

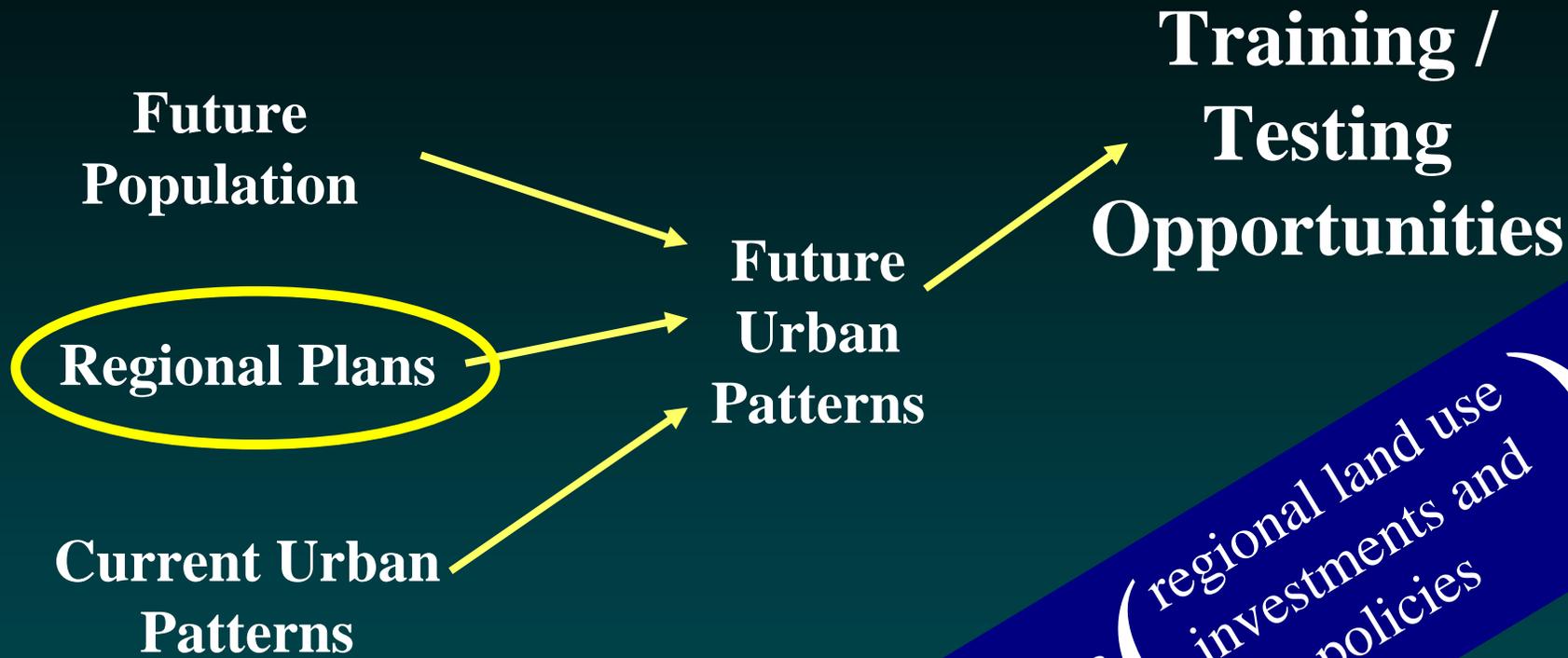
# Protecting Future Training and Testing Opportunities

Information Briefing for Sharing Future Space  
Workshop



Jim Westervelt  
ERDC-CERL

# Cause-Effect



Training and testing capacity = f ( regional land use investments and policies )

# Training/Testing Opportunity Implications of Projected Urban Patterns

# Future Training Activities?

- Tracked vehicle training
- Artillery Training
- Aircraft
- Helicopter
- Night training requiring dark nights
- Unmanned air/land vehicles
- High energy
- Joint operations
- In development, but unknown
- Yet to be thought of ..



Example: “Where on Fort Benning could these training activities occur in the future?”

# Sample LEAMtom Analyses

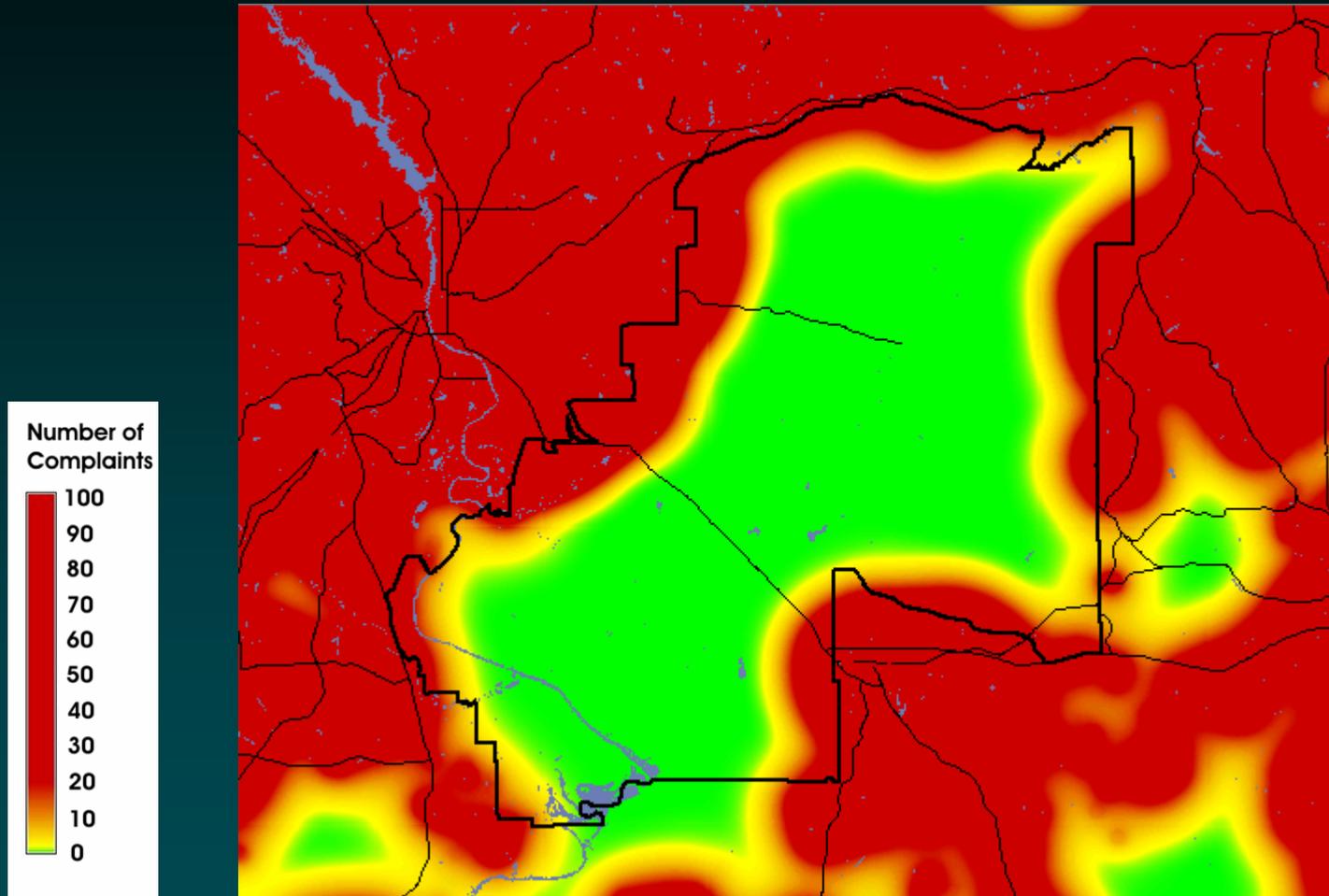
- Artillery training
- Tracked vehicle training
- An aircraft similar to the C-130 training at an altitude of 2000 meters
- Helicopter training with the Bell\_J\_2A at an altitude of 300 meters
- An F-22 Raptor training at an altitude of 4500 meters
- Dust generated by tracked vehicle training
- Night training requiring dark nights

# Probability of complaint for an artillery training exercise

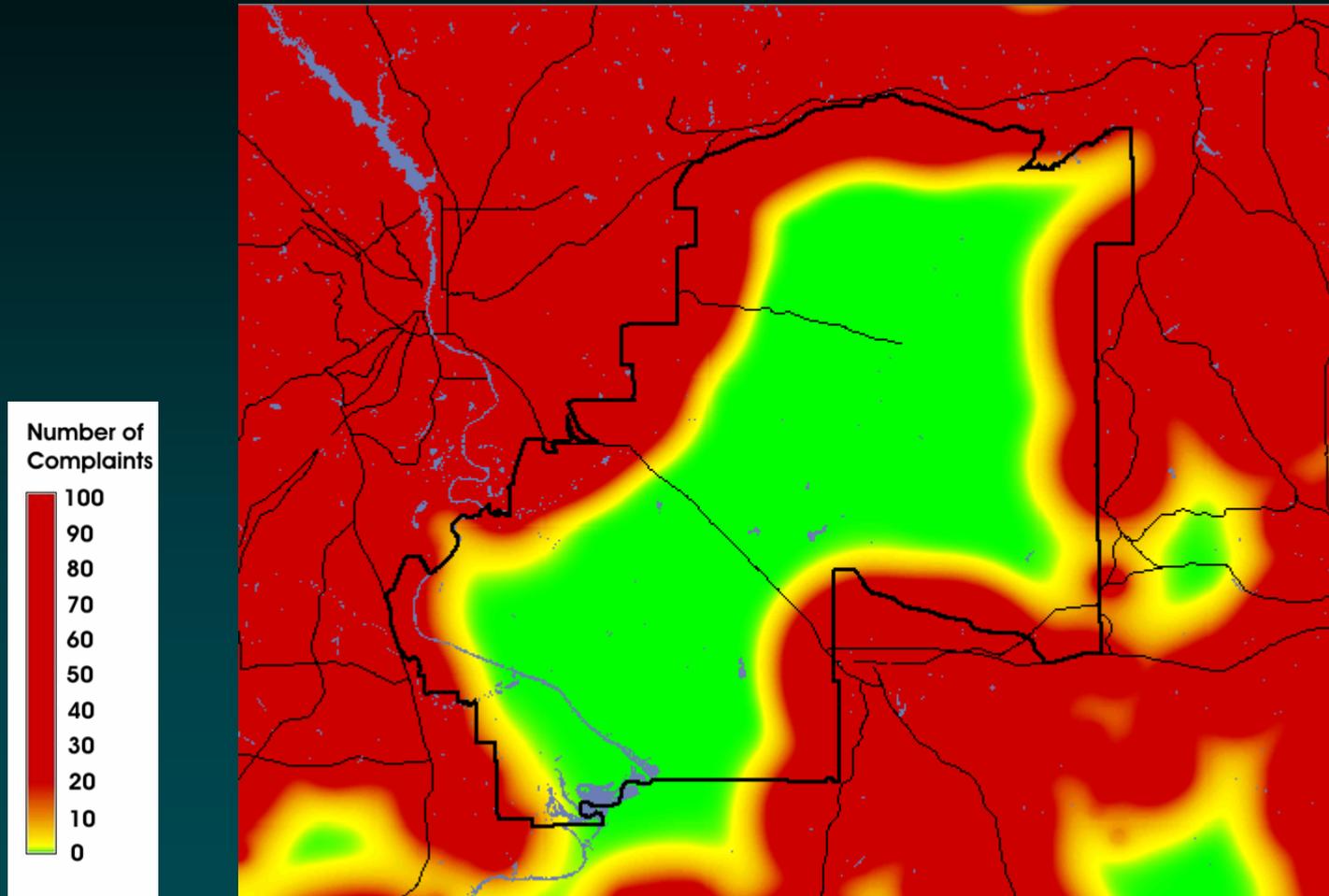


Noise is measured at 80dB at 600 meters, with a decay rate of 2.0.

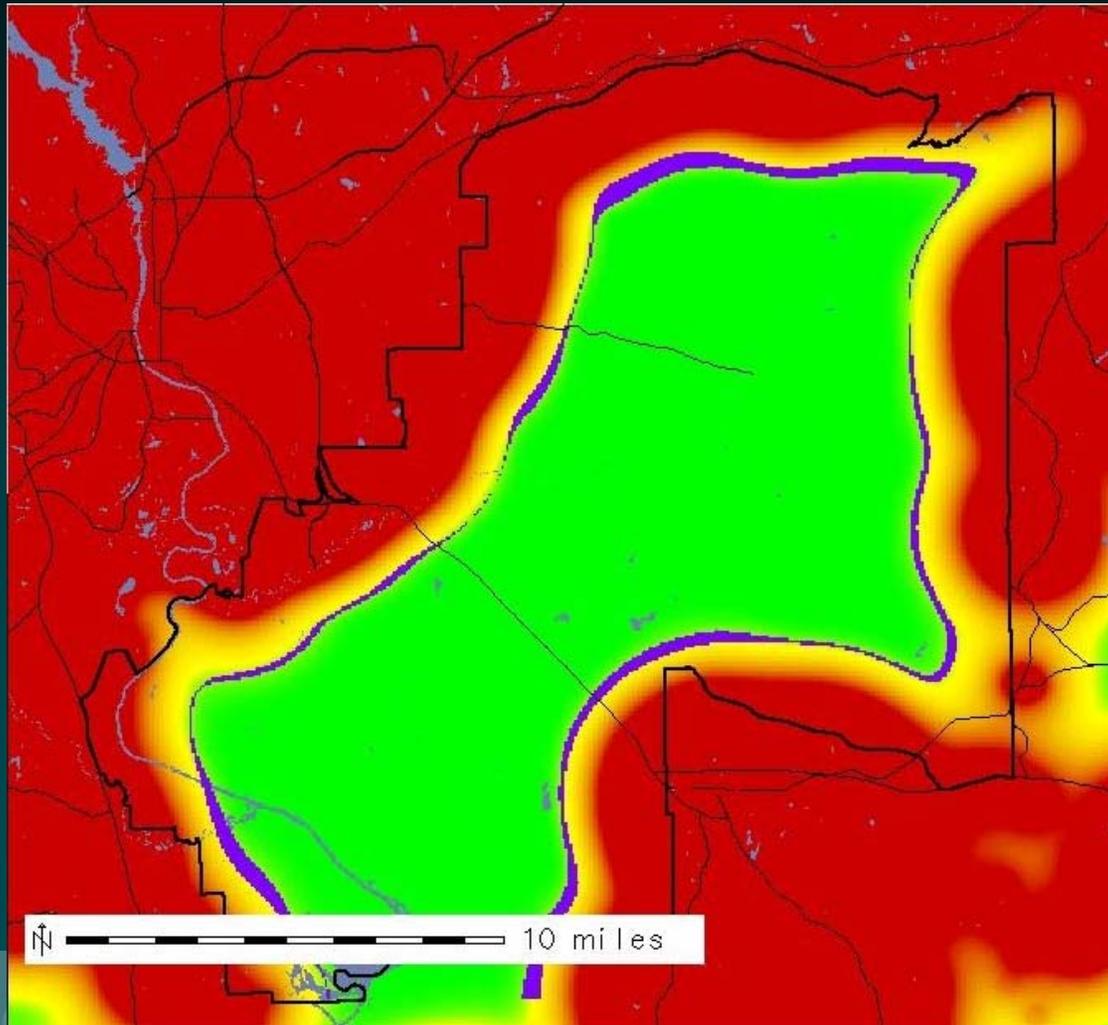
# 2000



# 2030



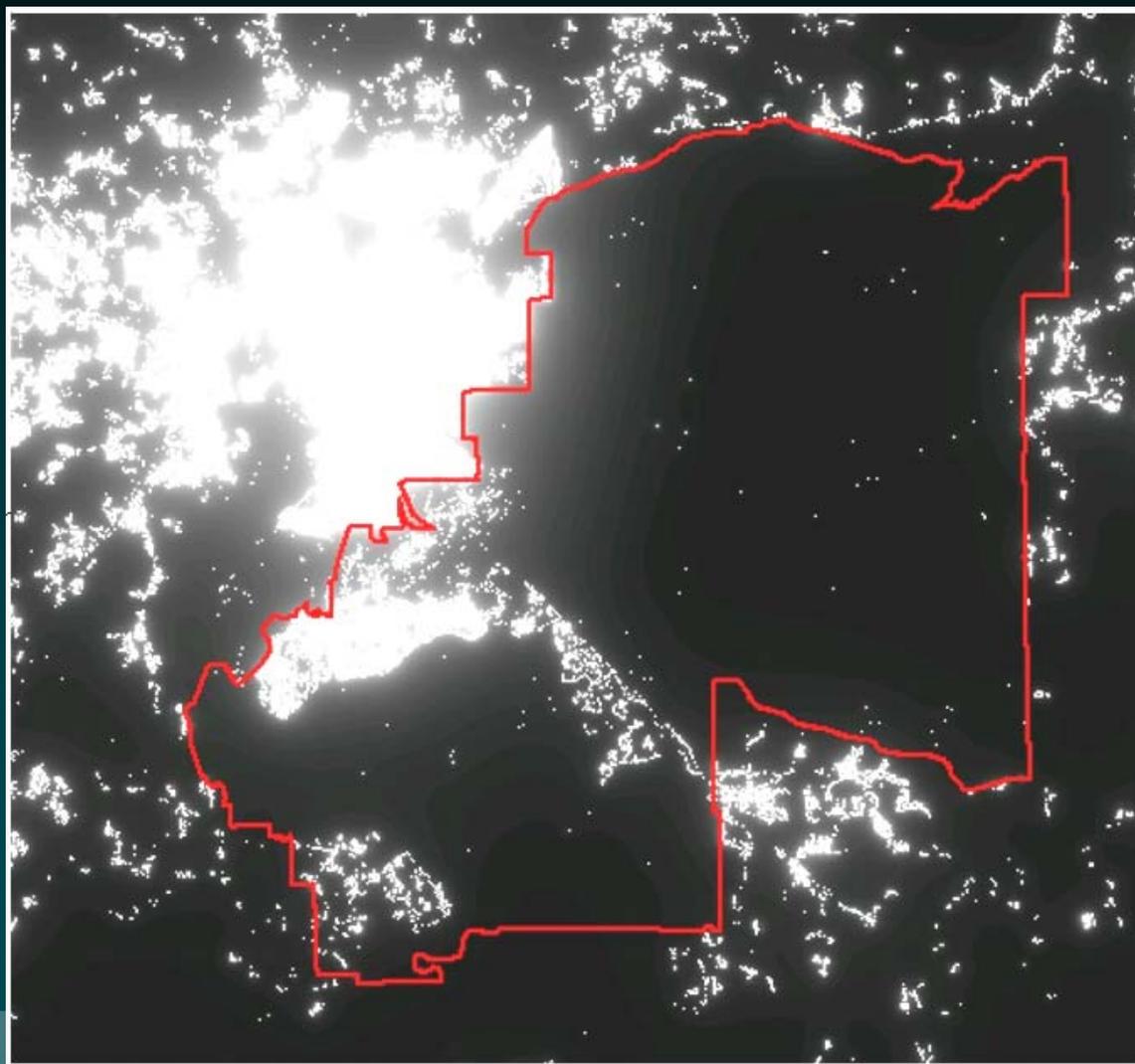
# Potential Artillery Training area with low risk of complaint lost by 2030



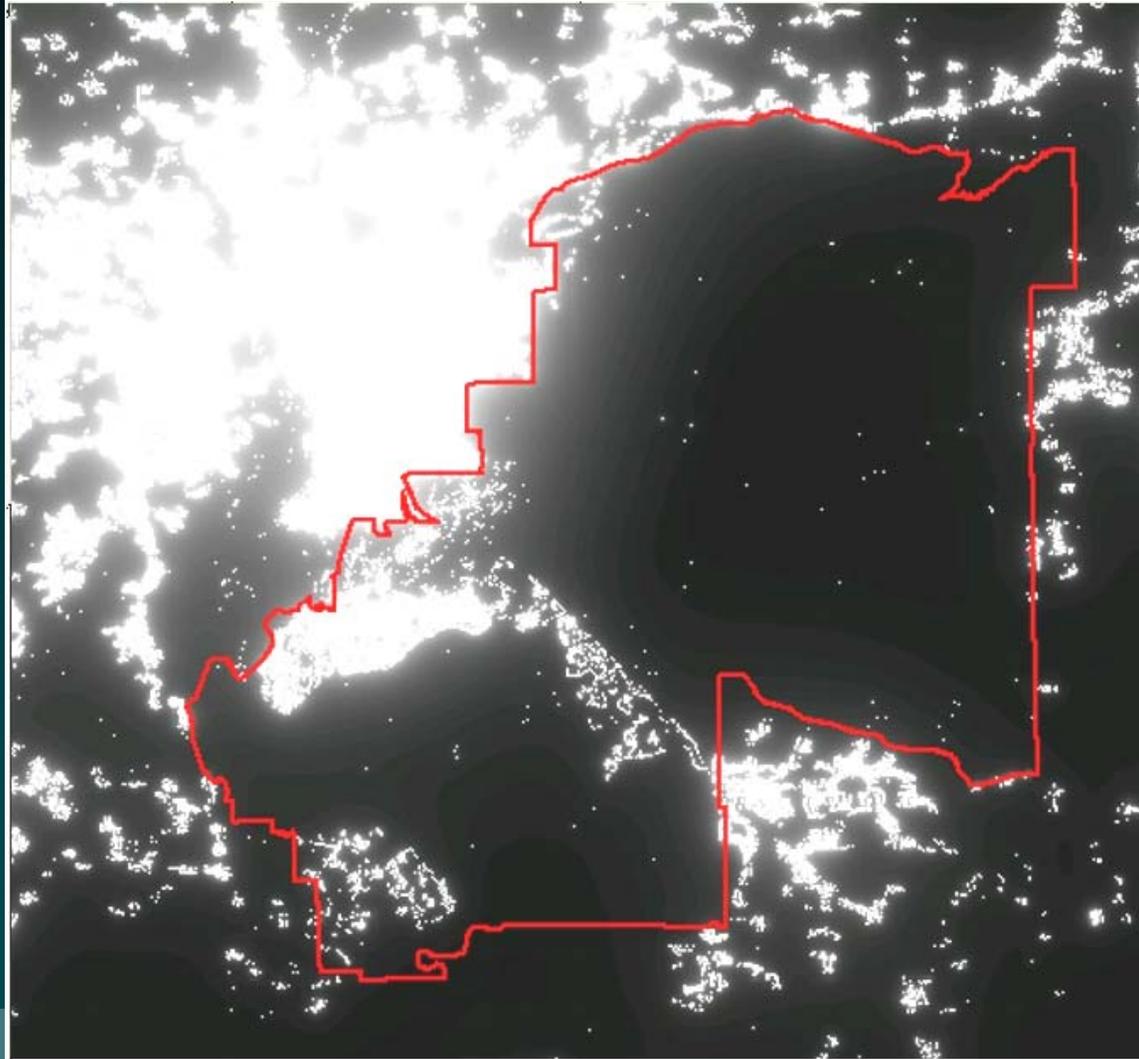
# Light pollution from civilian sources and its effect on usable training land



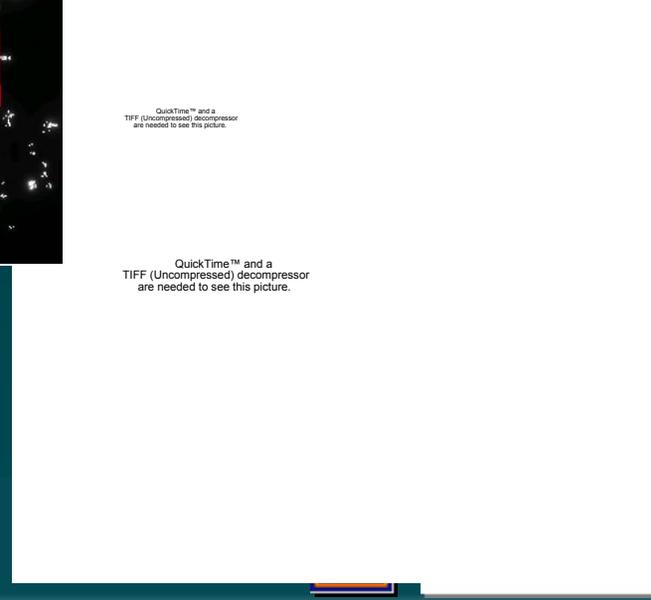
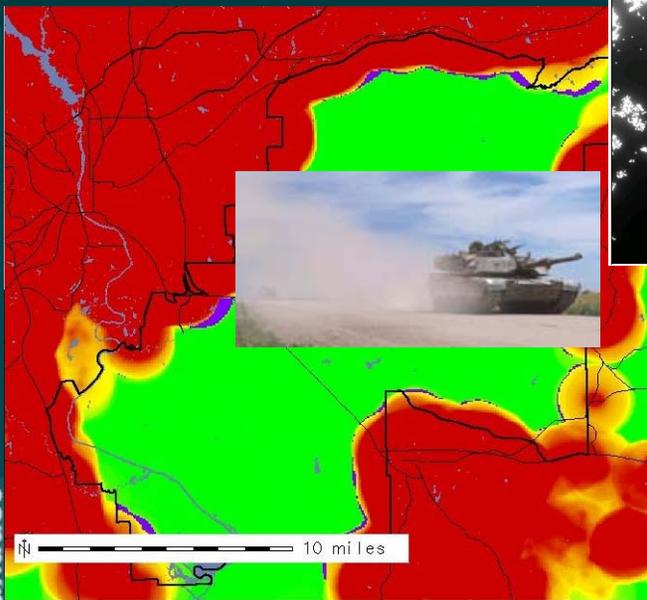
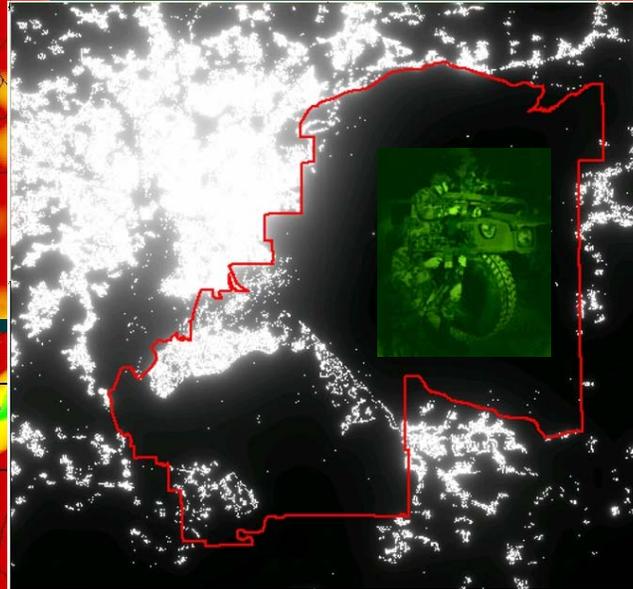
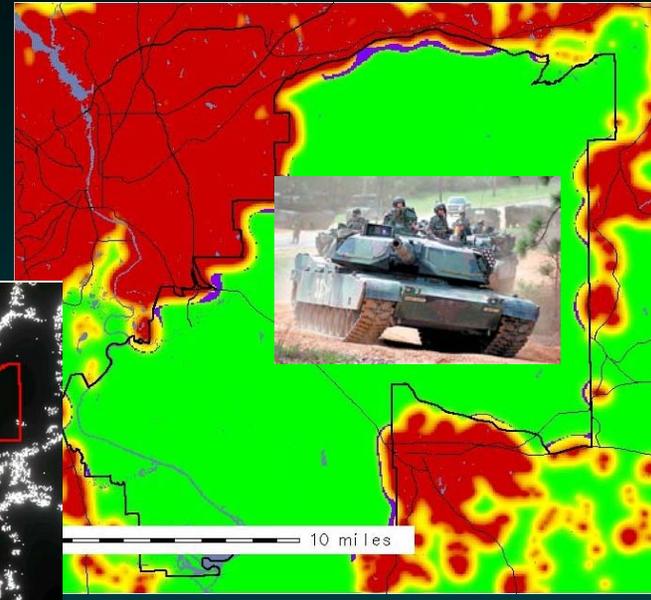
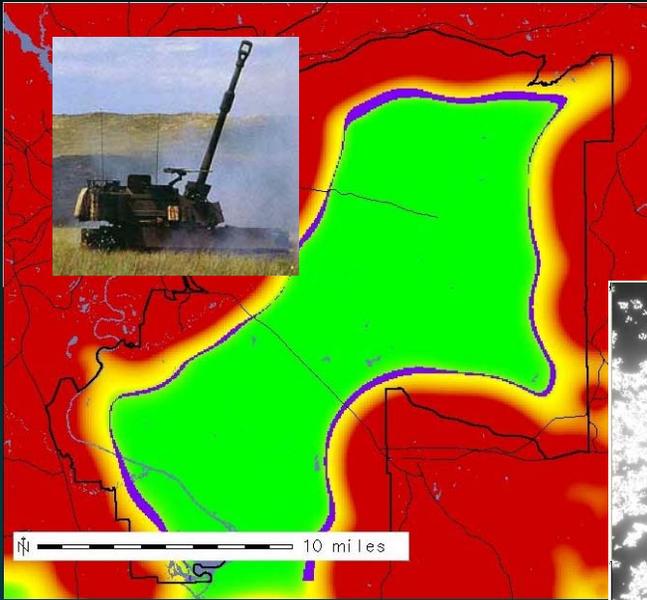
# 2000



# 2030



# LEAMtom: training opportunities model



Long-term  
Consequences on  
Military Training

landuse

variation

QuickTime™ and a  
TIFF (Uncompressed) decompressor  
are needed to see this picture.

QuickTime™ and a  
TIFF (Uncompressed) decompressor  
are needed to see this picture.



# Urban Growth Analysis Model Results

To the right are working and preliminary results from testing the effect of alternative regional plans on the opportunities for military training decades into the future.

All analyses are GIS based. The steps are as follows:

1. Prepare from national (and optionally local) GIS data sources a set of raster maps
2. Process these maps with **LEAMram**, the LEAM residential attractiveness model. This generates:
  - Residential attractiveness map
  - Inputs for the next step
3. Process the results with **LEAMluc**, the LEAM land use change model. The results:
  - Time-series maps (displayable as short movies) of urban development
  - Inputs for the next step
4. Process the LEAMluc results with **LEAMtom**, the LEAM training opportunities model to identify future training and testing opportunities.

Locations are matched with user defined scenarios that involve modifying the inputs to capture such things as:

- Population projections
- Property (and property rights) purchases
- Zoning
- Highway construction
- Limited access ramp creation (to interstates)

**LEAM** is a modeling software suite and process developed by the Dept. of Urban and Regional Planning at the University of Illinois Urbana-Champaign and the Construction Engineering Research Laboratory (**CERL**), part of the Army Corps' Engineer Research and Development Center (**ERDC**).



LEAM user f

LEAM part of the [Fort Future](#) R&D effort.

Locations	Scenarios
atterbury	<a href="#">scenarioBase</a>
benning	<a href="#">scenarioBase</a>
benning-mleam	<a href="#">scenarioBase</a>
bragg	<a href="#">scenarioBase</a> <a href="#">tmp</a> <a href="#">newRoad</a>
bragg-mleam	<a href="#">scenarioBase</a>
bragg-new	<a href="#">scenarioBase</a>
carson	<a href="#">scenarioBase</a>
champaign	<a href="#">scenarioBase</a> <a href="#">test</a>
kish	<a href="#">kyle1</a> <a href="#">eastCenter</a> <a href="#">newNeighbor</a> <a href="#">scenarioBase</a>
knox	<a href="#">scenarioBase</a> <a href="#">prop KY hwys</a> <a href="#">test</a> <a href="#">prop roads</a>
knox-new	<a href="#">prop roads</a> <a href="#">scenarioBase</a> <a href="#">prop road</a>
	<a href="#">scenarioBase</a> <a href="#">new</a> <a href="#">prop roads</a> <a href="#">newtest</a>

<http://earth.cecer.army.mil/FF>



# Urban Growth Analysis Model Results

Location: Benning

Area: Benning  
Scenario: ACUB  
02/14/06

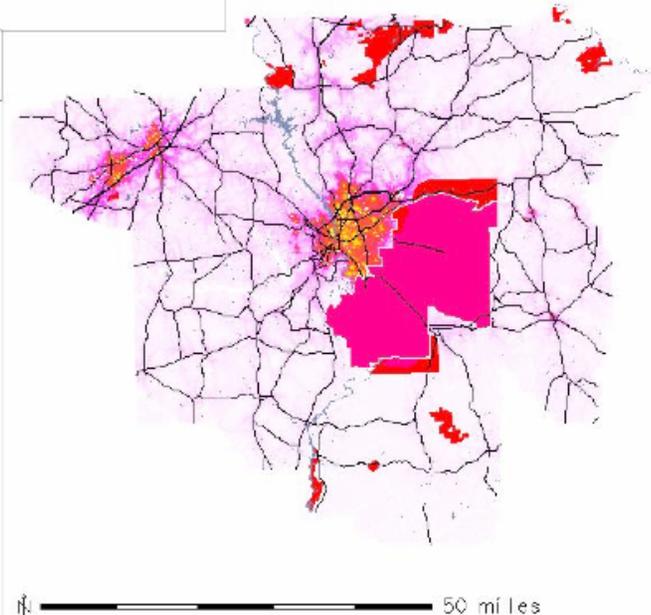
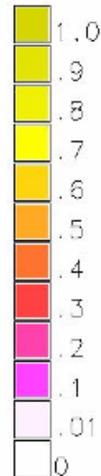
Scenario: ACUB

Date: Wed Feb 22 15:40:05 CST 2006

Operator: Jim Westervelt

Analysis of the impacts of proposed regional planning and projected population growth on future training and testing opportunities. Based on the [mLEAM](#) simulation modeling and analysis tools, part of [Fort Future](#).

Percent Residential Developed



Available Results (click on the ● for images)

Area	Residential Attract	Residential Attract Difference	Residential Movie	Time	Tracked Vehicle Training Dust	Tracked Vehicle Training Noise	Artillery Training Noise	C-130 Aircraft Noise	F-22 Aircraft Noise	Bell J-2A Helicopter Noise	Boeing 757 Noise	Night Light - High Humidity	Night Light - Low Humidity
Benning	●	●	●	Now	●	●	●	●	●	●	●	●	●
				Future	●	●	●	●	●	●	●	●	●
East	●	●	●	Now	●	●	●	●	●	●	●	●	●
				Future	●	●	●	●	●	●	●	●	●

# Potential loss of lands used for training within the boundaries of Fort Benning by training disturbance and land use scenario

Training Disturbance	Tracked Vehicle Dust	Tracked Vehicle Training Noise	Artillery Training Noise	C-130 Aircraft Noise	F-22 Aircraft Noise	Bell J-2A Helicopter Noise
Scenario	Potential Training Area Loss (%)					
ACUB	-1.93%	-0.94%	-4.37%	0.00%	-9.58%	-0.28%
CompactDev	-1.32%	-1.10%	-4.19%	0.00%	-8.47%	-0.33%
I14	-2.12%	-1.68%	-6.52%	0.00%	-12.99%	-0.41%
IndPark	-1.97%	-1.55%	-6.12%	0.00%	-12.19%	-0.43%
RT280	-2.05%	-1.71%	-6.68%	0.00%	-13.26%	-0.45%
SewerExp	-2.21%	-1.73%	-7.04%	0.00%	-13.52%	-0.44%
StreamBuf	-2.16%	-1.56%	-6.09%	0.00%	-12.10%	-0.40%
US431_SR165	-2.28%	-1.62%	-6.44%	0.00%	-12.45%	-0.44%
US431_update	-2.23%	-1.68%	-6.22%	0.00%	-12.00%	-0.46%

# Journal Articles

## Accepted:

- Deal, Brian M. and Daniel Schunk. 2004. Spatial Dynamic Modeling and Urban Land Use Transformation: A Simulation Approach to Assessing the Costs of Urban Sprawl. *Ecological Economics* 51:79-95.
- Deal, Brian, D. Schunk. 2004. An Ecological Approach to Modeling Urban Environments. *The Journal of Ecological Economics*. Accepted for publication.
- Deal, Brian, D. Schunk. 2004. Spatial Dynamic Modeling and Urban Land Use Transformation: A Simulation Approach to Assessing the Costs of Urban Sprawl. *The Journal of Ecological Economics*. Accepted for publication. 51:1-2 (2004), 79-95
- Deal, Brian, Z. Sun. 2005. *A Spatially Explicit Urban Simulation Model: The Land-use Evolution and Impact Assessment Model (LEAM)*. to be published in: *Regional Development, Infrastructure, and Adaptation to Climate Variability and Change*. Ruth, M (ed). Springer, New York
- Sun, Zhanli, Brian Deal, V. Pallathucheril. 2005. The Land-use Evolution and Impact Assessment Model: A Comprehensive Urban Planning Support System. *The Journal of Urban and Regional Information Systems*. accepted for publication.
- Yang, Limin, G. Xian, J. Klaver, and Brian M. Deal. 2003. Urban Land Cover Change Detection Through Sub-Pixel Imperviousness Mapping Using Remotely Sensed Data. *Photogrammetric Engineering & Remote Sensing* 69, no. 9:1003-1010. Aurambout, J.-P., A. G. Endress, Deal, B.M. In press. A spatial model to estimate habitat fragmentation and its consequences on long-term persistence of animal populations. *Environmental Monitoring and Assessment*.

## Submitted:

- Aurambout, J.P., Endress, A. G., Deal B. M. A spatial dynamic model to simulate population variations and movements within fragmented landscapes. (Submitted to *Ecological Modeling* 2004).
- Aurambout, J.P., Endress, A.G., Kim, Y.W., Deal, B.M. A GIS method to identify species habitat usage in multiple landscapes. (Submitted to *Biological Conservation*)
- Aurambout, Jean-Phillippe, Anton G. Endress, and Brian M. Deal. (submitted) A spatial dynamic model to simulate population variations and movements within fragmented landscapes. *Ecological Modeling*.
- Aurambout, Jean-Phillippe, Anton G. Endress, and Brian M. Deal. (submitted) A spatial model to estimate habitat fragmentation and its consequences on long-term persistence of animal populations. *Environmental Modeling and Assessment*.
- Choi, W., Y. Wang and B. Deal, Under review. Identifying the Most Sensitive Area with Respect to Non-point Source Pollutant Loading by Combining BASINS, L-THIA and LEAM, *Environmental Modeling & Assessment*

## Our Special Issue of Journal of Military Operations Research (JMORS)

- Eastgate, C. J. and D. A. Morrison, (submitted) Exploring impact indicators for military and urban land use incompatibilities *Journal of Military Operations Research*.
- Ginsberg, M. D. (submitted) Frequency encroachment on military installations *Journal of Military Operations Research*.
- Ginsberg, M. D. (submitted) Light pollution encroachment on military installations *Journal of Military Operations Research*.
- Kemme, M. and J. Westervelt, (submitted) Military Unique Particulate Matter Emissions and Urban Encroachment, *Journal of Military Operations Research*.
- Westervelt, J and M. White, (submitted) Identifying future military land use opportunities, *Journal of Military Operations Research*.

# Conference Presentations

- Case, M., Brian M. Deal, William Goran, R. Lacey, and James Westervelt. 2002. Fort Future: Installation Transformation Using A Virtual World. Paper presented at The US Army Science and Technology Conference.
- Choi, Woonsup. 2004. "Future Impacts of Urbanization on Runoff and Water Quality". Paper presented at 100th Annual Meeting of the Association of American Geographers, at Philadelphia, Pennsylvania (March ).
- Deal, Brian M. 2001. "An Operational Model for Sustainable Installations: A Dynamic Spatial Decision Support System for Sustainable Military Communities". Paper presented at The Joint Services Pollution Prevention Conference, at San Antonio, TX (August).
- Deal, Brian M. 2001. "The Land use Evolution and Impact Assessment Model: a distributed modeling environment". Paper presented at Invited presentation at The USGS Urban Dynamics Workshop, at (January).
- Deal, Brian M. 2001. "Urban Dynamics and Sustainability: and Ecological Approach". Paper presented at American Collegiate Schools of Planning Conference, at (November).
- Deal, Brian M. and Varkki George Pallathucheril. 2001. "Ecological Sustainability and the Urban Dynamics: A Disaggregated Modeling Approach to Sustainable Design". Paper presented at Computers in Urban Planning and Urban Management, at Honolulu, HA (July).
- Deal, Brian M. and Varkki George Pallathucheril. 2001. Ecological Sustainability and the Urban Dynamics: A Disaggregated Modeling Approach to Sustainable Design. Paper presented at Computers in Urban Planning and Urban Management, at Honolulu, HA (July).
- Deal, Brian M. and Varkki George Pallathucheril. 2001. Ecological Sustainability and the Urban Environment. Paper presented at The Environmental Design and Research Association Conference, at Glasgow, Scotland (July).
- Goran, William, Brian M. Deal, T Aden, and D. Timlin. 2000. Urban Growth: A Challenge to Sustaining U.S. Department of Defense Land Uses. Paper presented at Bioregional Planning: Resources Management Beyond the New Millennium, at Australia.
- Sun, Zhanli and Brian M. Deal. 2004. A Spatially Explicit Urban Sprawl Simulation Model: Land-use Evolution and impact Assessment Model (LEAM). Paper presented at Urban and Regional Information Systems Association Annual Conference, at Reno, Nevada.
- Westervelt, J. D., B. Deal, M. Davis 2005, "Urban Encroachment Analysis of the Norfolk Area", 2<sup>nd</sup> DOD Sustainable Ranges Initiative, August 22-25, San Antonio TX.
- Westervelt, J. D., Byrd, A., Russell, S. 2004, "Connecting proposed regional plans to future hydrologic implications", presented at the Ecological Society of America Annual Conference, Portland, Oregon
- Westervelt, J. D., M. White, D. Morrison, M. Kemme, M. Ginsberg 2005, "Where Can I Train?", 2<sup>nd</sup> DOD Sustainable Ranges Initiative, August 22-25, San Antonio TX.
- Westervelt, J. D., W.D. Goran, and J.M. Davis 2004, "Future Land Dynamics: Linking Changes to Range Sustainability", Sustainable Range Management, January 5-8, New Orleans, LA.

# Technical Reports

- Deal, B. M. The Military Land use Evolution and impact Assessment Model (mLEAM). Technical Note TN-01-2. 2001. Champaign, IL, Engineer Research and Development Center [CERL].
- Deal, B. M., D. Timlin, and W. D. Goran. Urban Encroachment of Military lands: Military Installations at Risk. TR-02-3. 2002. Champaign, IL, Engineer Research and Development Center [CERL].
- Deal, B. M., D. Fournier, and D. Timlin. An Assessment of Encroachment Mitigation Techniques for Army Lands. TR-02. 2002. Champaign, IL, Research and Development Center [CERL].
- Deal, B., D Fournier, D Timlin. 2002. *An Assessment of Encroachment Mitigation Techniques for Army Lands*. Engineering Research and Development Center [CERL]. TR02.
- Fournier, D. F., B. M. Deal, Elisabeth M. Jenicek, and Adam J. Sagert. 2002. *Sustainable Installation Risk Assessment and Stationing Implications*. Engineer Research and Development Center [CERL], Champaign, IL, August SR02
- Fournier, D., B. M. Deal, E. M. Jenicek, and Adam J Sagert. Sustainable Installation Risk Assessment and Stationing Implications. August SR-02. 2002. Champaign, IL, Engineer Research and Development Center [CERL].
- Jenicek, E.J. et al. 2004 *The Sustainable Installation Regional Resource Assessment (SIRRA) Capability: Version 1* ,, Report Number ERDC/CERL TR-04-9
- Jenicek, E. M., Brian M. Deal, and Adam J Sagert. Sustainable Indices and Metrics: An Annotated Bibliography. TR02-25. 2002. Champaign, IL, Engineering Research and
- Jenicek, E., B Deal, D Fournier. *Sustainable Indices and Metrics*. 2002. Engineering Research and Development Center. TR902.
- Timlin, D., D. Johnston, and Brian M. Deal. Guidelines for Developing Historic Urban Growth Series for Military Installation Risk Assessment. TR-02-06 (January). 2002. Champaign, IL, Engineer Research and Development Center [ERDC], Construction Engineering Research Laboratory [CERL].
- Westervelt, J. 2004. Approaches for Evaluating the Impact of Encroachment on Installation Training/Testing. Engineering Research and Development Center.
- Westervelt, J. and Joseph Rank. (in editing) LEAMram: Residential Attractiveness Model. ERDC/CERL TR-06-xx. Champaign, Illinois, US Army Corps of Engineers Engineer Research and Development Center.
- Westervelt, J., K. Brock, W. Choi, and Y. W. Kim. (2004) Development of Input Maps for the military Land use Evolution and Assessment Model (LEAM) Land Use Change (LUC) Simulation Model. ERDC/CERL TR-04-24. 2004. Champaign, Illinois, US Army Corps of Engineers Engineer Research and Development Center.

# Joint Distributed Regional Training Capacity

# Premise

- The Army must eventually look outside current installations for training areas because of requirements associated with:
  - New weapon systems
  - New training doctrine
  - Joint service training
  - Force transformation

# Evidence

- “Encroachment” is a primary Army & DoD concern
  - Army’s Sustainable Ranges Program
  - Congressional requested annual 320/366 DoD reports
  - Annual Conferences
    - Range Training Land Program
    - Joint Services Environmental Management Conference
    - DoD Sustainable Range Initiative
- Loss of military training land and/or times
- Persistent move towards more Joint Training
- Future Force / Objective Force / Units of Action
  - Need far more training area than currently available
- Off-installation Training Exercises
  - Desert Scimitar
  - Roving Sands
  - Joint Red Flag
- Development of training simulators

# Invisible Regional Encroachment

## Current battleground

- The Army and DoD are fighting to sustain ranges
  - DoD brought encroachment complaints to Congress
  - Congress has asked for encroachment analyses (320/366)
  - Army's Sustainable Ranges Program (SRP)

## Meanwhile ...

- The Army and DoD are quietly losing expansion opportunities

# Proposal-ideas in development

- Identification of suitable Army training areas in US
- Optimization of future land use patterns to optimize DoD and competing interests
- Regional training designer
- Optimizing training throughput
- Impact of occasional regional training exercises on TES
- Natural and civilian reaction to infrequent military training noise

# Proposal-ideas in development

- Impact of occasional regional training exercises on archeological sites
- Alleviating the risks of spreading exotic plant species during regional exercises
- Optimal strategies for coordinating regional exercise planning with communities
- Predicting future pressures on regional airspace
- Designing “Mobile Training Facilities”

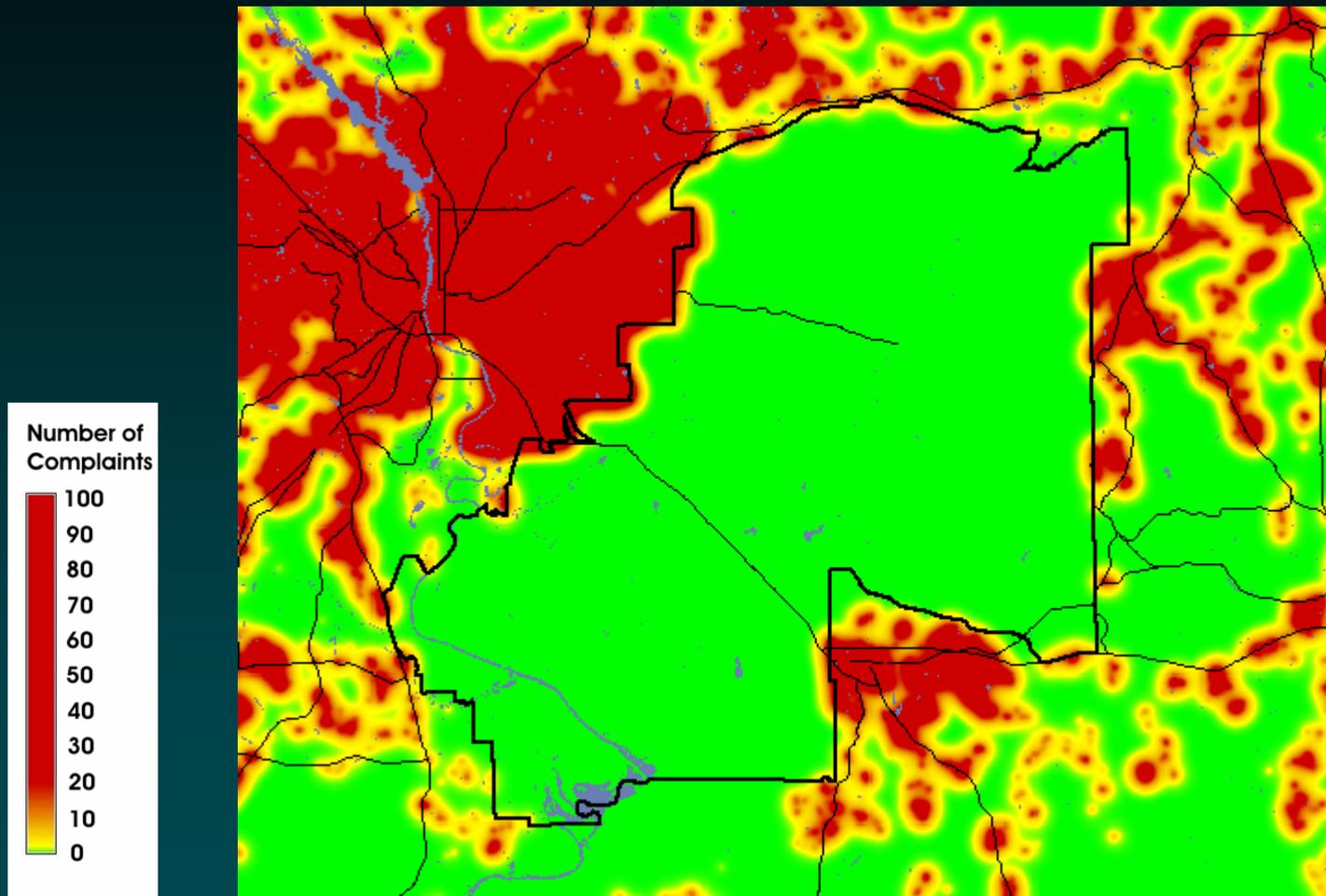
# Backups

# Probability of complaint for a tracked vehicle training exercise for the base scenario simulated in LEAMtom

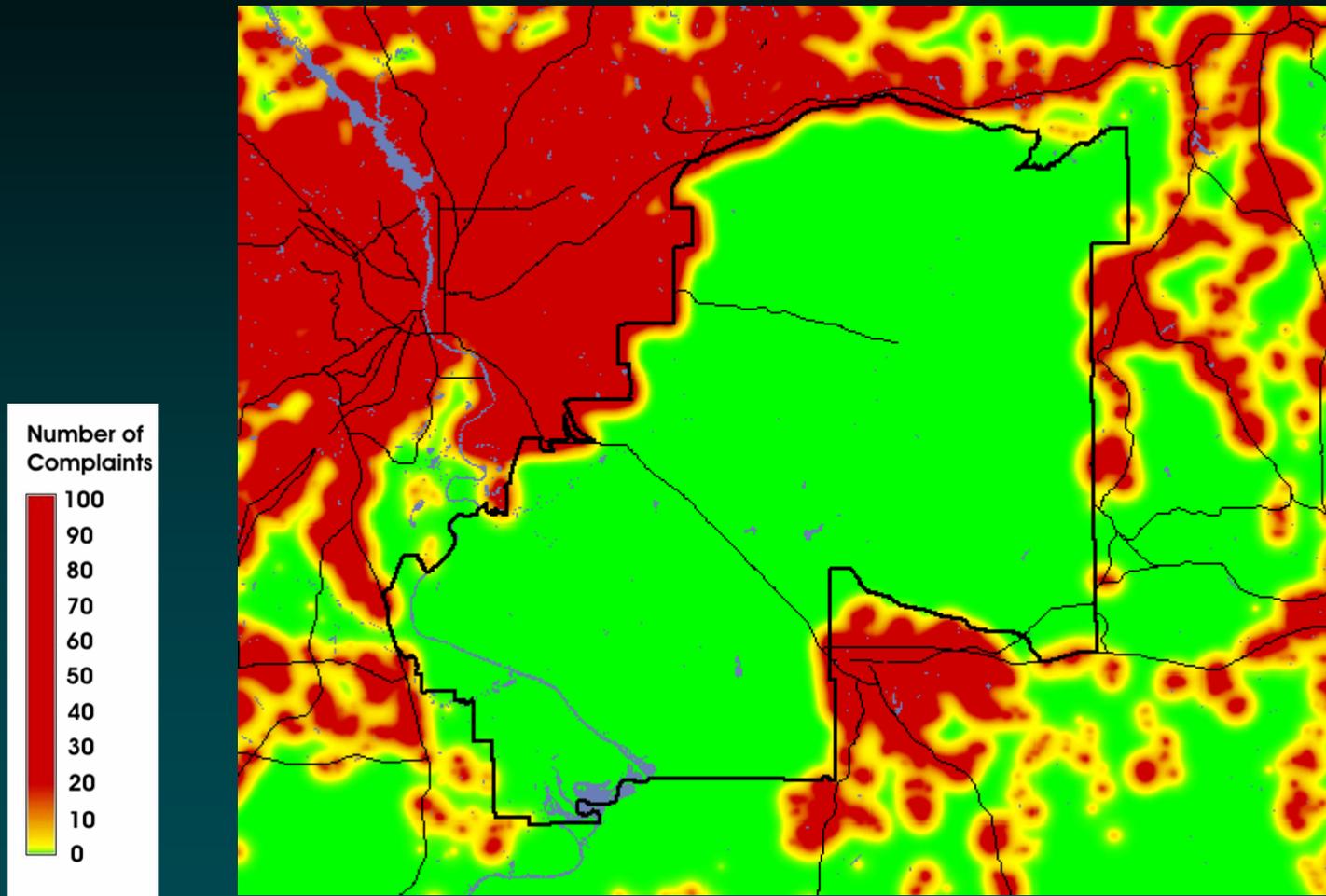


A tracked vehicle training exercise generating noise of 60 dB @ 600 meters.

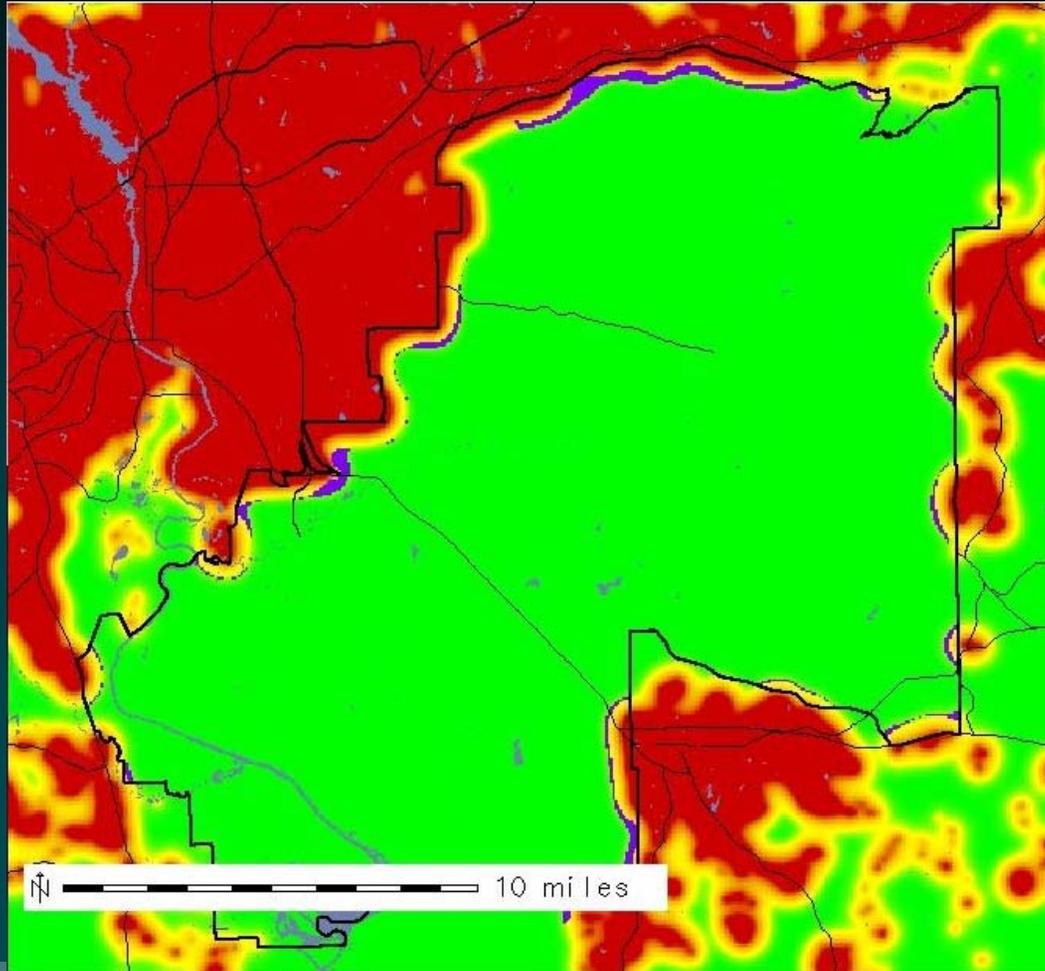
# 2000



# 2030



# Potential tracked vehicle training area with low risk of complaint lost by 2030

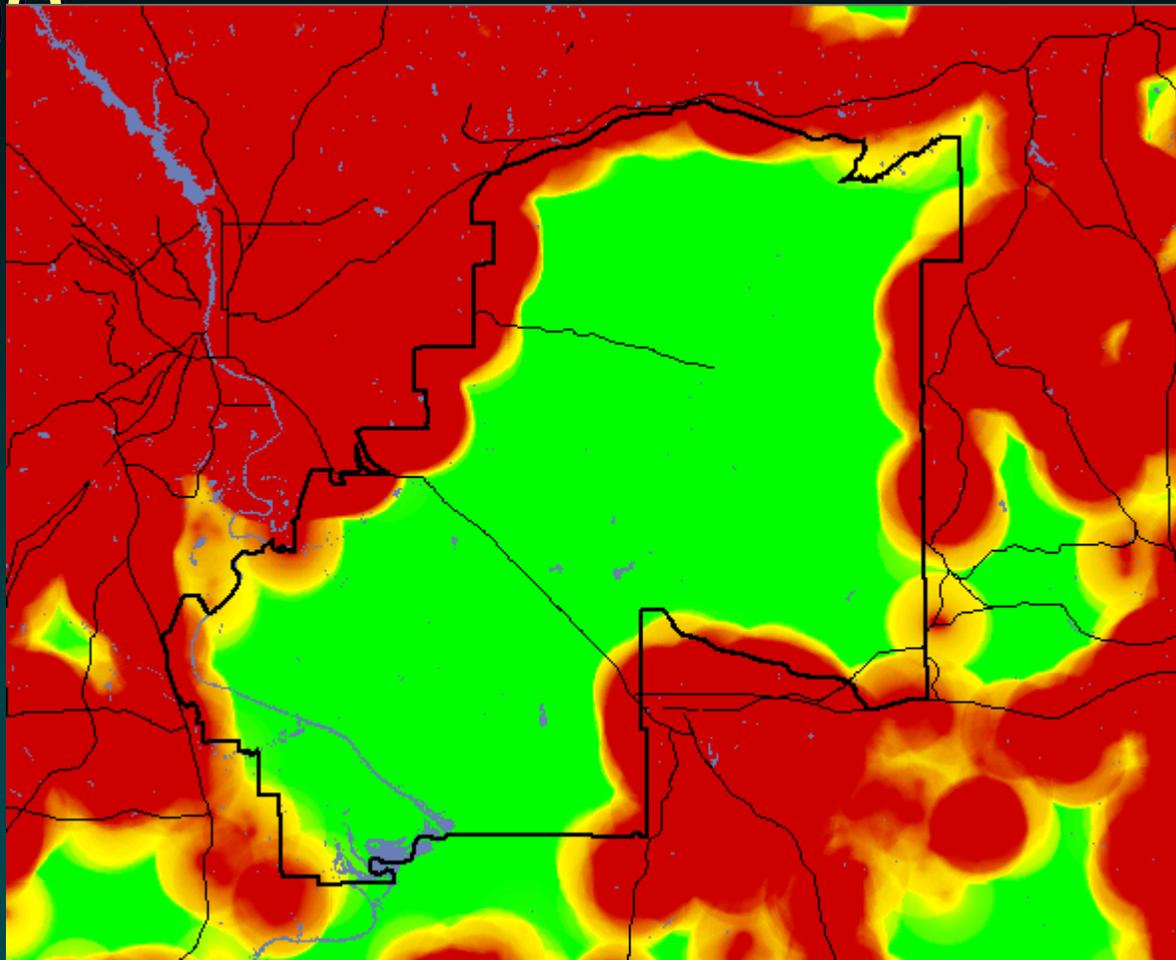
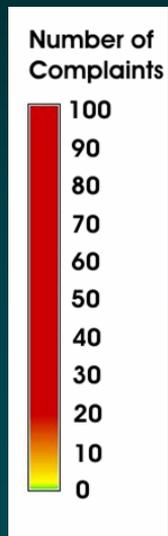


# Probability of dust complaints for a tracked vehicle training exercise for the base scenario simulated in LEAMtom

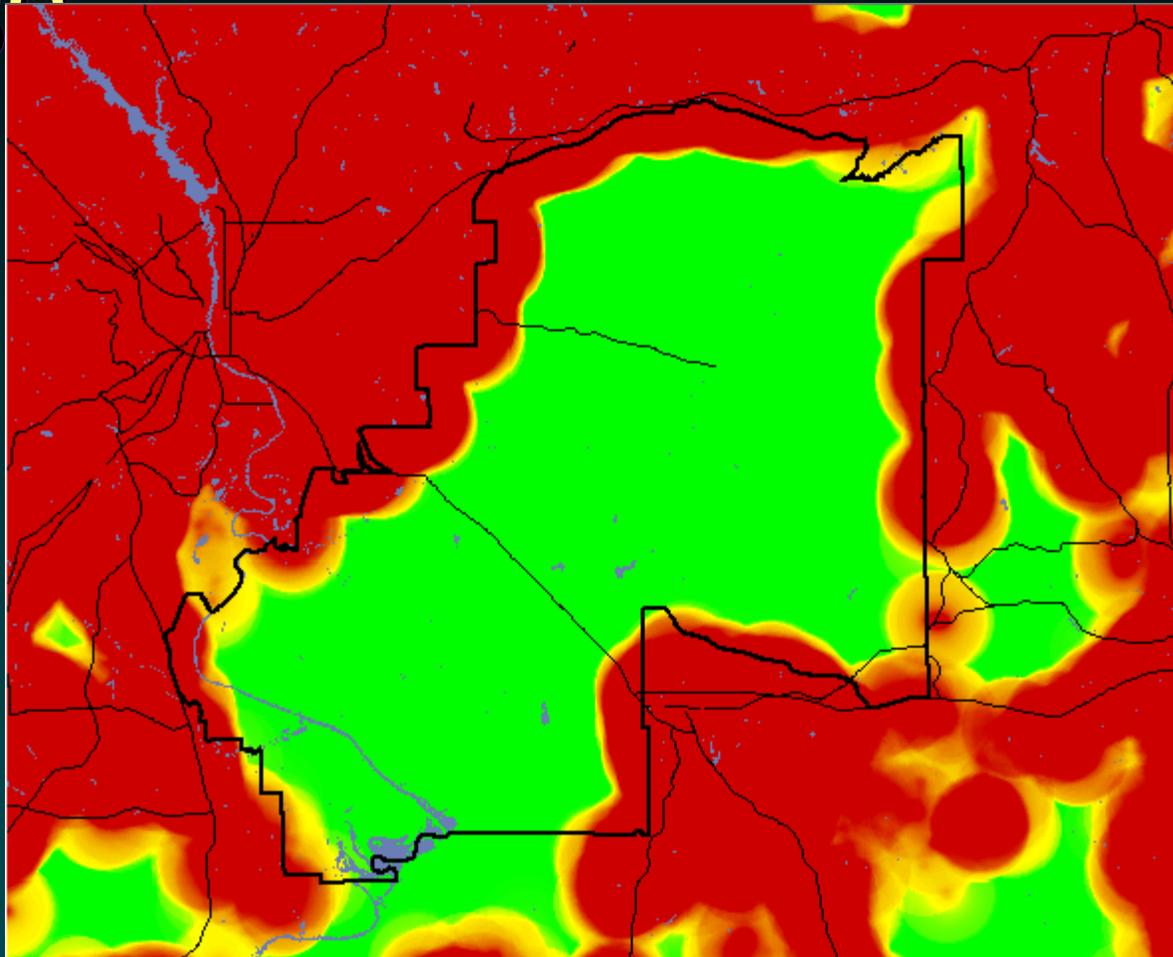
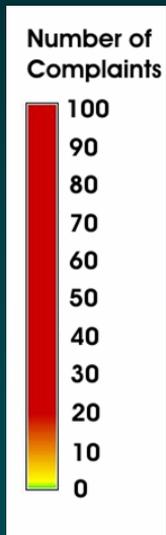


tracked vehicle training exercise releasing 10 grams/sec with a wind speed of 5 meters/sec.

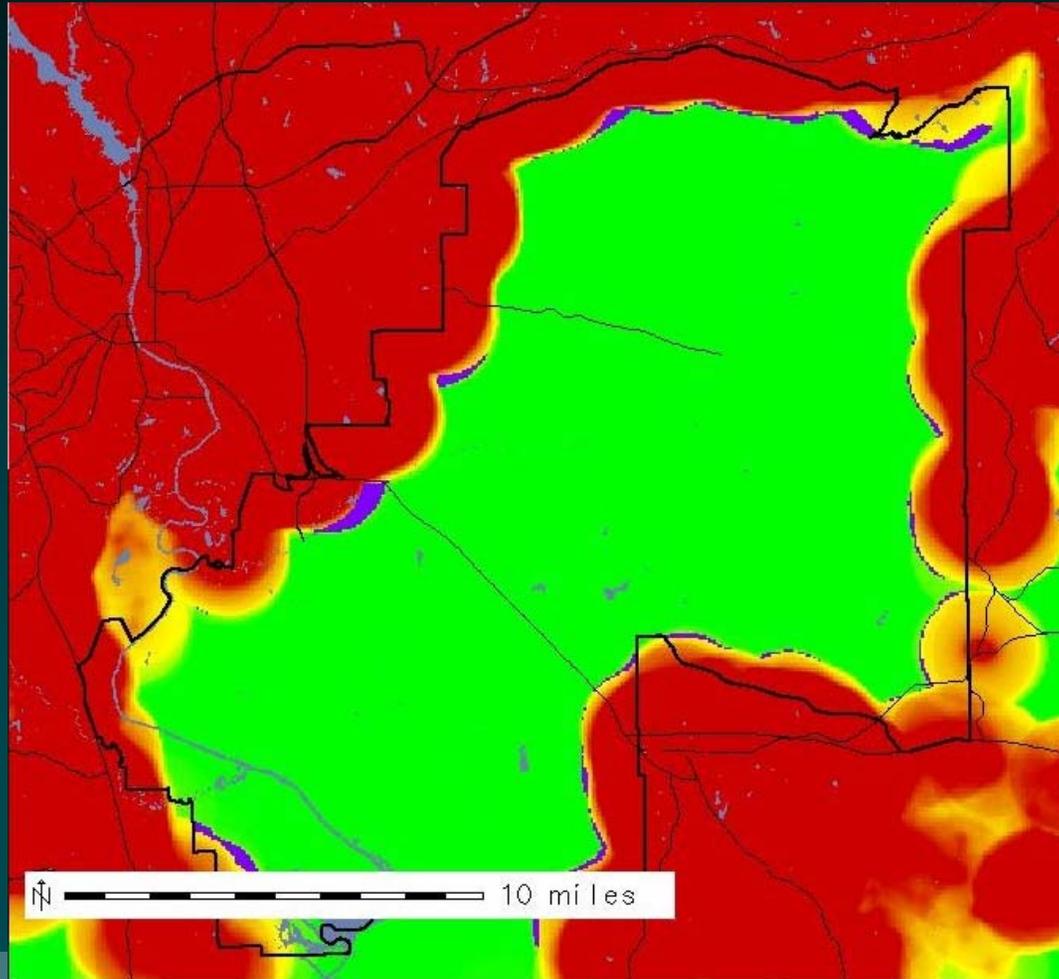
2000



# 2030



# Potential tracked vehicle training area with low risk of complaint of dust lost by 2030

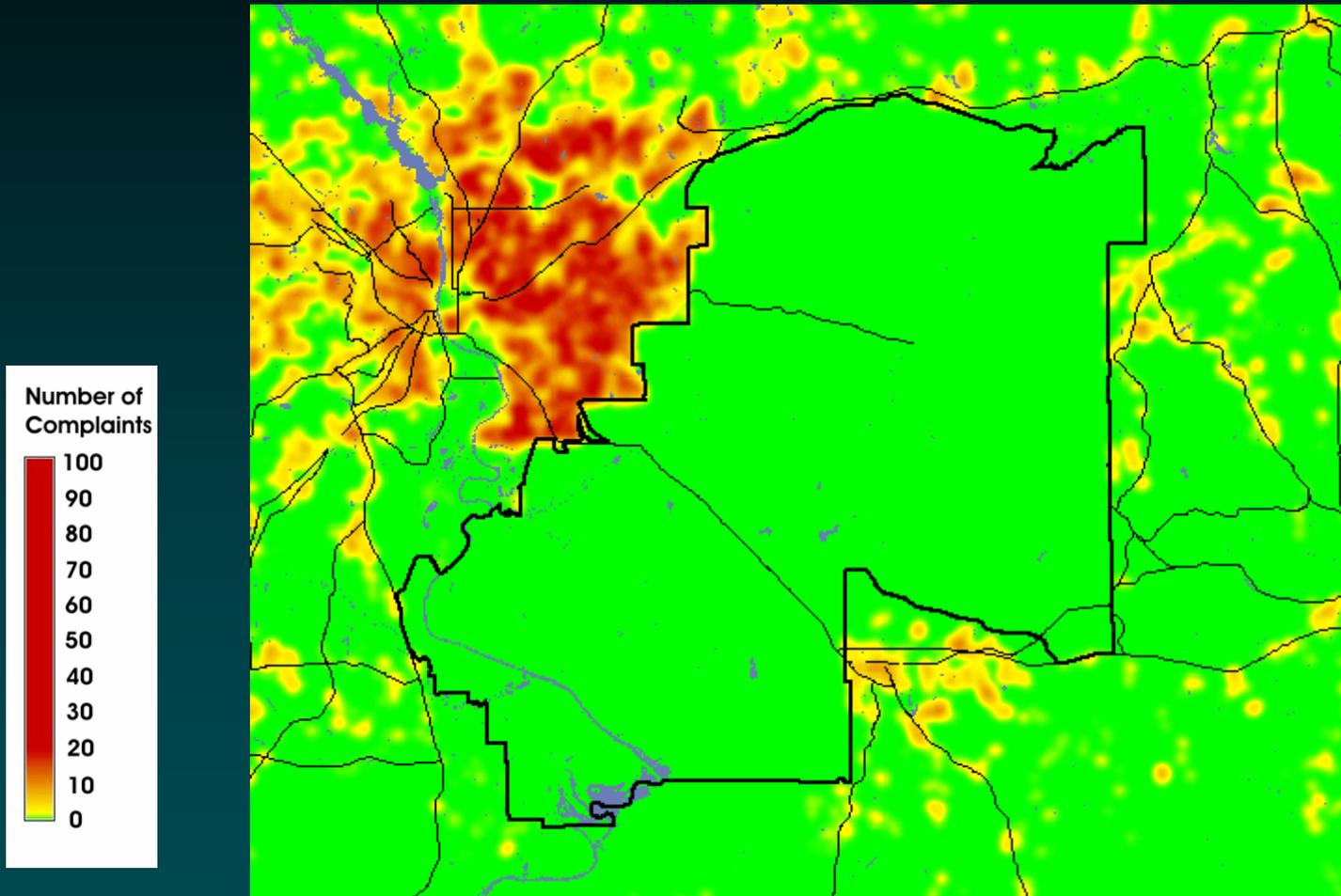


# Probability of complaint for a helicopter similar to the Bell J2A for the base scenario simulated in LEAMtom

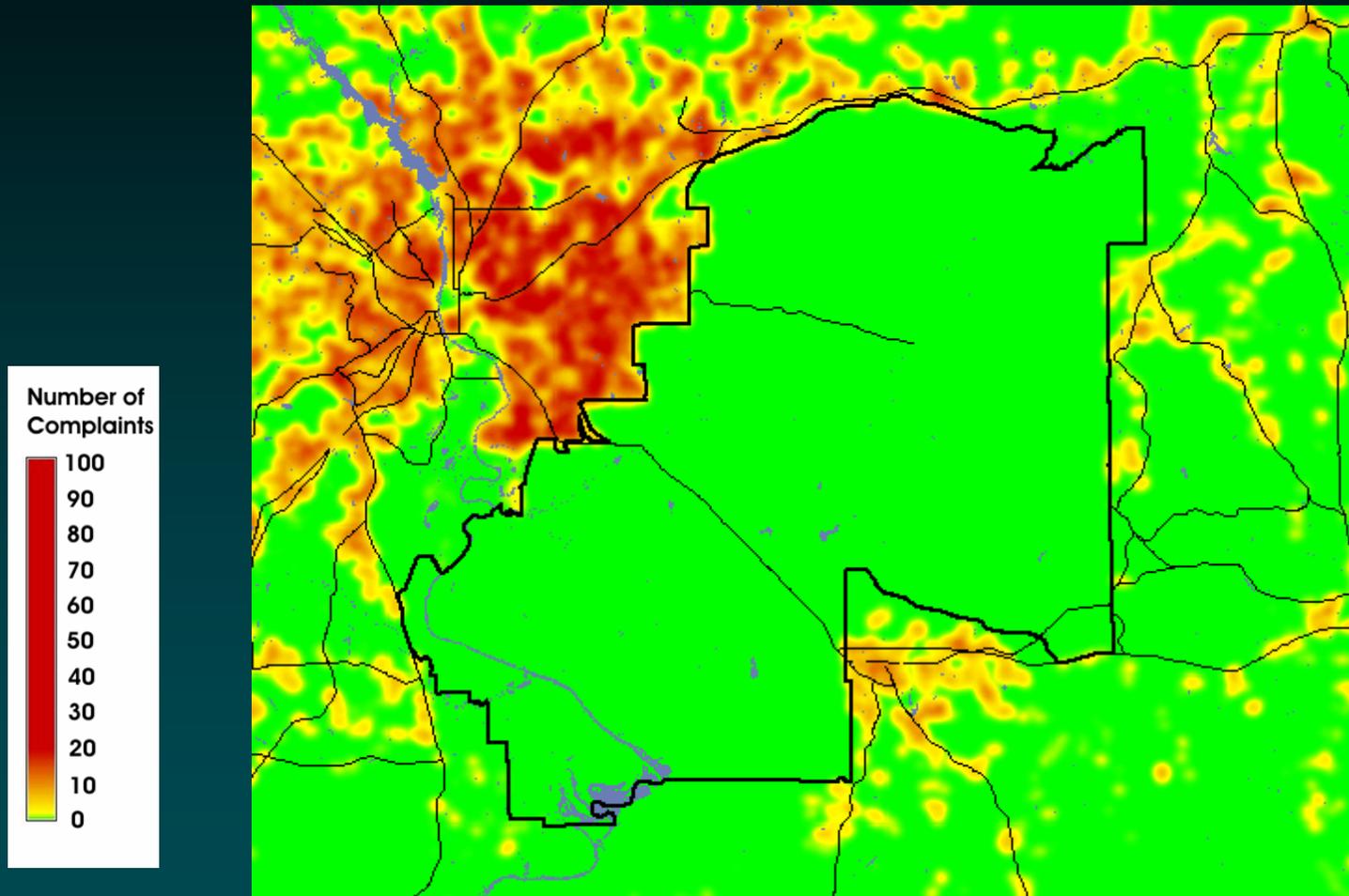


Helicopter generating noise of 100 dB @ 30 meters at an altitude of 300 meters

# 2000



# 2030



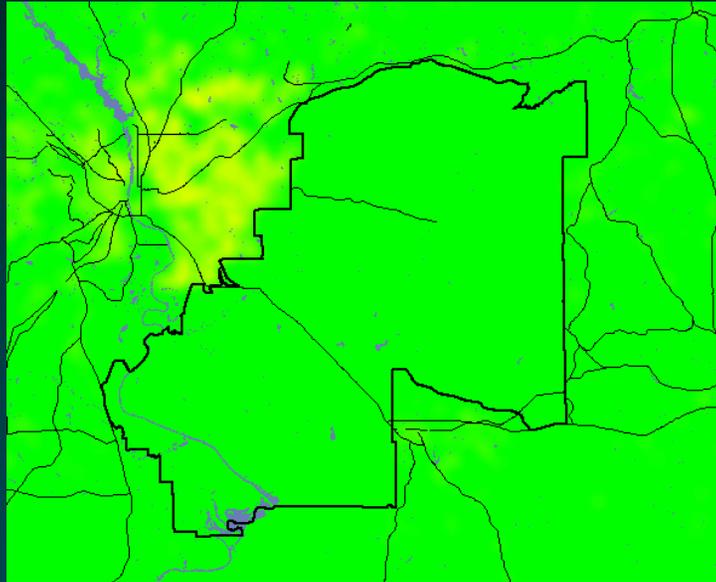
# Probability of complaint for a C-130 training exercise for the base scenario simulated in LEAMtom

C-130 aircraft at an altitude of 2000 meters generating noise of 99 dB @ 92 meters.

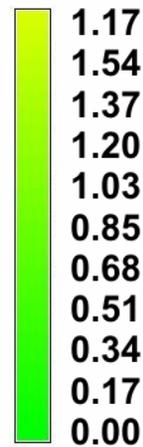


Complaint probability from residential areas BEFORE and AFTER growth, in response to a C-130 aircraft at an altitude of 2000 meters generating noise of 99 dB @ 92 meters.

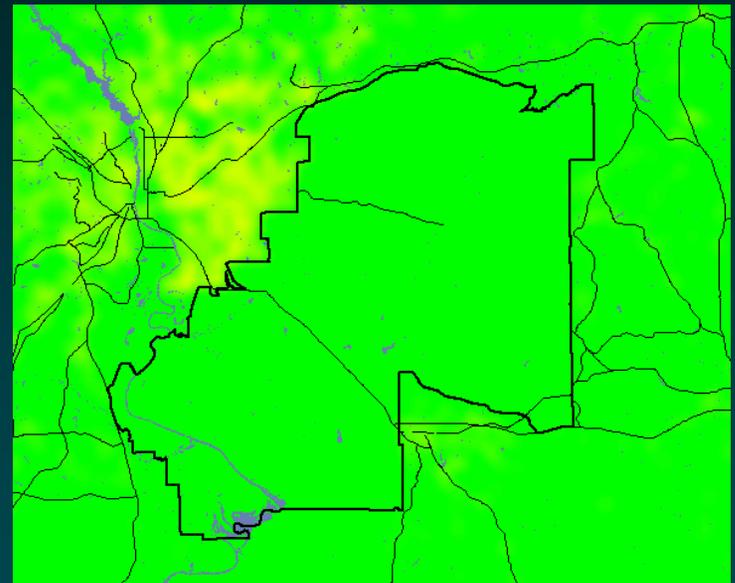
2000



Number of  
Complaints

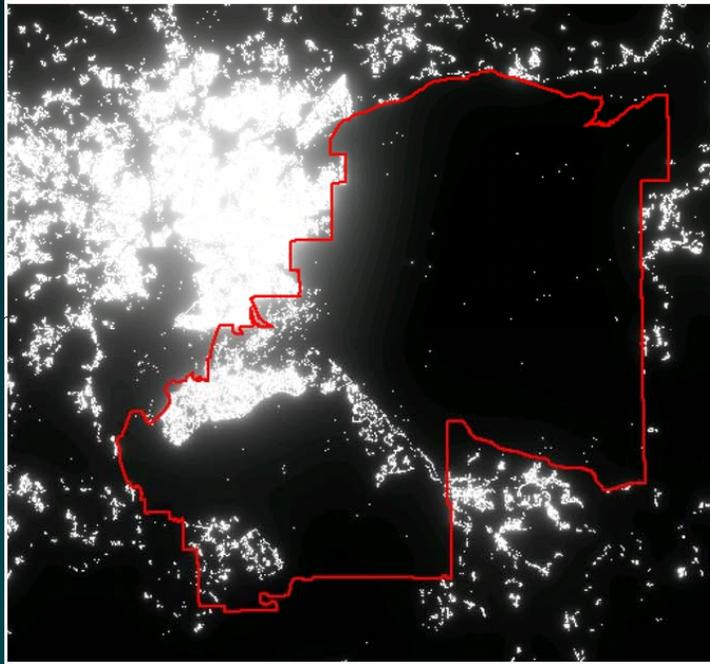


2030



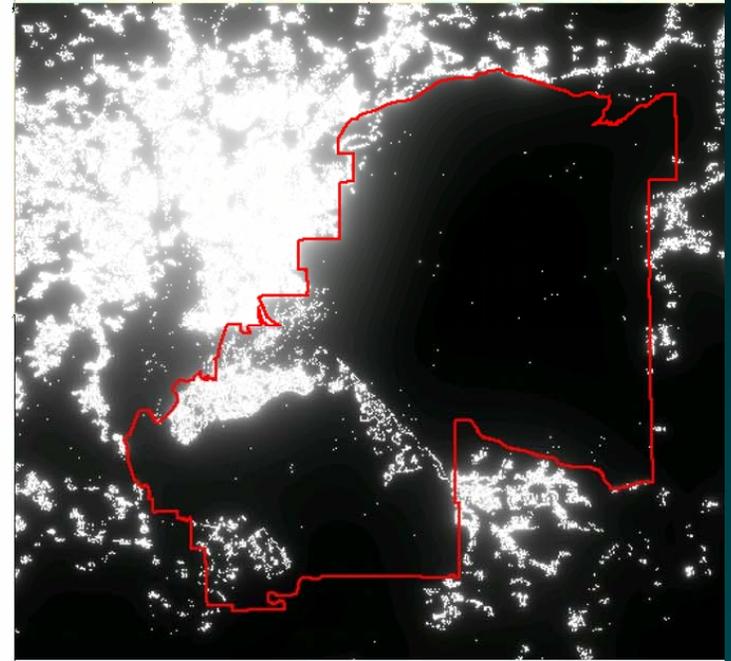
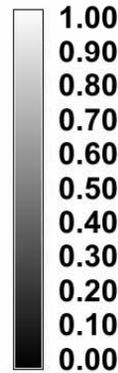
# Relative potential for night training exercises BEFORE and AFTER growth in response to residential and commercial lights reflecting off clouds along with high atmospheric humidity.

Scenario: LEAMbase Time: Wed Mar 15 17:11 CST 2006



2000

Night sky glow  
from urban lights:  
High humidity



2030