Re-creation of crime scene usingDifferential Global Positioning System (DGPS) in outdoor simulated scene.

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Submitted in partial fulfillment of the requirements of the award of the degree of

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In

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By

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Certificate of Original Work

This is to certify that the thesis entitled **"Recreation of Crime Scene using Differential Global Positioning System (DGPS) in outdoor simulated crime scene"** submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Forensic Science, Department of Forensic Science, Faculty of Science, Sam Higginbottom University of Agriculture, Technology and Sciences, is a bonafide research carried out by **Miss Puleno Kennao, I.D. No. 13PHFS101** under my supervision and guidance.

The experimental findings presented in this thesis are genuine and original to the best of my knowledge, the script of the thesis has been written by the candidate herself and no part of this thesis has been submitted for any other degree or diploma in any other University. The assistance and help received during the course of this investigation has been duly acknowledged.

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Dedication

This Thesis is dedicated with LOVE and AFFECTION to my loving

Father and Mother,

Whose loving spirit, encouragement and prays of day and night make me able to get such success and honor.

And as

Every challenging work needs self-efforts, motivation as well as guidance.

My humble effort I dedicate to all my

Siblings, Friends and my respected Teachers.

SELF ATTESTATION

This is to certify that I have personally worked on the thesis entitled **"Re-creation of crime scene using Differential Global Positioning System (DGPS) in Outdoor Simulated Scene".**The data mentioned in the thesis has been generated during the work and are genuine. The content of this thesis has not been submitted to any other University or Institution for the award of any degree or Diploma.

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Puleno Kennao

ABSTRACT

It is vital to envisage the location of the evidence to get an idea on how the crime took place and in what manner. Managing outdoor crime scenes with the application of conventional method can be a demanding job to achieve exclusively when the crime emerged in big space, where there is lack of reference points and tress being surrounded. In this research, fifteen simulated outdoor crime scenes were created, where both manual tape measurement and DGPS unit was applied to see if the differential GPS offers an accurate and reliable alternative for mapping the scene over the baseline method. To develop a final digital map of the simulated outdoor scenes, Geographical Information System (GIS) was utilized. The result indicates that the DGPS unit provides a consistent reading when compared to manual tape measurement giving an average reading difference of 0.1, 0.2, 0.12, 0.13, 0.01, 0.2, 0.06, 0.04, 0.2, 0.2, 0.3, 0.1, 0.1, 0.06, (inch) from fourteen simulated outdoor crime scenes. The study concluded that DGPS unit can be a viable alternative for mapping the outdoor crime scenes.

With the population exceeding 1 million people, the Allahabad city is in the ten most populous cities of the state and highest crime recorded according NCRB. It is one of the fastest developing cities of the area. This research also studies the spatial distribution of Police Station in each zone of Allahabad city based on crime and population in corporation with Differential Global Positioning System (DGPS) by visiting each Police Station to get the exact locations (latitude and longitude) while the primary data, secondary data and the demographic data were all sourced from SSP, Police Station and Municipal Cooperation, Allahabad. The data were analyzed using simple descriptive, pie chart and frequency distribution table. ArcGIS 10.4 software was used to draw the map of each zone showing the presence of Police Station. Chi-square test has shown that the Police Station in each zone is not evenly distributed. It was also discovered through

Coefficient Correlation and T-test that as population increase, crime also increases. This research concludes that crime increases with tremendous growth in population, and there is a need for the population consideration in deployment of police stations in the concerned zones for achieving better security situations in the city.

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 different crime 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.

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CHAPTER 1

INTRODUCTION

1. INTRODUCTION

Crime scene examination is a multi-stage practice which includes gathering evidences as well as scene recording, documentation, and scene recreation, and so forth. Outdoor crime scenes are the most hard to explore. To apply the traditional method for crime scene management on outdoor crime scenes, can be taxing and challenging especially when the evidence are covered in a big space. Error can occur as human beings are liable to mistakes. In the case of outdoor scenes, inclement weather conditions can quickly damage evidence and create additional challenges for the investigator. It is clear that outdoor scenes are not processed with the same high standards as indoor scenes **(Dirkmaat and Cabo, 2009).** Law-enforcement procedures for handling indoor scenes are settled and give logically approved, court defendable recreations of past occasions. Nonetheless, law-requirement conventions for handling open air scenes are essentially nonexistent. Forensic Archaeology had provided a successful outcome from rigorous collection and documentation of all pertinent items that enhanced and maximizes the amount of data retrieved at the scene **(Dirkmaat, 2012).** The photographic documentation of crime scenes is the cornerstone of any criminal investigation **(Houck, 2010).** However, the camera was never proposed to supplant vision since it surely can't **(Weiss, 2009).** From a single image, clues can support during the time of investigation process and images used as only evidences have much greater potential. Copious information can be obtained from a single image and how these traces can become clues of a past event. However, a scientific and structured approach to using images in the reconstruction process does not exist, and no methodology has been developed to articulate such an approach (**Milliet *et al.* 2015).** Due to this reason, sketch was considered as a crucial task to perform as it represents the layout of the crime scenes. The crime scene sketch is a

valuable guide in recording investigative information. It is a durable record that gives supplemental data that isn't effortlessly refined with the selective utilization of crime scene photos and notes. The sketch serves to illuminate the uncommon data exhibit inside the photos and video documentation because of the fact that alternate strategies don't enable the observer to effectively check separations and measurements. The location of the evidences is vital to analyze the spatial distribution of the evidence to support the investigation report and eventually to accommodate a reconstruction. In cold cases, the lack of specific information or improper documentation as in how the crime happened and in what manner, have caused havoc and problems in solving the cases ultimately leading to poor investigation.

Tape measurements, total stations, and photogrammetry were once popular and steadfast in documenting the crime scenes. Tapes and GPS provide a limited number of measurements. They are composed down in field books, and it is difficult to review accurately where the deliberate spots were found. And above all, these measurements may easily contain manual mistakes and are not accessible in all situations. Other studies also demonstrated that the use of Total Station (TS) in combination with DGPS is the most convenient for documenting the outdoor crime scene **(Wolf and Asche, 2010).** The range and speed of the total stations allowed greater accuracy. However, the total station in obtaining the data is very limited. Each point must be first selected by the technicians, targeted, collected and labelled. This will eventually lead to human error. Moreover, total stations are considered not viable for mapping method because obstruction of the line site over long distances which will result to a constant relocation of the transit point **(Listi, 2007, Napton, 2009 and Dupra, 2001).** In the recent year, 3D laser scanning has caught so much of attention to many law enforcement agencies in many countries. Since a laser scanner has the capacity to gather huge measure of information protecting the shreds of

evidences for future investigation that goes past that of conventional methods **(Liscio *et al.* 2009).** The agent utilizing a laser scanner does not have to figure out what evidence to capture because the fact is that the scanner has the ability to snatch the whole scene. The most prominent advantages is the means by which it takes to check a scene and report it totally by catching a large number of evidences information data points that frame a photographic point cloud. However, the ground truth is the utilization of laser scanners is costly and tedious, and the fragile instruments should be worked via prepared experts. Some different issues to mull over are the deterrent of laser bars and the trouble of finding fitting areas to set up the scanners, bringing about missing point. The specialist utilizing a laser scanner does not have to figure out what evidence to catch on the grounds as the scanner snatches the whole scene. The most prominent advantages is the way it takes to examine a scene and report it totally by catching a large number of evidence information that frame a photographic point cloud. Yet, the ground truth is the utilization of laser scanners is costly and tedious, and the fragile instruments should be worked via prepared experts. Some different issues to contemplate are the obstacle of laser shafts and the trouble of finding fitting areas to set up the scanners, bringing about missing point cloud information of critical data in some difficult to-reach yet engaged territories. Another recent technology called Unmanned Aerial Vehicles (UAVs) in crime scene investigation has also received much attention. This drone provides a live monitoring action when police officers respond to a criminal incident. Videos and photos are stored in the drone memory providing hard evidences which ultimately improves the performances. With every advantages come disadvantages; these drones have short battery life where the officers must replace another drone that is newly charged to continue with the documentation on the crime scene. The risk of hacking the data's have high chances as the hackers can easily decode encrypted data to any network

connected to a police drone. Another disadvantage is that the device can affect police operation due to interposing several computer systems.

1.1 Baseline Mapping:

This is the most basic and simplest method form of crime scene mapping utilized more in outdoor crime scenes. For this method, a baseline is developed or identified from which to conduct measurements **(Aric, 2010).**

This can be an existing region, for example, the edge of a roadway, a divider, fence, and so forth., or it can be created manually, for example, by setting a string or measuring tape through the scene and leading estimations from that point. After which, the line ought to be kept running between two known immovable points, for example, trees or other identifiable points, with the goal that the objects could be found later on and the scene recreated if essential. Once the baseline is perceived, estimations are taken from the baseline at an approximate 90 degree point from the standard to some degree at the recognized object or area of the crime scene. Ordinarily, most measurements are made either to center mass of the item or to the nearest point of the item to the baseline. Since it is difficult to guarantee that the estimation was taken at 90 degrees, the likelihood exists that the estimation will be longer if the estimation is more than 90 degrees from the standard, or in the event that it is less than 90 degrees from the gauge. Thus, this strategy isn't as exact as a portion of alternate techniques; notwithstanding, it is fast and to a great degree simple to utilize.

1.2 Global Positioning System

Global Positioning System (G.P.S) networks have become a part of everyday life. GPS is a satellite based navigation system that uses a constellation of 24 satellites to give the user an accurate position developed by the U.S Department of Defense in the early 1970s. Initially, GPS

was developed as a military system to fulfil U.S military needs. Nevertheless, it was later made accessible to regular citizens, and is presently a double utilize framework that can be utilized by both military and non-military personnel. GPS satellites communicate exact time signals by radio to GPS collectors, enabling them to precisely decide the GPS beneficiary area in any climate, day or night, any place on earth **(Leica, 1999).** This is done by triangulation in which a user's GPS receiver gets signals from at least three satellites. The information derived by the satellite signals allows the receiver to pinpoint its position and the time and the velocity of movement **(Rick Navarro, 2007).**

1.2.1 GPS Segments:

Navstar GPS is made of three elements called "control", "space" and "user" segment **(Jones *et al*. 2008).**

1.2.2 The space segment:

The space segment currently consists of 28 operational satellites orbiting the Earth on six different orbital planes. They circle at a height of 20,180 km above the Earth's surface and are inclined at 55° to the equator. This excessive altitude lets in the signals to cover a greater location. The satellites are arranged in their orbits so a GPS receiver on the planet can obtain a signal from as a minimum 4 satellites at any given time to determine user's location. Experience shows that there are at the least 5 satellites seen above but most of the time, 6 or 7 satellites are typically visible. **(Leica, 1999).**

1.2.3 Control Segment

The control segment tracks the satellites which later offers them with balanced orbital and time realities. The control portion consolidates five unmanned Monitor Stations and one Master

Control Station. The five unmanned stations screen GPS satellite signals and after that send that data to the Master Control Station where inconsistencies are adjusted and sent back to the GPS satellites through ground antennas

1.2.4 User Segment

The GPS receivers are owned by way of civilians and military. The user segment consists of the users and their GPS receivers. With a GPS receiver connected to a GPS antenna, a user can receive the GPS signals, which can be used to determine his or her position anywhere in the world **(Rabbany, 2002).**

1.3 Working of Global Positioning System (GPS)

GPS satellites circle the earth twice every day in an extremely exact circle and transmit signal data to earth. There are 28 satellites that make up the GPS space portion that are circling the earth at around 19,000 kilometers above us. They are continually moving, making two finish circles in less than 24 hours. These satellites are going at velocities of approximately 11,000 kilometers for every hour. GPS beneficiaries take this data and utilize triangulation to compute the receivers correct area. Basically, the GPS beneficiary analyzes the time a signal was transmitted by a satellite with the time it was received. The time distinction tells the GPS receiver how far away the satellite is. Now, with distance measurements from some greater satellites, the receiver can decide the user's position and display it at the unit's digital map. A GPS receiver need to hyperlink communique with as a minimum three satellites to calculate a 2D position (latitude and longitude). With four or more satellites in view, the receiver can decide the receivers 3D function (latitude, longitude and altitude) because of the iterative nature of triangulation algorithm, the accuracy of the placement statistics totally depends on the wide variety of satellites speaking with the GPS receivers **(Sanchez and Heunn, 2011).**

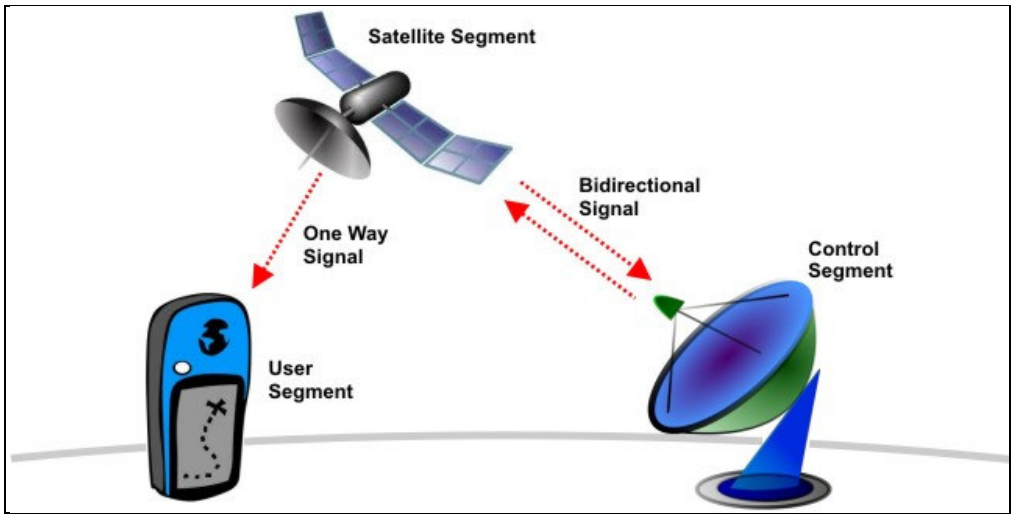


Fig 1.1: Segments of GPS

1.4 Differential Global Positioning System (DGPS):

Differential Global Positioning System (DGPS) is an advance method or upgrade to Global Positioning System that gives enhanced area exactness, from the 15m minimal GPS precision to that in the best usage of around 10 cm**.** Differential GPS (DGPS) was established to address the requirements of positioning and distance-measuring applications that required higher precisions than stand-alone Precise Positioning Service (PPS) or Standard Positioning Service (SPS) GPS could provide **(Sabatini and Palmerini, 2008).** The errors effecting the accuracy by the atmospheric conditions and system errors are least affected by the Differential Global Positioning System **(Trimble, 2007).** DGPS utilizes a fixed, known position to adjust real time GPS signals to wipe out pseudo range errors. Differential GPS has the effect between finding a road and finding a specific house on that road.

1.5 Working of Differential Global Positioning System (DGPS)

Differential GPS essentially involves GPS receivers. This sort of receivers is stationary (base or reference station) and the alternative is roving and making role measurements. Because the base station knows its location exactly, it is able to decide satellite signals mistakes. That is carried out by way of measuring the levels to every satellite using the obtained signals which are compared to the real ranges calculated from its known place. These differential corrections for each tracked satellite are transmitted to the roving GPS receiver and carried out to its calculations. Calculations also can be recorded for post-processing.

This station calculates the differential error and makes the differential corrections for the location and time. Corrections once made by the stations broadcast these radio signals to all the DGPS receivers giving accurate locations than the ordinary receivers.

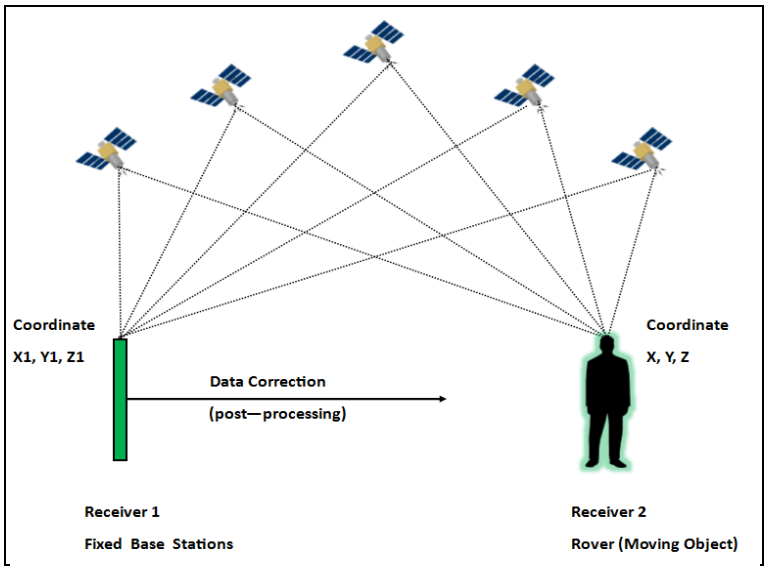


Fig 1.2: Differential Global Positioning System

Table 1: Ranging Errors between GPS and DGPS

TYPICAL GPS RANGING ERRORS		
Error Source	**Autonomous GPS**	**Differential GPS**
User Range Errors (URE)		
SYSTEM ERRORS		
Ephemeris Data	0.4–0.5m	Removed
Satellite Clocks	1– 1.2m	Removed
ATMOSPHERIC ERRORS		
Ionosphere	0.5–5m	Mostly Removed
Troposphere	0.2m–0.7m	Removed
Subtotals	1.7–7.0m*	0.2–2.0m
User Equipment Errors (UEE)		
Receiver	0.1–3m	0.1–3m
Multipath (location dependent)	1– 10m	0–10m

1.6 Geographical Information System (GIS):

(Heikkila, 1998) defines Geographical Information Systems as an systematized collection of, geographical data, computer hardware, software and personnel designed to proficiently capture, store, update, manipulate, analyze and display all forms of geographically referenced materials. GIS also has the capacity to create a map but also has the potential of storing the data that makes the data visible. It can be seen as consisting of five components: hardware, software, data, methods, and people connected by a computer network **(Longley *et al*. 2005).** These capacities

recognize GIS from other data frameworks and make it helpful to an extensive variety of open and private enterprises for predicting the outcomes, and planning policies. Map making and geographic investigation are not new, but rather a GIS plays out these assignments preferred and speedier over to the old manual techniques. By removing SA, any modern receiver can be accurate to 10 m. But for GIS, centimeter level accuracy is needed, hence DGPS is used. Most of the GPS data obtained for GIS is differentially corrected.

GPS is a phenomenal information accumulation instrument for making and keeping up a GIS. It gives precise positions to point, line, and polygon features. By confirming the area of already recorded positions, GPS can be utilized for assessing, preserving, and updating GIS information. GPS offers a superb apparatus to authenticate the features, updating characteristics, and gathering new features.

Global Navigation Satellite System (GNSS) technology is intensively used in GIS to acquire its geographical reference component of data and as a time and cost effective method in cartography. Further, GNSS technology can be used for GIS data verification and mapping **(El-Rabbany, 2006).** A GIS has been used to store, manage, analyze and present the spatial information involved in the forensic investigation. Investigators now rely on intelligence for mapping and analyzing crime patterns as the utilization of this new innovation keeps on advancing, police organizations will rely upon crime GIS analysts to take advantage of the cutting-edge tools and industry innovations that GIS offers **(Beaty, 2012).** GPS innovation gives the quickest, simplest and most beneficial strategy for mapping the areas and geometries of ground features for a GIS database. GPS/GIS information accumulation programming enables the user to take computerized GIS maps into the field for real time creation features layers and attribute tables. With its ease-of-use and relatively low operating costs, mobile GIS enables users

to accurately map the locations of features and quickly enter a breadth of attribute details that was previously impractical, if not impossible **(Trimble, 2007).** In spite of a relative absence of published research articles in criminology and criminological related journals, geospatial advancements additionally fill in as profoundly valuable devices in criminal examinations. **(Dongre, 2011)** defined Forensic GIS as the application of geographic and spatial tools, principles, and methodologies to investigate and establish facts within the boundaries of forensics. The main utility of forensic GIS is to provide correlated evidence, which assists in either proving or disproving geographic, spatial, or temporal links between people, places, and objects as they relate to the court of law. When compiling such maps, great care needs to be taken over the accuracy of the data, which includes revisiting the scenes with a GPS receiver to record their coordinates **(Cooper *et al*, 2009).**

1.7 Recreation of crime scene

The final phase in the forensic examination process is the reconstruction. This stage is totally reliant upon appropriate recognition, recognizable proof, individualization and translation of pertinent evidences. Recreation uses investigative data, crime scene data, and laboratory analysis of the physical and pattern evidence. The reconstruction process has been defined as one that involves the use of both inductive and deductive logic **(Lee *et al*. 2001).** Scientific crime scene examination is a procedure that not just incorporates the above mechanical parts of scene security, crime scene documentation, and physical evidence gathering and safeguarding, yet in addition requests and expects more powerful methodologies, for example, scene review, scene investigation, improvement of speculations through the linkage of the scene, physical proof and people, and the reconstruction of the crime scene **(Lee *et al.* 2001).** Forensic science reconstructs the past, based on evidence of a physical nature that are signs indicative or associated with

criminal events. The importance of time in forensic science is therefore not questionable and situating events in time is generally acknowledged as a fundamental issue **(Wayermann and Rebaux, 2012).** Without an understanding of where the remains were found and in what condition, questions regarding taphonomic issues or interpretations of bone surface modifications, especially with respect to differentiating postmortem from perimortem trauma, cannot be answered with any degree of scientific justification, backing, or certainty **(Dirkmaat, 2009).** Potential reconstructions of circumstances surrounding the death event, or even the original position and orientation of the body, suffer greatly, or may not even be possible; therefore, they may not be defendable in a court of law. It is vital to perceive, gather, safeguard and process the physical evidence. But, the amount of data that a reconstruction may give is constrained by the above elements. The more pertinent and exact the information compiled in a specific case, the more prominent the recreation work will be of a great help to the investigator. **(Miller *et al,* 2009).** Finally, based on the examination outcomes of physical evidence, the examiner ought to have the capacity to precisely recreate the crime scene **(Lee and Pagliaro, 2013).**

1.8 Background

The Global Positioning System is not new, but its applications are continuing to expand into the law enforcement community. Police are being tasked with increasingly complicated challenges every day and to perform the traditional methods for crime scene management could be demanding especially for outdoor crime scenes which are considered as one of the difficult tasks to perform. Living in the technological age, every police personnel from constable to higher police officers are all well acquainted with the most common and influential technology- smart

phones. We are faster and smarter in learning these technology devices however indolent in learning to adapt and apply methods which are taught in literature.

The documentation of the structure and appearance of physical environments in an outdoor crime scene is often a critical process in many applications. This is primarily true in areas of security and criminal justice in which efficient and careful collection of data is paramount. Forensic scientists are required to collect evidential data, locations of objects, as well as topological and metric layouts. They are required to do so in a meticulous and resourceful manner, with careful and traceable recording of findings, often within constrained time limits. Mapping or sketching is considered one of the primary means of documentation as it portrays the distance and dimensions of the crime scene and the physical evidence within it **(Dutella, 2010).** A documentation hiatus occurs when the exact location of evidence is not visualized. Mapping evidence clarifies spatial relations and aids the reconstruction of events **(Leeuwe, 2017)**

However, the exact position or location of the evidence cannot always be derived from the photographs or videography. Advance technology like 360°, total stations, UAVs and 3D laser scans are available, but require specific expertise and it's cost effective. The use of such methods are routinely applied in the field of archaeology fieldwork but seldom used in forensic field **(Leeuwe, 2017).** In situations where crime happened in a big even or uneven surfaces, where evidences are widely scattered or varied due to animal activity or others factors, hand drawn maps or traditional manual method become difficult to complete even with the help of total station. In such cases, Global Positioning System (GPS) could be a useful implementation. No research has been conducted concerning the use of GPS technology in crime scene management for outdoor crime scene; however few limited research has been conducted with the use of GPS in mapping the skeletal remains in open environment. **Listi *et al*. (2013)** examined

the Global Positioning System (GPS) as a tool for field mapping of scattered human remains or other materials in forensic investigation. It was determined that the mid –range GPS was not as accurate as traditional mapping techniques because of the factors that hinders the accuracy like tree cover, position of the satellites, density etc. which resulted in sporadic data. However, when they considered multiple positions, the data produced on different days were not consistent. Further, the GPS receiver used in this study could not distinguish items in close association. So, thus they concluded that these results indicate that traditional techniques and photographs are still indispensable for mapping scattered remains or artifacts. In order for the GPS to be a useful tool in forensic investigation, whether for locating the artifacts, mapping the scattered remains or locating a single position, the accuracy must be high. Affordable models that are more accurate have been developed that offer decimeter accuracy with post processing. Thus, it is vital that the accuracy of these new and enhanced DGPS units be assessed. In one of the study conducted by **Spradley and Hamilton, (2012)** utilized a DGPS for a scene involving taphonomic research. This research primarily focused on the analysis of scavenging patterns of vultures on a human cadaver rather than the development of a methodology concerning the DGPS. This study is an imperative example of applying this technology to analyze the dispersal of a body. **Walter and Schultz, (2013)** in their study quantified the accuracy of a DGPS unit for mapping skeletal remains and to determine the applicability of this utility in mapping a scene with dispersed remains. Firstly, they determined the accuracy of the DGPS unit in open environments using known survey markers in open areas. Secondly, three simulated scenes exhibiting different types of dispersals were constructed and mapped in an open environment using the DGPS and post processing was done for desired accuracy and the data were compared in a geographic information system (GIS) to evaluate the best recordation method. Results of this study

demonstrate that the DGPS is a viable option for mapping dispersed human remains in open areas. The accuracy of collected point data was 11.52 and 9.55 cm for 50s and 100s where they recommended the collection time to be 100s as it gives a better accuracy. Though, several factors may influence the accuracy of the DGPS unit, the error determined for this unit in an open environment is appropriate for mapping skeletal dispersals.

The DGPS unit conducted in past research has determined a good result for artifacts found at the open environment but the accuracy limitation was covered only when the data were differentially corrected using post – processing against closest base station. However, there is a limitation to post processing as it requires an additional work where the unprocessed data are transferred to a desktop computer and imported to Trimble Path finder to get the processed data.

Furthermore, the use of DGPS (Trimble R1GNSS) without the need of post processing in crime scene management is unheard as it is relatively a new technology that needs to be comprehensively employed in mapping the scene concerning the different aspects of this utility, uneven ground, lack of reference points, close proximity. Such type of DGPS which does not need post processing further reduces potential sources of error, hence, increased accuracy. The present study focuses on utilizing such type of DGPS which does not require post processing. The overall objective of the study is to investigate the viability of DGPS in crime scene management. Therefore, the purpose of this research is to recognize the use of DGPS (Differential Global Positioning System) that attempts to produce a comparable result with that of traditional manual method (baseline line method). To understand what caused the crime and to help the crime investigators, one needs to capture and preserve the scene as quickly and accurately as possible. Knowing the exact position or location of the artifacts or evidences found at the crime scene is one of the vital roles in assisting the investigation process. Thus, sketching

and mapping the scene is a necessity in completing the proper documentation of crime to present before the juries, judges and others to visualize the crime scene. Mapping the scene which is relatively large can be time consuming and are susceptible to human errors. There are cases where the evidences are found from one end to other or where no reference points are found in assisting the scene mapping and thus, the complication occurs during this time. In Indian context, the use of conventional method is still very much in use by the investigators. And in order to ease the work of the police investigators, this particular research has been conducted to see if DGPS could be a viable alternative over the conventional method.

1.9 Assessment of Police Stations in Allahabad city

The phrase "serve and protect" is common in the precept of many regulation enforcement corporations. Simply, by the presence of a police station can make a network or community more secure, irrespective of the size and condition of the Police Stations. Population distribution is a considerable factor in the distribution of Police Stations. Crime can happen anywhere and anytime. Nevertheless, there are situations where the victim had to travel for more than 2 to 3 km to reach a Police Station to complain or file an FIR. In one of the study by **Ahmed et al. (2013)**, nearest neighborhood analysis was conducted in Kano metropolis and the results shows that the police stations are random in the area. Protection of the society being the paramount consideration, the laws, procedures and police practices must be achieved in the determination of any case but to achieve this, the investigating officers must be properly trained and supervised and necessary scientific and logistical support should be made available to them. The level of advancement in any community depends to a substantial degree on its condition of security **(Fajemirokun *et al.* 2006)**

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. **Murray et al. (2001),** in his study mentioned that the rate of crime occurrence had grew abruptly to nearly epidemic proportions, particularly in Lagos and other urbanized areas due to population explosion. In the same way, crime rate is increasing in Indian country due to poor socio, political and environmental conditions and hike in population. Police Stations therefore play a vital role in safeguarding the concerned citizen. According to **Crime in India (Statistics, NCRB, 2016,),** a total of 48, 31,515 cognizable crimes comprising 29, 75,711 Indian Penal Code (IPC) crimes and 18, 55,804 Special & Local Laws (SLL) crimes were reported in 2016, showing an increase of 2.6% over 2015 (47, 10,676 cases). During 2016, IPC crimes have increased by 0.9% and SLL crimes have increased by 5.4% over 2015**.** 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 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%).

As per details from Census 2011, Uttar Pradesh has population of 19.98 Crores, an increase from figure of 16.62 Crore in 2001 census. Allahabad is the most populous district of Uttar Pradesh while Mahoba being the least populated. Allahabad District has a population of 5,959,798, roughly equal to the nation of Eritrea or the US state of Missouri. This gives it a ranking of 13th in India (out of a total of 640). As of 2011, the most populous district was Uttar Pradesh (out of 71). The district has a population density of 1,087 inhabitants per square

kilometer (2,820/sq. mi). Its population growth rate over the decade 2001-2011 was 20.74%. According to the Bureau of Police Research and Development (BPRD), there are 15,555 police stations in the country today. These stations are organized under various administrative units like circles, subdivisions, districts, ranges and zones. There are a total of about 1.8 million police personnel employed by Indian state police organizations today and there are also 300,000 vacancies. This results in a median 200 policemen for every 100,000 people, though it ranges widely from 76 in Bihar to 700 in Delhi. According to a Takshashila Institution survey of public trust, state police organizations rank dead last among government organizations and agencies.

Times News Network (TNN) on 7th December, 2017, reported that officials posted at the DGP headquarters maintained that a four-member committee has recommended the setting up of 20 new police stations in the Allahabad zone which comprises eight zones. As per norms set by the state government, 2,891 police stations are needed but there are only 1,463 across the state. The committee has also recommended setting up of at least 150 new police stations every year.

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**). It is utilized worldwide by police offices, both expansive and little, in giving envisioned answers for wrongdoing investigation and following hoodlums. Maps that shows 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)**. In addition it can help crime officers determine potential crime sites by examining complex seemingly unrelated criteria and

displaying them all in a graphical, layered, spatial interface or map. Applications of GIS to crime mapping and management have been successful in many developed 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).**

Rising crime in the country gets extensive coverage, but what gets overlooked is the state of police forces, which have to cope without even basic infrastructure to fulfill their duties. Many police stations lack vehicles, phones and wireless. As per the report, there are a total of 15,555 police stations in the country and out of these, 188 police stations are without a single vehicle, 402 lack telephone lines and 134 don't have wireless sets. 65 of these neither have a telephone line nor wireless set, as per the data accumulated by the Bureau of Police Research and Development (BPRD). Uttar Pradesh also has 51 police stations without a telephone line and 17 without wireless. This cannot be an excuse as police need at least phones, vehicles and wireless sets for communication and mobility," said an official.

The primary role of police forces is to uphold and enforce laws, investigate crimes and ensure security for people in the country. In a large and populous country like India, police forces need to be well-equipped, in terms of personnel, weaponry, forensic, communication and transport support, to perform their role well. Further, they need to have the operational freedom to carry out their responsibilities professionally, and satisfactory working conditions (e.g., regulated working hours and promotion opportunities), while being held accountable for poor performance or misuse of power.

1.10 Crime mapping using GIS

Police departments are on the duty day and night of protecting the citizen's safety and taking precautions to minimize the risk of crime. It has long been common practice for the police to identify locations and times that are more prone to criminal activity **(Lab, 2000).** Crime is infrequently random or evenly distributed across space **(Eck *et al*. 2005; Paynich and Hill, 2010)** which means, some areas have more crime than others, and some areas have different kinds of crimes than others. Identifying high crime areas or hot spots plays a key role in how law enforcement agencies operate and address crime in problem areas. For strategic and problem-solving purposes, identifying high crime areas can be useful for the development and evaluation of police responses, and testing for spatial displacement or diffusion of benefits **(Boba, 2009).** For tactical purposes, hot spot analysis may signal the presence of a crime pattern and/or help law enforcement agencies better prioritize and allocate resources to specific areas **(Eck *et al*. 2005; Sherman and Weisburd, 1995; Eck and Weisburd, 1995).** Thus, supporting and providing officers with the necessary insight they need to prevent, respond, or investigate crime is at the heart of crime analysis. Therefore, to diminish the crime, crime prevention actions or methods need to be implemented. Crime analysis and crime maps, achieved by GIS, have a major role in reducing crime and improving the effective police activities. This Hot Spot are one of the fundamental fields in crime prevention in terms of crime and place relationship**. Ratcliffe and McCullagh, (1999)** define highest incident concentration areas as "hotspots". GIS identifies areas that contain dense clusters of events (hotspots). These high concentration areas usually demand special police attention. For example, GIS allows an analyst to identify all of the areas in a police station area where at least 5 robberies occurred within a 1km radius. These areas are then outlined on the map. Using GIS to identify hotspots provides a consistent method to

measure concentrations of criminal events over time. Hot-spot policing aims to identify locations where crime and disorder are most prevalent and take law enforcement action in those areas as a deterrent. 'Hot-spotting' involves the careful analysis of patterns of crime, thus enabling police to target their response where it is needed most. Hotspots of violent crime, robbery, residential burglary, commercial burglary, auto theft, rape, etc. can be calculated for each police station area. Crime mapping and analysis takes advantage of these clusters or hot-spot areas for tactical and strategic planning to prevent and reduce crime, reduce suffering by victims, punish guilty and identify crime ridden areas. **(Johnson, 2000; Akpinar, 1997)**.

This study was confined to Allahabad city of Allahabad district considering three parameters for effective security in each zone. These are number of police stations in each zone, population in each zone and total crime in each zone. The main aim of this study is to see if the police stations are evenly distributed based on crime and population in each zone. The use of GIS was implemented in the study to analyze the distribution of Police Stations in each zone and crime hot spot was studied using interpolation method in each Police Station.

Justification

Outdoor scenes contain too many variables, including the size of the scene, that do not easily allow for distinguishing forensically significant evidence from natural artefacts. The purpose of this research is to find a method with the use of DGPS (Differential Global Positioning System) that attempts to produce a comparable result with that of traditional manual method. To understand what caused the crime and to help the crime investigators, one needs to capture and preserve the scene as quickly and accurately as possible. Knowing the exact position or location of the artifacts or evidences found at the crime scene is one of the vital roles in assisting the

investigation process. Thus, sketching and mapping the scene is a necessity in completing the proper documentation of crime and accident scenes to present before the juries, judges and others to visualize the crime scene. Mapping the scene which is relatively large can be time consuming and are susceptible to human errors. There are cases where the evidences are found from one end to other or where no reference points are found in assisting the scene mapping. In such situation, use of DGPS could be of viable option in locating the exact position of the evidences or references found at the crime scene. In order for the GPS to be a useful tool in forensic investigation, whether for locating the artifacts, mapping the scattered remains or locating a single position, the accuracy must be high **(Listi, 2007).** The paper will outline these methods and show examples of the valuable information they can provide for outdoor crime. It will also show the accuracy of DGPS used in outdoor crime scene which will further help in reconstruction/ recreation of crime scene.

Police Stations play an important role in the society as their main task is to serve and protect the community, society and the state. Allahabad or Prayag being the populous city exceeding 1 million people is the tenth most populous cities of the state. It is one of the fastest developing cities of the area**.** With increasing crime rate every year, it was the need of the hour to see if the police stations in the Allahabad city are evenly distributed based on crime and population in each zone and to define the hotspot area based on different crimes as most of the time police are handicapped in managing it due to obsolete methods which ultimately effect the police activities. The use GIS will be a useful tool for event analysis allowing the police personnel to map effectively, analyze past event, predict future events and will eventually help the crime officers to determine possible event locations. Therefore, the present study has been carried out with the following objectives:

- To study the utility of DGPS system in crime scene investigation.
- To compare the effectiveness of DGPS and manual measurements in Crime Scene Investigation on outdoor simulated crime scene.
- To re-create outdoor simulated crime scene using DGPS coordinates.
- To develop a new technique for re-creation of crime scene using DGPS coordinates.
- To create a geo-database of crimes (Allahabad city) reported under various police stations.
- To delineate the hotspots of various crimes reported under each police station.
- To access and analyze the zonal distribution of police stations with respect to crime and population of the respective zone.
- To evaluate the correlation between crime and population.

CHAPTER 2

REVIEW OF LITERATURE

2. REVIEW OF LITERATURE

Leica (1999) opined that the space segment currently consists of 28 operational satellites orbiting the Earth on 6 different orbital planes. They orbit at a height of 20,180 km above the Earth's surface and are inclined at 55° to the equator. This excessive altitude lets in the signals to cover a greater location. The satellites are arranged in their orbits so a GPS receiver on the planet can obtain a signal from as a minimum 4 satellites at any given time. Each satellite contains several atomic clocks. The satellites transmit low radio signals with a completely unique code on special frequencies, permitting the GPS receiver to pick out the alerts. The core purpose of these coded alerts is to permit the GPS receiver to calculate tour time of the radio sign from the satellite to the receiver. Four satellites are the minimal that have to be seen for most application. Experience shows that there are at the least 5 satellites seen above but most of the time, 6 or 7 satellites are typically visible.

GIS identifies areas that contain dense clusters of events (hotspots). These high concentration areas usually demand special police attention. For example, GIS allows an analyst to identify all of the areas in a police station area where at least 5 robberies occurred within a 1km radius. These areas are then outlined on the map. Using GIS to identify hotspots provides a consistent method to measure concentrations of criminal events over time. Hotspots of violent crime, robbery, residential burglary, commercial burglary, auto theft, rape, etc. can be calculated for each police station area. Crime mapping and analysis takes advantage of these clusters or hot-spot areas for tactical and strategic planning to prevent and reduce crime **(Johnson, 2000).**

Police departments are on the duty day and night of protecting the citizen's safety and taking precautions to minimize the risk of crime. It has long been common practice for the police to identify locations and times that are more prone to criminal activity **(Lab, 2000).**

Lee *et al.* (2001) concluded that scientific crime scene investigation is a process that not only includes the above mechanical aspects of scene security, crime scene documentation, and physical evidence collection and preservation, but also demands and expects more dynamic approaches such as scene survey, scene analysis, development of hypotheses through the linkage of the scene, physical evidence and persons, and the reconstruction of the crime scene.

El-Rabbany (2002) demonstrated that the GPS receivers are owned by civilians as well as military. The user segment consists of the users and their GPS receivers. With a GPS receiver connected to a GPS antenna, a user can receive the GPS signals, which can be used to determine his or her position anywhere in the world.

Davies *et al.* (2004) proposed a new technique for the development of virtual 3D environments for crime scene reconstruction. They developed a technique called Crime Scene Creator that provides a cheap and quicker alternative that allows quasi-accurate scenes to be constructed and populated with the results turn out to be encouraging. They also proposed for implementing voice recognition and natured language processing for crime investigation.

Byrd (2004) reported that gathering of evidence begins at the crime scene, because the crime scene contains visible and hidden information. Normally the evidence identifies at a crime scene during interviews with complaints, victims and witnesses can identify the nature of events. The forensic investigator should be able to recognize and identify all relevant information that can shed light in the crime committed before it has been gathered

Ogle *et al.* (2004) indicated the crime scene investigation as the foundation for the role of criminalist to recognize and collect these evidence exchanges at the crime scene with great care. And the basic objective of crime scene investigation is to reconstruct the event of the crime, in order to provide answers to what happened and who is responsible.

Layton, (2005) opined that processing a crime scene is a long, dreary process that includes decisive documentation of the conditions at the scene and the gathering of any physical confirmation that could edify what happened and point to who did it.

Longley *et al.* (2005) defined GIS as a computer system for capturing, managing, integrating, manipulating, analyzing, and displaying geographically referenced data. It can be seen as consisting of five components: hardware, software, data, methods, and people connected by a computer network.

Navarro (2007) summarised that current GPS bracelets, or the use of implants to accomplish the same goals, can save lives as well as money. The purpose of tracking all parolees, probationers and sex registrants, however, should not be based on financial savings alone. In the end, its use and application will be a balance of its benefits versus the intrusion into the lives of those selected for monitoring by the government.

Chisum and Turvey (2007) define crime reconstruction as, the determination of actions and events surrounding the commission of crime. The book examines the history of crime reconstruction from the point of view of forensic generalist, who understands that crime reconstruction is the result of objectivity examines a whole related system of evidence rather than narrow, specialized position. The history of crime reconstruction built of succession of inspiration, expectation and disappointment. a reconstruction maybe accomplished by using the

statement of evidences, confession of a suspect, statement of the living victim or the examination and interpretation of physical evidence.

Thornton (2007) examines different aspects of the ethics of crime reconstruction and justifies that it is always imperative to "get it right". He voiced out saying that unless a reconstruction hour the truth, it will be a pervasion of reason and unsuited for any use. Speaking the fundamental truth and not just the perception by the observer must be essential step. Sincere but misguided beliefs do violence to the ethos of crime reconstruction.

Trimble (2007) opined that various factors like satellite position, ionospheric delay; density of tress etc. affects the accuracy. However, the errors effecting the accuracy by the atmospheric conditions and system errors are least effected by the Differential Global Positioning System.

Chisum and Turvey (2007) focused on techniques that perform crime reconstruction that is known as event analysis. They describe some of the most conceptual approaches to crime reconstruction and ultimately provide more organization to the reconstruction tool box. The most common method of CR is to base interpretation on experience and also explains that the scientific investigation must take pains to learn from everything he observes, not only in his work but also in his daily life.

Listi *et al.* (2007) examined the Global Positioning System (GPS) as a tool for field mapping of scattered human remains or other materials in forensic investigation. This project tests whether or not the GPS offers an accurate and reliable alternative for mapping scattered artifacts. The positional accuracy of the GPS receiver was tested using a National Geodetic survey (NGS) point location in Baton Ronge, LA. Thus, the utility of the GPS for mapping was investigated by setting up a mock field recovery and mapping the remains using both the GPS and traditional

methods. The results indicated that the positional error for a single location using GPS was less than ½ meter. However, when they considered multiple positions, the data produced on different days were not consistent. Further, the GPS receiver used in this study could not distinguish items in close association. So, thus they concluded that these results indicate that traditional techniques and photographs are still indispensable for mapping scattered remains or artifacts.

Ball (2008) opined that locational artefacts are of great value to investigators, as they can place a suspect on a crime scene within and timeframe.

Navstar GPS is made of three elements called "control", "space" and "user" segment **Jones *et al.* (2008).** The "control segment" is in charge to control the satellites, which represent the "space segment". The "user segment" represents the end-user devices, such as our common navigational systems.

Sabitini and Palmerini (2008) demonstrated that differential GPS (DGPS) was developed to meet the needs of positioning and distance-measuring applications that required higher accuracies than stand-alone Precise Positioning Service (PPS) or Standard Positioning service (SPS) GPS could deliver. It is an advance method or upgrade to Global Positioning System that gives enhanced area exactness, from the 15m minimal GPS precision to that in the best usage of around 10 cm**.**

Dirkmaat (2009) mentioned that outdoor scenes contain too many variables, including the size of the scene, that do not easily allow for distinguishing forensically significant evidence from natural artifacts. Perhaps too many “agents,” such as animals, rain, snow, and even gravity have conspired to modify the scene since the time of the original deposition of the body. These factors often make it seem to be nearly impossible to accurately reconstruct events surrounding the

incident. Whatever the reasoning, it is clear that outdoor scenes are not processed with the same high standards as indoor scenes.

Weiss (2009) reported that the camera was never proposed to supplant vision since it surely can't. Nevertheless, when appropriately taken, a photo is one of the main approaches to catch a moment of time and is extraordinary compared to other bits of confirmation with respect to documentation of a crime scene. Photos are all around acknowledged by the courts and permitted into prove independent of their picture quality so far as the pictures contained inside them are not provocative or biased in nature.

Cooper *et al.* (2009) discussed on wild life crime scene that ranges from the carcass of an animal to terrain that encompasses topography as forest or desert may include diverse natural and man-made structures. The location of the wildlife crime scene is isolated most of the time, with few facilities for proper investigation and collection of evidence. Effective investigation under field conditions is likely to require a combination of portable and easy to use laboratory equipment coupled with modern methods of data collection and information transmission like GPS and GIS. When compiling such maps, great care needs to be taken over the accuracy of the data, which includes revisiting the scenes with a GPS receiver to record their coordinates.

Dutelle (2010) in his book mentioned that Crime Scene Sketch is a permanent record of the size and distance relationship of the crime scene and the physical evidence within it. Since the other methods do not allow the viewer to gauge the distances and dimensions easily, the sketch serves to clarify the special information present within the photographs and videography. As much as its importance, sketch is considered the most simplistic manner in presenting crime scene layout and measurement. He also mentioned that baseline method is the most basic form of crime scene mapping. For this method, a baseline is developed or identified from which to conduct

measurements. This can be an existing area, such as the edge of a roadway, a wall, fence, etc., or it can be developed by personnel, such as by placing a string or tape measure through the scene and conducting measurements from there. The line should be run between two known fixed points, such as trees or other identifiable points, so that the points could be found in the future and the scene reconstructed if necessary

Gee *et al.* (2010) presented a system that is efficient for recording, representation and visualization of information in the context of physical environment as documenting the structures and appearance of physical environment is often a critical process in many applications. They designed a system called robust visual SLAM framework that provides accurate registration of AR annotations with the real world and are combined with the absolute positioning technologies to create a virtual "incident map" that can be used for co-ordination and navigation. The system has the ability to support multiple users and can be used to assist in the collection and processing data. They also suggested for future work to validate the incorporation of initial sensors and a digital compass to provide absolute orientation and improve estimation of absolute position in areas with poor GPS coverage.

Sandvik, (2010) interpreted that the crime scene as an augmented space, a crucial part of a crime scene coordinator's operations: The spatial practice consisting of reading and analyzing the place is part of the investigation and creating a mental image of the crime helps the crime scene coordinator to determine how the investigation should be conducted and on what it should be concentrated. This practice of investigating a crime's space and actions, the chronotopian convergence or blending of place and plot is best described as a narrative but also as a specific spatial and performative practice; a systematic and expertise based work of imagination through which the interpretation of the place (the crime scene) is producing the plot (the crime)

and through which simulations of the potential criminal actions are performed (if not physically, so mentally) in order to reconstruct the events which have taken place and physically, informational, emotionally have changed the crime scene as an actual place into an augmented place.

Chisum *et al.* (2011) examine thoroughly on the development of Locard's exchange principle and historical and contemporary philosophies surrounding crime reconstruction. They also discussed the fallacy of assuming the integrity of physical evidence and provide a logical foundation for the concept of Evidence Dynamics. Evidence Dynamics refers to any that changes, relocates or obliterates and physical evidence, regardless of intent. The failure to consider evidence dynamics as a part of any crime reconstruction process has the potential to provide misinterpretation of physical evidence, and inaccurate and incomplete crime reconstruction. To perform reconstruction of the circumstances and behavior involved in a crime with care and to be aware of the possibility of the Evidence Dynamics is a responsibility of the forensic scientists, in order that opinions regarding reconstruction of the crime reflects the most informed and accurate rendering of the evidence.

Dongre (2011) in his study define forensic GIS as the application of geographic and spatial tools, principles, and methodologies to investigate and establish facts within the boundaries of forensics. The main utility of forensic GIS is to provide correlated evidence, which assists in either proving or disproving geographic, spatial, or temporal links between people, places, and objects as they relate to the court of law.

Sanchez and Heunn (2011) discussed in their study that GPS uses global network of orbiting satellites and ground stations that provide positioning information. This positioning is based on the mathematical principle of trilateration that requires a precise timing of radio signals

transmitted from orbiting satellites to GPS receivers on the ground. A GPS receiver must link communication with at least four satellites and calculate its distance from them. With four or more satellites in view, the receiver can decide the receiver's 3D function (latitude, longitude and altitude) because of the iterative nature of triangulation algorithm, the accuracy of the placement statistics totally depends on the wide variety of satellites speaking with the GPS receivers.

Weyermann and Ribaux (2012) concluded that forensic reconstruct crime scene from past based on evidence of a physical nature that are signs indicative. Situating events and traces in time is an essential problem in investigations. The study of problems encountered by practitioners and reported in the literature, common mechanisms were extracted and provide understanding of underlying factors encountered in forensic practice. The main issues come from the fact that when a person commits a criminal offence, there is always a unity of time, place and action. The investigation will therefore aim at demonstrating this unity, by proving that a suspect was on the crime scene (i.e., unity of place) at a certain time (i.e., unity of time). The unity of action is generally inferred from the association of all observations. Through an iterative process consisting of extracting recurrent aspects discovered from In this article, three main approaches were extracted and described to situate traces, people and events in time: (1) time tags, (2) ageing, and (3) chronologies. Their formalization may help scientists and investigators to apply them more consciously in practice and in a complementary way. This preliminary framework is therefore a useful first step towards a global methodology for approaching dating issues in forensic science.

Dirkmaat (2012) stated law-authorization conventions for preparing indoor scenes are entrenched and give experimentally approved, court defendable recreations of past occasions. Be

that as it may, law-requirement conventions for preparing outside scenes are fundamentally nonexistent.

Sipes (2012) illustrated the use of GPS technology is not a panacea and will not replace good old traditional law enforcement investigation techniques, but it is another helpful tool to assist in fighting crime.

Beaty (2012) presented that GIS has been used to store, manage, analyze and present the spatial information involved in the forensic investigation. As the use of this new technology continues to evolve, police agencies will depend on crime GIS analysts to take advantage of the cutting-edge tools and industry innovations that GIS offers. Investigators now rely on actionable intelligence for mapping and analyzing crime patterns.

In one of the study conducted by **Spradley *et al.* (2012)** utilized a DGPS for a scene involving taphonomic research. This research primarily focused on the analysis of scavenging patterns of vultures on a human cadaver rather than the development of a methodology concerning the DGPS. This study is an imperative example of applying this technology to analyze the dispersal of a body.

Sangamithra *et al.* (2012) presents a survey on how GIS is implemented in various crime activities. The GIS software is used to view the crime hotspot for particular type of crime activity. The crimes are classified and then clustered; clustering was done based on the type of crimes. For classification and clustering the crimes the data mining techniques was used. By using this, police department could give more protection on the particular place and crime activities will be reduced in future.

Singh *et al.* (2012) proposed a simple, useful and cost-effective solution for crime mapping. Google could resource like satellite data, application and GIS software have been used to developed the application, they proposed to build a blog which will have daily, weekly and monthly crime maps which will help to identify crime patterns and clusters. The crime was categorized into theft, murder, snatching and other classes. The main objectives were to identify prone areas and also to map ancillary information like location of the police station, fire brigade, and hospitals etc. using google imagery. The develops require only a simple computer connected to the external. The source of crime data is the RSS (Really Simple syndication) feeds from various new websites.

Ahmed and Salihu (2013) proposed a geographical information system and spatial database of crime characteristics which was used to determine the hotspots. The crime was divided into four categories: offence against person, offence against property, offence against authority and offence against local act. ArcGIS version 9.3 was used for crime rate analysis. The buffer zones of 2Kms were analyzed in need of police stations. Results revealed that crime rate is higher outside the city wall and there are more hotspots outside the city wall. It also shows that crime doesn't occur closer to police stations, but seldom occur around outpost police stations.

Lee and Pagliaro (2013) concluded that it is the police officers, detectives, crime scene investigators or evidence technicians that usually complete the crime scene search and begin the forensic investigation stages. Crime scene investigators and laboratory personnel continue the forensic analysis of evidence to obtain data that can be useful to the justice system. Based upon the examination results of physical evidence, the investigator should be able to accurately reconstruct the crime scene.

Walter and Schultz (2013) quantified the accuracy of a DGPS unit for mapping skeletal remains and to determine the applicability of this utility in mapping a scene with dispersed remains. Firstly, they determined the accuracy of the DGPS unit in open environments using unknown survey markers in open areas. Secondly, three simulated scenes exhibiting different types of dispersals were constructed and mapped in an open environment using the DGPS. Results of this study demonstrate that the DGPS is a viable option for mapping dispersed human remains in open areas. The accuracy of collected point data was 11.52 and 9.55 cm for 50s and 100s collection times and the orientation and maximum length of long bones was maintained. Though, several factors may influence the accuracy of the DGPS unit, the error determined for this unit in an open environment is appropriate for mapping skeletal dispersals. Most importantly, the used of errors buffers for point data of bones in map demonstrated the error of the DGPS unit, while the point data successfully maintained the entire context of the dispersed skeletal over the area. Further research with these tools is necessary to determine their utility when analyzing and displaying skeletal dispersals for both small and large scale situations.

Chisum (2013) stated that reconstruction of the crime is the reason for crime scene investigation. Critical thinking, logic, imagination and scientific reasoning are required in developing the analysis and in reconstruction. This would help in identifying the evidence to support the various phases of the crime and recognizing the changes that occur to the evidence due to time and environment or to the emergency response.

Ayee and Greene (2013) illustrate how geospatial technologies ranging from GIS software to GPS hardware are currently used to combat crime in Jamiaca. These technologies enabled state holders to overlay various types of data be it socio-economic or infrastructural information on crime data to inform policies awareness and capacity levels regarding geo spatial technologies

are yet to be raised. Individual and organization seeking to enhance security at the local level and beyond is likely to grow with the implication of this utility.

Balogun *et al.* (2014) had attempted a study to operationalize the application and utilization of geographical information system in crime management and in security situation analysis for efficient community policing in Nigeria, using Benin as case study. They created three methods that shows digital land use map showing the crime locations, crime geo-spatial database, and spatial analysis such as buffering using ILWIS and ArcGIS software and GPS. The study proved that GIS can give a better synoptic perspective to crime study, analysis, mapping, proactive decision making and prevention of crime. It however suggests that migrating from traditional method of crime management to GIS demands capacity building in the area of personnel, laboratory and facilities backed up with policy statement.

Houck and Siegal (2015) discussed in their paper saying that training, experience and education all play a major role in adapting to each unit crime scene though standard operating procedures and protocols guide the Crime Scene investigation. They also mentioned that crime scene is the centre of the forensic world.

Parmar (2015) studied on several reviews and came into conclusion that for rebuilding purposes, the worth of physical evidence and citations of the crime scene by experienced human resources cannot be over emphasized. The Reconstruction analyst relies on correct, complete information to render a reconstruction of the procedures of a crime. The work load at the crime laboratories has become so great and thick that workers no longer respond to crime scenes and competent personnel are not available to respond to crime scenes. There are no developing skills that are essential for crime reconstruction. Therefore, the forensic scientist must recognize the uses of the physical evidence and the meaning of reconstructing the crime.

Sivaranjani and Sivakumari (2015) analyzed the crime hotspot mapping by implementing Radial Basis function and Triangular with Linear interpolation method. This combined approach helps the police personnel to easily analyze the hotspots in a computerized form by which the frequent crime occurring areas can be protected more efficiently. In future work, Latent Dirichlet Analysis method may be used for analyzing most recent criminal Hotspots in an effective manner.

Palmbach (2016) deliberated that the key component to successful investigation is the proper recognition, documentation, collection and preservation of evidence from crime scene. And therefore, failing to establish a scientifically sound and legally defensible chain of custody for an item of evidence will likely diminish the value of that evidence in judicial proceedings.

Leeuwe (2017) opined that a documentation hiatus occurs when the exact location of evidence is not visualized. Mapping evidence clarifies spatial relations and aids the reconstruction of events.

CHAPTER 3

MATERIALS AND METHODS

3. MATERIALS AND METHODS

Chapter 3 describes the process used to conduct this research. A crime scene is vigorous in regards to itself and other similar crime scenes. Crime scenes might show up strikingly comparable toward in, however further examination turns out those uniqueness for each scene's. Certain features or characteristics primarily may appear identical, but the more an investigation proceeds, the subtler differences are found.

3.1 Study Area:

The campus of Sam Higginbottom University of Agriculture, Technology and Sciences (SHUATS) is situated in Naini of Allahabad on the banks of river Yamuna (Fig 1). It lies between latitude 25.4131ºN and longitude 81.8479ºE. The University is spread over a territory for 900 sections of land lush-green campus, which incorporates 300 sections of land from claiming examination ranches. 15 mock Crime Scenes were set up inside the Campus yard itself in distinctive areas.

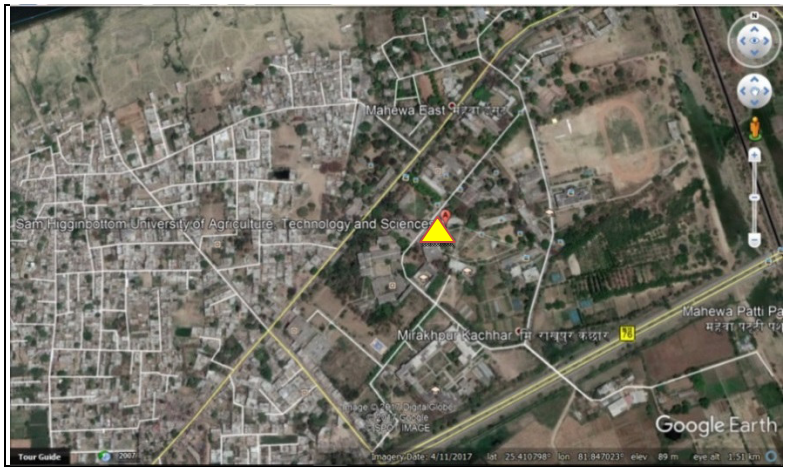


Figure 3.1: Google image of Study area (SHUATS, Allahabad)

3.2 Materials Used

The materials employed for the mock crime scenes are as follows-

- Directional marker/compass.
- Crime Scene barricade tape.
- Measuring Tape (30m)
- Traffic Cones
- Evidence Identifiers (Numbers/ Placards)
- Photographic scale (Ruler)
- Digital Camera
- Pencil/ Eraser
- Note Pad/ Hard Board
- Human Dummy
- Graph Paper
- DGPS device

Figure 3.2 Overall Materials

Figure 3.3 Trimble R1GNSS receiver

Figure 3.4 Compass

Figure 3.5 Evidence Identifiers

Figure 3.6 Photographic scales

Figure 3.7 Measuring tape (30 m)

Figure 3.8 Crime Scene tape

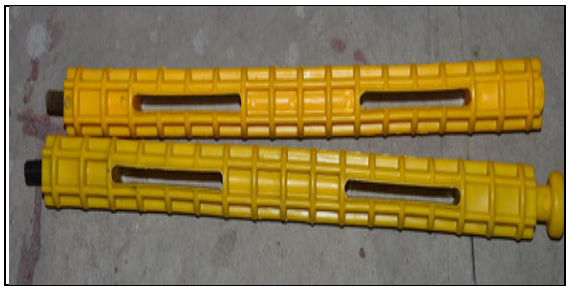


Figure 3.9 Barricade stands

3.3 Differential GPS Unit

Differential Global Positioning System (GPS) was employed to determine the exact position of an object (**Spradley, 2012**). So, to explore the value of differential GPS in outdoor crime scene, the differential GPS unit used for this research was Trimble R1GNSS receiver. The Trimble R1 is a rugged, compact, lightweight GNSS receiver that provides professional-grade positioning information to any connected mobile device using bluetooth connectivity. The standalone Trimble R1 receiver enables to collect higher-accuracy location data with any modern smart device, such as a mobile phone or tablet. In this research, the device used a Samsung Tablet (Sm-T561) which integrates with GIS software Trimble Terra Flex for professional data collection.

Fig 3.10 Trimble R1GNSS specifications

3.4 Methodology:

An open air crime scene is the most vulnerable to misfortune, tainting and harming consequences for organic confirmation in a brief timeframe. Individuals with access to the scene can potentially alter, destroy or contaminate evidence. The risk is greatest when the crime scene is

not properly secured. Mapping the objects found at the outdoor crime scenes are challenging due to the distance over which the remains are found and therefore the traditional forensic method could be time consuming and liable to human errors (**Listi et al, 2007**). Taking this into consideration, this project will test whether or not the differential GPS offers an accurate and reliable alternative for mapping the scene over the Baseline method.

To investigate the estimation of differential GPS and manual estimations in open air crime scenes, a mock crime scene of fifteen was set up at various areas where trees, electric shafts, settled posts were encompassed while in couple of areas there were no settled focuses. There are cases where crime take place in a big farm, field where there is absent of fixed points. The main practical started on 2nd February 2017 to 30th April, 2017. The creations of crime scene were done early morning where the manual methods and differential GPS were applied.

3.4.1 Simulated Outdoor Scene Creation

The places within the campus have been visited to look whether or not mock scenes were feasible. All the simulated crime scenes were created within the University Campus, SHUATS , Allahabad. For each crime scene, a story line was arranged and scenes were made in like manner. At that point the evidences were set altogether. Static Reference Points were selected vigilantly so as to apply the Baseline Method.

3.4.2 Protection of crime scene

The first and foremost thing done was barricading the crime scene with the help of traffic cones and the crime scene tapes were used making it sure all the evidences are covered within the scene.

3.4.3 Photography of the crime scene

Then overall, mid-range and close-up photographs of the crime scenes were taken. The overall photographs were taken from every angle making sure all the four corners of the crime scenes (CRP's) were covered. The mid-range photographs were taken in order to cover all the evidences within the scene thus showing the relationships of specific items of evidence to each other. The close up photographs was to show the details of important pieces of evidence which had been already identified in mid-range photographs. Items were photographed with and without a scale as to know the relative sizes. The scale is placed on the same plane as the item, and making sure the film plane was parallel to the scale.

3.4.4 Note Making

Since the notes are typically the principal record of the crime scene itself, it plays a crucial part in the examinations of crime. So Note making was performed in each crime scene.

3.4.5 Sketching and Mapping

To perform a rough sketch of the crime scene, the compass was first used to see the direction of the North after which the scene was sketch from the south direction.

One of the most vital tasks in crime scene sketching is obtaining accurate measurements. Mapping is the term associated with crime scene measurements which simply applies measurements in the sketching to represents the items. There are a variety of methods for mapping a crime scene, depending upon whether the crime scene is an interior or exterior scene. In this scenario, the simplest, basic method called the Baseline method was utilized as it is considered as one of the most useful on the large outdoor crime scenes. Rough sketch was

performed using paper and pencil recording all the measurements. The sketch was drawn after photography has been taken and when no items were removed.

3.4.6 Application of Baseline Mapping

This is the most basic and simplest form of crime scene mapping. For this method, a baseline was developed or identified from which to conduct measurements and basically it requires two fixed points. It was an existing area, such as tress, electric poles, bushes and the edge of a roadway, a wall and fence. In places where no fixed points were located, it was developed by personnel, such as by placing a string or tape measure through the scene and conducting measurements from there. In the case of the latter, the line was run between two known fixed points, such as trees or other identifiable points, so that the points could be found in the future and the scene reconstructed if necessary. Once the baseline was established, measurements were taken from the baseline at an approximate 90 degree angle from the baseline to a point on the identified item or area of the crime scene. Most measurements were made either to center mass of the item or to the nearest point of the item to the baseline. As it is impossible to ensure that the measurement was taken at exact 90 degrees, the possibility exists that the measurement will be longer if the measurement was over 90 degrees from the baseline, or if it was less than 90 degrees from the baseline. For this reason, this method is considered not as accurate as some of the other methods; however, it is quick and extremely easy to use. Time taken to perform the baseline measurement was recorded.

3.4.7 Data collection parameters of Differential GPS

The differential GPS data collection was done right after the manual measurement was completed. The R1GNSS receiver was placed in vertical direction as it was found to be more accurate than horizontal direction **(Schultz and Walter, 2013).** Furthermore, while collecting the data, the device was positioned at predetermined point adjacent or close to the evidences on the ground and remained stationery throughout the collection of each data. The exactness of the DGPS information for every area was checked and the length of time taken to finish the information data collection of each scene was recorded.

3.4.8 Trimble Terra Flex Software:

Trimble Terra Flex Software which provided "real time" differential correction was used. In order to collect the data a device was required so in this study Samsung Tablet (SM-T5S) was used. This particular software was installed in the Samsung tablet that provides a set of tools where Crime Scene Project was created and 15 templates were designed by utilizing the drop and drag box. For the collection of data to be more organized, various attributes based on outdoor crime scenes were listed down for all the 15 crime scenes which includes information like date, type of crime, location of crime, overall photographs, evidences, types of evidences, photograph of the evidences, collector name, signature etc. Data's collected from the field were automatically synced; the plugin automatically pulls the data back from Terra Flex into the feature class without any intermediary file import or export steps, saving time and effort. The data's were downloaded directly as CSV format that includes all the crime scene pictures and locations (latitude and longitude) of all the data which was saved automatically in Microsoft Excel sheet.

3.4.9 Map creation using ArcGIS software

ArcGIS Software is collectively referred to as “ArcGIS Desktop”. Software Modules consists of ArcMap software used to display, analyze, and create GIS data, ArcEditor includes data editing capabilities, ArcCatalog is a tool for viewing and managing spatial data files, ArcToolbox is a set of tools and functions used to convert data formats, manage map projections, perform analysis, and modify data. An ArcGIS is basically a computer-based technology that links geographic information with descriptive information which is used to capture, display, and analyze data spatially. The mapping of the scene DGPS data was integrated using the ArcGIS software. The tools available in GIS analysis have not yet been utilized to assess their usefulness for an outdoor crime scene. The collected point data by the receiver (R1GNSS) were downloaded in CSV format and was then exported to ArcGIS software with the point data for analysis and creation of map for the outdoor scene. The distances between the points of the corners, reference points and the evidences to that of the baseline were measured using the measuring tool in ArcGIS and was further compared with the manual measurement. The final map was created and the base map was layered to give the geography of the crime scene.

3.4.10 Recreation of Crime Scene:

After a gap of six months considering the environmental change, the recreation of the entire 15 crime scene using DGPS coordinates in collaboration with google earth/google map was utilized. The DGPS co-ordinates (Latitude and Longitude) were imported in the google map to see whether the data’s took us to the exact location. The scene was then recreated to check the estimations. For the recreation of crime scenes, the evidences were not put on the grounds

because here the fundamental concerned was to see and check the measurements. The overall photographs, mid -range photographs and close up was taken once again for each crime scene.

3.5 Statistical Data Analysis:

In the present experiment, T-test was applied for drawing conclusions from the data. The calculated value of T was compared with tabulated value at 5% level of probability for the appropriate degree of freedom **(Fisher and Pearson, 1970).** T test is used to compare two different set of values for comparison. In this study, T-test was applied to see if DGPS unit gives a consistent reading as that of manual reading. The formula for T test is given below:

$$t = \frac{\overline{X}_1 - \overline{X}_2}{S_{x_1 x_2} \cdot \sqrt{\frac{1}{\sqrt{n_1}} + \frac{1}{\sqrt{n_2}}}}$$

Where,

X_1 = Sample mean for first set of values.

X_2 = Sample mean for second set of values.

$S_{x\square x\square}$ = Standard Deviation.

$n\square$ = Total number of values in first set.

$n\square$ = Total number of values in second set.

Assessment of Police Stations in Allahabad city

3.6 Study Area

A large metropolitan city Allahabad or Prayag is located in the state of Uttar Pradesh, India. The city lies between latitude 25° 28' 22.9224" N and longitude 81° 52' 42.0852" E at an altitude 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. The study area is divided into four zones based on water, revenue and sanitation sourced from Allahabad Municipal Corporation. The total population of Allahabad city based on 2011 census was 1,142,751 and the population comprising on each zone are Zone 1 (303943), Zone 2 (198412), Zone 3 (296674) and Zone 4 (190236).

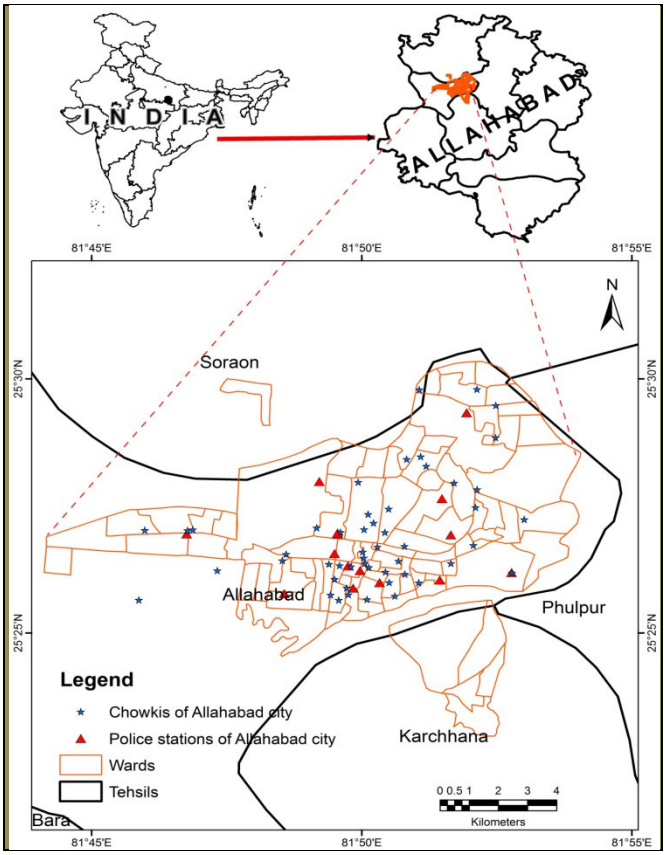


Figure 3.11 Map showing study area (Allahabad city)

3.7 Source of Data:

The locations of all the Police Stations present in Allahabad city were collected using differential GPS (R1GNSS). 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. Demographic data of the population of the area, wards distribution in zone wise were all collected from the Municipal Corporation of Allahabad (Nagar Nigam)

3.8 Data Analysis:

The data were summarized using simple descriptive statistics to get the percentage and proportions. Frequency distribution table were used for data presentations. Pie Chart was used to see the highest crime reported in all the Police Stations. To see whether the Police Stations are evenly distributed based on crime and population for each zone, an inferential statistics Chi Square test was applied. Correlation Coefficient and 'T' test was applied to see if there is any correlation between crime and population, where if population increase crimes do increase or if population decrease crime occurs less.

3.9 Statistical Approach:

3.9.1 Statistical Analysis by Chi-square test:

Observed data were statistically evaluated using Chi-Square method. Chi square is a method used in statistics that calculates the difference between observed and expected data values. It is used to determine how closely actual data fit expected data. The value of chi square helps us to answer the question, 'is the difference in expected and observed data statistically significant?' A small chi square value tells us that any differences in actual and expected data are due to chance, so the data is not statistically significant. A large value tells us the data is statistically significant and there is something causing the differences in data. This method is applied to know "Goodness of fit" which is used to compare the observed sample distribution with the expected

probability distribution and is used to determine whether sample data are consistent with a hypothesized distribution. The Chi-square equation is given below:

$$\chi^2 = \sum_{i=1}^{n} = \frac{(Oi - Ei)^2}{Ei}$$

Where:

χ^2 – Pearson's cumulative test statistic, which asymptotically approaches a X^2 distribution.

O_i – Observed data

E_i – Expected (theoretical) frequency, asserted by null hypothesis.

N – The number of cells in the table.

The hypothesis for Chi-Square goodness of fit test was set up as:

A. Null hypothesis (H_o): In Chi-Square goodness of fit test, the null hypothesis assumes that Police Stations on each zones are evenly distributed based on crime and population.

B. **Alternative hypothesis (H_1):** In Chi-Square goodness of fit test, the alternative hypothesis assumes that Police Stations on each zones are not evenly distributed based on crime and population.

3.9.2 Statistical Analysis by Coefficient Correlation and T-test:

Correlation coefficients are used in statistics to measure how strong a relationship is between two variables. The formulas return a value between -1 and 1 wherein one shows -1 shows negative correlation and +1 show a positive correlation. The correlation coefficient value is positive when both variables increases in the same directions or manner and the negative value

shows the two variables and coefficient correlation is zero which indicates no relationship at all.

The formula is given below:

$$r = \frac{n(\Sigma xy) - (\Sigma x)(\Sigma y)}{\sqrt{[\, n\Sigma x^2 - (\Sigma x)^2 \,][\, n\Sigma y^2 - (\Sigma y)^2 \,]}}$$

Where,

N = Quantity of information.

Σx = Total of the first variable value.

Σy = Total of the second variable value.

Σxy = Sum of the product of first & second value.

Σx^2 = Sum of the squares of the first value.

Σy^2 = Sum of the squares of the second value.

The hypothesis for Coefficient Correlation test was set up as:

A. Null hypothesis (H_o): There is a no relationship between crime and population

B. **Alternative hypothesis (H):** There is relation between crime and population.

3.9.3 Testing the significance of Coefficient Correlation through T-Test:

The simplest formula for computing the appropriate **t value** to test significance of a correlation coefficient employs the t distribution:

$$t = r\sqrt{\frac{n-2}{1-r^2}}$$

Where,

T =

r = Coefficient Correlation

n = Number of variables

3.10 Analysis and Presentation of Maps through ArcGIS 10.4

ArcGIS Software is collectively referred to as "ArcGIS Desktop". Software Modules consists of ArcMap software used to display, analyze, and create GIS data, Arc Editor includes data editing capabilities, Arc Catalog is a tool for viewing and managing spatial data files, Arc Toolbox is a set of tools and functions used to convert data formats, manage map projections, perform analysis, and modify data. An ArcGIS is basically a computer-based technology that links geographic information with descriptive information which is used to capture, display, and analyze data spatially. The latitude and longitude of the Police Stations, Allahabad boundary, digitize wards boundaries were then imported to the Arc GIS 10.3 for analysis and presentation of maps. The zones were demarcated with the help of the data's sourced from the Municipal Corporation.

3.11 Determination of Hot Spot Maps through GIS by 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 i.e. It is meant for the prediction of the new data point which is missing from the data set with the help of known discrete data points. According to the literature, the interpolation of data is done by using inverse distance weighting method. This method is used to find the unknown value of 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, interpolation method was used to predict the values of cells at locations that lack sampled points. It is based on the principle of spatial autocorrelation or spatial dependence, which measures degree of relationship/dependence between near and distant objects**.** 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. IDW determines cell values using a linear-weighted combination set of sample points. The weight assigned is a function of the distance of an input point from the output cell location. The greater the distance, the less influence the cell has on the output value.

CHAPTER 4

RESULTS AND DISCUSSION

4. RESULTS AND DISCUSSION

4.1 Simulated Outdoor Crime Scene One

Simulated outdoor crime scene one was created at the open area behind Chemistry Department. The accuracy of DGPS for this area was 57 cm. In this scenario, five evidences were placed at random distance and the evidences comprises of medicine cover, watch, blood drops, key chain and pen. Overall photographs, mid-range photographs and Close-up photographs were taken for the simulated crime scene (Fig 4.1.1- 4.1.4). Fixed reference points were identified to draw the baselines and conduct the measurements. The baseline method was applied where two trees were made the Static Reference Points (SRP) and the four corners were marked as Corner Reference Points (CRP). Measurements were conducted manually by using tape (in meter) after which rough sketch was drawn at the crime scene from the south direction (Fig. 4.1.5). Directly from that point onward, differential GPS was set vertically at the mid focal point of all the CRP's, RP's and the evidences to collect the locations. Final sketch was drawn using the graph paper (Fig. 4.1.6). Finally, Arc map and base map with real world imagery was created (Fig 4.1.7). The average difference between these two methods was 0.1 (cm). The recreation method was conducted by exporting the data (Latitude and Longitude) to the google map (Fig 4.1.8- 4.1.10) and measurement was conducted with the help of measuring tape. The readings for three methods are shown in (Table 4.1.1). Statistical t-test was conducted to see if differential GPS method is giving a consistent reading to that of manual reading. The measurements of both the manual reading and differential GPS reading were analyzed (Table 4.1.2).

Fig 4.1.1 Overall Photographs

Fig 4.1.2 Close Up photograph

Fig 4.1.3 Mid-range photographs

Fig 4.1.4 Trimble R1GNSS receiver

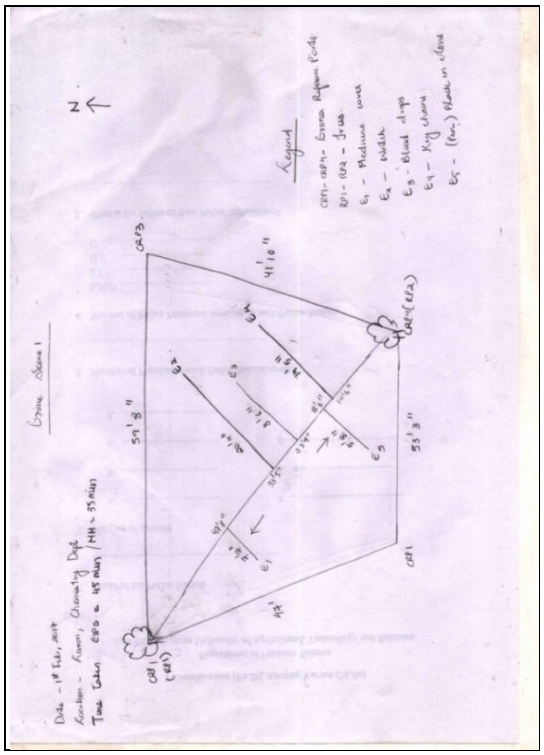


Fig 4.1.5 Rough Sketch 1

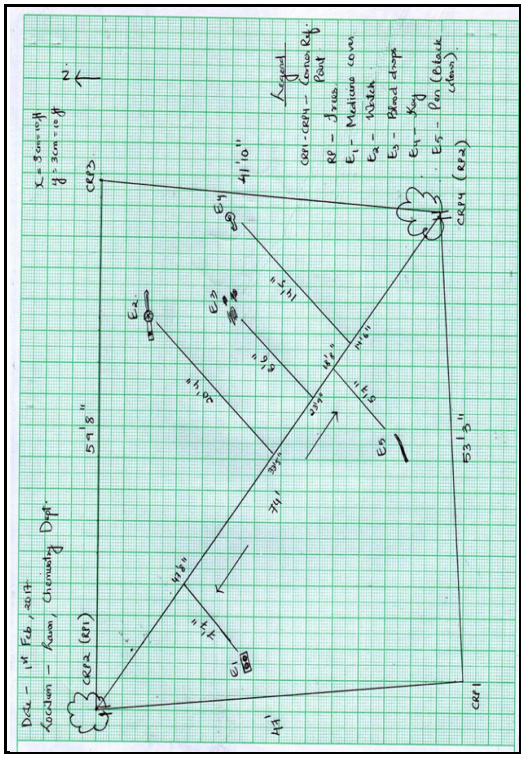


Fig 4.1.6 Final Sketch 1

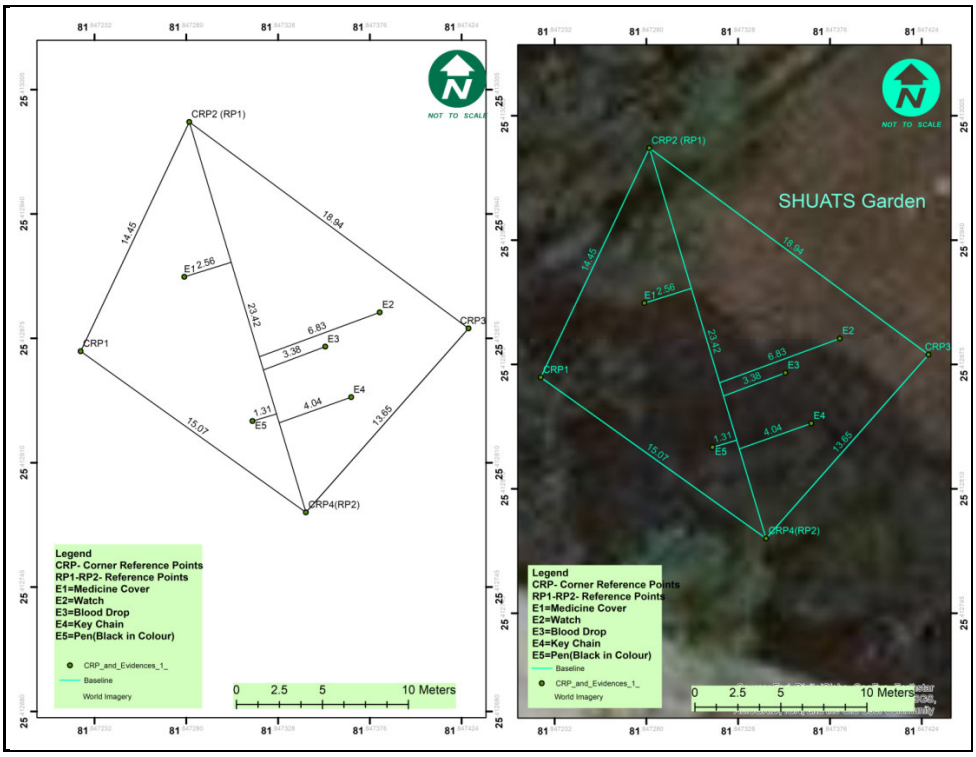


Fig 4.1.7 Final map through ArcGIS software

Fig 4.1.8 Recreation Photographs (SRPs)

Fig 4.1.9 Evidences

Fig 4.1.10 DGPS coordinates through google map

Table 4.1.1 Measurements of Manual, DGPS unit and Recreation of scene 1

Sl. no	Code	Name of the Evidences	MM (M1)	DGPS (M2)	Diff. Between M1 and M2	Average diff.	Recreation Measurement.
1.	CRP1	CRP1-CRP2	14.32	14.45	-0.13		14.44
2.	CRP2	CRP2-CRP3	18.21	18.94	-0.73		18.95
3.	CRP3	CRP3-CRP4	12.79	13.65	-0.86		13.6
4.	CRP4	CRP4-CRP1	12.79	15.07	-2.28		15.19
5.	SRP1-SRP2	Trees (RP1-RP2)	22.55	23.42	-0.87	0.1 cm	23.42
6.	E1	Tablet cover	2.35	2.56	-0.21		2.56
7.	E2	Watch	6.21	6.83	-0.62		6.74
8.	E3	Blood droplet	2.62	3.38	-0.76		3.41
9	E4	Key Chain	4.41	4.04	0.37		4.03
10.	E5	Pen (Black Cover)	1.72	1.31	0.41		1.3

Table 4.1.2 Unpaired T-test for two samples assuming equal variance of scene 1

Category	Calculated value	Table Value	Degree of Freedom	Alternate Hypothesis	S/NS
Crime Scene 1	0.16	2.10	18	Rejected	NS

Since, the calculated value of ‘t’ is smaller than the table value of 't' on 18 degree of freedom and at 5% level of significance, so the Null Hypothesis was accepted. Therefore, it can be concluded from the above data that there is no technical difference between the two methods, however practically with the use of DGPS unit it is more accurate and reliable because human beings are liable to error especially when the area is big and objects are widely scattered. With the use of DGPS coordinates, recreation of the scene is possible multiples because the coordinates once taken will never get changed.

4.2 Outdoor Simulated Scene Two

Simulated outdoor crime scene two was created at the terrace, Department of Forensic Science. The accuracy of DGPS for this area was 41 cm. In this scenario, five evidences were placed at random distance and the evidence comprises of dummy male body, footprints, blood drops, cartridge shell. Since there was no wall or trees to take as fixed reference points and corner reference points, four corners were taken randomly to barricade the scene and two diagonal corners were made as baselines to conduct the measurements. Overall photographs, mid-range photographs and Close-up photographs were taken for the simulated crime scene (Fig 4.2.1-4.2.4). The baseline method was applied where two corners were made the Static Reference Points (SRP) and the four corners were marked as Corner Reference Points (CRP). Measurements were conducted manually by using tape (in meter) after which rough sketch was drawn at the crime scene from the south direction (Fig. 4.2.5). After which, differential GPS was set vertically at the mid focal point of all the CRP's, RP's and the evidences to collect the locations. Final sketch was drawn using the graph paper (Fig. 4.2.6). The final Arcmap and base map with real world imagery was created (Fig 4.2.7). The average difference between these two methods was 0.21 (cm). The recreation method was conducted by exporting the data (Latitude and Longitude) to the google map (Fig 4.2.8 – 4.2 10) and measurement was conducted with the help of measuring tape. The readings for three methods are shown in (Table 4.2.1). Statistical t-test was conducted to see if differential GPS method is giving a consistent reading to that of manual reading. The measurements of both the manual reading and differential GPS reading were analyzed(Table4.2.2).

Fig 4.2.1 Overall Photographs

Fig 4.2.3 R1GNSS receiver

Fig 4.2.2 Mid – range photographs

Fig 4.2.4 Close-up photographs

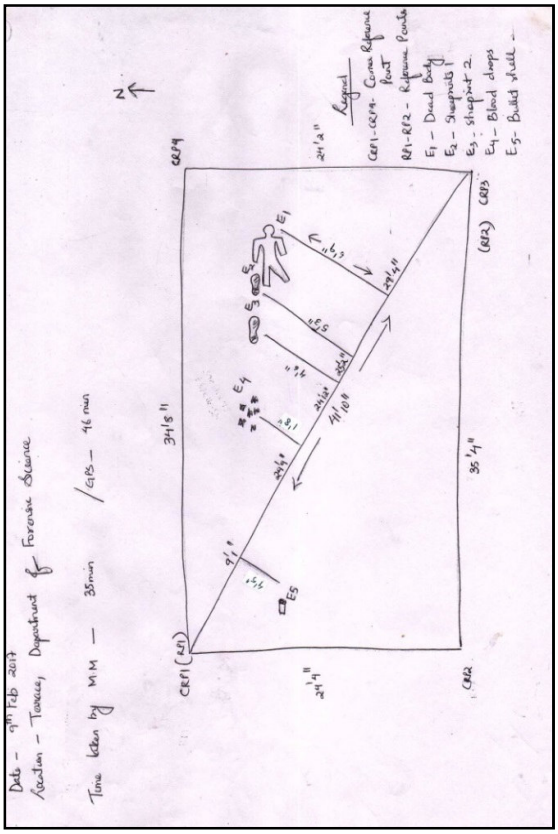


Fig 4.2.5 Rough Sketch 2

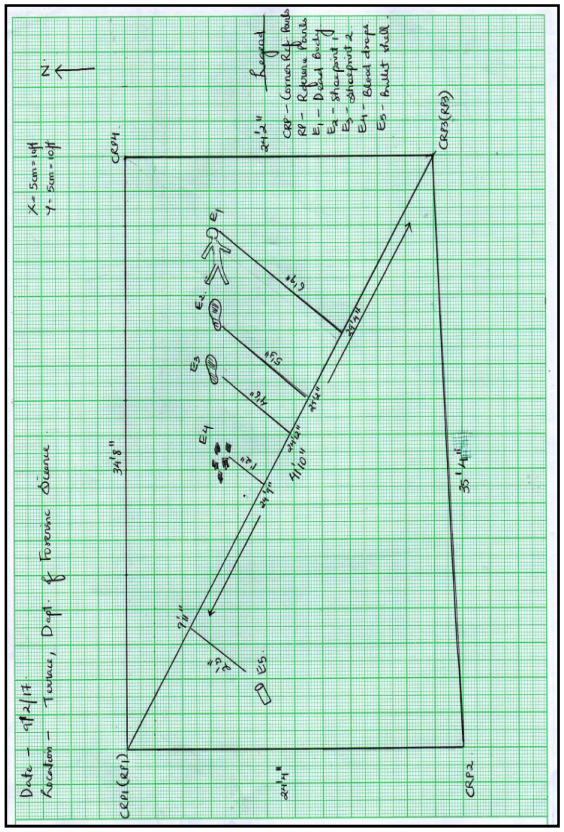


Fig 4.2.6 Final Sketch 2

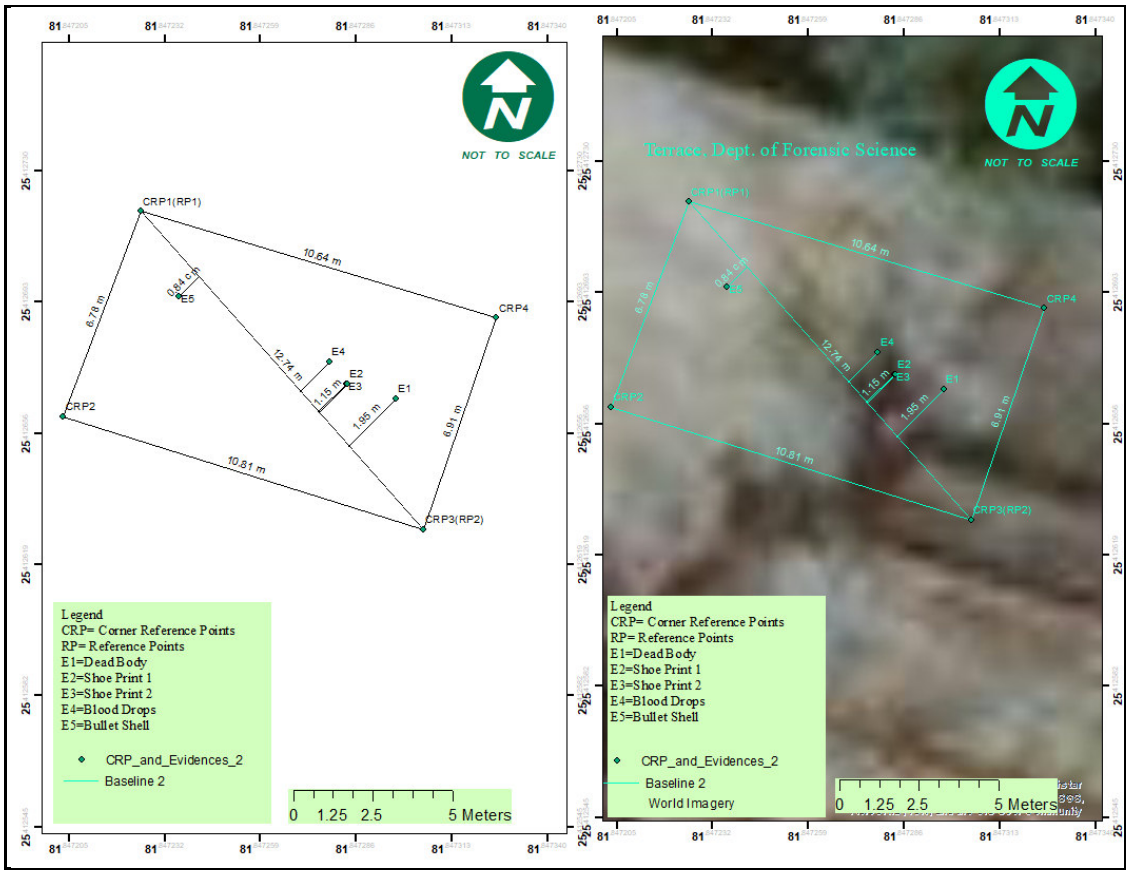


Fig 4.2.7 Final Map through ArcGIS

Fig 4.2.8 Recreation Photographs

Fig 4.2.9 Evidences

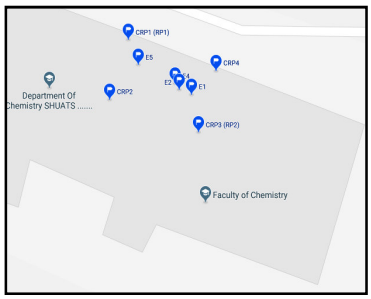


Fig 4.2.10 DGPS coordinates through google map

Table 4.2.1 Measurements of Manual, DGPS unit and Recreation of scene 2

Sl. no	Code	Name of the Evidences	MM (M1)	DGPS (M2)	Diff. Between M1 and M2	Average diff.	Recreation Measurement.
1.	CRP1	CRP1-CRP2	7.42	6.78	0.64		6.81
2.	CRP2	CRP2-CRP3	10.79	10.81	-0.02		10.84
3.	CRP3	CRP3-CRP4	7.37	6.91	0.46		6.9
4.	CRP4	CRP4-CRP1	10.59	10.64	-0.05		10.64
5.	SRP1-SRP2	Trees (RP1-RP2)	12.79	12.74	0.05	0.2 cm	12.73
6.	E1	Tablet cover	2.09	1.95	0.14		2.04
7.	E2	Watch	1.61	1.15	0.46		1.14
8.	E3	Blood droplet	1.39	1.14	0.25		1.1
9	E4	Key Chain	0.53	0.79	-0.26		0.78
10.	E5	Pen (Black Cover)	1.35	0.84	0.51		0.82

Table 4.2.2 Unpaired T-test for two samples assuming equal variance of scene 2

Category	Calculated value	Table Value	Degree of Freedom	Alternate Hypothesis	S/NS
Crime Scene 2	0.10	2.10	18	Rejected	NS

Since, the calculated value of ‘t’ is smaller than the table value of 't' on 18 degree of freedom and at 5% level of significance, so the Null Hypothesis was accepted. Therefore, it can be concluded from the above data that there is no technical difference between the two methods, however practically with the use of DGPS unit it is more accurate and reliable because human beings are liable to error especially when the area is big and objects are widely scattered. With the use of DGPS coordinates, recreation of the scene is possible multiples because the coordinates once taken will never get changed.

4.3 Simulated Outdoor Crime Scene Three

Simulated outdoor crime scene three was created at the parking lot below the Department of Forensic Science. The accuracy of DGPS for this area was 90 cm to 1meter. In this scenario, five evidences were placed at random distance and the evidences comprises of series of dead body, pool of blood, watch, female sandal, umbrella. Overall photographs, mid-range photographs and close-up photographs were taken for the simulated crime scene (Fig 4.3.1- 4.3.4). The baseline method was applied where a bush and a tree were made the Static Reference Points (SRP) and the four corners were marked as Corner Reference Points (CRP). Measurements were conducted manually by using tape (in meter) after which rough sketch was drawn at the crime scene from the south direction (Fig. 4.3.5). Directly from that point onward, differential GPS was set vertically at the mid focal point of all the CRP's, RP's and the evidences to collect the locations. Final sketch was drawn using the graph paper (Fig. 4.3.6). The collected point data by the receiver (R1GNSS) were downloaded in CSV format and was then exported to ArcGIS for data analysis i.e., to measure the points using the measuring tool but in this particular scene the arc map was not able to established because when the DGPS data were exported to ArcGIS software, the data were all club in particular area shown in (Fig. 4.3.7).

The recreation of crime scene was not possible with the data collected by the DGPS unit therefore statistical analysis was not conducted for this particular crime scene.

Fig 4.3.1 Overall photographs

Fig 4.3.2 Mid-range photographs

Fig 4.3.3 Close up photograph

Fig 4.3.4 R1GNSS receiver at vertical position

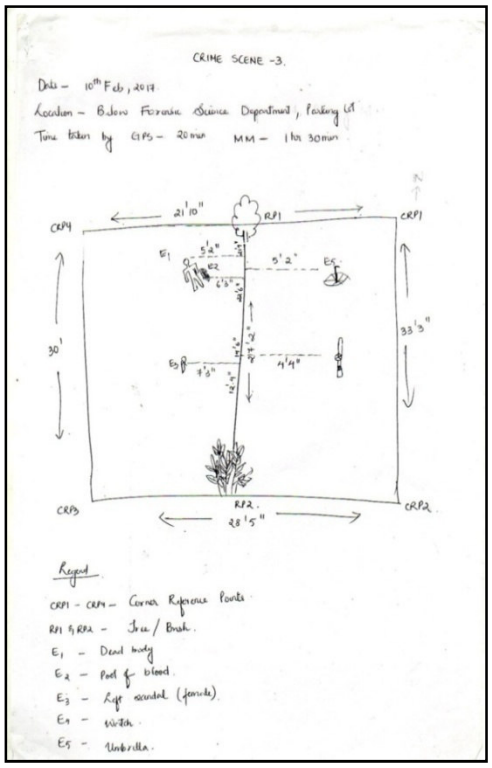


Fig 4.3.5 Rough Sketch 3

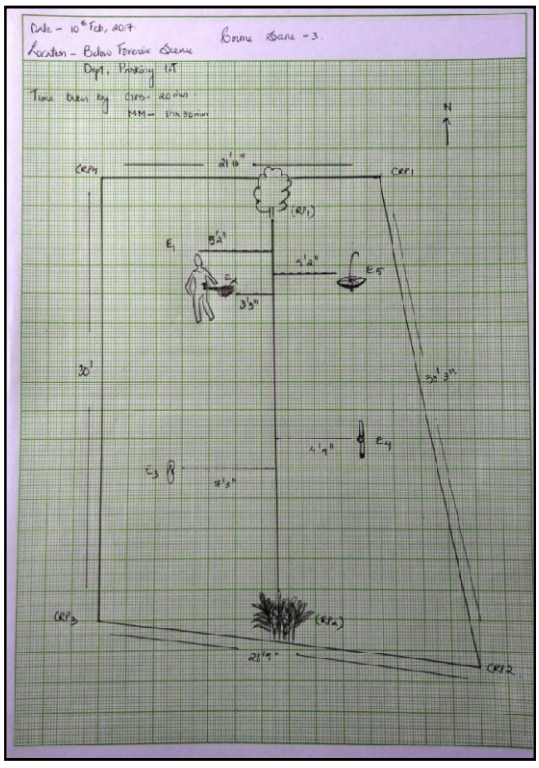


Fig 4.3.6 Final Sketch 3

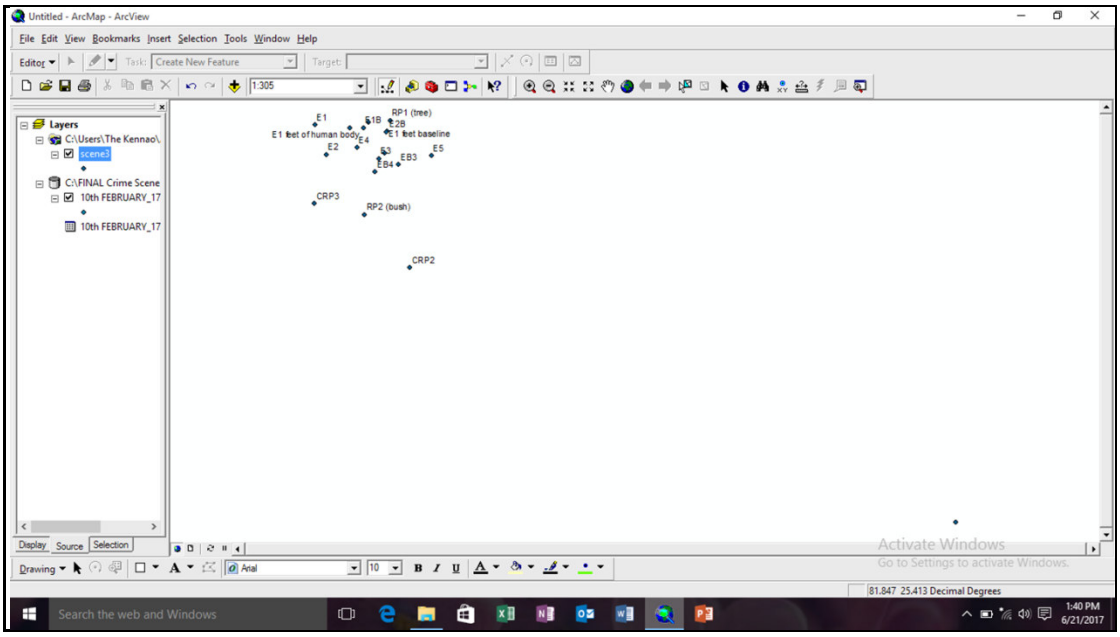


Fig 4.3.7 DGPS data when exported to ArcGIS software

Fig 4.3.7 presents the data points taken at the time of crime scene documentation. When the datas were exported to ArcGIS software, the datas were all club together at one location. This have produced a havoc therefore, to conduct the measurements and map creation was not possible. From the literature survey, it was found that the DGPS accuracy could be affected with the presence of building and density of trees which could obstruct the satellite signals **(Listi *et al.* 2007).** The probable reason could be the presence of the building shade in the area where crime was created which has obstructed the satellite signals failing to give the desired accuracy.

4.4 Simulated Outdoor Crime Scene Four

Simulated outdoor crime scene four was created at the terrace at the Department of Forensic Science. The accuracy of DGPS for this area was 41 cm. In this situation, only three evidences were placed at random distance and the evidences comprises of rubber glove, blood drop, blade. Overall photographs, mid-range photographs and Close-up photographs were taken for the simulated crime scene (Fig 4.4.1- 4.4.4). In this case, no corner references points were taken but two random points were taken to perform the baseline method marked as the Static Reference Points (SRP). Measurements were conducted manually by using tape (in meter) after which rough sketch was drawn at the crime scene from the south direction (Fig. 4.4.5). Directly from that point onward, differential GPS was set vertically at the mid focal point of all the CRP's, RP's and the evidences to collect the locations. Final sketch was drawn using the graph paper (Fig. 4.4.6). The final Arc map and base map with real world imagery was created (Fig 4.4.7). The average difference between these two methods was 0.12 (cm).

The recreation method was conducted by exporting the data (Latitude and Longitude) to the google map (Fig 4.4.8 – 4.4.10) and measurement was conducted with the help of measuring tape. The readings for three methods are shown in (Table 4.4.1).

Statistical t-test was conducted to see if differential GPS method is giving a consistent reading to that of manual reading. The measurements of both the manual reading and differential GPS reading were analyzed (Table 4.4.2).

Fig 4.4.1 Overall photographs

Fig 4.4.2 Point taken as Static point

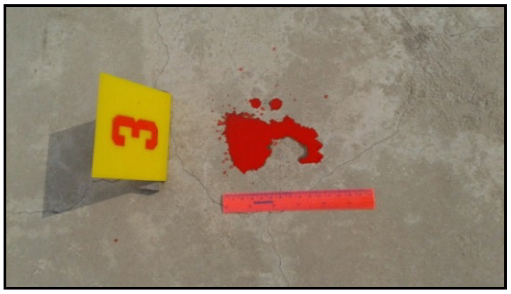


Fig 4.4.3 Close up photographs

Fig 4.4.4 R1GNSS receiver

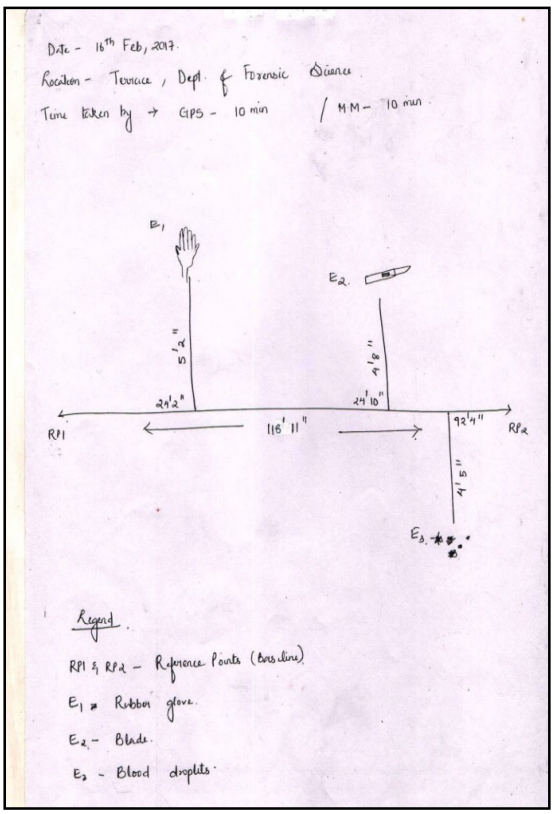


Fig 4.4.5 Rough Sketch 4

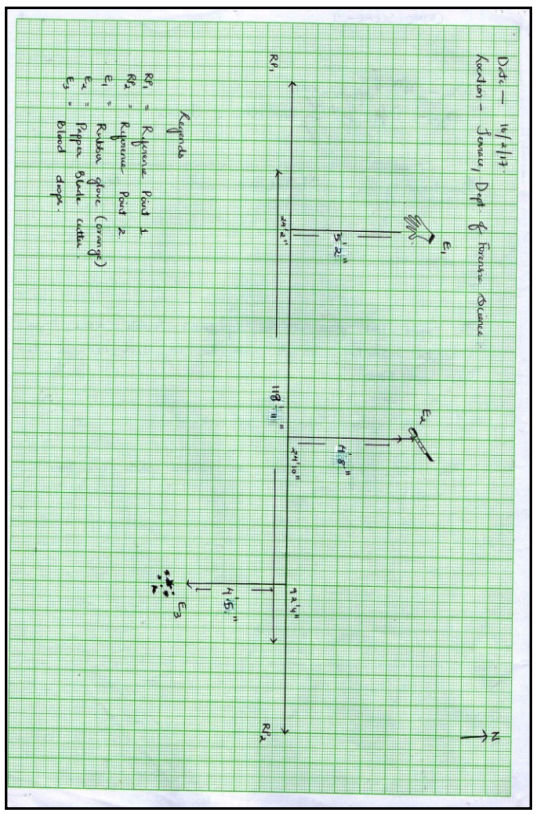


Fig 4.4.6 Final Sketch 4

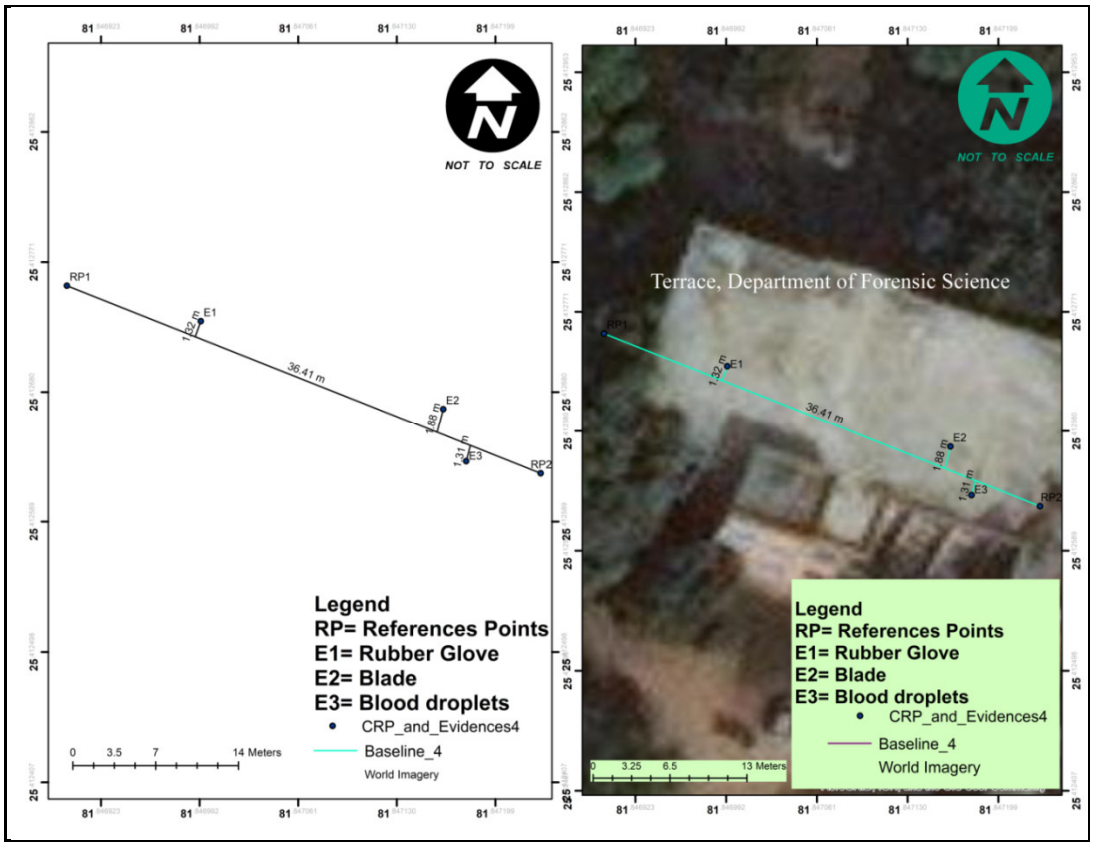


Fig 4.4.7 Final map through ArcGIS

Fig 4.4.8 Recreation photograph

Fig 4.4.9 Mid range photographs

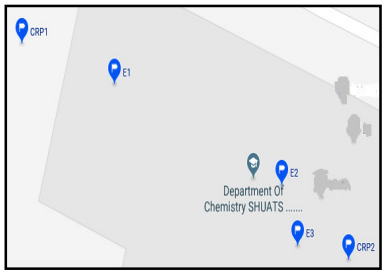


Fig 4.4.10 DGPS coordinates through google

Table 4.4.1 Measurements between Manual, DGPS unit and Recreation of scene 4

Sl. no	Code	Name of the Evidences	MM (M1)	DGPS (M2)	Diff. Between M1 and M2	Average diff.	Recreation Measurement.
1.	RP1-RP2	Static Reference Points	36.00	36.41	-0.41		36.28
2.	E1	Rubber Glove	1.58	1.32	0.27	0.12	1.36
3.	E2	Blade	1.46	1.88	-0.42		1.88
4.	E3	Blood Droplets	1.37	1.31	0.06		1.22

Table 4.4.2 Unpaired T-test for two samples assuming equal variance of scene 4

Category	Calculated value	Table Value	Degree of Freedom	Alternate Hypothesis	S/NS
Crime Scene 4	0.01	2.44	6	Rejected	NS

Since, the calculated value of ‘t’ is smaller than the table value of 't' on 6 degree of freedom and at 5% level of significance, so the Null Hypothesis was accepted. Therefore, it can be concluded from the above data that there is no technical difference between the two methods, however practically with the use of DGPS unit it is more accurate and reliable because human beings are liable to error especially when the area is big and objects are widely scattered. With the use of DGPS coordinates, recreation of the scene is possible multiples because the coordinates once taken will never get changed.

4.5 Simulated Outdoor Crime Scene Five

Simulated outdoor crime scene five was created at the garbage area near SIET Department. The accuracy of DGPS for this area was 51 cm. In this scenario, the ground was found to be uneven where manual measurement was difficult to perform. Evidences were placed at random distance and the evidences comprises of wallet and blood on the brick. Overall photographs, mid-range photographs and Close-up photographs were taken for the simulated crime scene (Fig 4.5.1-4.5.4). The baseline method was applied where a tree and electric pole were made the Static Reference Points (SRP) and the four corners were marked as Corner Reference Points (CRP). Measurements were conducted manually and carefully by using tape (in meter) after which rough sketch was drawn at the crime scene from the south direction (Fig. 4.5.5). Directly from that point onward, differential GPS was set vertically at the mid focal point of all the CRP's, RP's and the evidences to collect the locations. Final sketch was drawn using the graph paper (Fig. 4.5.6). Finally, Arcmap and base map with real world imagery was created (Fig 4.5.7). The average difference between these two methods was 0.13 (cm).

The recreation method was conducted by exporting the data (Latitude and Longitude) to the google map (Fig 4.5.8 – 4. 5. 10) and measurement was conducted with the help of measuring tape. The readings for three methods are shown in (Table 4.5.1).

Statistical t-test was conducted to see if differential GPS method is giving a consistent reading to that of manual reading. The measurements of both the manual reading and differential GPS reading were analyzed (Table 4.5.2).

Fig 4.5.1 Over all Photograph

Fig 4.5.2 Mid range photographs

Fig 4.5.3 Close up photograph

Fig 4.5.4 R1GNSS receiver

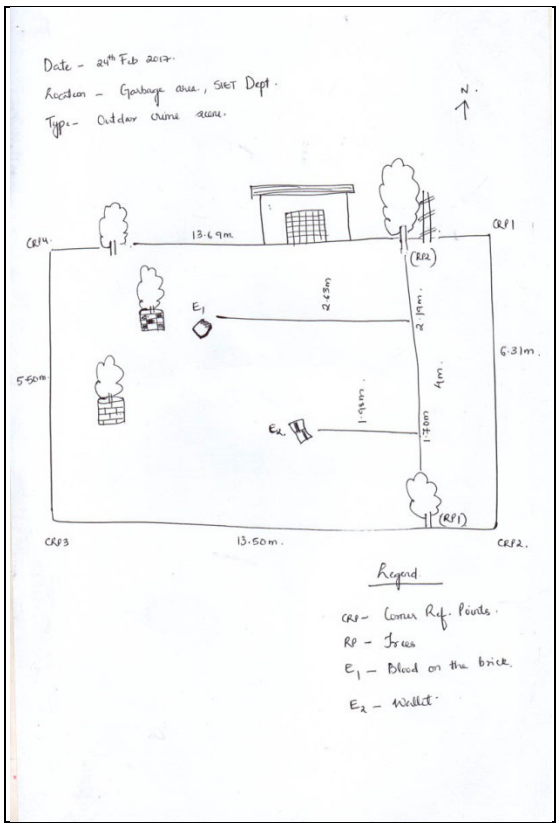


Fig 4.5.5 Rough Sketch 5

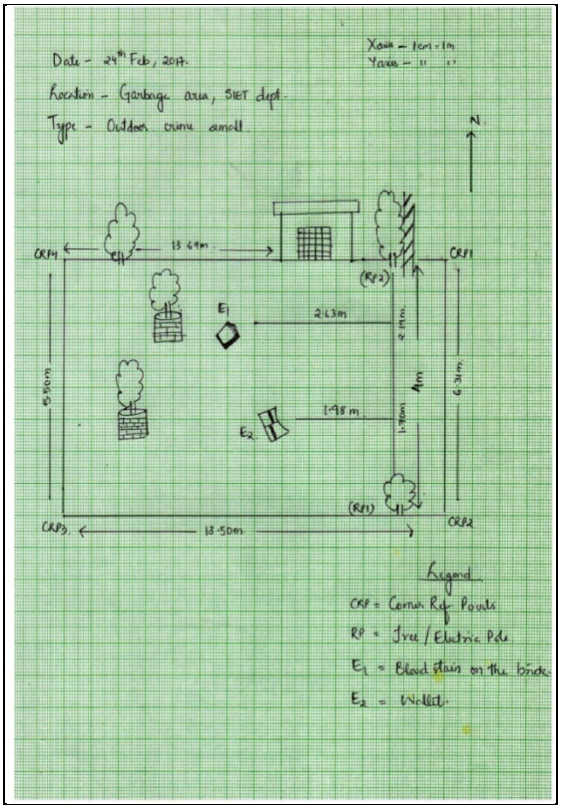


Fig 4.5.6 Final sketch 5

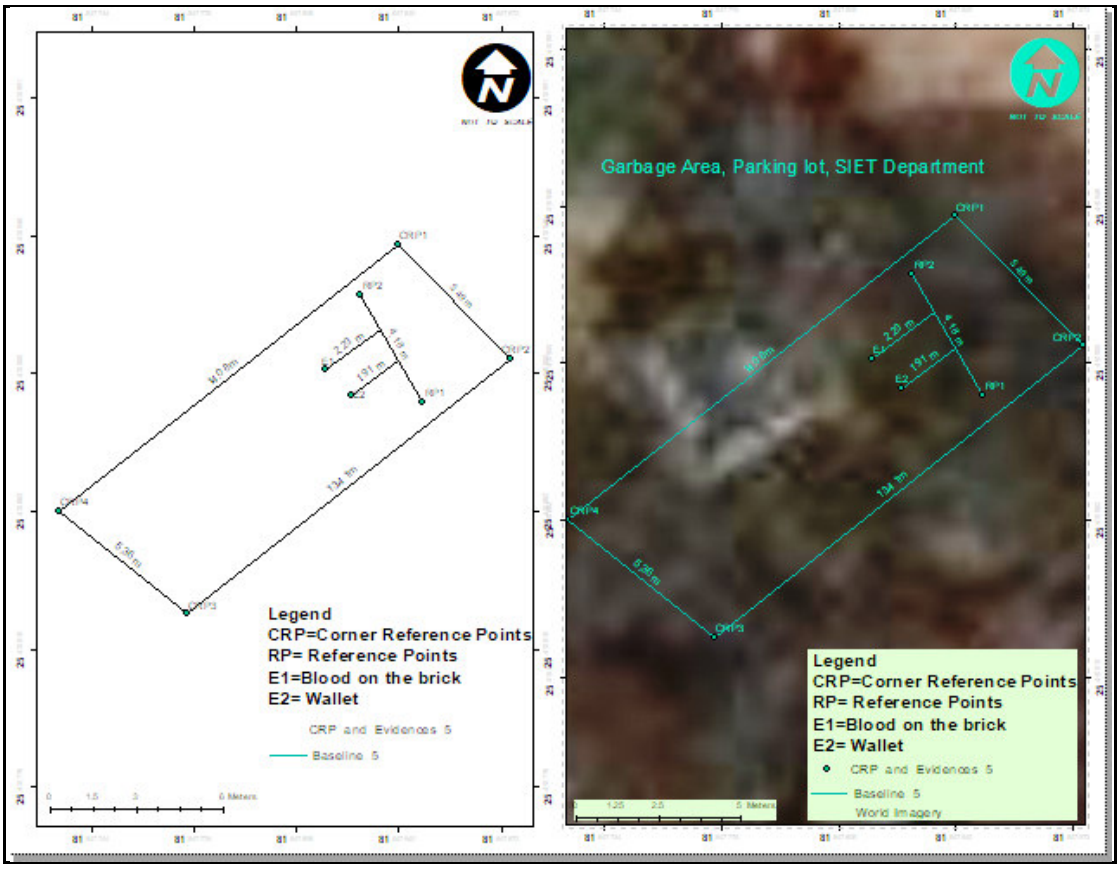


Fig 4.5.7 Final ArcMap Base Map through ArcGIS

Fig 4.5.8 Recreation (SRPs)

Fig 4.5.9 Mid range photgraph

Fig 4.5.10 DGPS coordinates through google map

Table 4.5.1 Measurements between Manual, DGPS unit and Recreation of scene 5

Sl. no	Code	Name of the Evidences	MM (M1)	DGPS (M2)	Diff. Between M1 and M2	Average diff.	Recreation Measurement
1.	CRP1	CRP1-CRP2	6.31	5.49	0.82		5.55
2.	CRP2	CRP2-CRP3	13.50	13.41	0.09		13.46
3.	CRP3	CRP3-CRP4	5.50	5.36	0.14		5.39
4.	CRP4	CRP4-CRP1	13.69	14.08	-0.39	0.13	14.05
5.	SRP1-SRP2	Trees (RP1-RP2)	4.00	4.18	-0.18		4.19
6.	E1	Tablet cover	2.63	2.23	0.40		2.24
7.	E2	Watch	1.98	1.91	0.06		1.96

Table 4.5.2 Unpaired T-test for two samples assuming equal variance of scene 5

Category	Calculated value	Table Value	Degree of Freedom	Alternate Hypothesis	S/NS
Crime Scene 5	0.05	2.17	12	Rejected	NS

Since, the calculated value of ‘t’ is smaller than the table value of 't' on 12 degree of freedom and at 5% level of significance, so the Null Hypothesis was accepted. Therefore, it can be concluded from the above data that there is no technical difference between the two methods, however practically with the use of DGPS unit it is more accurate and reliable because human beings are liable to error especially when the area is big and objects are widely scattered. With the use of DGPS coordinates, recreation of the scene is possible multiples because the coordinates once taken will never get changed.

4.6 Simulated Outdoor Crime Scene Six

Simulated outdoor crime scene six was created at the parking lot near SIET Department. The accuracy of DGPS for this area was 46 cm. Crime can happen anywhere, and at places where no static reference points like tress, buildings, electric poles would not be found. Therefore considering such scene or cases crime scene was created in a big area where evidences were placed at random distance. The four corners were cordon off with the crime scene tape making it sure all the evidences are confined within the area. The evidences comprises of wallet and blood on the brick. Overall photographs, mid-range photographs and Close-up photographs were taken for the simulated crime scene (Fig 4.6.1- 4.6.4). Since there was no tress or poles to conduct the measurements, the baseline was taken from the two sides at 15 m each so as to measure the evidences at 90 degree to the baseline. Measurements were conducted manually and carefully by using tape (in meter) after which rough sketch was drawn at the crime scene from the south direction (Fig. 4.6.5). Directly from that point onward, differential GPS was set vertically at the mid focal point of all the CRP's, RP's and the evidences to collect the locations. Final sketch was drawn using the graph paper (Fig. 4.6.6). Finally, Arc map was created and base map was layered to give a better view of the locations geography (Fig 4.6.7). The average difference between these two methods was 0.01 (cm).

The recreation method was conducted by exporting the data (Latitude and Longitude) to the google map (Fig 4.6.8) and measurement was conducted with the help of measuring tape. The readings for three methods are shown in (Table 4.6.1).

Statistical t-test was conducted to see if differential GPS method is giving a consistent reading to that of manual reading. The measurements of both the manual reading and differential GPS reading were analyzed (Table 4.6.2).

Fig 4.6.1 Overall Photographs

Fig 4.6.2 Mid-Range photographs

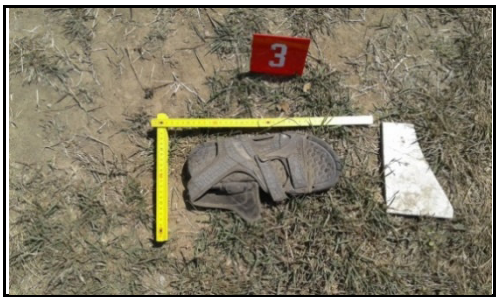


Fig 4.6.3 Close-up photographs

Fig 4.6.4 R1GNSS receiver

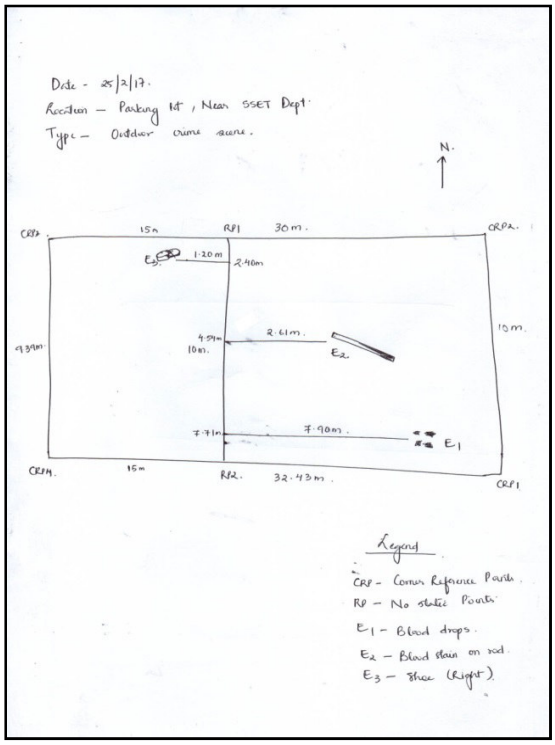


Fig 4.6.5 Rough Sketch 6

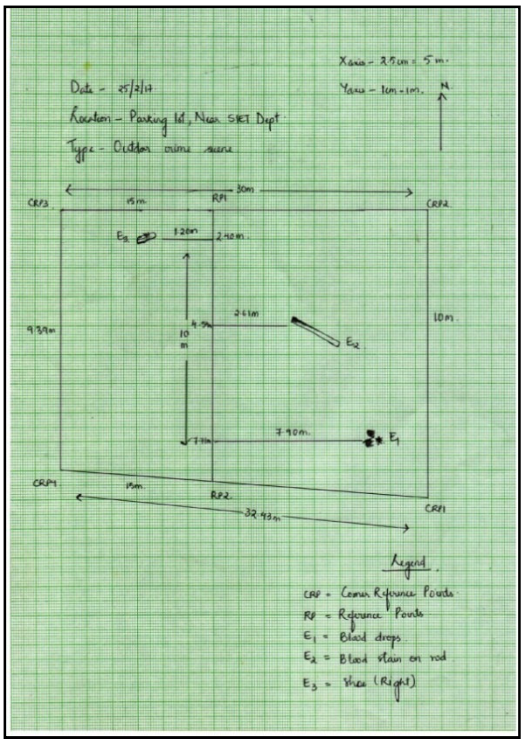


Fig 4.6.6 Final Sketch 6

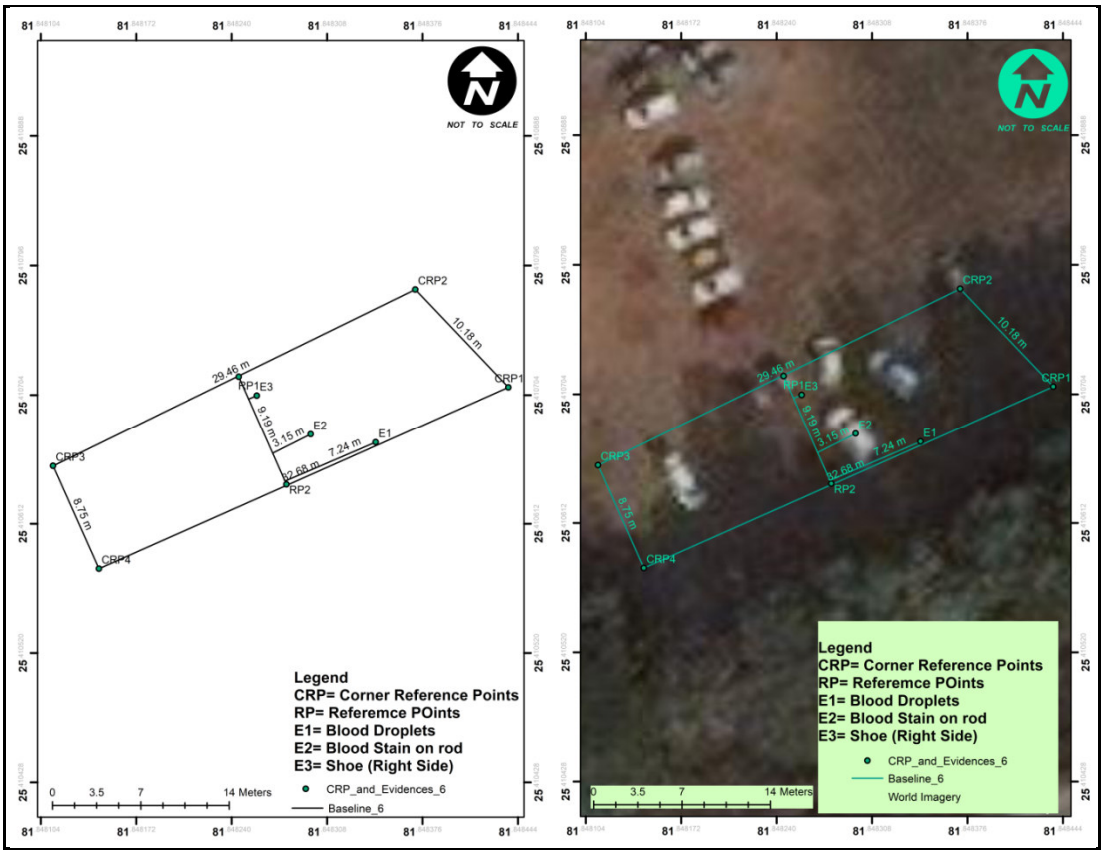


Fig 4.6.7 Final ArcMap Base Map through ArcGIS

Fig 4.6.8 Recreation (CRPs)

Fig 4.6.9 Mid range photographs

Fig 4.6.10 DGPS coordinates through google

Table 4.6.1 Measurements between Manual, DGPS unit and Recreation of scene 6

Sl. no	Code	Name of the Evidences	MM (M1)	DGPS (M2)	Diff. Between M1 and M2	Average diff.	Recreation Measurement
1.	CRP1	CRP1-CRP2	32.8	33.39	-0.59		33.39
2.	CRP2	CRP2-CRP3	98.42	96.66	1.76		96.69
3.	CRP3	CRP3-CRP4	30.8	28.7	2.1		28.64
4.	CRP4	CRP4-CRP1	106.4	107.21	-0.81	0.01	107.02
5.	SRP1-SRP2	Null	32.8	30.15	2.65		30.16
6.	E1	Blood drops	25.91	23.75	2.16		23.72
7.	E2	Blood stain on rod	8.56	10.34	-1.78		10.67
8.	E3	Sandal (right)	3.93	2.4	1.53		2.66

Table 4.6.2 Unpaired T-test for two samples assuming equal variance of scene 6

Category	Calculated value	Table Value	Degree of Freedom	Alternate Hypothesis	S/NS
Crime Scene 6	0.04	2.14	14	Rejected	NS

Since, the calculated value of ‘t’ is smaller than the table value of 't' on 14 degree of freedom and at 5% level of significance, so the Null Hypothesis was accepted. Therefore, it can be concluded from the above data that there is no technical difference between the two methods, however practically with the use of DGPS unit it is more accurate and reliable because human beings are liable to error especially when the area is big and objects are widely scattered. With the use of DGPS coordinates, recreation of the scene is possible multiples because the coordinates once taken will never get changed.

4.7 Simulated Outdoor Crime Scene Seven

Simulated outdoor crime scene five was created at the garbage area near SIET Department. The accuracy of DGPS for this area was 49 cm. In this scenario, the ground was found to be uneven where manual measurement was difficult to perform. Evidences were placed at random distance and the evidences comprises of steel rod with blood stain, cigarette bud, local weed and junks. Overall photographs, mid-range photographs and Close-up photographs were taken for the simulated crime scene (Fig 4.7.1- 4.7.4). The baseline method was applied where a tree and electric pole were made the Static Reference Points (SRP) and the four corners were marked as Corner Reference Points (CRP). Measurements were conducted manually and carefully by using tape (in meter) after which rough sketch was drawn at the crime scene from the south direction (Fig. 4.7.5). Directly from that point onward, differential GPS was set vertically at the mid focal point of all the CRP's, RP's and the evidences to collect the locations. Final sketch was drawn using the graph paper (Fig. 4.7.6). Finally, Arcmap and base map with real world imagery was created (Fig 4.7.7). The average difference between these two methods was 0.2 (cm).

The recreation method was conducted by exporting the data (Latitude and Longitude) to the google map (Fig 4.7.8 – 4.7.10) and measurement was conducted with the help of measuring tape. The readings for three methods are shown in (Table 4.7.1).

Statistical t-test was conducted to see if differential GPS method is giving a consistent reading to that of manual reading. The measurements of both the manual reading and differential GPS reading were analyzed (Table 4.7.2).

Fig 4.7. 1 Overall Photograph

Fig 4.7.2 Mid Range Photograph

Fig 4.7.3 Close Up Photograph

Fig 4.7.4 R1GNSS receiver

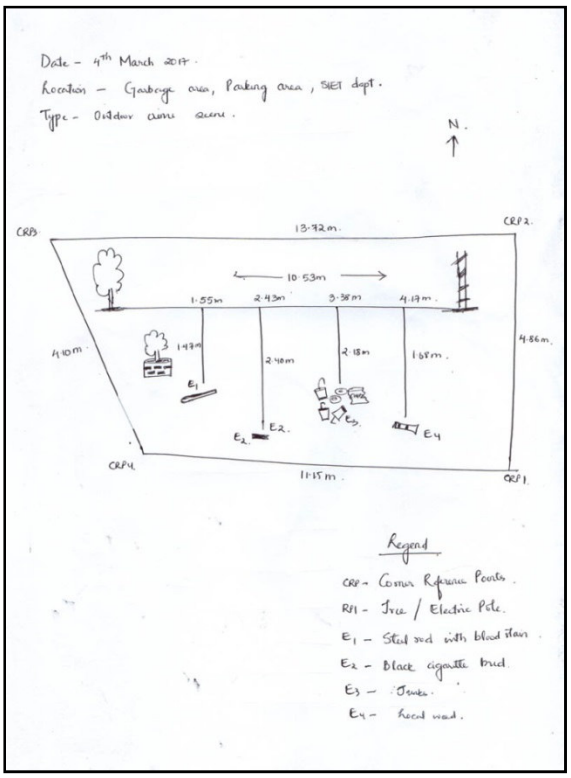


Fig 4.7.5 Rough Sketch 7

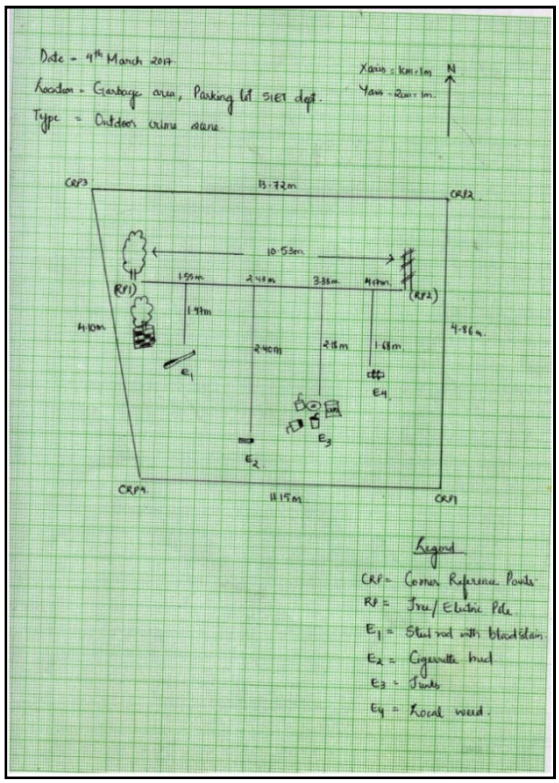


Fig 4.7.6 Final Sketch 7

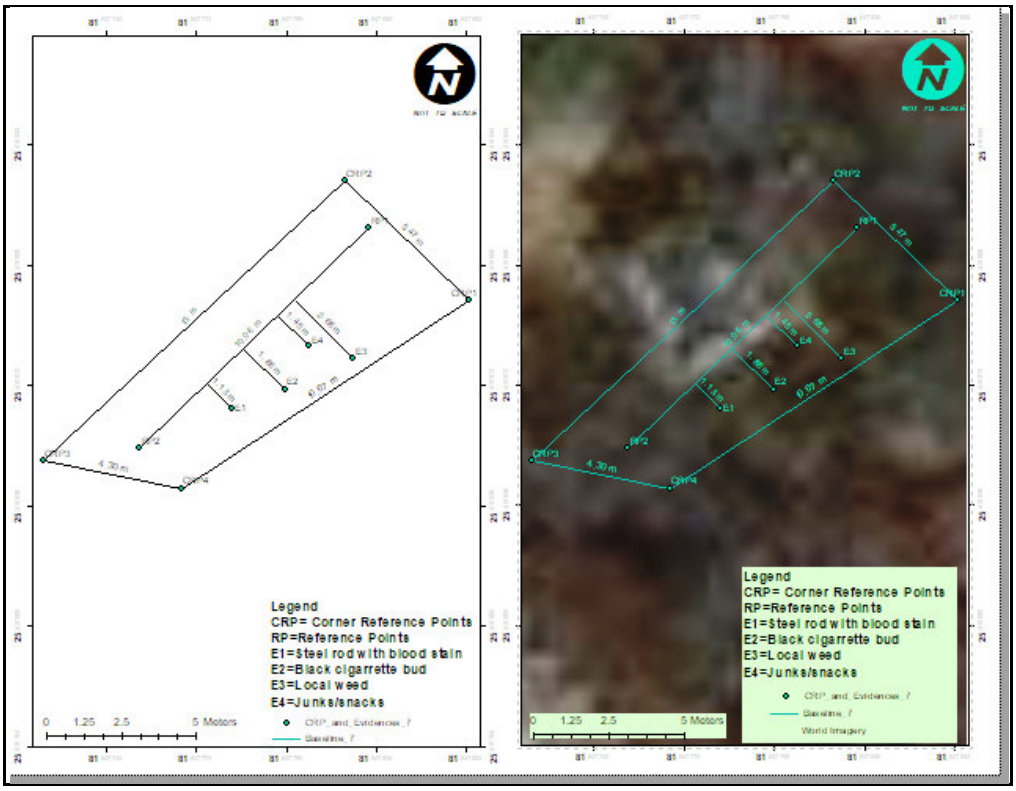


Fig 4.7.7 Final Arc map and Base Map through ArcGIS

Fig 4.7.8 Recreation (RPs)

Fig 4.7.9 Mid Range Photographs

Fig 4.7.10 DGPS coordinates through google map

Table 4.7.1 Measurements of Manual, DGPS unit and Recreation of scene 7

Sl. no	Code	Name of the Evidences	MM (M1)	DGPS (M2)	Diff. Between M1 and M2	Avg. diff.	Recreation Measurement
1.	CRP1	CRP1-CRP2	15.94	17.95	-2.01		17.82
2.	CRP2	CRP2-CRP3	45	42.71	2.29		42.44
3.	CRP3	CRP3-CRP4	13.45	14.1	-0.65		14.36
4.	CRP4	CRP4-CRP1	36.58	35	1.58		35.09
5.	SRP1-SRP2	Tree/ Electric Pole	34.54	33	1.54	0.2	33.3
6.	E1	Steel rod with blood stain	4.82	3.71	1.11		3.89
7.	E2	Cigarette bud	7.87	6.1	1.77		6.09
8.	E3	Junks	7.15	8.8	-1.65		8.78
9.	E4	Local weed	5.51	4.76	0.75		4.38

Table 4.7.2 Unpaired T-test for two samples assuming equal variance of scene 7

Category	Calculated value	Table Value	Degree of Freedom	Alternate Hypothesis	S/NS
Crime Scene 7	0.07	2.11	16	Rejected	NS

Since, the calculated value of ‘t’ is smaller than the table value of 't' on 16 degree of freedom and at 5% level of significance, so the Null Hypothesis was accepted. Therefore, it can be concluded from the above data that there is no technical difference between the two methods, however practically with the use of DGPS unit it is more accurate and reliable because human beings are liable to error especially when the area is big and objects are widely scattered. With the use of DGPS coordinates, recreation of the scene is possible multiples because the coordinates once taken will never get changed.

4.8 Simulated Outdoor Crime Scene Eight

Simulated outdoor crime scene eight was created at the terrace, Department of Forensic Science. The accuracy of DGPS for this area was 43 cm. In this situation, a story line was created where seven evidences were found and the evidences comprises of fallen cup, pool of blood, cigarette bud, fallen chair, unconscious body, series of blood. Overall photographs, mid-range photographs and Close-up photographs were taken for the simulated crime scene (Fig 4.8.1-4.8.4). In this case, the four sides of the terrace border were taken as corner references points (CRP) and static reference points (SRP) to perform the baseline method. Measurements were conducted manually by using tape (in meter) after which rough sketch was drawn at the crime scene from the south direction (Fig. 4.8.5). Directly from that point onward, differential GPS was set vertically at the mid focal point of all the CRP's, RP's and the evidences to collect the locations. Final sketch was drawn using the graph paper (Fig. 4.8.6). The final Arc map and base map with real world imagery was created (Fig 4.8.7). The average difference between these two methods was 0.06 (cm).

The recreation method was conducted by exporting the data (Latitude and Longitude) to the google map (Fig 4.8.8 – 4.8.10) and measurement was conducted with the help of measuring tape. The readings for three methods are shown in (Table 4.8.1).

Statistical t-test was conducted to see if differential GPS method is giving a consistent reading to that of manual reading. The measurements of both the manual reading and differential GPS reading were analyzed (Table 4.8.2).

Fig 4.8.1 Overall Photograph

Fig 4.8.2 Mid - range photograph

Fig 4.8.3 Close up photograph

Fig 4.8.4 R1GNSS receiver

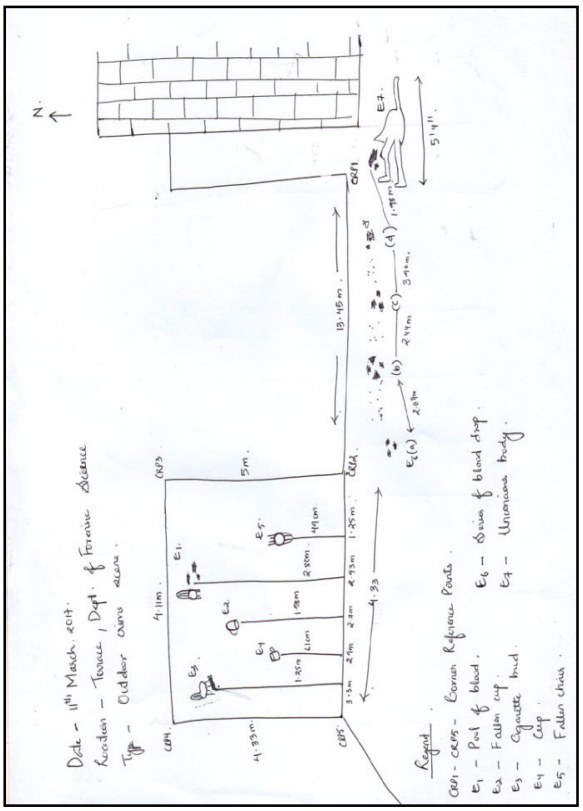


Fig 4.8.5 Rough Sketch 8

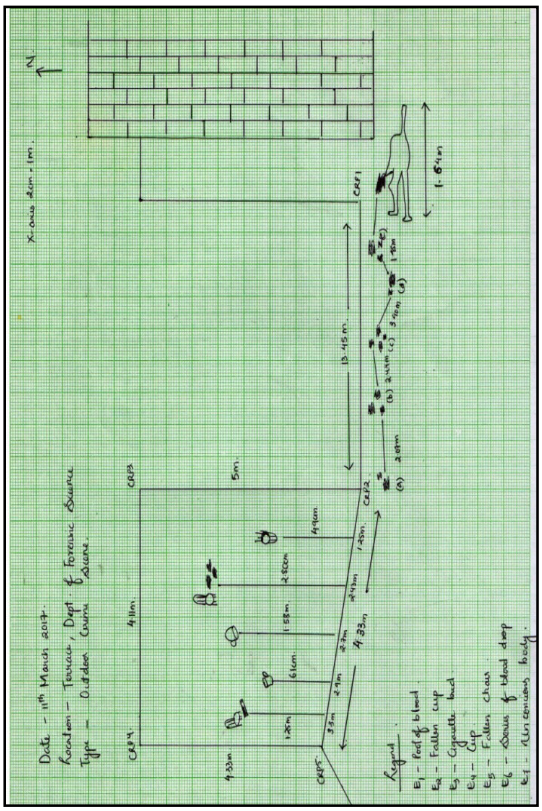


Fig 4.8.6 Final Sketch 8

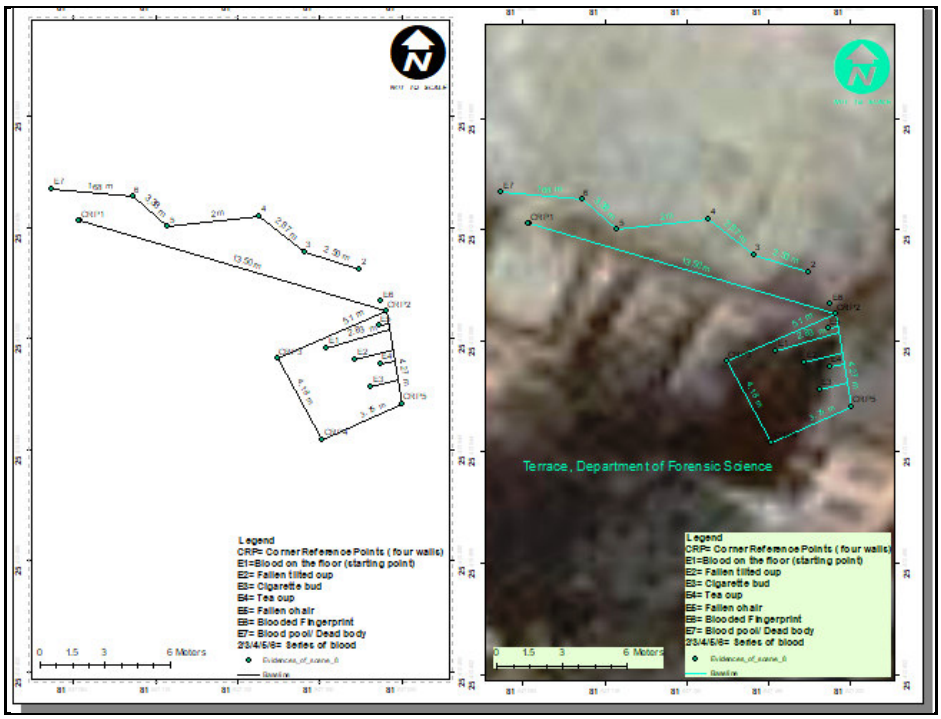


Fig 4.8.7 Final ArcGIS Map and Base Map through ArcGIS

Fig 4.8.8 Recreation Overall Photograph (CRPs)

Fig 4.8.9 Mid-range Photograph

Fig 4.8.10 DGPS coordinates through google map

Table 4.8.1 Measurements of Manual, DGPS unit and Recreation of scene 8

Sl.No	Code	Name of the Evidences	MM (M1) (In meter)	DGPS (M2)	Diff. Between M1 and M2	Avg. diff. (cm)	Recreation Measurement
1.	CRP1	CRP1-CRP2	44.12	44.3	-0.18		44.17
2.	CRP2	CRP2-CRP3	16.4	16.7	-0.3		16.72
3.	CRP3	CRP3-CRP4	13.5	13.7	-0.2		13.51
4.	CRP4	CRP4-CRP5	11.3	12.3	-1		11.25
5.	CRP5	CRP5-CRP2	14.2	14	0.2		14.24
6.	E1	Pool of blood	9.2	9.3	-0.1		9.1
7.	E2	Fallen Cup	5.2	5.5	-0.3	0.06	5.53
8.	E3	Cigarette bud	4.1	4	0.1		4.13
9.	E4	Cup	2	2.1	-0.1		2.14
10.	E5	Fallen chair	1.6	1.4	0.2		1.4
11.	E6 (2-3)	Series of blood	6.8	7	-0.2		7.13
12.	E6 (3-4)	-do-	8	8.2	-0.2		8.34
13.	E6 (4-5)	-do-	12.8	12.7	0.1		12.71
14.	E6 (5-6)	-do-	6.5	6.6	-0.1		6.63
15.	E6 (6-7)	-do-	10	11.1	-1.1		11.21
16.	E7	Unconcious body	5.4	5.5	-0.1		5.45

Table 4.8.2 Unpaired T-test for two samples assuming equal variance of scene 8

Category	Calculated value	Table Value	Degree of Freedom	Alternate Hypothesis	S/NS
Crime Scene 8	0.05	2.04	30	Rejected	NS

Since, the calculated value of ‘t’ is smaller than the table value of 't' on 30 degree of freedom and at 5% level of significance, so the Null Hypothesis was accepted. Therefore, it can be concluded from the above data that there is no technical difference between the two methods, however practically with the use of DGPS unit it is more accurate and reliable because human beings are liable to error especially when the area is big and objects are widely scattered. With the use of DGPS coordinates, recreation of the scene is possible multiples because the coordinates once taken will never get changed.

4.9 Simulated Outdoor Crime Scene Nine

Simulated outdoor crime scene nine was created at the road lane, near Khana Khazana Canteen. The accuracy of DGPS for this area was 48 cm. In this scenario, an accident scene cum murder scene was created where the evidences comprises of skid marks, tilted active bike, broken parts of bike, blood drops, cartridge shell. Overall photographs, mid-range photographs and Close-up photographs were taken for the simulated crime scene (Fig 4.9.1- 4.9.4). To conduct the measurements trees were made the Static Reference Points (SRP) and the four corners were marked as Corner Reference Points (CRP). Measurements were conducted manually and carefully by using tape (in meter) after which rough sketch was drawn at the crime scene from the south direction (Fig. 4.9.5). Thereafter, differential GPS was set vertically at the mid focal point of all the CRP's, RP's and the evidences to collect the locations. Final sketch was drawn using the graph paper (Fig. 4.9.6). Final Arcmap and base map with real world imagery was created (Fig 4.9.7). The average difference between these two methods was 0.04 (cm).

The recreation method was conducted by exporting the data (Latitude and Longitude) to the google map (Fig 4.9.8 – 4. 9. 10) and measurement was conducted with the help of measuring tape. The readings for three methods are shown in (Table 4.9.1).

Statistical t-test was conducted to see if differential GPS method is giving a consistent reading to that of manual reading. The measurements of both the manual reading and differential GPS reading were analyzed (Table 4.9.2).

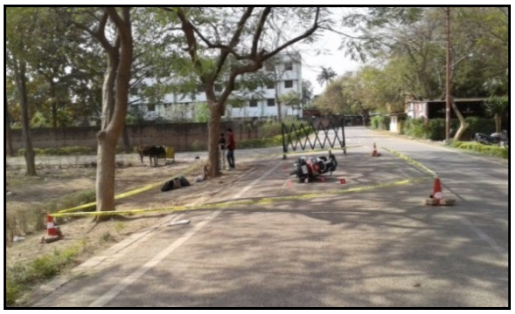


Fig 4.9.1 Overall Photograph

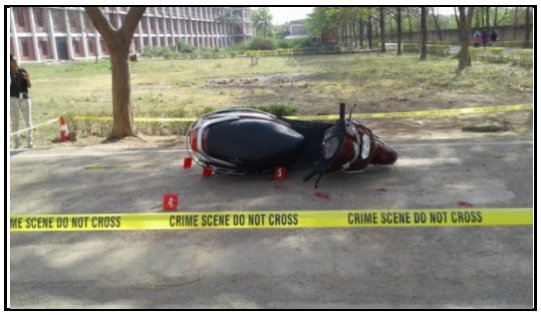


Fig 4.9.2 Mid-range Photograph

Fig 4.9.3 Close-up Photograph

Fig 4.9.4 R1GNSS receiver

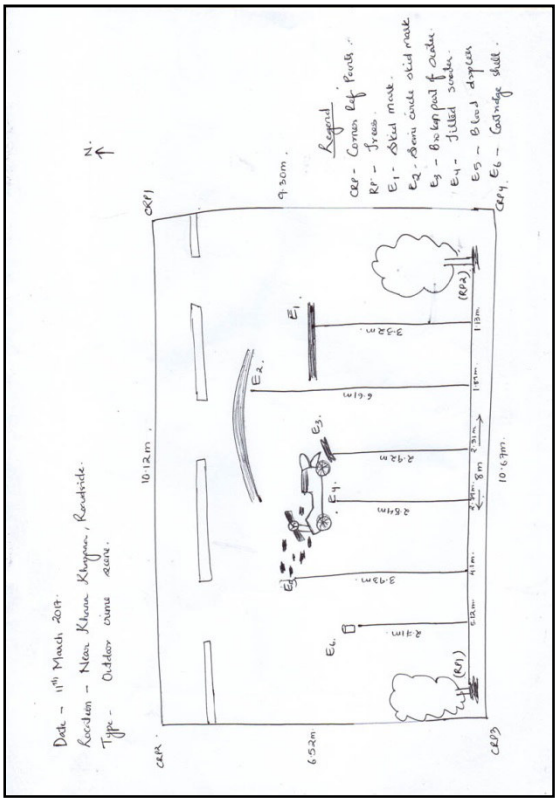


Fig 4.9.5 Rough Sketch 9

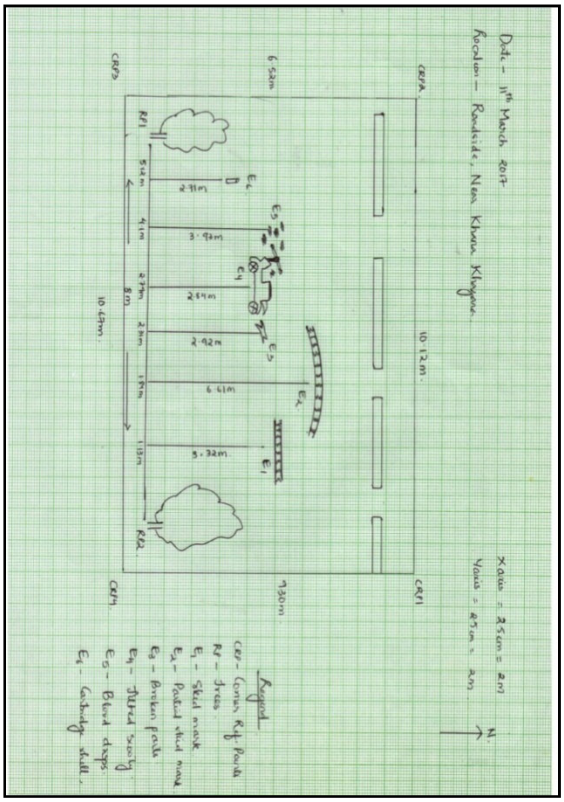


Fig 4.9.6 Final Sketch 9

Fig 4.9.7 Final ArcMap and Base Map through Arc GIS

Fig 4.9.8 Overall Photograph (CRPs)

Fig 4.9.9 Mid range photograph

Fig 4.9.10 DGPS coordinates through google map

Table 4.9.1 Measurements of Manual, DGPS unit and Recreation of scene 9

Sl. no	Code	Name of the Evidences	MM (M1) In meter	DGPS (M2)	Diff. Between M1 and M2	Avg. diff. (cm)	Recreation Measurement
1.	CRP1	CRP1-CRP2	33.2	29.87	3.33		29.51
2.	CRP2	CRP2-CRP3	21.4	22.71	-1.31		22.85
3.	CRP3	CRP3-CRP4	35	34.54	0.46		34.46
4.	CRP4	CRP4-CRP1	30.5	31.62	-1.12		31.65
5.	SRP1-SRP2	Trees	26.24	25.1	1.14		25.02
6.	E1	Skid Marks	10.9	11.86	-0.96	0.04	11.39
7.	E2	Partial Skid marks	21.7	23.98	-2.28		23.78
8.	E3	Broken parts of bike	9.57	10.36	-0.79		10.37
9.	E4	Tilted bike	9.32	10.28	-0.96		10.27
10.	E5	Blood drops	12.9	13.41	-0.51		13.08
11.	E6	Cartridge shell	8.9	7.59	1.31		7.62

Table 4.9.2 Unpaired T-test for two samples assuming equal variance of scene 9

Category	Calculated value	Table Value	Degree of Freedom	Alternate Hypothesis	S/NS
Crime Scene 7	0.03	2.08	20	Rejected	NS

Since, the calculated value of ‘t’ is smaller than the table value of 't' on 20 degree of freedom and at 5% level of significance, so the Null Hypothesis was accepted. Therefore, it can be concluded from the above data that there is no technical difference between the two methods, however practically with the use of DGPS unit it is more accurate and reliable because human beings are liable to error especially when the area is big and objects are widely scattered. With the use of DGPS coordinates, recreation of the scene is possible multiples because the coordinates once taken will never get changed.

4.10 Simulated Outdoor Crime Scene Ten

Simulated outdoor crime scene ten was created at the parking area near B.ed Department. The accuracy of DGPS for this area was 51 cm. This scene was created in a big spacious where two tress at the mid-point were taken as the Static Reference Points to conduct the measurements. Evidences were placed based on the story created. In this scenario, series of blood drops were found close to each other and the other evidences comprises of pistol and cartridge shell. Overall photographs, mid-range photographs and Close-up photographs were taken for the simulated crime scene (Fig 4.10.1- 4.10.4). The baseline method was applied where trees were made the Static Reference Points (SRP) and the four corners were marked as Corner Reference Points (CRP). Measurements were conducted manually and carefully by using tape (in meter) after which rough sketch was drawn at the crime scene from the south direction (Fig. 4.10.5). Directly from that point onward, differential GPS was set vertically at the mid focal point of all the CRP's, RP's and the evidences to collect the locations. Final sketch was drawn using the graph paper (Fig. 4.10.6). Final Arcmap and base map with real world imagery was created (Fig 4.10.7). This particular device was able to differentiate even at close proximity within a minimum distance of 24cm. The average difference between these two methods was 0.2 (cm).

The recreation method was conducted by exporting the data (Latitude and Longitude) to the google map (Fig 4.10.8 – 4.10.10) and measurement was conducted with the help of measuring tape. The readings for three methods are shown in (Table 4.10.1).

Statistical t-test was conducted to see if differential GPS method is giving a consistent reading to that of manual reading. The measurements of both the manual reading and differential GPS reading were analyzed (Table 4.10.2).

Fig 4.10.1 Overall Photograph

Fig 4.10.2 Mid-range photograph

Fig 4.10.3 Close up photohraph

Fig 4.10.4 R1GNSS receiver

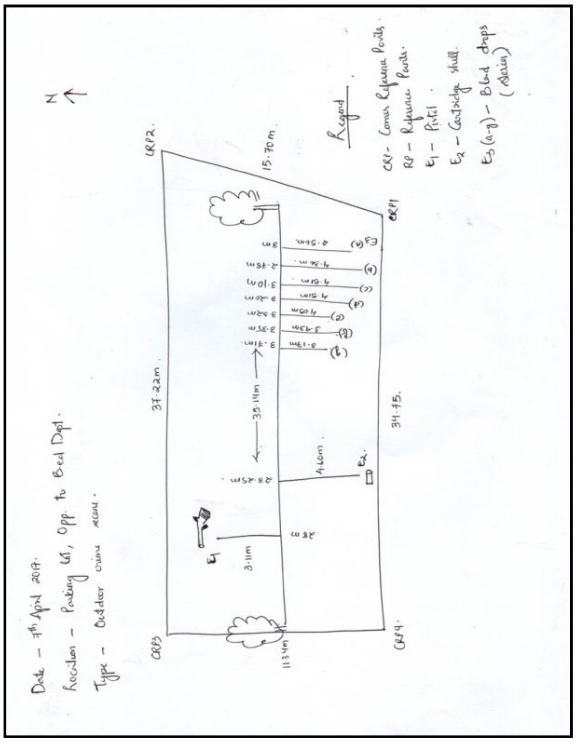


Fig 4.10.5 Rough Sketch 10

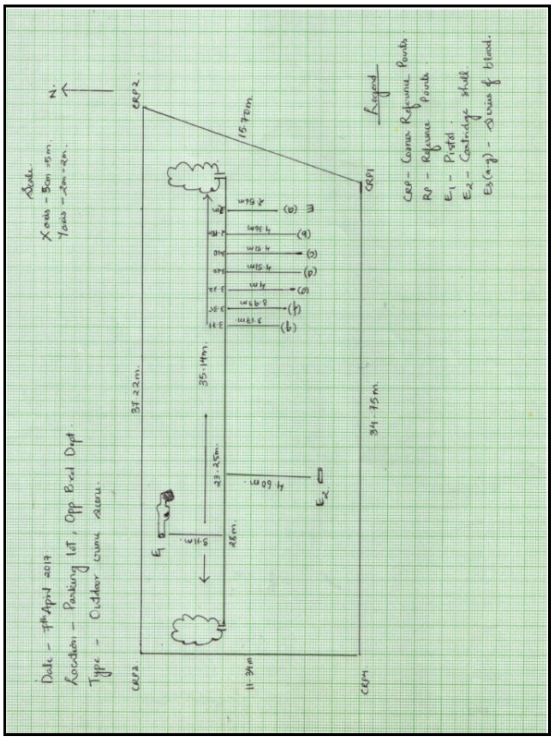


Fig 4.10.6 Final Sketch 10

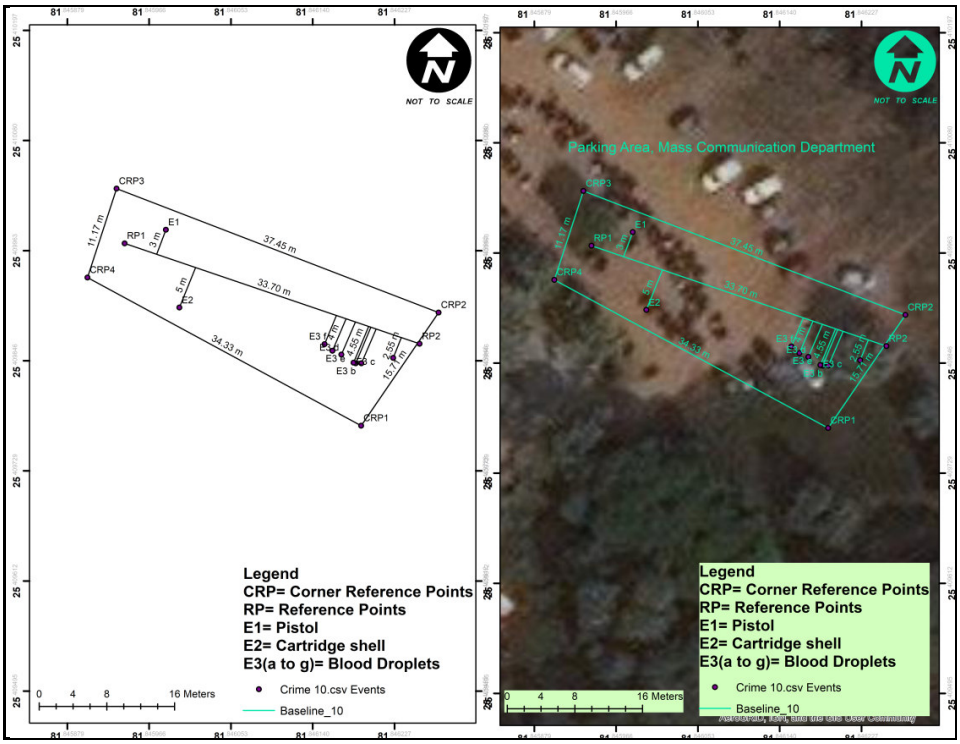


Fig 4.10.7 Final ArcGIS map and Base map through ArcGIS

Fig 4.10.8 Recreation (RP)

Fig 4.10.9 Mid-range photograph

Fig 4.10.10 DGPS coordinates through google map

Table 4.10.1 Measurements of Manual, DGPS unit and Recreation of scene 10

Sl.No	Code	Name of the Evidences	MM (M1) (In meter)	DGPS (M2)	Diff. Between M1 and M2	Avg. diff. (cm)	Recreation Measurement
1.	CRP1	CRP1-CRP2	51.5	51.54	-0.04		51.5
2.	CRP2	CRP2-CRP3	122.1	122.88	-0.78		122.47
3.	CRP3	CRP3-CRP4	37.2	36.65	0.55		36.3
4.	CRP4	CRP4-CRP5	114	112.63	1.37		112.06
5.	CRP5	CRP5-CRP2	115.3	110.55	4.75		110.22
6.	E1	Pistol	10.2	9.99	0.21		9.47
7.	E2	Cartridge	15.1	16.45	-1.35	0.2	16.56
8.	E3	Series of blood	8.4	8.35	0.05		8.58
9.	b	-do-	14.3	14.21	0.09		14.05
10.	c	-do-	14.8	14.89	-0.09		14.33
11.	d	-do-	14.8	14.93	-0.13		14.96
12.	e	-do-	13.3	13.51	-0.21		13.09
13.	f	-do-	12.9	13.23	-0.33		13.21
14.	g	-do-	10.4	11.79	-1.39		11.53

Table 4.10.2 Unpaired T-test for two samples assuming equal variance of scene 10

Category	Calculated value	Table Value	Degree of Freedom	Alternate Hypothesis	S/NS
Crime Scene 10	0.01	2.05	26	Rejected	NS

Since, the calculated value of ‘t’ is smaller than the table value of 't' on 26 degree of freedom and at 5% level of significance, so the Null Hypothesis was accepted. Therefore, it can be concluded from the above data that there is no technical difference between the two methods, however practically with the use of DGPS unit it is more accurate and reliable because human beings are liable to error especially when the area is big and objects are widely scattered. With the use of DGPS coordinates, recreation of the scene is possible multiples because the coordinates once taken will never get changed.

4.11 Simulated Outdoor Crime Scene Eleven

Simulated outdoor crime scene eleven was created at the open lawn behind NH2 hostel. The accuracy of DGPS for this area was 49 cm. This scene was created in an open space where tree and electric pole was taken as the Static Reference Points to conduct the measurements. Evidences comprises of sandal, partial blood stain on the brick and blood drops. Overall photographs, mid-range photographs and Close-up photographs were taken for the simulated crime scene (Fig 4.11.1- 4.11.4). The baseline method was applied where tree and electric pole were made the Static Reference Points (SRP) and the four corners were marked as Corner Reference Points (CRP). Measurements were conducted manually and carefully by using tape (in meter) after which rough sketch was drawn at the crime scene from the south direction (Fig. 4.11.5). Directly from that point onward, differential GPS was set vertically at the mid focal point of all the CRP's, RP's and the evidences to collect the locations. Final sketch was drawn using the graph paper (Fig. 4.11.6). The final Arcmap and base map with real world imagery was created (Fig 4.11.7). The average difference between these two methods was 0.2 (cm).

The recreation method was conducted by exporting the data (Latitude and Longitude) to the google map (Fig 4.11.8 – 4.11.10) and measurement was conducted with the help of measuring tape. The readings for three methods are shown in (Table 4.11.1).

Statistical t-test was conducted to see if differential GPS method is giving a consistent reading to that of manual reading. The measurements of both the manual reading and differential GPS reading were analyzed (Table 4.11.2).

Fig 4.11.1 Overall Photograph

Fig 4.11.2 Mid-range photograph

Fig 4.11.3 Close Up photograph

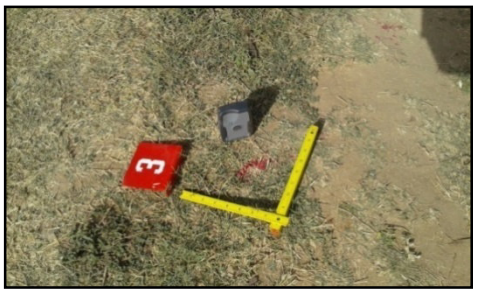


Fig 4.11.4 R1GNSS receiver

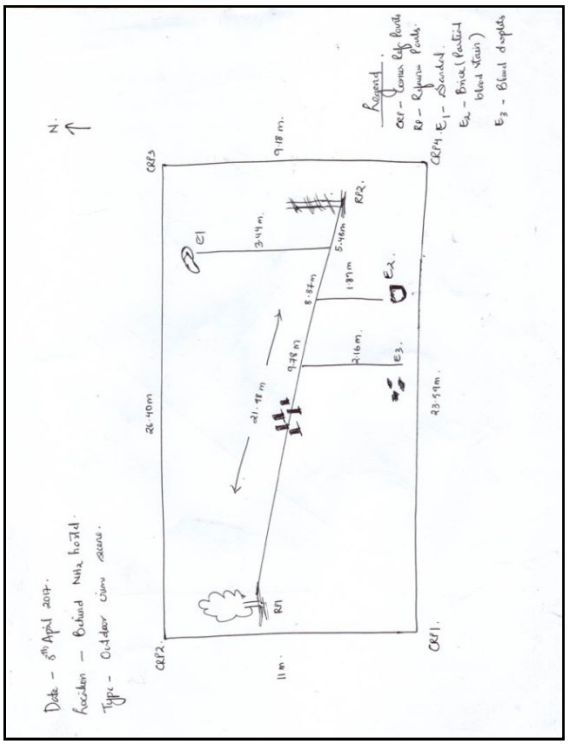


Fig 4.11.5 Rough Sketch 11

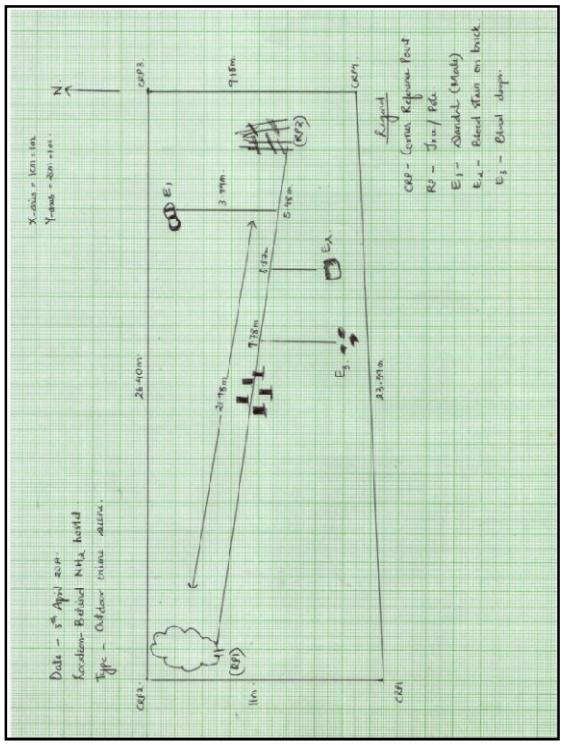


Fig 4.11.6 Final Sketch 11

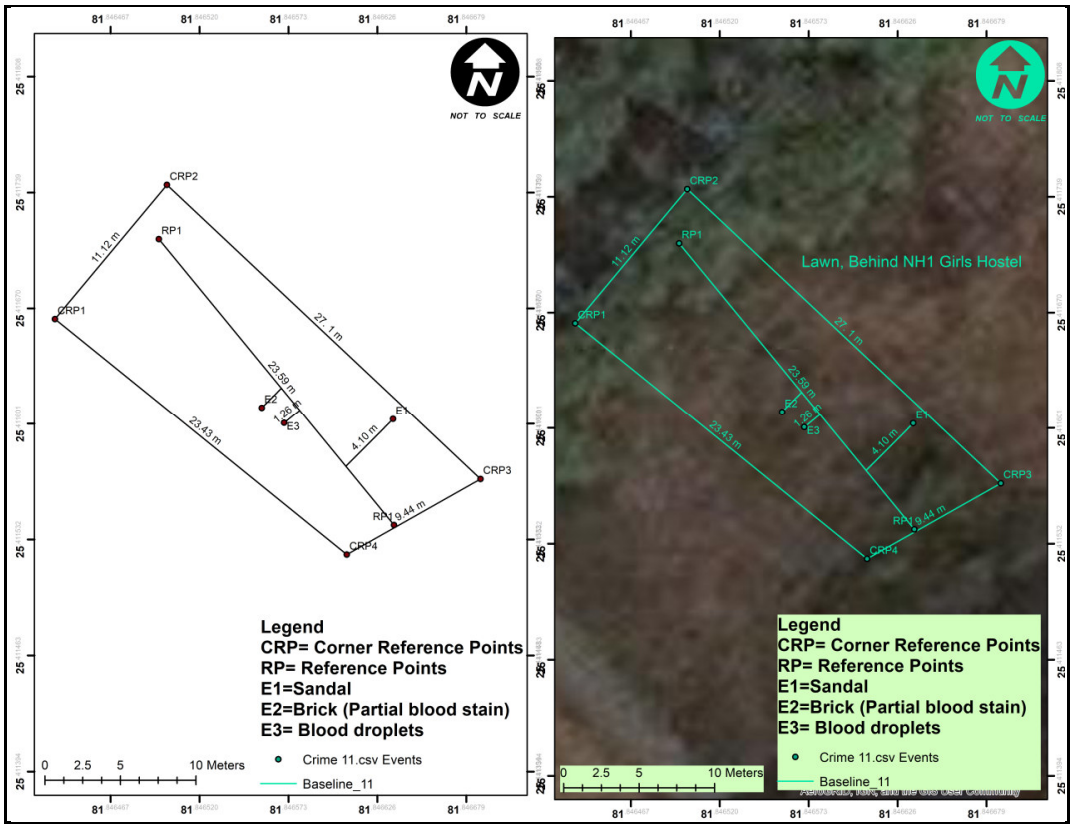


Fig 4.11.7 Final ArcMap and Base Map through ArcGIS

Fig 4.11.8 Recreation (RPs)

Fig 4.11.9 Mid-range photograph

Fig 4.11.9 DGPS coordinates through google map

Table 4.11.1 Measurements of Manual, DGPS unit and Recreation of scene 11

Sl.No	Code	Name of the Evidences	MM (M1) (In meter)	DGPS (M2)	Diff. Between M1 and M2	Avg. diff. (cm)	Recreation Measurement
1.	CRP1	CRP1-CRP2	36.1	36.47	-0.37		36.46
2.	CRP2	CRP2-CRP3	86.6	88.77	-2.17		88.92
3.	CRP3	CRP3-CRP4	30.11	30.98	-0.87		30.78
4.	CRP4	CRP4-CRP5	77.4	76.87	0.53	0.2	76.62
5.	CRP5	CRP5-CRP2	72.1	77.41	-5.31		77.38
6.	E1	Sandal	11.3	13.46	-2.16		13.16
7.	E2	Partial blood on brick	6.2	5.37	0.83		5.48
8.	E3	Blood Drops	7.1	4.12	2.98		4.69

Table 4.11.2 Unpaired T-test for two samples assuming equal variance of scene 11

Category	Calculated value	Table Value	Degree of Freedom	Alternate Hypothesis	S/NS
Crime Scene 10	0.04	2.14	14	Rejected	NS

Since, the calculated value of ‘t’ is smaller than the table value of 't' on 14 degree of freedom and at 5% level of significance, so the Null Hypothesis was accepted. Therefore, it can be concluded from the above data that there is no technical difference between the two methods, however practically with the use of DGPS unit it is more accurate and reliable because human beings are liable to error especially when the area is big and objects are widely scattered. With the use of DGPS coordinates, recreation of the scene is possible multiples because the coordinates once taken will never get changed.

4.12 Simulated Outddor Crime Scene Twelve

Simulated outdoor crime scene twelve was created at the open lawn behind Chemistry Department. The accuracy of DGPS for this area was 51 cm. This scene was created at the garden where plant bush and creeper forming a gate was taken as the Static Reference Points to conduct the measurements. Evidences comprises of knife, sunglass and blood drops. Overall photographs, mid-range photographs and Close-up photographs were taken for the simulated crime scene (Fig 4.12.1- 4.12.4). The baseline method was applied where bush and creeper gate were made the Static Reference Points (SRP) and the four corners were marked as Corner Reference Points (CRP). Measurements were conducted manually and carefully by using tape (in meter) after which rough sketch was drawn at the crime scene from the south direction (Fig. 4.12.5). Directly from that point onward, differential GPS was set vertically at the mid focal point of all the CRP's, RP's and the evidences to collect the locations. Final sketch was drawn using the graph paper (Fig. 4.12.6). Arcmap and base map with real world imagery was finally created (Fig 4.12.7). The average difference between these two methods was 0.3 (cm).

The recreation method was conducted by exporting the data (Latitude and Longitude) to the google map (Fig 4.12.8 – 4.12.10) and measurement was conducted with the help of measuring tape. The readings for three methods are shown in (Table 4.12.1).

Statistical t-test was conducted to see if differential GPS method is giving a consistent reading to that of manual reading. The measurements of both the manual reading and differential GPS reading were analyzed (Table 4.12.2).

Fig 4.12.1 Overall Photographs

Fig 4.12.2 Mid range photograph

Fig 4.12.3 Close-Up photograph

Fig 4.12.4 R1GNSS receiver

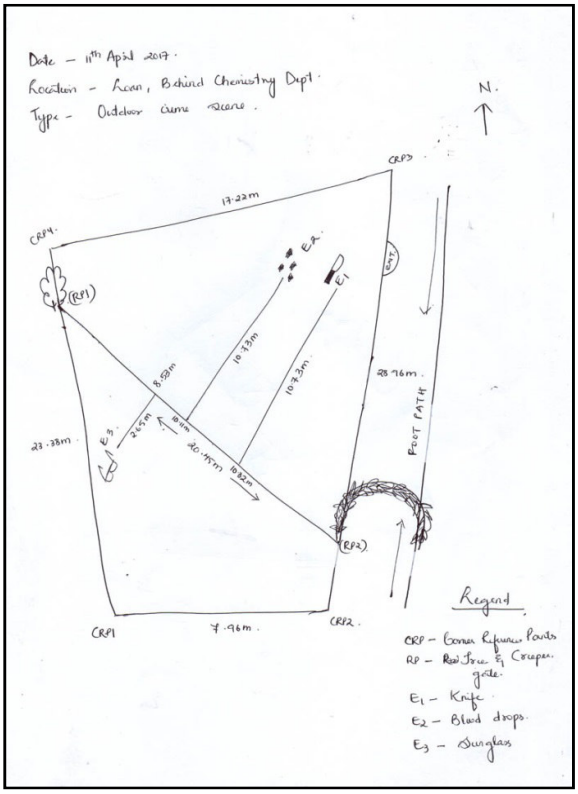


Fig 4.12.5 Rough Sketch

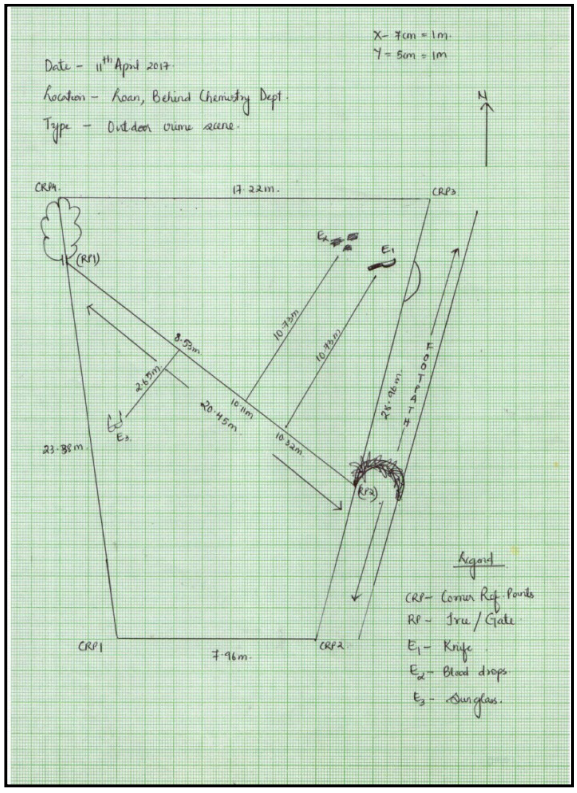


Fig 4.12.6 Final Sketch

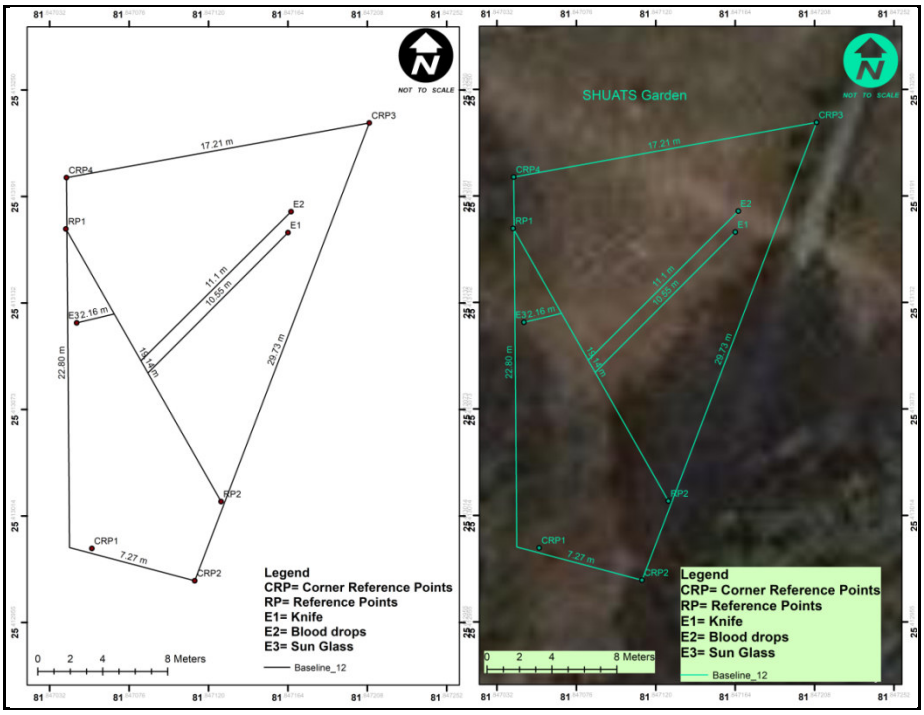


Fig 4.12.7 Final ArcMap and Base Map through ArcGIS

Fig 4.12.8 Recreation (RPs)

Fig 4.12.9 Mid-range photograph

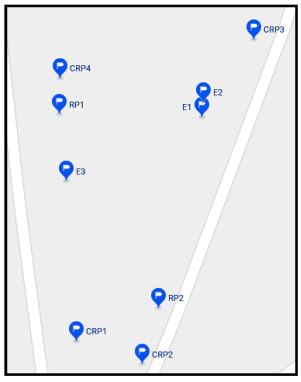


Fig 4.12.9 DGPS coordinates through google map

Table 4.12.1 Measurements of Manual, DGPS unit and Recreation of scene 12

Sl.No	Code	Name of the Evidences	MM (M1) (In meter)	DGPS (M2)	Diff. Between M1 and M2	Avg. diff. (cm)	Recreation Measurement
1.	CRP1	CRP1-CRP2	26.1	23.86	2.24		23.76
2.	CRP2	CRP2-CRP3	95	97.53	-2.53		97.82
3.	CRP3	CRP3-CRP4	56.5	56.46	0.04		56.3
4.	CRP4	CRP4-CRP5	76.7	74.79	1.91	0.3	74.59
5.	CRP5	CRP5-CRP2	67.1	62.8	4.3		62.23
6.	E1	Knife	35.2	34.6	0.6		34.8
7.	E2	Blood Drops	35.2	36.26	-1.06		36.46
8.	E3	Sun Glass	8.7	7.09	1.61		7.12

Table 4.12.2 Unpaired T-test for two samples assuming equal variance of scene 12

Category	Calculated value	Table Value	Degree of Freedom	Alternate Hypothesis	S/NS
Crime Scene 10	0.06	2.144	14	Rejected	NS

Since, the calculated value of ‘t’ is smaller than the table value of 't' on 14 degree of freedom and at 5% level of significance, so the Null Hypothesis was accepted. Therefore, it can be concluded from the above data that there is no technical difference between the two methods, however practically with the use of DGPS unit it is more accurate and reliable because human beings are liable to error especially when the area is big and objects are widely scattered. With the use of DGPS coordinates, recreation of the scene is possible multiples because the coordinates once taken will never get changed.

4.13 Simulated Outdoor Crime Scene Thirteen

Simulated outdoor crime scene thirteen was created at the garden, near the Central Library. The accuracy of DGPS for this area was 47 cm. This scene was created at the garden where the trees diagonal to each other were taken as the Static Reference Points to conduct the measurements. Evidences comprises of scarf, broken glass with blood stain and blood droplets. Overall photographs, mid-range photographs and Close-up photographs were taken for the simulated crime scene (Fig 4.13.1- 4.13.4). The baseline method was applied where bush and creeper gate were made the Static Reference Points (SRP) and the four corners were marked as Corner Reference Points (CRP). Measurements were conducted manually and carefully by using tape (in meter) after which rough sketch was drawn at the crime scene from the south direction (Fig. 4.13.5). Directly from that point onward, differential GPS was set vertically at the mid focal point of all the CRP's, RP's and the evidences to collect the locations. Final sketch was drawn using the graph paper (Fig. 4.13.6). Finally, Arcmap and base map with real world imagery was created (Fig 4.13.7). The average difference between these two methods was 0.1 (cm).

The recreation method was conducted by exporting the data (Latitude and Longitude) to the google map (Fig 4.13.8 – 4.13.10) and measurement was conducted with the help of measuring tape. The readings for three methods are shown in (Table 4.13.1).

Statistical t-test was conducted to see if differential GPS method is giving a consistent reading to that of manual reading. The measurements of both the manual reading and differential GPS reading were analyzed (Table 4.13.2).

Fig 4.13.1 Overall Photograph

Fig 4.13.2 Mid Range Photograph

Fig 4.13.4 Closeup Photograph

Fig 4.13.5 R1GNSS receiver

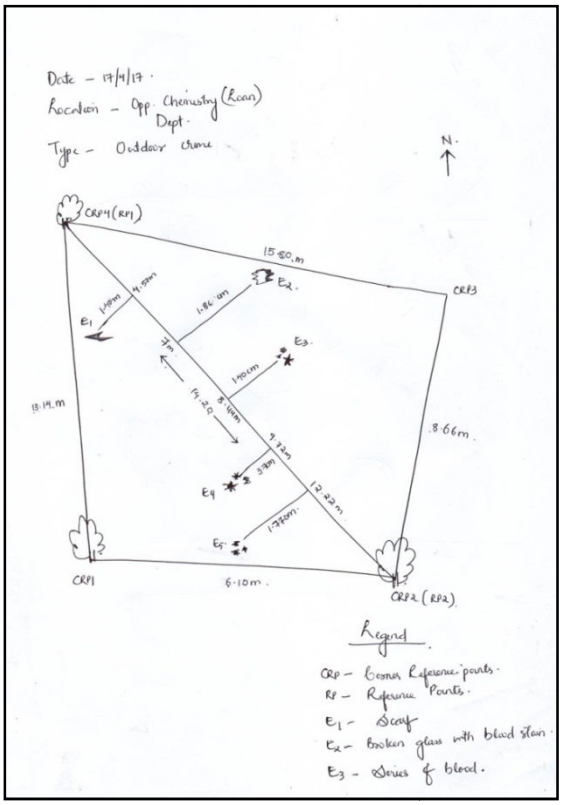


Fig 4.13.5 Rough Sketch 13

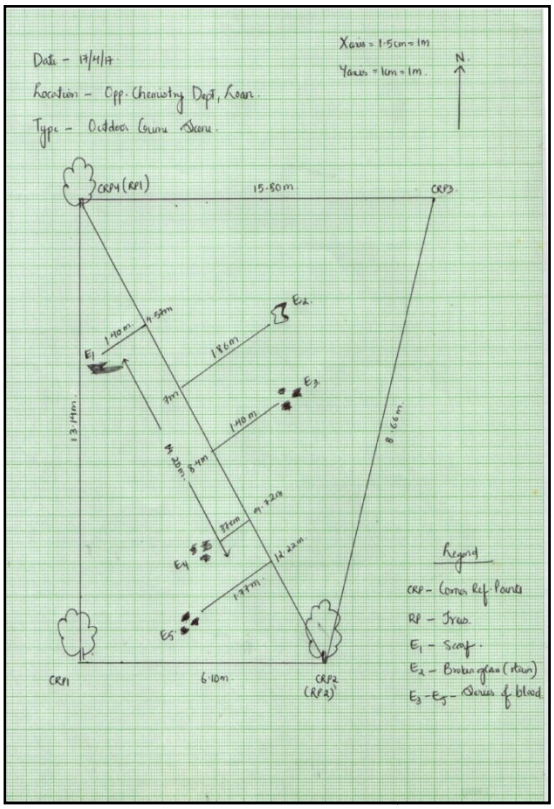


Fig 4.13.6 Final Sketch 13

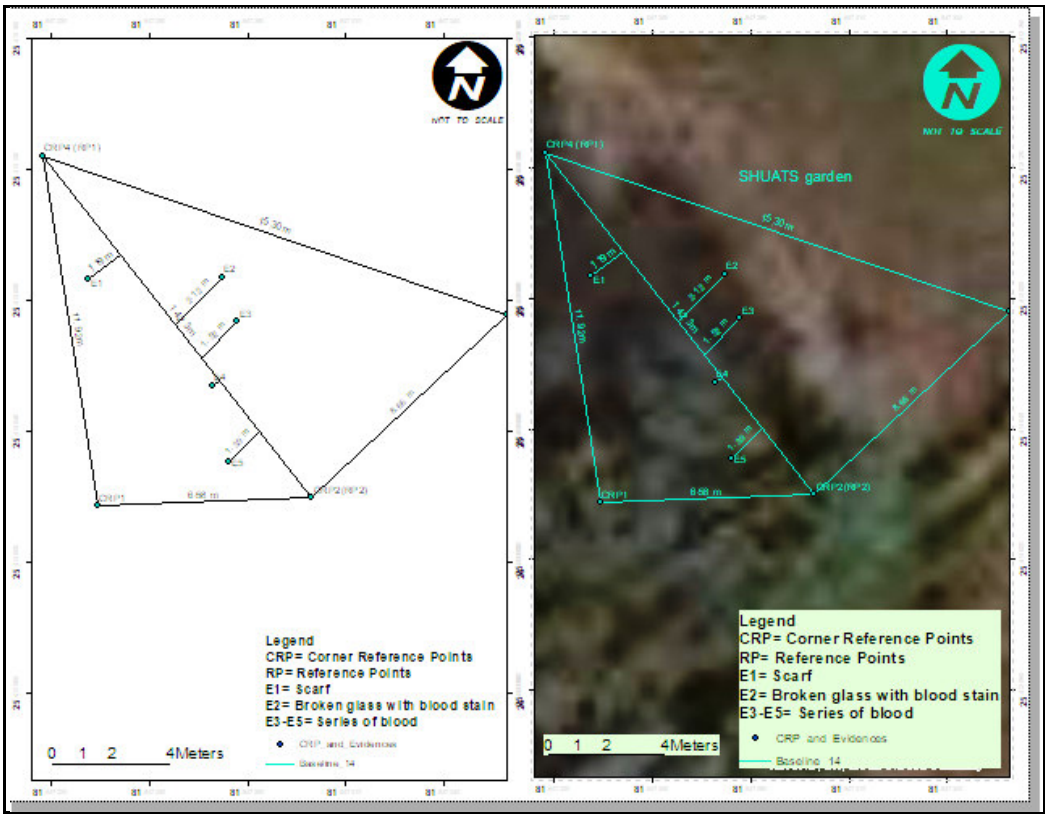


Fig 4.13.7 Final ArcMap and Base Map through ArcGIS

Fig 4.13.8 Recreation (CRPs)

Fig 4.13.9 Mid Range photograph (RP)

Fig 4.13.10 DGPS coordinates through google map

Table 4.13.1 Measurements of Manual, DGPS unit and Recreation of scene 13

Sl.No	Code	Name of the Evidences	MM (M1) (In meter)	DGPS (M2)	Diff. Between M1 and M2	Avg. diff. (cm)	Recreation Measurement
1.	CRP1	CRP1-CRP2	20	21.6	-1.6		21.47
2.	CRP2	CRP2-CRP3	28.4	28.4	0		28.44
3.	CRP3	CRP3-CRP4	51.85	50.2	1.65		50.15
4.	CRP4	CRP4-CRP5	43.1	39.11	3.99		39.5
5.	CRP5	CRP5-CRP2	46.6	46.69	-0.09	0.1	46.72
6.	E1	Scarf	4.6	3.9	0.7		3.87
7.	E2	Broken glass with blood stain	6.1	6.95	-0.85		6.62
8.	E3	Series of blood	4.6	5	-0.4		5.21
9.	E4	-do-	1.2	1	0.2		1.17
10.	E5	-do-	5.8	4.56	1.24		4.13

Table 4.13.2 Unpaired T-test for two samples assuming equal variance of scene 13

Category	Calculated value	Table Value	Degree of Freedom	Alternate Hypothesis	S/NS
Crime Scene 13	0.04	2.18	14	Rejected	NS

Since, the calculated value of ‘t’ is smaller than the table value of 't' on 14 degree of freedom and at 5% level of significance, so the Null Hypothesis was accepted. Therefore, it can be concluded from the above data that there is no technical difference between the two methods, however practically with the use of DGPS unit it is more accurate and reliable because human beings are liable to error especially when the area is big and objects are widely scattered. With the use of DGPS coordinates, recreation of the scene is possible multiples because the coordinates once taken will never get changed.

4.14 Simulated Outdoor Crime Scene Fourteen

Simulated outdoor crime scene fourteen was created at the parking lot, near the SIET department. The accuracy of DGPS for this area was 44 cm. This scene was created at the corner side of the big ground. There was no trees, electric poles or building edges to take the measurements so with the help of measuring tape the line was drawn and the crime scene was cordon off with the traffic cones covering all the important evidences within the rectangle area. Evidences comprise of female bracelet, broken glass and series of blood. Overall photographs, mid-range photographs and Close-up photographs were taken for the simulated crime scene (Fig 4.14.1- 4.14.4). The baseline method was applied where bush and creeper gate were made the Static Reference Points (SRP) and the four corners were marked as Corner Reference Points (CRP). Measurements were conducted manually and carefully by using tape (in meter) after which rough sketch was drawn at the crime scene from the south direction (Fig. 4.14.5). Directly from that point onward, differential GPS was set vertically at the mid focal point of all the CRP's, RP's and the evidences to collect the locations. Final sketch was drawn using the graph paper (Fig. 4.14.6). The final Arcmap and base map with real world imagery was created (Fig 4.14.7). The average difference between these two methods was 0.1 (cm).

The recreation method was conducted by exporting the data (Latitude and Longitude) to the google map (Fig 4.14.8 – 4.14.10) and measurement was conducted with the help of measuring tape. The readings for three methods are shown in (Table 4.14.1).

Statistical t-test was conducted to see if differential GPS method is giving a consistent reading to that of manual reading. The measurements of both the manual reading and differential GPS reading were analyzed (Table 4.14.2).

Fig 4.14.1 Overall Photograph

Fig 4.14.2 Mid Range Photograph

Fig 4.14.4 Closeup Photograph

Fig 4.14.5 R1GNSS receiver

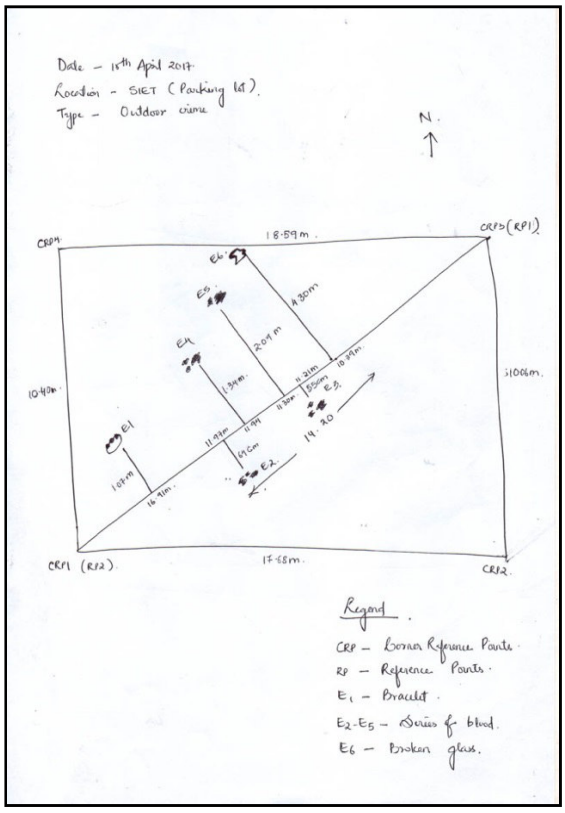


Fig 4.14.5 Rough Sketch 14

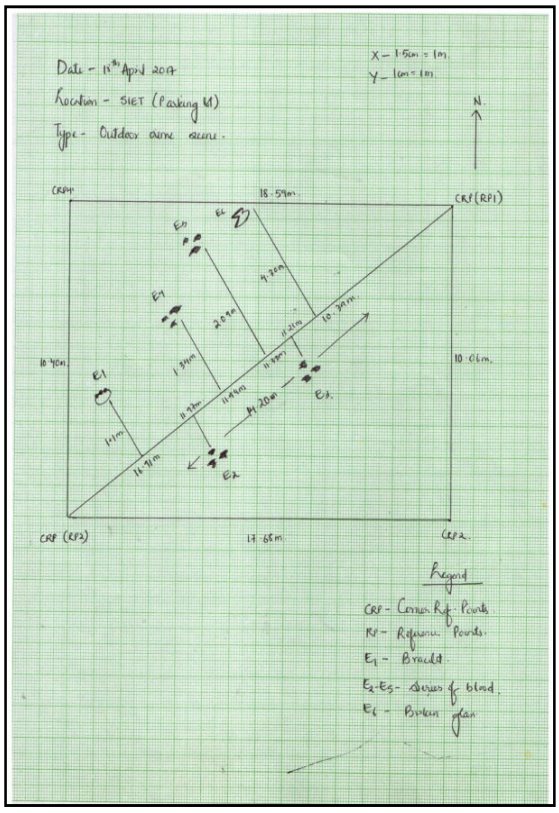


Fig 4.14.6 Final Sketch 1

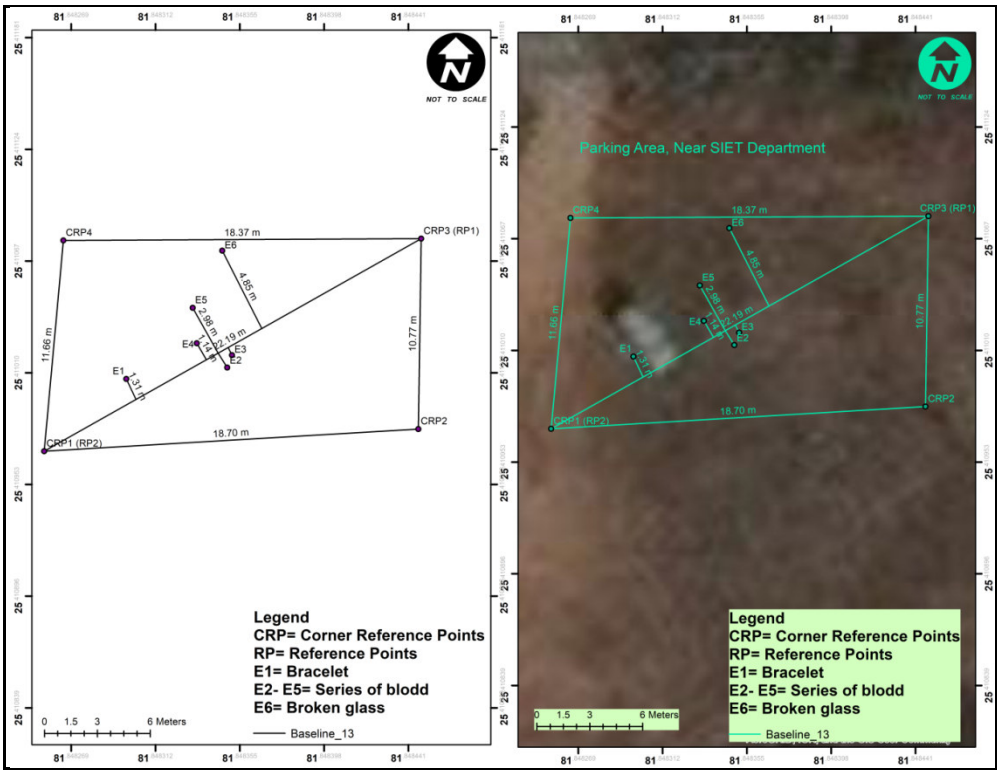


Fig 4.14.7 Final ArcMap and Base Map through ArcGIS

Fig 4.14.8 Recreation (CRPs)

Fig 4.14.9 Mid Range photograph (RP)

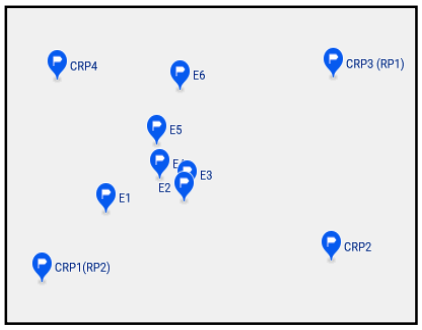


Fig 4.14.10 DGPS coordinates through google map

Table 4.14.1 Measurements of Manual, DGPS unit and Recreation of scene 14

Sl.No	Code	Name of the Evidences	MM (M1) (In meter)	DGPS (M2)	Diff. Between M1 and M2	Avg. diff. (cm)	Recreation Measurement
1.	CRP1	CRP1-CRP2	58	61.35	-3.35		62.89
2.	CRP2	CRP2-CRP3	33	35.32	-2.32		35.8
3.	CRP3	CRP3-CRP4	61	60.27	0.73		60.1
4.	CRP4	CRP4-CRP5	34.11	38.24	-4.13		38.73
5.	CRP5	CRP5-CRP2	71.5	72.79	-1.29	0.1	74.62
6.	E1	Bracelet	3.5	4.3	-0.8		4.47
7.	E2	Sereis of blood	2.1	2.43	-0.33		2.2
8.	E3	-do-	1.8	1.27	0.53		1.53
9.	E4	-do-	4.4	3.73	0.67		3.74
10.	E5	-do-	9.5	9.77	-0.27		9.63
11.	E6	Broken Glass	14.11	15.9	-1.79		16.24

Table 4.14.2 Unpaired T-test for two samples assuming equal variance of scene 14

Category	Calculated value	Table Value	Degree of Freedom	Alternate Hypothesis	S/NS
Crime Scene 14	0.09	2.08	20	Rejected	NS

Since, the calculated value of ‘t’ is smaller than the table value of 't' on 20 degree of freedom and at 5% level of significance, so the Null Hypothesis was accepted. Therefore, it can be concluded from the above data that there is no technical difference between the two methods, however practically with the use of DGPS unit it is more accurate and reliable because human beings are liable to error especially when the area is big and objects are widely scattered. With the use of DGPS coordinates, recreation of the scene is possible multiples because the coordinates once taken will never get changed.

4.15 Simulated Outdoor Crime Scene Fifteen

Simulated outdoor crime scene fifteen was created at the open space, behind B.Ed Department. The accuracy of DGPS for this area was 41 cm. In this scenario, the evidences comprises of female hair clip, Knife with blood stain and series of blood. Overall photographs, mid-range photographs and Close-up photographs were taken for the simulated crime scene (Fig 4.15.1-4.15.4). The baseline method was applied where two trees were made the Static Reference Points (SRP) and the four corners were marked as Corner Reference Points (CRP). Measurements were conducted manually and carefully by using tape (in meter) after which rough sketch was drawn at the crime scene from the south direction (Fig. 4.15.5). After which, differential GPS was set vertically at the mid focal point of all the CRP's, RP's and the evidences to collect the locations. Final sketch was drawn using the graph paper (Fig. 4.15.6). Final Arcmap and base map with real world imagery was created (Fig 4.15.7). The average difference between these two methods was 0.6(cm).

The recreation method was conducted by exporting the data (Latitude and Longitude) to the google map (Fig 4.15.8 – 4.15.10) and measurement was conducted with the help of measuring tape. The readings for three methods are shown in (Table 4.15.1).

Statistical t-test was conducted to see if differential GPS method is giving a consistent reading to that of manual reading. The measurements of both the manual reading and differential GPS reading were analyzed (Table 4.15.2).

Fig 4.15.1 Overall Photograph

Fig 4.15.2 Mid Range Photograph

Fig 4.15.4 Closeup Photograph

Fig 4.15.5 R1GNSS receiver

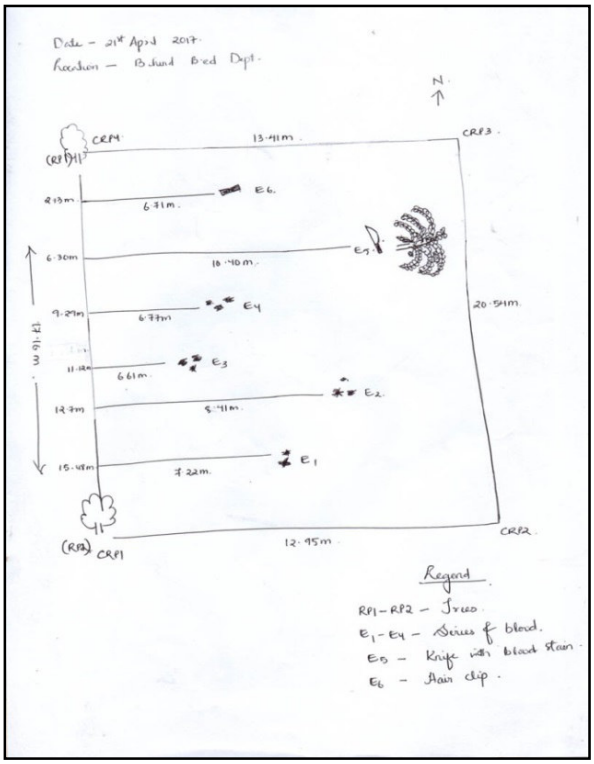


Fig 4.15.5 Rough Sketch 15

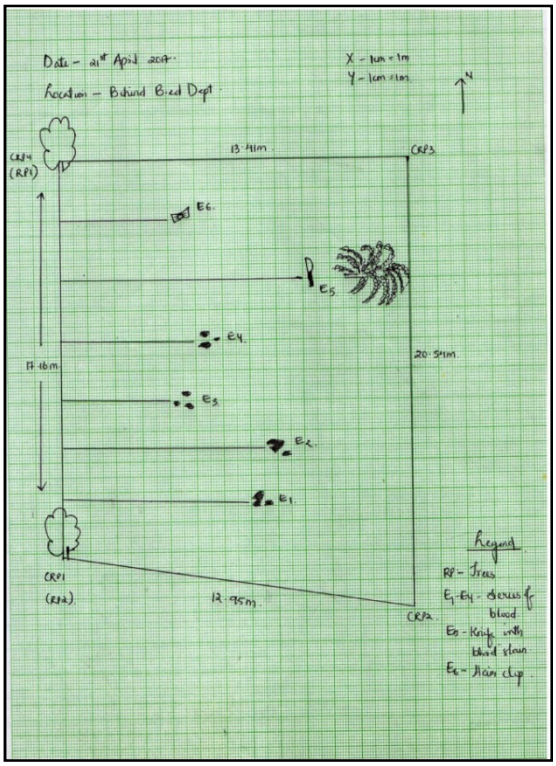


Fig 4.15.6 Final Sketch 15

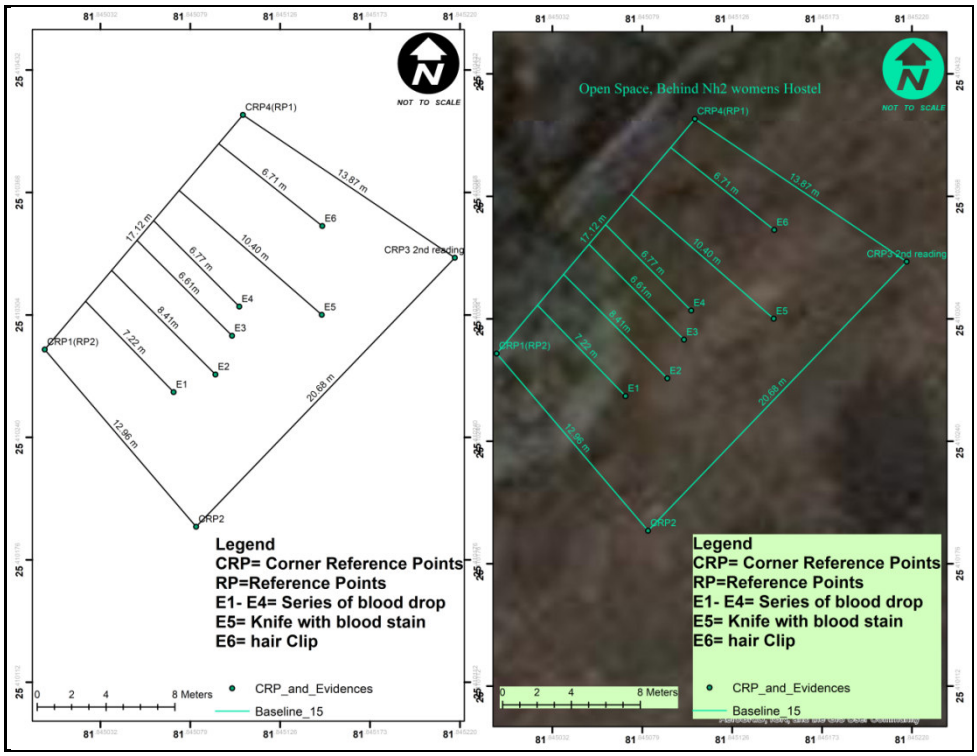


Fig 4.15.7 Final ArcMap and Base Map through ArcGIS

Fig 4.15.8 Recreation (CRPs)

Fig 4.15.9 Mid Range photograph (RP)

Fig 4.15.10 DGPS coordinates through google map

Table 4.15.1 Measurements of Manual, DGPS unit and Recreation of scene 15

Sl.No	Code	Name of the Evidences	MM (M1) (In meter)	DGPS (M2)	Diff. Between M1 and M2	Avg. diff. (cm)	Recreation Measurement
1.	CRP1	CRP1-CRP2	42.5	42.53	-0.03		42.62
2.	CRP2	CRP2-CRP3	67.4	67.86	-0.46		67.78
3.	CRP3	CRP3-CRP4	44	45.52	-1.52		45.78
4.	CRP4	CRP4-CRP5	56.3	56.18	0.12		56.3
5.	CRP5	CRP5-CRP2	56.3	56.18	0.12		56.3
6.	E1	Series of blood	23.7	22.62	1.08	0.06	22.37
7.	E2	-do-	27.6	26.19	1.41		26.25
8.	E3	-do-	21.7	24	-2.3		24.22
9.	E4	-do-	22.2	21.7	0.5		21.82
10.	E5	Knife with blood stain	34.11	33.9	0.21		33.95
11.	E6	Hair clip	22	23.8	-1.8		23.73

Table 4.15.2 Unpaired T-test for two samples assuming equal variance of scene 15

Category	Calculated value	Table Value	Degree of Freedom	Alternate Hypothesis	S/NS
Crime Scene 15	0.03	2.08	20	Rejected	NS

Since, the calculated value of ‘t’ is smaller than the table value of 't' on 20 degree of freedom and at 5% level of significance, so the Null Hypothesis was accepted. Therefore, it can be concluded from the above data that there is no technical difference between the two methods, however practically with the use of DGPS unit it is more accurate and reliable because human beings are liable to error especially when the area is big and objects are widely scattered. With the use of DGPS coordinates, recreation of the scene is possible multiples because the coordinates once taken will never get changed.

4.16 DGPS based Outdoor Crime Scene Management Protocol

Outdoor crime scenes vary from each other. They can be intricate and perplexing. Nevertheless, there are rules or guidelines that exist in all the cases for processing the crime scene. A recommended guideline with the use of DGPS (Trimble R1GNSS) especially for outdoor crime scene management is developed. They are as follows:

1. **Reaching of Crime Scene**

   On reaching the crime scene, it is vital to glance around and ensure any spectators, media people and inquisitive individuals are kept away from entering the scene as transfer, loss, or contamination of evidence can occur if the area is left unsecured (Locard's exchange principle).

2. **Protection of Crime Scene**

   Protect and barricade the crime scene with traffic cones, crime tapes making sure all the evidences concentrated mostly are confined within the barricaded tape.

3. **Notes/Reports/ History of crime.**

   Investigative notes and reports are critical part of criminal investigation. It will supplement the photographs at the time of investigation. Who? What? Where? When? How? Why? are the questions to be pondered upon while taking a note. Notes are dictated into a tape or digital recording device, yet at some point are transcribed into a written format for court purposes. Here, therefore, notes and reports are defined as being both audio and written. Notes and reports are not sufficient by themselves because they do not accurately portray the scene in detail. Detailed descriptions will help the investigator to remember the evidence when presented with it at a later date, such as when a case is reopened or goes on trial. Following points to be considered:

a. Date

b. Location

c. Time

d. Victim & Witness Statements.

e. Who Was Present at the Scene?

f. Lighting Conditions.

g. Date & Time Indicators e.g. Newspapers, Mail.

h. General Descriptions of The scene & Surrounding Area.

i. Name of the evidence collector.

4. Photographs

Photographs are the absolutely essential that is to be taken for documenting the crime scene so that they show the scene preserved in an unaltered condition. All photographs must contain three elements: the subject, a scale, and a reference object. Crime scene photographs should always be in focus, with the subject of the photograph as the main object of the scene. There should always be a scale or ruler present. This will allow the investigators the ability to resize the image to accurately reconstruct the scene. Ensure the optimum photographic condition. There are three types of photographs in documenting the crime scene.

a. Overall Photographs- Pictures of surrounding area should be taken from all the four corners and point of view (Fig 5). It will allow the viewer to see a large area in the scene at eye-level.

Fig 4.16.1: Overall photographs from the entire four corners

b. **Mid-range Photographs**- These shots show key pieces of evidence in context (Fig 6), so the photo includes not only the evidence but also its location in an area and its distance from other pieces of evidence.

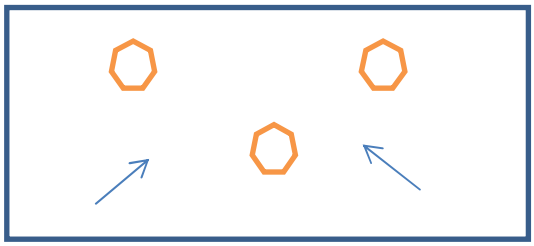


Fig 4.16.2: Picture showing the evidences and the surroundings

c. **Close up Photograph**- This type of photograph will allow the viewer to see all evident detail on the item of evidence. This photo should be close and fill the frame with the evidence itself. They are taken with and without a scale.

Fig 4.16.3: Evidence taken in close up photograph

5. About R1GNSS receiver

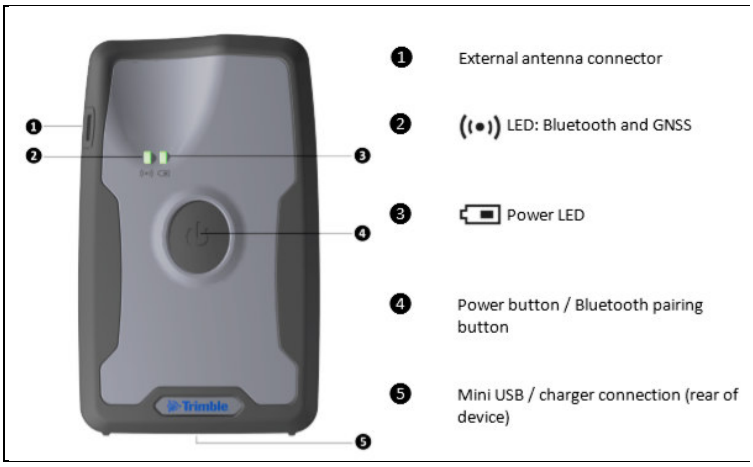


Fig 4.16.4: Parts of the R1GNSS receiver

1. Determine the accuracy of the DGPS (R1GNSS receiver) unit

a) Make sure the device you are using has Bluetooth connectivity turned on (Fig 4.16.5).

b) While pairing the R1GNSS and device in Bluetooth pairing mode, press and hold the button until the Led turns blue and then wait for a second until both LEDs turns green, then release the Power bottom (Fig 4.16.6). Once the Led gives solid green colour, the GNSS status shows that it's connected.

Fig 4.16.5: Device and the receiver in pairing mode through Bluetooth connectivity

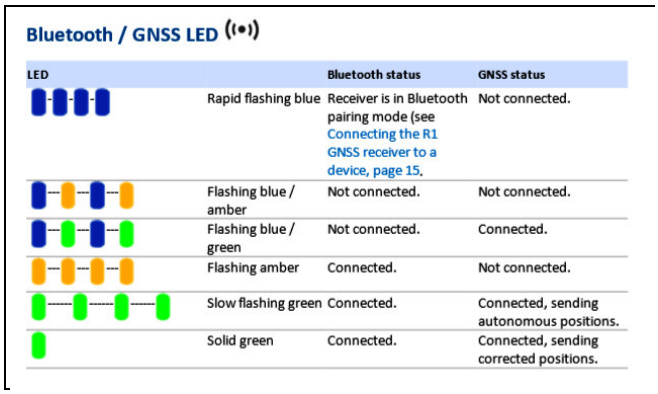


Fig 4.16.6: Pairing mode of the device and the GNSS receiver.

c) Open the Terra Flex software by entering the user ID and password (Fig 4.16.7).

d) Go to settings and pair the devices (Fig 4.16.8 and 4.16.9)

e) After pairing, go to location status and check the accuracy (Fig 4.16.10). Once the accuracy fluctuates and comes down, data collection can be started.

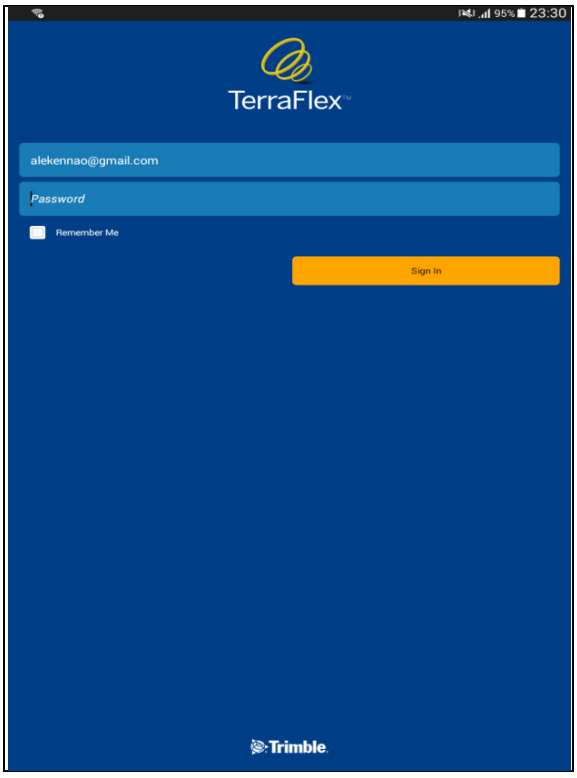


Fig 4.16.7: Log in page

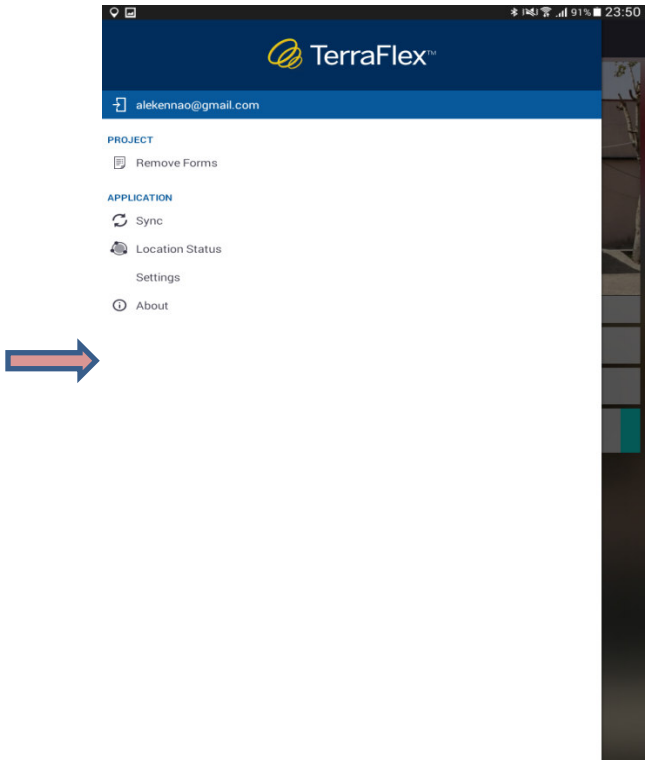


Fig 4.16.8: Setting page

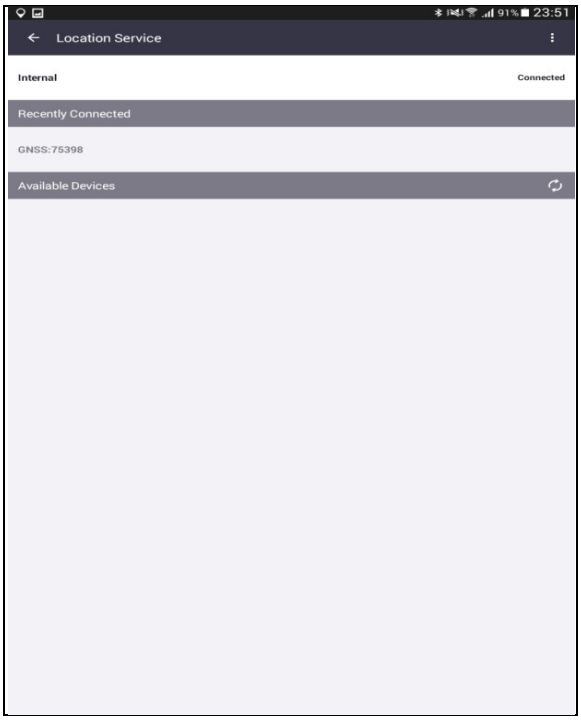


Fig 4.16.9: Page for pairing the receiver

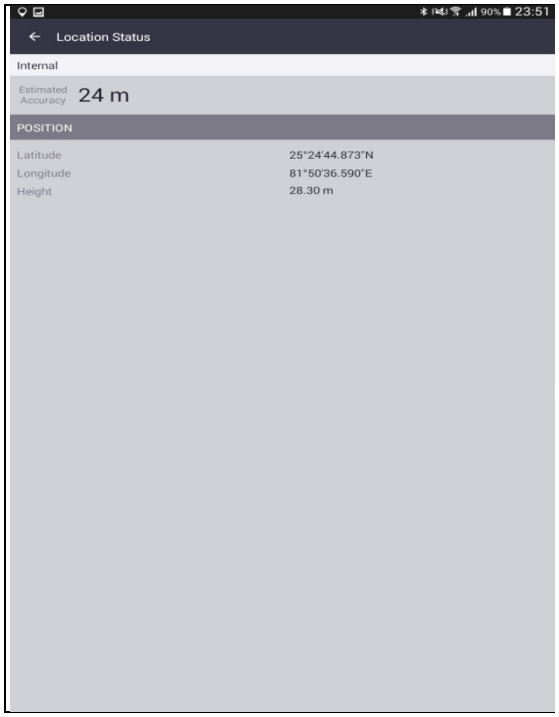


Fig 4.16.10: Location Status page

7. **Determine what points to be collected**

Before any points are collected, the measurement method must be determined and reference points like the Static Reference Points (SRP), Four Corner Reference Points (CRP) and the Evidence Points must be established.

7.1 Corner Reference Points (CRPs) - The prime work is to identify the four corners where this four corner could be of existing trees, electric poles. If the trees are not available for all the four corners, traffic cones or stand could be utilized. Make sure all the essential evidences are within the confined space.

7.2 Static Reference Points (SRPs) – The static reference points should be any trees or electric poles, mobile towers so that measurements could be conducted for all the evidences to the baseline at 90 degree.

7.3 Evidences Points – The evidences found at the crime scene should be labelled as E1, E2, E3……The device is kept at the center or side part near the evidence for collection of data (Latitude, Longitude and Height).

8. **Orientation of the device**

The device has to be kept vertically and not horizontally as it gives more accurate result

(Fig 14.16.11)

Fig.4.16.11: The device kept in vertical position

9. **Data collection**

Once the device is set, open the data template and start the collection (Fig 15-16). To handle the device, single person is required. Keep the device in every point (Corner Reference Points, Fixed Reference Points and Evidences points) and start collecting them in clockwise or anticlockwise direction (Fig 17-20). Make sure all the data's are collected and photographs are taken.

Fig 4.16.12: Project File

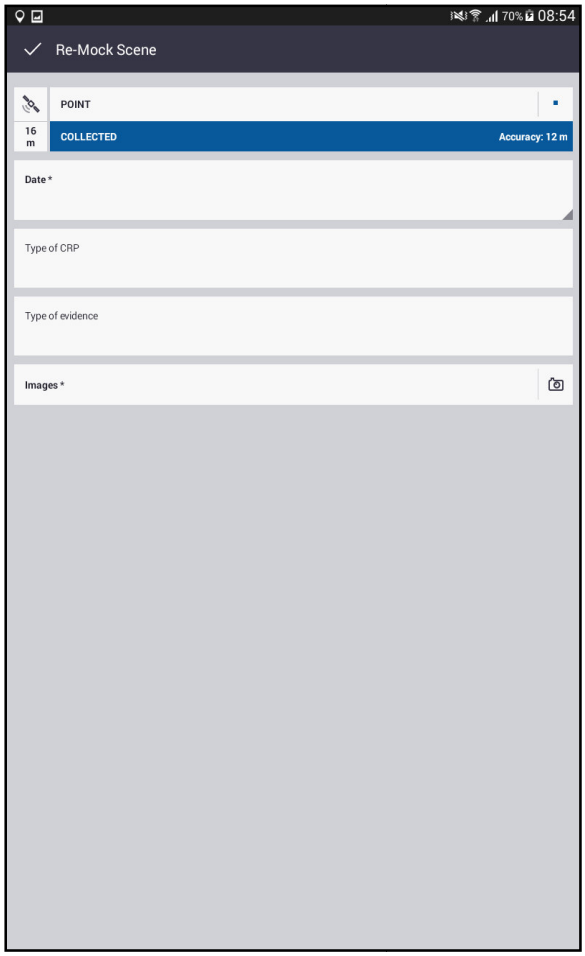


Fig 4.16.13: Data collection template

10. **Synchronization of data**

Once the data gets collected, it will synchronize to the server. Open the computer and go to Terra Flex Software home page (www.trimbleinsphere.com). To log in enter the user name and password. Go the project file and download the data. The data is directly downloaded from the Trimble terra flex home page which is automatically saved in Excel file format showing the (latitude, longitude, height) of all the collected points.

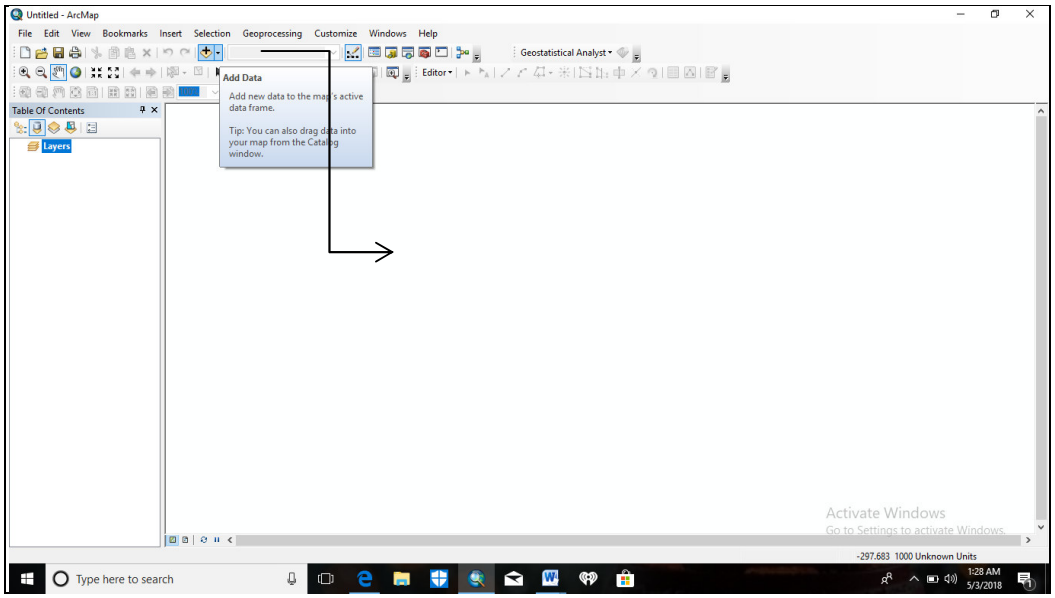
11. **Map creation with ArcGIS software**

ArcGIS Software is collectively referred to as "ArcGIS Desktop". Software Modules consists of ArcMap software used to display, analyze, and create GIS data, Arc Editor includes data

editing capabilities, Arc Catalog is a tool for viewing and managing spatial data files, Arc Toolbox is a set of tools and functions used to convert data formats, manage map projections, perform analysis, and modify data. An ArcGIS is basically a computer-based technology that links geographic information with descriptive information which is used to capture, display, and analyze data spatially. The collected data must be then exported as a shapefile for analysis in a GIS, maintaining the same coordinate system and datum used during the collection. Finally, measurements are done by using the Arc tool box and map is created. It's an optional on whether to apply the base map to give a better context of the scene. Detailed method on creating the map using ArcGIS desktop is given below.

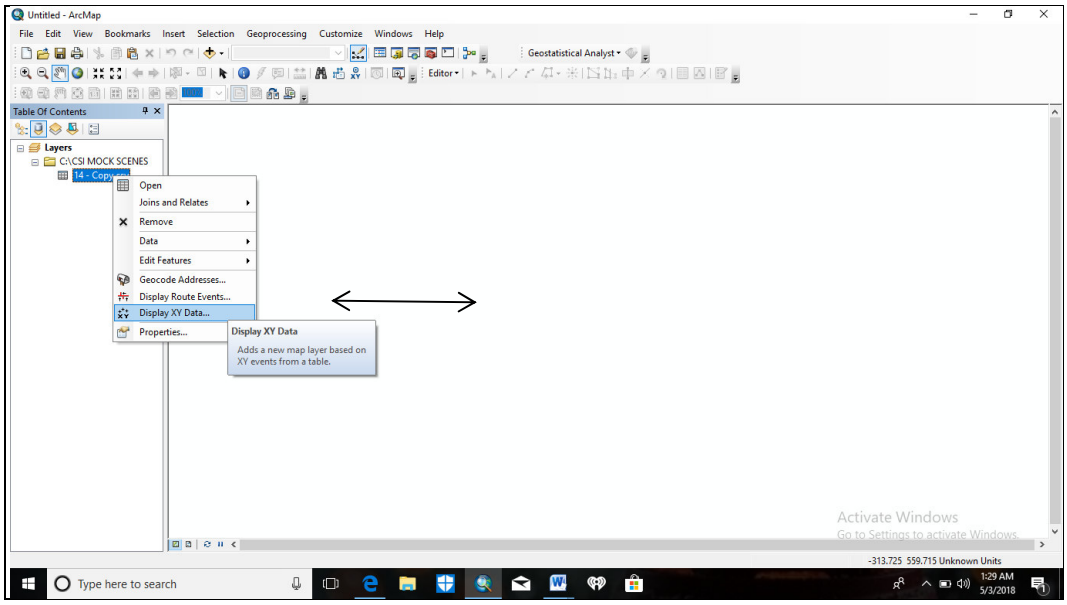
Step 1: Add the data

Take the cursor and add **(+)** the data file to the map's active data frame from your folder.



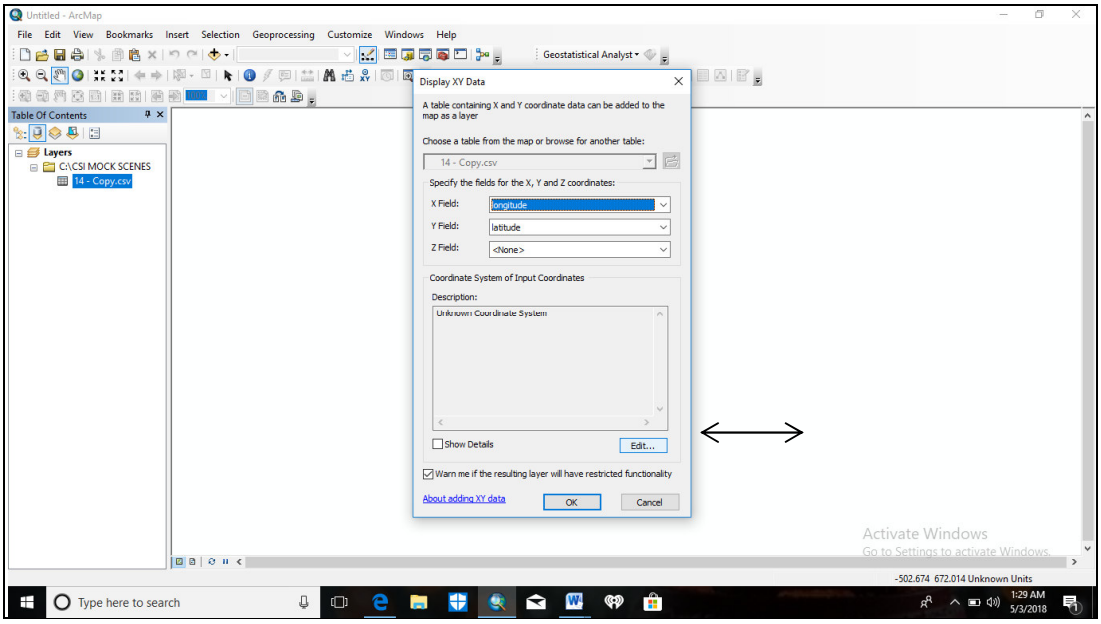
Step 2: Display x and y coordinates.

Go to the left corner; click the added data by clicking the right button in the mouse. This will add the first layer of the map.



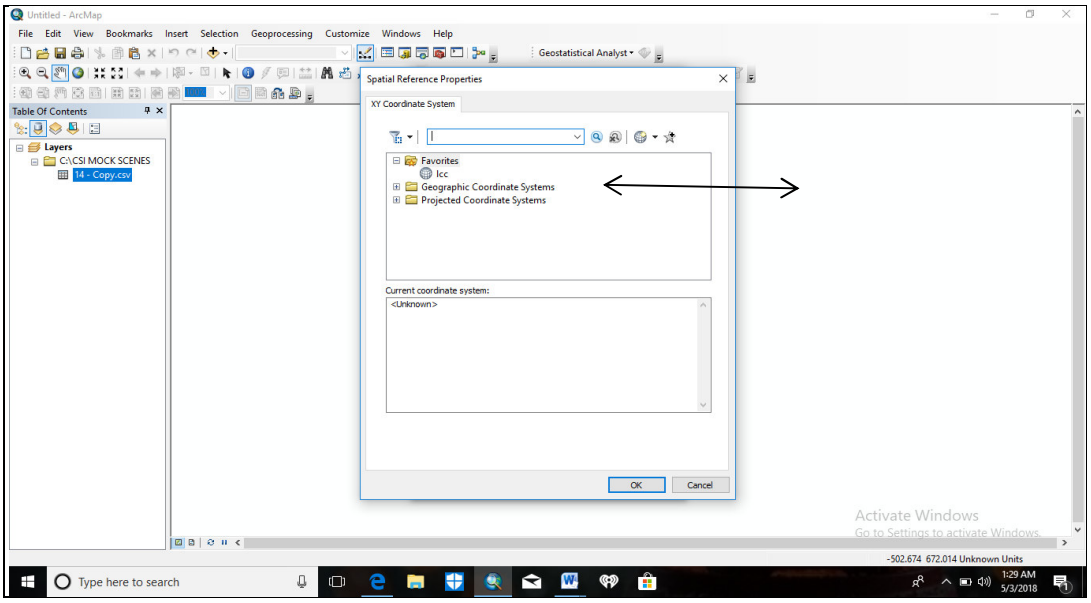
Step 3: Click the edit button

Double click the edit button.



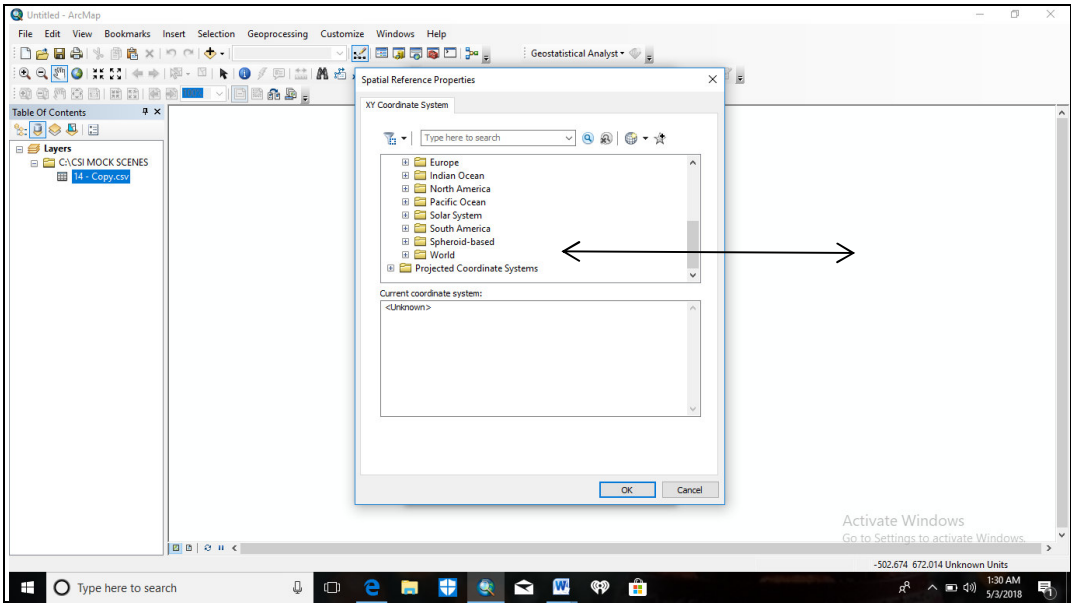
Step 4: Click Geographic Coordinate System

After clicking the edit button, another folder will appear. Double click the Geographic Coordinate System as this uses three-dimensional spherical surface to define locations on the earth.



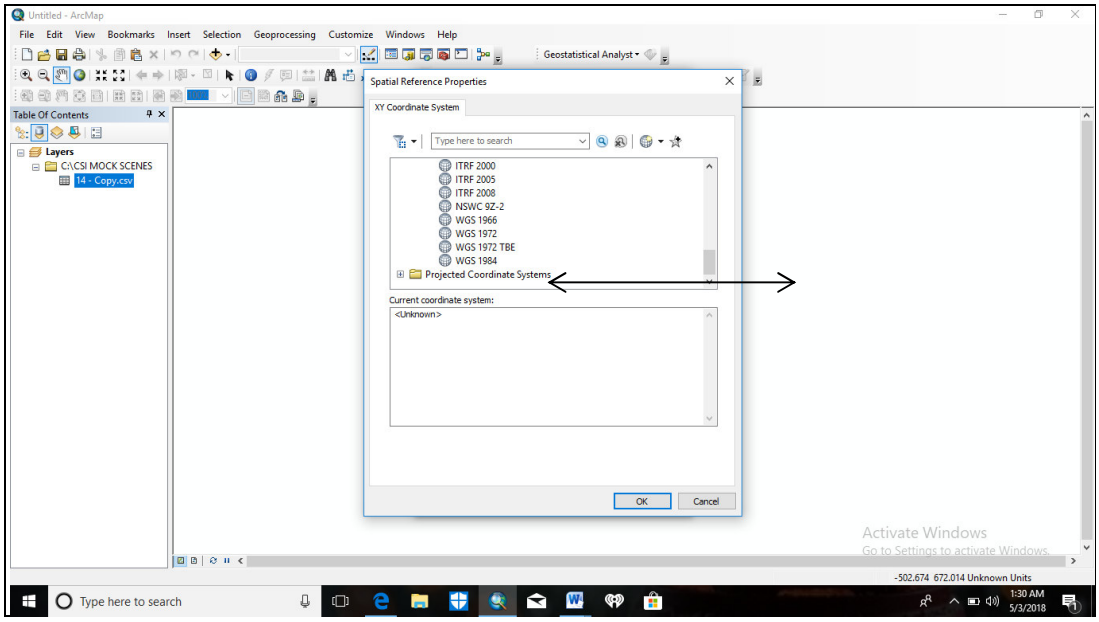
Step 5: Click "World"

Click the folder world

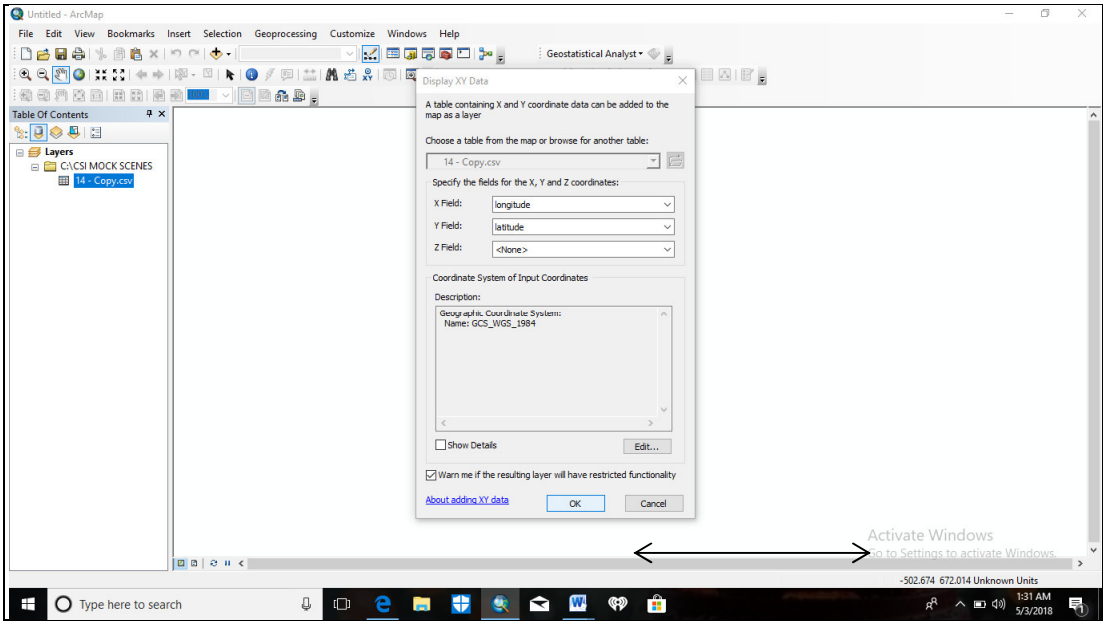


Step 6: Click WGS 1984

Double click World Geodetic Survey (WGS) as it is the standard for use in cartography, geodesy and navigation including GPS.



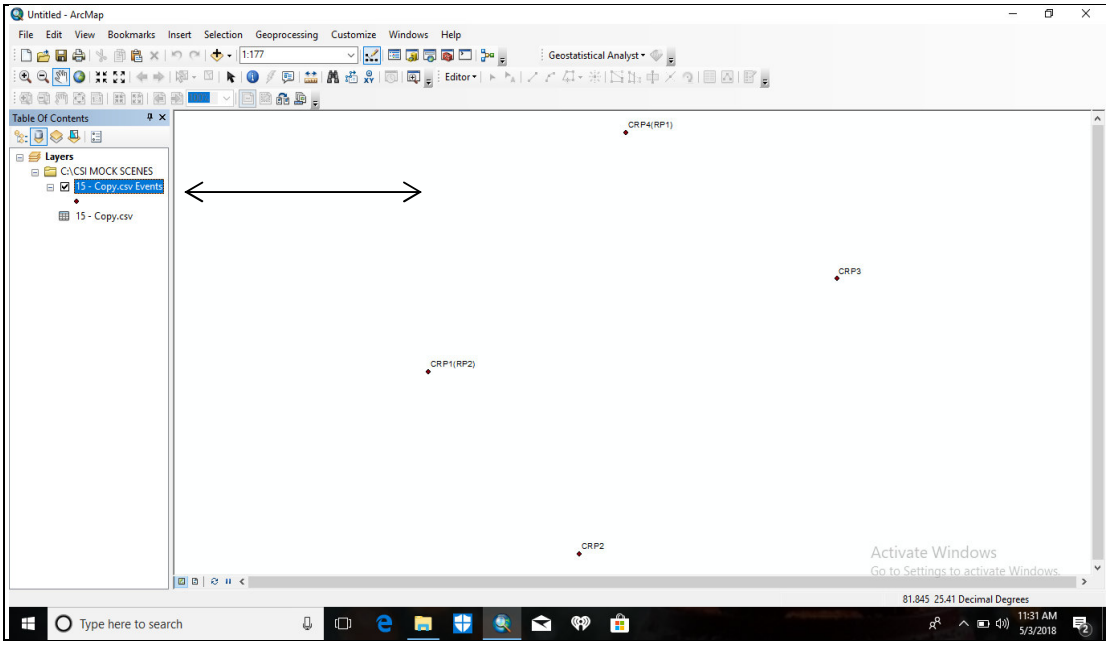
Step 7: Click OK



Step 8: Showing Four Corner Reference Points and Static Reference Points

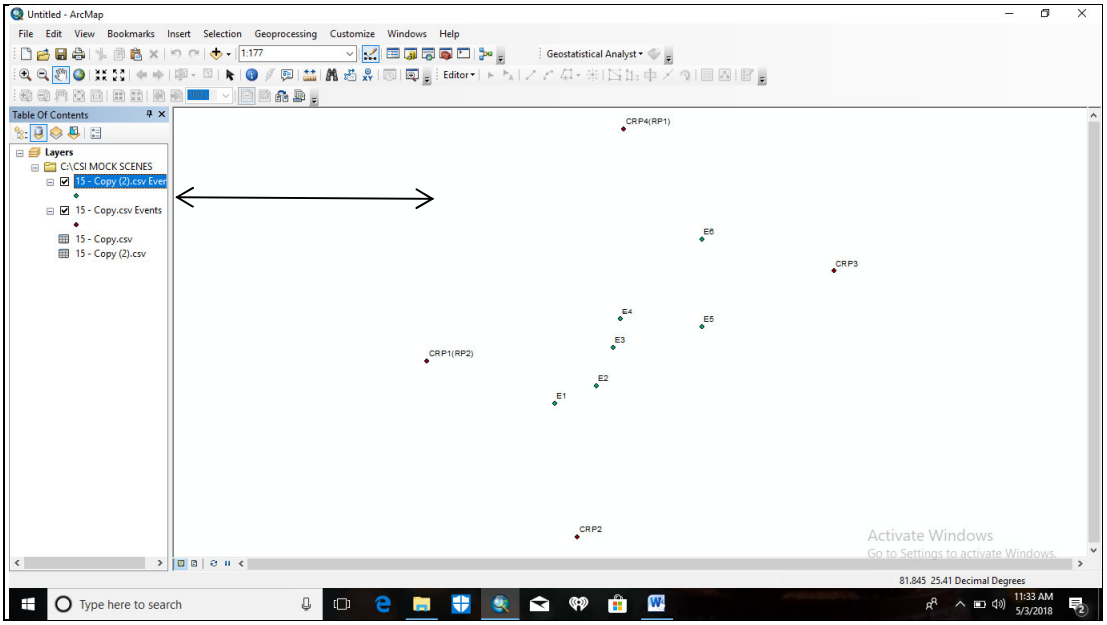
Once the layer is created, the four corner reference points will be shown in the map. Move the cursor to left side and right click the data and go to properties to add the label, click the name

written as Corner Reference Points. The four corner reference points as in CRP will be projected on the map.



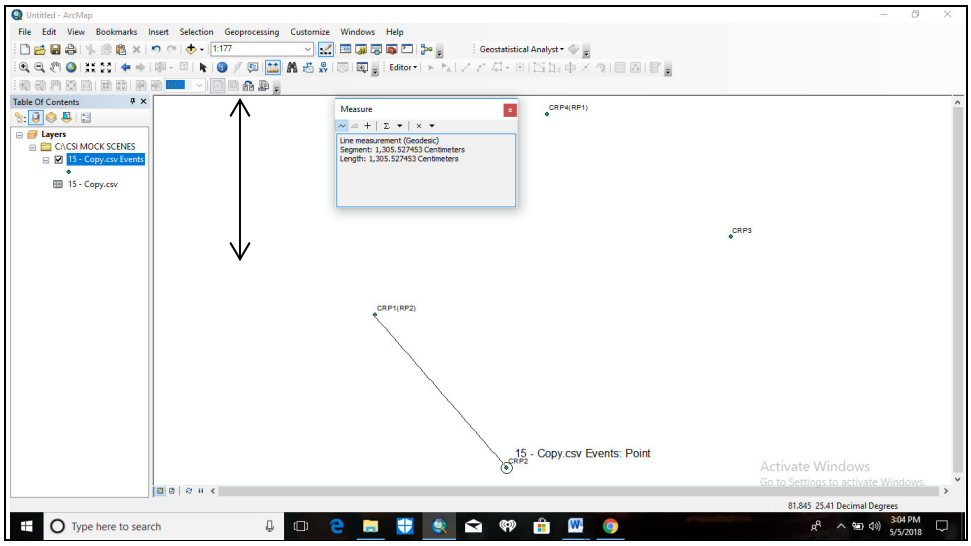
Step 9: Add the evidences data

In order to add the evidences points follow the same steps to add another layer from Step 1-8.



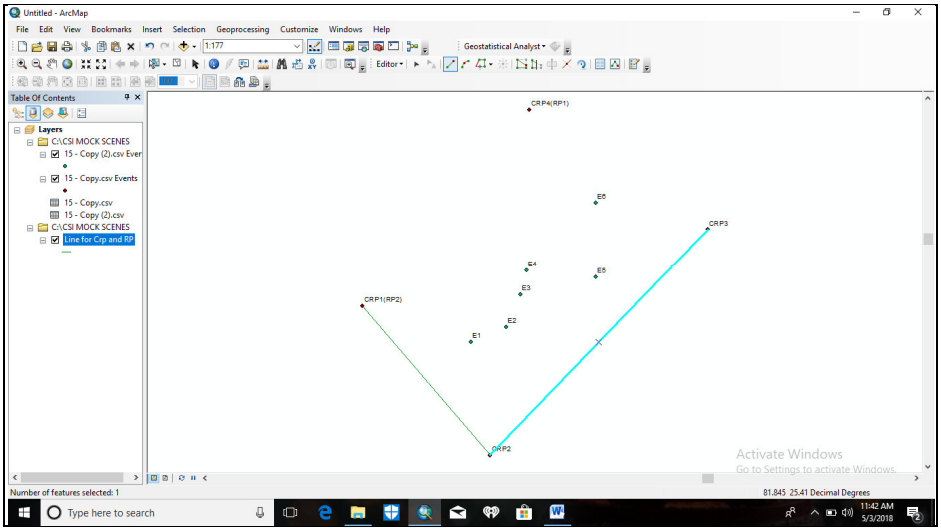
Step 10: Measurements of distance

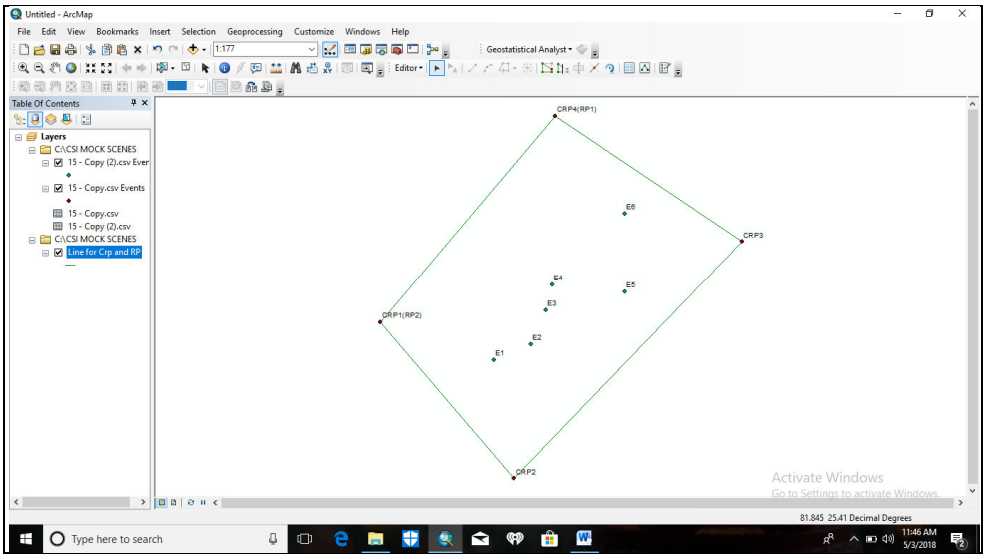
From the Tool bar, click the measuring box to calculate the distance. Once the box pop out, click the distance option and change the unit according to the desired work.

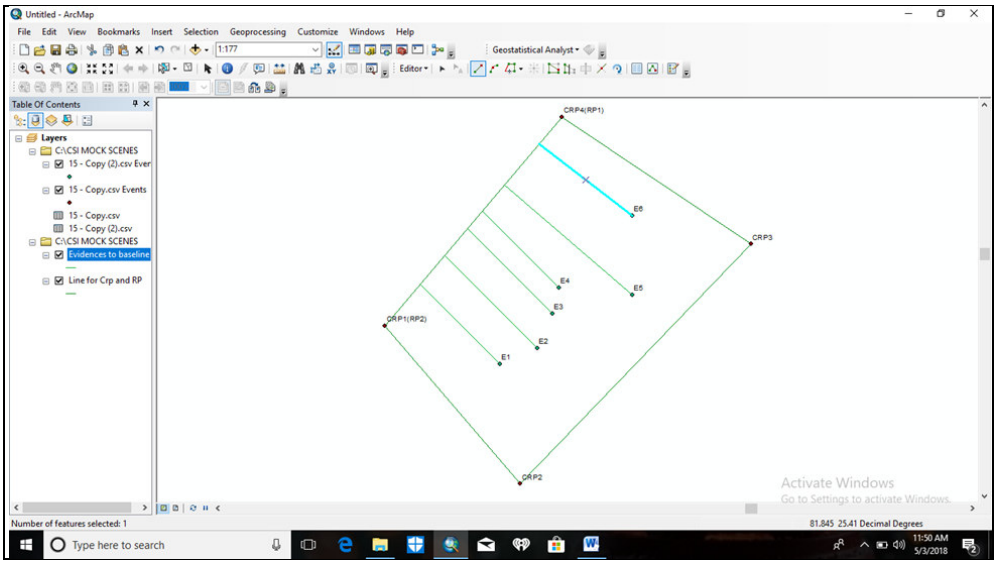


Step 11: Drawing the lines.

Go to Arc Catalog box and create a new Shapefile, name the file and choose Polyline in the next box as the next step is to form a line. Identify the baseline and draw a straight line from all the evidences point at 90 degree.

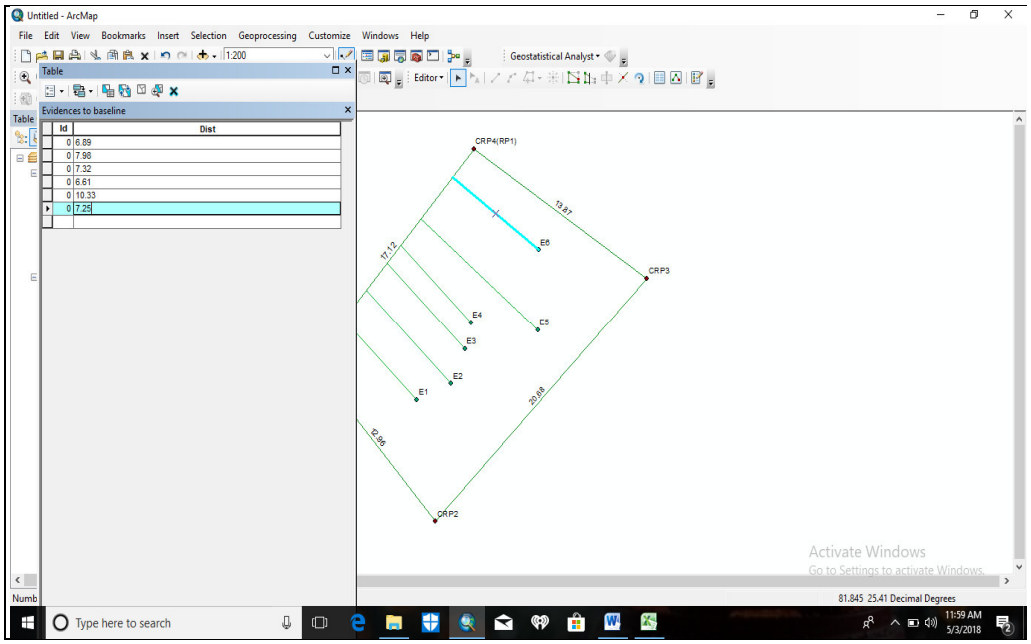






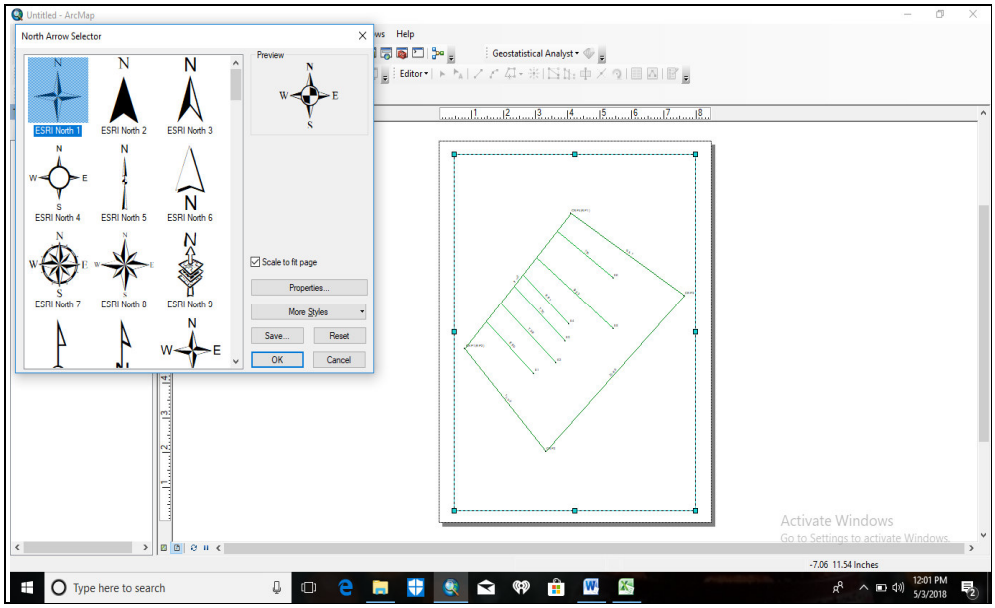
Step 12: Adding the measurements

Open the attribute tables of the shapefile form and enters the measurements systematically for all the four corners and the evidences, then click the save button.



Step 13: Final Map

To draw the final map, go to insert box and add the North direction, the legends, the scale and the title of the scene if required (Fig 19).



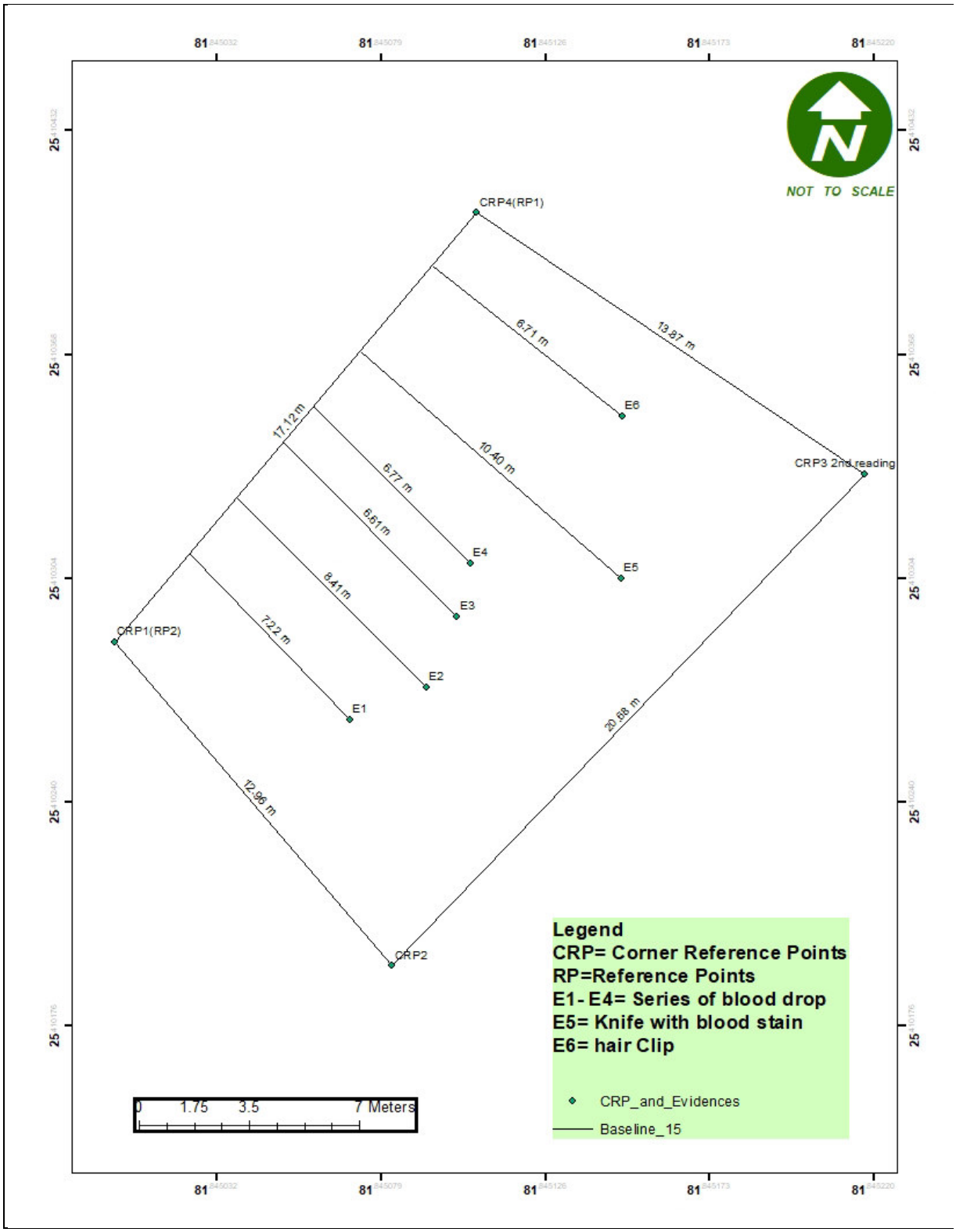


Fig 14.16.14 Map showing the outdoor scene using the DGPS data and ArcGIS software.

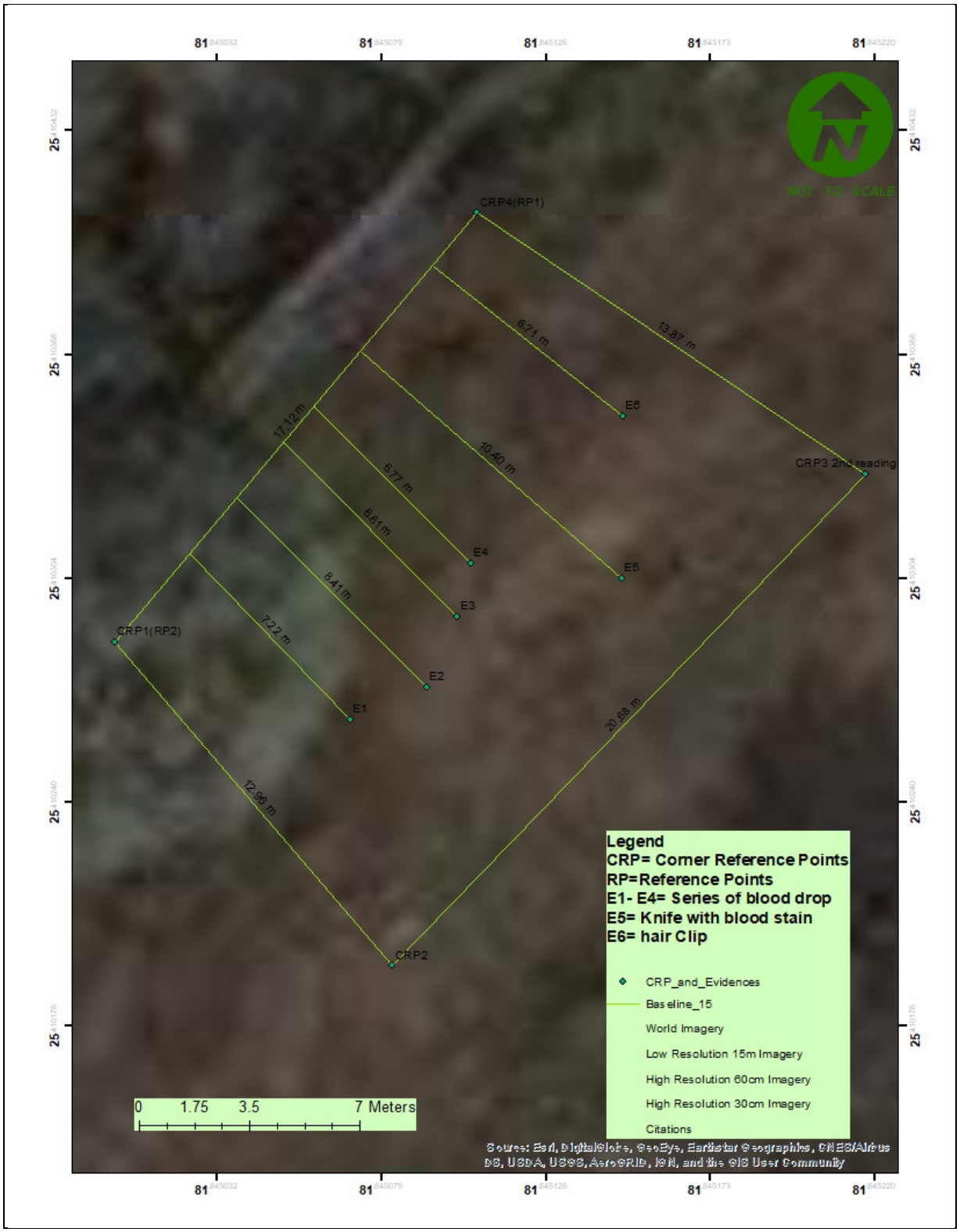


Fig 14.16.15: Base Map (World Imagery

Step 14. Recreation of Scene

To recreate a crime scene, the collected data are exported to Google Map or Google Earth. Once you enter the latitude and longitude of the data of every point, it will directly take the user to the place or the exact location. Simultaneously, save the data's in the google map account (Fig 19).

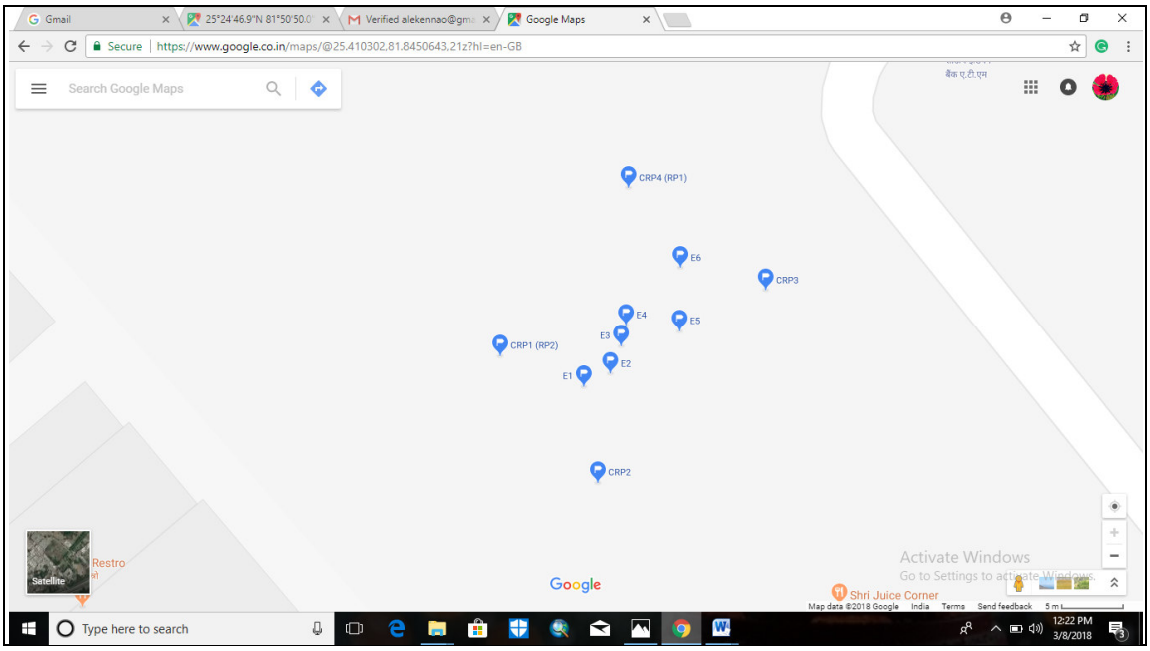


Fig 14.16.16 Google map showing the recreation points.

Notes:

Data template has the ability to create or design the attributes to default selections to a field with the help of drag and drop system such as data collected by, type of evidences with description, photographs of the crime scene and the evidences, signature etc., which are to be entered manually. However, date of the collection can be automatically generated by the software rather than being entered manually. Another preferred standpoint of utilizing a data dictionary reference is that the software won't permit the user to spare the designed attributes unless all the required data is entered, guaranteeing that essential data isn't missed in the field. Additional information can be created or added by dropping the text box. Finally, it is recommended that the template be as generic as possible, so that it may be applied to all the points and the several outdoor crime scenes that need to be collected rather than creating a new template each time a scene need to be mapped. The template could be designed according to the types of crime that is to be expected in the near future.

In order to acquire an optimal accuracy during data collection, good satellite geometry, desired number and position of satellites is an important aspect that needs to be considered **(Bolstad, 2000).** The DGPS unit implemented for this research is moderately simple and friendly to use. The standalone Trimble R1GNSS receiver has the capability of supporting multiple satellite constellations, including GPS, GLONASS, Galileo and BeiDou. It delivers GNSS positions in real-time without the need for post-processing. Correction sources such as SBAS and RTX networks are applied to suit the location giving the desired accuracy in achieving reliable GNSS information anywhere in the world.

The collection time for every point data can be determined however in order to maintain the accuracy the number of satellites were observed and the accuracy was made to come down till

an average of 40cm to 50cm. Therefore, that accuracy is to be implemented for outdoor scenes with the use of this unit. Once the point is collected, DGPS unit can be transferred to the next point for collection. After the object of interest has been collected, the points should be crosschecked with the device being used as this robust application provides a full collection and accurate geo-located GIS and asset information all in one workflow. This could be done by creating lines for roads, polygons for crime scene, buildings or simply with the point data using this DGPS unit.

Once all the data has been collected and since post processing is not required for this unit, the data is directly downloaded from the Trimble terra flex home page which is automatically saved in Excel file format showing the (latitude, longitude, height) of all the collected points. This collected must be then exported as a shapefile for analysis in a GIS, maintaining the same coordinate system and datum used during the collection. Finally, measurements are done by using the Arc tool box and map is created. It's an optional on whether to apply the base map to give a better context of the scene. A flowchart of the recommended protocol provided from this research for DGPS based Outdoor Crime Scene Management is given below:

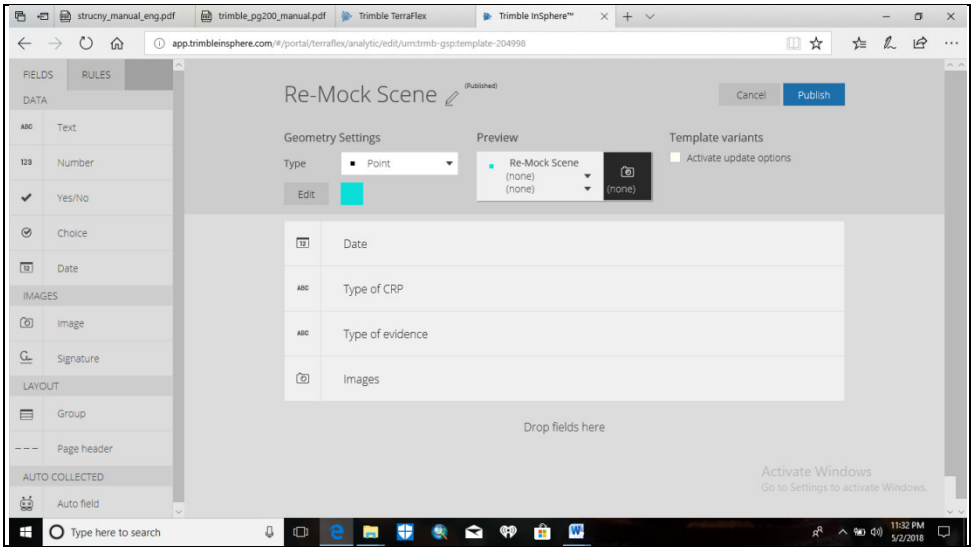
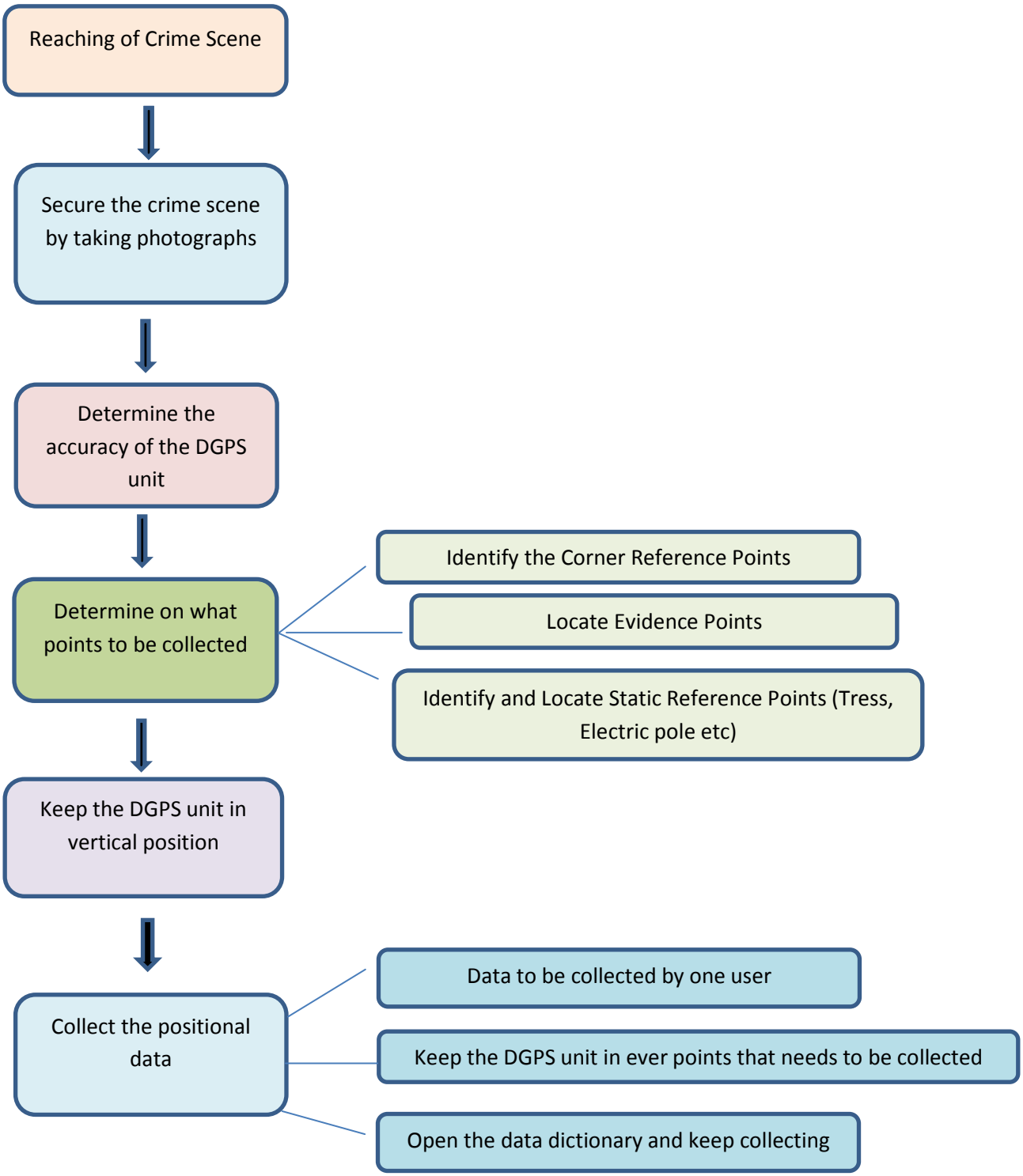
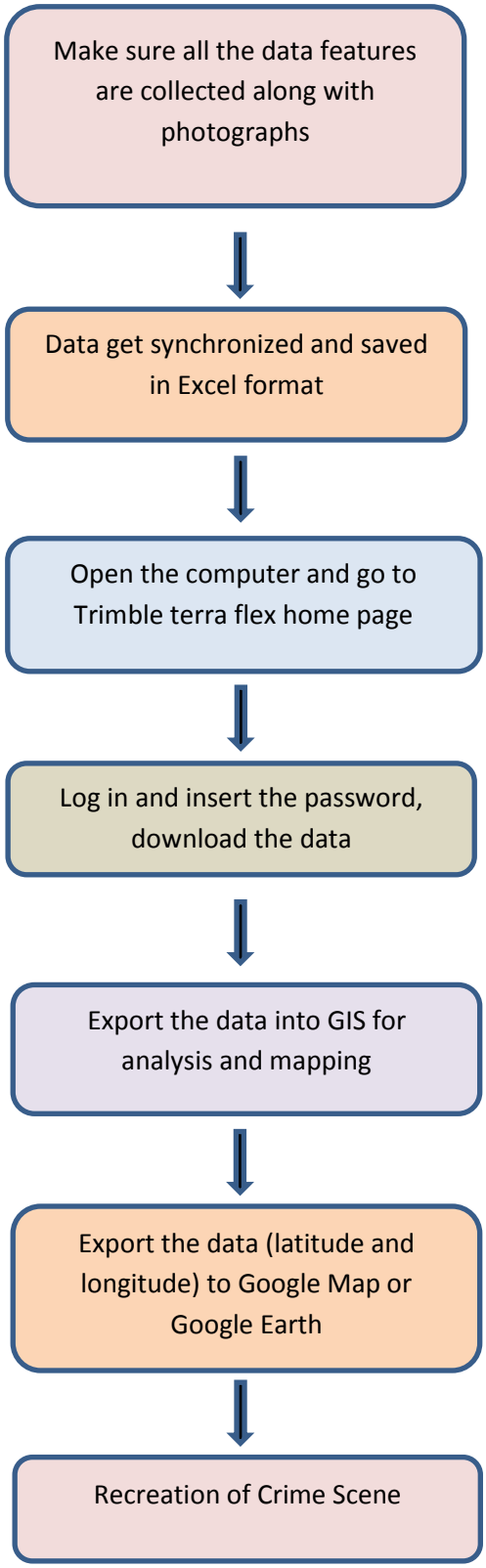


Fig. 14.16.17 Designing a template with the help of drag and drop system.

4.17 A flowchart of the recommended guidelines provided from this research/ Protocol developed




Make sure all the data features are collected along with photographs
Data get synchronized and saved in Excel format
Open the computer and go to Trimble terra flex home page
Log in and insert the password, download the data
Export the data into GIS for analysis and mapping
Export the data (latitude and longitude) to Google Map or Google Earth
Recreation of Crime Scene

4.17 Discussion of Total Crime with the help of Pie Chart.

The total number of crimes (as percentage) reported in respective police stations of Allahabad city for the period 2015-17 are presented in Figure 4. The highest percent of crimes were

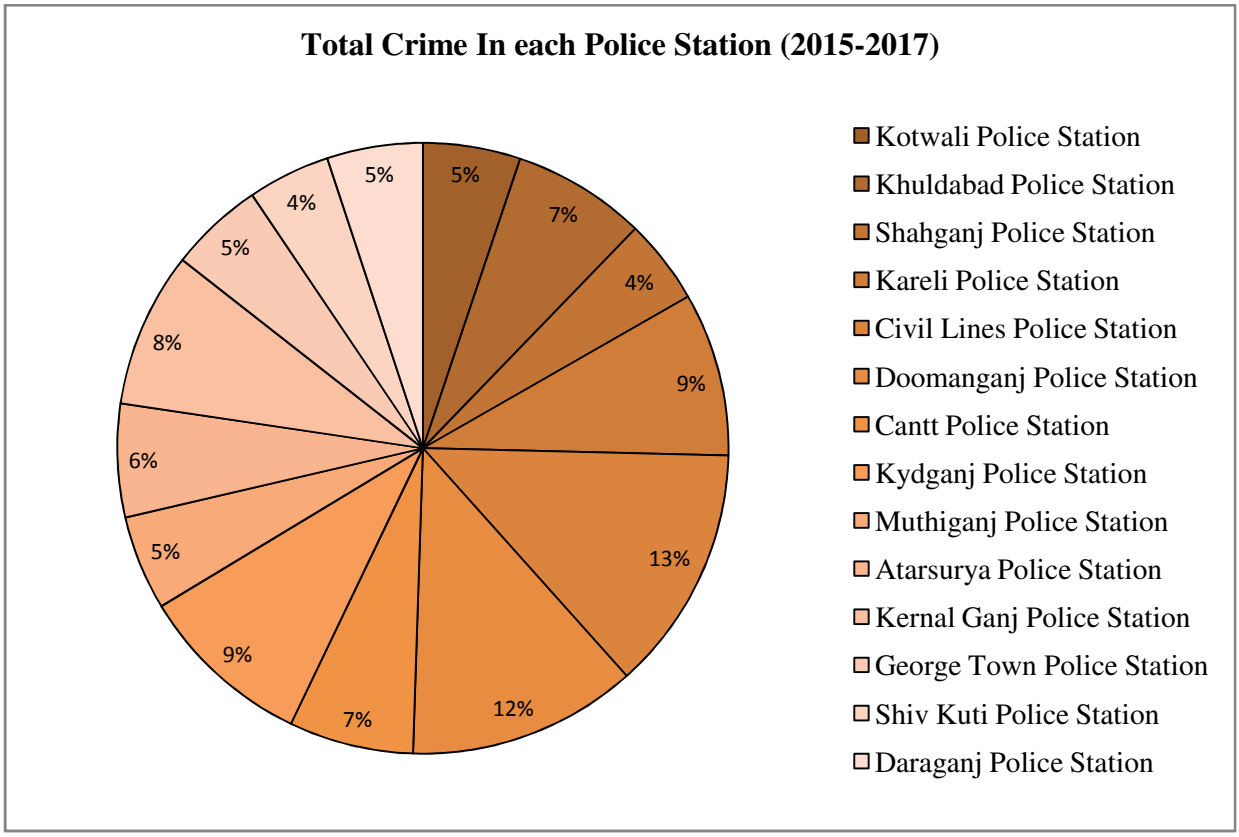


Figure 4.17 Total Crimes in each Police Station (2015-2017)

reported in Civil Lines Police Station (13%), followed by Doomanganj Police Station (12%), Kareli Police Station and Kydganj Police Station (9%), Kernal Ganj Police Station (8%) Khuldabad Police Station and Cantt Police Station (7%), Attarsuiya Police Station (6%) , Daraganj Police Station, Muthiganj Police Station, Kotwali Police Station and George Town Police Station (5%) Shahganj Police Station and Shivkuti Police Station (4%).

Type of crime reported in each police station of Allahabad city was also investigated for the period 2015-17 (Jan-Oct). The individual crimes reported in each police station were grouped in 'Offences against life', 'Offences against property' and then 'Individual crimes'.

4.17.1 Kotwali Police Station

Figures 4.17.1.1 – 4.17.1.5 presents a summary of all types of crimes reported in Kotwali Police Station. It is apparent from figure 4.17.1.1 that highest percent of crime under the group of 'Offence Affecting life' was other Kidnapping (33.3%)' followed by Murder and

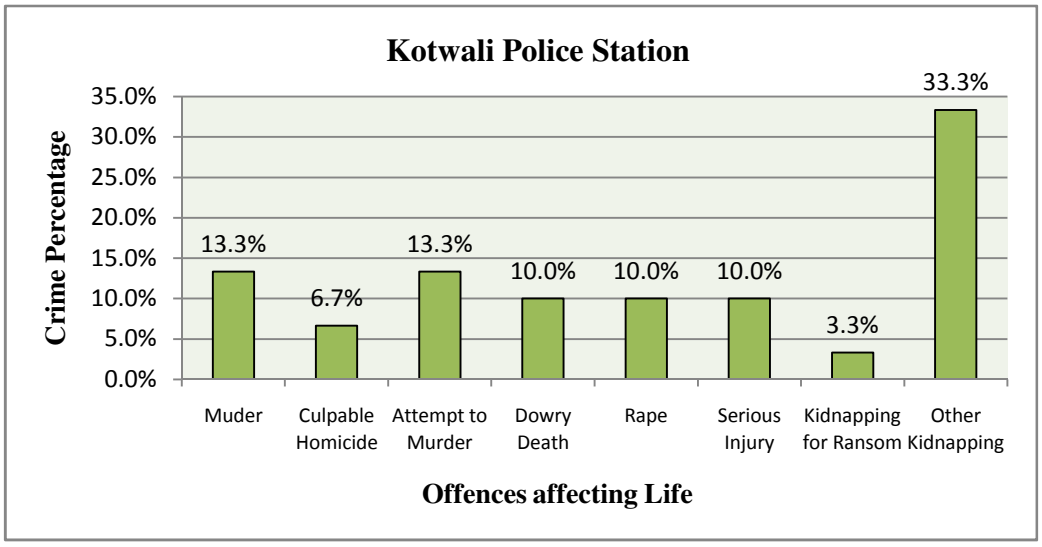


Figure 4.17.1.1 Percentage of Offences affecting Life in Kotwali Police Station.

Attempt to Murder (13.3%), Dowry Death, Rape and Serious Injury (10.0%), Culpable Homicide (6.7%) and Kidnapping for Ransom (3.3%).

It is apparent from Figure 4.17.1.2 that highest percent of crime under the group of 'Offence against property' was Vehicle Theft (85.6%) followed by Other Theft (9.1%), House Breaking (3.9%),

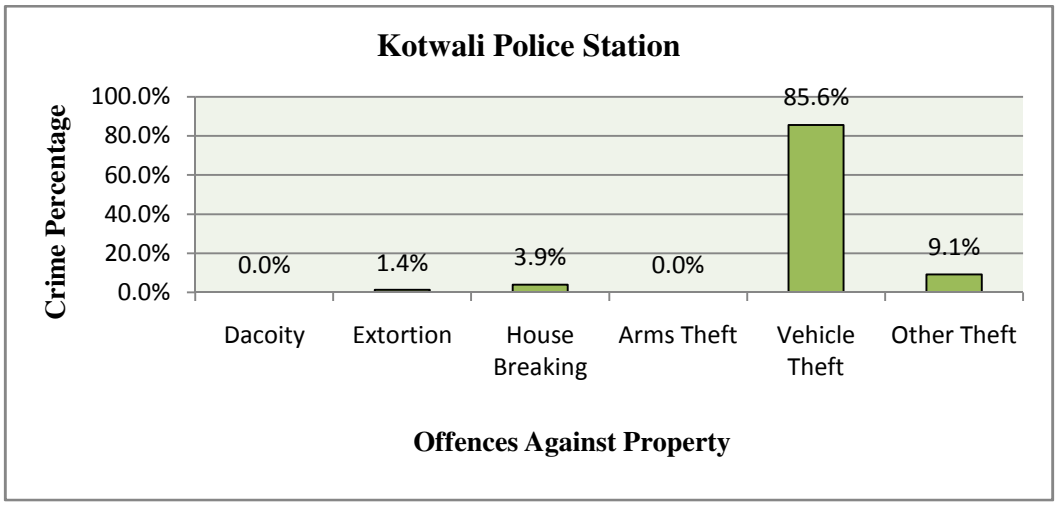


Figure 4.17.1.2 Percentage of Offences Against property in Kotwali Police Station

Extortion (1.4%). The rest of the crimes in addition to the aforementioned groups of crime are presented in Figure 4.17.1.3. It is apparent from figure that crimes conducted under 'Motor Vehicle Act' were the largest group (64.4%) followed by The Police Act (19%), Other IPC (4.8%), 110 CrPC (3.6%), and Others Act (2.9%), Excise Act and Goonda Act (1.1%), Arms Act

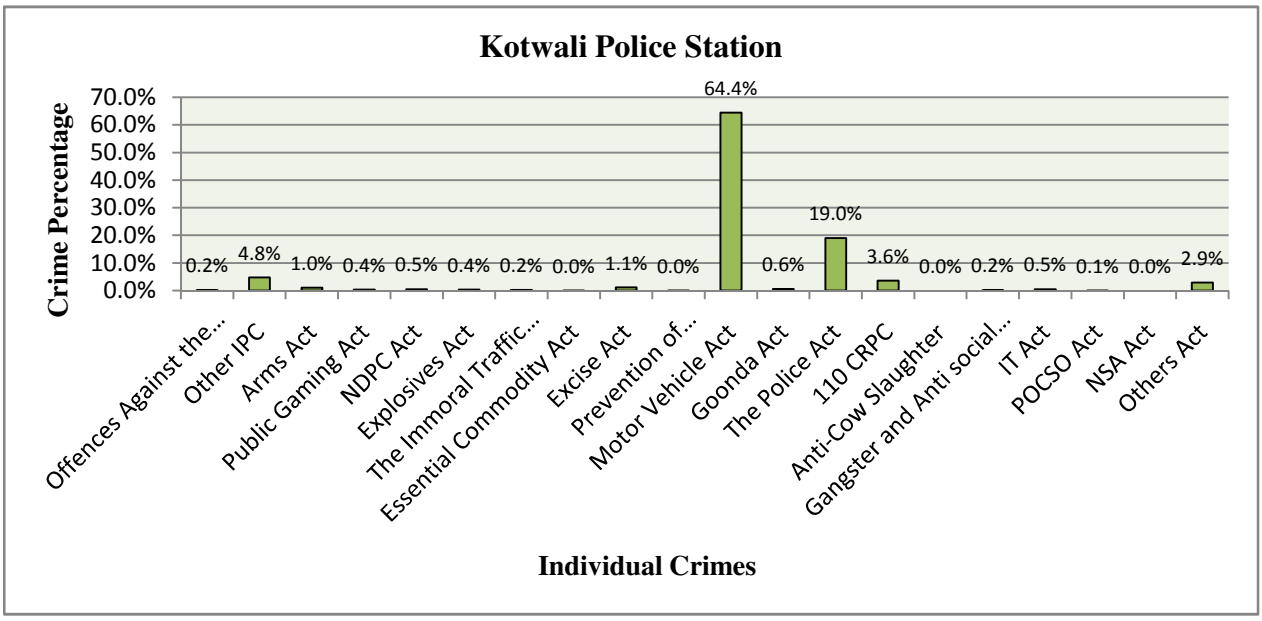


Figure 4.17.1.3 Percentage of Individual Crimes in Kotwali Police Station

(1%),Goonda Act (0.6%),NDPS Act and IT Act (0.5%), Public Gaming Act and Explosives Act (0.4%), The Immoral Traffic Prevention Act, Anti-Cow Slaughter, Gangster and Anti-Social Act and Offences Against Public Tranquility (0.2%), POCSO Act (0.1%).

From figure 4.17.1.4, if we see the overall crimes, the highest percent of crimes reported in Kotwali Police Station were under 'motor vehicle act (57%), followed by The Police Act (17%), Offences

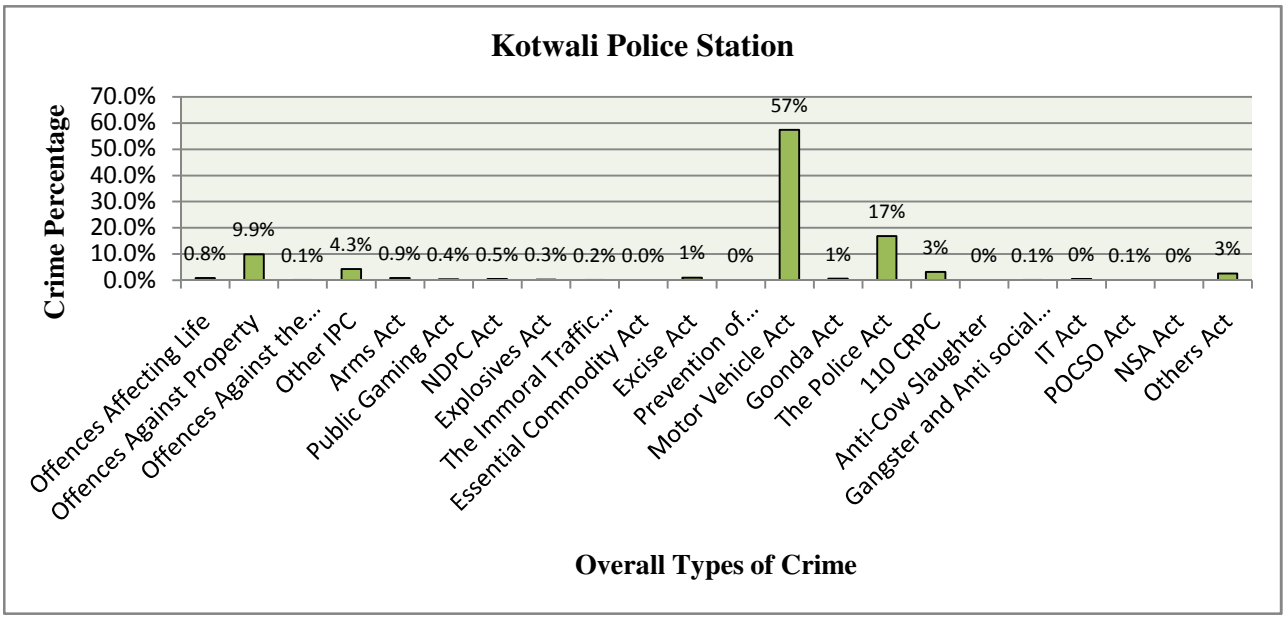


Figure 4.17.1.4 Percentage of Overall type of Crime in Kotwali Police Station

against Property (9.9%), IPC (4.3%), 110 CrPC and Others Act (3%), Excise Act and Goonda Act (1%), Arms Act (0.9%), Offences Affecting Life (0.8%), NDPS Act (0.5%), Public Gaming Act (0.4%), Explosives Act (0.3%), The Immoral Traffic Prevention Act (0.2%), Offences Against Public Tranquility, Gangster and Anti-Social Act and POCSO Act (0.1%).

4.17.2 Khuldabad Police Station

Figures 4.17.2.1 – 4.17.2.4 presents a summary of all types of crimes reported in Khuldabad Police Station. It is apparent from figure 4.17.2.1 that highest percent of crime under the group of 'Offence Affecting

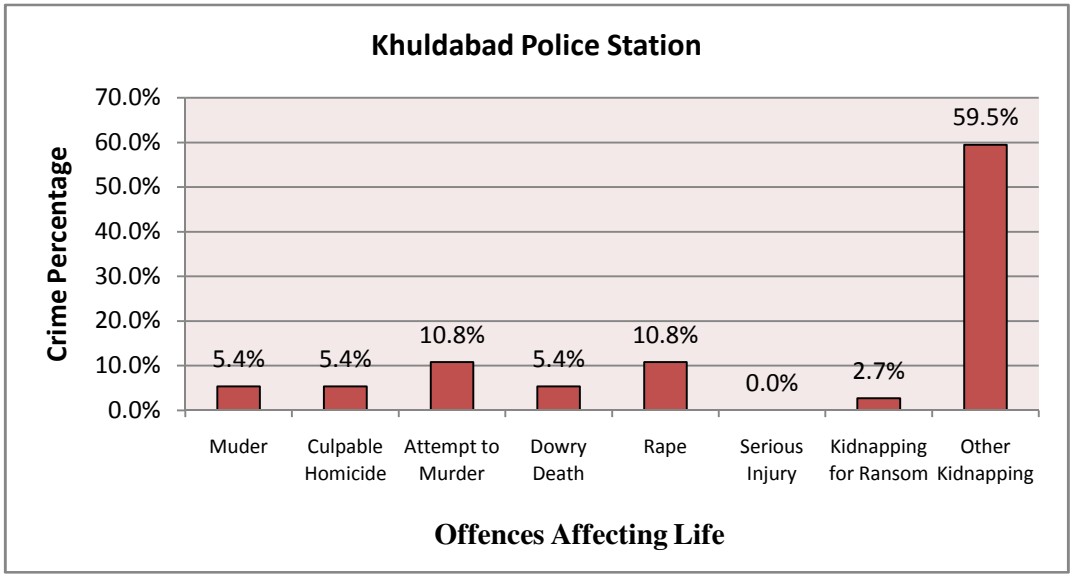


Figure 4.17.2.1 Percentage of Offences Affecting of Life in Khuldabad Police Station

life' was other kidnapping (59.5%) followed by Rape and Attempt to Murder (10.8%), Dowry Death, Culpable Homicide and Murder (5.4%) and Kidnapping for Ransom (2.7%).

It is apparent from Figure 4.17.2.2 that highest percent of crime under the group of 'Offence against

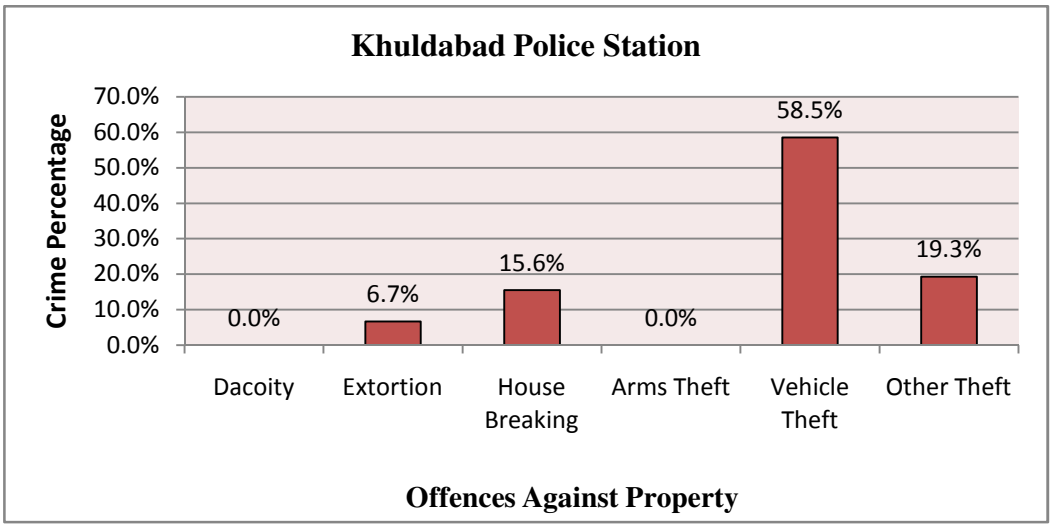


Figure 4.17.2.2 Percentage of Offences against Property in Khuldabad Police Station

property' was Vehicle Theft (58.5%)' followed by Other Theft (19.3%), House Breaking (15.6%), Extortion (6.7%). The rest of the crimes in addition to the aforementioned groups of crime are presented in Figure 4.17.2.3. It is apparent from figure 5.3 that crimes conducted under 'Motor Vehicle Act' were the largest group (63.1%) followed by The Police Act (17.6%),

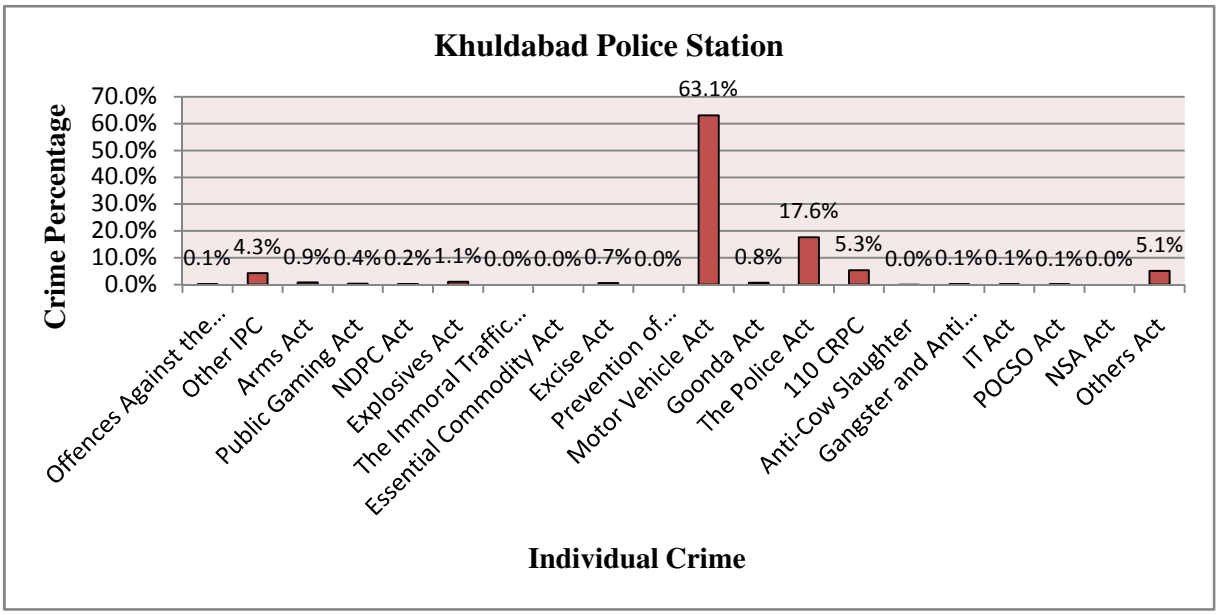


Figure 4.17.2.3 Percentage of Individual Crime in Khuldabad Police Station

110 Crpc (5.3%), Others Act (5.1%), Other IPC (4.3%), Explosives Act (1.1%), Arms Act (0.9%), Goonda Act (0.8%), Excise Act (0.7%), Public Gaming Act (0.4%), NDPS Act (0.2%), IT Act, Offences Against Public Tranquility, POCSO Act, IT Act, Gangster and Anti-Social Act (0.1%). From figure 4.17.2.4, if we see the overall crimes, the highest percent of crimes reported in Khuldabad Police Station were under Motor Vehicle Act (61%), followed by The Police Act (17%),

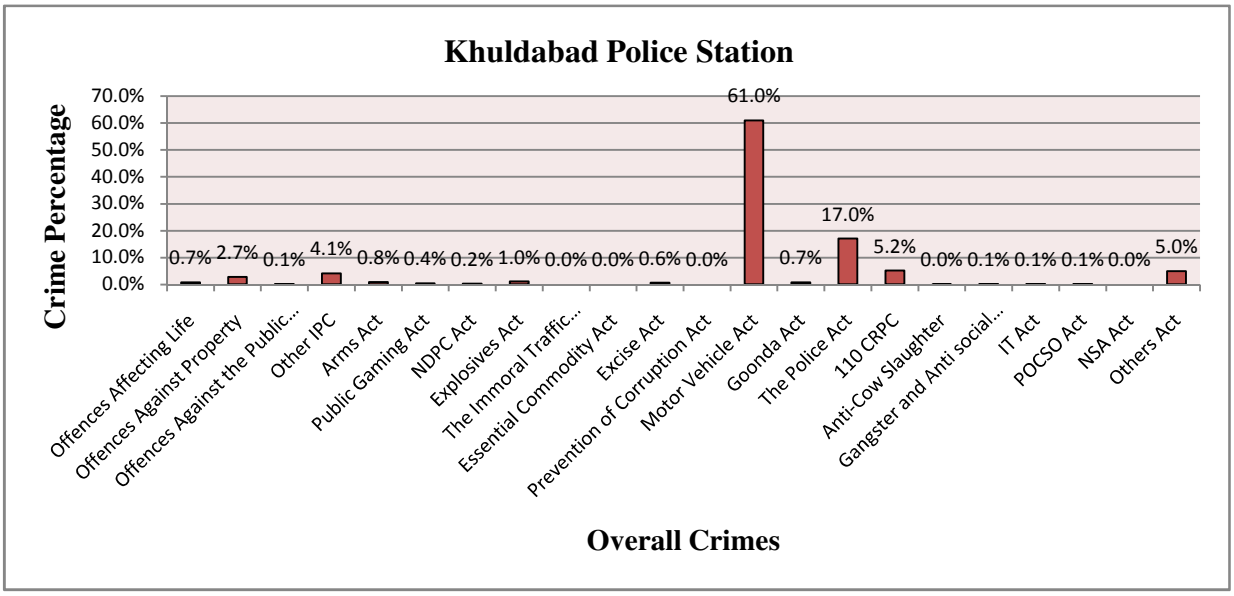


Figure 4.17.2.4 Percentage of Overall Crimes in Khuldabad Police Station

110 CrPC (5.2%),Others Act (5%), Other IPC (4.1%), Offences against Property (2.7%), Explosives Act (1%), Arms Act (0.8%), Goonda Act and Offences Affecting Life (0.7%)and Excise Act(0.6%), Public Gaming Act (0.4%), NDPS Act (0.2%), Offences Against Public Tranquility, Gangster and Anti-Social Act, IT Act and POCSO Act (0.1%).

4.17.3 Shahganj Police Station

Figures 4.17.3.1 – 4.17.3.4 presents a summary of all types of crimes reported in Shahganj Police Station.

It is apparent from figure 4.17.3.1 that highest percent of crime under the group of 'Offence Affecting

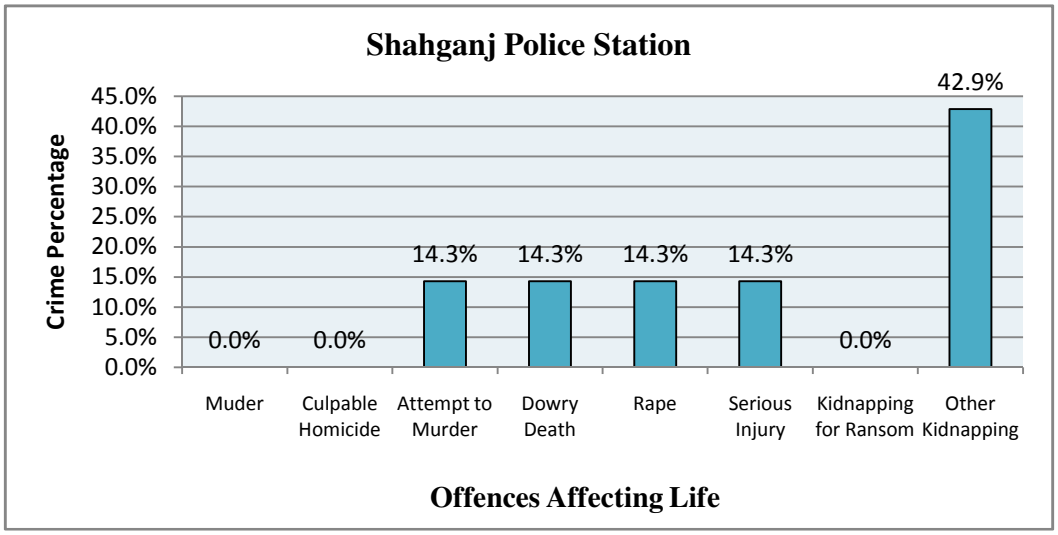


Figure 4.17.3.1 Percentage of Offences affecting Life in Shahganj Police Station

life' was other kidnapping (42.9%) followed by Rape and Attempt to Murder, Dowry Death and Serious Injury (14.3%). It is apparent from Figure 4.17.3.2 that highest percent of crime under the group of 'Offence against

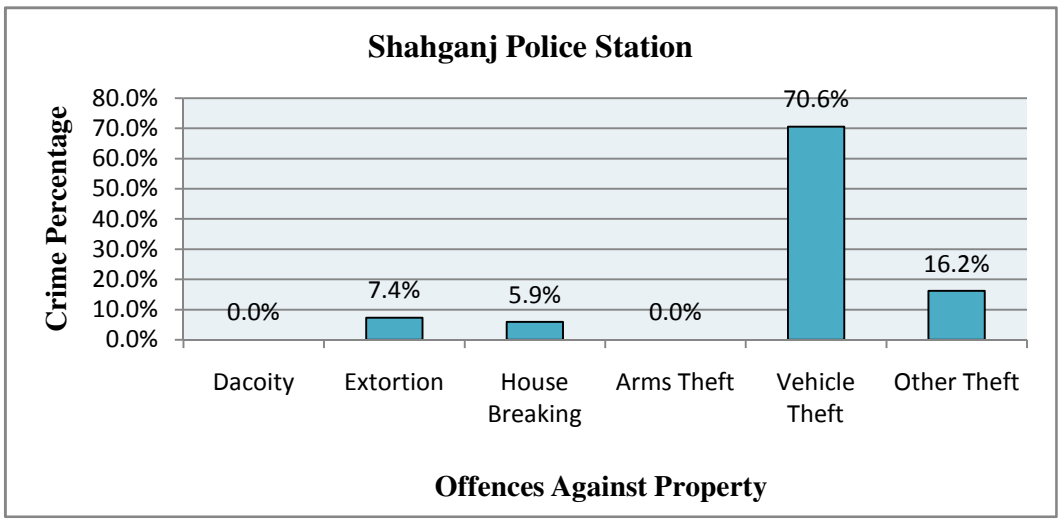


Figure 4.17.3.2 Percentage of Offences against Property in Shahganj Police Station

property' was Vehicle Theft (70.6%) followed by Other Theft (16.2%), Extortion (7.4%), House Breaking (5.9%). The rest of the crimes in addition to the aforementioned groups of crime are presented in Figure 4.17.3.3. It is apparent from figure 4.17.3.3 that crimes conducted under 'Motor Vehicle Act' were the largest group (56.6%) followed by The Police Act (28.3%), 110 CrPC , (3.8%), Others Act (3.1%), Other IPC (3%), Explosives Act (1.7%), Excise Act (1%), Arms Act (0.7%),

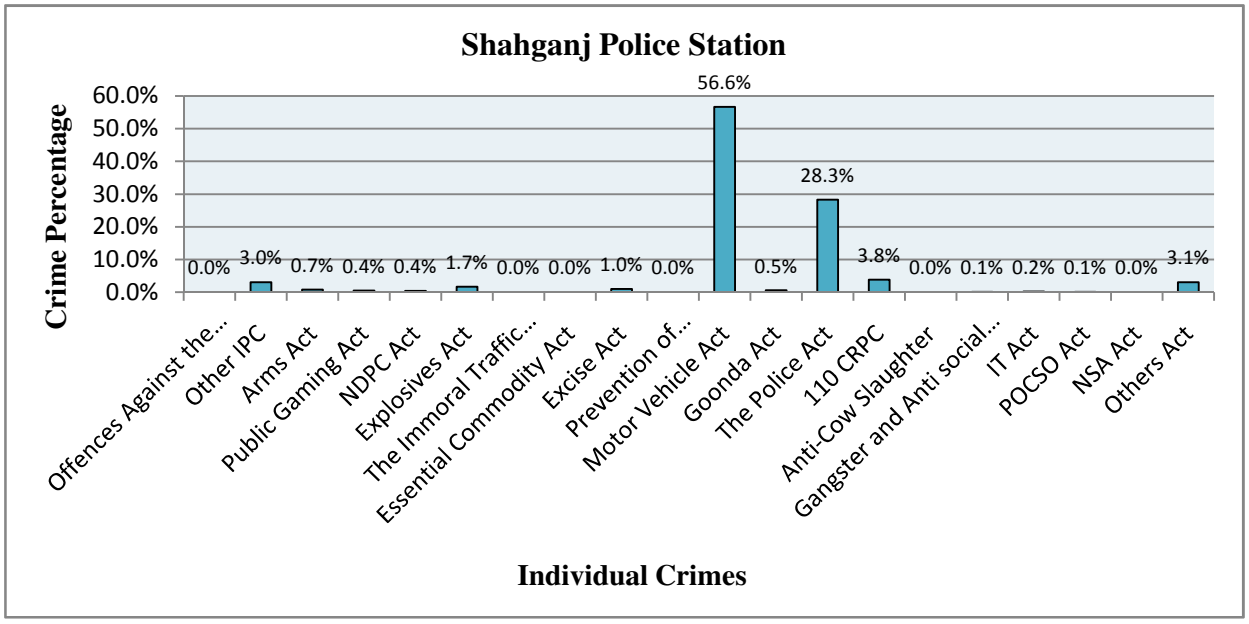


Figure 4.17.3.3 Percentage of Individual Crimes in Shahganj Police Station

Goonda Act (0.5%), Public Gaming Act, NDPS Act (0.4%), IT Act (0.2), POCSO Act and Gangster and Anti-Social Act (0.1%). From figure 4.17.3.4, if we see the overall crimes, the highest percent of crimes reported in Shahganj Police Station were under Motor Vehicle Act

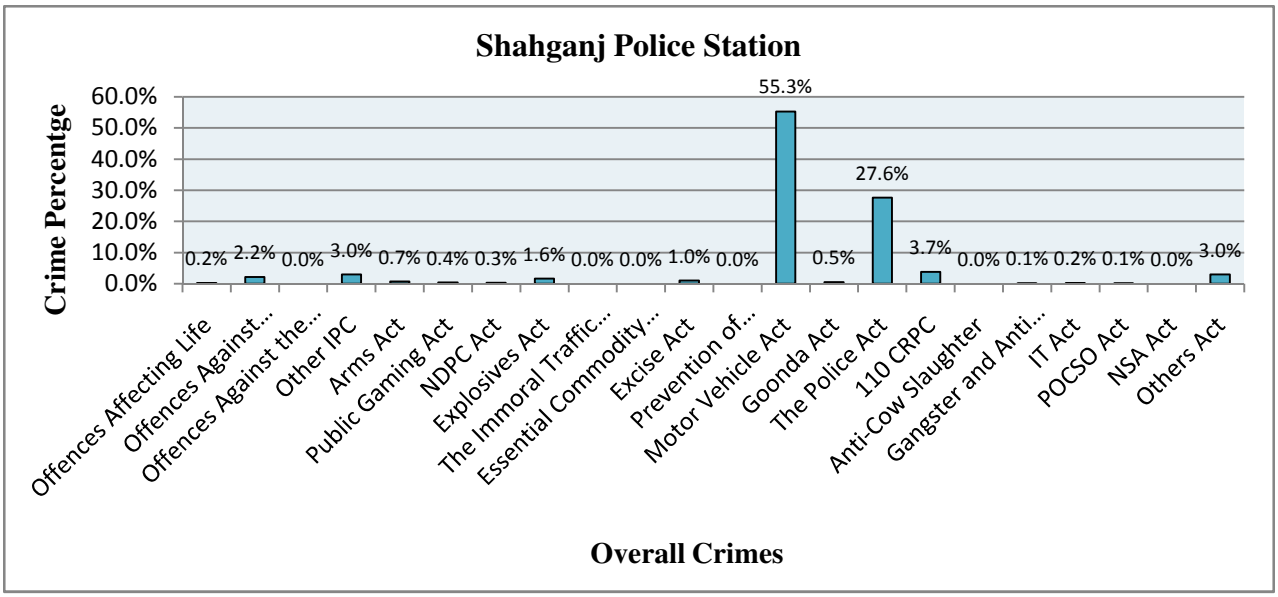


Figure 4.17.3.4 Percentage of Overall Crimes in Shahganj Police Station

(55.3%), followed by The Police Act(27.6%), 110 CrPC (3.7%), Others Act and Other IPC (3%), Offences against Property (2.2%), Explosives Act (1.6%), Excise Act(1%), Arms Act (0.7%), Goonda Act(0.5%), Public Gaming Act (0.4%), NDPS Act (0.3%), Offences Affecting Life and IT Act (0.2%)and Gangster and Anti-Social Act and POCSO Act (0.1%).

4.17.4 Kareli Police Station

Figures 4.17.4.1 – 4.17.4.4 presents a summary of all types of crimes reported in Kareli Police Station.

It is apparent from figure 4.17.4.1 that highest percent of crime under the group of 'Offence Affecting life' was other kidnapping (42.9%) followed by Serious Injury (15.7%), Murder (14.3 %),

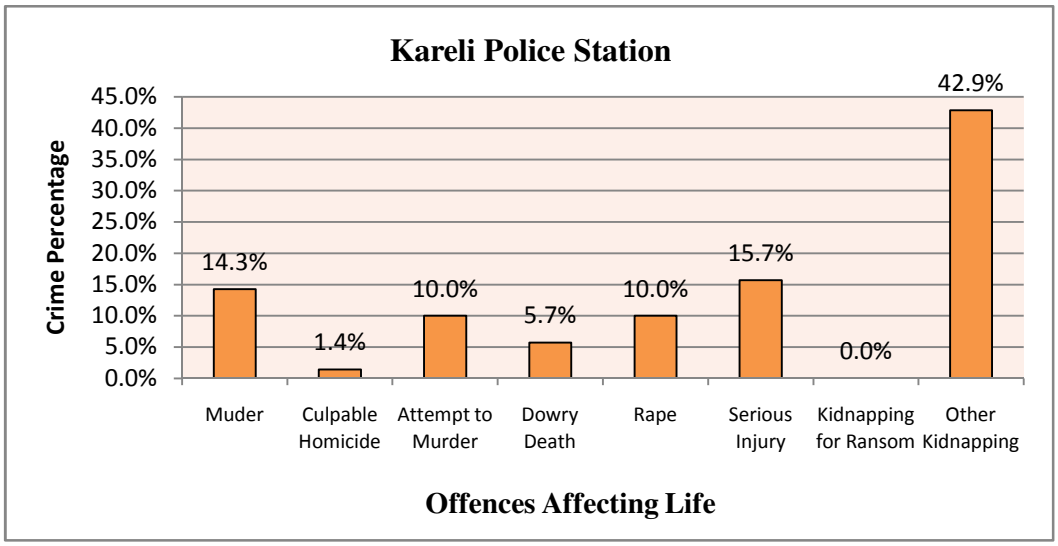


Figure 4.17.4.1 Percentage of Offences affecting Life in Kareli Police Station

Rape and Attempt to Murder (10%), Dowry Death (5.7%) and Culpable Homicide (1.4%).

It is apparent from Figure 4.17.4.2 that highest percent of crime under the group of 'Offence against

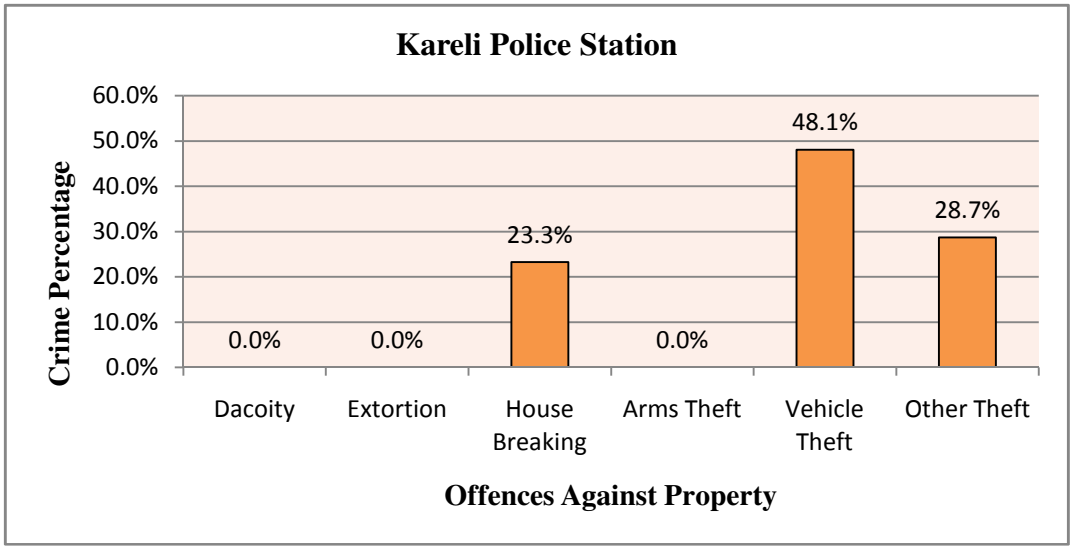


Figure 4.17.4.2 Percentage of Offence against Property in Kareli Police Station

Property' was Vehicle Theft (48.1%) followed by Other Theft (28.7%), House breaking (23.3%).

The rest of the crimes in addition to the aforementioned groups of crime are presented in Figure 4.17.4.3. It is apparent from figure 4.17.4.3 that crimes conducted under Motor Vehicle Act were the largest group (63%) followed by The Police Act (21.2%), Others Act (4.4%), Other IPC (3.9%),

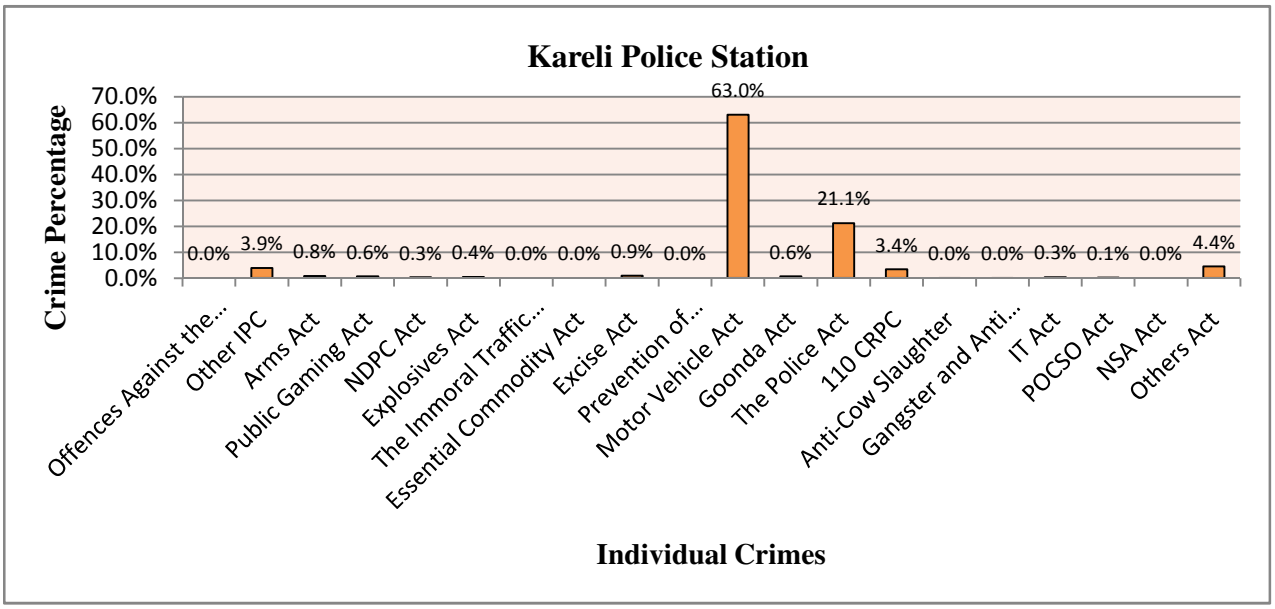


Figure 4.17.4.3 Percentage of Individual Crimes in Kareli Police Sation

110 CrPC, (3.4%), Excise Act (0.9%), Arms Act (0.8%), Goonda Act Public Gaming Act (0.6%), Explosives Act (0.4%), NDPS Act and IT Act (0.3%), POCSO Act (0.1). From figure 4.17.4.4, if we see the overall crimes, the highest percent of crimes reported in Kareli Police Station were under

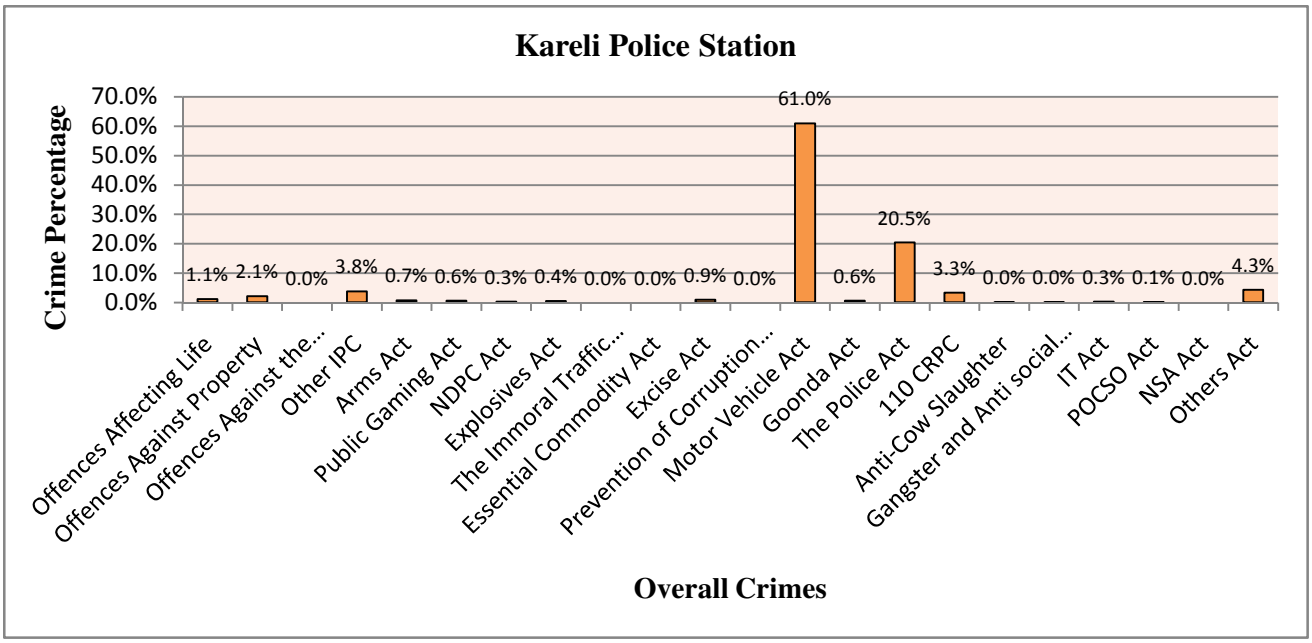


Figure 4.17.4.4 Percentage of Overall Crimes in Kareli Police Station

Motor Vehicle Act (61%), followed by The Police Act (20.5%),Others Act (4.3%), Other IPC (3.8%),110 CrPC (3.3%), Offences against Property (2.1%),Offences Affecting Life (1.1%), Excise Act(0.9%), Arms Act (0.7%), Goonda Act and Public Gaming Act (0.6%), Explosives Act (0.4%), NDPS Act and IT Act (0.3%) and POCSO Act (0.1%).

4.17.5 Doomanganj Police Station

Figures 4.17.5.1 – 4.17.5.4 presents a summary of all types of crimes reported in Kareli Police Station.

It is apparent from figure 4.17.5.1 that highest percent of crime under the group of 'Offence Affecting

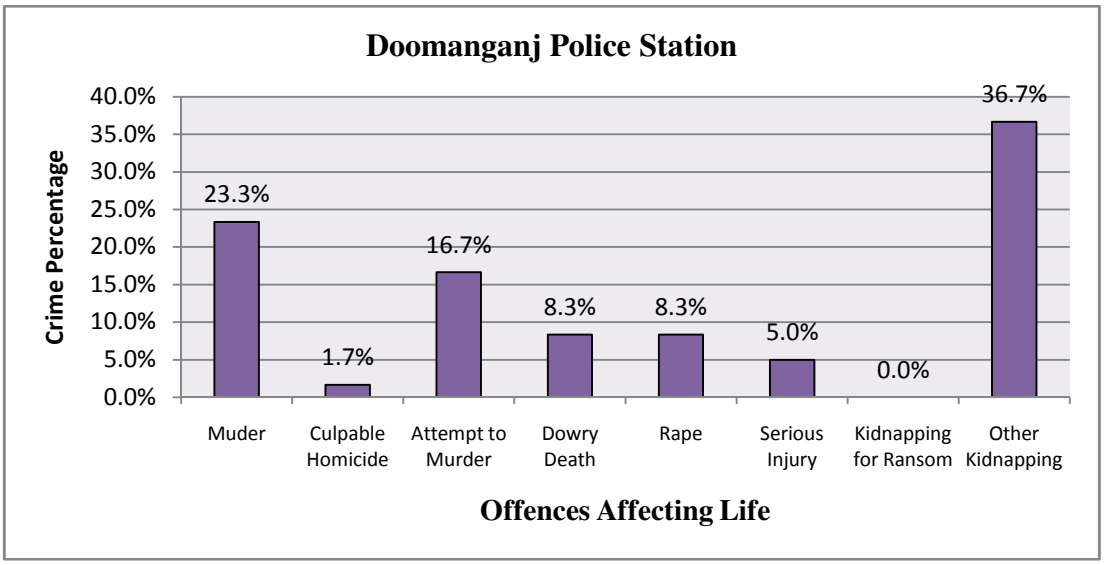


Figure 4.17.5.1 Percentage of Offences affecting Life in Doomanganj Police Station

life' was other kidnapping (36.7%) followed by, Murder (23.3 %), Attempt to Murder (16.7%), Dowry Death and Rape (8.3) Serious Injury (5.0) and Culpable Homicide (1.7%).

It is apparent from Figure 4.17.5.2 that highest percent of crime under the group of 'Offence against

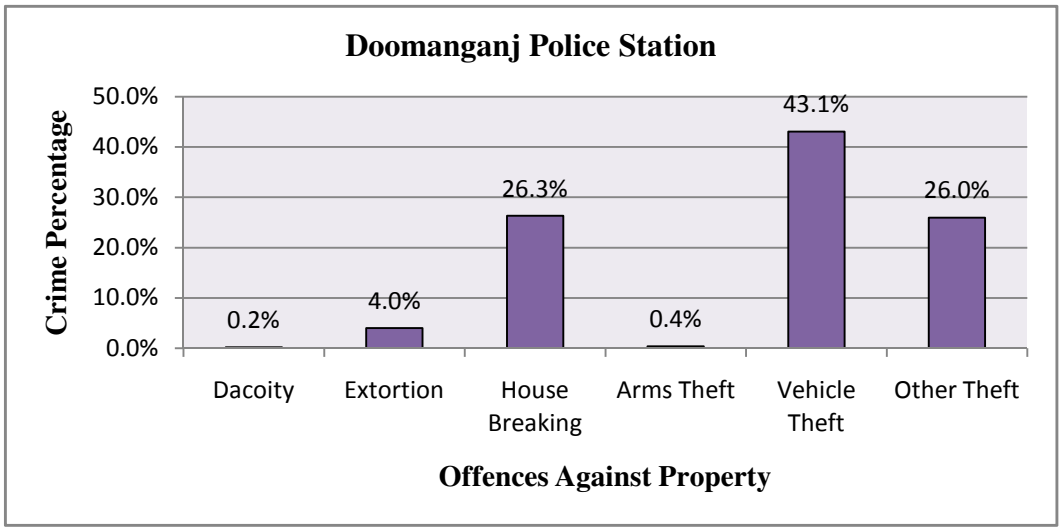


Figure 4.17.5.2 Percentage of Offences against Property in Doomanganj Police Station

Property' was Vehicle Theft (43.1%) followed by House breaking (26.3%), Other Theft (26%), Extortion (4%), Arms Theft (0.4%) and Dacoity (0.2%).

The rest of the crimes in addition to the aforementioned groups of crime are presented in Figure 4.17.5.3 It is apparent from figure 5.17.5.3 that crimes conducted under Motor Vehicle Act were the largest group (76.3%) followed by Other IPC (12.6%),The Police Act (8.2%), Others Act (4.3%),

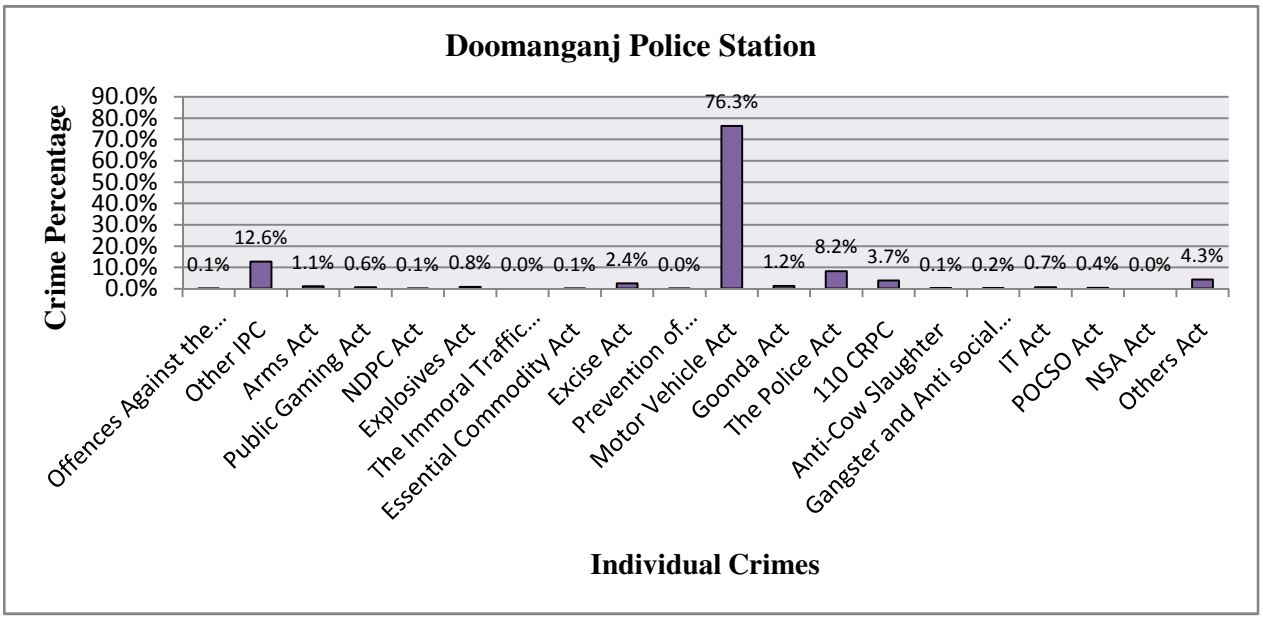


Figure 4.17.5.3 Percentage of Individual Crimes in Doomanganj Police Station

110 CrPC, (3.7%), Excise Act (2.4%), Goonda Act (1.2%), Arms Act (1.1%), Explosives Act (0.8%), IT Act (0.7%), Public Gaming Act (0.6%), POCSO Act (0.4%), Gangster and Anti-social Act (0.2%), NDPS Act, Offences Against public tranquility, Essential Commodity Act, Anti- cow Slaughter (0.1%).

From figure 4.17.5.4, if we see the overall crimes, the highest percent of crimes reported in Doomanganj Police Station were under Motor Vehicle Act (62.7%), followed by Other IPC

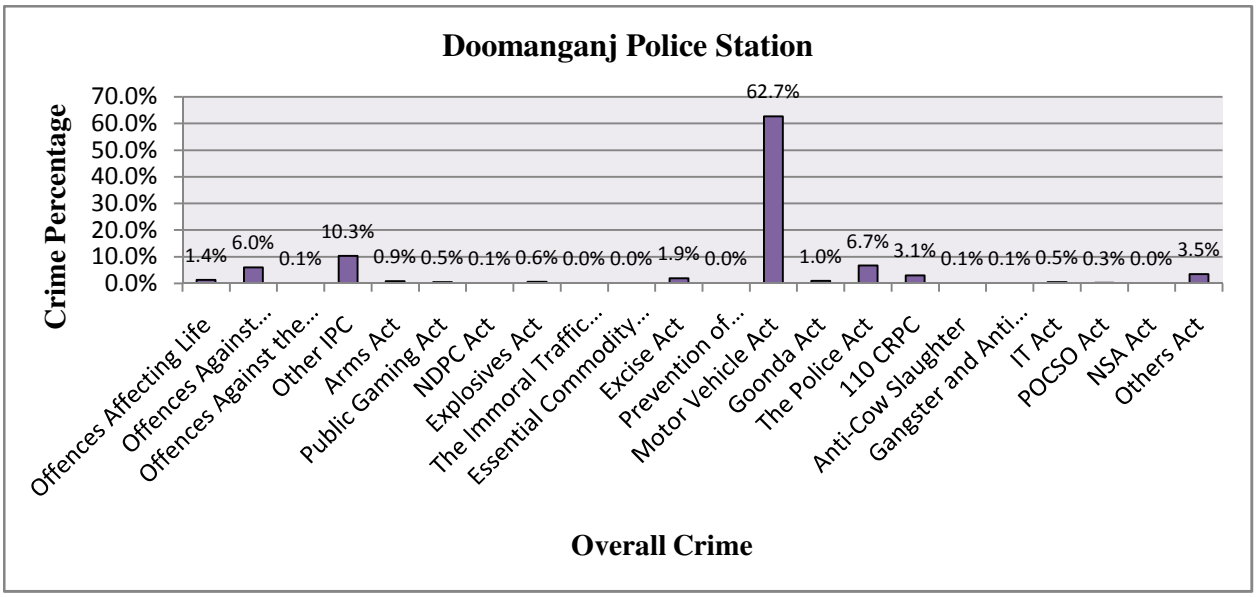


Figure 4.17.5.4 Percentage of Overall Crimes in Doomanganj Police Station

(10.3%), The Police Act (6.7%), Offences against Property (6%),Others Act (3.5%), 110 CrPC (3.1%), Excise Act(1.9%), Offences Affecting Life (1.4 %), Goonda Act (1%), Arms Act (0.9%), Explosives Act (0.6%), Public Gaming Act and IT Act (0.5%), POCSO Act (0.3%), NDPS Act, Offences Against Public Tranquility, Anti-Cow Slaughter, Gangster and Anti-Social Act (0.1%).

4.17.6 Civil Lines Police Station

Figures 4.17.6.1 –14.17.6.4 presents a summary of all types of crimes reported in Civil Lines Police Station. It is apparent from figure 4.17.6.1 that highest percent of crime under the group of 'Offence Affecting

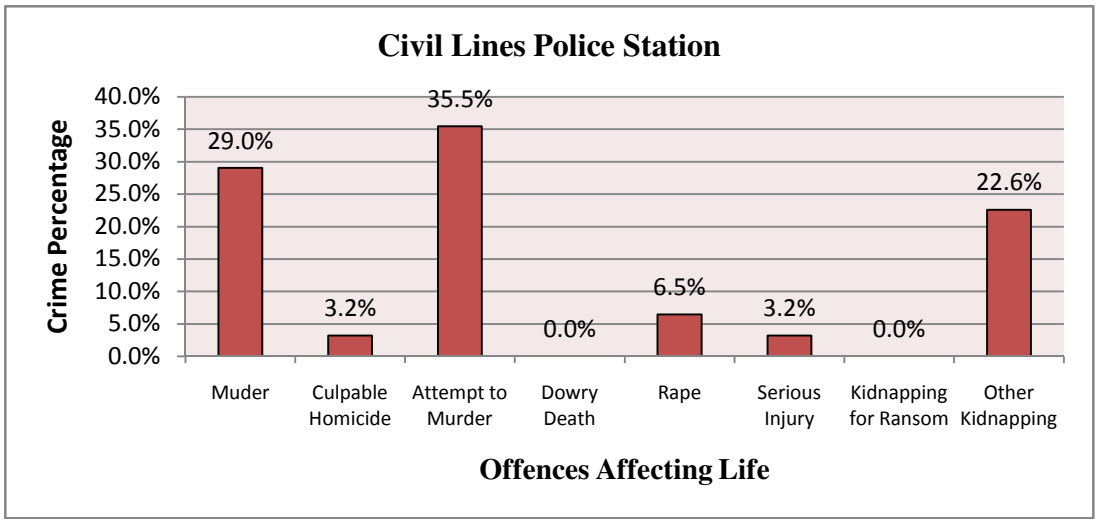


Figure 4.17.6.1 Percentage of Offences affecting Life in Civil Lines Police Station

Life' was Attempt to Murder (35.5%), Murder (29 %), other kidnapping (22.6%), Rape (6.5%), Serious Injury and Culpable Homicide (3.2%).

It is apparent from Figure 4.17.6.2 that highest percent of crime under the group of 'Offence against

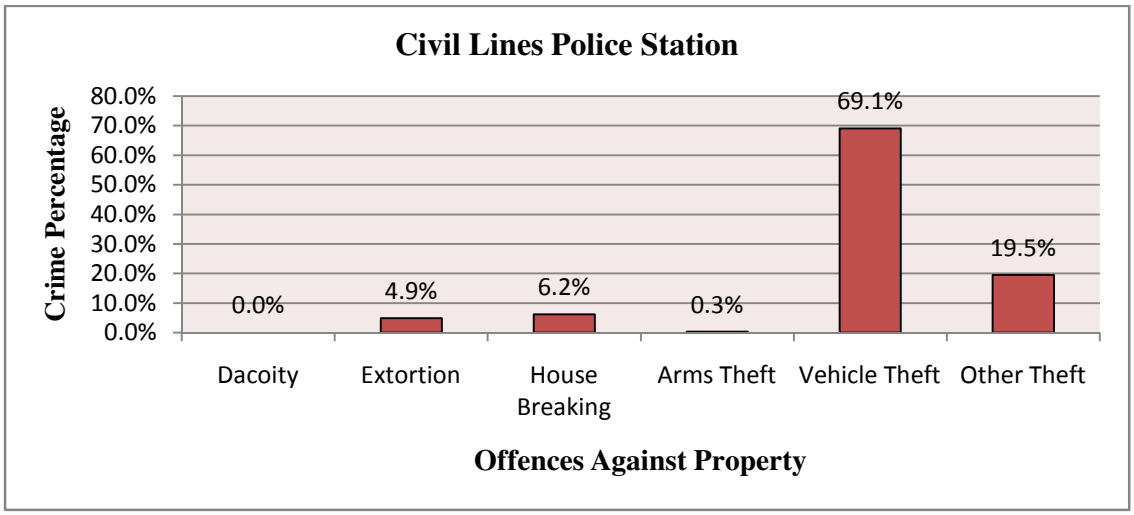


Figure 4.17.6.2 Percentage of Offences against Property in Civil Lines Police Station

Property' was Vehicle Theft (69.1%) followed by Other Theft (19.5%), House breaking (6.2%), Extortion (4.9%) and Arms Theft (0.3%).

The rest of the crimes in addition to the aforementioned groups of crime are presented in Figure 4.17.6.3 It is apparent from figure that crimes conducted under Motor Vehicle Act were the largest group (58.3%) followed by The Police Act (25.6%), Other IPC (10.5%), 110 CrPC (1.7%),

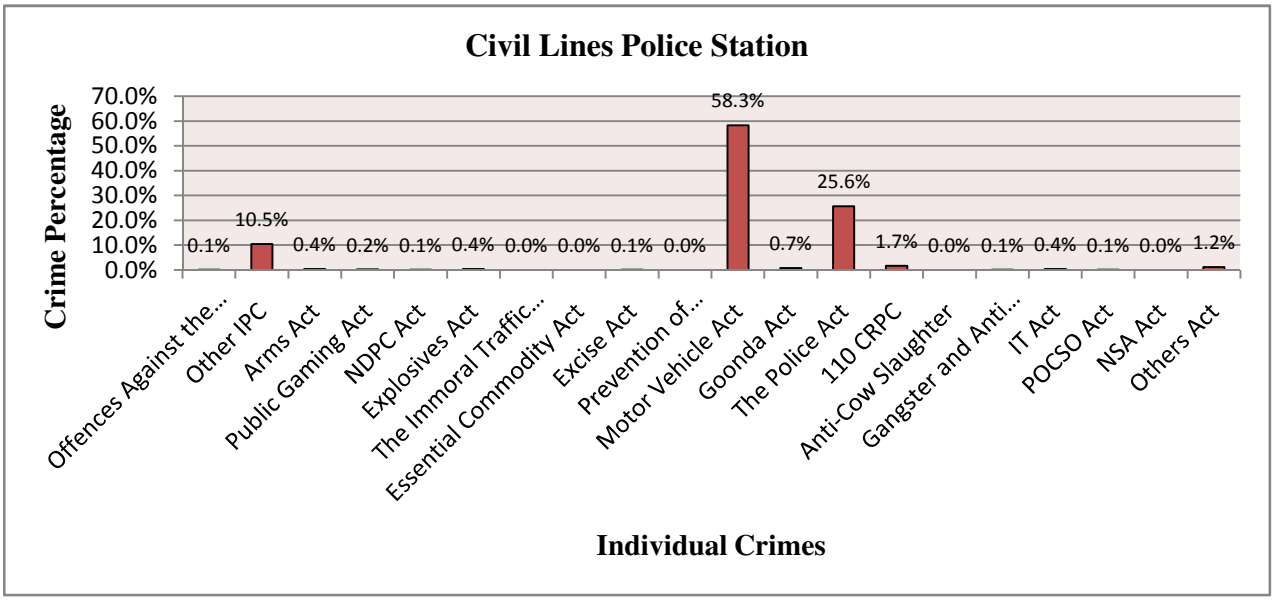


Figure 4.17.6.3 Percentage of Individual Crimes in Civil Lines Police Station

Others Act (1.2%), Goonda Act (0.7%), Arms Act, Explosives Act and IT Act(0.4%), Public Gaming Act (0.2%), Excise Act, NDPS Act, Offences Against public tranquility, Gangster and Anti-social Act, POCSO Act (0.1%).

From figure 4.17.6.4, if we see the overall crimes, the highest percent of crimes reported in Civil Lines

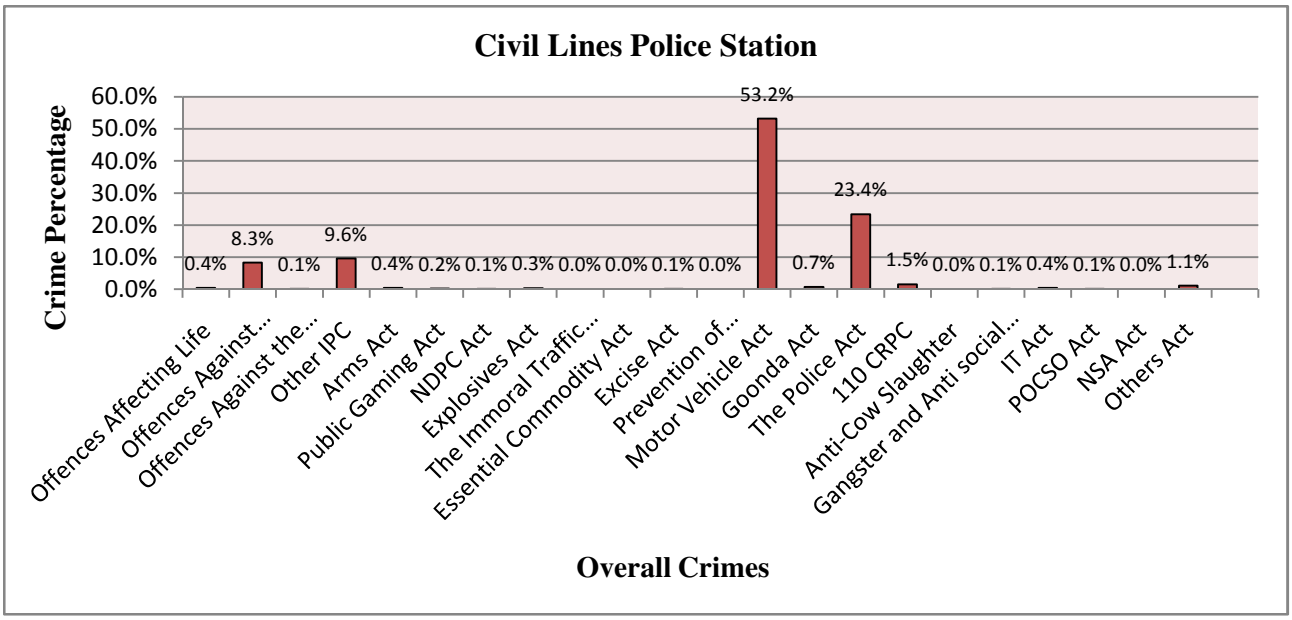


Figure 4.17.6.4 Percentage of Overall Crimes in Civil Lines Police Station

Police Station were under Motor Vehicle Act (53.2%), followed by The Police Act (23.4%), Other IPC (9.6%), Offences Against Property (8.3), 110 CrPC (1.5%), Others Act (1.1%), Goonda Act (0.7%),Offences Affecting Life, Arms Act and IT Act(0.4%), Explosives Act (0.3%), Public Gaming Act (0.2%), Excise Act, NDPS Act, Offences Against public tranquility, Gangster and Anti-social Act, POCSO Act (0.1%).

4.17.7 Cantt Police Station

Figures 4.17.7.1-4.17.7.4 presents a summary of all types of crimes reported in Civil Lines Police Station. It is apparent from figure 4.17.7.1 that highest percent of crime under the group of 'Offence

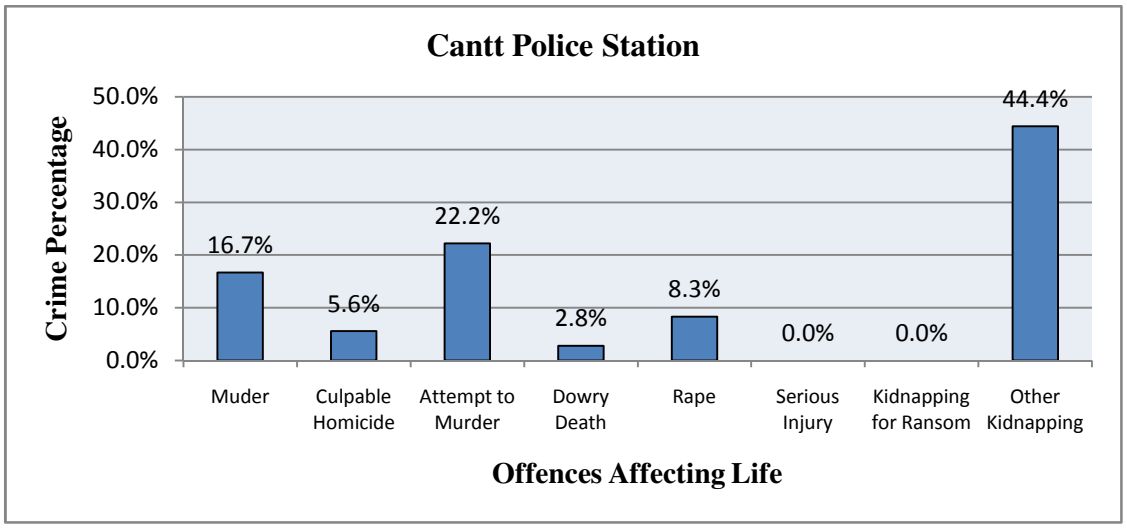


Figure 4.17.7.1 Percentage of Offences affecting Life in Cantt Police Station

Affecting life' was other kidnapping (44.4%) followed by Attempt to Murder (22.2%), Murder (16.7 %), Rape (8.3%), Culpable Homicide (5.6%) and Dowry Death (2.8%).

It is apparent from Figure 4.17.7.2 that highest percent of crime under the group of 'Offence against

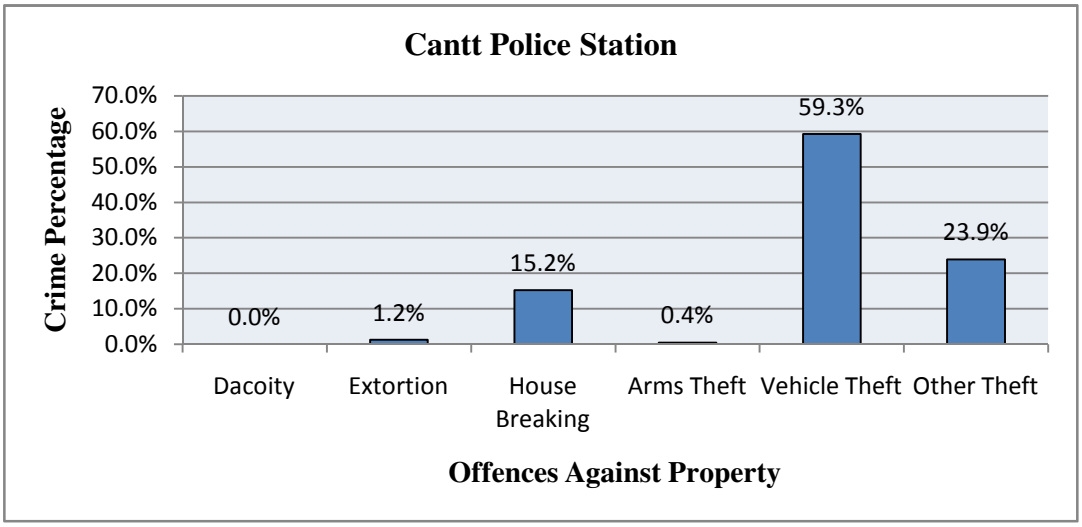


Figure 4.17.7.2 Percentage of Offences against Property in Cantt Police Station

Property' was Vehicle Theft (59.3%) followed by Other Theft (23.9%), House breaking (15.2%), Extortion (1.2%) and Arms Theft (0.4%).The rest of the crimes in addition to the aforementioned groups of crime are presented in Figure 4.17.7.3.

It is apparent from figure that crimes conducted under Motor Vehicle Act were the largest group (57.8%) followed by The Police Act (21.1%), Other IPC (8.9%), 110 CrPC (4%),

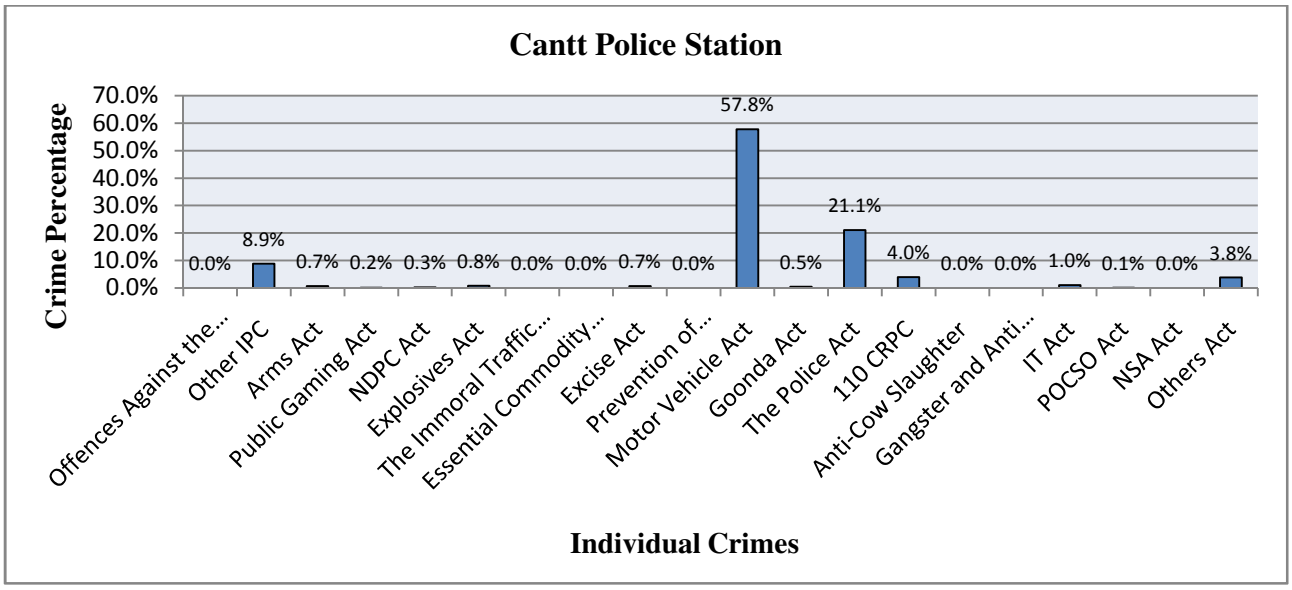


Figure 4.17.7.3 Percentage of Individual Crimes in Cantt Police Station

Others Act (3.8%), IT Act (1%), Explosives Act (0.8%), Arms Act and Excise Act (0.7%), Goonda Act (0.5%), NDPS Act (0.3%), Public Gaming Act (0.2%) and POCSO Act (0.1%).

From figure 4.17.7.4, if we see the overall crimes, the highest percent of crimes reported in Cantt Police

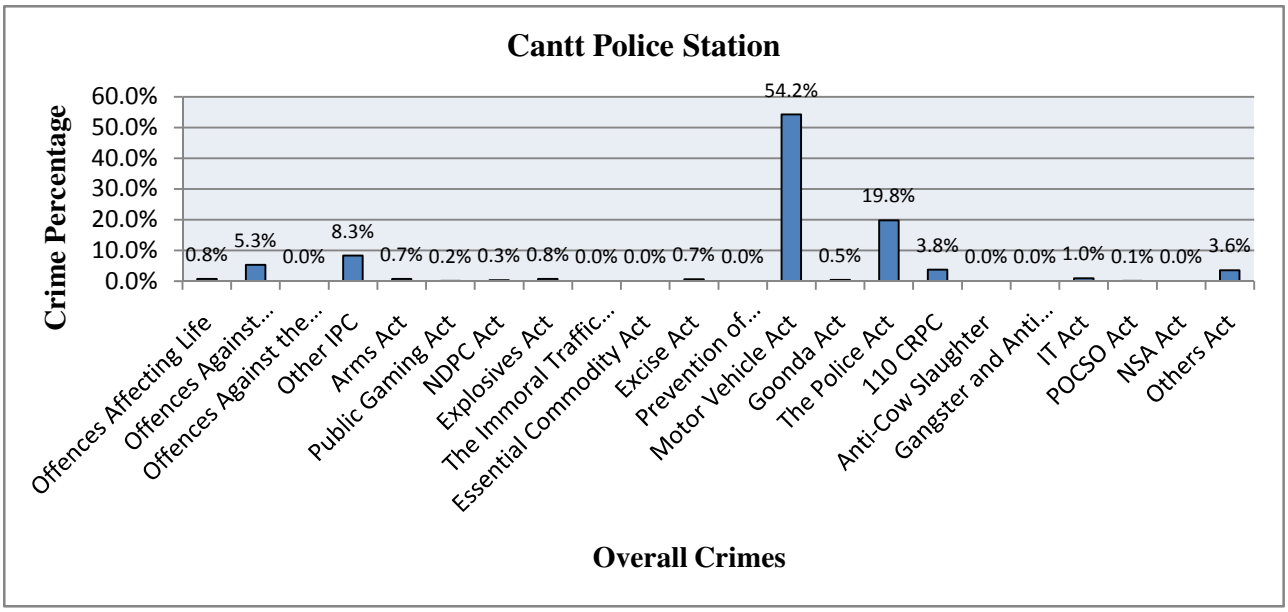


Figure 4.17.7.4 Percentage of Overall Crimes in Cantt Police Station

Station were under Motor Vehicle Act (54.2%), followed by The Police Act (19.8%), Other IPC (8.3%), Offences Against Property (5.3%), 110 CrPC (3.8%), Others Act (3.6%), IT Act (1%), Offences Affecting Life and Explosives Act (0.8%), Arms Act and Excise Act (0.7%), Goonda Act (0.5%), NDPS Act (0.3%), Public Gaming Act (0.2%), POCSO Act (0.1%).

4.17.8 Kydganj Police Station

Figures 4.17.8.1-4.17.8.4 presents a summary of all types of crimes reported in Kydganj Police Station. It is apparent from figure 4.17.8.1 that highest percent of crime under the group of 'Offence Affecting life' was other kidnapping (45.8%) followed by Murder (18.8%),

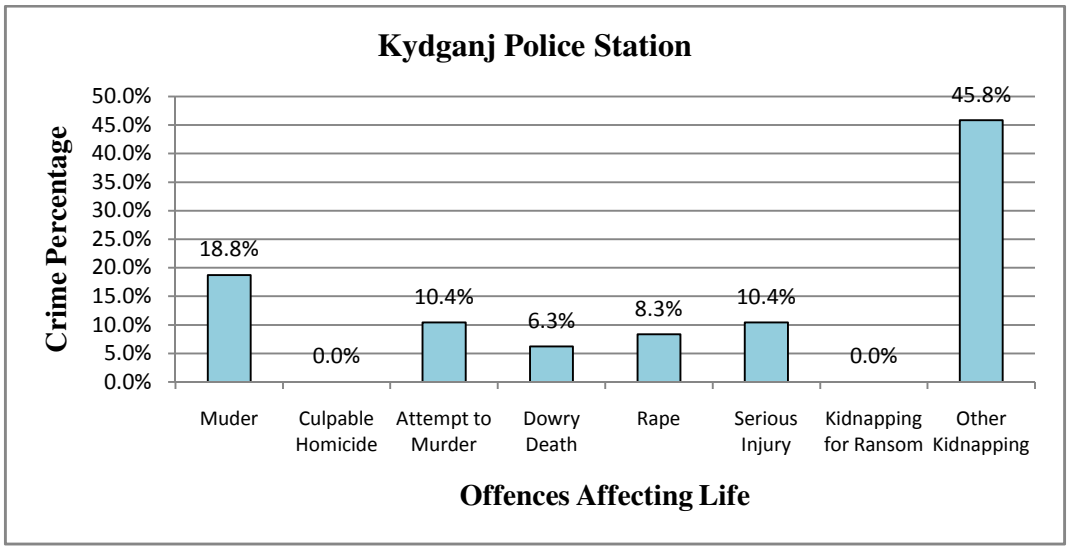


Figure 4.17.8.1 Percentage of Offences affecting Life in Kydganj Police Station

Attempt to Murder and Serious Injury (10.4%), Rape (8.3%), Dowry Death (6.3%).

It is apparent from Figure 4.17.8.2 that highest percent of crime under the group of 'Offence against

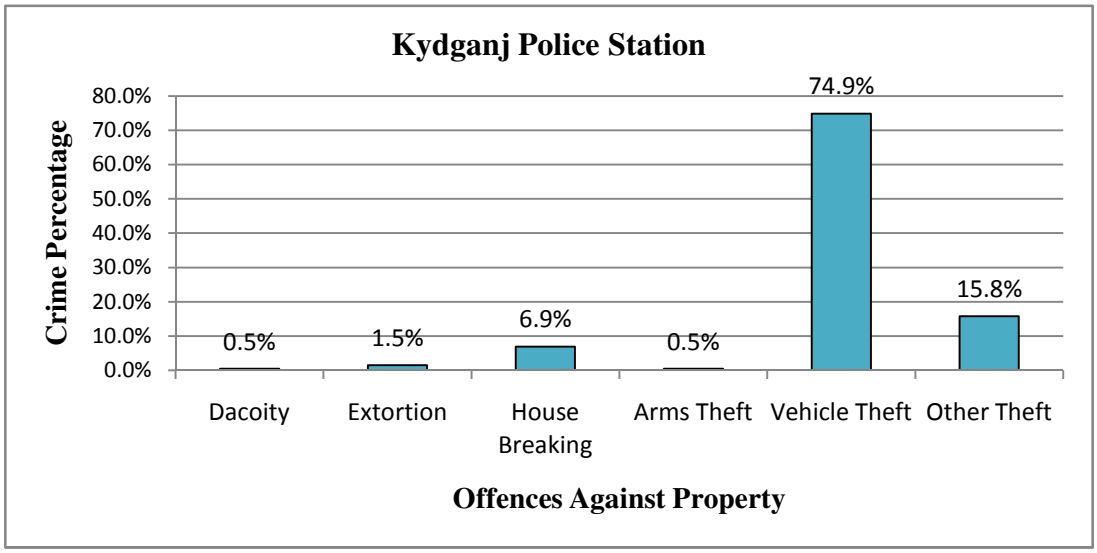


Figure 4.17.8.2 Percentage of Offences against Property in Kydganj Police Station

Property' was Vehicle Theft (74.9%) followed by Other Theft (15.8%), House breaking (6.9%), Extortion (1.5%), Dacoity and Arms Theft (0.5%).The rest of the crimes in addition to the aforementioned groups of crime are presented in Figure 4.17.8.3

It is apparent from figure that crimes conducted under Motor Vehicle Act were the largest group (56.6%) followed by The Police Act (30.9%), Other IPC (4.7%), Others Act (3%),

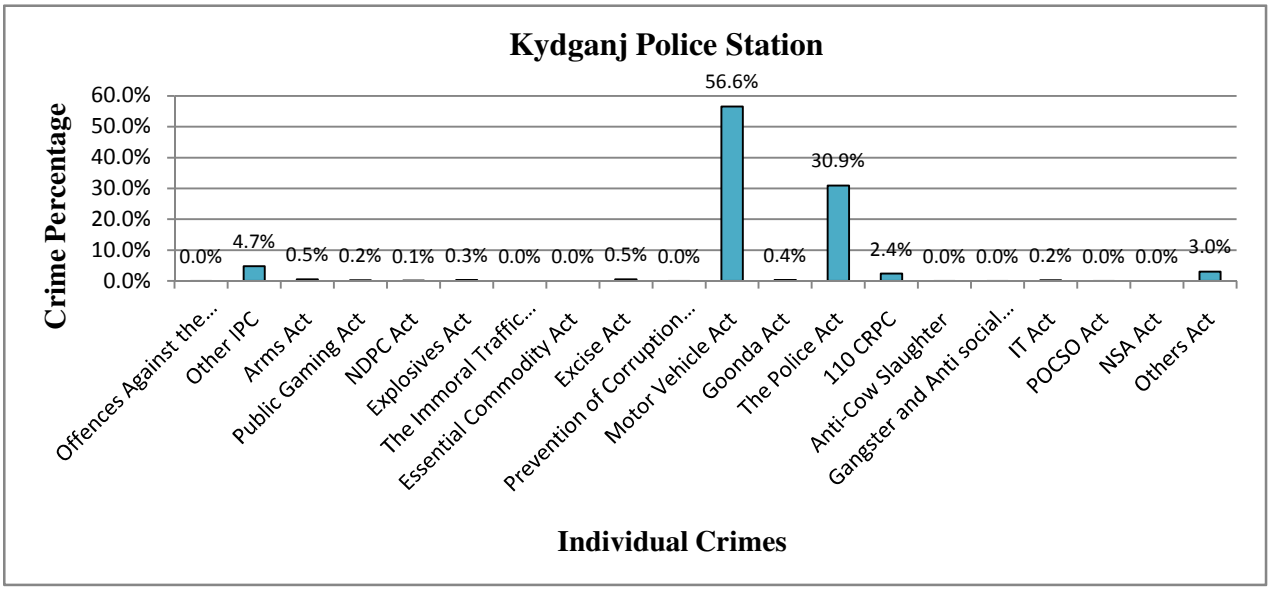


Figure 4.17.8.3 Percentage of Individual Crimes Life in Kydganj Police Station

110 CrPC (2.4%), Arms Act and Excise Act (0.5%), Goonda Act (0.4%), Explosives Act (0.3%), Public Gaming Act and IT Act (0.2%) and NDPS Act (0.1%).

From figure 4.17.8.4, if we see the overall crimes, the highest percent of crimes reported in Kydganj

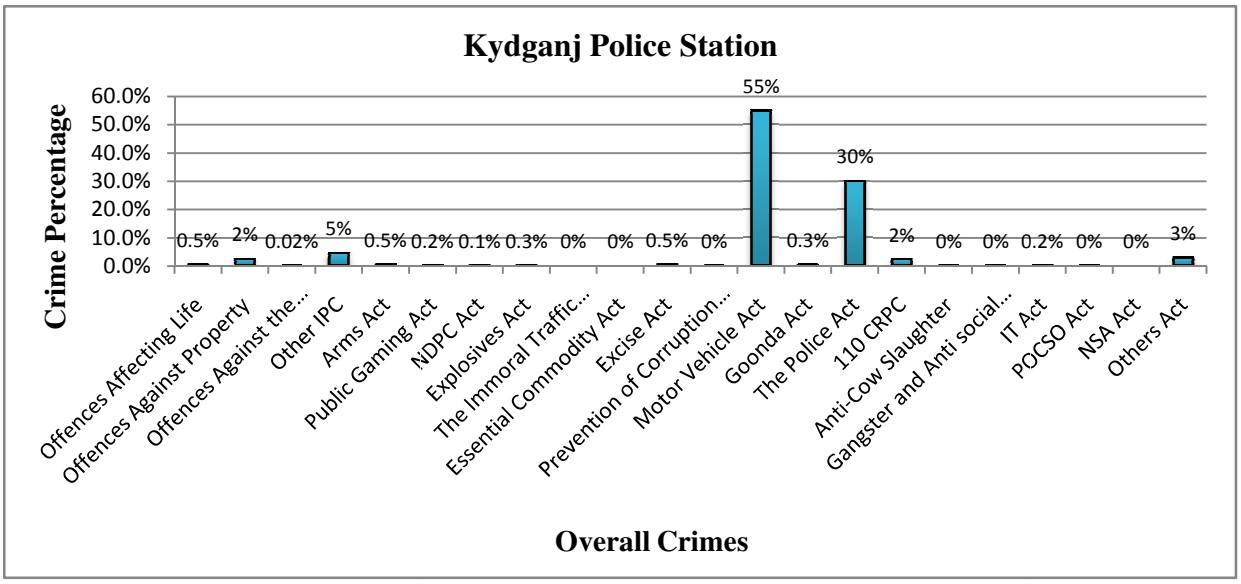


Figure 4.17.8.4 Percentage of Overall Crimes in Kydganj Police Station

Police Station were under Motor Vehicle Act (55%), followed by The Police Act (30%), Other IPC (5%), Others Act (3%), Offences Against Property and 110 CrPC (2%), Offences Affecting Life, Arms Act and Excise Act (0.5%), Goonda Act and Explosives Act (0.3%), Public Gaming Act, Gangster and Anti - Social Activities and IT Act (0.2%), NDPS Act (0.1%).

4.17.9 Muthiganj Police Station

Figures 4.17.9.1-4.17.9.4 presents a summary of all types of crimes reported in Muthiganj Police Station. It is apparent from figure 4.17.9.1 that highest percent of crime under the group of 'Offence Affecting life' was other kidnapping (45.5%), followed by

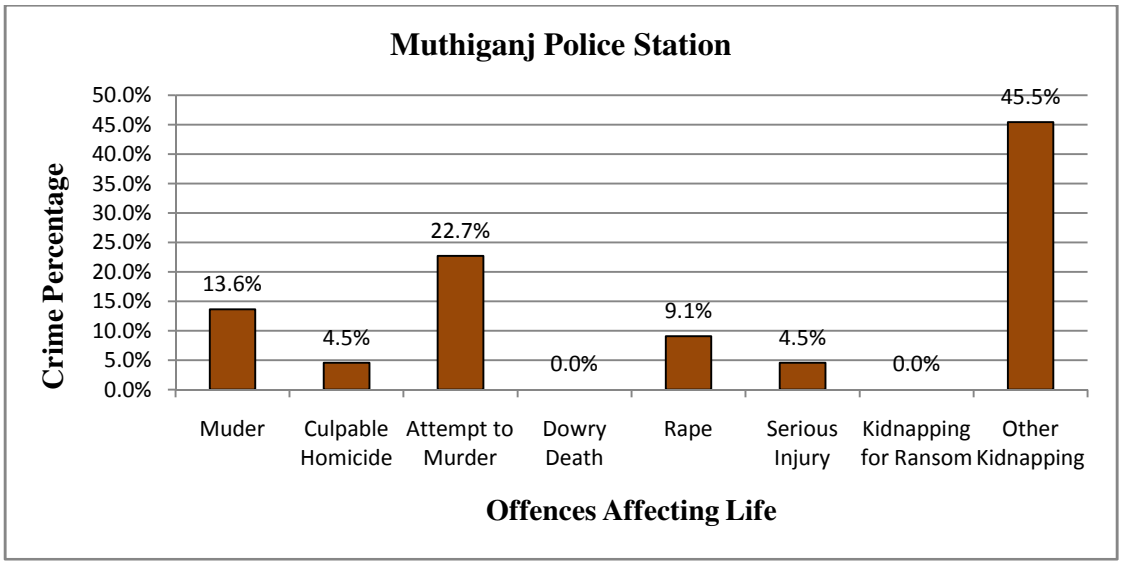


Figure 4.17.9.1 Percentage of Offences affecting Life in Muthiganj Police Station

Attempt to Murder (22.7), Murder (13.6%), Rape (9.1%), Culpable Homicide and Serious Injury (4.5%).

It is apparent from Figure 4.17.9.2 that highest percent of crime under the group of 'Offence against

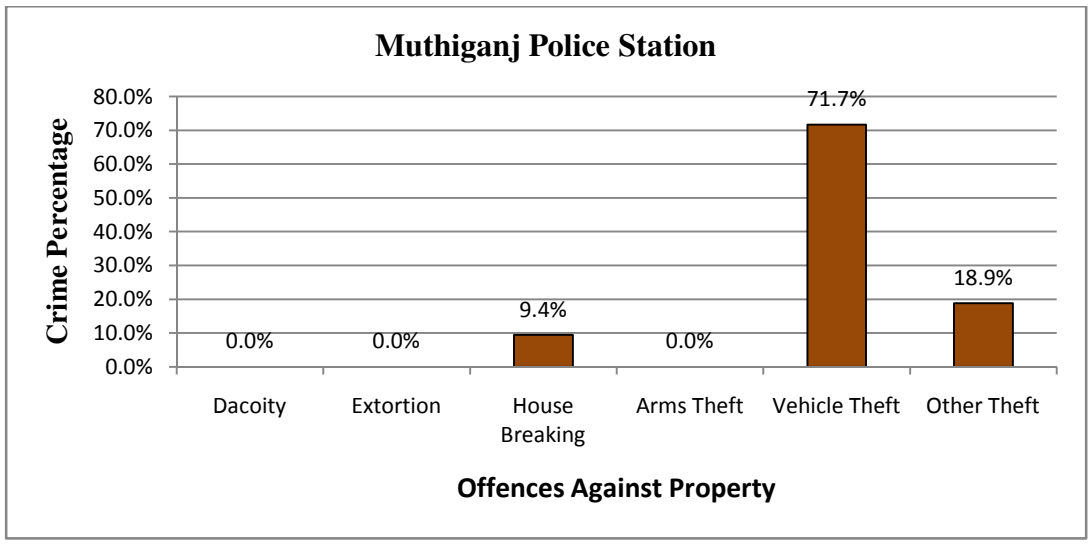


Figure 4.17.9.2 Percentage of Offences against Property in Muthiganj Police Station

Property' was Vehicle Theft (71.7%) followed by other Theft (18.9%) and House breaking (9.4%). The rest of the crimes in addition to the aforementioned groups of crime are presented in Figure 4.17.9.3.

It is apparent from figure that crimes conducted under Motor Vehicle Act were the largest group (73.7%) followed by The Police Act (12.4%), Other IPC (3.8%), Others Act (3.6%),

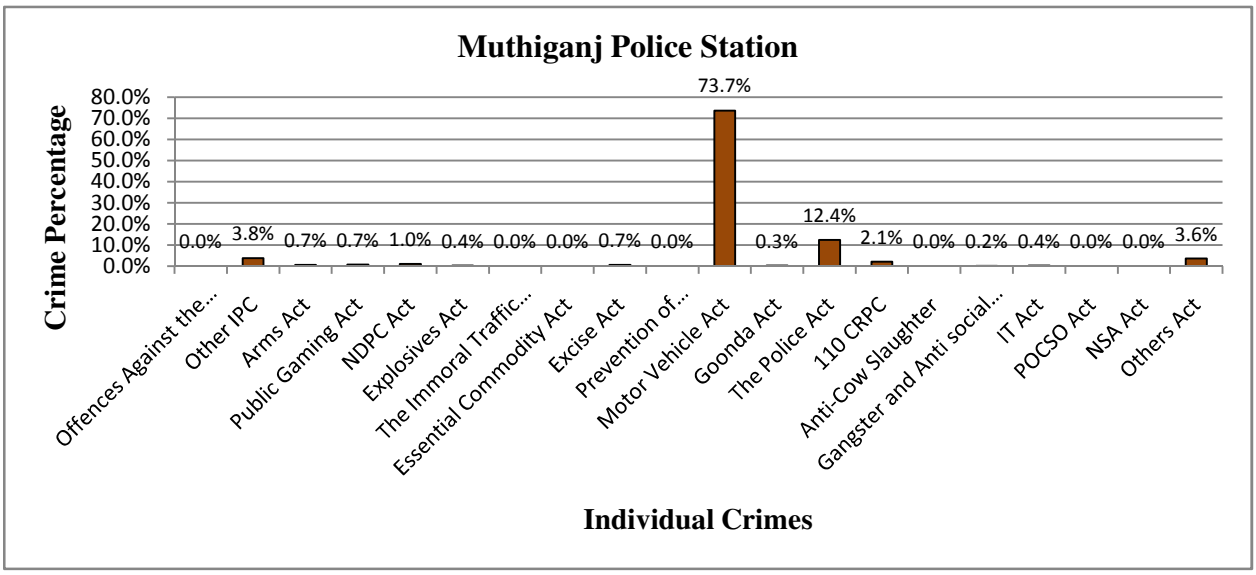


Figure 4.17.9.3 Percentage of Individual Crimes in Muthiganj Police Station

110 CrPC (2.1%), NDPS Act (1%), Arms Act, Excise Act and Public Gaming Act (0.7%), IT Act and Explosives Act (0.4%), Goonda Act (0.3%), Gangster and Anti-Social Activities (0.2%).

From figure 4.17.9.4, if we see the overall crimes, the highest percent of crimes reported in Muthiganj

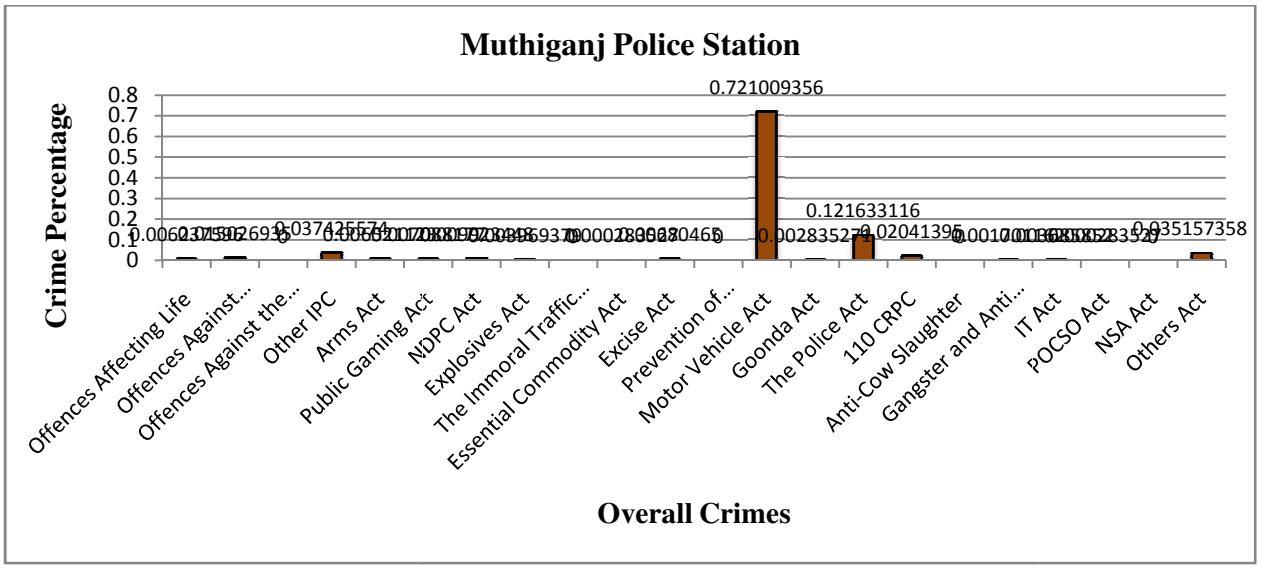


Figure 4.17.9.4 Percentage of Overall Crimes Life in Muthiganj Police Station

Police Station were under Motor Vehicle Act (72.1%), followed by The Police Act (12.2%), Other IPC (3.7%), Others Act (3.5%), 110 CrPC (2%), Offences Against Property (1.5%), NDPS Act (1%), Arms Act, Public Gaming Act and Excise Act(0.7%), Offences Affecting Life (0.6%), and (0.5%), IT Act and Explosives Act (0.4%), Goonda Act (0.3%), Gangster and Anti - Social Activities and (0.2%).

4.17.10 Attarsuiya Police Station

Figures 4.17.10.1 – 4.17.10.4 presents a summary of all types of crimes reported in Attarsuiya Police Station. It is apparent from figure4.17.10.1 that highest percent of crime under the group of 'Offence Affecting

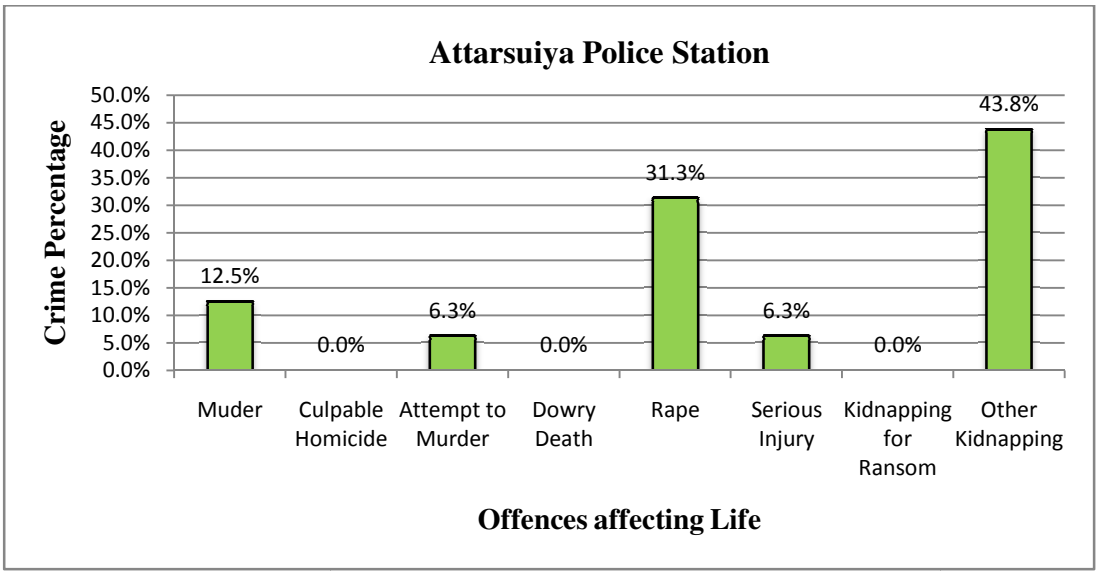


Figure 4.17.10.1 Percentage of Offences affecting Life in Attarsuiya Police Station

Affecting life' was other kidnapping (43.8%) followed by Rape (31.3%), Homicide (4.5%). It is apparent from Figure 4.17.10.2 that highest percent of crime under the group of 'Offence against

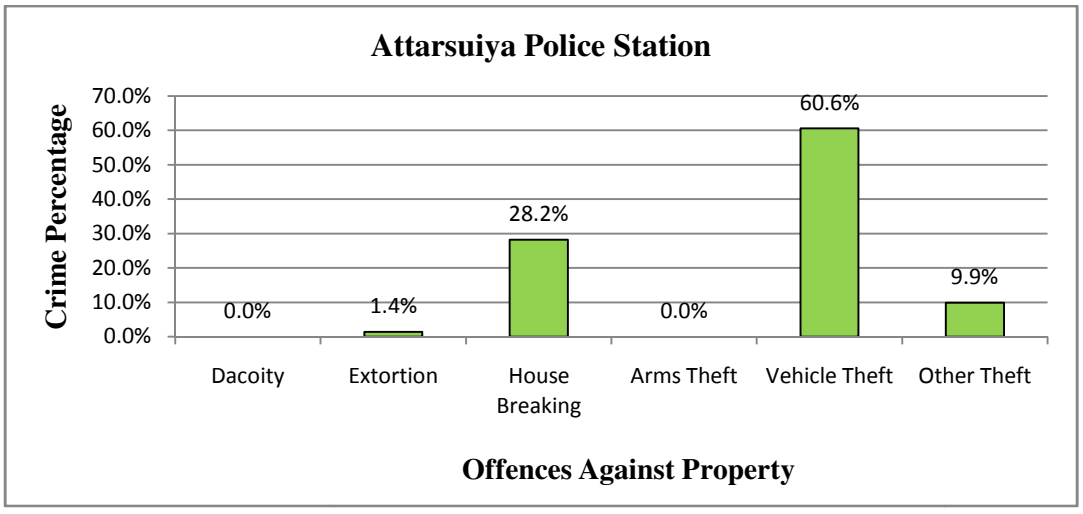


Figure 4.17.10.2 Percentage of Offences affecting Property in Attarsuiya Police Station

Property' was Vehicle Theft (60.6%) followed by House breaking (28.2%), Other Theft (9.9%) and Extortion (1.4%). The rest of the crimes in addition to the aforementioned groups of crime are presented in Figure 4.17.10. 3.

It is apparent from figure that crimes conducted under Motor Vehicle Act were the largest group (82.8%) followed by The Police Act (7%), Other IPC (3.2%), Others Act (2.3%),

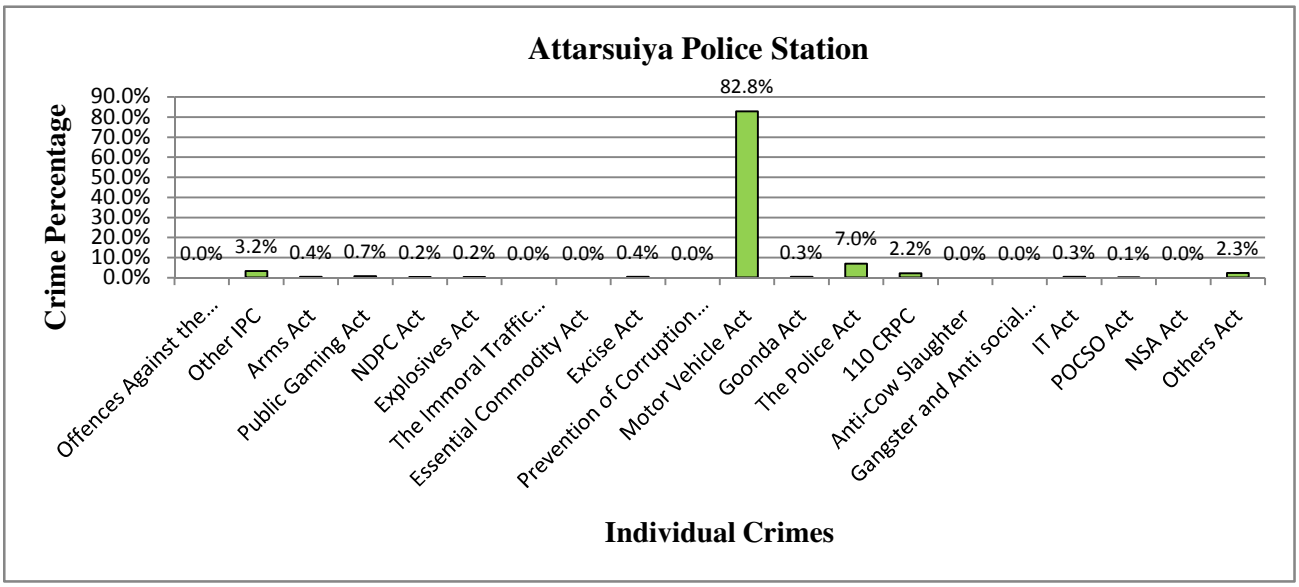


Figure 4.17.10.3 Percentage of Individual Crimesin Attarsuiya Police Station

110 CrPC (2.2%), Public Gaming Act (0.7%), Arms Act and Excise Act (0.4%), Goonda Act and IT Act (0.3%), NDPS Act and Explosives Act (0.2%) and POCSO Act (0.1%).

From figure 4.17.10.4, if we see the overall crimes, the highest percent of crimes reported in Attarsuiya

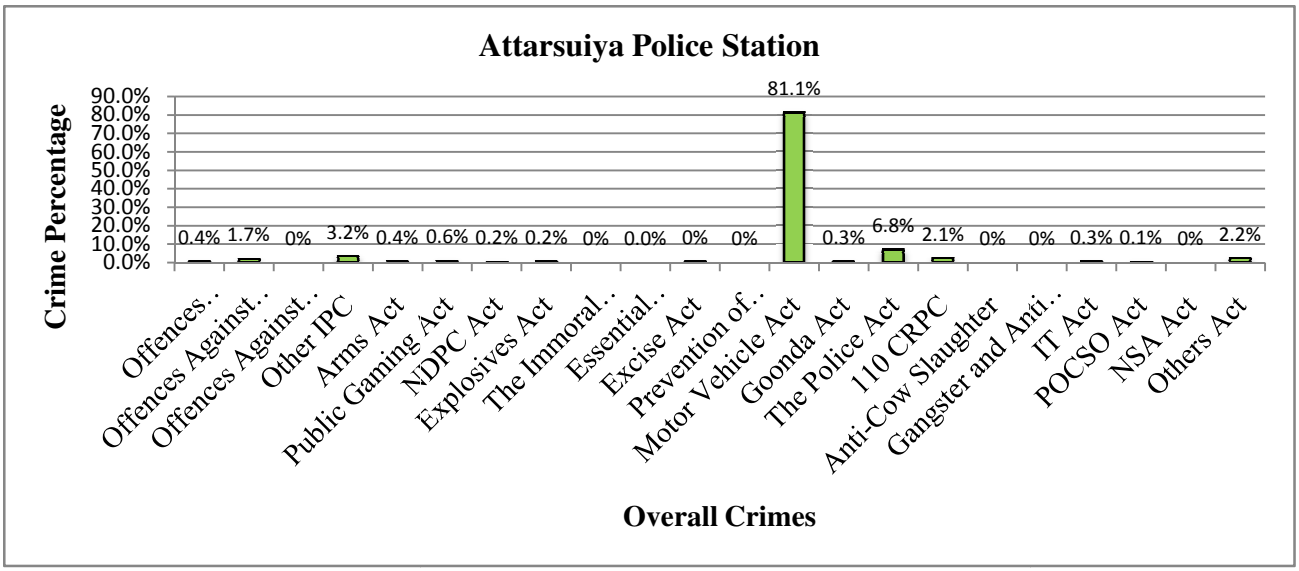


Figure 4.17.10.4 Percentage of Overall Crimes in Attarsuiya Police Station

Police Station was under Motor Vehicle Act (81.1%), followed by The Police Act (6.8%), Other IPC (3.2%), Others Act (2.2%), 110 CrPC (2.1%), Offences Against Property (1.7%), Public Gaming Act (0.6%), Arms Act and Offences Affecting Life (0.4%), IT Act and Goonda Act (0.3%), NDPS Act and Explosives Act (0.2%), POCSO Act (0.1%).

4.17.11 George Town Police Station

Figures 4.17.11.1 – 14.17.11.4 presents a summary of all types of crimes reported in George Town Police Station. It is apparent from figure that highest percent of crime under the group of 'Offence

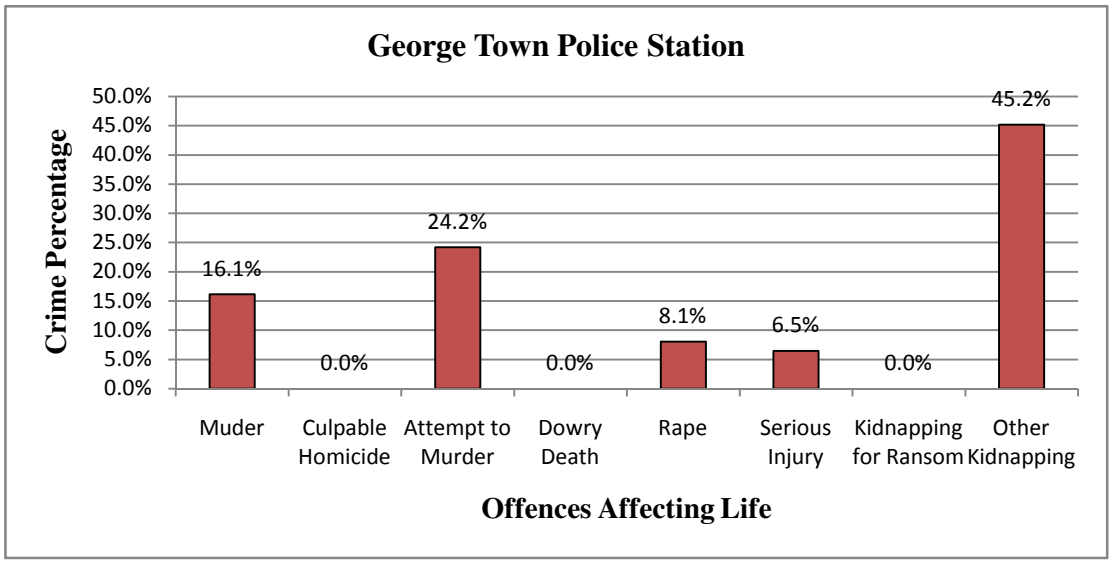


Figure 4.17.11.1 Percentage of Offences affecting Life in George Town Police Station

Affecting life' was other kidnapping (45.2%) followed by Attempt to Murder (24.2%), Murder (16.1%), Rape (8.1%), Serious Injury (6.5%).

It is apparent from Figure 4.17.11.2 that highest percent of crime under the group of 'Offence against

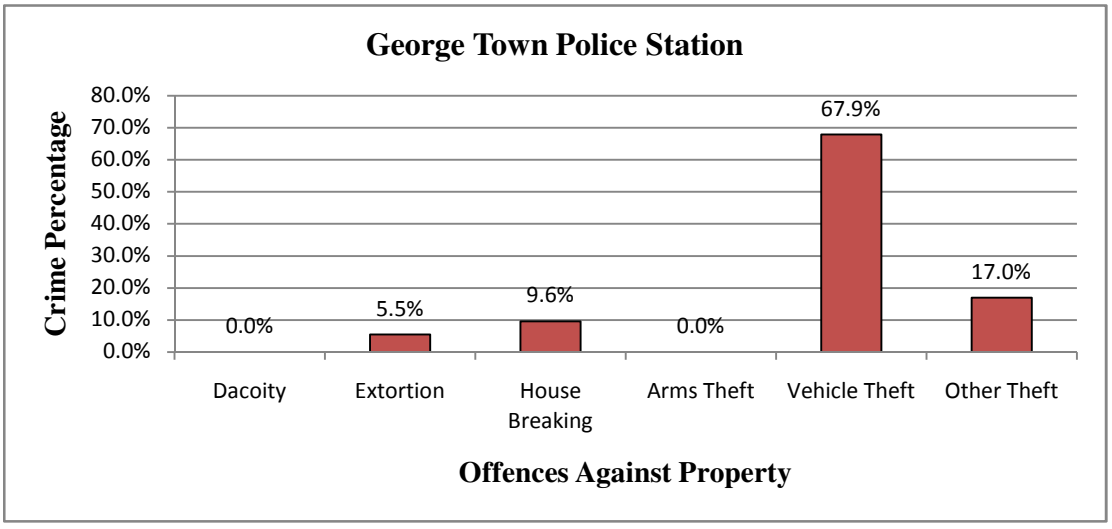


Figure 4.17.11.2 Percentage of Offences affecting Property in George Town Police Station

Property' was Vehicle Theft (67.9%) followed by Other Theft (17%), House breaking (9.6%) and Extortion (5.5%). The rest of the crimes in addition to the aforementioned groups of crime are presented in Figure 4.17.11.3.

It is apparent from figure that crimes conducted under Motor Vehicle Act were the largest group (49.6%) followed by The Police Act (17.4%), Other IPC (16.2%), Others Act (5.5%),

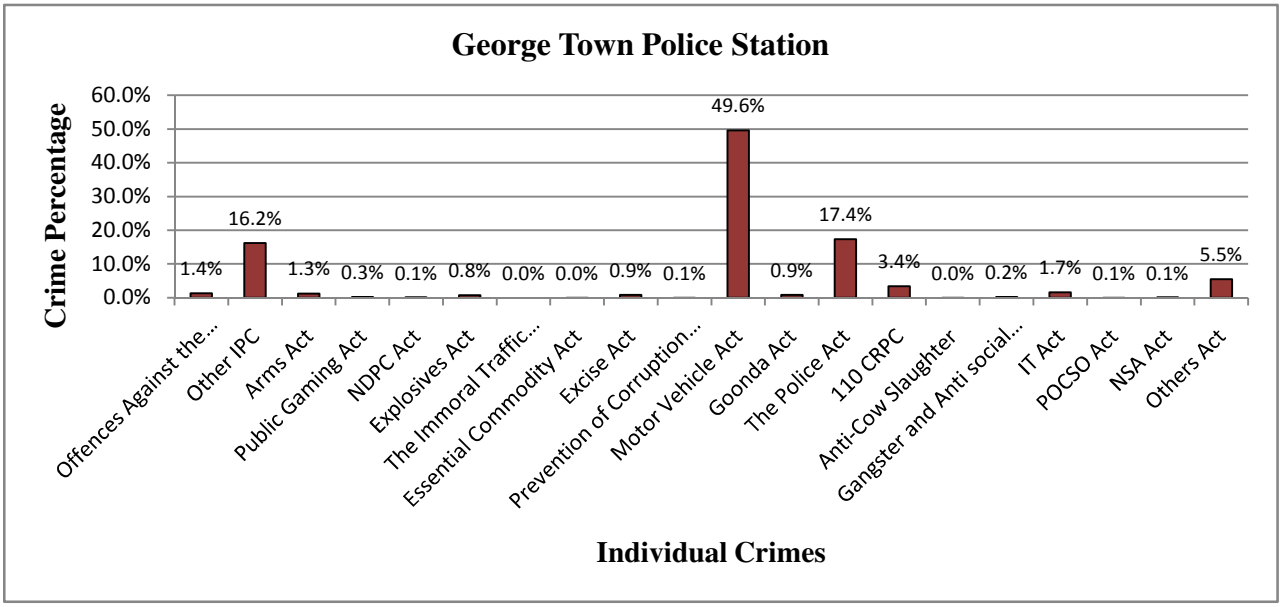


Figure 4.17.11.3 Percentage of Individual Crimes in George Town Police Station

110 CrPC (3.4%), IT Act (1.7%), Offences Against Public tranquility (1.4%), Arms Act (1.3%), Excise Act and Goonda Act (0.9%), Explosives Act (0.8%), Public Gaming Act (0.3%), Gangster and Anti - Social Activities (0.2%), NDPS Act, POCSO Act, NSA Act, Prevention of Corruption Act (0.1%).

From figure 4.17.11.4, if we see the overall crimes, the highest percent of crimes reported in George

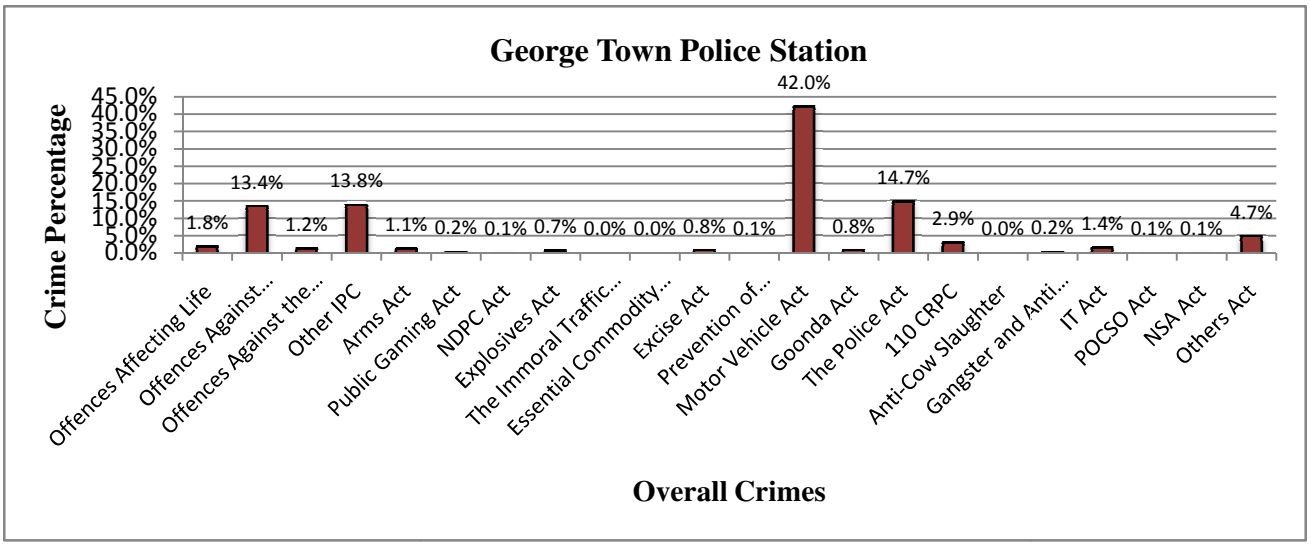


Figure 4.17.11.4 Percentage of Overall Crimes in George Town Police Station

Town Police Station were under Motor Vehicle Act (42%), followed by The Police Act (14.7%), Other IPC (13.8%), Offences Against Property (13.4%), Others Act (4.7%), 110 CrPC (2.9%), Offences Affecting Life (1.8%), IT Act (1.4%), Offences Against Public tranquility (1.2%), Arms Act (1.1%), Goonda Act and Excise Act (0.8%), Explosives Act (0.7%), Public Gaming Act and Gangster and Anti-Social Act(0.2%), NDPS Act, Prevention of Corruption Act, NSA Act and POCSO Act (0.1%).

4.17.12 Kernal Ganj Police Station

Figures 4.17.12.1-4.17.12.4 presents a summary of all types of crimes reported in Kernal Ganj Town Police Station. It is apparent from figure 4.17.12.1 that highest percent of crime under the group of 'Offence

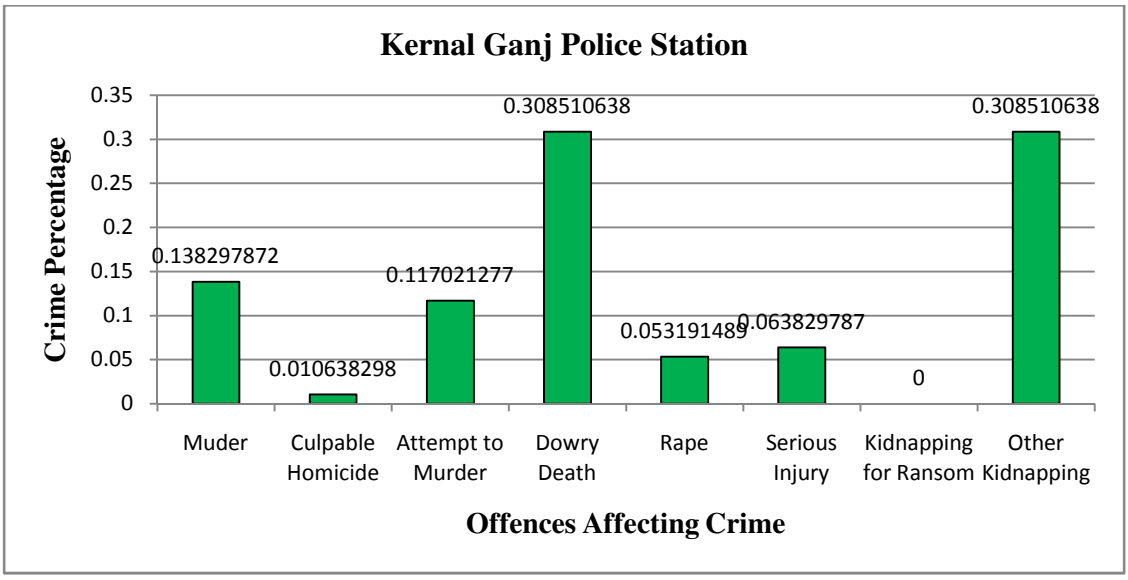


Figure 4.17.12.1 Percentage of Offences affecting Life in Kernal Ganj Police Station

Affecting life' was Dowry Death and Other kidnapping (30.9%) followed by Murder (13.8%), Attempt to Murder (11.7%), Serious Injury (6.4%), Rape (5.3%) and Culpable Homicide (1.1%). It is apparent from Figure 4.17.12.2 that highest percent of crime under the group of 'Offence against

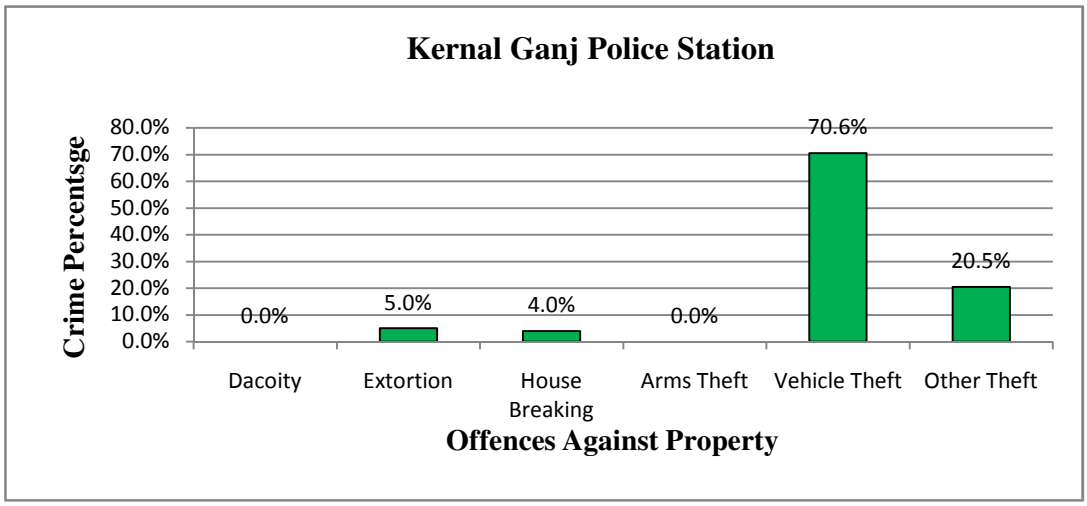


Figure 4.17.12.2 Percentage of Offences affecting Property in Kernal Ganj Police Station

Property' was Vehicle Theft (70.6%) followed by Other Theft (20.5%), Extortion (5%) and House breaking (4%) and The rest of the crimes in addition to the aforementioned groups of crime are presented in Figure 4.17.12.3

It is apparent from figure that crimes conducted under Motor Vehicle Act were the largest group (36.8%) followed by The Police Act (26.6%), Other IPC (23.4%), Others Act (4.5%),

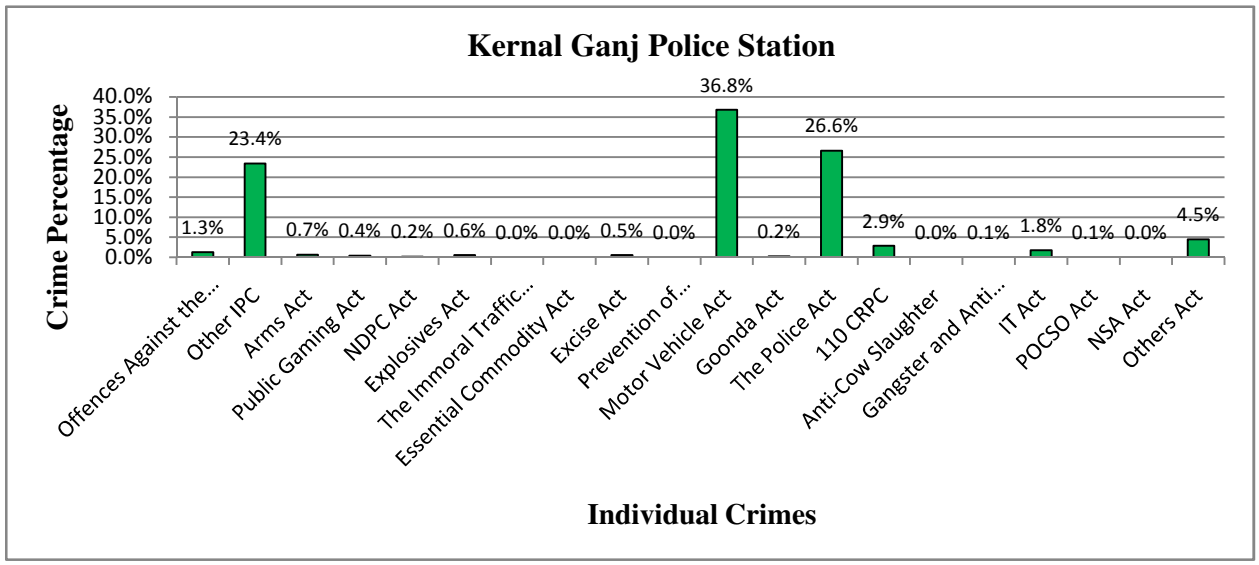


Figure 4.17.12.3 Percentage of Individual Crimes in Kernal Ganj Police Station

110 CrPC (2.9%), IT Act (1.8%), Offences Against Public tranquility (1.3%), Arms Act (0.7%), Explosives Act (0.6%), Excise Act (0.5%), Public Gaming Act (0.4%), NDPS Act and Goonda Act (0.2%), Gangster and Anti - Social Activities and POCSO Act (0.1%).

From figure 4.17.12.4, if we see the overall crimes, the highest percent of crimes reported in Kernal Ganj

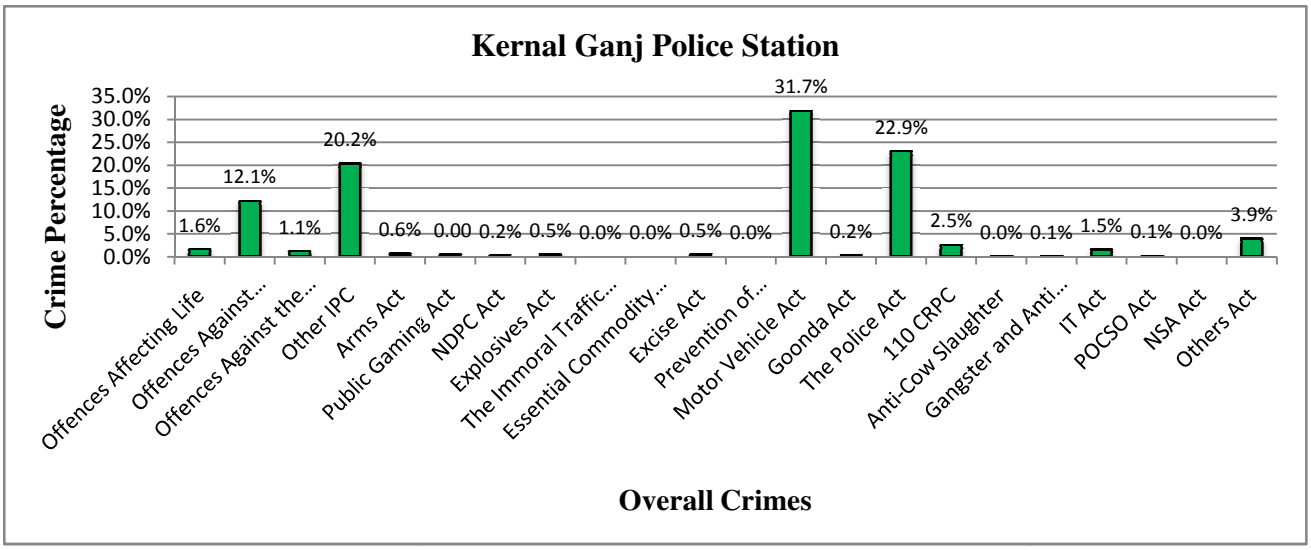


Figure 4.17.12.4 Percentage of Overall Crimes in Kernal Ganj Police Station

Town Police Station were under Motor Vehicle Act (31.7%), followed by The Police Act (22.9%), Other IPC (20.2%), Offences Against Property (12.1%), Others Act (3.9%), 110 CrPC (2.5%), Offences Affecting Life (1.6%), IT Act (1.5%), Offences Against Public tranquility (1.1%), Arms Act (0.6%), Explosives Act and Excise Act (0.5%), NDPS Act and Goonda Act (0.2%), Gangster and Anti - Social Activities and POCSO Act (0.1%).

4.17.13 Shivkuti Police Station

Figures 4.17.13.1-4.17.13.2 presents a summary of all types of crimes reported in Shivkuti Police Station. It is apparent from figure 4.17.13.1 that highest percent of crime under the group of 'Offence

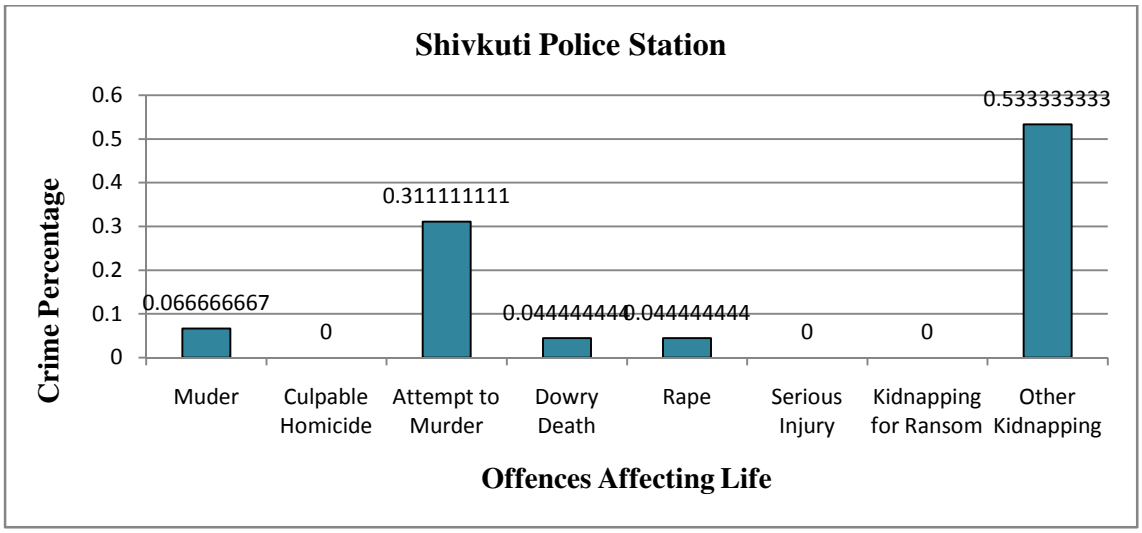


Figure 4.17.13.1 Percentage of Offences affecting Life in Shiv Kuti Police Station

Affecting life' was Other kidnapping (53.3%) followed by Attempt to Murder (31.1%), Murder (6.7%), Dowry Death and Rape (4.4%).

It is apparent from Figure4.17.13.2 that highest percent of crime under the group of 'Offence against

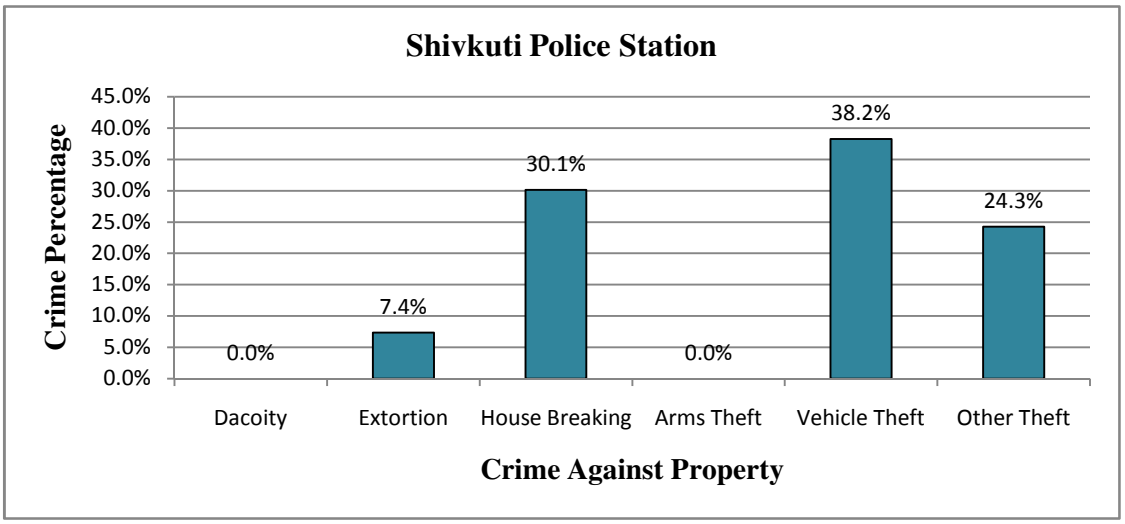


Figure 4.17.13.2 Percentage of Offences affecting Property in Shiv Kuti Police Station

Property' was Vehicle Theft (38.2%) followed by House breaking (30.1%), Other Theft (24.3%), Extortion (7.4%). The rest of the crimes in addition to the aforementioned groups of crime are presented in Figure 4.17.13.3

It is apparent from figure that crimes conducted under Motor Vehicle Act were the largest group (63.6%) followed by The Police Act (9.6%), Other IPC (9.5%), 110 CrPC (3.7%),

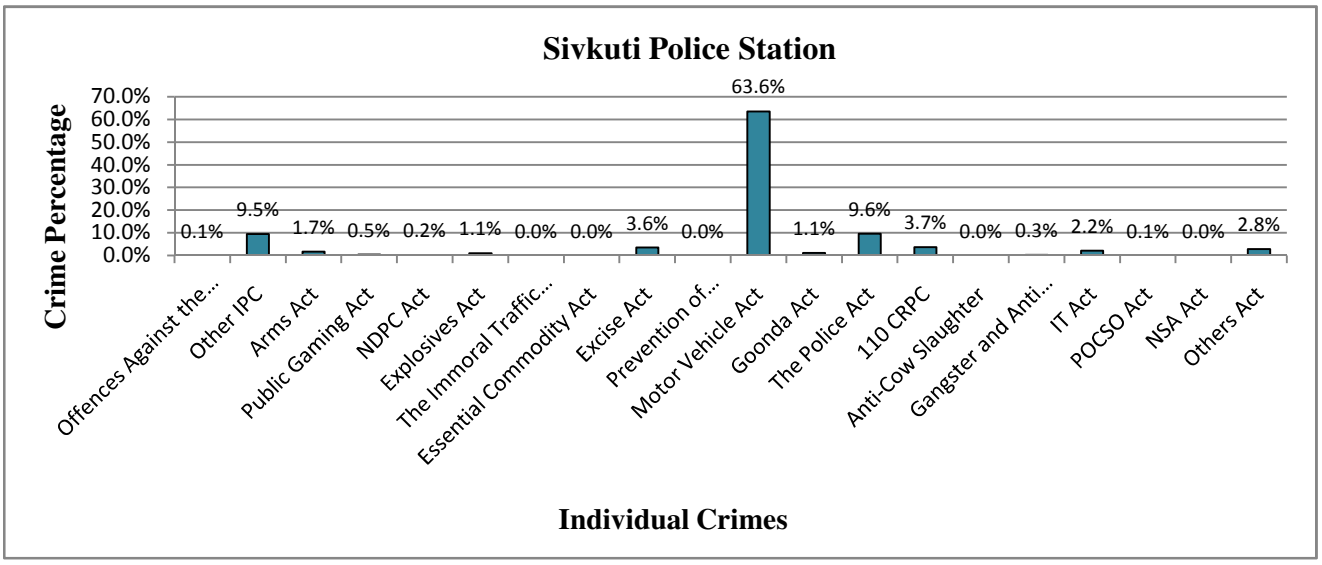


Figure 4.17.13.3 Percentage of Individual Crimes in Shiv Kuti Police Station

Excise Act (3.6%), Others Act (2.8%), IT Act (2.2%), Arms Act (1.7%), Explosives Act and Goonda Act (1.1%), Public Gaming Act (0.5%), Gangster and Anti - Social Activities (0.3%), NDPS Act (0.2%), Offences against Public tranquility and POCSO Act (0.1%).

From figure 4.17.13.4, if we see the overall crimes, the highest percent of crimes reported in Shivkuti

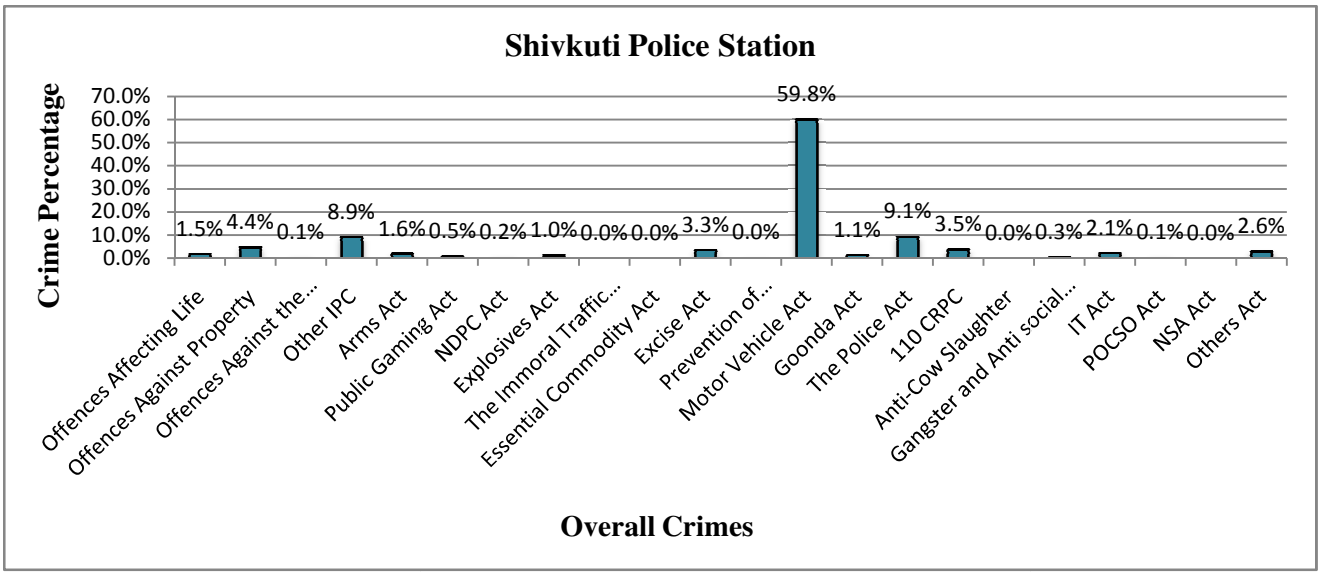


Figure 4.17.13.4 Percentage of Overall Crimes Property in Shiv Kuti Police Station

Police Station were under Motor Vehicle Act (59.8%), followed by The Police Act (9.1%), Other IPC (8.9%), Offences Against Property (4.4%), 110 CrPC (3.5%), Excise Act (3.3%), Others Act (2.6%), IT Act (2.1%), Arms Act (1.6%), Offences Affecting Life (1.5%), Goonda Act (1.1%), Explosives Act (1%), Public Gaming Act (0.5%), Gangster and Anti - Social Activities (0.3%), NDPS Act (0.2%), Offences Against Public tranquility and POCSO Act (0.1%).

4.17.14 Daraganj Police Station

Figures 4.17.14.1 – 4.17.14.4 presents a summary of all types of crimes reported in Daraganj Police Station. It is apparent from figure 4.17.14.1 that highest percent of crime under the group of 'Offence

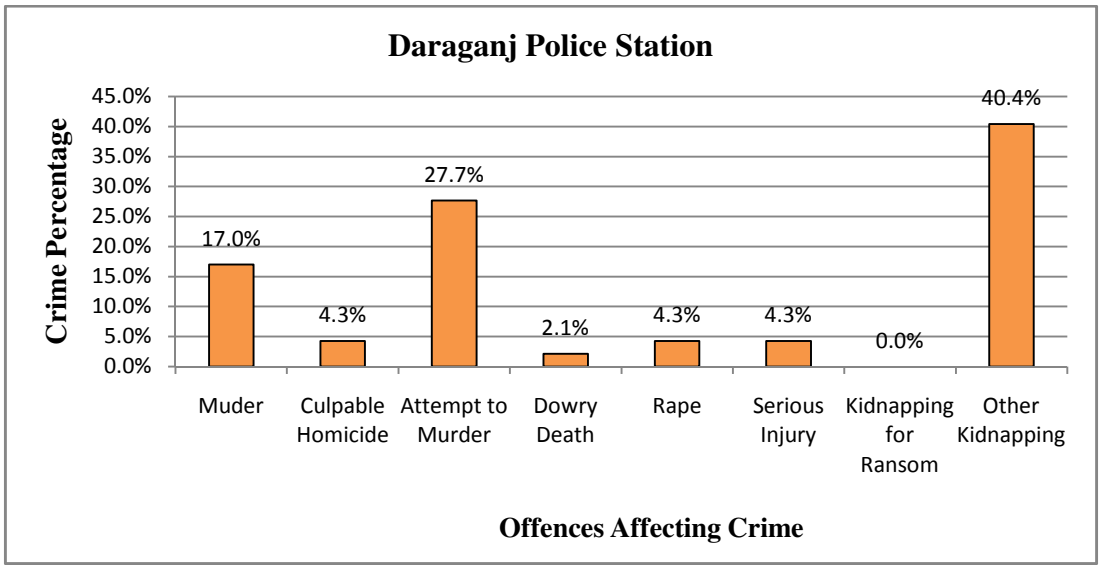


Figure 4.17.14.1 Percentage of Offences affecting Life in Daraganj Police Station

Affecting life' was Other kidnapping (40.4%) followed by Attempt to Murder (27.7%), Murder (17%), Culpable Homicide, Serious Injury and Rape (4.3%), Dowry Death (2.1%).

It is apparent from Figure 4.17.14.2 that highest percent of crime under the group of 'Offence against

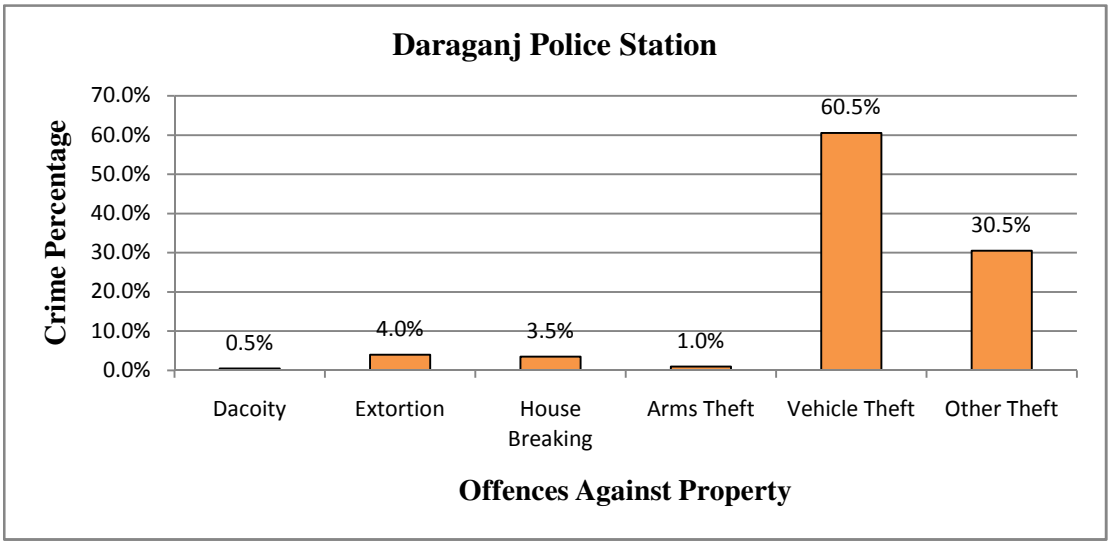


Figure 4.17.14.2 Percentage of Offences against Property in Daraganj Police Station

Property' was Vehicle Theft (60.5%) followed by Other Theft (30.5%), Extortion (4%), House breaking (3.5%) and Arms Theft (1%). The rest of the crimes in addition to the aforementioned groups of crime are presented in Figure 4.17.14.3 It is apparent from figure that crimes conducted under Motor Vehicle Act were the largest group (65.4%) followed by The Police Act (15.7%), Other IPC (6%), 110 CrPC (4.7%), Others Act (2.6%), Excise Act (1.6%),

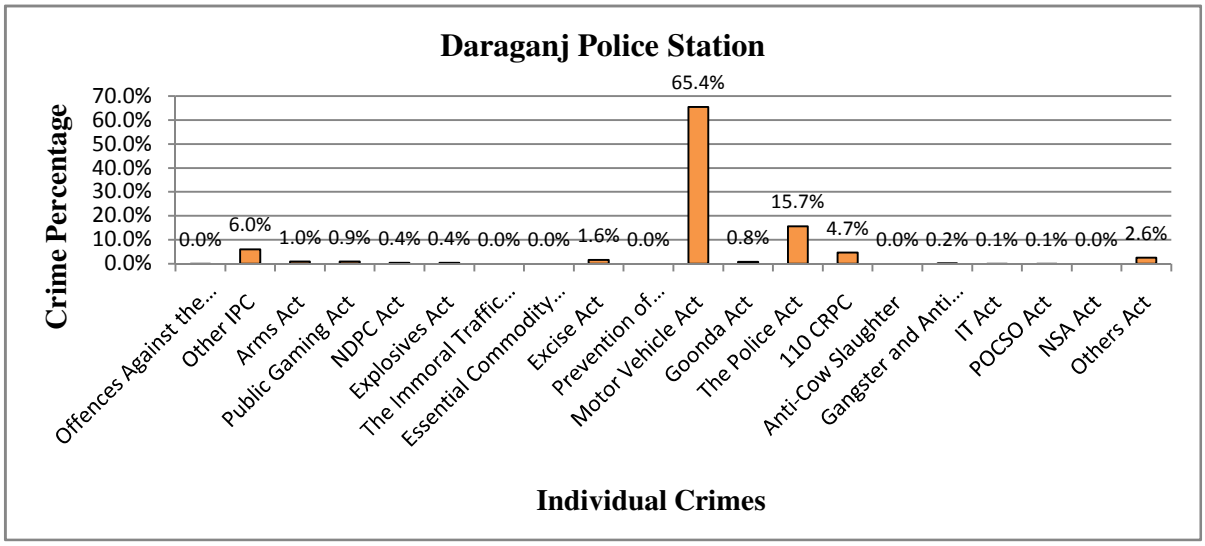


Figure 4.17.14.3 Percentage of Individual Crimes in Daraganj Police Station

Arms Act (1%), Public Gaming Act (0.9%), Goonda Act (0.8%), NDPS Act and Explosives Act (0.4%), Gangster and Anti - Social Activities (0.2%), IT Act and POCSO Act (0.1%).

From figure 4.17.14.4, if we see the overall crimes, the highest percent of crimes reported in Daraganj

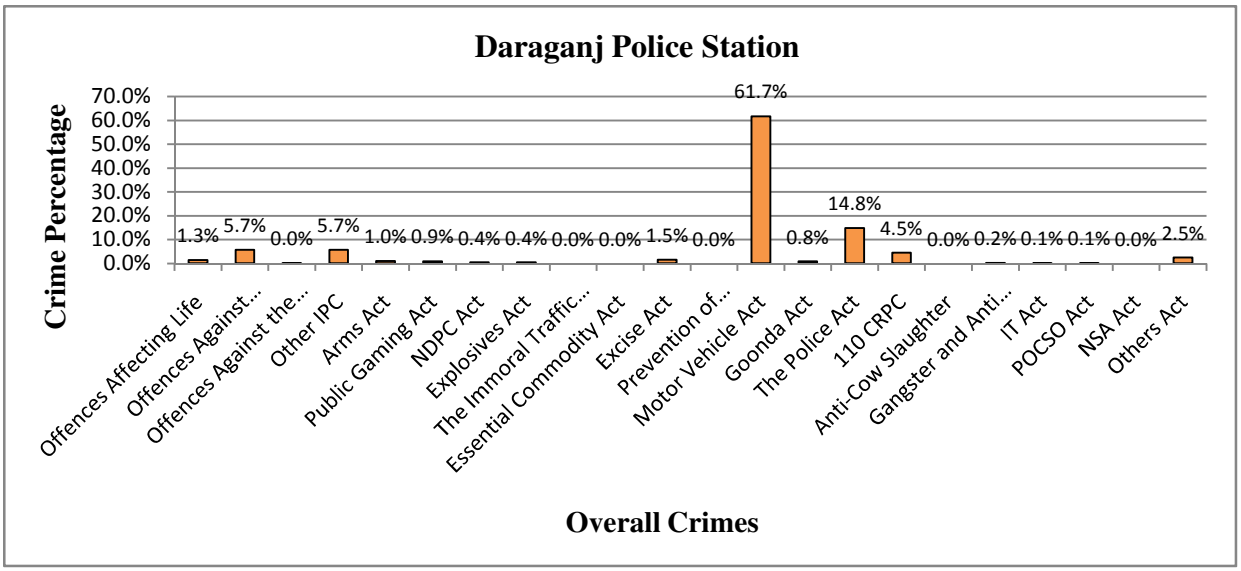


Figure 4.17.14.4 Percentage of Overall Crimes in Daraganj Police Station

Police Station were under Motor Vehicle Act (61.7%), followed by The Police Act (14.8%), Other IPC and Offences Against Property (5.7%), 110 CrPC (4.5%), Others Act (2.5%),Excise Act (1.5%), Offences Affecting Life (1.3%), Arms Act (1%), Public Gaming Act (0.9%), Goonda Act (0.8%), NDPS Act and Explosives Act (0.4%), Gangster and Anti - Social Activities (0.2%), IT Act and POCSO Act (0.1%).

4.18 Zone Wise Analysis:

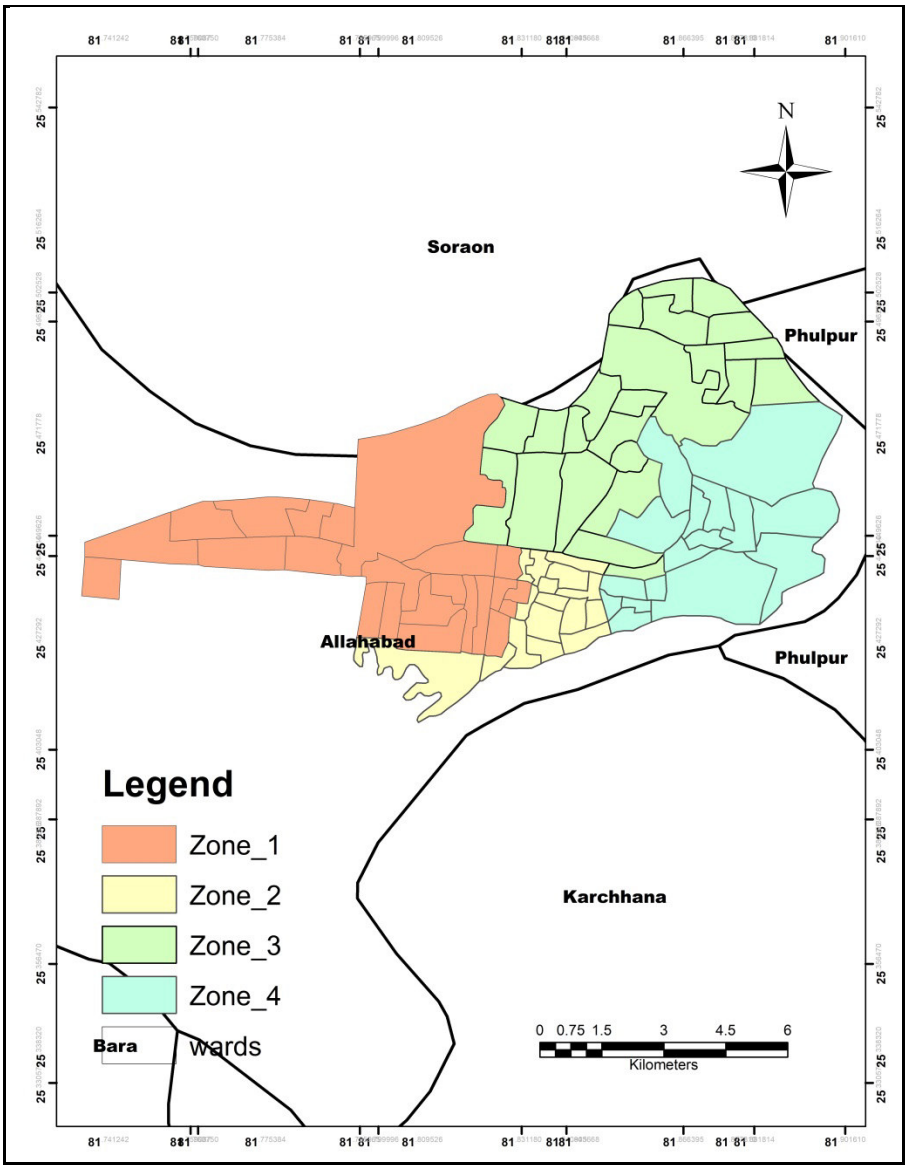


Fig 4.18 Map showing the four Zones

4.18.1 Zone 1

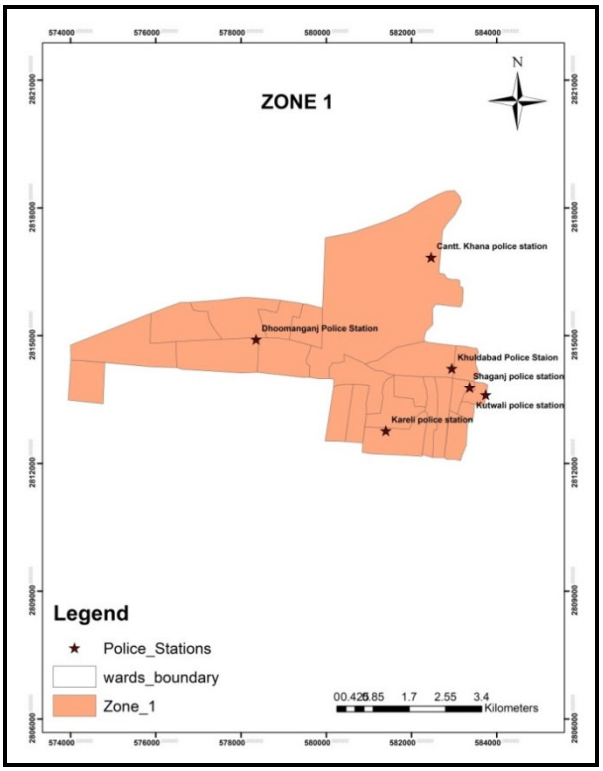


Fig 4.18.1.1 Map showing the location of Police Stations in Zone 1

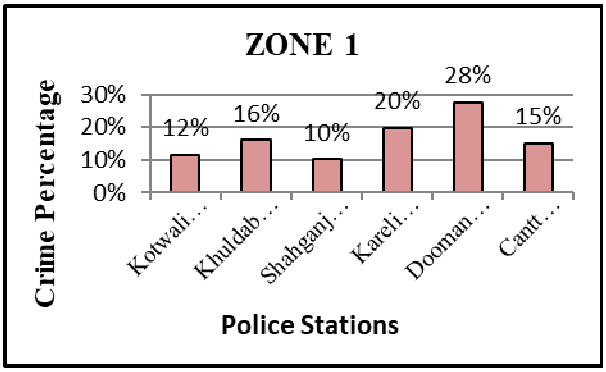


Figure 4.18.1.2 Number of Police Station in Zone 1 with crime percentage

The total number of Police Stations and the percentage of crime reported in each Police Station are presented in Figure 4.18.1.1 and 4.18.1.2. There are six Police Stations in Zone 1 namely Kareli Police Station, Khuldabad Police Station, Shahganj Police Station, Kareli Police Station, Doomanganj Police Station and Cantt Police Station. Out of total 6 Police Stations, Doomanganj Police Station was reported to have the highest crime (28%) followed by Kareli Police Station (20%), Khuldabad Police Station (16%), Cantt Police Station (15%), Kotwali Police Station (12%) and Shahganj Police Station (10%).

4.18.2 Zone 2

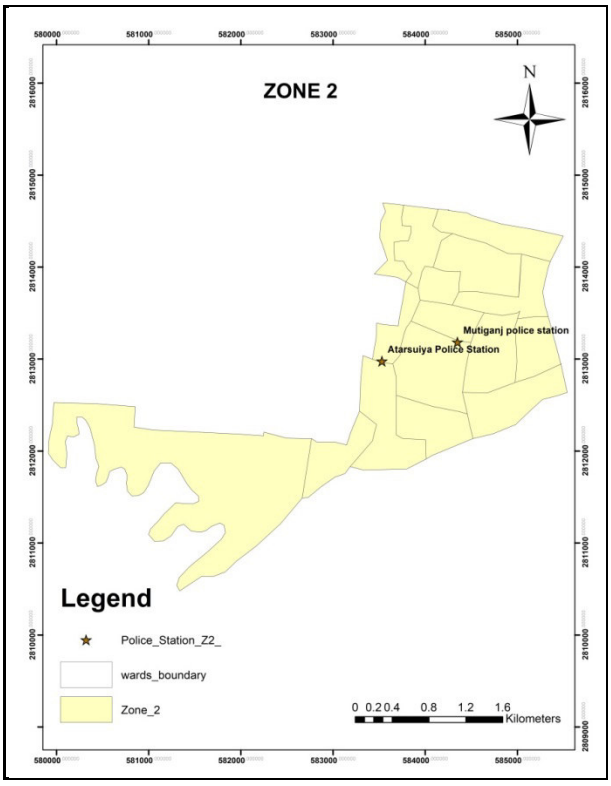


Figure 4.18.2.1 Map showing the location of Police Stations in Zone 2

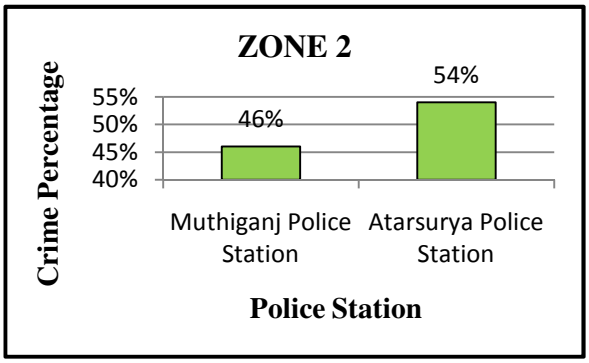


Figure 4.18.2.2 Number of Police Station in Zone with crime percentage

From Figure 4.18.2.2.1 we can apprehend that there are two Police Stations in Zone 2 and figure 4.18.2.2 shows the crime percentage of each Police Station namely Muthiganj Police Station abd Atarsuiya Police Station. Among the two, Attarsuiya Police Station was reported to have higher crime records (54%) and Muthiganj Police Station (46%).

4.18.3 Zone 3

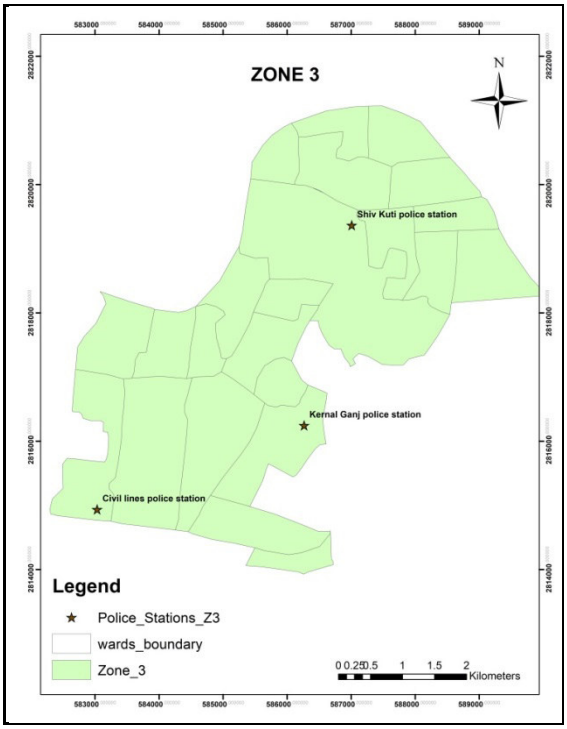


Figure 4.18.3.1 Map showing the location of Police Stations in Zone 3.

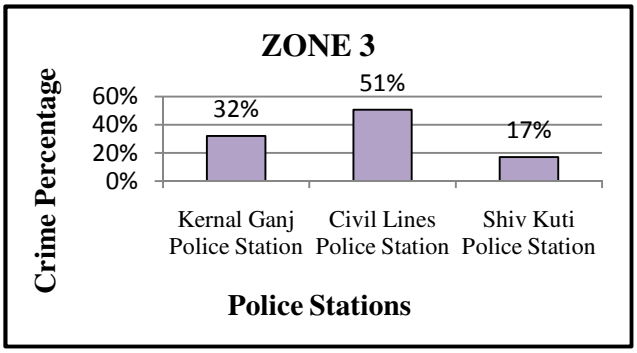


Figure 4.18.3.2 Number of Police Station in Zone 3 with crime percentage.

From figure 4.18.3.1 we can apprehend that there are three Police Stations present in Zone 3 namely Colonel Ganj Police Station, Civil lines Police Station and Shiv Kuti Police Station and figure 4.18.3.2 shows the crime percentage. Among the three, Civil Lines was reported to have the highest crime (51%) followed by Kernal Ganj Police Station (32%) and Shiv Kuti Police Station (17%).

4.18.4 Zone 4

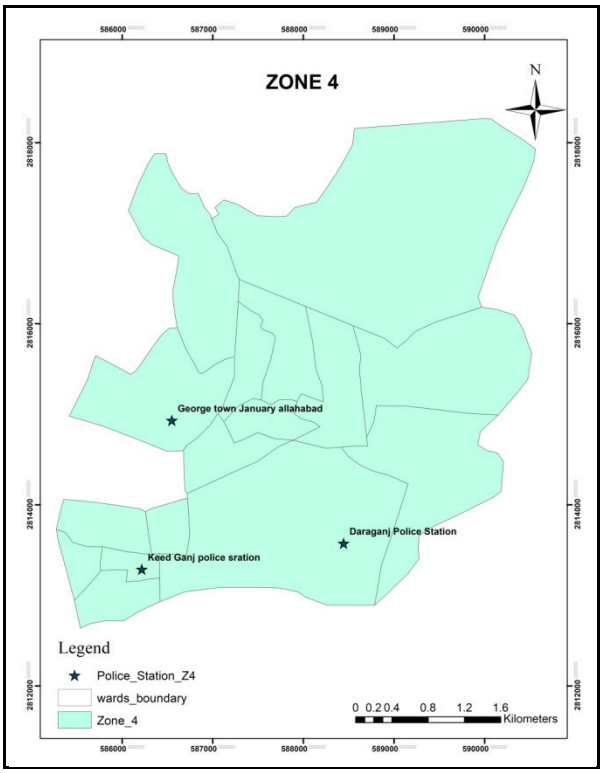


Figure 4.18.4.1 Map showing the location of Police Stations in Zone 4.

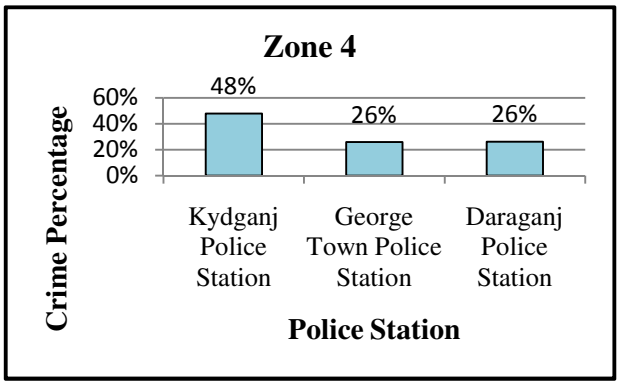


Figure 4.18.4.2 Number of Police Station in Zone 4 with crime percentage.

From figure 4.18.4.1 the map shows the presence of three Police Stations in Zone 4 and figure 4.18.4.2 show the percentage of crime. Among them, Kydganj Police Stations has the highest crime reported (48%) followed by George Town Police Station and Daraganj Police Station with same crime report (26%).

4.19 Comparison between Crime and Population of each Zone:

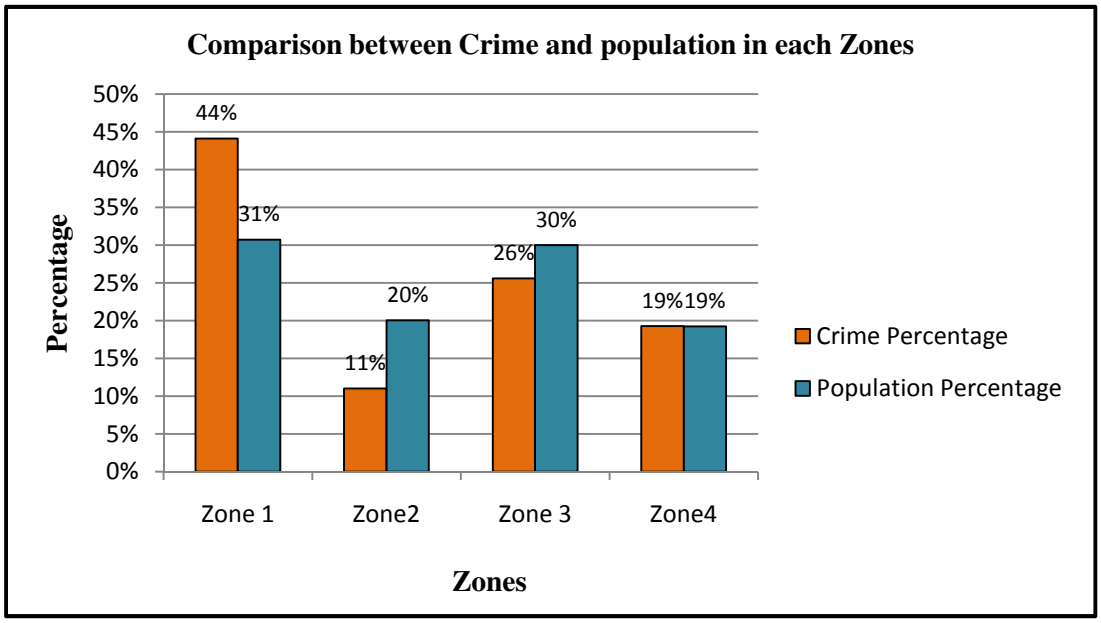


Figure 4.19 Comparisons between Crime and Population of each Zone

Figure 4.19 represents the population and crime in percentage of each zone. The highest population among the four zones was found in Zone one with increasing crime rate. In case of Zone 2 and Zone 3 crime was found to be upsurge as compared to that of population. Zone 4 has almost the same crime rate percentage as compared to the population.

Table 4.19.1 Chi-Square test to see if Police Stations in each zone are evenly distributed based on Crime

Category	Percentage	Chi Square	Degree of freedom	Tabulated value	Alternative Hypothesis
Zone 1	44.1	23.74	3	3.182	S
Zone 2	11				
Zone 3	25.6				
Zone 4	19.3				

The calculated value of Chi square is greater than the table value of Chi square on 5 % probability level and at 3 degree of freedom, so Null hypothesis will be rejected. Hence, it can be concluded from the above data that Police Stations on each Zones are not evenly distributed based on crime.

Table 4.19.2 Chi-Square test to see if Police Stations in each zone are evenly distributed based on Population

Category	Percentage	Chi Square	Degree of freedom	Tabulated value	Alternative Hypothesis
Zone 1	31	4.88	3	3.182	S
Zone 2	20				
Zone 3	30				
Zone 4	19				

The calculated value of Chi square is greater than the table value of Chi square on 5 % probability level and at 3 degree of freedom, so Null hypothesis will be rejected. Hence, it can be concluded from the above data that Police Stations on each Zones are not evenly distributed based on population.

Table 4.19.3 Coefficient-Correlation test to see if there is any relation between Crime and Population

Category	Crime (%)	Population (%)	Coefficient Correlation (r)	T- test (t_o)	Critical Value of T-test (t□)	Null Hypothesis	S/NS
Zone 1	44.1	31	0.82	2.05	1.886	Rejected	S
Zone 2	11	20					
Zone 3	25.6	30					
Zone 4	19.3	19					

Since, the observed (t_o) is greater than the critical value (t_c), Since, the observed (t_o) is greater than the critical value (t□), thus it can say that t_o value is statistically significant. Hence, it can be concluded that as population size increases, crime also increase. Coefficient Correlation is showing positive correlation between the crime and population.

4.20 Determination of Hot Spot by interpolation method (IDW)

The crime data set consists of information about the number and type of the crimes that was reported in each Police Station for three consecutive years (2015-2017) from the month of January – October. This work tends to mitigate the hot spots of locations where the number of crimes happened are more. And also this hot spot mitigation will give the knowledge about the type of crimes that were happened in different locations. This performance evaluation proves the proposed work in this research which is named as interpolation and triangular basis method with the graph measures are compared with the existing work called the Inverse Distance Weighted (IDW) method in terms of performance parameters called the accuracy, precision and recall values. These values are calculated for the different types of crimes which are namely Offences against Life, Offences Against Property, Excise Act, Explosives Act, Goonda Act, Gangster and Anti- social Activity Act, IPC, IT Act, Motor Vehicle Act, NDPS Act, Offences Against Public Tranquility, Others Act, POCSO Act, Public Gaming Act. The GIS representation of clustered results of crimes which reported in various Police Station and crime locations are depicted as follows:

4.20.1 Offences Affecting Life

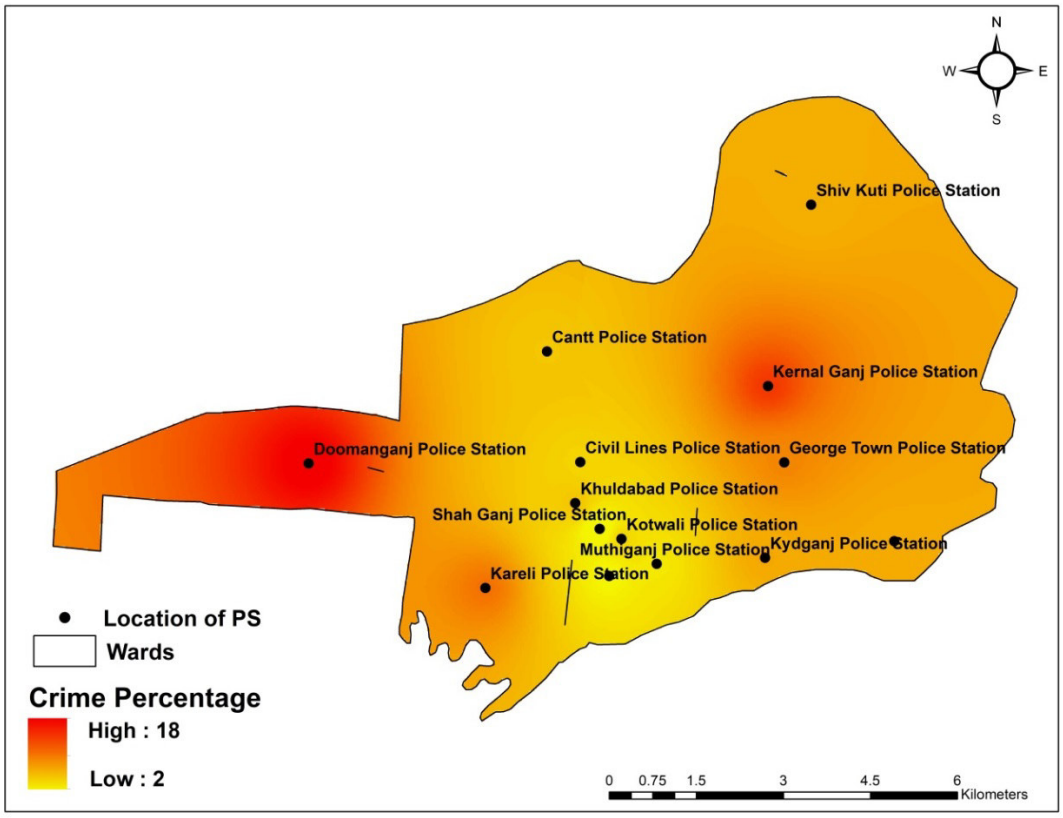


Figure 4.20.1 Map of crime cases related to Offences affecting Life

Figure 4.20.1 depicted the crime density of each Police Station under Offences Against Life were reported 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%), Khuldabad 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%).

4.20.2 Offences Against Property

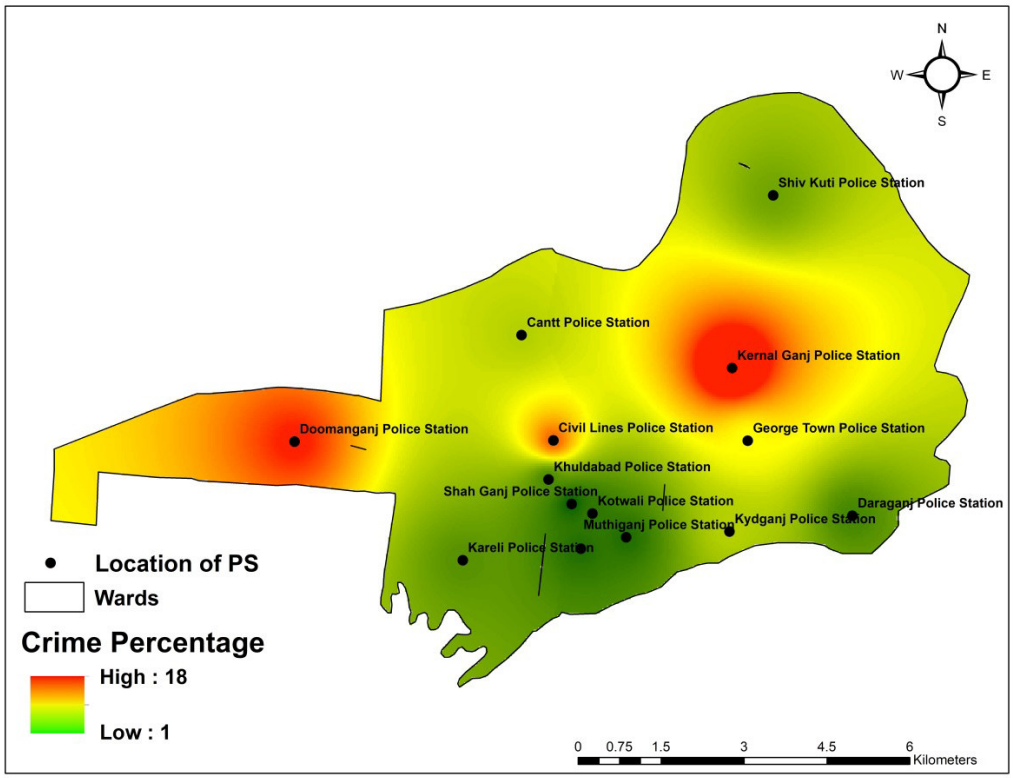


Figure 4.20.2 Map of crime cases related to Offences Against property

Figure 4.20.2 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%), Kotwali Police Station (9%), 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%) and the least were found affected in Attarsuiya Police Station (2%), Shah Ganj Police Station (2%) and Muthiganj Police Station (1%).

4.20.3 Excise Act

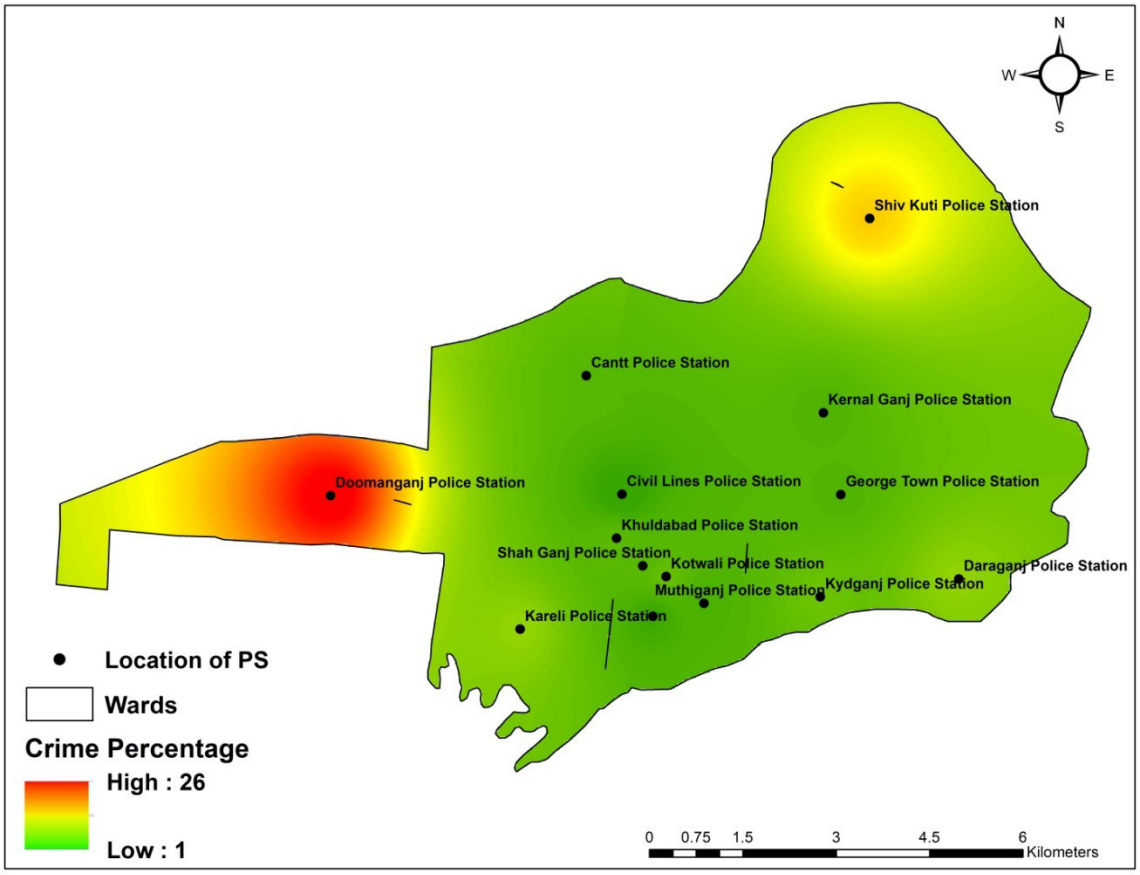


Figure 4.20.3 Map of crime cases related to Excise Act

Figure 4.20.3 presents the spatial distribution of crime under Excise Act. It is apparent from the figure that Doomanganj Police Station (26%) was found to be highly concentrated followed by Shiv Kuti Police Station (16%) Kareli Police Station (8%), Daraganj Police Station(8%), Kotwali Police Station (6%), Kydganj Police Station (6%), Khuldabad police Station (5%), Shah Ganj Police Station (5%), Cantt Police Station (5%), Kernal Ganj Police Station (4%), George Town Police Station (4%), Muthiganj Police Station (4%), Attarsuiya Police Station (2%) and Civil Lines Police Station(1%).

4.20.4 Explosives Act

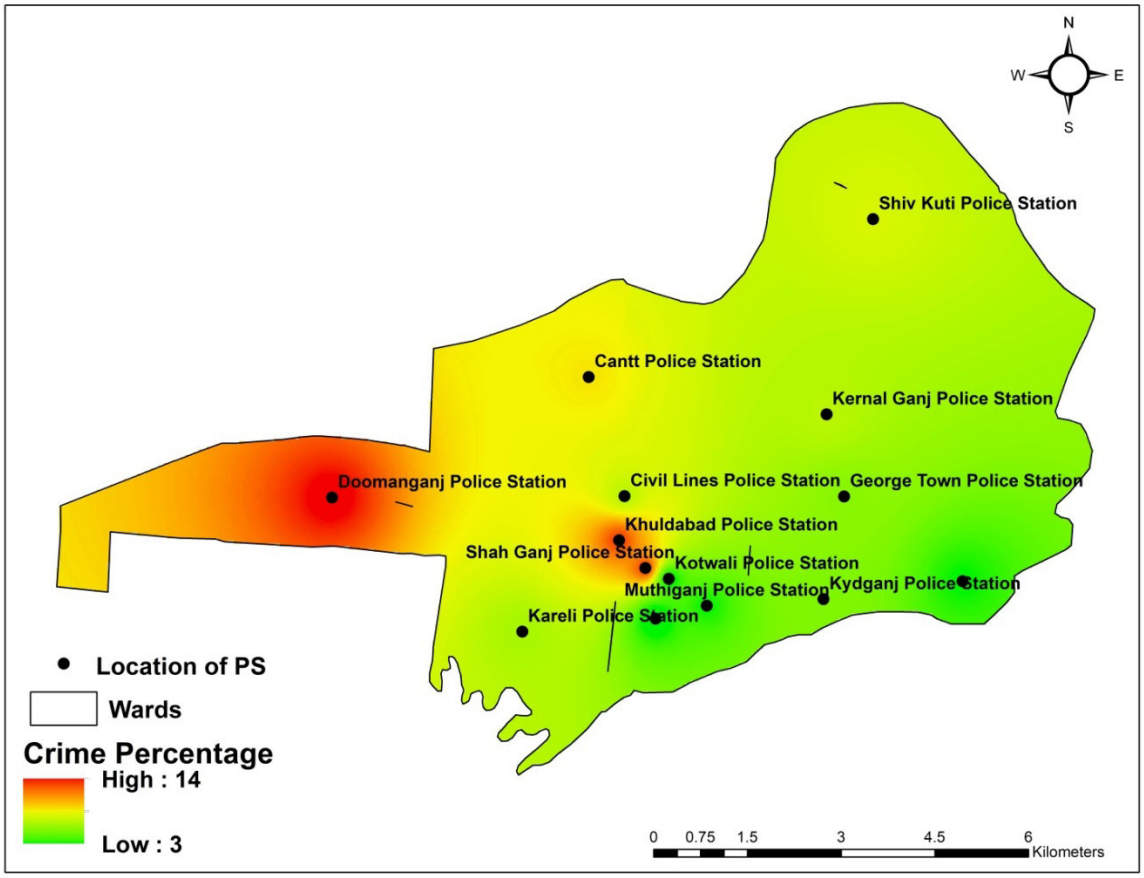


Figure 4.20.4 Map of crime cases related to Explosives Act

It is apparent from Figure 4.20.4 that under the crime of Explosives Act, Doomanganj Police Station (14%) was highly concentrated followed by Khuldabad Police Station (13%), Shah Ganj Police Station.(13%), Cannt Police Station (9%), Shiv Kuti Police Station (8%), Kernal Ganj Police Station (7%), Civil lines Police Station (7%), Kareli Police Station (6%), George Town Police Station (6%), Kydganj Police Station (5%),Muthiganj Police Station (4%), Daraganj police Station (4%). However, Kotwali Police Station and Attarsuiya Police Station were found to be least affected with (3%) under Explosives Act.

4.20.5 Goonda Act

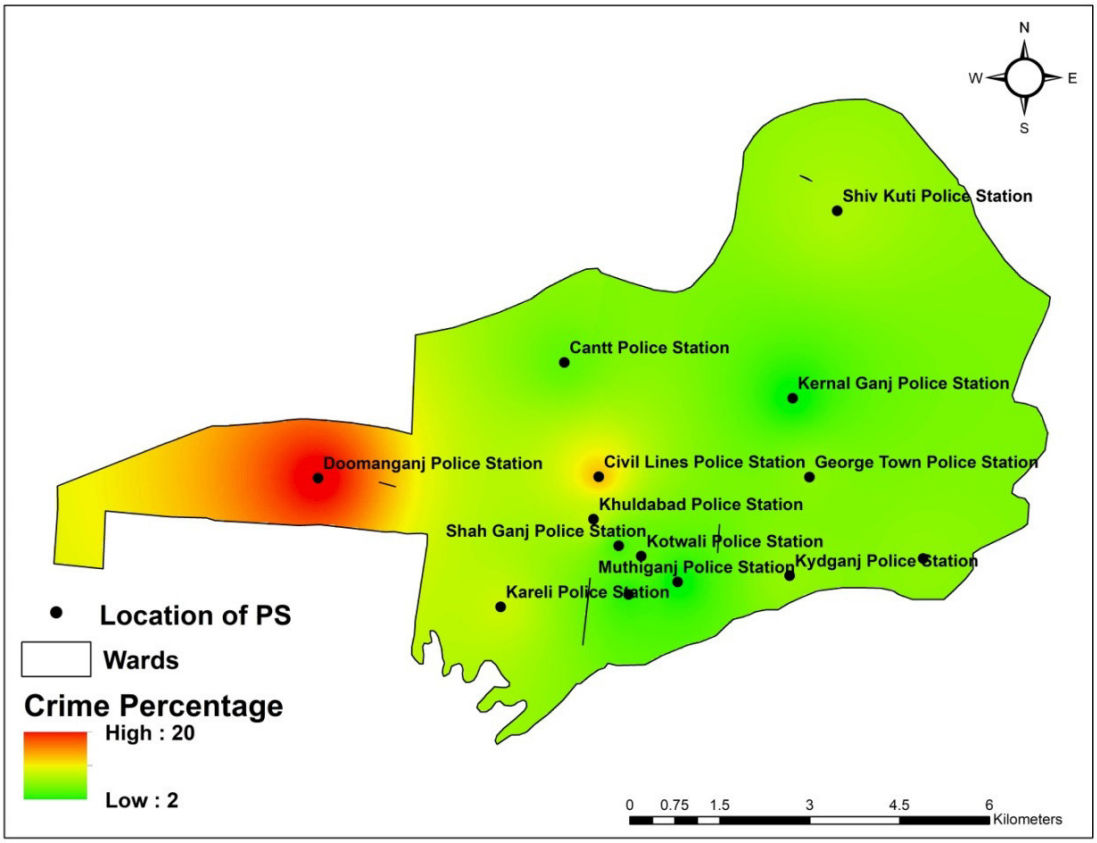


Figure 4.20.5 Map of crime cases related to Goonda Act

Figure 4.20.5 presents the spatial distribution of crime under Goonda Act. It is apparent from the figure that Doomanganj Police Station (20%) was found highly concentrated followed by Civil Lines Police Station (13%, Kareli Police Station(9%), Khuldabad Police Station (9%), Shiv Kuti Police Station (8%), Kydganj Police Station (7%), Daraganj Police Station (7%), George Town Police Station (6%), Kotwali Police Station (5%), Cantt Police Station (5%), Shahganj Police Station (4%). The rest of the Police Station including Attarsuiya Police Station (3%), Kernal Ganj Police Station (3%) and Muthiganj Police Station (2%) shows green shade which depicts that crime under Goonda Act are relatively low.

4.20.6 Gangster Act

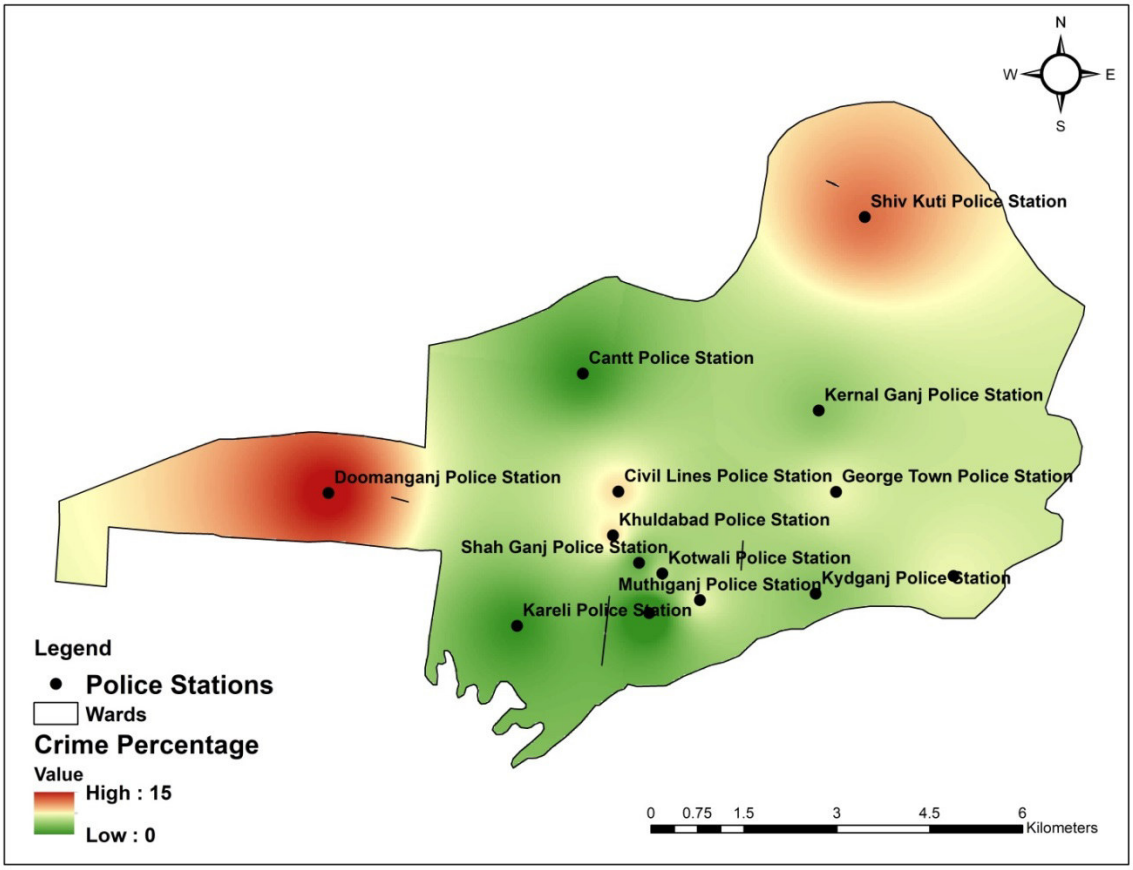


Figure 4.20.6 Map of crime cases of Gangster and Anti-Social Activity Act

It is apparent from Figure 4.20.6 that Doomanganj Police Station (15%) is severely concentrated followed by Shiv Kuti Police Station (13%), Khuldabad Police Station (10%), Civil Lines Police Station (10%), Muthiganj Police Station (8%), George Town Police Station (8%), Daraganj Police Station (8%), Kotwali Police Station (7%), Kyd Ganj Police Station (6%), Kernal Ganj Police Station (6%), Shah Ganj Police Station (3%) , Karel Police Station (3%), Cantt Police Station (3%) and Attarsuiya Police Station with (0%) under Gangster and Anti-Social Activity Act.

4.20.7 Indian Penal Code (IPC)

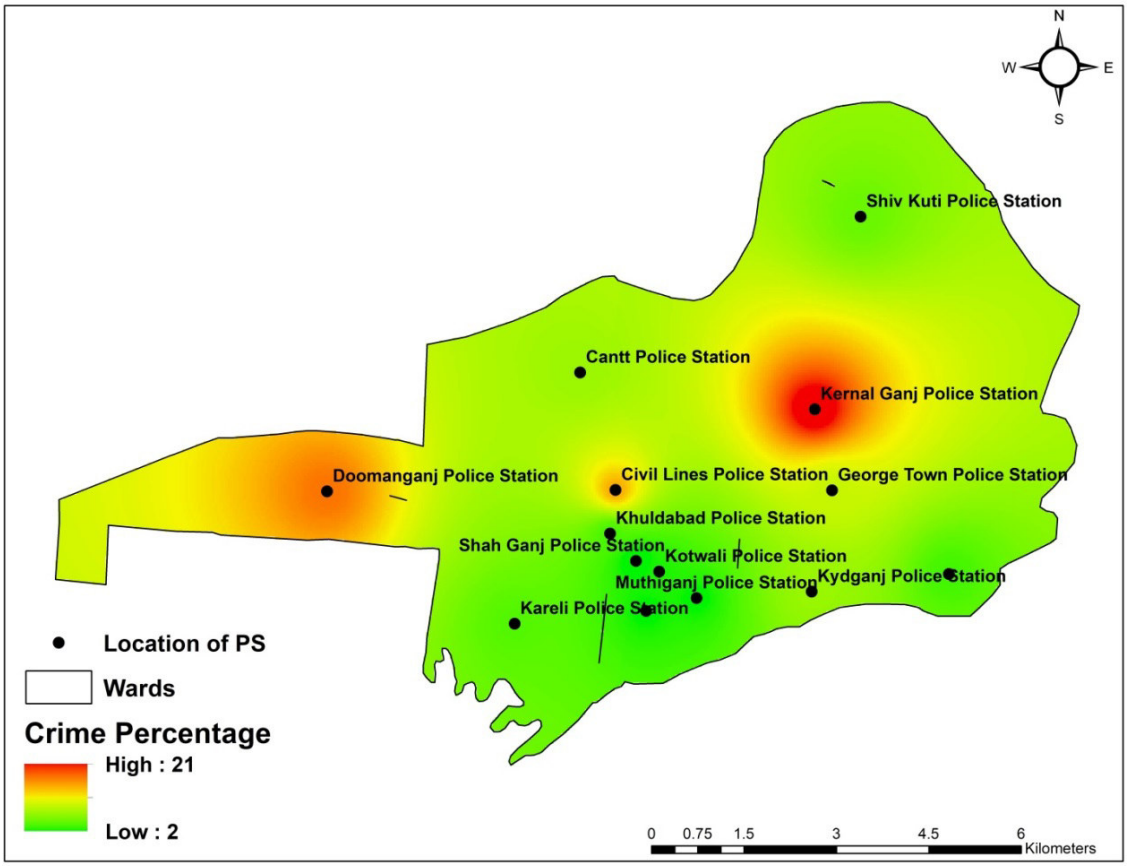


Figure 4.20.7 Map of crime cases related to IPC

From figure 4.20.7 it is apparent that Indian Penal Code (IPC) crime is highly concentrated in Kernal Ganj Police Station(21%), followed by Doomanganj Police Station (16%), Civil Lines Police Station (14%) George Town Police Station (9%), Cantt. Police Station (7%), Kydganj Police Station (7%), Shiv Kuti Police Station (5%), Kareli Police Station (4%), Khuldabad Police Station (4%) and Daraganj Police Station (4%) and Kotwali Police Station (3%). The rest of the Police Station including Muthiganj Police Station, Attarsuiya Police Station and Shahganj Police Station with (2%) as the least crime under IPC.

4.20.8 IT Act

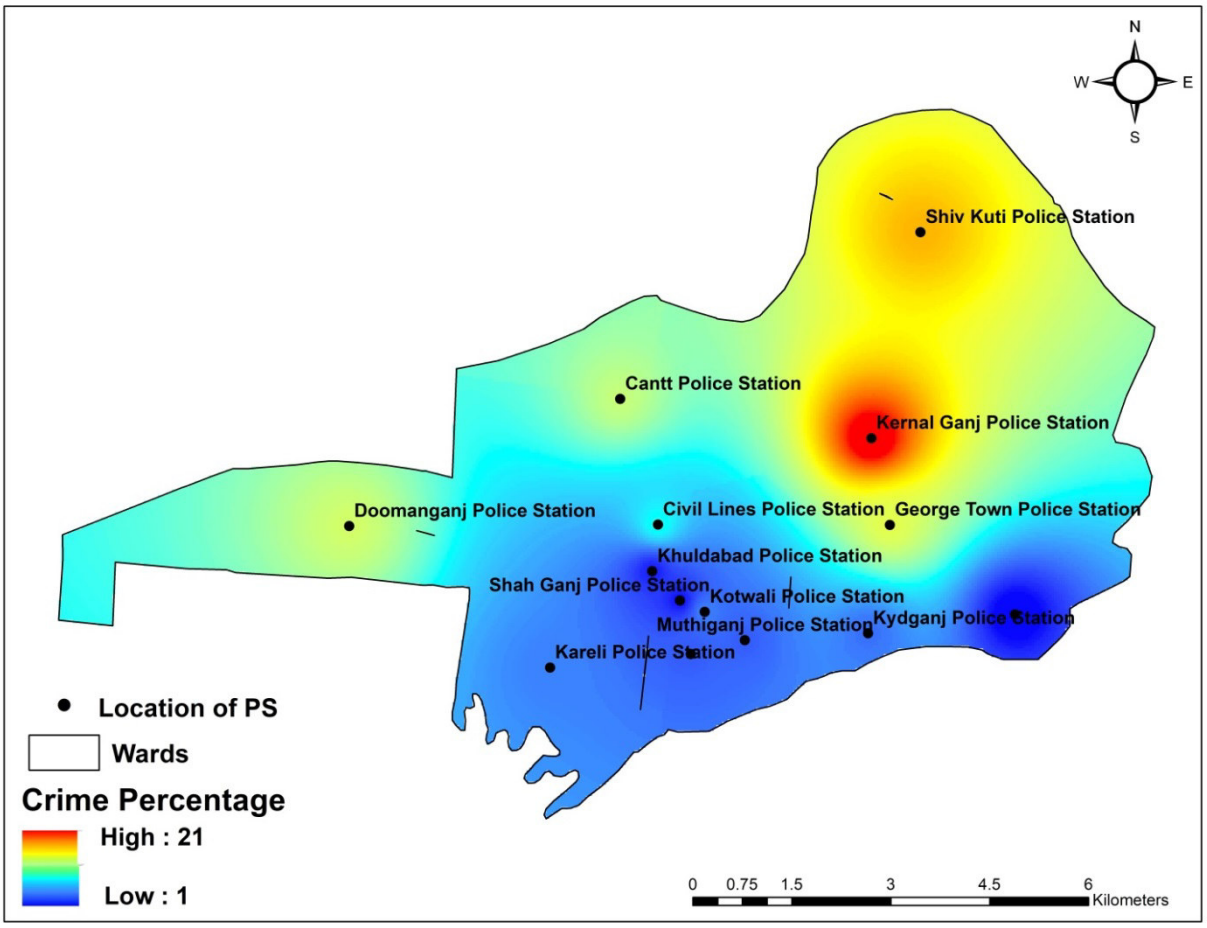


Figure 4.20.8 Map of crime cases related to IT Act

Figure 4.20.8 presents high density of IT Act in Kernal Ganj Police Station (21%) followed by Shiv Kuti Police Station (16%), George Town Police Station (12%), Doomanganj Police Station (11%), Cantt. Police Station (11%) and Civil Lines Police Station (8%). The rest of the Police Station including Kotwali Police Station, Kareli Police Station, Kydganj Police Station with (4%), Muthiganj Police Station, Attarsuiya Police Station with 3% and the least with 1% were affected in Khuldabad Police Station, Shahganj Police Station and Daraganj Police Station.

4.20.9 Motor Vehicle Act

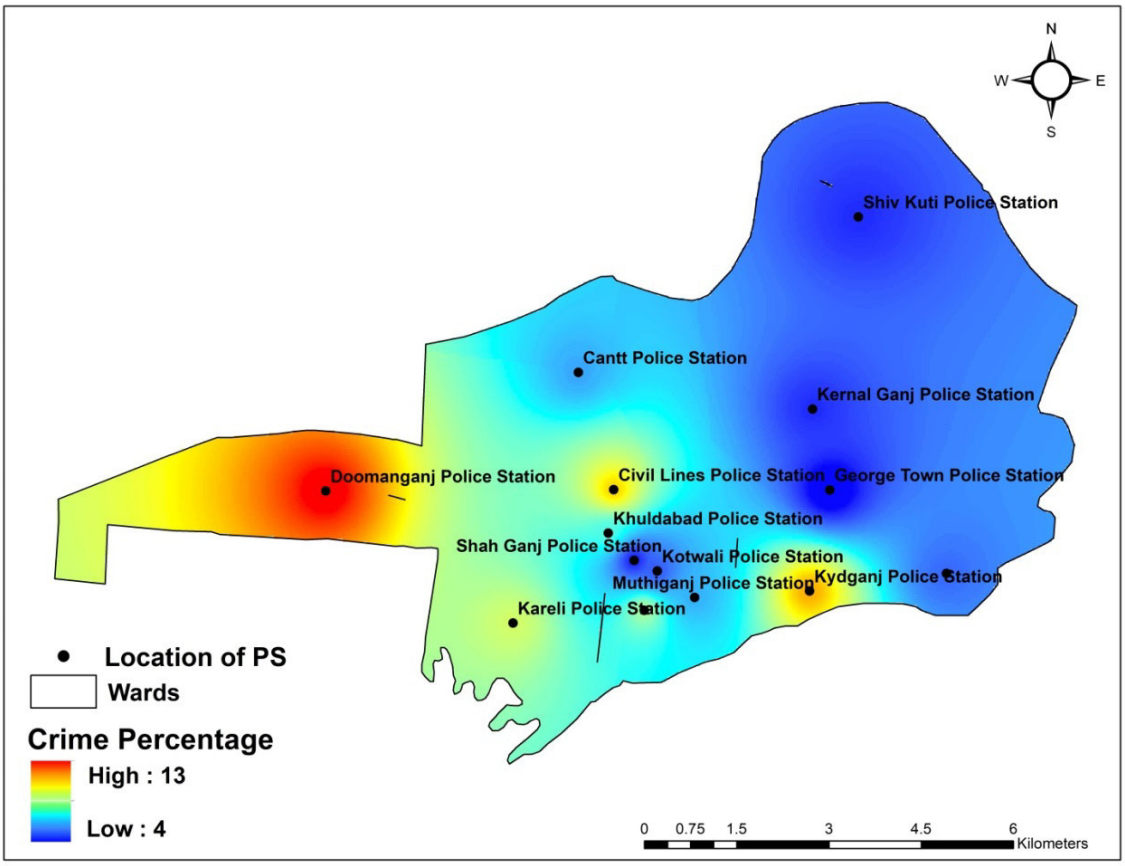


Figure 4.20.9 Map of crime cases related to Motor Vehicle Act

Figure 4.20.9 presents the spatial distribution of crime under Motor Vehicle Act of the city Allahabad from the year 2015 - 2017. It is apparent from the figure that crime under Motor Vehicle Act was found more concentrated in Doomanganj Police Station (13%), followed by Kydganj Police Station (11%), Civil Lines Police Station (11%), Kareli Police Station (9%), Khuldabad Police Station (8%), Attarsuiya Police Station (8%), Cantt Police Station (6%), Muthiganj Police Station (6%), Daraganj Police Station (5%), Kotwali Police Station (5%), Kernal Ganj Police Station (5%), Shiv Kuti Police Station (5%) and slight moderate at Shah Ganj Police Station (4%) and George Town Police Station (4%) under Motor Vehicle Act.

4.20.10 NDPS Act

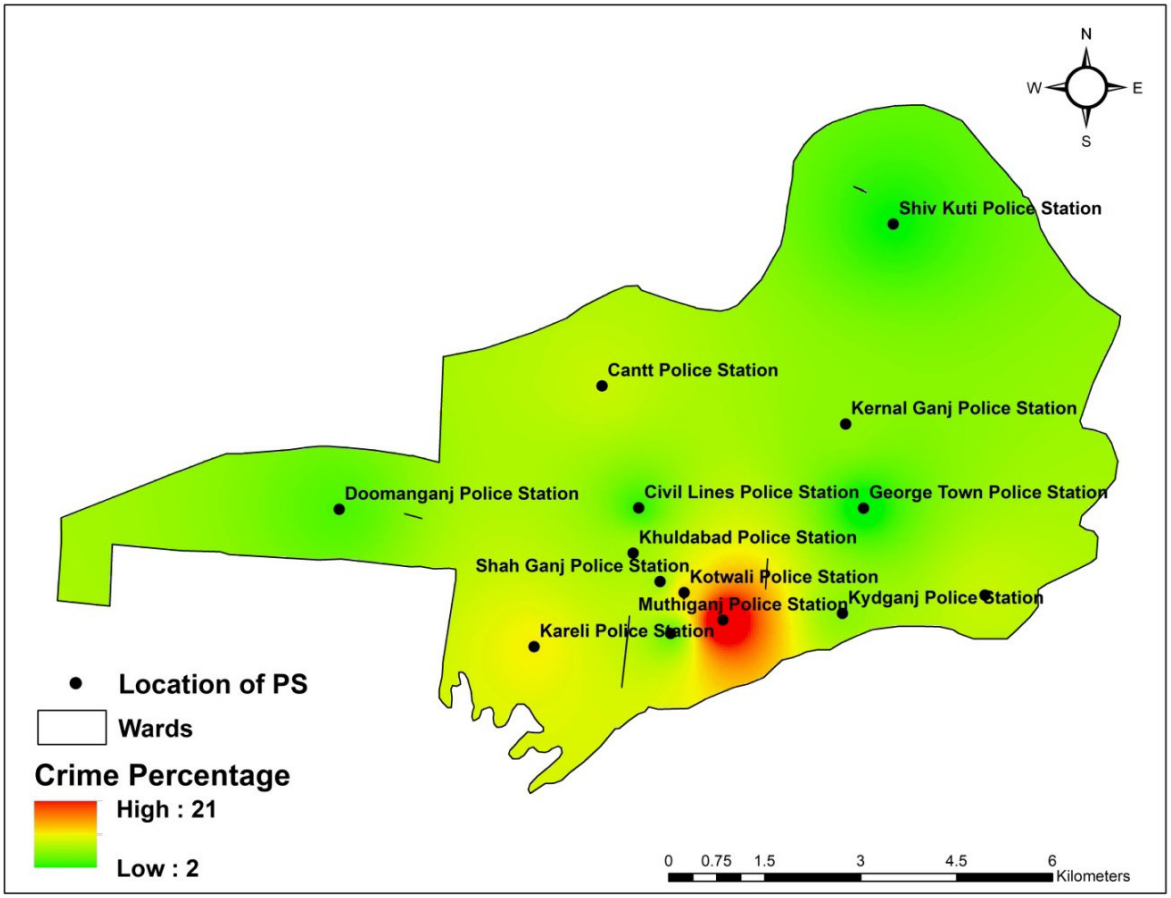


Figure 4.20.10 Map of crime cases related to NDPS Act

It is apparent from Figure 4.20.10 that Muthiganj Police Station (21%) is highly densed with NDPS Act crime followed by Kareli Police Station (10%) and Kotwali Police Station (10%). While Daraganj Police Station (8%), Cantt Police station (8%), Khuldabad Police Station (7%), Shah Ganj Police Station (7%), Kydganj Police Station (6%) and Kernal Ganj Police Station (6%) are moderately affected. Whereas, Attarsuiya Police Station (5%), Civil Line Police Station (4%) and Doomanganj Police Station (4%). Shiv Kuti Police Station and George Town Police Station were found to be least affected (3%).

4.20.11 Offences against Public Tranquility

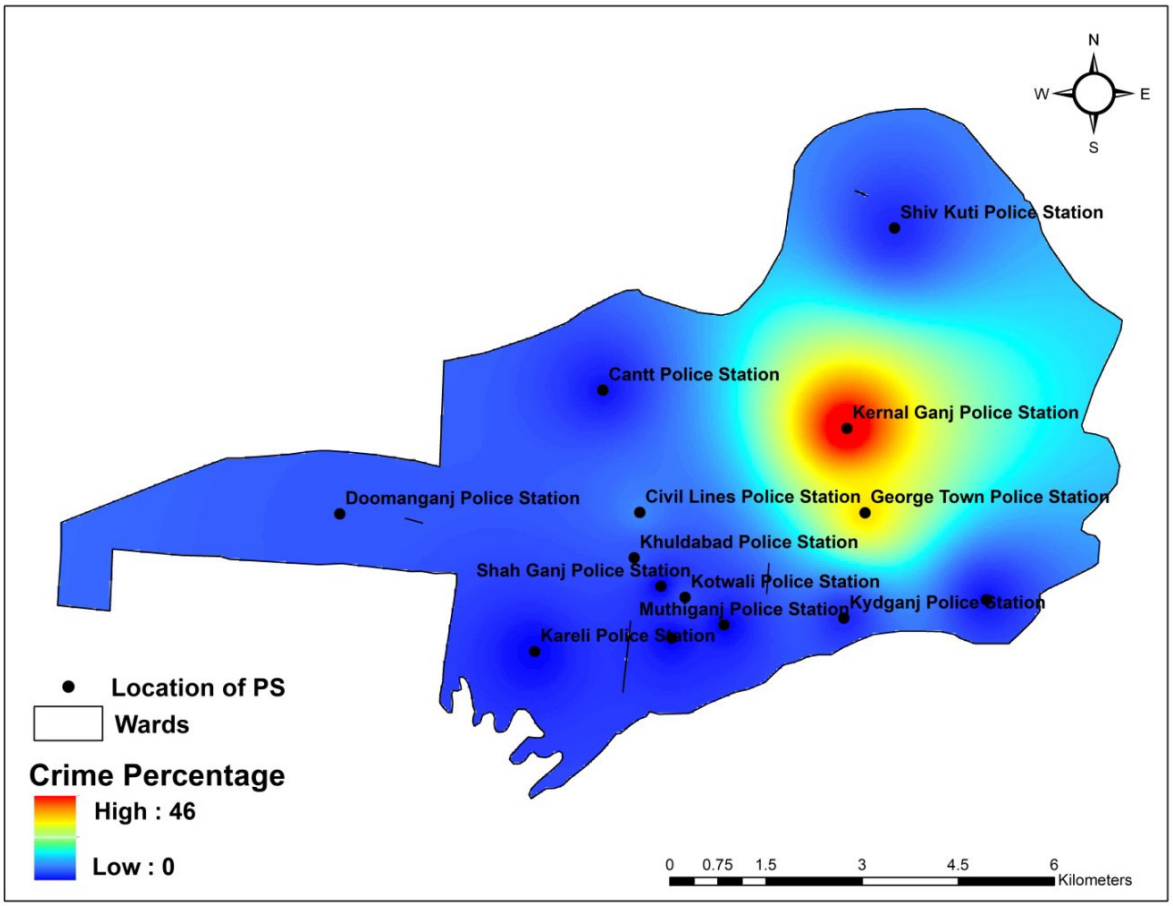


Figure 4.20.11 Map of crime cases related to Offences against Public Tranquility

Figure 4.20.11 presents that the density of crime found highly concentrated in Kernal Ganj Police Station (46%), George Town Police Station (30%) and Civil Lines Police Station (7%). However, Kotwali Police Station, Khuldabad Police Station, Doomanganj Police Station were affected with (4%), whereas Kydganj Police Station and Shiv Kuti Police Station (2%), Cantt Police Station, Daraganj Police Station (1%) and the rest of the Police Stations including Shah Ganj Police Station, Kareli Police Station, Muthiganj Police Station, Attarsuiya Police Station with zero percent.

4.20.12 Others Act

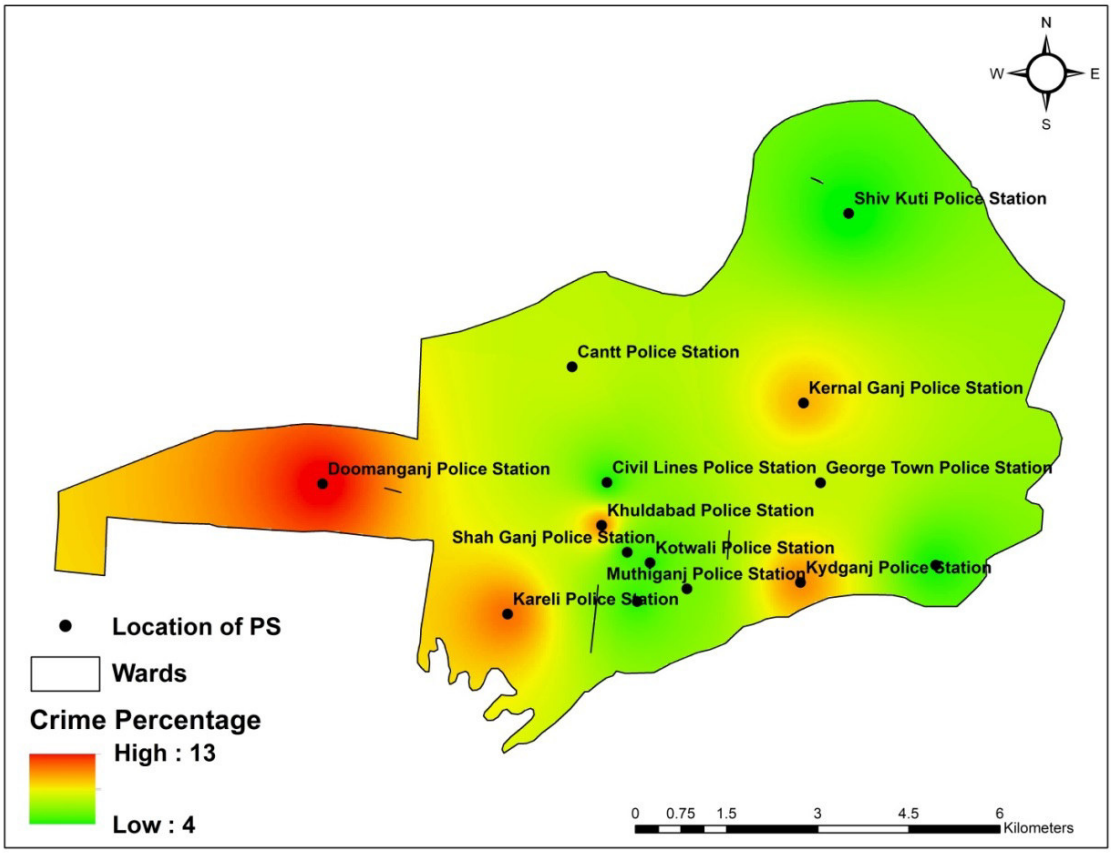


Figure 4.20.12 Map of crime cases related to Others Act

Figure 4.20.12 presents the spatial distribution of crimes reported under Others Act from the period 2015-2017. Doomanganj Police Station was found to be highly concentrated (13%) followed by Kareli Police Station (12%), Kydganj Police Station (11%), Khuldabad Police Station (11%), Kernal Ganj Police Station (10%), George Police Station (7%), Cantt. Police Station (7%), Muthiganj Police Station (5%) and the rest of the Police Station including Kotwali Police Station, Shah Ganj Police Station, Civil Lines Police Station, Attarsuiya Police Station, Shiv Kuti Police Station and Daraganj Police Station were all affected by 4% from Other Act Crime.

4.20.13 POCSO Act

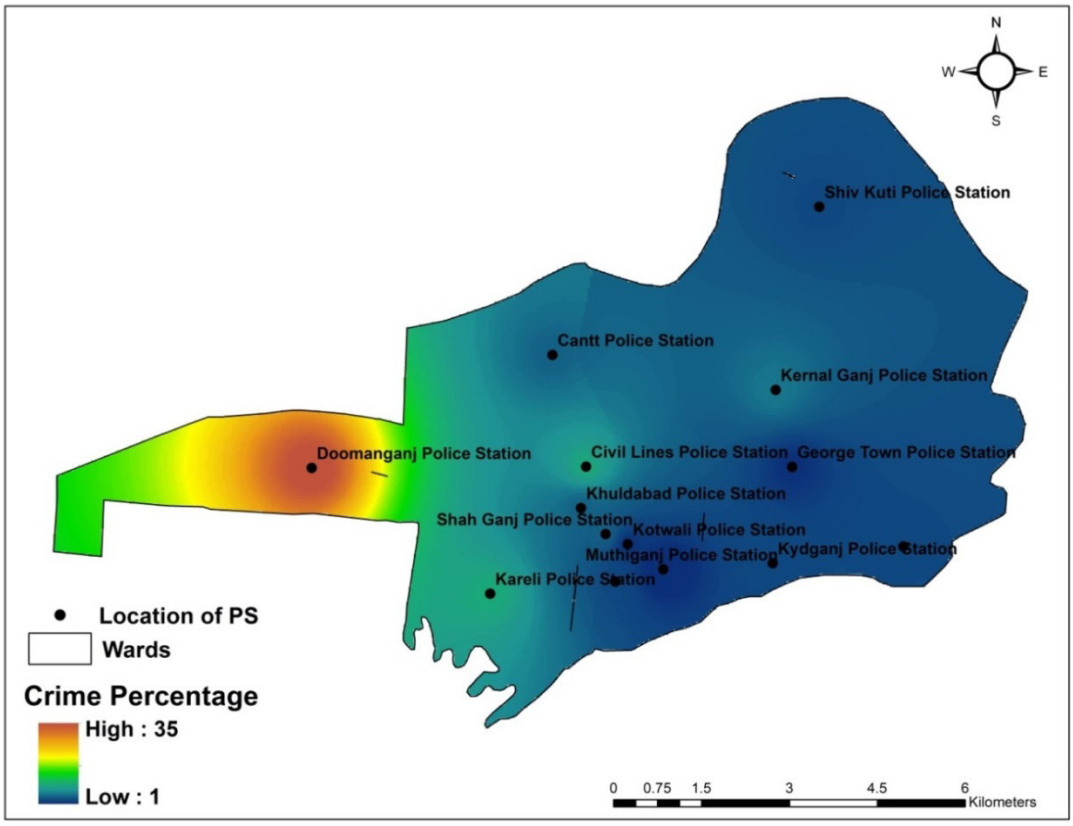


Figure 4.20.13 Map of crime cases related to POCSO Act

Figure 4.20.13 presents the spatial distribution of crimes reported under Protection of Children Against Sexual Offences (POCSO) in the city of Allahabad for the period 2015-2017. It is apparent from Figure 4.34 that crimes under POCSO act were found mostly concentrated around Doomanganj Police Station (35%). Next highest percantage of such crimes were found to be reported at Civil Lines Police Station (10%), Kareli Police Station (10%), Kernal Ganj Police Station (7%), Khuldabad Police Station (5%), Shah Ganj Police Station (5%) and Cantt Police Station (5%) respectively. The rest of the Police Stations including Kotwali Police Station, Kydganj Police Station, Muthiganj Police Station, Attarsuiya Police Station, George Town Police Station, Shiv Kuti Police Station and Daraganj Police Sation were least affected from POCSO crime.

4.20.14 Public Gaming Act

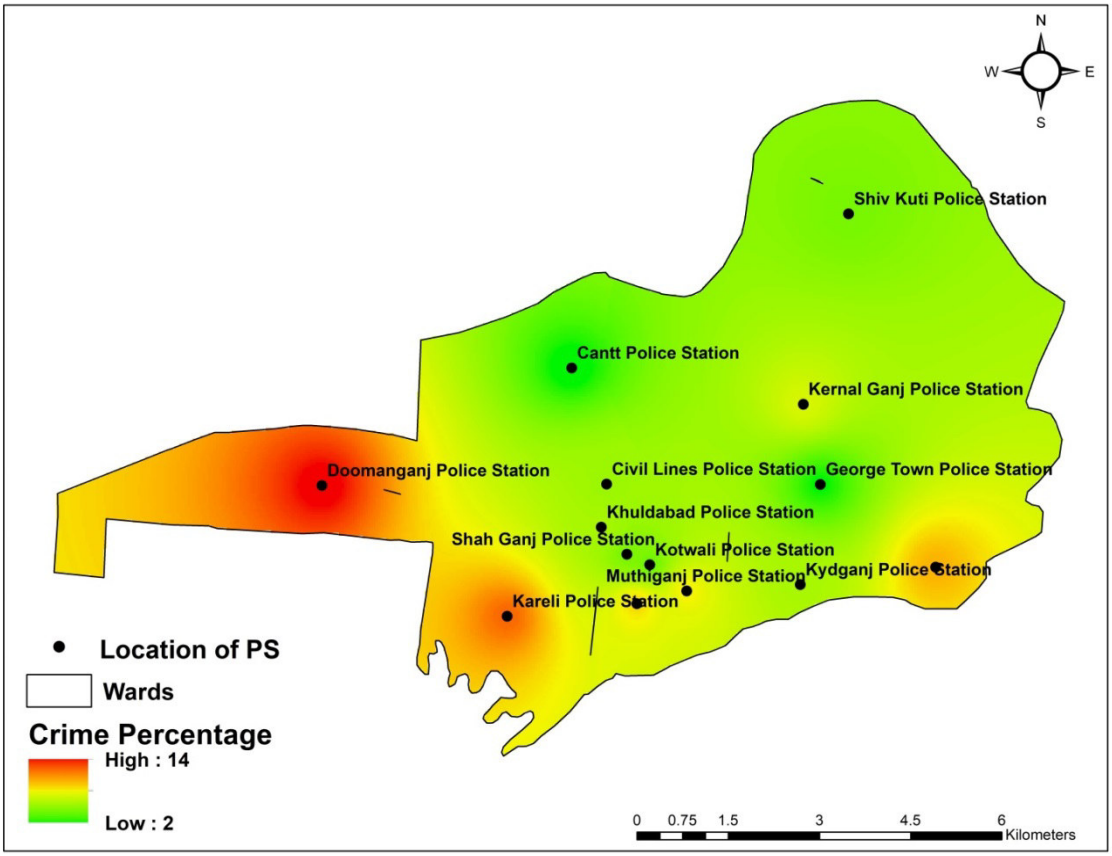


Figure 4.20.13 Map of crime cases related to Public Gaming Act

From the above Figure 4.20.13, it is apparent that Doomanganj Police station was found to be highly concentrated (14%) followed by Daraganj Police Station (10%), Attarsuiya Police Station(9%), Muthiganj Police Station (9%), Kernal Ganj Police Station (8%), Khuldabad Police Station (6%), Kydganj Police Station (6%), Civil Lines Police Station (6%), Shah Ganj Police Station (5%), Kotwali Police Station (5%), and Shiv Kuti Police Station (5%) respectively. The rest of the Police Station like George Town Police Station and Cantt Police Station are least affceted (3%) under Public Gaming Act.

DISCUSSION

The Global Positioning System is not new, but its applications are continuing to expand into the law enforcement community. Police are being tasked with increasingly complicated challenges every day and to perform the traditional methods for crime scene management could be taxing especially for outdoor crime scenes which are considered as one of the difficult tasks to perform. Living in the technological age, every police personnel from constable to higher police officers are all well acquainted with the most common and influential technology 'smart phones'. We are faster and smarter in learning these technology devices however indolent in learning to adapt and apply methods which are taught in literature. In present study, fifteen simulated outdoor crime scenes were created, where both manual tape measurement and DGPS unit was applied to see if the differential GPS offers an accurate and reliable alternative for mapping the scene over the baseline method and to determine the applicability of DGPS utility in mapping outdoor crime scenes. The use of Geographic Information System (GIS) was used to derive a map of the simulated outdoor scenes. There has been very few research done in relation to outdoor crime scenes.

Locational artefacts are of great value to investigators, as they can place a suspect on a crime scene within and timeframe (**Ball, 2008).**

Dutella (2010) opined that mapping or sketching is considered one of the primary means of documentation as it portrays the distance and dimensions of the crime scene and the physical evidence within it.

Dirkmatt (2012) in his study mentioned that there are no standard law enforcement protocols for outdoor crime scenes but further concluded that the same standard protocol applied for indoor

crime scene should be expected at the outdoor crime scene as well. However, the protocols of indoor crime scene applied to outdoor crime scenes were not effective. Therefore, he turned to other disciplines where Forensic Archaeology has provided the solution. Locating the forensic site efficiently and meticulously to the arduous collection and documentation of all relevant evidence, standard forensic archaeological methodologies have enhanced and maximize the amount and quality of data retrieved at the scene. Better understanding of the context of the body certainly helps law enforcement and forensic specialists conduct their analyses and interpretations.

Walter and Schults (2013) demonstrated that the use of traditional baseline mapping may introduce additional error from long distance and obstruction for widely scattered objects. In their study, the accuracy of DGPS (Trimble GeoExplorer 2008 Series Geo XH handheld with Zephyr antenna) was studied for mapping skeletal remains. Firstly, the accuracy of DGPS unit in open environment was determined using the known survey markers. Secondly, three simulated scene exhibiting different types of dispersals were constructed and mapped in an open environment using the DGPS unit. Data were then differentially post-processed (Trimble Path finder version 5.2) and compared in GIS to evaluate the data. The accuracy of the collected point data was 11.52 cm and 9.55cm for 50 sec and 100 sec. Results of this study demonstrates that the DGPS is a viable option for mapping dispersed human remains in open area and to collect the data at 100 sec as it gives a better result. Though, several factors may influence the accuracy of the DGPS unit, the error determined for this unit in an open environment is appropriate for mapping skeletal dispersals.

Listi *et al* (2007) in their project tests whether or not the GPS (GeoExplorer 3 data collection system (TRIMBLE)) offers an accurate and reliable alternative for mapping scattered artifacts. They used a moderately priced unit which offered a good reasonable accuracy in marking just a

single location such as burial site or crime scene. However, the type of GPS used for mapping scattered human remains in close association was not possible in their study. So, they concluded that traditional archeological surveying methods are still indispensable.

Leeuwe (2017) opined that hiatus in crime occurs when the exact location of piece of evidence is not visualized. The recording and visualizing of this spatial distribution is needed in order to reconstruct or recreate the crime scene. He also recommended the use of Geographical Information System (GIS) to ensure successful combination of all the data and subsequent mapping of the distribution of the evidence and its context. By recording the exact location of crime scene documentation could lead to further benefits for investigations as analysis and reconstruction techniques evolve.

In my study, fifteen outdoor simulated crime scenes were created for comparative study by applying manual tape measurement carefully and use of DGPS unit for mapping the crime scene in open environment was implemented. The parameters considered and which could happen in reality are uneven spaces, lack of reference points, density of trees and close proximity The DGPS (R1GNSS receiver) used for this study requires no post processing as Correction sources such as SBAS and RTX networks are applied to suit the location giving the desired accuracy.The readings collected from the manual method and DGPS unit produced consistent result which was statically analyzed using T-test. In all the fifteen scenarios,except for crime scene three which took place below the buiding shade gave a reading from 90 cm to 1m where after exporting the coordinates to ArcGIS for comaprison, it cretaed a havoc which was impossible to conduct the measurements, however for the rest of the scene the accuracy was maintained up to 57cm,41cm, 41cm, 51cm, 46cm, 49cm, 43cm, 48cm, 51cm, 49cm, 51cm, 44cm, 47 cm, 41cm which produced a good consistent result giving an average difference of only 0.5, 0.2, 0.4, 0.1, 0.01, 0.2, 0.06, 0.04, 0.05, 0.2, 0.3, 0.1, 0.1, 0.06 (cm) as compared with manual method and DGPS

method. The minimum distance between two points the device can acquire is 24cm. For the objects lying close to each other below 20cm, tape measurements are recommended and therefore considered indispensable.

ArcGIS was incorporated to present the map of the outdoor scenes. Recreation of scenes after couple of months were conducted using the DGPS unit data which shows the exact location even after environmental changes took place.

Both the manual method and DGPS unit has its own advantages and disadvantages. For conventional method, it requires at least two people to conduct the measurements. However, with the use of DGPS unit single person can handle the crime mapping. Both rough sketch and final sketch is mandatory to complete the documentation process whereas with the help of the DGPS cooridnates, single ArcMap can be established which includes all the measurements as well giving a final map in addition of real world imagery which will definelty gives a better scenerio and georgraphy about the crime scene.Recreation / Reconstruct is not possible at the actual crime scene after decades due to change in nature and environmental factors. With the use of DGPS coordinates, recreation / reconstruction of crime scenes is possible for cold cases as the coordinates once taken will never change. Human are liable to mistakes so manual measurements may cause error. With the use of this device, an error could be reduced. Future research could be conducted on development of a software where by exporting the DGPS coordinates will directly give a 2D or 3D view of the crime scene. This will definelty help the law enforcements, the investigators with integrity to the justice system.

With massive increase in population, crime rate is also increasing drastically. In order to combat crimes, a well prepared police force with sufficient Police Station in every nook and corner and a robust logistic is the primary essential. The problem does not end with lack of facilities or lack of police stations. Most of the police officers are overworked. The issue is particularly critical in

Andhra Pradesh, Bihar, Uttar Pradesh, West Bengal, Dadar and Nagar Haveli and Delhi where there is one policeman for 1,100 people, while the UN recommended ratio is one policeman for every 450 people, but in India there is one policeman for 709 people. This study enunciates that even with decrease in population, crime rate is increasing from the data sourced for three consecutive years (Jan 2015-Oct 2017). (**Ahmed *et al*. 2013)** in his study applied Nearest Neighborhood Analysis and discovered that the police station in his study area is generally random and uneven, with a little clustering at the center . However, in the present study it is found that as one moves away from the center, the sparser the police stations becomes. Among all the four zones, six police stations present in zone one has the highest intensity of crime as compared to other zones. Zone two has only two police stations with 11% of crime rate. Whereas zone three and zone four both has three police stations each where the study shows that crime intensity is utterly high, requiring an attention by setting up few more police stations in these zones as well. The use of GIS is useful for any variety of event analysis **(Kumar and Chandrasekar, 2011)**. This study has implemented the use of Arc GIS to acquire the study area map, zones and wards division and to comprehend the number of police stations present in each zone. **Balogun, (2014)** opined in his study that crime control and management is still mundane monotonous and grossly inefficient to effectively combat the present day gush of crime. This is evidently true in this study being conducted. The need of the hour and the first priority of all the police personnel are to see the safety and security of the community. Therefore, police Stations should be evenly distributed to meet the needs of the society which will ultimately enhance safety of lives within the state.

The hotspot map of various crime reported in the police stations were determined through Interpoation method (IDW). This method was used to find the unknown value of 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. 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. The present study shows that the concentration of crime such as Offences against Life, Excise Act, Explosives Act, Goonda Act, Gangster Act, Motor Vehicle Act, Others Act, POCSO Act, Public Gaming Act was found more in the jurisdiction of Doomanganj Police Station. However, Offences against Property, IPC, IT Act, Offences against Public Tranquility were found more concentrated in the jurisdiction of Kernal Ganj Police Station. Among all the fourteen police stations, Doomanganj Police Station, Kernal Ganj Police Station, Civil Lines Police Station, Shiv Kuti Police Stations, and Kareli Police Station were found to have reported more crimes. The concerned jurisdictions need to have a better patrolling by the police personnel in the near future.

5.SUMMARY AND CONCLUSION

The use of DGPS unit for simulated outdoor crime scene shows its significance over conventional method. The implementation of this device for outdoor crime scene management could be a viable alternative for crime scene management as the DGPS unit has its own advantages which conventional does not have. The main aim of this research was to see if DGPS could be instigated for outdoor scene management and to ultimately present or provide a map of the scene with the use of DGPS coodrinates as managing the outdoor scene can be a tedious job for the police investigators. Therefore, fifteen simulated outdoor crime scenes were all conducted at the open space in different locations within the university campus itself, SHUATS, Allahabad. The visitation of the locations were foremost done to see if a crime could be created. The crime were conducted at places where there were trees and building being surrounded, uneven spaces and at places where there was no single reference points. For each crime scene both the manual tape measurement and DGPS unit was applied carefully. Furthermore, the rough sketches were drawn at the scene itself to show the crime scene layout and the inter distances from one object to another. Final sketches were made on the graph paper. ArcGIS software was implemeted on the research to draw the final map of the crime scenes with the use of DGPS coordinates.

In conclusion, the receiver R1GNSS and software Trimble Terra Flex used in this research was found applicable for outdoor crime scenes because to know the position of the evidences location, the device need to kept at the mid centre at vertical position, which will directly gives the X,Y and Z coordinates whereas in case of manual method two measuremnts from X and Y need to be measured to know the exact location. Traditional method and DGPS unit showed

consistent reading between the readings which made it conclusive that DGPS can be applied over conventional method.

Outdoor simulated scene No. 5 and No.7 were created in a place where the ground was uneven and in such case manual measurement becomes a hinder, however careful measurements were taken and the DGPS method was feasible offering a good mapping in such scenarios as well. Crime scene 2,4,6, 8 and 14 were conducted at places where there were no fixed points, but with the use of this device, the exact locations of the evidences found at the crime scenes could be retrieve back anytime. Crime Scene 1,9,11,12,13,14,15 were conducted at places where trees and elctric poles were surrounded and taken as static reference points. The device could differentiate the objects that lies within 24cm to each other. The overall results between the two methods shows a consistent reading giving a strong conclusion that accuarte mapping of crime scene is possible and recreation of crime scene even after years is possible with the use of DGPS data maintaining integrity and exactness of the crime scene of how it happened. A DGPS base protocol was developed for outdoor crime scene management. This protocol was applied for recreation of crime scene which provide a good outcome.

Recommendations

1. Future studies can be taken forward on real crime scenes or case studies.
2. Design a software that can directly give a 3D mapping of the crime scene when DGPS coordinates are imported.

Limitations

1. In places where buildings are surrounded or being obstructed, maintaining accuracy level was a problem.
2. However, this could be a drawback for indoor crime scenes as the accuracy of the DGPS data can be affected by the obstruction of the buildings and other factors.

In the second part of the study, it was discovered that the distribution of police stations are not evenly distributed based on crime and population. The highest number of Police station present in Zone one had six with increasing crime rate. Zone two and Zone three has only two police stations and three police stations respectively but crime was found to be upsurge as compared to that of population. Zone four has almost the same crime rate percentage as compared to the population. Chi-square test for crime gives a value of 23.74 which shows a greater value than the table value (3.182), whereas the population gives a value of 4.88 which also shows a greater value than the table value (3.182) at 5% probability level showing that the police stations in Allahabad city are not evenly distributed based on crime and population.

Coefficient correlation and t-test gives a value r □ 0.82 and t_o□2.05. Since, the observed value is greater than the critical value (1.886) at 10 % probability level; we can say that t_o value is statistically significant. Coefficient Correlation is showing positive correlation between the crime and population. Hence, we can conclude that as population size increases, crime also increases.

The study also shows that the proximity of all the different types of crime concentration was found more in the jurisdiction of Doomanganj Police Station, Kernal Ganj Police Station, Civil Lines Police Station, Shiv Kuti 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 research 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 the crime pattern in relation to police stations, offenders residence and to identify the hotspot of crime in a locality.

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APPENDIX

APPENDIX A- DGPS (R1GNSS) Coordinates and T-test table

Crime Scene 1

Sl. no	Code name	Name of the Evidences	Differential GPS Co-ordinates		
			Longitude	Latitude	Height
1.	CRP1	CRP1-CRP2	81.8472248	25.41286822	25.66138417
2.	CRP2	CRP2-CRP3	81.84728155	25.41298808	16.02537496
3.	CRP3	CRP3-CRP4	81.84742757	25.41288016	29.59602692
4.	CRP4	CRP4-CRP1	81.84734259	25.41278404	26.56947769
5.	RP1	Tree (RP1-RP2	81.84728155	25.41298808	16.02537496
6.	RP2	Tree	81.84734259	25.41278404	26.56947769
7.	E1	Tablet cover	81.84727902	25.41290712	25.43689428
8.	E2	Watch	81.84738119	25.41288858	23.67247678
9.	E3	Blood droplet	81.84735266	25.41287064	23.83182726
10.	E4	Key Chain	81.84736623	25.41284422	23.33188473
11.	E5	Pen (Black Outer Cover)	81.84731463	25.41283174	24.40075983

Crime Scene 2

Sl.no	Code name	Name of the Evidences	Differential GPS Co-ordinates		
			Longitude	Latitude	Height
1.	CRP1	CRP1-CRP2	81.84722504	25.41271866	38.69853938
2.	CRP2	CRP2-CRP3	81.84720314	25.41266071	39.2199485
3.	CRP3	CRP3-CRP4	81.84730478	25.41262898	38.33446491
4.	CRP4	CRP4-CRP1	81.84732554	25.41268852	39.68676611
5.	RP1	Corner as reference	81.84722504	25.41271866	38.69853938
6.	RP2	Corner as reference	81.84730478	25.41262898	38.33446491
7.	E1	Dead Body	81.84729712	25.41266571	38.99744773
8.	E2	Shoeprint1	81.84728307	25.41267005	38.45683791
9.	E3	Shoeprint2	81.84728352	25.41266999	38.57814591
10.	E4	Blood drop	81.84727853	25.41267611	39.4913566
11.	E5	Bullet Shell	81.84723588	25.41269452	38.64716766

Crime Scene 3

Sl.no	Code name	Name of the Evidences	Differential GPS Co-ordinates		
			Longitude	Latitude	Height
1.	CRP1	CRP1-CRP2	81.84694455	25.41252979	22.92296949
2.	CRP2	CRP2-CRP3	81.84696667	25.41242747	38.91661579
3.	CRP3	CRP3-CRP4	81.84688117	25.41248482	30.46789145
4.	CRP4	CRP4-CRP1	81.84692973	25.41255754	28.60442237
5.	RP1	Corner as reference	81.8469492	25.41255906	27.80173762
6.	RP2	Corner as reference	81.84692636	25.41247505	25.69502778
7.	E1	Dead Body	81.8468822	25.41255493	33.79684005
8.	E2	Blood pool	81.8468921	25.41252875	37.06868601
9.	E3	Sandal	81.84693958	25.41252519	20.67816855
10.	E4	Watch	81.84691998	25.41253485	36.71656655
11.	E5	Umbrella	81.84698615	25.41252743	22.9908998

Crime Scene 4

Sl.no	Code name	Name of the Evidences	Differential GPS Co-ordinates		
			Longitude	Latitude	Height
1.	RP1	Blank	81.84689913	25.41275439	49.86553425
2.	RP2	Blank	81.84723069	25.41262267	39.82866216
3.	E1	Rubber Glove (Orange)	81.84699287	25.41272957	40.10169244
4.	E2	Paper Blade Cutter	81.84716252	25.412668	38.87706511
5.	E3	Blood Droplets	81.8471786	25.41263111	39.45619768

Crime Scene 5

Sl. no	Code name	Name of the Evidences	Differential GPS Co-ordinates		
			Longitude	Latitude	Height
1.	CRP1	CRP1-CRP2	81.84783981	25.41094516	24.85789542
2.	CRP2	CRP2-CRP3	81.8478747	25.41090963	26.25538947
3.	CRP3	CRP3-CRP4	81.847774	25.41083	24.52805903
4.	CRP4	CRP4-CRP1	81.847734	25.410862	25.01601549
5.	RP1	Trees	81.84784729	25.41089606	26.80737929
6.	RP2	Electric Pole	81.84782787	25.41092941	24.19345265
7.	E1	Partial Brick with blood	81.847817	25.41090612	27.89691308

		stain			
8.	E2	Wallet	81.847825	25.41089823	24.90653592

Crime Scene 6

Sl.no	**Code name**	**Name of the Evidences**	**Differential GPS Co-ordinates**		
			Longitude	**Latitude**	**Height**
1.	CRP1	CRP1-CRP2	81.84843718	25.41070951	27.17976447
2.	CRP2	CRP2-CRP3	81.84837078	25.41077891	24.61187754
3.	CRP3	CRP3-CRP4	81.84811272	25.41065318	27.96412531
4.	CRP4	CRP4-CRP1	81.84814538	25.41057996	28.48473867
5.	RP1	No Static Point	81.848245	25.410717	25.0804271
6.	RP2	No Static Point	81.848279	25.41064	30.14798969
7.	E1	Blood Droplets	81.84834259	25.41067011	26.06291563
8.	E2	Blood Stain on Rod	81.84829628	25.41067582	24.03850623
9.	E3	Shoe (Right Side)	81.84825791	25.41070356	25.575089

Crime Scene 7

Sl.no	Code name	Name of the Evidences	Differential GPS Co-ordinates		
			Longitude	Latitude	Height
1.	CRP1	CRP1-CRP2	81.84785419	25.41089721	23.99772292
2.	CRP2	CRP2-CRP3	81.84781683	25.41093311	22.98733166
3.	CRP3	CRP3-CRP4	81.84772624	25.41084919	27.72454853
4.	CRP4	CRP4-CRP1	81.847768	25.410841	22.18793375
5.	RP1	Tree	81.847824	25.410919	24.92558025
6.	RP2	Electric Pole	81.847755	25.410853	23.34521
7.	E1	Steel rod with blood stain	81.847783	25.410865	23.94498163
8.	E2	Black Cigarette bud	81.84779877	25.41087061	23.3742136
9.	E3	Junks	81.84781934	25.41087982	26.5322444
10.	E4	Local weed	81.84780605	25.41088358	25.89781072

Crime Scene 8

Sl.no	Code name	Name of the Evidences	Differential GPS Co-ordinates		
			Longitude	Latitude	Height
1.	CRP1	CRP1-CRP2	81.847113	25.412605	41.43525397
2.	CRP2	CRP2-CRP3	81.847209	25.412569	40.33482744
3.	CRP3	CRP3-CRP4	81.847199	25.412533	40.23547842
4.	CRP4	CRP4-CRP5	81.84724	25.412518	41.43527653
5.	CRP5	CRP5-CRP2	81.847256	25.412543	41.24367541
6.	E1	Pool of blood	81.847215	25.412538	42.41351267
7.	E2	Fallen Cup	81.847227	25.412542	41.45370213
8.	E3	Cigarette bud	81.847241	25.412542	41.31414362
9.	E4	Cup	81.847238	25.412546	42.50233398
10.	E5	Fallen chair	81.847216	25.412558	41.39906033
11.	E6 (2-3)	Series of blood	81.847215	25.412577	40.78939011
12.	E6 (3-4)	-do-	81.847188	25.412588	42.79323151
13.	E6 (4-5)	-do-	81.847159	25.412596	41.77304085
14.	E6 (5-6)	-do-	81.847133	25.412611	44.10836151
15.	E6 (6-7)	-do-	81.847092	25.412629	40.61473856
16.	E7	Unconcious body	81.847092	25.412629	40.61473856

Crime Scene 9

Sl. no	Code name	Name of the Evidences	Differential GPS Co-ordinates		
			Longitude	**Latitude**	**Height**
1.	CRP1	CRP1-CRP2	81.84681917	25.41189824	30.08054615
2.	CRP2	CRP2-CRP3	81.84673542	25.41192943	30.66908808
3.	CRP3	CRP3-CRP4	81.8466804	25.41189187	27.01030914
4.	CRP4	CRP4-CRP1	81.8467598	25.41182995	30.0296359
5.	RP1	Tree	81.846753	25.411846	25.95716946
6.	RP2	Tree	81.846691	25.411886	26.73425466
7.	E1	St. skid mark	81.84676512	25.41187657	28.50299613
8.	E2	Partial skid mark	81.84676876	25.41187649	27.02831549
9.	E3	Silencer guard	81.84676551	25.41188619	28.37743509
10.	E4	Tilted scooter	81.84678383	25.4119074	24.12900396
11.	E5	Blood drops	81.84676339	25.41188278	26.7604491
12.	E6	Cartridge shell	81.84672048	25.41189606	19.35471961

Crime Scene 10

Sl.no	Code name	Name of the Evidences	Differential GPS Co-ordinates		
			Longitude	Latitude	Height
1.	CRP1	CRP1-CRP2	81.84619151	25.40977698	24.34791617
2.	CRP2	CRP2-CRP3	81.8462738	25.4098972	26.77969983
3.	CRP3	CRP3-CRP4	81.84593131	25.41002883	25.06659146
4.	CRP4	CRP4-CRP1	81.84590037	25.4099344	25.08843995
5.	RP1	Tree	81.84593993	25.40997071	24.75236931
6.	RP2	Tree	81.84625356	25.40986396	24.59099293
7.	E1	Pistol	81.84598379	25.40998514	24.60933491
8.	E2	Cartridge shell	81.84599816	25.40990254	24.19972212
9.	E3(a)	Blood droplet 1	81.84622556	25.40984895	23.55373702
10.	E3(b)	Blood droplet 2	81.84619175	25.40984322	24.84870734
11.	E3(c)	Blood droplet 3	81.84618569	25.40984329	27.21340832
12.	E3(d)	Blood droplet 4	81.84618334	25.40984398	24.78040745
13.	E3(e)	Blood droplet 5	81.84617048	25.40985253	23.76356268
14.	E3(f)	Blood droplet 6	81.84616098	25.40985659	23.69526288
15.	E3(g)	Blood droplet 7	81.84615257	25.40986369	24.78430542

Crime Scene 11

Sl.no	Code name	Name of the Evidences	Differential GPS Co-ordinates		
			Longitude	Latitude	Height
1.	CRP1	CRP1-CRP2	81.84643386	25.41166364	28.15394403
2.	CRP2	CRP2-CRP3	81.84650062	25.4117436	25.90673385
3.	CRP3	CRP3-CRP4	81.84668755	25.41156798	26.0696184
4.	CRP4	CRP4-CRP1	81.84660781	25.41152299	22.17788039
5.	RP1	Tree	81.84663597	25.41154054	30.3388374
6.	RP2	Electric Pole	81.84649579	25.41171132	27.05322041
7.	E1	Tablet cover	81.84663536	25.41160379	17.53144663
8.	E2	Partial blood stain	81.84655716	25.41161064	25.36542885
9.	E3	Blood Droplets	81.84657041	25.41160152	29.93668947

Crime Scene 12

Sl. no	Code name	Name of the Evidences	Differential GPS Co-ordinates		
			Longitude	Latitude	Height
1.	CRP1	CRP1-CRP2	81.84705544	25.41299604	23.77290059
2.	CRP2	CRP2-CRP3	81.84711241	25.41297814	27.69160657
3.	CRP3	CRP3-CRP4	81.84720911	25.41323173	26.91175646
4.	CRP4	CRP4-CRP1	81.84704133	25.41320143	25.88051781
5.	RP1	Tree	81.847041	25.413173	25.6970205
6.	RP2	Creeper (Gate)	81.847127	25.413022	27.79441115
7.	E1	Knife	81.8471641	25.41317097	24.38356133
8.	E2	Blood drops	81.84716574	25.4131826	21.35696248
9.	E3	Sun glass	81.847047	25.413121	23.89994385

Crime Scene 13

Sl.no	Code name	Name of the Evidences	Differential GPS Co-ordinates		
			Longitude	Latitude	Height
1.	CRP1	CRP1-CRP2	81.84825517	25.41096994	23.65421661
2.	CRP2	CRP2-CRP3	81.84844613	25.41098127	18.86930526
3.	CRP3	CRP3-CRP4	81.8484476	25.41107845	20.76637923
4.	CRP4	CRP4-CRP1	81.84826501	25.41107753	23.45347574
5.	RP1	Blank	81.8484476	25.41107845	20.76637923
6.	RP2	Blank	81.84825517	25.41096994	23.65421661
7.	E1	Bracelet	81.84829711	25.41100683	27.36211164
8.	E2	Blood Series 1	81.84834861	25.41101266	24.20247301
9.	E3	Blood Series 2	81.84835106	25.41101901	23.38128366
10.	E4	Blood Series 3	81.8483331	25.41102503	22.42236506
11.	E5	Blood Series 4	81.84833099	25.41104313	22.92593681
12.	E6	Broken Glass	81.84834607	25.41107231	24.52834488

Crime Scene 14

Sl. no	Code name	Name of the Evidences	Differential GPS Co-ordinates		
			Longitude	Latitude	Height
1.	CRP1	CRP1-CRP2	81.84723399	25.41301737	24.53030906
2.	CRP2	CRP2-CRP3	81.84729959	25.41301967	24.20245187
3.	CRP3	CRP3-CRP4	81.84735955	25.41307607	25.25362886
4.	CRP4	CRP4-CRP1	81.84721711	25.41312463	23.86212559
5.	RP1	Tree	81.84721711	25.41312463	23.86212559
6.	RP2	Tree	81.84729959	25.41301967	24.20245187
7.	E1	Scarf	81.84723135	25.41308663	24.44170198
8.	E2	Blood stain on broken glass	81.84727214	25.41308732	24.12439363
9.	E3	Blood droplet 1	81.84727675	25.41307368	24.19048819
10.	E4	Blood droplet 2	81.84726909	25.41305433	23.85420608
11.	E5	Blood droplet 3	81.84727424	25.41303098	23.46392136

Crime Scene 15

Sl.no	Code name	Name of the Evidences	Differential GPS Co-ordinates		
			Longitude	Latitude	Height
1.	CRP1	CRP1-CRP2	81.8450029	25.41028585	29.06621694
2.	CRP2	CRP2-CRP3	81.84508205	25.41019323	26.54298649
3.	CRP3	CRP3-CRP4	81.84521731	25.41033386	25.09052152
4.	CRP4	CRP4-CRP1	81.84510652	25.41040848	22.35622554
5.	RP1	Tree	81.84510652	25.41040848	22.35622554
6.	RP2	Tree	81.8450029	25.41028585	29.06621694
7.	E1	Blood droplet 1	81.84507027	25.41026359	25.2313353
8.	E2	Blood droplet 2	81.84509217	25.41027281	24.28794606
9.	E3	Blood droplet 3	81.84510086	25.41029305	24.77042842
10.	E4	Blood droplet 4	81.84510465	25.4103083	24.40289091
11.	E5	Blood stain on knife	81.84514775	25.41030403	26.62042955
12.	E6	Hair Clip	81.845148	25.41035041	24.33577365

CS1	*Variable 1*	*Variable 2*
Mean	9.797	10.365
Variance	53.98695667	59.75358333
Observations	10	10
Pooled Variance	56.87027	
Hypothesized Mean Difference	0	
df	18	
t Stat	0.168418848	
P(T<=t) one-tail	0.434065891	
t Critical one-tail	1.734063607	
P(T<=t) two-tail	0.868131783	
t Critical two-tail	2.10092204	

CS5	*Variable 1*	*Variable 2*
Mean	*22.31142857*	*21.86571429*
Variance	*256.2149476*	*272.6331286*
Observations	*7*	*7*
Pooled Variance	*264.4240381*	
Hypothesized Mean Difference	*0*	
df	*12*	
t Stat	*0.051279066*	
P(T<=t) one-tail	*0.479973428*	
t Critical one-tail	*1.782287556*	
P(T<=t) two-tail	*0.959946856*	
t Critical two-tail	*2.17881283*	

CS2	*Variable 1*	*Variable 2*
Mean	18.376	17.647
Variance	238.9108711	245.07389
Observations	10	10
Pooled Variance	241.9923806	
Hypothesized Mean Difference	0	
df	18	
t Stat	0.104788032	
P(T<=t) one-tail	0.458851423	
t Critical one-tail	1.734063607	
P(T<=t) two-tail	0.917702846	
t Critical two-tail	2.10092204	

CS4	*Variable 1*	*Variable 2*
Mean	10.104882	10.22909
Variance	298.0313753	304.6733
Observations	4	4
Pooled Variance	301.3523543	
Hypothesized Mean Difference	0	
df	6	
t Stat	0.010118597	
P(T<=t) one-tail	0.496127359	
t Critical one-tail	1.943180281	
P(T<=t) two-tail	0.992254717	
t Critical two-tail	2.446911851	

CS 6	*Variable 1*	*Variable 2*
Mean	42.4525	41.575
Variance	1492.872136	1504.805343
Observations	8	8
Pooled Variance	1498.838739	
Hypothesized Mean Difference	0	
df	14	
t Stat	0.045331456	
P(T<=t) one-tail	0.482241688	
t Critical one-tail	1.761310136	
P(T<=t) two-tail	0.964483375	
t Critical two-tail	2.144786688	

CS 7	*Variable 1*	*Variable 2*
Mean	18.98444444	18.45888889
Variance	239.2579778	217.9566361
Observations	9	9
Pooled Variance	228.6073069	
Hypothesized Mean Difference	0	
df	16	
t Stat	0.073736044	
P(T<=t) one-tail	0.471067197	
t Critical one-tail	1.745883676	
P(T<=t) two-tail	0.942134394	
t Critical two-tail	2.119905299	

CS8	*Variable 1*	*Variable 2*
Mean	10.695	10.9
Variance	98.50173333	99.27066667
Observations	16	16
Pooled Variance	98.8862	
Hypothesized Mean Difference	0	
df	30	
t Stat	0.058308385	
P(T<=t) one-tail	0.476944826	
t Critical one-tail	1.697260887	
P(T<=t) two-tail	0.953889653	
t Critical two-tail	2.042272456	

CS 11	*Variable 1*	*Variable 2*
Mean	40.86375	41.68125
Variance	1108.046227	1199.944184
Observations	8	8
Pooled Variance	1153.995205	
Hypothesized Mean Difference	0	
df	14	
t Stat	-0.048129988	
P(T<=t) one-tail	0.48114626	
t Critical one-tail	1.761310136	
P(T<=t) two-tail	0.962292521	
t Critical two-tail	2.144786688	

CS9	*Variable 1*	*Variable 2*
Mean	19.96636364	20.12
Variance	103.2542455	94.39928
Observations	11	11
Pooled Variance	98.82676273	
Hypothesized Mean Difference	0	
df	20	
t Stat	0.036244163	
P(T<=t) one-tail	0.485723495	
t Critical one-tail	1.724718243	
P(T<=t) two-tail	0.971446991	
t Critical two-tail	2.085963447	

CS12	*Variable 1*	*Variable 2*
Mean	50.0625	49.17375
Variance	826.7855357	860.6100554
Observations	8	8
Pooled Variance	843.6977955	
Hypothesized Mean Difference	0	
df	14	
t Stat	0.06119503	
P(T<=t) one-tail	0.476034461	
t Critical one-tail	1.761310136	
P(T<=t) two-tail	0.952068923	
t Critical two-tail	2.144786688	

CS10	*Variable 1*	*Variable 2*
Mean	39.59285714	39.43642857
Variance	1906.531484	1898.449532
Observations	14	14
Pooled Variance	1902.490508	
Hypothesized Mean Difference	0	
df	26	
t Stat	0.009488637	
P(T<=t) one-tail	0.496250855	
t Critical one-tail	1.70561792	
P(T<=t) two-tail	0.992501709	
t Critical two-tail	2.055529439	

CS13	*Variable 1*	*Variable 2*
Mean	26.63818182	27.76090909
Variance	697.2824164	731.5314291
Observations	11	11
Pooled Variance	714.4069227	
Hypothesized Mean Difference	0	
df	20	
t Stat	-0.09851056	
P(T<=t) one-tail	0.461253766	
t Critical one-tail	1.724718243	
P(T<=t) two-tail	0.922507533	
t Critical two-tail	2.085963447	

CS15	*Variable 1*	*Variable 2*
Mean	37.98272727	38.22545455
Variance	268.9498818	268.5317073
Observations	11	11
Pooled Variance	268.7407945	
Hypothesized Mean Difference	0	
df	20	
t Stat	-0.03472427	
P(T<=t) one-tail	0.48632192	
t Critical one-tail	1.724718243	
P(T<=t) two-tail	0.972643841	
t Critical two-tail	2.085963447	

Chi-square test for crime and Population

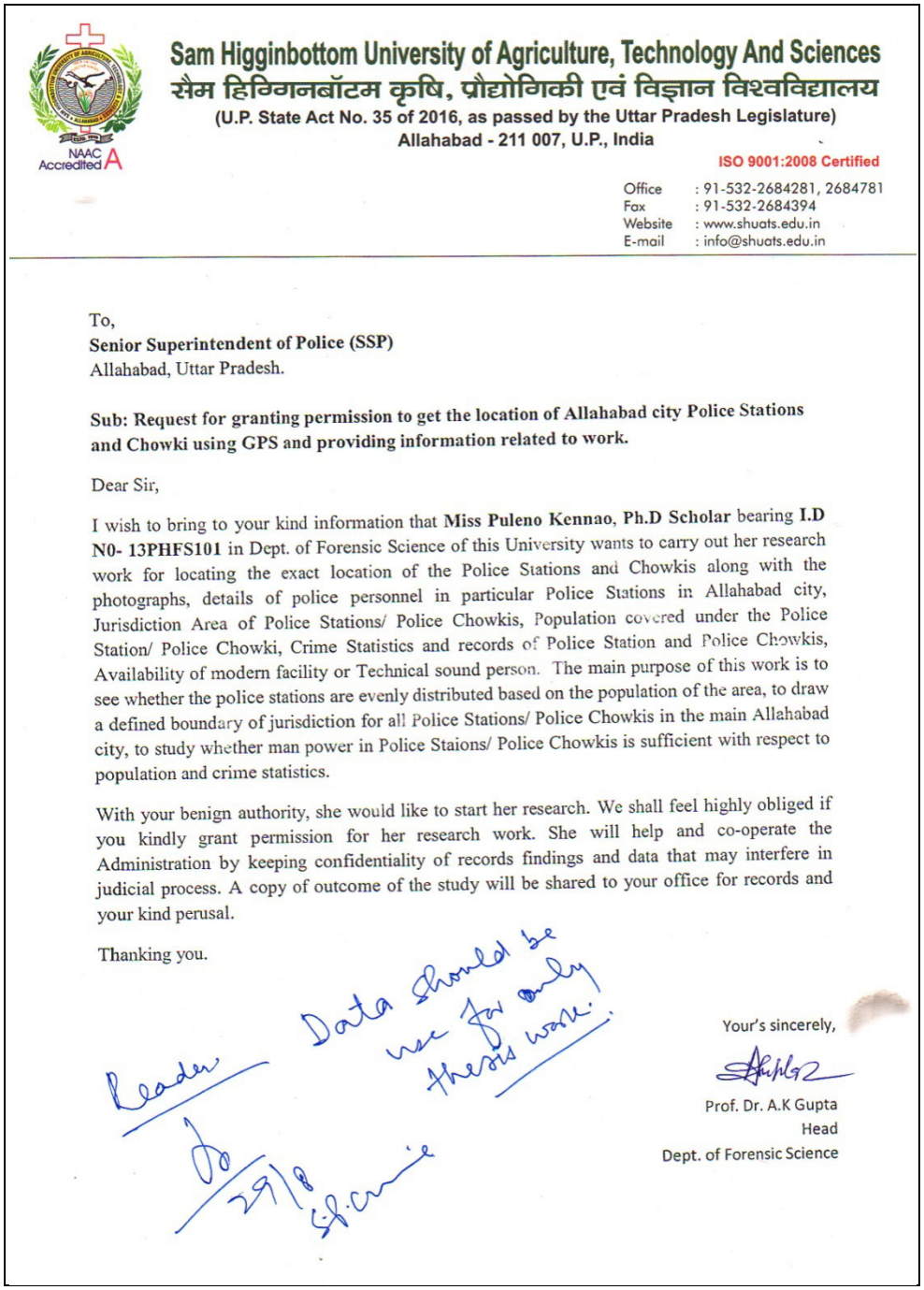
Crime

Zones	**Crime in percentage (Oi)**	**Ei**	**Oi-Ei**	**$(Oi-Ei)^2$**	**$(Oi-Ei)^2/Ei$**
Zone 1	44.1	25	19.1	364.81	14.5924
Zone2	11	25	-14	196	7.84
Zone 3	25.6	25	0.6	0.36	0.0144
Zone4	19.3	25	-5.7	32.49	1.2996
Total	**100**				**23.7464**

Population

Zones	**Population(Oi)**	**Ei**	**Oi-Ei**	**$(Oi-Ei)^2$**	**$(Oi-Ei)^2/Ei$**
Zone 1	31	25	6	36	1.44
Zone2	20	25	-5	25	1
Zone 3	30	25	5	25	1
Zone4	19	25	-6	36	1.44
Total	**100**				**4.88**

APPENDIX B- Letter forwarded to SSP for collection of data.



Sam Higginbottom University of Agriculture, Technology And Sciences
सैम हिग्गिनबॉटम कृषि, प्रौद्योगिकी एवं विज्ञान विश्वविद्यालय
(U.P. State Act No. 35 of 2016, as passed by the Uttar Pradesh Legislature)
Allahabad - 211 007, U.P., India

NAAC Accredited A

ISO 9001:2008 Certified

Office : 91-532-2684281, 2684781
Fax : 91-532-2684394
Website : www.shuats.edu.in
E-mail : info@shuats.edu.in

To,
Senior Superintendent of Police (SSP)
Allahabad, Uttar Pradesh.

Sub: Request for granting permission to get the location of Allahabad city Police Stations and Chowki using GPS and providing information related to work.

Dear Sir,

I wish to bring to your kind information that **Miss Puleno Kennao, Ph.D Scholar** bearing **I.D N0- 13PHFS101** in Dept. of Forensic Science of this University wants to carry out her research work for locating the exact location of the Police Stations and Chowkis along with the photographs, details of police personnel in particular Police Stations in Allahabad city, Jurisdiction Area of Police Stations/ Police Chowkis, Population covered under the Police Station/ Police Chowki, Crime Statistics and records of Police Station and Police Chowkis, Availability of modern facility or Technical sound person. The main purpose of this work is to see whether the police stations are evenly distributed based on the population of the area, to draw a defined boundary of jurisdiction for all Police Stations/ Police Chowkis in the main Allahabad city, to study whether man power in Police Staions/ Police Chowkis is sufficient with respect to population and crime statistics.

With your benign authority, she would like to start her research. We shall feel highly obliged if you kindly grant permission for her research work. She will help and co-operate the Administration by keeping confidentiality of records findings and data that may interfere in judicial process. A copy of outcome of the study will be shared to your office for records and your kind perusal.

Thanking you.

Data should be use for only thesis work.

Reader

29/8

Your's sincerely,

Prof. Dr. A.K Gupta
Head
Dept. of Forensic Science

APPENDIX C- Approval letter from University to avail the DGPS device

सैम हिग्गिनबॉटम इन्स्टीट्यूट ऑफ एग्रीकल्चर, टेक्नालॉजी एण्ड साइंसेज
Sam Higginbottom Institute of Agriculture, Technology & Sciences
(Formerly Allahabad Agricultural Institute)
(Deemed to be University)
Allahabad - 211 007, India
Established: 1910
NAAC Accredited
ISO 9001:2008 Certified
Office : 91-532-2684281, 2684781
Fax : 91-532-2684394
Website : www.shiats.edu.in
E-mail : info@shiats.edu.in

MS/CSPC-ICAR/ANIPL/15-16/040
24.02.2016

To,
M/s. ASIM Navigation India Pvt.Ltd.
104-105, Kirti Deep, Nangal Raya Business Centre,
New Delhi-46
Ph:91-11—28524546; 45558010-16

Sub: Order for Supply

I am pleased to inform you that your rates submitted to Central Sales & Purchase Committee have been approved.

Kindly supply the required items to the **Department of Forensic Science, Sam Higginbottom Institute of Agriculture, Technology & Sciences,** Allahabad.

Thanking You,

Yours Sincerely,

(Prof. (Dr.) Gautam Ghosh)
Member Secretary
Central Sales Purchase Committee
SHIATS

Encl: Annexure

Copy to:

1. Pro-VC, Academics
2. Chairman, CSPC
3. Registrar
4. **Head, Department of Forensic Science**
5. Finance Comptroller – for information and expenses under **ICAR 2.1 A/c**
6. P.S. to VC for Kind information of the Hon'ble Vice-Chancellor

ANNEXURE

S.no	Name of article	qty	Rate per unit	Amount in Rs.
1	Trimble R1 GNSS System with 1 year RTX online correction subscription	1.00	2,05,000.00	2,05,000.00
2	Trimble Terraflex Basic Software with 1 year subscription	1.00	22,000.00	22,000.00
Total				**2,27,000.00**
Less: Discount				**18,500.00**
Add: Vat				**10,425.00**
Grand Total (Rupees Two Lakh Eighteen Thousand Nine Hundred & Twenty Five Only)				**2,18,925.00**

Gautam Ghosh

(Prof. (Dr.) Gautam Ghosh)

Member Secretary
Central Sales Purchase Committee
SHIATS

APPENDIX D- Quotation for Trimble R1GNSS Receiver

asim
A Navigation & Communication Venture
An ISO 9001 : 2008 Certified Company

ASIM Navigation India Pvt. Ltd.
104-105, Kirti Deep, Nangal Raya Business Centre, New Delhi-46
Ph. : 91-11-28524546, 91-11-45558010-16, Fax : 91-11-45558017
E-mail : info@asimindia.com
URL : www.asimindia.com / www.atraker.com

Ref. No. ANIPL-2015-16-RI-064 Dated 04-2-2016

To
Company Secretary
CSPC Department
Shaits, Allahabad, Uttar Pradesh 211007

Subject: **Quotation for Trimble R1 GNSS Receiver**
Dear Sir
As per your query regarding the Trimble Devices for your project, please find the price as below.

Sno	Particulars- Hardware	QTY	Unit Price
1	Trimble R1 GNSS System With 1 year RTX online correction subscription	1	2,05,000/-
	Discount		16,000/-
	Total Amount Without Tax		1,89,000/-
	Tax		9,450/-
A	Total amount with Tax		1,98,450/-

Sno	Particulars- Software	QTY	Unit Price
1	Trimble Terraflex Basic Software with 1 Year subscription	1	22,000/-
	Discount		2,500/-
	Total Amount Without Tax		19,500/-
	Tax		975/-
B	Total amount with Tax		20,475/-
C	TOTAL [A+ B]		2,18,925/-

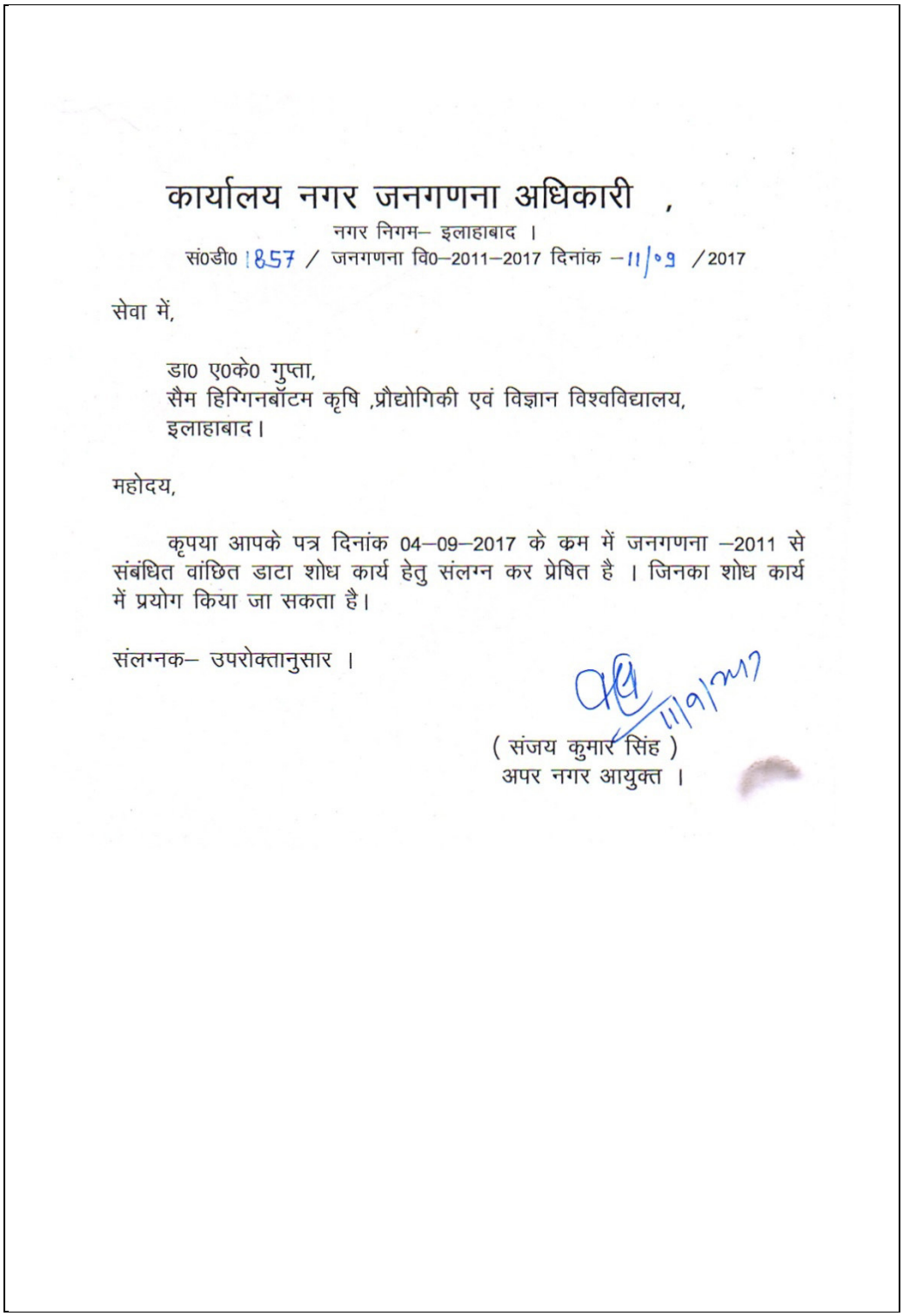
In Words: Two Lac Eighteen Thousand Nine Hundred and Twenty Five Only.

Terms and condition
1. **Taxes: Extra @ 5%as stated above.**
2. **Payment: 100% against Delivery**
3. **Quote Validity: 30 days**
4. **Delivery: Within 7 days**
5. **Warranty: 1 year**
6. **Discount: As stated above**
7. **Billing Address: ASIM NAVIGATION INDIA (P) LTD. C-418, Sector-10, Noida -201301 (UP)**
8. **TIN No: 09465713530C**
9. **PAN: AALCA6667M**

Any Queries and Questions do let us know.
For Asim Navigation India Pvt Ltd

Thanking you,
Your's sincerely
Rajat Gulati
+91-9717702862

APPENDIX E- Approval letter from Municipal Department for collection of Population data



कार्यालय नगर जनगणना अधिकारी ,
नगर निगम– इलाहाबाद ।
सं०डी० 857 / जनगणना वि०–2011–2017 दिनांक –11/09 /2017

सेवा में,

डा० ए०के० गुप्ता,
सैम हिग्गिनबॉटम कृषि ,प्रौद्योगिकी एवं विज्ञान विश्वविद्यालय,
इलाहाबाद।

महोदय,

कृपया आपके पत्र दिनांक 04–09–2017 के कम में जनगणना –2011 से संबंधित वांछित डाटा शोध कार्य हेतु संलग्न कर प्रेषित है । जिनका शोध कार्य में प्रयोग किया जा सकता है।

संलग्नक– उपरोक्तानुसार ।

11/9/2017

(संजय कुमार सिंह)
अपर नगर आयुक्त ।

भारत की जनगणना 2011

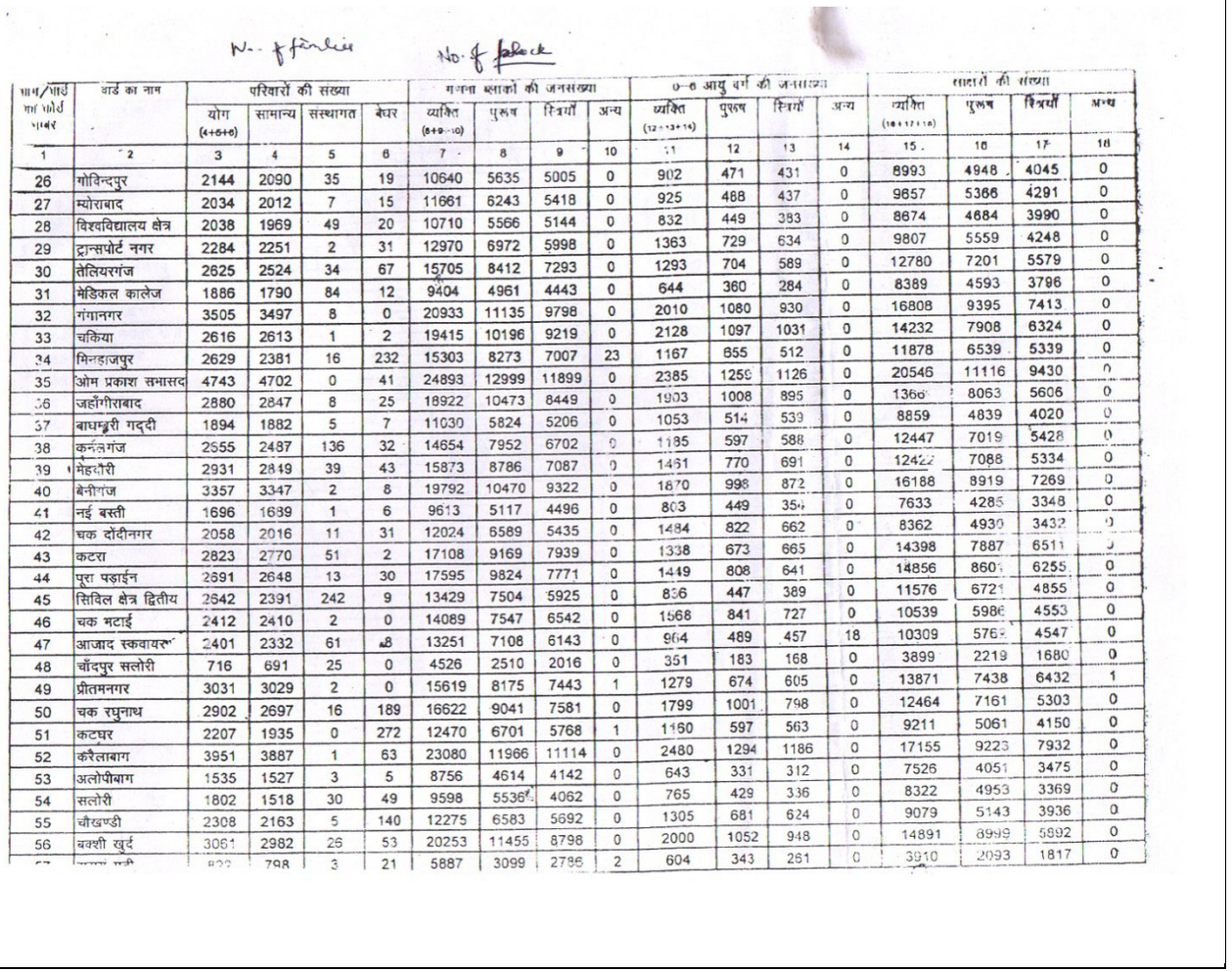
गोपनीय

प्रगणना ब्लॉकों के योग की प्रविष्टि हेतु रजिस्टर

ग्रामीण/नगरीय कोड (ग्रामीण–1, नगरीय–2) 2 चार्ज का प्रकार (सामान्य–1/स्पेशल चार्ज–2) चार्ज का नाम

राज्य : उत्तर प्रदेश कोड : 09 | जिला : इलाहाबाद कोड : 44 | तहसील : सदर कोड : 03 | नगर : नगर निगम, इलाहाबाद कोड : 7460

ग्राम/वार्ड का कोड नम्बर	वार्ड का नाम	परिवारों की संख्या				गणना ब्लाकों की जनसंख्या				0–6 आयु वर्ग की जनसंख्या Age				Literacy साक्षरों की संख्या			
		योग (4+5+6)	सामान्य	संस्थागत	बेघर	व्यक्ति (8+9+10)	पुरुष M	स्त्रियाँ F	अन्य	व्यक्ति (12+13+14)	पुरुष M	स्त्रियाँ F	अन्य	व्यक्ति (16+17+18)	पुरुष Male	स्त्रियाँ Female	अन्य
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	सुलेम सरायं	2905	2888	0	17	18130	9605	8525	0	1642	910	732	0	13561	7635	5926	0
2	सादियाबाद	1905	1823	60	22	12113	6767	5346	0	1150	636	514	0	9336	5573	3763	0
3	जयन्तीपुर	2421	2409	0	12	14887	7852	7035	0	1682	932	750	0	10289	5807	4482	0
4	राजापुर	2627	2627	0	0	14100	7520	6580	0	1302	654	648	0	11288	6468	4820	0
5	मम्फोर्डगंज	2770	2703	5	62	14423	7571	6852	0	1106	576	530	0	12373	6642	5731	0
6	अशोक नगर	2190	2177	0	13	11537	6145	5392	0	874	491	383	0	8833	4952	3881	0
7	ईश्वर शरण आश्रम	1030	898	113	19	6736	4281	2455	0	501	256	245	0	5791	3917	1874	0
8	नीम सरायं	3433	3320	2	111	20340	10876	9464	0	2043	1112	931	0	15161	8489	6672	0
9	शिवकुटी	1951	1881	21	49	12111	7030	5081	0	1146	611	535	0	9907	6114	3793	0
10	सिविल क्षेत्र प्रथम	3238	3141	12	85	16594	8642	7952	0	1286	698	588	0	14002	7546	6456	0
11	काजीपुर	2195	2119	10	66	12295	6623	5672	0	1165	617	548	0	9979	5809	4170	0
12	मलाकराज	2254	2060	114	80	12111	6394	5711	6	1029	539	490	0	9278	5237	4041	0
13	हरवारा	2336	2336	0	0	13337	7112	6225	0	1461	759	702	0	9565	5538	4027	0
14	एलनगंज	2598	2508	40	50	14517	8095	6422	0	931	492	439	0	12605	7334	5271	0
15	हिम्मतगंज	1438	1418	0	20	8662	4563	4099	0	691	376	315	0	6634	3624	3010	0
16	चक निरातुल	1396	1395	0	1	9593	5082	4511	0	948	509	439	0	7204	4040	3164	0
17	न्यायमार्ग	2415	2191	11	213	10709	5673	5036	0	794	429	365	0	9047	5001	4046	0
18	इन्जिनियरिंग कालेज	2460	2349	61	50	15639	9185	6454	0	1325	684	641	0	12415	7836	4579	0
19	मुण्डेरा	1540	1540	0	0	8490	4498	3992	0	850	431	419	0	6899	3853	3046	0
20	झूलेलाल नगर	2182	2167	1	14	11541	6072	5469	0	901	499	402	0	10053	5357	4696	0
21	फाफामऊ	3014	2901	14	99	18289	9780	8509	0	2557	1383	1174	0	12982	7505	5477	0
22	न्यू कटरा	2574	2386	35	153	12078	6473	5605	0	867	476	391	0	10559	5725	4834	0
23	कृष्णा नगर	2193	2114	4	75	12180	6445	5735	0	912	460	452	0	9638	5321	4317	0
24	मधवापुर	3221	3157	13	51	15323	8126	7197	0	1169	605	564	0	12180	6654	5526	0
25	भारद्वाजपरम	3458	3433	19	6	20148	10554	9494	0	1844	1011	833	0	16947	9320	7627	0



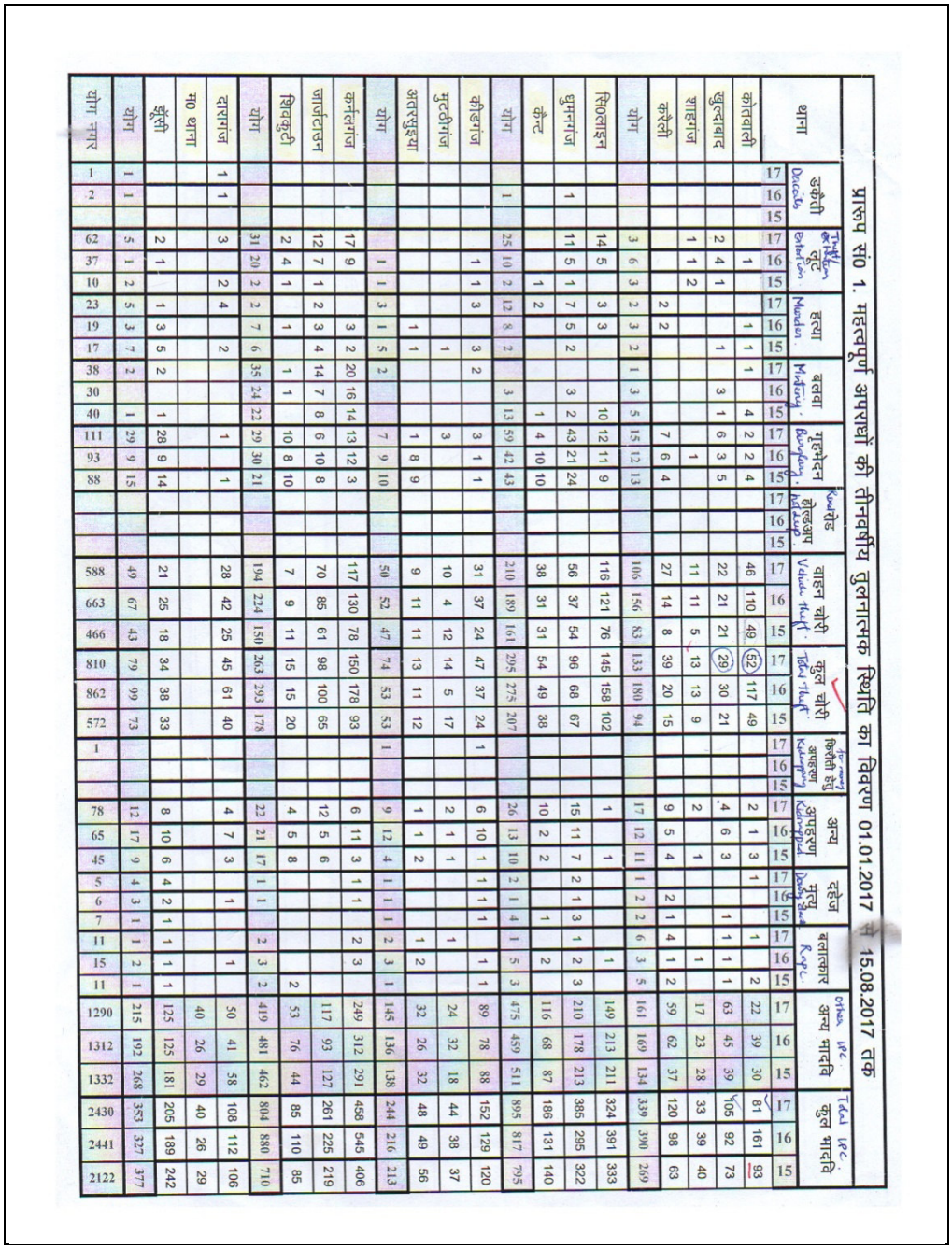
No. of families No. of block

वार्ड/पोलिंग एरिया नंबर	वार्ड का नाम	परिवारों की संख्या				गणना ब्लाकों की जनसंख्या				0–6 आयु वर्ग की जनसंख्या				साक्षरों की संख्या			
		योग (4+5+6)	सामान्य	संस्थागत	बेघर	व्यक्ति (8+9+10)	पुरुष	स्त्रियाँ	अन्य	व्यक्ति (12+13+14)	पुरुष	स्त्रियाँ	अन्य	व्यक्ति (16+17+18)	पुरुष	स्त्रियाँ	अन्य
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
26	गोविन्दपुर	2144	2090	35	19	10640	5635	5005	0	902	471	431	0	8993	4948	4045	0
27	म्योराबाद	2034	2012	7	15	11661	6243	5418	0	925	488	437	0	9657	5366	4291	0
28	विश्वविद्यालय क्षेत्र	2038	1969	49	20	10710	5566	5144	0	832	449	383	0	8674	4684	3990	0
29	ट्रान्सपोर्ट नगर	2284	2251	2	31	12970	6972	5998	0	1363	729	634	0	9807	5559	4248	0
30	तेलियरगंज	2625	2524	34	67	15705	8412	7293	0	1293	704	589	0	12780	7201	5579	0
31	मेडिकल कालेज	1886	1790	84	12	9404	4961	4443	0	644	360	284	0	8389	4593	3796	0
32	गंगानगर	3505	3497	8	0	20933	11135	9798	0	2010	1080	930	0	16808	9395	7413	0
33	चकिया	2616	2613	1	2	19415	10196	9219	0	2128	1097	1031	0	14232	7908	6324	0
34	मिलाजपुर	2629	2381	16	232	15303	8273	7007	23	1167	655	512	0	11878	6539	5339	0
35	ओम प्रकाश सभासद	4743	4702	0	41	24893	12999	11899	0	2385	1259	1126	0	20546	11116	9430	0
36	जहाँगीराबाद	2880	2847	8	25	18922	10473	8449	0	1903	1008	895	0	1366	8063	5606	0
37	बाघम्बरी गद्दी	1894	1882	5	7	11030	5824	5206	0	1053	514	539	0	8859	4839	4020	0
38	कर्नलगंज	2555	2487	136	32	14654	7952	6702	0	1185	597	588	0	12447	7019	5428	0
39	मेहदौरी	2931	2849	39	43	15873	8786	7087	0	1461	770	691	0	12422	7088	5334	0
40	बेनीगंज	3357	3347	2	8	19792	10470	9322	0	1870	998	872	0	16188	8919	7269	0
41	नई बस्ती	1696	1689	1	6	9613	5117	4496	0	803	449	354	0	7633	4285	3348	0
42	चक दोंदीनगर	2058	2016	11	31	12024	6589	5435	0	1484	822	662	0	8362	4930	3432	0
43	कटरा	2823	2770	51	2	17108	9169	7939	0	1338	673	665	0	14398	7887	6511	0
44	पुरा पड़ाईन	2691	2648	13	30	17595	9824	7771	0	1449	808	641	0	14856	8601	6255	0
45	सिविल क्षेत्र द्वितीय	2542	2391	242	9	13429	7504	5925	0	836	447	389	0	11576	6721	4855	0
46	चक भटाई	2412	2410	2	0	14089	7547	6542	0	1568	841	727	0	10539	5986	4553	0
47	आजाद स्कवायर	2401	2332	61	8	13251	7108	6143	0	964	489	457	18	10309	5762	4547	0
48	चाँदपुर सलोरी	716	691	25	0	4526	2510	2016	0	351	183	168	0	3899	2219	1680	0
49	प्रीतमनगर	3031	3029	2	0	15619	8175	7443	1	1279	674	605	0	13871	7438	6432	1
50	चक रघुनाथ	2902	2697	16	189	16622	9041	7581	0	1799	1001	798	0	12464	7161	5303	0
51	कटघर	2207	1935	0	272	12470	6701	5768	1	1160	597	563	0	9211	5061	4150	0
52	करैलाबाग	3951	3887	1	63	23080	11966	11114	0	2480	1294	1186	0	17155	9223	7932	0
53	अलोपीबाग	1535	1527	3	5	8756	4614	4142	0	643	331	312	0	7526	4051	3475	0
54	सलोरी	1802	1518	30	49	9598	5536	4062	0	765	429	336	0	8322	4953	3369	0
55	चौखण्डी	2308	2163	5	140	12275	6583	5692	0	1305	681	624	0	9079	5143	3936	0
56	बक्शी खुर्द	3061	2982	26	53	20253	11455	8798	0	2000	1052	948	0	14891	8999	5892	0
57	[illegible]	832	798	3	21	5887	3099	2786	2	604	343	261	0	3910	2093	1817	0

वार्ड/बोर्ड का नंबर	वार्ड का नाम	परिवारों की संख्या				गणना ब्लाकों की जनसंख्या				0–6 आयु वर्ग की जनसंख्या				साक्षरों की संख्या			
		योग (4+5+6)	सामान्य	संस्थागत	बेघर	व्यक्ति (8+9+10)	पुरुष	स्त्रियाँ	अन्य	व्यक्ति (12+13+14)	पुरुष	स्त्रियाँ	अन्य	व्यक्ति (16+17+18)	पुरुष	स्त्रियाँ	अन्य
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
58	दरियाबाद	1829	1823	2	4	11451	6169	5282	0	1088	603	485	0	9316	5197	4119	0
59	दारागंज	2818	2039	20	759	14828	8187	6641	0	1748	965	783	0	10412	5853	4559	0
60	मुट्ठीगंज भाग–1	1232	1224	7	1	7371	3902	3469	0	616	328	288	0	6479	3534	2945	0
61	खलासी लाईन	1614	1614	0	0	9592	5063	4529	0	907	481	426	0	7672	4203	3469	0
62	मीरापुर	1982	1932	0	50	10824	5686	5138	0	920	514	406	0	8858	4718	4140	0
63	शाहगंज	2318	2251	3	64	14943	7945	6998	0	1448	758	690	0	11538	6218	5320	0
64	पूरा मनोहर दास	1724	1623	23	78	11212	5920	5292	0	1175	586	589	0	8659	4673	3986	0
65	दरियाबाद	2920	2824	0	96	17763	9336	8427	0	1809	950	859	0	13020	7000	6020	0
66	मोहत्सिमगंज	2347	2312	2	33	12919	6859	6060	0	1096	617	479	0	10201	5576	4625	0
67	रामबाग	1144	919	16	209	6084	3622	2462	0	400	214	186	0	5066	3026	2040	0
68	मुट्ठीगंज भाग–1	2288	2283	1	4	13535	7186	6349	0	1134	642	492	0	11595	6324	5271	0
69	सदिग्गापुर	1971	1958	4	9	12330	6525	5805	0	1465	760	705	0	7590	4287	3303	0
70	तुलसीपुर	1892	1828	0	64	11056	5747	5309	0	1222	623	599	0	7782	4206	3576	0
71	नारायण सिंह नगर	1617	1604	1	12	8615	4535	4080	0	566	313	253	0	7635	4113	3522	0
72	सुल्तानपुर भावा	2916	2811	2	103	18664	9861	8803	0	1759	920	839	0	14489	7895	6594	0
73	मालवीय नगर	2620	1928	691	1	11431	6147	5284	0	991	546	445	0	9554	5261	4293	0
74	बहादुरगंज	1613	1597	0	16	10716	5758	4958	0	1057	549	508	0	7152	3871	3281	0
75	मीरगंज	2172	2126	6	40	12207	6428	5779	0	882	446	436	0	10650	5829	4821	0
76	करेली	4268	4262	5	1	25259	13347	11912	0	2589	1355	1234	0	19647	10649	8998	0
77	बक्शी बाजार	1997	1893	3	101	13090	7073	6017	0	1146	623	523	0	10674	5878	4796	0
78	अटाला	2098	2020	2	76	14679	7823	6856	0	1481	764	717	0	8532	4561	3971	0
79	अतरसुईया	2114	2102	0	12	12870	6694	6176	0	1095	531	564	0	10497	5615	4882	0
80	दायरा शाह अजमल	1889	1844	5	40	11690	6179	5511	0	1300	707	593	0	8206	4391	3815	0
81	सुबेदारगंज	288	273	0	15	1568	829	739	0	137	69	68	0	1274	724	550	0
82	त्रिवेणी नगर	589	573	0	16	3618	1996	1622	0	229	124	105	0	3251	1750	1501	0
83	टी0एस0एल0	142	136	0	6	751	426	325	0	121	67	54	0	467	285	182	0
84	मुक्ता विहार	97	97	0	0	537	295	242	0	30	16	14	0	495	277	218	0
85	बी0पी0सी0 एल0	120	120	0	0	650	367	283	0	56	23	33	0	534	349	185	0
86	ए0डी0ए0 नैनी	4475	4422	5	48	22792	12265	10527	0	1913	1073	840	0	17098	9606	7492	0
87	दूरवाणी नगर	121	115	0	6	539	309	230	0	51	30	21	0	432	250	182	0
88	आई0टी0 आई0	49	35	0	14	219	115	104	0	0	0	0	0	126	69	57	0
89	शिवनगर नैनी	213	188	0	25	1347	709	638	0	237	137	100	0	943	528	415	0

ग्राम/वार्ड का कोर्ड नम्बर	वार्ड का नाम	परिवारों की संख्या				गणना ब्लाकों की जनसंख्या				0–6 आयु वर्ग की जनसंख्या				साक्षरों की संख्या			
		योग (4+5+6)	सामान्य	संस्थागत	बेघर	व्यक्ति (8+9+10)	पुरूष	स्त्रियाँ	अन्य	व्यक्ति (12+13+14)	पुरुष	स्त्रियाँ	अन्य	व्यक्ति (16+17+18)	पुरुष	स्त्रियाँ	अन्य
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
90	गुरू नानक नगर	216	203	0	13	912	486	426	0	102	65	37	0	807	435	372	0
91	गाँधी नगर नैनी	1437	1419	0	18	6310	3378	2932	0	609	323	286	0	5191	2927	2264	0
92	गंगोत्री नगर	1171	1084	51	36	6768	3948	2820	0	603	320	283	0	5408	3134	2274	0
93	महेवा पट्टी पूरब उ	338	332	6	0	2069	1063	1006	0	302	151	151	0	1369	787	582	0
94	बेगम बाजार	140	140	0	0	850	463	387	0	35	20	15	0	749	421	328	0
95	भागल पुरवा	139	129	0	10	1028	578	450	0	72	39	33	0	796	461	335	0
96	कोडरा	88	83	0	5	595	360	235	0	74	41	33	0	378	241	137	0
97	आई0ओ0सी0	1001	996	0	5	5081	2714	2367	0	500	258	242	0	4002	2289	1713	0
योग :–		199030	191827	2308	4690	1142751	613792	528926	33	105090	55990	49082	18	898420	502458	395961	1

APPENDIX G- Crime Data of 15 Police Stations in Allahabad City (2015-2017)



प्रारूप सं0 1. महत्वपूर्ण अपराधों की तीनवर्षीय तुलनात्मक स्थिति का विवरण 01.01.2017 से 15.08.2017 तक

थाना		डकैती Dacoity	लूट Robbery	हत्या Murder	बलवा Rioting	गृहभेदन Burglary	फिरौती हेतु अपहरण Kidnapping for Ransom	कुल चोरी Total Theft	वाहन चोरी Vehicle Theft	होलअप Hold up	फिरौती हेतु अपहरण Kidnapping	अन्य अपहरण Other Kidnapping	दहेज मृत्यु Dowry Death	बलात्कार Rape	अन्य भादवि Other IPC	कुल भादवि Total IPC
कोतवाली	17							49	49			2		1	22	93
	16		1			4		(62)	110			1			39	161
	15			1	1	2		117	46				1	1	30	93
खुल्दाबाद	17											4		1	63	105
	16		4	1	3	2		21	21			6	1	1	45	92
	15		2	1	1	4		30	22			3	1	1	39	73
शाहगंज	17														17	81
	16		1	1	3	1		(29)	21			1			23	161
	15		1	2		6		13	11						28	93
करैली	17											2			33	40
	16		2	2		3		13	11						39	63
	15					5		9	5			1		1	17	98
योग			3	6	3	2	3	5	15	12	13				106	156
															83	133
															180	94
															17	12
															11	1
															2	2
															6	3
															5	161
															169	134
															339	390
															269	
सि0लाइन	17														1	149
	16			14	5										213	211
	15				3	3		10	12	11	9				324	391
घुमनगंज	17														333	
	16		1	11	5	1	7	5	2			3	2	43	21	24
	15				1	2										
कैन्ट	17															
	16				1	2										
	15				1	4	10	10								
योग		1		25	10	2	12	8	2		3	13	59	42	43	
कीडगंज	17				1	1	3		3	2			3	1	1	
	16															
	15															
मुटठीगंज	17															
	16								1							
	15								3							
अतरसुइया	17															
	16								1	1						
	15								1	1	8					
योग				1	1	3	1	5	2		7	9	10			
कर्नलगंज	17															
	16			17	9			3	2	20	16	14	13	12	3	
	15				1	1	3	4	14	7	8	6	10	8		
जार्जटाउन	17															
	16			12	7	1	2	3	4	1						
	15			2	4	1			1	1						
शिवकुटी	17															
	16															
	15															
योग				31	20	2	2	7	6	35	24	22	29	30	21	
दारागंज	17															
	16			3		2	4		2				1			
	15															
म0 थाना	17															
	16															
	15															
झूँसी	17															
	16			2	1		1	3	5	2		1	28	9	14	
	15															
योग		1		5	1	2	5	3	7	2		1	29	9	15	
योग नगर		1	2	62	37	10	23	19	17	38	30	40	111	93	88	

थाना	डकैती			लूट			हत्या			बलवा			गृहभेदन			रोड होल्डअप			वाहन चोरी			कुल चोरी			फिरौती हेतु अपहरण			अन्य अपहरण			दहेज मृत्यु			बलात्कार			अन्य भादवि			कुल भादवि		
	17	16	15	17	16	15	17	16	15	17	16	15	17	16	15	17	16	15	17	16	15	17	16	15	17	16	15	17	16	15	17	16	15	17	16	15	17	16	15	17	16	15
सोरांव		1		7	2	10	2	3	4		5	3	9	23	12				37	36	58	49	40	69				9	10	10	1		1	1	2	2	195	170	162	273	256	273
मउआइमा			2	3	4	2	3	2			7	5	4	4	3				15	14	5	19	20	7				14	10	6	1	3	2	4	4	1	105	86	123	153	140	151
नवाबगंज			1	4	2	2	2	6	7	1	4	7	11	17	5				18	17	8	27	24	14	1			10	4	14	2	2		2	4	4	25	164	157	85	227	211
होलागढ़				1		2	1	2	1			1	2	1					2	3	2	2	7	4				3	7	2			1		1	3	36	56	51	45	74	65
योग		1	3	15	8	16	8	13	12	1	16	16	26	45	20				72	70	73	97	91	94	1			36	31	32	4	5	4	7	11	10	361	476	493	556	697	700
फूलपुर					2	3	2	1	1	4		2	6	6	2				18	17	4	24	24	11				10	11	7	1	2	1	3	1		105	110	139	155	157	166
थरवई				1	2	5	2	1	2	3	1	3	2	4	1				11	6	7	19	10	12					2	5	2	1	1	2	1	1	91	90	107	122	112	137
बहरिया				1	1	3	2	2		3	2		7	2					18	5	3	21	8	7				4	3	2	3	1	2	1		1	65	53	58	107	72	73
स0इनायत				1		2	2	3	4		4		6	6	4				15	4	3	22	9	9				4	12	10	2	1		2	3	2	121	127	141	160	165	172
योग				3	5	13	8	7	7	10	7	5	21	18	7				62	32	17	86	51	39				18	28	24	8	5	4	8	5	4	382	380	445	544	506	548
हण्डिया		1		2	4	2	2	5	4	1			9	2	5				16	20	14	28	37	23				6	9	9	1	2	3	3	1	2	186	239	116	238	300	164
स0ममरेज				1	1		2	2	1			1	8	2					6	4		9	6	2				4	2	4		5	4		3	3	89	119	55	113	140	70
उतरांव				2	1		3	3	1	1	4		1	3	5				3	4	2	7	8	5			1	7	1	5		1	2	2	4		96	59	48	119	84	67
योग		1		5	6	2	7	10	6	2	4	1	18	7	10				25	28	16	44	51	30			1	17	12	18	1	8	9	5	8	5	371	417	219	470	524	301
योग गंगापार		2	3	25	20	31	24	33	30	15	27	23	93	79	51				180	155	124	261	231	196	1		1	79	81	80	17	20	18	21	25	20	1239	1398	1338	1775	1916	1791

थाना	डकैती			लूट			हत्या			बलवा			गृहभेदन			रोड होल्डअप			वाहन चोरी			कुल चोरी		
	17	16	15	17	16	15	17	16	15	17	16	15	17	16	15	17	16	15	17	16	15	17	16	15
नैनी				7	5	3	4	5	4	3	1	2	25	13	6				60	62	53	89	79	93
करछना				1	1		2		2	3	2	1	10	7	12				6	18	16	9	22	23
घूरपुर				1	1		1	4	4	1		2	8	5	5				14	7	17	18	16	25
औ0क्षेत्र				2	4		1	1	2	2	1		9	15	5				3	14	5	4	21	9
योग				11	11	3	8	10	12	9	4	5	52	40	28				83	101	91	120	138	150
मेजा			1		2	3	4	5	2	2		1	2	5	12				13	11	13	19	16	18
माण्डा						1	1	3	2	2			6	8	2				2	5	6	6	12	10
कोरांव					3	2	1	4	1		1	1	8	4	4				4	12	9	10	18	9
खीरी									1				2		3				5	1	1	7	8	3
योग			1		5	6	6	12	6	4	1	2	18	17	21				24	29	29	42	54	40
बारा					1		1	3						3	2					3	1	6	6	3
शंकरगढ़					2	1		3	3	3	3	2		4	4				9	7	10	16	21	17
लालापुर								3	2			1		2					1		1	3	3	1
कौंधियारा				1	1	1	1	3	2	2	1	3	3	6	2				3	3	5	7	4	7
योग				1	4	2	2	12	7	5	4	6	3	15	8				13	13	17	32	34	28
योग यमुनापार			1	12	20	11	16	34	25	18	9	13	73	72	57				120	143	137	194	226	218
योग जनपद	1	4	4	99	77	52	63	86	72	71	66	76	277	244	196				888	961	727	1265	1319	986

थाना	फिरौती हेतु अपहरण			अन्य अपहरण			दहेज मृत्यु			बलात्कार			अन्य भादवि			कुल भादवि		
	17	16	15	17	16	15	17	16	15	17	16	15	17	16	15	17	16	15
नैनी				18	14	3	1	1	4	5	1		222	190	238	374	309	353
करछना				7	8	1	3	4	1	1	4	3	126	156	114	162	204	157
घूरपुर				11	8	6	1	2		1	1		114	106	112	156	143	154
औ0क्षेत्र				2	4	1	1	1		2		1	57	94	48	80	141	66
योग				38	34	11	6	8	5	9	6	4	519	546	512	772	797	730
मेजा			1	13	7	8	4	4	7	3	2	2	184	137	109	231	178	164
माण्डा				5	3	3	1	2	2	2		1	68	83	92	91	111	113
कोरांव				6	3	7	3	1	2	1	1	4	78	96	84	107	131	114
खीरी				3	7	3	1		2	2	1		49	30	44	64	46	56
योग			1	27	20	21	9	7	13	8	4	7	379	346	329	493	466	447
बारा				5	3			1	2		1	1	48	35	19	60	53	27
शंकरगढ़				6	4	1	2		1	1	3	1	64	49	38	92	89	68
लालापुर					3	2		2	2			4	19	14	14	22	27	26
कौंधियारा				4	9	3	7	2	2	1	2		31	48	66	57	76	86
योग				15	19	6	9	5	7	2	6	6	162	146	137	231	245	207
योग यमुनापार			1	80	73	38	24	20	25	19	16	17	1060	1038	978	1496	1508	1384
योग जनपद	2		2	237	219	163	46	46	50	51	56	48	3589	3748	3648	5701	5865	5297