Towards Combating Security Challenges in Jimeta Metropolis Using Viewshed Analysis

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Abstract

The research was undertaken to propose strategic locations for establishing security posts in Jimeta metropolis. The issue of insecurity and increase crime rate in the study area motivated the need to study the terrain in order to effectively position security posts in the best location for efficient and maximum surveillance. Digital elevation model was analyzed and the locations of the proposed security points were determined by using the spatial analyst tool in ArcGIS software to create a viewshed. Eleven (11) proposed security posts were strategically identified based on their height and spatial locations in the study area and the height of the post was offsetted at 15m above the ground surface. The research indicated the significance of viewshed analysis in locating sites for security posts for maximum security.

Keywords: Viewshed analysis, Security Posts, Surveillance, Digitization

INTRODUCTION

Among the common uses of Terrain models is viewshed analysis; this is the identification of areas of Terrain that can be seen from a particular point on a Terrain surface (Heywood *et al*., 2011). Viewshed analysis is used in many different fields for both practical and aesthetic applications. It can play a vital role when planning for infrastructures (new buildings or road) or siting of security post especially in cities where obstructed views may raise safety and security concerns (Petrasova *et al*., 2015). Viewshed analysis is also essential when planning location of monitoring cameras or Security towers in order to maximize area coverage. The procedure involve in determining such locations/points is referred to as Viewshed/Visibility analysis. It involves topographical survey to obtain horizontal coordinates and elevation of points or Shuttle Radar Topographic Mission (SRTM) Digital Elevation Model (DEM); Advanced Space borne Thermal Emission and Reflection Radiometer Global Digital Elevation Model (ASTER GDEM) which can be 1 arc or 3 arc of a second (Rghar and Jayant 2003). The ASTER GDEM is used in analyzing the location and elevation of points, thereby achieving strategic location of points for better visibility and planning.

Security refers to the conditions that exists as a result of the establishment of measures for the protection of persons, information and property against hostile persons, influences and actions (Achumba *et al*., 2013). Hence, it is the existence of situations where individuals in the general public can go about their normal daily

businesses without any threats to their lives or properties. Insecurity therefore affects the physical, psychological, emotional, or financial wellbeing of an individual and his/her properties. Every human being, whether rich or poor, employed or unemployed, orphan or parented deserves to be protected against threat, extortion, humiliation, torture, terrorism and be given a sense of safety in a society. It is expected that every law abiding citizen is a tax payer, the mutual understanding is that he/she has already paid for social amenities provided by the government. Therefore, social amenities such as security are supposed to be equally beneficial irrespective of the location.

Security post is an installation at which a body of troops, guard or sentry stands or is assigned to stand in order to observe and provide firsthand information. Modern technology has offered a replacement of human at sentry post. For instance, Computer-based Closed Circuit Television cameras (CCTV) can be installed on the security post. This enhances surveillance as well as investigation of criminal related offences. Furthermore, heightening of physical security measures around the metropolis can deter or disrupt potential attacks, strengthening of security agencies through the provision of security facilities and the development and broadcast of security tips in mass media (Azazi, 2011). It will also aid in quick response to emergency situations since it will be more difficult for some intruders to attempt to break into such community/area without being noticed, identified and traced through those security measures.

The primary objective of every government is to provide security. In Nigeria, security agencies such as the Military, Police, Department of State Security (DSS) and the National Security and Civil Defense Corp (NSCDC) are the organizations or active institutional departments responsible for providing security. These agencies are charge with the responsibility of enforcing constitutional laws, rules and regulations as well as maintaining order for peaceful co-existence amongst dwellers in a community. However, the security agencies generally lack modern equipment or technology both in weaponry and training for intelligence gathering in the society (Achumba *et al*., 2013). The use of CCTV within the study area for intelligence gathering is lacking within the study area. There will not be real time intelligence gathering where these outposts don't exist. Furthermore, the rate of crime may increase. Hence this paper is focused on the used ASTER GDEM and ground Truthing in order to portray the undulating nature of the study area. From which various viewpoints will be generated and visibility analysis will be done to aid in curtailing criminal activities in the area of study. In their studies, Wang *et al*. (2016) carried out an Efficient Visibility Analysis for massive Observers, and proposed solution to support GIS systems to conduct efficient visibility analysis for massive observers. They formulate a novel computation framework which consists of three components, i.e., optimized line-of-sight algorithm, R * -tree filter and Map Reduce-based segmented computation. Wang *et al*., (2016) findings show that their proposed solution achieves at least an order of magnitude speedup over existing solutions.

Most of the security researches in Nigeria, particularly on the North eastern part is geared towards community participation in combating security challenges. In addition, the poor strategy to combat criminal activities in the metropolis poises tension among the populace (Ibrahim, 2017; Igbonwelundu, 2017). Coupled with that is the observation made by Ogbanna (2010) that the number of security personnel on constant surveillance is grossly

inadequate. Again the system of government lacks the technology of using CCTV in obtaining useful information in the country and the North east in particular is faced with the activities of insurgents. In the past few years, residents of Jimeta experience some restiveness and activities of the insurgents make the town uncomfortable for various development and business operation. People living in Jimeta metropolis do not have sound rest to the fear of insurgents, robbery, burglary and theft, snatching of valuable possessions in tricycles (popularly called 'keke Napep'), etc. Visitors are been scared away and the region appears as a risk zone to potential businesses that can initiate meaningful development in the region. One of the strategies to mitigate such security challenges is to provide firsthand information on the location and the type of such unwanted activities. To achieve that, security personnel and CCTV have to be stationed and installed respectively at locations with maximum view. Therefore, this paper aims at identifying a network of strategic points where visibility of the entire study area will be at optimum.

Study Area

Jimeta is the administrative capital of Adamawa State, Nigeria. It was established in 1912, by the then British Colonial Administration, as a model town to carter for the increasing influx of people into the town (Edan *et al*., 2013). It is located between Latitude 09º 13' N and 09º 18'N and Longitude 12º 22' E and 12º 29'E of Greenwich meridian as shown in Figure 1. Jimeta has become the administrative and commercial center of Adamawa state with a population of 282,356 at a growth rate of 3.2% as at 2017 (projected from the 2006 census). The figure comprises of 153,257 males representing 54.3% of the population. While and 129,099 representing 46.7% of the population are females.

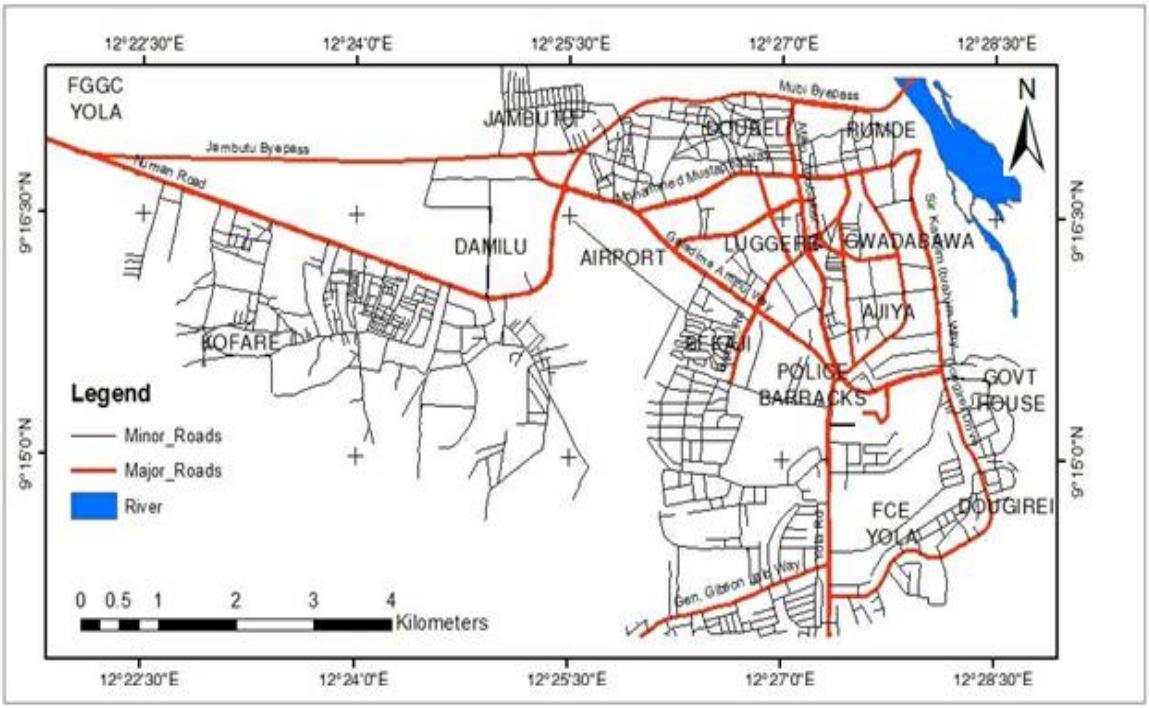

Figure 1: Map of the Study Area

MATERIALS AND METHOD

The ASTER GDEM2 captured in October 2011 from METI/NASA was used in the analysis. It has a resolution of 1'' arc of a second. The ASTER GDEM of the study area is shown in Figure 2. In order to determined the relationship between various locations, the slope map was used to show the visual significance of terrain which is heavily influenced by the vertical dimension (i.e. slope and elevation) as shown in Figure 3. Esri ArcGIS 10.1 was used and Hewlett Packard laptop with hard disc drive memory of 500GB, 2 GB RAMS, Intel(R) CPU @ 2.20 GHZ and 64 –bit operating system.

Digitization

In this study, analogue information or data were converted into digital format. An on screen digitization was carried out using the entities of lines and polygon for roads/street network and river respectively. Shape files for lines and polygon were created using same coordinate system of the satellite image of the study area. A digital road network of the area of study was produced as presented in Figure 4.

Viewshed Calculation

The basic algorithm for generating a viewshed from raster elevation data is basically an estimation of the elevation differences of the intermediate pixels between view points and targets pixels. This was done in order to estimate whether the target pixels will be seen from its surroundings. View point was performed by examining each of the intermediate pixels between two cells to determine the "line of sight". If the land surface rises above the line of sight, the target will not be visible otherwise, it is visible from the viewpoint if its lines of sight run parallel or above the view point. The line of sight computation was repeated for all the target pixels from a set of viewpoints as shown in Figure 5.

The ASTER GDEM was used to create the viewshed. As noted by Edan *et al*., (2013), a viewshed map represents both visible and non-visible points of the study area from chosen viewpoints. Each raster cell within the DEM was therefore considered a target. All cells that were visible from the observer point were coded as '1', while the non-visible ones as '0' in order to produce a binary (viewshed/visibility) map of the study area (Figure 6).

RESULTS AND DISCUSSION

Security agencies safeguard their base by security posts attached to their base in addition to security check points at their various entrances for maximum protection. While only temporary security check points are usually located in some selected locations to check wonderers and intruders within the community, this only results in periodic reduction in crime records.

The paper proposed a strategic security posts within the study area. The sites selected for the establishment of the proposed security posts are as a result of Viewshed Analysis which determines the raster surface locations visible to the post that was carried out by analyzing the Digital Elevation Model (DEM) (Figure 2) as shown in Figure 6. The slope Map (Figure 3) was used to show the visual significance of terrain which is heavily influenced by the vertical dimension or exaggeration of the DEM and the relationship between the various security posts. The road network in Figure 4 served as the based upon which the proposed

security post was draped. The line of sight in Figure 5 was created to determine the visibility of sight lines from the proposed security to features within the study area over the surface defined by the DEM in Figure 2. Eleven (11) proposed security post were strategically identified based on their height and spatial locations in the study area and the height of the post was offsetted at 15m above the ground surface. Furthermore, CCTV can be mounted or installed based on 15m heights of view as shown in Table 1.

Table 1: Coordinates of Proposed Security Posts with height of view 15m

SP I.D.	Easting (m)	Northing (m)	Height above msl (m)	Location
101	211623.774	1027056.701	168.633	FGGC Yola
102	216912.735	102713.252	155.765	Jambutu
103	218031.924	1026313.75	175.462	Market-Total
104	220594.948	1024397.634	193.774	Police Round about
105	220412.385	1021525.840	164.315	Yola Road
106	219295.577	1023235.581	192.671	Masakare
107	215402.225	1025034.754	175.773	Kofare Zone 3
108	220945.254	1026534.842	181.271	Rumde
109	220815.082	1027488.502	158.328	Jimeta Bridge
110	221763.714	1025484.911	218.241	Dougirei
111	212844.195	1022314.138	192.615	Kofare

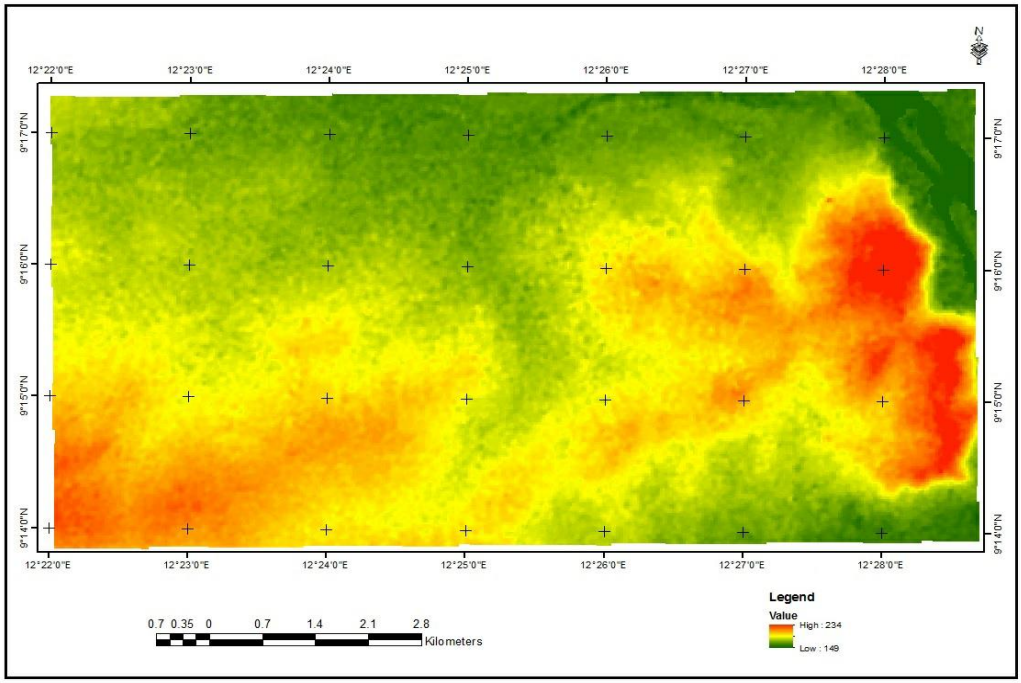

Figure 2: ASTER GDEM of the Study Area

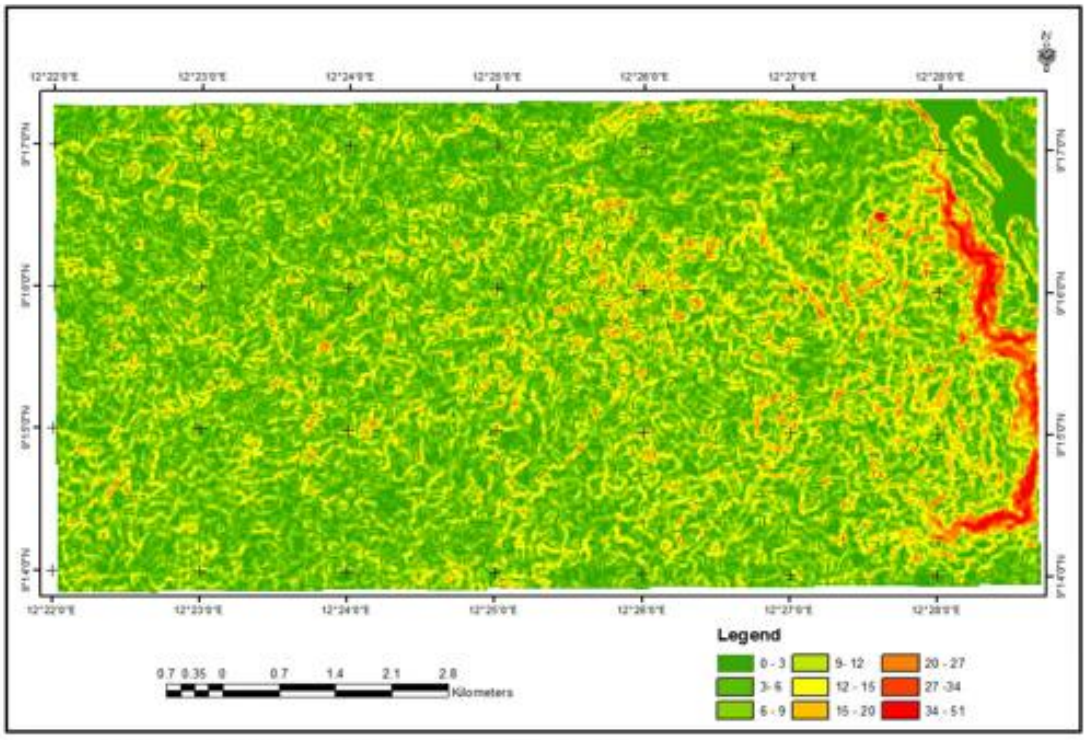

Figure 3: Slope Map of the Study Area

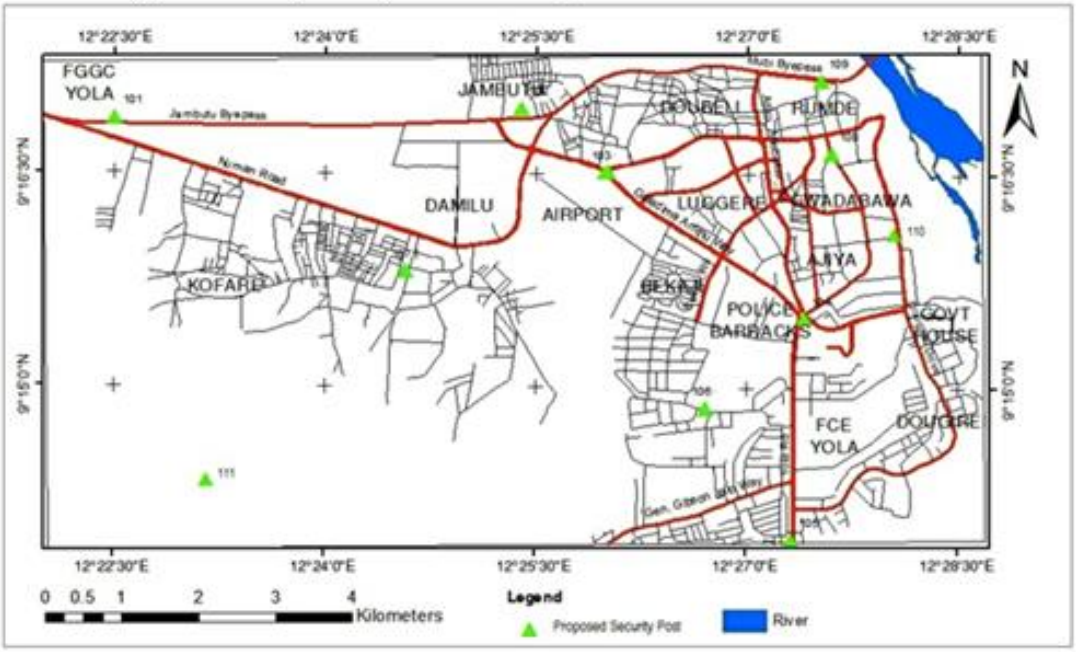

Figure 4: Digital Road Map showing Proposed Security Posts in the Study Area

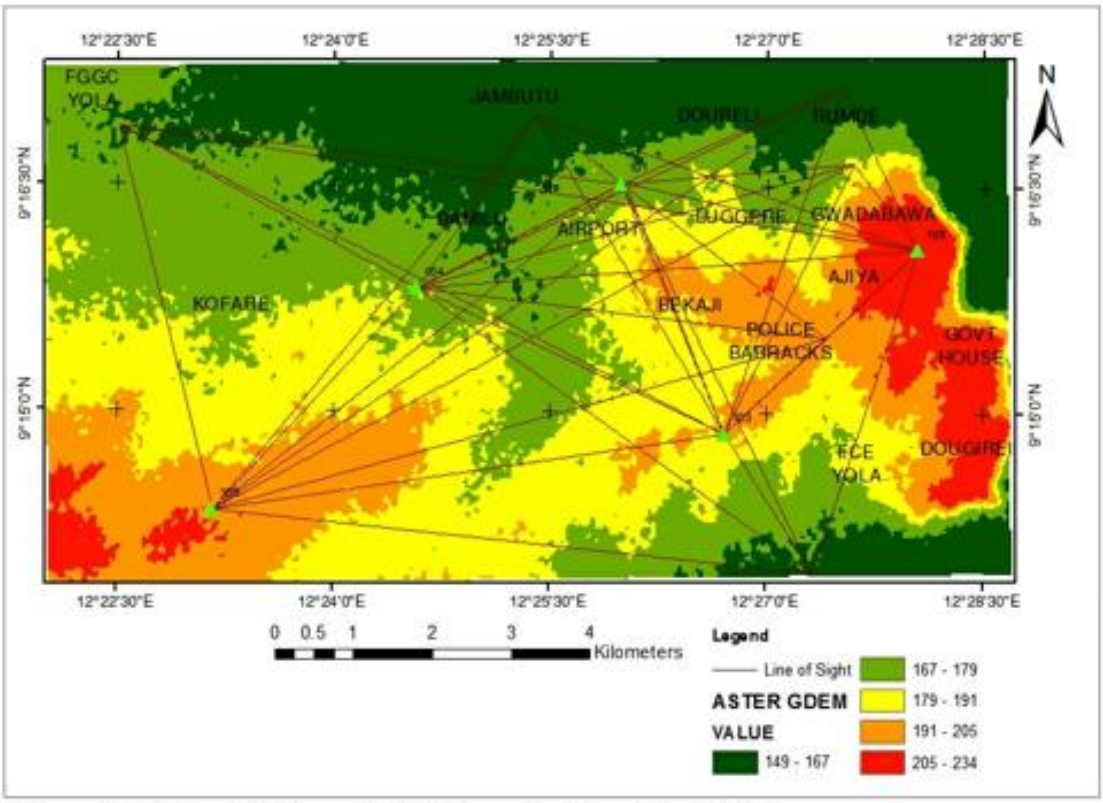

Figure 5: Map of Line of Sight overlaid on the DEM

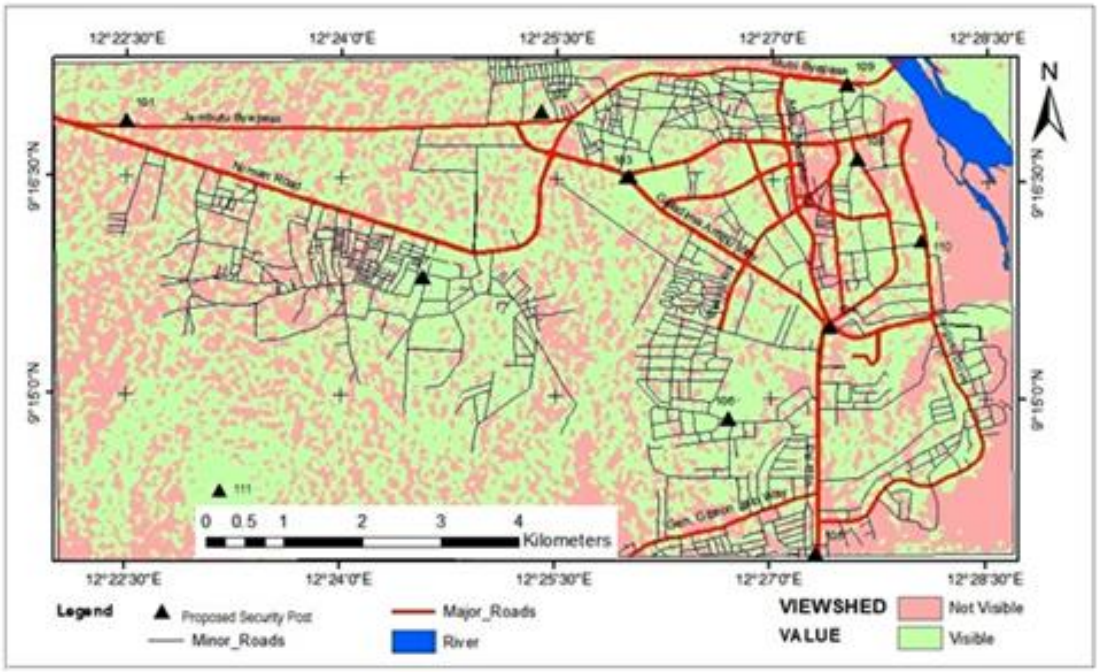

Figure 6: Map of Viewshed Analysis and proposed Security Post

SUMMARY

The ASTER GDEM plays a vital role to view the study area holistically with firsthand detailed information about the undulation of the study area. It further helped in analyzing the terrain which informs the strategic locations of the proposed security posts. It can therefore be inferred that viewshed analysis is an essential tool that helps to model condition of an area when dealing with very sensitive issues like combating insecurity. For effective and efficient surveillance, the method is recommended to enhance intelligence gathering and the used of cutting edge technology in the prevention of crimes and combating of potential treat to lives and properties of the populace.

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