Be Steady and Popular

A Modern Counter-insurgency ABM

Yicheng Shen

April 26, 2022

1. Introduction

Insurgency wars, similar to any other forms of warfare, have long been part of human society and played a significant role in shaping politics around the globe. Despite the fact that many of the goals and forms of insurgent behaviors have changed over time, the structure and functions of modern insurgency wars remain strongly consistent with the recent past (Sepp, 2005). Therefore, although one cannot confidently assume that insurgent activities of the same magnitude will always recur under the same conditions, examining simulated counter-insurgency scenarios is able to present valuable insights about how potential operations are likely to develop and how much damage that future insurgency may incur.

Due to the sheer difference in sizes and strengths of the opposing parties, insurgency wars are often characterized as asymmetrical warfare. As Manwaring (2020) points out, "victory in any kind of war, including insurgencies, is not simply the sum of the battles won over the course of a conflict." The side equipped with superior technologies and resources in insurgency conflicts is often more concerned with the costs of operations and collateral damages rather than winning battles (Shaver & Shapiro, 2021). Therefore, the outcomes of suppressing even poorly armed insurgency are variable. THe staggering social, economic and political problems and protracted conflicts arising from mounting casualties are often the direct thrust pressuring the governments or intervening forces to forgo strategic objectives (Eikenberry, 2013).

Inspired by Wheeler's study in understanding the interactions during peacekeeping operations, this paper focuses on short-term, small-scale counter-insurgency (CT) operations taking place across populated suburban and rural regions. The project relies on an agent-based approach to develop models and simulate scenarios. The results have both strengthened previous studies and pointed out new directions for more comprehensive and realistic CT models.

2. Literature

The study of behavior and actions of insurgent systems have facilitated modern U.S. implementation of counter-insurgency programs since the Vietnam war (Wolf, 1965). As the United States declared and gradually escalated its War on Terror in the early 2000s, counter-insurgency operations have increasingly become the main task for many Western forces deloyed overseas. Despite considerable efforts throughout the decade, countless loosely organized insurgency have continued to target American troops and UN peacekeepers, as well as local security forces and civilians, with devastating results (Hashim, 2011). The challenges from counter-insurgency operations have thus raised much scholarly and public attention since then.

For policy makers, the mechanism and spectrum of fatality and injury sustained in actions are of strong interest to consider. Ever since the Vietnam war, the U.S. politicians have worried that the domestic audience as well as the U.S. allies will support military operations only if the costs of the war, as measured in combat casualties and economic expenditures, are minimal (Gelpi, 2005). Meanwhile, public opinions in the conflict regions have also raised attention on the tensions and collateral damages inflicted from both armed sides (Kahl, 2007). Experts in the field have thus employed various methods to investigate factors that affect the number of casualties and durations of CT operations (Ramasamy et al., 2009; Schutte, 2015).

The study of civilian assistance and guerilla warfare by Dr. Scott Wheeler (2005) argues for the benefits imparted by friendly civilian populations in helping peacekeepers to conduct operations under the threat of guerrilla warfare, especially in reducing the casualty. Condra and Shaprio's study (2012) also supports that the information civilians share with government forces and their allies is a key constraint on insurgent violence. More similar findings have established the theoretical foundations of winning the hearts and minds of civilians (Berman et al., 2008).

However, Wheeler's model still has its limitations for several reasons. First, all engagements in the simulations are always accurate, meaning that no collateral damage of civilians is considered. The model also only incorporates civilians as cooperative agents to the government forces. No violence or hostile actions would diminish each citizen's predisposed level of loyalty to the government. Consequently, no civilians would be turned into insurgents and insurgents would operate with no assistance or communication from civilians.

Violence against civilians has long been viewed as a catalyst for new rounds of conflicts in insurgency wars (Lyall, 2019; Berman et al. 2011). To prevent or control the growth of future insurgency, the U.S. has combined both combat operations and local reconstruction plans in Iraq, Afghanistan and beyond (Branch & Woods, 2010). Despite these strategies, the difficulties in reconciling local politics and avoiding instigating public discontent still impose serious challenges in receiving enough civilian corporations, if not hostility, in practice.

The lack of accessibility and diversity of Wheeler's model calls for more explorations into its basics. In order to improve the applicability of Wheeler's existing model, my project works to recreate a functional version of the model, add new features to its settings and then collect and analyze simulation results. The findings could serve as the basis of CT operation guidelines to political as well as military decision-makers when facing future insurgency threats.

3. An Agent-Based Counter-Insurgency Model

Unfortunately, no published codes of Dr. Wheeler's original model is available. Therefore, I first rebuilt the essential parts of this classic Netlogo model from scratch, and explored new features of the simulations in order to unravel deeper relationships of various parties involved in the counter-insurgency operations, such as civilians, insurgents and soldiers.

3.1 Wheeler's model

Simulations are conducted on a two-dimensional 50 by 50 unit board. Each grid, or patch, is designated as containing either urban construction or vegetation. 120 grids with lowest density are urban areas colored in black, and the rest are green grasslands with vegetation density ranging from 1000 to 9000. The smoothing of terrains follows Wheeler's design and is repeated a total of three times. In addition, the smoothing algorithm allows urban grids to usually form in clusters, representing settlements and villages of various sizes.

There are three factions of agents modeled, including white local civilian populace, red insurgents and blue soldiers or peacekeepers. Each group has its own breed and should follow a set of movement / engagement rules. Their initial numbers spawned could also be adjusted.

Movements:

- *Civilian's rules*: There are two movement modes associated with civilians, determined by whether they have any knowledge of a known insurgent threat. At the beginning, each civilian will walk towards a random direction at each tick. If the heading patch has a density higher than 5000, the civilian will turn back and adjust to a new random heading. Therefore, civilians should have a natural tendency to stay in cities and areas with low vegetation density. If an insurgent is presented within three units, the civilian's status will become "panic" for the next 20 ticks. During this time, this agent will be colored yellow and run towards the nearest soldier until the panic countdown reduces to zero. That nearby insurgent will also be detected for the same amount of time.
- *Insurgent's rules*: Insurgents start by moving to the grid with the highest density in the radius of 20 patches. They will keep hiding unless being detected. Insurgents have a good

vision of spotting unalerted soldiers in the radius of 8 and ambush them. When detected, they move away from the spotter and find another high-density patch nearby to hide.

- *Soldier's rules:* Soldiers are spawned at the center of the map. They also have two modes of movements. When they are unalerted of any threat, soldiers move randomly and patrol together as small teams to ensure their safety. There are several conditions that can trigger their alertness: they see any panicked civilian in radius of 10; there are insurgents present in radius of 3; any teammate in the same group is alerted; any teammate is ambushed by insurgents. Once alerted, soldiers will move towards the source of the threat, the detected insurgents, and eliminate the threat before returning to patrol duty.

Engagements:

There are two types of engagements in this model. Every fight results in casualty and the outcomes of engagements are calculated by simple probabilistic formulas.

- *Insurgents ambush soldiers:* When insurgents ambush unalerted soldiers, they have a 70% chance of causing a soldier casualty and a 30% chance of being killed by returning fire. Insurgents cannot ambush alerted soldiers nearby.
- *Soldiers fight insurgents:* Alerted soldiers would gather towards detected insurgents. When they arrive, there is an 80% chance that the threat is eliminated (the insurgent is either killed or captured), and 20% chance that a soldier is killed. If the latter happens, nearby soldiers would engage the insurgent again until the threat is dealt with.

The movement and engagements overall can be complicated to understand at a first glance. Therefore the flowcharts in Figure 1 are present as a useful visualization to help clarify the settings. Moreover, the model allows the users to choose a "reinforcement" option: if yes, a group of ten soldiers would be spawned at the center when current soldiers in the field are fewer than five. This represents a dynamic in which the military or peacekeeping forces have enough manpower in the region to eventually overwhelm any insurgency.

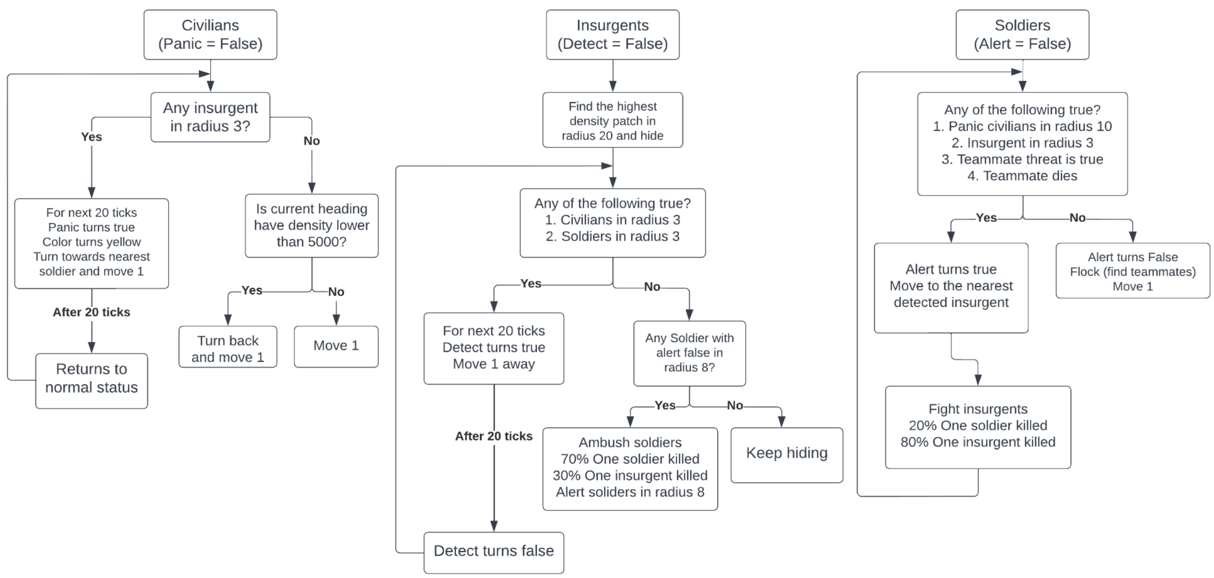

Figure 1. Agents' Movement and Engagement Rules.

3.2 Improved Wheeler's model

While Wheeler's model already has encompassed many essential characteristics of the counter-insurgency operations, there is some room for improvement. The second part of the project examines adjustments that better represent the civilian and soldier activities.

Motivated by Bennett's modeling of the early dynamics of insurgencies (2008), my adjustments first allow more diversity in engagement outcomes and civilian behaviors. During each type of engagements mentioned above, soldiers now have "accuracy" and "effectiveness" traits: accuracy controls the probability that soldiers cause any collateral damage, in this case it would be one civilian death; effectiveness measures the probability that soldiers eliminate the targeted insurgent in each engagement. These two parameters together allow much more diversified engagement outcomes and bring civilians into the engagement.

Civilians now have a new trait named "anger" to measure the overall attitude towards the soldiers. Civilian casualty is the main way of provoking anger. When engaging with an insurgent target, soldiers may cause collateral damage by hurting nearby civilians. Patrolling soldiers could also misfire towards civilians in sight. The probability of such misfires is determined by both the accuracy parameter and the density of their locations.

If the anger level reaches 10, one civilian will turn into an uncooperative protester at every tick. Protesters, colored pink, do not inform or communicate with soldiers. If the anger level exceeds 20, one civilian will turn into an insurgent at every tick, and follow all insurgent movement and engagement rules. All transformations are irreversible. The anger level will also decrease by 0.05 units per tick as long as it is positive, reflecting the gradual easement of sentiments. This parameter adds more volatile civilian behaviors and directly reflects the impacts of soldiers' accuracy and effectiveness in combat.

The collateral damage and anger level mechanism has been extensively studied both theoretically and in actual operations. In Iraq, for example, the coercive and destructive methods used by the joint force commanders were shown to incentivize local discontent and thus inculcate insurgency groups (Martin, 2005). Research has also illustrated that better training of troops could reduce collateral damage, which is critical to insurgents' recruitment capabilities (Cordesman, 2003; Jordan, 2016).

Moreover, the new model sets a threshold for subsequent soldier reinforcements so that the higher command would not send in more troops into the region if the forces have already sustained high casualties. By default, the threshold is set as two times the initial size of deployment. Once the threshold is reached, no more reinforcements are allowed and the operations will be declared a failure, with all remaining soldiers on the ground ordered to retreat.

The operations will also be stopped if all civilians turn into either protesters or insurgents. Infinite reinforcement without any political or human cost is not possible in real life. The rationales of such settings are that high casualty and local grievance would diminish political and public support, and thus put an end to the operations even if the stronger side is better equipped and has larger manpowers (Seligson & McElhinny, 1996).

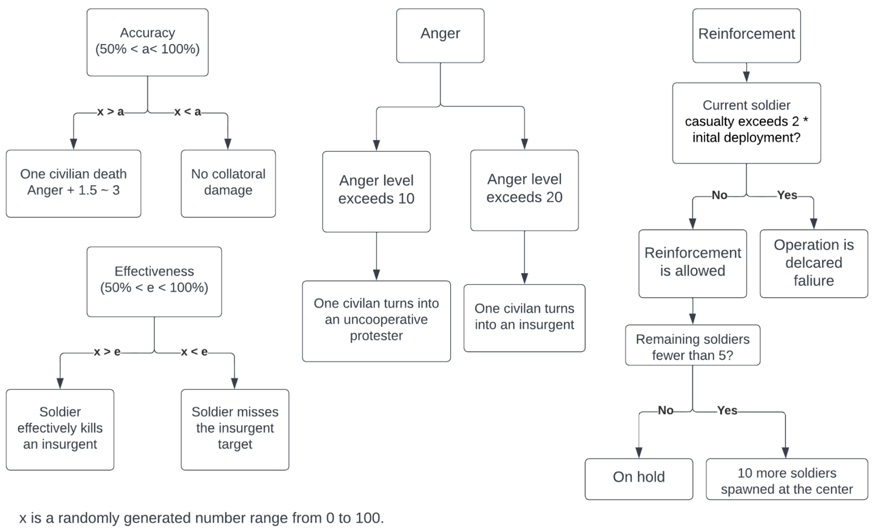

Figure 2. The new additions of the model’s algorithm.

The algorithm of my newly improved model is presented in Figure 2. All Netlogo agent-based models in this project are coded with Netlogo version 6.2.2. The final model, presented in Figure 3, is featured with six parameters in the interface section for users to choose from, including initial number of soldiers, civilians, insurgents, reinforcement, accuracy and effectiveness (See more information in Section 7 Appendix). Basic statistics like the remaining count of each group, current casualty of soldiers, insurgents and civilians, the number of new insurgent recruits, and the anger level of the civilian population are monitored at each tick and reported in the simulations as well.

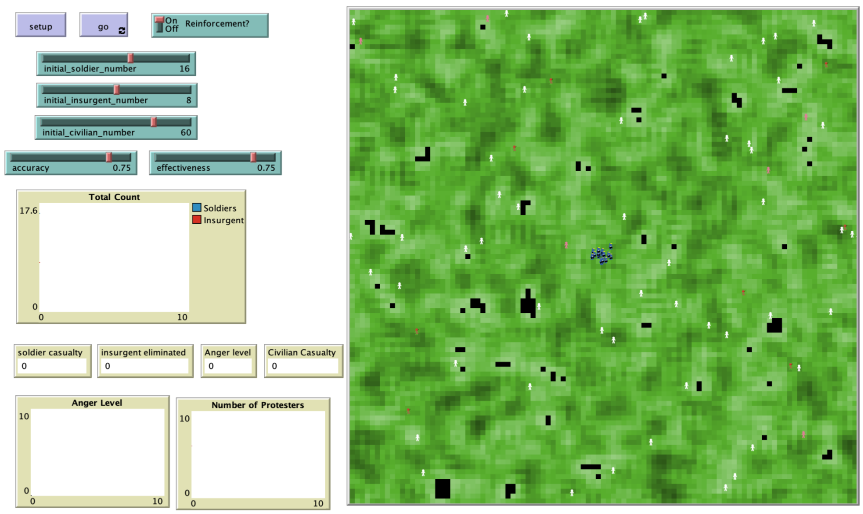

Figure 3. Example of initial patch setup and user interface.

4. Simulation Results

4.1 Wheeler's model

In order to verify Wheeler's findings, my model is simulated for 1000 runs at three levels of civilian populations in the regions, which are 0, 40 and 80. There are 8 insurgents and 16 soldiers initially spawned by default.

The vanilia model is able to present strong evidence to previous literature. As shown in Figure 4, the number of cooperative civilians is negatively associated with soldier casualty. Without any friendly civilians, the military needs to pay an average casualty of 15.343 to eliminate 8 insurgents. With 40 civilians, the average casualty drops to 11.256; and with 80 civilians, the average casualty is 8.186. Similar to Wheeler's argument, the knowledge that civilians provide to the soldiers can help reduce the chances of ambush, which is the main reason that leads to soldier casualty in actions. Interestingly, even with a high density of friendly civilians, the casualties on both sides are approximately equal, despite the fact that soldiers usually move in groups and have a better chance of eliminating detected lone insurgents.

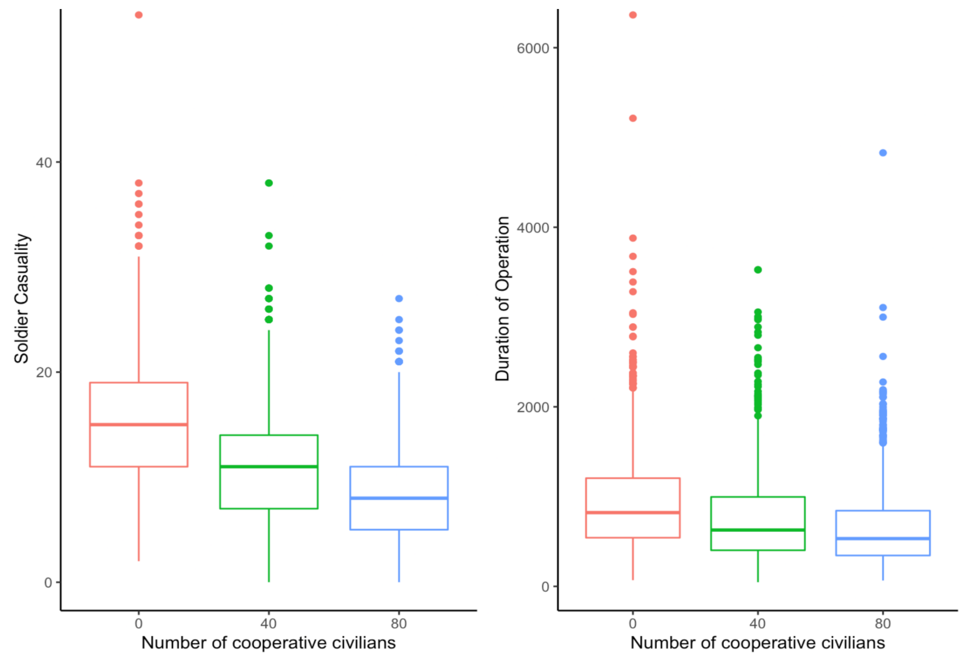

Figure 4. Casualty counts and operation length by different civilian populations.

Furthermore, the simulations also point to some new findings that Wheeler did not mention. The assistance of cooperative civilians not only helps avoid soldier casualty, but also effectively shortens the durations of the operations. When viewing one tick as one minute in real life, simulations suggest that on average an operation without civilian assistance needs 15.832 hours to finish; a medium number of civilians reduces the time to 12.763 hours; a high number of friendly civilians further cuts the time to 10.843 hours (650.567, 765.782 and 949.904 ticks respectively). The implications here are that by informing soldiers of known threats, the civilians' cooperation could reduce both casualty and overall time to clear the region of any insurgency, thus saving other potential costs associated with the operation.

4.2 Improved model

When looking at the improved model, the results reveal more insights as to how soldiers' accuracy and effectiveness in actions can affect the way operations turn out. As shown in Figure 5, better accuracy can reduce the number of uncooperative protesters and increase the number of friendly civilians at the end, whereas better effectiveness does not achieve the same outcomes. Since accuracy does not affect the engagements between soldiers and insurgents, it has little influence on their casualty, whereas effectiveness could slightly shorten operation lengths.

The simulations are consistent with Bennett's arguments, which suggest that accuracy (avoidance of collateral damage) is more important for the defeat of insurgency than is effectiveness at capturing insurgents in any given counterattack.

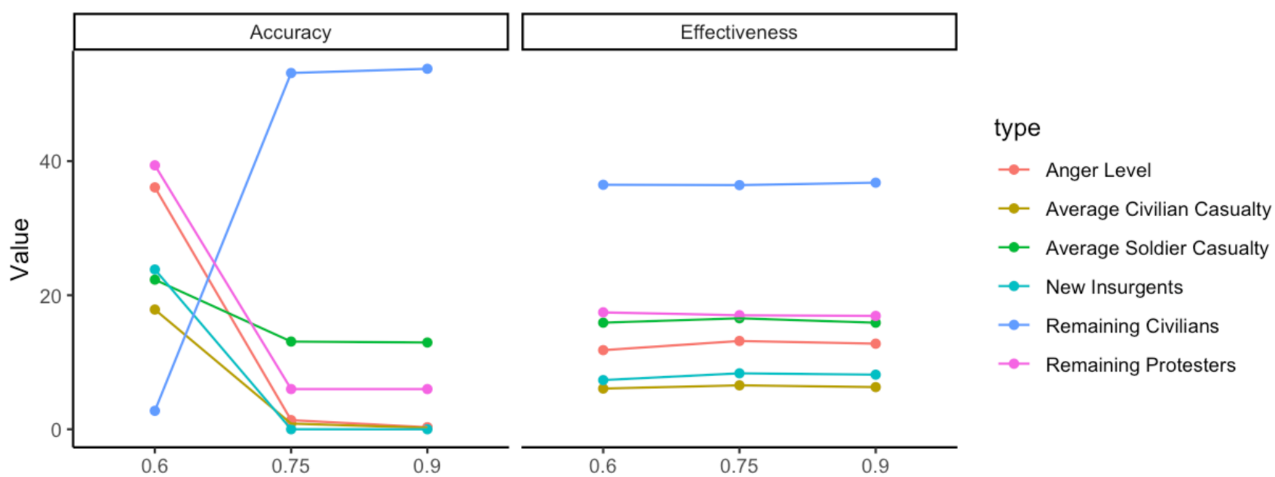

Figure 5. Comparison of Soldiers' Accuracy and Effectiveness in actions

The improved accuracy also has effects on how operations are likely to conclude. With low accuracy, in 74% of time the operation ends with the region fully infuriated and populated with protesters entirely and in 19.7% of time soldiers retreat with high casualties. The insurgency is eliminated in only 6.3% of simulations. In the improved accuracy setting, the operation will successfully eliminate all insurgents in over 98% of time, a considerable improvement in the proportion of successful operations. Nevertheless, the existence of protesters and the mechanism of new insurgent recurists still limit soldiers' chance of discovering and locating insurgents. Therefore, soldiers generally have to pay a higher casualty than before to clear the region.

Effectiveness, on the other hand, does not significantly change the distribution of outcomes. Though operations would take less time with higher effectiveness, we do not see a higher proportion of successful endings. The key reason behind the phenomenon is that high effectiveness does not help ameliorate the anger level in any way.

The results demonstrate that as accuracy drops below a critical tipping point, the chance that a full-blown protest and defiance breaks out in the regions increases dramatically. In the default setting, the tipping point of accuracy is around 0.65. When soldiers act with an accuracy lower than this tipping point, operations usually fail due to high casualty and hostile activities. Generally, with the number of friendly civilians diminishing due to collateral damage, soldiers are fighting with less support and more hostility since very poor accuracy in actions would turn more civilians into rebellious insurgents.

5. Conclusion

Throughout history, insurgency and guerrilla warfare have been one of most difficult and costly challenges to deal with as they impose enormous socio-economic losses and can often persist for decades (Trebbi & Weese, 2019). Lasting insurgency wars are also obstacles to effective international humanitarian intervention and reconstruction programs, motivating scholars and experts to develop better strategies to cope with the situations. Overall, this project not only is a replication and extension of Wheeler's classic ABM model of insurgency and guerilla warfare, but also explores new findings and directions for researchers.

The models created offer strong evidence to the existing literature and shew new light on more implications of the complicated dynamics in insurgency wars. It strengthens the notion that cooperation from a friendly civilian population can significantly reduce the combat casualty of the peacekeeping forces and the duration of operations. Furthermore, my model also shows that in the process of disrupting insurgency activities and winning hearts and minds in a region, the ability to avoid collateral damage outweighs the effectiveness of eliminating insurgents.

The implications of models call for better training of troops in terms of minimizing collateral damage and building more solid collaboration with the wider local population. Both factors play an important role in facilitating more successful outcomes with lowering casualty. They could also help to reduce the re-emergence of future insurgency.

This study, while carefully coded to reflect the essential mechanisms of insurgency wars, is still limited by repeated simulations of small-scale counter-insurgent operations, rather than long-term and continued conflicts. Further studies may consider ways to increase the scale of the operations over a longer time span while simplifying computations required in simulating individual agent's movement and engagement. Adding more settings, for example better tactical support for soldiers, the impacts of terrains on an agent's vision, movement and engagement, and the communication networks between insurgents and their sympathizers would also be of great interest to examine and verify the generalizability of current findings.

6. Reference

Bennett, D. S. (2008). Governments, civilians, and the evolution of insurgency: Modeling the early dynamics of insurgencies. *Journal of Artificial Societies and Social Simulation*, *11*(4), 7.

Berman, E., Shapiro, J. N., & Felter, J. H. (2008). *Can hearts and minds be bought? The economics of counterinsurgency in Iraq* (No. w14606). National Bureau of Economic Research.

Berman, E., Callen, M., Felter, J. H., & Shapiro, J. N. (2011). Do working men rebel? Insurgency and unemployment in Afghanistan, Iraq, and the Philippines. *Journal of Conflict Resolution*, *55*(4), 496-528.

Branch, D., & Wood, E. J. (2010). Revisiting counterinsurgency. *Politics & Society*, *38*(1), 3-14.

Condra, L. N., & Shapiro, J. N. (2012). Who takes the blame? The strategic effects of collateral damage. *American journal of political science*, *56*(1), 167-187.

Cordesman, A. H. (2003). *The Iraq War: strategy, tactics, and military lessons*. CSIS.

Eikenberry, K. W. (2013). The limits of counterinsurgency doctrine in Afghanistan: The other side of the COIN. *Foreign Aff.*, *92*, 59.

Gelpi, C., Feaver, P. D., & Reifler, J. (2005). Success matters: Casualty sensitivity and the war in Iraq. *International security*, *30*(3), 7-46.

Hashim, A. S. (2011). Insurgency and counter-insurgency in Iraq. In *Insurgency and Counter-Insurgency in Iraq*. Cornell University Press.

Jordan, J., Kosal, M. E., & Rubin, L. (2016). The strategic illogic of counterterrorism policy. *The Washington Quarterly*, *39*(4), 181-192.

Kahl, C. H. (2007). In the crossfire or the crosshairs? Norms, civilian casualties, and US conduct in Iraq. *International Security*, *32*(1), 7-46.

Lyall, J. (2019). Civilian casualties, humanitarian aid, and insurgent violence in civil wars. *The International Organization*, *73*(4), 901-926.

Manwaring, M. G. (2020). Toward an Understanding of Insurgency Wars: The Paradigm. In *Uncomfortable Wars* (pp. 19-28). Routledge.

Martin, J. D. (2005). *Misfire: An Operational Critique of Operation Iraqi Freedom (OIF) Targeting Strategy*. Naval War College Newport RI JOINT MILITARY OPERATIONS DEPT.

Ramasamy, A., Harrisson, S., Lasrado, I., & Stewart, M. P. (2009). A review of casualties during the Iraqi insurgency 2006–a British field hospital experience. *Injury*, *40*(5), 493-497.

Schutte, S. (2015). Geography, outcome, and casualties: A unified model of insurgency. *Journal of Conflict Resolution*, *59*(6), 1101-1128.

Seligson, M. A., & McElhinny, V. (1996). Low-intensity warfare, high-intensity death: the demographic impact of the wars in El Salvador and Nicaragua. *Canadian Journal of Latin American and Caribbean Studies*, *21*(42), 211-241.

Sepp, K. I. (2005). *Best practices in counterinsurgency*. Naval Postgraduate School, Department of Defense Analysis.

Shaver, A., & Shapiro, J. N. (2021). The Effect of Civilian Casualties on Wartime Informing: Evidence from the Iraq War. *Journal of Conflict Resolution*, *65*(7-8), 1337-1377.

Trebbi, F., & Weese, E. (2019). Insurgency and small wars: Estimation of unobserved coalition structures. *Econometrica*, *87*(2), 463-496.

Wheeler, S. (2005). It pays to be popular: A study of civilian assistance and guerilla warfare. *Journal of Artificial Societies and Social Simulation*, *8*(4).

Wolf Jr, C. (1965). *Insurgency and counterinsurgency: New myths and old realities*. Rand Corp Santa Monica Calif.

7. Appendix

Chosable Parameters	Information	Range
Reinforcement	Whether reinforcement of soldiers is allowed.	On / Off
Inital_solider_number	Initial number of Soldiers	10 - 20
Inital_insurgent_number	Initial number of Insurgents	1 - 15
Inital_civilian_number	Initial number of Civilians	0 - 80
accuracy	The probability that soldiers avoid collateral damage of civilian in each engagement	0.6 - 0.9
effectiveness	The probability that soldiers successfully eliminate the insurgent target in each engagement	0.6 - 0.9

Monitored Parameters	Information
Soldier casualty	The total number of soldiers killed or injured
Insurgents eliminated	The total number of insurgents killed or captured
Protesters	The total number of uncooperative protesters
Anger	The anger level that all civilians share
Civilians remaining	The current count of remaining civilians that are still friendly
Tick	The amount of time that the current operation lasts (in minutes)
Ending	There are three types of ending: 1. All civilians turn into protesters. 2. All insurgents are eliminated. 3. Soldier casualty exceeds 2*initial deployment.