Spatiotemporal Analysis of Crimes, A Case Study of Mardan City

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Abstract
This paper is aimed to study the crime with special reference to its spatial and temporal distribution. It also tries to analyze and study the effect of weather on the prevalence of crimes in Mardan city. Studying the crimes spatially and temporally helps understanding how crimes are distributed through space, and hence can help in combating them. The Geographical Information System (GIS) crime analyst is an important tool for dealing with spatial and temporal analysis and thus fighting crime. The computers have considerably increased the role of computer-aided mapping. The accessibility of easy to use GIS encourages its use in spatial analysis of crimes. For present study the data was collected about homicide and aggressive assaults from all the three police stations covering Mardan city. The collected data was analyzed under different scenarios. The temporal based analysis of data reveals that almost 50 % crimes reported in 2009, took place from May- September (summer) compared to 32% in winter (October to February). The spatial analysis reveals 05 hotspots. Skindary area was identified as the most crucial hotspot where within a 05 km radius, 11 crimes were committed in 2009 followed by Kalpani bridge area from where a total of 10 crimes of aggressive nature were reported. Similarly police station wise the city police station accounts for 47% of the aggressive crimes committed in 2009.

Keywords: Spatiotemporal, Analysis, Crime, Mardan City

Introduction

Geography of crime is a discipline of human geography, which explains with reference to space the study of criminal wrongdoer, the incidence of crimes and characteristic of victims. Throughout the history of geography, a number

of theories attempt to explain the ontogeny of the world societies (Amanda, 2013).One of the most prominent approach is determinism which is first found in the medical writing of Hippocrates (Isaac, 2004). This theory referred to as climatic, geographical or environmental determinism. This theory suggest that different aspects of physical environment notably climate determined the psychological mind set of individuals, which in turn influence the behavior and culture of the society. Traditionally criminologist focused on socio-demographic variables such as sex, age, race and socio-economic status of criminals for the possible causes of crimes. However, there is growing concern of researcher to investigate the influence and relationship of the physical environment on criminal behavior.

Fundamental theories that explain the criminal's behavior includes environmental criminology contrived by Patricia and Brantingham in 1981. Cohen and Felson's Routine activity theory (1979) and Rational Choice theory formulated by Derek et al. in 1986. In order to explain the relationship of weather and crime a number of theories have been devised. The Negative Affect Escape model (Baron, 1972; Bell and Baron 1976), General Affective Aggression model (Anderson et al 1995), Situational Routine activity theory (Cohen et al. 1979) and Social Escape/Avoidance theory (Cohen et al. 2004) suggests that crime rate and criminal behavior are significantly influenced by climate and weather.

A number of studies statistically explain the relationship between heat and hostility (Rotton and Cohn, 2003; Anderson et al. 1997; Anderson 1989; Cotton 1986; Anderson and Anderson 1984; Defronzo 1984). Researchers are sure that oppressive heat not only effects human health but also responsible for aggressive behavior (Baron and Bell, 1976; Harries et al. 1984; Harries and Stadler 1988; Cohn and James, 2000). Similarly researchers also highlighted the importance of temporal aspects in crime densities (Johnson et al. 2008; Paulson and Robinson, 2004; Ratcliffe, 2004).

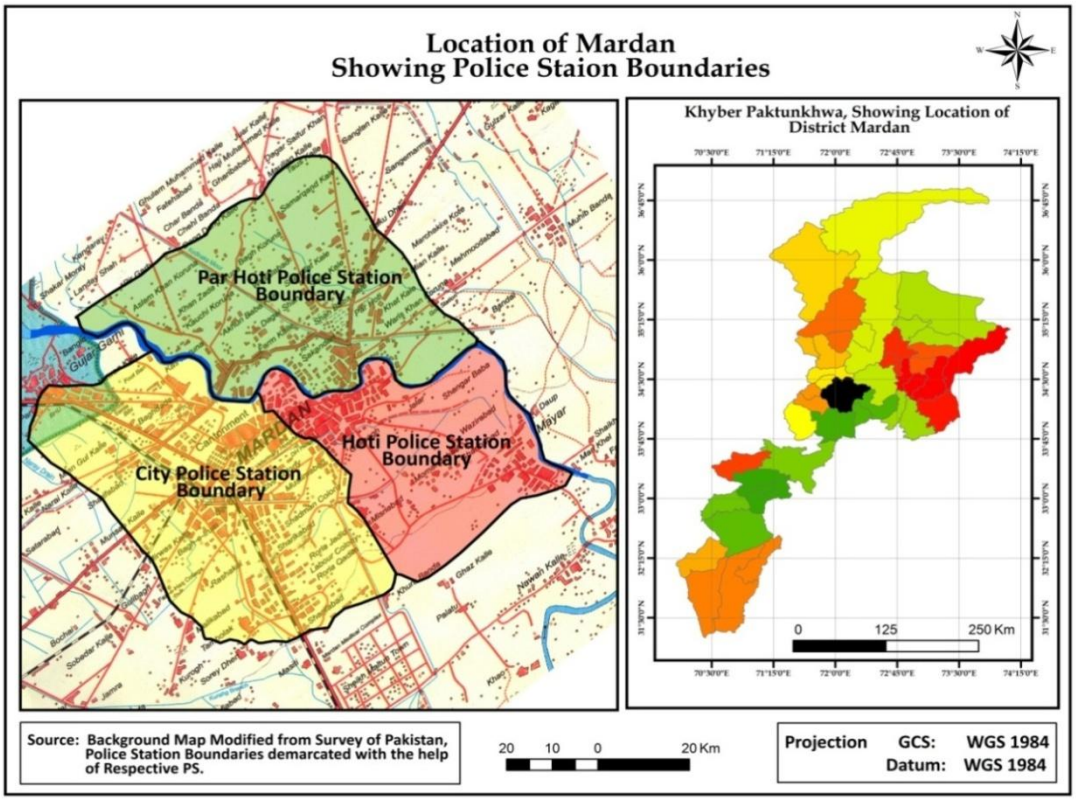
Crime mapping and spatial analysis helps in analyzing crime data and provide better understanding about why and where crime occurs. First ever crime

mapping was done by New York Police department in 1900's which make use of "Push Pins" which indicate crime that had occurred in a specific area (Rachel, 2001).During 1920s and 1930s University of Chicago's Sociologist used mapping to examine crimes and juvenile delinquency. Wall maps have long been used to indicate crimes and hot spots. Although these wall maps are useful but difficult to update (Weisbured & McEwen 1997; and Harries, 1999). During1960s and 70s the first computer based crime map was generated. During1990s the Geographic information System (GIS) become extensively used for mapping, and in late 1990s the use of GIS was started for crime analysis. Nowadays GIS is a powerful tool for crime mapping and spatial analysis. With the advancement in computers and development of GIS Technology, it's now possible to process large amount of spatial data to determine trends which may not be visible with conventional analysis. (Caitlin, 2012; Chainey & Ratcliffe, 2005; Grubesic & Mack, 2008; Goldsmith et al. 2000).

Cotton (1986) attempts to correlate the violent and nonviolent crime aggregates with the summer season for two cities of USA. He found a significant correlation between aggressive crimes and temperature. Similar results were reported by Harries and Stadler (1988). A series of experiments has been conducted on the effects of high ambient temperature on aggressive behavior (Baron, 1972;Baron & Bell, 1976; Dubitsky, et al. 1993) which suggests that aggression increase with increase in temperature.

Study area

Mardan is an important city and headquarters of Mardan District in the Khyber-Pakhtunkhwa province of Pakistan. It is the second largest populated city of NWFP. It is located at 34°12'0N 72°1'60E with an altitude of 283 meters (931 feet) lying to the south-west of the district. It was part of the ancient Gandhara Civilization. Most of its land is agricultural. (map1)



Objectives of the study

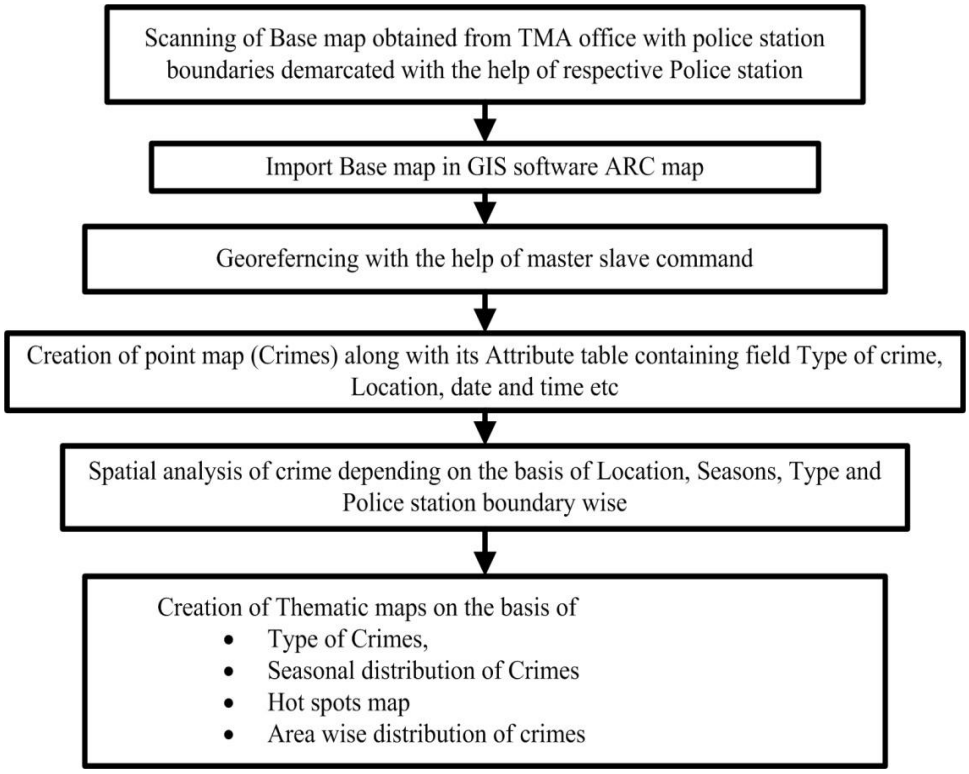
The aim of the present research is to determine the spatial distribution of aggressive crime in Mardan city for a period of 12 months i.e. January-December 2009. Besides, it also aims not only to find out the hot spots but also try to analyze the collected data temporally in order to find and establish any relationship between crime and weather. In order to achieve the mandated task the two major crimes i.e. Homicides (murder) and aggressive assaults (Crimes cause injuries) were selected for analysis. Ideally one should select the entire major and minor's crimes too, but data availability was the major constraint. Mardan city is controlled by three police stations i.e. City Police Station, Par Hoti Police Station and Hoti Police Station. The Present Study covers all the three Police Stations.

Data collection…

For the present research the data was collected from both Primary and Secondary sources, but it mainly dependent on primary data collected from all the three Police Stations. The data collected includes crimes type, location, and time of occurrence etc. Map of Mardan city was obtained from TMA (Tehsil Municipal Administration) office of Mardan. The boundary of each police station was demarcated with the help of police officers from respective police stations. The image of Mardan was downloaded from Google earth and the area of interest was cropped with help of ARC map. The image was printed and taken to the field to find various locations were crimes have been reported. Internet, literature and newspapers were also used to get more accurate picture of the respective crimes.

Data analysis

The data was analyzed for various argumentations i.e. Seasonal distribution of crimes, and identification of hot spots. For this purpose the district map was scanned and digitized in ARC map along with the police station boundaries demarcated with the help of respective police stations. After the creation of geo database, a point map "*crimes"* was created and the spatial distribution of different crimes was marked with the help of a point on map. The different attributes of crime was recorded in the attribute table of point map "crimes" i.e. location, time, date, type etc. Finally the maps were created reclassified with different fields from attribute table. The methodology is explained in the following flow chart.



The data collected was analyzed under the following parameters:

- Police Station Wise Distribution of different Crimes
- Distribution of Crimes on the Bases of Weather
- Determination of hotspots

Police Station wise Distribution of Crimes

Mardan city is divided into three police stations (Map 2.) City, Par Hoti and Hoti police station.The analysis of data reveals that as whole 98 crimes of aggressive nature were reported in Mardan City during 2009. Out of total 98 crimes, 47 % are reported in City Police station, Par Hoti 27 % and Hoti police station accounts for 24 % of total crimes reported during 2009. Crime wise

aggravated assaults account for 56 percent of the total crime, followed by murders 40 %.

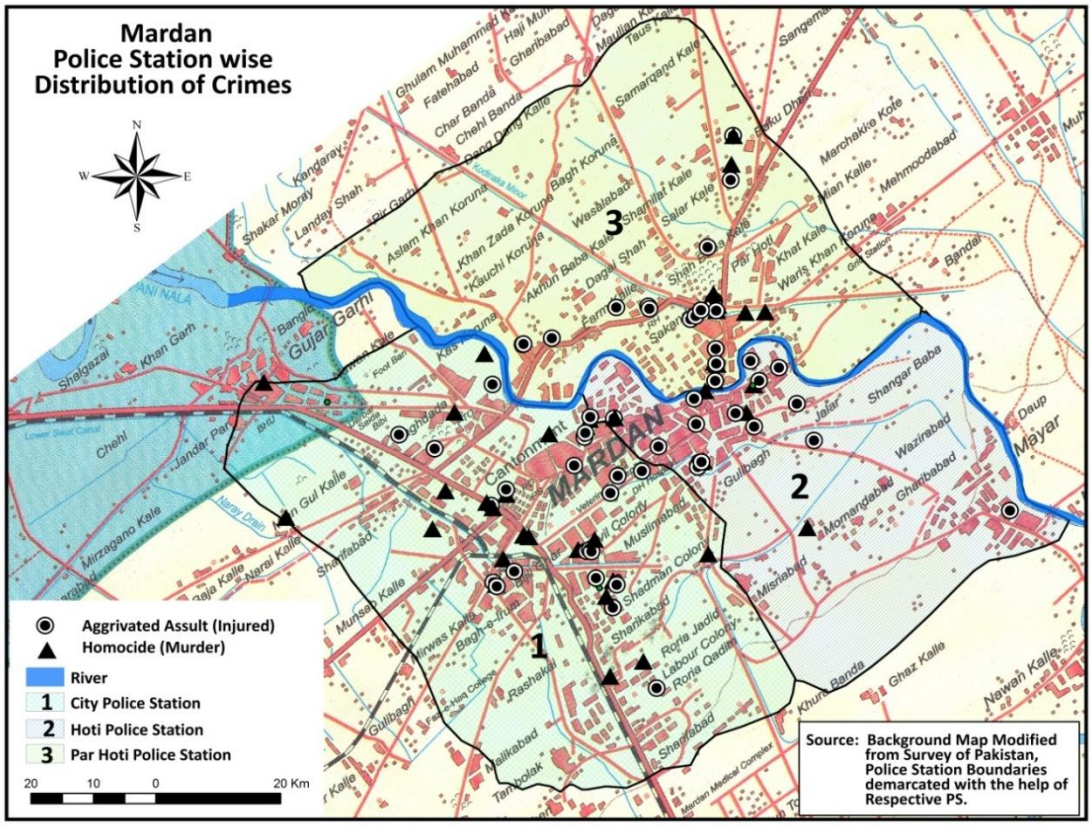
The Hoti police station cover the areas of Guli Bagh, Bibi Abay, Sangar Baba, Mayar, Sikandari, Landakay, Chato Chowk, Khwaja Gunj, Allah Dad Khel, Khan Koty, Belind Khel and Azi Khel , etc. analysis of the collected data reveals that as a whole a total of 24 aggressive crimes were committed within the Hoti Police station boundary. Out of these 24, 16 were aggravated assault, 07 were homicide, beside a case of kidnapping was also reported. The Par hoti police station cover the areas like Nehar Chowk, Mosam Korona, Pordal Abad, Faram Korona, Kacha Sarak, Muhib Banda, Shadan Baba, Tahir Abad , Bako Dery , Mardan Khaas etc. As whole 27 crimes were reported in the Par Hoti Police station out of which 10 was homicide and 17 were aggravated assaults.

The major areas included in the city police station are college chowk , Cantt area, Shamsi Road, Old Adda , New Adda, Kas Korona, Bijli Ghar, Bagh irum, Dosehra Chowk, Labor colony, and Bilal Masjid etc. A total of 47 crimes of aggressive nature were reported here out of which, 23 were homicide, 21 aggravated assaults and three cases of kidnapping were also reported. (Table 1,Map 2) The rate of murder is higher in city police station as compare to other police stations.

Table 1. Spatial Distribution of Crimes Reported in respective Police Station During 2009

Name of PS	Murder	Injured	Total	%age of Total
Hoti	7	16	24	25 %
Par Hoti	10	17	27	28%
City	23	21	47	47%
Total	40	54	94	100

Source: Respective Police Station



Weather and crime

It has been contended that there is always a motive behind a crime which may be enmity, hatred or a hundred other reasons. During investigation police tries to collect as much details as possible for clues to identify the wrongdoer and the motive for the umbrage. However, studies suggest that there may be other reasons why people commit crimes? One of the possible reasons suggested by various researches is the weather, the relationship of weather and crime is well documented. Researchers ascertain the relation between fluctuation in weather and the incidence of both aggressive and non-aggressive crimes (Brunsdon, et al. 2009; Bushman, et al. 2005; Cohn, 1990; Rotton & Cohn, 2003). Various weather conditions such as heat waves, higher temperatures, high humidity,

wind, air and water pollution along with overcrowded living conditions can lead to higher levels of criminal activity.

One of the objectives of the study was to analyze the reported aggressive crimes temporally in order to determine and establish any relationship, if any between crime and weather. Like most of the other parts of Pakistan, in Mardan, summers are extremely hot and last from May to September, June the hottest moth with an average temperature of 41.5 °C. Winters are cool to cold and last from October to February. The mean minimum temperature recorded for the month of January is 2.1 °C. Spring is too short and only last for two months. Most of the rainfall occurs in July and August from summer monsoon (125.85mm) and December and January from western depressions. The maximum humidity has been recorded in December i.e. 73.33% (GoP, 1998). The collected data was grouped from March to April (spring), May to September (summer) and October to February (winter) to correlate and establish any relationship between crimes and Season.

March to April (spring)

The analysis of the collected data reveals that during the spring season (March to April) of 2009, a total of 19 crimes were reported from all the three police stations. Out of these 19 crimes, 06 were homicide and rest 11 were aggravated assaults.

May to September (summer)

Summers in Mardan are hot, humid and last for 05 months. During the summer of 2009, a total of 44 crimes were reported, which were 48 % of the total aggressive crimes committed during 2009. Out of 44 reported crimes, 25 (56%) were aggravated assaults, and 19 (42%) were homicide. It is also important to mention that out of total 40 homicide cases reported in 2009, 48% were committed in summer. Likewise summer also accounts for 46% of the total aggravated assaults reported during the same period. The analysis of collected data also reveals that majority (24 out of total 44) of crimes reported during summer were committed in the premises of the city police station. It

comes as no surprise as the city police station is covering some of the densely populated region of Mardan city.

October to February (winter)

Analysis of data reveals that during winter (October-February) of 2009, a total of 31 crimes were committed. Out of these total 31, 18 were aggravated assault, 13 were homicide.

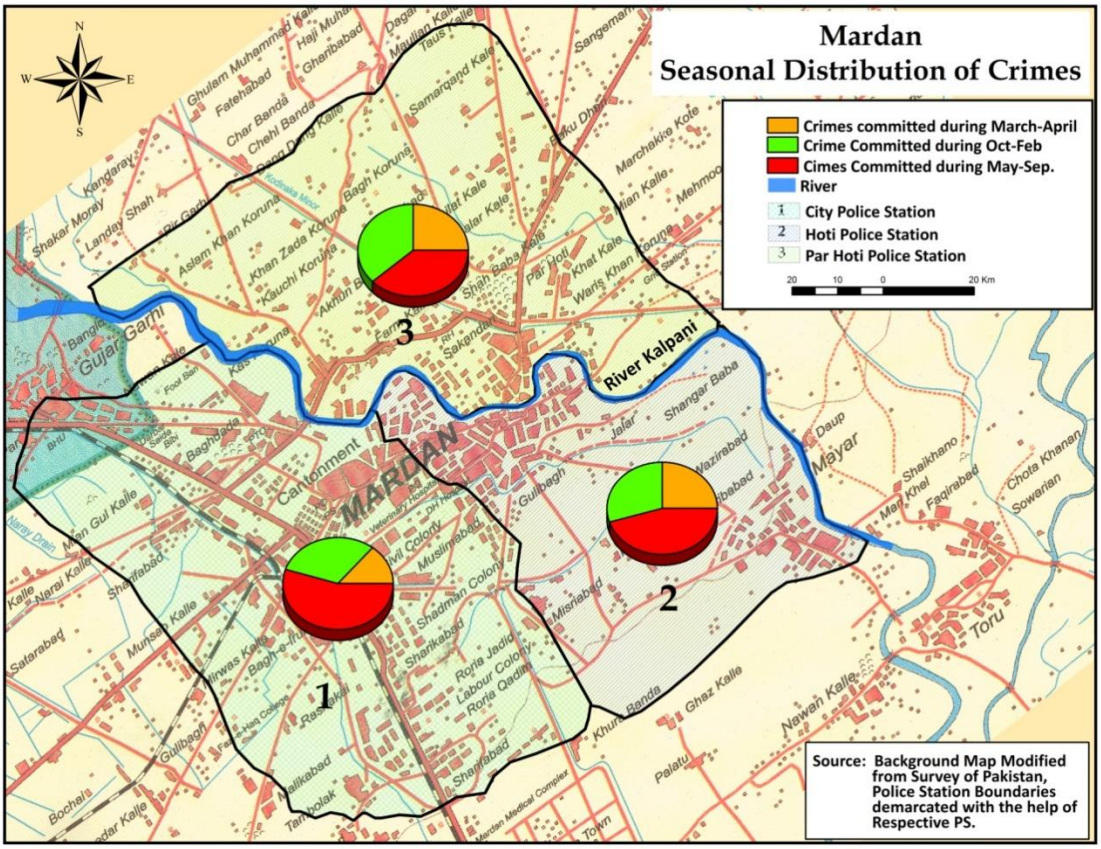
Discussion

The analysis of data on the basis of season reveals that 47 % of total crimes reported in all the three police stations during 2009, were committed from May- September (during summer season), followed by 33 % in winter and rest 20 % in Spring (March- April)(Table 2, map3). This temporal analysis reveals that the primary reason seems to be temperature/heat which can cause irritation. Weather get hot and people get aggressive more easily causing loss of tempers and problems between people. Though it's not the final verdict but still this study confirm the findings of most of the researches which indicate that most crime occurs in summer seasons. A series of weather and crime related studies conducted in UK, USA and France suggests aggressive crime i.e. domestic assaults, suicides, assaults were high during summers (Butke & Sheridan, 2010; Bushman et al. 2005 and Brunsdon et al. 2009).

Table 2. Mardan City, Seasonal Distribution of Crimes Committed During 2009

Time Period	Assaults	Homicide	Total
March-April (Spring)	11	06	19
May- September (Summer)	26	20	47
October-February (Winter)	17	14	32
Total	**54**	**40**	**94**

Source: Respective Police Station



Hotspots

Although the location where a crime occurs is important but equally crucial is the characteristic of the places where the crime take place. A hotspot is a condition indicating some sort of clustering in a spatial distribution or areas of high crime density. According to Sherman (1995) a hot spot is a small place where high number of crime occurs and is highly predictable in one year period. This terminology is commonly applicable to street crimes rather than more organized crimes. GIS helps and analyze crimes in many different ways. The most significant use of GIS is to visualize the crime in spatial context. This spatial visualization enables Police to identify hotspots and understand the

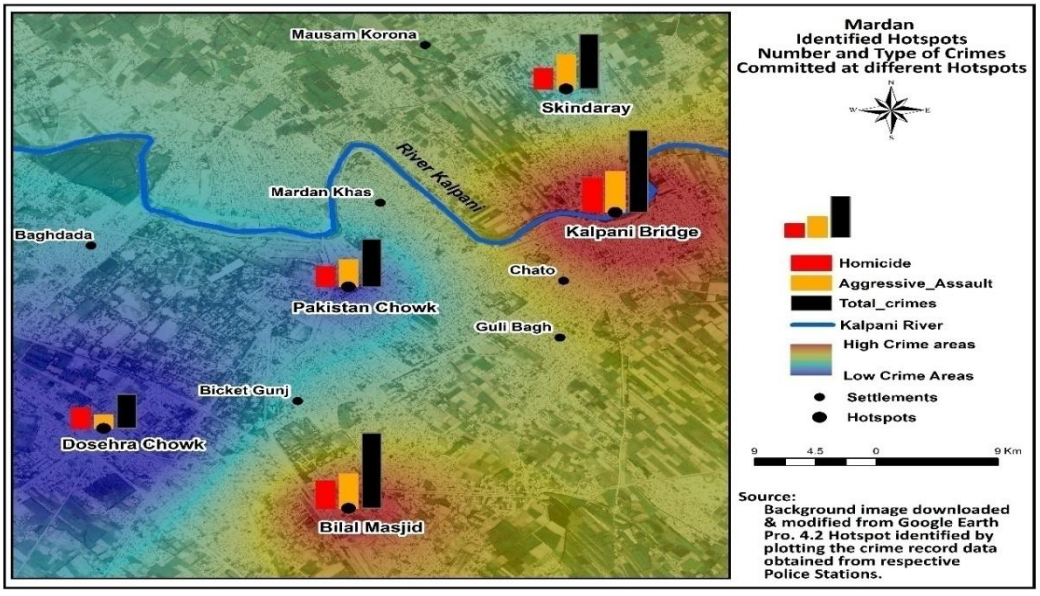
pattern of crime occurrence. The hotspot analysis can be helpful in fighting against the crime by increasing patrol around such locations or by protective measure

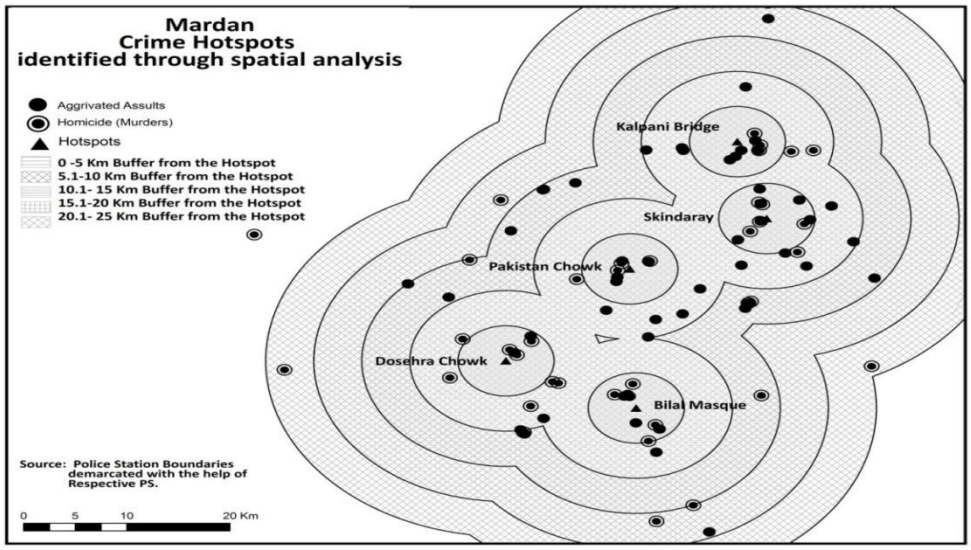
For spatial analysis the collected data was plotted with the help of police record of location where the crime take place. The analysis of data revealsa total of 05 hot spot in Mardan city. The most crucial seem to be Skindaray area where within 05 km radius a total of 11 crimes were committed during 2009, followed by Kalpani Bridge 10 and Bilal Mosque area 09. In terms of aggravated assaults Kalpani Bridge and Skindaray rank 1st with total of 07 and 06 cases reported from each respectively, followed by Bilal Mosque and Pakistan Chowk 05 and 04 cases respectively. (Table 3, Map 4, 5). In term of murders skindaray with 05cases of homicide rank 1st, Dosehra chock and Bilal mosque with 04 homicides each rank 2nd.

Table3. Mardan City, Hotspots 2009 Number and Type of Crimes committed within 05 Km radius of Hotspots

Name Of Hot Spots	Murders	Injured	Total
Dosehra chock	04	02	06
Kalpani Bridge	03	07	10
Bilal Masjid	04	05	09
Skindaray	05	06	11
Pakistan Chowk	03	04	07

Source: Respective Police Station





The common perception regarding crimes is that they are randomly distributed in space, but the evidence suggests this is wrong. The mapping of crime spatially is important as it allows knowing how they are distributed through space, and thus enables the police department to implement and monitor the mitigation policies. In this regard the Geographic Information System plays an important role to help fight crime. Maps depicting the spatial distribution of crimes in a specific area can not only be an effective tool to predict the occurrence of future crime but also provide efficient operational protective features.

The present research, analyze the collected data and find that almost 50% of reported aggressive crimes were committed during summer (May to September) compared to 32% in winter (October to February). The results seem conclusive and reveal that summer heat may play a significant role in pumping up the adrenaline. Summer in our part of the world is usually characterized by vacations and increased friends & family interaction. According to Walmsley (1986) majority of aggressive crimes occurs between

friend and family members. Uncomfortable heat tends to cause increased frustration, reducing tolerance for irritations that otherwise might be dismissed.

References

Amanda B.(2013). Geographic and Environmental Determinism, Education Journal No.154, The Education Publishing Company Ltd., Crediton, Devon, UK.

Anderson, C.A. (1989). Temperature Aggression: Ubiquitous effects of heat on the occurrence of human violence. Psychol. Bull., 106, 74-96.

Anderson, C.A. & Anderson, D.C. (1984). Ambient Temperature and Violent crime: Test of linear and curvilinear hypothesis. J. Pers. Soc. Psychol., 46, 91-97.

Anderson, C.A., Deuser, W.E. & DeNeve, K. (1995). Hot Temperature hostile effect, hostile effect cognition and arousal: Test of a general model of affective aggression. Pers. Soc. Psychol. Bull., 21, 434-448.

Anderson, C.A., Bushman, B.J. & Groom, R.W. (1997). Hot years and serious and deadly assaults: Empirical tests of the heat hypothesis. J. Pers. Soc. Psychol., 73, 1213-1223.

Baron, R.A. (1972). Aggression as a function of ambient temperature and prior anger arousal. J. Pers. Soc. Psychol., 24, 183-189.

Bell, P.A. & Baron, R.A. (1976) Aggression and heat: The mediating role negative affect. Journal of Applied Social psychology, 6, 18-30.

Baron, R.A. & Bell, P.A. (1976). Aggression and heat: The influence of ambient temperature, negative effects and a cooling drink on physical aggression J. Pers. Soc. Psychol., 33, 245-255.

Brantingham, P. J.; Brantingham. P. L., eds. (1981). Environmental criminology. Waveland Press. ISBN 0-88133-539-8.

Butke, P. & Sheridan, S.C. (2010). An analysis of the relationship between weather and aggressive crime in Cleveland, Ohio. Weather, Climate, and Society. 2: 127-139.

Bushman, B.J., Anderson, C.A. & Wang, M.C. (2005). Is the curve relating temperature to aggression linear or curvilinear? Assaults and

temperature in Minneapolis reexamined. J. Pers. Soc. Psychol., 89:62-6.

Brunsdon, C., Jonathan, C., Gary, H., & Andrew W. (2009). The Influence of Weather on Local Geographical Patterns of Police Calls for Service. Environment planning and design 36(5): 906-926.

Caitlin, D. (2012). Crime Mapping and Analysis, GIS Lounge. Retrieved November, 12, 2014 from: http:// gislounge.com

Cohen, L.E. & Felson, M. (1979). Social change and crime rate trends: A routine activity theory approach. Amer. Social. Rev., 44, 588-608.

Cohen, E., & James R. (2000). Weather, Seasonal Trends, and Property Crimes in Minneapolis, 1987-1988: A Moderator-Variable Time-Series Analysis of Routine Activities. Journal of Environmental Psychology 20(3): 257-272.

Cohen, E., Lawrence E. & Felson, M. (1979). Social change and crime rate trends: A routine Activity approach. American Sociological Review (American Sociological Association) 44(4): 588-607.

Cohen, E. (1990).Weather and Crime." British Journal of Criminology 30(1): 51-64.

Cohen, E., Peterson, A.G., & Tarr, D.B. (2004). Temperature, City Size and the southern subculture of violence: Support for Social Escape Avoidance (SEA) theory. Journal of Applied Social Psychology, 16, 786-801.

Cotton, J.L. (1986). Ambient temperature and violent crime. Journal of Applied Social Psychology, 6, 18-30.

Chainey, S. & Jerry R. (2005). GIS and Crime Mapping. John Wiley & Sons. ISBN 0-470-86099-5.

DenFronzo. J. (1984).Climate and crime: Test of an FBI assumption. Environment and Behavior, 16, 185-210.

Derek, C; Clarke & Ronald, V. (1986). The Reasoning Criminal. Springer-Verlag. ISBN 3-540-96272-7.

Dubitsky, S., Weber, R., & Rotten, J. (1993). Heat, hostility, and immune function: The moderating effects of gender and demand characteristics. Bulletin of the psychonomic Society, 31, 534-536.

Grubesic, T.H. & Mack, E.A. (2008). Spatio-temporal interaction of urban crime. Journal of Quantitative Criminology, 24: 285-306.

Goldsmith, V., McGuire. P.G., Mollenkopf, J. H. & Ross,T. A. (eds) (2000). Analyzing Crime Pattern: Frontiers of Practice. Thousand Oaks, CA, Sage Publications.

Harries, K. D. & Stadler, S.J. (1988). Heat and violence: New findings from Dallas field Data, 1980-1981.Journal of Applied Social Psychology, Volume 18, Issue 2, pages 129-138.

Harries, K. D., & Stadler, S.J. & Zdorowski, R.T. (1984).Seasonality and assault: Exploration in inter neighborhood variation, Dallas 1980. Annals of the Association of American Geographers, Volume 74 (4), 590-604.

Harries, K.(1999). Mapping Crime: Principal and practice. US Department of Justice; Washington DC. USA.

Isaac, B. (2004). The Invention of Racism in Classical Antiquity: Princeton University Press, Princeton, New Jersey,USA.

Johnson, S. D., Lab, S. P., & Bowers, K. J. (2008). Stable and fluid hotspot of crime: Differentiation and identification. Built Environment, 34: 32-45.

McKean, J. (2000). Hot Weather Helps Crime to Grow: Brief Article, USA Today (Society for the Advancement of Education). 20 May, 2010. Retrieved January, 13, 2015 from: http://findarticles.com/p/articles/mi_m1272/is_2662_129/ai_63668105/

Paulson, D.J. and Robinson, M. B. (2004). Spatial Aspect of Crime: Theory and Practice. Upper Saddle River, Prentice Hall, New Jersey.

Rotton, J. & Cohn, E.G. (2003). Global Warming and U.S. Crime rate: An applicant of Routine Activity Theory. Environmental and Behavior, 35, 803-825.

Ratcliffe, J. H. (2004). The hotspot matrix: A framework for the spatio-temporal targeting of crime reduction. Police Practice and Research 5(1), 5-23.

Rachel, B. (2001). Introductory Guide to Crime Analysis and Mapping. Report of the Office of Community Oriented Policing Services, US department of Justice.

Sherman, L. W. (1995). Hot spots of crime and criminal careers of places. In: J.E. Eck and D. Weisburd, eds., Crime and Place. Monsey, NY: Criminal Justice Press; and Washington, DC: Police Executive Research Forum, pp. 35-52.

Weisburd and McEwen (1997). Crime Prevention studies, Criminal Justice Press, USA.

Walmsley, R. (1986). Personal Violence. Home Office Research study 89. London: HMSO.

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