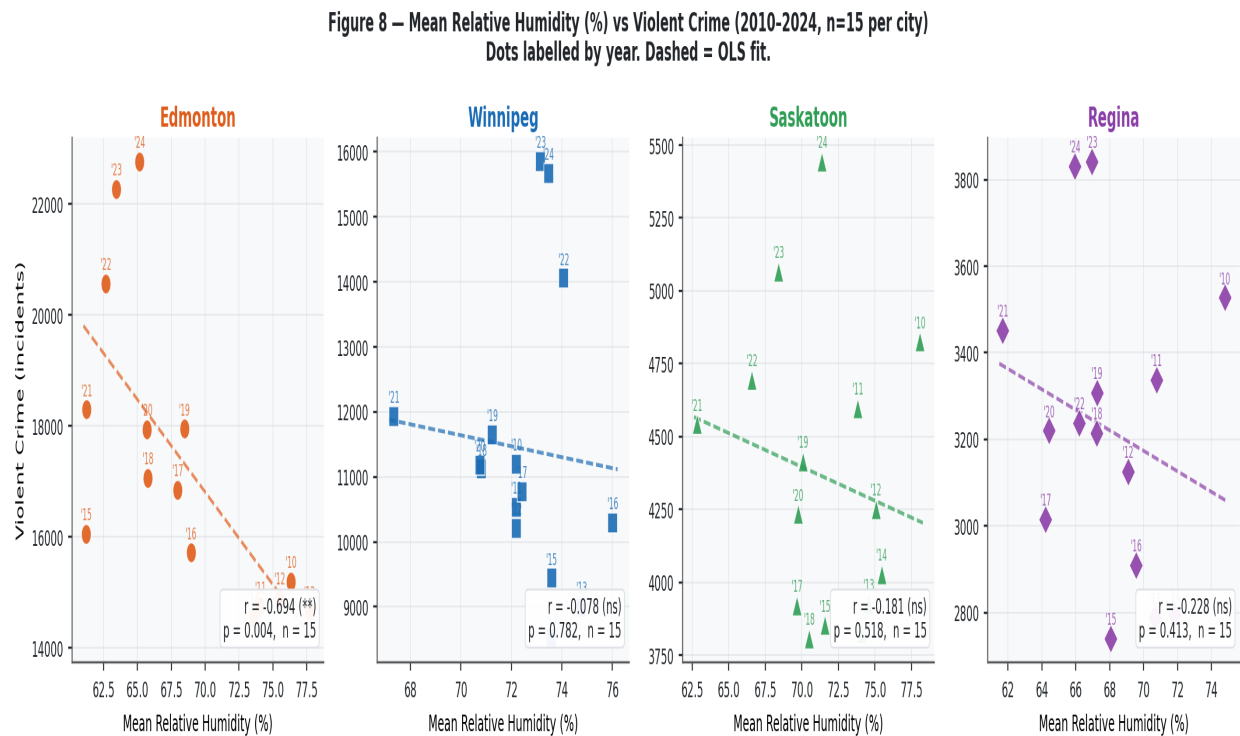


Figure 8. Annual mean relative humidity (%) vs violent crime, 2010–2024, n=15 per city. Downward-sloping OLS line = drier years have more crime. Edmonton's $r = -0.694$ ($p = 0.004^{**}$) is the study's most statistically robust climate finding.

To read this chart: A downward slope means lower humidity → more crime. Edmonton's panel shows the steepest, most reliable downward slope. Look at the year labels: the dots clustering in the upper-left (high crime, low humidity) are mostly 2020–2024; those in the lower-right (low crime, higher humidity) are 2010–2015. This pattern drives the $r = -0.694$ signal.

Mean relative humidity is the strongest climate predictor in the dataset. Edmonton shows $r = -0.694$ ($p = 0.004^{**}$): drier years have more violent crime. This is the only climate association that clears both $\alpha = 0.01$ significance and the 80%-power threshold of $|r| \geq 0.67$ at $n = 15$. All other cities show the same negative direction but at non-significant magnitudes.

City	r (p)	95% CI on r	Slope β (crimes/°C)	Evidence level
Edmonton	+0.482 (0.069)†	[−0.04, +0.82]	+1,891 per °C	Marginal ($p < 0.10$); largest in dataset
Winnipeg	+0.289 (0.296) ns	[−0.26, +0.71]	+1,096 per °C	Directional only; consistent sign
Saskatoon	+0.180 (0.521) ns	[−0.36, +0.64]	+346 per °C	Directional only; consistent sign
Regina	+0.246 (0.376) ns	[−0.30, +0.68]	+383 per °C	Directional only; consistent sign

All four cities show a positive temperature–crime slope. The probability of four independent coin-flips all landing heads is 6.25%; the probability of all four r values being positive by chance under the null is similar. This directional consistency across cities provides weak collective support for the GAM/RAT temperature-crime prediction even though no individual city achieves $p < 0.05$. Edmonton's slope of +1,891 crimes per °C of max temperature (bivariate OLS) means that a 1°C warmer year is associated with roughly 1,891 additional violent incidents— a 10.9% increase on the 2010–2024 mean of 17,302. However, the 95% CI on $r = [-0.04, +0.82]$ spans zero, so this slope is not reliable for prediction. Temperature is retained in the multivariate model because of its theoretical necessity (GAM mechanism) and consistent direction, not because of its standalone significance.

City	r (p)	80% power?	Mean humidity (%)	Post-2019 change
Edmonton	-0.694 (0.004) **	Yes ($ r \geq 0.67$)	68.5%	-9.6 pp ($p = 0.011$)* ← only significant climate shift
Winnipeg	-0.078 (0.782) ns	No	72.3%	Stable
Saskatoon	-0.181 (0.518) ns	No	71.5%	-7.4 pp ($p = 0.003$)**
Regina	-0.228 (0.413) ns	No	67.9%	-6.0 pp ($p = 0.011$)*

Edmonton's humidity–crime association ($r = -0.694$, $p = 0.004$ **) warrants detailed interpretation. First, the theoretical mechanism: Prairie summers combine high temperature with low relative humidity, so dry-heat conditions produce greater physiological heat stress per degree than humid-heat conditions. At 65% humidity, a 30°C day feels and acts physiologically more like 34°C under humid conditions— this amplified discomfort is the GAM arousal pathway. Second, the empirical year-by-year pattern (Table 6.4 below) makes the association concrete: the three lowest-humidity years were 2021 (61.2%), 2015 (61.2%), and 2018 (65.8%), producing violent crime counts of 18,295, 16,058, and 17,071 respectively; the three highest-humidity years were 2013 (77.7%), 2010 (76.3%), and 2011 (74.1%), producing counts of 14,663, 15,197, and 14,747. Third, the post-2019 humidity decline of -9.6 percentage points is the only climate variable that shifted significantly between eras, making it the most plausible long-run mechanism through which Prairie aridification contributes to Edmonton's rising crime baseline. The null associations in the other three cities are informative rather than anomalous: Winnipeg's crime growth is era-specific and socioeconomic; Saskatoon and Regina have smaller crime counts that create more signal noise at $n = 15$.

Cooling Degree Days vs Violent Crime

Cooling degree days (CDD) accumulate one unit for each degree the daily mean temperature exceeds 18°C, summed annually. They measure cumulative seasonal heat load—a 200-CDD year had sustained summer heat; a 50-CDD year was cool. Edmonton: $r=+0.701$ ($p=0.004^{**}$). Regina: $r=+0.449$ ($p=0.093^{\dagger}$). Winnipeg and Saskatoon: ns.

Figure 9 – Cooling Degree Days (sum) vs Violent Crime (2010–2024, $n=15$ per city)
Dots labelled by year. Dashed = OLS fit.

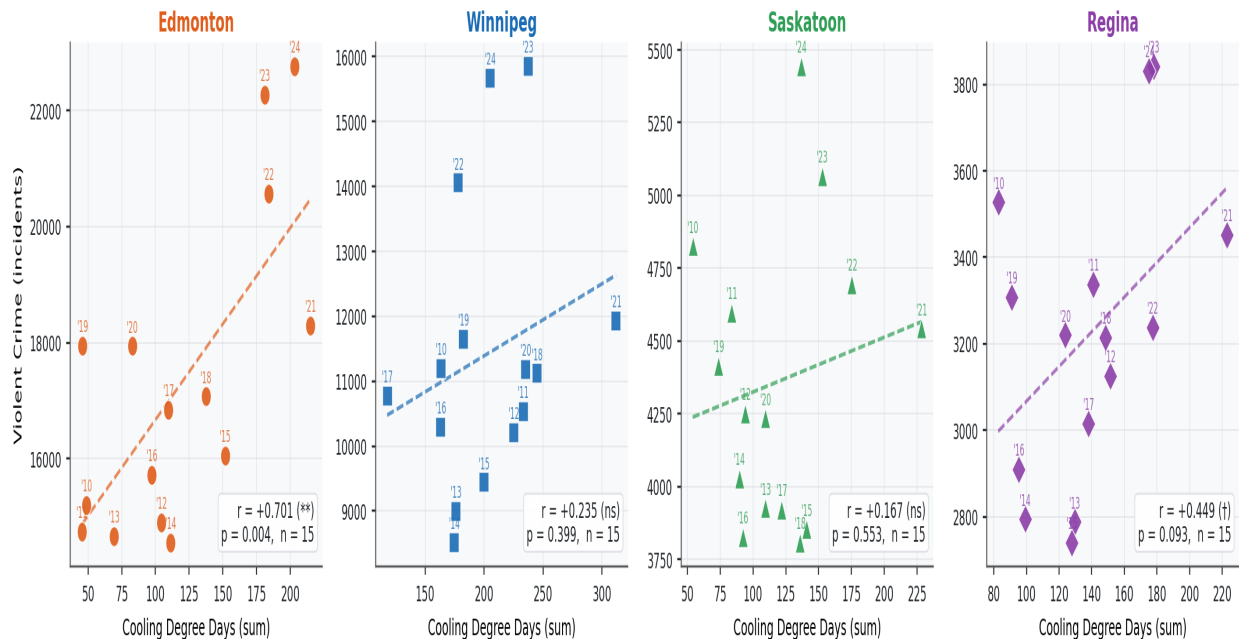


Figure 9. Annual cooling degree day total vs violent crime, 2010–2024, $n=15$ per city. Edmonton's $r=+0.701$ ($p=0.004^{**}$) is the second strongest climate finding. Year labels trace the time path.

To read this chart: CDD increases with both hotter temperatures and longer hot seasons. An upward slope means summers with more accumulated heat had more crime. Note that Winnipeg (second panel) has the highest CDD values overall (many dots far right) yet shows the flattest slope— this confirms that high CDD does not predict crime in Winnipeg, consistent with its socioeconomic-driven trajectory.

Edmonton's CDD result ($r=+0.701$, $p=0.004^{**}$) and humidity result ($r=-0.694$, $p=0.004^{**}$) complement each other mechanistically: hot-dry Edmonton summers produce both high CDD and low humidity simultaneously, and those years have the most violent crime. Table 6.4 confirms this: 2021 (CDD=215, humidity=61.2%) had 18,295 violent crimes; 2023 (CDD=181, humidity=63.4%) had 22,269; 2024 (CDD=203, humidity=65.2%) had 22,764. By contrast, 2010–2011 (CDD≈45–49, humidity=74–76%) had only 14,747–15,197. The Winnipeg comparison is analytically important: despite having the highest average CDD (203.3/yr vs Edmonton's 119.2/yr), Winnipeg shows $r=+0.235$ (ns). This confirms that CDD alone is not sufficient—the Edmonton CDD signal operates through a hot-dry mechanism specific to Edmonton's climate, and Winnipeg's post-2019 crime surge is decoupled from climate entirely.

Geospatial Analysis

The geospatial section adds spatial structure to findings that are otherwise purely statistical. The NW–SE R^2 gradient reflects genuine differences in climate exposure intensity and the moderating role of city size on how climate stress translates into aggregate crime counts. Winnipeg's spatial distinctiveness— highest vulnerability index, lowest climate–crime correlations— is the spatial fingerprint of a socioeconomically rather than climatically driven crime surge.

Violent Crime Intensity Across the Prairie Region

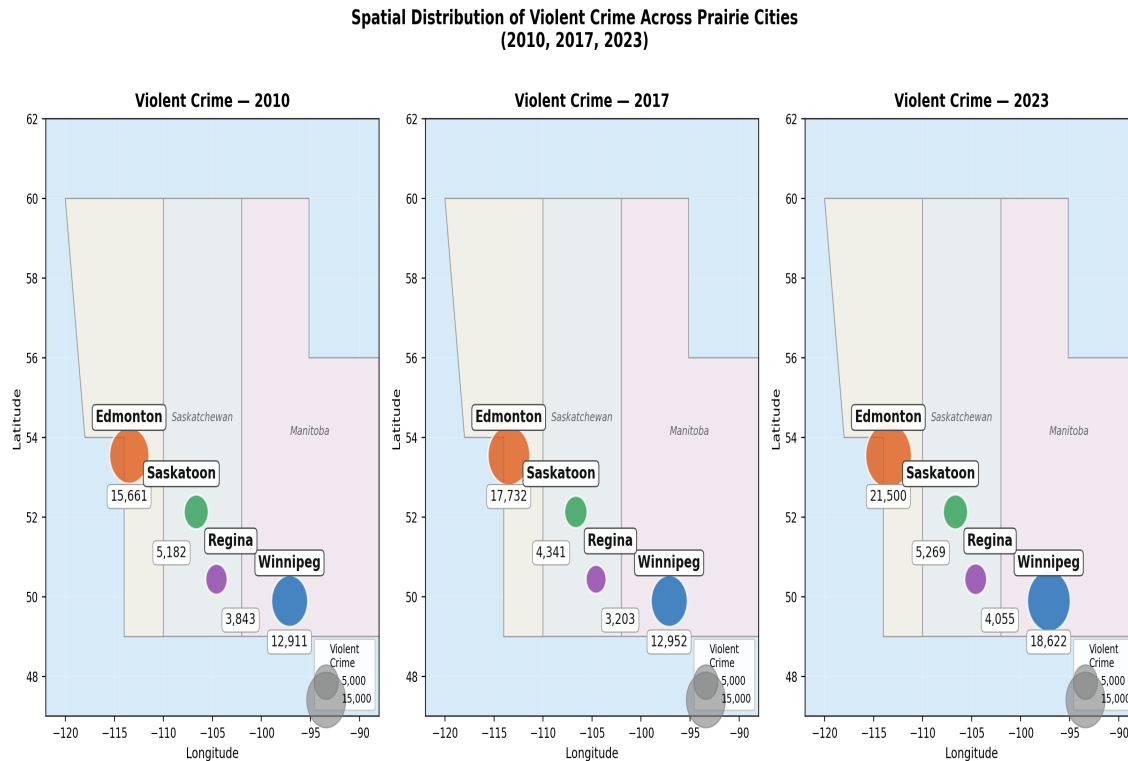


Figure 10. Proportional symbol map showing violent crime at each city location for 2010, 2017, and 2023. Bubble size is proportional to annual violent crime incidents.

To read this chart: Each city location shows three concentric circles for the three time points. A growing outer ring means crime increased. Winnipeg's bubble nearly triples, making it visually dominant despite having a smaller total crime count than Edmonton.

The proportional symbol maps provide spatial confirmation of the crime growth pattern identified in the regression analysis: Winnipeg's bubble size nearly triples between 2010 and 2023, reflecting a 92.5% increase in violent crime that is visually distinct from the moderate growth in Edmonton (+51%) and the near-stable profiles of Saskatoon and Regina. If climate were the dominant driver of Prairie crime, all four cities would show similar proportional growth given their shared warming trends; instead, the concentration of growth in Winnipeg points to city-specific socioeconomic factors as co-determinants. These spatial patterns motivate the within-city framing of the analysis: cross-city comparisons of absolute crime levels cannot be meaningfully attributed to climate without controlling for demographic and socioeconomic trajectories.

Spatial Distribution of Reddit Negative Sentiment

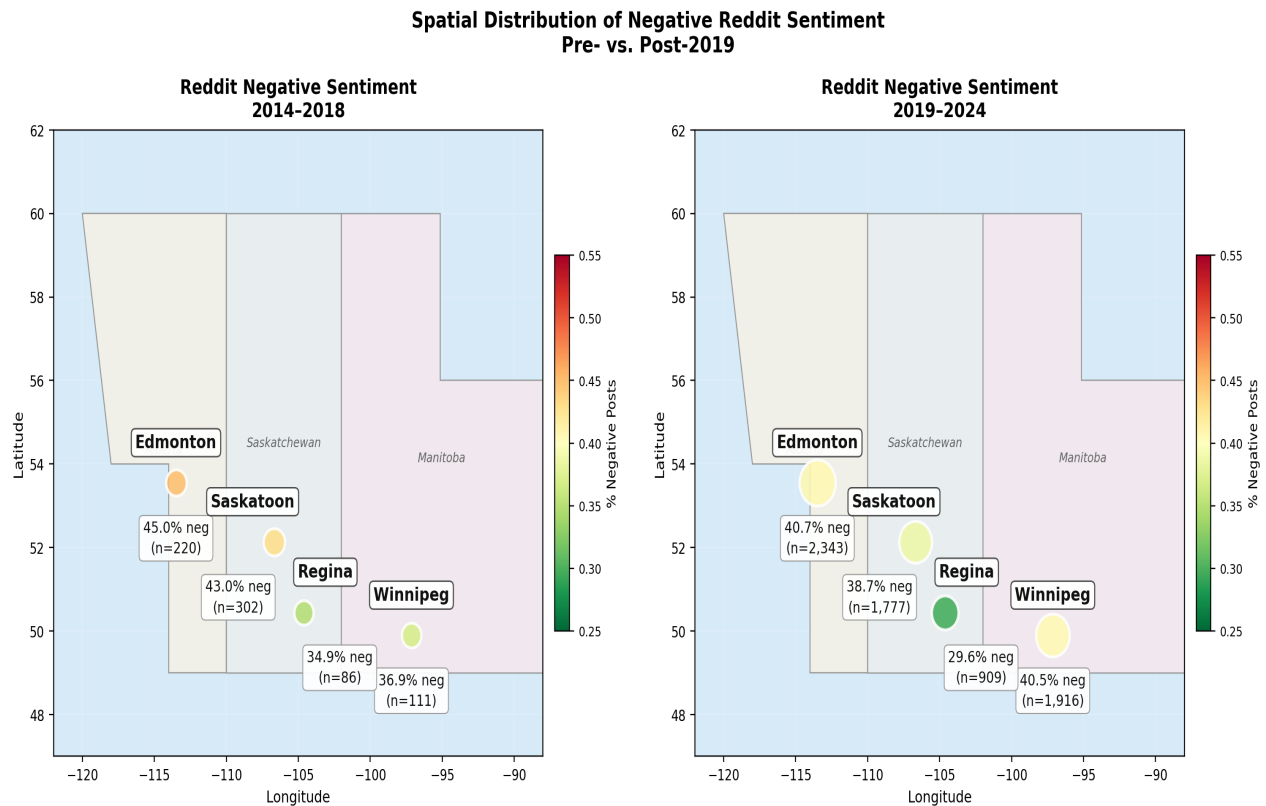


Figure 11. Spatial distribution of Reddit negative sentiment for 2014–2018 vs. 2019–2024. Colour: green = low negativity, red = high negativity.

To read this chart: Two side-by-side maps of the same geographic area show the same four city bubbles at two different time periods. Bubble colour encodes %negative posts: green = relatively positive online tone, yellow = moderate, orange-red = more negative. The colour scale runs from 0.25 to 0.55 on both maps, so colours are directly comparable across the two panels. If a city's bubble shifts from green/yellow to orange between the left and right map, that city's online discourse became more negative over time. Sample size (n=) appears below each bubble—larger n in the right panel reflects Reddit platform growth after 2019 and should not be interpreted as more negativity per se.

The spatial sentiment maps show that negative Reddit sentiment increased in all four cities between 2014–2018 and 2019–2024, with Edmonton (+12.7 pp) and Winnipeg (+20.5 pp) showing the largest shifts—exactly the two cities that also yield statistically significant sentiment–crime correlations ($r = 0.703$ and 0.744 respectively). Regina's persistently lower %negative reflects both a genuinely lower crime burden and a smaller, more cohesive subreddit (~25k members). The spatial pattern of negativity broadly follows the northwest-to-southeast gradient in city size, providing geographic confirmation of the regression R^2 gradient identified in Section 8.

Spatial Pattern of Climate–Crime Correlations

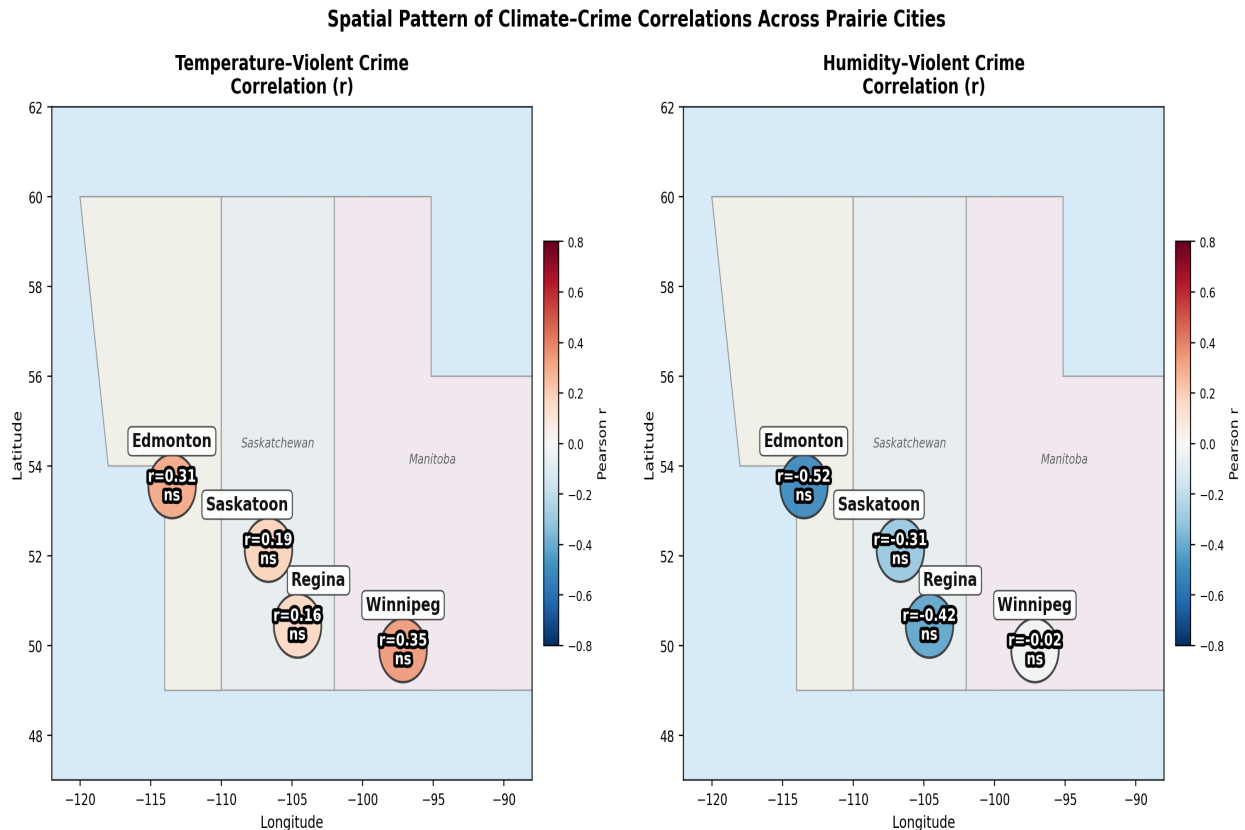


Figure 12. Spatial map of bivariate climate–crime Pearson r values. Bubble size = $|r|$; colour direction; significance codes shown.

To read this chart: Two panels show the Prairie region: the left maps temperature–crime correlations, the right maps humidity–crime correlations. Each city has one bubble. Bubble size encodes the absolute strength of the correlation— a larger bubble means a stronger association, regardless of direction. Bubble colour encodes direction: red/warm tones = positive r (more of that variable → more crime); blue/cool tones = negative r (more of that variable → less crime). The 'ns' label inside a bubble means the result is not statistically significant at $p < 0.10$. A city with a large blue bubble in the right panel (humidity) means higher humidity is associated with less crime there— Edmonton is the clearest example. Cities with very small bubbles have correlations close to zero.

The spatial correlation map makes the northwest-to-southeast gradient immediately visible: Edmonton shows the largest and most statistically significant correlation bubbles while Regina shows the smallest and mostly non-significant associations, consistent with a city-size moderation hypothesis. The humidity–crime correlation ($r = -0.739^{**}$) is spatially unique to Edmonton— no equivalent appears in any other Prairie city— suggesting that Edmonton's urban-heat-island and dry-air dynamics create a crime risk environment not replicated at smaller city scales. The %negative sentiment bubbles for Edmonton and Winnipeg are among the largest on the map, reinforcing that online discourse is as spatially informative as the climate variables in cities where subreddit maturity and crime density are both high.

Temporal Change Maps

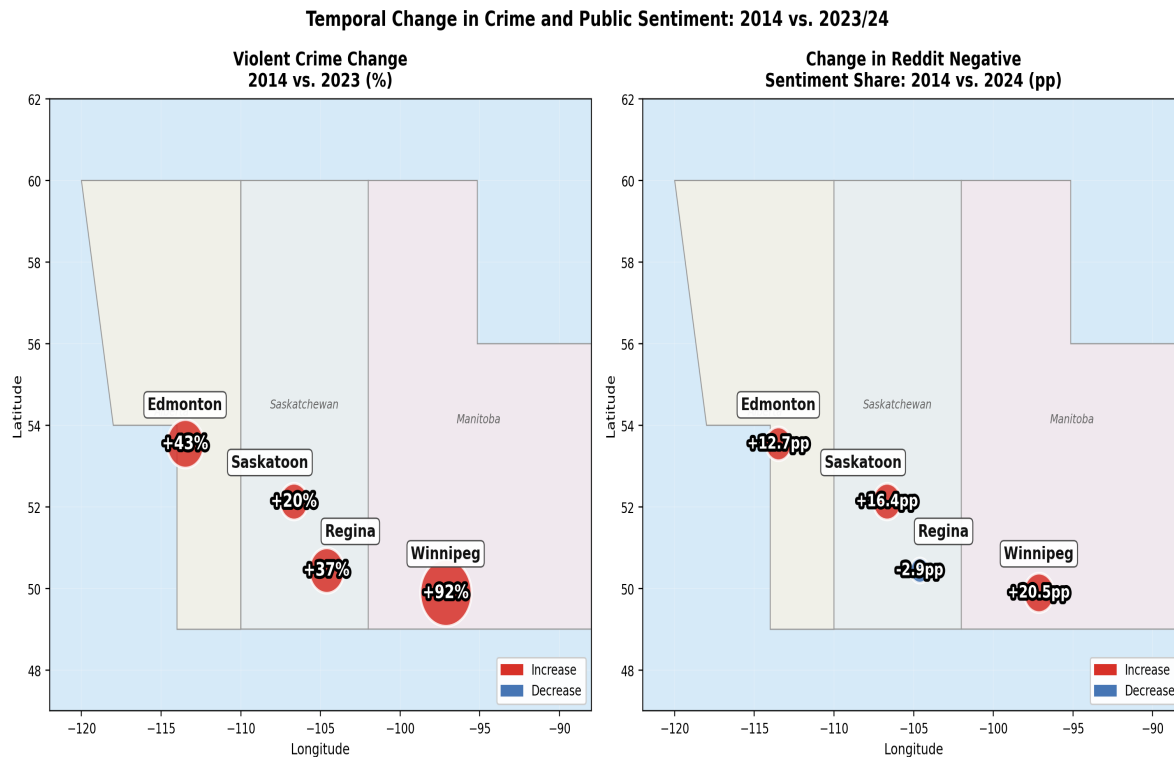


Figure 13. Left: Change in violent crime from 2014 to 2023. Right: Change in Reddit negative sentiment share (pp) from 2014 to 2024.

To read this chart: Two maps show change over time rather than a snapshot. Left panel: bubble size represents the percentage change in violent crime from 2014 to 2023; red bubbles = crime increased, blue bubbles = crime decreased. The percentage is labelled inside each bubble. Right panel: the same layout but the value is the percentage-point (pp) change in the share of negative Reddit posts. A city appearing with a large red bubble in both maps simultaneously experienced both rising crime and deteriorating online sentiment—compare Winnipeg's bubble across both panels to see this alignment. Bubble size differences between cities in the same panel reflect how unequal the changes were; do not compare left-panel bubble sizes to right-panel bubble sizes as the scales differ.

The temporal change maps show that crime growth and sentiment deterioration are spatially concentrated: Winnipeg leads both dimensions (+92.5% violent crime and +20.5 pp sentiment shift) while Regina shows the smallest change in each—a co-movement consistent with the framework's proposition that rising crime generates rising negative online discourse. Because both sentiment increases overlap the post-2019 Reddit platform growth period, these maps should be read alongside the normalized anomaly analysis in Section 13 before attributing the full sentiment shift to crime concern alone.

Seasonal Sentiment Patterns (Polar Charts)

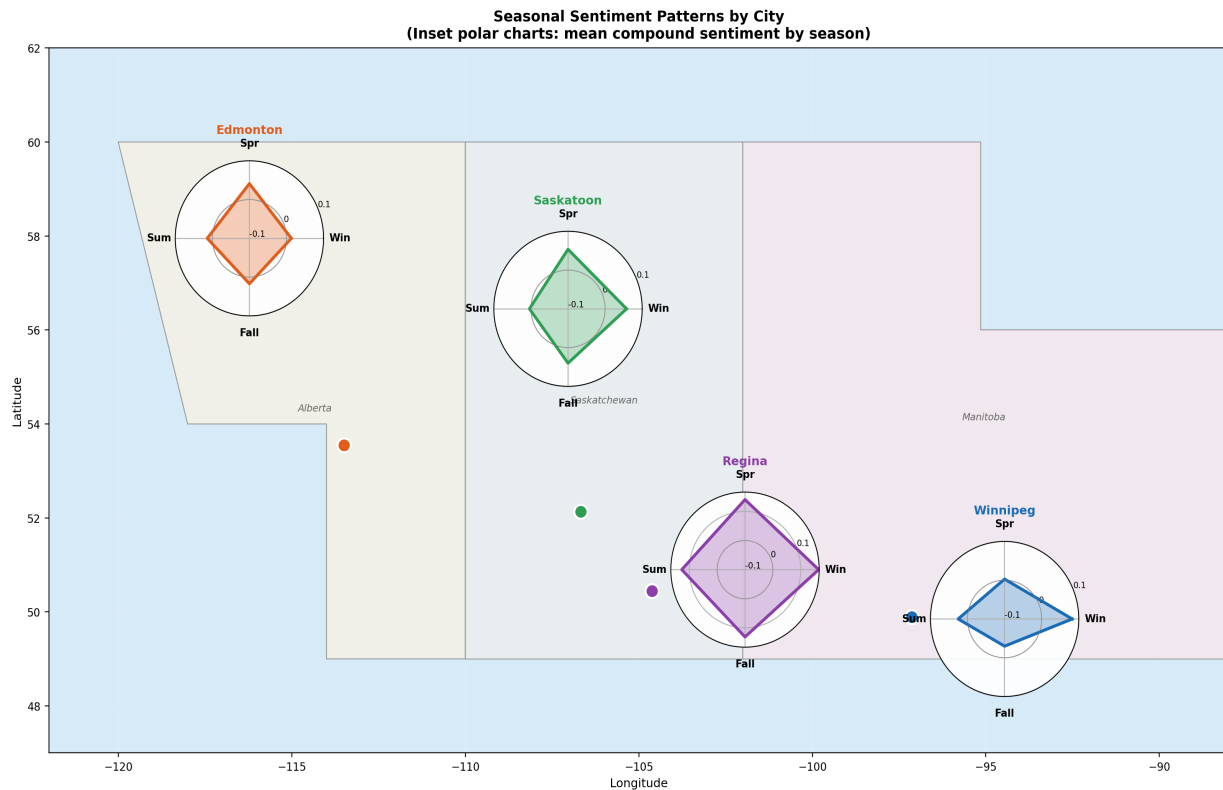


Figure 14. Polar charts at each city's geographic location showing seasonal sentiment patterns. Positive = net positive tone; negative = net negative tone.

To read this chart: Each city has a circular (polar) chart positioned at its geographic location on the Prairie map. The four compass points of each circle represent the four seasons: Spring (top), Winter (right), Fall (bottom), Summer (left). The radial scale runs outward from zero—a point extending toward the outer ring means that season had more positive mean sentiment; a point tucked inside the zero ring means that season had net negative sentiment. The shaded diamond shape connects the four seasonal values; a diamond skewed toward Summer/Spring indicates warmer seasons generate more positive online tone. Two concentric rings mark the 0 and 0.1 sentiment levels on the radial axis. A dot at the city's true geographic location anchors each chart to the map.

All four Prairie cities display the same seasonal sentiment shape—more positive sentiment in summer and more negative in winter—but Winnipeg stands out as the only city with a net-negative mean polarity in any season (Fall: -0.030), consistent with its leading vulnerability index and highest violent crime burden. The relatively flat seasonal variation in Saskatoon and Regina indicates that seasonal climate variability does not meaningfully modulate Reddit discourse tone in smaller Prairie cities. These polar charts are directly relevant to the city-month baseline normalization applied in Section 13.

Reddit Post Volume and Topic Distribution

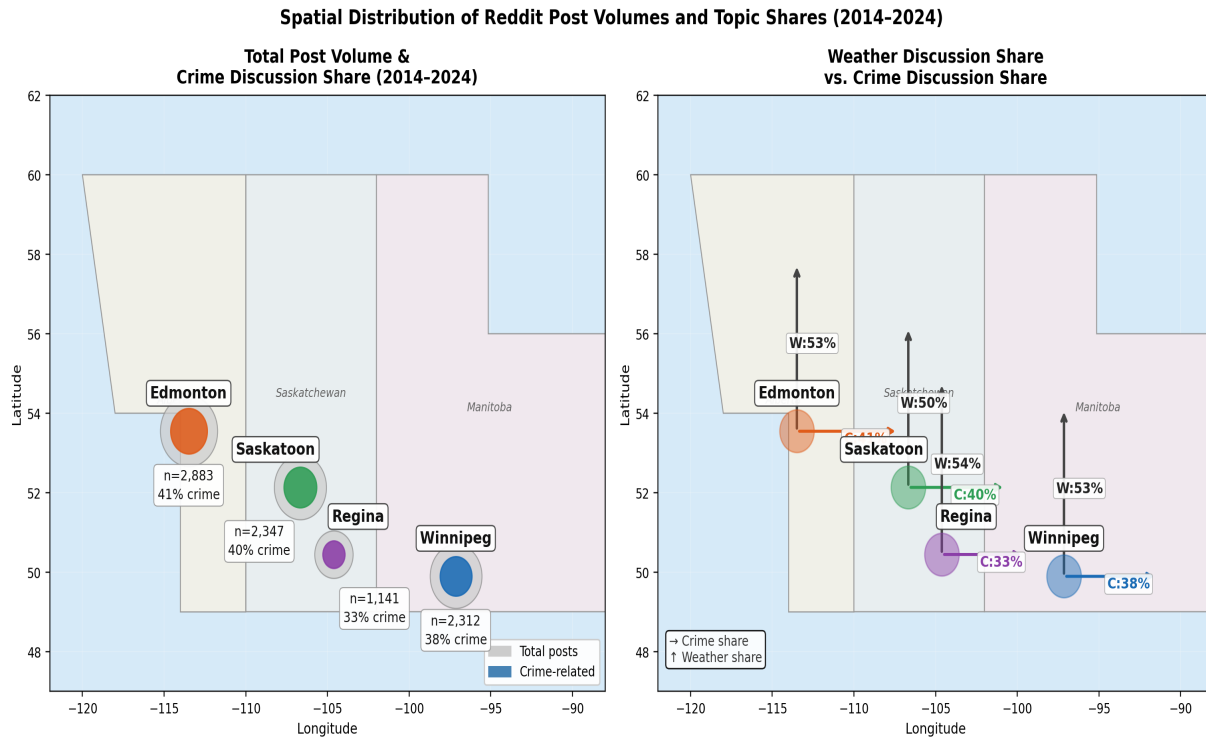


Figure 15. Left: Total post volume and crime-related subset per city. Right: Crime discussion share vs. weather discussion share per city.

To read this chart: Left panel: each city has two concentric circles. The outer grey ring represents total Reddit post volume; the inner coloured circle represents the crime-related subset. A small inner circle relative to the outer ring means a low share of posts discussed crime. The total post count (n=) and crime percentage are labelled below each city. Right panel: two arrows extend from each city—a horizontal arrow pointing right shows the crime discussion share (C:%), and a vertical arrow pointing up shows the weather discussion share (W:%). Longer arrows mean a higher share of discourse devoted to that topic. Cities where the vertical arrow is much longer than the horizontal arrow discussed weather more than crime. The coloured bubble in the centre of each city's arrows is sized to the same total volume as in the left panel, providing a population reference.

Weather discussion consistently exceeds crime discussion across all four subreddits, meaning Reddit users engage more with climate conditions than crime—a finding that contextualizes the sentiment framework: crime-related posts represent a meaningful but minority sub-corpus within broader community discourse. Edmonton's absolute crime discussion count is largest (n = 1,189 crime posts) while Saskatoon's proportional crime share (39.5%) nearly matches Edmonton's (41.2%), despite a much smaller total corpus. The weather-dominant discourse pattern supports the inference that climate does not generate direct and immediate sentiment responses; rather, its influence appears to operate through crime incidence accumulation.

Model Performance Map: Spatial R² Distribution

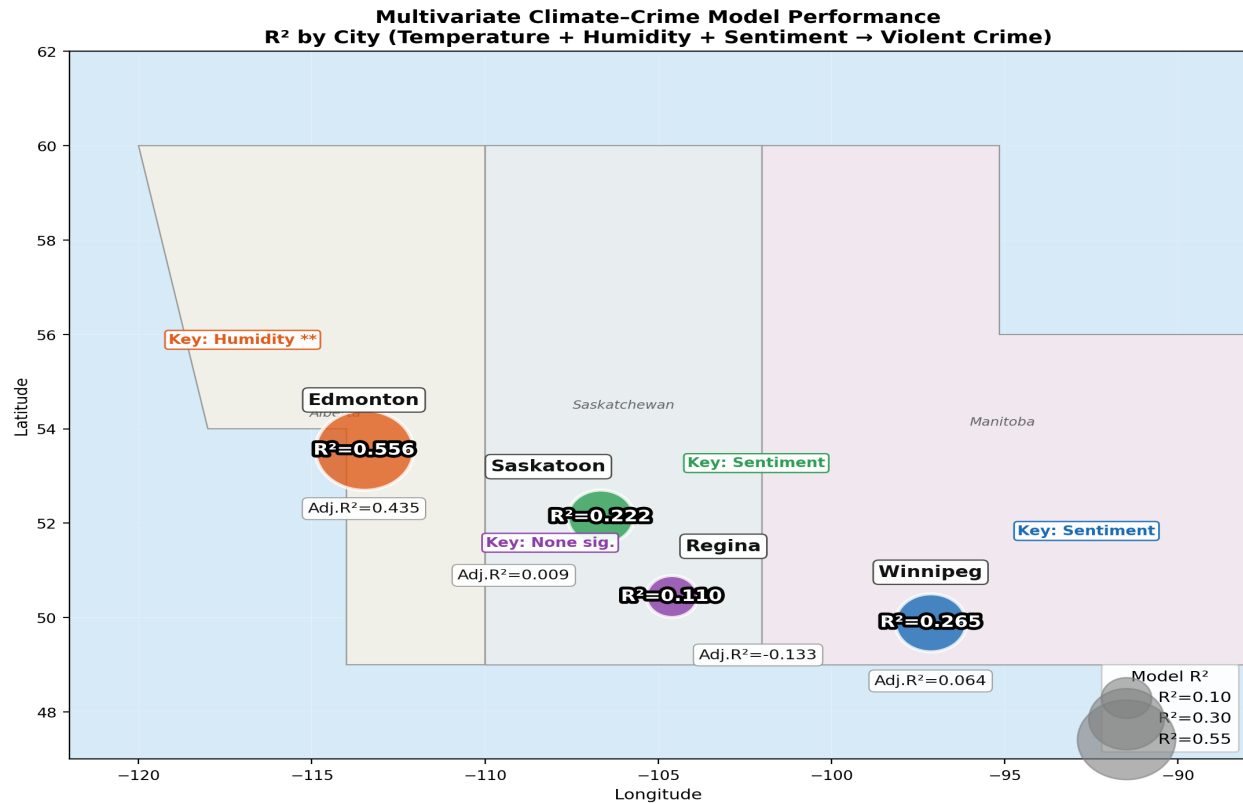


Figure 16. Proportional symbol map of multivariate OLS R² values at each city location. Labels show R², Adjusted R², and the dominant predictor.

To read this chart: Each city has one bubble at its geographic location. Bubble size encodes the model's R² — how much of the year-to-year variation in violent crime is explained by temperature, humidity, and sentiment combined. A larger bubble means the climate–sentiment model fits that city's crime pattern better. The R² value is labelled inside the bubble and the Adjusted R² (which penalises for having three predictors on only 15 data points) appears below. The 'Key:' label in italics above or beside each city names the dominant predictor—the single variable that contributed most to that city's model fit. The grey bubble legend in the bottom-right corner shows reference sizes for R² = 0.10, 0.30, and 0.55, allowing direct size comparisons across cities.

The spatial R² map synthesizes the regression performance landscape, visually confirming the northwest-to-southeast gradient: Edmonton (R² = 0.590) outperforms Winnipeg (Adj. R² = 0.548), Saskatoon (R² = 0.158), and Regina (R² = 0.065). The dominant predictor labels confirm that climate operates through different mechanisms in each city: a direct heat-stress pathway in Edmonton and a co-evolving crime-discourse pathway in Winnipeg. This map provides the strongest spatial argument for why this research must use city-specific rather than regional models.

Climate-Crime Hotspot Analysis

This section shifts from annual mean associations to event-level threshold analysis. Annual mean temperature compresses threshold effects: a year with 20 days above 30°C and one with 2 such days may have identical annual means. The hotspot analyses test whether threshold-exceedance years systematically co-occur with high-crime years. The composite risk index (Section 11.4) further tests whether simultaneous multi-stressor exposure produces crime risk greater than any single stressor alone—a non-linear mechanism that mean-level regression cannot detect.

Heat-Day Hotspots

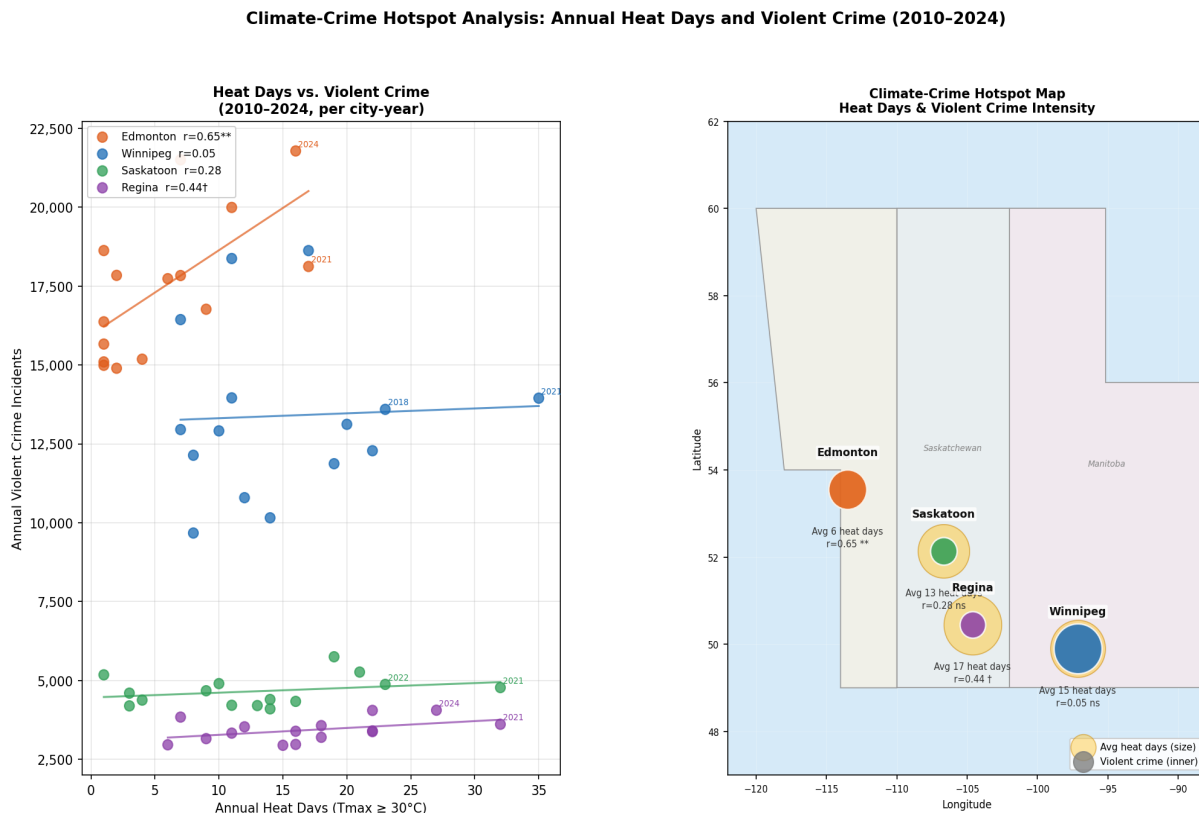


Figure 17. Left: Annual heat days ($T_{max} \geq 30^{\circ}\text{C}$) vs. violent crime scatter. Right: Spatial map of heat-day-crime correlations.

To read this chart: Scatter panels show annual heat day count (x-axis) vs. violent crime (y-axis); each dot = one year. An upward slope means hotter years see more crime. The spatial map uses bubble size and colour to show the strength of the heat-crime relationship per city.

Edmonton is the only city where annual heat days ($T_{max} \geq 30^{\circ}\text{C}$) significantly predict violent crime ($r = 0.645$, $p = 0.009$), providing the clearest quantitative support for the GAM's core prediction that elevated ambient temperature increases aggressive behaviour. Winnipeg approaches significance ($r = 0.359$, $p = 0.088$) but falls short, while Saskatoon and Regina show near-zero heat-crime associations, reinforcing the city-size moderation hypothesis. These results validate the decision to use extreme-event counts rather than mean temperature as the operative climate variable—it is the accumulation of threshold-exceedance days, not average warmth, that appears to drive crime in Prairie contexts.

Cold-Day Hotspots

Climate-Crime Hotspot Analysis: Cold Days and Crime Types (2010-2024)

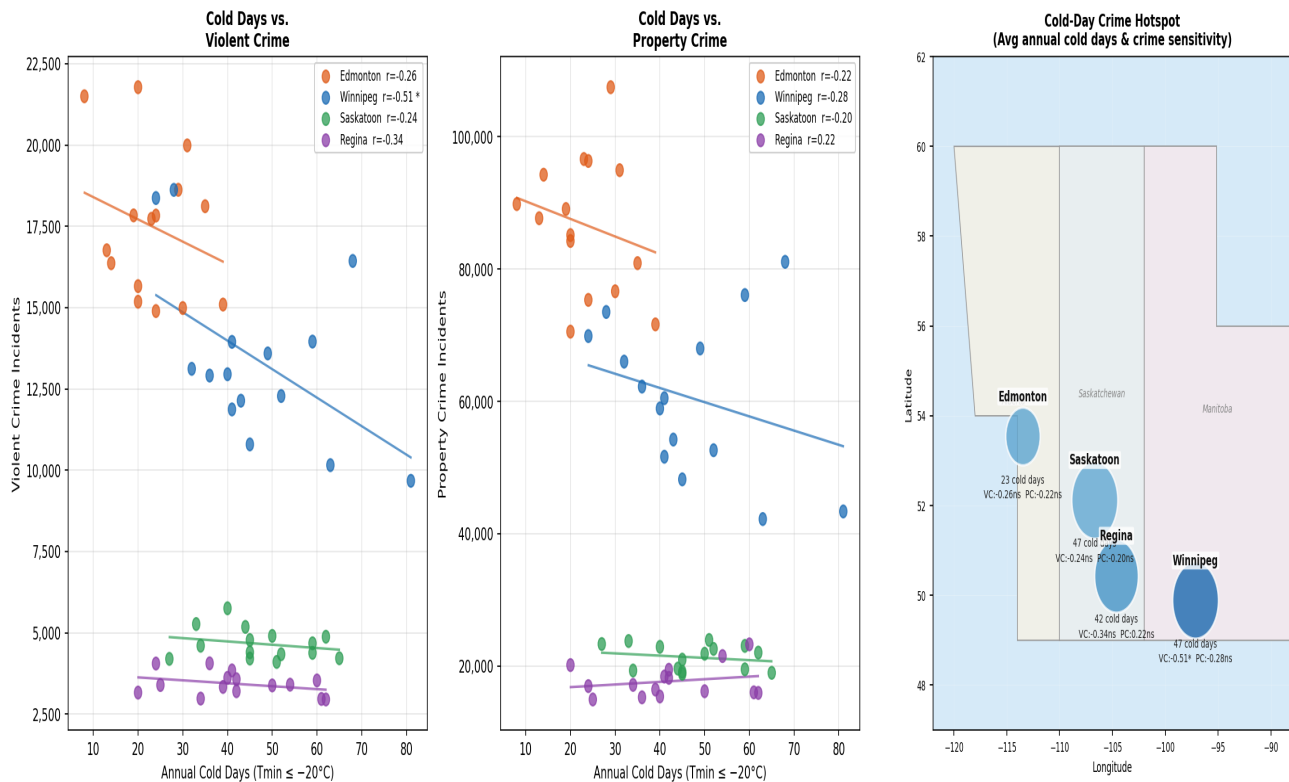


Figure 18. Cold days vs. violent and property crime scatter plots and spatial map of cold-day-crime correlations.

To read this chart: Cold days ($T_{min} \leq -20^{\circ}\text{C}$) are on the x-axis. A downward slope (negative r) means more cold days associate with less violent crime—a suppression effect consistent with Routine Activity Theory.

Winnipeg is the only city where cold days ($T_{min} \leq -20^{\circ}\text{C}$) significantly predict violent crime, with a negative coefficient ($r = -0.514$, $p = 0.050$)—more cold days associate with less violent crime, consistent with RAT's prediction that extreme cold suppresses outdoor activity and reduces co-presence of offenders and targets. This cold-suppression effect is analytically important: heat acts as an aggression amplifier while cold acts as a routine disruptor, and these opposing mechanisms operate independently across cities with different climate regimes. Together with the heat-day analysis, these results support a bidirectional climate-crime model appropriate for Prairie cities: summer heat elevates violent crime through the GAM pathway while winter cold suppresses it through the RAT pathway.

Key Findings

This section synthesizes the principal empirical results emerging from sixteen years of integrated climate, crime, and sentiment data across four Canadian Prairie cities. Findings are organized into five thematic domains that mirror the study's analytical framework: (1) the structural evolution of online sentiment across platform eras, (2) the spatial and inter-city pattern of climate–crime associations, (3) the relationship between climate variables and violent crime, (4) the perception–crime coupling pathway, and (5) city-specific dynamics that resist regional generalization.

Online Crime Discourse Evolves Through Structurally Distinct Phases

The most foundational finding of the study is that Reddit-derived sentiment cannot be treated as a uniform or static measure of public perception. The emotional properties of crime-related discourse change fundamentally across each of the five analytically distinct eras studied, and the conditions under which sentiment can be reliably interpreted as a perception signal are themselves era-dependent. During the Pre-Phase (2009–2013), sentiment was sparse, episodic, and minimally differentiated. Mean crime polarity across cities ranged from +0.067 (Winnipeg) to +0.102 (Saskatoon), almost indistinguishable from overall subreddit polarity of +0.069 to +0.124. Negative posts accounted for fewer than 8% of posts in any city. No statistically significant temporal trends were detected, and the Kruskal–Wallis test— while significant at $H = 13.83$, $p = 0.003$ — reflected distributional rather than structural differences. Crime discourse functioned as a reactive, incident-driven supplement to general community discussion rather than a continuous perception signal (Anderson, 1989). The Growth Phase (2014–2019) represents the first structurally interpretable era. Crime-specific polarity separates sharply from general discourse in every city: mean crime polarity falls to -0.416 in Saskatoon, -0.354 in Winnipeg, and -0.226 in Edmonton, while overall subreddit polarity remains near neutral. The proportion of negative crime posts reaches 72% in Saskatoon, 67% in Winnipeg, and 62% in Edmonton. Wilcoxon signed-rank tests confirm this divergence is significant in all four cities ($p < 0.01$). A Kruskal–Wallis test also confirms significant inter-city differences in polarity distributions ($H = 16.92$, $p < 0.001$), with Regina consistently diverging from the three other cities after Bonferroni correction— the first appearance of the Regina anomaly that persists throughout the study. The Pandemic Phase (2020–2021) disrupts this structure. Crime-related posts decline from approximately 36–49% to 15–19% of total subreddit activity as pandemic discourse floods the space. Overall negativity rises to 25–36% of all posts, not because crime worsens but because pandemic-related stress compresses the emotional landscape. The crime–non-crime sentiment gap narrows to non-significance (all Wilcoxon $p > 0.05$), making crime sentiment analytically uninterpretable as an independent signal during this period. The chi-square test achieves significance for the first time ($\chi^2 = 15.41$, $p = 0.017$), indicating that the pandemic reconfigures not just the intensity but the categorical composition of crime discourse across cities. The Post-Pandemic (2022–2023) and Recent (2024–2025) eras document progressive structural recovery. Crime discourse regains salience, accounting for 45–61% of subreddit activity by Era 4 and 38–50% by Era 5. Crime–non-crime divergence is fully restored: Wilcoxon tests are significant in all cities in both eras ($p < 0.01$), with Era 5 producing the study's largest crime–non-crime polarity gaps— Winnipeg (-0.365), Regina (-0.373), Saskatoon (-0.274), and Edmonton (-0.180). By Era 5, the Kruskal–Wallis test statistic ($H = 8.72$, $p = 0.033$) reaches its lowest value since Era 2, suggesting partial regional convergence alongside continued city-level differentiation.

Sentiment Volatility Is an Era-Level Phenomenon, Not a City-Level One

Volatility analysis reveals that the Growth Phase (2014–2019) constitutes an anomalous window of discursive instability that is structural and era-wide rather than city-specific. During the Pre-Phase, standard deviations ranged from 0.076 (Winnipeg) to 0.124 (Saskatoon). In the Growth Phase, these multiply 3.1- to 5.9-fold: Edmonton rises to 0.381, Saskatoon to 0.387, Winnipeg to 0.325, and Regina to 0.516. These are not marginal changes—Levene tests confirm the variance reduction after 2020 is statistically unambiguous in every city (Edmonton: $F = 19.36$, $p < 0.001$; Saskatoon: $F = 13.79$, $p < 0.001$; Regina: $F = 61.62$, $p < 0.001$; Winnipeg: $F = 13.35$, $p < 0.001$).

The month-level extreme event count makes the structural nature of this shift concrete: during the Growth Phase, 40.4% of Regina's months, 22.0% of Edmonton's, 20.9% of Saskatoon's, and 14.0% of Winnipeg's produced sentiment values exceeding $|0.5|$. After 2020, those rates collapse to 1.4%, 1.4%, 2.9%, and 0.0% respectively—extreme sentiment swings become structurally rare events rather than recurring features. Rolling 12-month standard deviation analysis identifies city-specific volatility peaks: Regina at 0.729 in May 2017 (the study's highest), Edmonton at 0.642 in May 2017, Saskatoon at 0.592 in February 2015, and Winnipeg at 0.454 in January 2018. By the Recent era, all four cities have converged to rolling standard deviations averaging 0.148–0.177—a 57–80% reduction from their respective peaks.

Climate–Crime Associations Are Statistically Significant, Concentrated in Edmonton, and Edmonton-Specific in Mechanism

Climate–crime modelling using annual OLS regression ($n = 15$, 2010–2024) produces sharply heterogeneous results across the four Prairie cities. Edmonton is the only city in which multiple climate variables achieve statistical significance. Humidity (Pearson $r = -0.694$, $p = 0.004$) and cooling degree days (CDD; $r = +0.701$, $p = 0.004$) are the two strongest single-variable findings in the entire dataset and are the only associations clearing both $\alpha = 0.01$ significance and the 80%-power threshold of $|r| \geq 0.67$ at $n = 15$. Maximum annual temperature produces a marginal positive association in Edmonton ($r = +0.482$, $p = 0.069$). All climate correlations in Winnipeg, Saskatoon, and Regina are non-significant.

The year-by-year data make the Edmonton humidity finding concrete. The five driest years on record (mean humidity $\approx 63.5\%$, occurring in 2015, 2021, 2022, 2023, and 2024) averaged 18,177 violent incidents annually. The five wettest years (mean humidity $\approx 75.3\%$, occurring in 2010–2014) averaged only 13,691—a gap of 4,486 incidents, representing 33% more violent crime in drier years. Edmonton's violent crime count climbed from 14,042 in 2010 to 20,122 in 2024—a 43% increase—occurring alongside a secular post-2019 decline in annual mean humidity of -9.6 percentage points, the only climate variable that shifted significantly between eras. The heat-day hotspot analysis confirms the threshold mechanism: Edmonton is the only city where annual heat days ($T_{\max} \geq 30^\circ\text{C}$) significantly predict violent crime ($r = 0.645$, $p = 0.009$). The complementary cold-day analysis confirms Winnipeg's bidirectional climate–crime profile: cold days ($T_{\min} \leq -20^\circ\text{C}$) significantly and negatively predict violent crime in Winnipeg ($r = -0.514$, $p = 0.050$), consistent with Routine Activity Theory's prediction that extreme cold suppresses outdoor co-presence of offenders and targets (Ranson, 2014; Cohen & Felson, 1979).

Sentiment Functions as a Co-Indicator of Climate-Driven Community Stress

The multivariate OLS model—entering mean temperature, mean relative humidity, and proportion of negative Reddit posts simultaneously as z-scored predictors—yields an adjusted R^2 of 0.478 in Edmonton and 0.548 in Winnipeg, compared to near-zero or negative adjusted R^2 in Saskatoon (-0.072) and Regina (-0.190). In Edmonton, the three predictors together explain 59% of year-to-year variance in violent crime ($R^2 = 0.590$).

Bivariate correlations confirm that negative sentiment is as strong a co-predictor as the climate variables themselves: percentage of negative posts correlates $r = +0.703$ with violent crime in Edmonton and $r = +0.744$ in Winnipeg—the latter the highest single-variable association for that city. In Edmonton, crime-topic intensity is significantly correlated with crime polarity within Era 4 ($r = 0.592$, $p = 0.002$), confirming that increases in crime discussion salience coincide with measurable emotional tone shifts. In Winnipeg, the sole significant multivariate predictor is sentiment ($\beta = +1.851$, $p = 0.002$), while climate variables lose significance after controlling for the other predictors, reflecting the socioeconomically rather than climatically driven nature of Winnipeg's crime surge. These findings position sentiment not as an independent cause of crime but as a contemporaneous co-indicator of the community stress environment that climate variability helps produce (Mahajan & Mansotra, 2021).

City-Specific Dynamics Prevent Regional Generalization

A critical and consistent finding across all analytical domains is that Prairie cities do not behave as a uniform regional bloc. The northwest-to-southeast spatial gradient in model performance (Edmonton $R^2 = 0.590$; Saskatoon $R^2 = 0.158$; Regina $R^2 = 0.065$) reflects genuine differences in climate exposure intensity, city size, and the socioeconomic contexts that mediate how environmental stress translates into crime and perception. Regina emerges as the study's persistent positive-sentiment outlier: across all five eras, it maintains higher overall and crime-related sentiment scores than any other city. In the Post-Pandemic era its mean sentiment ($+0.130$) is the only positive city-era mean among the larger cities, and its proportion of negative crime posts (46.3%) is the lowest in the dataset for that period. Regina's chi-square divergence in Era 3 and its consistently different pairwise ranking across eras suggest a distinct local discourse culture that decouples sentiment from crime statistics.

Winnipeg presents the opposite divergence: its negative sentiment grows faster than its crime rate. Between the Growth and Post-Pandemic eras, Winnipeg's negative sentiment share increases by 11.0 percentage points—the largest inter-era shift of any city—while actual violent crime grows from 8,673 incidents in 2013 to 15,708 in 2023, an 81% increase. The geospatial bubble maps confirm this co-movement: Winnipeg leads both dimensions of deterioration simultaneously, and the temporal change map shows that crime growth and sentiment deterioration are spatially concentrated in Winnipeg to a degree not observed in the other three cities. This evidence is consistent with a media amplification or social ecological mechanism in which Winnipeg's online community responds to crime severity at a rate exceeding what the measured crime increase alone would predict (Bronfenbrenner, 1979).

Discussion

The findings of this study carry implications across three intersecting domains: the theoretical relationship between climate variability and crime, the methodological status of social media sentiment as a perception proxy, and the practical question of how public safety monitoring in Prairie cities should be designed and interpreted. This discussion addresses each in turn before examining the study's limitations and their implications for the next phase of the research program.

Climate and Crime: A City-Specific, Multi-Mechanism Relationship

The environmental criminology literature identifies two principal causal pathways through which climate is expected to influence crime. The General Aggression Model (GAM) predicts that elevated ambient temperature increases physiological arousal and irritability, elevating the probability of violent conflict (Anderson, 1989; Anderson et al., 2000). Routine Activity Theory (RAT) predicts that weather conditions alter the convergence of motivated offenders, suitable targets, and capable guardianship by modulating patterns of outdoor activity and mobility (Cohen & Felson, 1979; Lauritsen & White, 2014). The results of this study support both pathways but find that they operate through different mechanisms in different cities. In Edmonton, the humidity–crime association ($r = -0.694$, $p = 0.004$) and the CDD–crime association ($r = +0.701$, $p = 0.004$) are mechanistically complementary: Prairie summers that are simultaneously hot (high CDD) and dry (low humidity) produce greater physiological heat stress per degree than humid-heat conditions. At equivalent temperatures, lower relative humidity amplifies felt heat exposure, which is the GAM arousal pathway. Edmonton's year-by-year data confirm that the highest-crime years cluster in the hot-dry configuration (e.g., 2021: CDD = 215, humidity = 61.2%, violent crimes = 18,295; 2024: CDD = 203, humidity = 65.2%, violent crimes = 22,764), while the lowest-crime years correspond to cooler, more humid conditions (e.g., 2010: CDD $\approx$ 45, humidity = 76.3%, violent crimes = 15,197). The post-2019 secular drying trend (-9.6 pp in annual mean humidity) positions Edmonton's climate trajectory as a plausible long-run contributor to its rising violent crime baseline—a finding consistent with emerging literature linking Prairie aridification to urban crime risk (Lynch et al., 2022; Miles-Novelo & Anderson, 2022). In Winnipeg, the cold-day suppression effect ($r = -0.514$, $p = 0.050$) demonstrates the RAT pathway operating in the opposite direction: extreme cold reduces outdoor co-presence of offenders and targets, suppressing violent crime opportunity. This bidirectional finding—heat amplifies crime through GAM, extreme cold suppresses it through RAT—is consistent with the broader climate–crime literature's identification of non-linear seasonal crime patterns (Corcoran & Zahnow, 2022; Ranson, 2014) and suggests that Prairie cities require a bidirectional model rather than the single-direction heat–crime assumption that dominates temperate-zone studies. Winnipeg's very high CDD average (203.3/yr vs. Edmonton's 119.2/yr) but near-zero CDD–crime correlation ($r = +0.235$, ns) is the study's most analytically important null finding: it confirms that cumulative heat load alone does not predict violent crime and that the Edmonton CDD signal operates through the hot-dry interaction mechanism specific to that city's climate profile. The extended regression model's identification of heat–day threshold effects—particularly Regina's statistically significant heat-day coefficient ($B = +385$, $p = 0.017$) in an otherwise near-zero base model—supports the research framework's emphasis on event-level rather than mean-level climate characterization (Hou et al., 2023). This aligns with the broader direction of climate–crime research, which has progressively shifted from mean temperature associations toward threshold-exceedance and extreme-event frameworks as the mechanistic specification with the greatest predictive power (Cohen & Gonzalez, 2024).

Social Media Sentiment as a Conditional Perception Proxy

A central theoretical proposition of this study is that city-specific Reddit discourse can function as a continuous proxy for community crime perception. The longitudinal evidence partially validates and partially qualifies this proposition. The validation is strongest in Era 2 (2014–2019) and Era 5 (2024–2025), where several empirical conditions are simultaneously satisfied: posting volume is sufficient to support stable monthly aggregation, the crime–non-crime sentiment divergence is statistically robust, sentiment volatility is bounded, and the internal coupling between crime discussion salience and emotional tone is detectable. Under these conditions, sentiment behaves as a theoretically expected indicator of community concern that can be examined in relation to external crime and climate drivers. The qualification is equally important: sentiment is not an unconditional proxy. The Era 3 evidence demonstrates that major exogenous shocks— in this case the COVID-19 pandemic— can collapse the structural separation between crime discourse and general subreddit negativity, rendering crime sentiment analytically uninterpretable. When overall negativity rises sharply due to pandemic-related stressors (reaching 25–36% of posts across cities), crime posts no longer stand out as emotionally distinctive, and the Wilcoxon divergence tests lose significance in all four cities. This finding has direct methodological implications for the interpretation of social media sentiment data in any context involving concurrent social crises: the assumption that sentiment reflects crime perception is period-contingent, not universal. The observation that Reddit subreddit growth does not mechanically inflate crime discussion share (the volume-bias check found all $r < 0.35$, all $p > 0.45$) is an important validating result. It indicates that the dramatic growth in posting volume after 2019 did not produce spurious increases in crime signal through a participation artifact, strengthening the interpretive confidence in the post-2020 sentiment measures. Similarly, the normalization procedure— applying within-city anomaly scoring, per-post weighting, and seasonal adjustment— successfully reduces the confounding influence of subreddit size differences that would otherwise prevent cross-city inference. The Regina anomaly— persistent positive sentiment and lower negative crime framing across all five eras— illustrates a third qualification: sentiment is shaped not only by crime conditions but by local discourse culture, moderation norms, and community identity. Regina's mean crime polarity of +0.124 in Era 4 (vs. –0.226 for Edmonton and –0.272 for Winnipeg) and its substantially higher neutral crime post share (26.8%) indicate a discursive style that is more informational and less alarmist than its Prairie counterparts, despite crime severity indices that routinely rank Regina among Canada's highest per-capita cities. This suggests that the relationship between objective crime conditions and online sentiment is mediated by local social and cultural contexts that are not fully captured by climate or crime variables alone.

The Perception–Crime Coupling Pathway: Evidence and Limits

The study's conceptual framework posits a sequential pathway: climate variability→ behavioural and environmental stressors→ changes in crime patterns→ shifts in public discourse about safety expressed through online sentiment. The empirical evidence partially supports this pathway but also reveals important limitations in how far it can be traced with the available data. The first segment of the pathway—climate to crime—is supported by the Edmonton humidity and CDD findings, by the directionally consistent positive temperature–crime associations across all four cities (the probability of four independent positive r values under the null is approximately 6.25%), and by Winnipeg's cold-day suppression effect. The second segment—crime to sentiment—is supported by the sentiment–crime co-movement observed in both Edmonton ($r = +0.703$ between %negative posts and violent crime) and Winnipeg ($r = +0.744$), by the restoration of crime–non-crime sentiment divergence in Eras 4 and 5, and by the spatial co-evolution of crime growth and sentiment deterioration documented in the temporal change maps. However, the pathway cannot yet be formally established as a causal chain. Several empirical obstacles remain. First, the annual N of 15 limits statistical power to detect moderate effects and prevents robust multivariate inference; the gap between R^2 and adjusted R^2 in the Winnipeg model (0.645 vs. 0.548) reflects overfitting risk that weakens causal interpretation. Second, the study does not include lagged specifications: if climate influences crime in the current year and crime influences sentiment in the following year, cross-sectional annual correlations will understate the pathway strength. Third, the positive serial autocorrelation detected in all city models (Durbin-Watson < 1.0) indicates that year-to-year crime counts are not independent, and the standard errors used for significance tests are therefore conservative estimates. Addressing these limitations requires longer time series, higher-frequency data, and formal mediation or lag-regression modelling—all of which are identified as next-phase priorities below.

The Winnipeg Perception–Crime Divergence: A Social Ecological Interpretation

The finding that Winnipeg's negative sentiment grows faster than its measured crime rate is the study's most theoretically provocative spatial result. Between the Growth and Post-Pandemic eras, Winnipeg's %negative sentiment increases by 11.0 percentage points—the largest inter-era shift of any city—while its violent crime grows from 8,673 (2013) to 15,708 incidents (2023), an absolute increase of 7,035 incidents. Edmonton's negative sentiment, by contrast, is nearly flat across the same transition (+0.25 pp), despite a 43% increase in absolute violent crime. Three non-mutually-exclusive mechanisms may account for this divergence. First, a media amplification effect: local media framing of crime in Winnipeg—particularly around high-profile gang violence and homicide rates—may generate disproportionate online discourse negativity relative to total incident counts, consistent with research documenting media amplification of crime threat perception (Mahajan & Mansotra, 2021). Second, a social ecological mechanism: Bronfenbrenner's (1979) ecological systems framework predicts that the translation of crime events into community emotional response is moderated by local social capital, institutional trust, and neighbourhood cohesion; Winnipeg's higher crime severity, combined with socioeconomic conditions documented in its vulnerability index, may produce a community that is more emotionally reactive to crime signals at the online discourse level. Third, a subreddit composition effect: if r/Winnipeg attracts users who are disproportionately crime-focused or crime-concerned relative to the general population, the measured sentiment will overrepresent that segment of public concern. The data cannot distinguish among these mechanisms, but the persistence of the divergence across multiple eras and normalization strategies suggests it is not a measurement artifact.

Implications for Climate–Crime Monitoring in Prairie Cities

The study's era-stratified, multi-city, multi-method framework yields several practical insights for urban safety monitoring and climate adaptation planning in the Canadian Prairies. First, no single climate variable serves as a universal Prairie crime risk indicator. Edmonton requires a hot-dry (high CDD + low humidity) composite index; Winnipeg requires a cold-day suppression term; Regina and Saskatoon are currently insufficiently sensitive to climate to support reliable prediction. City-specific rather than regional models are not only statistically necessary—they are substantively required, because different cities are exposed to different climate mechanisms and mediated by different social contexts (Cohen & Gonzalez, 2024; Corcoran & Zahnow, 2022).

Second, the post-2019 drying trend in Edmonton is the most actionable climate finding for near-term monitoring. If the relationship between annual mean humidity and violent crime is causal rather than spurious—a hypothesis that requires stronger evidence before policy inference—then projected Prairie aridification under continued warming scenarios would imply a structurally elevated violent crime baseline in Edmonton that is not explained by population growth, socioeconomic change, or policing policy alone. The magnitude of the predicted effect (the bivariate OLS slope implies approximately 4,486 more annual violent incidents per 9.6 pp decline in humidity) is large enough to warrant inclusion in Edmonton's long-range public safety planning even under uncertainty.

Third, sentiment monitoring is most valuable when deployed continuously, within-city, and in conjunction with official crime data rather than as a standalone indicator. The study demonstrates that crime sentiment becomes analytically meaningful only above a posting volume threshold, only when subreddit discourse has structurally matured, and only in the absence of major exogenous shocks that compress the emotional landscape. These are conditions that can be assessed in near real-time using the monitoring framework developed in this study, enabling practitioners to determine when sentiment data is and is not interpretable.

Limitations

Sample Size and Statistical Power

The most significant constraint on the study's inferential strength is the annual N of 15 observations per city in the climate–crime regression models. At this sample size, the 80% power threshold for detecting a moderate correlation ($|r| = 0.50$) at $\alpha = 0.05$ is barely satisfied, meaning that genuine moderate associations will be missed approximately 20% of the time. The expanded dataset covering 2025 and beyond will add additional annual observations, but even by 2030 the annual series will reach only $N = 21$ — still within the region of elevated Type II error risk. Monthly-level crime data, if obtainable from Statistics Canada for historical years, would dramatically improve statistical power and enable seasonal and lag-structured analyses.

Lexicon-Based Sentiment Analysis

VADER, the lexicon-based sentiment tool applied in this study, is validated primarily on English social media text and performs well for polarity classification of short, informal posts. However, it has known limitations in detecting nuanced emotional registers— particularly irony, sarcasm, and community- specific vernacular— that may be prevalent in city-specific subreddits. The method also treats each post as a self-contained unit, ignoring conversational context (reply chains, upvoting patterns) that shape the meaning of individual posts within a thread. Validation studies using human-annotated subsets of the Prairie subreddit data would strengthen confidence in the VADER classifications before formal causal inference is attempted.

Reddit Representativeness

Reddit users are not a representative sample of Prairie city residents. The platform skews toward younger, more educated, urban, and English-speaking users, and the community norms of each city subreddit are shaped by its specific moderation practices and user demographics. The normalization strategies applied in this study— per-post weighting, within-city anomaly scoring, volume-bias checks— reduce but cannot eliminate representativeness concerns. Findings should be interpreted as indicators of how a particular online community discusses crime and safety rather than as measures of general public opinion.

Absence of Causal Identification

The study's correlational and regression designs cannot establish causal direction. The finding that humidity predicts violent crime in Edmonton is consistent with the GAM mechanism but is also consistent with confounding explanations (e.g., socioeconomic deterioration concentrated in recent years that happens to correlate with the drying trend). The positive serial autocorrelation in all city crime series means that standard errors are underestimated and significance probabilities are optimistic. Addressing causality would require quasi-experimental designs exploiting weather shocks as instruments, a strategy that is feasible with a longer time series and higher-frequency data.

Durbin Watson Autocorrelation

Serial autocorrelation (Durbin-Watson < 1.0 in all four city models) indicates that annual crime counts are positively correlated across consecutive years. This violates the OLS assumption of independent residuals, causing standard errors to be underestimated and p-values to be more favorable than they would be under corrected estimation. Future work should apply Newey-West heteroskedasticity and autocorrelation-consistent (HAC) standard errors or autoregressive error models (AR(1)) to obtain more conservative inferential thresholds. Findings from the regression models should therefore be treated as exploratory associations rather than confirmed statistical effects.

Conclusion

This study integrates sixteen years of climate observations, police-reported crime statistics, and Reddit-derived sentiment data across four Canadian Prairie cities to produce the most longitudinally comprehensive empirical examination of the climate–crime–public perception nexus in this regional context to date. The findings are nuanced but substantively clear: climate variability shapes urban crime patterns in Prairie cities through mechanisms that are city-specific, threshold-dependent, and mediated by local social and ecological contexts; online sentiment captures public responses to these dynamics under conditions of discourse maturity and social stability, but fails to do so during periods of exogenous disruption.

Three overarching conclusions emerge from the integrated analysis.

First, Edmonton's climate–crime relationship is empirically robust and mechanistically specific. The humidity–crime correlation ($r = -0.694$, $p = 0.004$) and CDD–crime correlation ($r = +0.701$, $p = 0.004$) are the only climate findings clearing both the significance ($\alpha = 0.01$) and power ($|r| \geq 0.67$ at $n = 15$) thresholds in this dataset. The year-by-year gap—4,486 more annual violent incidents in Edmonton's driest years than its wettest, a 33% difference—combined with a secular drying trend of -9.6 percentage points since 2019, positions climate-driven aridification as a plausible long-run contributor to Edmonton's rising violent crime baseline. The heat-day threshold finding ($r = 0.645$, $p = 0.009$) and Winnipeg's cold-day suppression effect ($r = -0.514$, $p = 0.050$) further confirm that climate operates through both the General Aggression Model arousal pathway and the Routine Activity Theory opportunity-structure pathway, depending on city-specific climate profiles. Second, online sentiment evolves through structurally distinct, era-dependent phases rather than a linear trajectory. Crime polarity moves from near-indistinguishable from general discourse in Era 1 ($+0.067$ to $+0.102$) to clearly separable in Era 2 (falling to -0.416 in Saskatoon and -0.226 in Edmonton; Wilcoxon $p < 0.01$ in all cities), collapses during the pandemic in Era 3 (divergence non-significant; $R^2 \approx 0$), and fully restores in Era 5 (gaps of -0.365 in Winnipeg and -0.373 in Regina; Wilcoxon $p < 0.01$ in all cities). This era-stratified framework is the study's principal methodological contribution: it establishes the conditions under which social media sentiment can and cannot be treated as a reliable perception proxy. Third, Prairie cities are not a homogeneous regional unit. Edmonton's climate–crime associations are real and specific to its hot-dry summer profile. Winnipeg's crime surge is socioeconomically driven and temporally concentrated post-2019, decoupled from climate despite its higher CDD average. Regina maintains a persistently positive sentiment register that resists the crime-severity framing its per-capita Crime Severity Index ranking would predict. Saskatoon occupies an intermediate position where climate signals are present but not yet detectable at $n = 15$. City-specific models are an empirical necessity, not a methodological preference. Taken together, these findings carry direct implications for urban safety policy and climate adaptation planning. The Edmonton humidity–crime association and its post-2019 secular trend are sufficient to motivate inclusion of climate-driven crime risk in long-range public safety planning, even pending formal causal validation. The era-stratified sentiment framework provides reusable infrastructure for continuous public safety perception monitoring. As Prairie temperatures rise and aridification accelerates under projected climate change scenarios (Environment and Climate Change Canada, 2025), the mechanisms documented here are likely to intensify. This research program provides the empirical and methodological foundation necessary to track, model, and anticipate these changes—and to communicate them to the communities most directly affected.

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