Proof of Concept of The Range Ignition Probability(RIP) Tool

Project # 07-374

Background:

The past two decades have seen increasingly large and violent wildfires and this is expected to continue into the foreseeable future. Incendiary munitions, increasing range use, a disproportionate rate of rare species presence, and fire promoting invasive species outbreaks make military installations particularly vulnerable to this trend. Assessing wildfire risk and determining best management practices requires accurate information about where fires are likely to start as ignition location can make a dramatic difference in fire outcomes. Actual ignition location data from years of training is the ideal, but in the vast majority of cases this is not available. The RIP Tool is designed to fill this information gap.

Objective:

The RIP Tool's purpose is to accurately identify the spatial probability of any given location experiencing a military training related ignition. For this proof of concept, we focused on small arms tracer ammunition as these are responsible for a large portion of military ignited fires. Future efforts will include modeling capabilities for a wide variety of small arms, tank, mortar, artillery, and possibly small rockets.

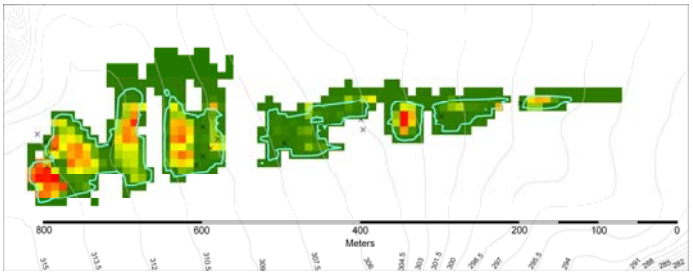
Summary of Approach:

We partnered with the Army Research, Development, and Engineering Center at Picatinny Arsenal in New Jersey to modify their ballistics models for use in the RIP Tool. The RIP Tool is based on a probabilistic surface danger zone (SDZ) methodology developed by Picatinny arsenal which considers a wide variety of physical parameters as well as aimer error. It is coupled with a robust ricochet model based on laboratory and field experiments to determine ricochet probability and trajectory. This model is capable of simulating SDZ's for stationary and moving targets as well as baffled ranges.

The RIP Tool adds an additional piece of information denoting the status of the tracer compound when the round impacts the surface. We modified Picatinny's model so that rounds are not counted in the probability calculations if they impact after the tracer burns out.

We tested the RIP Tool under increasingly complex situations on a hypothetical flat range to minimize sources of error. We then applied the RIP Tool to a real-world live-fire range using engineering drawings and engineering grade elevation point data.

The RIP Tool can produce both probability contours (similar to SDZ's) and grid output (below). Probability contours are useful for quickly identifying areas at risk while grid outputs are useful when more detailed information about the distribution of ignitions is desired.



The 1:1,000,000 RIP Tool probability contour (light blue line) compared to grid output for one lane on the MF-2 range at Schofield Barracks, Hawaii. The grid data ranges from low probability of ignition (green) to high probability (red). Grid data outside of the contour has a probability of less than 1:1,000,000.

Benefits:

The RIP Tool will first be utilized by the U.S. Army, Hawaii where high value natural resources exist in close proximity to live fire ranges. Damage to these resources from past fires has resulted in restrictions on the use of ranges and mitigation costs well into the millions of dollars per year. A portion of the mitigation costs are directly related to simulations of wildfires, which depend in part on an assessment of where ignitions are likely to occur. The standard bat wing SDZ is currently used by regulatory agencies for this purpose in Hawaii.

The RIP Tool provides a much more realistic estimation of where fires are likely to occur. Our real-world tests at Schofield Barracks revealed that the RIP Tool output for 5.56 mm ammunition was roughly 4% the size of the bat wing SDZ, a drastic reduction. Similar reductions for other ranges can be expected. Using the RIP Tool, the area considered at risk of ignition can be reduced, possibly by 90% or more. Additionally, the grid outputs allow further refinement of the ignition risk by demonstrating that ignitions are much more likely in the center of the ranges.

The RIP Tool has numerous applications. We foresee outputs from a fully-functional RIP Tool being used as an input to fire risk assessments, such as in the example

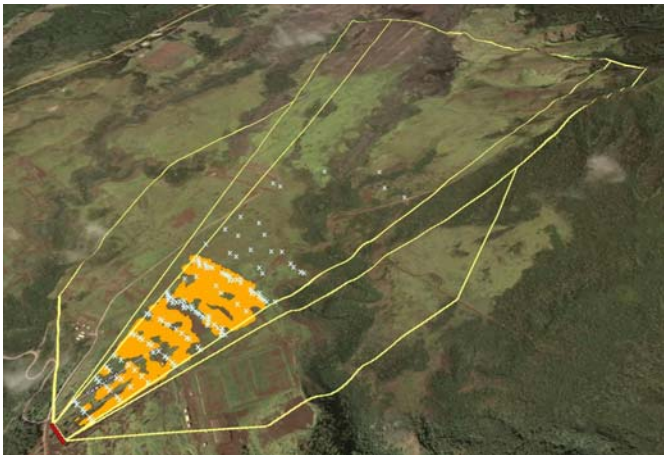
Proof of Concept of The Range Ignition Probability(RIP) Tool

Project # 07-374

above. Determining where ignitions should be placed on the landscape is often one of the most difficult parts of assessing fire risk. In this application, RIP Tool outputs are used to create very realistic ignition inputs into wildfire simulators, such as the commonly used Fire Area Simulator (FARSITE). These simulations and assessments are invaluable for wildfire management planning and determining where firebreaks and wildfire fuel treatments will be most effective.

Range Planners can use the RIP Tool to easily visualize where ignitions are likely and adjust their planning accordingly. By including fire mitigation in the range planning process, the potential for unintended ignitions and wildfires can be mitigated before they ever become a problem. As a result, installations can expect a lower incidence of fires in unexpected or sensitive locations and higher success rates in containing fires.

Finally, grid outputs from the RIP Tool can provide a better visual reference than the more abstract and homogenous idea of an SDZ for use when consulting with regulatory agencies, in environmental documentation, or at public meetings. Because the grid output represents the spectrum of ignition probabilities throughout the range, the task of explaining that ignitions are much more likely to occur near the targets and in the center of the range is greatly simplified.



Real-world test of the prototype RIP Tool on the MF-2 Range at Schofield Barracks, Hawaii for 5.56 mm M856 tracer ammunition. The area affected by potential ignitions according to the RIP Tool (orange) is 3.2% of the size of the bat wing SDZ (yellow line). Red points are firing points and X's are targets.

Accomplishments:

This proof of concept clearly demonstrates the feasibility of designing and implementing a tool to predict the spatial distribution of military munitions ignitions. A fully-functional RIP Tool, including a user interface, is under development. The finished RIP Tool will allow spatial ignition prediction for the following munitions:

- 5.56 and 7.62 mm Tracer
- .50 Caliber Tracer
- 40 mm Grenade
- 60 mm, 81 mm and 120 mm Mortar - HE, Smoke, Illumination
- 105 mm Artillery - HE, Smoke, Illumination
- 155 mm Artillery - HE, White Phosphorous, Smoke, Illumination
- 105 mm and 120 mm Tank/Stryker - HE
- 2.75" Rocket (pending available ricochet data)

Upon completion of the RIP Tool in fall 2010, it will be submitted for inclusion in the Range Manager's Toolkit.

Contact Information:

Andrew M. Beavers
Fire Ecology and Management Specialist
CEMML, Colorado State University
1490 Campus Delivery
Fort Collins, CO 80523-1490
Phone: 970-491-1005
Fax: 970-491-2713
Email: Andrew.Beavers@colostate.edu