

Agent-Based Modeling in Humanitarian Interventions

Emerging Research and Opportunities



John McCaskill

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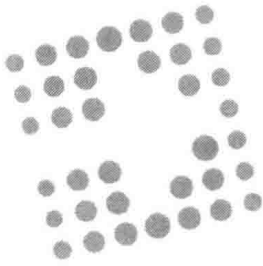
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Preface

Troubled nations pose a complex dilemma for policy makers in international organizations. The humanitarian urge to intervene to relieve suffering is strong but it also has a dark side. The delivery of aid to a distressed population in a troubled nation is never neutral: there are always winners and losers. The difficulty in formulating policy lies in the complexity of these types of scenarios. The cause and effect are frequently widely separated in either time or space. Compounding the complexity are the multiple feedback loops surrounding the problem. It is frequently impossible to determine which feedback loop provided the correct linkage between cause and effect until the scenario has played itself out.

The purpose of this study is to identify behavior patterns for the various entities operating among the population where there are varying degrees of stability operations being conducted and utilize these patterns in creation of behavioral models. Agent-based modeling is derived from complexity science. If complexity cannot be readily defined, some of the behavioral elements can be defined. The behavioral elements derived from the literature review are utilized to create the behavioral rules that the agents, or adaptive actors utilize in the simulations. Agent based modeling utilizes five principles that guide development:

1. Simple rules guide agent behavior and can generate complex behaviors;
2. There is no single agent that directs the other agents – there is no agent hierarchy;
3. Each agent has bounded rationality in that each can only respond to local situations in the environment and other agents in close proximity;
4. There is no global rule for agent behavior; and,
5. Emergent behavior is demonstrated by any behaviors that occur above the level of the individual (Kiel, 2005; Langton, 1989).

From these principles, agent-based modeling builds a macro social interactive structure from the interaction of individual units from the bottom-up versus the top-down approach typically taken in typical social science studies (Epstein & Axtell, 1996).

These types of simulations could provide a viable method for assessing risk of various strategic and operational strategies as well as reducing the level of uncertainty associated with counterinsurgency and stability operations. The promise of allowing analysis of patterns of structural emergence and destruction is real and provides an improved adaptive response to the environment (Kiel, 2005). These agent behavioral models are utilized in agent based modeling simulations to help identify emergent behavioral outcomes of the agents in the population. By varying the level of coordination between the NGOs and the Governmental agents (United Nations Development Program, USAID, military), different strategies can be identified to increase the effectiveness of those agents and the utilization of resources in the execution of rebuilding a war torn society. This dissertation uses agent based modeling to run simulations involving NGO / government coordination policies and their effects during stability / counterinsurgency operations. The goal is to develop a better understanding of whether a high level of coordination between 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 for both the indigenous government and/or the insurgency movement, have an impact on the levels of effectiveness – if any – derived from this military-NGO coordination?

Within this study, a generalized and abstract theory of the interaction of the military and civilian NGOs is derived from the views of the participants through the literature on this interaction process. The goal is to maximize the similarities and differences of the information within the emerging categories, and from those differences, revise and present parameter estimates for dealing with the vague, uncertain, confusing, and ambiguous interface between the military and the civilian NGO stratum (Creswell, 2009). The simulation is conducted in conditions described in Roberts (2010) quadrant IV diagram: low domain consensus between agents and a high level of martial threat to all the agents involved. The simulation resource in the landscape for this study is the support of the indigenous population. The following are the agent types and their rules for the simulation. There are two levels of violence set - low and high – for each set of agent rule parameters.

- International governmental agents whose rules vary with different policy initiatives: high levels of coordination, no coordination, and subjugation of either the civilian or military agencies by the other.
- International governmental, local government and insurgent agent numbers vary (low, medium, and high) for each policy initiative.
- Local governmental agents have three rules regarding the legitimacy interaction with the population: low, medium, and high levels of legitimacy defined by the governmental agents' likelihood to reproduce (recruit additional members from the population).
- Insurgent agents have three rules regarding the legitimacy interaction with the population: low, medium, and high levels of legitimacy defined by the insurgent agents' likelihood to reproduce (recruit additional members from the population).

The landscape (local population) initial conditions of being are in one of three states: loyal to the local government, neutral, or loyal to the insurgency. The three states of the population are randomly distributed in roughly equal proportion.

This study focuses on two concepts: the characteristics of the policies available to United Nations agencies in conducting stability and / or counterinsurgency operations and the delivery of development aid and the characteristics of the NGOs engaged in the delivery of development aid in the same operating areas. The categories of case studies of policy that have been examined for this study are:

- 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 categories for the characteristics of NGOs that have been identified at this point are:

- The level of coordination with government agencies – either high or low (Curry, 2010; Szanyina et al., 2009).
- The propensity to operate independently from other organizations either NGO or governmental – either high or low (de Haan, 2009; Flanigan, 2010).
- The religious affiliation of the NGO – either affiliated.

These characteristics are utilized in building agent based modeling simulations. Their relative impact in describing the initial conditions of the simulation (to establish the mathematical relationships for programming) is determined and inserted in the agent based model equations to control the magnitude of the relationship between variables.

The agent based modeling simulations utilize parameter estimates derived in the method described above as a general starting point. The current Afghan counterinsurgency scenario is used to set the initial conditions for the simulation. With this baseline established, additional simulations are run that vary the policy parameters in accordance with the options available to policy makers as described in the previous paragraphs. The outcomes of the simulations are captured with particular emphasis placed upon the interface dynamics between the groups and the effects of those dynamics on the outcomes observed.

The modeling software to be used for the simulations is NetLogo. NetLogo was developed by Uri Wilensky in 1999 at the Center for Connected Learning and Computer-Based Modeling. It is the agent based modeling software that is used to run the simulations. This software is designed to simulate social phenomena in a programmable modeling environment. The software should be well suited to this research because it allows instructions to be given to hundreds or even thousands of agents which can all operate independently making it possible to explore the linkages between macro-level patterns of emergent behavior and the micro-level behavior of individuals. NetLogo also allows for simulations to be opened and the conditions varied which are critical to exploring agent behavior and scenario outcomes when policy changes are made and introduced. The software also allows for a multitude of graphic representations of the outputs which are extremely useful in presenting the findings of this research (Wilensky, 1999). There have been some fascinating studies on how foreign aid, NGOs, and diplomacy work together (or at odds) in foreign development and national security (Lacquement, 2010).

Flanigan (2010) has conducted a study of how NGOs can frequently be very partisan in strife ridden areas causing them to be problematic for cooperative associations with United Nations agencies. Roberts (2010) has conducted a review of where the current state of affairs has progressed. While providing a framework to understand the depth and breadth of the issues involved, the thrust of her work calls for additional research into the appropriate methodologies for dealing with “The Civilian-Military Conundrum in the Post-Cold War Era” (Roberts, 2010, p. 213).

While in some cases, these studies have provided a great depth of information on how NGOs function along with their interaction with the populations they are providing assistance. In other cases there have been very broad surveys of why population centric counterinsurgency operations are a critical capability that should be resident within the Department of Defense (DOD). Sara Lischer has been examining the challenges being faced when integration of NGOs into the planning process in nation building does not take place. Nancy Roberts, a professor of defense analysis at the Naval Postgraduate School in Monterey, has recently published an article lamenting this very issue (Roberts, 2010). Roberts suggest that one of the main issues is the “bleeding boundary” between the military and civilian NGO roles in providing services to distressed populations. From her article, the crux of the issue is the new field manual on COIN that has the military displacing the NGOs in the domain of providing humanitarian relief and thereby causing domain consensus to disappear and friction between the groups to escalate.

The problem unfortunately is not as simple as establishing domain consensus. The varieties of NGOs that can be operating in any given area form their own mosaic of goals and intentions. Some of these goals align with those of the interests of the United States – and therefore with the U. S. military – while others may be diametrically opposed. The problem then, for the military commander and other governmental organizations, becomes multifaceted yet the objective remains singular; the population. Even the basic and critical activity of identifying friend from foe, for all organizations involved, becomes complex and constantly shifting. There is a lack of synergy across disciplines in the study of how to establish where the common goals lie and how they can be effectively integrated (Franke & Guttieri, 2009). Additionally, this integration needs to occur without adversely affecting the ability of each of the organizations involved to operate effectively in accomplishing its goals (Mann, 2008; United States Institute of Peace and Peacekeeping, 2009; United States Africa Command 2009 Posture Statement).

ORGANIZATION OF THE BOOK

The study described in this book utilizes the recent international coalition efforts to stabilize Afghanistan as the backdrop for the simulation experiment. While there are some very Afghan specific data used to build the landscape for this research simulation, they serve to inform more broadly applicable latent variables that can be found in many “troubled state” scenarios. Several components of background and theory are covered to address the research question with the literature review being the first element. The introductory literature review in Chapter 1 contains a brief examination of the ethical choices facing policy makers in stability and nation building operations. From there a review of the change capacity of Afghan society and how it limits the policy goals of international intervention is conducted (the current policy environment chosen to provide the baseline for the model’s landscape). Chapter 2 contains a more in depth literature review that includes the roles that the military, NGOs, and complexity theory play in the study.

Chapter 3 reviews the methodology used in the study including a discussion of origin of the parameters and rule sets used to conduct the simulation. Chapter 4 fully presents the model itself in the ODD protocol (Overview, Design concepts, and Details), which contains the data analysis of the model runs and the outcomes of the statistical tests on the parameter sets. The final chapter contains policy implications, conclusions, and suggestions for further research.

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Chapter 1

Introduction

INTRODUCTION

Conflict within a nation state is frequently accompanied by a humanitarian crisis. Internally displaced persons, hunger, disease, and other maladies conspire to tear the fabric of a society apart. While the first instinct of many in the international community is to help, that help can lead to trouble. Human interaction is highly complex yet our capacity to make sense of it all is limited. This state of affairs frequently causes the world community to stand by and let the upheaval take its course, and only then attempt to pick up the pieces of a broken society if things work out poorly. Even in the best case, the provision of aid has the potential to prolong the conflict. We cannot readily forecast the outcomes of intervention because our top-down models have difficulties dealing with the complex interactions associated with these types of events. Bottom-up approaches are not necessarily any better at prediction, but they do have the capacity to provide insights into the interaction of the variables involved in complex humanitarian interventions; much like a flight simulator allows a pilot to try various procedural options when presented with a system failure.

BACKGROUND

The international community has become more attuned to the number of complex humanitarian issues developing throughout the world (United Na-

tions General Assembly Resolution 52/167, 1998). This is particularly true in parts of the developing world where civil war or some other driver of civil strife overwhelms the region's capacity for emergency response. When this occurs, the international community feels obligated to act as stated in a series of Guiding Principles contained within the United Nations General Assembly resolution 46/182 (1992):

The magnitude and duration of many emergencies may be beyond the response capacity of many affected countries. International cooperation to address emergency situations and to strengthen the response capacity of affected countries is thus of great importance. ... Intergovernmental and non-governmental organizations working impartially and with strictly humanitarian motives should continue to make a significant contribution in supplementing national efforts. ... There is a clear relationship between emergency, rehabilitation and development. In order to ensure a smooth transition from relief to rehabilitation and development, emergency assistance should be provided in ways that will be supportive of recovery and long-term development. (Annex, p. 50)

MAIN FOCUS OF THE CHAPTER

For this study, the statement above is the operationalized definition of stability: the effort to address complex humanitarian emergencies in a way that supplements and rebuilds the receiving nation's capacity to take care of its citizens. This international effort can include, but is not limited to providing security and development aid, assisting with the establishment or reestablishment of the rule of law and governance, as well as humanitarian assistance.

Policy makers face a conundrum in failed or failing nation states: how to provide humanitarian relief while weaving the torn fabric of a society back together. Humanitarian action alone is rarely neutral. The advance of humanitarian care and supplies frequently frees belligerents to militarize the refugees and continue the conflict on a wider scale. Other times it takes on a "placebo effect" and nullifies the impetus to provide the military or political engagement necessary to address the cause of the strife (Lischer, 2007). Policy makers that lead with military forces acting as humanitarian workers (such as the Provisional Reconstruction Teams operating in Afghanistan) often find they cannot create the stability they hope for due to inadequate security. Lischer describes the military planners' goal as gaining a "force multiplier effect" from engaging in humanitarian operations. This force multiplier effect is quite simply an increase in efficiency; an ability to do