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Range Days Lost to Fire Risk Model User's Guide

Byron M. Garton

July 2019

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Range Days Lost to Fire Risk 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.

Prepared for Headquarters, U.S. Army Corps of Engineers
Washington, DC 20314-1000

Under Project 402188 Integrated Climate Assessment for Army Enterprise Planning

Abstract

Maintaining and increasing the capacity to perform live fire training exercises on Department of Defense (DoD) lands is essential to future force readiness and effectiveness. The risk of fire on ranges as a potential result of climate change is one factor affecting the availability of training areas. Assessing the impact of future climate change is an essential part of ensuring future availability of live fire ranges.

This document describes the process of executing the Range Days Lost to Fire Risk 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

The Range Days Lost to Fire Risk Model attempts to predict the likelihood of fires on ranges by calculating a Keetch–Byram drought index (KBDI) for each installation included in the study (USFS-WFAS 2017). The KBDI was devised based on mathematical models for predicting the likelihood of wildfires based on soil moisture and other conditions related to drought. The KBDI is a soil/duff drought index that ranges from 0 (no drought) to 800 (extreme drought) and is based on the soil capacity in 8 inches (200 mm) of water (USFS-WFAS 2017). The depth of soil required to hold 8 inches of moisture varies. A prolonged drought (high KBDI) influences fire intensity largely because fuels have a lower moisture content (USFS-WFAS 2017).

1.2 Purpose

High risk of fire on ranges effects the availability of training areas. Maintaining and increasing the capacity to perform live fire training exercises on Department of Defense (DoD) lands is essential to future force readiness and effectiveness. Assessing the impact of future climate change is an essential part of ensuring future availability of live fire ranges. The predicted effect of climate change on range fire risk is intended to be utilized in other force stationing analysis applications as a Military Value Analysis (MVA) attribute.

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 reference section.

Executing the model is a two-step process that requires using Python IDLE development environment, MS Excel®, and a basic text editor such as MS

Notepad®. 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 Days Lost to Fire Risk Model include the Python IDLE development environment, a basic text editor such as MS Notepad®, and MS Excel® version 2013 or higher.

A working knowledge of Microsoft Office products is recommended as well as a basic understanding of editing file paths in a text file and executing Python code within the IDLE environment.

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 Days Lost to Fire Risk Model icon.

Figure 3. Range Days Lost to Fire Risk Model first screen.

The second screen within the model (Figure 4) allows the end user to view the datasets in graphical or tabular mode. Users can choose the desired view type from the *View* drop down combo box. Options within this box

are *Graphs* and *Tabular*. Graphs displays the data as standard line graphs while Tabular displays the data in a table layout within an MS Excel® spreadsheet.

Figure 4. Range Days Lost to Fire Risk Model second screen.

CC Wizard

Welcome

Range Days Lost to Fire Risk

This model calculates a Keetch-Byram Drought Index (KBDI) to indicated potential fire risk. KBDI is an index developed to determining forest fire potential.

Predicted temperature and precipitation values are available for several GCMs (Global Climate Models) and RCPs (Representative Concentration Pathways).

Two data view types are also available. You may view the raw KBDI values in tabular form, or you may view the data on a series of graphs. First choose a view type below to populate the Model drop down then choose a model.

View

GCM

Documentation for this model has been prepared in PDF format. Click the button below to view the documentation.

New KBDI data may be processed as well. Click next to start this process.

Maintenance Balance Days

Next, choose a General Circulation Model (GCM) and Representative Concentration Pathway (RCP) type from the drop down combo box to filter only data related to that GCM/RCP. At the time of this publication, there are ten GCMs within the dataset for this model. RCP 2.6, 4.5, and 8.5 were chosen to represent lower bound, middle, and upper bounds for each GCM. Each GCM contains these RCPs, with the exception of CNRM-CM-5 and GFDL-CM3.

Once both of the choices are made, click the *View Data* button to launch the chart viewer window (Figure 5).

Figure 5. Results in the chart viewer window.

The average number of days in four different fire risk categories are plotted as line graphs with the number of days charted on the Y-axis, and 10-year epochs are charted on the X-axis. The user can change the charted values by choosing a different geographical location from the drop down combo box near the bottom left of the window (Figure 5). Upon selecting a location, the data will automatically filter to include only those values found within the chosen area. Table 1 lists and describes each of the four fire risk (KBDI) categories.

Table 1. KBDI fire risk categories (USFS-WFAS 2017).

Category	Fire Danger Condition	Expected Fire Behavior	Training Restrictions	Fire-Fighting Detail Requirements	Derived KBDI*
1	GREEN	Fires are difficult to start and do not burn with vigor. Fires can easily be controlled using direct attack.	None.	None.	0-300
2	AMBER	Fires start easily and may burn quickly through grass and shrub fuels. Fires can be controlled using direct attack, but in some circumstances may require indirect attack methods.	No aerial flares outside the live-fire training areas. Pyrotechnics must be used on roadways, tank trails, or barren areas.	None.	300-600
3	RED	Fires start easily, move quickly, burn intensely, and may be difficult to control.	No pyrotechnics, incendiary munitions, tracers.	10-person fire-fighting detail required. On-call helicopter required on 20-minute standby.	600-750
4	BLACK	Fires start very easily and are impossible to control.	No live-fire training. No pyrotechnics. Non-live-fire training must be authorized by the Senior Mission Commander.	None.	750-800

Charts can be saved to the user's computer by clicking the *Save Image* button near the bottom right of the window (Figure 5). The resulting file is saved to a location of the user's choosing in the universal Joint Photographic Experts Group (JPEG) image file format.

3 Building New Data

Building new datasets is not possible within the Wizard interface but can be accomplished within the VM by running a Python Script from the Python IDLE development environment. The following instructions should be followed carefully to produce new data from this model.

The Python IDLE development environment is pre-installed inside the VM, and may be launched automatically from the Wizard application or accessed from the Windows Start menu (Figure 6 and Figure 7).

Figure 6. Launch Python IDLE from the third model screen within the Wizard.

Figure 7. Python IDLE development environment.

After opening IDLE, open the Python script by selecting File->Open and browse to the file `C:\Models\Shared-Data\Model\heat-fire risk days climate projections.py`. Once the file is loaded, please ensure line 19 points to a text file that contains a list of GCMs to process. This file has been pre-made, so no adjustments to it should be necessary, unless new GCMs are to be processed. The file location is `C:\Models\Data-2\GCM Model Runs.txt`. Use a text editor such as Microsoft Notepad to make modifications to this file. Also note that daily climate data from the Temperature and Precipitation Model must be processed prior to running this Fire Risk on Ranges Model. Refer to lines 16–18 for the file paths. If new climate data is to be processed, the files that are output from the Temperature and Precipitation Model must be located in the same prior directory, or lines 16–18 must be modified to match the location of the output files. Refer to the user's guide for that model for more information about its output files.

Output from this model is in the form of Comma Separated Values (CSV) files, one for each GCM/RCP combination. Please note that this process can be rather lengthy, depending on the number of GCMs that are being processed. It is not unusual for the script to run for several hours.

After running the Python script, another post processing script must be run. Locate the EXE file in the model folder within virtual machine. (`C:\Models\Shared-Data\DataFixer.exe`). Set the input and

output paths by clicking the *Change* buttons. Ensure that the output folder that's entered exists before starting the process. Finally, click *Fix It* to process the data (Figure 8).

Figure 8. Data Fixer tool.

Post processing the data is fairly quick. It should not take more than a couple of minutes to complete. After this step, the data is ready to be viewed within the Wizard application. The post processing app source code is located at `C:\Models\VS Projects\DataFixerHeatFire`.

4 Known Issues and Limitations

The KBDI is a measure of meteorological drought and reflects water gain or loss within the soil (USFS-WFAS 2017). It does not measure fuel moisture levels in the 1–10-hour fuel classes, which must be measured by other means for an accurate assessment of fuel moisture regardless of the drought index readings.

Building new data with this model can be a very lengthy process. Depending on the number of GCMs being processed, it's not unusual for the Python script 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

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Appendix A: Acronyms and Abbreviations

Term	Definition
CSV	Comma Separated Values
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
GCM	Global Circulation Model
JPEG	Joint Photographic Experts Group
KBDI	Keetch–Byram Drought Index
MVA	Military Value Analysis
NSN	National Supply Number
OMB	Office of Management and Budget
PM	Program Manager
RCP	Representative Concentration Pathway
SAR	Same As Report
USFS	U.S. Forest Service
VM	Virtual Machine
WFAS	Wildland Fire Assessment System

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing this collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden to Department of Defense, Washington Headquarters Services, Directorate for Information Operations and Reports (0704-0188), 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to any penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number. **PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ADDRESS.**

1. REPORT DATE (DD-MM-YYYY) July 2019			2. REPORT TYPE Final		3. DATES COVERED (From - To)	
4. TITLE AND SUBTITLE Range Days Lost to Fire Risk Model User's Guide					5a. CONTRACT NUMBER	
					5b. GRANT NUMBER	
					5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S) Byron M. Garton					5d. PROJECT NUMBER 402188	
					5e. TASK NUMBER	
					5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Information Technology Laboratory U.S. Army Engineer Research and Development Center 3909 Halls Ferry Road Vicksburg, MS 39180					8. PERFORMING ORGANIZATION REPORT NUMBER ERDC/ITL SR-19-7	
9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES) Headquarters, U.S. Army Corps of Engineers Washington, DC 20314-1000					10. SPONSOR/MONITOR'S ACRONYM(S)	
					11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION / AVAILABILITY STATEMENT Approved for public release; distribution is unlimited.						
13. SUPPLEMENTARY NOTES						
14. ABSTRACT Maintaining and increasing the capacity to perform live fire training exercises on Department of Defense (DoD) lands is essential to future force readiness and effectiveness. The risk of fire on ranges as a potential result of climate change is one factor affecting the availability of training areas. Assessing the impact of future climate change is an essential part of ensuring future availability of live fire ranges. This document describes the process of executing the Range Days Lost to Fire Risk 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 Bombing and gunnery ranges Rifle-ranges		Fire risk assessment Climatic changes--Risk assessment	
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT SAR	18. NUMBER OF PAGES 22	19a. NAME OF RESPONSIBLE PERSON	
a. REPORT Unclassified	b. ABSTRACT Unclassified	c. THIS PAGE Unclassified			19b. TELEPHONE NUMBER (include area code)	