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Integrated Climate Assessment for Army Enterprise Planning

Range Encroachment Model User's Guide

Byron M. Garton

July 2019

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Range Encroachment Model User's Guide

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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.

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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.

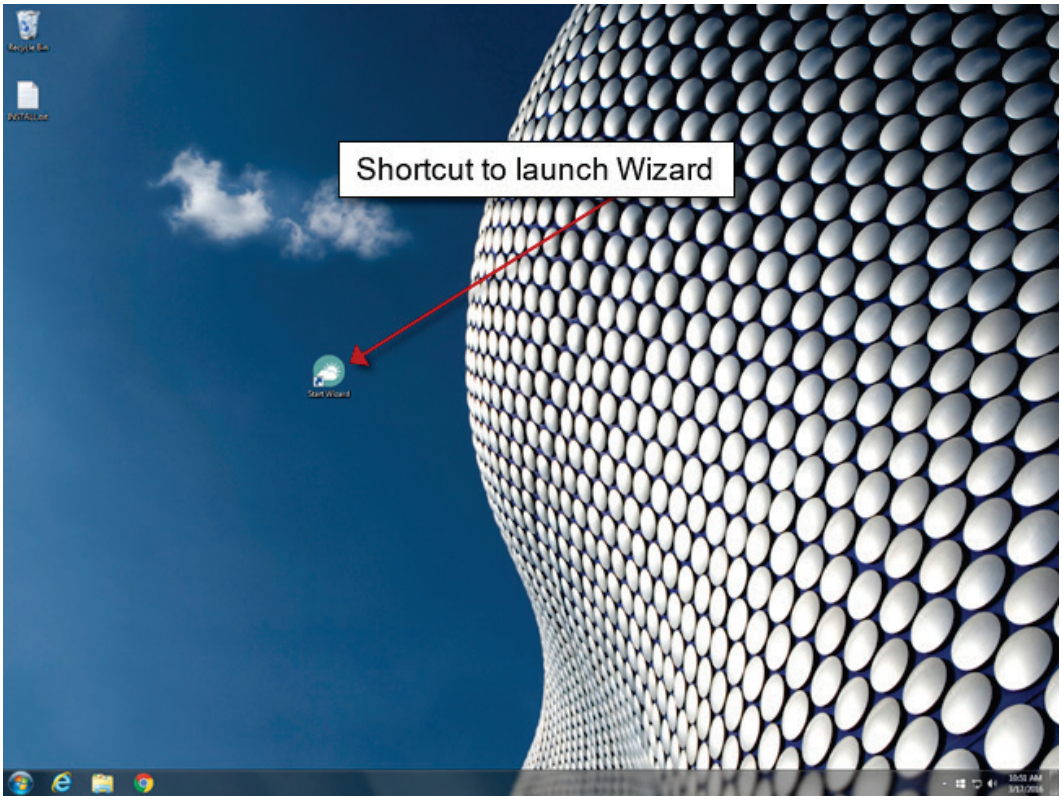


Figure 2. Range Encroachment Model icon.

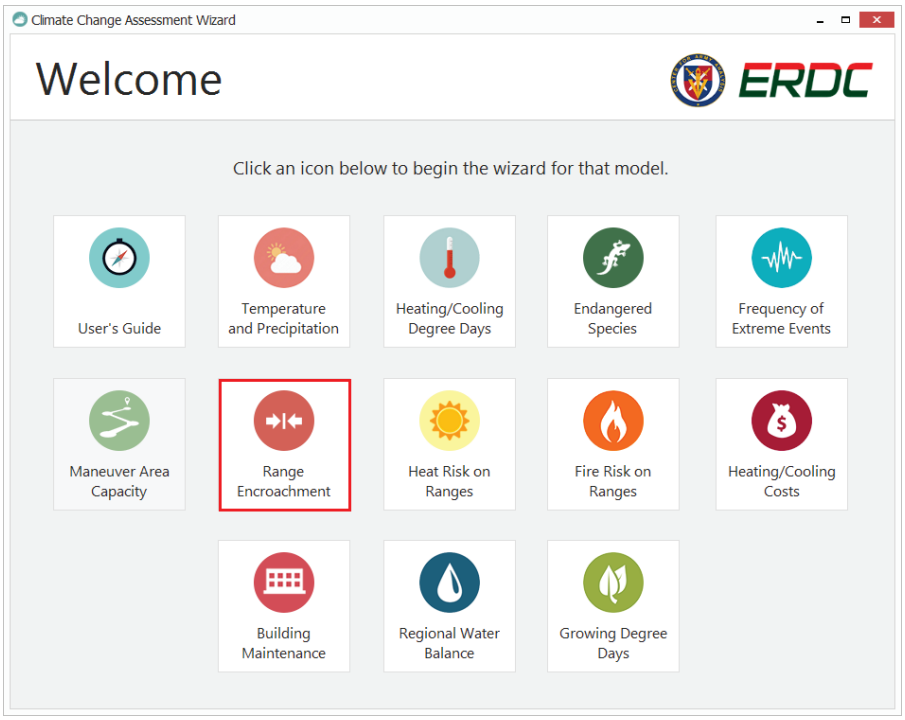
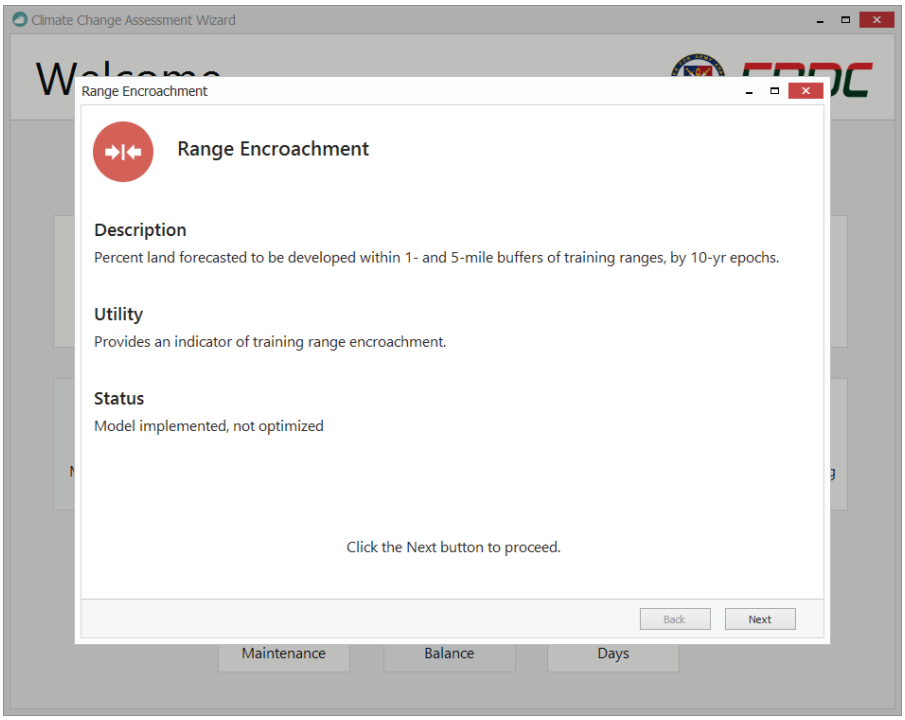


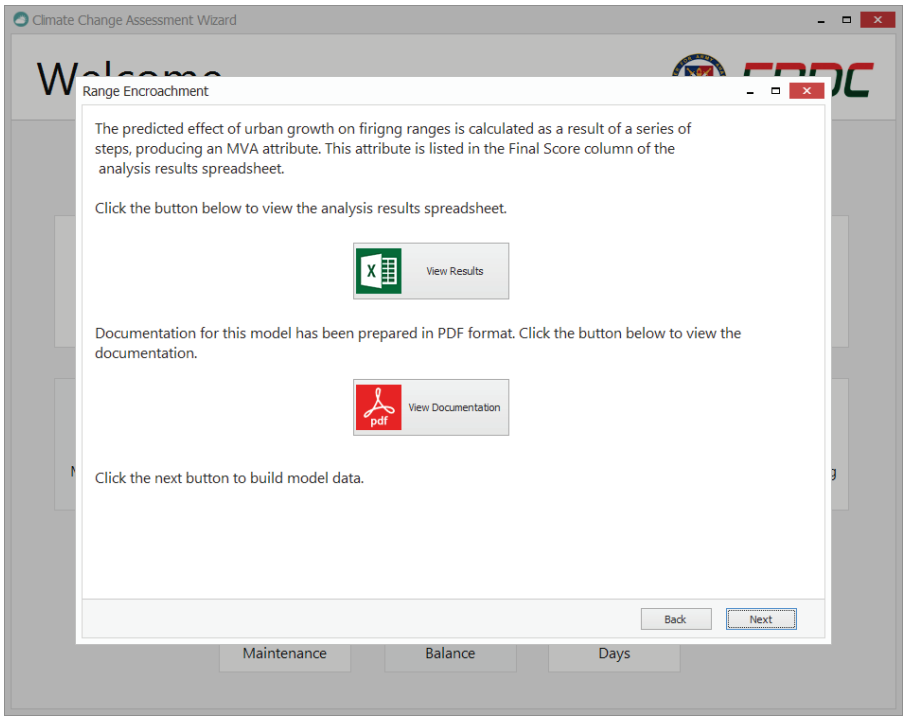
Figure 3. Range Encroachment Model first screen.



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 1. Online data sources.

Data	Source
Army Installations	Army Mapper Program (http://mapper.army.mil/).
Training Areas	Sustainable Range Program can be found at: https://srp.army.mil/
Digital Elevation Model	(http://viewer.nationalmap.gov)
Landcover map	(http://www.mrlc.gov/).
Roads	(http://viewer.nationalmap.gov/).
Flood Hazard	HIFLD@hq.dhs.gov or by calling (202) 282-9541
Protected Areas	http://gapanalysis.usgs.gov/padus/data/download/
ACUB	http://www.aec.army.mil/Services/Conserve/ArmyCompatibleUseBufferProgram.aspx.
LandScan Data	HIFLD@hq.dhs.gov or by calling (202) 282-9541

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).

Figure 5. Launch buttons on the third model screen within the Wizard.

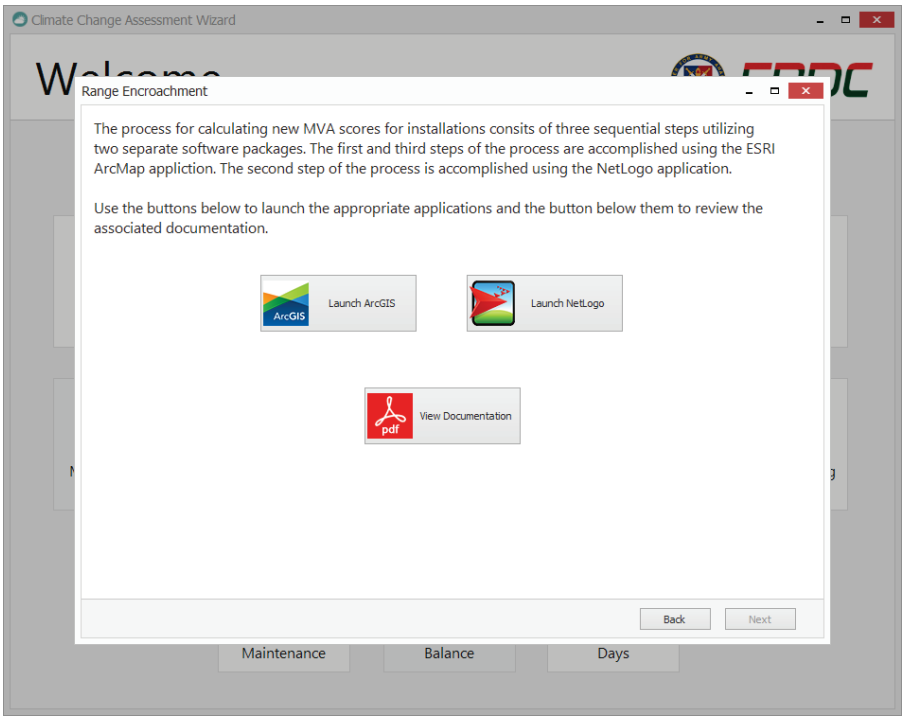
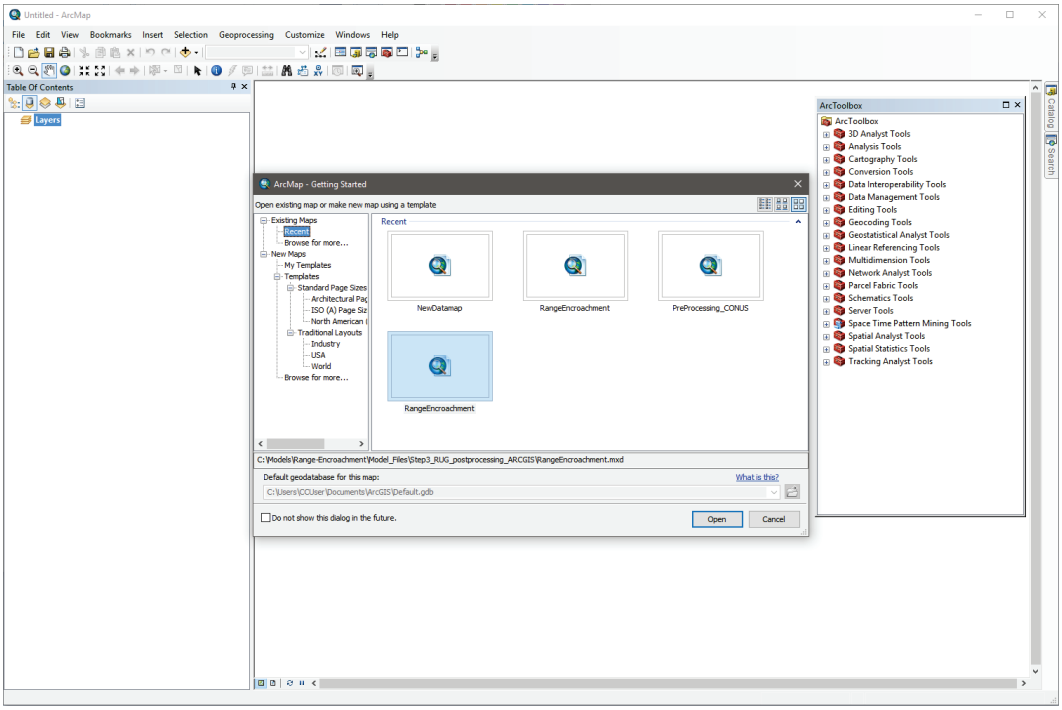


Figure 6. ESRI ArcMap application.



After opening ArcMap, open the range encroachment data preprocessing project by selecting `File->Open and browse to the file C:\Models\Range-`

`Encroachment\Model_Files\Step1_RUG_preprocessing_ARCGIS\PreProcessing_CONUS.mxd` (or `PreProcessing_ALASKA.mxd` if analysis of Alaska is desired). This file may also be in the *Recent* list as seen in Figure 8.

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 Net Logo.

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).

Figure 7. Run command prompt as administrator.

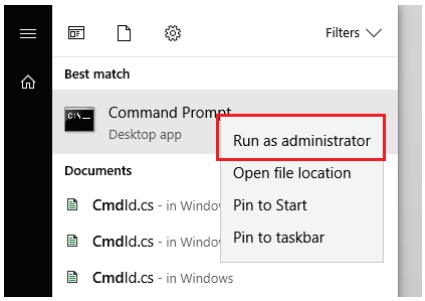
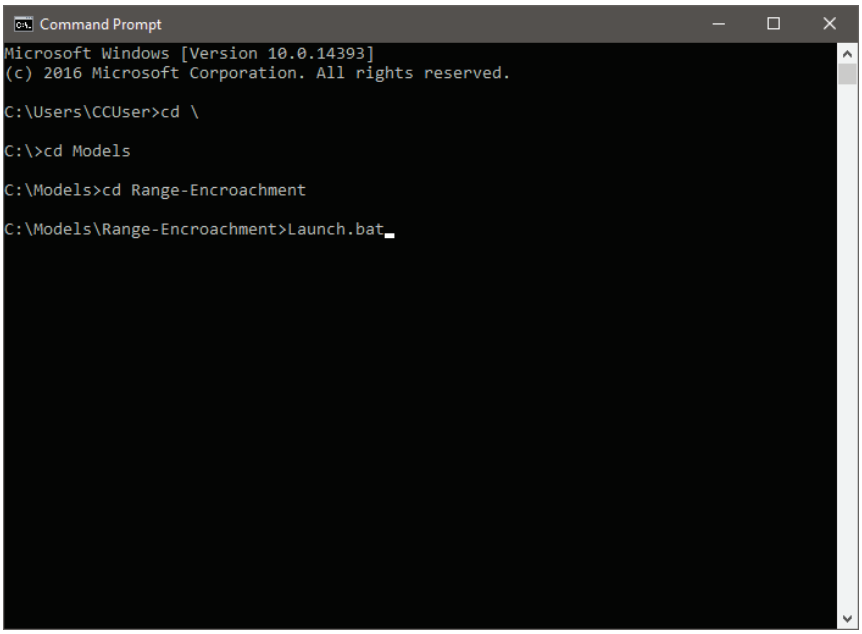


Figure 8. Command prompt window with Launch.bat command.



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).

Figure 9. NetLogo with model file loaded.

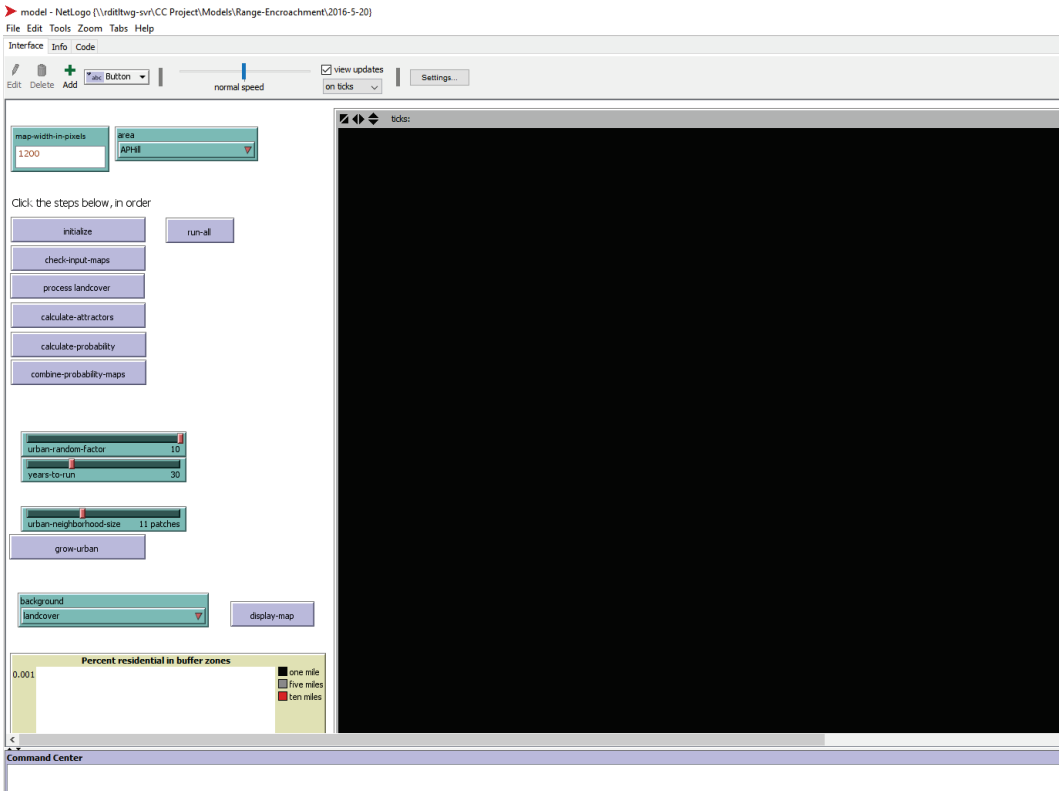
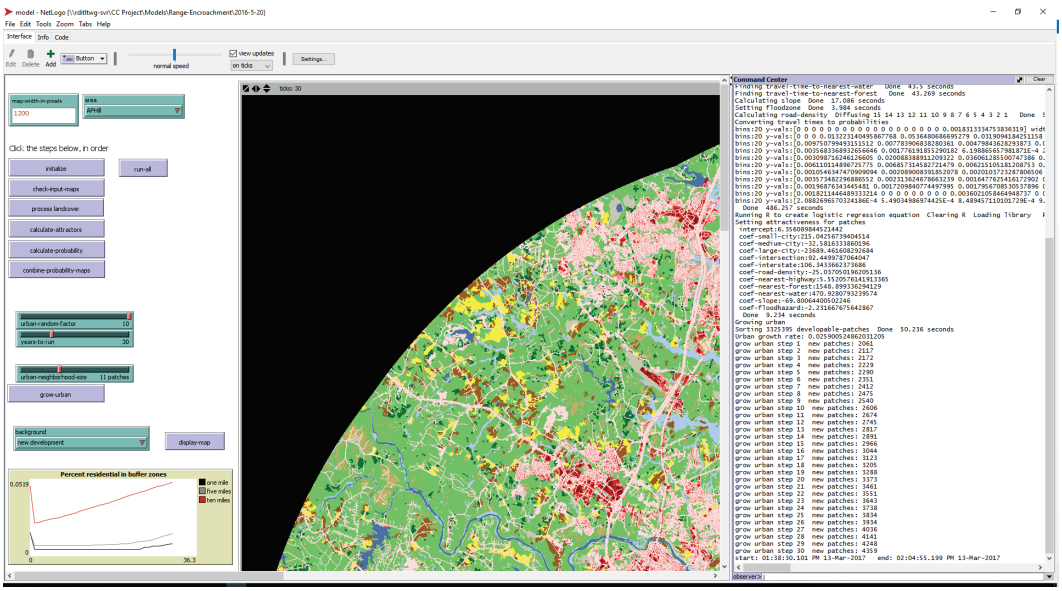


Figure 10. NetLogo with model execution complete.



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.

Final_score

A	B	C	D	E	F	G	H	I	J	K	L	M
UECT	INSTALL	Growth_1mile	Growth_5mile	Growth_10mile	Pop_Den5	Pop_Den1	Pop_Den10	Final_score	?Dev_100FP_Year	?Dev_100FP_Year2	?Dev_500FP_Year	?Dev_500FP_Year2
1	Aphill	0.09	0.09	0.59	0.07	0.12	0.35	1.32	21.58578626	8.194112967	6.463317836	11.94579884
2	Benning	1.73	0.51	0.98	0.26	0.38	0.61	4.46	16.74608023	5.567094278	7.58422365	16.93937353
3	Bliss	0.72	0.42	1.56	0.27	0.42	0.74	4.13	0	0	39.65568418	47.46215494
4	Bragg	0.40	0.29	0.73	0.31	0.41	0.77	2.92	6.990478486	4.821019646	4.343000141	6.948396601
5	Campbell	0.16	0.19	0.58	0.14	0.08	0.39	1.54	4.798906836	0.760727688	1.906439989	6.820959728
6	Carson	0.57	0.34	0.64	0.17	0.11	0.59	2.42	30.34013605	15.10204082	24.34291329	37.87767133
7	Dix	0.59	0.44	1.70	0.23	0.48	0.82	4.26	21.27487625	16.50671785	23.0246966	26.07570228
8	Drum	0.19	0.10	0.33	0.05	0.07	0.16	0.91	8.47107438	2.685950413	2.808988764	7.784911717
9	Hood	1.93	1.00	2.00	0.33	0.44	0.75	6.46	9.5253347	1.287553648	1.592251311	10.95825855
10	Huachuca	0.32	0.14	0.65	0.17	0.67	0.28	2.23	24.55977757	21.68674699	12.25895317	21.78276269
11	Irwin	0.09	0.05	0.14	0.00	0.00	0.00	0.27	6.694356218	0.537503054	16.49565904	19.16929755
12	Jackson	2.00	0.53	1.19	0.86	1.86	1.70	8.13	12.28481479	3.565766852	6.219701573	13.91803389
13	Knox	0.32	0.25	0.48	0.21	0.44	0.58	2.29	15.49588223	6.000513263	19.4779233	26.89829951
14	Leonardwood	0.29	0.19	0.22	0.06	0.11	0.12	0.99	4.266055046	1.077981651	1.814807177	5.526912766
15	Lewis	1.00	0.49	1.00	0.64	0.97	1.76	5.87	8.557951482	1.752021563	3.979143798	8.850164654
16	Polk	0.08	0.04	0.12	0.03	0.03	0.09	0.39	2.757212152	2.757212152	2.553044678	2.553044678
17	Richardson	1.28	0.62	1.20	1.00	2.00	2.00	8.10	17.38030714	2.547425474	3.636963696	19.22112211
18	Riley	1.14	0.37	0.49	0.13	0.23	0.27	2.63	3.757058891	2.054281434	5.091032264	8.175120671
19	Rucker	0.31	0.13	0.22	0.14	0.24	0.29	1.32	4.893841289	1.039000151	4.609869111	7.427199242
20	Sill	1.05	0.40	0.52	0.20	0.49	0.36	3.02	14.21147763	4.665612291	6.926367935	16.02792164
21	Stewart	0.95	0.67	1.63	0.14	0.07	0.40	3.86	18.82456916	8.197083517	6.123198384	11.55274029
22	Wainright	0.00	0.00	0.00	0.06	0.08	0.14	0.28	0.59473549	0.587393076	13.63964519	14.47895601

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.

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Reference

Garton, B. M. 2019. *Analytical model software integration methods*. ERDC/ITL SR-19-4. Vicksburg, MS: U.S. Engineer Research and Development Center.

Appendix A: Acronyms and Abbreviations

Term	Definition
ASCII	American Standard Code for Information Interchange
CSV	Comma Separated Values
CONUS	Continental United States
DoD	Department of Defense
ERDC	Engineer Research and Development Center
ERDC-CERL	Engineer Research and Development Center-Construction Engineering Research Laboratory
ERDC-ITL	Engineer Research and Development Center-Information Technology Laboratory
GB	Gigabytes
GCM	Global Circulation Model
MVA	Military Value Analysis
NSN	National Supply Number
OMB	Office of Management and Budget
PM	Program Manager
RAM	Random Access Memory
RCP	Representative Concentration Pathway
RUG	Regional Urban Growth
SAR	Same As Report

SF	Standard Form
TB	Terabyte
USGS	U.S. Geological Survey
VM	Virtual Machine

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13. SUPPLEMENTARY NOTES

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.

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15. SUBJECT TERMS

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Cities and towns--Growth
Land use--Planning

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