Applying Existing System Dynamics Business Formulations to Model Terror Organizations

Munaf Syed Aamir

Sandia National Laboratories[1], Albuquerque, New Mexico, USA

msaamir@sandia.gov

[SANDXXXXX]

Abstract. A growing body of literature has shown that terror groups in particular have similarities to organizations whose operation are recognizable to the author and the readers – the firm. If terror groups and businesses are similar it would have significant implications to counter-terrorism community. It would enable the application of a broad set of existing theory (regarding the firm) to inform counter-terror policy, and possibly elucidate structures previously hidden to the decision-making communities. This paper highlights and references the public policy literature to build a case for describing terror organizations as businesses. System dynamics and system thinking models of terror and insurgency organizations are reviewed. The author develops a Vensim model out of well-known system dynamics business formulations. The author then simulates the model to demonstrate logical flow and test policy. Finally, this paper outlines further development goals and a long-term research agenda for further development of the developed model.

Keywords: Terrorism, Insurgency

1. INTRODUCTION

There have been several efforts to model and characterize terror organizations using system dynamics and systems thinking. These efforts use relevant literature to help characterize operational flows [1, 2], the effects of financing [3], the importance of material flows [3, 4], factors affecting recruiting and training [2, 5, 6], population support of insurgent groups [2, 4-6], and possible means of reducing the effectiveness of these groups [1-7].

Each of the referenced efforts has, in some way, tried to characterize the internal operations of insurgent or terror groups. However, each effort has only attempted to characterize terror as unique organizations requiring a unique model structure. A growing body of literature has shown that terror groups in particular have similarities to organizations whose operation are recognizable to the author and the readers – the firm.

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The goal of this paper is to:

1. Present evidence from literature that terror organizations have operations similar to business organizations, and that business model structure can be used to represent them;
2. Review and adapt existing system dynamics business models that are relevant to modeling the terror organization; and
3. Present an initial model of the terror organization through the use of business models.

There are substantial implications if terrorist groups can be modeled as a business. Firstly, the structure of businesses is easily recognizable and describable, making terror organization potentially intuitive. Secondly, business organizations are subject to a great amount of study by people in various fields including economics, psychology, and sociology and there is a great amount of theory that can be applied to studying terror organizations in this way. Lastly, (and the reason why this paper is aimed at the system dynamics community) there exists a long list of tried and tested business models, especially within the discipline of system dynamics, that the author can utilize to characterize how terror groups function.

This paper presents initial efforts in achieving the stated goals for the purposes of obtaining feedback to enable future improvement and is not intended as a final "standard model."

1.1. Methodology

Figure 1 describes the process that is used to develop this paper. The literature review serves as a means to justify the use of business models for characterizing the terrorist organization and will also help delineate important processes within terror organizations (item a in Figure 1). The literature will also help in identifying the relationship between processes (item b in Figure 1). Once this is complete a search for existing system dynamics models that adequately describe the processes that take place within terror organizations (item c in Figure 1). Once models are found and chosen, they will be integrated and modified to represent the information flows within terror organizaitons (item d in Figure 1).

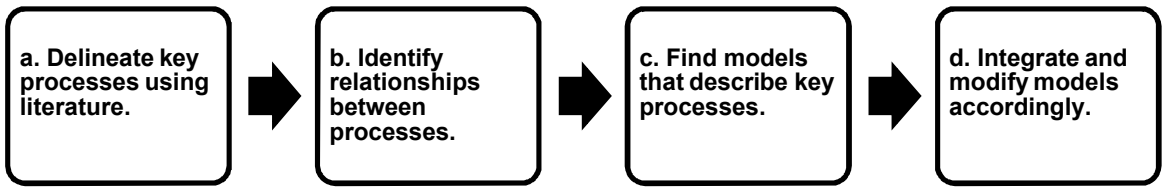

Figure 1. Development process for this paper.

Notably missing from the process in Figure 1 is in-depth analysis, calibration, and sensitivity testing. There are several reasons for not pursuing this, primarily amongst these reasons is that the available public data would not adequately allow for useful calibration. The lack of this data underlies the national security concerns regarding these groups. Future development may apply the resulting models to less sensitive organizations (notably: gangs, crime organizations, etc.) as these groups may have structural similarities, but such application would require further research to substantiate the appropriateness of this approach.

1.2. Scope

This paper aims to model a generic terrorist organization using existing business models as described by the literature. This paper does not, however, endogenously model counter-terrorism policy and decisions as others have previously done [5, 6]. Counter-terror levers are exogenously implemented and are discussed. The reason for this is that the author wishes to focus on the internal operations of the terror organization.

The system dynamics based efforts discussed in the introduction used the available information and, with exception of Anderson 2011, made no mention of the potential to use a model as a means of revealing unknown characteristics of terrorist groups. This can be achieved through as a decision support level, where more data is available. While this endeavor is out of scope for this paper, it is a central aim for this effort in the long-term.

1.3. Creating an impactful model: a long-term research agenda

The goal of system dynamics is to enable good public policy through the consideration of the complex interactions that occur in complex systems to avoid unintended consequences [8]. The dream of every model developer is to create models that have impact. This impact is generated through the use of models to provide decision support to policy makers.

While it is the endeavor of the author to have a positive impact in the modeled system, the author realizes that having impact in this area of research means that as the modeling effort develops the results of efforts become less and less sharable. However, the author also recognizes that there is broad interest by many intelligent individuals to assist in efforts to reduce the risk of terrorism.

Figure 2 summarizes the envisioned relationships between the policy-making community and academic community that are central to this modeling effort. The aim is to involve the academic community in an effort to garner theory and validation through historical events for which there exists public data. The effort would also provide research challenges to the academic community for which there are important gaps in theory. With respect to the policy making community the effort would enable decision support and a data exchange to those who can handle the data. This effort therefore helps in the goal for achieving policy impact.

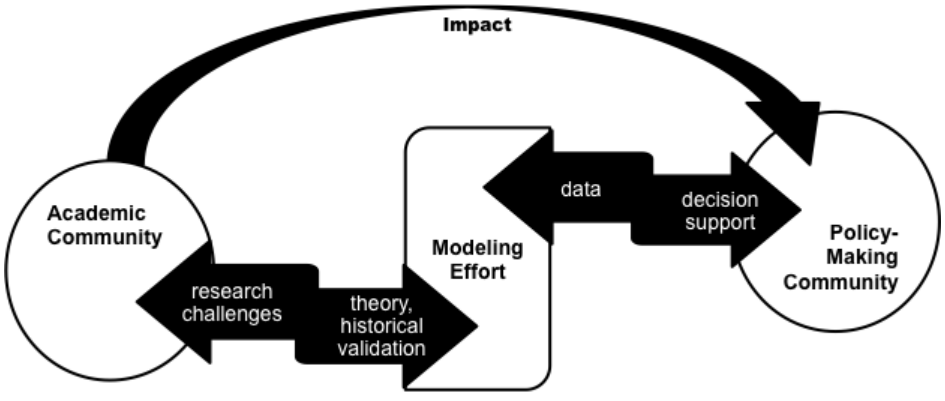

Figure 2. Overview of relationships between the academic community, the policy-making community, and this effort.

2. LITERATURE REVIEW

This section summarizes the relevant public policy literature that provides evidence for representing terror groups as businesses organizations. The literature also provides the "business" processes key to the operation of the terror organization. These are summarized in Section 2.2. In addition, Section 2.2 lists relevant ready-built models within the system dynamics community that can be easily integrated to characterize these groups.

2.1. Evidence supporting the representation of terror groups as a business organization

This is not the first attempt to model terrorist groups as a business. In 2009 Schoenwald et al. developed a simple model that described insurgency as a business enterprise. This effort covered a review of major work undertaken to dynamically model terror organizations [3]. The model focused on the importance of financing of terror organizations and did include some aspects of organizational support and resources emanating from positive response to insurgency acts. However this effort did not cover structure that is key to the operation of terror groups.

A major source for this review is the book The Terrorist's Dilemma in which Shapiro (2013) reviews 108 memoirs written by participants of terror organizations [9]. Shapiro also examines several other accounts of terrorist activities to provide a qualitative picture as to the major managerial hurdles that terrorism organizations face. Through his extensive review, Shapiro posits that "… the core managerial challenges of terrorist organizations are actually quite similar to those faced by other more traditional human organizations …" and that this is the reason"…why their organizations employ many of the same managerial tools that we find in business firms and government bureaucracies [9]."(pgs.14-15) Shapiro substantiates his claim by citing formal documentation such as employment contracts (p.28), vacation policies (p.28), and compensation practices (p.31) gathered from the various raids targeting al-Qaida as well as interviews with captured operatives.

According to Shapiro, the central issues that terror organizations begin with the notion that "leaders need to control how violence is executed and how finances are managed, but the tools to do so create some measure of operational vulnerabilities and therefore increase the likelihood of operatives being caught and a group compromised." (p.17). He states that a central component of terrorism is the proper balance of targeted violence that will produce a politically benefit to the cause (what Shapiro claims is the measure of success for a terror organization); too much violence can lead to a reduction in population support and too much government attention [9]. Maintaining a proper level of violence control is important in that many of the operatives joined the organization with violence in mind, and thusly they wish to pursue many more violence motivated opportunities than desired by leadership [9]. Shapiro's book defines and corroborates many of the processes key to terror organizations as described in Section 2.2.

Whereas Shapiro uses a broad source of literature, a single source of internal terror group doctrine such as Abu Bakr Naji's (Al-Qaida operative) The Management of Barbarism can also be revealing as to challenges that terror groups face. Brachman and McCants (2006) translated, analyzed, and summarized Naji's work for the academic community. The analysis of the text shows that Naji advocates that jihadis study "works on administration so that they will be able to administer regions that fall into political chaos [10]." Furthermore, in support of Shapiro's view, Naji describes organizational struggles to maintain a chain of command, controlling overzealous

recruits from conducting high-level attacks, and challenges in stopping spies [10]. In addition to providing a publically accessible analysis of internal Al-Qaida doctrine, Brachman and McCants ground their effort in the notion that strategic communications is a key component of combatting terrorism. They also imply that terrorist organizations ideologies represent their organizations' strategic communication and such communication is inseparable from policies pursued by terror groups [10].

Helfstein (2009) also makes use of Naji's writings as well as Shapiro's early work (not cited here) to assert that terror groups have a "high level of organizational bureaucratization, evidenced by seized documents …" Furthermore he posits that terror organizations are "subject to basic institutional forces," engage in non-market transactions (e.g. contracts), and have regularized communications (i.e. action report forms) [11].

A major distinction that Helfstein makes is isomorphism vs. autonomy organizational structures. He states that heterogeneity of terror organizations such as al-Qaida, principal-agent problems (as described by Shapiro) make it such that leaders do not necessarily trust operatives, and therefore, the terror groups become isomorphic and bureaucratic [11]. The problem with bureaucratic activities is that they have a large footprint that counter-terrorism efforts can take advantage of and create higher costs for terror groups by necessitating terror groups to use less cost effective alternatives [11]. Helfstein also discusses the population that is recruited into terrorists groups stating that they are not psychologically deficient, but rather cites that terrorist have become unremarkable average people as a result of being forced away from the traditional recruitment, training, and screening cycle.

While Shapiro (2013) and Helfstein (2009) go into depth to describe the terror organization, Takeyh and Gvosdev's (2002) early work made use of international business organizations as analogies for terror organization. Their work focused largely on the institutional nature of the terror organization, asking if terror groups needed to have a stable location where they could organize operations, or if terror organizations could operate without a base [12]. Takeyh and Gvosdev noted that terror groups can take advantage of failed states to set up revenue generating enterprises, training camps, and serve as a pool for recruiting. The central objective of their paper was to point out that rehabilitation of failed states is needed in order curtail the ability of terror groups using these states as bases [12].

The work by Takeyh and Gvosdev may not be as relevant as terror groups morph into what Sageman (2008) calls the leaderless jihad. Sageman's concept is that terrorist groups are becoming increasing decentralized due to counter-terrorism policy and that groups are increasingly moving on-line to radicalize youths in host countries [13]. However, the notion that institutions need "save haven" to operate is still relevant to some terror organizations, and may become increasingly relevant as the Arab Spring creates openings for terrorist group formation, destabilize countries, and decrease international intelligence sharing [14].

While the texts referenced above represent significant work in a growing body of literature that shows that show terror groups bear similarities to business enterprises, there is additional research that is useful in understanding how terror groups make decisions. The author briefly reviews these below.

The U.N. compiled early work on the linkages between terrorism and organized crime, and how organized crime provides a means of financing. This work also provides a theory of how terror group financing evolves and potential origins of terror groups [15].

Benmelech and Berrebi (2007) used data from the Israeli Security Agency to better understand what kinds of people terrorist groups recruited, and how recruitment impacted target selection by these groups. They found that suicide bombers' age and education closely correlated to the targets assigned to bombers as well as attack effectiveness [16].

Moghadam (2003) also studied Palestinian suicide bombers but focused on motivations for Palestinians becoming suicide bombers and the training and indoctrination practices used by suicide bombing planners. Moghadam outlines how motivations lead individuals to volunteer for suicide attacks and how those motivations are reinforced by the terror "institution" to a point where the individual is pressured into not being able to change his mind. The paper also outlines how the organizational aspect of the terror organization are key in weapons procurement, division of labor, and target selection [17].

Feinstein and Kaplan (2009) developed a theoretical model for how terrorist organizations choose their target size. The central purpose of the modeling effort was that larger organizations will select larger targets because they have the organizational capability to, whereas smaller organizations will attack smaller targets [18].

Finally, Jones and Libicki (2008) provide a great resource that document the various reasons as to how terrorist organizations have historically ended. They counter the commonly held belief that terrorist organizations are not successful. Through a comprehensive analysis of 648 terrorist groups they found that 43% ended through effective political transitions (the more narrow the policy goal the more likely the terror group succeeds in a political transition) [19]. The report also found that where groups where not willing to make political transition, 40% were ended through policing and intelligence gathering, 10% of organizations were ended because goals were achieved, and only 7% of terrorist groups were ended through military action (most effective when dealing with an insurgency) [19]. Jones and Libicki analysis provides with potential anti-terrorism strategies that would be useful to test as this work progresses, but are currently outside of the scope of this paper.

2.2. Key processes and available system dynamics models

Table 1 summarizes the relevant literature in various business processes of terror organization. The table also lists the textbook system dynamics business models. For the supporting literature the references included under non-system dynamics column qualified, at some level, how the particular process that are used in terror organizations; the references included under the system dynamics / systems thinking column included, at minimum, a model or systems thinking structure that represent the business process. The selected textbook business models are literally taken from textbooks. For the purposes of this version of the paper and model the author used standard modeling constructs from Sterman's Business Dynamics and Warren's Strategic Management Dynamics [20].

Table 1. Summary of key business processes of the terror organization and textbook system dynamics business models.

Key Business Processes of the Terror Organization	Supporting Terror / Insurgency Literature		Selected Textbook Business Model
	Non-System Dynamics	System Dynamics / Systems Thinking	
Attack and Agency Logic	Brachman et al. 2007 Feinstein et al. 2010 Helfstein 2009 Shapiro 2013	Saeed 2009 Coyle 1985	None found.[2]
Financial Resources	Brachman et al. 2007 Helfstein 2009 Schmid et al. 2004 Shapiro 2013 Takeyh et al. 2002	Schoenwald et al. 2009	Stock Flow Bank Account Structure (Warren 2008, p.126)
Population Support	Brachman et al. 2007 Helfstein 2009 Moghadam 2003 Shapiro 2013	Anderson 2011 Coyle 1985 Saeed 2009 Schoenwald et al. 2009 Weaver 2009	Rivalry Model (Warren 2008, p.487)
Human Resources **(Recruiting, Training, and Experience)**	Bemelech et al. 2007 Brachman et al. 2007 Feinstein et al. 2010 Helfstein 2009 Moghadam 2003 Schmid et al. 2004 Shapiro 2013 Takeyh et al. 2002	Akcam et al. 2005 Anderson 2011 Coyle 1985 Saeed 2009 Weaver 2009	Promotion and Learning Chains (Sterman 2000, p. 490)
Supply Chain Management	Feinstein et al. 2010 Moghadam 2003 Schmid et al. 2004 Takeyh et al. 2002	Coyle 1985	Stock Management Structure (Sterman 2000, pp. 681)
Territory / Capital Management	Brachman et al. 2007 Helfstein 2009 Schmid et al. 2004 Shapiro 2013 Takeyh et al. 2002	Ackam et al. 2005 Coyle 1985	Desired Capacity Model (Sterman 2000, p.806)

2.3. Exogenously modeled policies

For the purposes of this version of the model and for reasons explained in Section 1.2 counter-terror policies will be represented exogenously. The list below captures some of the observed set

[2] Since no good choices for modeling this aspect of the model existed, the author chose to model this aspect in a simplistic pulse train. This is, however, an area for future research.

of counter-terror / counter-insurgency policy that others have modeled or references have mentioned:

- Military action / target elimination
- Policing / Detention
- Supply disruption (money and supply)
- Anti-subversion (to prevent population from joining group)
- Defection through intelligence
- Disrupting leadership / communication

This list is not comprehensive and not all of these policies were tested in this version of the model.

3. THE MODEL

3.1. Sector connectivity

As the approach adapts existing business models, the author has dispensed with using causal loop diagrams to describe the major forces inside the model, and has instead opted to diagram sector connectivity (Figure 3). If the reader wishes to have greater detail on the causal nature of the business components of the model the author provides the proper references that detail the internal causal structure of component sectors in Table 1.

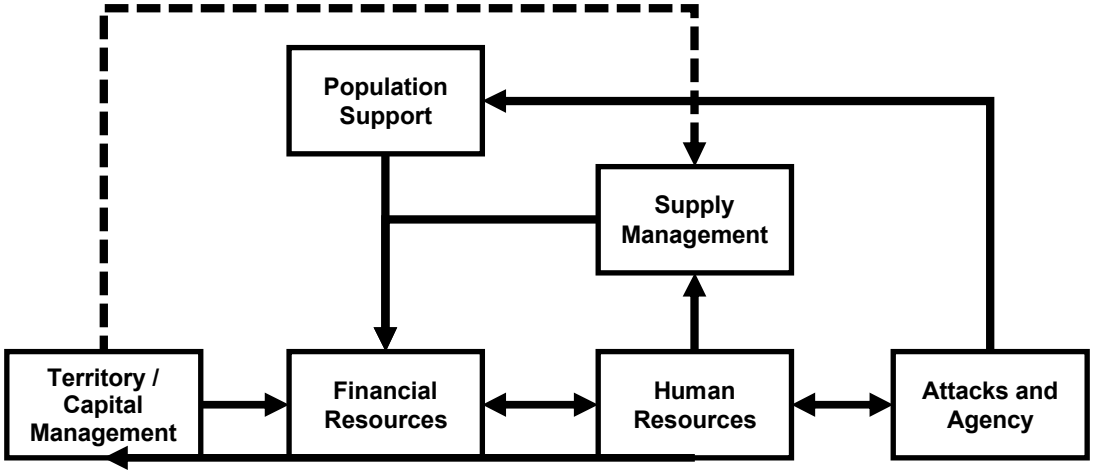

Figure 3. Model sector connectivity.

The Human Resources sector plays a central role in the model. The sector is interconnected to the Financial Resources sector wherein the number of operatives determines the cost of labor for the organization, and conversely the level of financial resources impacts the ability to increase the number of operatives. The number of operatives directly drives the Supply Management sector's supply levels to ensure that each operative has a sufficient number of weapons/ammo. The Human Resources sector also influences the Territory/Capital Management sector by determining the ability to expand territory based on the number of operatives available to allow for expansion. Finally, the Human Resources Sector is interconnected the Attacks and Agency Sector where the number of attacks carried out determine how many operatives are killed, and the ratio of expert operatives vs. rookie operatives drives the agency of rookie operatives (i.e. the

lower the number of experts/leader operatives, the more violent against the population the attacks are which has further impacts).

The Territory / Capital Management sector measures the amount of territory the organizations holds, and determines (by using the number of operatives in the organization) when to expand territory. Territory is a key item in this model because it represents a major source of revenue (connectivity with Financial Resources sector) for the organization (i.e. in this model the more territory the organization controls, the more revenue they earn). Finally, the sector impacts the Supply Management sector whenever an expansion decision is made (extra resources are needed to enable expansion).

The Supply Management sector tracks weapons/ammo that the organization has available for use. It is influenced by the Human Resources and the Territory / Capital Management Sectors (relationships explained above). It influences the Financial Resources sector when weapon orders are placed (i.e. reducing money on hand to obtain weapons).

The Attacks and Agency sector model relevant attacks using an exogenous formulation. The sector is influenced by the Human Resources sector. The sector influences the Population Support sector by influencing public support depending on if an attack is aligned or is not aligned with the relevant population's wishes.

Meanwhile, the Population Support sector influences the Financial Resources sector by raising funds for the organization. In the model the greater the public support the more fund raising the organization achieves. Conversely when public support decreases (because of a poorly targeted attack) the organization receives less money.

Finally, the Financial Resources sector keeps track of the accounting for the organization's expenditures. The current formulation is not sophisticated enough to make allocations based on priority, and may be lacking some connectivity to other sectors to enable better management of financial resources (in the model). However, there are significant feedback loops from the Financial Resources sector that control major aspects of the organization.

3.2. Human Resources sector

The Human Resources sector (Figure 4) plays a central role in the model. The sector tracks the number of operatives (or "bad guys") at relative experience levels (rookie and experienced operatives). The structure, found in Figure 4, is adapted from Promotion and Learning Chains Model from Sterman 2000 (p. 490). There are only minor modifications to Sterman's structure centered on tracking costs (e.g. "Total Labor Costs"), keeping track of operatives or operative rations, and the development of effects that influence the departure of rookies in the system.

Figure 5 contains a stacked graph that displays the number of experienced/leaders vs. rookie operatives. The model runs in equilibrium until month 20 where the organization is allowed to grow the number of operatives in the organization. The mild decrease at about month 200 is due to expansion of territory reducing financial resources and thus temporarily making the organization reduce the rookie replacement rate, however, the stock of operatives quickly recovers and continues to rise.

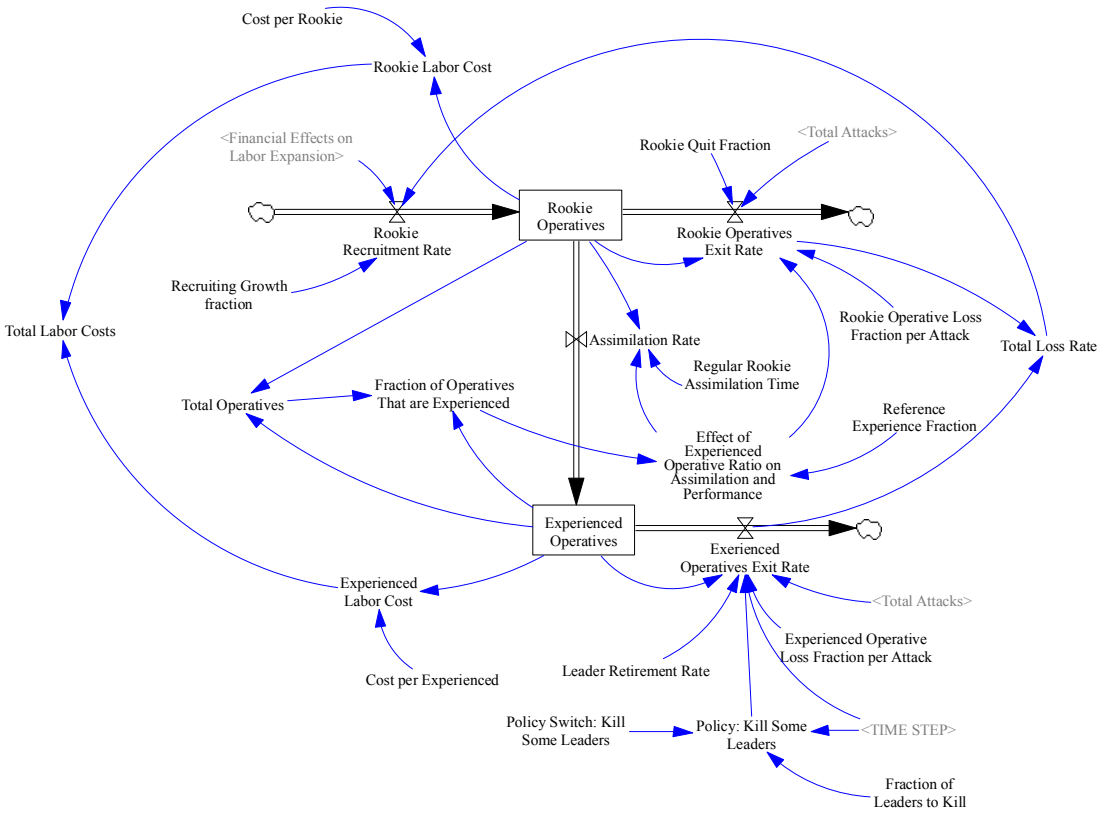

Figure 4. Human Resources sector structure.

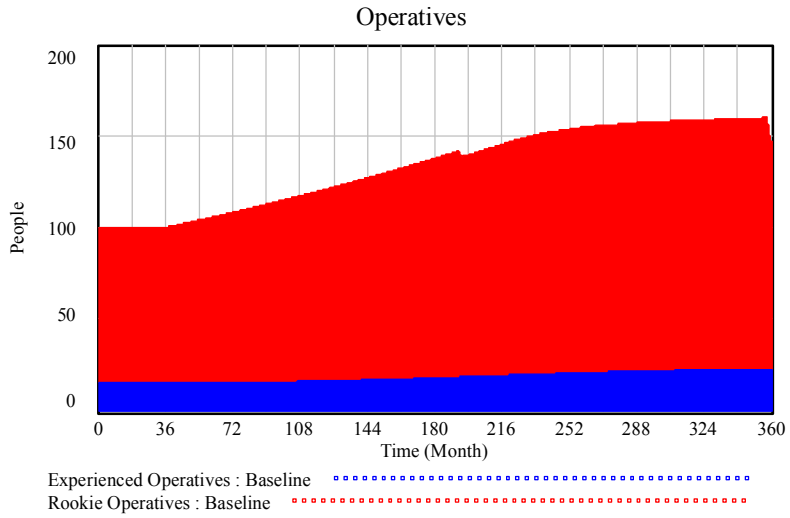

Figure 5. Stacked graphs of operatives from baseline simulation run.

3.3. Territory / Capital Management sector

The territory / Capital Management sector (Figure 6) tracks the area that the organization controls. Based on the Desired Capacity Model by Sterman 2000 (p.806), the amount of territory that the organization controls is a major determinant of income for the organization. The major difference with the standard business model is the decision structure that determines when the organization can expand territory (based on the number of operatives in the organization). Figure 7 is a stacked graph of territorial control (blue not controlled by the organization, green controlled by the organization, and red is in transition.

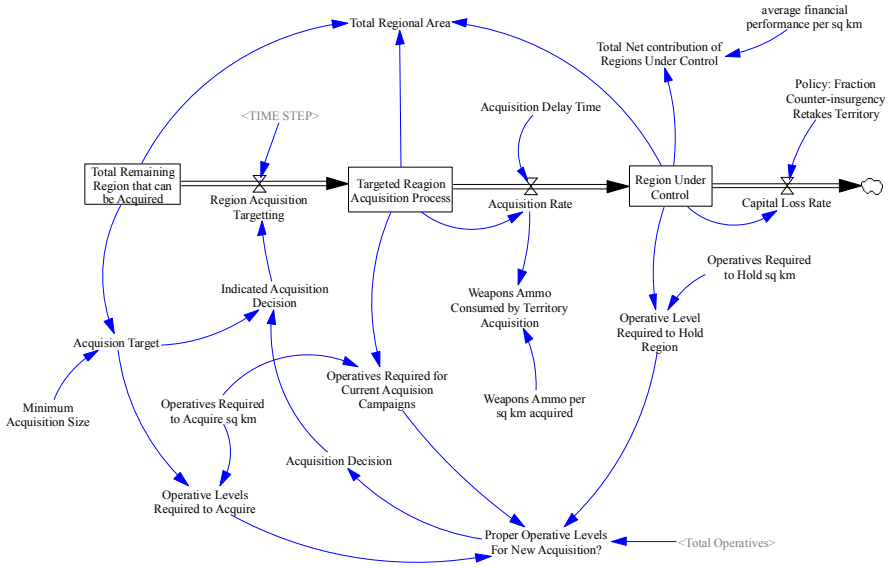

Figure 6. Territory / Capital Management sector structure.

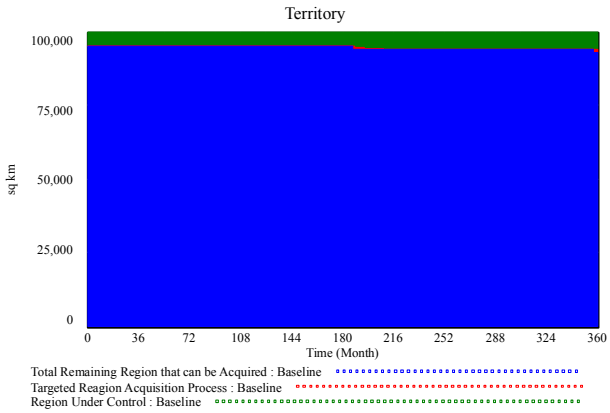

Figure 7. Stacked graph detailing territorial control.

3.4. Supply Management sector

Based on the generic structure Stock Management Structure from Sterman 2000 (pp. 681), the Supply Management sector (Figure 8) tracks the acquisition and inventory of weapons / ammo

by the organization. The amount of ammunition desired in stock is determined by number of operatives in the organization. Also the use of weapons is determined by the amount of territory acquired. In future developments of this model (when attacks are endogenously determined), attacks will also impact the weapons stock. Figure 9 is a stock which measures the weapons stock and supply line.

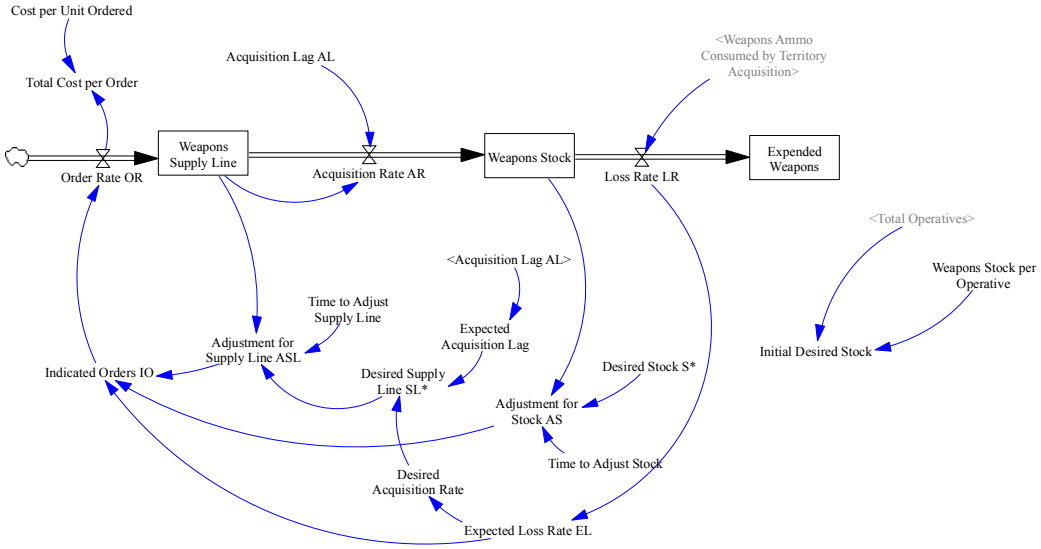

Figure 8. Supply Management sector structure.

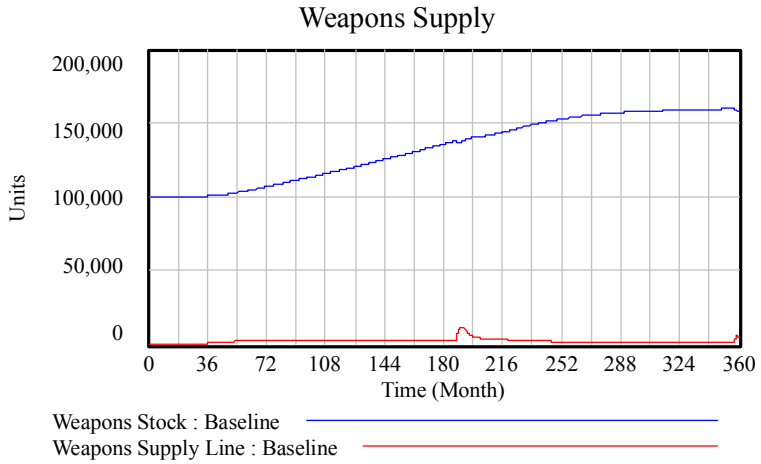

Figure 9. Weapons supply.

3.5. Population Support sector

The Population Support sector (Figure 10) is key because it enables fundraising by the organization. This fundraising enables group expansion and provides critical reserves for territorial expansion operations. The structure used in this sector includes Rivalry Model in

Warren 2008 (p.487) to determine the share of population that is pro or anti the terror organization. The share of the pro population is increased when there are attacks that are aligned with the population's interest. The population against the organization increases when an attack against the interest of the population is committed. Any attack committed against the population lives on in the memory of the people. This is formulated as a ratchet delay from Sterman 2000 (p.437). Figure 11 is a stacked graph that accounts for support in the population. The current model does not include population growth, nor does it use the supporting population as a source for operatives; these dynamics will be modeled in future versions.

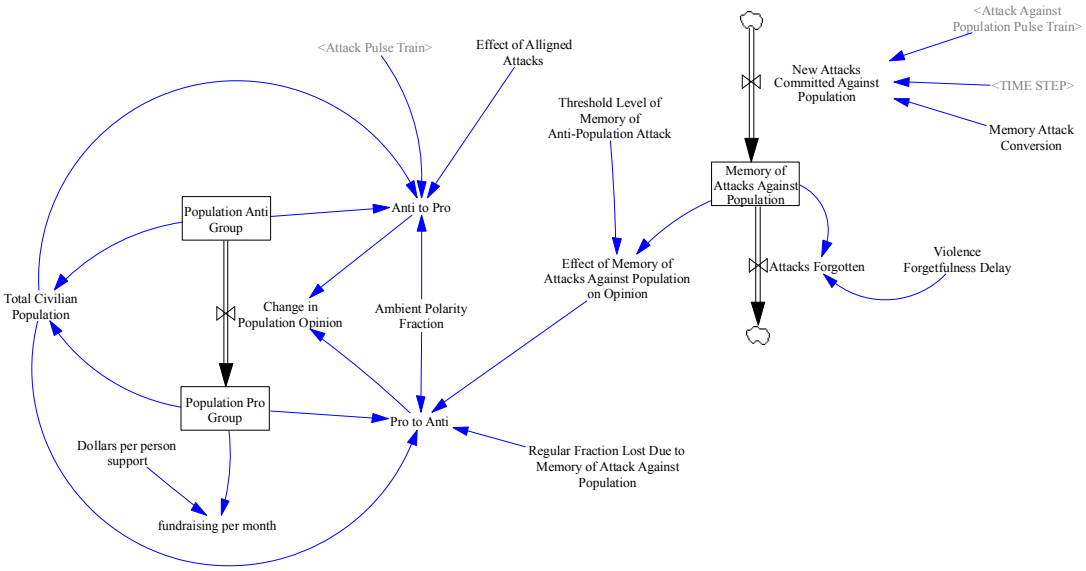

Figure 10. Population Support sector structure.

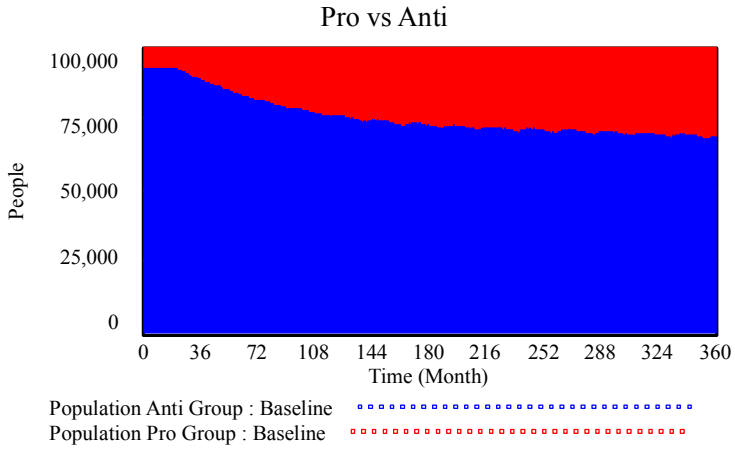

Figure 11. Organization's supporters vs. non supporters.

3.6. Attack and Agency sector

This version of the model includes an exogenous Attack and Agency sector (Figure 12). The formulation includes two pulse trains, one for aligned attacks and one for attacks against the population (for greater details on how this affects other portions of the model see Sections 3.2

and 3.5). The aligned attack is always the same size (valued at 1) and occurs every 2 months and an attack against the population occurs every 12 months (see Figure 13). The attacks against the population changes with respect to the fraction of experienced operatives compared to rookie operatives. The lower the number of experienced operatives the greater the size of the attacks against the population; this is a characterization, albeit a poor one, of the principal agent problem described in the literature. The greatest opportunities for additional development within this model is in this sector as the decision to attack should depend on other factors and should be endogenous.

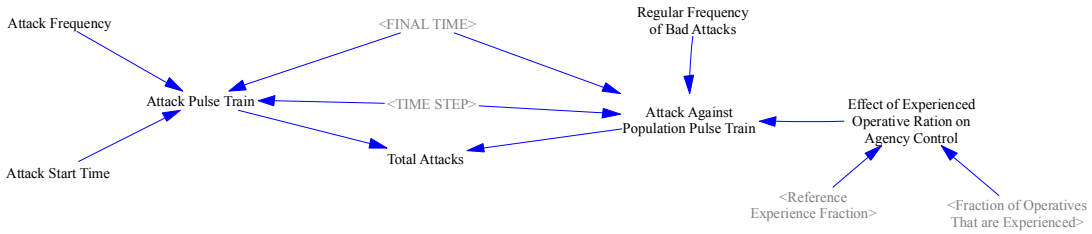

Figure 12. Attacks and Agency sector structure.

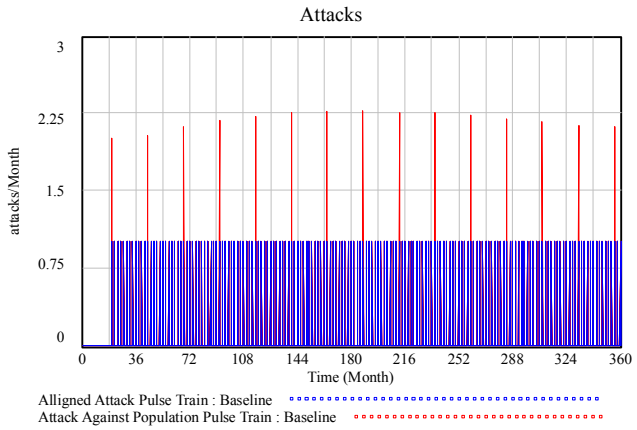

Figure 13. Attack pulse trains.

3.7. Financial Resources sector

Financial decisions are important to any organization. The Financial Resources sector (Figure 14) is represented using a simple stock and flow representation provided by Warren 2008 (p.126). This sector allows the measurement of financial reserve level (see Figure 15) that influence recruiting decisions. Future development will include a more intricate Financial Resources sector with greater first order control, as well as a means of allocating financial resources to various sectors depending on inflows and reserves.

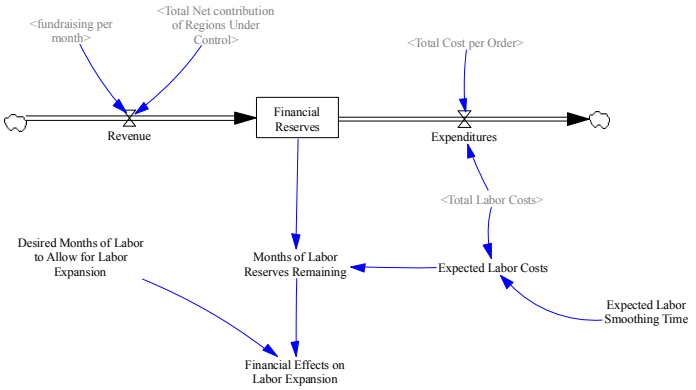

Figure 14. Financial Resources sector structure.

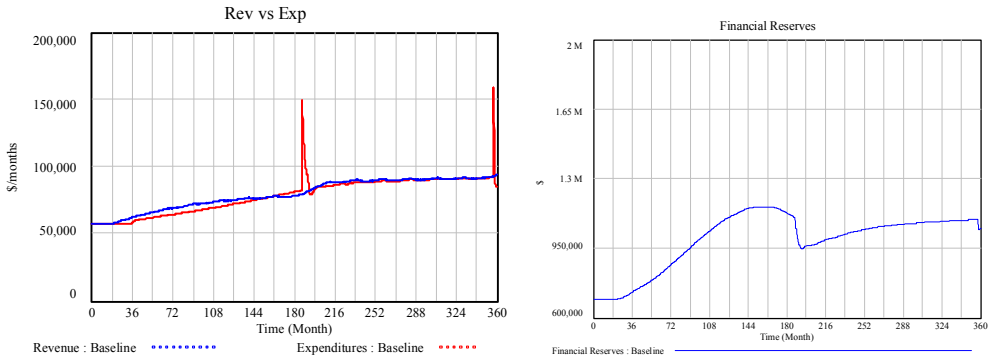

Figure 15. (a) Revenue vs. Expenditure and (b) Financial Reserves

4. DISCUSSION

4.1. Policy test: kill leaders / experienced operatives

This section demonstrates the model by testing it to a policy of killing leaders / experience operatives. For this scenario the author ran three simulations [see Figure 16 (a,b,c,d)] in addition to the baseline in which 0% (blue), 20% (red), 50% (green), and 75% (grey) of experienced operatives were killed [Figure 16(a)]. The death of experienced operatives leads to a loss of agency amongst rookie operatives, which causes more attacks against the population leading to a loss of population support; this is particularly true in the 75% loss scenario, which greatly reduced the ability of the organization to raise money [Figure 16(d)] and therefore has impacts on the organization's ability to grow and keep operatives.

A particularly interesting run is the 50% experienced loss scenario. Figure 16(b) shows that while all runs are able to recruit rookie operatives to replace the experienced ones, when it comes to acquiring new territory (a costly venture) all the organizations reduce their organizational size in response to financial strain of obtaining a new region (in terms of weapons used). The organization in the 50% scenario reduces its population such that it can build its reserves in the short-term (not having the agency problems as the 75% scenario). These dynamics mean that in the long-term the organization affected by a 50% leader loss is able to become more successful and control more territory.

While these results do make the author question about the robustness of this initial version of the model, it is interesting to consider the possibility that a short-term policy like removing a significant portion of leadership could influence long-term the performance of the terror organization positively.

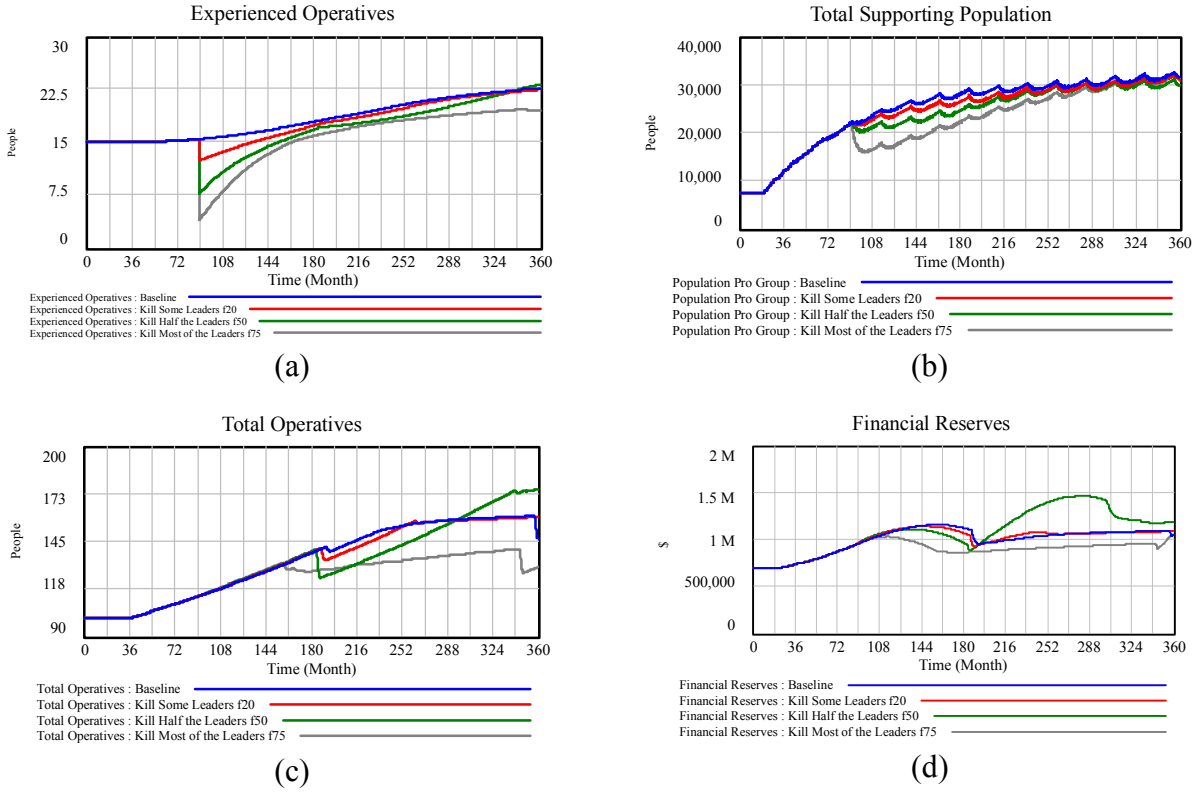

Figure 16. Result of killing leaders/experienced operatives (a) Experienced Operatives, (b) Total Supporting Population, (c) Total Operatives, and (d) Financial reserves.

4.2. Conclusions and future directions

This effort began with an interesting question: is it proper to model terror organizations the same way one would a business? After an extensive literature review the author concludes that not only are there significant benefits of thinking about terror organizations as businesses, but that there is a growing body of literature that supports assessing and thinking about terror groups as businesses. This paper presents important components that any model of terror organizations should include. The author then develops an initial model of terror groups using business models to demonstrate the utility gained from understanding the problem of terrorism from an operations perspective.

Despite the large terrain covered in this paper, there is a lot more to be done. A deeper review of the system dynamics literature including the important book on the subject Paradise Lost, needs to be reviewed for potential model structure. Development of the model needs to continue, to improve model robustness, and better define some of the overall structure. Lastly, the author would like to highlight the importance of developing a cohesive academic community to continue to develop these kinds of models in collaboration with policy makers to reduce threats to national and international security.

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