تأثير أنماط الطقس على الجريمة العنيفة في منطقة كرميان، كردستان العراق

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The impact of weather patterns on violent crime in the Garmian region, Iraqi Kurdistan

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Abstract

This study aimed to statistically analyze the impact of climate on the rate of violent crime in the Garmian region, Iraqi Kurdistan. For this purpose, data related to climatic variables (temperature and rainfall) and recorded crimes during 2024 were analyzed. According to the results, the increase in temperature during the hot months of the year caused a significant increase in violent crimes (intimidation, sexual assault, corruption, and assault), and in contrast, rainfall shocks in the form of drought significantly increased the rate of these crimes. The high coefficients of

determination (R^2) for the temperature variable indicate its strong effect on violent behavior. The findings of the present study appear to be consistent with previous literature on expectations that human behavior changes in hot weather and that aggression levels are likely to increase with temperature. Therefore, it is recommended that law enforcement and social institutions implement special monitoring and educational programs during the hot months of the year to reduce and control violent crimes. In urban planning, creating cool, shaded public spaces and better access to amenities in the summer can be effective in reducing aggression and urban conflicts. Future research could provide more detailed statistical analyses of the relationship between climate and crime using multi-year data and psychological or economic variables.

ملخص

هدفت هذه الدراسة إلى تحليل تأثير المناخ إحصائيًا على معدل الجرائم العنيفة في منطقة كرميان، إقليم كردستان العراق. ولتحقيق هذا الهدف، تم تحليل البيانات المتعلقة بالمتغيرات المناخية (درجة الحرارة وهطول الأمطار) والجرائم المسجلة خلال عام ٢٠٢٤. ووفقًا للنتائج، أدى ارتفاع درجة الحرارة خلال أشهر الصيف الحارة إلى زيادة ملحوظة في الجرائم العنيفة (الترهيب، والاعتداء الجنسي، والفساد، والاعتداء)، وفي المقابل، أدت موجات الجفاف إلى زيادة ملحوظة في معدل هذه الجرائم. وتشير معاملات التحديد العالية (R^2) لمتغير درجة الحرارة إلى تأثيره القوي على السلوك العنيف. وتتفق نتائج هذه الدراسة مع الدراسات السابقة التي تشير إلى تغير السلوك البشري في الطقس الحار، وإلى احتمال ارتفاع مستويات العدوان مع ارتفاع درجة الحرارة.

لذا، يُوصى بأن تُنفذ جهات إنفاذ القانون والمؤسسات الاجتماعية برامج رصد وتوعية خاصة خلال أشهر الصيف الحارة للحد من الجرائم العنيفة والسيطرة عليها. وفي مجال التخطيط الحضري، يُمكن أن يكون إنشاء مساحات عامة باردة ومظللة، وتوفير وصول أفضل إلى المرافق خلال فصل الصيف، فعالًا في الحد من العدوان والنزاعات الحضرية. يمكن أن توفر الأبحاث المستقبلية تحليلات إحصائية أكثر تفصيلاً للعلاقة بين المناخ والجريمة باستخدام بيانات متعددة السنوات ومتغيرات نفسية أو اقتصادية.

Introduction

Climate change has become one of the most important global challenges, manifested in the continuous increase in temperature and changes in rainfall patterns (Lin and Jiang, 2025). These events have profound impacts on agricultural production, energy supply, infrastructure operations, and social stability (Portner et al., 2022). Furthermore, they may act as key factors in social dysfunction, as individuals in extreme climates are more exposed to various stresses, resulting in increased anger, confusion, and fear. Such emotions may lead to impaired rational decision-making and lead individuals to take undesirable actions. Thus, crime is seen as a coping mechanism to reduce or escape negative emotions (Ranson, 2014). The impact of climate variables on violent crime appears to be realized through both economic and non-economic

channels, with the non-economic channel being more important (Yao et al., 2025; Blakeslee et al., 2021). Diurnal activity and temperature-aggression theories help explain this (Choi et al., 2024). Temperature or rainfall affect the probability of crime by changing individual daily activity patterns such as increased outdoor activities, changing transportation modes, etc. (Cruz et al., 2020). Since people go on vacation more often in the summer, they are more likely to be robbed (Cohn and Rotton, 2000). Frequent rainfall makes it easier for criminals to evade surveillance, leading to increased crime rates on rainy days (Shen et al., 2020). Reduced daylight makes it easier to conceal crimes and increases the frequency of crimes committed by criminals on cloudy days (Peng and Zhan, 2020). Relatively high temperatures facilitate mobility and social interaction, and also mean exposure to vulnerable targets. In such conditions, more crimes are likely to occur (Hu et al., 2024). Heavy rainfall may also lead to less crowding in public spaces or reduced police patrols (Jacob et al., 2007). Conversely, high crowding in public spaces can provide a more favorable environment for crime. Therefore, understanding the factors that cause crime, including weather, is essential in preventing social disorders in order to make appropriate decisions by relevant institutions to control and minimize these disorders. Considering these factors can help provide valuable guidance in reducing crime or violence (Reimann et al., 2022). In recent years, numerous studies have been conducted on the impact of climate variables on social and human behavior. Among them, the impact of climate on crime is a relatively new topic that has been considered in different countries (Hu et al., 2024; Gahar et al., 2024; Dadgar et al., 2022). The Garmian region in the Kurdistan Region of Iraq is suitable for analyzing this relationship due to its specific geographical features and large seasonal differences in environmental temperature and rainfall. This study aimed to statistically analyze the effect of two important climatic variables, namely temperature and rainfall, on the crime rate in this region. The present study is innovative in that there is not much evidence on the effect of climate on crime from Iraqi Kurdistan, especially the Garmian region.

Literature Review

Investigating the impact of climate on crime rates began in the 1800s, when a Belgian astronomer observed seasonal trends and summer peaks in violent crime in France (Dexter, 1899). Scientific advances in this area continued in the following decades, reaching a significant peak in criminological studies in the 1990s. Many studies have confirmed that human activities are affected by climate change. Rotton and Cohn (2003)

used time series data from several decades in the United States to examine the relationship between temperature and crime. They found effects of temperature on some violent crimes. Studies show that attempted murder rates are higher in the warmer months of the year (Simister and Van de Vliert, 2005). Higher temperatures increase the likelihood of interpersonal violence, intergroup conflict, and criminal behavior. The effect of rainfall varies with temperature. Simister and Van de Vliert (2005) suggested that rain cools the body in hot weather but increases heat stress in cold weather. However, when a humid summer arrives, the graph of violence levels forms an almost vertical or slightly sloping line due to the intervening humidity variable. Thus, rainfall tends to reduce violence, while humidity tends to increase it, but temperature plays an important role in interpreting the correlations (Simister and Van de Vliert, 2005). Ranson (2014) used a 30-year monthly data set and found that increasing temperature in the United States led to increases in murder, rape, assault, and robbery. Hu et al. (2017) examined the effects of temperature stress on violent and non-violent robberies in Beijing, China. The results showed that robbery patterns changed under the influence of environmental factors, most notably the social dynamics surrounding major events such as the 2008 Beijing Olympics. Tiihonen et al. (2017) suggested that extreme temperatures may increase violence and general human activity levels, thereby increasing social interaction and the risk of violent behavior. Blakeslee and Fishman (2018) used a 30-year data set of crime and weather in the United States and found a significant effect of temperature on violent crime. They found no evidence for an effect of rainfall. Gates et al. (2019) used mortality data from South Africa to examine the impact of temperature on homicide. They found that a one-degree increase in temperature was associated with a two-percent increase in homicide. The impact of rainfall on social interaction is less well understood, but some studies in developing countries suggest that negative rainfall shocks increase conflict through their impact on agriculture (Hodler and Raschky, 2014). In poor agricultural regions such as India, anomalies in rainfall patterns affect crime rates due to the role of reduced agricultural production as a mediating factor (Sekhri and Storeygard, 2014). However, studies examining the impact of climate on crime in Iraq are relatively limited.

Data and Methods

Study Area

Kalar is one of the important and populous cities in the south of Sulaymaniyah Province, Iraqi Kurdistan, and is known as the

administrative center of the Garmian region. This region is located between the coordinates of 44° to 45°, east longitude and 34° to 35° north latitude (Figure 1). It has a semi-arid climate with hot summers and relatively wet winters, such that the air temperature sometimes reaches more than 45°C and the average annual rainfall is about 300 to 400 mm. The Sirvan River is the most important water source in the region and plays a vital role in agriculture and drinking water supply. The geographical, climatic, and demographic characteristics of this region, along with its role as a center for administrative institutions, have made it particularly important to examine its social and security situation (crime statistics) (Aziz et al., 2023).

Data collection

- Climate variables

Mean monthly air temperatures during 2024 were collected from the European Centre for Medium-Range Climate Forecasts (ECMWF) ERA5 reanalysis dataset in degrees Celsius. ERA5 uses the latest modeling and data assimilation approaches and offers improvements over other reanalysis datasets (Jourdier, 2020). Mean monthly precipitation was calculated using Climate Hazards Group Infrared Precipitation with Station (CHIRPS) data in millimeters. The CHIRP/S algorithm combines three main data sources (Climate Hazards Group Precipitation Climatology (CHPclim), TIR-based satellite precipitation estimates (IRP), and in situ rain gauge measurements (Dinku et al., 2018).

- Violent Crimes

In this study, in order to examine the temporal pattern of crime occurrence and its relationship with climatic variables, data on the number of monthly crimes including four types of crimes: threats and intimidation, sexual assault, administrative corruption, and assault were collected. This data was extracted from official statistical sources and reports recorded by the Iraqi Kurdistan Criminal Police (Garmian Police) over a one-year period (2024).

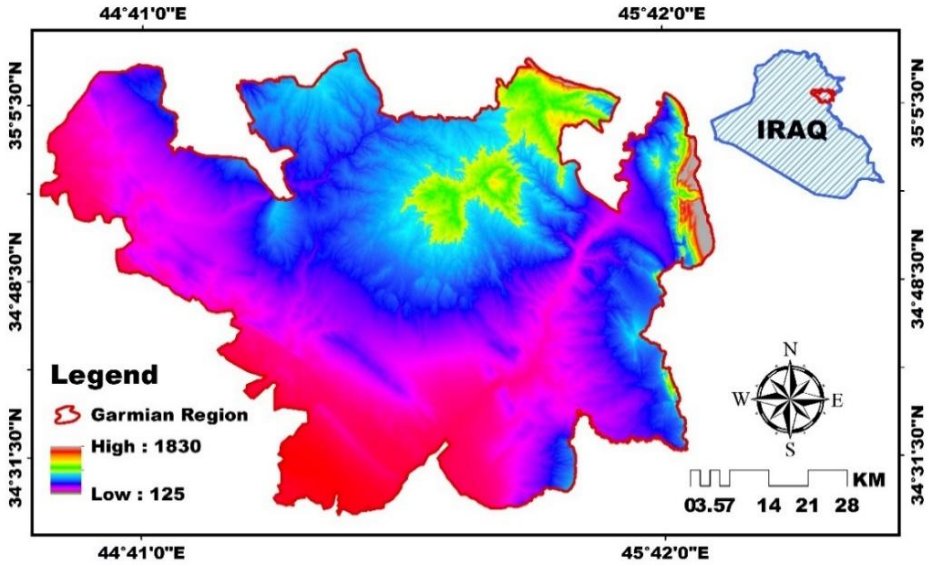


Figure 1. Study area

Data Analysis

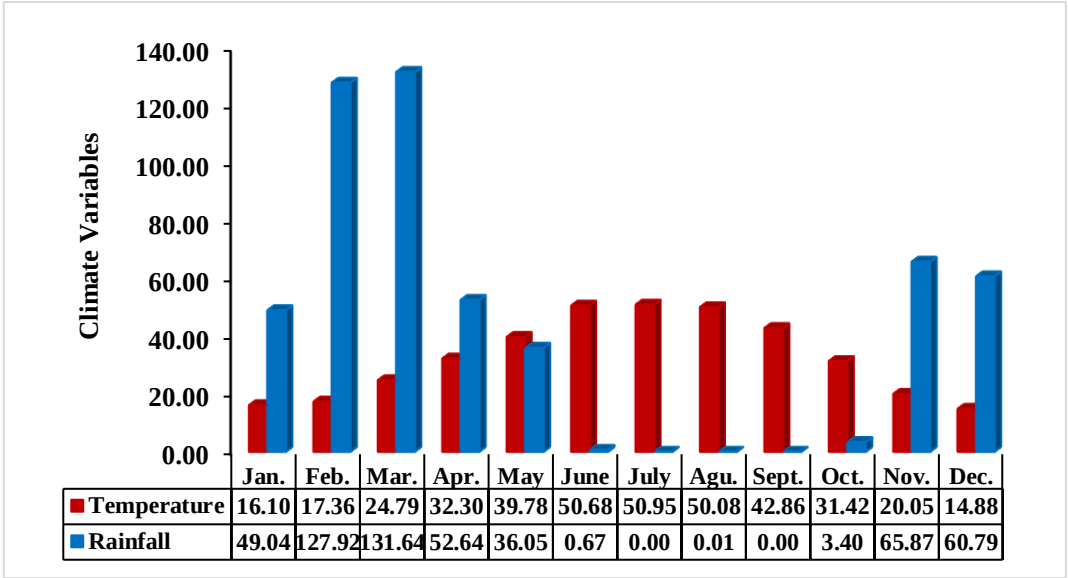
First, the data were organized monthly and quarterly, and then descriptive charts were drawn to show the changes over time. Next, correlation/regression was used to examine the relationship between crime rates and climate variables. With this method, the intensity and direction of the relationship between climate variables and crime rates were calculated and interpreted.

Results

Monthly and Seasonal Changes in Climatic Variables

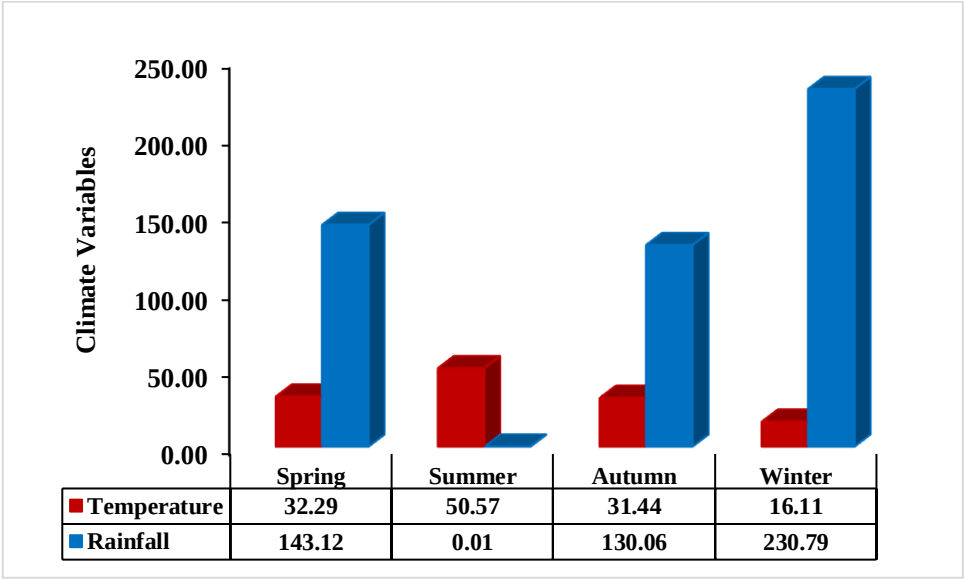
According to Figure 2, the average air temperature values change from month to month in the Garmian region. The monthly temperature pattern starts from a relatively low value in the winter months (about 16 to 17°C in January and February) and gradually increases until early summer, reaching its peak in June and July, which is more than 50°C. Then, from August onwards, the temperature starts to decrease and by the end of autumn and winter it decreases again to about 15 to 20°C. In contrast, the rainfall pattern has a completely opposite trend to the temperature. The highest amount of precipitation occurs in the winter months and early spring, especially in February and March, when the rainfall reaches more than 120 to 130 mm. From April onwards, the amount of precipitation decreases and in summer (June to August) it reaches almost zero. Then, in late autumn (October and November), precipitation begins again and reaches its annual maximum as winter approaches. Seasonal analysis of the data also clearly confirms this pattern. The average temperature in winter is about 16°C and reaches more than 50°C in summer; while the

average temperature in spring and autumn is about 31 to 32°C. On the other hand, seasonal precipitation is highest in winter (about 230.79 mm) and lowest in summer (almost zero). Spring and autumn are also considered relatively wet seasons with an average precipitation of 130 to 140 mm (Figure 3).



	Jan.	Feb.	Mar.	Apr.	May	June	July	Agu.	Sept.	Oct.	Nov.	Dec.
Temperature	16.10	17.36	24.79	32.30	39.78	50.68	50.95	50.08	42.86	31.42	20.05	14.88
Rainfall	49.04	127.92	131.64	52.64	36.05	0.67	0.00	0.01	0.00	3.40	65.87	60.79

Figure 2. Monthly average of climate variables during 2024

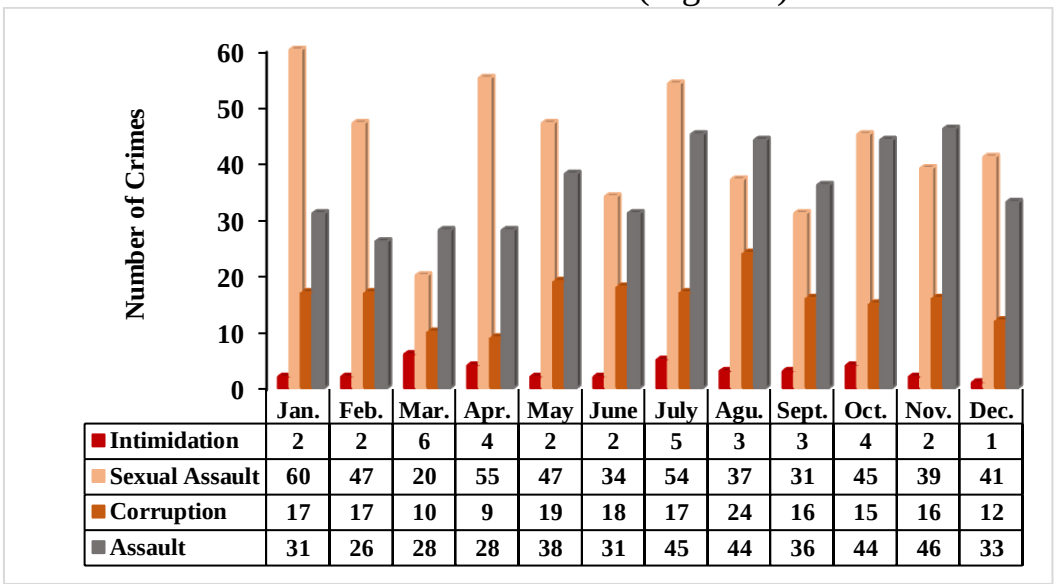


	Spring	Summer	Autumn	Winter
Temperature	32.29	50.57	31.44	16.11
Rainfall	143.12	0.01	130.06	230.79

Figure 3. Seasonal average of climate variables during 2024

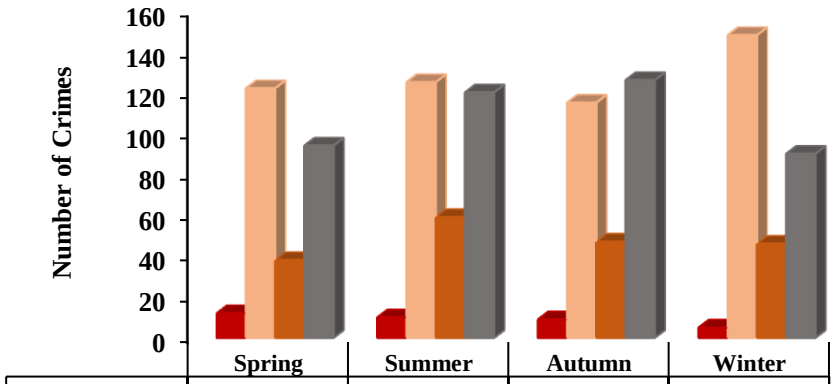
Monthly and Seasonal Analysis of Violent Crime Patterns

Based on data obtained from the number of crimes during the months and seasons of 2024, it is observed that crime patterns differ significantly over time. As can be seen in Figure 4, sexual assault was the most common type of crime, peaking in January (60). This rate decreased in the middle months of the year and increased again towards the end of the year. In contrast, the crime of threats and intimidation has been at a very low level throughout the year and no noticeable change in its trend is observed. On the other hand, administrative corruption and assault also show different time patterns. Corruption occurs most frequently in August (24), followed by May (19) and June (18). While assault has a relatively stable trend, it shows a significant increase in the autumn and late-year months. Sexual assault peaks in winter (148), while decreasing in autumn. On the other hand, administrative corruption shows an increase in summer (59), which is probably related to the growth of economic and administrative activities in this season. Also, assault is highest in autumn (126) and decreases in winter. In contrast, threats and intimidation have the lowest incidence and show little seasonal variation (Figure 5).



	Jan.	Feb.	Mar.	Apr.	May	June	July	Agu.	Sept.	Oct.	Nov.	Dec.
Intimidation	2	2	6	4	2	2	5	3	3	4	2	1
Sexual Assault	60	47	20	55	47	34	54	37	31	45	39	41
Corruption	17	17	10	9	19	18	17	24	16	15	16	12
Assault	31	26	28	28	38	31	45	44	36	44	46	33

Figure 4. Monthly changes in violent crime rates during 2024



	Spring	Summer	Autumn	Winter
Intimidation	12	10	9	5
Sexual Assault	122	125	115	148
Corruption	38	59	47	46
Assault	94	120	126	90

Figure 5. Seasonal changes in violent crime rates during 2024

Investigating the relationship between climatic variables and violent crimes

As presented in Table 1, there is a significant relationship between climatic variables (average temperature and rainfall) and the incidence of crimes in the study area. The monthly trend of crime incidence indicates that in the months of June, July and August, when the temperature reaches more than 50 degrees, the highest rate of violent crimes such as assault, intimidation and sexual harassment is recorded, while in the months of November and December, with a temperature of about 15 degrees Celsius, the frequency of violent crimes is minimized. On the other hand, in the months with higher rainfall, the crime rate has decreased significantly, which could be due to the reduction in social mobility and outdoor activities of people in adverse weather conditions. This pattern shows that weather conditions can be one of the factors affecting the occurrence or reduction of violent behaviors in society. A statistical study of the frequency of violence showed that the highest rate of crime was related to sexual assault with 510 cases during the year, while assault with 430 cases and administrative corruption and intimidation with lower rates were in the next ranks.

Table 1. Violent crimes in the study area during 2024

				Month	Average Temperature	Average Rainfall	Intimidation	Sexual Assault	Corruption	Assault
			Nu	Per	Numb	Perc	Numb	Per	Num	Per

مجلة مركز بابل للدراسات الإنسانية ٢٠٢٦ المجلد ١٦/ العدد ٣

			mber	cent	er	ent	er	cent	ber	cent
January	16.10	49.04	2	5.56	60	11.76	17	8.95	31	7.21
February	17.36	127.92	2	5.56	47	9.22	17	8.95	26	6.05
March	24.79	131.64	6	16.67	20	3.92	10	5.26	28	6.51
April	32.30	52.64	4	11.11	55	10.78	9	4.74	28	6.51
May	39.78	36.05	2	5.56	47	9.22	19	10.00	38	8.84
June	50.68	0.67	2	5.56	34	6.67	18	9.47	31	7.21
July	50.95	0.00	5	13.89	54	10.59	17	8.95	45	10.47
August	50.08	0.01	3	8.33	37	7.25	24	12.63	44	10.23

September	42.86	0.00	3	8.33	31	6.08	16	8.42	36	8.37
October	31.42	3.40	4	11.11	45	8.82	15	7.89	44	10.23
November	20.05	65.87	2	5.56	39	7.65	16	8.42	46	10.70
December	14.88	60.79	1	2.78	41	8.04	12	6.32	33	7.67
Total	33.60	44.00	36	100	510	100	190	100	430	100

The results of the regression analysis also confirmed these findings from a statistical perspective (Table 2). Climate variables are directly correlated with various crimes. The values of the coefficients of determination (R^2) show that the average temperature has a much stronger effect on violent crimes, such that for the temperature variable, the R^2 value for the crime of intimidation was 0.78, sexual assault was 0.77, administrative corruption was 0.88, and assault was 0.87. These numbers indicate that a high percentage of the variation in crime can be explained by temperature changes. In contrast, the effect of rainfall on violent crime was weaker than that of average temperature. The highest correlations were observed between intimidation, sexual assault, and average rainfall of 0.41 with slopes of 12.37 and 0.92, respectively. The lowest correlation was found between administrative corruption and average rainfall of 0.34 with slopes of 2.29.

Table 2. Statistical analysis between climate variables and violent crime in the study area

	Variables	R^2	Change in gradient
Intimidation	Average Temperature	0.78	9.39
	Average Rainfall	0.41	12.37
Sexual Assault	Average Temperature	0.77	0.71
	Average Rainfall	0.41	0.92
Corruption	Average Temperature	0.88	2.03

	Average Rainfall	0.34	2.29
Assault	Average Temperature	0.87	0.90
	Average Rainfall	0.35	1.03

Discussion

Monthly and seasonal data showed that the Garmian region has a hot and dry climate with characteristics close to the Mediterranean or tropical semi-arid climate. This climate is characterized by hot and dry summers and cool and wet winters. The increase in average temperatures in summer can be attributed to the movement of the subtropical high-pressure belt towards the northern hemisphere, which affects the whole of Iraq (Al-Samarrai, 2000). In summary, it can be said that increasing climatic variables, especially temperature, are one of the driving factors in increasing aggressive behavior and violent crime in the study area. On the other hand, decreasing rainfall is usually associated with increased outdoor activities and indirectly increases the likelihood of crime. These findings are supported by temperature-aggression and daily activity theories, both of which predict higher levels of violent crime during warmer periods. From the perspective of temperature-aggression theory, people in hot climates have a bad temper, which may lead to acts of violence and intolerance, resulting in attacks, suicides, and sexual assaults, because heat weakens the ability of nerves to resist and increases the strength of emotions and feelings (Gahar et al., 2024). From the perspective of daily activities, universities, institutes and schools are closed during the summer, resulting in social mixing and closeness, which may lead to relatively high crime rates. On the other hand, many workers and migrants from abroad return home during this season, causing traffic congestion on the streets, leading to traffic accidents and other incidents that increase the relative crime rate in the study area (Tawfiq, 2006). Various studies have shown a positive correlation between climatic variables and crime rates. Field (1992) analyzed a data set of crime incidents in England and Wales and found that there was a positive correlation between temperature and violent crimes (murder, sexual offences, self-harm, assault, etc.). Hu et al. (2017) confirmed a strong correlation between temperature and crime in China. Rinderu et al. (2018) observed that inequality and hot weather have a positive effect on violent crime. Stevens et al. (2019) found that violent crime increases significantly in the summer months, which is consistent with the findings

of the present study. Berman et al. (2020) found that a 10°C increase in daily temperature and prolonged exposure to abnormal temperatures were associated with an 11.92% and 10.37% increase in violent crime, respectively. Xu et al. (2021) reported that every 5°C increase in average daily temperature was associated with a 4.5% increase in sexual crime over the next eight days. Mares (2013) collected 10 years of data for short-term studies. Abnormal monthly weather conditions were still associated with most types of crime except sexual assault. However, the correlation with precipitation did not appear. Habibullah (2017) showed that high temperatures have a positive effect, while precipitation has a negative effect, on crime. In Boston, rainy days have fewer reported crimes on average than dry days (Sommer et al., 2018). Schutte and Breetzke (2018) examined daily temperature and rainfall variations for the city of Tshwane, South Africa, and found an increase in violent crime rates in response to high temperatures and, to a lesser extent, rainfall, which is consistent with the findings of the present study. In regions with tropical and humid climates such as Saudi Arabia and Taiwan, they have mostly reported positive associations between daily or monthly or annual mean temperatures and crime, violence, or both (criminal arrests, murders, assaults, robberies, etc.), while studies focusing on countries with temperate climates such as some cities in the United States and Canada have shown positive, negative, or both relationships between daily or monthly mean temperatures or maximum temperatures and crime, violence, or both (Choi et al., 2024). The above findings show that high temperatures cause irritability, reduce tolerance thresholds, and increase the likelihood of aggressive behaviors. Therefore, it can be concluded that climate considerations should be taken into account in the analysis of crime patterns and preventive urban security planning.

Conclusion

This study examined the impact of climate variables on the incidence of violent crimes in the Garmian region of Iraqi Kurdistan. According to the results, the increase in temperature during the hot months of the year caused a significant increase in violent crimes (intimidation, sexual assault, corruption, and assault), while rainfall shocks in the form of drought significantly increased the rate of these crimes. The high coefficients of determination (R^2) for the temperature variable indicate its strong effect on violent behavior. The findings of the present study appear to be consistent with previous literature on expectations that human behavior changes in hot weather and that aggression levels are likely to increase with temperature. Therefore, it is suggested that law enforcement

and social institutions implement special monitoring and educational programs to reduce and control violent crimes during the hot months of the year. In urban planning, creating cool and shaded public spaces and better access to amenities in the summer can be effective in reducing aggression and urban conflicts. Future research can provide more accurate statistical analyses of the relationship between climate and crime using multi-year data and psychological or economic variables.

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