

Crime Hotspot mapping and GIS analysis based on Police Station in Allahabad city using Inverse Distance Weighted (IDW) interpolation method.

Puleno Kennao ¹, Deepak Lal ², Lav Kesharwani ³

1. Puleno Kennao

Ph.d Scholar

Department of forensic science

Sam Higginbottom University of Agriculture, Technology and Sciences, Allahabad, India.

Address- Department of Forensic Science, SHUATS, Niani, Allahabad-211007, Uttar Pradesh

E-mail- alekennao@gmail.com

Ph. no – 919848330342

2. Dr. Deepak Lal

Dean, Shepherd Institute of Engineering and Technology

Sam Higginbottom University of Agriculture, Technology and Sciences, Allahabad, India

Address- Dean, SIET, SHUATS, Niani, Allahabad-211007, Uttar Pradesh

Email- deepakl@shiats.edu.in

Ph. No- 918172999940

3. Dr. Lav Kesharwani

Assistant Professor

Department of Forensic Science

Sam Higginbottom University of Agriculture, Technology and Sciences, Allahabad, India

Address- Department of Forensic Science, SHUATS, Niani, Allahabad-211007, Uttar Pradesh

Email- lavkesharwani@gmail.com

Ph.no- 919336862259

ABSTRACT

Crime analysis plays a crucial role in devising solutions in formulating crime preventions strategies and crime problems. This study highlights the importance of identifying the most reported crime in the police stations of Allahabad city through the thematic map that can be utilized by the police departments. GIS can be used as a tool to identify factors contributing to crime, and thus allow police to proactively respond to the situation before they show a red signal. Hotspot map was determined

through interpolation method (IDW) to see the concentration of crime (Offences against Life and Offences against property) in each police station. The crime challenges faced by the police department need to pursue to implement computerizes crime mapping for crime analysis. The result shows that the jurisdiction of Doomanganj Police Station and Kernal Ganj Police Station needs high patrolling and effective measures for the type of crime being conducted in this study.

Keywords: Crime analysis, Hotspot, Police Stations, GIS, Interpolation method.

1. INTRODUCTION

Policing agencies are not specific at predicting where and when particular future crime will occur (**Fattah, 1997**). Hence, geography comes into play as a significant role in law enforcement and criminal justice. The rate of crime is increasing drastically with time and year. India is one country which reports a lot of crime and with increase rate police has become handicapped to curb the crime. (**Murray et al. 2001**), in his study mentioned that the rate of crime occurrence had grown abruptly to nearly epidemic proportions, particularly in urbanized areas due to the population explosion. In the same way, the crime rate is increasing in Indian country due to poor socio, political and environmental conditions and hike in population.

Uttar Pradesh is the [most populous state](#) in the [Republic of India](#) as well as the [most populous country subdivision in the world](#). The densely populated state, located in the [northern region](#) of the Indian subcontinent, has over 200 million

inhabitants. With the increase in population, Uttar Pradesh accounted for 9.5% of total IPC crime reported in the country followed by Madhya Pradesh (8.9%), Maharashtra (8.8%) and Kerala (8.7%).

Patrolling can be enhanced by giving the maps showing the crime area or the territory where the grouping of crime is high. Although the manual wall maps are useful, they are difficult to keep updated. Geographic Information System (GIS) can be used as a tool by police personnel to plan efficiently for emergency response, determine mitigation priorities, analyze historical events, and predict future events (**Johnson, 2000**). The purpose of utilizing GIS technologies is to enable officers to settle on better-educated choices about which territories of the city require extra police control (**Anne 2004**). Maps that show the problem areas are extremely useful in crime mapping for the police patrol to find the spots that they are most needed (**Sivaranjani and Sivakumari, 2015**). Also, it can help crime officers decide potential crime locales by inspecting complex apparently random criteria and showing them all in a graphical, layered, spatial interface or map. The term hotspot has

become an integral part of the study called crime analysis and is popular with most of the analyst. Hotspot literally means the cluster of geographical areas consisting of a habitually high number of crime events which will help to easily determine the site where the action can be taken. Uses of GIS to crime mapping and management have been successful in many urbanized countries (Murray *et al*, 2005). GIS permits police personnel to make policies adequately for crisis reaction, it encourages crime officers to decide potential occurrence destinations and encourages investigating the connection amongst between incident and land use (Fajemirokun, *et al*, 2006). This study, therefore, seeks to explore the hot spot mapping of the crime under Offences against Life and Offences against Property that had been reported in all the 15 police station of Allahabad city by Interpolation method (IDW), using Allahabad city as a case study.

2. MATERIAL AND METHODS:

2.1 Study Area

A large metropolitan city Allahabad or Prayag is located in the state of Uttar

Pradesh, India (Fig. 1). The city lies between latitude 25° 28' 22.9224" N and longitude 81° 52' 42.0852" E at an altitude of 90 meters height, that is equal to 295 feet above sea levels. With the population exceeding 1 million people, the city is in the ten most populous cities of the state. It is one of the fastest developing cities of the area. The city of Allahabad has 15 Police Stations with 56 chowkis.

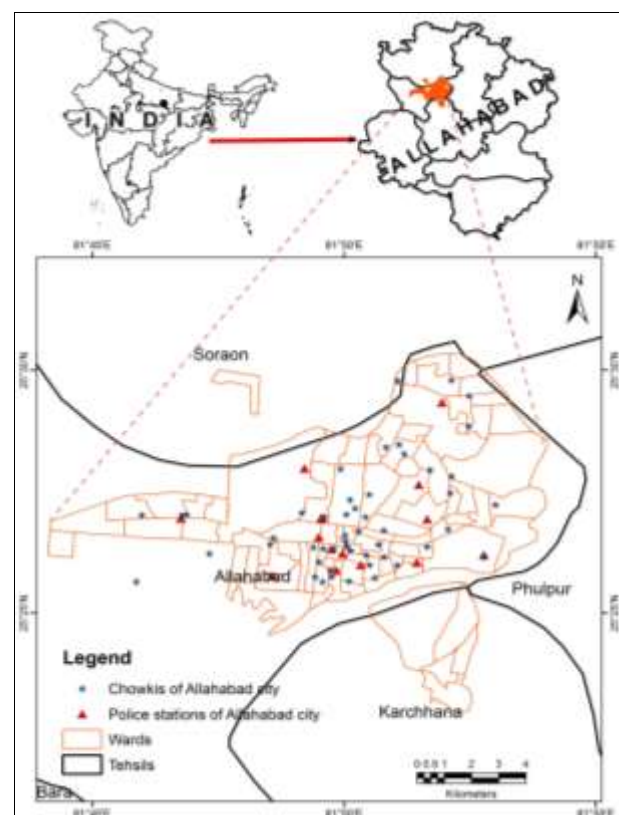


Fig 1: Map showing study area (Allahabad city)

2.2 Source of Data:

The locations of all the Police Stations present in Allahabad city were collected using differential GPS (R1GNSS) by visiting each Police Station. The primary data were sourced by oral conversations with Station House Officers through relevant questions related to the research. The secondary data were then collected from the SSP office, Kacheri, Allahabad where the crime data's of three years of all the Police Stations were collected.

2.3 Determination of Hot Spot Maps through GIS Interpolation method (IDW)

Interpolation is the method of victimization points with known values to propose values at alternate unknown points. It is one of the most popular methodologies which are used to find the missing values with the help of the values that are present in the nearer places. ie. It is meant for the prediction of the new data point which is missing from the dataset with the help of known discrete data points. According to the literature, the interpolation of data is done by the using inverse distance weighting method. This method is used to find the unknown value of

a particular point by taking the average weight of surrounded known points (**Sivaranjani and Sivakumari, 2015**). The research shows that identifying and formulating a strategic response to hot spots can reduce crime in both the hot spot and surrounding areas. Therefore, to identify the hot spots, the interpolation method was used to predict the values of cells at locations that lack sampled points. It depends on the guideline of spatial autocorrelation or spatial reliance, which estimates the level of relationship/reliance among close and far off items. The Inverse Distance Weighted (IDW) function was used for the set of points which is dense enough to capture the extent of local surface variation needed for analysis.

3. RESULTS AND DISCUSSIONS

Base guide for the investigation zone was set up for plotting the crime occurrences. The base map consists of all settlements and zone boundary for Allahabad city. Crime density rate reported in each Police Station was prepared with the help of crime data using the base map zone boundary. Hotspot and buffer zones were identified after

getting the crime map for the type of crimes
i.e., Offences against Life and Offences

against Property.

3.1 Offences Against Life

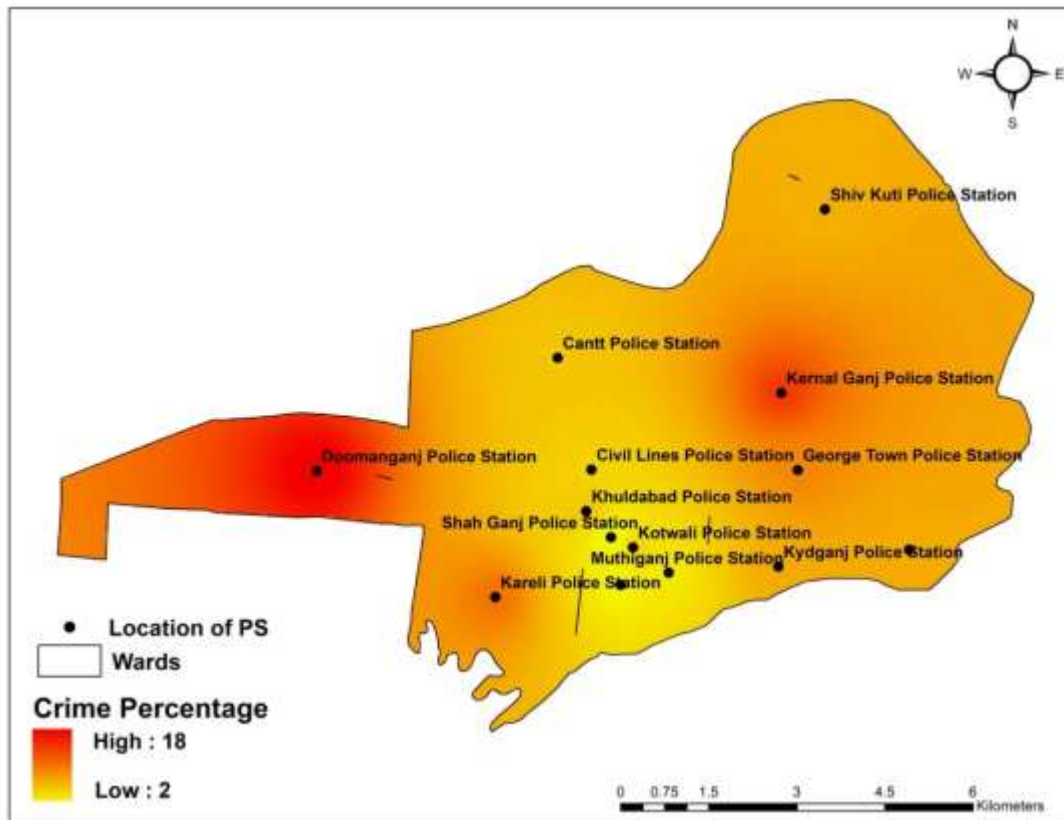


Fig 2: Hotspot Map of crime under Offences against Life

Figure 2 depict the crime density of each Police Station under Offences Against Life was found highly concentrated in Doomanganj Police Station (18%) covering almost the whole jurisdiction, followed by Kernal Ganj Police Station (14%) and Kereli

Police Station (11%), George Town Police Station (7%), Daraganj Police Station (7%), Shiv Kuti Police Station (7%), Kydganj Police Station (7%), Khulabad Police Station (6%), Civil Lines Police Station (5%), Kotwali Police Station (5%) Cantt

Police Station (5%), Muthiganj Police Station (3%), Attarsuiya Police Station (2%)

and Shah Ganj Police Station (1%).

4.2 Offences Against Property

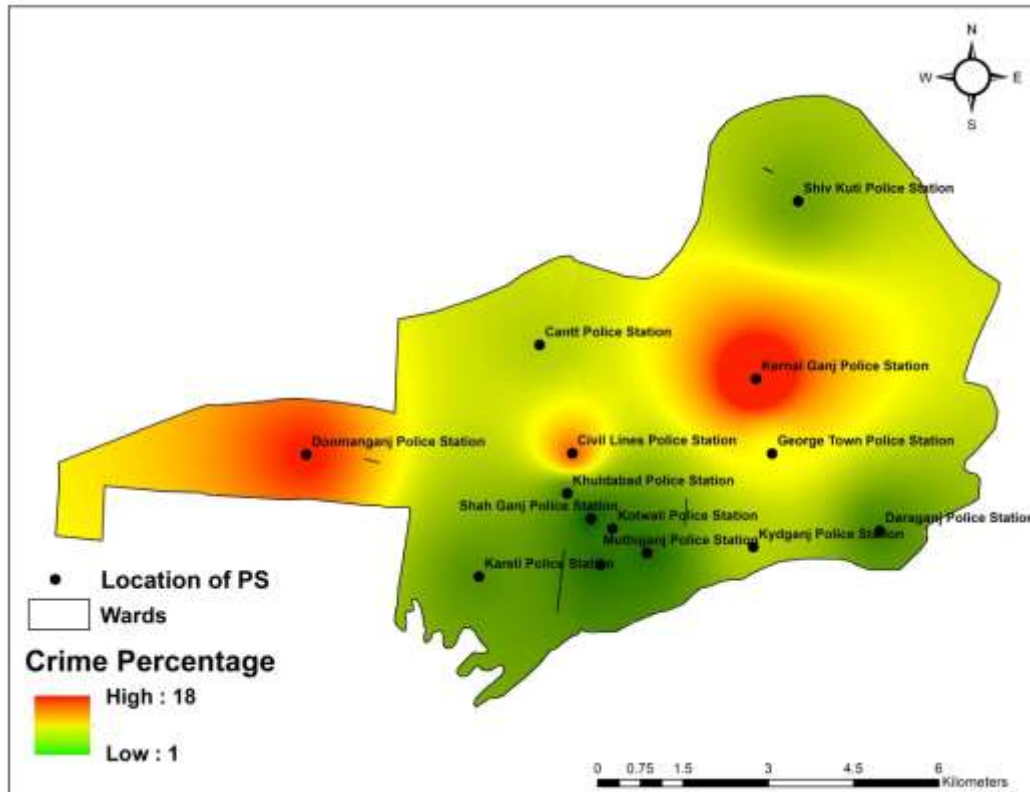


Fig 3: Hotspot Map of crime under Offences against Property

Figure 3 presents the spatial distribution of crime under Offences against Property. It is apparent from the figure that the crime concentration is found highest in Kernal Ganj Police Station (18%) followed by Civil Lines Police Station (17%), Dhoomanganj Police Station (13%), George Town Police Station (12%), Kantt Police Station (6%), Kydganj Police Station (5%), Daraganj Police Station (5%), Khuldabad Police Station (3%), Shiv Kuti Police Station (3%), Kareli Police Station (3%), Attarsuiya Police Station (2%), Shah Ganj Police Station (1%), and Muthiganj Police Station (1%).

Cantt Police Station (6%), Kydganj Police Station (5%), Daraganj Police Station (5%), Khuldabad Police Station (3%), Shiv Kuti Police Station (3%), Kareli Police Station (3%), Attarsuiya Police Station (2%), Shah Ganj Police Station (1%), and Muthiganj Police Station (1%).

4. CONCLUSION

The study has attempted to operationalize the application and utilization of geographical information system in crime management and security situation analysis for effective community policing in Allahabad city. The present study was confined to only two types of crime i.e., Offences against Life and Offences against Property. The study shows that the proximity of crime concentration was found more in the jurisdiction of Doomanganj Police Station, Kernal Ganj Police Station, and Civil Lines Police Station. Knowing the hotspot, effective measures and policing can be taken into an action of different crimes that come under Offences against Life and Offences against property in the affected jurisdiction in the near future.

The result of this paper demonstrated that GIS technology can be of great importance to the law enforcement agency, as it will allow police personnel to map effectively for crisis reply, determine improvements priority, analyze past events, and predict future events and help to determine possible events locations thus making the police react quickly and proactively. Hence, it is

recommended that for effective crime control and management, the police force should be engaged in the modern standard of policing by adopting and integrating GIS methodology as this will definitely help in crime mapping to improve the understanding of crime pattern in relation to police stations, offenders residence and to identify the hotspot of crime in a locality.

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Offences against Life:

Sl.no	Name of Police Station	No. of Crime	Percentage	Latitude	Longitude
1.	Kernal Ganj Police Station	94	14.10%	25.46076375	81.85810393
2.	Civil Lines Police Station	31	4.70%	25.44912817	81.8258573
3.	Doomanganj Police Station	120	18.00%	25.44917	81.779305
4.	George Town Police Station	62	9.30%	25.44888906	81.86082084
5.	Kotwali Police Station	30	4.50%	25.43714455	81.83281482
6.	Cantt Police Station	36	5.40%	25.46635508	81.82025625
7.	Kydganj Police Station	48	7.20%	25.43406697	81.85742202
8.	Daraganj Police Station	47	7.10%	25.436522	81.879574
9.	Khuldabad Police Station	37	5.60%	25.44275064	81.82494701

10.	Shiv Kuti Police Station	45	6.80%	25.48890079	81.86570108
11.	Kareli Police Station	70	10.50%	25.42965018	81.80945102
12.	Attarsuiya Police Station	16	2.40%	25.4314072	81.83068307
13.	Shah Ganj Police Station	7	1.10%	25.43871589	81.82908926
14.	Muthiganj Police Station	22	3.30%	25.4332266	81.83884256

Offences against Property:

Sl.no	Name of Police Station	No. of Crime	Percentage	Latitude	Longitude
1.	Kernal Ganj Police Station	703	17.7 %	25.46076375	81.85810393
2.	Civil Lines Police Station	676	17 %	25.44912817	81.8258573
3.	Doomanganj Police Station	520	13.1 %	25.44917	81.779305
4.	George Town Police Station	470	11.8 %	25.44888906	81.86082084
5.	Kotwali Police Station	361	9.1 %	25.43714455	81.83281482
6.	Cantt Police Station	243	6.1 %	25.46635508	81.82025625
7.	Kydganj Police Station	203	5.1 %	25.43406697	81.85742202
8.	Daraganj Police Station	200	5 %	25.436522	81.879574
9.	Khuldabad Police Station	135	3.4 %	25.44275064	81.82494701
10.	Shiv Kuti Police Station	136	3.4 %	25.48890079	81.86570108
11.	Kareli Police Station	129	3.3 %	25.42965018	81.80945102
12.	Attarsuiya Police Station	71	1.8 %	25.4314072	81.83068307
13.	Shah Ganj Police Station	68	1.7 %	25.43871589	81.82908926
14.	Muthiganj Police Station	53	1.3 %	25.4332266	81.83884256