Universe International Journal of Interdisciplinary Research
(Peer Reviewed Refereed Journal)
© UIJIR | ISSN (O) – 2582-6417
FEB. 2021 | Vol. 1 Issue 9
www.uijir.com

APPLICATIONS OF SATELLITE REMOTE SENSING OF NIGHTTIME LIGHT OBSERVATIONSIN MONITORING TERRORIST ACTIVITIES IN NIGERIA

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DOI No. – 08.2020-25662434

Abstract

This paper reviews the contributions of nighttime light remote sensing in monitoring terrorist activities. Night-time light (NTL) remote sensing images have been widely applied in many aspect researches, also insisted to have great potential for monitoring terrorist activities in Nigeria. The study review some applicable validity in monitoring terrorist activities and found it to be possible, despite being some challenges and limitations. Being able to implement such issue of monitoring, would offers the best approach for the mapping possible tracking their activities.

Keywords: *Remote; Sensing; Nighttime; terrorist; activities*

INTRODUCTION

National security threat has been an issue of concern for the government of Nigeria in recent years. Meanwhile, "unlawful" means an act which is done, given, or effected outside the course of laws of a state or that is not founded upon, or unconnected with the law of a state [1].

Activities in the form of militants, kidnappers, criminals, bunkering, armed robbers, hoodlums, terrorists, thugs, livestock stolen, illegal mining, miscreants, bandits, thieves, insurgents, cultists, rebels, ragabonds has often been attributed to this terrorism, happening in different parts of the Nigeria. These groups are numerous, the most noticeable and deadly are the Boko Haram sect and Niger Delta Militants. People are burdened on a daily basis with psychological and emotional trauma resulting from gory sights of lifeless and mutilated bodies of loved family members, close associates and colleagues littered on the streets, public squares and everywhere [2].

Terrorism is spreading like a wildfire in every part of the world and its impact reverberates beyond the location of the actual incident [3].

Widening global to a high degree of proficiency with more sophisticated weapons and tactics. The inability of the government to monitor the conflict dynamics as to locate early warning signs to prevent outbreak of hostility was a serious issue not only in the instance of Boko-Haram but other conflicts that have threatened sustained peace in Nigeria [4].

However, a number of methods or approaches have been prescribed as solution to insecurity, by different people as citizens both within the country and outside, and as foreign observers[5]. And the use of brute force has obviously proved insufficient to checkmate their activities, rather it makes them have more recruits [4].

One of the major measures necessary to condemned, resisted, fought and eliminated at all levels-local, regional, states, and national in this regard is to trace, map and monitor their activities by security agencies. Their activities are always changing; thus, it is also necessary to monitor their hidden activities using some newer and higher resolution night-time light data. Therefore, the main aimed of this study focused on the applications of satellite remote sensing of nighttime light observations in monitoring terrorist activities in Nigeria, with the objective to provide a comprehensive reviewed application from the outlooks challenges. Being able to monitor their locations on a continuous basis offers the possibility of tracking their movement, financial assets, illegal weapons, skills and expertise they adopted. Such a capability is critical to intelligence gathering and necessary precondition for threat interception and the prevention of the escalation of insecurity [5].

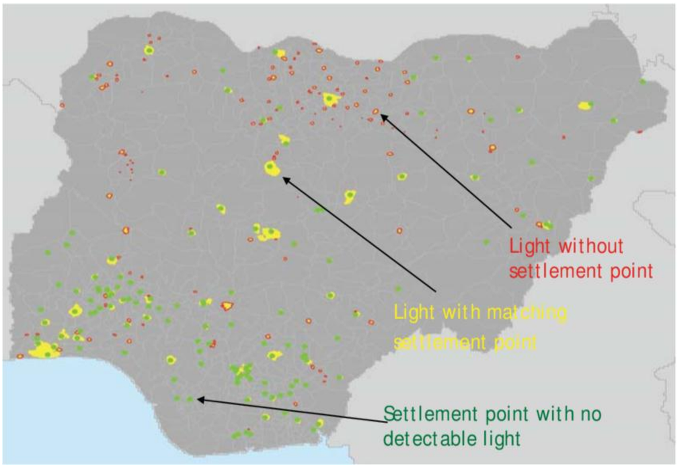

Figure 1: Night-time Lights, Nigeria[6]

MONITARING TERRORIST ACTIVITIES

To prevent terrorism, various dimensions of the problem have to be considered, particularly monitoring. Monitoring enable security agencies to strike a much needed balance between counter-terrorism operations and breaking the funding, track trade consignments between countries, beef up border control and surveillance, enhance intelligence gathering and analysis, and garner the support of people and logistics supply chains used by terrorist. Monitoring terrorist activities were also capable of dictating which tactics they adopted in planning intelligence to successfully conduct the operation.

Nigeria is a region where remote settlements are sparse and scattered. Furthermore, the settlements in Africa are often small and sparsely scattered [7]. The region is ideal for terrorist hideout in every part of the country. They include those areas which are politically volatile, and with a large mass of uneducated and abjectly poor population that can easily be recruited as terrorist operatives; areas in which people have high level of attachment to opinion leaders, and the leaders-followers ties are very strong; towns and states on border lines with other countries, and which have cultural and language links with other societies outside the country, which allow for a network of transnational criminals and terrorists [5].

The Nigeria has to take the most drastic precautions, including the monitoring of terrorist activities for the safety of their citizens, by preventing terrorists at their hideout from acquiring supplies of sophisticated conventional weapons, as well as chemical and biological agents, materials, training, money, intelligence, logistics, and operational support. As this would provide them great freedom of movement, plans and increase their opportunities to attack. As responses of changes in NTL to human activities vary over space and time, analyses without considering sociocultural, lighting sources, outliers, and a sizeable portion of dark or dim areas could lead to biases of estimated human activities [8]-[9]. However, one pioneering study, using 159 countries as samples, shows that the NTL fluctuation, measured by an NTL variation index, is correlated to armed conflicts, with higher fluctuations indicating higher probability of occurrence of armed conflicts [10]. For this study, remote sensing of NTL observatory (as shown in figure 1) were insisted to provides an accurate monitoring, and straightforward way to map out terrorist activities, as this would greatly assist in unveiling unlawful activities related to light usage at night time in Nigeria.

SATELLITE REMOTE SENSING OF NIGHTTIME LIGHT OBSERVATIONS

Visible light emitted on Earth surface at night has become a commonly used for monitoring human activity. Satellites have been recording images of the earth at night, identifying areas with anthropogenic lighting, for about fifty years [11]. That is, since the 1970s, night light imagery has been captured and produced by satellites from the United States Air Force Defense Meteorological Satellite Program-Operational Linescan System (DMSP-OLS), with the digital archive of this product beginning in 1992[12]. Originally used to detect the global distribution of clouds and cloud-top temperatures, OLS sensors also detect visible and near-infrared emissions at night from different sources on Earth, such as city lights, auroras, gas flares, and fires[13].

Remote sensing is the science that deals with obtaining information about objects on earth surface by the analysis of data, received from a remote area. Remote sensing observation is done by detection and real-time display devices or recording devices of energy (light or another form), which is emitted or reflected from an object or a scene of electromagnetic radiation or acoustic energy at a distance without physical contact with the object of interest. The nighttime light remote sensing technology has a unique night imaging capability, which can overcome the problem that traditional daytime remote sensing images that cannot monitor targets at night [14].An example of satellite remote sensing applications is the monitoring of forest fires in disaster control, where hotspots can be monitored by satellite sensors [15].Nighttime light observations from remote sensing provide us with a timely and spatially explicit measure of human activities, and therefore enable a host of applications such as tracking urbanization and socioeconomic dynamics, evaluating armed conflicts and disasters, investigating fisheries, assessing greenhouse gas emissions and energy use, and analyzing light pollution and health effects [9].

Although the initial purpose of DMSP/OLS was designed to observe the clouds illuminated by moonlight using two broad spectral bands: visible-near infrared (VNIR, ranged from 0.5 to 0.9 μm) and thermal infrared (TIR, ranged from 10.5 to 12.5 μm), DMSP/OLS images have been extensively used in urban studies due to the low-light sensing capabilities at night without moonlight [16]-[17]. More recent data acquired by the National Polar-orbiting Partnership Visible Infrared Imaging Radiometer Suite (NPP-VIIRS) were applied for the same purpose [18].An alternative, and thus likely vitally important, source of remotely sensed spatial and temporal data on the spectrum of artificial nighttime lighting is photographs taken by astronauts on the International Space Station (ISS) [19]. So also, space Station (ISS), EROS-B, Jilin 1-3B, and Luojia 1-01, with better spatial and temporal resolutions, and even multispectral information, have been launched[20], offers nominal 1-kilometer resolution, and are now easy to access and process [21], which can work at night and detect light from cities or even low-

intensity light from small-scale residential areas and vehicles [22]. This show that the new 2016 nighttime light image can very effectively identify even small settlements[7].
DMSP/OLS nighttime light data is used as a comprehensive factor to characterize the intensity of human activities [22]. The sensors are designed to help identify cloud coverage at night through detecting moonlight reflections, but on cloud-free nights they record light emissions from the earth's surface[23]. Most remote sensing satellites operate in one of two orbits: geostationary or sun-synchronous [21]. While geostationary satellites orbit around the Earth in a way that keeps them directly above a fixed point on the Equator, Sun-synchronous satellites orbit typically within 6,000 kilometers and often much more closely. In the DMSP program, typically two satellites are orbiting simultaneously, in a sun-synchronous low earth orbit, at an 833 km altitude [24].These satellites circle the earth several times per day and collect a digital stream of images relevant to nighttime light intensities on the earth's surface over a given time. In addition, this data set has a near global coverage (spanning from −180° to 180° in longitude and −65° to 65° in latitude)[25].

Application of NTL for Monitoring Terrorist Activities

Remote sensing night-time data probably give some information for the area which has high activity in the night that shown by high reflectance of light [26]. Nighttime light remote sensing images show significant application potential in marine ship monitoring[15], monitoring of forest fires in disaster control [16], humanitarian crisis [27]. Indeed, remote sensing NTL observatory could provide us a new perspective for monitoring terrorist activities and it would able to illuminate image commonly prescribed by outdoor lighting at night. Remotely sensed data may provide a cost-effective method to reduce expensive ground data collection. Also providing better coverage in time and in area extent than aircraft.

NTL Data for Monitoring Terrorist Activities

Light spectral is a unique indicator of human activity that can be measured from space at night. The spectra were collected as irradiances, heading directly at each light source. Night lights data offer unique advantages to researchers, which can be summarized into three categories: 1) access to information that is hard to obtain at large scale and low marginal cost; 2) higher degree of spatial resolution than traditional data; 3) usually full geographic coverage [12]; [21]. Spectra were acquired of a suite of outdoor lighting types, including streetlights (mercury vapor lamps and high pressure sodium vapor lamps), incandescent lights from vehicles and homes, and lights present at commercial and government facilities (fluorescent, neon and low-pressure sodium vapor lamps) [28].

Historically, terrorist groups and organizations have been closely related to a certain geographical area and executed in that area [29]. Mostly at bushes or forests to carryout their activities. Persistent light is a clear indicator of the presence of human settlements [24]. Hardly for someone in bush or forest not using light to carry his activities, so also terrorist. Nighttime light induced by human beings is mainly generated by electric lighting [30]-[31]; [7]. [32] suggested that nighttime lights is a surprisingly accurate measure of village household electrification. Most terrorist activities were carryout by light at night time by using electric generator to power their camp, bicycle, motorcycle and car for logistics. These features make it possible to trace their location and monitor them over time. With the expectation that the target area to be small, because vast areas, especially where there are many unpopulated areas and settlements are difficult for interpretation. Therefore, the lights use by terrorist are marked separately to achieve a fair comparison for monitoring human activities over a given time and area.

Most of the built-up catchment areas (legal settlements) over the past years are known and being control by the government, they may have access electrical lighting, densely populated than terrorist settlements. Whereas terrorist activities area, sometime abide and not accessible to a common citizen can be identified for the monitoring. As the goal of this study is to monitor terrorist hideout, legal settlements should be filter in order to avoid misinterpretation of data (filtering of unwanted lights spot). This helps in avoiding the effects of the any kinds of stray light around the terrorist activities areas by NTL image. The preprocessed satellite images for the legal settlement should manually marked for accurate verifications. These manually marked areas will be used as a reference point on map to trace terrorist from legal settlements, making it easier to identify terrorist settlement using remote sensing NTL observatory satellite.

The appearance of the terrorist lights and the characteristics of the radiation value can completely identify terrorist positions, but not all types of outdoor lighting. And the appearance of a small number of terrorist lights or data with a set of low-light imaging band is relatively challenging. Hence, there are several examples of this inability to detect low density areas [33]. One reason is that the sort of lights typically used in rural villages are not the type easily detectable from space[11]. But it might still effective in identifying light radiation values. In addition, nightlight imagery is available at a low temporal resolution due to the uniqueness of the satellite collection and its orbit[26]. In this regard, the nighttime light used by legal settlements, land-use and land-cover maps are neglected due to the strong brightness, usually classified by multi-spectral satellite images at the high spatial resolution record, spanning from 0 to 63, with higher values implying more intense nighttime light.

Light sources in each area taken has a comprehensive index to adopt. Scholars have used the maximum digital number (DN), the DN sum within an area, the number of non-zero DN pixels, the average DN within an area, and others [32]. Based on nightlight data, three choices are required: (1) the minimum number of pixels that constitute a catchment area; (2) the govern parameter values and (3) proposal of the minimum DN to be adopted. Pixels have a resolution of 30 arc seconds, or approximately 1km × 1km[13].These parameters are suitable for monitoring terrorist activities at this stage, but further studies are much more required.

Limitations of NTL in Monitoring Terrorist Activities

Remote sensing NTL observatory has been applied to different issues of human activities. The improved remote sensing NTL observations, with strong capabilities for capturing nightscape activities will open new avenues for monitoring terrorist activities. However, there are still many limitations and significant gap in NTL remote sensing satellites and users who are seeking high quality NTL remote sensing data. And the causes of observed light changes across space and time, which are crucial for investigating the relationship between NTL observations and human activities, however, are still limitedly considered in previous studies [9]. For instance, factors such as the exact position of satellites at the time of capturing the information, and the satellite-specific degradation of the capturing sensors imply that recorded images can suffer from misalignment within a satellite across time, and across satellites within the same year, making DN values vary for reasons other than the actual luminosity intensity of pixels[34]. In addition to these flaws in the DMSP data, it is becoming clear that satellite data on night lights (including from VIIRS) are poorly suited to the study of areas of low population density, which includes most rural places [11], drawing conclusions overlooking challenges in small terrorist settlements.

Collecting data with a set of low-light imaging bands, specifically tailored for nighttime lights, would be indispensable to (i) obtain quantities that can be related directly to international recognized measurements and standards for outdoor lighting, (ii) define the predominant type or mixture of lighting present, and consequently (iii) detect changes in lighting type over time [28]. These can only be addressed in calibration framework for the future.

Lack of technological knowhow majorly in the aspect of using remote sensing as a tool to unveil their hideout should be considered as a major challenge in tackling terrorist activities in Nigeria. That's takes considerable knowledge to evaluate, interpret and classify satellite data [35], especially with the application satellite remote sensing NTL observations to monitor terrorist activities.

CONCLUSION

This paper aimed at reviewing applications of satellite remote sensing NTL observatory in monitoring terrorist activities in Nigeria.High-resolution nighttime light images have shown excellent development potential in many fields. However, such a fundamental issue has not been fully addressed in previous researches in monitaring terrorist activities. And the limitations of technologies in data generation and processing challenges are still existing in accessing NTL data to a high quality especially Nigeria, due to the shortage of skills and knowledge and being that the previous data is not guarantee to be available at terrorist catchment areas. It was insisted from this study that the application satellite remote sensing NTL observations could provided more accurate information on terrorist activities at the global scale. Therefore, it is of great significance to give more attention to multidisciplinary and interdisciplinary analyses of satellite remote sensing NTL observations for the purpose of monitoring terrorist activities.

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