ARTICLE

Darkest nights of the Marawi siege

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ABSTRACT

The peaceful afternoon of May 23, 2017, in Marawi City, turned the battleground as the government forces clashed with the Islamic State of Iraq and the Levent (ISIL)-affiliated militants of Abu Sayyaf Salafi Jihadist and the Maute group. The 2016-2020 Marawi City night-time light imageries captured by the Visual Infrared Imaging Radiometer Suite (VIIRS) satellite undergo pixel count and linear interpolation through Python Spyder programming, and were rastered and clipped using the Quantum Geographic Information System (QGIS). It was revealed that the Marawi City was not light polluted (red pixels: ~80 x 10-9 W/cm^2*sr) in 2016 and shows a significant decrease on the radiance value in 2017 siege. Around 72% of the night-time light (NTL) of the pre-siege (May 2017) has depleted on post-siege (October 2017), indicating the great gravity of the mass destruction within the main battle areas. The battle caused detrimental scars in Marawi City which was reflected in the imageries, pixel counts and radiance value. The relief operations and rehabilitation in Marawi warrant the health care, welfare, security, economy, peace and empowerment to its residents organized by the Task Force Bangon Marawi (TFBM) in cooperations with several government agencies and international organizations and governments. The radiance value in 2020 shows the reestablishment of the condition in 2016, even so, other villages show the revitalization of urbanization. This coincides with the report made in April 2021 by the TFBM that the rehabilitation is nearing its completion by the end of December 2021 and June 2022 report which summarizes 72% of the infrastructures are complete.

INTRODUCTION

Nearly 300 people died in the Marawi City as it turned battlefield during the attack of the militants affiliated with the Islamic State of Iraq and the Levent (ISIL) groups Abu Sayyaf Salafi jihadist and the Maute. In an interview with Lt. Gen Carlito Galvez, the attack intends to declare the city as “wilayat” or another provincial territory of the ISI (GMA News, 2017). Reports also mentioned recruitments among the young and innocent soldiers. According to the Philippines armed forces commander, ISIS was able to fund $600,000 through Dr. Mahmud bin Ahmad, a Malaysian believed to be the liaison for major ISIS-networks in Indonesia. This served as funds to access firearms, food and other supplies for the attack in Marawi (Associated Press, 2017). The same group was blamed for the bombing in the Davao City a year before the siege (Betteridge-Moes, 2017).

About 400 militants transported by trucks and loaded with 50-calibre machine guns, rocket-propelled grenades and high-powered rifles seized the city (Inton et al., n.d.). They took over familiar infrastructures such as the Camp Ranao, set into a fire the Saint Mary’s Cathedral, Ninoy Aquino School, and Dansalan College (Global Ministries, 2017); and occupied several buildings in the city including a hospital, city jail, the Marawi City Hall, and even the Mindanao State University (MSU) (Inquirer, 2017). In effect, residents had to locked indoors for the first few days of the siege until deciding to fled the city. According to Betteridge-Moes (2017), around 300,000 people that were forced to leave the city and stayed in safe shelters where many suffered diseases and hunger. As of September 2023, the Task Force Bangong Marawi reported that there are 80,300 people (16,070 families) still displaced since the siege (OCHA, 2023).

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KEYWORDS

Night time light, Marawi siege, spatial analysis, VIIRS, Marawi rehabilitation

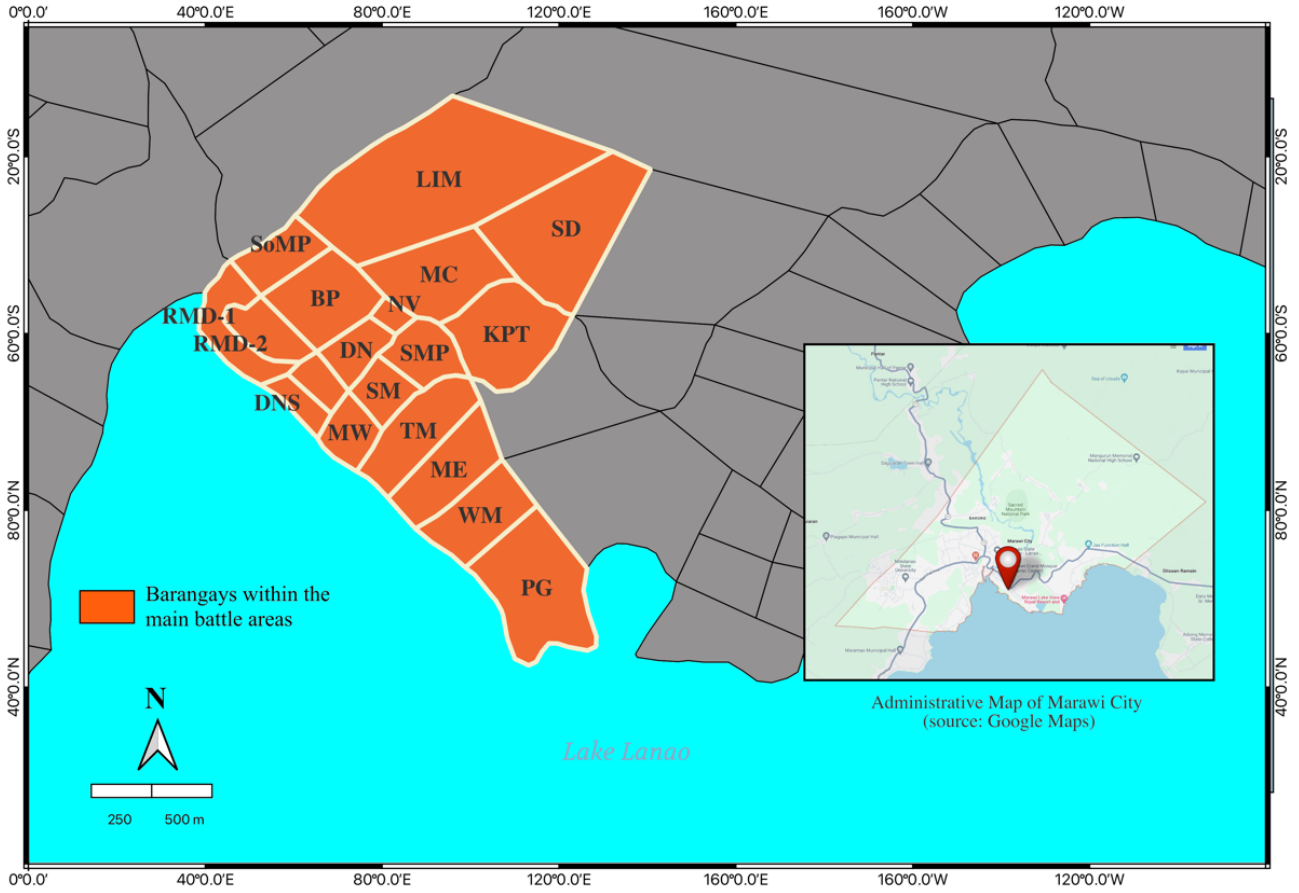


Figure 1: Main Battle Areas During the Marawi Siege

Philippine President Rodrigo Duterte eventually declared Martial Law in the entire island of Mindanao and suspended the *writ habeas corpus* in the entire island of Mindanao (Amnesty International, 2017) almost a decade after the former President Gloria Macapagal Arroyo declared the 2009 Maguindanao state of emergency.

The darkest nights of the Marawi City finally ended on the 23rd day of October 2017. Philippine Defense Minister Delfin Lorenzana declared the end of the five-month long battle. Two of the most influential militants, Hapilon and Maute, were killed on October 16 (Bolledo, 2021). The implemention of martial law continued to safeguard the Marawi City and its people. Countless help and support extended for the city and its inhabitants, one of these was exerted by the Australian government that funded 20 million Australian Dollars (~14.6 USD) to resolve conflicts, humanitarian assistance, and build peace (Australian Embassy, 2018).

Media journalists and even government investigators would find it difficult and dangerous to access Marawi during the siege; thus, there is a need to monitor and evaluate humanitarian conditions through remote sensing techniques (Witmer, 2015; Jiang et al. 2017). This has become one of the safest and faster method to initially assess the situations. Civil wars and armed conflicts in Iraq (Li et al. 2018), Russia and Georgia (Witmer and O'Loughlin, 2013), in Congo (Nackoney, 2014), and in Yemen (Jiang et al., 2017) were all assessed through satellite imageries. This technique has been used also in other applications that provide remote perspective on human activities including energy consumption (Gaston et al. 2012; Cole et al. 2017; Mann et al. 2016), urbanization (Liu et al. 2012; Li et al. 2016), poverty assessment (Yu et al. 2015), regional inequality (Wu et al., 2018; Zhou et al., 2015), Gross Domestic Product (GDP) approximation (Bautista 2021), economic growth (Henderson et al. 2012), and even COVID-19 monitoring (Argentiero et al. 2021). Several physical variables can be linked to the artificial light involving multi-year observation (Bennie et al. 2013).

The night-time composites show the spatial dispersal and saturation to artificial light at night (ALAN), which in excess, constitutes the Light Pollution (LP). According to the International Dark Sky Association (n.d), LP is the consequence of industrial civilization which includes building exterior and interior lighting, commercial properties, advertising, offices, factories, streetlights, and illuminated sporting venues. In addition, the brightness of the sky essentially increases as the cloudiness increases, with the emphasis on lowest clouds (Ściężor 2019). The ALAN can distrupt natural activities of nocturnal species such as bats (Stone et al. 2015; Guido and Kalaw 2021), turtle hatchlings (Kamrowski et al., 2012), and bettle (Foster et al., 2021).

Satellite imageries has gained a lot of different usage to monitor activities on the remote areas, wildfires, and even country-wide conflicts. Researchers (Hang et al. 2024) used this approach as a proxy to compare light intensity during and after the conflict. The nighttime light shows widespread blackout across the battleground city and human activities were completely wreaked havoc in the Russian-Ukranian war. The light changes is correlated to the stages of the conflict. Thus, Li et al. (2018) showed that when the Islamic State of Iraq and Syria (ISIS) attacked the region between December 2013 and December 2014, the visible light rapidly declines. Some provinces have even light depleted up to 88% (Ninawa) but regained its light following the Iraqi Security Forces in 2017. The electricity resupplied as construction continues, indicating its link to socioeconomic factor.

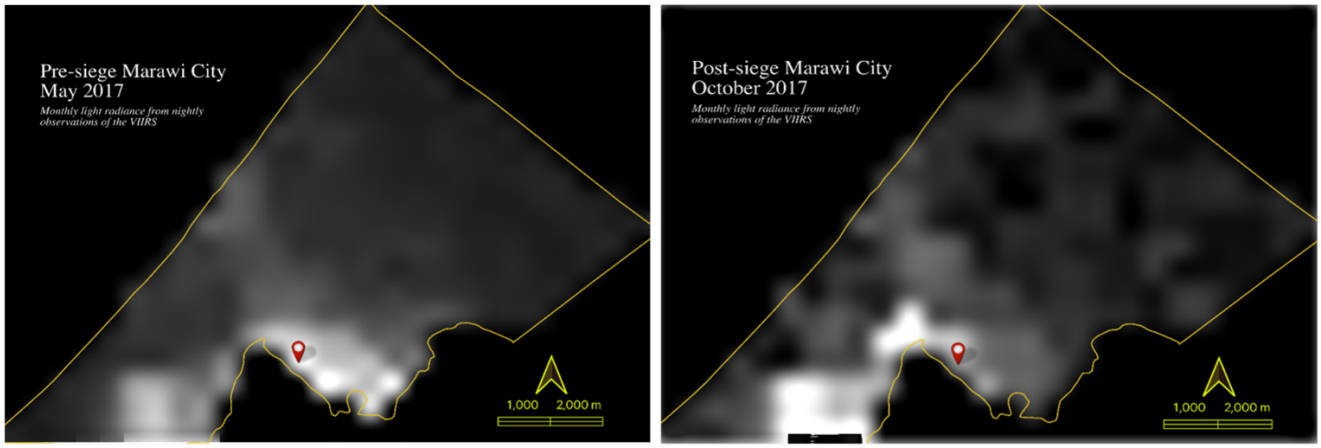


Figure 2: VIIRS night-time light image of the Marawi City (Pre- and Post-siege)

MATERIALS AND METHODS

Study Area

Formerly known as Dansalan - the center of the Lanao Province from 1907 to 1940, the Marawi City (fig.1) is now the provincial capital of the Lanao Del Sur and one of the five provinces of the Autonomous Region in Muslim Mindanao (ARMM). It is located at 8° 0' North, 124° 17' East and covers landlocked area of 87.55 km^2 (33.80 sq mi) consisted of mountains, valleys, hills, and the placid Lanao lake. The city has 96 barangays or villages occupied by the 19.03% of the total population of the Lanao del Sur. Marawi City is with different kinds of topography; the Lanao lake, rolling hills, valleys, and Mt. Mupo were ideal for militants hideouts. It is the largest urban city in the ARMM with diverse commercial and institutional programs and activities. Even so, Lanao del Sur recorded a poverty threshold of about $442.8 (Php 22,802) in 2015 which was the highest incidence of poverty in the Philippines (PhilAtlas, 2021). With the 96% of the total population are Muslim Maranaos, the Marawi City is known as the Islamic City in the Philippines. The siege has destroyed several infrastructures and houses in the Marawi City, mostly felt in the inner cities where the majority of the population is dense. According to Malicdem (2017), there were twenty-nine (29) barangays affected in the siege and amongst were Datu Sa Dansalan, Sangcay Dansalan, Dansalan, Datu Naga, Norhaya Village, Raya Madaya, Sabala Manao suffered the most.

We utilized night-time light (NTL) images (nW/cm^2 *sr) in the Marawi City, Philippines from 2016 to 2023 using the Visible Infrared Imaging Radiometer Suite (VIIRS) that captures satellite imageries in visible and infrared across land, ocean, and atmosphere and with a spatial resolution of 750 m. The light radiance is the reflected ambient light at night from several sources. The VIIRS has higher resolution than the Defense Meteorological Satellite Program (DMSP) - Operational Linescan System (OLS) which can detect low light imaging data (Elvidge et al. 2013). This is essential to differentiate inhabited areas, for example: higher values of concentrated radiance (232 nW/cm^2 *sr) are mostly seen in the city center while lowest radiance (32 nW/cm^2 *sr) were seen in landscapes and large green spaces in Warsaw, Poland (Czarnecka et al. 2021).

Working with large field of view spatial resolution can be challenging and small sized maps such as in the Marawi City may show little to no changes. In this regard, we described the darkest nights in Marawi through the depletion of monthly night-time lights, and the recovery of the city through annual NTL images using the Visible Infrared Radiometer Suite (VIIRS), so we accessed two different repositories:

1. Monthly Night-time light images. A total of five (5) monthly images from May – October 2017 were acquired to represent pre-siege, on-siege, and post-siege Marawi City. Gathered by the VIIRS (Figure 2), downloaded through the Colorado School of Mines (https://eogdata.mines.edu/products/vnl/). We omitted the July 2017 which shows plain black image with an empty data.
2. Annual Night-time light images. A total of five (5) annual images from 2016-2020 were obtained through the VIIRS (https://www.lightpollutionmap.info/#google_vignette).

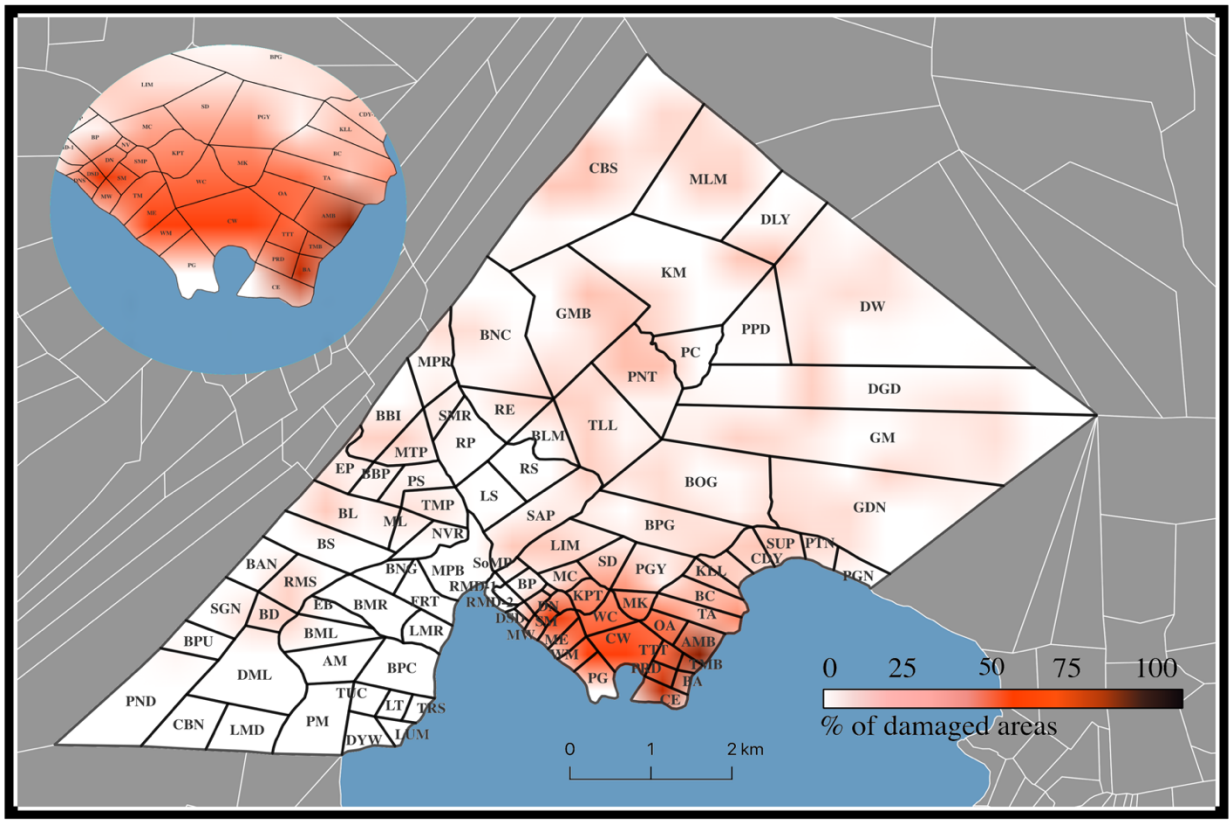
Data Pre-processing

All night-time light images of the Marawi City and its neighboring barangays were rastered and reclassified through QGIS version 3.18.1-Zürich. We only used the color scheme available in the lightpollutionmap.info for the reclassification of the annual images, the monthly NTL images remained in single band. To work with high-resolution reclassified annual images, a linear image interpolation through Spyder program was done.

For the annual images, primary (RGB - red, green, and blue) and secondary (CYMK- cyan and yellow) were used for pixel counting. Here we referred them as RYGCB.

Table 1: Image Reclassification Notation and Radiance Equivalence

Color	HTML notation	Min. Radiance Value (nW/cm^2 *sr)
	#000A61	0.30
	#66DD54	2.00
	#FFFF40	15.00
	#FDAE61	30.00
	#D7191C	65.00



AMB	Ambolong	CBS	Cabasaran	GMB	Guimba	NVR	Navarro	RE	Rorogagus East
AM	Amito Marantao	CBN	Cabingan	KPT	Kapantaran	NV	Norhaya Village	SM	Sabala Manao
BPC	Bacolod Chico Proper	CDY	Cadayonan	KLL	Kilala	OA	Olawa Ambolong	SMP	Sabala Manao Proper
BAN	Banga	CDY-I	Cadayonan I	KM	Kormatan Matampay	PG	Pagalamatan Gambai	SAP	Saduc Proper
BNC	Bangco	CE	Calocan East	LIM	Lilod Madaya	PGY	Pagawayan	SGN	Sagonsongan
BG	Bangon	CW	Calocan West	LS	Lilod Saduc	PS	Panggao Saduc	SD	Sangcay Dansalan
BP	Banggolo Poblacion	DGD	Daguduban	LM	Lumbac Marinaut	PNT	Pantaon	SMR	Somiorang
BML	Basak Malutlut	DNS	Dansalan	LUM	Lumbaca Madaya	PPD	Papandayan	SoMP	South Madaya Proper
BD	Beyaba-Damag	DSD	Datu Sa Dansalan	LT	Lumbaca Toros	PC	Papandayan Caniogan	SUP	Sugod Proper
BBI	Bito Buadi Itowa	DN	Datu Naga	LMD	Lumidong	PRD	Paradi	TMP	Tampilong
BBP	Bito Buadi Parba	DYW	Dayawan	MLM	Malimo	PTN	Patani	TMB	Timbalangan
BOG	Boganga	DML	Dimaluna	MPB	Marawi Poblacion	PND	Pindolonan	TA	Tuca Ambolong
BA	Boto Ambolong	DLY	Dulay	ME	Marinaut East	PM	Poona Marantao	TLL	Tolali
BS	Buadi Sacayo	DW	Dulay West	MW	Marinaut West	PGN	Pugaan	TRS	Toros
BL	Bubong Lumbac	EB	East Basak	MTP	Matampay	RMS	Rapasun Msu	TUC	Tuca
BC	Bubonga Cadayonan	EP	Emie Punud	MPR	Mipaga Proper	RMD-1	Raya Madaya I	TM	Tuca Marinaut
BLM	Bubonga Lilod Madaya	FRT	Fort	MC	Moncado Colony	RMD-2	Raya Madaya II	TTT	Tongantongan-Tuca Timbalangan
BMR	Bubonga Marawi	GDN	Gadongan	MK	Moncado Kadingilan	RS	Raya Saduc	WC	Wawalayan Calocan
BPG	Bubonga Pagalamatan	GM	Gadongan Mapantao	ML	Monriatao Loksadato	RP	Rorogagus Proper	WM	Wawalayan Marinaut
BPU	Bubonga Punod								

Figure 3: Impact of the Marawi Siege as seen on the Night Time Light

Rate of Change of the Night-Time Light

The monthly rate of change of NTL during the siege in Marawi City is computed using Raster Calculator in QGIS. The same method is used to reveal how the siege impacted several barangays, as described on May 2017 and October 2017 NTL.

We determined the R-square value of the annual NTL to reveal the impact of the 2017 siege versus its succeeding years. We first estimated the radiance profile of the images in accordance to table 1, then the trend is used to describe the siege's improvement until 2020.

RESULTS AND DISCUSSION

Monthly Night-time Light Dynamics of the Marawi Siege

Since the start of the siege in May 2017, the militants occupied large areas in the city. The conflict also resulted in destruction and damage of over 95% of the structures in the main battle areas, with more than 3000 structures were uninhabitable (Malicdem, 2017). The residents had to vacate the main battle areas to find shelter to its neighboring barangays in the western side of the city (Figure 2).

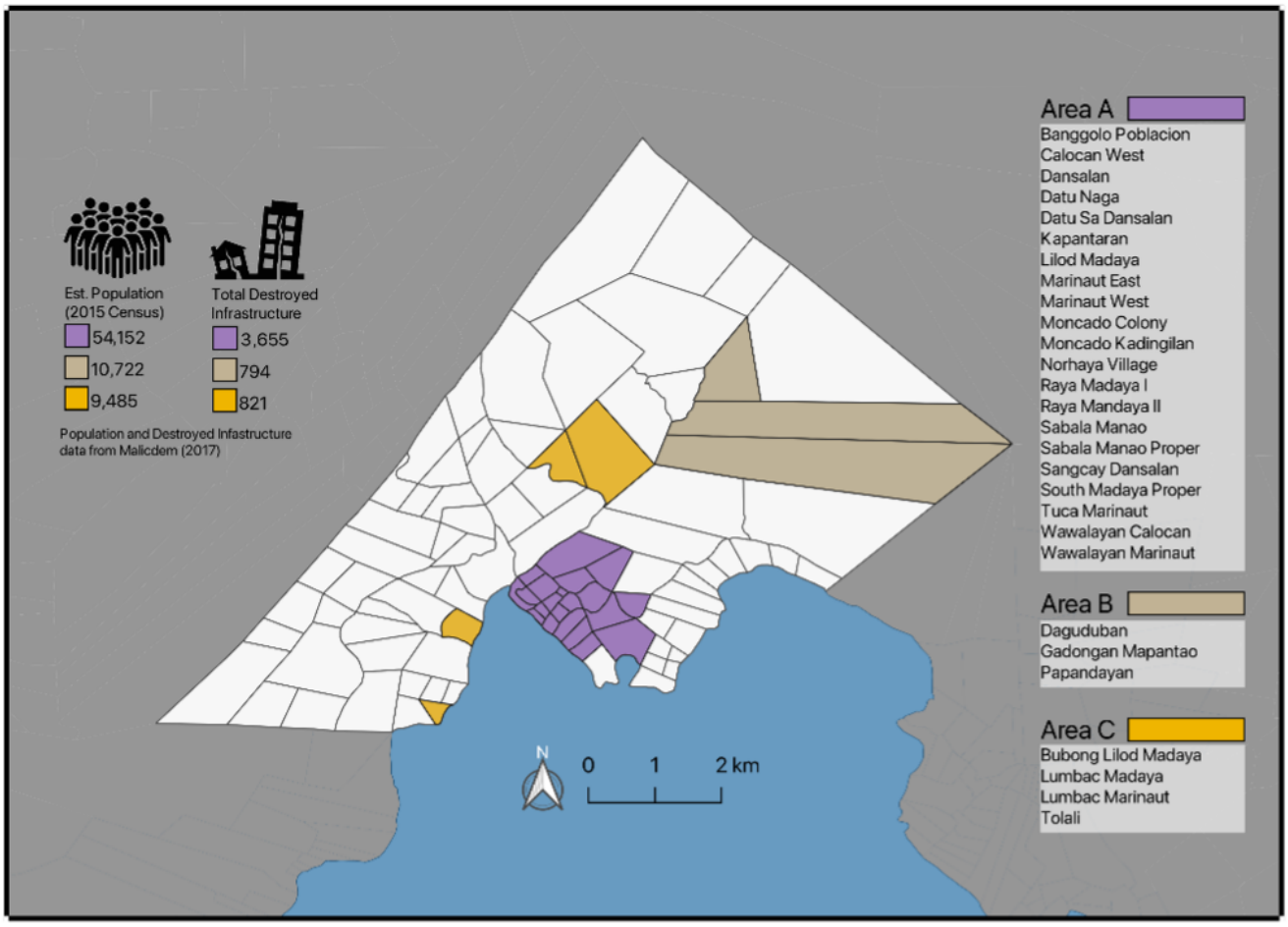


Figure 4: Affected Barangays During the Marawi Siege

The main battle areas experienced relatively darker nights since the development of the siege than the pre-war level (figure 2). The siege indicates the expansion of the battle areas (figure 3) also affected the eastern Barangays such as the Moncado Kadingilan, Wawalayan Calocan, Olawa Ambolong, Ambolong, Calocan West, Tongantongan-Tuca Timbang, Timbangalan, Paridi, Boto Ambolong and Calocan East. The NTL in the Marawi City changed drastically for over 72 percent and (UNCHR 2018) around 98 percent of the total population sought refuge in different evacuation centers within and outside the city. In one of the UNICEF Philippines (2017) interview, a family in Basak Malutlut with eleven (11) children had to abandon their home, days after the siege started. The family described the battle as horrible and full of fears as they witnessed several men in black surrounding their house, deafening bomb explosions and rapid gunshots echoed through the land.

The narratives from the locals reveal more than what any satellite imagery can. One widowed senior has to dodge rapid shots and bullets amidst burying her husband who unfortunately was unalive in one of the explosions. The families who successfully evacuated still experienced another hard situation in the safe shelters as limited food and clean water is available (UNICEF Philippines, 2017).

It is not surprising to see the decline of the NTL on the main battle areas during the war in May to October 2017 as the electricity supply was cut off and destroyed as well. The electricity system is an important economic indicator (Olsen et al., 2013) and in this case, an important monitoring scheme for the siege. As the siege progress, the NTL depletes, indicating the gravity of ruined infrastructures and electricity system. The NTL did not recover to its pre-siege condition even after siege has finally concluded in October 2017. The siege did not only destroyed the infrastructure in the main battle areas but also in other barangays. In total, there are 29 barangays that are affected by the conflict. We attempted to calculate the rate of NTL change of each barangay, however, the individual area is too small for our methods. The rastered images could not establish a usable data and only returns with an empty pixel. In exchange, we segmented the barangays into three main areas (figure 4), where Area A is the main battle area. Majority of the destroyed buildings, mostly houses and government infrastractures are within this area.

Annual Night-time Light Dynamics of the Marawi Siege

The night light went back in some areas of the city and its neighboring villages in 2018. Around 70% of the residents returned to their homes in the city and some infrastructures were reconstructed. In 2019, the NTL continues to progress, and by 2020 as the chair of Task Force Bangon Marawi declared that 20 percent to 30 percent of Marawi City had been rehabilitated (Ilas, 2020), we can see that most areas were already lit as the city developed.

Relief operations continued to support the Internally Displaced Persons (IDPs) at the same time as the rehabilitation in the Marawi City. Even with the declaration of the end of the siege, the Martial Law has continued in the Mindanao for security measures. The World Health Organization, with implementing partner Muslim Youth Religious Organization. This project of the TFBM is in cooperation with the National Housing Authority (NHA). In the April 2022 TFBM report, there were 1,201 approved applications for permit to rebuild homes out of the 2,700 applications. While 95 homes were successfully erected and 361 are still under construction (Cahiles, 2022).

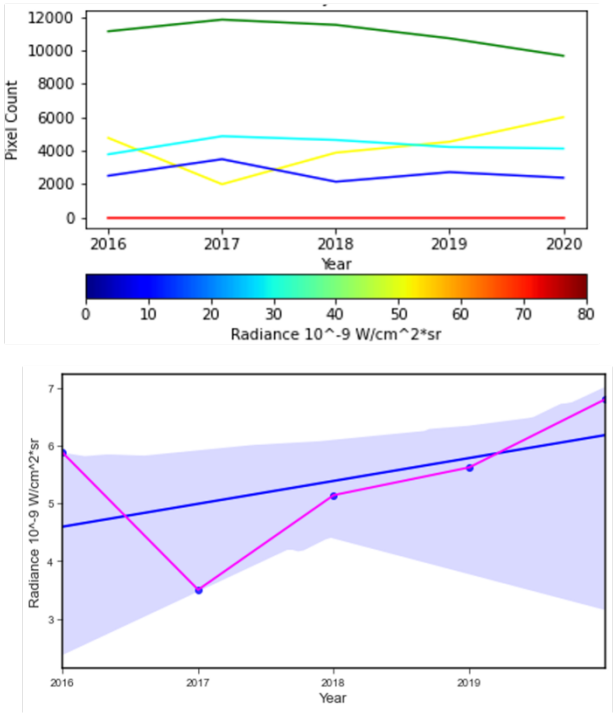


Figure 5: Annual Night Time Light per pixel identified (top) and Linear Coefficient (bottom)

The half-decade artificial light radiance in the Marawi City as projected in figure 5 reveals an obvious depression in 2017. Since the siege took for five months, the annual radiance is expected to be the least at 3.5 nW/cm^2*sr. An increasing trend in radiance emitted from the ground is present 5.8008 nW/cm^2*sr. A linear regression coefficient of 0.3962 and an R^2 value of 0.2663 translates into having a weak positive relationship which reveals that the battle in Marawi has a significant effect on the light radiance in the city. Even so, the presence of artificial light has increased since 2018 indicating the re-establishment of lighting systems.

Rehabilitation of the Marawi City

We present here the five-year rehabilitation of the Marawi using the same technique. In 2016 imagery, the *yellow pixel* concentration can be observed in forty-five (45) barangays of Marawi City (figure 6). This was the urbanization before the siege. A more concentrated radiance is observed in the municipality of Marawi Poblacion (MP). In response to the siege's aftermath, the Philippine government and extensive assistance from many other countries started the rehabilitation of Marawi City. From the 2020 VIIRS imagery (right), *yellow pixel* concentrations has returned in the thirty-nine (39) of the identified 45 barangays in 2016. Marinaut East, Marinaut West, Sabala Manao, South Madaya Proper, Tuca Marinaut, and Wawalayan Calocan were not part of this 2020 observation. Furthermore, concentrations of light radiance have extended in fifteen (15) barangays as presented in fig. 5.

As soon as the war has officially ended, the rehabilitation of Marawi City has started. As previously mentioned, Task Force Bangon Marawi (TFBM) announced 3,338 out of 5,266 shelter units have been occupied by the residents at the end of October 2020. To empower the women and youth, the Japanese government with the Asian Development Bank (ADB) and Department of Public Works and Highways (DPWH) constructed the Raheemah Eco Hub and Development Center (Bagumbaran, 2020). Youth mobilization in post-terrorist attack recovery activities is seen through volunteering, legal mandate, and access to resources (Ferolin and Fernandez, 2019). These efforts are linked to their motivations having seen the gruesome Marawi siege.

By the end of April 2021, 491 housing units have been constructed in Marawi City as organized by the UN-Habitat with Holcim and the Technical Education and Skills Development Authority (TESDA) (Bolledo, 2021). The Department of Human Settlements and Urban Development (DHSUD) and TFBM have rehabilitated the city up to 60%

International coalitions and organizations joined the rehabilitation of Marawi City. Aside from the big amount for humanitarian assistance, the Australian government initiated the Marawi Reconstruction Conflict Watch in 2018 (Australian Embassy, 2018). The World Health Organization(2019) assisted health services and facilities, while the US government assured more than $63.6 million (Php 3.4 billion). The USAID of the US government pledged more than $63.6 million (Php 3.4 billion) for humanitarian assistance and support for the rehabilitation of Marawi City. Through the USAID, the Marawi City is being rehabilitated for its economic development, livelihoods, governance, education, energy, health, water and sanitation (USAID, 2021). According to Kabagani (2021), the rehabilitation of the Marawi City is expected to accomplish in December 2021. However, the TFBM July 2022 report summarizes 72% infrastructure completion in Marawi City (Senate of the Philippines, 2022).

The Bangsamoro Government, European Union in the Philippines and UNICEF has launched a three-year project "Building Community Resilience and Delivery of Essential Services for Post Conflict Recovery in Lanao del Sur/ Marawi" last January 18, 2023. This 245-million peso (4 million Euros) project will focus on strengthening community resilience, health education, increase coverage of essential services, and promote peaceful community in forty-four (44) barangays in Lanao del Sur, Lanao del Norte and Bukidnon (UNICEF, 2023). Another momentous effort is the approval for the release of Php 44,380,000 from the Department of Budget and Management (DBM) to equipage and support operations of the Marawi City General Hospital (MCGH) for the improvement of health care system in the city (DBM, 2022).

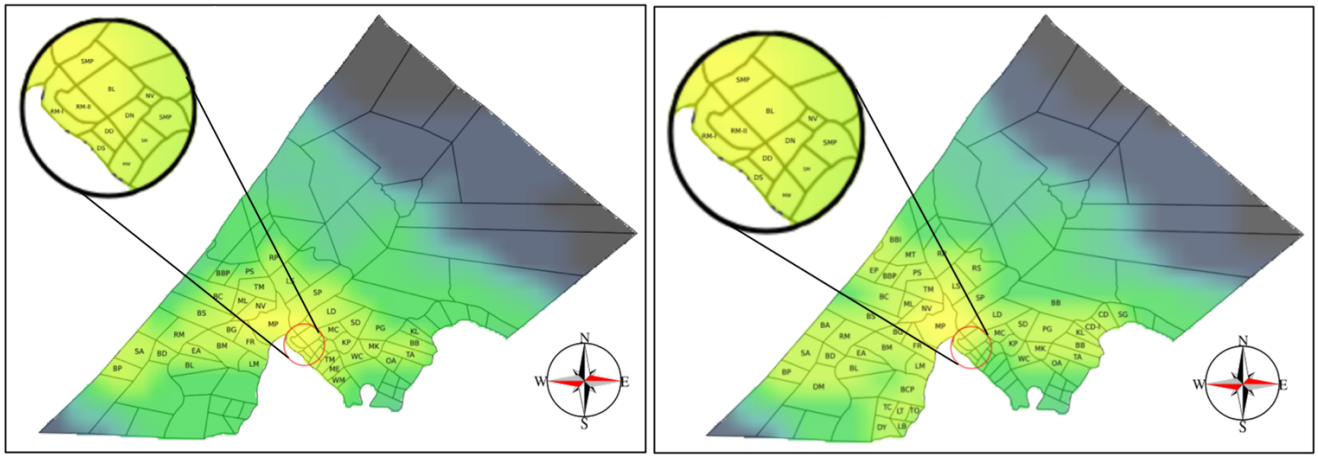


Figure 6: Two maps showing the increased in Night Time Light in Marawi City since 2016 (left) and 2020 (right)

In addition to several activities to regain the lively Marawi City, the TFBM mentioned during the July 2022 Accomplishment Report about the enactment of the Republic Act No. 11696 of the Marawi Siege Victims Compensation Act of 2022. As mentioned also, the infrastructures in Marawi City is at 72% completion. This movement was also in full support by the Senate of the Philippines who approved on August 15, 2022, the resolution reconstituting a special committee to oversee the continuous Marawi City rehabilitation. This was filed and sponsored by Senate Majority Leader Joel Villanueva (Senate of the Philippines, 2022).

CONCLUSION

In this study, we utilized the remote sensing imageries to proxy human mobility and activity regarding the gruesome Marawi Siege. We showed that this technique can also be used to other applications, especially for places and situations where ground surveys are not possible. However, we also noted some limitations on the study. While we used cloud-free imageries, dealing with small areas such as the barangays and overlaying them with VIIRS imageries can be challenging. When applying the similar technique, one must consider ground validations and actual observations of the post-war scene. The vast application of light monitoring can be used to proxy urbanization, socioeconomics, conflict maps, and even linking it to ecological factors.

The five-month battle in the Marawi has extended to Moncado Kadingilan, Wawalayan Calocan, Olawa Ambolong, Ambolong, Calocan West, Tongantongan-Tuca Timbang, Timbangalan, Paridi, Boto Ambolong and Calocan East. The primary areas for the battle suffered 72% destruction as presented through the nighttime lights. Annual images show that Marawi City did not represent light polluted (red pixel) areas even before the 2017. The battle in Marawi City has caused detrimental effects to the infrastructure, economy, security, welfare; and, more importantly, the physical and psychological impacts to the residents who were soon forced to evacuate the city to relocate to temporary shelters.

It reveals the effect of the five-month battle between ISIL-affiliated groups of Abu Sayyaf and the Maute militants and the Philippine forces resulted in a decrease of more than 70 percent of the night-time light pre-siege and post-siege events. Consequently, there is an increase in observed light radiance in the consecutive years where residents started to return home, and also in the neighboring villages where residents may have taken shelter accord to the siege. Relief operations assisted the Internally Displaced Persons (IDPs) while the reconstruction is underway. Youth participation in acts of volunteering has also made significant improvement to the rehabilitation. Originally, the rehabilitation in Marawi City is targeted to complete by the end of December 2021 with thousands of housing units have already been occupied by the residents. According to the June 2022 TFBM report, 72% of the identified infrastructure projects have been completed. In addition, hundreds of housing units were constructed in cooperation with the UN-Habitat, Holcim, and TESDA. The DepEd ensured the construction of mosques and schools. Healthcare facilities and services were provided by the TFBM, WHO, and MYROI. To warrant the safety, security, peace, and empowerment in Marawi, the Bangon Marawi Comprehensive Rehabilitation and Recovery Program (BMCRRP), Australia's Marawi Reconstruction Conflict Watch, and the Raheemah Eco Hub and Development Center by the Japanese government in cooperation with the ADB and DPWH were constructed. Even more, the Bangsamoro Organic Law was enacted to build peace and strengthen the BARM; and the 2022 approval of the Senate of the Philippines to reconstitute committee for Marawi City rehab. The quick response from the Philippines government and assistance of the governments of the United States, Australia, Japan, and the others paved the way for the rehabilitation. To continue this, a 245-million peso post-conflict recovery project initiated by the Bangsamoro Government, EU and UNICEF will support and assist the rehabilitation for three years. The DBM has approved as well the release of more than 44 million peso for the improvement of health care system in the city.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

CONTRIBUTIONS OF INDIVIDUAL AUTHORS

JB Kalaw and RMD Guido conceptualized the entire study. JB Kalaw gathered the satellite imageries, did the data visualization, and prepared the initial write-up. RMD Guido reviewed and edited the manuscript. JB Kalaw and RMD Guido supervised the entire study until its completion.

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