

INTRODUCTION & BACKGROUND

Math is the basis of everything and can be a formula, which can be accurately modeled. From the air dispersion of smallpox over a major metropolis on a specific day at a specified time, to the paradoxical relationship between probability and a game show, all things can be, to some degree of accuracy, predicted and modeled. This modeling effort is the mission of the men and women of the United States Army Chemical and Biological Center. The predictive analysis conducted by those at the CBC provides vital protection to all Americans.

In Math Modeling:

- Formulas, descriptions, and approaches represent real systems and occurrences
- More variables, assumptions, and occurrences are used to solve complex problems
- Professionals examine, predict, and analyze behavior and events

MATERIALS AND METHODS

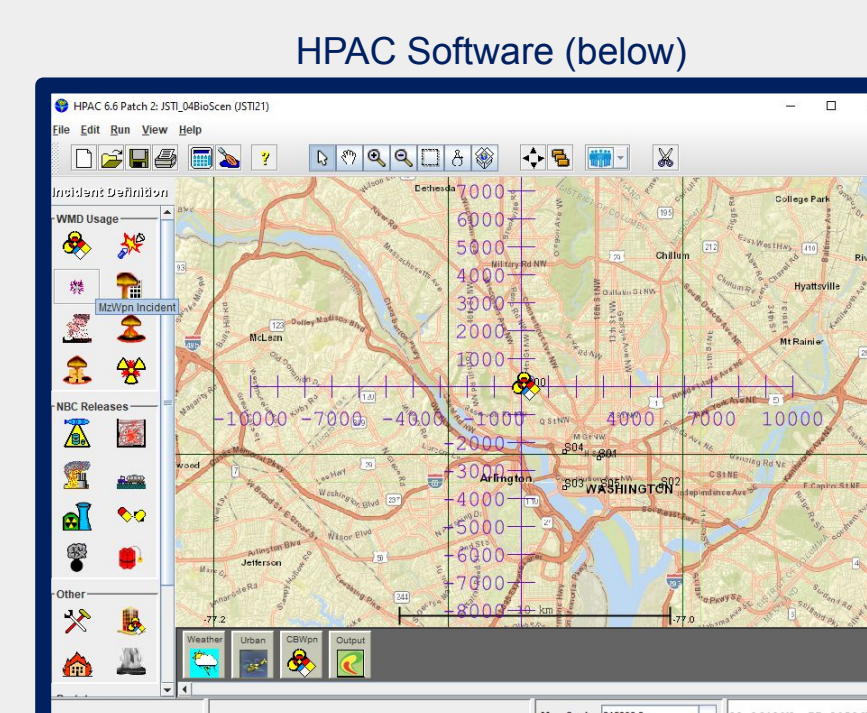
1. Hazard Prediction and Assessment Capability (HPAC)

Materials:

- laptop
- HPAC software
 - developed by DTRA in order to provide quick assessment of Chemical, Biological, Radiological, and Nuclear (CBRN) threats
- notepad
- Google map

Methods:

- navigated and simulated an attack on Washington DC
- discussed and analyzed possible impacts of such an attack.



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## (above) R Language Inputs to develop Graph A
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(above) R Language
Inputs to develop Graph A

2. Statapult Materials and Methods

Materials:

- Statapult
- Rubber bands and balls
- SigmaZone Online Digital Statapult Simulator
- random target

Methods:

- predict the statapult behavior
- compared the prediction to data collected using the physical statapults

3. R Simulation

Materials:

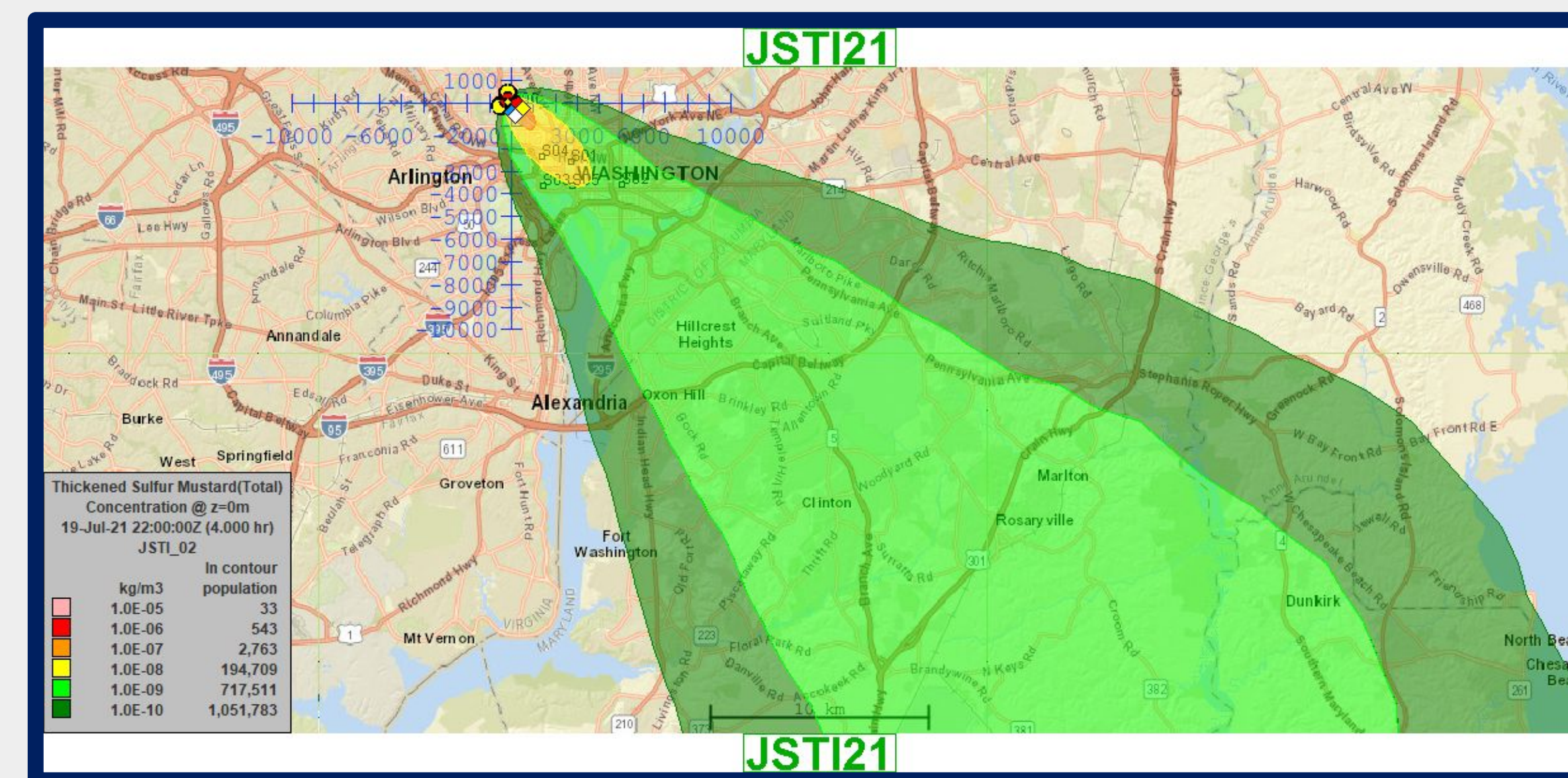
- laptop
- R programming
- Notepad application

Methods:

- notepad used to track inputs in R
- modeled hidden object counting
- perform statistical calculations
- create graphs

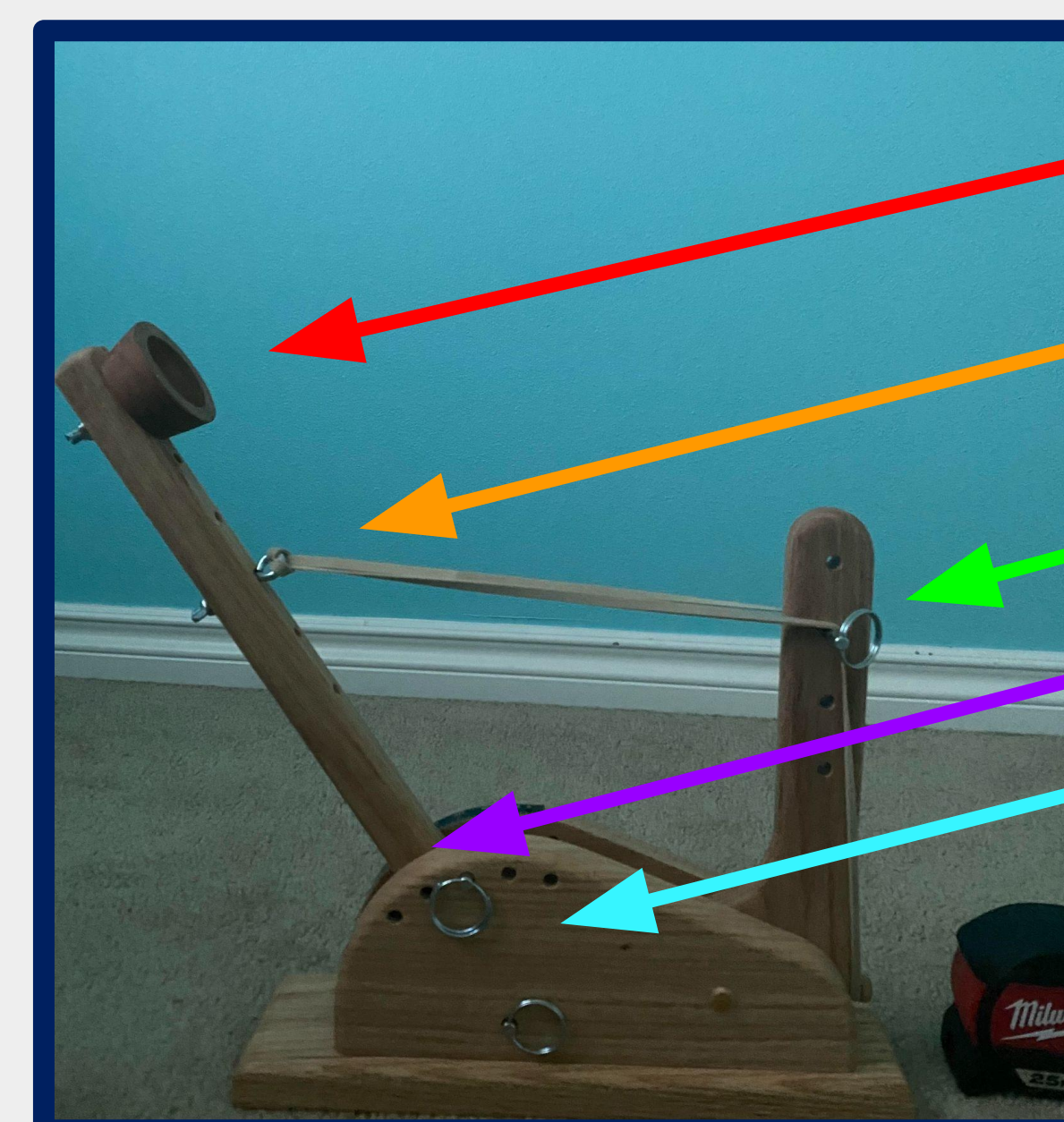
RESULTS

With HPAC, a thickened sulfur mustard (THD) chemical attack on Washington D.C. was modeled and the diagram exemplifies ways to optimize the spread of the attack, and predict what would happen as a result of the attack.



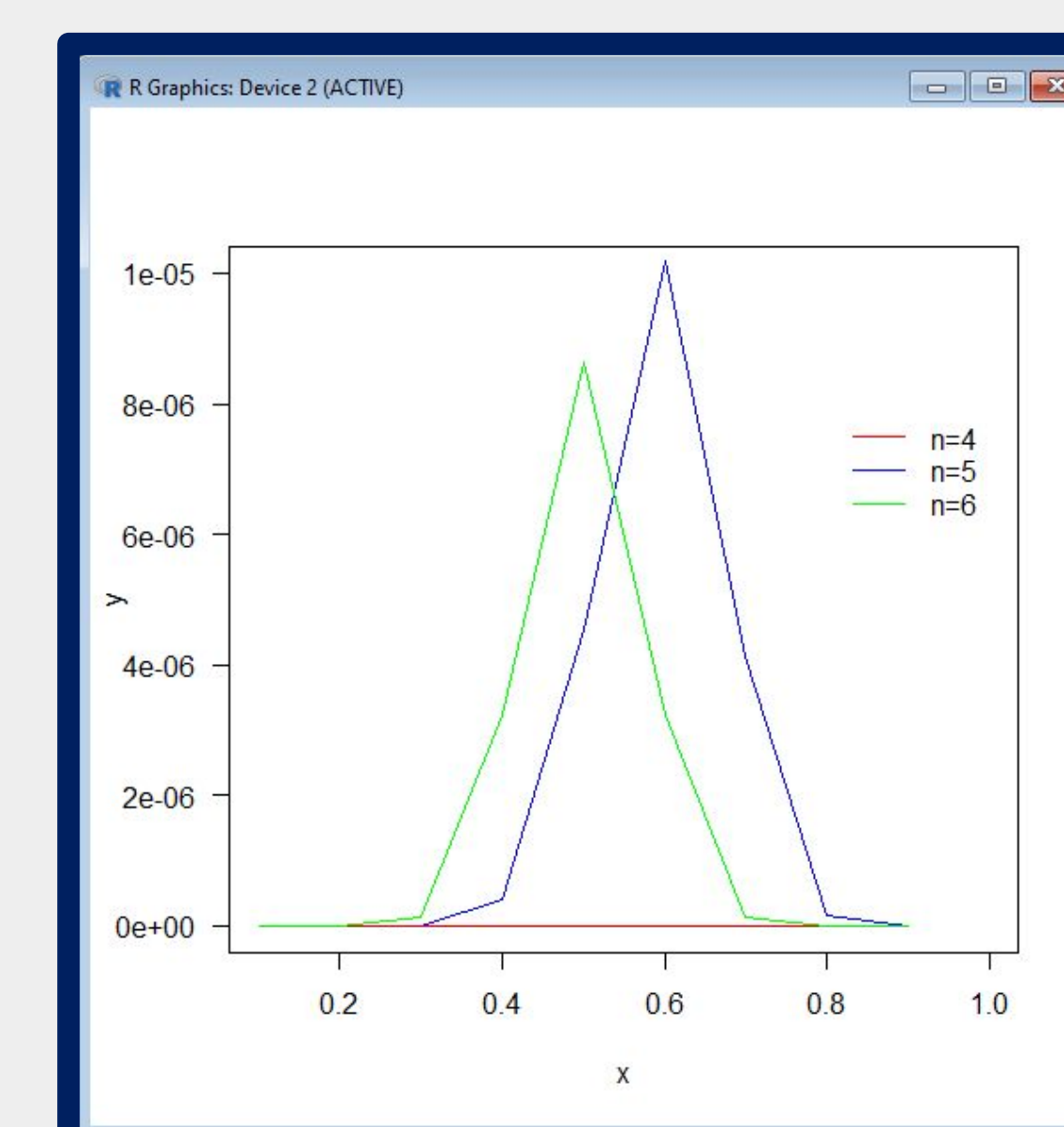
A contour map depicting the concentration of a Thickened Sulfur Mustard chemical attack on Washington, DC

The research group also ran several iterations of a test launching a ball to a target that was 91 inches away. The optimum settings for the statapult to hit targets at that distance were determined through both physical and digital tests. The results are shown below.



LEGEND

- Cup Position
- Bungee Position
- Pin Elevation
- Firing Angle
- Release Angle



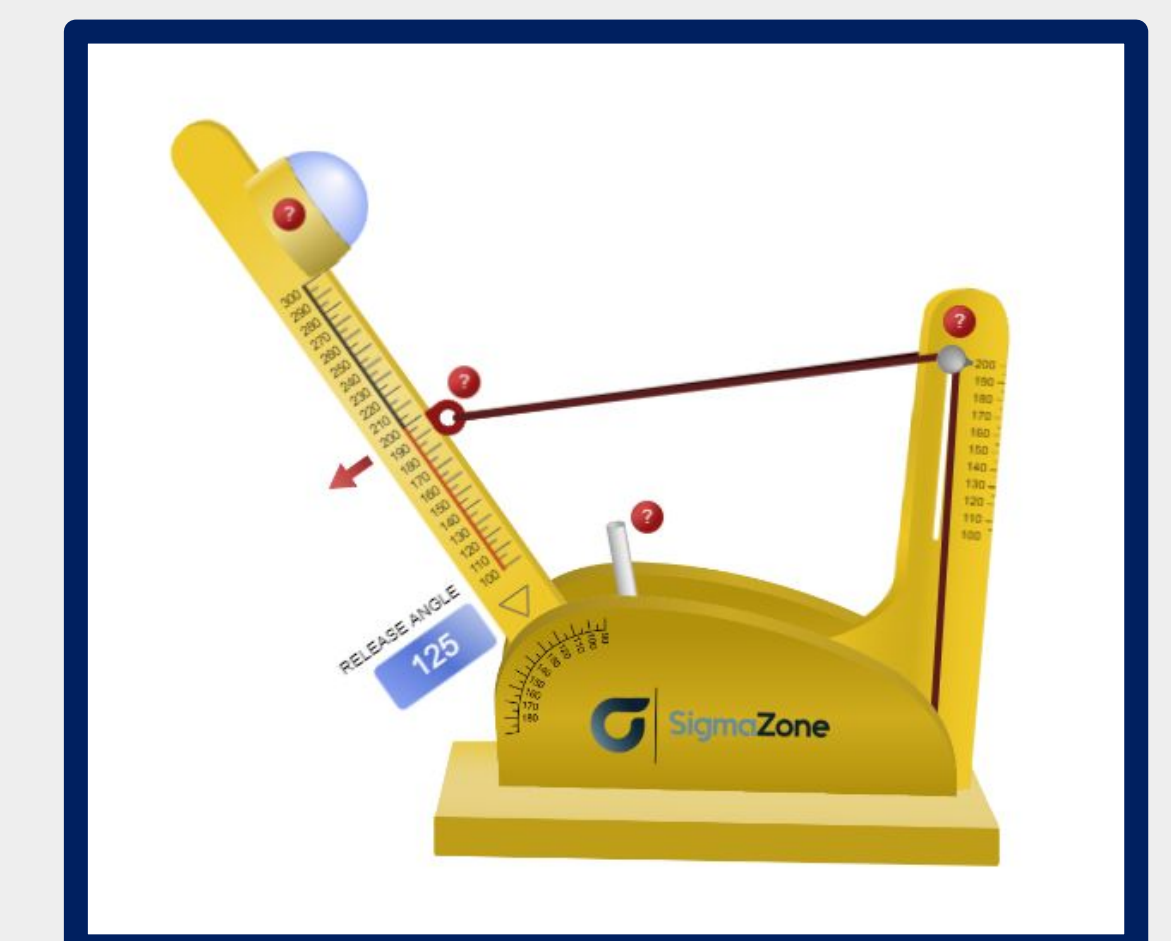
Graph A composed in R
showing possible populations

CONCLUSIONS

Throughout the past two weeks the research group learned probability and statistics skills, as well as how to utilize online simulations to represent real life scenarios. Researchers began with Excel functions, used to calculate basic probability and unit conversions, and worked up to simulating real life scenarios using HPAC and R. Although these projects cover a wide range of subjects and disciplines, they all use mathematical formulas and simulation to predict an answer.

Statapult- Individual variables altered the outcome of a physical system. These principles could be used to:

- Fire modern weapons
- Calculate rocket launches



Digital Statapult Simulator

Tabun(Total)		
Concentration @ z=0m		
20-Jul-21 05:29:00Z (1.250 hr)		
	kg/m3	In contour population
	1.0E-06	49
	1.0E-07	329
	1.0E-08	16,361
	1.0E-09	66,260
	1.0E-10	102,337
	1.0E-11	137,156

HPAC legend shows affected population

Using these statistical models, the group has been able to illustrate the efficacy of models and simulations in analyzing the effects and impacts of defense related scenarios.

HPAC- Defense research with modeling and simulation systems can increase preparedness and awareness of CBRN and industrial incidents, thus mitigating future severity and lethality of disasters.

ACKNOWLEDGEMENTS

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