Building a Low-Carbon Emission Concept for Tourism Industry Resort

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Abstract. Energy crisis and increased of energy consumption initiates depletion of natural resources and environmental degradation and that will leads to global warming and climate change. Nowadays, tourism considered being one of the important industries in the world. It also acknowledged as significant largest consumers of energy through many sectors, included supporting facilities for tourist that were focus of this paper. Bali most important tourist destination and become proponent of economic has many resort that surrounded by business trade support. Increasing of electricity demand become present issues. This paper proposes a method to build community base initiatives to reducing carbon emissions and saving energy. The method consists of procedural to build light threshold regulation that will offer a sustainable solution for Bali's tourism industry to maintain electricity demand. The procedural uses radiance of nighttime satellite data i.e. DMSP-OLS and NPP VIIRS as main dataset. This method provides the most effective on procedural to assessing the excessive lighting by applying the satellite remote sensing technology. **Keyword**: Emission; Energy; Radiance; Threshold.

1. Introduction

Climate change has emerged as one of increasing importance issue to tourism and hospitality industries in terms of both the potential effects of climate change on tourism and the contribution of tourism to climate change [1]. Krstinic et al. [2] reports that efficiency of energy on tourism and hospitality sector is not just result of investment in sophisticated technology, but also modified by monitoring and active management of energy consumption. Boer et al. [3] point out that, the role of community in reducing carbon emissions and saving energy is essential. Community initiatives can be carrying out by increasing efficiency through use of energy-saving technologies and behaviors in the commercial and residential sectors. Bali most important tourist destination and represents the world's best tourism laboratory and embraces a complete island together with a language and religion that separates it from other areas. In addition, Cole, et al. [4] states that, Bali is an important case study because mainly economic depends on tourism. Bali population has 1.62 percent of total national (about 258.7 million) and tourism growth rate of 23.1 percent (about 11.5 million) (2017 BPS, National Statistics Data) [5]. Bali electricity demand is set to grow with customer's rate by 8.5 percent per year. Customers dominated by business followed by household, industrial type only two percent of total customers. The location of customers, mostly concentrated in southern Bali, Denpasar city and Badung regency (BPS 2016, Data Statistics Bali) [6]. Research and regulations that relate to the role of community or stakeholder in reducing carbon emissions and saving electricity in Indonesia has not regulated well and limited. Rapid development on Bali's tourism industry, Bali needs regulations to maintain the sustainability of electricity by involving the community or stakeholder in energy-saving behavior roles. It is urgent to carry out fundamental research in order to build low-carbon emission societies generally in Indonesia.

Research relates to saving electricity in Bali has been carried out by Swardika and Putri [7], with remote sensing technology equipped with low-light night-time imagery instruments showed large differences in uses of lighting energy (nighttime lighting) on tourism resort centers in municipality of Denpasar and Badung regency with other regions. Various tourism support businesses in the area use excessive lighting energy overlap and accumulate into a source of light energy pollution that monitored up to remote sensing satellites. However, research that has been carry still limited, more comprehensive and holistic researches needed. This paper is one part of publication series with theme light threshold for tourism resort in the role of low-carbon emissions community, and energy savings using nighttime satellite data.

2. Methods

Figure 1 below shows the procedural on building of a low-carbon emission concept for tourist industry resort. There are two of dataset as input into method, i.e. The Defense Meteorological Satellite Program Operational Linescan System (DMSP-OLS) and Visible Infrared Imaging Radiometer Suite (VIIRS) radiances and Light meter surveys dataset.

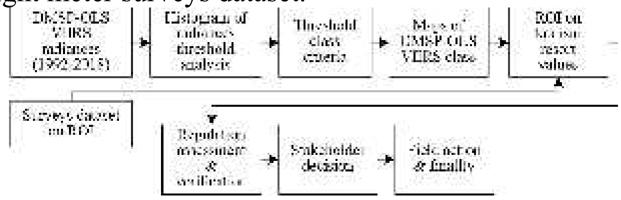

Figure 1. The procedural flow of implementation of low carbon emission on tourist resort.

Procedural concept method starts from collecting DMSP-OLS and VIIRS radiances from world-space agencies i.e. National Oceanic and Atmospheric Administration Comprehensive Large Array-data Stewardship System (NOAA CLASS) https://www. bou.class.noaa.gov and NOAA National Centers for Environmental Information Earth Observation Group (NCEI EOG) https://ngdc.noaa.gov/eog. Dataset is sub-setting into Indonesian region (6ºN-11ºS, 95ºE-141ºE), removes other neighborhood country (Singapore, Malaysia), and sub-setting into Bali Island (7.34ºS-9.54ºS, 113.49ºE-116.87ºE). The processing step of the satellite data before uses explained on section 3 below. DPMS-OLS VIIRS radians characteristic obtains from combining long-term years from 1992 until 2018. Histogram analysis uses to determine the radiance threshold criteria, called ambient, moderate and excessive class. Maps of region of interest values confirms with light meter from field surveys. Stakeholder is in charge to assessed and verified results. For completely understand of problem, supporting dataset surveys also conducted i.e. perception of stakeholder about emission and climate change, observations of environmental impact from excessive nocturnal light [8] and focus group discussion on light threshold limitation regulation [9].

2.1. Defense Meteorological Satellite Operational Linescan System (DMSP-OLS)

The Operational Linescan System is a passive panchromatic low-light imaging on the spectral channel at 0.47 µm to 0.95 µm carried by Defense Meteorological Satellite Program. DMSP satellite is a sun-synchronized polar orbit, with local overpass times at descending node and ascending node roughly at 08:30 and 20:30, respectively. OLS sensor is an oscillating scan device with visible and thermal-infrared bands designed to map clouds in both day and night. The visible band uses a photo multiplier tube (PMT) to collect radiance (W/cm2/µm/sr). Detailed details of the specifications of VIIRS and DMSP-OLS data as described in Li et al. [10]. The OLS has no onboard calibrator. Hence, calibration steps to correct nighttime light data of OLS DMSP that tend to be saturated are very important to do, including inconsistent each data sensor in several years of mission. Elvidge et al. [11] and Liu et al. [12], the first to introduced the nighttime light inter-calibration method. Wu et al. [13] refined the inter-calibration method by introducing the invariant region method to inter- calibrate nighttime light data. The processing of satellite data before use must be carries out with several pre-processing steps, such as an inter-calibration process [14]–[17], the process of eliminating saturation effects and the process of applying thresholds. The DPMS OLS starts operational in year 1992 and end in 2013.

2.2. Visible Infrared Imaging Radiometer Suite (VIIRS)
The VIIRS instrument onboard on the National Polar-orbiting Operational Environmental Satellite System (NPOESS) with 827 km altitude polar orbit and nighttime overpass at 01:30 AM. The VIIRS sensors have 3 000 km swath width, 0.742 km spatial resolution. The low-light sensor is panchromatic imaging band-pass 0.5 to 0.9 µm, 14-bit data quantization without saturation. The VIIRS has mission objectives to imaging nighttime on visible band of moon light clouds in NOAA Technical Report (2013) [18]. The VIIRS starts operational in year 2012 until present.

2.3. Light meter surveys
Measurement of light meter aims to enforce stakeholder decision. Location of sampling point initially obtains from threshold criteria map of DPSM-OLS VIIR data. Surveys carried out with GPS and GIS utilities. Measuring instrument used are a high sensitive radiance lux meter (MS6612 model) and meteorology meter i.e. temp scanner, anemometer, humidity. Measurement points determined where the light strongest occurs, in a 1 Km square area that same as spatial resolution of DPSM-OLS VIIR data. The purpose of measurements is to obtain the characteristics of existing lighting sources, such as it is important light (essential or decorative), how much energy is used and others (items as in form surveys). Light meter surveys data collected and analyzed with description statistics to get their characteristics.

2.4. Supporting dataset
The procedural steps on figure 1 shows two major processes i.e. processing of nighttime satellite data, and light meter surveys on regions of interest (ROI). As this research aims to raise awareness of society on climate change and carbon emission reduction, holistic study conducts also by surveys of observations of environmental impact from excessive nocturnal light, and focus group discussion about local regulation (items as in form surveys).

3. Results

3.1. Procedural constraints
Collection and processing of long-term nighttime satellite remote sensing data requires large data storage and reliable of processing computers. Hence, annual or one scene per year of DPMS OLS data decided to use as collection of dataset [10] . DNB data product of DPMS OLS distributed to end-user not in radiance unit data, but in digital number (DN) non-unit data. Therefore, a routine requires calibration of DMSP OLS DN into radiance unit [14]–[17]. Moreover, DMSP OLS known as narrow band of sensitivity and saturated over urban area, the area that focus of this research. DPMS OLS eras end in 1992, VIIRS continues nighttime satellite mission with significant improved until present. As program changes, technical, format and specific data also changes. Light meter surveys of procedures carried out as simple, many factors and methods of measuring light that are complex and require trained personnel is limited [19], [20] .

3.2. General View of Indonesian nighttime light

3.2.1. Maps of Indonesian nighttime light from DPMS OLS (1992-2013)
Figure 2 shows maps of Indonesian nighttime light DMSP-OLS after calibrated using Modified Invariant Region (MIR) method. Coastline overlays in white-color, ocean seems in dark and other in black-color means lowest radiance level. Bright white-color means lit pixels or source of nocturnal light. Insert map is Bali island. On figure in year 1992 indicated few sources of nocturnal light (lit pixels) emerges over Sumatra, Java island. In 2013, within 21 years sources of nocturnal light much

escalate mainly over Java Island. DMSP-OLS data in 2013 shows evident that Java Island more develops than other region. The statistical data before and after calibration shows Bali more develop than whole of Indonesia region.

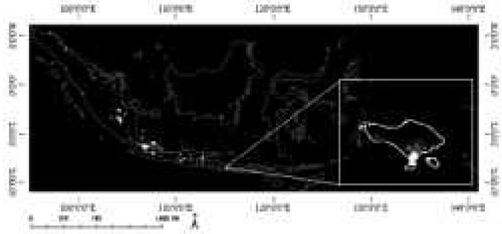

Figure. 2. DPMS-OLS Calibrated radiance in year 1992 Indonesian subset.

3.2.2. Maps of Indonesian nighttime light from VIIRS (2012-2018)

Figure 3 shows Indonesian nighttime light from VIIRS in year 2018. Comparison of three figures of nighttime data from year 1992, 2013 and 2018 indicates light source spreading wider to the southern part of Bali Island and lit pixels emerges also at the northern coast of Bali Island. On the east, Lombok (Mataram city) and the west, East Java (Banyuwangi city) of Bali Island, lit pixels also emerges that shows economic development progress extends on Indonesia country.

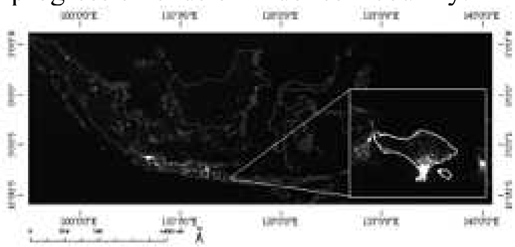

Figure 3. VIIRS nighttime radiance Indonesian subset with map Bali inset in year 2018.

3.3. Procedural of light meter surveys

The first step on surveys is to determine point of location. Base on maps of annual averaged VIIRS nighttime radiance data in year 2018. Strong and weak radiances mainly around tourism resort i.e. Kuta, Nusa dua, Jimbaran, Ubud and Denpasar city. Total of 64 point marked on the map and get latitude longitude values. Light meter equipment (MS6612 and AS802 model) adjusted to zero with black cloth cover before uses (Figure 4).

Figure 4. Lux meter MS6612 and AS802 model.

Light measured are in three mode of measurement i.e. hold, max, min mode in lux unit. Measurement did not consider of factors such as light incidence angle, shadows, etc. Measurements made several times and recorded highest results, at point of latitude and longitude of GPS. Light meter surveys result on March-July 2018 shows on Table 3 below. Numerous of light exist at point of measurement, light source can be from streetlight, advertising, settlement, household, amusement, moon or stray light, etc. Hence, measurement results considered as cumulative of all sources. This is appropriate with dataset of nighttime satellite that used. Table 1 also shows mean of VIIRS radiance about 15 nW/cm2/µm/sr. VIIRS has high sensitivity factor. Hence, VIIRS minimum radiance shows none zero value.

Table 1. Statistical data of light meter surveys results

	Hold(lux)	Max(lux)	Min(lux)	VIIRS Data (nW/cm2/um/sr)
Min	0.00	0.00	0.00	1.15
Max	97.78	98.19	78.98	57.94
Mean	28.62	28.08	23.65	15.03

3.4. Procedural of environment indices surveys

Before surveys, weather condition must be clear sky. It is implies light sources from earth surface and stray light from atmosphere can penetrates into sky and vice versa. Figure 5 surveyor sampling of environment indices i.e. measures of spot temperature of overhead light source.

Figure 5. Surveyor measures of spot temperature of overhead light source.

Field surveys conducted in March-June 2019 on North-West Monsoon. On that time, Indonesia has rainy season until start of dry season. Weather is warm around 25°C and humid about 80%. Wind blows low on speed less than 1 m/s or in Beaufort scale, sometime cloudy and rain. Table 2 below shows environment indices at location of field surveys

Table 2. Environmental indices Surveys results

	Spot Temp. (°C)	Temp.(°C)	Wind (m/s)	Beaufort Scale	Humidity (%)
Min	10.00	25.80	0.00	0	51.00
Max	32.00	39.10	3.30	3	95.00
Mean	25.20	29.93	0.32	1	79.58

4. Conclusions

This paper proposes a procedure to encounter an energy crisis that is certain to come about. The method in this paper provides a sustainable solution for Bali's tourism industry to maintain electricity needed and even its can be applied into general electricity crisis issue. Tourism has known as a large amount of energy absorbs and become one of the source causes of environmental change and degradation. Moreover, becomes a threatened industry that has provided many economic benefits to developing countries that depend on tourism industry. The monitoring and active management patterns in regulating use of energy in tourism industry is important and more effective rather than investing of renewable energy. This method provides the most effective in procedural of assessing the excessive uses of electricity by applying the satellite remote sensing technology.

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