Integrated Climate Assessment for Army Enterprise Planning

Range Encroachment Model User’s Guide

Byron M. Garton

July 2019

Approved for public release; distribution is unlimited.
The U.S. Army Engineer Research and Development Center (ERDC) solves the nation’s toughest engineering and environmental challenges. ERDC develops innovative solutions in civil and military engineering, geospatial sciences, water resources, and environmental sciences for the Army, the Department of Defense, civilian agencies, and our nation’s public good. Find out more at www.erdc.usace.army.mil.

To search for other technical reports published by ERDC, visit the ERDC online library at http://acwc.sdp.sirsi.net/client/default.
Range Encroachment Model User’s Guide

Byron M. Garton
Information Technology Laboratory
U.S. Army Engineer Research and Development Center
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

Final report
Approved for public release; distribution is unlimited.
Abstract

Encroachment of urban development upon military installations can be expected to have an impact on the Army’s costs and ability to fulfill its missions due to issues relating to noise complaints, reduction of natural buffer land surrounding installation boundaries, light pollution effects on nighttime training operations, and other potential impacts to operations on installations. This model attempts to predict the effect of urban encroachment for several scenarios and various Department of Defense (DoD) installations.

This document describes the process of executing the Range Encroachment Model, as it exists at the time of this writing, within the common computational environment established under the software integration effort of the Integrated Climate Assessment for Army Enterprise Planning work package.
Contents

Abstract .................................................................................................................................... ii

Figures and Tables .................................................................................................................. iv

Preface ...................................................................................................................................... v

1 Introduction ...................................................................................................................... 1
   1.1 Background ........................................................................................................ 1
   1.2 Purpose .............................................................................................................. 1
   1.3 Requirements .................................................................................................... 1

2 Viewing Computed Data .................................................................................................. 3

3 Building New Data ........................................................................................................... 6

4 Known Issues and Limitations ..................................................................................... 13

5 Additional Help ............................................................................................................... 14

Reference ............................................................................................................................... 15

Appendix A: Acronyms and Abbreviations ......................................................................... 16

Report Documentation Page
Figures and Tables

Figures

Figure 1. Wizard application shortcut................................................................. 3
Figure 2. Range Encroachment Model icon. ............................................................. 4
Figure 3. Range Encroachment Model first screen. ............................................... 4
Figure 4. Range Encroachment Model second screen. .......................................... 5
Figure 5. Launch buttons on the third model screen within the Wizard. ............. 7
Figure 6. ESRI ArcMap application. ................................................................. 7
Figure 7. Run command prompt as administrator. ........................................... 9
Figure 8. Command prompt window with Launch.bat command. ....................... 9
Figure 9. NetLogo with model file loaded. ......................................................... 10
Figure 10. NetLogo with model execution complete....................................... 10

Tables

Table 1. Online data sources................................................................................. 6
Table 2. Example model output file................................................................. 12
Preface

This research was conducted for the U.S. Engineer Research and Development Center-Construction Engineering Research Laboratory (ERDC-CERL) under Project 402188, Integrated Climate Assessment for Army Enterprise Planning. The Technical Monitor was Dr. James D. Westervelt of ERDC-CERL.

The work was performed by the Information Technology Laboratory (ITL), Scientific Software Branch (SSB), of the Computational Science and Engineering Division (CSED). At the time of publication, Mr. Timothy W. Dunaway was Chief of the SSB, Dr. Jerrell R. Ballard was Chief of the CSED, and Dr. Robert M. Wallace was the Technical Director. The Deputy Director of ERDC-ITL was Ms. Patti S. Duett, and the Director was Dr. David A. Horner.

COL Ivan P. Beckman was the Commander of ERDC, and Dr. David W. Pittman was the Director.
1 Introduction

1.1 Background

Encroachment of urban development upon military installations and training areas can have a negative impact on future force readiness and effectiveness. It can be expected to impact the Army’s costs and ability to fulfill its missions due to issues relating to noise complaints, reduction of natural buffer land surrounding installation boundaries, light pollution effects on nighttime training operations, and other potential impacts to operations on installations. This model attempts to predict the risk of urban growth and development around military installations with active training and firing ranges. The predicted encroachment values are intended to be utilized in other force stationing analysis applications as a Military Value Analysis (MVA) attribute.

1.2 Purpose

This model makes use of a common computational environment and a user assistance application that were implemented as part of the Software Integration effort within the Integrated Climate Assessment for Army Enterprise Planning work package. The virtual environment will be referred to throughout this document as the Virtual Machine or VM, and the user assistance application will be referred to as the Wizard. For more information about the Software Integration effort, the virtual environment, and the user assistance application, refer to the Analytical Model Integration Methods technical report listed in the references section of this document.

Executing the model is a multi-step process that requires using Environmental Systems Research Institute (ESRI) ArcMap, NetLogo, and MS Excel® applications. Each step for viewing and building data sets is thoroughly documented in the following sections to limit user confusion and ensure accurate results.

1.3 Requirements

Software requirements for the Range Encroachment Model include ESRI ArcMap 10.3.1, NetLogo 5.3, a basic text editor such as MS Notepad®, MS
Excel® version 2013 or higher, and an internet connection and internet browser.

A working knowledge of ArcMap, NetLogo, and Microsoft Office products is recommended as well as a basic understanding of accessing websites and downloading files from the internet.

Hardware requirements for this model are substantial. A minimum of nine processor cores (eight required for script) are required to execute the code. Memory minimum requirements are 100 gigabytes (GB) of random access memory (RAM) and 1 terabyte (TB) of hard disk storage space (local or network).
2 Viewing Computed Data

Pre-built dataset viewing is available to end users by accessing the model from within the Wizard application. The Wizard is accessible from the Integrated Climate Assessment for Army Enterprise Planning VM by clicking the shortcut located on the desktop (Figures 1–3).

Figure 1. Wizard application shortcut.
The second screen within the model allows the end user to view the datasets in tabular mode. Use the View Results button on the second model screen to view the data in a table layout within an MS Excel®.
spreadsheet. This MS Excel® file is located within the VM at C:\Models\Range-Encroachment\Output\Postprocessing_Output_ArcGIS\results-RUG\Rug-Output_Clean.xls.

Figure 4. Range Encroachment Model second screen.

Each installation that was analyzed is assigned a Final Score which ranks it against other installations. Installations with lower scores are less likely to experience range encroachment as a result of urban development. The final score value may be used as an MVA attribute in other force stationing analysis applications.
3 Building New Data

New datasets are built within the VM by executing a series of steps that require using two different data processing applications. The following instructions should be followed carefully to produce new data from this model.

The first step in building new data is to collect the necessary source data from sources online. Table 1 lists the sources for the required data.

<table>
<thead>
<tr>
<th>Data</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Training Areas</td>
<td>Sustainable Range Program can be found at: <a href="https://srp.army.mil/">https://srp.army.mil/</a></td>
</tr>
<tr>
<td>Digital Elevation Model</td>
<td>(<a href="http://viewer.nationalmap.gov">http://viewer.nationalmap.gov</a>)</td>
</tr>
<tr>
<td>Landcover map</td>
<td><a href="http://www.mrlc.gov">http://www.mrlc.gov</a></td>
</tr>
<tr>
<td>Flood Hazard</td>
<td><a href="mailto:HIRLD@hq.dhs.gov">HIRLD@hq.dhs.gov</a> or by calling (202) 282-9541</td>
</tr>
<tr>
<td>Protected Areas</td>
<td><a href="https://assets.usgs.gov/CADYS/data/download/">https://assets.usgs.gov/ CADYS/data/download/</a></td>
</tr>
<tr>
<td>LandScan Data</td>
<td><a href="mailto:HIRLD@hq.dhs.gov">HIRLD@hq.dhs.gov</a> or by calling (202) 282-9541</td>
</tr>
</tbody>
</table>

After the data has been collected, the data must be formatted in a particular fashion. This formatting is accomplished by using the ESRI ArcMap application. ArcMap can be launched automatically from within the Wizard application on the third model screen or from the Windows start menu (Figure 5 and Figure 6).
After opening ArcMap, open the range encroachment data preprocessing project by selecting File->Open and browse to the file C:\Models\Range-
Once the project is loaded, open the toolbox viewer by clicking the Toolbox menu bar icon . Add the Regional Urban Growth (RUG) RUG_preprocessing_10.2 toolbox by right clicking ArcToolbox at the top of the viewer then clicking Add Toolbox. The toolbox file is located at C:\Models\ Range-Encroachment\Model-Files\Step1_RUG_preprocessing_ARCGIS\RUG_PreProcessing_10.2.tbx. Expand the newly added toolbox by clicking the plus sign to the left to show the models inside.

Next, it’s necessary to reproject all the data to a common projection, for the Continental United States (CONUS) use USA Contiguous Albers Equal Area Conic United States Geological Survey (USGS) version, and for Alaska use NAD 1983 Alaska Albers. Right click the 1. Project Data CONUS (or 1. Project Data Alaska) model and choose Edit. Inside the editor, click the Run menu bar icon .

Once all the data is in the same projection, run the Population Impact Data Processing in a similar fashion by right clicking the Population Impact Data Processing CONUS (or Population Impact Data Processing ALASKA) model and choose Edit. Inside the editor, click the Run menu bar icon . The output of the Population Impact Data Processing models (AK and CONUS) will be in American Standard Code for Information Interchange (ASCII) data format, which will be used in the RUG model inside of NetLogo.

The next step in the process is running the NetLogo application which accepts the previously processed data as input. NetLogo can be launched automatically from on the third model screen within the Wizard as illustrated in Figure 7. Another method of launching the application is from the Windows command prompt. Click the Windows start button, then type CMD. Note that the command prompt must be run as administrator and 100GBs of RAM must be available in the computer (Figure 7 and Figure 8).
Inside NetLogo, click on File->Open and navigate to the model.nlogo file located at C:/Models/Range-Encroachment/Model_Files/Step2_RUG_NetLogo/NetLogo/model.nlogo to launch the range encroachment model. From the area drop down list, choose the desired area (fort or location) to run the model on, and click the run-all button (Figure 9 and Figure 10).
Output from NetLogo will be saved to the results folder (C:\Models\Range-Encroachment\Model_Files\Step2_RUG_NetLogo\results) with a separate folder for each installation. Each folder should contain four
files: annual-growth.txt, equation.txt, results.png, and pct_low_density_urban_in_buffers.csv.

The final step is post-processing of the RUG results in ArcGIS using the Population Impact toolbox. Launch ArcMap again from the wizard and open the model file located at C:\Models\Range-Encroachment\Model-Files\Step3_RUG_postprocessing_ARCGIS\RangeEncroachment.mxd.

Open the toolbox viewer by clicking the Toolbox menu bar icon 🖼️. Add the Population_Impact_10.2.xxx toolbox by right clicking ArcToolbox at the top of the viewer then clicking Add Toolbox. The toolbox file is located at C:\Models\ Range-Encroachment\Model-Files\Step3_RUG_postprocessing_ARCGIS\Population_Impact.tbx. Expand the newly added toolbox by clicking the plus sign to the left to show the models inside.

Next step is to create a Workspace folder. This is a work-around because of an ESRI Model Builder error. Right click the 1. Create Workspace Folder model and choose Edit. Inside the editor, click the Run menu bar icon ⏀. Select a location for the folder to be created then choose OK. The model will create the empty Workspace folder.

The next step is the main model 2. Post Process data from RUG to MVA. Right click on the model and choose Edit. Validate the model by clicking the Validate menu bar icon ✅. If after validation the model processes turns white, this indicates the model has lost connection to a file that is necessary to run. This is a known issue with the model. A work-around is to change the results folder, then change back to the original results folder and revalidate. To change the results folder, double click on the Results Folder process, and browse to results-1. Click OK. Repeat step one to change the Results Folder back to results. Validate the model again, all processes should be repaired.

After the model has run, the final output is an MS Excel® spreadsheet and the final MVA score is shown in the Final_score column. The MVA scores show the risk of encroachment to the training area of each installation, where the higher MVA score represents a higher risk of encroachment. The spreadsheet file should be located at C:\Models\Range-Encroachment\Output\Postprocessing_Output_ArcGIS\results-RUG\Rug-Output_Clean.xls.
Table 2. Example model output file.

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>I</th>
<th>J</th>
<th>K</th>
<th>L</th>
<th>M</th>
<th>N</th>
<th>O</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>10</td>
<td>11</td>
<td>12</td>
<td>13</td>
<td>14</td>
<td>15</td>
<td>16</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>10</td>
<td>11</td>
<td>12</td>
<td>13</td>
<td>14</td>
<td>15</td>
<td>16</td>
</tr>
</tbody>
</table>
4 Known Issues and Limitations

Building new data with this model requires a substantial amount of memory and processing power. NetLogo reserves 100GB of RAM before running. Therefore, more than 100GB must be present in the computer before attempting to run.

NetLogo also takes a substantial amount execution time to run. It’s not unusual for the process to take several hours complete, even on very powerful, modern computers.
5 Additional Help

Additional questions or concerns should be directed to the Program Manager of the Integrated Climate Assessment for Army Enterprise Planning program.

Paul M. Loechl  
ERDC-CERL  
Paul.M.Loechl@usace.army.mil  
217-373-5892  

Marty Garton  
ERDC-ITL  
Byron.m.garton@usace.army.mil  
601-634-2888
Reference

### Appendix A: Acronyms and Abbreviations

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASCII</td>
<td>American Standard Code for Information Interchange</td>
</tr>
<tr>
<td>CSV</td>
<td>Comma Separated Values</td>
</tr>
<tr>
<td>CONUS</td>
<td>Continental United States</td>
</tr>
<tr>
<td>DoD</td>
<td>Department of Defense</td>
</tr>
<tr>
<td>ERDC</td>
<td>Engineer Research and Development Center</td>
</tr>
<tr>
<td>ERDC-CERL</td>
<td>Engineer Research and Development Center-Construction Engineering Research Laboratory</td>
</tr>
<tr>
<td>ERDC-ITL</td>
<td>Engineer Research and Development Center-Information Technology Laboratory</td>
</tr>
<tr>
<td>GB</td>
<td>Gigabytes</td>
</tr>
<tr>
<td>GCM</td>
<td>Global Circulation Model</td>
</tr>
<tr>
<td>MVA</td>
<td>Military Value Analysis</td>
</tr>
<tr>
<td>NSN</td>
<td>National Supply Number</td>
</tr>
<tr>
<td>OMB</td>
<td>Office of Management and Budget</td>
</tr>
<tr>
<td>PM</td>
<td>Program Manager</td>
</tr>
<tr>
<td>RAM</td>
<td>Random Access Memory</td>
</tr>
<tr>
<td>RCP</td>
<td>Representative Concentration Pathway</td>
</tr>
<tr>
<td>RUG</td>
<td>Regional Urban Growth</td>
</tr>
<tr>
<td>SAR</td>
<td>Same As Report</td>
</tr>
<tr>
<td>Abbreviation</td>
<td>Description</td>
</tr>
<tr>
<td>--------------</td>
<td>------------------------------</td>
</tr>
<tr>
<td>SF</td>
<td>Standard Form</td>
</tr>
<tr>
<td>TB</td>
<td>Terabyte</td>
</tr>
<tr>
<td>USGS</td>
<td>U.S. Geological Survey</td>
</tr>
<tr>
<td>VM</td>
<td>Virtual Machine</td>
</tr>
</tbody>
</table>
### 14. ABSTRACT

Encroachment of urban development upon military installations can be expected to have an impact on the Army’s costs and ability to fulfill its missions due to issues relating to noise complaints, reduction of natural buffer land surrounding installation boundaries, light pollution effects on nighttime training operations, and other potential impacts to operations on installations. This model attempts to predict the effect of urban encroachment for several scenarios and various Department of Defense (DoD) installations.

This document describes the process of executing the Range Encroachment Model, as it exists at the time of this writing, within the common computational environment established under the software integration effort of the Integrated Climate Assessment for Army Enterprise Planning work package.

### 15. SUBJECT TERMS

- Military bases
- Cities and towns--Growth
- Land use--Planning

### 16. SECURITY CLASSIFICATION OF:

<table>
<thead>
<tr>
<th></th>
<th>a. REPORT</th>
<th>b. ABSTRACT</th>
<th>c. THIS PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unclassified</td>
<td>Unclassified</td>
<td>Unclassified</td>
<td></td>
</tr>
</tbody>
</table>

### 17. LIMITATION OF ABSTRACT

Approved for public release; distribution is unlimited

### 18. NUMBER OF PAGES

25