# Complex Humanitarian Intervention Simulation

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**Abstract.** Troubled nations pose a complex dilemma for policy makers in international organizations. This study seeks to identify behavior patterns for the multiple entities operating among populations where there are varying degrees of United Nations authorized operations being conducted, and utilize these patterns in creation of behavioral models. These proto-agent behavioral models are utilized in agent based modeling simulations to help identify possible emergent behavioral outcomes of the populations in the area of interest. By varying the rules governing the behavior of the multinational and incumbent government proto-agents, different strategies can be identified for increasing the effectiveness of those proto-agents and the utilization of resources. The goal of this research is to develop a better understanding of how the policies of international governmental organizations may affect the interactions of the incumbent government, nongovernmental organizations, the insurgent movement, and ultimately the population in the troubled nations where complex humanitarian operations are conducted.

**Keywords:** Humanitarian Intervention, Agent-Based Modeling, Policy Simulation, Interagency Coordination.

## 1 Overview

### 1.1 Introduction

**The understanding of the integration of military force with NGOs in complex humanitarian interventions is critical to reestablishing stability within a fractured society.** Will the agencies of Western powers be met with a handshake or a fist by the populations they are attempting to help? There is a continuum of intervention alternatives available to policy makers ranging from humanitarian aid to full scale military intervention. Understanding the military-NGO interaction is a crucial item of policy framework that will determine feasible courses of action to international governmental agencies. Further, what level and type of integration should be attempted? At present, Western militaries have no clear structure or formal process for determining how to either integrate the efforts of NGOs with coincident military interests or neutralize NGOs with counter interests. This lack of structure is thought to reduce the effectiveness of stability and development efforts both in terms of direct and indirect mission success (Roberts 2010; Lischer 2007). Additionally, these issues exhibit nonlinear behavior. Unexpected events – such as the Sunni awakening in Iraq - may

change the course of history. It seems that small differences in inputs can become enormous differences in output. This phenomenon is referred to by James Gleick (1988, 8) as a "sensitive dependence on initial conditions."

These are the type of problems that defy explanation by traditional top-down theories of social reality because the top-down theories tend to operate in a linear paradigm. The difficulty in utilizing statistical tools, even those as advanced as structural equation modeling, which subsumes path analysis, OLS regression, ANOVA, and others is that it is extremely difficult to test the interaction among latent variables. The results from agent based models allow for addressing system aspects that these other models have not; such as transient, nonequilibrium conditions and dependence on initial conditions, which is the intent of this study (North and Macal 2007).

Verification testing of this model was conducted by observing the outputs of the model at the extremes of the simulation to ensure that the results moved in predicted directions. Validation of the model involved comparisons of the model outcomes to a series of case studies involving counterinsurgency operations and the delivery of development aid. The case studies utilized included:

- Police in the lead with military support or vice versa (Sepp 2004).
- The timing of development aid delivery vis-à-vis the stage of the counterinsurgency campaign – either early or late (Barlow 2010).
- The integration of local population into security forces – either high or low (Barton 2010; Megahan 2010; Sepp 2004).
- The level of local population inclusion in development aid delivery – either high or low (Brinkerhoff 2010; Guttieri 2010; Pimbo 2010).
- The level of local institutional development - either high or low (Brinkerhoff 2010; Pandya 2010; Sepp 2004; von Hippel 2010).
- The level of security from violence - either high or low (Guttieri 2010; Sepp 2004).
- The level of local population cooperation with counterinsurgency forces vis-à-vis the insurgents - either high or low (Galula 1964).
- The level of coordination with government agencies – either high or low (Curry 2010; Szanyna et al. 2009).
- The propensity to operate independently from other organizations either NGO or governmental - either high or low (Curry 2010).
- The religious affiliation of the NGO – either affiliated with the local religious majority, minority, or secular (de Haan 2009; Flanigan 2010).

The case studies also informed the initial settings and ranges of the model variables in the simulation.

### 1.2 Purpose

**This study tests the hypothesis that a high level of coordination between military and NGO operations can be a force multiplier in the effort to bring stability to a strife torn region.** The research question is: "Does a high level of coordination be-

tween military and NGO activities have a force multiplying effect?" Further conditions examined are: "Does the level of violence present in the area of operations, or the levels of legitimacy of the indigenous government have an impact on the levels of effectiveness – if any – derived from this military-NGO coordination?" and "What is the impact of a surge in the numbers of international forces in the region?"

### 1.3 Entities, state variables, and scales

**The landscape of this model includes the following variables and setting parameters.** The landscape the mobile agent types traverse is a square grid of 51 X 51 patches. The length of one time step is 3 months: 4 time steps equal one year.

| Variable | Attribute | Range | Settings |
|---|---|---|---|
| Level of violence | Energy cost to attack | 10 - 100 | 40, 95 |
| Initial number of insurgents | Beginning number of insurgent combatants | 0 - 250 | 30 |
| Initial number of international agents | Beginning number of international agent combatants & civilian staff | 0 - 250 | 20 |
| Secondary number of international agents | Beginning number of international agent combatants & civilian staff if no surge | 0 - 250 | 10 |
| Initial number of incumbent government agents | Beginning number of incumbent government agent combatants | 0 - 250 | 30 |
| Government legitimacy | Ability to recruit from the population | 1 - 20 | 3.5, 3.92 |
| Insurgent legitimacy | Ability to recruit from the population | 1 - 20 | 4.0 |
| Government gain from indigenous population | Support given to the agents in the form of energy units | 0 - 10 | 3.0 |
| Insurgent gain from indigenous population | Support given to the agents in the form of energy units | 0 - 10 | 3.0 |
| International gain from indigenous population | Support given to the agents in the form of energy units | 0 – 10 | 2.0 |
| Level of coordination between international governmental agents | Increased coordination causes individuals within the population to become more sympathetic toward indigenous government | 0 - 2.0 | 0.0, 2.0 |

**Table 1. Variables and Setting Parameters.**

### 1.4 Process overview and scheduling

**There are several processes that occur within each time step of this model.** Each agent is asked to move (which uses energy); to attack an opposing agent if contacted (again expending energy); to die if energy reserves are depleted. Two agent types, insurgent agents and incumbent government agents, reproduce during each tick. The patches (which are stationary agents) interact with each of the mobile agents. Each of the patches changes color to represent their loyalties to the respective mobile agents. As the mobile agents traverse a patch, they have an influence on the color (loyalty) of the patch. Patches loyal to a mobile agent provide that agent with energy thereby assisting the mobile agent's cause. The patch's color can change over time based upon the varying amount of contact it has with various mobile agents.

## 2 Design Concepts

### 2.1 Basic principles

**The basic principle addressed by this model is the attempt by the mobile agents, representing the combatants, to win favor of the stationary agents, the population.** This concept is addressed by setting up feedback loops between the mobile and stationary agents; as the mobile agents have success influencing the stationary agents, the stationary agents in turn provide support to those same mobile agent types. This adaptive behavior reflects the simple empirical rule that control (or at least acquiescence) of the population is necessary to prevail in counterinsurgency warfare which is therefore the objective of the mobile agents (Galula 1964).

### 2.2 Learning, prediction

**There is no learning in the model and therefore prediction is not explicitly considered.** To include learning in the model, a much higher level of agent complexity would be involved due to the mitigating influences of the deep structures of the society. Additionally, for the span of time involved in the counterinsurgency scenario, the agent behaviors tend to be ridged with learning taking place upon reflection when hostilities have ended. The sensing, interaction and stochastic processes used in the model are described in the following narrative which includes a discussion of the variable settings, initialization, and submodels used.

### 2.3 Sensing, interaction, and stochastic processes

**Variable one (see table 1) is the "level of violence" that is present in the simulation.** This interface determines the amount of energy (or life force units) that each agent sacrifices to attack another. In a highly contested environment, there is a cost for one group to attack another. Western military forces may have an advantage in terms of pure fire power and destructive force but the insurgents have the advantage of local terrain knowledge. When all sides are prepared for attack, each will extract a toll from the other for an attack and this variable sets the level of overall preparedness for all the agents in the simulation.

The agent energy level is defined as the life force an individual agent has. Another metaphor for the energy level used in the model is the will to preserver in the mission. The energy levels for agents are set relative to each other based upon agent type. This energy is expended through actions taken to include simple existence (which would be the agent's base metabolism rate). Each agent type has a beginning energy level that must remain above zero or else the individual agent dies. The energy level for each agent type has a stochastic element because individual agents within each type are heterogeneous in their motivations and abilities to reflect the reality of the populations they are modeling. For the international agent types, which include international development agents, nongovernmental organization agents, and military agents, their

initial energy level is set at a random number between one and twenty. This level was chosen because it is within the range of the other agent types but it is not influenced by the indigenous population but rather by the myriad of influences ranging from donor motives to home nation public support. The governmental agent types have their initial energy set at a random number between one and five times the "government gain from the population" interface control. The insurgent agent type has a similar attribute with the formula for their initial energy level being set between one and five times the "insurgent gain from the population" interface control. All of the agents are moving at random within the simulation.

Variables two, three, and four (see table 1) are simply the number of stationary agents (patches) of each type initially present in the landscape. Within this simulation space, there are 2,601 patches that represent the indigenous population. Those patches vary in color with regard to their affiliations or sympathies. White patches are loyal to the incumbent government and the black are loyal to the insurgency. The brown patches are neutral. Initially upon set up, each patch color is randomly assigned and randomly distributed throughout the simulation space with equal numbers of black, brown, and white patches.

# 3 Details

## 3.1 Initialization, input data, submodels

**The indigenous population (the patches) change color as they interact with the various agents.** Insurgents passing over the dark colored patches gather energy (or life force in the form of moral and material support) from them and cause them to darken at a preset rate. Government and international agents have a similar effect on light colored patches by causing them to lighten while gaining energy. International agents lose energy when they come in contact with a dark colored patch (insurgency sympathizer), but they are the exception. When a patch has reached white or black, its color change stops in that direction but it continues to give energy to those preferred agents that pass over it.

Variables five and six (see table 1) account for the legitimacy of both the incumbent government and that of the insurgent agent cause, respectively. Legitimacy is a latent variable that is a combination of other more directly accessible and measurable variables. For the government, this roll up of variables includes the relative degree of corruption, the degree of fit with local culture (are changes counter to societal norms being forced), security for the local population, and perceived efforts at good governance (economic development and support of infrastructure, civil law, and providing day to day needs such as potable water). For the insurgent side, the less successful the incumbent government is at governance, the greater the appeal of an alternative cause. The insurgency gains legitimacy by controlling unincorporated areas of the country where the government has little or no control. By establishing a shadow government and operating with lower levels of corruption and more effective governance, greater

levels of legitimacy are established (Kilcullen 2010). This can be seen in this scenario as establishing pockets of theocratic rule (Sharia Law). This state of affairs however, can be a double edged sword for the insurgent. A repressive and oppressive rule can have a counterproductive effect on the attitudes of the ruled population.

Variables seven and eight (see table 1) are the amount of support the competing agents receive from the patches. This correlates to and should move in conjunction with the legitimacy variable for each agent type. This attribute is separated in this model as a programming convenience because the support variable provides sustenance to the existing agents while the legitimacy variable provides for new agents. There may be circumstances that would cause these two variables to move counter to each other. For example, a radical school corrupting the young to join an insurgent movement, that the general population finds abhorrent, is not a case type that is investigated in this research. Each movement by an agent causes the agent to expend energy. The only way an agent can gain energy is by contacting (moving across) a patch representing a population segment (see table 2).

| Agent | Action | Outcome |
|---|---|---|
| Insurgent | Moves across light patch | No Change |
| | Moves across dark patch | Gains energy |
| International agent | Moves across light patch | Gains energy |
| | Moves across dark patch | Loses energy |
| Incumbent Government agent | Moves across light patch | Gains energy |
| | Moves across dark patch | No change |

**Table 2. Agent Energy Changes.**

Finally, variable nine (see table 1) is the level of coordination of activities between the international governmental agents, the military arm of the international government agents, and the nongovernmental agents, within the scope of the operation attempting to bring stability to the society. In this study, the act of bringing stability is more specifically defined as: "… maintain or reestablish a safe and secure environment, provide essential governmental services, emergency infrastructure reconstruction, and humanitarian relief" (JP 3-07 2008, vi). The level of cooperation variable is operationalized in this model as an attribute of how much of a color change a patch will undergo when contacting international type agents. If the level of coordination among the international agencies is zero, the color change for the patch is zero. As the level of coordination becomes greater, the degree of positive color change for the patch increases. The opposite occurs when the international agencies are acting in a less coordinated (domain conflicted) manner. When domain conflicted partners attempt to provide stability, they frequently achieve suboptimal or even counterproductive outcomes (Roberts 2010; Lischer 2007). Controlling this variable in relation to the other variables in the simulation allows for an examination of the relative importance of each of the variables in the final outcome.

There were 16,000 simulation runs conducted varying the primary research variables against the secondary research variables (see table 3). There were three variables adjusted within the simulation runs; the level of cooperation between international agents, the level of violence within the simulation scenario, and the level of legitimacy of the incumbent government. When each of these variables was adjusted, the others were held constant yielding the matrix shown in table 3. In this type of scenario, agent based modeling allows for the isolation of variables in a dynamic environment.

| **Initial runs** | **Level of coordination low** | **Level of coordination medium** | **Level of coordination high** |
|---|---|---|---|
| Level of violence low / Level of legitimacy low | 1000 Runs | 1000 Runs | 1000 Runs |
| Level of violence low / Level of legitimacy high | 1000 Runs | 1000 Runs | 1000 Runs |
| Level of violence high / Level of legitimacy low | 1000 Runs | 1000 Runs | 1000 Runs |
| Level of violence high / Level of legitimacy high | 1000 Runs | 1000 Runs | 1000 Runs |
| **Secondary runs** | **Level of coordination low** | | **Level of coordination high** |
| Level of violence low / Level of legitimacy low | 1000 Runs | | |
| Level of violence low / Level of legitimacy high | | | 1000 Runs |
| Level of violence high / Level of legitimacy low | 1000 Runs | | |
| Level of violence high / Level of legitimacy high | | | 1000 Runs |

**Table 3. Simulation Execution Matrix**

Earlier in this discussion, we considered the nine variables that are adjustable within the framework of this agent based model. There are four variables that remain static during all of the simulation runs. These variables were the initial number of insurgent agents, the initial number of incumbent government agents, and the initial number of international agents (these agent numbers were reduced by fifty percent in the last four simulation run sets), and are shown in Table 1. The ratio represented in the model of thirty, twenty, and thirty respectively is an equal number of government and insurgent agents (thirty) versus twenty international agents. There were multiple reasons for the selection of this ratio. According to the Brookings Afghanistan Index (Livingston and O'Hanlon 2011) there were just over 200,000 international agents in Afghanistan at the end of 2011. Of those, roughly 120,000 are combat troops and the remainders are civilian contractors, non-military governmental employees, and non-governmental organizational personnel. The Afghan government is fielding a security force of just over 300,000 including both the Afghan National Army and the Afghan National Police force. The insurgency in Afghanistan is a bit more difficult to pin down. According to the same Brookings document, there is a core of 30,000 insurgents operating at any giving time within Afghanistan. With these types of force ratios, the insurgency should have been stopped with relative ease; but instead, insurgent attacks have increased fourfold and security of the population is hardly guaranteed (Livingston and O'Hanlon 2011).

The question becomes, how does a small cadre of determined insurgents have an effect as though they have ten times that number? One of the dominant factors within this scenario is that as late as November of 2010, up to ten percent of the Afghan people had a favorable view of the Taliban and nine percent would rather have the Taliban ruling the country (ABC News/BBC/ARD Poll, "Afghanistan: Where Things Stand", released December 6, 2010). In a country of almost thirty-three million, having over three million desiring to have the primary component of the insurgency regain control of the country is significant. The other critical issue is the size of the illicit economy within Afghanistan. The opium trade approaches $1.6 billion with the legitimate economic GDP standing at $17 billion (United Nations Office on Drugs and Crime 2011). The opium trade is almost twenty percent greater than the general revenue intake of the Afghan government (Livingston and O'Hanlon 2011).

Researchers at the World Bank argued that areas of Afghanistan became a fragmented narco-state in which local drug lords took control of district- and provincial-level state institutions of government with the assistance of insurgent groups. Compounding these issues are the relative differences in pay scales for insurgent fighters versus those employed by the Afghan government. (Jones 2008, 48). The average daily pay for Afghan soldiers and police is under three dollars while the insurgents are paid between five and ten dollars per day (Ackerman 2009; O'Hanlon and Livingston 2011; Livingston and O'Hanlon 2011). Additionally, the recruiting ground for insurgent fighters is rich with over 352,000 internally displaced persons, most of whom live below the poverty line (forty-two percent of the total Afghan population lives below the poverty line) of fourteen dollars per month of income (Livingston and O'Hanlon 2011).

Given the level of poverty, the corrupting influence of a robust opium trade, and significant insurgent sympathies across the population, a multiplier of ten is a conservative estimate for the relative force fielded by the insurgent groups. This puts the number of insurgents operating in the simulation at an equivalent strength to that of the government. It is important to note that during the runs of this simulation, both the insurgent agent population numbers as well as the incumbent government agent population numbers can increase in keeping with the concept of each side recruiting from within the indigenous population. The international agents cannot increase their numbers as the simulation moves forward in time. This stipulation is in place to keep the perspective of the unstable state maintaining sovereignty during the course of the simulation.

The other ratios that remain fixed for all of the simulation runs are the government and insurgent energy gains from contact with the population (see table 1). These variables (insurgent gains from the population and government gains from the population) are set at three (3) which is a relative setting, not an absolute indication of a physical transfer of energy as discussed in the preceding chapter. Once again, this measure is a latent variable that is a combination of several factors such as respect within society, the feeling on the part of the belligerents that they are making a positive impact on the

everyday lives of their fellow citizens, and the reflection of the citizenry's view of the role the groups are playing within the greater context of society. These attributes are difficult to quantify in an absolute sense but are relevant in relation to the morale of the individuals within the group and their will to continue with their cause. These have been set at parity because when the Afghan statistical variables published by the Brookings Institute are viewed in the aggregate, there is no clear reason to give one group an advantage over the other in this measure (Livingston and O'Hanlon 2011).

At this point, with the context of the static variables set, the measures of interest in the research questions can be addressed. The level of coordination for this simulation is the measure represented by the variable of the level of coordination between international governmental agents (see Table 1). The effect this attribute has on the simulation is the higher the number the greater the positive impact the international agents have on creating loyalists to the incumbent government when they interact with the population. This in turn increases the number of "patches" that give energy to the government forces and withhold it from the insurgents. The secondary runs were conducted at the extremes of the primary run parameters. These runs were conducted to determine the relative effects of a fifty percent reduction in the initial number of international agents involved in the simulation.

## 4 Conclusion

**The primary runs did not support the null hypothesis; all of the intervention strategies from increasing the level of coordination between military and NGO activities and increasing levels of legitimacy for the indigenous government have a positive effect on the outcomes.** Increased levels of violence present in the area of operations, decreased government legitimacy, and lower interagency coordination have a negative impact across the board on the success of the counterinsurgency efforts (see figure 1). The model successfully emulated the empirical trends on all of these counts and did so with reasonable fidelity as to the scale and proportion described in the case studies.

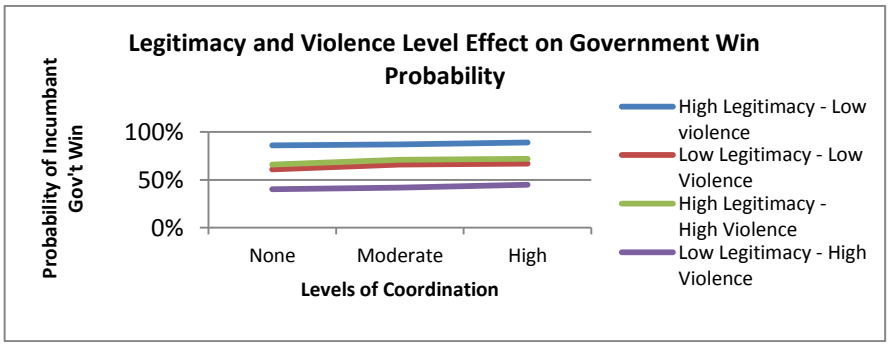


**Fig. 1.**

This particular abstraction was chosen to experiment with concepts such as Provincial Reconstruction Teams in an attempt to determine their effect on the outcomes of counterinsurgency efforts; which were shown to be positive. There was however, one area that generated a surprising result that initially appeared counterintuitive.

When the number of international agents was reduced by fifty percent in the simulation, there was a corresponding drop in the probability of a successful counterinsurgency effort; however, the drop was relatively minor in comparison (on average less than ten percent – see figure 2). This outcome is of interest because the modeled mechanism reflects that of real policy, namely the relatively short period of time the

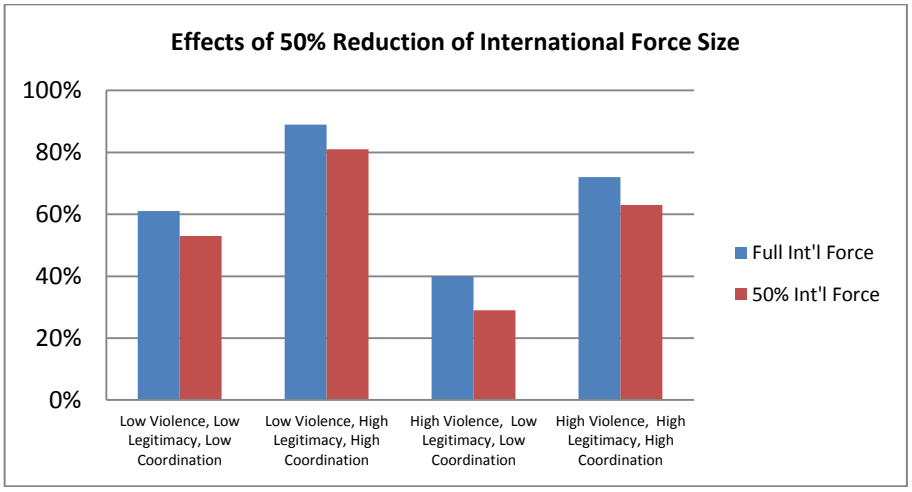


**Fig. 2.**

international forces are present. The average length of time the international agents were active in the simulations was slightly less than one fourth of the time the scenarios took to complete (8.1 out of 32.5 years). In each case the international agents set the conditions in which the indigenous agents finished out the simulation. The simulation certainly should not be viewed as supporting the halving of aid delivery or security support. It does however raise the question of priorities of aid delivery and stability assistance. The general observation of de Haan's (2009) that "how much aid is given matters less than how it is given" holds in this particular simulation. A troop surge would not seem to be as impactful as other policy options in the model which raises the issue within real policy applications; notwithstanding the steady parade of senior officials making sweeping statements regarding the success enjoyed due to the surge (yet being rather vague on the specifics causation versus correlation of the successes) (Clinton 2011).

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