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Ambient Light Encroachment at Military Installations

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Introduction

Light Encroachment is the direction of lighting energy resources (e.g., street lights) to areas where they are unintended (e.g., onto military training lands instead of down on the road where it is expected to be useful). It is also called “Light Trespass.”

The military needs to consider light encroachment because of its potential to limit a soldier’s ability to train at night. In addition, the current trend is that light encroachment is likely to increase in the future; so further limits may be placed on nighttime training.

“We Own the Night!” is often heard from members of our military services. Our hi-tech gear allows soldiers to operate well in the dark (Figure 1). Unfortunately, as residential and commercial encroachment increases near our military installation training lands, the capability of military installations to support night training is at risk.

In addition to light encroachment on night training, another of the military’s major land management issues is Threatened and Endangered Species (TES) and sensitive species (Species at Risk).



Figure 1. Night exercises in Iraq.

Many such animals are nocturnal. The most common reason for an organism to become listed as a TES is due to loss of habitat. It is possible that for nocturnal animals light encroachment impacts their habitat, but little is understood about the effects of light on nocturnal TES habitat.

Objective

The objective of this research project was to summarize methods to characterize light encroachment.

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Light Encroachment Impacts on Night Training

Though “We Own the Night!” is an important part of Army doctrine, as ambient light encroachment increases near our military installation lands the ability of the soldiers to train in the dark (Figure 2) is negatively impacted. The current trend is likely to increase, thus further limiting nighttime training.

Military night operations are becoming more common, yet they are difficult. In order to improve nighttime proficiency, it is essential to identify the most critical problems; the problems that arise in many units despite differences in equipment and training resources; the problems that can lead to mission failure; and the problems that occur across time...All soldiers and leaders recognized the criticality of realistic, demanding, repetitive, and intensive training at night.¹



Figure 2. Night infantry mission.

You can only “own the night” if you have trained for it. If light encroachment limits a soldier’s training, there is limited ownership.

It was important to know what the situation was at the “Home of the Infantry,” Fort Benning, GA. Significant

night training is conducted at Fort Benning. As an initial step, researchers downloaded a portion of an image from the Lights at Night dataset.² It is derived from the visible band of the Defense Meteorological Satellite Program (DMSP) satellites. DMSP operates three satellites carrying the Operational Linescan System (OLS) in low-altitude polar orbits. One of the program’s tasks is to record nighttime data. The nighttime data set generated from the DMSP was first compiled from October 1994 through March 1995. Researchers then integrated the Nighttime Lights of the World data into a Geographical Information System (GIS) format to generate Figure 3.

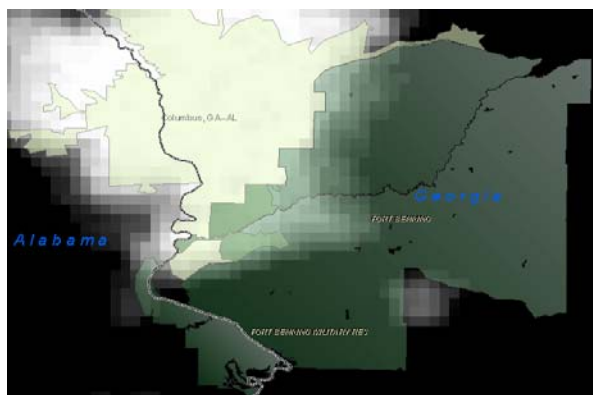


Figure 3. Light encroachment at Fort Benning, GA, in 1994.

An analysis of Figure 4 shows that in 1994 already more than 30% of Fort Benning was affected by city night-lights. Recently a new survey for the year 2000 was completed using new DMSP images.

Comparison of the images in only 6 years (Figure 4 and Figure 5) shows significant changes. In Figure 4, darker red indicates greater change, as presented in Figure 5. What is interesting from Figure 4 is the trend in the increase. Urban centers are saturated already, so by these DMSP images, they have not changed at all. Instead, most of the increases

¹ What Soldiers Say About Night Operations (Research Report 1741) (DTIC No. AD B243 649) Dyer, J.L., et al. (1999).

² <http://dmsp.ngdc.noaa.gov/html/download.html>

occurred at the urban edge and decreased with distance from that edge. Other areas of increase are in new developments with good road access.

Sutton (1997) shows how these images are also useful for estimating population increases. In fact they are likely to be a more reliable source for actual encroachment intensity increase because the use of light is a good indicator of human presence in the culture of the United States.

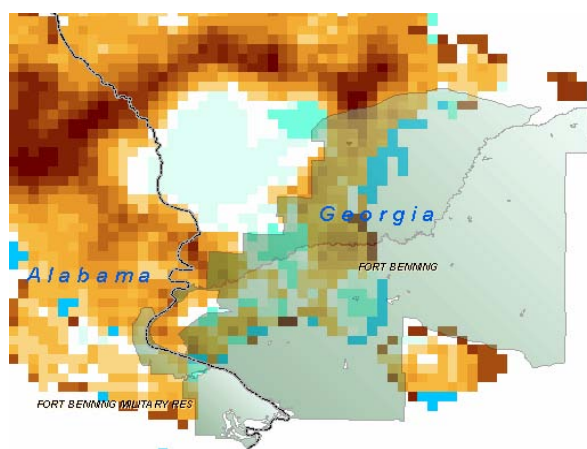


Figure 4. Changes in night light levels at Fort Benning in 6 years.

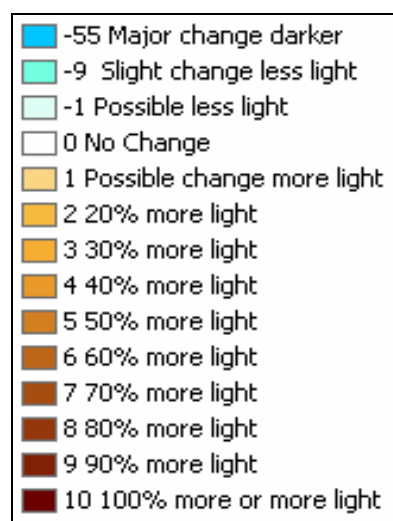


Figure 5. Color scale for night light change from 1994 to 2000.

Suppose one does a simple growth analysis based on the trend to the year 2000. Since the difference between 1994 and 2000 is 6 years, one would “grow” the maximum light levels twice to get a projection for roughly the year 2015 (Figure 6). Figure 6 suggests that in the near future, 53% of Fort Benning land will be impacted by ambient light that may affect night training.

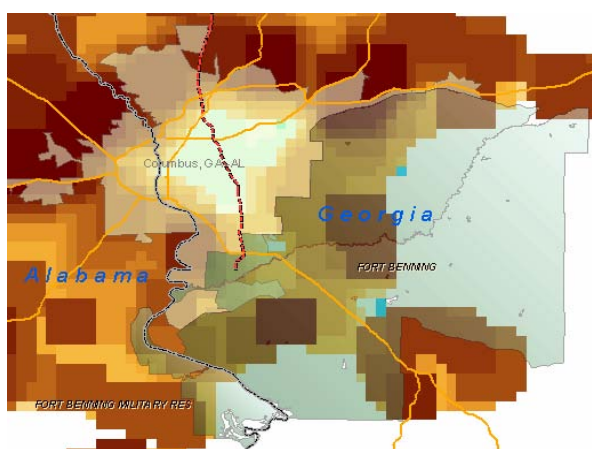


Figure 6. Projected light encroachment for 2015.

However, the question is, “Is this a real impact on the actual Training Mission?” Night exercises can be carried out anywhere on the installation; however, in cooperation with Fort Benning staff³ researchers identified those training areas most heavily used for night exercises. Figure 7 shows this arrangement. In fact, some training is already being rescheduled to avoid:

- Lighting from the dependent housing (cantonment) areas south of Columbus and largely affecting the Compartment A20 Impact Area.
- Encroachment of ambient lighting from the Columbus metropolitan area in some of the “O” compartments.

³ “Skip” Caldwell, Deputy Range Management Officer.

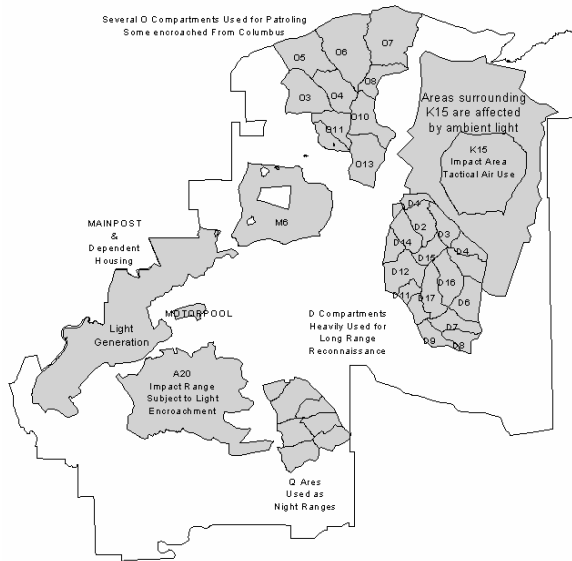


Figure 7. Areas on Fort Benning most used for night training.

Assuming that the training configuration does not change, the amount of light-encroached land within these training areas will increase from the current level of 36% to roughly 48% in 2015. This trend suggests that the policy of accommodation will become more and more difficult to successfully implement in the near term.

Is Fort Benning an anomaly? To test this question, we did a similar analysis for Camp Lejeune, NC, home of the Marines 2nd Expeditionary Force. These Marines do a great deal of night training, particularly for scenarios involving coastal landing. Does the buffer of nearby water areas help to mitigate the impact of light encroachment? Figures 8, 9, and 10 show the same analysis as at Fort Benning, using the same scale for change as in Figure 5. As can readily be seen, all of the same pressures at Fort Benning are in place at MCB Camp Lejeune. In fact, currently at MCB Camp Lejeune, 54% of the land is light encroached and the rough prediction for 2015 is 83%.

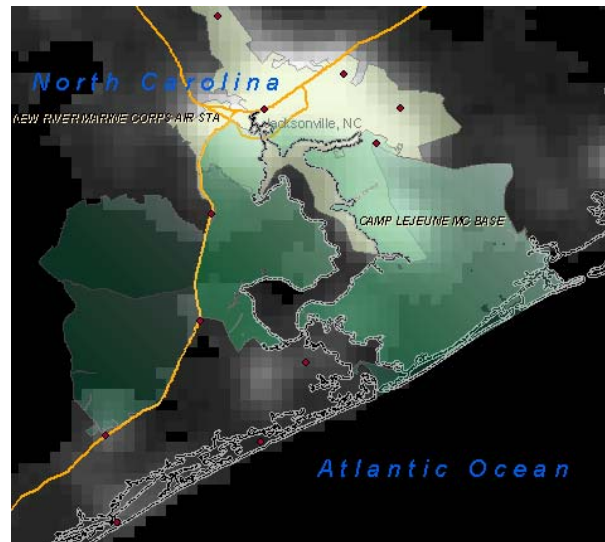


Figure 8. Light encroachment at Camp Lejeune, NC, in 1994

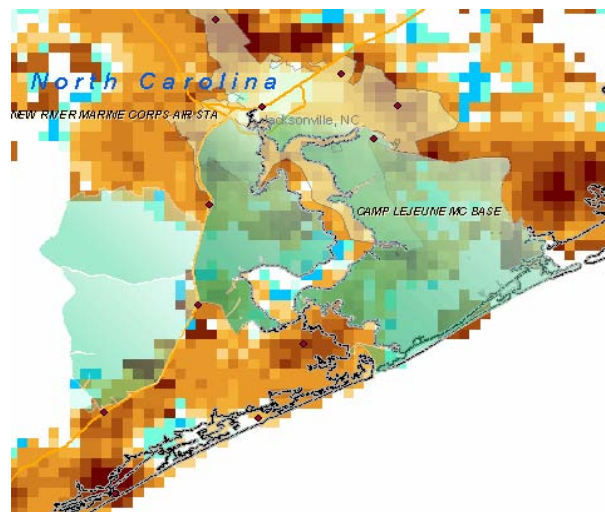


Figure 9. Changes in night light levels at Camp Lejeune in 6 years.

These examples show that the problem of night training for the military services exists and will increase unless the military takes a proactive role to protect its interest in its night-training mission responsibility. Further, although the military has adopted Light Pollution Reduction measures on the installation, from these examples, that will clearly not be adequate. Light encroachment from off post will still be an issue.

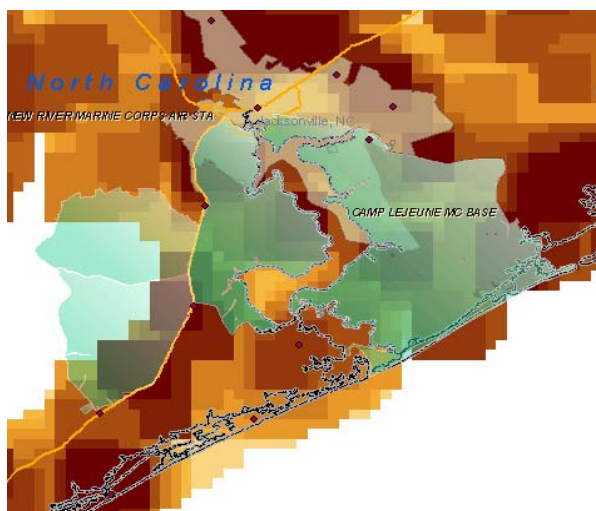


Figure 10. Projected light encroachment at Camp Lejeune for 2015.

Military Design Standards

The military has recognized that it is a good idea to discourage light encroachment and that energy can be saved if less light is used. ‘Light Pollution Reduction’ is now considered by all military services as one of the elements of the planning, design, construction, and operation of ‘green buildings.’

The Army adopted SPiRiT (the Sustainable Project Rating Tool) in April of 2001 for all MILCON projects as a means of providing a complete framework for assessing building performance and meeting sustainability goals. SPiRiT is based on LEED® Green Building Rating System Version 2.0, a product of the U.S. Green Building Council (USGBC) and used with their permission. LEED, which stands for Leadership in Energy and Environmental Design, rates buildings according to five environmental categories: Sustainable Sites, Water Efficiency, Energy & Atmosphere, Materials & Resources, and Indoor Environmental Quality, and an additional category, Innovation & Design Process. In addition, SPiRiT addresses Facility Delivery Process, Current Mission,

and Future Missions. Both the Navy and Air Force have adopted LEED, supplemented for their own applications.

Both LEED and SPiRiT rate buildings for Light Pollution Reduction, with the intent to eliminate light trespass from the building site, improve night sky access, and reduce development impact on nocturnal environments. Lighting fixtures must not exceed Illuminating Engineering Society of North America (IESNA) foot-candle level requirements as stated in the Recommended Practice Manual: *Lighting for Exterior Environments*. In addition, the design of interior and exterior lighting must ensure that zero direct-beam illumination leaves the building site.

Conclusions

Even a quick review of the light encroachment issue with installation staff at the Infantry School at Fort Benning shows recognition of the current problem and existing work-arounds. Unfortunately, unless the current trend is addressed, large portions of military lands will be affected in the future, making work-arounds increasingly difficult to successfully implement. A similar evaluation at MCB Camp Lejeune shows that the problem is not unique to Fort Benning.

Light encroachment threatens the loss of a valuable military resource: darkness. This translates into reduced training effectiveness and mission competency.

Recommendations

- Using the DMSP maps and change detection techniques discussed here, determine exactly how widespread the light encroachment issue is among military installations.
- Compare light encroachment impacts (as determined above) to the installation night

training areas as illustrated for Fort Benning.

- Prioritize the light encroachment issue across installations.
- Set standards/thresholds for acceptable levels for training.
- Proactively work with local communities and planning agencies to implement regulations or ordinances that will ensure the installation training standards can be met.

For urbanization encroachment studies:

- Investigate the feasibility and limits of using the Night Lights Data and the regularly collected night DMSP images for urbanization encroachment studies and trends analysis.

Point of Contact

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References

- Grigione, Melissa M., February 2002, *Turning night into day: the effects of artificial night lighting on endangered and other mammal species*, Department of Environmental Science and Policy, University of South Florida, Tampa, Florida 33620.
- *Lighting for Exterior Environments*, February 1999, Illuminating Engineering Society of North America.
- Sutton, P., D. Roberts, C. Elvidge, and H. Meij. 1997. "A Comparison of Night-time Satellite Imagery and Population Density for the Continental United States." *Photogram-metric Engineering and Remote Sensing*, 63(11), pp. 1303-1313.
- TM 11-5855-203-10 Operator's Manual for Night Vision Sight, Individual Served Weapon AN/PVS-2, AN/PVS-2A, and AN/PVS-2A.

Internet References

Defense Meteorological Satellite Program:
<http://dmisp.ngdc.noaa.gov/dmisp.html>

DMSP Stable Night Lights
http://dmisp.ngdc.noaa.gov/html/download/Night_time_lights_94-95.html