Emerging-State Actor Model (E-SAM) Supplementary Materials

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Section A Discussion of Model Structure & Parameter Values

A-1 Introduction

The Emerging-State Actor Model (E-SAM) enables policy makers, researchers and military operational planners to understand conflicts involving non-state actors. This includes insurgencies, terrorism, emerging-state actors as well as non-lethal conflicts such as propaganda. Policy makers can use E-SAM to educate themselves on the unanticipated consequences of policy choices. Researchers can instantiate specific iterations of the model to a time and location to study a specific conflict, or more broadly study these conflicts in general. Military operational planners can instantiate a model for a specific theatre or region of interest and analyze courses of action, testing them against baseline scenarios and assess the merits prior to adopting, as well as using the tool to monitor ongoing conflicts.

E-SAM is a simulation that can run to cover up to a 20-year period of conflict between a state-actor government ("Green") and a non-state actor ("Red.") The model can simulate the potential path of progression from initial assumptions, understand the impact of changing conditions or entrance of third party state-sponsors backing either side, or evaluate courses of action for intervention.

 E-SAM is a Systems Dynamics simulation designed primarily to support military operational planning and research into violence and instability. E-SAM is constructed to evaluate and understand medium-to-long term effects (several years to decades) of choices made by state and non-state actors. Within one structure E-SAM integrates territorial data of the region of interest, ethnographic demographics and perception to actors including reaction to grievances, the actors themselves (including governance, financial performance, military activities).

The E-SAM has been designed to support operational planning and research around policy design, testing and monitoring in conflict zones. E-SAM can be used individually or in a game context by multiple users each taking the role of an actor (to educate and inform stakeholders) or run by AI players competing against one another. In any of these configurations E-SAM can be used to test national strategies, forecast the impact on current and future operations of new intelligence, validate existing counter-insurgency theories and uncover new insights into how to conduct conflict in these arenas. Exercises in any of these often involve creating a baseline scenario where performance can be modeled absent significant change. Then intervention portfolios, enemy strategies, and changes in the environment can be simulated along-side the baseline. Significant gaps between strategic

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goals and simulation results indicate potential changes required in allocations as well as possibly adding or removing intervention options.

A-1.1 General Capabilities of E-SAM

E-SAM is designed to be a stand-alone theater/region operational-planning and research tool. E-SAM has capabilities to:

- Simulate the government ("Green") and non-state actor ("Red) activities and decision making across economic, financial, governance, military, terrorist, law enforcement and ethnic relations.
- Incorporate unaligned opposition groups of fighters against both Green and Red Actors to simulate the emergence of loose militias and coalitions that may orbit around, but not be a part of, either Actor.
- Model an unlimited number of ethnographic groups including their perception of both Actors and distribution of population across a four-stage model of increasing legitimacy: Unaligned, Coerced, Calculated Legitimacy and Governed.
- Represent external state-sponsors intervening on behalf of a side ("Blue" for Green Actor and "Purple" for Red Actor) to provide additional capabilities and support for a local Actor.
- Simulate in aggregate terrorism, ethnic cleansing, prison breaks, propaganda and other guerilla activities.
- Simulate conventional military conflict using the RAND Situational Force Scoring combat simulation methodology for force on force conflicts.
- Represents the relevant complexity of above facets including feedback, time delays and nonlinear behavior necessary for understanding the dynamics of conflict.
- Can be instantiated for a specific geographic theatre and point in time for scenarios that might range from political grievances only, clandestine terror networks, insurgencies up through full blown emerging-state actor conflicts.

A-1.2 Realism versus Precision

The analysis generated from these capabilities is intended to be *realistic* even if it is not always *precise.* By *realistic* it is meant that it is the causal interactions of the elements of structure within the model that generate behavior, that over time the behavior is reasonable, and the results familiar enough in behavior shapes to be observed historically. Parameter values represent what is known from sources or modeler judgement on plausible values. All sectors dynamically interact with one another allowing for propagation of 2nd and 3rd order effects. What is meant about not being *precise* is that the parameter values are left as they were found in evidence or estimated by prudent means. They are not further subjected to 'fitting' with exogenous factors that may produce slightly more accurate results, but at the cost of creating inaccurate or implausible parameter values. Time delays in the model are kept relatively constant. What in some cases might take 30 days in others might take 27 and in a third 33. Although the average 30, the accumulation of differences can result in different time delays to manifest historical behavior. Therefore, the behavior patterns, with a desire for realistic behavior, do not always line up on the same timeline as what we know to be historically true. However, they should

replicate the existence of inflection points, tipping points and threshold effects appropriately. (*See Section B-8 Behavior Reproduction for examples.*)

A-1.3 Structural & Formulation Calibration

This is not to say calibration wasn't performed. Where model behavior differed significantly from historical behavior – calibration was accomplished by Structure Assessments (see Validation Section B-5). These assessments identified weaknesses in structure conceptualization or formulation which contributed to unrealistic behavior. By improving the model based on these assessment, "calibration" was achieved with more and more realistic behavior without having to resort to parameter modification based on numerically computed payoff scenarios.

The purpose of this approach, valuing vividly explicit structure generating realistic behavior over numerical precision is to ensure that the model can generate many plausible behaviors – and not just the single behavior historically observed. We know that ISIS captured Mosul in June of 2014 during a rapid advance across Iraq known as the *Anbar Offensive.* The model endogenously creates a similar rapid expansion in the baseline scenario – but at a slightly different time. "Fitting" the model via calibration to ensure that ISIS does indeed take Mosul in June of 2014 may be more *precise* to the historical mode, but such a model may no longer be able to create an endogenously generated behavior mode where ISIS doesn't capture Mosul, whether in June of 2014 or earlier or later. The causal mechanism by which ISIS fails to reach a strength enabling a breakout is more important to research, policy analysis and operational planning than a numerical fitting which ensures what we already know to be true appears in the baseline scenario.

It is the breadth of potential scenario outcomes that E-SAM can generate which makes it ideal to analyze (for operational planners and policy analysts) the allocation of resources among a variety of policy options, including the choice of *not* undertaking a specific action. For researchers it is the ability to remove key components of a known environment and ask, "but for this would this have happened." In ISIS's case what happens if there is no ready oil under the first lands that they capture? Can they grow without the valuable resource? These and other research insights can help understand under what conditions insurgencies form, or insurgencies become emerging-state actors. Because the focus is on *realism* versus *precision* these results should be taken as reasonable approximations of what is likely to happen to behavior over time, given the values of the parameters and underlying assumptions of the model as described in this section – but not necessarily indicative of precise timing down to the day.

A-1.4 Structure of the Sections of Document

The four sections of the supplementary materials to E-SAM.

Section A: Discussion of Structure & Parameterization

This section provides more detailed discussion of the structure, formulation and parametrization approach of select portions of the model. Due to length and other considerations it is available only upon request by contacting the author tbclancy@wpi.edu.

Section B: Validation & Confidence Building Tests

This section provides full documentation on validation and confidence building tests performed on the model. Included are boundary adequacy, structure assessment, dimensional consistency, parameter assessment, extreme condition, integration error, behavior reproduction, behavior anomaly, family member test, surprise behavior, sensitivity analysis, and system improvement tests.

Section C: User Manual for E-SAM

This section provides a stand-alone proposed user-manual for use of E-SAM in wargaming and military planning scenarios. It includes an overview of how to set the scenarios, determine Theatre Strategy, and execute Operational Orders. Also includes a glossary of term linked to current US military doctrine sources.

Section D Model Documentation

This section includes an overview of model-structure by sector, the complete equations for the model, command scripts for the Baseline Historical and Baseline without Intervention scenarios, and all starting model values. It is sufficient to replicate the model in its entirety and recreate the experiments detailed in this paper.

The structure of Section B is:

A-2 Emerging-State Actor Model Overview: Overview of E-SAM, key concepts and capabilities.

A-3 Review of Causal Loop Structures: Overview of the key dynamic hypothesis for emerging-state actors. This section also lists all the conflict archetypes and where they are located.

A-4 Sector by Sector Review of Strategic Architecture: These are the sectors depicting core functions and dynamics of internal elements of both Green and Red Actors. Each sector contains an overview, discussion and presentation of select key dynamics in both baseline scenarios as well as select parameterization values and how they were obtained. (*See Section D for full model equations.*)

A-5 Sector by Sector Overview of World Model: These are the sectors recreating the physical and human terrain within which Green and Red Actors will compete. Covered in similar manner to section B-3.

A-6 Bibliography of Section A

The Section also serves as a repository for discussion of parameterization of key dynamics found within the model that cannot be covered in the article due to space limitations. The full documentation of this Section is intended to allow further development, testing, reproduction and replication testing as well as ongoing refinement of the E-SAM.

A-2 Emerging-State Actor Model Overview

A-2.1 Actors

Local Actors

The Simulator models the development of conflict between two actors: Green and Red. Green represents the status-quo government, ostensibly allied with the United States. Red is the local competing actor – be it a guerilla group, insurgency or emerging-state actor. However, Green is simply the designation of the state actor, and Red the non-state actor – in a scenario.

Nearly any form of less-than-full-spectrum conflict can be modeled using the simulator. The Red Actor may represent terrorist networks operating clandestinely with little or no support of the population. To guerilla movements or insurgencies that have conventional military forces but can't control the territory sovereignly or seek to govern openly. To emerging-state actors who openly seize, and govern as a sovereign, territory. Although these can be influenced by the Theatre Strategy settings (see below) in some cases the Red Actor may endogenously move through these different states. Likewise, the Green actor responses can wildly vary from a counter-terrorism centric approach, population centric, political (address ethnographic grievances) to conventional warfare against the Red Actor.

Ethnographies

The model can depict any number of different Ethnographies that the Green and Red actor are influencing and being influenced by. These ethnographic populations drive many important dynamics as they select which side, Green or Red, they will support and to what extent. An ethnographic population may be split between three states of support with any Actor, and their support may cross different actors:

- Governed is a state where the population views the Actor as the legitimate government.
- Calculated is a state where the population views the Actor as the "best-choice" government for now but is open to switching.

- Coerced is a state where that population would switch sides or leave the government but is prevented by force of arms from doing so.
- Unaligned is a state where the population supports no Actor currently and evaluates the two Actors on where they appear to be heading in terms of support for the Ethnography.

Additionally, under certain conditions members of an Ethnographic population will rise as local-opposition fighters within the Actor. They may not formally be aligned with Green or Red but represent additional indigenous sources of conflict.

Foreign Actors

External state-sponsored support to the Green or Red actor is depicted by Blue or Purple actors. Blue actors support through intervention with accompanying training, equipment provision, combat training etc. the Green actor, while Purple supports the Red actor.

A-2.2 Baseline Scenarios

The E-SAM comes preloaded with two baseline scenarios called "Baseline without Intervention" and "Historical Baseline". These two scenarios are a synthetic representation of events between 2010-2030. Both scenarios are described more fully in the section below "Detailed Baseline Scenario Information." In both scenarios the State Actors of Syria and Iraq, combined, are the Green Actor. While the Non-State Actor of the Islamic State of Syria and Iraq (ISIS) is the Red Actor. The scenarios both progress through a series of common initial stages, then fork at the point when foreign and foreign-supported interventions against ISIS occurred. The *Baseline Without Intervention* represents a counterfactual of what might have happened, had no external intervention occurred. While the *Historical Baseline* represents the same origins as the other scenario, but this time adding the interventions we know happened. These two scenarios are used to illustrate many properties of the E-SAM model structure, and how feedback can drive differing behavior. Three primary measures of effectiveness: territory captured, total combatants and population controlled, are shown in Figure A-1 through Figure A-3Figure A-4 below to illustrate that the models roughly replicate realistic behavior.

Territory Controlled by Actor
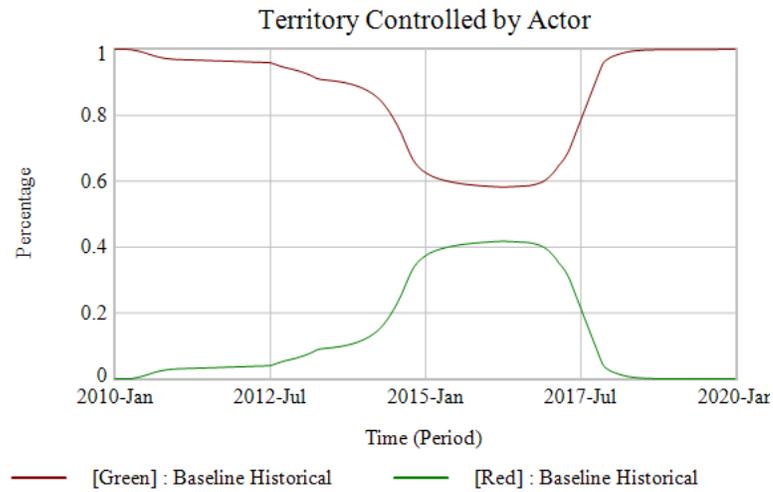
Figure A-1: Historical Baseline – Territory Controlled

Territory Controlled by Actor
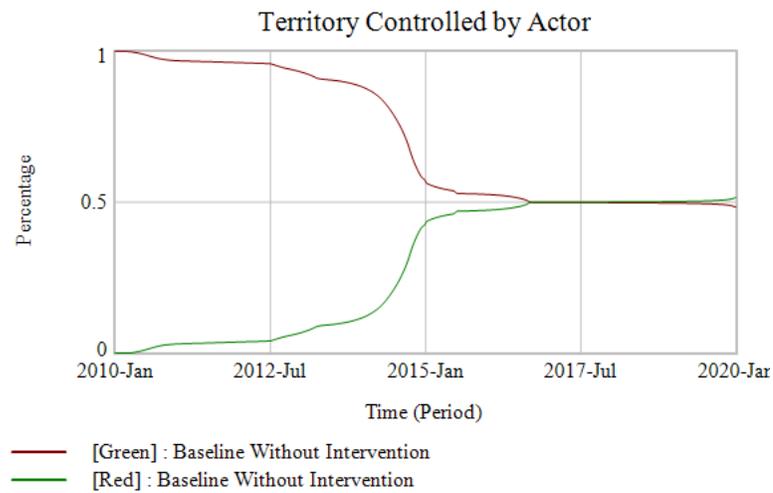
Figure A-2: Baseline without Intervention - Territory Controlled

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Total Combatants[Red]
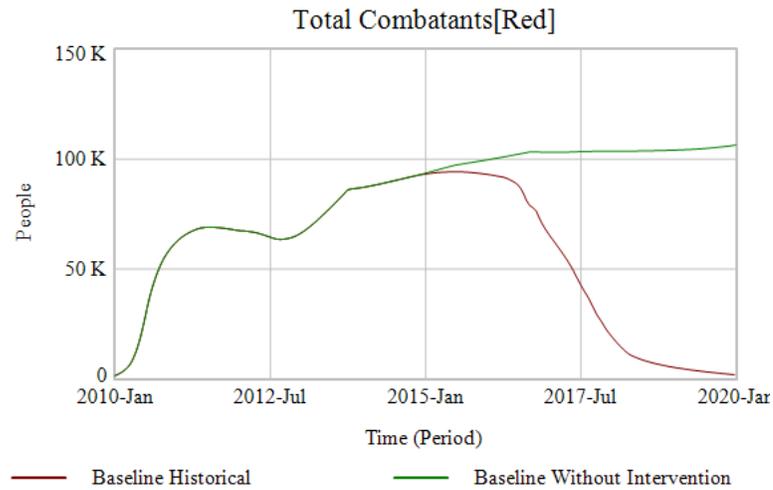
Figure A-3: Baseline Scenarios - Total Combatants for Red (ISIS)

Total Population by Actor[Red]
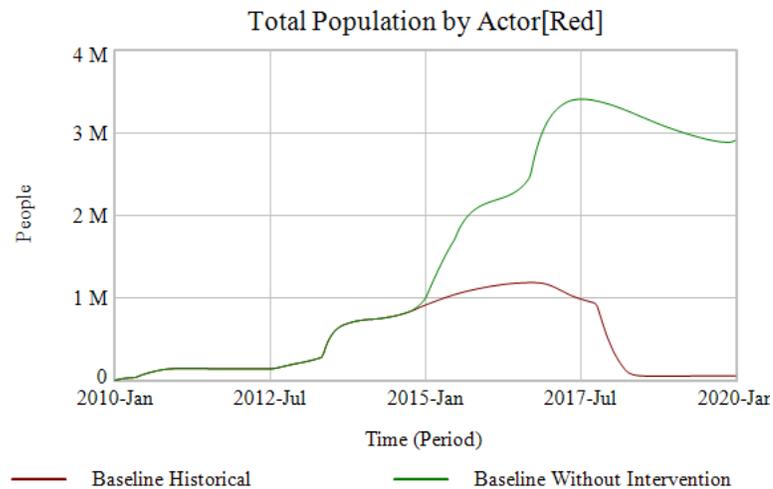
Figure A-4: Baseline Scenarios - Total Population Controlled by Red (ISIS)

A-2.3 Running the Simulation

Every simulation is played by one or more "planners", which may be human participant or a machine learning algorithm. These planners then compete against one another, or against the simulation itself. Note that the

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simulation in this context is ***not*** a learning environment, it creates dynamic conditions upon which a machine learning algorithm can learn.

The progress of simulation activities in each game is the same, regardless of who is portraying a planner.

Selecting Theater Strategies:

First, each planner reviews available Theater Strategies and picks one for their side. A Theater Strategy represents parameter values for numerous starting conditions for either Actor, the Ethnographies, the Territories they are conflicting over or the limitations of external help from Blue or Purple.

Technically, the selection of each Theater Strategy identifies a Scenario file in the database to pull and merge into one unified "scenario" which is then loaded. This unified scenario determines the boundaries of the model, geospatial data of troops, resources, ethnographic population and perceptions and other simulation data. If deterministic strategies are needed, for example what path the Red Actor will seek to conquer cities, this is loaded in as well.

For both actors the Theater Strategies represent decision making by leaders dictating the constraints within which they can create a campaign plan. For the Red Actor this might be fatwa's, the beliefs or grand strategies of key leaders or tribal realities. For the Blue Actor this represents national security objectives, policy constraints, SOFA agreements etc. Once selected each Theater Strategy is fixed for the length of the game. This means there is a bit of game-theory between each planner when picking a Theater Strategy to determine what the other side is picking. However, picking the 'wrong' Theater Strategy versus an opponent selection doesn't guarantee a loss, it just makes the operational campaign much harder.

Operational Orders:

The bulk of the game is played within the simulation as each planner issues operation orders (OPORDs) at regular intervals within the game. These are issued every six months. Because the perspective is operational, the focus is on orders at the campaign plan level and not the tactical. These are choices of allocations of available resources to various tasks. For example, the Red Actor may allocate 20% of their personnel to Recruiting and 5% to Propaganda, but there is no tactical decision making in how recruiting and propaganda are conducted. Constants can be set to mimic general effectiveness of the known tactics of the Actor, but this is part of Theatre Strategy selection and not something the player will be able to modify.

The Operational Orders available to Green and Red Actor are listed in Table A-1.

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A-2 Emerging-State Actor Model Overview

Table A-1: Local Actor Operational Orders

Local Actor Operational Orders	Description
AFV/IFV Purchases	Per Period Purchase Rate of Armored or Improvised Fighting Vehicles
Artillery Purchases	Per Period Purchase Rate of Artillery Pieces
OpOrder Armed Civil Affairs	Pct. of Military Actions allocated to Armed Civil Affairs. This creates government capacity via military force.
OpOrder Combatting Terrorism	Pct. of Military Actions allocated to Combatting Terrorism (AT & CT) activities. CT effectiveness is useful for exposing and thwarting Terrorism and Prison Breaks (though Prison Breaks also require Prison Duty.)
OpOrder Conventional Warfare	Pct. of Military Actions allocated to Conventional Warfare - either capturing or reclaiming Territory.
OpOrder Indirect IED VBIED or SVIED	Pct. of Military Actions allocated to Indirect attacks using IED - these attacks influence conventional combat and are not targeting the civilian population (see Terrorism.)
OpOrder Prison Breaks	Pct. of Military Actions allocated to attempting to break Actor Detainees out of Prison.
OpOrder Prison Duty	Pct. of Military Actions allocated to attempting to prevent Prison Breaks.
OpOrder Propaganda	Pct. of Military Actions allocated to Propaganda efforts.
OpOrder Recruiting	Pct. of Military Actions allocated to Recruiting, by Ethnography.
OpOrder Terrorism	Pct. of Military Actions allocated to conducting terrorism, of all forms, against a civilian population by Ethnography.
OpOrder War Crimes	Pct. of Military Actions allocated to War Crimes, by Ethnography. War Crimes are ethnic cleansing, massacres, forced eviction etc.

Operational Orders available to external actors Blue and Purple are listed in Table A-2.

Table A-2: Foreign Actor Operational Orders

Foreign Actor Operational Orders	Description
Blue or Purple Airpower Targeting Combatants	Pct. of state-sponsor airpower sorties per day that are used in close-combat supports to attack conventional fighters of the opponent.
Blue or Purple Airpower Targeting Government Capacity	Pct. of state-sponsor airpower sorties per day that target the opponents governing capacity.
Blue or Purple Airpower Targeting Resources	Pct. of state-sponsor airpower sorties per day that target resources and resource production.

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Blue or Purple OpOrder Advanced Equipment Provision	Pct. of state-sponsor military actions allocated to the provision and training of advanced equipment use by front-line conventional troops.
Blue or Purple OpOrder Airpower	Pct. of state-sponsor military actions allocated to sustaining airpower operations. The number of troops sustaining airpower determine the number of sorties per day available.
Blue or Purple OpOrder Armed Civil Affairs	Pct. of state-sponsor military actions allocated to increasing government capacity through military units.
Blue or Purple OpOrder Embedded Combat Advisers	Pct. of state-sponsor military actions allocated to embedding troops into local actor units as combat advisers. This will risk these troops to death or detention.
Blue or Purple OpOrder Information Operations	Pct. of state-sponsor military actions engaging in Information Operations, which functions similarly to Propaganda.
Blue or Purple OpOrder Training Local Actor	Pct. of state-sponsor military actions allocated to training local actor in security issues, this improves CT effectiveness.
Intervention Size	The number of people that Blue/Purple desire to have in Theatre supporting the Green or Red Actors respectively.

A-2.4 Primary Measures of Effectiveness

E-SAM tracks multiple measures of effect throughout the course of a single simulation. These measures indicate the current state of the system at any point in time and accumulated over time can create behavior modes. Behavior modes can be compared across simulations to understand the difference between outcomes over time.

In addition to scoring and victory conditions the following primary measures of effectiveness can be tracked. A primary measure of effectiveness is an aggregate measure of the state of the entire system, the two primary actors (Red and Green) in comparison to one another, or a high level of aggregate data for a specific actor. A list of example primary measures of effect are included in Table A-3.

Table A-3: Sample Primary Measures of Effect

Sample Primary Measures of Effect	Description
Actor Combatants that are Local	The percentage of combatants within an actor who are locally recruited vs. the total which includes foreign fighters and Blue/Purple support.

A-2 Emerging-State Actor Model Overview

Actual Garrison	The actual number of allocated military personnel assigned to garrison and/or policing duty from the Actor.
Civilian Deaths	All civilian deaths in total, can be segmented by Ethnography.
Finances	The cash reserves, by Actor. A high surplus indicates available funds to send abroad to sponsor foreign actions by the Actor.
Foreign Combatants	The number of foreign fighters who have traveled to the theatre and joined Green or Red side.
Local Opposition Fighters to Actor	The unaligned or loosely organized local combatants who oppose the Actor, but are not formally part of Green or Red.
Territory Controlled by Actor	The percentage of the overall territory that an Emerging-State Actor has seized control of.
Total Combatants	The total number of combatants or combatants within an Actor.
Total Conflict Deaths	The aggregate number of Green, Red, Blue, Purple combatant deaths, deaths of the local opposition and civilian deaths.
Total Ethno by Actor	The total number of ethnographic civilian population who are in the Green or Red Control.
Total Garrison Needed	The number of combatants who are required to adequately garrison & police the population. Garrisoning at less than this amount will result in the rise of Local Opposition Actors.
Total Population by Actor	The total number of civilian population, across all ethnographies, who are in the Green or Red control.
Total Refugees all Ethnicities	The total number of refugees, either IDP or having exited the country, that have been produced across all ethnographies over the course of the conflict.
Total Terrorist Attacks	The total number of Terrorist attacks by an Actor, regardless of Ethnography targeted or success of an attack.
View Actor as Best Choice for Now	The population wide view of an Actor, across all ethnographies. Represents the percentage of the population who at least view the Actor from a standpoint of calculated legitimacy. When combined with *View Actor as Legitimate Government this* primary measure is referred to as the "conflict narrative."
View Actor as Legitimate Government	The population wide view of an Actor, across all ethnographies. Represents the percentage of the population who view the Actor as the legitimate government. When combined with *View Actor as Best Choice for Now* this primary measure is referred to as the "conflict narrative."

Some sample primary measures of effect from two Baseline Scenarios are shown below in Figure A-5 & Figure A-6.

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Selected Variables

Total Civilians Killed all Ethnographies : Baseline Historical
Total Civilians Killed all Ethnographies : Baseline Without Intervention
Total Refugees all Ethnicities : Baseline Historical
Total Refugees all Ethnicities : Baseline Without Intervention
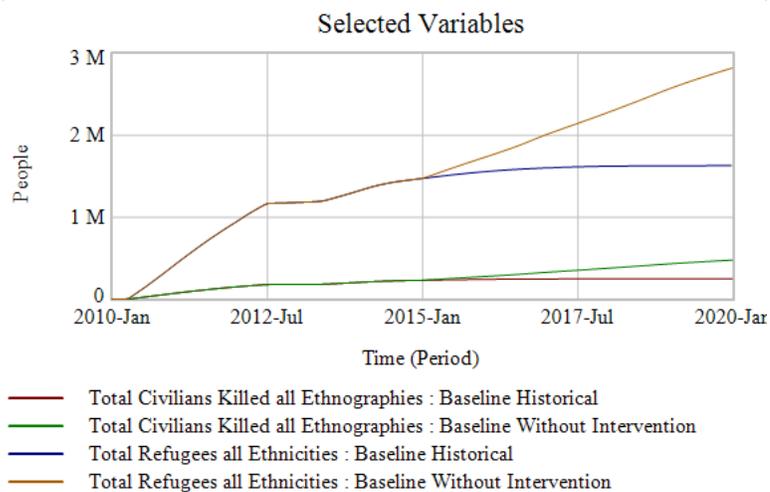
Figure A-5: Baseline Scenarios – Civilian Deaths & Total Refugee Comparison

Pct views Actor as best choice for now

[Arab Suuni,Green] : Baseline Historical
[Arab Shia,Green] : Baseline Historical
[Kurdish Suuni,Green] : Baseline Historical
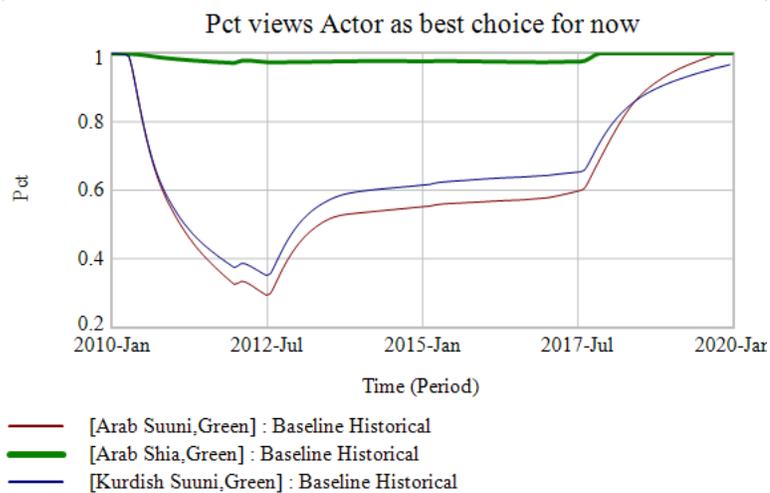
Figure A-6: Baseline Historical - Calculated Legitimacy of Green Actor by Ethnography

A-2.5 Secondary Measures of Effectiveness

Secondary measures of effectiveness are those measures which disaggregate primary measures of effectiveness into greater fidelity. Aggregate population measures may be broken up by ethnography, and total terrorist attacks may be distinguished between successful or unsuccessful. Or a breakout of the expatriate fighters returning from abroad versus truly foreign fighters joining a conflict.

Secondary measures may vary greatly based on the specific topic of study or Theatre Strategy. For example, if a counter-terrorism strategy is envisioned, then the number of terrorist attacks attempted, completed, thwarted and the deaths/refugees specifically from terrorism may be important as a secondary measure of effectiveness.

A-2.6 Sector Overview

E-SAM contains fifteen sectors, split between the strategic architecture and world model. The sectors are listed in Table A-4.

Table A-4: Sector list of E-SAM

Strategic Architecture Sector	World Model Sector
AFV, IFV & Artillery	Ethnographic Perceptions
Combatant Recruiting & Losses	Ethnographic Side-Choosing & Actor Legitimacy
Expenses	Expenses
Foreign Intervention OpOrder Allocations	OpOrder Impacts on World
Governance	Resistance & Uprising
OpOrder Allocations	Revenue
Resource Stocks	SFS Combat Simulator
Revenue	Territory Dynamics

Strategic Architecture sectors represents the capabilities and capacities of the Green or Red Actor that will be used to compete with one another and interact with ethnographic populations in the World Model. The sectors interact in endogenous feedback to create dynamics as displayed in Figure A-7.
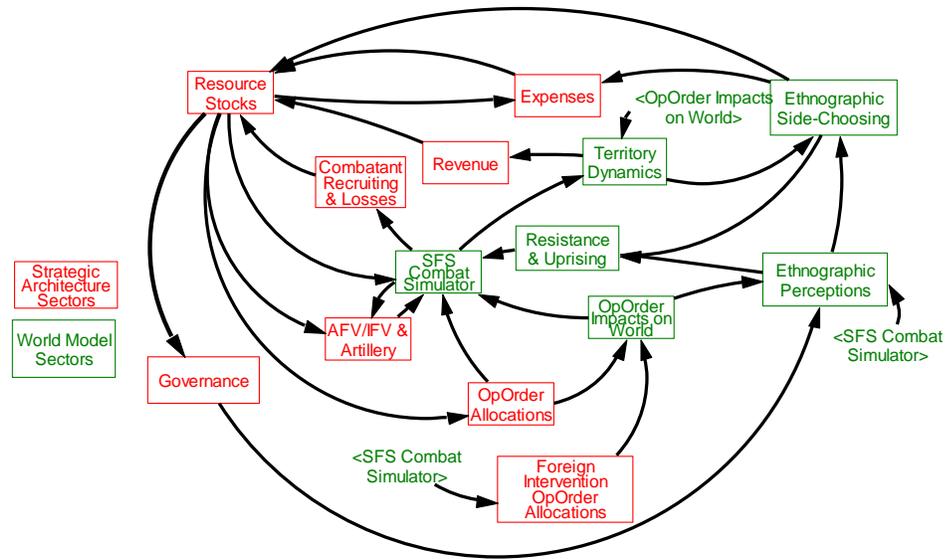
Figure A-7: Overview of Sectors and Interactions

Note that Figure A-7 is not a causal loop diagram of feedback effects. These connections may be working in positive or negative feedback effects depending on the effects of the simulation. For feedback dynamics of reinforcing or balancing loops see section B-2 Review of Causal Loop Structure. Each sector is described briefly below.

Greater detail on these sectors can be found in Section B-3 of the Strategic Architecture and B-4 for sectors of World Model. Sectors are presented in the same order as the structure and equations are provided in Section D. The focus however is not on equations – but review and discussion of key subsystems, notes on parameters and highlighting key dynamics where appropriate. As Section D already includes the equations they are not repeated here. Neither *A-4 Sector by Sector Review of Strategic Architecture* nor *A-5 Sector by Sector Overview of World Model* includes all the parameters contained in the model and some are visually hidden on the structural diagrams for clarity. Given the size of the model it is not feasible to cover every parameter. Physical examination of the structure, formulations and parameters in Vensim is the most comprehensive review.

A-2.7 Notes on Model Software & Settings

The model was created using Software. Final testing of the current version of the model was performed in Vensim 7.1. Using the model in other versions of the software may produce different results.

The model settings are:

Initial Time: 2010 (0)

Final Time: 2020 (40)

Units for Time: Period (= 3months)

Time Step: .0111 (= ~1/day)

Integration Type: RK4 Fixed

A-2.8 Discussion of Time Period Selection & Integration Method

The model is designed to enable review of policies by policy makers. This led to very specific decisions being made on how to set the overall time period, as well as the dt at which each time slice the continuous integration would occur. The time period is equal to 3 months, or 90 days. A dt of .011 corresponds almost exactly to a single day (90days*.011 =.99days).   This is useful because this allows the activity occurring to be understood in the context of any one calendar day. This aligns with standard military approach of setting operational capabilities such as air-strikes per day, rather than air-strikes per month or air-strikes per hour etc.

To ensure there are no DT errors, the lowest time variables in the model are set to = .033, which equates to approximately three days. For example, the length of time a "battle" takes is .033, or 3-day setting. Although this isn't precise as to how long any-one battle may take, some may take hours, some may be diffused over weeks – it does generate realistic behavior. The time delays of each conflict modeled with the E-SAM may vary considerably, especially in different historical time periods. Therefore, determining what constitutes a "period" and what the lowest DT should be are important considerations to make. Setting a DT higher than the lowest time-value of parameters could create visual result of this "sputtering" are graphically spiky graphs, with rapid up & downs that represent the integration calculation reacting to very rapid changes in values that occur at each dt.

Under the current configuration, the model passes integration validation tests. The model performs almost the same across every integration method. However, time delays remain sensitive in some circumstances. This is covered in more detail under Validation & Confidence Building Tests (*see Section B*.)

A-3 Review of Causal Loop Structures

A-3.1 Emerging-State Actor CLD

E-SAM was constructed using a dynamic hypothesis that included a core causal-loop diagram (CLD) structure of the simulation. After construction, the CLD was then revised to include additional loops uncovered in validation & confidence building (*see Section B*) as well as remove redundant loops. The focus of the CLD was also broadened to incorporate multiple modes of unconventional or irregular conflict: clandestine terrorism, insurgency, and emerging-state actor simultaneously. The current causal-loop structure of E-SAM is depicted below in Figure A-8.

Figure A-8: Emerging-State Actor Causal Loop Structure

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The emerging-state actor theory from this CLD can be stated as a series of propositions. These propositions were then tested to explore their contingency space and applicability in different circumstances.[1] The propositions are:

1.   A failure of governance by the state-actor and inability to tolerate civil reforms decreases legitimacy, increases grievance and leads to general uprising and resistance.

2.   This resistance manifests first in the form of clandestine terrorism which increases the perception of instability, further decreasing the legitimacy of the state. Likewise, violent acts reduce incentives of the State Actor to credibly govern the ethnographic group from within which these actions emerge.

3.   Local grievances bring militants and a non-state actor either emerges or is drawn into conflict.

4.   The non-state actor uses militants and finances to conduct military actions.

5.   As the non-state actor gains controlled population begins extracting coercive revenues through criminal activities and recruiting locally from within the controlled population.

6.   Within its territory, the non-state actor attempts to monopolize the use of force, taxation, control of movement, and regulation of the economy. By operating in a sovereign manner, the non-state actor shifts to an emerging state actor.

7.   Coercive revenues & territorial revenues are used to finance governing mechanisms which can begin building legitimacy to shift the controlled population into a governed population.

8.   As the emerging-state actor gains a governed population, it also gains taxation revenue and increases its draw of non-local foreign recruits by propagandizing its non-local grievances, which may or may not align to local grievances.

9.   The loops complete into a positive feedback loop of exponential growth. More militants mean more military actions, which means more territory and access to controlled populations, which can begin to be governed, fueling finances, which fund more militants and military actions.

A-3.2 Conflict Archetypes

In addition to this core CLD, additional dynamics of importance were uncovered in development of the model. Whenever possible these were represented by subsuming classical archetypes from the system dynamics field, either alone or in combination. This is done to make it easier to understand the behavior of these conflict archetypes from existing literature. Conflict Archetypes are not intended to be a "double click" or deeper-dive of any single or multiple loops above in the emerging-state actor CLD. Instead they should be taken as stand-alone archetypes of dynamic behavior that can emerge in irregular conflict. They can be used within the context of E-

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[1] Clancy, "Dynamics of ISIS - An Emerging State Actor."

SAM, or independently without reference to simulation. The current list of conflict archetypes, and where they can be found, is detailed in Table A-5.

Table A-5: Overview of Conflict Archetypes

Conflict Archetype	Classical Archetypes Subsumed	Description	Location
Arming the Enemy	Fixes that Fail	Arms provided to allies frequently end up in the hands of insurgents.	B-3 "AFV & IFV Sector Overview"
Losing the War by Winning the Battles Archetype	Fixes that Fail, Success to the Successful, & Drifting Goals	How military victory against the insurgents can still result in a failed state.	B-3 "Governance Sector Overview"
Revolving Doors	Fixes that Fail & Success to the Successful	How detained insurgents can escape and return to aid the enemy.	B-3 "Combatant Recruiting & Losses Sector Overview"
Foreign Recruiting	Limits to Growth	How foreign recruits can influence a local conflict.	B-3 "Combatant Recruiting & Losses Sector Overview"
Local forces should mirror the enemy, not ourselves.	Fixes that Fail	Training capabilities in our own image can undercut success.	C-12 "Sensitivity Analysis"

A-4 Sector by Sector Review of Strategic Architecture

A-4.1 AFV, IFV & Artillery

Overview

The AFV, IFV & Artillery sector models the acquisition of fighting vehicles of various types. Increasingly insurgencies and emerging-state actors scavenge these vehicles off the battlefield and use them in conflict. Conventional platforms in this vein are known as armored fighting vehicles (AFV). Where a Red Actor, or an underfunded Green Actor, has taken weapons and improvised their use in technical (pickups) these are known as improvised fighting vehicles (IFV). Artillery includes towed and self-propelled cannon and rocket launchers.

This sector is relatively simple consisting of only two subsystems that interact with other sectors in the model as displayed in Figure A-9.
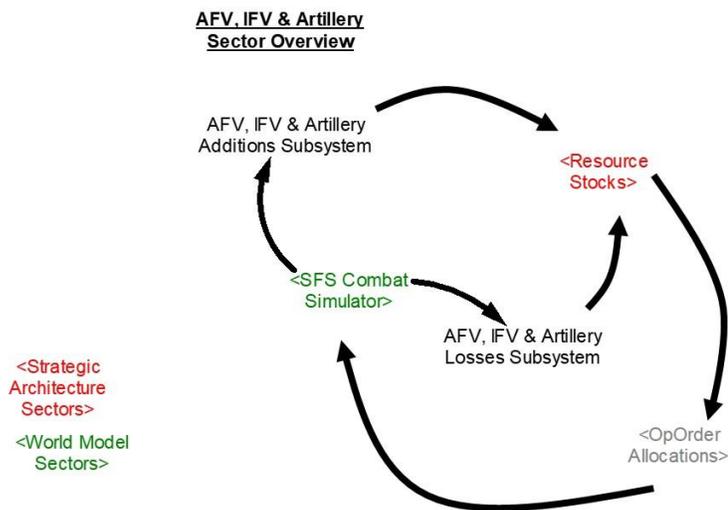
Figure A-9: AFV, IFV & Artillery Sector

These Resource Stocks of AFV/IFV and Artillery represent capabilities the Actor has available to them in pursuit of combat objectives. These intents are expressed through OpOrder Allocations to *Conventional Warfare.* Collectively AFV, IFV & Artillery are a force multiplier in terms of an Actor's ability to attack strongly defended positions and their opponents own armored formations. Historically the prolific use of AFV & IFV is new to ISIS. During US occupation the gaining of these items by AQI was virtually impossible and the use of such weapons would have brought quick retaliation. The environment in Syria and Iraq that ISIS operated in depicted by the Baseline Historical was more permissive – both for gaining AFV & IFV and using them openly. The E-SAM model assumes that Red cannot manufacture this equipment and must instead scavenge them from combat or obtain them from a foreign supplier.

Dynamics

The primary feedback dynamic for this sector originates in the SFS Combat Simulator Sector. There when Green Actor loses these kinds of heavy weapons there is a chance for the Red Actor to scavenge them from the battlefield. This feedback effect can be seen in the loss rates of Green compared to the addition rates of Red. The Historical Baseline without Intervention is selected because it does not contain the interventions from foreign powers. Figure A-10 shows that as the losses of Green occur, the gains in Red match closely.

Selected Variables
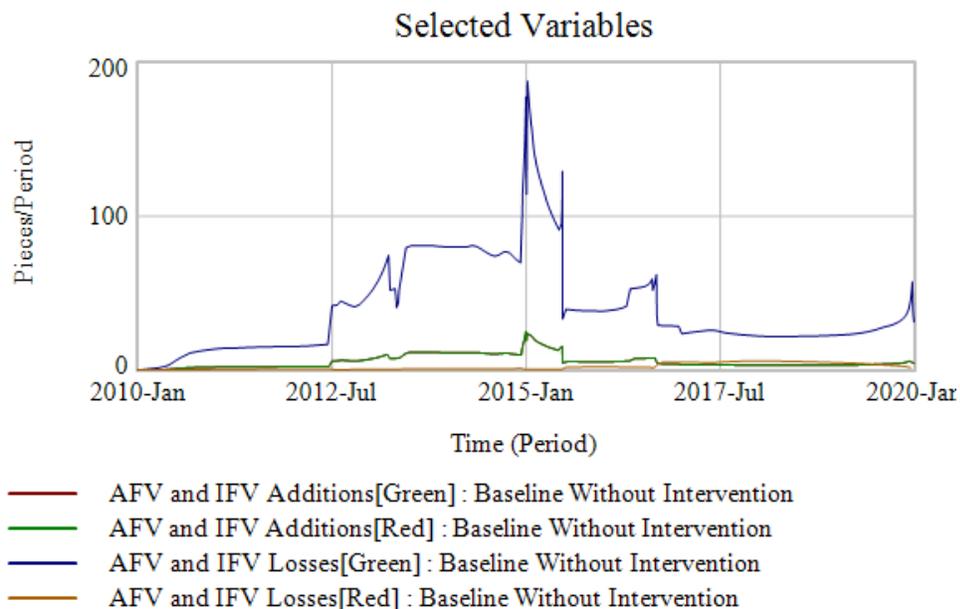
Figure A-10: Losses & Gains of AFV for Green and Red

This effect can be exacerbated when foreign powers provide fleet-additions to AFV & Artillery capacity because it increases the total amount of fielded hardware that the Red Actor can now scavenge. What determines the ultimate effect is the success of Green overall. If it can use the equipment to press an advantage on Red and defeat it, then the intermittent scavenging won't make a difference. Which was the case after the intervention of foreign forces into Syria and Iraq. But prior to that the left-over US equipment that had been provided to Iraq greatly aided ISIS as it was able to scavenge defeated or abandoned material as the Iraqi Army retreated. As shown in Figure A-11.

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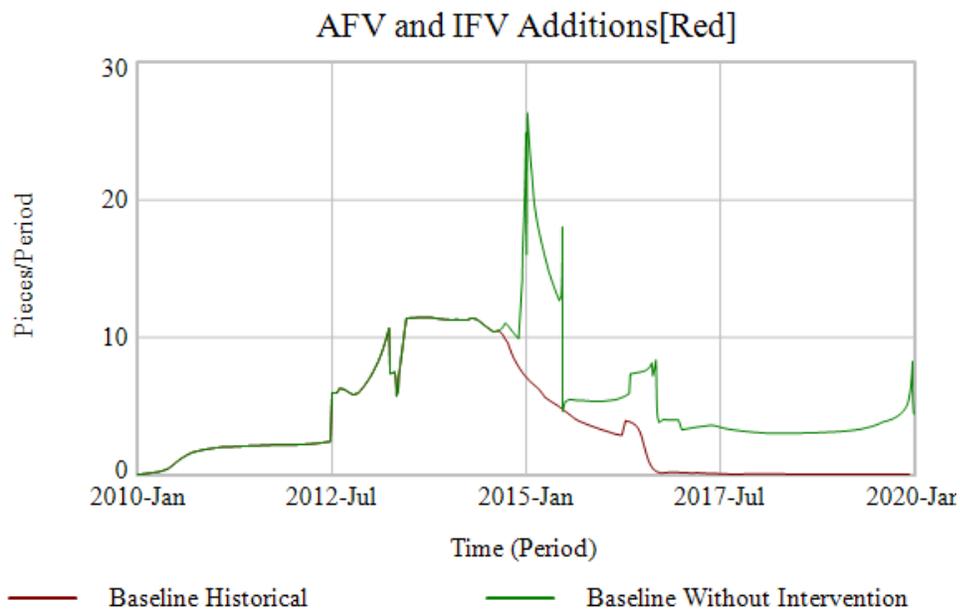
Figure A-11: AFV Gains by Red Actor Both Scenarios

This dynamic can be best understood as a variant of the Fixes that Fail archetype termed "Arming the Enemy." As an Actor purchases or is provided heavier equipment to fight an insurgent threat, there is a risk that this equipment will fall into enemy hands. This archetype is not only something to consider with heavy equipment but also with advanced infantry arms.

Arming the Enemy
(Fixes that Fail)
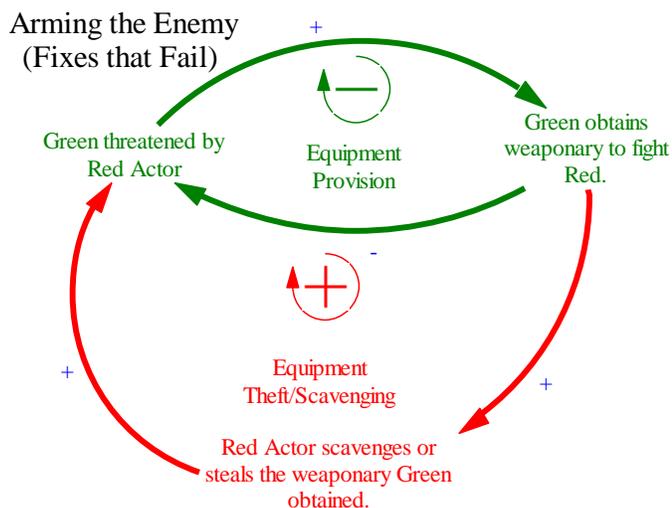
Figure A-12: Arming the Enemy Archetype

Parameterization

In both baseline scenarios Green is initialized with 2137 AFV/IFV and 594 Artillery. The Red Actor is initialized with zero assets of either type. This bears emphasis. As Red Actor receives no foreign support under either scenario all AFV/IFV and Artillery that Red eventually earns comes from the Green Actor.

A-4.2 Combatant Recruiting & Losses

Overview

The Combatant Recruiting & Loss Sector deals with the human resources of Actors that can be used for Military Actions, how they are gained and lost, and how their experience grows over time.
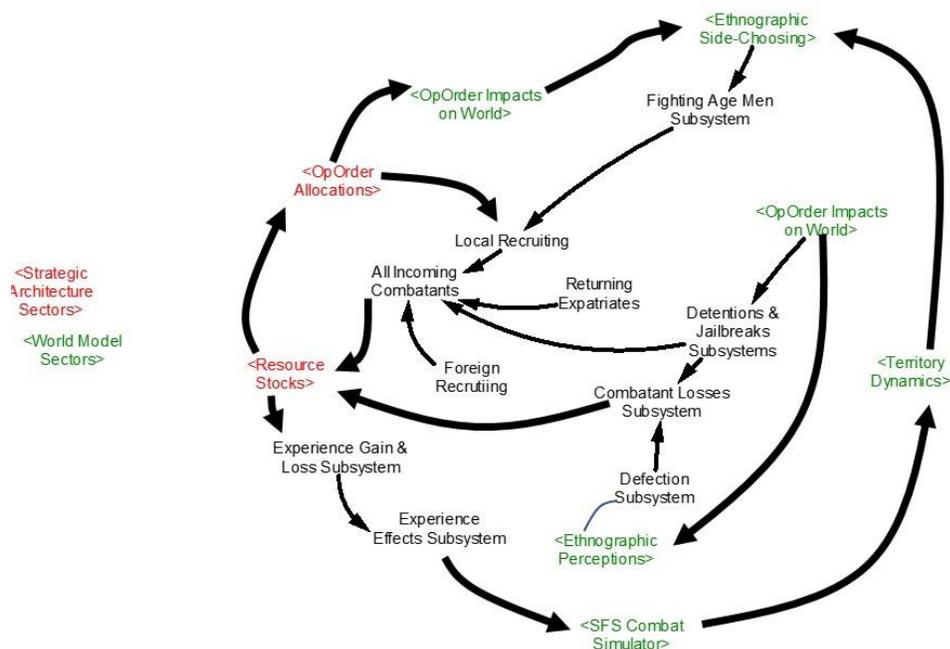
Figure A-13: Combatant Recruiting & Losses Sector

This is a key sector for both Red and Green Actors, though not all the functionality is used all the time. Both actors will typically conduct in *Local Recruiting* at some time or another, and the gain of *Combatant Experience* is automatic. However – only in a scenario that includes expatriated fighters returning from abroad (see: Indonesian Scenario in Validation Tests) will that subsystem be used. Likewise, in the two baseline scenarios the Red Actor (ISIS) is the only one engaging in foreign recruiting from abroad, or freeing it's captured combatants from prison.

Dynamics
Recruiting

Each Actor can gain recruits from several sources as shown in Figure A-14.
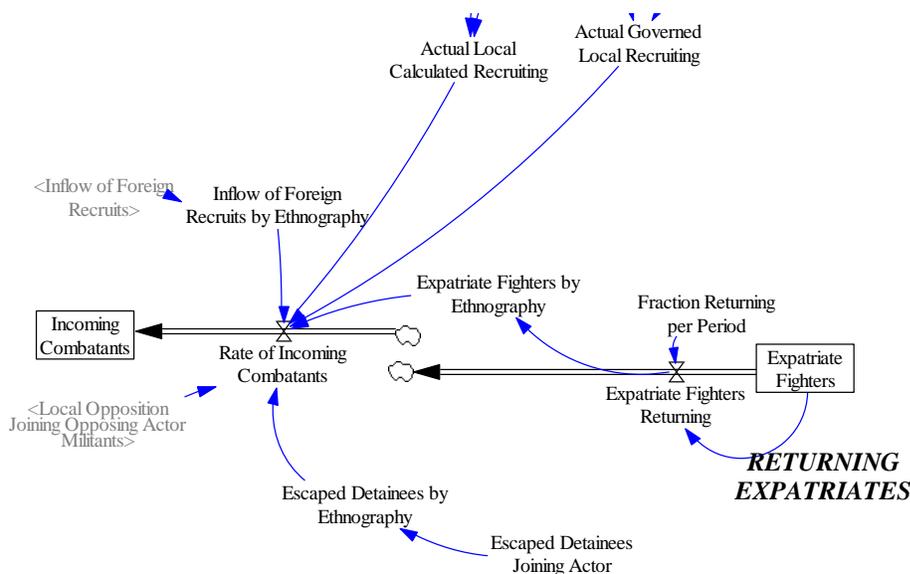
Figure A-14: Structure of Incoming Combatants

This structure is subscripted for each ethnography. Untyped recruits such as *Inflow of Foreign Recruits* and *Escaped Detainees Joining Actor* are distributed for model purposes among the ethnographic groups based on the current representation of that ethnographic group in the Actor's forces. *Actual Local Recruiting* require Military Actions and only apply against the Fighting Age Men (FAM) of the *Calculated Legitimacy* or *Governed* ethnographic population. *Escaped Detainees* are obtained by successfully completing *Prison Break* OpOrders against the opposing Actor's *Prison Duty.* The opposing actor's inability to control its population may result in *Local Opposition Joining Opposing Actor.* What this means is if the Green Actor is fighting *Local Opposition Fighters* in the Resistance & Uprising Sector some of those will commit and pick the Red Actors side. *Expatriate Fighters Returning* is not used in either baseline – but is included for circumstances in other countries where fighters who went abroad as *Foreign Recruits* then return. There is a brief example of this in the Validation & Testing section under the Indonesian scenario within the Family Tests.

These flows activate at different times and to different levels as shown in Figure A-15 from the Baseline Historical for Sunni Arab [Red Actor] only.

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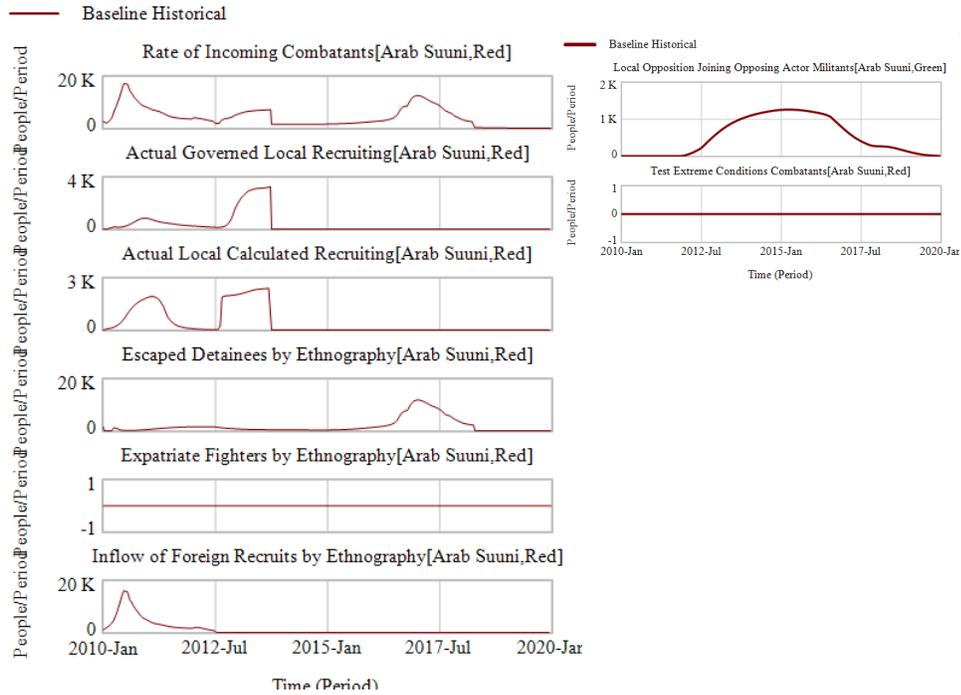
Figure A-15: Incoming Combatants by Source [Sunni Arab, Red]

As is demonstrated in Figure A-15 these inflows activate at different times and to different levels. This is important for policy making as it identifies when, and how, recruiting will travel along these flows. *Foreign Recruits* for example are more important earlier while *Escaped Detainees* peak later, and both in their peaks provide more combatants than local recruiting. These are mapped side by side to provide sufficient scale as shown in Figure A-16.

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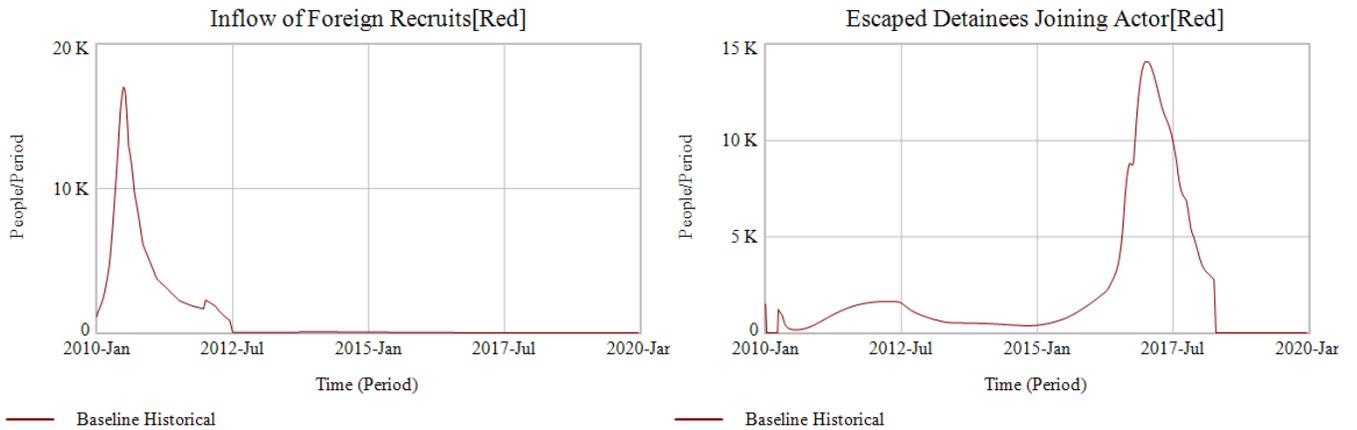
Figure A-16: Foreign Recruits & Escaped Detainees [Red]

Although Escaped detainees provides a continuous rate of incoming combatants as high as the early peak of *Calculated* or *Governed* recruited. But they also themselves provide an enormous recruiting potential later in the conflict. This makes sense considering the highest concentration of potential Red combatants is not in the limited population supporting Red in the early stages of the conflict – but rather in prisons where they have been accumulated by counter-terrorism or law-enforcement actions.

Escaped Detainees

Jail breaks and mass prison escapes are a primary recruiting tactic of the Islamic State to obtain experienced combatants.[2] Table A-6 lists specific jail breaks that have may have provided recruits to the Islamic State by providing the location, date, event name, estimated combatants and the percentage of combatants that are believed to have joined the Islamic State (or its previous incarnations) and the total estimated takfiri combatants who escaped. The percentage allocation is an estimate at best. Open-source details of where combatants went after being free is difficult to obtain. Guidelines used are prison escapes directly attributed to the Islamic State, or its previous incarnations, or within their sphere of influence (Syria or Iraq) are allocated at 100%. Likewise, operations conducted during the (then ISIS) campaign of "Destroying the Walls" which ran from July 2012 through the end of 2013 excepting those obviously conducted by a separate group with no operational linkage to the Islamic State (e.g. Boko Haram) which are not listed. In August of 2013 INTERPOL issued an alert regarding this effort after "a series of prison escapes across nine INTERPOL member countries in the past month alone, including Iraq, Libya and Pakistan." [3] The close clustering of many major prison breaks during the 2012-2013, and especially Jun-August of 2013, indicate a potential operational tie with the Islamic State's campaign. The assumption that these combatants eventually in part came to ISIS is in part based both on the stated aims of "Destroying the Walls", personnel accounts of escapees joining ISIS[4] and that ISIS specifically tracks "Prison Escapes" as a strategic metric in its 2013 Annual Report.[5] Operations conducted in Yemen are allocated 50% to the Islamic State and assumed that 50% of the combatants returned to Al-Queda in the Arabian Peninsula (AQAP) or other factions. This is based off the strong ties between the two groups prior to the Islamic State's breakoff from Al-Queda. Operations conducted in Afghanistan by the Taliban, are allocated at 25% of the

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[2] Evidence suggests Boko Haram has also adopted this tactic of recruitment through jail breaks. Over several incidents 2012-2013 Boko Haram combatants freed several hundred of their fellow combatants from Nigerian prisons. However, these are not included because there is no strong evidence that Nigerian combatants have joined ISIS.

[3] INTERPOL, "INTERPOL issues global security alert advising increased vigilance for terrorist activity," INTERPOL, http://www.interpol.int/News-and-media/News/2013/PR091, accessed September 19th, 2014

[4] Tim Arango and Eric Schmitt, "Escaped Inmates from Iraq fuel Syrian Insurgency," New York Times, http://mobile.nytimes.com/2014/02/13/world/middleeast/escaped-inmates-from-iraq-fuel-syria-insurgency.html?referrer=&_r=0, accessed September 29th, 2014.

[5] ISIS Annual Report TBD.

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Islamic State – these operations occurred while the Islamic State, primarily known then as Al-Queda in Iraq, was strongly connected to the Al-Queda global network and leading the insurgency in Iraq.

Table A-6: List of Militant Jail Breaks

Location	Date	Event	% Allocated to Islamic State	Estimated Jihadi Combatants Released and/or Escaped
Sana'a, Yemen	6/2/2006	Political Security Prison Break	12 (50%)	23 combatants[6]
Kandahar, Afghanistan	6/14/2008	Sarposa Prison Break	300 (25%)	~1200 combatants[7]
Baghdad, Iraq	7/20/2010	Camp Croppe Prison Escape	4 (100%	4 senior AQ leaders[8]
Kandahar, Afghanistan	4/25/2011	Sarposa Prison Break	122 (25%)	~488 combatants freed[9]
Sedanya Prison, Syria[10]	6/20/2011	Syrian Amnesty Orders #53 & #61	700 (50%)	~700 combatants released[11]
Al-Mukalla, Yemen	6/22/2011	Al-Munawara Prison Break	31 (50%)	62 combatants freed[12]
Tikrit, Iraq	9/28/2011	Tasfirat Prison Break	90 (100%)	~90 combatants freed[13]
Aden, Yemen	12/12/2011	Aden Prison Break	14 (100%)	14 combatants freed[14]

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[6] Adel Al-Haddad, "23 Al-Queda suspects escape from Political Security Prison," Yemen Times, http://www.webcitation.org/query?url=http%3A%2F%2Fwww.yementimes.com%2Farticle.shtml%3Fi%3D918%26p%3Dfront%26a%3D1&date=2009-09-07, accessed September 23rd, 2014.

[7] Carlotta Gall, "Taliban free 1,200 inmates in attack on Afghan Prison," nytimes.com, http://www.nytimes.com/2008/06/14/world/asia/14kandahar.html, accessed September 23rd, 2014.

[8] Martin Chulov, "Iraqi officials investigate warden's involvement in al-Qaidia jailbreak," theguardian.com, http://www.theguardian.com/world/2010/jul/25/iraq-al-qaida-prison-warden, accessed September 23rd, 2014.

[9] Taimoor Shah & Alissa J. Rubin, "Taliban breach Afghan Prison: Hundreds Free," nytimes.com, http://www.nytimes.com/2011/04/26/world/asia/26afghanistan.html?hp&_r=0 accessed September 23rd, 2014.

[10] In 2011 Syrian President Assad issued Amnesty Orders #53 & #61 which emptied Sedanya prison of all Islamic Combatants. Although this was presented as a 'reform' it was considered at the time an intentional act by Assad to radicalize the opposition. Although not a prison 'break', the influx of hardened combatants into ISIS ranks is included in the Prison Break/Amnesty flow.

[11] Rania Abouzeid, "The Jihad Next Door: The Syrian roots of Iraq's newest civil war," Politico.com, http://www.politico.com/magazine/story/2014/06/al-qaeda-iraq-syria-108214.html#.VByn7xafgzd accessed September 19th, 2014.

[12] Reuters News, "Dozens of Al Queda militants escape from Yemen Jail" reuters.com, http://www.reuters.com/article/2011/06/22/oukwd-uk-yemen-qaeda-idAFTRE75L1KG20110622, accessed September 23rd, 2014.

[13] BBC News, "Iraq combatants attack Tikrit prison, freeing 90 inmates", BBC.com, http://www.bbc.com/news/world-middle-east-19750039, accessed September 19th, 2014

[14] ABC News, "Al Queda Combatants tunnel out of Yemen Jail," abc.net.au, http://www.abc.net.au/news/2011-12-12/al-qaeda-combatants-tunnel-out-of-yemen-jail/3727376, accessed September 23rd, 2014.

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Abu Graib, Iraq	7/21/2013	Abu Ghraib Prison Break	500 (100%)	~500 combatants freed[15]
Benghazi, Libya	7/27/2013	Kuafiya Prison Break	1117 (100%)	**1,117 combatants freed[16]**
Dera Ismail Khan, Pakistan	**7/29/2013**	**Dera Ismail Prison Break**	**250 (100%)**	**~250 combatants freed[17]**

Detainees in Iraq & Syria were initialized at 1500, or about half the sum of all entries above. The subsystem of Detentions & Jail Breaks provides conceptual understanding of what will happen with this pool of detainees, as well as those that are detained by Green over the course of the conflict.
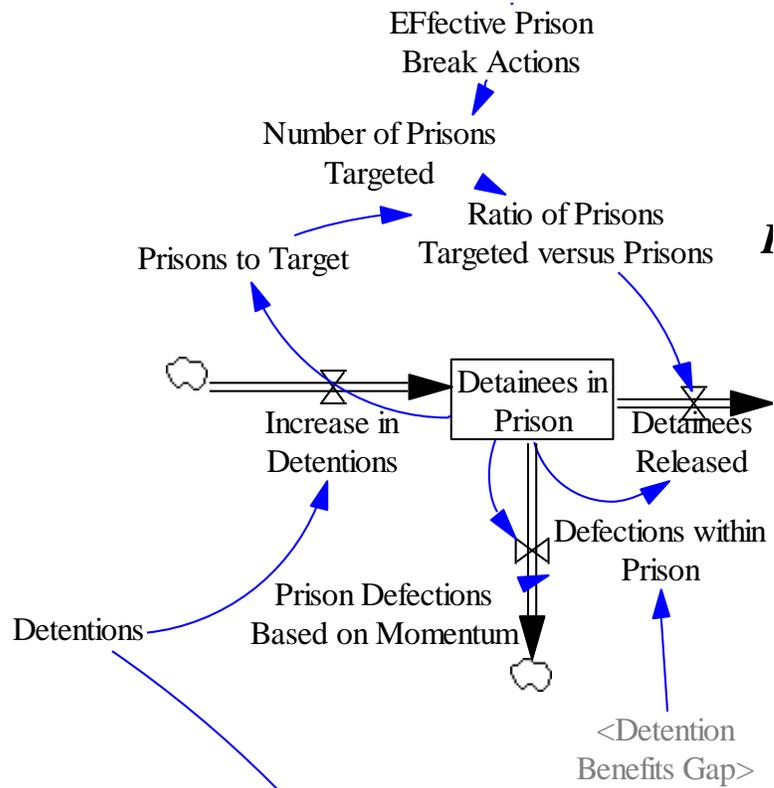
Figure A-17: Detention & Jail Break Subsystems

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[15] Bill Roggio, "Al Queda Assaults Iraqi jails, free hundreds of prisoners," longwarjournal.com, http://www.longwarjournal.org/archives/2013/07/al_qaeda_assaults_ir.php, accessed September 19th, 2014.
[16] Al Jazeera News, "Explosions Target Benghazi judicial buildings," Aljazeera.com, http://www.aljazeera.com/news/africa/2013/07/2013728185027351689.html, accessed September 23rd, 2014.
[17] Al Jazeera News, "Pakistan Taliban prison raid frees hundreds," aljazeera.com, http://www.aljazeera.com/news/asia/2013/07/2013729201057462974.html, accessed September 23, 2014.

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New detainees enter the structure from battlefield losses of the Red Actor or thwarted Terrorist or Prison Break actions. Red Detainees leave either by being released through a prison break or defecting away from Red while within prison. This defection rate is based on two factors. The perception of Actor momentum and the continuing payment of detention benefits. Red Actor Detainees will stay more loyal if they think their side is winning or if they or their families continue receiving payments while they remain in jail. *Effective Prison Break Actions* is a function of the OpOrder allocations of the two sides. *Prison Duty* for Green and *Prison Break* for Red. Detentions

Revolving Doors System Archetype

It's important to understand the feedback dynamics of this structure. Even if counter-terrorism is successful a failure to adequately guard prisons creates a "Revolving Doors" archetype at work, which combines the features of a Success-to-the-Successful with a Fixes-that-Fail archetype as depicted below in Figure A-18.
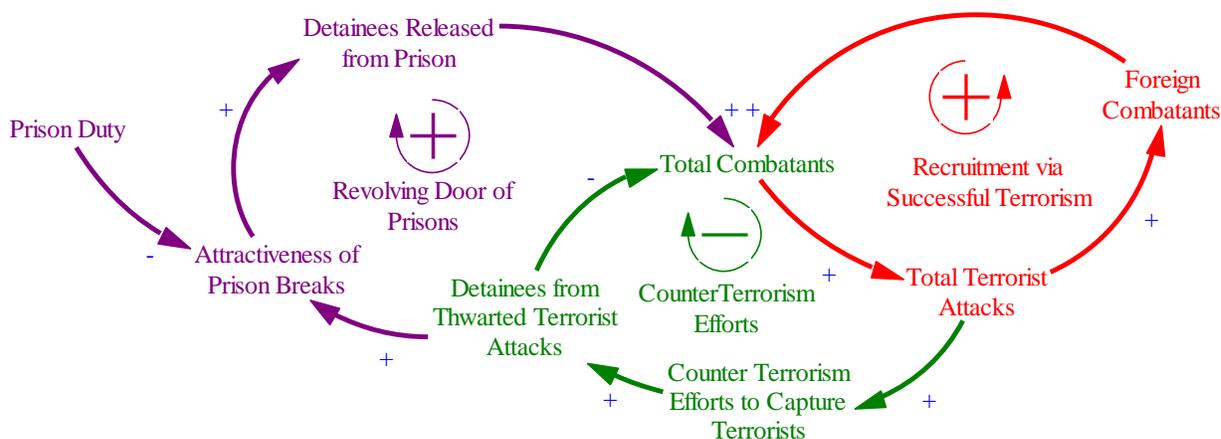
Figure A-18: Revolving Door Archetype

The more terrorist captured by CT efforts, the more detainees there are to be released in weakly secured prisons. This is the Fixes-that-Fail archetype, a balancing and positive loop combined. However, because terrorist attacks in this case also serve as recruitment for *Foreign Combatants,* there's an additional positive feedback loop creating a Success-to-the-Successful archetype through *Total Combatants.* Except instead of a losing party and a winning party as in normal Success-to-the-Successful, the non-state actor benefits by "losing" since any fighters caught will potentially be returned by jail breaks later. This "Revolving-Door" is a persistent problem in countries with an inability to secure their prisons adequately. The way to break the cycle is through adequately trained troops providing sufficient *Prison Duty*.

Foreign Combatants

As mentioned above *Foreign Combatants* are an important source of early incoming combatants to Red Actor. The structure of this subsystem is displayed in Figure A-19 below.
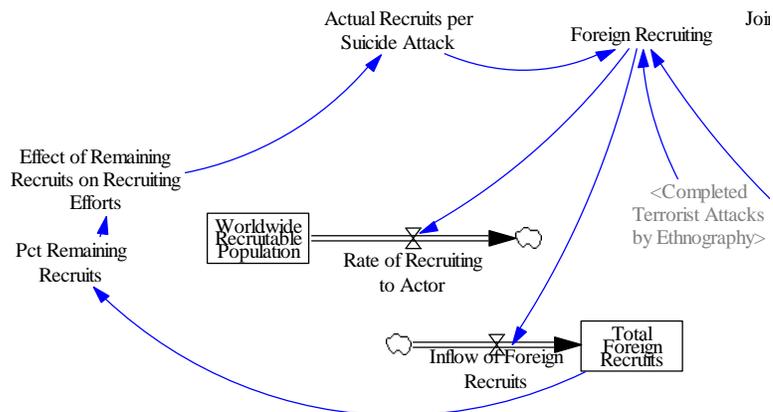
Figure A-19: Foreign Recruiting Subsystem

The instigating mechanism of foreign recruits are *Completed Terrorist Attacks by Ethnography*. These attacks, one broadcast online via social media and other forms of propaganda, reach out and attract members of the *Worldwide Recruitable Population.* This population is an estimate, set at 50,000 for both baseline scenarios, of the total number of potential Red Actor sympathizers who will respond to terrorist propaganda and travel abroad to join Red Actor. The dynamic fuels a brief, yet powerful, limit to growth archetype, depicted in Figure A-20.
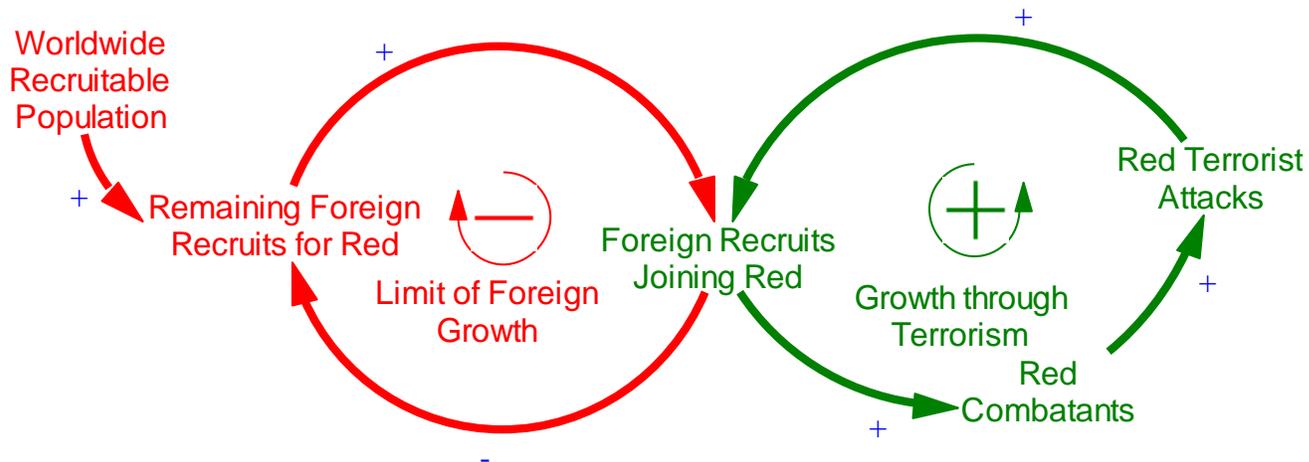
Figure A-20: Foreign Recruiting Archetype

As Red commits *Terrorist Attacks, Foreign Recruits* are attracted from overseas and join as *Red Combatants* which then allows Red to commit more *Terrorist Attacks.* If there is a sufficient remaining worldwide recruitable population to draw upon – Red will experience exponential growth in its *Combatants.* Actors who employ this tactic will enjoy larger initial growth while the other methods of gaining recruits – recruiting among local populations for example – aren't yet as productive. Likewise, *Foreign Combatants,* once having joined Red Actor, do not defect out of disaffection of a local ethnography to that Actor (see defections below.) This is one critical reason emerging-state actors with a global narrative fare better than local-only insurgency actors. They can attract a foreign military force that will not be beholden to local conditions and will continue to support the emerging-state actor even as local sympathies begin to fade.

Militant Experience

Militant Experience is a co-flow attribute stock in the Resources Sector tracking the accumulated experience of both Red and Green Combatants. However, the main structure driving this stock is in the Combatant Recruiting & Losses sector and is depicted in Figure A-21 below.
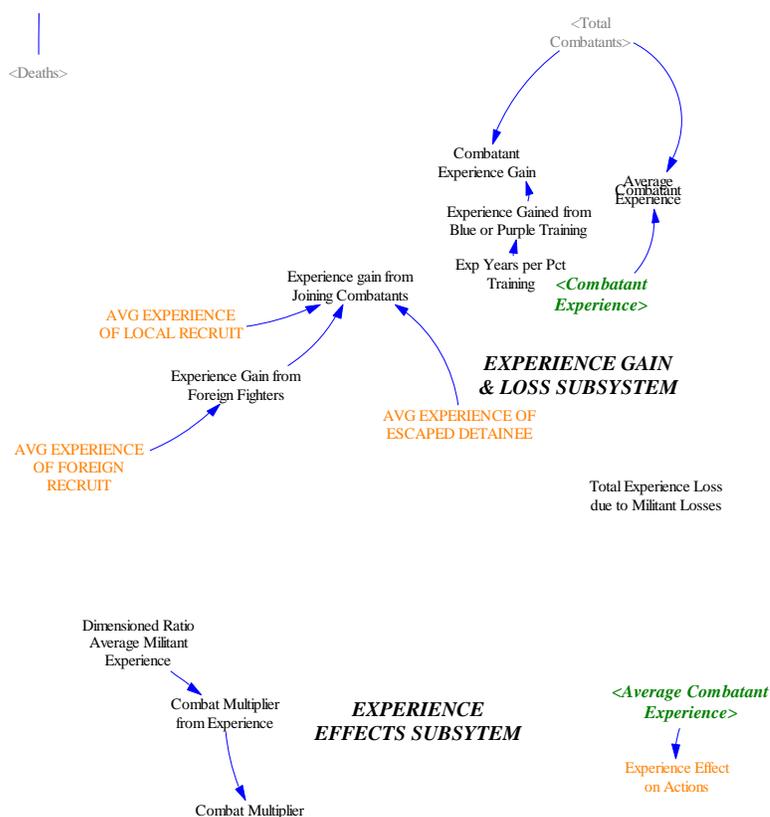
Figure A-21: Co-Flow Structure of Militant Experience to ISIS Combatants

The source of incoming combatants has a large influence on the overall gain in the experience. A Foreign Recruit arrives with an average of only 3 months (1 Period) of experience, while *Local Recruits* bring 9 months (3 Periods) and *Escaped Detainees* have the most at an average of ~2.5 years (10 periods). This reflects the important function of prisons acting as training schools for detained combatants. Poorly securely or run jails allow *Detainees* to learn new tactics, network and form relationships with other imprisoned Combatants and gain skills quickly.

Experience offers a wide degree of benefits. It influences the *Combat Multiplier* and through *Experience Effect on Actions* several non-combat functions. The percentage of the population which can normally be recruited from is limited to the Fighting Age Males (~23% in the baseline scenarios.) Experienced *Combatants* will increase or decrease this percentage representing the ability to 'grow the pool' of potential recruits. This is not intended to imply children soldiers, which is out of the boundary scope of this model. *Experience Effect on Actions* also helps prevent decay in *Current Security Effectiveness* – more experienced soldiers can retain the technical information of counter terrorist training for longer than untrained.

Parameterization

ISIS Detainees

This is set to 0 in the current model.

ISIS Combatants

This value is determined by the Scenario loaded. In Table A-7 are the historical estimated manpower of ISIS and its predecessor incarnations, as well as the implied inflow to maintain the estimated size.

Table A-7: Historical Demographic Estimates of ISIS & AQI

Year	ISIS Estimated Size[18]	Size – Losses	Implied Inflow to Maintain Size	Deaths	Detentions	Total Losses
2004	300[19]	134		78	88	**166**
2004.5	300	157	143	65	78	**143**
2005	1000	591	409	182	228	**409**
2005.5	1000	661	339	147	192	**339**
2006	12000[20]	6290	5710	2595	3115	**5710**
2006.5	10000	4312	5688	2682	3006	**5688**

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[18] All years include estimates from U.S. Department of State. *Country Reports on Terrorism Chapter 6: Terrorist Groups.* ONLINE 2004-2013. Bureau of Counterterrorism. Available: http://www.state.gov/j/ct/rls/crt/index.htm [19 Sep. 2014].
[19] Peter Bergen & Paul Cruikshank "Al Queda in Iraq: Self-Fulfilling Prophecy", Mother Jones, October 31, 2007, http://www.newamerica.net/files/Al%20Qaeda%20in%20Iraq%20Study.pdf accessed September 20th, 2014.
[20] Bergen et. al., "Al Queda in Iraq: Self-Fulfilling Prophecy."

2007	7500[2122]	3016	4484	2141	2343	**4484**
2007.5	3000	1040	1960	960	1000	**1960**
2008	1500	986	514	223	291	**514**
2008.5	1500	1212	288	119	168	**288**
2009	1500	1448	52	21	31	**52**
2009.5	1500	1448	52	21	31	**52**
2010	1500	1448	52	21	31	**52**
2010.5	1500	1448	52	21	31	**52**
2011	1750	1689	61	24	37	**61**
2011.5	2000	1931	69	28	42	**69**
2012	2000	1931	69	28	42	**69**
2012.5	8500	6870	1630	676	954	**1630**
2013	13200[23]	9648	3552	1507	2045	**3552**
2013.5	13200	8675	4525	1964	2561	**4525**
2014	30000[24]	18758	11242	4931	6311	**11242**
2014.5	**80000[25]**	**48628**	**31372**	**13840**	**17532**	**31372**

Recruits Inspired per Suicide Attack

This is set on the normal value of 26 but can be influenced by higher experienced *Combatants.*

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[21] Ibid.

[22] Kenneth Katzman, "Al Qaeda in Iraq: Assessment and Outside Links," Congressional Research Services, RL32217, August 15, 2008, fas.org/sgp/crs/terror/RL32217.pdf accessed Sepember 20th, 2014.

[23] Nour Malas, "Rebel on Rebel Violence Seizes Syria," The Wall Street Journal, 18 Sept, 2013 http://online.wsj.com/news/articles/SB10001424127887324807704579082924138453120?mg=reno64-wsj&url=http%3A%2F%2Fonline.wsj.com%2Farticle%2FSB10001424127887324807704579082924138453120.html, accessed September 20th, 2014

[24] "Islamic State 'has 50,000 fighters in Syria'" . Al Jazeera. 19 August 2014. Retrieved 19 August 2014.

[25] "IS has 20,000-31,500 fighters in Iraq and Syria: CIA", Yahoo.com, September 12, 2014 http://news.yahoo.com/20-000-31-500-fighters-iraq-syria-cia-230059844.html, accessed September 20th 2014.

Average Experience of Escaped Detainee

This is currently assumed at 2.5 years (10 periods).

Average Experience of Foreign Recruit

This is currently assumed at three months on average (1 Period), reflecting an assumption that there is a mix of foreign recruits some of whom come from countries in conflict and bring experience (e.g. Tunisia, Libya, Egypt, Lebanon) and those from further abroad with no direct experience (e.g. Europe, Australia, India etc.)

Average Experience of Local Recruit

This is currently assumed at nine months (3 periods), reflecting an assumption that in both Syria and Iraq a state of either civil war or insurgency has existed for the better part of four and twelve years respectively.

Detentions & Deaths

Detentions are determined endogenously by the *Current Security Effectiveness* and allocation of the opposing Actor to *CounterTerrorism* activities. Detainees are created when *Terrorist Attacks* and *Prison Breaks* are thwarted. Detainees and deaths are also a byproduct of combat in the SFS Combat Simulator, based on whether the Actor takes prisoners or not. In the baseline scenario Green takes prisoners while Red does not. This means there is never any Green detained combatant population to conduct prison breaks to free.

As for deaths that previous data that 23-30% of all combatants who had joined AQI by 2006 were captured is not clear on whether that is cumulative of all recruits, or of the group size in 2006.[26] Taking the above insurgent mortality figures as a proxy for the increased or decreased risk of capture, the average of 26.5% capture rate will be used as "normal" with a low value of 2% capture in times of low pressure on the insurgents and 45% for an extreme value of capture. Captured combatants enter the stock of Prison combatants.

Alternative Mortality Values

In this model deaths are explicitly calculated using a combat simulator described in the SFS Sector. However, an alternative mortality calculation is presented here. This can be used to greatly simplify the model by not incorporating the simulator. According to documents studied between 2005-2006 AQI had a mortality rate of its

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[26] Benjamin Brahey et. al., *An Economic Analysis of the Financial Records of al-Qa'ida in Iraq* (Santa Monica CA: RAND National Institute of Defense Research 2010), 49.

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combatants of 173 per 1,000 combatants/year or .173%.[27] To determine where this falls in terms of "normal value" of a nonlinear curve it is necessary first to determine average yearly deaths of insurgents over a set time period which is 3,997 between 2004 and 2009.[28] This period covers both the first year of insurgency in which AQI participated, the period covered by the RAND research (2005-2006) as well as the most violent period of the Anbar Awakening and Shia/Sunni civil war in 2007, finally dropping to the very low post-surge pre-withdrawal rate in 2009. The sample period of 2005-2006 averaged together equals 103%, close to "average" (90% + 117%) so the 173 deaths per 1,000 Combatants can be taken as "normal". The extreme low value occurs in 2009 at 14 deaths per 1,000 combatants and the extreme high value of 294 per 1,000 combatants during all out civil war.

Table A-8: Lethality Estimates of Past AQI Conflicts

Year	Enemy Death	Distance from Average of Enemy Death	Est Militant Deaths per 1,000/People
2004	5995	150%	259/1k people
2005	3594	90%	(Sample period: 173/1k people)
2006	4657	117%	(Sample period: 173/1k people)
2007	6793	170%	294/1kpeople`
2008	2635	66%	114/1kpeople
2009	**310**	**8%**	14/1kpeople

Defections

In earlier version of the models there was no ability for *Combatants* to defect. This created unrealistic behavior where an Actor could be losing very badly – but still retain all its *Combatants* who weren't otherwise detained or killed. This was improved during confidence building efforts that identified the weakness. (*See Section C.*)

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[27] Benjamin Brahey et. al., *An Economic Analysis of the Financial Records of al-Qa'ida in Iraq* (Santa Monica CA: RAND National Institute of Defense Research 2010), 50.

[28] The Guardian, "Wikileaks Iraq: data journalism maps every death", theguardian.com http://www.theguardian.com/news/datablog/2010/oct/23/wikileaks-iraq-data-journalism, accessed September 29th, 2014. Data download is at: https://spreadsheets.google.com/ccc?key=0AonYZs4MzlZbdFd5LU9Yamp3NGhrbnMxdTFjMWNadUE&hl=en&authkey= CLGhleIC, also accessed on September 29th, 2014.

Defections are now driven by three main pressures: Ethnographic Perceptions, Lack of Pay and Perception of Actor Momentum. This covers the various ways in which a Combatant may lose faith in the Actor. Because the Actor acts against the ethnographic group the *Combatant* belongs too. The *Combatant* isn't being paid. Or because the *Combatant* perceives that the Actor is losing heavily.

Defections themselves either occur while a *Combatant* is fighting with the Actor – or while they are in Prison being detained. Since Red does not take Green prisoners, no Green detainees will defect. But the behavior of the other three circumstances over the Historical Baseline is depicted in Figure A-22.

Selected Variables

Defections within Prison[Green] : Baseline Historical
Defections within Prison[Red] : Baseline Historical
Total Defections Outside of Prison[Green] : Baseline Historical
Total Defections Outside of Prison[Red] : Baseline Historical
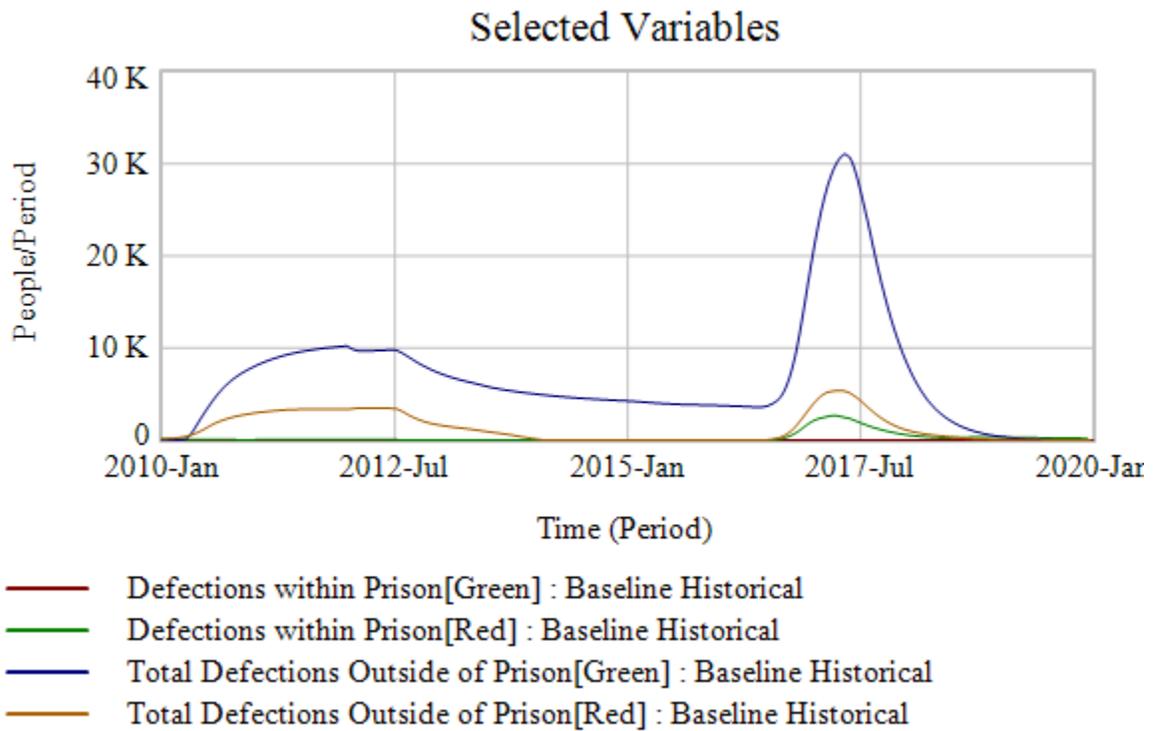
Figure A-22: Defection rates of Combatants & Detainees [Green, Red]

The early defections of Green are driven by the oppressive behavior Green displays to both Arab Sunni and Kurdish Sunni. The maximum value defections due to ethnographic grievances can reach is 10%/Period and both Arab Sunni and Kurdish Sunni approach that value, while Shia Sunni *Combatants* retain a high perception of Green as shown in Figure A-23.
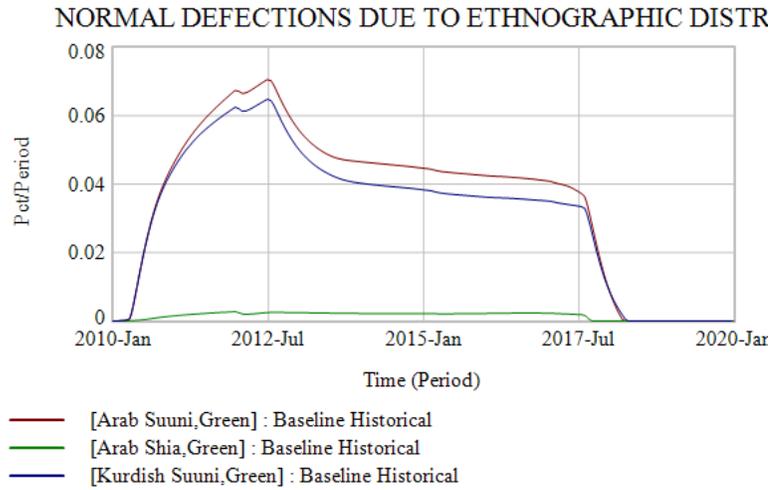
Figure A-23: Ethnographic Distrust driving Green Defections

This compound the problem of a sufficient military force. Even as Sunni Arabs and Kurdish Sunni leave the Green force, their low opinions of the Green actor cause them to shift from *Governed* to *Calculated Legitimacy* and into the *Coerced* population stocks (see Governance Sector.) This requires more garrison troops per 1,000 population – putting further strains on an already depleted force.

A-4.3 GOVERNANCE SECTOR

Overview

The subsystem structure of the Governance is simple. But it provides a crucial linkage between an Actor and the Ethnographic groups they are trying to influence.
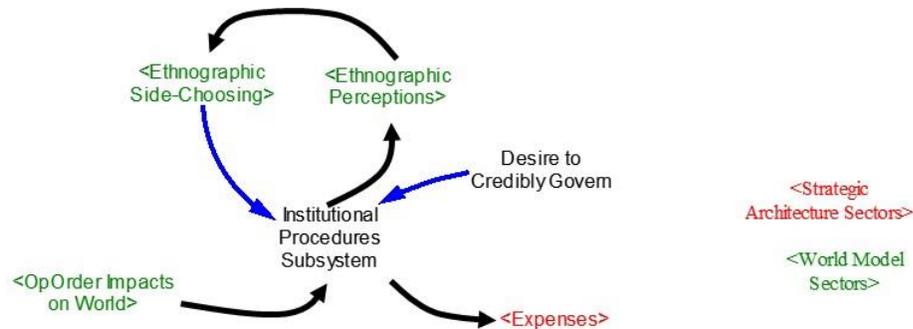
Figure A-24: Governance Sector Overview

A-4 Sector by Sector Review of Strategic Architecture

At the heart of the sector is the Institutional Procedure subsystem. This is the "engine of legitimacy" by which an Actor will influence Ethnographic Perceptions that cause them to adopt or reject increasing levels of legitimacy with an Actor. The gasoline that fuels this engine are the credible institutional procedures that accumulate over both time and number. This structure exists as a single stock, subscripted for each Ethnographic group, with multiple influencing factors as depicted in Figure A-25.
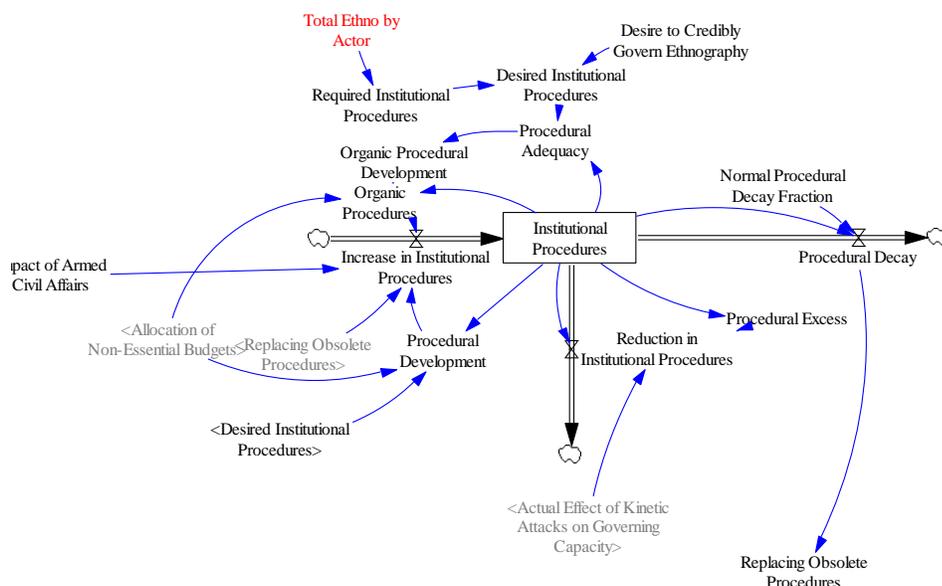
Figure A-25: Structure of Institutional Procedures Subsystem

The behavior of this stock for Green in the Historical Baseline Case is displayed in Figure A-26.

Institutional Procedures

[Arab Suuni,Green] : Baseline Historical
[Arab Shia,Green] : Baseline Historical
[Kurdish Suuni,Green] : Baseline Historical
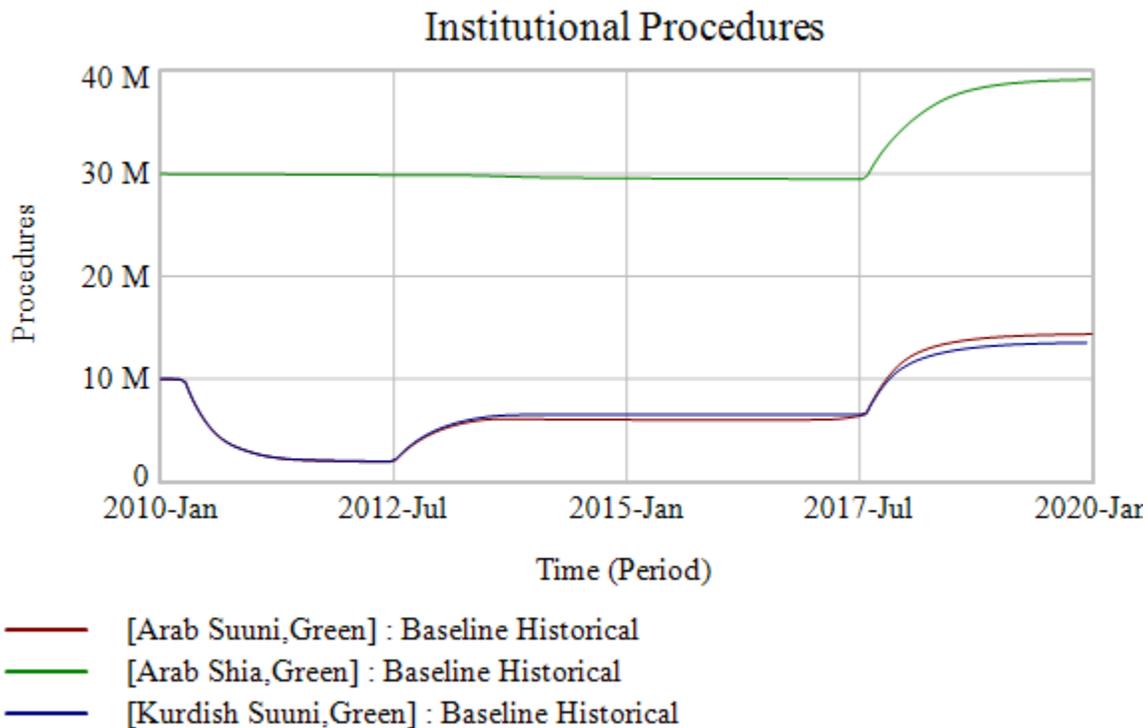
Figure A-26: Credible Institutional Procedures by Ethnography [Green]

The chart displays the different levels of credible government services being provided to the three ethnographic groups. The desire and capability to openly govern a population is one of the defining features of an emerging-state actor.

One of the most central insights of this sector is the feedback relationship between the Green and Red Actor in terms of how their credible processes influence perception, or drive grievances, within the Ethnography. If Ethnographic Perceptions represent the "contest of narratives" between Green and Red as described by Kilcullen, then the credible institutional procedures play a key role in this. This can be described by a conflict archetype called "Losing the War by Winning the Battles." This archetype, depicted below in Figure A-27, represents a common challenge confronting counter-insurgency operation.
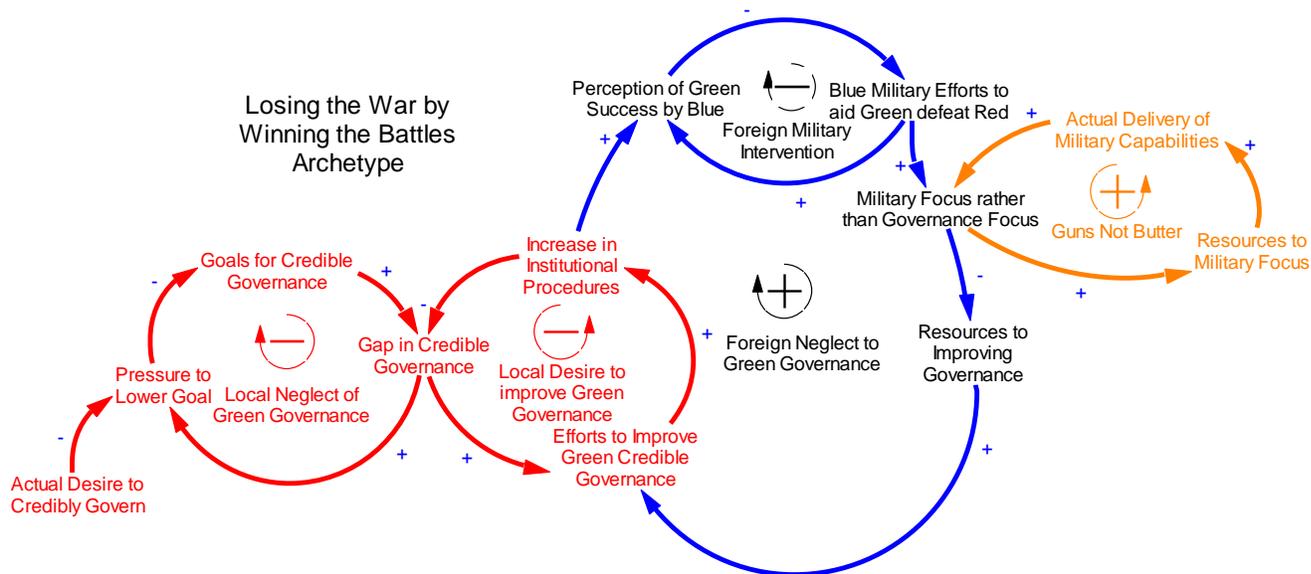
Figure A-27: Losing the War by Winning the Battles Archetype

As depicted this archetype includes the foreign intervention of Blue to support Green, though this need not be the case. But the archetype combines the systems thinking archetypes of Fixes that Fail (blue loops), success to the successful (blue and orange loop) and drifting goals (red loops.) The behavior of this archetype is that when a military intervention occurs it creates a fix that fails where military successes on the field of battle will weaken the resources and attention being paid to Green government whose inability to provide credible institutional procedures in the first place helped create the Grievance for Red. The more resources focused to a military solution, which is the "successful" loop of Guns not Butter, the less resources, organizational emphasis and attention is paid to improving governance or creating the political conditions for success. This then carries through as a fixes that fail positive feedback loop where the less resources that go into increasing credible governance, the less increases in actual credible processes. This exacerbates the military situation which then demands more military fixes. Meanwhile the fixes-that-fail archetype intersects with a drifting goals archetype. These are the internal pressures of the existing Green Government to maintain the status quo, including what is often endemic corruption, criminal behavior and other activities which provoke a grievance. Even as the credible institutions erode from lack of focus in favor of military efforts, the internal pressures are exerted to decrease the goal. This will create a scenario where the level of governance will be lower than the *Actual Desire to Credibly Govern.*

This effect is demonstrated in Figure A-28 which depicts the lifecycle of Arab Sunni relations to the Green government.
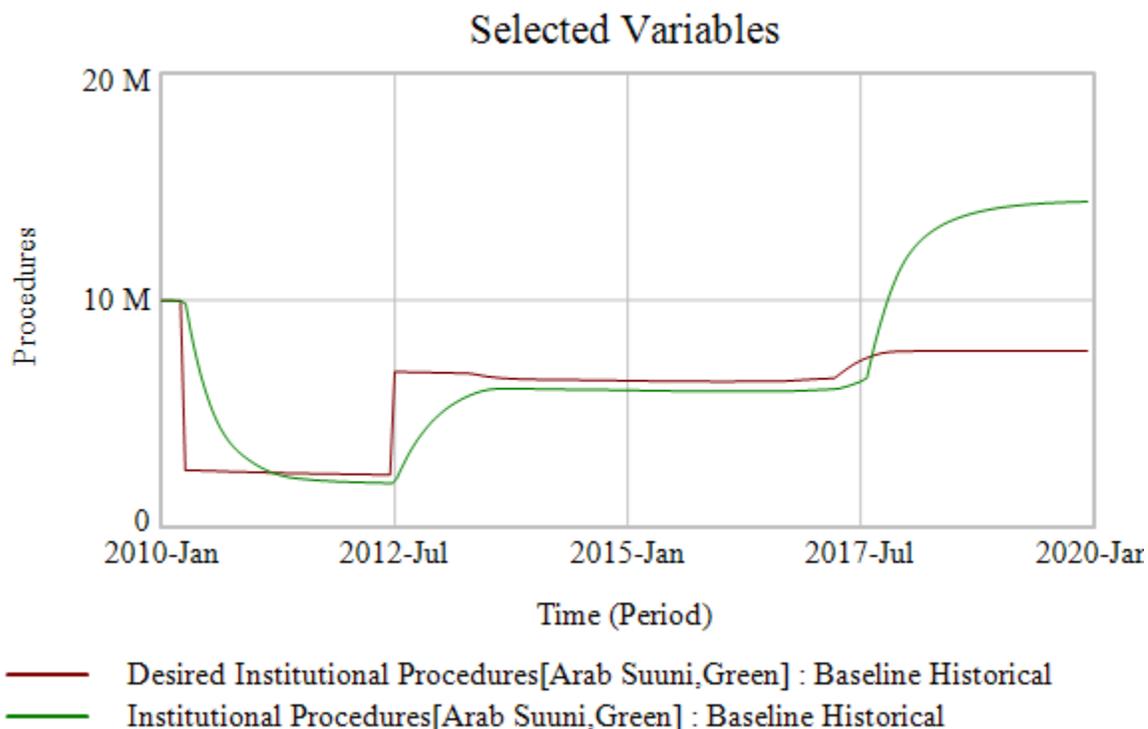
Figure A-28: Demonstration of Losing the War by Winning the Battle Archetype Dynamics

The drop of the *Desired Institutional Procedures* during the period of oppression leads the decline of provision of *Institutional Procedures* to Sunni Arabs. However, even when the *Desire to Credibly Govern* is increased leading to an increase in the goal of *Desired Institutional Procedures* the actual *Institutional Procedures* lag in time and then never quite reach the goal. Where they finally exceed the goal, after Red's defeat, is after the conflict has ended. This theory is also explored in Khalid Saeed's research on the feedback between the government and actors engaged in political violence.[29]

A-4.4 OpOrder Allocations Local & Foreign

Overview

The two sectors for OpOrder allocation are covered together. Both sectors represent command and control at the theatre or regional level by Actors. Green and Red are local actors engaged in conflict, Blue or Purple are Foreign actors intervening to support Green and Red respectively. These sectors serve as the key bridge between the Strategic Architecture and the World Model. The other half of this bridge is OpOrder Impacts on World. These sectors are almost entirely exogenously controlled based on inputs from planners, analysts or users of ESAM. When played as a wargame, E-SAM gives an opportunity every 4 periods (~1 year) to adjust allocation priorities for the different tasks. This represents a reasonable time delay for a regional-level activity. If desired "turns" can be reduced to only being a period in length but caution is advised as its not realistic a large

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[29] Saeed, "The Dynamics of Economic Growth and Political Instability in Developing Countries."

military organization could react rapidly to adjustments made in prioritizations. Analysts and researchers adjust the allocation through the writing of Game Scripts that simulate different policy choices at various time throughout the simulation. (*See Section D-3.4 OpOrder Allocations* for more details.) Below in Figure A-29 is the structure of OpOrder Allocations for the Green and Red Actors.
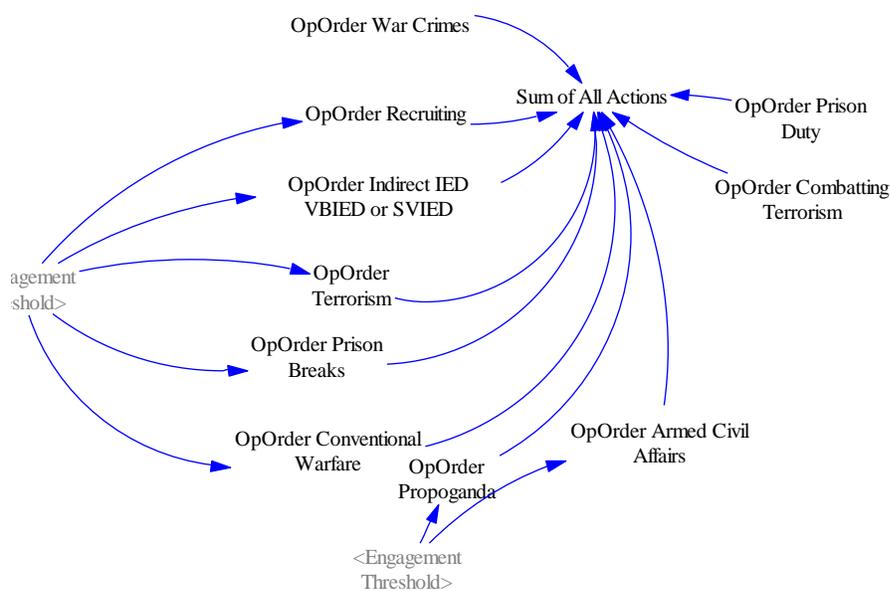
Figure A-29: Allocation of Operational Orders Structure

Most of these parameters are exogenous – either determined by player choice or input by historical cases. One exception is the *Engagement Threshold* for the Red Actor. This threshold is determined by an input called *Minimum Force Size to Engage* and if the *Total Combatants* of Red Actor are less than that value there are actions they won't take against Green. Even if there are Operational Orders to do so. *Conventional Military Attacks* is one such example.

Foreign actor support comes from Blue or Purple forces and these actors have theater-level allocations to make as well. This structure is depicted below.
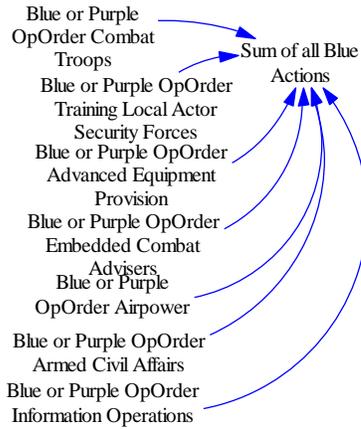
Figure A-30: Structure of Foreign OpOrder Allocation

The Foreign OpOrder allocation also has a subsystem for allocating airpower. This is done by assigning percentages to three sets of targets: *Combatants, Resources* and *Government Capacity.*
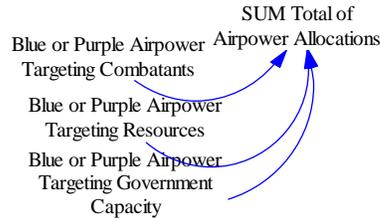
Figure A-31: Airpower Allocation Subsystem

This allocation will determine the number of sorties that fly against each target. The number of sorties is determined by the overall force assigned to airpower in the OpOrders depicted in Figure A-31. Airpower used in ground-support will continue as long as there model runs. However, the other two OpOrders, targeting Resources andor Government Capacity need to be able to dynamically shift off of those operational orders, presumably once an actor thinks an opponent's infrastructure in that regards is completely destgroyed. To accomplish this in the simulation a dynamic-targeting structure is added depicted in Figure A-32.
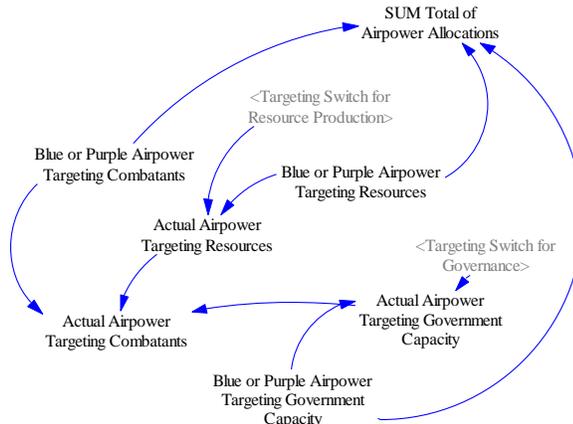
Figure A-32: Dynamic Targeting of Air Power Missions

The switches are embedded in the respective secvtors of the model where resource production (Territory Dynamics) and government capacity (Governance) are. The switches are activated based on information stocks that perceive when a strategic target: oil production for example, has been reduced to zero. The time delays of these information stocks can be adjusted to reflect intelligence gathering delays or inefficiencies. But once an actor perceives that their strategic target has been exhausted, they will dynamically switch that allocation of airpower to support the ground campaign. If new infrastructure is perceived – then the allocation will switch back to targeting it until it too is destroyed. In this way a realistic setting of priorities can be established between ground combat support, targeting resources, and governance. In the current model the default is always ground combat support, so airpower assigned to destroy resources will switch to that dynamically, rather than government capacity.

A-4.5 Resource Stocks

Overview
The resources stocks sector brings together many of the latent capabilities, knowledge and efforts of the Actors into manifest tangible expressions. The resource stocks represent those accumulations of what the Actor can use to compete with one another and exert influence over a population. In some ways then the current system performance at any given time can in part be expressed as an understanding of the levels of the resources stocks.

AFV, IFV & Artillery

These piece of heavy weaponry for the Actor are tracked in two stocks. Even though armored fighting vehicles and improvised fighting vehicles vary significantly in capability for a regional contest they are aggregated. Artillery is tracked separately given the different role it plays in the SFS Combat Simulator.

A-4 Sector by Sector Review of Strategic Architecture

Combatants

Actor Combatants are the personnel in either Actor's military forces, represented by ethnography. They can be part of a formal organization such as soldiers; paramilitary organizations such as militias or even affiliated supporters who are willing to conduct violence. What it does not include is fighters of truly separate or unaligned opposition to an Actor. These are represented in *Local Opposition Combatants to Actor.* Not all Combatants will typically be engaged in front-line combat. They must see to the logistics need of the fighting force, garrison occupied territory and can only act if there are sufficient funds to pay for Military Actions (see OpOrder Impact on World).

Combatant Experience

A second co-flow of *Combatants* is this stock that tracks professional military skills. This is represented by the number of years of experience the average Combatants in an Actor possesses. More experienced Combatants fight harder, have higher morale, are better recruiters, gain more revenue from taxes and criminal activities. As Combatants join an Actor they bring any existing experience with them and as Combatants are captured, die or defect they reduce the overall level of experience. The effect of this dynamic is explored further in the Combatant Recruiting & Losses Sector.

Finances

Actor Finances are expressed in US Dollars. Actors gain revenues across a variety of sources ranging from natural resources (oil) to ransom. Likewise, they spend those funds on their internal expenses or send surpluses abroad to gain power. The Finances stock represents the cash-on-hand in various forms for an Actor. It can go negative representing the ability of an Actor to operate without funding, but only for limited amounts of time as the inability to pay non-essential or even essential budget items quickly erode an Actor's position.

Foreign Combatants

This stock is a co-flow of Combatants that tracks foreign fighters who do not share a common ethnographic tie with the local populations but have joined the conflict. For purposes of conducting Military Actions they are fungible with local Combatants, and the model does not distinguish at the level of the Squad who is foreign of which ethnographic group. But the overall level of foreign fighters has an influence on the garrison requirements of an occupying force (see Uprising & Resistance Sector.)

Squads

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Military Actions are the primary means by which an Actor conducts Operational Orders. These are prioritized based on the OpOrder Allocation – but the muscle-mover of an Operational Order is typically a Squad. The number of Squads either actor has available at a time represents the *Total Combatants – Number of Green or Red Logistics - Actual Garrison* divided into *Normal Size per Squad.* Operational Orders cannot be assigned to units smaller than Squads, though some allocations take a larger-than-squad-size to affect a single Military Action (such as Airpower.) The Islamic State configures its military forces into Battalions, Brigades and Groups.[30] The Squad is the smallest tactical unit of operation, consisting of between 8 and 13 men, and an average size of 11men are used to model what size of men are needed to accomplish either a Military Action.[31] ISIS uses training camps to educate recruits in combat skills and provide ideological indoctrination. Recruits spend 15days in the camp before moving to frontline combat units.[32]   For simplicities sake these values are also adopted for the Green Actor.

Territory Controlled by Actor

How much of the overall population is under physical control by either Actor is determined by the amount of Territory an Actor controls. For this report, the total territory of Iraq and Syria, 619,308km^2 are combined into an overall territory. As Red gains Territory, it conquers the ethnographic population which lives upon that territory, determined by scenario. These populations are removed in proportional measures from the *Coerced, Calculated Legitimacy* and *Governed* populations of Green and enter Red in the *Coerced* stock. (See the sector of Ethnographic Side-Choosing in the World Model.) Territory plays a much larger role in the simulation model as well however. Territory controlled determines the values of a series of geographic attributes that either Actor will encounter given its location within the territory: oil wells to seize, type of terrain and nature of battle to fight, garrisons of the other Actor to fight, and changing ethnographic envelopes of local sympathies that affect the ability to recruit locally etc.

A-4.6 Revenue & Expenses

Overview

These two sectors of the Strategic Architecture are handled jointly because when combined they represent the inflow and outflow of funding from "the world" into the key performance resource stocks and from there into

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[30] Bahney et al., "An Economic Analysis of the Financial Records of Al-Qa'ida in Iraq."
[31] Roggio, "Islamic State Touts Training Camp in Northern Iraq."
[32] Yenginsu, "ISIS Draws a Steady Stream of Recruits From Turkey - NYTimes.Com."

other capabilities of the strategic architecture. These in turn impact the "world" as represented in Figure A-33 below.
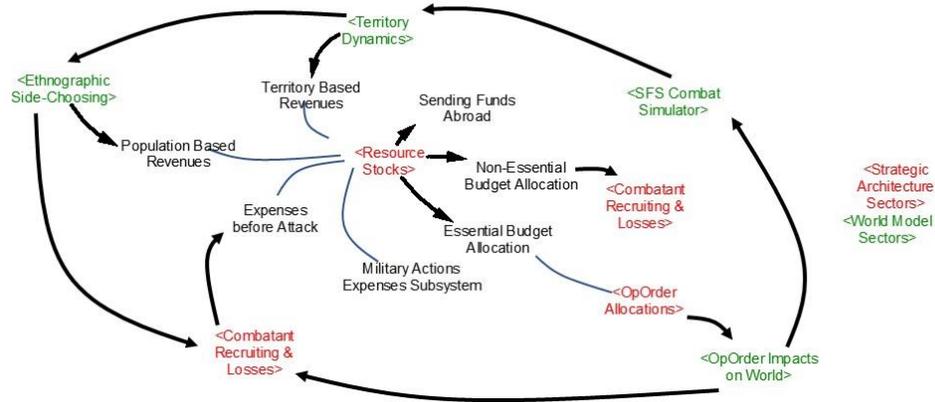
Figure A-33: Revenue & Expenses Sector Overview

Dynamics

The resource dynamics for ISIS Finances are some of the best documented. This is due to a large amount of intelligence obtained on AQI's financial operations and the highly bureaucratic nature of AQI, and subsequently assumed to be, ISIS's financial administration. The basic resource structure is depicted below in Figure A-34 with a single in-flow of revenue (Dollars per Period) and outflow of expenses (Dollars per Period).
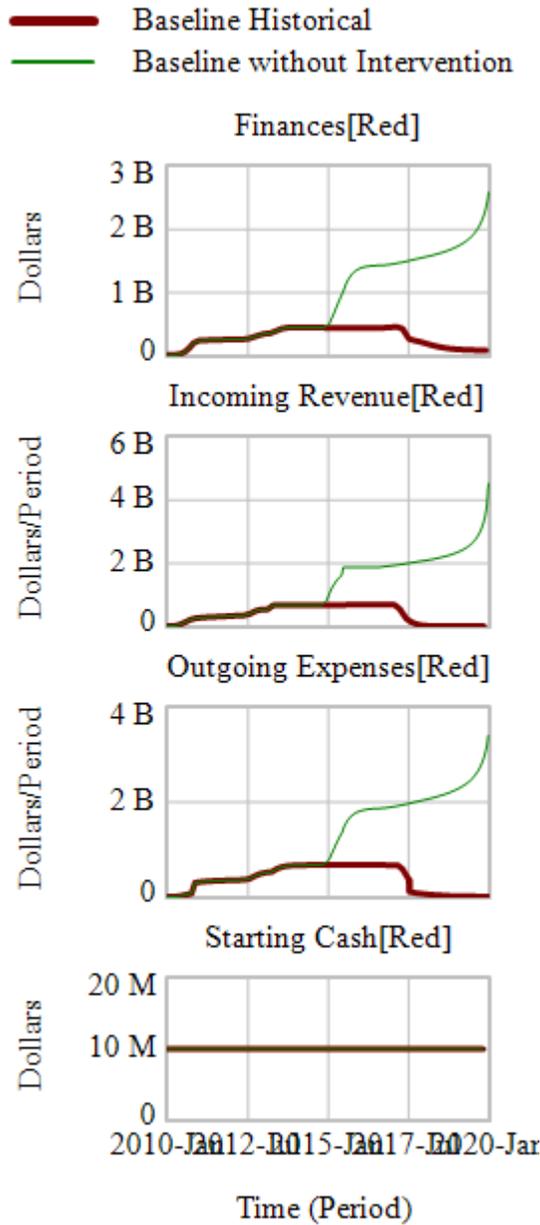
Figure A-34: Incoming Revenue & Outgoing Expenses [Red]

Again, the aggregated inflows and outflows are simplified representations of the disaggregated

subsystems that feed them. Pictured in Figure A-35 are the actual components of Revenue that are explained in more detail below. Expenses are handled after Revenue.

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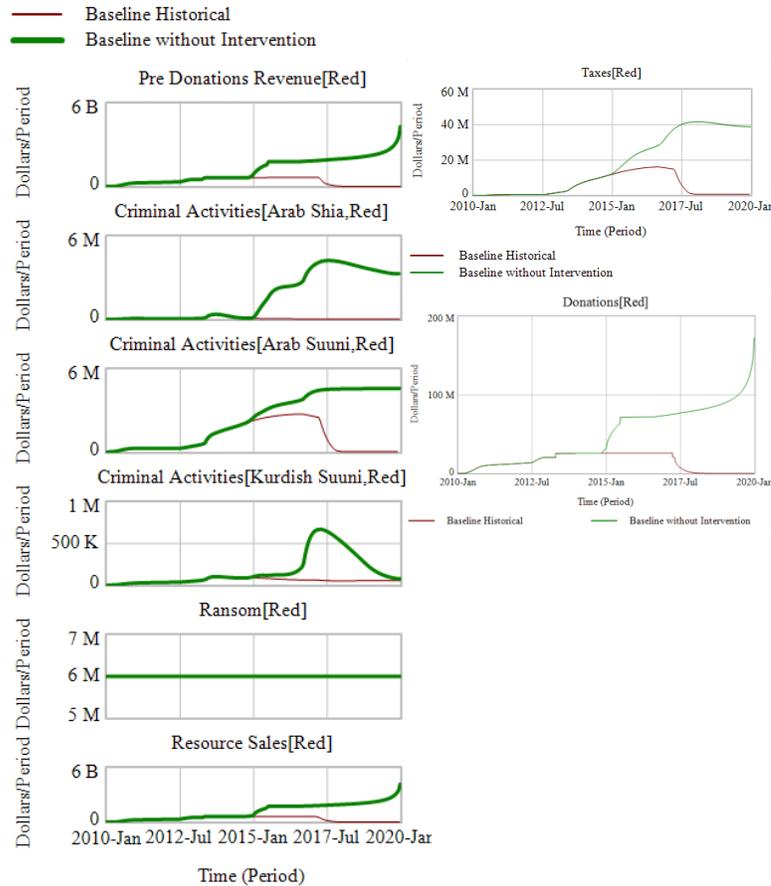
Figure A-35: Sources of Revenue [Red]

Revenue Dynamics

There are five primary sources of revenue either Actor can exploit within the World Model. Two of these – *Taxes* and *Criminal Activities* are based on the population they have access too. *Taxes* are levied on *Calculated Legitimacy* and *Governed* populations while *Criminal Activities* are applied to *Coerced* populations. In the Baseline case Green only collects taxes and does not engage in *Criminal Activities* while Red does. A third revenue source, Ransom, is set at a base rate for Red based on research. A fourth revenue stream, Resource Sales, comes to both Actors based on how much resource production (oil) they have still functioning on the territory they control plus any military actions to destroy oil production capacity. And finally, Donations represent an exogenous source of income from abroad, and typically set at a percentage of total revenue based on research.

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Revenue Parameterization

This information is largely based from over 1,200 financial records, payrolls, ledgers and over materials recovered by US Forces in Iraq in 2006 and later analyzed by the RAND Institute.[33] The documents reveal sophisticated hierarchical control exercised in financial matters at national, province and sector levels. The financial organization was not personnel dependent as evidenced by a change in Emir's during the period the financial records covered. [34] AQI functional structure cascaded down through national, provincial, sector, brigade and final group levels were largely similar at both provincial and sector level across seven functional areas: movement & maintenance, legal, military, security, medical, spoils and media.[35] Command was divided between operational control and administrative *mas'ul* [person responsible] control. The administrators maintained the bureaucratic organization of AQI and were responsible for tracking, tallying and reporting all financial activities back up the chain of command to higher levels.[36]

RAND depicted the financial flows of revenue and expenses in Figure A-36 below:[37]

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[33] The documents analyzed by RAND are held in Harmony Batch ALA DAHAM HANUSH, documents NMEC-2007-633541, NMEC-2007-633700, NMEC-2007-633893, and NMEC-2007-633919. The master financial ledgers are NMEC-2007-633541, NMEC-2007-633700, NMEC-2007-633893, and NMEC-2007-633919. Harmony Batch MA7029-5, documents MNFA-2007-000560, MNFA-2007-000562, MNFA-2007-000564, MNFA-2007-000566, MNFA-2007-000570, MNFA-2007-000572, MNFA-2007-000573, and MNFA-2007-000574. The Arabic term used for western is "Gharbiyah."

[34] Bahney et al., "An Economic Analysis of the Financial Records of Al-Qa'ida in Iraq," 31–32.
[35] Bahney et al., 32.
[36] Bahney et al., 34.
[37]Ibid, 34.
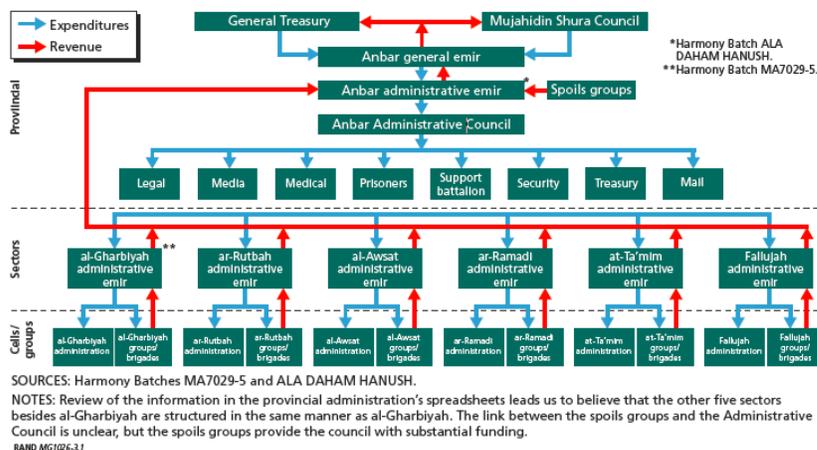
Figure A-36: AQI Financial Flows as Reported by RAND

Spoils are the sale of stolen goods taken from apostates or collaborators as well as looting. This revenue did not include 'black market fuel sales, international ransoms or 'direct taxation' indicating that at this point in time the financing model was 'local, religiously radical and politically destabilizing.'[38] The destabilizing effect became most apparent when Car Sales, Spoils & Stolen Goods (combined) rose from 74% of revenue, or $2,703.74 per 10k people/month to 93% or $6,501.21 per 10k people/month. The outcome of this destabilization according to RAND was the formation of the Sunni Awakening Councils and a rejection of AQI governance in the fall of 2006. This implies a nonlinear dynamic in the acceptable amount of Spoils & Loot sales above which the population begins to reject governance.

Criminal Activities Revenue per Capita from Controlled Population

Converting these to $/Person/Period works out from a range of $1.62 to $3.90/Person/Period for Population Controlled.   A midpoint of $2.76/Person/Period is selected.

Taxation Revenue per Capita from Governed Population

Both Actors can tax populations that have granted their governance some form of legitimacy. Legitimacy and how it is gained is discussed in the Ethnographic Side-Choosing Sector. However here an important reminder is that population who view Red with *Calculated Legitimacy* might not be in a territory sovereignly controlled by Red. This allows for scenarios to be explored in E-SAM where an insurgency institutes a shadow-tax even in

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[38] Bahney et al., "An Economic Analysis of the Financial Records of Al-Qa'ida in Iraq," 39.

territory fully occupied by the government. This taxation amount is currently estimated at $1m/day or approximately $90m/Period.[39] Dividing this amount into the estimated Population governed for the 2014 Period results in a range from $11.99-$20 Person/Period for Population Governed.

Donation Revenue Inflow

Given the research by RAND it appears external donations to Red amounted to between 3-5% of all revenues. This will be calculated in the model by taking 4% of the sum of all other revenues and adding it to donations.

Oil Revenue

Historically it is estimated that AQI was generating nearly $200m annually ($100m/period) from black market oil sales declining to $13.5m/period by early 2008.[40] At the assumed $45/Barrel cost this implies a production of 2,222,222 BPD dropping to a low of 300,000 BPD by 2008. As AQI maintained its dominant position as the largest insurgent in the country it is conservatively assumed they controlled 25% of this market, or 555,555 BPD to 75,000 BPD respectively.

Prior to US airstrikes ISIS was producing between 25,000-40,000 barrels of oil a day (BPD) across a dozen oil wells. This fetched a black-market price of between $1.2m-$2m/day. Taking the middle of each estimate a $/BPD parameter of (35,000 BPD / $1,600,000 black market daily revenue) arrives at a $45/BPD revenue. Since this price is significantly below prevailing oil prices which have ranged between $80/barrel and $110/barrel it is assumed that global oil prices will not significantly impact this black-market price.[41] As an update to this, since the collapse of world market prices boundary testing was conducted in the main paper via Proposition 2b and 2c, testing ISIS's performance at $22/bbl. and $11/bbl. respectively. The results showed that although the size of ISIS's cash reserves at the end of the simulation were smaller, the performance as an emerging-state actor was similar. This indicates a price point between $0 and $11/bbl. would be necessary to cause ISIS to stop growing, and only when occurring in the early stages of growth before coercive revenues and taxation can make up the difference.

Comparing this estimated production versus the original production in the same region indicates that ISIS can currently produce ~28% of normal production. Estimates put ISIS's efficiency of producing working oil wells at only 50% of normal BPD.[42] The remaining loss in productive capacity is assigned to the effects of combat in acquiring/defending the oil wells and lack of maintenance over time.

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[39] Sanger and Davis, "Struggling to Starve ISIS of Oil Revenue, U.S. Seeks Assistance From Turkey."
[40] Bahney et al., "An Economic Analysis of the Financial Records of Al-Qa'ida in Iraq," 15.
[41] Sanger and Davis, "Struggling to Starve ISIS of Oil Revenue, U.S. Seeks Assistance From Turkey."
[42] Bacci, "Syria's Oil Sector in the Fall of 2014."

Ransom Revenue

Unlike its predecessor AQI, ISIS has sufficient territorial control, reach and capabilities to turn kidnapping and ransoming into a business model. The US Treasury Department estimates that in 2014 ISIS has earned nearly $20M alone in ransoming, and this is not included in their Criminal Activities Revenue.[43] Assuming a simple $2M/Month for ransoms results in $6M/Period.

Expenses Dynamics

There are seven factors contributing to expenses. Governance expenses; military procurement; media, border security & other expenses; payroll for combatants; detention benefits; death benefits and expenses related to attacks. The flow rates for these are depicted in Figure A-37 for the Baseline Historical Case of Red.
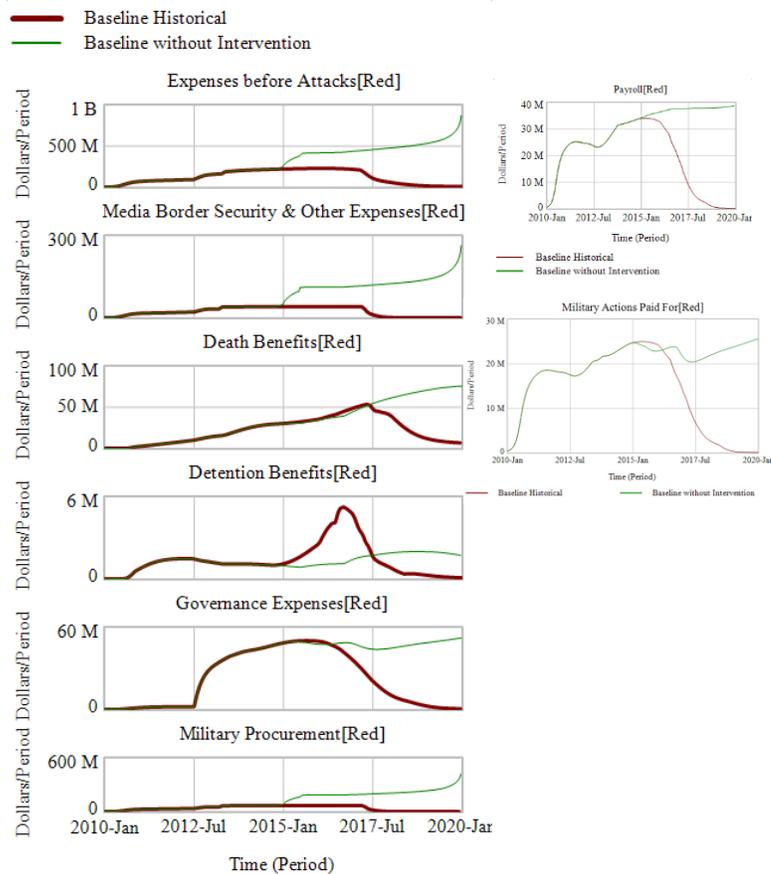
Figure A-37: Sources of Expenses [Red]

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[43] Cohen, ""Attacking ISIL's Financial Foundation"."

There are two important subsystems in the expenses structure worthy of mention. Both deal with trying to represent human decision-making as Actors manage their cashflow to exert influence in the World Model. Part of this is based on research that ISIS prioritized paying operational budget items first and then used leftover funds to fund military actions or to send abroad to support other insurgent groups. This means that all other expenses are paid first, and then leftover amounts are used to fund military actions to the extent that there are sufficient Squads to carry them out, funds more than that are sent abroad. This is covered more thoroughly in the OpOrder Allocation Sector. The second subsystem however must deal with how either Actor reacts to running out of funds, and how they prioritize Essential and Non-Essential Payments.
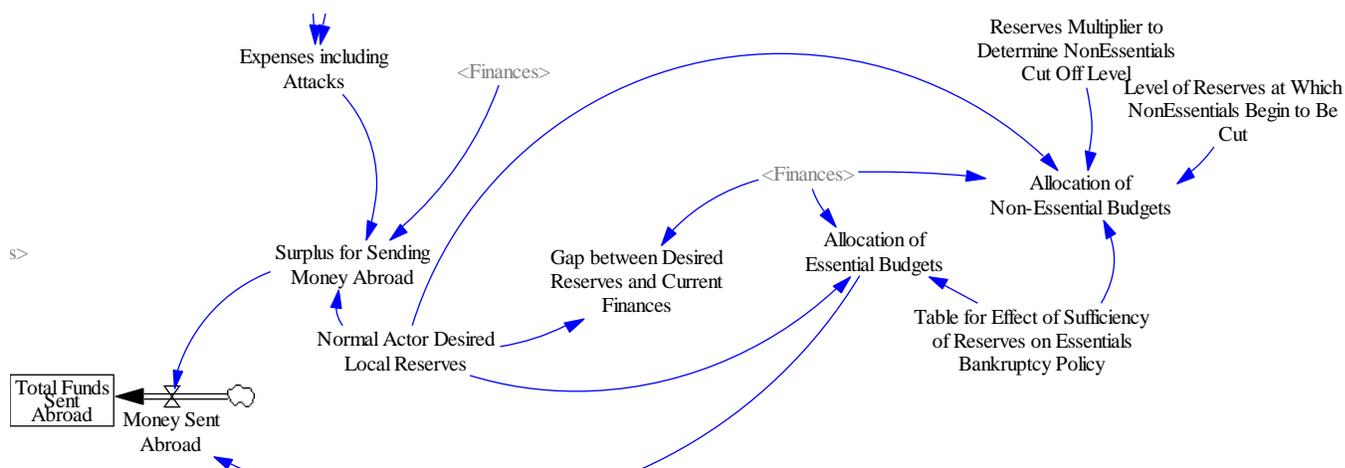
Figure A-38: Funds Sent Abroad & Essential Budget Allocations

This subsystem drains away excess Red Funds as *Funds Sent Abroad.* However, this is only done if *Normal Actor Desired Local Reserves* are maintained. Once a gap emerges between these desired cash amounts locally and Finances the actor ceases overseas funding and begins making choices between *Essential* and *Non-Essential* budget items. *Essential* budget items include Military Procurement; Payroll; Military Actions; and Media, Border Security & Other expenses. Non-essential budget items are *Detention Benefits* and *Death Benefits.*

This structure creates a "stance" by Red leadership based on their perception of available funds. The more funds they have above their desired reserves, the more aggressive they are in using all these funds. The greater the gap between desired and actual reserves Red leadership begins not-paying out key items. This is depicted for the Baseline Historical scenario below in Figure A-39.
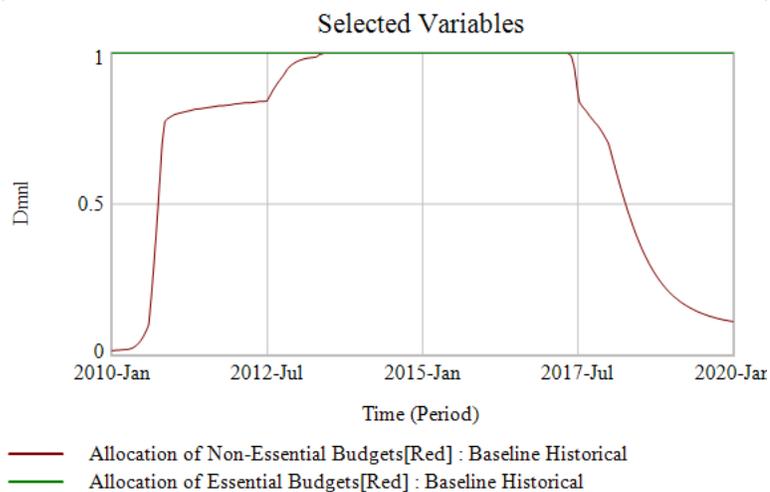
Figure A-39: Allocation of Essential & Non-Essential Budgets [Red]

As demonstrated in Figure A-39, Red begins paying 100% of its Essential Budgets. But it underpays its non-essential budgets until it has made sufficient earnings to meet the required reserves. Operations continue normally until Red begins running out of cash after it has lost its territory and population. Then Red ceases paying *Non-Essential* items. At the same time, Red is losing both territory and combatants, so expenses are reducing. But the *Essential Allocation* would kick in situations where Red's expenses exceeded its revenue significantly. When *Essential Allocation* triggers it begins cutting payroll to fighters, which links to the dynamics found in the Defections subsystem of Combatant Recruiting & Losses Sector. Detained Red Actors who stop receiving detention benefits will also begin to defect when *Non-Essential* payments are stopped. Active *Combatants* will also begin to defect, to some degree, when their *Payroll* is not meant. This subsystem creates a plausible dynamic of simplified cash-management that reflects available research as described in more detail below.

Expenses Parameterization
Cash on Hand & Transfer Delays

The financial records indicated that for the volume of money, very little was held on hand, between $25,000-$250,000 and most funds received were allocated and moved within a day.[44] To represent this, and the focus on operational tempo, excess funds of $250,000 on hand are divided into the attack rate (see below) to determine the funded military attacks of that period. However, the final number of attacks is determined by the available Squads (see above). Excess funds are then compared to a desired local reserve determined by the scenario. Any funds above and beyond this amount are sent abroad, outside the model boundaries. Although there is not much detail in E-SAM as to where the money goes or what impact it has the stock of *Total Funds Sent Abroad* are stored and could be used as a Secondary Measure of Effectiveness. This cumulative amount for both the

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[44] Bahney et al., "An Economic Analysis of the Financial Records of Al-Qa'ida in Iraq," 45–48.

Baseline Historical and Baseline without Intervention are compared below, showing how this measure can be used for policy analysis.
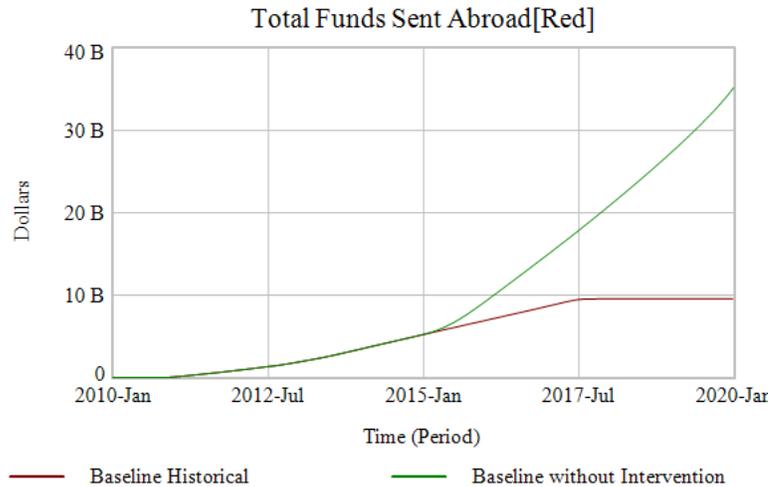
Figure A-40: Total Funds Sent Abroad both Scenarios [Red]

Payroll Amount

According to the Travelstar documents AQI played a flat rate salary per militant per month, and an additional amount per dependent per month per militant. This amount is shown below, and RAND estimated averaged about ¼ of the average per capita GDP earning power of a non-militant Iraqi, indicating motivations other than financial for participation in the group.[45]

Table A-9: Red Actor Payroll Amounts

Payee	Monthly Payroll	Period Payroll
Combatant	$ 41	$246
Dependent	$ 20	$120
Total Payroll	$61	$366/Person/Period

This amount assumes on average 1 Dependent per Militant.

Military Procurement

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[45] Bahney et al., 45–48.

According to the RAND analysis purchases related to military procurement – heavy weapons, ammunition, logistics and maintenance ran about 10% of all revenues.[46]

Governance Costs

Overhead administration cost was 11% of Anbar revenues, or $2,329,746 for a controlled population of 1,382,803. This implies a cost per Controlled Person for overhead administration of $1.68 per Controlled Person/Period.[47] This is rounded down to a nominal $1/Procedure/Period for existing *Institutional Procedures* and a $10/Procedure for *Total New Procedures.*

Media, Border Security & Other

All other expenses were combined into a single bucket that amounts to 6% of all revenue.[48]

Death & Prison Benefits

Death benefits are paid to dependents of combatants and over the period of study over 2/3rd's of personnel payroll went to family members rather than actual combatants. Additionally, between 23% to 30% of all combatants on the Anbar payroll were in detention at the time.[49] For purposes of the model at the organizational changes in 2007 and 2013 a "cut-off" is put in place to stop paying out Death Benefits for deaths prior to that organizational change.

A-4.7 Further Insights of the Strategic Architecture

A crucial insight emerges after a review of Strategic Architecture structures. When operating as an emerging-state actor with physical control over territory and governing capabilities groups like ISIS differ significantly from other non-state actors. There are only limited avenues to "harm" ISIS from outside the territory it operates in. Except for a minimal amount of foreign donations and the flow of foreign recruits – all other key resources ISIS relies upon to be successful can be found within the territory they control. Therefore, Territory Controlled is key to understanding the Red Actor's success. Even if this is not 100% control of vast areas of desert, which is realistic to the historical case – it's the question of who's influence prevails in each territory.

ISIS's leadership aims to maximize these strengths as the Red Actor. ISIS targeted Territory rich in sympathetic population of oppressed Sunni tribesmen, knowing that the fight will be easier, the transition to governance

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[46] Bahney et al., 64.
[47] Bahney et al., 40.
[48] Bahney et al., 64.
[49] Bahney et al., 49.

faster, and the ability to recruit locally stronger in these areas. This is shown in Figure A-41 of Fighting Age Men in the *Calculated Legitimacy* population.
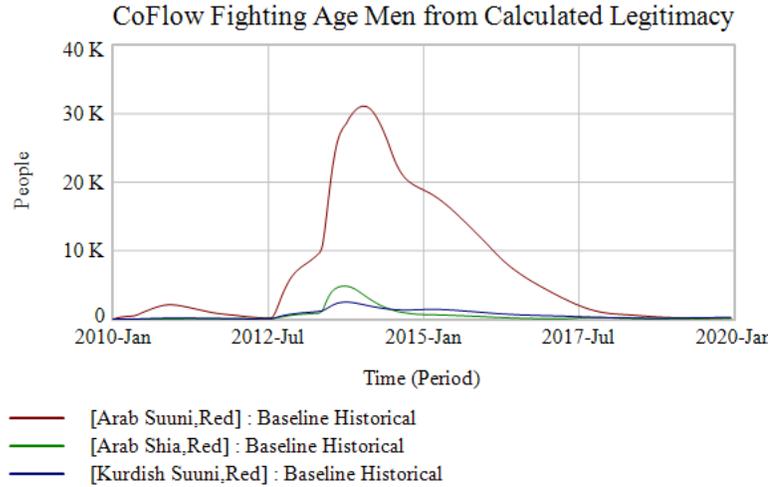
Figure A-41: Fighting Age Men in Calculated Legitimacy by Ethnography [Red]

Calculated Legitimacy is the earliest in the legitimacy material-chain from which Red can begin recruiting. And by conquering areas high in Sunni Arabs first, ISIS encountered greater sympathies to their cause resulting in more recruits. The same dynamic applies to how ISIS acquired resources.
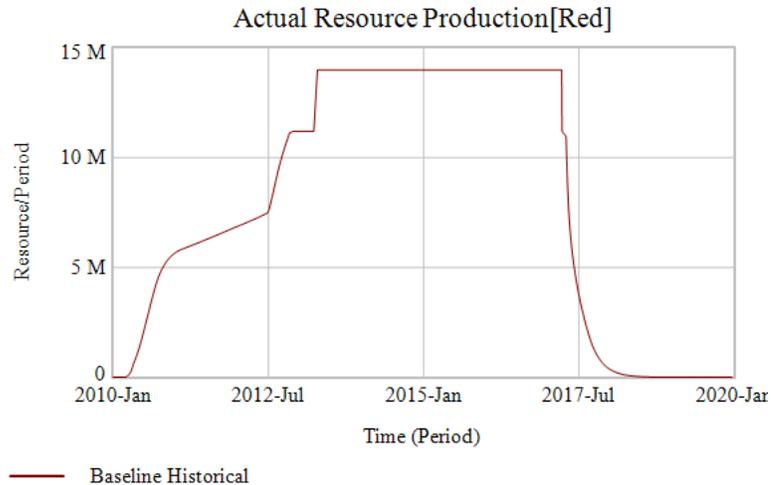
Figure A-42: Oil Production before Air Strikes [Red]

This heuristic in decision making explains much of ISIS's behavior in the pathways it has followed to seize territory. Beginning in the oil-rich northeast of Syria and moving along pathways of Sunni discontent into Fallujah, Ramadi and then Mosul. It also gives a hint of what ISIS would've done had they pressed on to successful encircle reach Damascus and Baghdad – both extremely large metropolitan area filled with a population hostile to ISIS and with little oil to exploit. Red Actor may have simply sat outside the city and sought its collapse through indirect attacks, suicide bombings and IED's, without ever 'invading' the city as a military force.

A-5 *Sector by Sector Overview of World Model*

The next section reviews the world model within which the strategic architecture of ISIS operates. Although the strategic architecture provides an explanation of the dynamics of how Red Actors operate, it must be in a "world" to function. This world is then populated with target populations the emerging state actor seeks to govern, competitors it must defeat to do, resources (both financial and human) that it must harness to compete and internal organizational efforts to manage such activities. Each instantiation of this "world" with such data represents a scenario for a Red Actor with, given explicit assumptions, can then be tested for policy analysis and proposal or planning.

Each sector of the World Model is briefly explained in order.

A-5.1 Ethnographic Perceptions

Overview

There are two perceptions of every ethnographic group to each Actor: a short term and long-term perception. These perceptions are formed based on inputs from both the world around them (World Model) but also the specific actions taken by an Actor (Strategic architecture.) This is shown in Figure A-43.
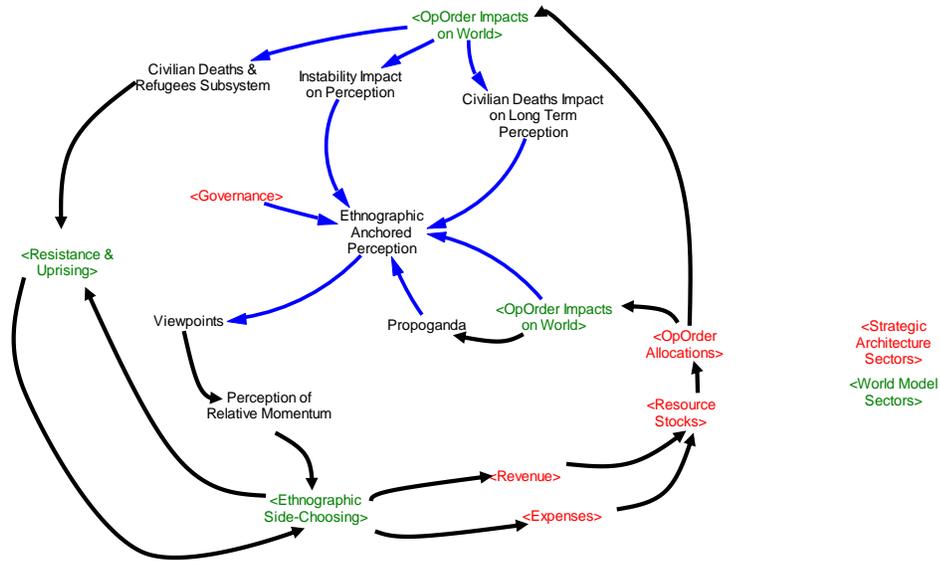
Figure A-43: Ethnographic Perceptions Sector Overview

Each ethnographic entity has a dual-anchor structure of perception (current and long term) of every actor. These perceptions represent both recent and deep cultural perspectives of each Actor's governing capability. The structure of this subsystem is depicted in Figure A-44.
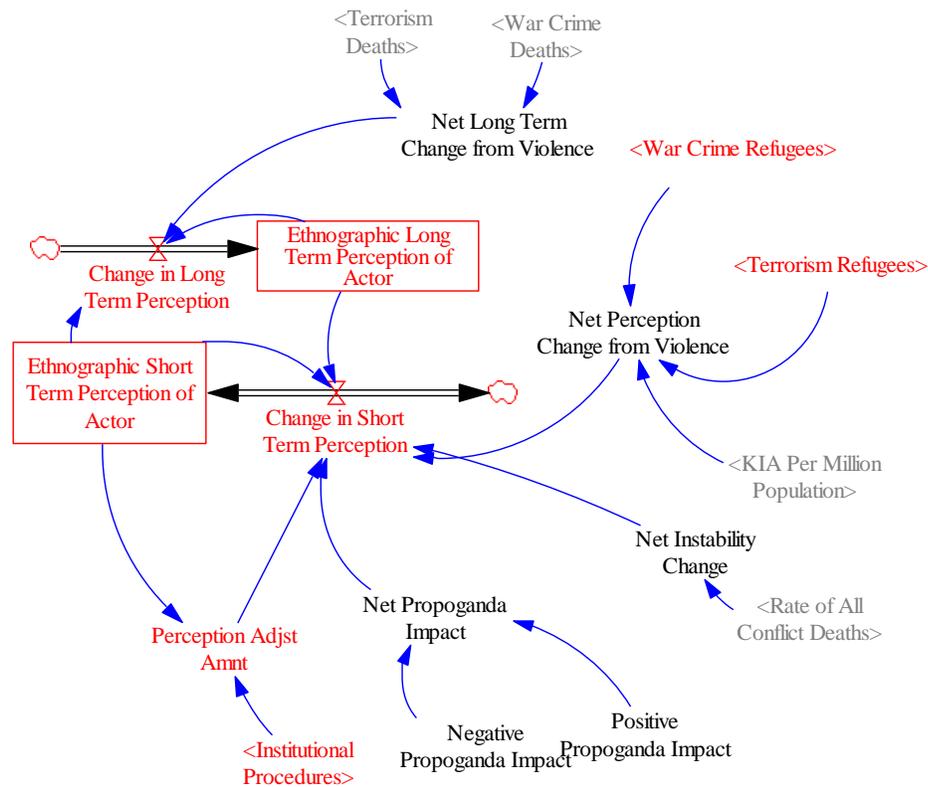
Figure A-44: Anchored Ethnographic Perception of Actor

The short-term perception adjusts in reaction to the perception of presence or absence of "credible institutional procedures"[50] on a shorter time frame. Propaganda efforts by the opposing Actor can also influence the short-term perception of an ethnographic group. Two 'anxieties' also influence short term perception. An overall perception of instability which is based on the *Rate of all Conflict Deaths.* This value includes both civilians and combatants, regardless of actor or ethnographic affiliation. More particularly, *Net Perception Change from Violence* adjusts to actions taken against a specific ethnographic group. Refugees of an ethnographic group plus a KIA per Million Population of that ethnography are reflected here.

The anchored, long term perception, is driven by the short-term perception at a slower averaging time of perception-formation. Plus – deaths of the ethnographic group via *Terrorism* or *War Crimes* conducted by an Actor against the ethnography are reflected here.

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[50] Turnley et al., "COIN 2.0 Formulation."

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Taken in combination this structure creates two gears of perception formation that influence how ethnographies choose side. Ethnographies will take a deep and lasting negative reaction to the deaths of their own ethnographic civilians from *Terrorism* or *War Crimes* committed against them by an Actor. They will also react to the overall violence level they perceive in the environment that they understand from the movement of refugees within their group and more generalized perceptions of deaths.

The two stocks each drive a key perception of the ethnography to the actor. The current value of the *Long-Term Perception of Actor* reflects the percentage of that ethnography that view the Actor as the Legitimate Government. The *Short-Term Perception of the Actor* reflects the percentage of that ethnography that view the Actor with *Calculated Legitimacy.* This structure is presented below in Figure A-45.
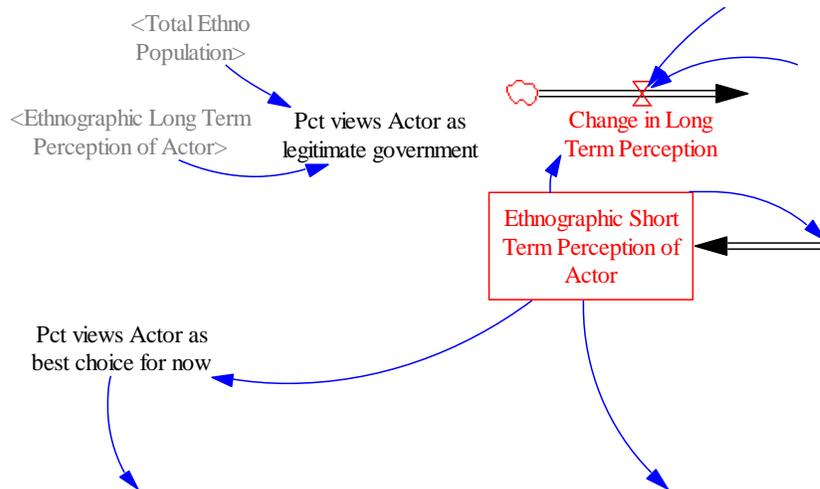
Figure A-45: Ethnographic Perception on Legitimacy

These views are held independently, and there may be periods of time where the percentage of population viewing the actor as legitimate exceeds that who view it in a calculated way. These represent the varying trends in what might be considered a national opinion poll.
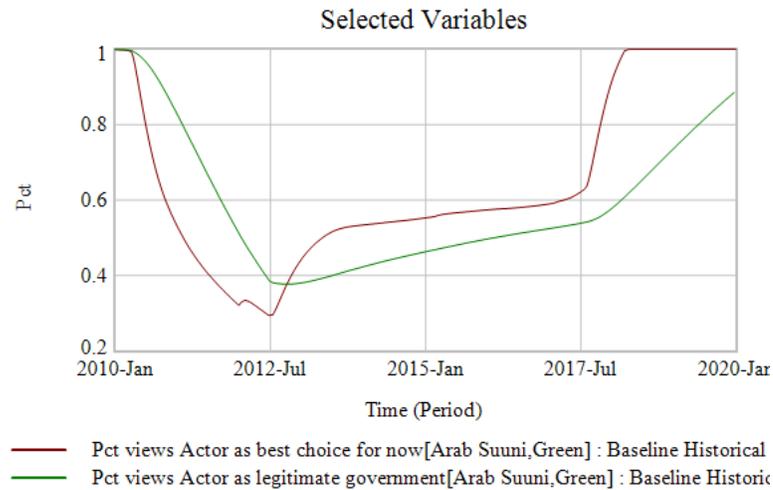
Figure A-46: Sentiments of Legitimacy of Green [Sunni Arab]

It is this structure which allows the Red Actor to further its own advances often by targeting its own aligned ethnographic group. In the <u>Baseline Historical</u> scenario, even as the Green Actor commits extra-legal killings as *War Crimes* Red is conducted terrorism campaign against its own supporters in Sunni Arabs. However, even though Red takes a penalty in perception for these acts in the long run, in the short term the government is held responsible for the breakdown of order and increased perceptions of instability and violence. This effect is demonstrated when looking at the rates of change of Sunni Arab Ethnographic perceptions of the Green Actor. First the *Change in Long Term Perceptions* shows the impact of the extra-legal killing policies, modeled as *War Crimes* by the Green Actor at the start of the <u>Baseline Historical.</u>
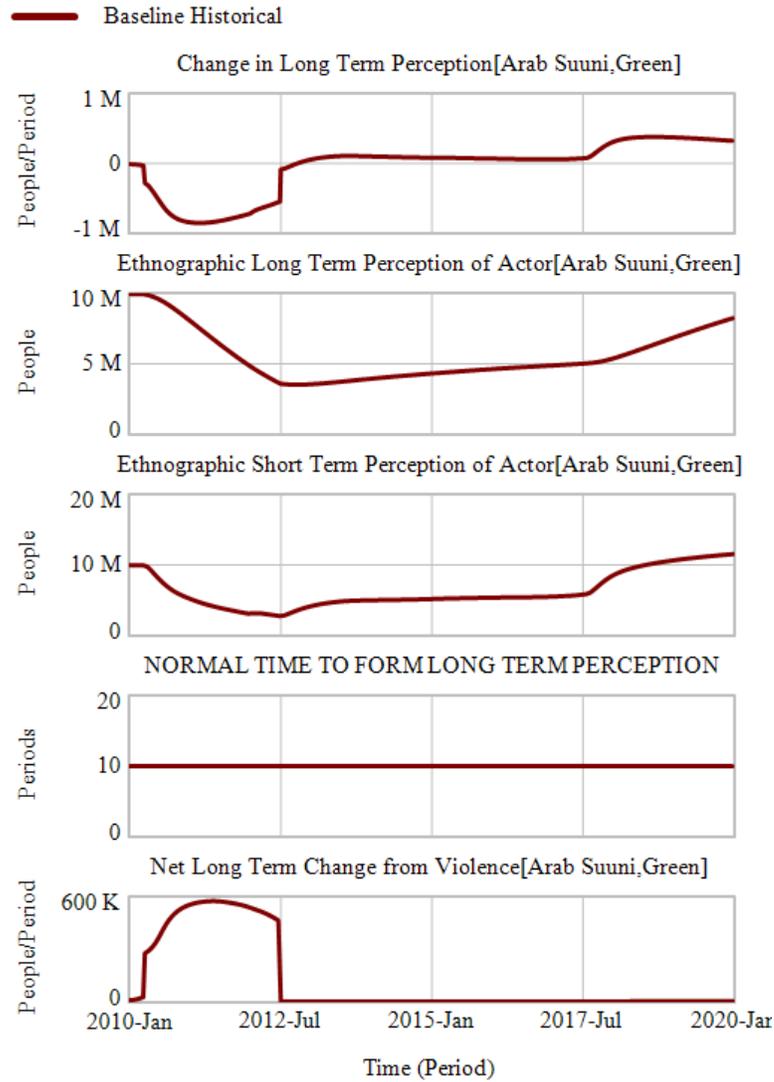
Figure A-47: Change in Long Term Perception [Arab Sunni, Green]

The reduction in long-term perception by Sunni Arab's through 2012-Jul represents the creation of deep grievances. The formula for this flow is:

((Ethnographic Short-Term Perception of Actor[Ethnographies,Actors]-

Ethnographic Long-Term Perception of Actor[Ethnographies,Actors])/

NORMAL TIME TO FORM LONG TERM PERCEPTION)-

Net Long-Term Change from Violence[Ethnographies,Actors]

What's important to note is that that impact to the Long-Term Perception from *Net Long-Term Change from Violence* is not delayed by a long-term perception formation. This means the *Net Long Term Change from Violence,* which reflects the deaths caused by Green among Arab Sunni's immediately deducts from the stock. The influence of the withdrawal of credible government services however is delayed by the *Normal Time to Form Long Term Perception* (10 periods or 2.5 years). Therefore, intentional violence done by the State Actor to an ethnographic actor has a very high influence on perception, which is plausible. Although it is beyond the boundaries of this problem – it appears that to create an insurgency from a population that begins with 100% viewing the government as legitimate requires this sharp decline corresponding to institutional violence against a target group.

The second rate-flow charts in Figure A-48 show the influencers to *Change in Short Term Perception.*
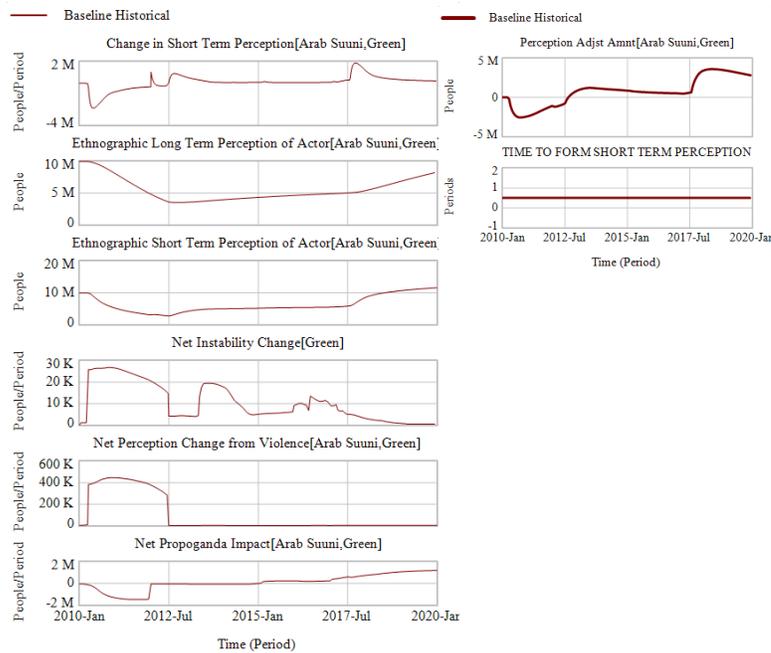
Figure A-48: Change in Short Term Perception [Arab Sunni, Green Actor]

This flow rate shows the dragging influence of the anchor-stock as well as shorter-periodicity fluctuations. Just as in the *Long-Term Perception* certain influencers do not have a delayed averaging period of perception formation.

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((Perception Adjst Amnt[Ethnographies,Actors]+

(Ethnographic Long Term Perception of Actor[Ethnographies,Actors]-

Ethnographic Short-Term Perception of Actor[Ethnographies,Actors]))

/TIME TO FORM SHORT TERM PERCEPTION)+

Net Propaganda Impact[Ethnographies,Actors]-

(Net Perception Change from Violence[Ethnographies,Actors]+Net Instability Change[Actors])

Net Propaganda, Net Perception Change from Violence and *Net Instability Change* all have an immediate influence on perception. While the withdrawal of credible institutional procedures reflected in the *Perception Adjustment Amount* has a slightly delayed, but far broader impact on millions of Sunnis Arabs. This structure implies that violence and instability have two effects:

- An immediate adjustment to short term perception based on environmental feelings of violence which include the number of mobile refugees of one's ethnographic group, the Killed per Million of an Ethnographic group and the overall Conflict Deaths.
- An immediate adjustment to long term perceptions based on the direct targeting of an ethnographic group with *War Crimes* and *Terrorism* by an Actor.

This short and long view of violence can help explain the intractability of many of these conflicts once begun. Until the environment of violence ceases, there will not be room for political solution. But even during that window the drag of long-term perception formation influenced by kin and relatives killed by opponents still impedes improved relations.

One other structural component of the *Ethnographic Perception* sector is noteworthy, and this is the way an ethnographies perception of relative momentum between the two Actors affects how *Unaligned* population switch sides. The structure of this subsystem is depicted in Figure A-49.
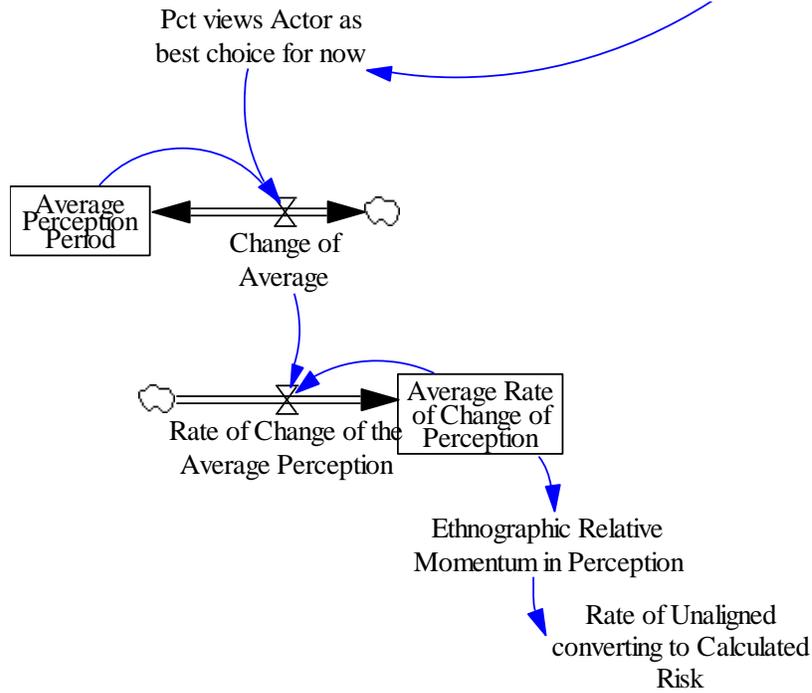
Figure A-49: Relative Momentum Structure for Ethnographic Perception between Actors

In most circumstances the sentiments determined by stock levels are sufficient for determining how an ethnographic population views an Actor they may or may not have a choice of associating with. However, for *Unaligned Population,* where they do have the opportunity to pick a side – this second structure is used. The structure is designed to reflect future-expectation formation based on current information. Rather than a sense of each Actor in total, the *Unaligned Population* compares the relative momentum of each actor regarding the ethnographic perception. The Actor with the higher relative performance in the recent past is perceived to be "heading in the right direction" and will attract *Unaligned* population. These rates over the Historical Baseline conflict are shown below.
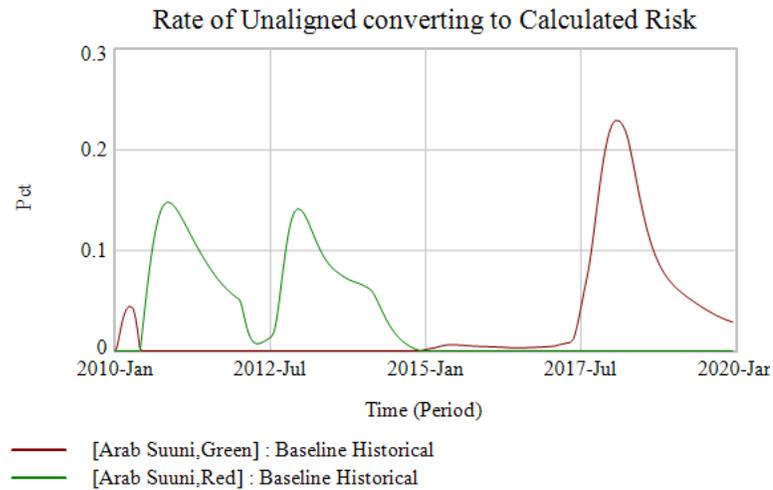
Figure A-50: Rate of Unaligned Converting to Calculated Risk [Sunni Arab]

These flows show the ebb-and-flow of an ethnography's future-expectation perception. During the oppression of Green to Sunni Arabs, the perception of relative momentum strongly favors Red, which is reasonable. However, as the Red fails to deliver this belief and doesn't deliver any greater security, the perception of which side is best suited for the *Unaligned* shifts away from Red and back to Green.

There is no weighting however onto "how sure" the *Unaligned* is with this choice. Rather they simply enter over a time delay the Actor perceived to be heading in the better direction, but only into the stock of *Calculated Legitimacy* (see Ethnographic Side-Choosing sector below.) This reflects a certain strategic calculation appropriate to these kinds of choices.

A-5.2 Ethnographic Side-Choosing & Actor Legitimacy
Overview

Ethnographic Side-Choosing & Actor Legitimacy is the sector where the conflict between Green and Red Actors plays out for control of an ethnographic population.

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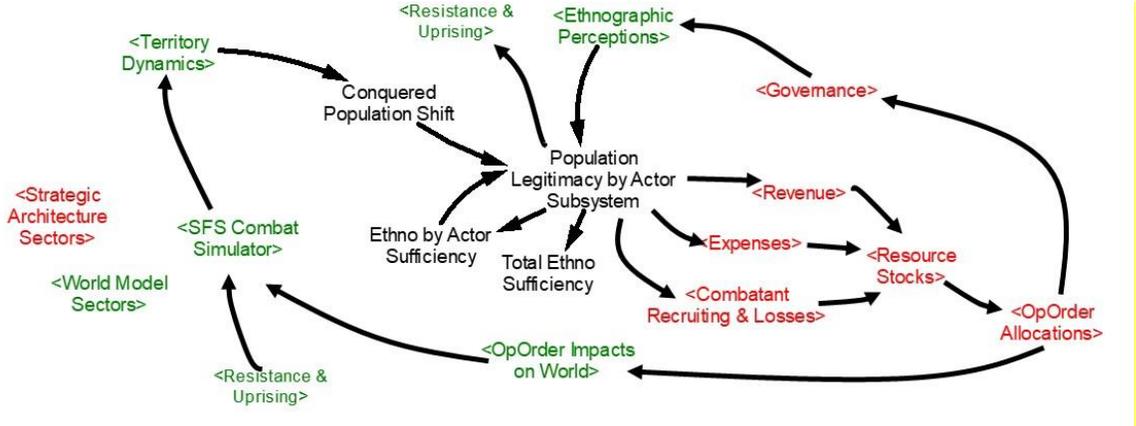
Figure A-51: Ethnographic Side-Choosing & Legitimacy Structure

At the heart of this sector is the population legitimacy by actor subsystem, which consists of four population stocks. These stocks represent the four stages of legitimacy: Unaligned, Coerced, Calculated Legitimacy and Governed. When considered by Actor, the three stocks Coerced, Calculated Legitimacy and Governed represent the total population they have some form of control over. Unaligned represents population that are no longer under the control of any Actor and are considering all actors to switch sides to or stay unaligned.
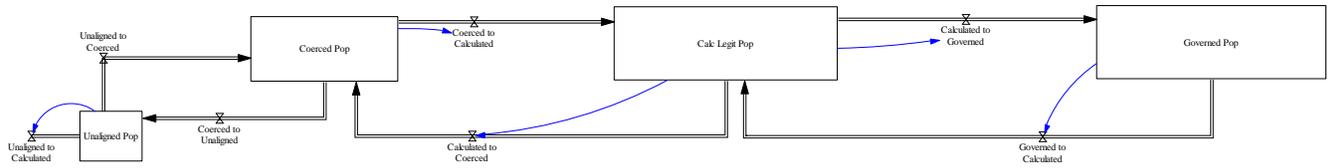
Figure A-52: Stock Structure of Population Legitimacy Subsystem

Not depicted for clarity are additional inflows and outflows that represent changes to the ethnographic population an actor controls. Table A-10T lists all the inflows and outflows by stock.

Table A-10: Inflows & Outflows of Population Legitimacy Subsystem

Type of Flow	Unaligned	Coerced	Calculated	Governed
Inflow	• Defections to Unaligned	• Unaligned Conquered to Coerced	• Coerced to Calculated	• Calculated to Governed

	• Coerced to Unaligned	• Conquest • Calculated to Coerced	• Governed to Calculated	
Outflow	• Unaligned to Calculated	• Coerced to Unaligned • Coerced Lost to Conquest • Coerced Dying • Coerced Opposition Recruitment • Coerced Refugees Leaving	• Calculated to Coerced • Calculated Lost to Conquest • Calculated Dying • Calculated Recruited • Calculated Refugees Leaving	• Governed to Calculated • Governed • Governed lost to Conquest • Governed Dying • Governed Recruited • Governed Refugees Leaving

The dual-anchor perception formation structure in the Ethnographic Perceptions Sector is the primary driver of movement between the stocks. As the perceived legitimacy of an Actor increases – population will shift from left to right across the material chain. Coerced will take a calculated risk if they view the Actor as the "best choice for now" and over time and repeated credible delivery of institutional procedures they may opt into being governed. Again, this does not mean that the governance system is "fair", but rather whether the population continues to actively resist the Actor as a state or has opted into following the system. These adjustments to perception are also influence by *Propaganda,* the violence an Actor may inflict upon an ethnographic group within its control and the overall perception of instability and violence in an area. (See Ethnographic Perceptions Sector.)

As an Actor loses credibility with a population, this process is reversed, and population will begin accumulating in the Coerced stock. If an Actor's garrison is sufficient to physically control the population, they will stay in this stock. However, if an Actor's garrison is insufficient Coerced population may opt out of the state to become *Unaligned* or join *Local Opposition Fighters to Actor* in a form of general uprising. (See Uprising & Resistance Sector.)

When an Actor takes sovereign control of a territory previously held by another actor, the ethnographic population that was living there leaves the material chain of the previous government and joins as *Coerced* of the new government. If the new controlling Actor is perceived more favorable they will quickly shift from *Coerced* into *Calculated Legitimacy* or *Governed.*

It is this structure that allows a wholly endogenous insurgency to form in the E-SAM, without exogenous starting points or switches. Given a starting ethnographic population viewing Green as 100% Legitimate, mistreatment by Green can erode population support shifting the population left into *Calculated Legitimacy* and then into *Coercion.* From there an inability to police & garrison the population will result in a general uprising, some members of whom will defect to the Red Actor*.* This allows scenario where no current Red Actor exists and completely emerges wholly in response to the actions of Green.

Emerging State Actor Lifecycle

The Baseline Historical scenario demonstrates this important concept in part by assuming the premise that Sunni Arab view the Iraq & Syrian governments as 100% legitimate at the start of the scenario. Although this is not historically accurate it helps illustrate the full lifecycle that E-SAM can manifest of an insurgent conflict. Figure A-53 charts the Arab Sunni Ethnographic group within Green as they shift from *Governed* stock through the material chain of stocks in this subsystem.
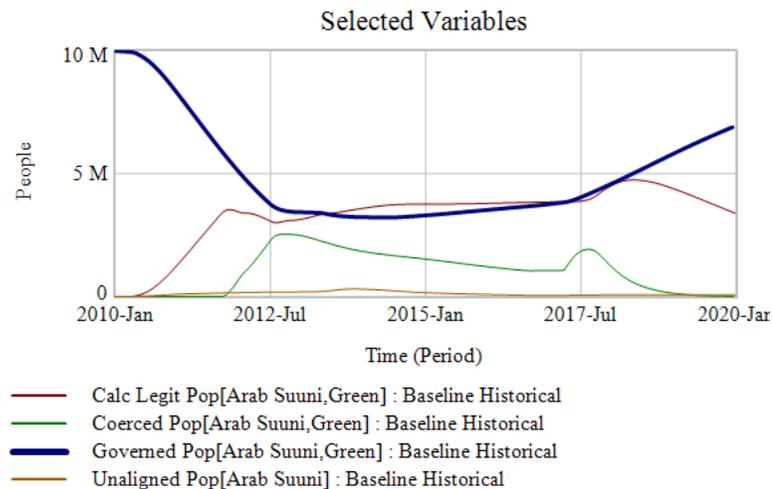
Figure A-53: Distribution of Arab Sunnis Across Legitimacy Subsystem [Green]

The entire population of Sunni Arabs start out viewing Green as the legitimate actor. Then as the oppression and extra-legal violence from Green is committed against Sunni Arabs this belief rapidly erodes. Population begins shifting out of *Governed* and into *Calculated Legitimacy.* It's important to note that this transition might be hard to physically see in an environment – people remain in their homes, showing up to work, following through on their daily lives. They may or may not participate in protests, marches, political organizing activities. But as oppression continues more population leave *Governed* into *Calculated Legitimacy* and some begin leaving *Calculated Legitimacy* into the *Coerced* stock. Those in the *Coerced* are more likely to show signs of discontent – increased protests, riots, anti-government efforts etc. As *Coerced* increase the necessary amount of Garrison & Police required to maintain control increases as well. If Green is unable to meet that, then some of the *Coerced*

will be recruited into becoming a general resistance or uprising against Green. This breakdown in stability is shown in Figure A-54.
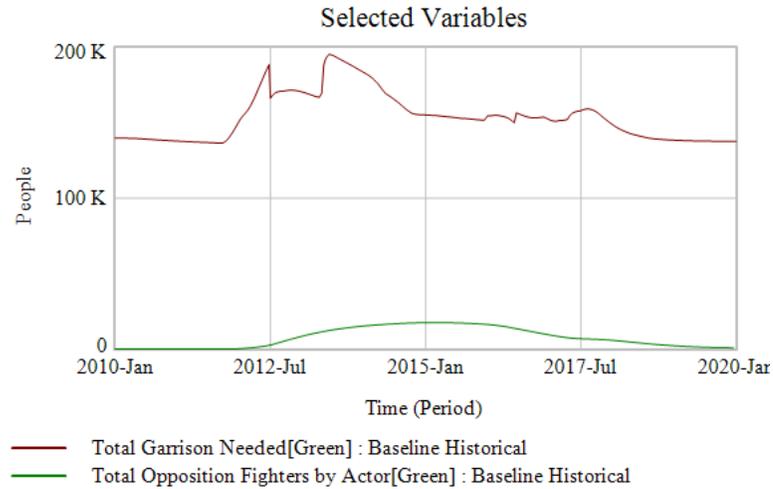
Figure A-54: Breakdown in Stability   [Green]

Turning now to the Red Actor, the collapse in belief of the legitimacy of Green is matched in part by the increase of perceived legitimacy of Red. In Figure A-55 the population stocks are again shown but this time for Sunni Arab ethnographic groups that are part of Red.
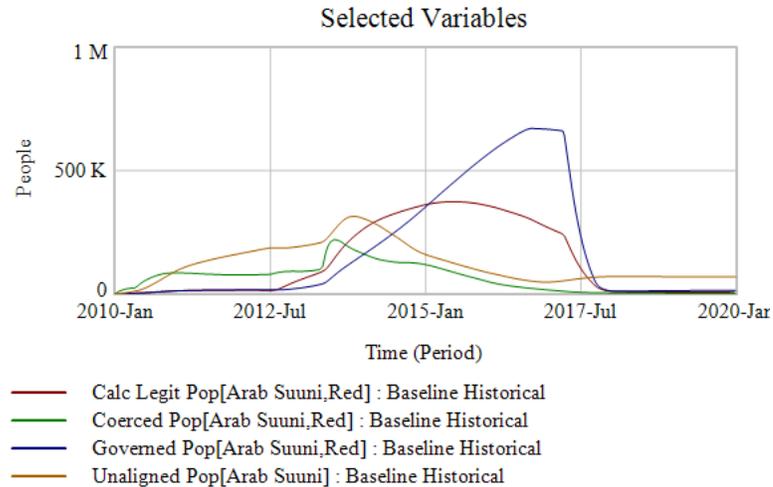
Figure A-55: Rise and Fall of Red Legitimacy

Red starts with zero population and begins gaining *Calculated Legitimacy* population shortly thereafter as they leave Green. After a time, delay, the *Governed* population begins accumulating as well. At any point in time the success of Red as an emerging-state actor, or Green as a failed-state actor, can be expressed by looking at the levels within the legitimacy subsystem or the rates-of-change between levels.

Parameterization

Normal Time for Population Transition

The Normal Time to transition from one level of the legitimacy subsystem to another is 1 Period, or 3 months. This is estimated based on the time it took ISIS to establish governance in Ar Raqqah city from March 2013 to June 2013. Considering the city had already been occupied by salafi-takfiri aligned rebels and was jointly governed by a coalition that included Al-Nusrah (an Al-Queda Branch) the population was assumed to have already accepted that government via *Calculated Legitimacy.* It's important to remember however that the entire chain of transition is larger than 3 months. Transition of population among the stocks is driven by *Time to form Short Term Perception* in the Ethnographic Perception sector. That's currently set to .5 while the *Time to form Long Term Perceptions* is set to 10 Periods, or 2.5 years. (See *B-12.3 Time Delay Sensitivity Tests* for more information on sensitivity analysis of these time delays.)

A-5.3 OpOrder Impacts on World

Overview

The OpOrder Impacts on the World sector is the other half of the bridge that begins with OpOrder Allocations. These two sectors combine bridge the Strategic Architecture which represent an Actor's resources, capabilities and skills into tangible actions that impact the World. Dynamics emerge via feedback when the World reacts to these actions – gaining or losing resources for the Actor tin the Strategic Architecture. The sector's major subsystems and how it interacts with other sectors is displayed in Figure A-56.
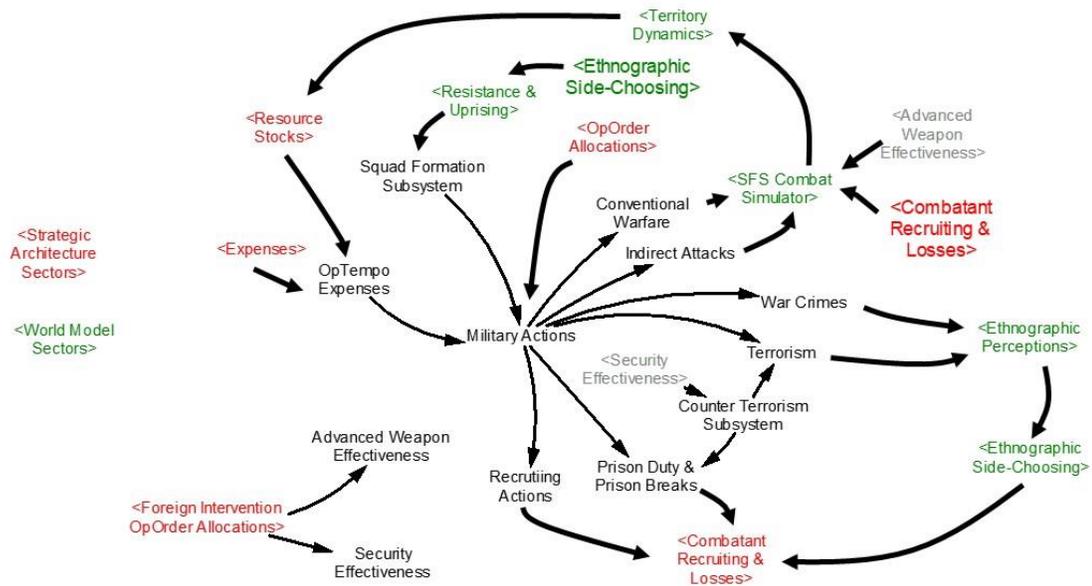
Figure A-56: OpOrder Impacts in World Sector Overview

Whereas the OpOrder Allocation sector simply established priorities of how to use Military Actions at the theater level, this sector determines the results of those actions. As such many of the subsystems noted above include formulations specific to determining the effectiveness or impact of an action.

Dynamics

There are several dynamics represented in this sector.

Squad Formation and Op-Tempo Expenses

In E-SAM the allocation of available forces between different Military Actions is determined by OpOrder Allocations Sector. But two requirements must be met before any individual Military Action can be taken: there must be a Squad of *Combatants* with available manpower to conduct the action. And there must be sufficient cash flow to finance the Military Action. These two subsystems, Squad Formation and OpTempo expenses work in conjunction as limits to the number of Military Actions any Actor can undertake. Insufficient troops, or finances, will prevent an Actor from acting. The structure for this subsystem is depicted in Figure A-57.
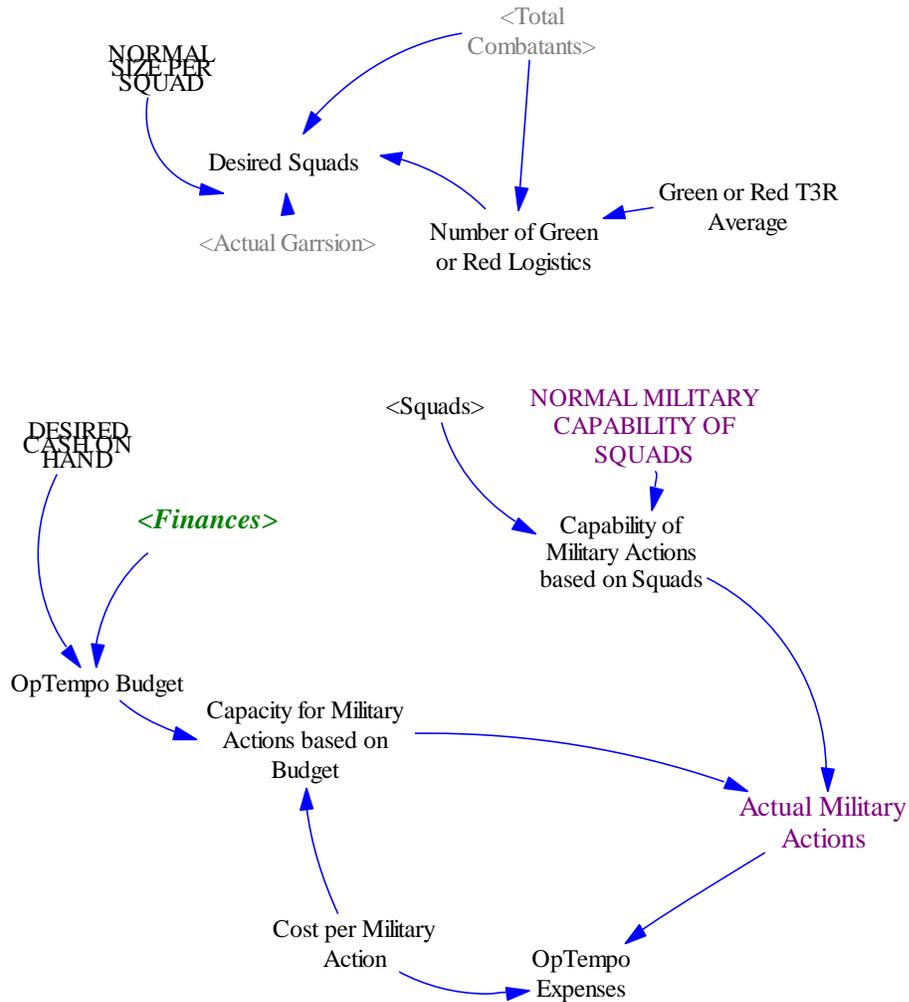
Figure A-57: Squad Formation & OpTempo Expenses Subsystems

The number of available *Squads* for any Actor is based on the *Total Combatants* minus the number of Combatants occupied in T3R duties (logistics, administration and headquarters personnel) and the number of Combatants assigned to *Actual Garrison.* The percentage of troops that are required for T3R are determined by scenario and *Actual Garrison* is endogenously determined in the Resistance & Uprising Sector.

Even once an Actor has available Squads to conduct Military Actions it must be able to afford the attacks. This is not normally a problem for the Green Actor but can become a key constraint for Red. The Cost per Attack is discussed in the Expense Sector above but the way it is used to regulate the frequency of attacks is depicted in Figure A-57. The system looks at the desired budget to remain on have, identifying a *Capacity for Military Actions based on Budget.* The number of Military Actions is thus capped at the lower of the available manpower

or money in that period. If an Actor is short on cash, they may have more Squads than they can perform military actions. Whereas if they are cash-flush but combatant poor, they may have funds that go unused for lack of *Combatants* to execute the military actions.

Counter-Terrorism

Another key dynamic is the counter-terrorism subsystem. Counter-Terrorism aims to detect and thwart clandestine acts such as Terrorism and Prison Breaks. It is a very asymmetrical structure to reflect the difficulties of effective CT programs. This structure is depicted on Figure A-58.
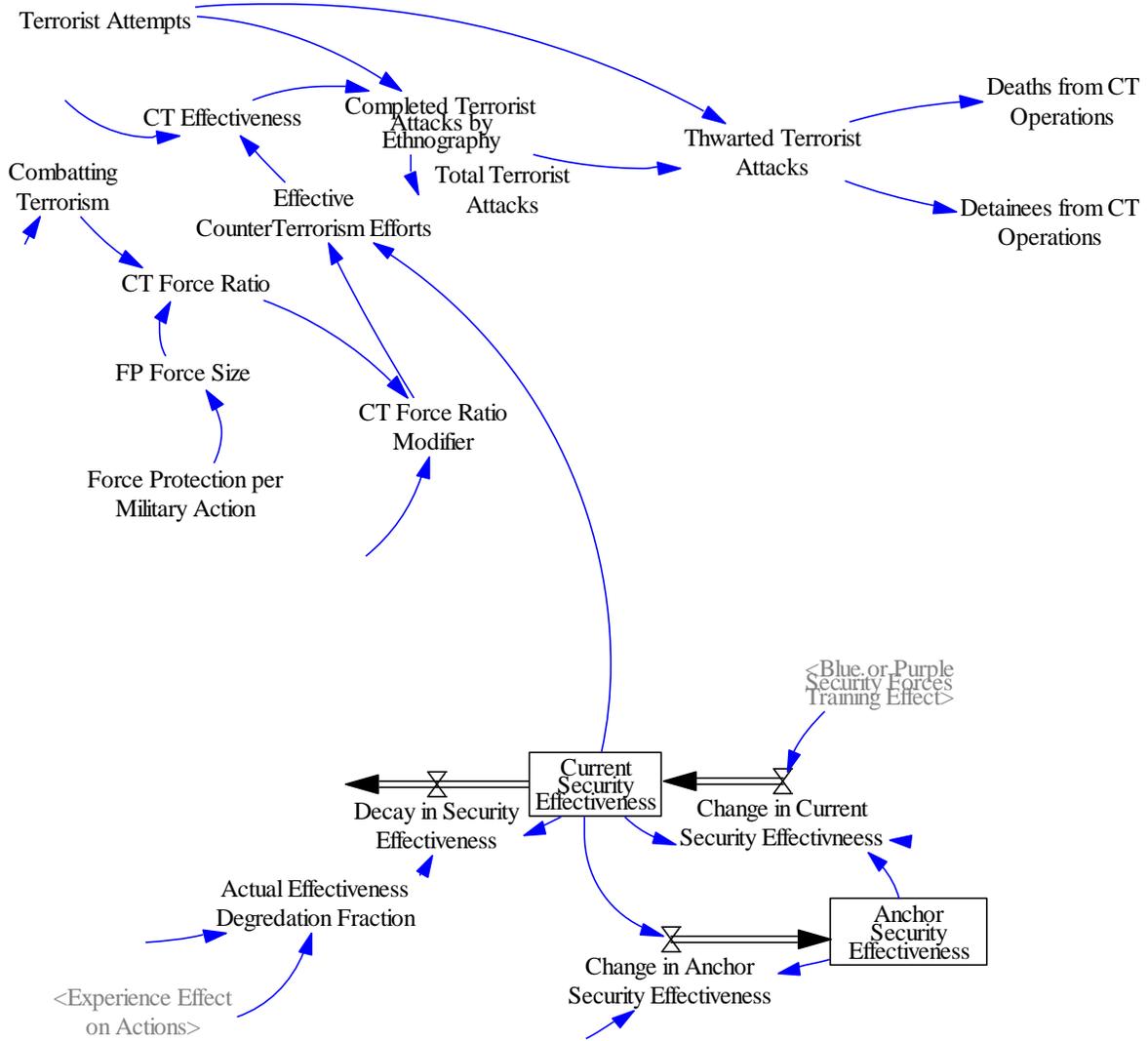
Figure A-58: Counter Terrorism Subsystem

The counter-terrorism subsystem is based on an anchored skill capability of both *Current Security Effectiveness* and *Anchor Security Effectiveness.* Although these start at the same level, *Blue or Purple Security Training* can increase security effectiveness. However, because there is an anchor – it takes time for these lessons to be institutionalized in a sustainable way. Likewise, there is a decay in skills that occurs at a normal degradation rate minus the *Experience* of the Actor's Combatants. The way this structure is that highly experienced, well trained *Combatants* will be highly effective at CT efforts. However, attempting to bring this level of skill to conscript troops that only ever have low *Experience* will take a significant investment of time and resources.

Current Effectiveness is only one part of CT efforts. The second part is a ratio of the overall effort allocated to CT efforts relative to the size of the force being protected. This means that to be effective at CT there both must be sufficient skill, and sufficient personnel to cover the area under threat. Even with all this – CT is never 100% effective. *Effective Counter Terrorism Efforts* ranges in value from 0 to 1, and this then is compared to a graphical lookup function to determine what percentage of terrorist attacks are stopped.
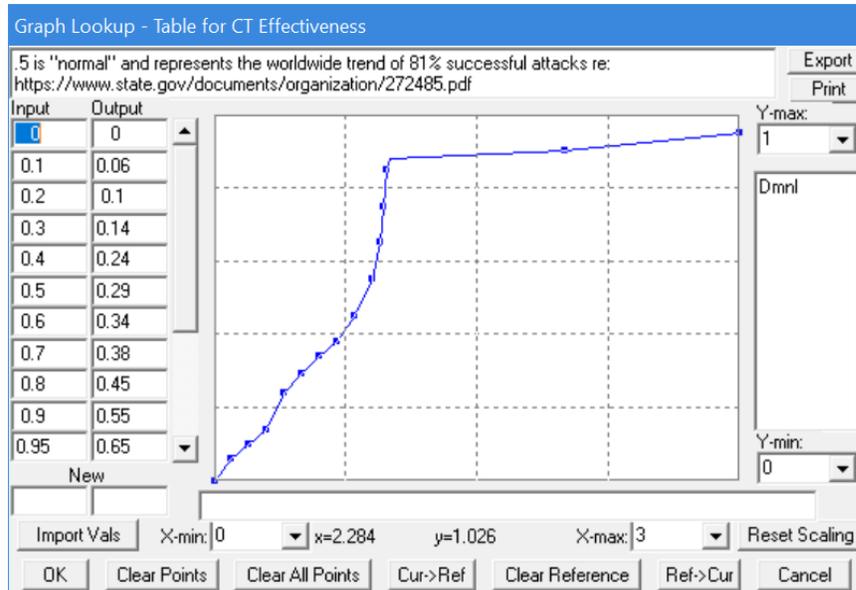
Figure A-59: Graphical Lookup Function for Counter Terrorism

The lookup table establishes ".5" as "normal" representing that 81% of attacks are thwarted. This is the average worldwide according to the United States State Department.[51]

Parameters

Cost per Military Action

Analysis showed that for each $2700 transferred to a sector command, an AQI attack was launched. This cost includes not only direct costs of the attack, but indirect costs of all the other factors necessary for AQI to perform in that sector outside Media, Courts, Administration. Furthermore, there was a strong correlation (.66)

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[51] "Annex of Statistical Information - Country Reports on Terrorism 2015," 12.

between the rate of fund flows increasing or decreasing and corresponding changes in the pace of attacks.[52] The $2700 is rounded up to establish a $3000/Military Action cost estimate.

Values for War Crimes

Without verified data for purposes of the model War Crimes are estimated to cause 25 deaths and create 125 refugees within the ethnographic group targeted.

Values for Terrorism

Without verified data for purposes of the model Terrorism Attacks are estimated to cause 10 deaths and create 10 refugees within the ethnographic group targeted.

A-5.4 Resistance & Uprising

Overview

Green and Red Actors not only have to contend with one another, but restive ethnographic populations. The Resistance & Uprising Sector calculates actor requirements for policing and garrisoning based on the perception of legitimacy by controlled population. It can also endogenously emerge *Local Opposition Fighters* to the Actor. Although these fighters can contribute to battle, they are not formally aligned with either Red or Green. Some however will eventually be recruited into those forces – which is often the first way a general uprising consolidates into a Red Actor. The sector overview of subsystems and interactions with other E-SAM sectors is shown in Figure A-60.

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[52] Bahney et al., "An Economic Analysis of the Financial Records of Al-Qa'ida in Iraq," 57–69. For additional detailed analysis including a full vetting of how this figure was arrived at and multiple tests of the statistical correlation of this figure see the RAND report.
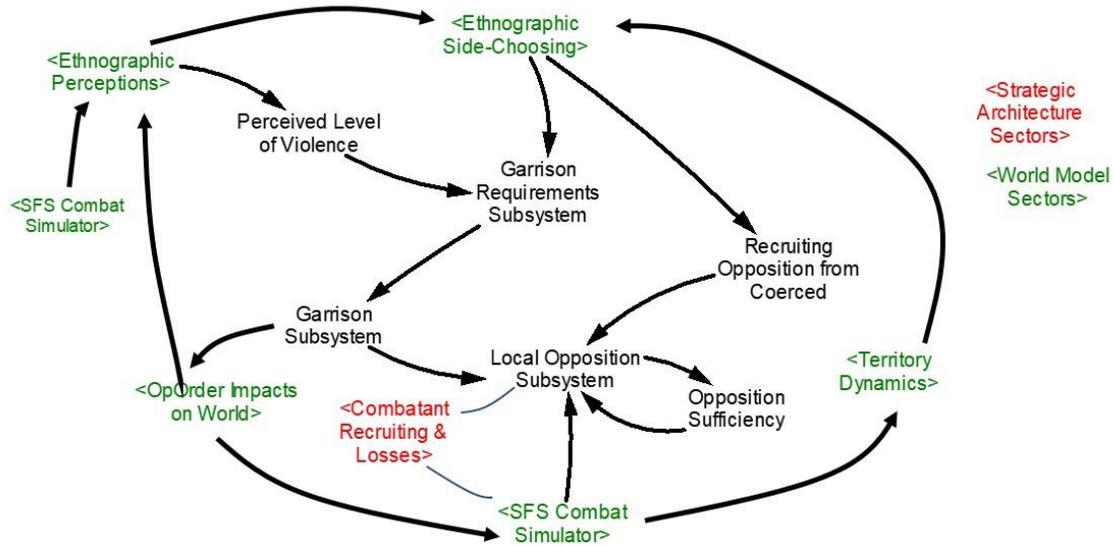
Figure A-60: Sector Overview of Resistance & Uprising

Dynamics

The sector is driven by the Garrison Requirements Subsystem. This subsystem incorporates population perceptions of the overall level of violence and instability, as well as their perception of legitimacy of an Actor, to determine the number of Garrison & Police required to prevent discontent from turning into an uprising.
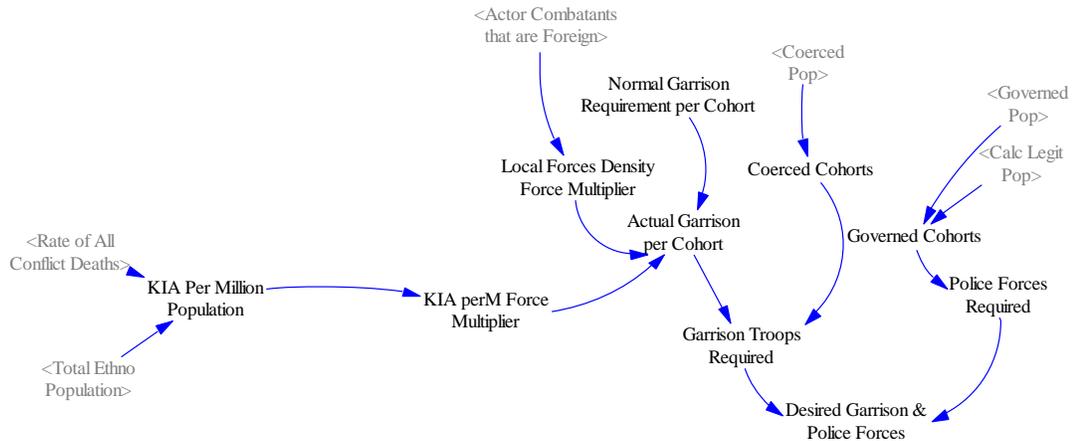
Figure A-61: Level of Violence & Garrison Requirements Subsystems

This subsystem models a key negative feedback loop that serves as a limit to the growth of the Red Actor. It considers both Green and Red as occupying forces in it must conduct counter-insurgency operations on the populations it controls through *Coercive* power. Traditionally troop requirements are represented as forcer-ratios which is the number of troops allocated to counter-insurgency and/or garrison per 1,000 civilians. In a study by Goode of historical force ratios he found that a "minimum" ratio of 2.8 soldiers could then be dynamically adjusted by two factors. The first is local troop density, expressed as a percentage of the counterinsurgency forces that are drawn from the local population. The second is a severity of violence, expressed as the number of combatants killed per 1,000,000 civilians. Pulling from Goode's work a matrix of historical conflicts with varying levels of violence severity, as well as troop densities, results in the following lookup functions:[53]

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[53] Steven Goode, "A Historical Basis for Force Requirements in Counterinsurgency," 54.

Table A-11: Historical Force Ratios (Goode) and Implied Lookup Functions

Force Ratios per 1k Population			% of Forces that are Local		
Conflict	KIA pM	100%	65%	10%
Columbian Civil War	28	8	9	18
Afghanistan	50	10	11	22
Malayan Emergency	67	11	12	25
Iraq	120	13	15	31
Algerian War	298	18	21	45
Contras in Nicaragua	490	21	25	55

KIA pM Function			% of Local Forces	
Input	Output		Input	Output
1	1		100%	1
1.8	1.23		65%	1.14
2.4	1.36		10%	2.38
4.3	1.67			
10.6	2.36			
17.5	2.8			

Table for Local vs. Foreign Forces on Garrison Force Multiplier

The lookup function is derived from Goode's table by establishing that "normal" or 100% Local Troop Density is 1. Then for each conflict the mid-point ratio (at 65%) divided into the 100% rate, these are then averaged amongst one another to arrive at a 1.14 multiplier for 65% local density. The same calculation is performed for 10% entries resulting in a 2.38 multiplier. The lookup table is displayed below:[54]

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[54] Steven Goode, 54.

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Figure A-62: Lookup Table for Local Troop Density effect on Garrison

Table for effect of Severity of Violence on Garrison Force Multiplier

The lookup table for the effect of severity of violence (combatants KIA per 1,000,000) is derived in a similar fashion for the effect of Local Troop Density. The input is kept as a discrete KIA per M taken from each conflict. The output is an average of the force ratios at all levels of Local Troop Density. This creates a relative comparison that Afghanistan was ~180% more severe than Columbia. This relative ratio serves as the input on the left-hand side of the table. The output is taken as an average of ratios at all levels of Local Troop Density for that conflict.[55]

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[55] Steven Goode, 54.

Figure A-63: Table for the Effect of Conflict Severity on Garrison Force Ratio

In the simulation Local Troop Density is endogenously determined by *Actor Combatants that are Foreign.* The higher this percentage, the greater number of troops necessary to properly Garrison the local population will be. This is important because a proposition of the emerging-state actor theory is that by exploiting global, rather than local grievances, it can create a global draw for foreign recruits. The more foreign troops a counter-insurgency force has however, the greater the number of troops required to garrison a local population. The severity of violence (*KIA* perm) is also determined by taking the *Rate of All Conflict Deaths* per period (3months) and dividing it into the *Total Ethnographic Population.* (This is a slight variation on Goode's approach which uses an annual metric.) Taken together these two inputs, *Actor Combatants that are Foreign*, and KIA per M Function combine to determine many combatants required per 1,000 civilian cohort. These Garrison requirements for Red are compared across these factors in both the <u>Historical Baseline</u> and <u>Baseline without Intervention</u> scenarios.

The second contributor to Garrison & Police forces are those troops which are used in a policing role within the population that is governed through legitimate means. Goode presents a range of force multipliers for police-to-population ratios but for purposes of this simulation the aggregate average of 2.8:1000 police-to-population is used. [56] This significant difference in the troops needed for coercive power control of a population versus governing through legitimacy is one of the strengths proposed of an emerging-state actor has over a traditional insurgent. Through the structures of creating credible institutional procedures and increasing legitimacy within

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[56] Steven Goode, 56.

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a controlled population, *Coerced* can be quickly converted into at least *Calculated Legitimacy* population. This reduces the number of garrison required and free those troops up for further Military Actions. The *Total Garrison Needed* for ISIS is shown in Figure A-64 for both the <u>Historical Baseline</u> and <u>Baseline without Intervention.</u>

Figure A-64: Garrison & Police Forces Baseline Scenarios

Understanding what ISIS's Garrison requirements would be had there not been an intervention is key to understanding what would activate its limits to growth. Even though most of its population is being converted away from *Coerced* and into *Calculated Legitimacy* and *Governed,* Red needs to maintain a large Garrison & Police force. This draws away front-line fighters capable of performing Military Actions such as *Conventional Warfare* to gain additional territory. As ISIS's territory progress slows down perception of momentum by commanders declines, and they are less willing to aggressively allocate fighters for offensive operations. (see Territory Dynamics Sector) Territory gain reaches a stalemate with Green Actor and an endogenous "territorial boundary" of ISIS emerges as shown again in the *Territory Controlled by Actor* for both scenarios in Figure A-65.

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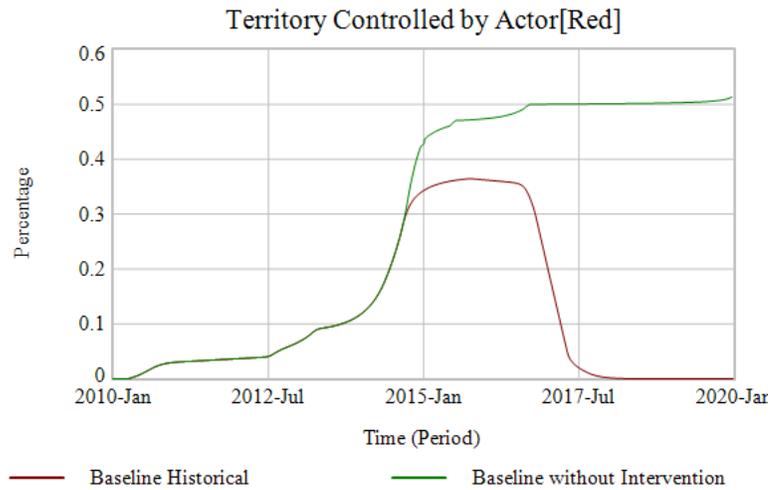
Figure A-65: Territorial Boundary Endogenously Created by Limits to Growth

A-5.5 SFS Combat Simulator

Overview

This sector attempts to simulate realistic combat conditions between Red and Green using the US Military's Situational Force Scoring (SFS) Combat Simulator.[57] The key subsystems and interacting sectors are depicted in Figure A-66.

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[57] Allen, Patrick, "Situational Force Scoring: Accounting for Combined Arms Effects in Aggregate Combat Models."
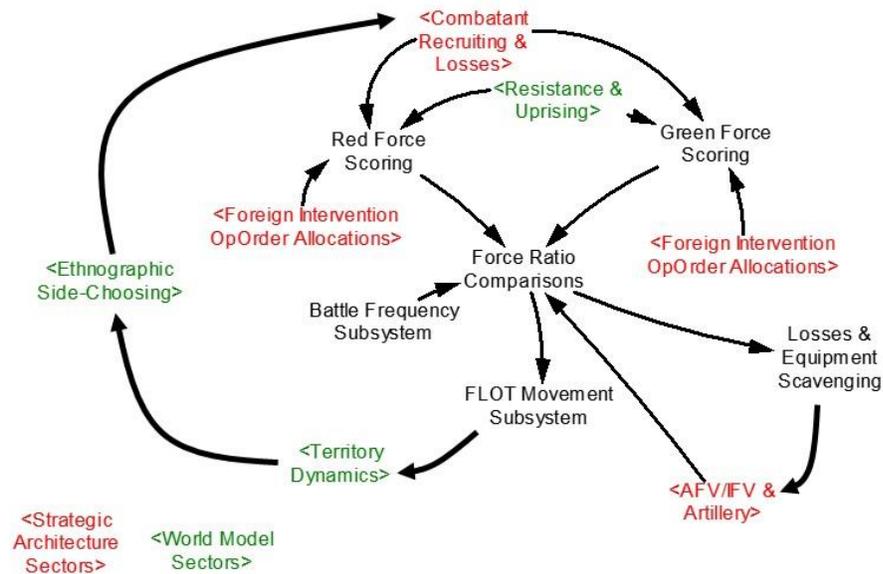
Figure A-66: Overview of SFS Combat Simulator Sector

The Combat Simulator is used to determine how Green and Red Actors will compete in conventional conflict to gain or lose Territory. The Combat Simulator takes the *Conventional Military Actions* by both Actors from the OpOrder Impact on Word Sector. It uses this in combination with other factor to determine the number of actual fighters. Then locates the positions of both Actors on a synthetic map to determine the battle simulated while a Frequency Subsystem determines how frequently conflicts occur. For each battle simulated a variety of factors determine success or loss including: type of battle; terrain; disparity of forces involved; numbers of AFV & IFV, infantry and indirect attacks (suicide bombers or artillery); quality and morale of troops etc. Whoever wins the battle can move the Forward Line of Troops (FLOT) which represents the rough geographical extent of territorial control. FLOT should not be mistaken as a hard-and-fast demarcation as in traditional military context. In Iraq & Syria ISIS's FLOT may have included wide swaths of unpopulated deserts through which both Actors could move – but it's a general designation to incorporate what population centers, territorial resources and other territorial based characteristics are attributed to the Green or Red Actor. Also, the movement rates of FLOT have been adjusted to reflect the conditions of Syria and Iraq from the original published SFS.

In this model all opponents of Green, to include Red combatants, local opposition fighters to Green and Purple Foreign Troops are grouped together as the "RED FORCE." Likewise, Iraq & Syria, the local opposition fighters to ISIS, and foreign intervention support is aggregated into one "GREEN FORCE."

A-5 Sector by Sector Overview of World Model

The SFS Combat Simulator connects combat to other aspects of the model to create endogenous feedback – such as with the Militant Experience resource stock. The more experienced the combatants are the faster they can attack and the higher their morale and combat effectiveness. As an Actor gains territory, they can take population away from the other Actor and eventually gain recruits from that population. The use of a simulator also allows the scenario to detect where battles occur under a wide variety of conditions. This fidelity enables the ability to highlight differences in fighting across open desert, versus much harder fighting in urban areas. This is important as the territorial differences tie directly into differences in what a victory may mean. Victories in the desert may gain significant territory, without much population, while the much harder fights in urban areas allows ISIS to gain a large amount of target population without nearly as much territory. Victories or losses determined by the Combat Simulator determine losses for both sides include killed, detained/captured (only Green takes prisoners) as well as lost AFV/IFV & Artillery pieces. Only ISIS as Red can scavenge AFV/IFV & Artillery. Since this is the only means by which ISIS can gain access to armored vehicles and advanced equipment it represents a key dynamic to their growing strength.

The choice of the SFS Combat Simulator is not without its potential controversy. Other simulators were reviewed beginning with system dynamic models of the Lanchester Laws by Artelli[58], Combat Power Density by Zanella[59], Joint Integrated Contingency Model (JCIM) developed by RAND[60] before settling on the SFS Combat Simulator. Most of the flaws of other modeling approaches were either too high a level of aggregation (Lanchester), too abstracted (Combat Power Density) or improper application – JCIM is better used for strategic combat. Additionally, the SFS Combat Simulator was designed for an entirely different scenario, conventional force engagements. Finally, the SFS Combat Simulator is a reductionist Cartesian approach challenged by Kilcullen.

However, SFS Combat Simulator, in comparison to other combat simulators, had the ability to vary terrain of engagement, type of engagement and key criteria related to the combatants including morale, training, specific equipment values that would be necessary details for some of the policies intended to review. Given that the Simulator is in a subsystem, rather than a stand-alone simulator, and receives dynamic feedback from other sectors, it is no longer limited to a simple reductionist equation. Key parameters of the SFS Combat Simulator adjust and change with the successes or setback of ISIS over time. For example, the Simulator identified how many Heavy Weapon pieces end up as scavenge for ISIS, and this then feeds back into future combats as a benefit to the ISIS side. Likewise, Militant Experience dynamically adjusts Morale and Training variables, and is itself a dynamic determined by the success of military actions which enable territory to be recruited from and suicide attacks that draw in foreign fighters.

[58] Artelli, M.J. and Deckro, R.F., "Modeling the Lanchester Laws with System Dynamics."
[59] Zanella, James, "Combat Power Analysis Is Combat Power Density."
[60] Bennet, Bruce W. et al., "JICM 1.0 Summary."

Additionally, this paper proposes that SFS Combat Simulator, or one like it has some advantages with traditional insurgent combat modeling. For much of 2013-2014, ISIS was conducting irregular, yet conventional, attacks – using formations of uniformed soldiers moving in convoys of vehicles equipped with heavy weapons and attacking in open fashion to destroy the enemy. They were not operating in an unconventional manner with guerrilla movements and clandestine networks. Their use of IED's and suicide bombing in a military context operate much like artillery – denial of maneuver, attack on supply lines and rear-attacks; and when used against populated towns and cities like long-term sieges where sustained attacks on checkpoints, police or paramilitary headquarters, and civilian targets "soften up" a target prior to a direct attack. Additionally, tactical and strategic air support is removed as these are not significant factors in the environment ISIS faces. However, tactical air support is added back in as a potential policy option when coalition or Iranian air strikes are conducted to attack ISIS as part of a policy analysis.

A-5.6 Territory Dynamics

Overview

The purpose of the Territory Dynamics Sector is to create a synthetic geography within which Green and Red will compete. This Sector also distributes key stocks such as ethnographic population, oil production, garrison locations across this geography. Additionally, this sector handles dynamics of Actor decision making based on their perception of how their competitor is moving through an environment, the momentum of the conflict, and how they should adjust conventional forces in reaction to that. An overview of this sector is shown in Figure A-67.
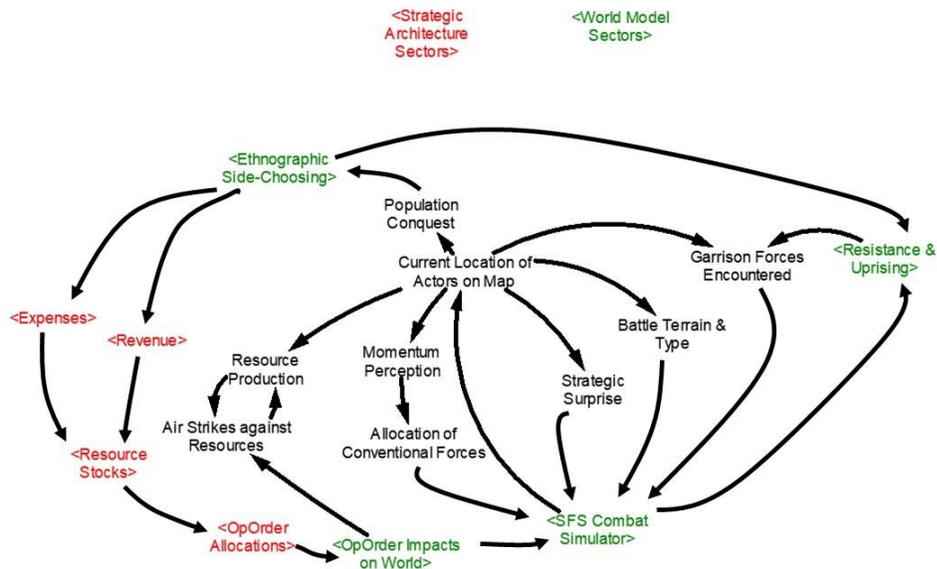
Figure A-67: Overview of Territory Dynamics Sector

The sector is initialized from scenario data to represent the geography being simulated in E-SAM. For this report, the total territory of Iraq and Syria, 619,308km^2 are combined into an overall territory to represent a regional action. However, the territory could represent a single country, such as Indonesia (*see B-10 Family Member Test*); regions within a country; or even cross-border regions that overlap many countries but don't include the entirety of any of them. In this last instance for example E-SAM can be used to model cross-border regions such as the Afghanistan-Pakistan border region, the Kashmir Province as contested by Pakistan and India or the region of Boko Haram operations that includes Nigeria, Niger, Cameron and Chad.

It is important to remember that in terms of *Conventional Military Actions* to seize territory, the choices of where to attack next are determined by Theatre Strategies and not Operational Orders. (*See C-4 Green/Red Operation Orders for a full description of operational orders.*) These Theatre Strategies are expressed in E-SAM by the lookup tables that lay a path through the territory Red will follow, if it is able too; and what it encounters as it gets there. Likewise, Green's counteroffensive actions, if any, will be along the same path. There is nothing in the model to represent Red taking an endogenously generated choice between Option A and Option B about where to attack next. This reflects the constraints that Red is still acting within a hierarchy that reacts to leadership decision making and the strategy leadership will arrive at is often exogenously generated. For this reason, scenarios should be built informed by plausible choices the Red Actor could make. If greater coverage of alternate options is needed, only slight changes need to be made to the Theatre Strategy portion of the Scenario Builder, in effect changing the path of progress.

Dynamics
Much of the Territory Sector consists of lookup functions and returning of values of what is found in each piece of territory as Red or Green gains or loses it. The dynamics this generates are carried through to other sectors. In this way the "geography" is deformable. If Red Actor precedes *Conventional Military* attacks with an extended campaign of *Terrorism* against Green Actor's areas this will reduce the population of the ethnography targeted, through *Deaths* or *Refugees.* If Red later occupies that territory – there will be less population to tax or recruit from. Likewise, Red can use *War Crimes* against ethnographic groups in territory it controls. This will act as an ethnic-cleansing function – reducing the ethnographic population again through *Deaths* or fleeing *Refugees.* Were Green to reconquer that area, they would liberate a much-reduced population. Another example is if Red were to seize territory that included resources. This could represent oil in the current scenario, cocaine fields, opium or whatever is appropriate to the scenario. If Green then targets that resource production for eradication, the values of production will drop. If Green is then able to reoccupy that area, the resource production will be at the new, lower value.

Although combat itself is governed by the SFS Combat Simulator Sector, discussed later, the combat impact on Territory is relevant to this sector. The boundaries of each actor's area of control is referred to as the as the Forward Line of Troops (FLOT). Obviously, military actions in the environment of Iraq and Syria are mobile and

fluid, it would be hard on the ground to observe a true FLOT. Also, territory gained often looks more like a checkerboard, with military installations holding out long after a city has been taken or different towns along the same highway having different levels of control. The use of FLOT is simply a modeling convenience and represents an aggregate representation of where an Actor can significantly deny or disrupt opponent Actor military functions such as the manning of checkpoints, freedom to move supplies or troops etc. More importantly for the model FLOT represents the boundary at which Population come under the control of either Actor.

For each battle simulated a variety of factors determine success or loss including: type of battle; terrain; disparity of forces involved; numbers of heavy weapons, infantry and indirect attacks (suicide bombers or artillery); quality and morale of troops etc. If a battle is won, the FLOT is moved forward for that Actor by movement rate determined by both the battle terrain and type and the movement capabilities of the Actor.

Garrison Forces

One of the challenges of territory is to distribute the forces that have already been determined in the Resistance & Uprising section as *Actual Garrison*. Garrison & Police forces must be spread out to be effective in their roles. When Red emerges the entire Garrison, force can't congregate to where they emerge, or else they will leave the areas where they are needed open to worse discontent and possible uprising. Also allocating garrisons often reflects strategic values of leadership on what is important, and what can be lost. High population centers of friendly ethnographic populations, key strategic locations or hubs of economic activity all will receive higher Garrison & Police forces. This exogenous process of value-selection and allocation is handled via Theatre Strategy, set as initial conditions. These conditions are then compared to the actual position of the Red Actor, to determine what percentage of the entire garrison forces Red encounters. This is added to *Conventional Military Actions* as well as *Local Opposition to Actor* to determine the total force an Actor must face at any point in time. Figure A-68 demonstrates how this structure results in determining Green garrison forces Red encounters in the Baseline Historical compared to the Baseline without Intervention.
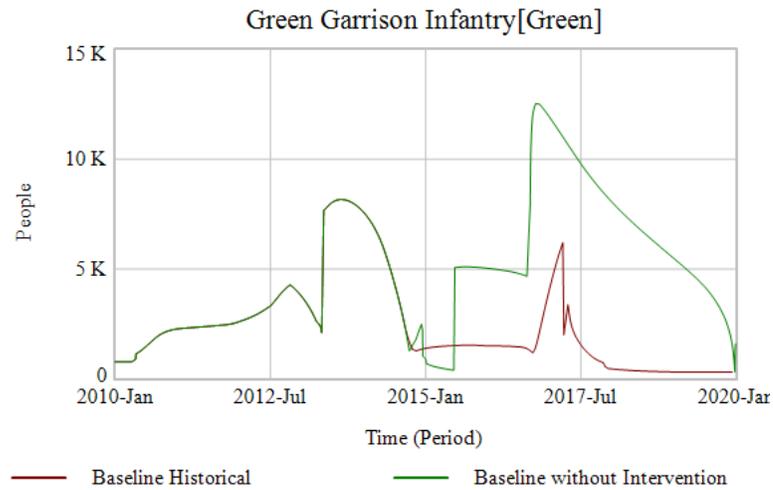
Figure A-68: Green Garrison Encountered in Baseline Scenarios

These aren't the only forces Red fights – just the portion allocated to Garrison duties it will encounter. Note the large spike that occurs after 2015-Jan in the <u>Baseline Without Intervention.</u> This represents the advance of the Red Actor into critical areas of the Green Actor that they have guarded with more forces. This doesn't occur in the <u>Baseline Historical Scenario </u>because the intervention is already underway at that point – and the only garrison forces Red encounters are those assigned to the areas they have already conquered. In effect "joining up" with the offensive push to take back territory they have taken.

Perception of Momentum

The Garrison forces mechanic described above is only one dynamic in the Territory Dynamics that regulates the size of forces that are committed to a battle. Another dynamic that is very important in understanding the progress of conflict between Green and Red in E-SAM is the *Actor Perception of Momentum.*

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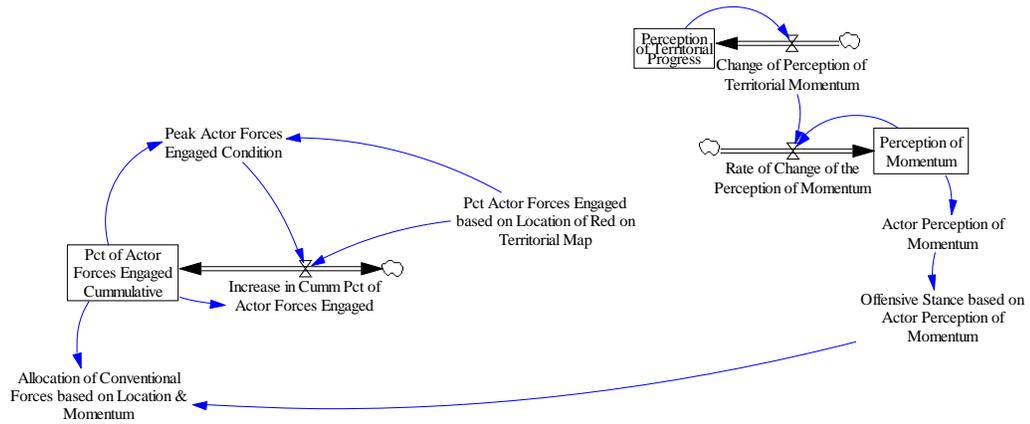
Figure A-69: Perception of Momentum Structure

This structure represents in part the fog-of-war and the very human behavior in reaction to who is perceived to have momentum in battle. The movement of Red in gaining or losing Territory is tracked as a stock in *Perception of Territorial Progress.* But the rate of change of that stock itself then becomes an averaging measure in the stock *Perception of Momentum* which feeds an *Actor's Perception of Momentum.* What this part of the subsystem seeks to replicate is a "sense" of who is winning or losing in terms of territory recently. In Figure A-70 , the *Actor Perception of Momentum* is charted for both Green and Red in the Historical Baseline.
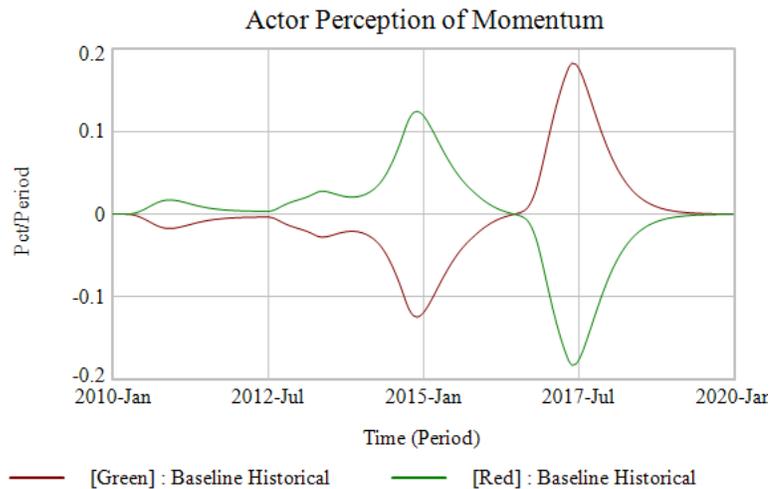
Figure A-70: Actor Perception of Momentum in Baseline Historical

As currently formulated, the Actors have mirror image perceptions of each other's momentum. Positive values relate to a sense of "winning" and negative values relate to a sense of "losing." As values approach zero, the

perception of both sides is of stalemate. This is shown in Figure A-71 which looks at the same value for the Baseline without Intervention.
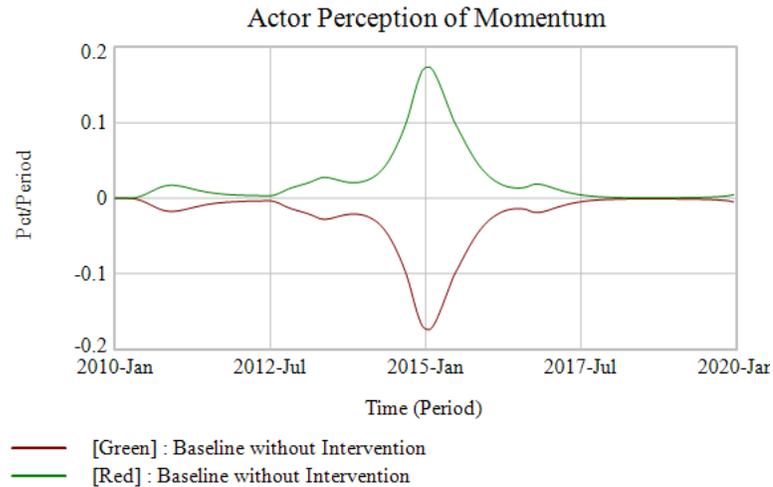
Figure A-71: Actor Perception of Momentum in Baseline without Intervention

Although the first half of the conflict proceeds along the same half, the second half, without the intervention is different. Green is never able to perceive itself as winning against Red, nor does Red perceive itself as losing. Rather the *Perceptions of Momentum* of both approach and stay near zero, reflecting a leadership recognition that they may have reached a stalemate.

The second half of the subsystem is the structure that takes this leadership perception and converts it into tangible action. The perception is converted into an *Offensive Stance* and this stance modifies the allocation of *Conventional Forces.* Normally *Conventional Forces* are distributed in the territory based on the Theatre Strategy of what is high or low value areas for Green to protect. As Red moves it will encounter larger groups as they approach more critical areas while far away areas have less forces other than the Garrison in that area. However, the *Actor Perception of Momentum* influences this static relationship based on the perception of leadership. If an Actor perceives themselves as winning – they will be more aggressive, allocating more *Conventional Forces* to exploit an advantage. But if they think they are losing, they will be more conservative – perhaps holding some forces back to ensure reserves.

This dynamic can help replicate some of the behavior seen in the early stages of the conflict with ISIS where Iraqi and Syrian forces were reluctant to engage what appeared at the time to be a rampaging opponent. However, the dynamic also replicates the behavior of ISIS that as they were put on the defensive they began retreating to

their city strongholds in Mosul and no longer as aggressively conducting offensive operations. Figure A-72 shows this *Allocation* dynamic as a function of *Perception* in the Baseline Historical scenario.
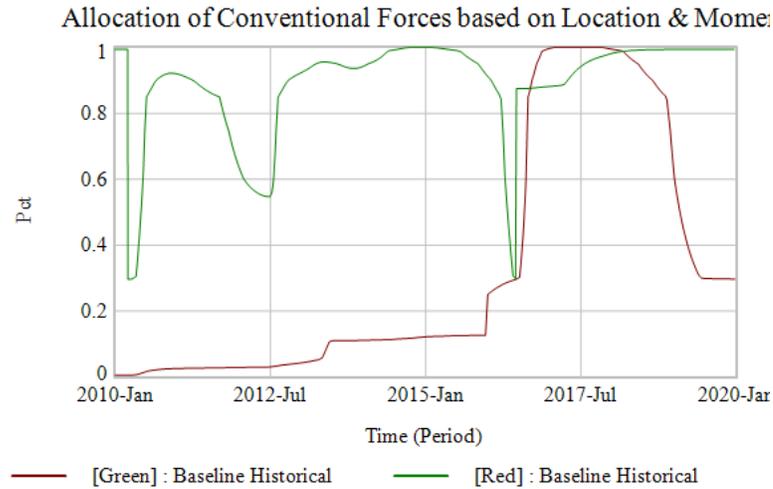
Figure A-72: Allocation of Forces Baseline Historical

In Figure A-72 the Red Actor can seize territory with relatively few forces, and gradually increases their allocation based on the perception their winning. Green on the other hand suffers repeated blows to confidence, withdrawing troops under the face of unexpected victories. However, as the Green intervention gains strength and begins to threaten the core areas of Red, ISIS throws as many troops into defense as they can, reflecting the final holdout sieges of Mosul, Fallujah and Ar-Raqqah.

In the Baseline without Intervention displayed in Figure A-73 however, this existential threat to Red never materializes. Both sides perceive a relative stalemate and adjust their forces accordingly.
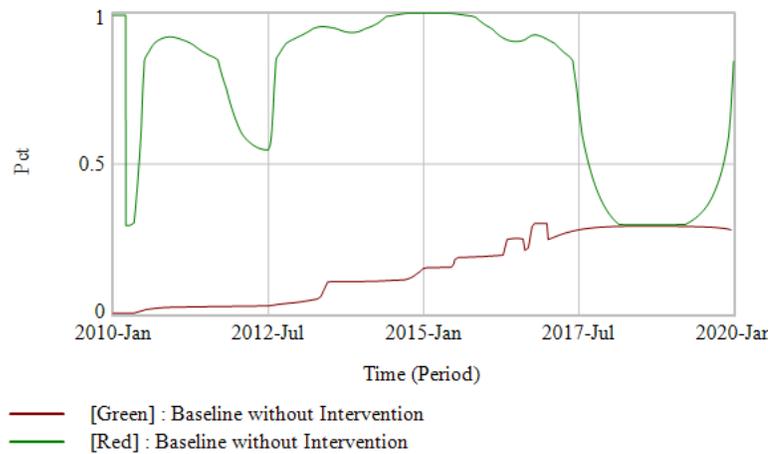
Figure A-73: Allocation of Conventional Forces Baseline without Intervention

From the distance of viewing the entire system – it seems logical that Red should allocate 100% of its forces into a final push to break through the stalemate. But Red leaders do not have that knowledge, limited instead by the Bake Rule to only know what they know at a point in time – which is their perception of relative momentum.

Parameterization

Two parameters of the Territory Dynamics Sector: Terrain Type and Battle Type, displayed in Table A-12 are provided in the RAND SFS Combat Simulator. Each characteristic returns an individual multiplier modifier to the effectiveness of AFV/IFV, Artillery or IED and Infantry depending on whether one is attacking or defending. The Terrain Type and Battle Type multiplier are then themselves multiplied and used to adjust the Combat Values of the of the troops engaged in that conflict.[61]

Table A-12: Terrain & Battle Type in the Territory & Scenario Sector

Terrain Type	Battle Type
1) Open	1) Breakthrough
2) Mixed	2) Hasty Defense
3) Rough	3) Prepared Defense
4) Urban	4) Deliberate Defense
5) Mountain	5) Fortified
	6) Meeting

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[61] Allen, Patrick, "Situational Force Scoring: Accounting for Combined Arms Effects in Aggregate Combat Models," 17–26.

Battle Type additionally is used to determine the amount of movement (terrain gained or lost) by the participants.[62]

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[62] Allen, Patrick, 40–43. Note the values in the RAND study are based off European engagements of conventional US and Soviet forces that were less mobile than the kinds of fighting found in Syria and Iraq with ISIS. The movement rates have been adjusted in the Combat Simulator to account for this.

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Section B Validation & Confidence Building

B-1 Introduction

The Emerging-State Actor Model (E-SAM) enables policy makers, researchers and military operational planners to understand conflicts involving non-state actors. This includes insurgencies, terrorism, emerging-state actors as well as non-lethal conflicts such as propaganda. Policy makers can use E-SAM to educate themselves on the unanticipated consequences of policy choices. Researchers can instantiate specific iterations of E-SAM to a time and location to study a specific conflict, or more broadly study these conflicts in general. Military operational planners can instantiate a model for a specific theatre or region of interest and analyze courses of action, testing them against baseline scenarios and assess the merits prior to adopting, as well as using the tool to monitor ongoing conflicts.

E-SAM is a simulation that can run to cover up to a 20-year period of conflict between a state-actor government ("Green") and a non-state actor ("Red.") E-SAM can simulate the potential path of progression from initial assumptions, understand the impact of changing conditions or entrance of third party state-sponsors backing either side, or evaluate courses of action for intervention.

 E-SAM is a Systems Dynamics simulation designed primarily to support military operational planning and research into violence and instability. E-SAM is constructed to evaluate and understand medium-to-long term effects (several years to decades) of choices made by state and non-state actors. Within one structure E-SAM integrates territorial data of the region of interest, ethnographic demographics and perception to actors including reaction to grievances, the actors themselves (including governance, financial performance, military activities).

The E-SAM has been designed to support operational planning and research around policy design, testing and monitoring in conflict zones. E-SAM can be used individually or in a game context by multiple users each taking the role of an actor (to educate and inform stakeholders) or run by AI players competing against one another. In any of these configurations E-SAM can be used to test national strategies, forecast the impact on current and future operations of new intelligence, validate existing counter-insurgency theories and uncover new insights into how to conduct conflict in these arenas. Exercises in any of these often involve creating a baseline scenario where performance can be modeled absent significant change. Then intervention portfolios, enemy strategies, and changes in the environment can be simulated along-side the baseline. Significant gaps between strategic goals and simulation results indicate potential changes required in allocations as well as possibly adding or removing intervention options.

B-1.1 Section Overview

This section focuses exclusive on a suite of validation and confidence building tests following standard practices within the field of system dynamics.[63] These are labeled B-2 throupgh B-13 for each of the validation and confidence building tests run against E-SAM.

- B-2 Boundary Adequacy
- B-3 Structure Assessment
- B-4 Dimensional Consistency
- B-5 Parameter Assessment
- B-6 Extreme Condition
- B-7 Integration Error
- B-8 Behavior Reproduction
- B-9 Behavior Anomaly
- B-10 Family Member Test
- B-11 Surprise Behavior
- B-12 Sensitivity Analysis
- B-13 System Improvement

The section concludes with B-14 Bibliography for Section B.

B-2 Boundary Adequacy

For both baseline scenarios, *Historical* and *Without Intervention,* the following boundaries were established in Table B-1.

Table B-1: List of E-SAM Boundaries

Boundary Topic	Boundary
Geography	Combined geography of Iraq & Syria
Ethnographic Groups	Arab Sunni, Arab Shia & Kurdish Sunni populations.
State-Sponsored Foreign Intervention [Purple]	Iran, Hezbollah, US backed Coalition, Russia & Turkey on behalf of [Green]. (Only in *Historical.)*
State-Sponsored Non-State Actor Interventions [Green]	Kurdish Syrian Defense Force (SDF) & Arab Shia Popular Mobilization Forces (PMF)
Time Duration	10 Years (40 Periods)
Strategic Architecture Sectors:	Resource Stocks, AFV/IFV, OpOrder Allocations, Governance, Combatant Recruiting & Losses, Foreign Intervention OpOrder Allocations
World Model Sectors:	Sources of Revenue, Sources of Expenses, Territory & Scenario Data, SFS Combat Simulator, Resistance & Uprising, Ethnographic Perceptions, Militant Recruiting & Losses, Actor Legitimacy & Side Choosing, OpOrder Impacts on World,

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[63] Sterman, "System Dynamics Modeling," 843.

B-2.1 Boundary Tests

Time: The Time boundary was originally selected at 10 years. A boundary test was conducted by expanding the duration to 20 years. Results were compared against the primary measures of *Territory Controlled by Actor[Red]* and *Total Population Controlled by Actor[Red]* in Figure B-1 and Figure B-2.
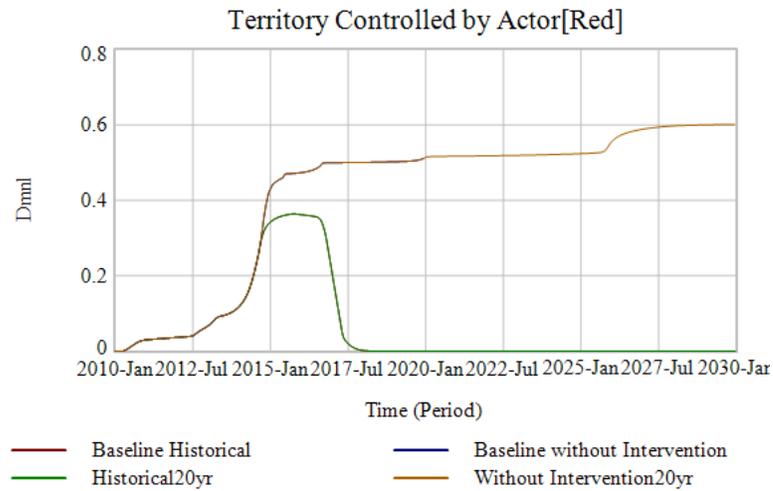
Figure B-1: Time Boundary Test on Territory 20yr
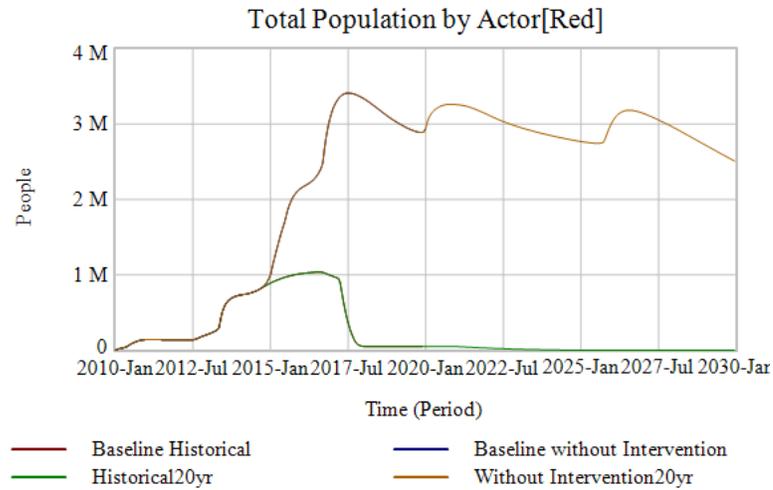
Figure B-2: Time Boundary Test on Population 20yr

B-2 Boundary Adequacy

Figure B-2 shows in *Territory* that a rough equilibrium is found upon which an extended time-horizon does not significantly change. Likewise, in *Total Population* for Red a dynamic equilibrium consisting of a similar repeating oscillation pattern emerges. These fluctuations can be accounted for in parametrization choices. Although E-SAM has the capability for demographic growth built into the structure, for both baseline scenarios the *Demographic Growth* of all ethnographies is set to 0. This parameter is found in the World Model sector "Actor Legitimacy & Side Choosing." When this parameter is set to a nominal 2.5% and run for 20 years, what had appeared to be a slight increase in *Territory* for Red in 2026 disappears and the new equilibrium is unchanging from the 10yr scenario as seen in Figure B-3.
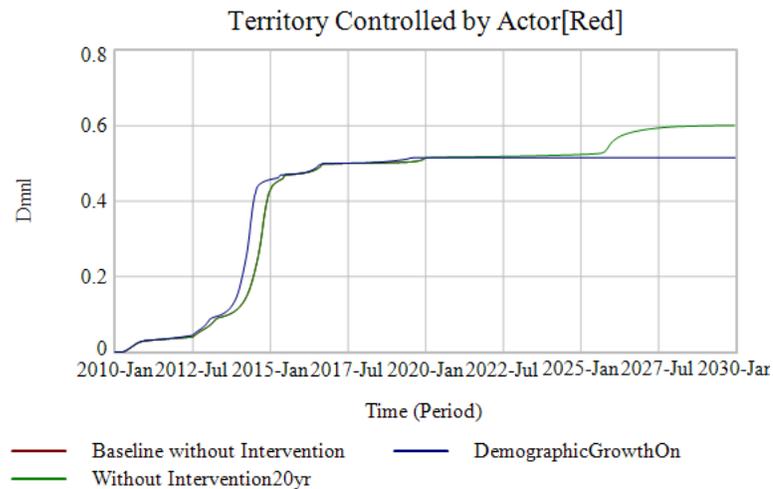
Figure B-3: Time Boundary Test with Demographics Activated

Given these tests a 10year model duration is an acceptable boundary.

Intervention Tests

The boundary on what to include in terms of intervention can be examined conceptually by looking at sufficiency. The *Baseline without Intervention* presents the counter-factual "what-if" behavior of Red with no external intervention. What is necessary and sufficient to explain the actual historical behavior in terms of intervention? The *Baseline with Historical Intervention* successfully recreated such behavior by including two kinds of intervention responses. A foreign-supported one that included the responses of Hezbollah, Iran, Russia, Turkey and the US etc. And a second local-supported intervention that arose from indigenous populations, including the Kurdish Sunni based Syrian Defense Force (SDF) and the Arab Shia based Popular Mobilization Force (PMF). Two tests were conducted, each one excluding one half of this intervention response. The first by removing all foreign interventions named *Local Only* and the second test which removed the local non-state actor interventions but preserves foreign interventions called *External Only*. These two tests were then compared to see if only one form of response to ISIS was sufficient, or both required to recreate historically observed behavior. Results were compared against the primary measures of *Territory Controlled by Actor[Red]*

and *Total Population Controlled by Actor[Red]* in Figure B-4 and Figure B-5. The secondary measures of *Blue or Purple Intervention Size[Green], Combatants[Arab Shia, Green]* and *Combatants[Kurdish Sunni, Green]* demonstrate the removal of these forces as shown in Figure B-6 and Figure B-7.
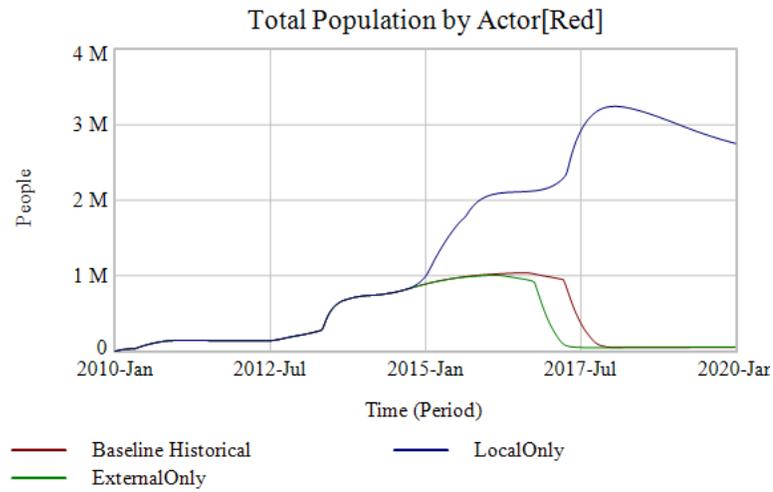
Figure B-4: Interventions Boundary Test on Total Population
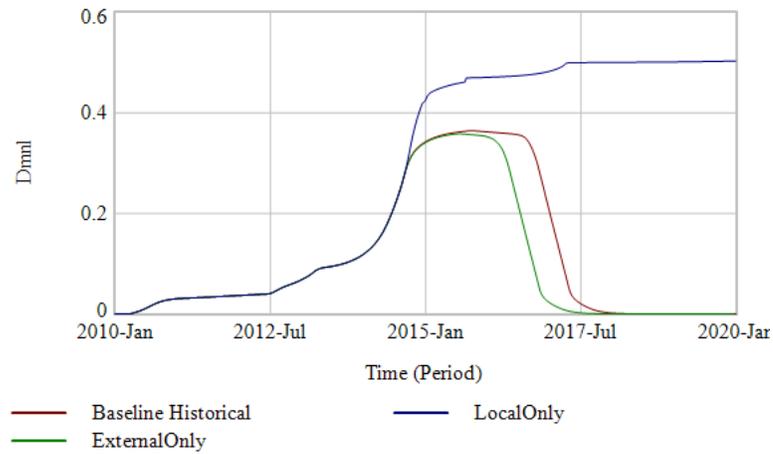
Figure B-5: Intervention Boundary Test on Territory

B-2 Boundary Adequacy
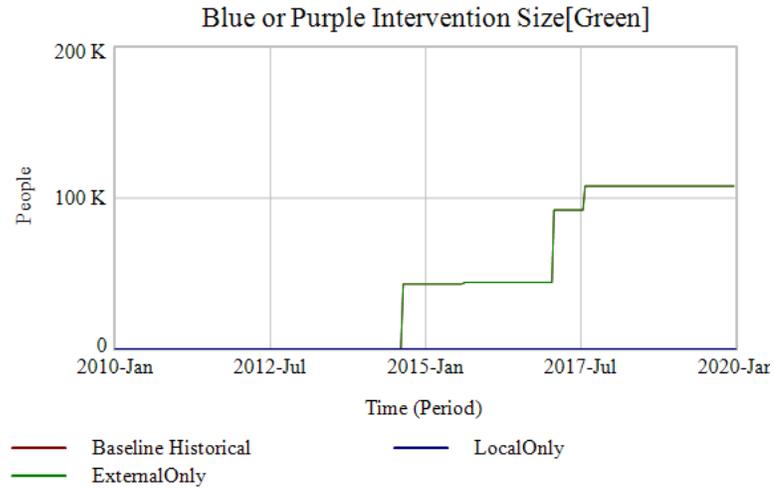
Figure B-6: Intervention Boundary Test External Intervention Sizes
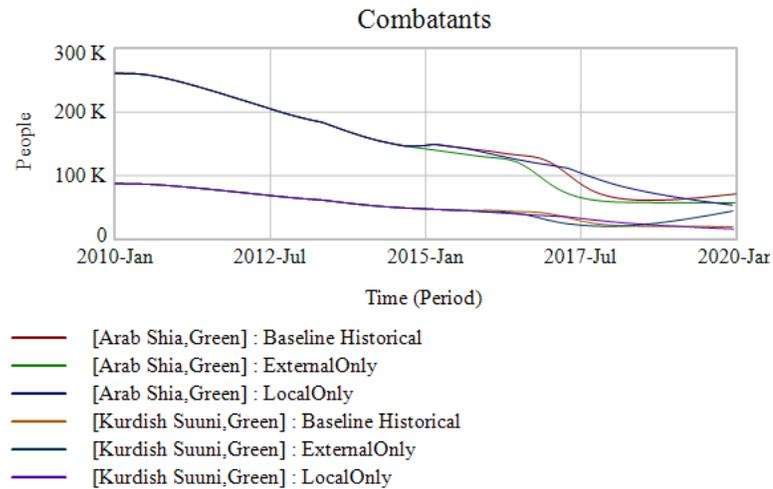
Figure B-7: Intervention Boundary Test - Local Intervention Sizes

The test indicated that *Local Only* interventions were not sufficient to recreate the baseline behavior. The amount of *Territory* the Red Actor controls flatlines and does not decrease as was historically observed. A surprising behavior is that not only does *External Only* recreate the appropriate historical behavior, but it does it sooner than the *Historical Baseline* which combined both types of interventions. This is a counterintuitive result – *External Only* has nearly 100,000 less combatants than the *Historical Baseline.* So why did it perform better?

B-2 Boundary Adequacy

The cause for this improved performance is found in *Average Combatant Experience[Green]* and how it increases more rapidly in the *ExternalOnly* test as shown in Figure B-8.
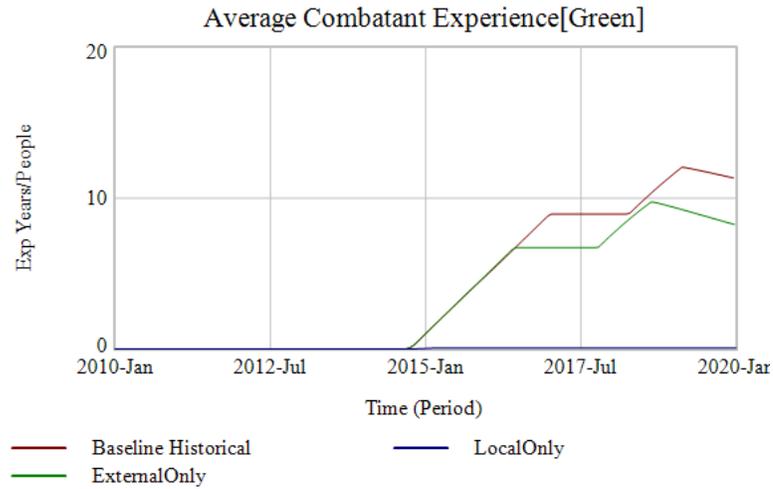
Figure B-8: Intervention Boundary Test - Average Combatant Experience

This is another manifestation of the well understand Brook's Law. Adding more people to a project slows down progress as new arrivals must be trained. Foreign soldiers deployed into Syria and Iraq did not require the same training as local civilians who joined militias such as the SDF or PMF. Without the experience drag of these local non-state actors, in the *ExternalOnly* scenario Green combatants are trained faster, have more experience and perform better in combat. This allows Green to take a more aggressive offensive stance sooner in the conflict, resulting in the faster achievement of the defeat of Red as shown in Fig 9.

B-2 Boundary Adequacy
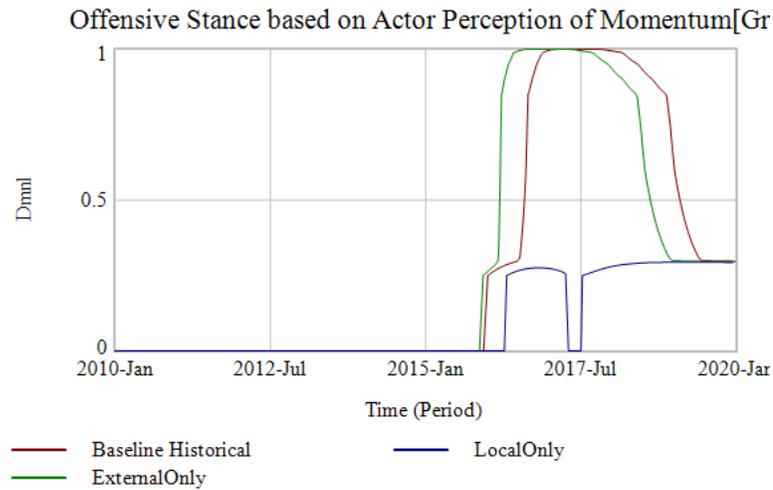
Figure B-9: Intervention Boundary Test - Offensive Stance of Green

Returning to the original boundary test: *ExternalOnly* in isolation has sufficient capability to recreate historical performance while *LocalOnly* does not. However, it would be inappropriate to exclude local non-state actor responses when we know historically that they occurred. Therefore, the boundary of including both local responses as well as foreign interventions is considered a sufficient boundary.

Ethnographic Boundary Tests

The ethnographic boundary for E-SAM in both baselines is selected to include the three dominant ethnographic groups found in both countries: Arab Sunni, Arab Shia and Kurdish Sunni. These ethnographic groups are constructed from combining an ethnic distinction, such as Arab or Kurd, with a religious denomination affiliation such as Sunni or Shia. All other ethnographic groupings including the ethnicities of Turkomen and Assyrian or the religious affiliations of Druze, Yazidi, Christian etc. are excluded by this boundary selection. The reasoning is that within the selected ethnicities 90-95% of the population is represented, and a similar coverage is obtained within religion.

The E-SAM model can handle any number of ethnographic groups because they are subscripted. However, because the research questions answered by the *Historical Baseline* and *Baseline without Intervention* are not focused specifically on ethnographic performance under conflict and is rather focusing on the theater level conflict it is not plausible that these small minorities would have significant impact on the conflict that wasn't already represented by the behavior of one of the three main groupings. For example, Turkomen Sunni might be both targeted for recruitment by Red even as their ethnographic group is persecuted, but at a lower level than Arab Shia. These circumstances are already captured in the Kurdish Sunni ethnographic group.

Therefore, the ethnographic boundary of only including three groups is considered plausible since adding additional groups would not significantly alter the outcome. For research questions specifically targeting ethnographic performance in periods of conflict, such a refugee status, additional ethnographic distinctions can be added as needed.

B-3 Structure Assessment

As discussed in Precision vs. Realism section in the overview, structural assessment was a primary means of calibration over numerical payoff optimization. As a note for clarity, many of these charts were collected during the evolution of the E-SAM project. Therefore, the Baseline Historical in comparison to the identified structural error may not always appear to behave in the same way it does as in the current version. These copies are preserved intentionally in this way to represent the evolution over time.

B-3.1 Conservation of Mass Errors

Earlier versions of E-SAM at times resulted in negative ethnographic populations under various circumstances. This was a function of having multiply independently calculated outflows to the same stock. Some of these were ratio outflows, for example Governed Population transitioning to Calculated Legitimacy. Others were integer outflows produced by other sectors in E-SAM: civilian deaths due to terrorism or war crimes, refugees fleeing the area. Though each outflow itself had first order negative control – there was no overall first order control that could govern all the outflows at the same time. Figure B-10 demonstrates an example of this problem when *Historical Baseline* is compared *Historical Population Conservation Error* on the primary measure of *Total Population[Red].*

Total Population by Actor[Red]
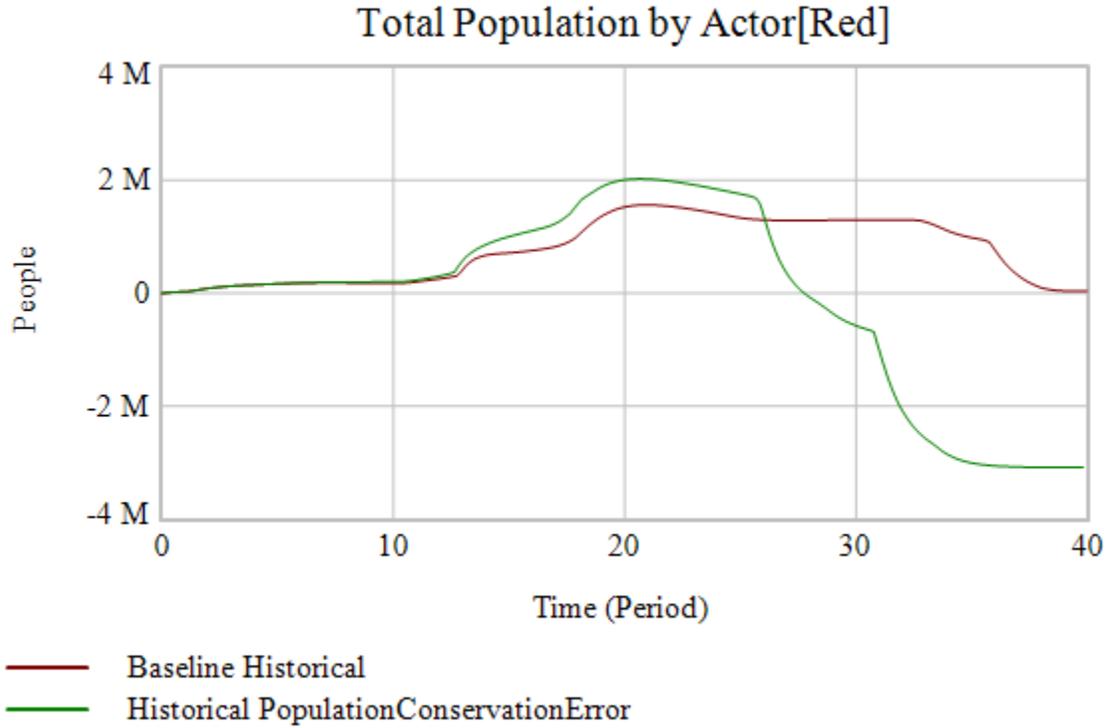
Figure B-10: Structure Assessment - Conservation of Mass Error

This class of structural errors was solved by creating a single first-order control called *Ethno by Actor Sufficiency* displayed in Figure B-11.
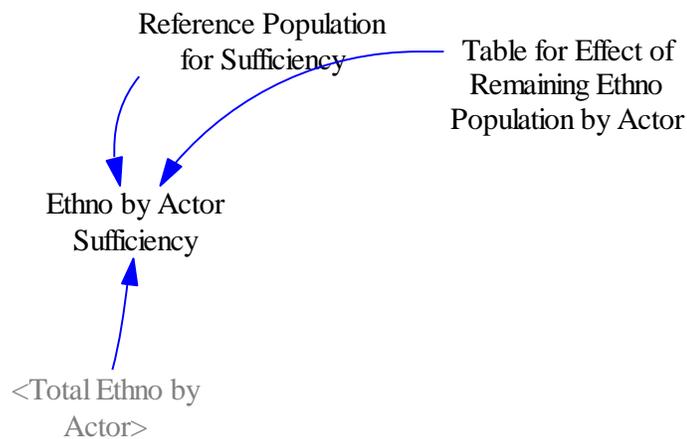
Figure B-11: Structure Assessment - Conservation of Mass Correction

The formulation of this structure is to compare the current ethnographic population versus a reference number and apply a lookup function that reduces the sufficiency by the resulting ratio. Conceptually as a population of an actor becomes scarce – the effectiveness of any act against them reduces as they become harder to locate or target. As the actual population dipped beneath the reference level a reduction percentage is calculated and applied to the outflows preventing populations from going below zero due to civilian deaths, refugees and civilians lost to conquest. The values of these modifiers for *Historical Baseline* are shown in Figure B-12.
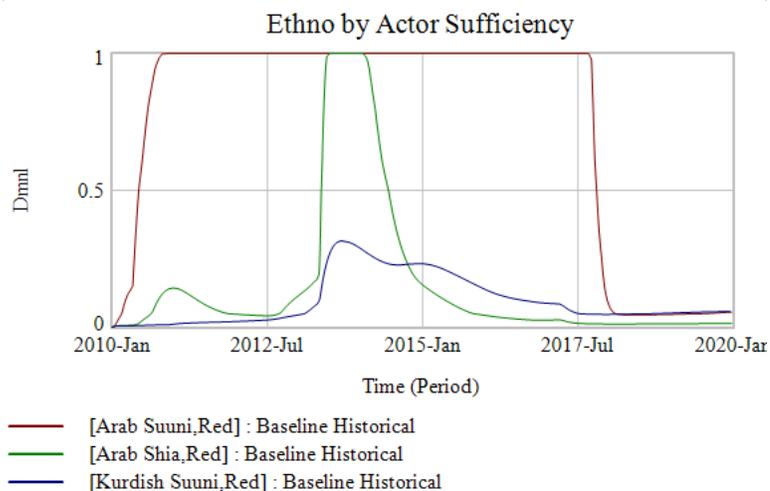
Figure B-12: Structure Assessment - Ethno by Actor Sufficiency Values

B-3.2 Free Lunch Errors

Another class of errors are called "free lunch" errors. An actor continues to undertake an activity even if they don't have the resources or means to plausibly do so. This is demonstrated by comparing the *Historical Baseline* to *Historical Free Lunch Error* across the primary measures of Territory, Total Combatants and Terrorist Attacks in Figure B-13, Figure B-14, and Figure B-15.

B-3 Structure Assessment
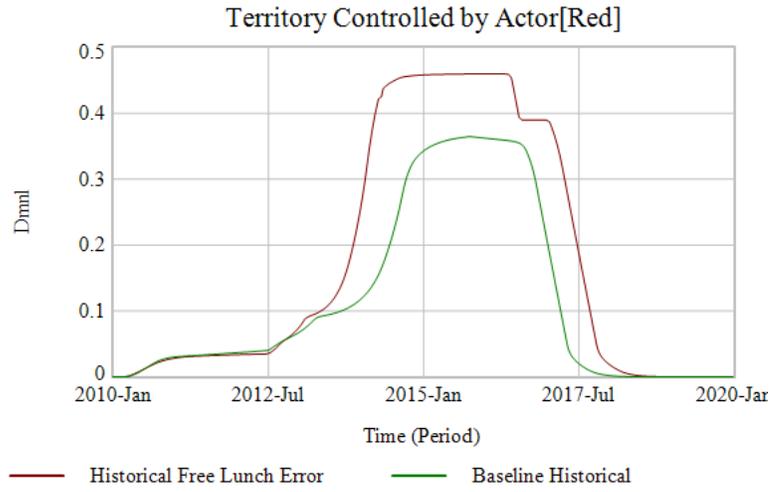
Figure B-13: Structure Assessment - Free Lunch Error Territory
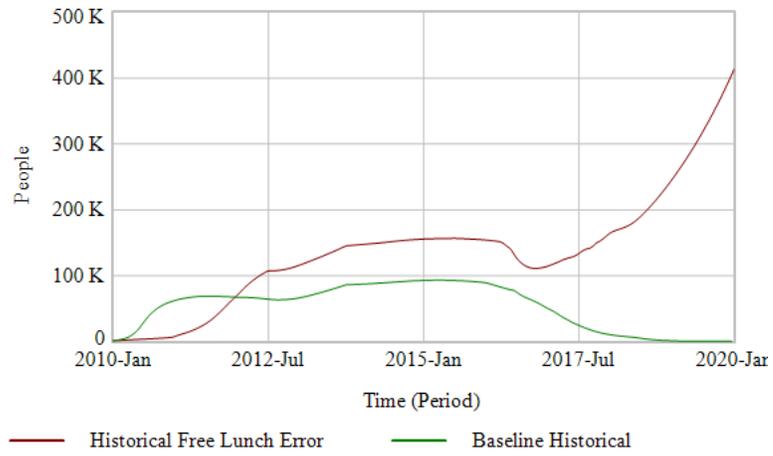
Figure B-14: Structure Assessment - Free Lunch Error Total Combatants

B-3 Structure Assessment
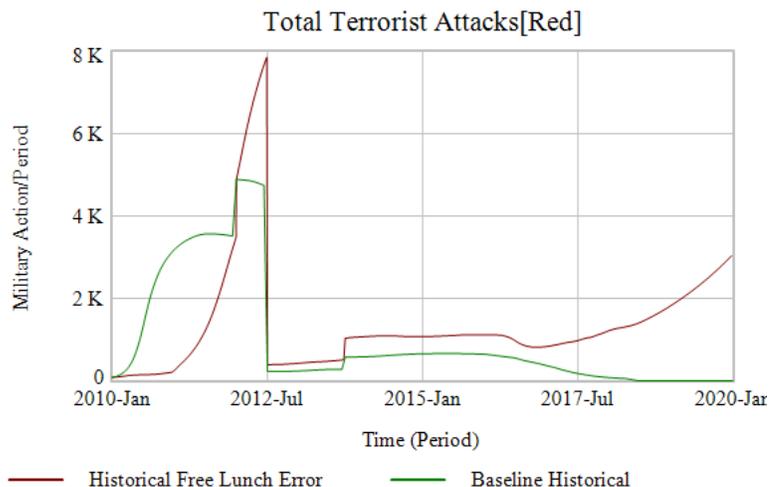
Figure B-15: Structure Assessment - Free Lunch Error Total Terrorist Attacks

It did not seem plausible that Red actor could lose all its territory and yet experience significant increases in *Total Combatants* and *Total Terrorist Attacks.* This wouldn't match the historically observed behavior. Although ISIS certainly continues to conduct terrorist attacks and recruit combatants outside of Syria and Iraq, E-SAM is bounded to Iraq and Syria only precluding those as logical explanations.

The error was found in the financial sector of the Strategic Architecture. In previous versions monies accumulated above and beyond what was necessary to conduct operations were stored as reserves. This excess was described as likely being sent to actors abroad, but since E-SAM was focused on Syria and Iraq, structure was not added to explicitly demonstrate this spending abroad. As a result, even when all Territory, and population derived resources and territorial derived resources were taken, Red Actor still had significant reserves from which to operate from as shown below in Figure B-16.

B-3 Structure Assessment
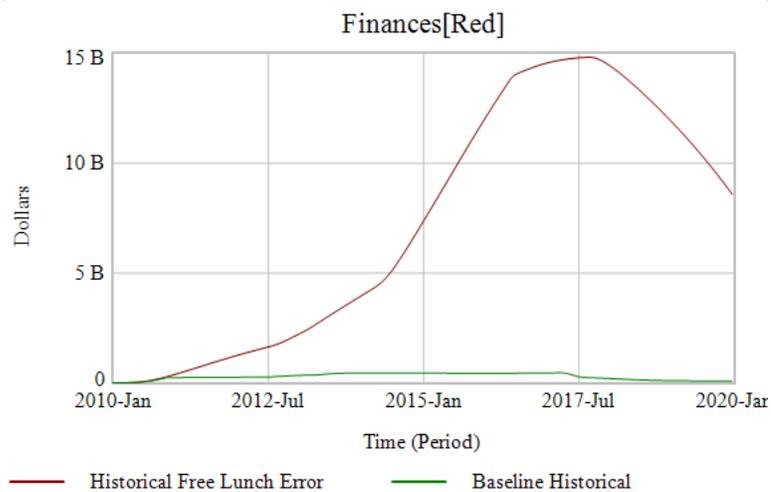
Figure B-16: Structure Assessment - Source of Free Lunch Error

If funds are not sent abroad, Red Actor has a significant surplus of reserves built up it can continue to use even after it has lost all Territory. The solution was to add structure realistically replicating Red Actor sending money overseas to fund different efforts. However, another problem quickly arose that E-SAM had no means for either Actor to prioritize the funding of essential or non-essential tasks. This was considered a sufficient level of aggregation in earlier versions of the working draft. But as Red Actor ran out of funds, it became apparent that they would realistically begin to cut non-essential payments: such as detention benefits to ISIS members in prison and death benefits. Ultimately essential services would have to be cut as well as bankruptcy loomed. Additional structure – both to allow Red to send money abroad and to prioritize between essential and non-essential payments was added as shown in Figure B-17 below.

B-3 Structure Assessment
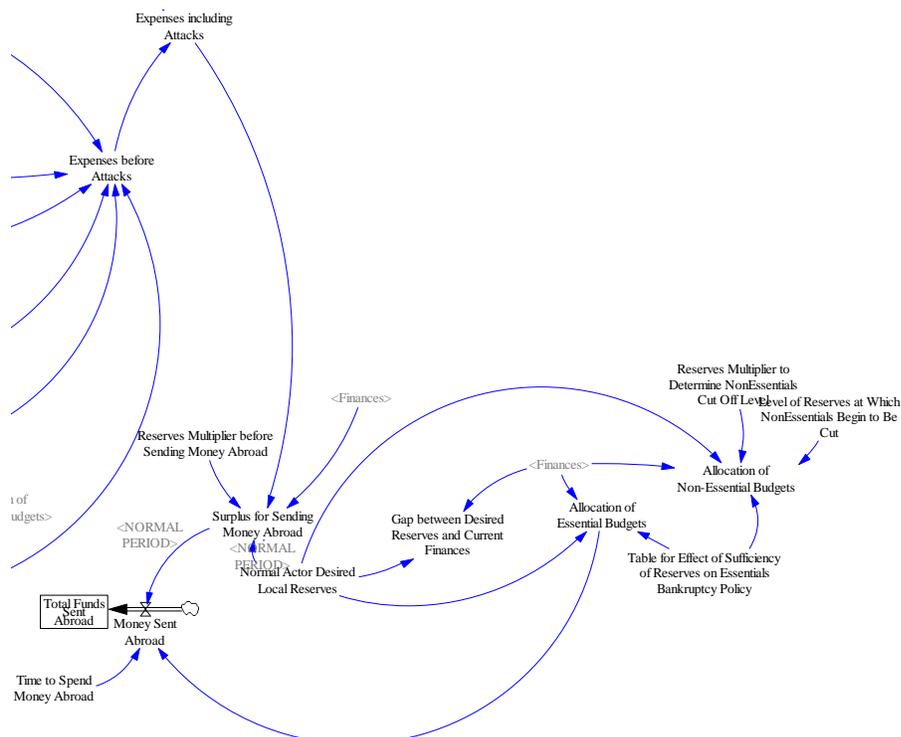
Figure B-17: Fixing Free Lunch Errors - Sending Funds Abroad & Spending Prioritization

This simple structure allowed for ISIS to spend money abroad when times were plentiful, restrict sending money abroad as funds dried up, then begin to cut first non-essential payments and ultimately essential payments as they headed towards bankruptcy. When Red Actor doesn't have funds, it can't pay for military actions and can't continue to recruit or conduct terrorist attacks, creating more realistic – and historically accurate behavior.

A cascading benefit of this new structure is it enabled a fix of two other structural assessment problems. Although *Total Defections* were already calculated using the ethnographic perception of the actor, this wasn't sufficiently depleting *Combatants* through defections as was historically perceived. Likewise, Red Actor *Detainees in Prison*, simply accumulated over time to massive levels allowing unrealistically high inflows of *Detainees Released* through *Prison Breaks* to rejoin the Red Actor force. By adding structure to reduce payments in response to budget pressures to non-essential (*Detention Benefits)* and essential budget reductions to essential (*Payroll)* the gap between desired and actual payments in these areas could be considered in additional *Defections* from either the active, or imprisoned, ranks of an Actor. Figure B-18 shows the structure added in the Expenses sector of the Strategic Architecture, Figure B-19 structure added to *Total Defections* from *Combatants* and Figure B-20 structure added to *Detainees in Prison.*
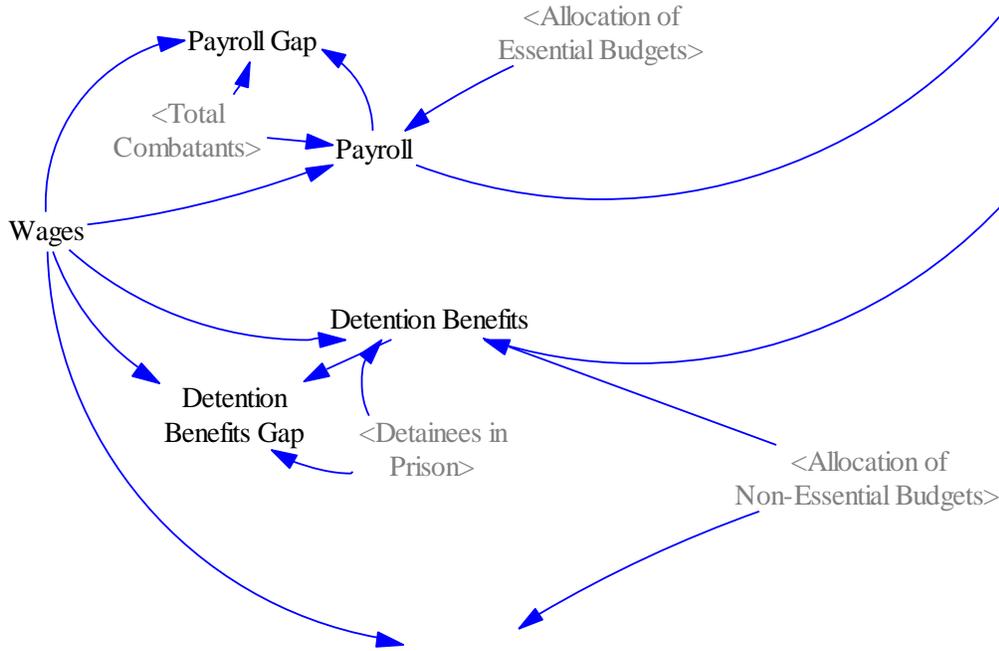
Figure B-18: Fixing Free Lunch Errors - Allocation of Essential & Non-Essential Budget Priorities
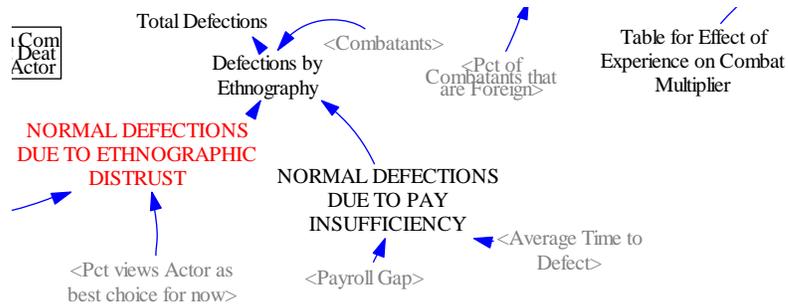
Figure B-19: Fixing Free Lunch Errors - Payroll Gap Structure added to Total Defections Rate

B-3 Structure Assessment
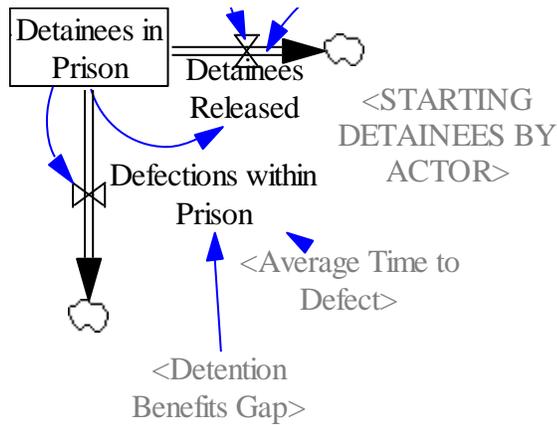
Figure B-20: Fixing Free Lunch Errors - Detention Benefits Structure added to Defections within Prison

These three additional structures generated the following behavioral changes in the model. First gaps emerged between desired and paid *Payroll* as well as *Detention Benefits.*
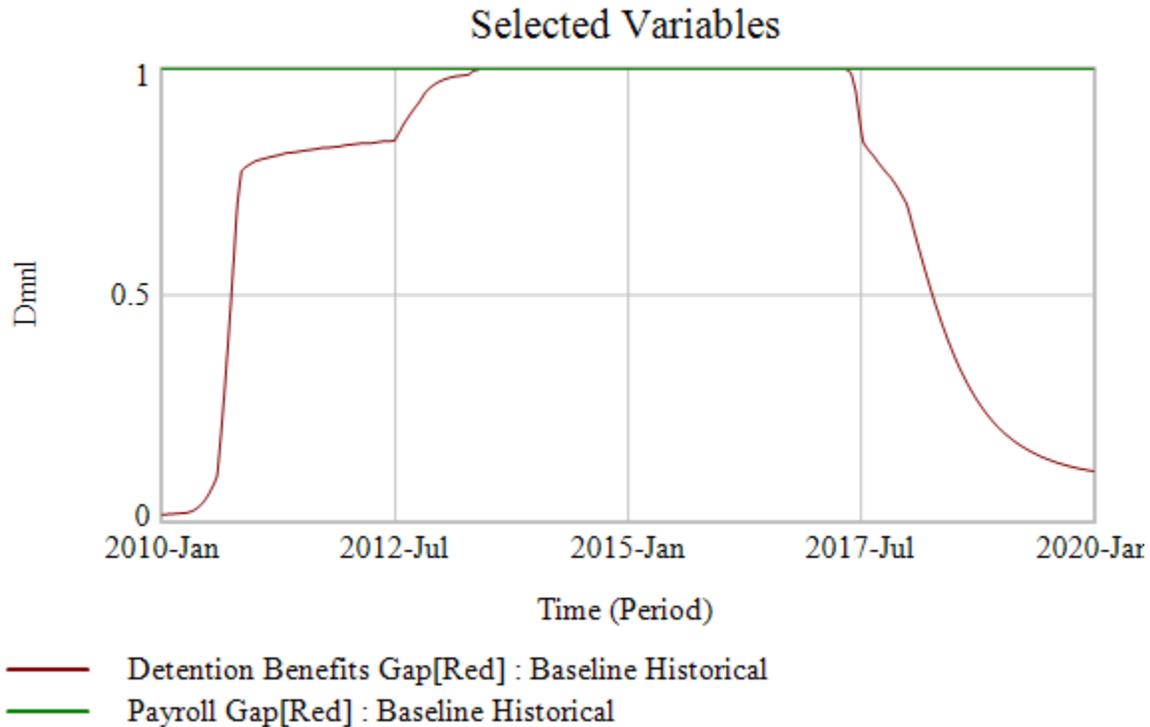
Figure B-21: Fixing Free Lunch Errors - Gaps based on prioritization of Spending

As this information reaches *Combatants* and *Detainees in Prison* respectively, the defection rates for both adjusted accordingly. Especially when compared to behavior without these structural changes as shown in Figure B-22 for *Total Defections*.
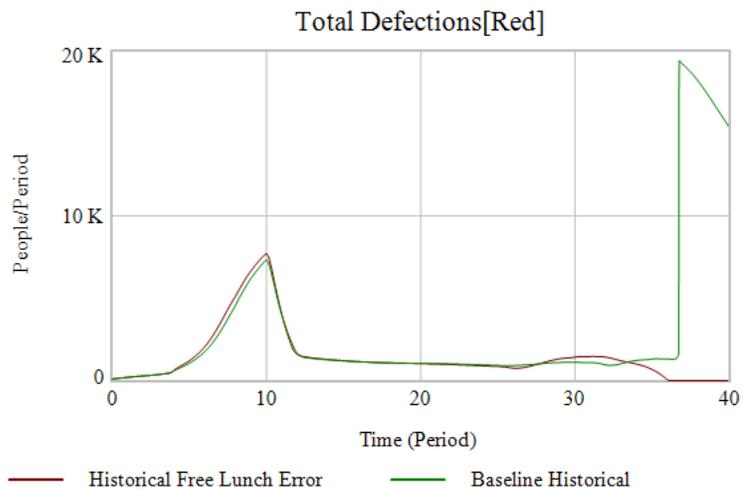
Figure B-22: Fixing Free Lunch Errors - Comparison of Total Defections Rates

Although there are many reasons a combatant might abandon ISIS other than a gap in payroll including ideological, tribal, psychological pressures – using payroll gap was considered sufficient to aggregate this behavior. As ISIS begins losing to the point it can no longer pay its troops – they begin defecting. Likewise, where prior to this structural change there was no way to reduce the *Detainees in Prison* except by prison breaks, with the change imprisoned ISIS followed naturally defect endogenously as their benefits stop getting paid. This effect is shown in Figure B-23.
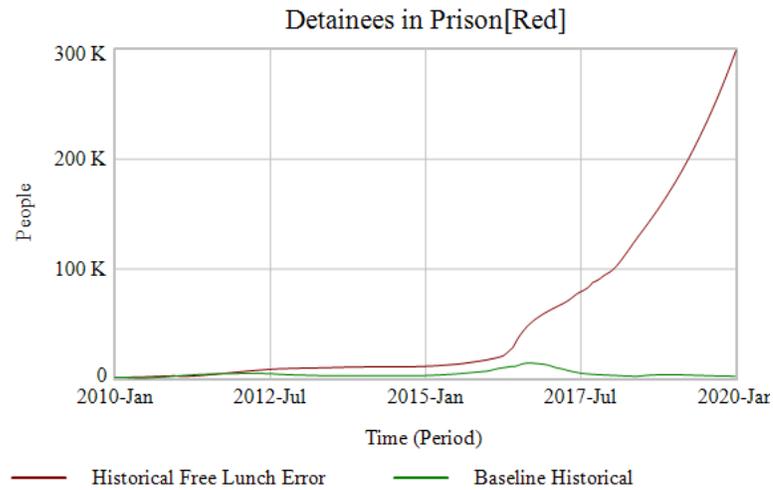
Figure B-23: Fixing Free Lunch Errors - Comparison of Detainees in Prison

These structural changes resulted in a much more realistic behavior of E-SAM. When ISIS lost all its territory, it lost its ability to generate resources, this led to first a reduction in sending money abroad, then in spending non-essential payments and finally suspension of essential payments. As a result, they could no longer afford to perform *Military Actions* even as defection rates from active *Combatants* and *Detainees in Prison* increased. All based on endogenous feedback rather than parameter calibration.

B-3.3 Conservation of Information Errors

A final class of errors discovered via structural assessment tests was the conservation of information. In the original E-SAM models there was very little in the way of "leadership intelligence" on how an Actor viewed themselves in relative competition to the opposing Actor. If Red Actor had money, they would fight to expand their territory. Green Actor would defend. But there was no point Green Actor was able to "realize" that the expansion of Red was beginning to slow and thus adopt a more offensive posture of their own forces. This is demonstrated in Figure B-24 on three different versions of the model where the *Baseline Historical* is compared against an *Error Type 1* and an *Error Type 2.*

B-3 Structure Assessment

Current Location of Red Actor on Territorial Map[Red]
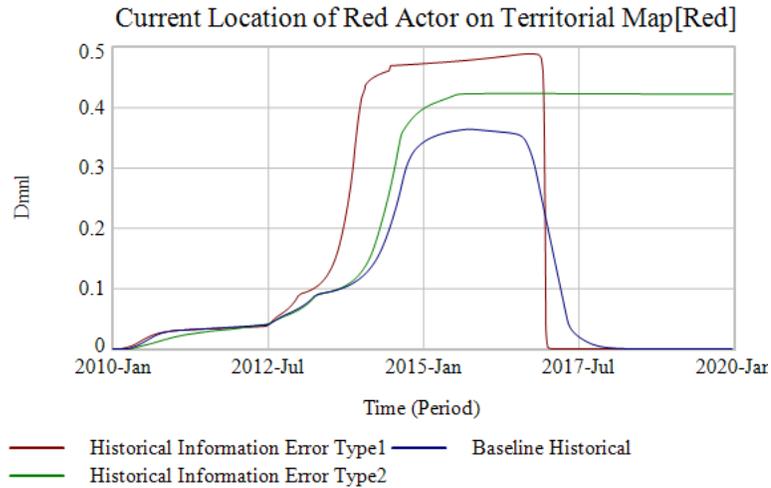
Figure B-24: Structure Assessment - Information Error

In all three scenarios the same foreign and local interventions occur. In Error Type 1, the shift in momentum is binary – resulting in a historically unrealistic immediate defeat of ISIS. In Error Type 2, even though Green has brought Red forward progress to a halt, Green doesn't "realize" this and shift to a more offensive posture. Resulting in an unrealistic stalemate.

This structural error was corrected by adding 'intelligence' at the leadership level of each Actor as shown in Figure B-25.
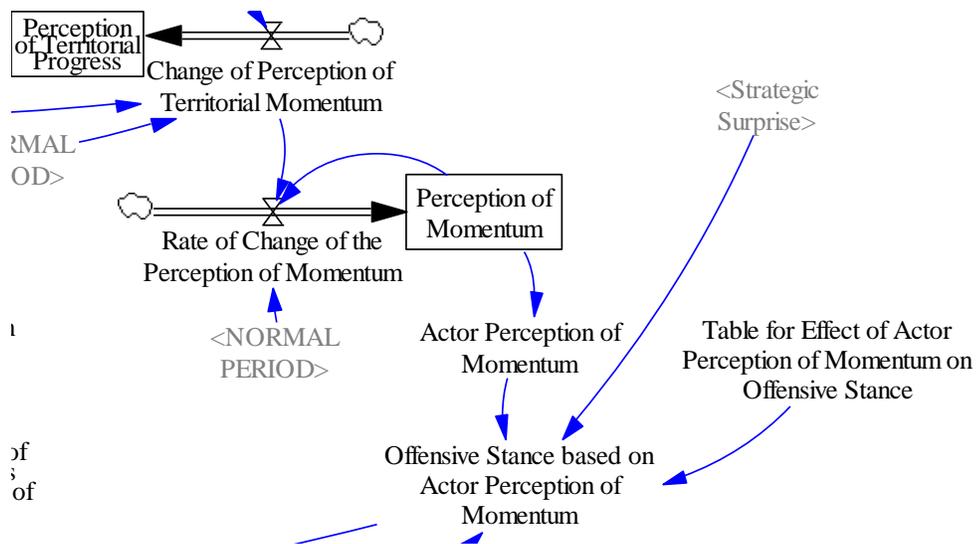
Figure B-25: Structure Assessment - Correction to Information Error in Perception of Momentum

120

The structure takes as an input changes in territorial control and tracks as a stock *Perception of Territorial Progress.* However, an average of the rate-of-change in that stock is then an input to another inflow to a stock which tracks *Perception of Momentum.* This stock then converts into an *Actor Perception of Momentum* which is the leadership understanding if they are winning or losing, territorially, and by how much. This perception is then compared to a lookup function which converts perception into an *Offensive Stance.* The more an Actor perceives themselves to be winning – the higher their *Offensive Stance.* The concept of *Strategic Surprise* also plays an influence. An actor subject to strategic surprise, which can be determined by scenario – is not going to suddenly shift offensively as they are still "remembering" the impact of surprise. The result of this structure is a "posture" that the Actor takes in terms of allocating offensive actions based on their perception of how the conflict is going, subject to surprise. This allocation is further modified by how much territory the Actor has remaining – they are willing to commit more forces to defense as they lose more territory than when the opponent is taking away farther portions from their center. The *Allocations* are shown below for both Green and Red Actors for the Historical Baseline in Figure B-26.
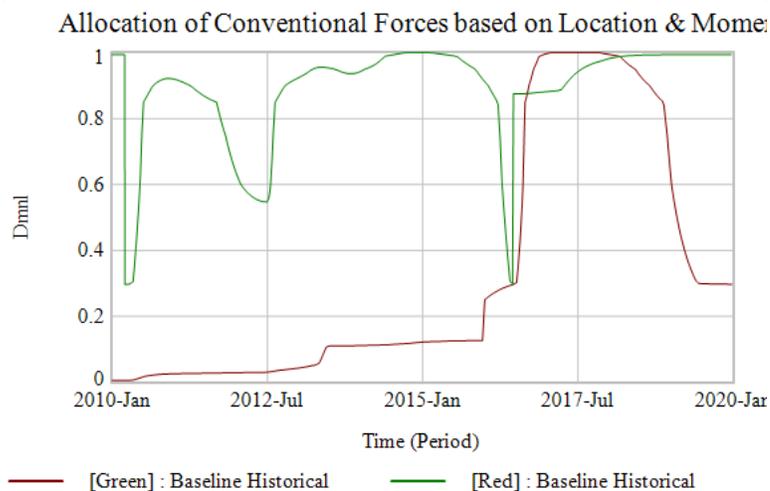
Figure B-26: Structure Assessment - Allocation of Conventional Forces Historical

Importantly, the new structure results in independent assessments of momentum by each Actor. As Red Actor struggles to progress during drawn out city-sieges or hostile ethnographic terrains – they pull back a little on their offensive allocation. Meanwhile, as Green Actor perceives the progress of Red Actor diminishing they begin gradually increasing their willingness to go on the offense until final, just after period a tipping point is reached, and Green goes on a full offensive. The reason Red Actor remains at a high allocation is because of the desire to increasingly defend the last pieces of territory they possess. This is contrasted with the Baseline Without Intervention scenario as depicted in Figure B-27.

B-3 Structure Assessment

Allocation of Conventional Forces based on Location & Mome...
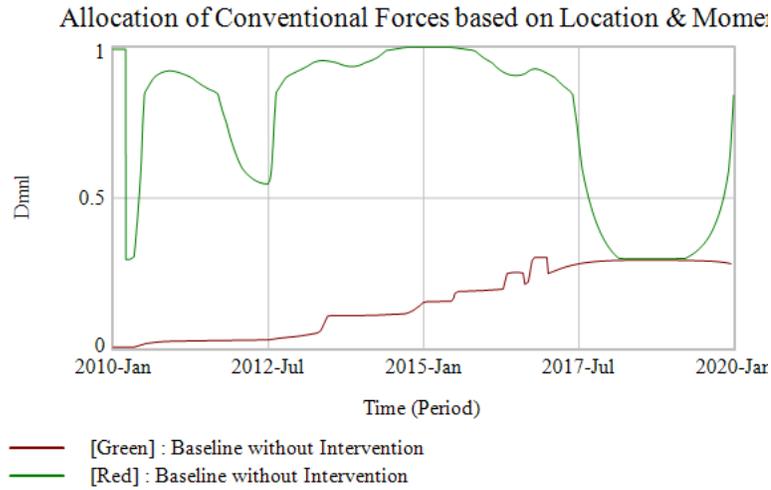
Figure B-27: Structure Assessment - Allocation of Conventional Forces without Intervention

In this scenario although Red experiences varying perceptions of their own progress, Green never accumulates a confidence that it is beginning to win. Although they do increase their offensive allocation, it is at a lower rate. Note that these perceptions of winning and losing endogenously create a natural equilibrium when the two sides reach a stalemate point.

This kind of structural assessment to correct an information error can also be found in how Ethnographic populations in the Unaligned category pick between two sides on who to join. This structure is depicted below in Figure B-28.

B-3 Structure Assessment
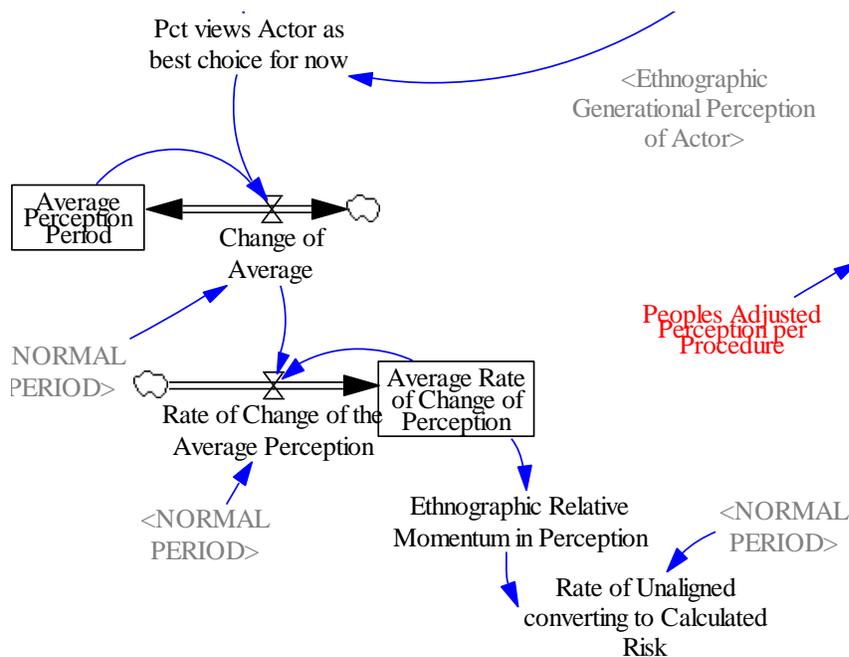
Figure B-28: Structure Assessment - Correction of Information Error

The information error in this case was the ability for an ethnographic group to perceive the relative momentum between a State and Non-State Actor in terms of Calculated Legitimacy, represented by *Pct views Actor as Best Choice for Now.* Each separate Ethnographic group evaluates this relative momentum to determine – not who is the best for them – but who appears to be getting better and who appears to be getting worse in terms of legitimacy. This then fuels the rate of change out of the *Unaligned Population* stock and into the *Calculated Legitimacy* population stock for either Actor. It represents a realistic side-selection of those willing to take a gamble that current conditions indicate a better future by aligning themselves with a certain actor. The results of this information error correction structure are shown in the chart below which depicts *Ethnographic Relative Momentum Perception* in Figure B-29 for the *Historical Baseline.* Note that negative perceptions are in favor of Unaligned converting to Red, and positive perceptions are in favor of Unaligned converting to Green.

B-3 Structure Assessment

Ethnographic Relative Momentum in Perception
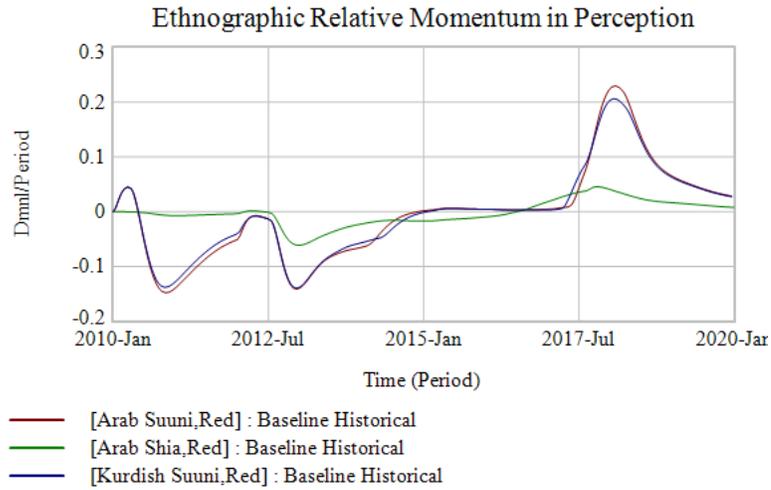
Figure B-29: Structure Assessment - Relative Ethnographic Perception of Momentum Historical

It's important to remember that this is a perception. The rational observer in retrospect might find no circumstance under which it was plausible for *Kurdish Sunni* or *Arab Shia* to ever desire to join ISIS. However, E-SAM is treating ethnographic groups as agents with bounded rationality. They only know what they can perceive, weighted to recent events. Arab Shia do indeed show less willingness to convert to the Red Actor due to their persecution, and more willingness to convert back when the tide seems to be shifting. Compared to the *Baseline without Intervention* below where the two sides reach a stalemate of perceived momentum in serving any ethnographic group as shown in Figure B-30.

Ethnographic Relative Momentum in Perception
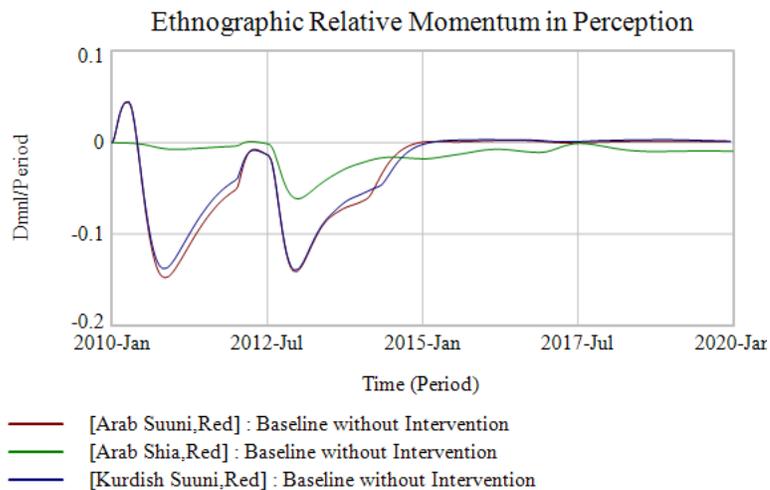
Figure B-30: Structure Assessment - Ethnographic Perception of Relative Momentum

B-3.4 Formulation Reviews

In some cases, even if a structural concept was plausible and sound – the formulas within the structures were flawed creating unrealistic behaviors. Two examples of this were the calculation of *Actual Starting Garrison* and the *Initial Ethnographic Perception.*

In early testing, *Actual Garrison* was initialized through a computation of existing model structure. This created a simultaneous equation error and to avoid was set at zero. This created unrealistic behavior where the *Actual Garrison* would have to "adjust up" to a normal level which had consequences on the rest of the model. This was fixed by manually taking the initial *Desired Garrison & Police Forces* and manually setting that as a separate *Actor Starting Conditions Initial Garrison* removing the simultaneous equation problem and creating more realistic behavior. This is shown below in Figure B-31, which compares *Actual Starting Garrison* in a <u>Baseline</u> Historical (before fix) and <u>Test Historical</u> after the fix.

B-3 Structure Assessment
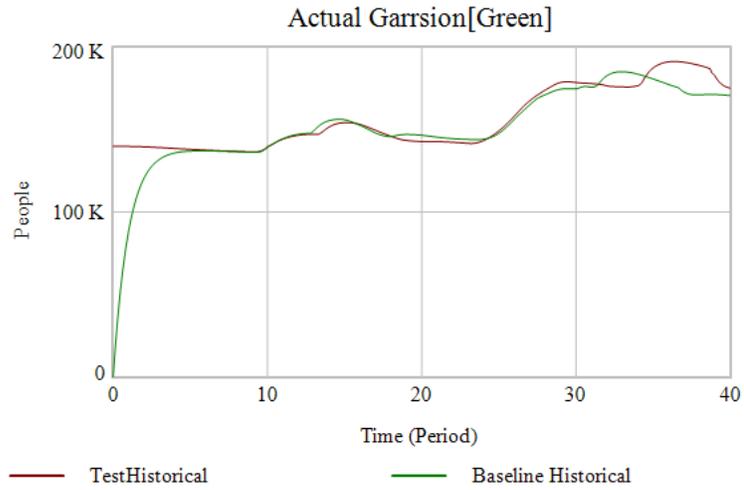
Figure B-31: Formulation Review on Actual Garrison[Green]

It is implausible that there were no troops conducting garrison or law enforcement so the Test Historical with formulation fix is more realistic. This change impacts the Primary Measure of Effect *Territory Actor Controls* as shown in Figure B-32.
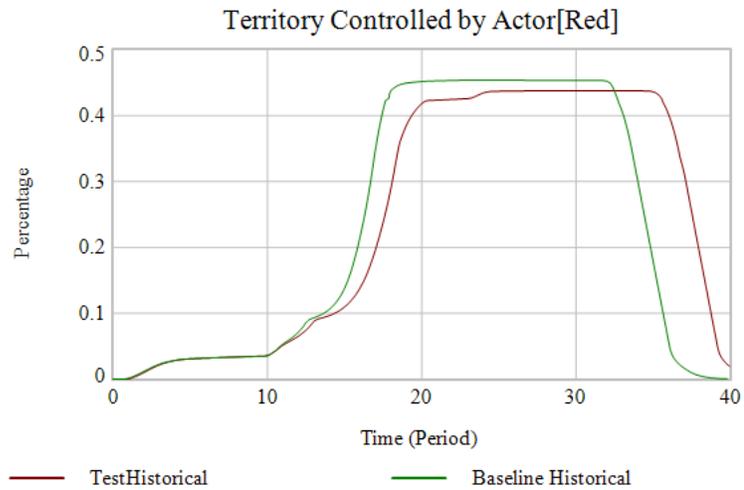
Figure B-32: Formulation Review on Territory Controlled[Red]

Without having to "ramp up" a Garrison in the Test Historical Red performs slightly worse with a later breakout and corresponding decline.

B-3 Structure Assessment

A second example of using formulation review to structurally calibrate E-SAM was in how Initial Ethnographic Perceptions, both current and the generational anchor, were calculated. As a result, in earlier runs of the model Red was starting off and reaching 100% Legitimacy almost immediately, which is not realistic. This is demonstrated below in Figure B-33 which compares *View Actor as Legitimate [Red]* pre and post fix.
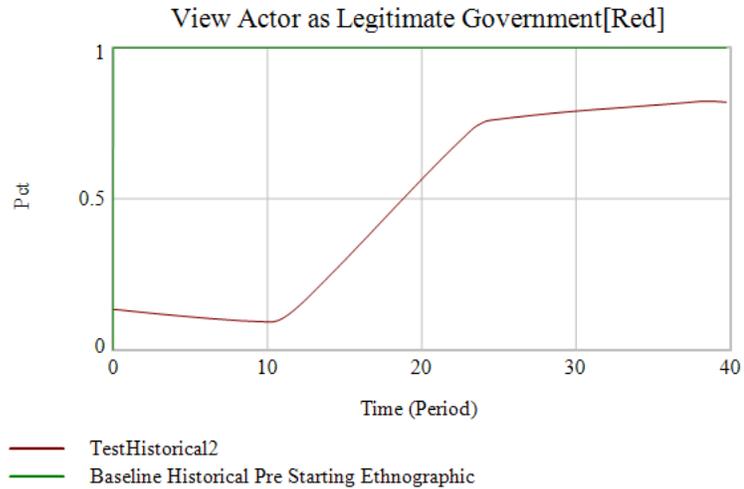
Figure B-33: Formulation Review on View of Actor as Legitimate Government[Red]

The impact of this formulation error was that Red was able to convert population into Governed, gaining more benefits, faster than was realistic. When the formulation is fixed a slightly more realistic behavior appears in *Total Population by Actor [Red]* indicating as shown in Figure B-34.

B-3 Structure Assessment
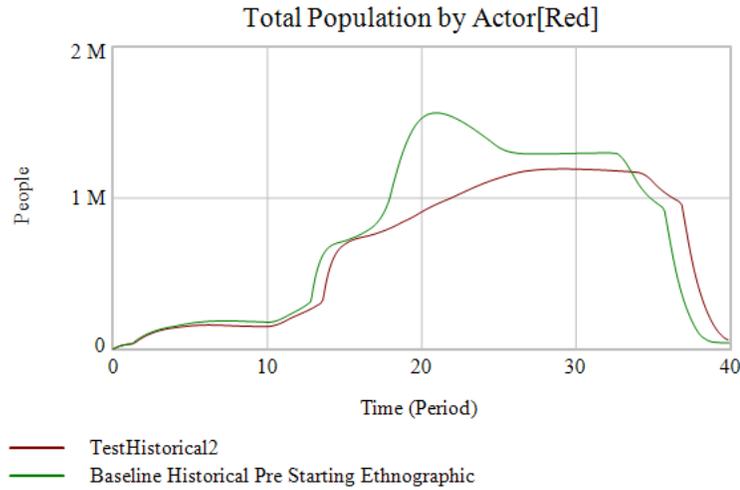
Figure B-34: Formulation Review of Total Population by Actor[Red]

This is just a sample of all the activities performed under structural calibration. But they demonstrate how calibration by structural assessment and formulation review helped improve the "fit" of E-SAM to historical behavior without numerical optimization of parameters to achieve a higher payoff via brute computation. Structural calibration also operates in environments where numerical "fit" cannot. For example, the actual population controlled by ISIS historically may never be known. This would prohibit even the attempt to numerically calibrate a model. But structural calibration continued to improve the 'fit' of behavior patterns relating to population by eliminating implausible structures and errors in formulation.

In the following figures the effects of this structural calibration effort are demonstrated in several primary measures of effect. Note that in all examples "Test Historical 2" is the most realistic 'fit'. Figure B-35 demonstrates the different results throughout the structure assessment on the Primary Measure of Effect on *Territory Controlled by Actor.*

Territory Controlled by Actor[Red]
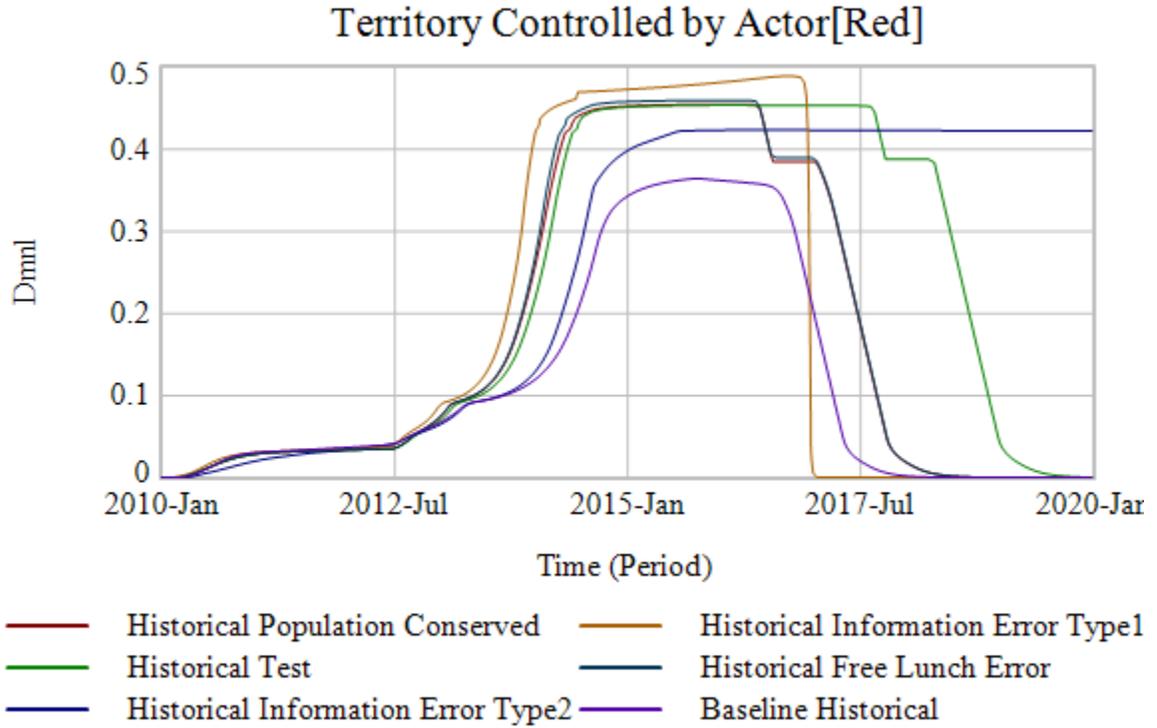
Figure B-35: Evolution of Structural Assessments on Territory Controlled[Red]

Figure B-36 demonstrates the same on *Total Population by Actor.*
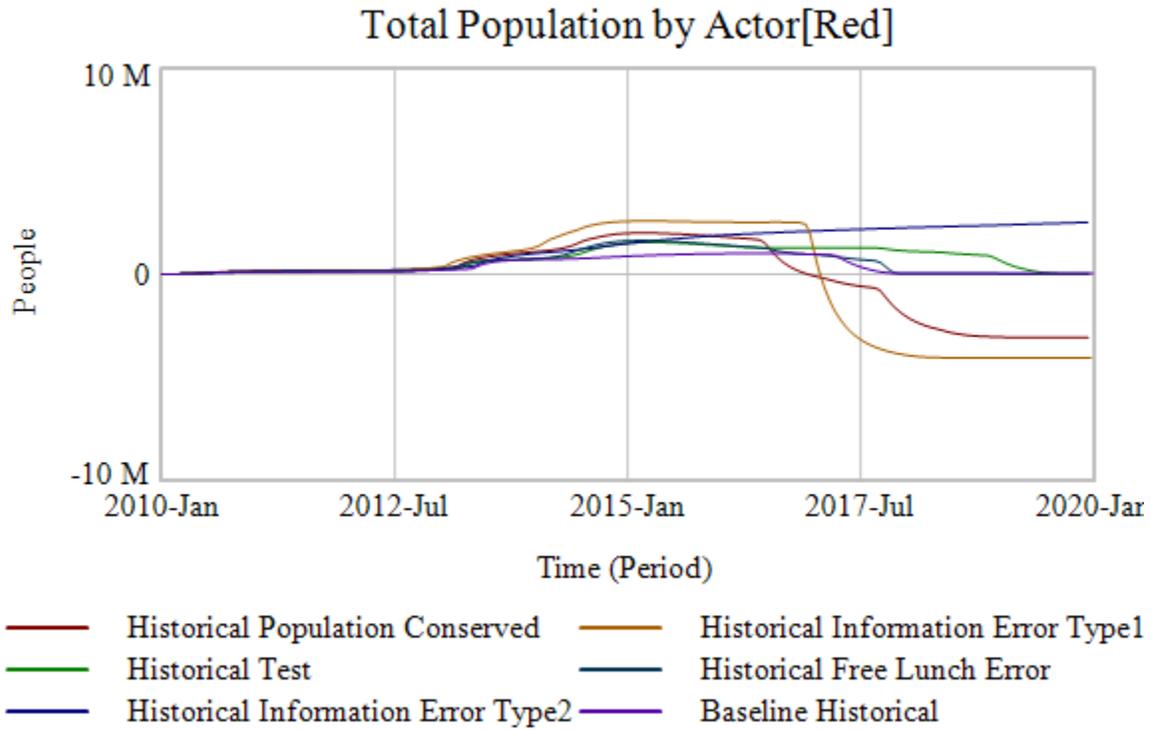
Figure B-36: Structural Assessment Evolution on Total Population by Actor[Red]

And Figure B-37 on *Total Combatants.*
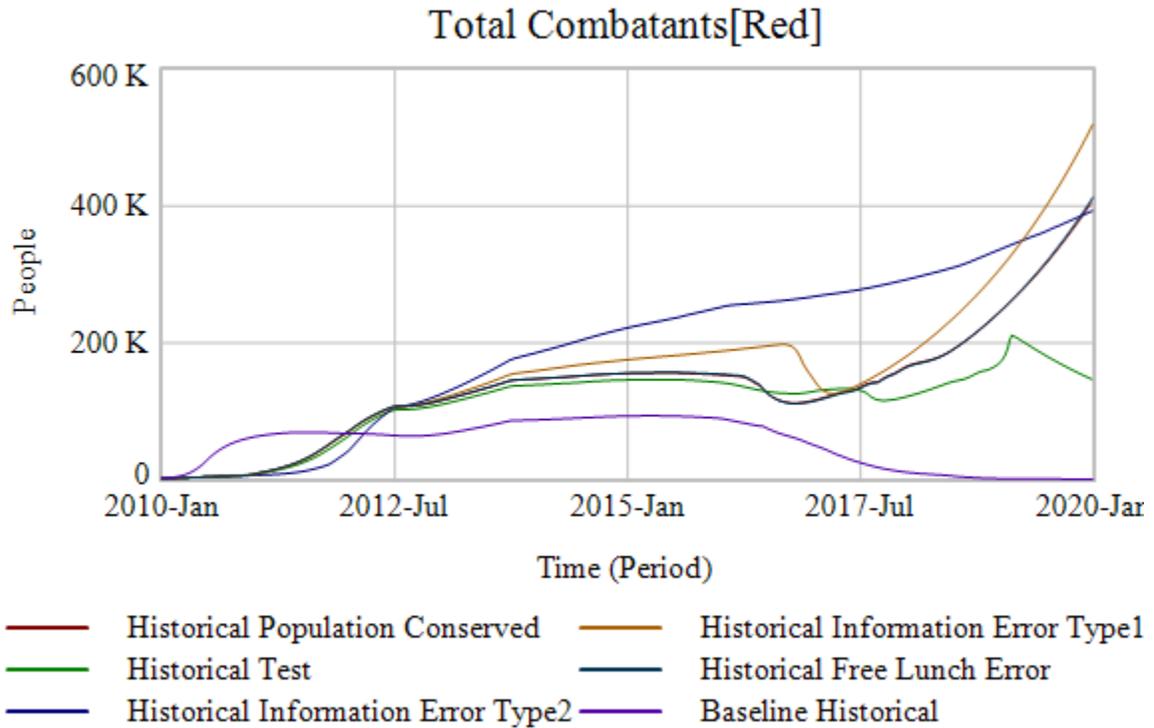
Figure B-37: Structural Assessment Evolution on Total Combatants[Red]

In conclusion since figures like the actual population controlled by ISIS may never be known – it doesn't mean that structural calibration resulted in more "accurate" parameter estimates that drive Red's population in E-SAM. But by focusing on structural assessment and formulation review errors were uncovered that created clearly implausible or unrealistic behavior in subsystems of E-SAM. Had numerical calibration been attempted instead, these errors might have been overlooked in favor of parameter adjustments to find the right "fit." This would virtually ensure that the parameters which displayed the best fit were clearly wrong as they included what are now known to be structural and formulation errors. Although we may never know if the parameters found in the model are accurate – through structural calibration confidence has been increased that the structure and formulations within which those parameters reside are realistic building confidence in E-SAM results.

B-4 Dimensional Consistency

The dimensional consistency of E-SAM is checked both by software and manually inspected. The software review returns a value of acceptable unit consistency as shown in Figure B-38.

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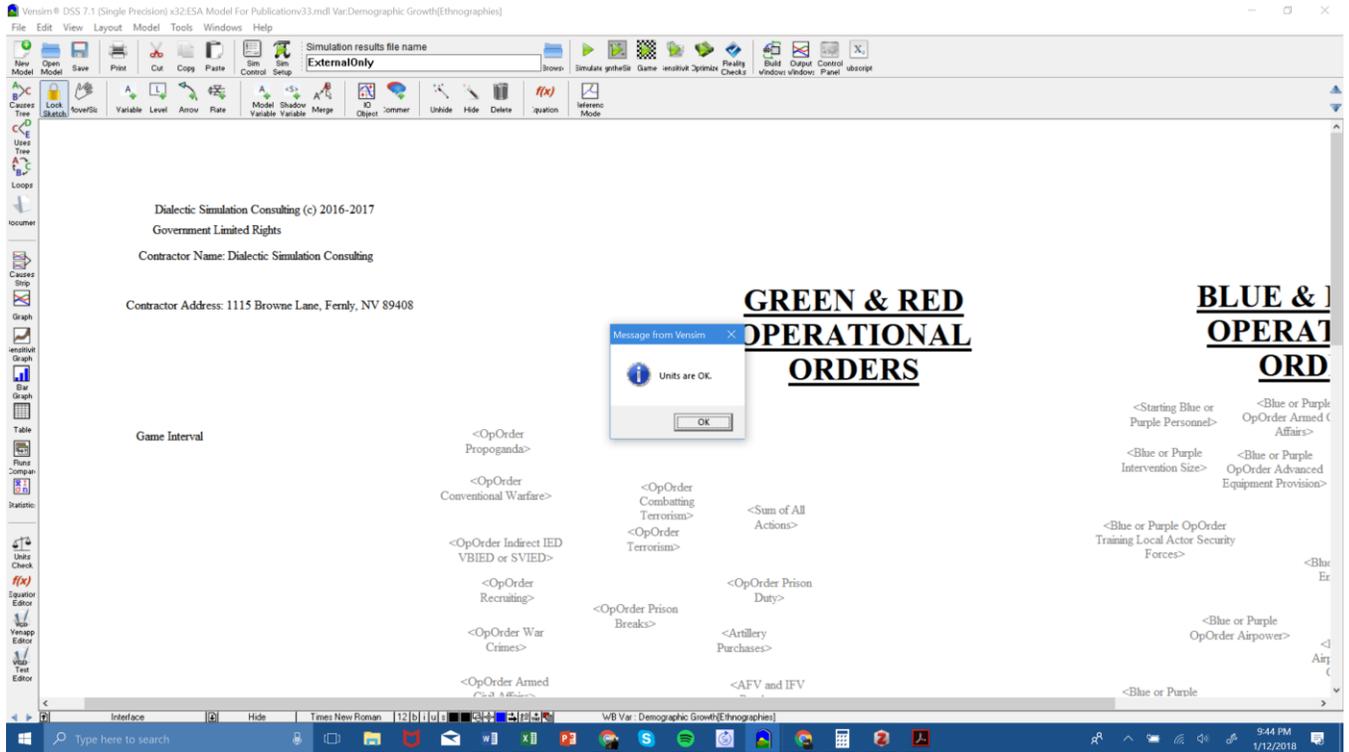
Figure B-38: Unit Consistency

B-5 Parameter Assessment

The source of parameter estimations is covered in the sector-by-sector overview. As noted in the *Precision vs. Realism* section in the Overview, the focus was made on obtaining real-world data where applicable. Unfortunately, as ISIS was a fast-moving phenomenon and much about them is either unknown or classified most of this parameter information came from publicly available, unclassified or declassified sources. Where numerical estimates were not available – modeler judgement was used to create causally realistic parameter values.

However, E-SAM itself provides a framework for future parameter assessment. As research is undertaken and published that isolates and focuses on the specific parameters which build the model – these parameters can be updated for E-SAM. A historical implementation of E-SAM may have more robust parameterization benefitting from the distance of time – though historical conflict also won't have the kind of numerically robust research associated with it outside of the field of cliodynamics that modeling often asks for. Time delays specifically, which have a large impact on the speed at which behavior develops and emerges – may be very difficult to ever formally quantify outside prudent modeler judgement and use of correct structures.

As future versions of E-SAM are updated newly available verified parametric data will be incorporated.

B-6 Extreme Condition

The E-SAM performs robustly under extreme conditions. Many errors of conservation were identified in structural assessment and while creating the model. However, simulation tests at a system level can be performed by creating unrealistic extreme conditions and ensuring E-SAM behaves realistically. For example, a billion combatants joining either side should bring the conflict to a rapid, but not immediate conclusion. Likewise, the mere introduction of such a large force should have second-order consequences in addition to providing a temporary combat advantage – how to pay them all for instance. To test extreme conditions behavior two unrealistic extreme conditions will be introduced. First a billion *Combatants* join Green and Red respectively in the *Baseline Without Intervention* scenario at the start of 2015. This is done by means of a gaming test input *Test Extreme Conditions* which allows a direct addition to the inflow of incoming combatants as shown below in Figure B-39.
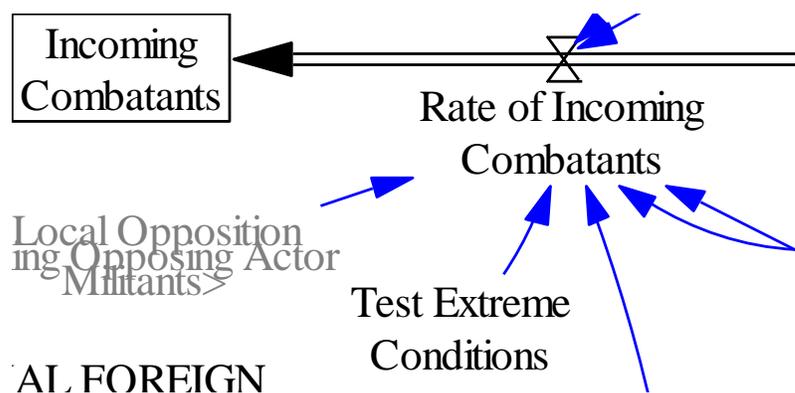
Figure B-39: Extreme Condition - Test Structure

Two lines are added to the simulation game script:

```
:Time=18.557
Test Extreme Conditions[Green]=1000000000
:Time=19.5539
Test Extreme Conditions[Arab Shia,Green]=0
```

When executing the script, we see first that the one billion combatants do join the total force for Green in Figure B-40. But when examining the primary measures of effect for *Territory Controlled by Actor [Red]* we do not see expected results of the fight being quickly concluded in Figure B-41.

B-6 Extreme Condition

Total Combatants[Green]
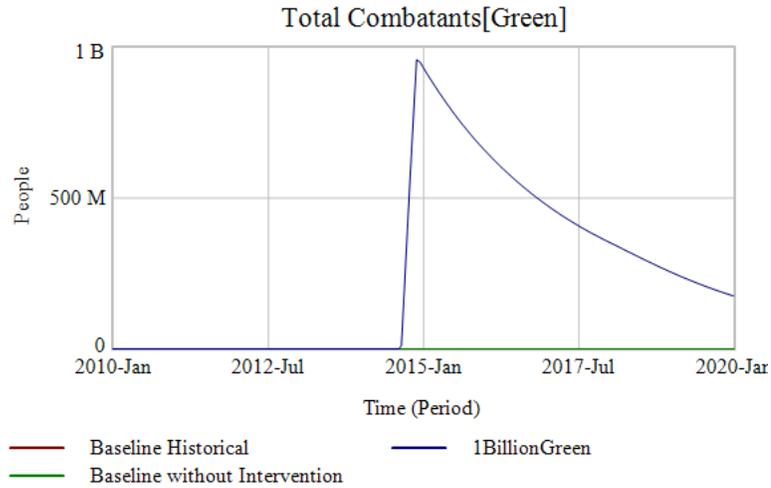
Figure B-40: Extreme Conditions 1B Combatants for Green

Territory Controlled by Actor[Red]
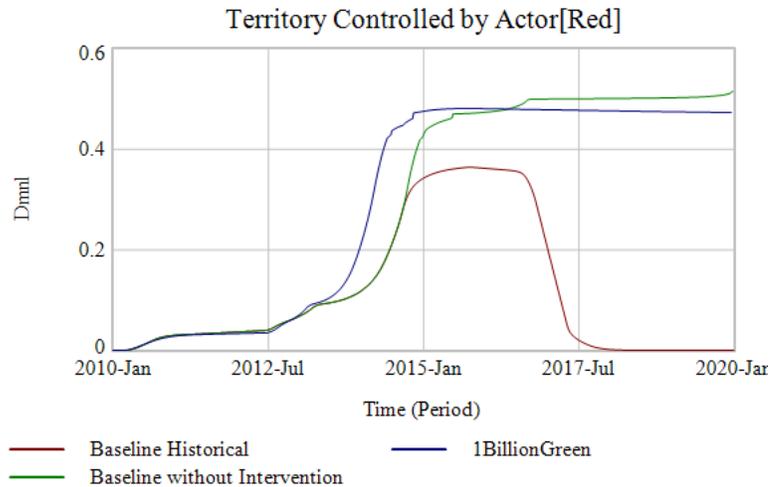
Figure B-41: Extreme Conditions Territory Controlled[Red]

It appears that despite adding a billion extra fighters, Green reaches a stalemate with Red, rather than defeating it. Yet we know from the *Baseline Historical* that Red can be defeated with the intervention of only 150,000 more combatants. Although this at first appears counter intuitive E-SAM is producing realistic results that ripple throughout the sectors. For example, although a billion fighters were added – there was no additional budget provided to pay for this force. This results in a sharp reduction in Green's ability to conduct offensive military actions as Green goes bankrupt demonstrated in Figure B-42.

B-6 Extreme Condition
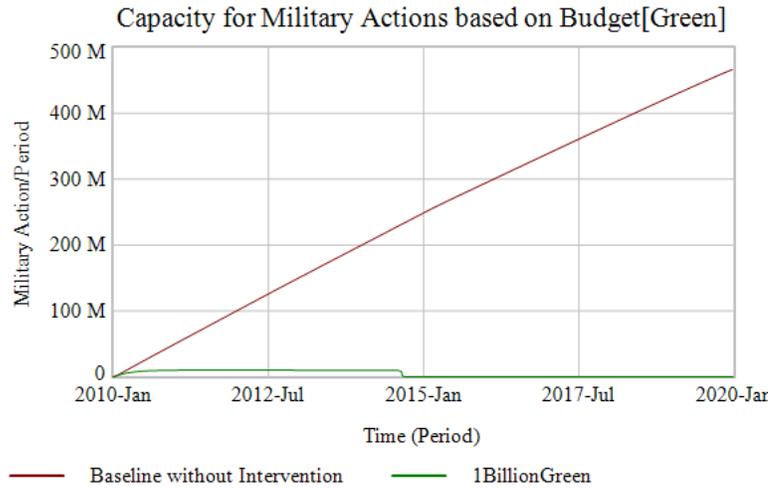
Figure B-42: Extreme Conditions Capacity for Military Actions Based on Budget[Green]

As described in the sector-by-sector overview Green, does not need to use Military Actions to defend Territory with Garrison- which still occurs. But they cannot conduct offensive actions without funds to pay for them. This creates territorial stalemate. But the extreme conditions demonstrate robustness in many additional ways which are described below as the ripple effects of adding a billion troops to a Territory begins to take hold. First is that Green cannot afford to pay the wages of its military force, resulting in increased defections as shown in Figure B-43.
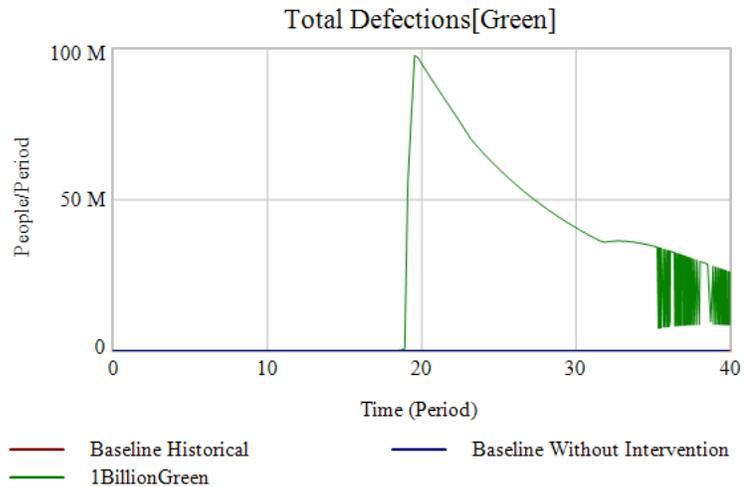
Figure B-43: Total Defections under Extreme Conditions[Green]

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B-6 Extreme Condition

In the model defecting *Combatants* don't just disappear, they return to civilian life as *Unaligned Population* which will then make a choice of which side to join. The large increase in Unaligned Population resulting from mass defections of Arab Shia from Green is shown in Figure B-44.
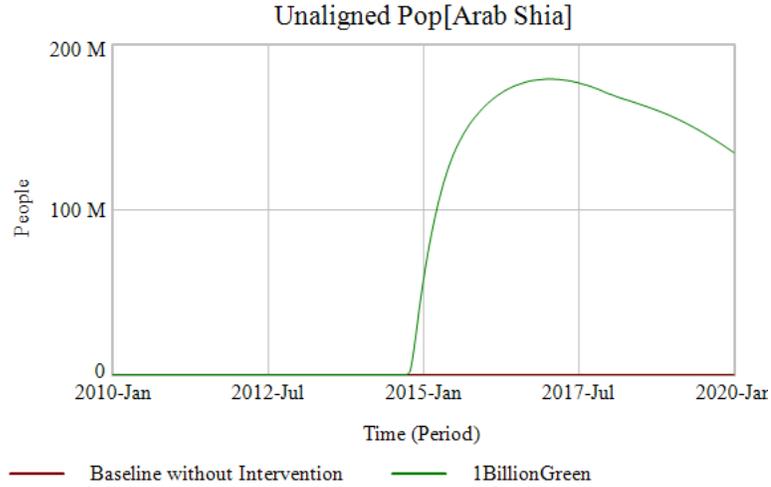
Figure B-44: Impact of Extreme Conditions on Unaligned Pop[Arab Shia]

Because at the time the billion combatants are added the perception of relative momentum is working against Green, some of these former *Combatants* but now *Unaligned Population* begin choosing the Red side as shown in Figure B-45.
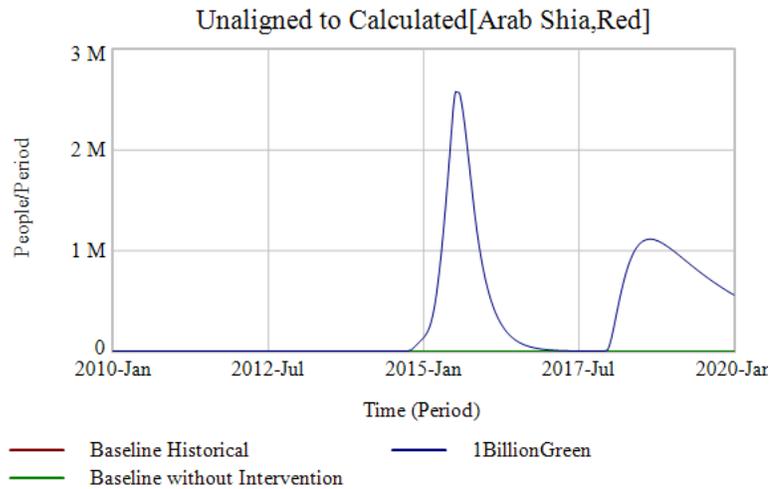
Figure B-45: Impact of Extreme Conditions on Unaligned to Calculated Flow[Red]

In the model Unaligned are distributed linearly throughout Territory. If Red conquers 50% of the Territory, it will have conquered 50% of the Unaligned. Although this isn't precise it does reflect that unaligned populations may be mobile – and Red indeed captures a large amount of unaligned Arab Shia which it adds to its own *Coerced Population* in Figure B-46.
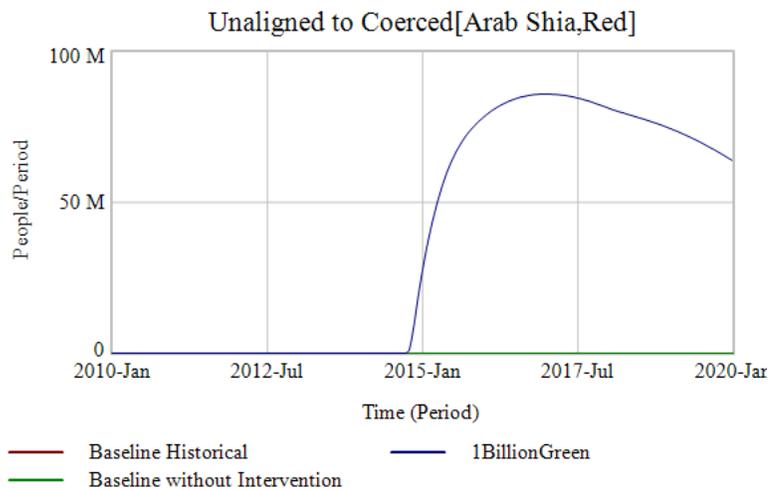
Figure B-46: Impact of Extreme Conditions on Unaligned to Coerced via Conquest[Arab Shia, Red]

This unrealistic influx of population caused 2nd and 3rd order effects for Red. Although *Coerced* populations do not pay taxes, they can be criminally exploited, and this allows ISIS to collect massive revenue from the new Arab Shia population. This is demonstrated in Figure B-47.

B-6 Extreme Condition
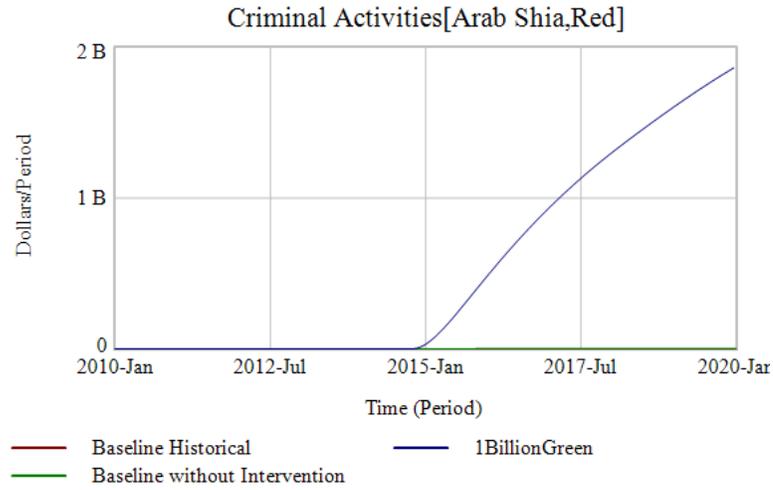
Figure B-47: Impact of Extreme Conditions on Criminal Activities[Red]

This provides the funds for ISIS to continue operating while Green, which brought the people in as *Combatants* was bankrupted immediately. However, because of Arab Shia distaste for ISIS, and that this entire population is *Coerced* Red rapidly runs into problems of providing sufficient *Actual Garrison*. Figure B-48 below shows the large increase in *Total Garrison Needed* versus the *Actual Garrison* that Red can provide based on its available manpower.

B-6 Extreme Condition

Selected Variables
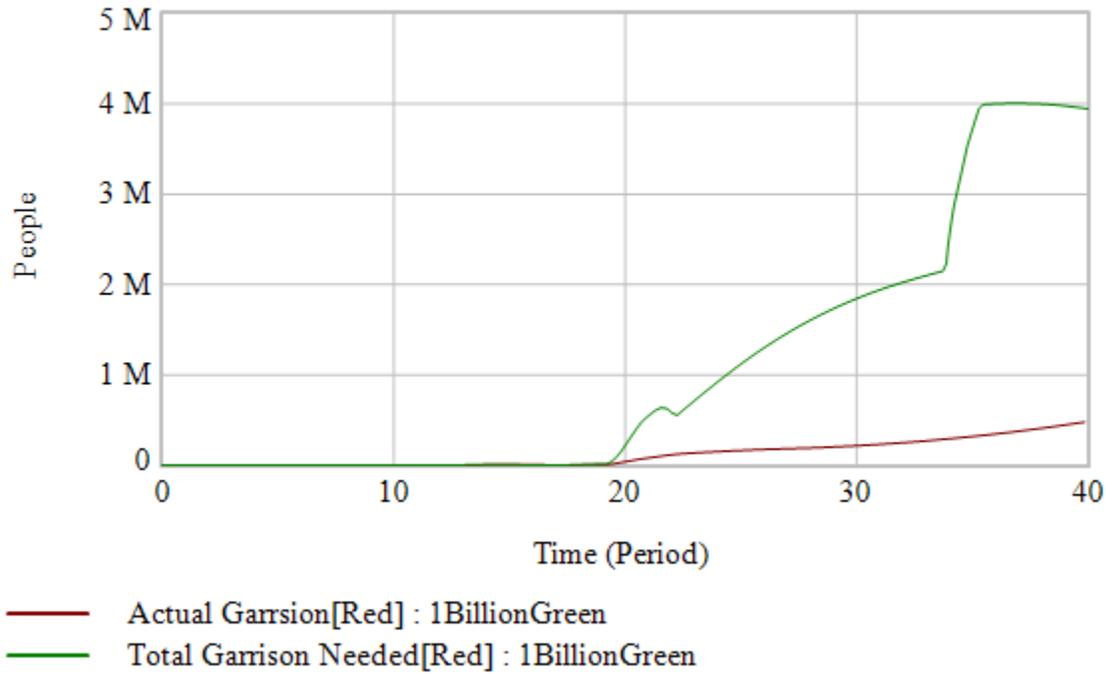
Figure B-48: Gap between Total Garrison Needed vs. Actual Garrison [Red]

Because of its inability to sufficiently garrison this population, Red quickly faces an increase in *Local Opposition Fighters to Actor* from among the Arab Shia population as shown in Figure B-49.
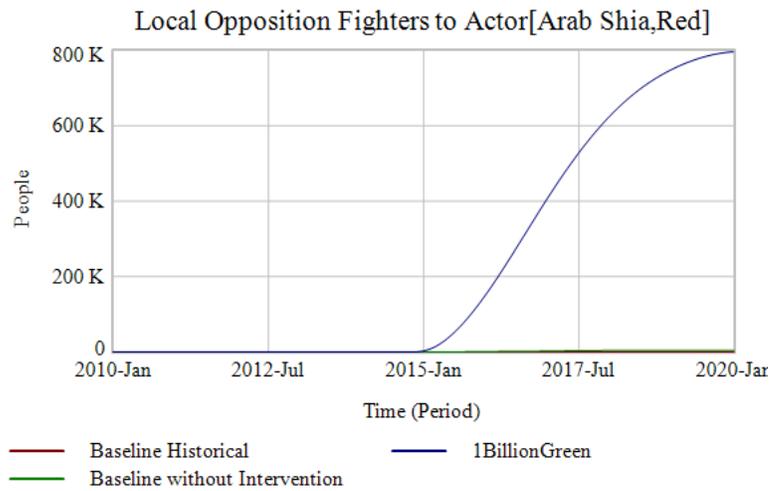
Figure B-49: Impact of Extreme Conditions on Local Opposition Fighters to Actor[Arab Shia, Red]

This creates the second component of stalemate – ISIS is too busy fighting an uprising twice the size of the normal Green *Total Combatants.* And from these *Local Opposition Fighters,* some combatants will end up rejoining Green as *Combatants* again as shown in Figure B-50.
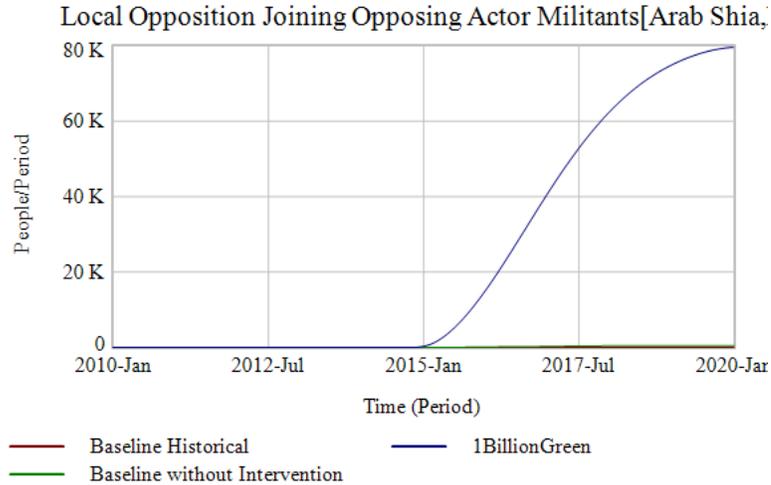
Figure B-50 Impact of Extreme Conditions on Opposition Joining Opposing Actor[Arab Shia, Red]

In summary the extreme conditions test is unrealistic by premise – but creates robust and realistic reactions as it causes ripple effects throughout the model. A billion Arab Shia *Combatants* cannot be paid for by Green, so there is little to no offensive benefit. Unpaid *Combatants* begin defecting to *Unaligned Population* as civilians leaving the battlefield – some of whom are attracted to Red but many more of which are conquered by Red. This causes problems for Red for although it can exploit criminal revenue from this massive mobile population, it does not have the means to provide sufficient *Actual Garrison.* As a result, *Local Opposition Fighters* to Red increases in an outbreak of conflict and strife. The inability for Green to pay for additional offensive military actions, and Red's need to dedicate all its *Combatants* in a failed effort to prevent internal rebellion results in the territorial stalemate.

B-6.1 Billion Combatants & Ten Trillion Dollars

A second extreme test is to ask what would happen if the billion Arab Shia *Combatants* were matched with sufficient funds to pay them such that they would not defect, and military operations could be conducted? This can be tested by adding *Revenue* of ten trillion dollars at the same time the one billion *Combatants* are added via a *Test Extreme Conditions Revenue.*

B-6 Extreme Condition

Incoming
Revenue

Test Extreme
Conditions Revenue
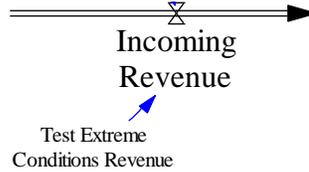
In the game script the following parameters are added:

:Time=18.557

Test Extreme Conditions Combatants[Arab Shia,Green]=1000000000

Test Extreme Conditions Revenue[Green]=10000000000000

:Time=19.5539

Test Extreme Conditions Combatants[Arab Shia,Green]=0

Test Extreme Conditions Revenue[Green]=0

When sufficient funds are added to the extreme tests the results are what we might predict would happen if one billion equipped and funded *Combatants* entered a conflict – the conflict would quickly end. This is demonstrated by looking at the primary measure of effect *Territory Controlled by Actor* in Figure B-51 below.
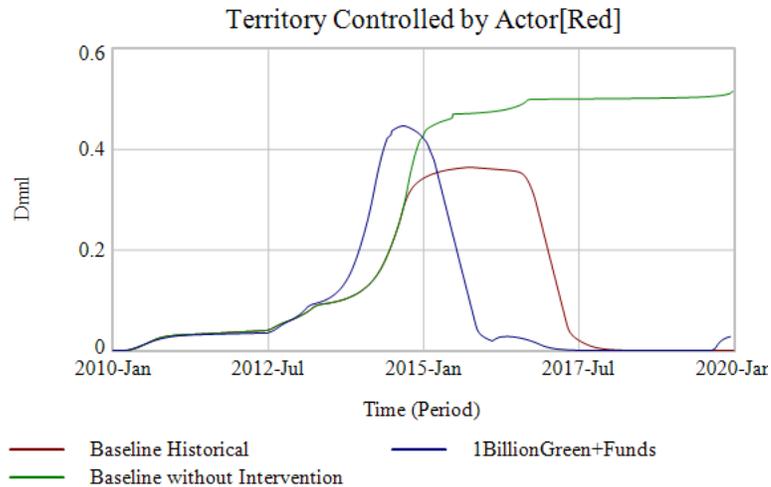
Figure B-51: Impact of Extreme Conditions with Funding on Territory Controlled[Red]

Now that the billion combatants can be paid, and there are sufficient funds to conduct military operations, the Green actor is rapidly able to decrease Red's territory to zero. Note that it doesn't happen overnight, and still takes time. This is realistic that one billion combatants can't be everywhere at once – battles must take time to finish and troops to recover etc. But Red does lose territory. Outside of the military success however some of the ripple effects of introducing a billion *Combatants* to the theater persist even when funds are available. Again, this is a demonstration of robustness – defections will still happen at some rate, those defecting will become civilian population and able to pick sides etc. Therefore, in Figure B-52 below there is still some population for Red – even though the military conflict has ended.
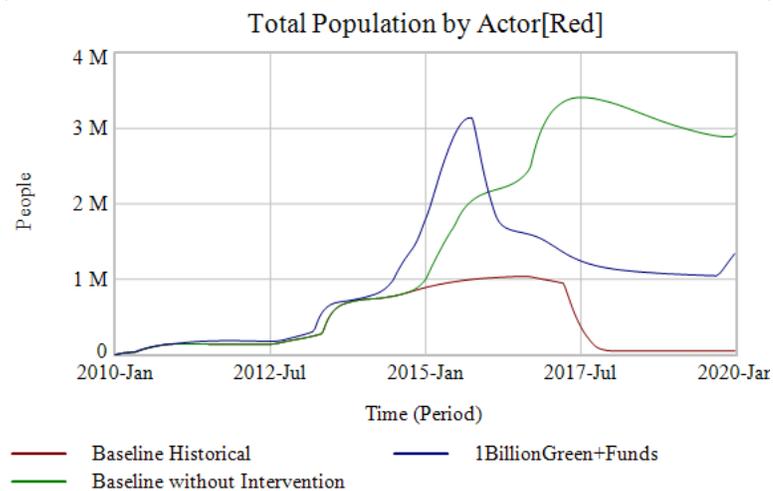
Figure B-52: Impact of Extreme Conditions with Sufficient Funding on Total Pop[Red]

This example is just one way in which E-SAM demonstrates robustness to extreme conditions. Performing in realistic ways after accepting a fantastic premise that one billion *Combatants* can be added. If they cannot be paid for, there's little military benefit even as the soldiers begin defecting and choosing different sides upon returning to civilian life. Some of these populations are conquered by Red, who does not have the manpower to garrison them and faces large internal uprisings. Even when *Combatants* can be paid for – the military success does not eliminate the consequences of having to deal with a huge influx of people, which is an acceptable validation of the test.

B-7 Integration Error

Earlier versions of E-SAM suffered from an integration error. This error most commonly occurred in parameters directly influenced by the time length of a battle, which originally was at a single day .011. This matched the DT interval of .011, violating the common rule of thumb that DT should be at least $1/4^{th}$-$1/5^{th}$ the smallest time interval in E-SAM. This resulted in visibly observable as "choppy" behavior graphs in parameters such as *KIA per Million Population* which is directly tied to military losses in battles as well as terrorism deaths. Because *KIA per Million Population* influences through structure *Local Opposition Fighters to Actor* by creating an unstable

environment that requires more garrison – this integration error did cause different behaviors to emerge over time. But improvements in structure and formulation (see System Tests below) have mostly eliminated this problem. In Figure B-53 and Difference, Euler and RK2 Auto integration methods are compared against the *Historical Baseline* which uses an RK4 Fixed integration method for both *KIA per Million Population* and *Local Opposition Fighters to Actor.*
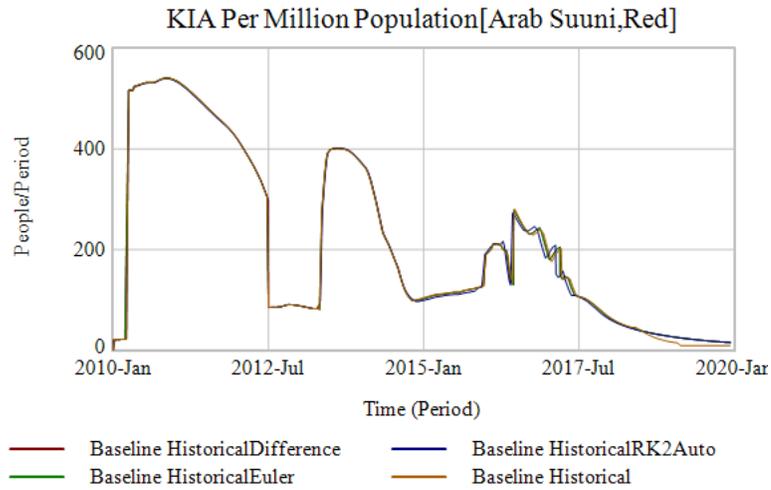
Figure B-53: Integration Test Results KIA per Million Population[Arab Sunni, Red]

Although there is little difference between the integrations, the base behavior is still very choppy because battles are still short relative to a period, 3 days (or .033) rather than 1-day (.011) long. However, this system choppiness does not propagate through the model as it used to as perceptions are smoothed in *Actual Garrison* structure. Which is why the behavior of *Local Opposition Fighters to Actor* is smoothed in Figure B-54.

B-7 Integration Error
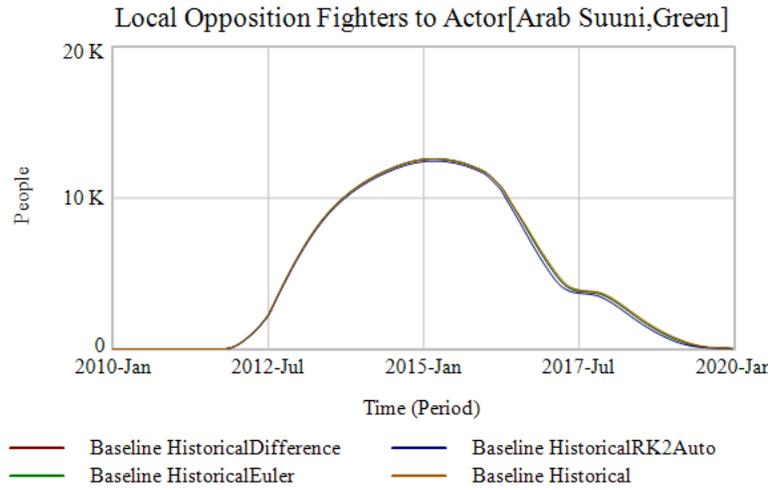
Figure B-54: Integration Test Results Local Opposition Fighters to Actor[Arab Sunni, Green]

Examining in detail the numerical differences of integration reveal some slight differences between the four methods as depicted in Figure B-55 and Figure B-56 below. However, these are not significant differences.

Figure B-55: Integration Test - Differences in KIA per M by Method

Vensim® DSS 7.1 (Single Precision) x32:ESA Model For Publication FINAL.mdl Var:Local Opposition Fighters to Actor[Ethnographies,Actors]

File Edit View Insert Model Tools Windows Help

Simulation results file name
Baseline HistoricalDifference

Year	"Local Opposition Fighters to Actor[Ethnographies,Actors]" Runs:	Local Opposition Fighters to Actor[Arab Suuni,Green]			
2014-Mar	"Local	11,440	11,440	11,300	11,410
2014-Mar	Opposition	11,450	11,450	11,310	11,420
2014-Mar	Fighters to	11,450	11,450	11,310	11,420
2014-Mar	Actor[Ethnograp	11,460	11,460	11,320	11,430
2014-Mar	hies,Actors]"	11,460	11,460	11,330	11,430
2014-Mar	Runs:	11,470	11,470	11,330	11,440
2014-Mar	Baseline	11,480	11,480	11,340	11,450
2014-Mar	Historical	11,480	11,480	11,340	11,450
2014-Mar	Difference	11,490	11,490	11,350	11,460
2014-Mar	Baseline	11,490	11,490	11,360	11,460
2014-Mar	HistoricalEuler	11,500	11,500	11,360	11,470
2014-Mar	Baseline	11,510	11,510	11,370	11,480
2014-Mar	Historical	11,510	11,510	11,370	11,480
2014-Mar	RK2Auto	11,520	11,520	11,380	11,490
2014-Mar	Baseline	11,520	11,520	11,390	11,490
2014-Mar	Historical	11,530	11,530	11,390	11,500
2014-Mar		11,540	11,540	11,400	11,510
2014-Mar		11,540	11,540	11,400	11,510
2014-Mar		11,550	11,550	11,410	11,520
2014-Apr		11,550	11,550	11,410	11,520
2014-Apr		11,560	11,560	11,420	11,530
2014-Apr		11,560	11,560	11,430	11,540
2014-Apr		11,570	11,570	11,430	11,540
2014-Apr		11,580	11,580	11,440	11,550
2014-Apr		11,580	11,580	11,440	11,550
2014-Apr		11,590	11,590	11,450	11,560
2014-Apr		11,590	11,590	11,450	11,560
2014-Apr		11,600	11,600	11,460	11,570
2014-Apr		11,600	11,600	11,470	11,580
2014-Apr		11,610	11,610	11,470	11,580
2014-Apr		11,620	11,620	11,480	11,590
2014-Apr		11,620	11,620	11,480	11,590
2014-Apr		11,630	11,630	11,490	11,600
2014-Apr		11,630	11,630	11,490	11,600
2014-Apr		11,640	11,640	11,500	11,610

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                                                      3/7/2018

Figure B-56: Integration Test - Differences in Local Opposition to Actor by Method

B-8 Behavior Reproduction

A challenge of building confidence through behavior reproduction is the paucity of data about ISIS itself to compare against. Although ISIS did publish some data on its own size and performance, this was clearly propaganda. Independent estimates, though many in number, typically provide a point in time and no behavior over time. By and large the most effective behavioral reproduction tests will therefore come from the reader comparing what they know and understand occurred to the behaviors in the model. Is it realistic and within reason to what they know to have occurred?

Three behaviors are reproduced related to *Total Combatants[Red]*. The first behavior is reproduced entirely from US State Department estimates described in Section A (*See Table A-7: Historical Demographic Estimates of*

ISIS & AQI.)[64] A second behavior comes from the Stanford University Project Mapping Militant Organizations.[65] And the third behavior is a composite of contemporaneous reports of ISIS's size.[66,67,68,69,70,71] These are compared against the Baseline Historical run in Figure B-57.
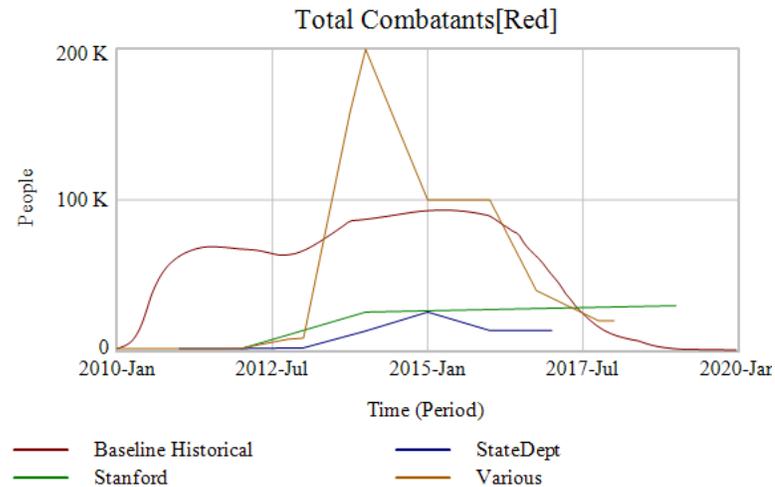
Figure B-57: Behavior Comparison on Total Combatants[Red]

The Baseline Historical performance falls within the range of the low end established by the State Department and the Stanford effort, and underneath the high end of the various sources. It also roughly matches the behavior pattern of the US State Department and Various sources, in that there is a sharp rise, followed by a fall.

Size estimates of the total territory controlled, and the population falling within that territory by ISIS are even more difficult to come by than combatant estimates. RAND published a report claiming a certain peak level of ISIS control and subsequent declines by 2017. Interpolating behavior from those peaks and falls allows reproduction of gross behavior mode of *Territory Actor Controls[Red]* and *Total Population[Red]* to compare to the Historical Baseline in Figure B-58.

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[64] Department of State. The Office of Website Management, "Country Reports on Terrorism."
[65] Crenshaw, "Islamic State in Iraq and Syria."
[66] Abouzeid, "The Jihad Next Door: The Syrian Roots of Iraq's Newest Civil War."
[67] Roggio, "Al Qaeda in Iraq Claims Credit for Tikrit Jailbreak."
[68] Cockburn, "War with Isis: Islamic Militants Have Army of 200,000, Claims Senior Kurdish Leader."
[69] Nakhoul, "Saddam's Former Army Is Secret of Baghdadi's Success."
[70] Sciutto, Starr, and Liptak, "ISIS Fighters in Libya Surge as Group Suffers Setbacks in Syria, Iraq."
[71] McIntyre, "ISIS down to 6,500 Fighters, Holds Only 3 Percent of Iraq."

B-8 Behavior Reproduction
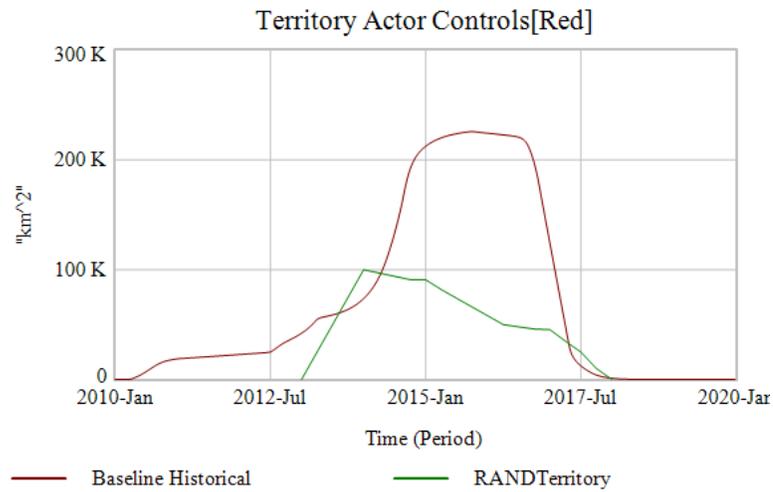
Figure B-58: Behavior Comparison on Territory Controlled by Actor[Red]

Although the magnitude is clearly off, the behavior closely replicates inflection points signaling the growth and decline of the territory held. The behavior reproduction for *Total Population by Actor[Red]* is shown in Figure B-59.
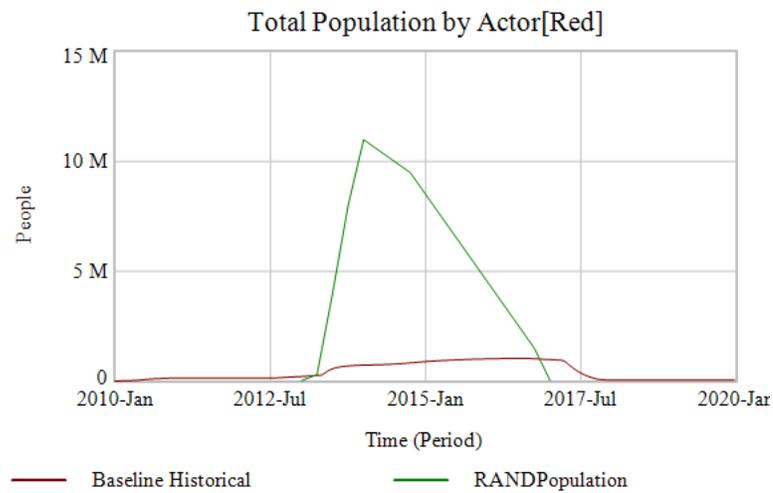
Figure B-59: Behavior Comparison Total Population by Actor[Red]

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Interestingly the RAND population estimates are an order of magnitude larger than E-SAM demonstrates, even though the territory controlled was an order of magnitude lower. This represents the difficulty in comparing datasets. One possible explanation is that the RAND estimates used pre-conflict data of population centers and did not consider the clearing-function that war crimes and terrorism by ISIS would have on populations in the area. The inflection points, and general behavior of rise and decline, remain consistent.

In summary although behavior reproduction is not a perfect match, often by magnitude in terms of peak, the key behaviors of growth and decline, as well as the timing of inflection points is presented as sufficient given the data limitations on the subject. As future peer-reviewed publications are made available with more consistent reporting of ISIS indicators over time these can be compared against the model results to continue to evaluate behavior reproduction.

B-9 Behavior Anomaly

Behavior anomaly tests are a supplement to behavior reproduction tests when statistical comparison cannot be as easily established. This is more important in E-SAM because of its focus on realism versus precision and thus having a larger statistical error implicitly than a model that may have been fit through numerical calibration to a single specific historic behavior mode.

B-9.1 Loop Knockout Tests

Loop knockout tests help established the importance of specific feedback structures by eliminating them from the model and seeing if performance significantly changes. Several of these have already been demonstrated in validation tests found elsewhere in this section:

- *Leadership Perception of Conflict Momentum:* When the feedback structure that connects *Territory Controlled by Actor* to *Offensive Stance based on Actor Perception of Momentum* is removed or simplified, unrealistic behavior emerges (see Figure B-24 in Section B-3.3 Conservation of Information Errors.)
- *Ethnographic Perception of Actors:* If feedback is eliminated between *Ethnographic Perception of Actor* and *Rate of Unaligned Converting to Calculated Legitimacy* Then Unaligned Population will fail to choose sides over time, resulting in a gradual accumulation of unreasonably high unaligned populations because they cannot "sense" what should be an obvious choice of actors. Note this isn't the same as neither Actor being a good choice, which can occur in certain circumstances.
- *Fiscal Connections to Population and Territory:* Several feedback loops exist between the ability to gain revenue, pay expenses, and continue to do more actions. As was demonstrated in Figure B-42: Extreme Conditions Capacity for Military Actions Based on Budget[Green] when Extreme Conditions resulted in more troops than could be paid for – military activity ground to a halt. Likewise, if the feedback between the various types of population controlled by an actor

(Coerced, Calculated Legitimacy & Governed) and the ability to gain revenue off them is severed – then the acquisition of population does not result in continued military capability, which is not realistic. This can be tested by setting *Criminal Activities per Person, Tax Rates* and *Territory Conditions Price per Unit* all to zero, in effect severing this feedback. The results of this test are examined in the primary measures of effect of *Territory Controlled by Actor [Red]* and *Total Combatants [Red]* in Figure B-60 and Figure B-61. For this test all conditions are held the same as *Baseline Without Intervention* other than the loop knockout.
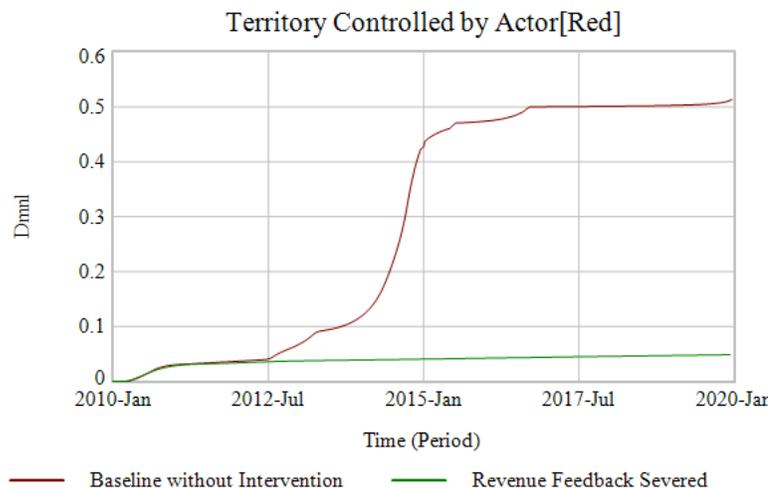
Figure B-60: Loop Knockout of Revenue Feedback effect on Territory Controlled

As seen in the above figure, Red actor gains a minor amount of Territory at the periphery of Green but is not able to expand. This is because Red starts in the scenario with $10M USD. And initially *Total Combatants* begins rising due to the systemic repression of Green Actor against Arab Sunni and Kurdish Sunni populations. But without the feedback of finances, these *Combatants* cannot be paid and gradually winnow away through defections and other losses.
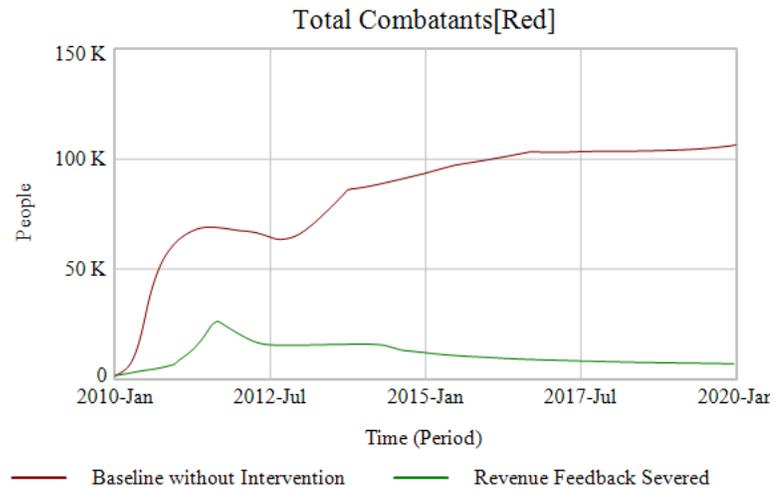
Figure B-61: Loop Knockout of Revenue Feedback effect on Total Combatants

B-10 Family Member Test

Since the E-SAM model is designed to be used in a wide variety of historical and regional circumstances to represent many forms of conflict less-than-full-spectrum, family tests are a key validation. Although the size of the model prohibits a full family test in this section, a single rudimentary family test can be constructed. Importantly the rudimentary family test should be fundamentally different than ISIS in Syria and Iraq which resulted in a full-scale insurgency and emerging-state actors. So, recreating the Taliban in Afghanistan, Boko Haram in Nigeria would not be a good test.

B-10.1 Family Test: Indonesia Counter-Terrorism Scenario

Instead a family-test will be created to explore capabilities in an environment where local fighters have not progressed outside of clandestine terrorist operations only. And the research question will be one being asked in many countries: given a small local ISIS population operating clandestinely and in jail, what happens when expatriate local fighters operating in Syria and Iraq on behalf of ISIS return?

To establish this scenario some liberties are taken. As ISIS is still the Red Actor, most parameters relating to ISIS performance will be held the same. Additionally, even though the Indonesia Army has significant differences than Iraq and Syria, for purposes of a rudimentary family test most values will be held constant. What changes will be made are about ethnographic distribution, starting force size changes, and the addition of fighters abroad that can return to Indonesia who are not themselves foreign recruits.

B-10 Family Member Test

To preserve subscript numbering for convenience, five of Indonesia's many ethnographic divisions will be compiled into three groups: Javanese (43%), Sundanese (15%) and Malay, Madurese and Batak (10%). Although these three ethnographic groups only comprise 68% of the total 140M population normally they can be assigned proportionally equal waits to create a "whole" population (thus for now assuming there are no other ethnographies.)

Unlike the *Baseline* scenarios, in the *Indonesia Family* tests 100% political legitimacy at start will not be assumed. Rather the historical realities of previous conflict between civilian and government until 2006 will be considered, and 24% of the population will be set at *Calculated Legitimacy.* The military also has greater professional ability having not been devastated by invasion, civil war and sectarian divisions as was the case in Iraq & Syria. The scenario will start in the beginning of 2017. At this point ISIS in Iraq had largely been pushed back into Mosul, which was already under siege, and was losing ground steadily in Syria to a combination of Turkish, SDF supported by the US and Syrian forces.

Table B-2: Ethnographic Starting Values for Indonesia Family Test

Parameter	Javanese	Sundanese	Malay
Starting Ethnographic Population	88,014,450	31,800,766	20,636,448
Starting Population that is Calculated Legitimacy [Green]	24%	24%	24%
Starting Population that is Governed[Green]	74%	66%	66%
Starting Ethnographic Generational Perception[Green]	59,240,000	21,540,000	14,140,000
Starting Ethnographic Current Perception [Green]	31,700,000	11,400,000	7000000
Starting Ethnographic Generational Perception[Red]	3,500,000	1,300,000	825,000
Starting Ethnographic Current Perception [Red]	15,800,000	5,700,000	3,700,000
Actual Desire to Credibly Govern[Green]	76%	76%	76%

Table B-3: Actor Starting Conditions for Indonesia Family Test

Parameter	Green Actor	Red Actor
Starting Cash	$25B USD	$10M USD
Starting Total Combatants	273,824	500

B-10 Family Member Test

Starting Detainees by Actor	0.00E+00	270
Starting Experience	3	3
Starting Worldwide Population of Foreign Recruits	0	10,000
Starting Combatants by Ethnography	171,593 61,998 40,232	313 113 74
Normal Experience Gained per Person	1	.5
Starting AFV/IFV	2137	0
Starting Artillery	594	0
Starting Actor Conditions Expatriate Fighters	0	300
Starting Actor Security Effectiveness	1	.5
Minimum Force Size to Engage	0	20,000

The game script for this family test is:

```
:Time=0
STARTING ETHNOGRAPHIC PERCEPTION OF ACTOR
STARTING ETHNOGRAPHIC PERCEPTION OF ACTOR[Javanese,Green]= 88014451
STARTING ETHNOGRAPHIC PERCEPTION OF ACTOR[Sundanese,Green]= 31800766
STARTING ETHNOGRAPHIC PERCEPTION OF ACTOR[MalayMadureseBatak,Green]=20636448
STARTING ETHNOGRAPHIC GENERATIONAL PERCEPTION[Javanese,Green]= 65130694
STARTING ETHNOGRAPHIC GENERATIONAL PERCEPTION[Sundanese,Green]= 23532567
STARTING ETHNOGRAPHIC GENERATIONAL PERCEPTION[MalayMadureseBatak,Green]=
15270972
Actual Desire to Credibly Govern[Javanese,Green]=0.74
Actual Desire to Credibly Govern [Sundanese,Green]=0.74
Actual Desire to Credibly Govern [MalayMadureseBatak,Green]=0.74
Actual Desire to Credibly Govern[Javanese,Red]=0.0
Actual Desire to Credibly Govern [Sundanese,Red]=0.0
Actual Desire to Credibly Govern [MalayMadureseBatak,Red]=0.0
OpOrder Armed Civil Affairs[Green]=0.0
OpOrder Combatting Terrorism[Green]=0.6
OpOrder Conventional Warfare[Green]=0.2
OpOrder Indirect IED VBIED or SVIED[Green]=0
OpOrder Prison Breaks[Green]=0
OpOrder Prison Duty[Green]=0.0
OpOrder Propoganda[Green]=0.0
OpOrder Armed Civil Affairs[Red]=0.25
OpOrder Combatting Terrorism[Red]=0
OpOrder Conventional Warfare[Red]=0.2
OpOrder Indirect IED VBIED or SVIED[Red]=0
OpOrder Prison Breaks[Red]=0.05
OpOrder Prison Duty[Red]=0
OpOrder Propoganda[Red]=0.25
OpOrder Recruiting[Javanese,Green]=0.03
OpOrder Recruiting[Sundanese,Green]=0.01
```

```
OpOrder Recruiting[MalayMadureseBatak,Green]=0.01
OpOrder Recruiting[Javanese,Red]=0.01
OpOrder Recruiting[Sundanese,Red]=0.01
OpOrder Recruiting[MalayMadureseBatak,Red]=0.01
OpOrder Terrorism[Javanese,Red]=0.05
OpOrder Terrorism[Sundanese,Red]=0.05
OpOrder Terrorism[MalayMadureseBatak,Red]=0.05
:Time=39.99
```

In plain language what these settings and script represent is a very small indigenous ISIS presence in Indonesia. The group is militant – mixing terrorism, propaganda and armed civil affairs while seeking to recruit and grow their strength. They seek to target local prisons to free other combatants and will receive back fighters returning from abroad. They are not afraid of attacking the military conventionally – but will wait until their strength is at least 20,000 before launching an insurgency.

B-10.2 Family Test: Indonesia Counter Terrorism Baseline

The baseline run of the above scenario results in a wholly different outcome than ISIS in Syria & Iraq. Red begins the scenario with the return of expatriated Indonesian fighters returning from Syria & Iraq in Figure B-62 and prison breaks to free fellow combatants from Indonesia's weakly secured prison system in Figure B-63.
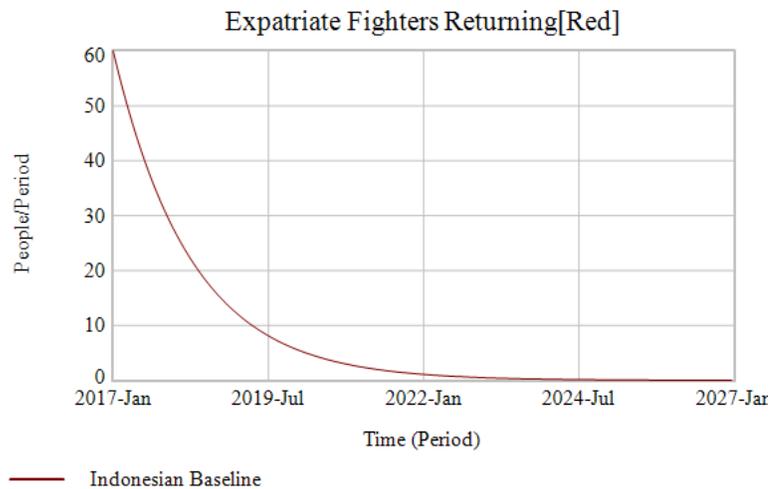
Figure B-62: Family Test - Indonesian Fighters Returning from Syria & Iraq

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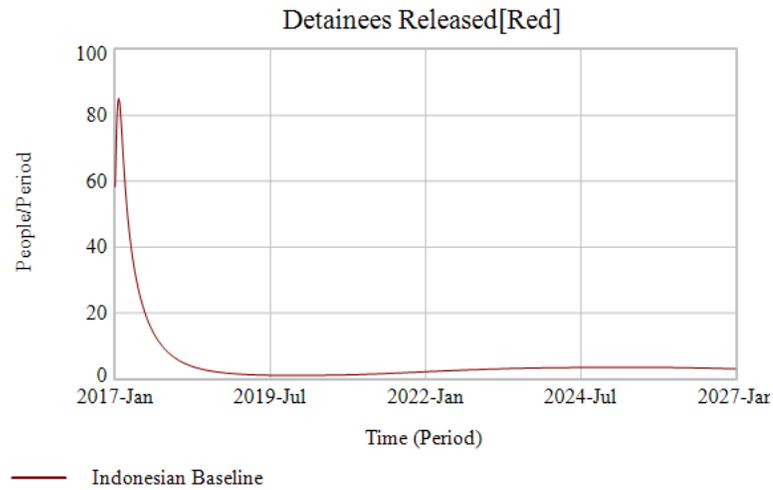
Figure B-63: Family Test - Indonesian ISIS Fighters Released in Jail Breaks

This provides an initial increase in *Combatants* which allows Red as shown in Figure B-64.
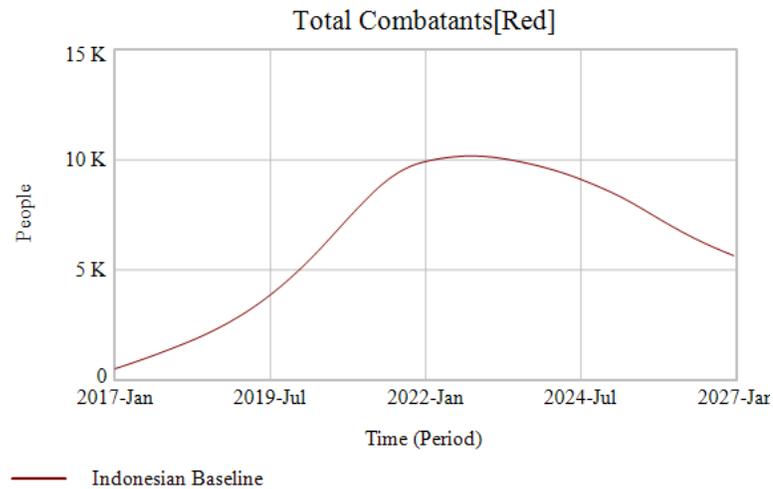
Figure B-64: Family Test - Indonesia Growth of ISIS

As Red gains forces, it continues to wage a largely clandestine terror campaign against Green. This draws foreign fighters via propaganda into the Indonesia region to join Red because of their terror successes. The results are shown in Figure B-65 as both the Total Terrorist Attacks (right side vertical axis) and *Foreign Combatants* (left side vertical axis).

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B-10 Family Member Test
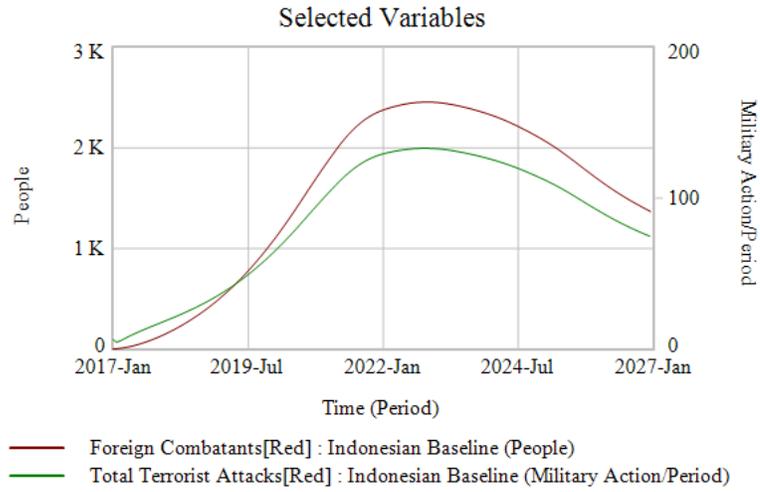
Figure B-65: Family Test - CounterTerrorism Results for Green

Green is not idle during this campaign. It's counter-terrorism forces can thwart attacks by Red. Red *Combatants* are killed in police raids while cells broken up result in more detainees of Red as shown in Figure B-66.
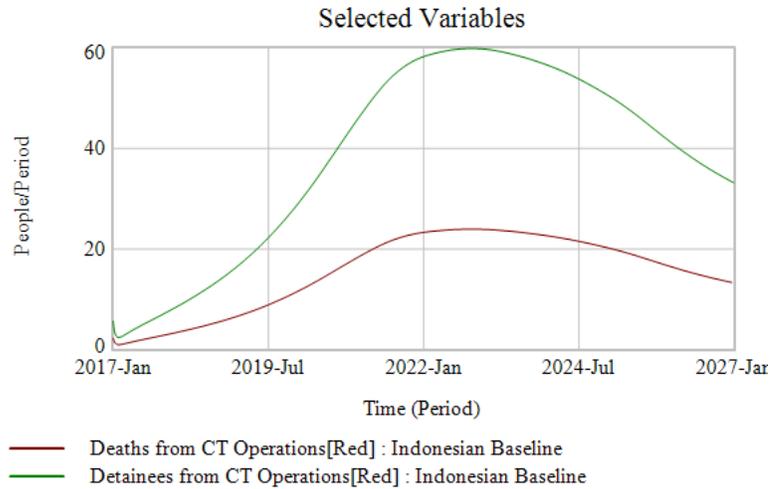
Figure B-66: Family Test - Indonesia Baseline CT Results

Still civilians are dying from terrorist actions as demonstrated in Figure B-67.

B-10 Family Member Test
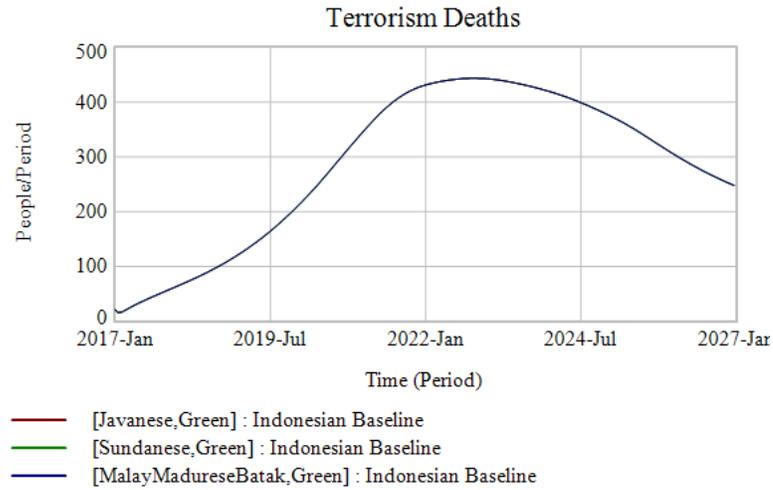
Terrorism Deaths

Figure B-67: Family Test - Indonesia Terrorism Deaths

In terms of the narrative of legitimacy between the state and non-state actor, Green's credibility is eroding over time as shown in Figure B-68.

Selected Variables
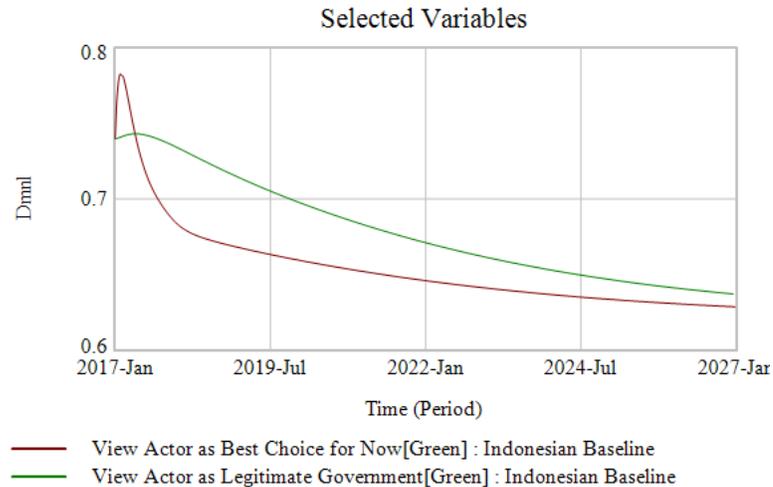
Figure B-68: Family Test - Indonesian Legitimacy of Green

But Red, despite its propaganda and armed civil affairs, is unable to gain much support in the population in Figure B-69.
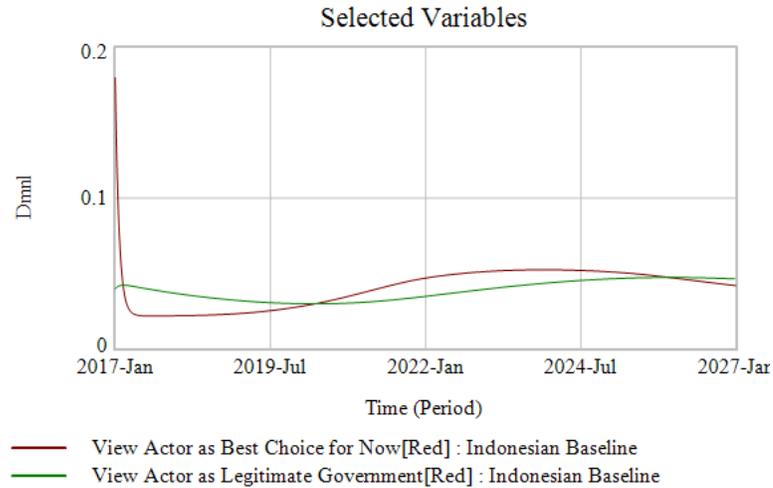
Figure B-69: Family Test - Indonesia Legitimacy of Red

The baseline demonstrates a persistent indigenous clandestine terrorism group causing harm – but not able to expand out of its niche. It reveals the weakness of Indonesian prisons which serve as a rotating training school. Combatants are captured by counter-terror operations, jailed where they gain more experience, and broken out by ISIS combatants later. The Red Actor is not able to launch an insurgency, let alone become an emerging-state actor. It is a threat best described as a law-enforcement and counter-terror operation than a military campaign. This is a realistic outcome, even if it is not precise.

But the proposed validity of E-SAM is not just in describing a hypothetical theater of operations – but allowing operational planners to prepare courses-of-actions (COA) for policy decision making. Suppose in this hypothetical the Indonesian government assigns operational planners a year in 2018 to prepare a set of policy recommendations that will be put in place to mitigate or contain ISIS from 2019 onward. To build confidence in this aspect of a Family Test three rudimentary COA's are proposed to represent this exercise and the results compared to the baseline. These in effect are an additional form of validation as System Improvement Tests. Can reasonable policies that are actionable to decision makers result in noticeably different performance levels of the underlying system? Table B-4 below lays out the three COA's including a plain language description and the specific game script changes that will be made at Period 8.01026 (e.g. Jan-2019).

Table B-4: Family Test Courses of Action Details

COA	Plain Description of Strategy	OpOrders @ Period 8
COA1	Begin aggressive measures against ethnographies supporting Red. Reduced government services and tolerate sporadic incidents of extra-legal violence.	1. Set Actual Desire to Credibly Govern [Green] to .5,.5,.5 2. Set OpOrder War Crimes [Green] to .001,.001,.001

COA2	Invite foreign intervention. Blue troops maintain non-combat capacity-building role supporting CT Training, Information Operations & Armed Civil Affairs on behalf of Green.	1. Set Blue or Purple Intervention Size[Green] to 50,000 2. Set Information Operations, Counter-Terrorism Training of Green, Provision of Advanced Equipment and Armed Civil Affairs to .25
COA3	Isolate Red from ethnographies by increasing government services to ethnic groups while prioritizing Counter-Terrorism, Prison Security and messaging (Propaganda & Armed Civil Affairs) over military engagement.	1. Set Conventional Military Actions[Green] to 0 2. Set Actual Desire to Credibly Govern [Green] to .8,.8,.8 3. Set OpOrder Combatting Terrorism [Green] to .8 4. Set OpOrder Prison Duty [Green] to .05 5. Set OpOrder Propoganda[Green] to .05 6. Set OpOrder ArmedCivilAffairs [Green] to .05

With these changes made in game scripts and run, the three COA's are compared against the baseline in a variety of primary and secondary measures. A Family Test validation would be plausible behavior combined with surprising behavior from what are admittedly rudimentary scenarios.

First presented is the conflict narrative of how the population, across all Ethnographies *View Actors as Best Choice for Now* as shown in Figure B-70 (Green) and Figure B-71 (Red.) Although the amount who *View Actor as Legitimate Government* is also important in many factors, the calculated legitimacy level is useful for identifying how many are susceptible to switching.

View Actor as Best Choice for Now[Green]
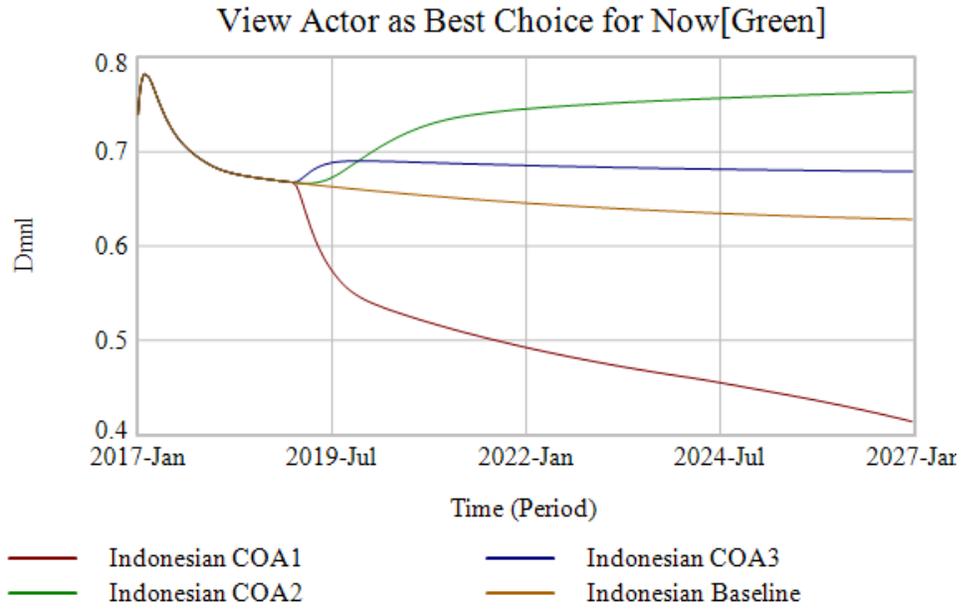
Figure B-70: Family Test - COA Impact on Green Legitimacy

A surprising behavior emerges in Figure B-71 wherein although COA3 is specifically focused on improving governance, it is COA2 with a foreign intervention that results in more calculated legitimacy for Green. This will be explained further on an expanded section of Special Behavior in the Family Test.

View Actor as Best Choice for Now[Red]
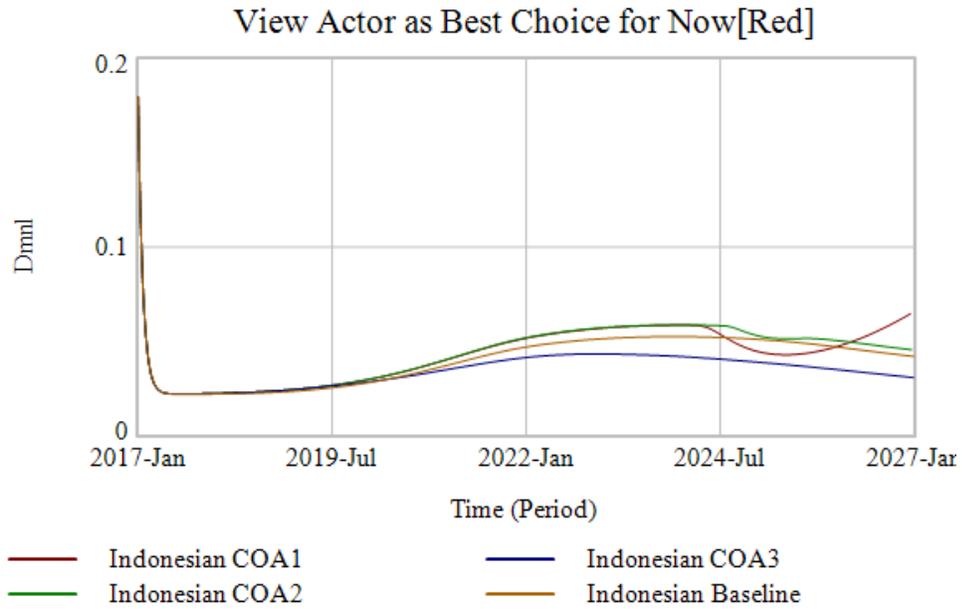
Figure B-71: Family Test - COA Impact on Green Legitimacy

These two snapshots demonstrate the impact of each COA on the perception of Green. The divergence of perception created between COA1 (aggressive retaliation) and COA2 & COA3 is striking – indicating that although many do not support Red, they are losing support of Green.

The next primary measure of effect to examine is the level of *Total Combatants* in Figure B-72.
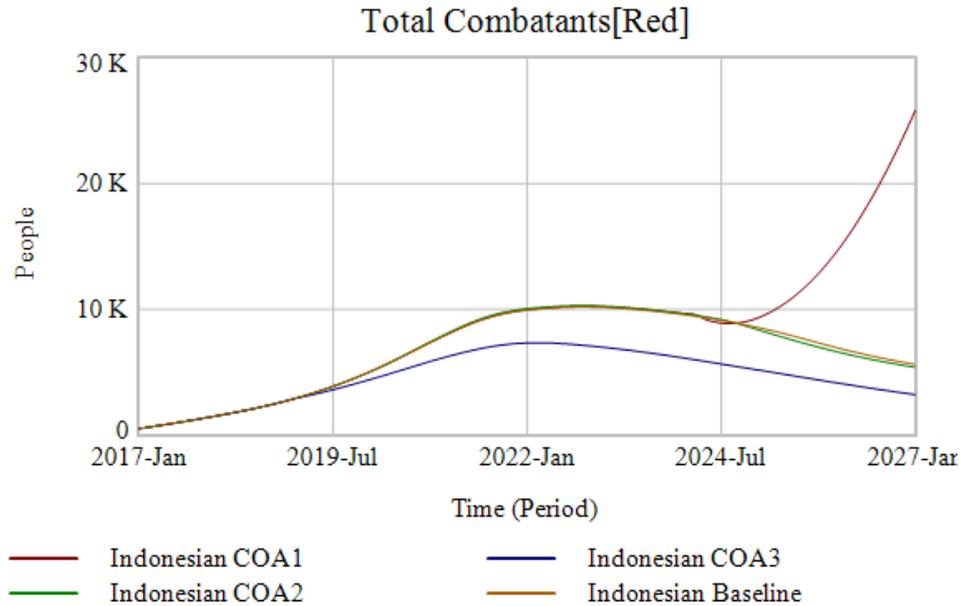
Figure B-72: Family Test - COA Impact on Total Combatants

According to Kilcullen's counterinsurgency theory of overreaction the results of COA1 are not surprising. Whereas COA3 has reduced the Red force to a fraction of its original size and COA2 at least maintains parity with baseline has advanced the system-state from clandestine terrorism to a full-blown insurgency. From the vignette settings, Red would not engage in *Conventional Warfare* until it had at least 10,000 *Combatants* which is achieved in COA1 near July of 2024. This results in beginning to fight for territory, as shown in Figure B-73.

Territory Controlled by Actor[Red]
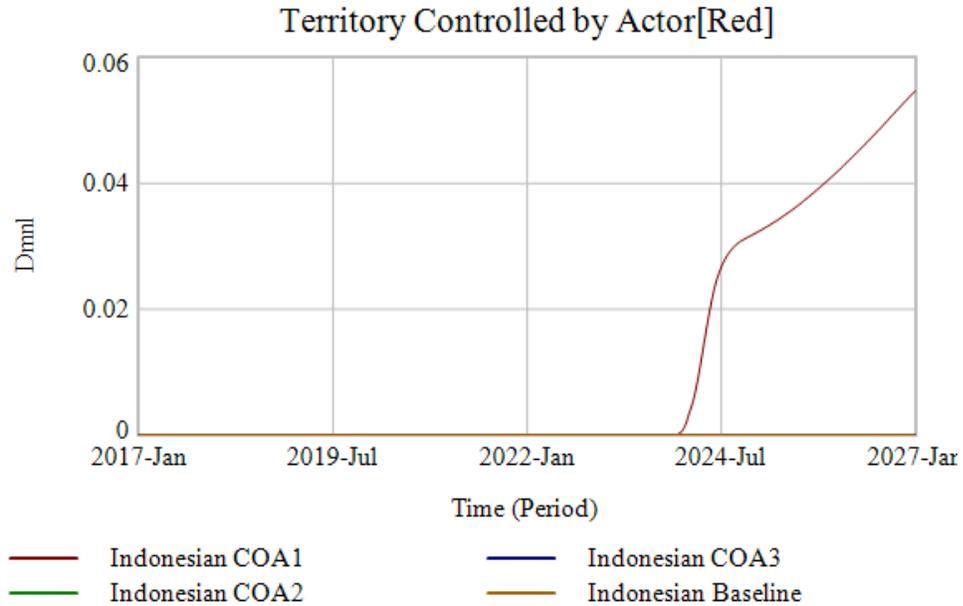
Figure B-73: Family Test - COA Impact on Territory Controlled

In the Baseline run, as well as COA2 and COA3, Red Actor never felt sufficiently strong to begin launching territorial attacks. But in COA1 Red can begin taking territory, albeit at small levels with the following caveat. Since the territorial map of Indonesia was never established in the scenario initialization, and the location of geography, battle type and ethnographic distribution based on territory percentage was borrowed from the Iraq & Syria model – this may be an inaccurate representation of how much territory is captured when. However, the important result is that an insurgency did emerge, sufficient to begin *Conventional Warfare* and COA1 is the only scenario of the vignette where this happens.

A secondary measure of effect related to *Total Combatants* is the amount of ISIS fighters who were able to escape prison and rejoin the fight. This is shown below by COA in Figure B-74.
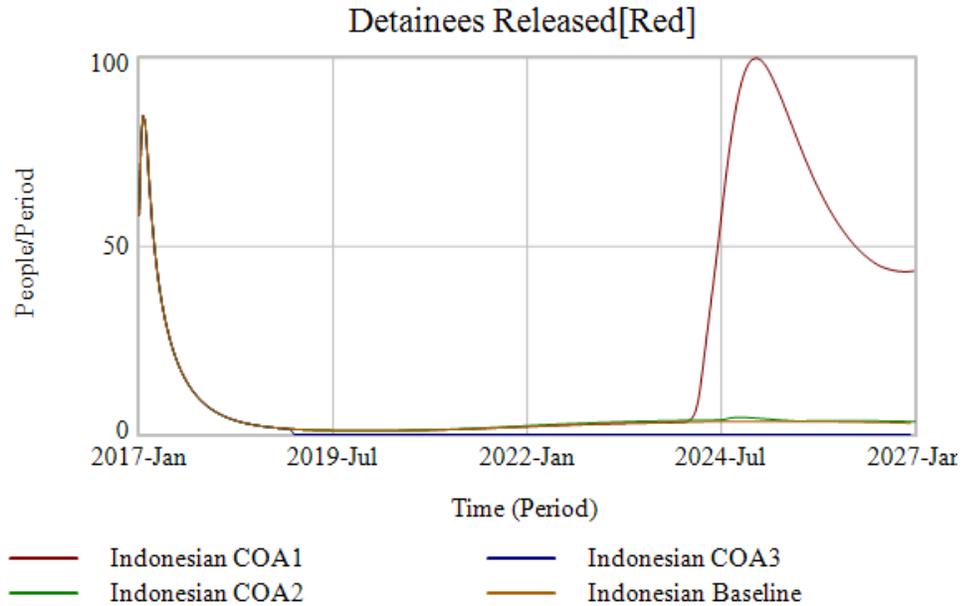
Figure B-74: Family Test - COA's impact on Detainees Released

Not surprisingly COA3, which focuses on securing prisons shows the *Detainees Released* dropping to zero which is a crucial factor in reducing the size of *Total Combatants.*

Given the original vignette of a clandestine terror network operating in Indonesia, another primary measure of interest was the impact on the COA's in terms of *Total Terrorist Attacks.*

Total Terrorist Attacks[Red]
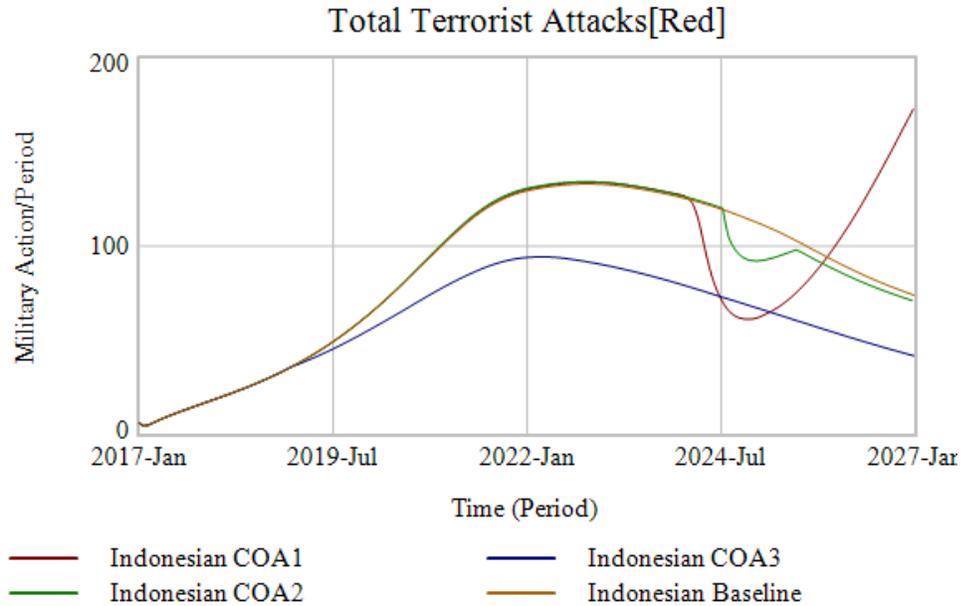
Figure B-75: Family Test - Impact of COA's on Terrorist Attacks

Clearly in this comparison COA3 performs better than the other COA's or baselines, effectively eliminating Red's capability to conduct terror. As shown above COA3 had the lowest *Total Combatants* in large part by cutting off escaped combatants from prison and this correlates to overall terrorism levels.

COA1 again demonstrates the consequence of an overly militaristic and widely violent response in reaction to terrorism – resulting in more terror attacks over time. Another surprising behavior here however is that COA2, with foreign intervention aimed at improving security effectiveness of local troops, has not significantly diminished the terrorist attacks from the baseline. This will be covered in the surprising behavior section below.

Although more primary, secondary and tertiary measures of effect could be evaluated a general picture is beginning to emerge.

- COA1 with its focus on ethnographic retaliation, including extra-legal violence, performs worse than any other COA1. In fact, only in COA1 can ISIS's clandestine terror network transform into a full insurgency including conventional military attacks and seizure of territory.

- COA2 with a foreign intervention provides a mixed result. It provides higher legitimacy than the baseline, while failing to significantly improve on the baseline results of reducing *Total Combatants* and *Total Terrorist Attacks.*
- COA3 performs best by reducing the *Detainees Released from Jail* which reduces *Total Combatants* and virtually eliminates *Terrorist Attacks.* The government is viewed just as favorably as in COA2.

In summary although the Indonesian vignette is merely a sketch of a scenario with rudimentary courses-of-action compared, it still demonstrates a variety of plausible behavior for a low-conflict environment such as a clandestine terrorist-network threat. It can reproduce system behaviors as anticipated – not every conflict ends up in an insurgency or emerging-state actor; some "simmer" for years with low-popularity terrorist actors continuing to plague security forces while failing to gain their own foothold. It demonstrates the validation of being able to propose system improvement tests, and provide insights based on those tests, which can be used to inform decision making and policy creation. Finally, even in this basic vignette E-SAM generated surprising behavior, as explained further below.

B-10.3 Surprising Behavior: Indonesia Vignette

Part of the Family Test is to show that E-SAM can be used within the same family on differing specifics. The generation of surprise behavior, which is a validation of the overall model – applies here as well. In this Vignette one notable surprise behavior occurred which is not observed in the *Baseline without Intervention* or *Baseline Historical* of the primary E-SAM model and is worth noting here.

1. The first surprising behavior was when COA2, a foreign intervention supporting Green, resulted in higher favorability of the government than COA3 which focused on delivering more credible governance through Green.
2. The second surprising behavior is when COA2, which focuses on improving counter terrorism effectiveness, failed to significantly lower terrorism versus COA3.

The first surprising behavior results from the interaction of three contributors to ethnographic perception formation. The *Net Perception of Violence, Net Instability, Net Propaganda Impact,* and *Institutional Procedures* impact. In Figure B-76 the *Net Perception of Violence* and *Net Instability Change* are compared for COA2 and COA3.

Selected Variables
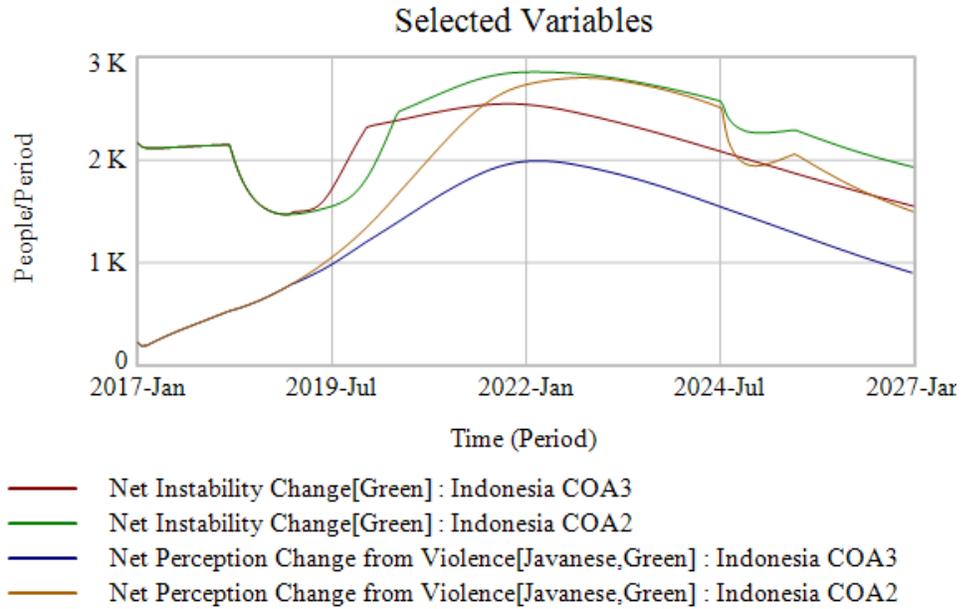
Figure B-76: Family Test Surprising Behavior - Net Instability Change

Net Perception Change from Violence is a factor of refugees from *War Crimes* committed by Green and refugees from *Terrorism* committed by Red plus the *KIA per Million Population.* Since these deaths are considered "the fault" of Green either for committing or not preventing, they have a multiplier. *Net Instability* is simply the overall *Conflict Deaths.* This clearly shows that COA3 with its more successful reduction in terrorism results in less ethnographic perception loss due to these factors of instability. But it's only a measured in terms of thousands since the violence level was not that high to begin with.

Likewise, in Figure B-77 *Net Propoganda Impact* is compared between COA2 and COA3.

Net Propoganda Impact[Javanese,Green]
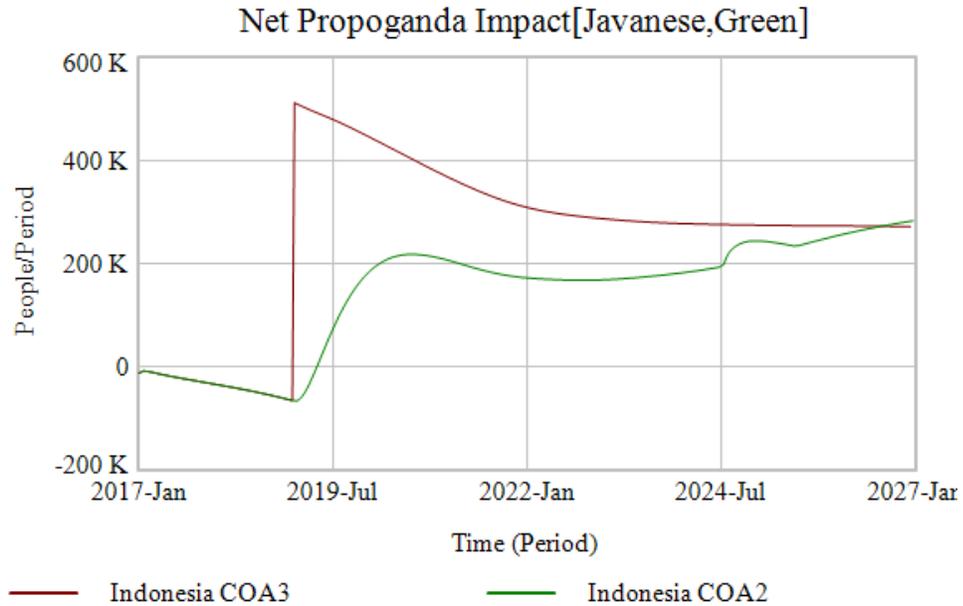
Figure B-77: Family Test Surprising Behavior - Net Propoganda Impact

Again, COA3 is performing better in *Net Propoganda Impact* to begin with though the benefit of this gradually declines. This is because Green *Total Combatants* are constantly reducing due to *Defections*, which affects the allocation of Green in Propoganda – while foreign intervention forces remain constant. This effect can be seen in Figure B-78.

Selected Variables

Blue or Purple Information Operations[Green] : Indonesia COA3
Blue or Purple Information Operations[Green] : Indonesia COA2
Propoganda Squads[Green] : Indonesia COA3
Propoganda Squads[Green] : Indonesia COA2
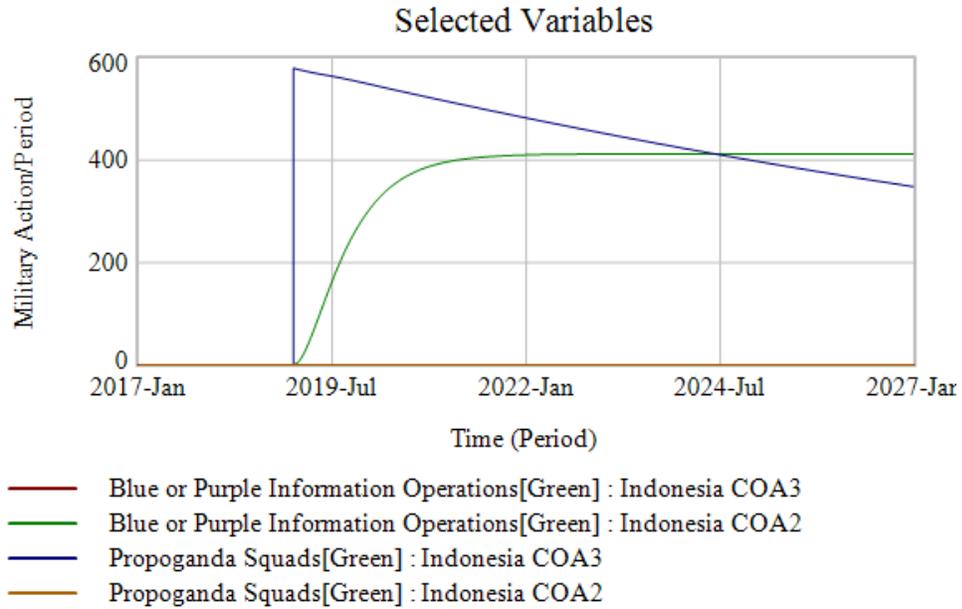
Figure B-78: Family Test Surprising Behavior Foreign IO & Green Propoganda Efforts

One benefit of foreign intervention is that the troops are less subject to local conditions of defections and thus may provide a more consistent basis of support.

But so far COA3 has generated slightly more positive *Ethnographic Perception* than COA2. So why does COA2 generate more legitimacy? It has to do with the credible number of *Institutional Procedures*, and specifically, the assignment of foreign troops to provide *Armed Civil Affairs.* These services provide a boost to credible government services where there might not otherwise be any. This provision of services is shown in Figure B-79.
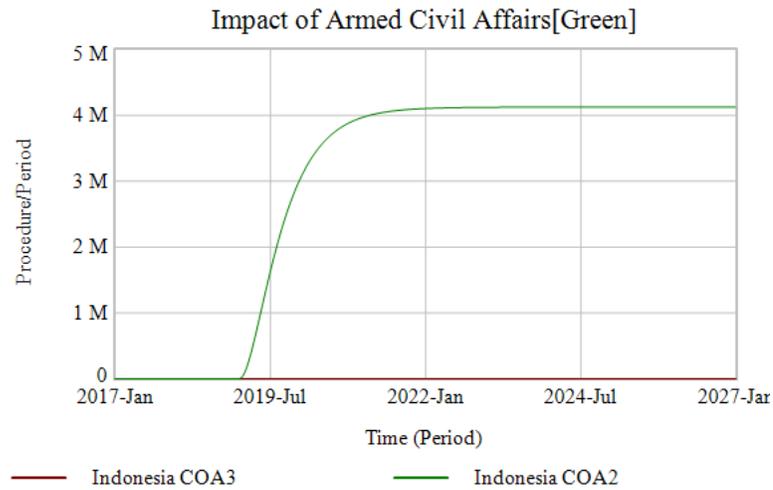
Figure B-79: Family Test Surprising Behavior Impact of Armed Civil Affairs

The benefit of these *Armed Civil Affairs* can be seen when looking at the Sundanese Ethnography *Institutional Procedures* in Figure B-80.
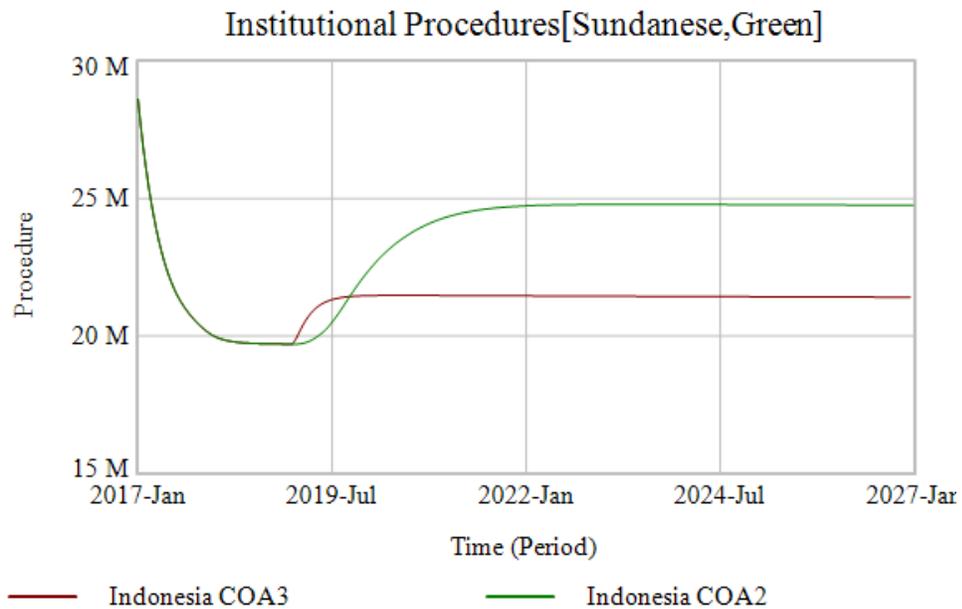
Figure B-80: Family Test Surprising Behavior Institutional Procedures

COA2 delivers nearly 3.5M more credible institutional procedural services, via the foreign troops providing civil affairs, than even the higher desire to provide governance in COA3. Whereas the violence and instability reductions experienced by COA3 only impact a few thousand people – these extra services help millions. It might

be different in an area of high conflict or instability. So, an important insight from this surprising behavior is that when violence is already low – provision of extra services may provide extra benefit because it will be realized by a larger percentage of the population.

The second surprising behavior of the Family Test is that COA2, despite providing foreign troops to increase the security effectiveness of Green's counter-terrorism forces, arises from the "Revolving Door" archetype (see Sector-by-Sector Overview B-3 for Prison Breaks and Prison Duty.)

COA2 provided additional training to counter-terrorism forces but left them at the same allocation as the baseline. COA3 not only increased that allocation by decreasing the use of conventional warfare, but also provided a higher priority to guarding prisons. This in effect cut the link of the "Revolving Door" archetype by ensuring that combatants once captured, remained in prison rather than breaking out to rejoin Red. The difference in this regard between COA2 and COA3 can be seen in the *Detainees Released* as shown in Figure B-81, which is zoomed in on the implementation time of the COA to more clearly show the difference.
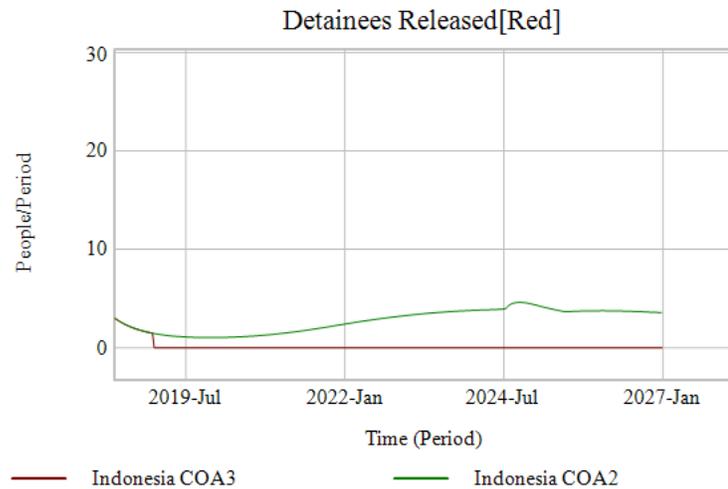
Figure B-81: Family Test Surprising Behavior Detainees Released

It doesn't look like much – indeed only handful of extra combatants per period. But the "Revolving Door Archetype" includes the positive feedback loop of the more *Total Combatants,* the more *Terrorist Attacks* and the more *Terrorist Attacks* the more *Foreign Combatants.* So that handful of combatants adds up when a few more successful *Terror Attacks* take place and draw in several hundred more recruits as seen in Figure B-82.

169
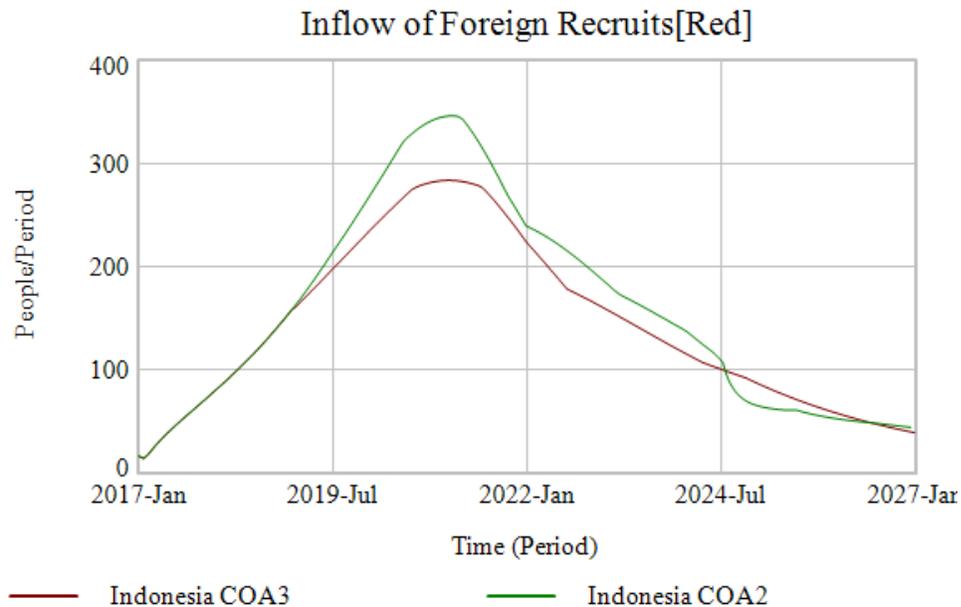
Figure B-82: Family Test Surprising Behavior Inflow of Foreign Recruits

This "Revolving Door" effect undermines COA2's increased security training at a critical juncture.

B-11 Surprise Behavior

Over the course of model development many surprise behaviors have been identified. This is unsurprising given the limited amount of robust simulation modeling that had been performed on insurgencies and emerging-state actors prior. A selection of surprising behavior includes the following.

- During boundary tests on the Historical Baseline two tests were run excluding the local historical intervention and excluding the external intervention forces. When local forces were excluded in the *External Only* test the result was a surprising faster defeat of ISIS than even the Historical Baseline. This was shown to be plausible however when looking at average experience levels and the negative impact of recruiting untrained local forces would have on the overall force. (See C-1 for more information on this.)
- Increasingly large foreign interventions with overlapping combat efforts had diminishing returns on effectiveness. This is plausible because a single ISIS combatant can only be killed once

regardless of whether it is from airpower, an advanced armament supplied to their opponents or encountering coalition embedded combat advisers or foreign troops.[72]

- A test designed to pin ISIS on its outer-ethnographic envelope alongside enhancing legitimacy of Green failed to produce the expected result. Instead increasing the legitimacy of the State actor proved so successful it contained ISIS to its position.[73]

B-12 Sensitivity Analysis

Many of the parameters used in E-SAM will always be subject to high uncertainty due to subject matter. Non-state actors do not submit themselves to double-blind peer reviewed experimental studies while even state actors classify much of their information for security reasons. Each conflict contains unique local circumstances and unrepeatable sequences of events. General parameters may identify causal relationships, but the exact ratio of these relationships may never be known. Modeler judgement and expert insight must substitute when empirically observed data is not available.

This makes sensitivity analysis especially important to understand if values assigned to parameters are plausible. Sensitivity tests can also narrow down the field of potential parameters of interest to the true leverage points and thus help focus future research.

Traditionally sensitivity analysis covers numerical, behavioral and policy. Since the

purpose of E-SAM is to favor realism of causal relationships for research purposes and policy creation over point-behavior, numerical sensitivity (changes in magnitude) are not tested, and instead accepted to exist in the in the premise of E-SAM. However, behavioral sensitivity (changes in the shape of the behavior mode) and policy sensitivity ("effective" policies become ineffective or worse on parameter change) are examined because these could have large ramifications. Research based on sensitive parameters inaccurately represented may lead to incorrect findings. While policies based on the same could lead to unintended harmful actions or wasted resources. In terms of future studies identifying the highly sensitive parameters can provide guidance to future efforts to more precisely quantify these in different times, regions or circumstances.

The method of sensitivity analysis conducted was to identify thirty-six Starting Conditions, Constants and Time Delays. Each parameter was then examined individually for sensitivity in the following manner.

1. E-SAM is set with starting conditions and all OpOrders follow the Historical Baseline run which incorporates historic interventions and replicates historical behavior.

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[72] Clancy, "Containing ISIS : Analysis of Intervention Policies."
[73] Clancy.

2. Saved parameters to compare for sensitivity were selected from Primary Measures of Effect: *Territory Controlled[Red], Total Combatants[Red], and Total Population Controlled by Actor[Red.]*
3. Control parameters were selected to be tested individually, often by subscript.
4. A minimum and maximum value of the parameter was established.
5. Modify control parameter using Vensim sensitivity control modified across 200 runs with Latin Hypercube sampling along a normal random distribution (Noise Seed 1234).
6. Results were graphed using sensitivity strips in Vensim with bands at 50%, 75%, 95% and 100% of the runs. These graphs were then manually inspected and categorized as follows:
   a. Negligible Sensitivity: Zero to very little behavior pattern change across any band.
   b. Minimum Sensitivity: behavior pattern changes observed only in the 100% band range.
   c. Moderate Sensitivity: behavior pattern changes observed only in the 95% and 100% bands.
   d. Significant Sensitivity: behavior pattern changes observed in the 75% and above bands.
   e. High Sensitivity: behavior pattern changes observed in the 50% and above bands.

These ratings were assigned to both Behavioral and Policy sensitivity. Behavioral sensitivity focused on the inflection points, timing and magnitude of behavior compared to the Historical Baseline.

Policy sensitivity focused on fundamental changes of the shape of behavior that diverged from the Historical Baseline or even resulted in behavior that exceeded the counterfactual Historical Without Baseline behavior. Considering the runs were conducted with intervention, then a variable wherein changes resulted in behavior by Red that exceeded even the case without intervention is of very high importance.

In each section below a summary table provides an overview of all parameters tested and the results. Then specific discussion follows on sensitive parameters and possible implications from a policy perspective. First tested are starting conditions, a summary of the results can be found in Table B-5.

B-12.1 Starting Conditions Sensitivity

Table B-5: Starting Conditions Sensitivity Test Results Overview

Starting Condition	Units	Normal	Minimum Value	Maximum Value	Behavior Sensitivity	Policy Sensitivity
Starting Ethnographic Generational Perception[Arab Sunni, Green]	People	5,000,000	10,000,000	15,000,000	High	High

B-12 Sensitivity Analysis

Starting Combatants[Red]	People	1,500	750	2,250	High	Moderate
Starting Ethnographic Generational Perception[Arab Shia, Green]	People	30,000,000	15,000,000	45,000,000	High	Moderate
Starting WorldWide Population of Recruitable Actors[Red]	People	500,000	25,000	75,000	High	Minimal
Starting Actor Security Effectiveness[Green]	Dmnl	0.5	0.25	0.75	High	Minimal
Starting Detainees by Actor [Red]	People	1,500	750	2,250	High	Minimal
Starting Ethnographic Generational Perception [Arab Sunni, Red]	People	-	(2,500,000)	2,500,000	Significant	Minimal
Starting Ethnographic Generational Perception [Arab Shia, Red]	People	-	(2,500,000)	2,500,000	Minimal	Minimal

Although the pool of *Starting Combatants, Starting WorldWide Population of Recruitable Actors* and *Starting Detainees by Actor* all showed a high degree of behavioral sensitivity, this is unsurprising. All of these relate in one way or another to obtaining more combatants for Red earlier in the conflict, and thus can be expected to create sensitivity in the outcomes. However, none of these resulted in outcomes that showed meaningful Policy Sensitivity except for *Starting Combatants* and that only for a handful of runs at the upper values.

The most interesting sensitivity results are starting *Ethnographic Generational Perceptions* to the various actors. Each Actor has a supporting or opposed ethnographic group – one which naturally favors them and one that dislikes them. In the *Baseline Historical* the Red actor enjoys more support, and thus higher starting perception, from *Arab Sunni* while the Green actor is supported by *Arab Shia.* Likewise, the Green actor is more opposed to *Arab Sunni* and Red Actor opposed to *Arab Shia.*

The sensitivity of *Ethnographic Generational Perceptions* varies based on this ethnographic relationship, whether they are supporting or opposed, and to which actor. The overview of these results is depicted in Table B-6 that matches Actors with their Supported or Opposing Ethnographic groups and the sensitivity results.

Table B-6: Ethnographic to Actor Relationship Matrix for Generational Perception Sensitivity

Actor	Supported By	Opposed To
Green	*Arab Shia*	*Arab Sunni*

B-12 Sensitivity Analysis

	High Behavioral Sensitivity Moderate Policy Sensitivity	High Behavioral Sensitivity High Policy Sensitivity
Red	*Arab Sunni* Significant Behavioral Sensitivity Minimal Policy Sensitivity	*Arab Shia* Minimal Behavioral Sensitivity Minimal Policy Sensitivity

This overview implies from a policy space that the starting ethnographic perceptions matter more in relation to the Green Actor, than to the Red. And furthermore, that it is the ethnographic perception of the group opposing the Green Actor that matters the most.

This can be demonstrated by comparing the sensitivity graphs of *Ethnographic Generational Perception [Arab Shia, Green]* and *[Arab Sunni, Green]* side by side below over the primary measures of effectiveness *Total Combatants[Red]* and *Total Population by Actor[Red]* in Figure B-83.

B-12 Sensitivity Analysis
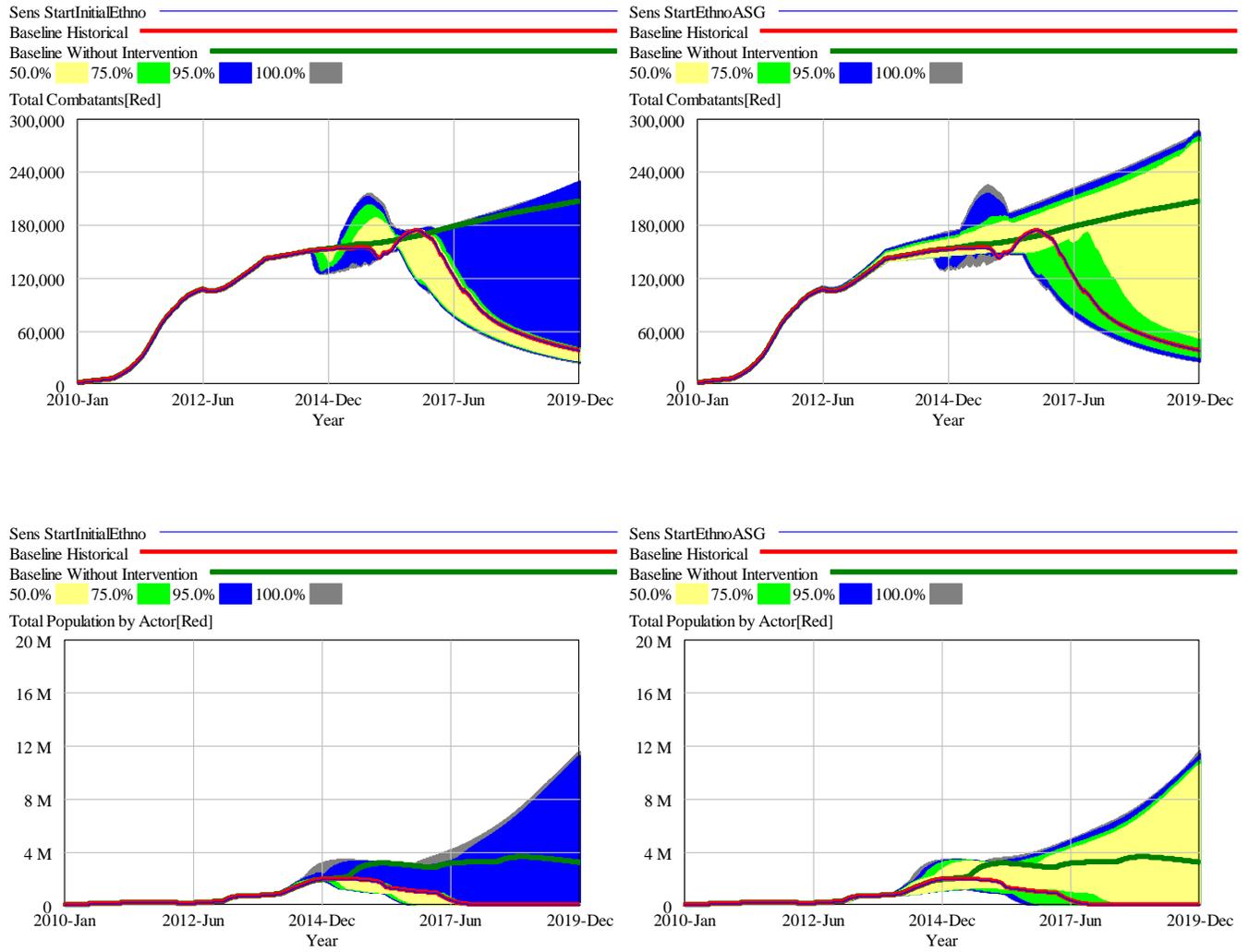
Figure B-83: Sensitivity Analysis Starting Ethnographic Generational Perception

To more closely examine this dynamic 10 runs, rather than 200, across the policy space from 5m starting ethnographic perception to 15m at increments of 1m is constructed. These are listed ASG5m through ASG15m. Note that the Historical Baseline begins with a normal value of 10m.

First a chart depicting the 15 runs shows that, as would be expected, when the opposition ethnographic perception starts higher, it ends higher.

175
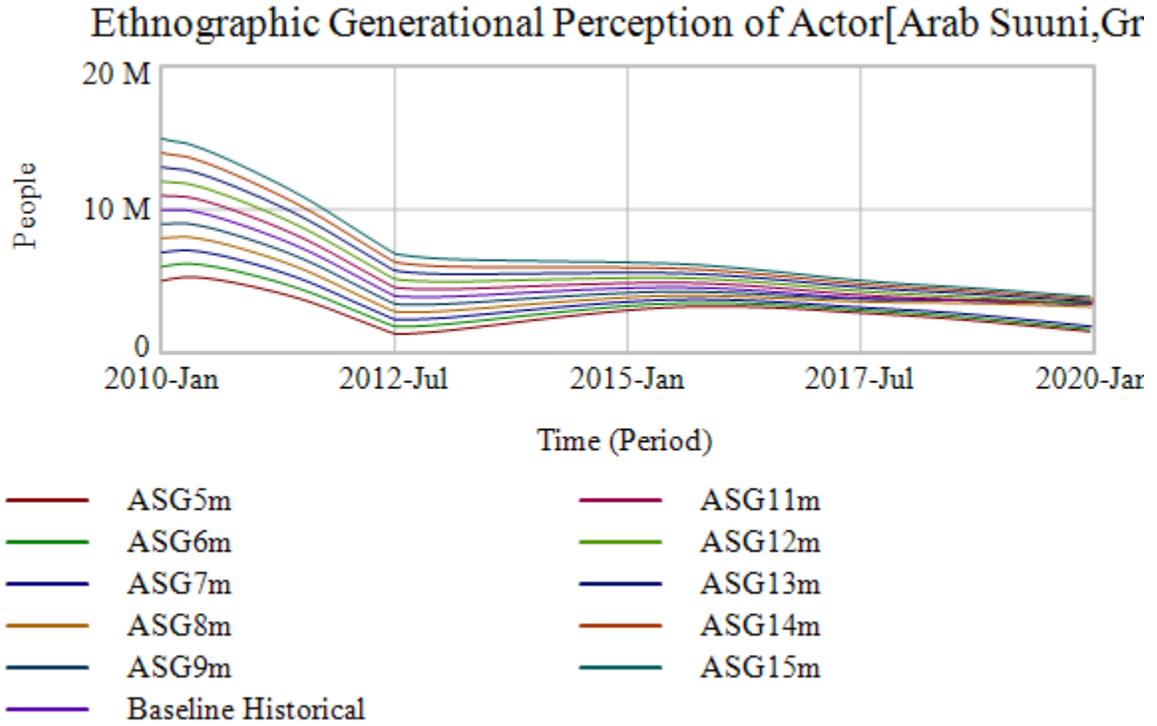
Figure B-84: Bifurcation Point in Ethnographic Generational Perception

However, the bifurcation of behavior around a hidden threshold becomes apparent when looking at *Total Combatants [Red]* as displayed in Figure B-85.

B-12 Sensitivity Analysis
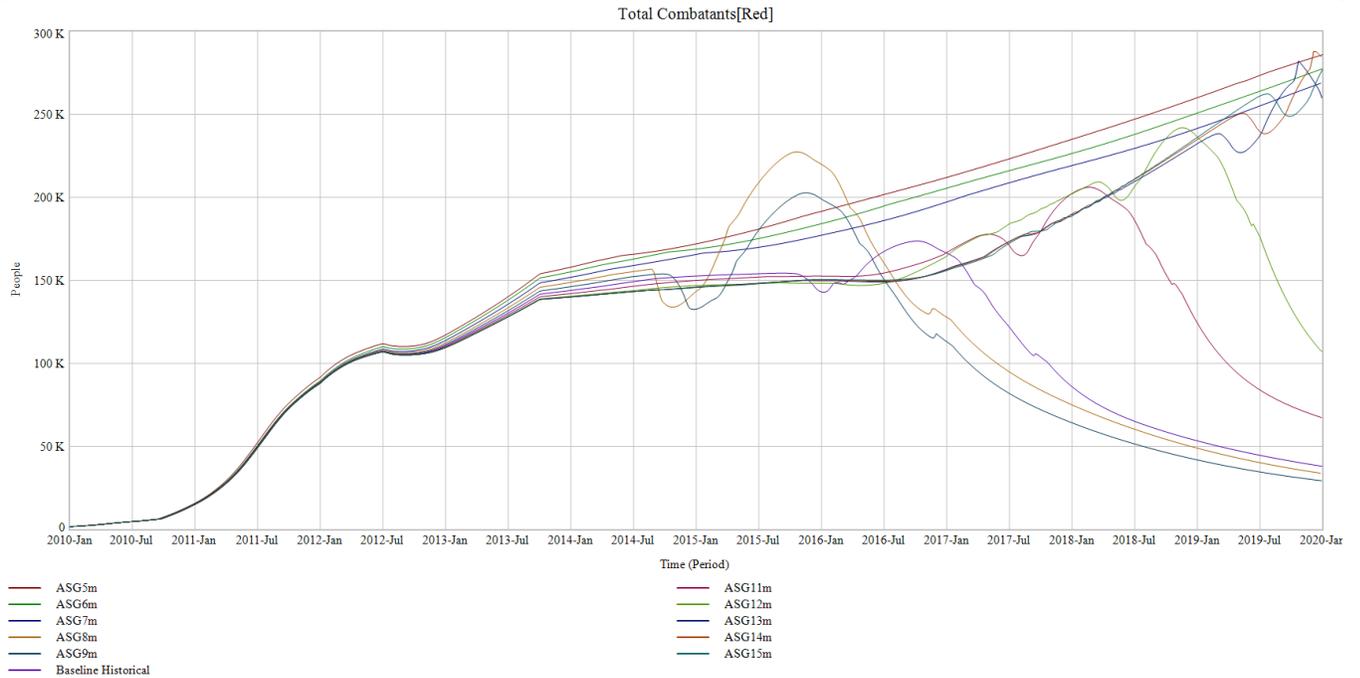
Figure B-85: Threshold Points of Starting Ethnographic Perception

The runs split between growth for the Red Actor and collapse. But they split along two threshold points the lower value of which is between 7m-8m starting ethnographic perception and the higher occurs between 11-12m starting ethnographic perception. This is more clearly seen in the numerical Table B-7 below of ending values for *Total Combatants[Red]*

Table B-7: Comparison of Total Combatants[Red]

Run	Total Combatants[Red] Ending Value
ASG5m	285,900
ASG6m	277,500
ASG7m	269,200
ASG8m	33,800
ASG9m	29,360
Baseline Historical (10m)	38,090
ASG11m	67,270
ASG12m	106,600
ASG13m	258,500
ASG14m	283,900
ASG15m	277,200

Note the first threshold point between ASG7m and ASG8m. This makes some sense – as the lower ethnographic support of ASG7m indicated Red Actor succeeded in mobilizing population grievances. The second threshold point between ASG11m and ASG12m is counterintuitive. Why would a very high starting ethnographic perception of an actor have a more-similar result to a much lower value than an in-between average?

This behavior, the second threshold, is caused because *Arab Sunni*, the opposing ethnographic group to the Green actor, has *too* favorable a position. As a result, less, military troops are required to garrison an unhappy population allowing Red Actor to expand more quickly when they begin. The *Actual Garrison[Green]* , displayed in Figure B-86, is much lower for ASG15m than for ASG7m. ASG7m is the highest run that demonstrates success for Red Actor before dipping into the failure-valley. Likewise, the *Total Combatants[Red]* at the same time in Figure B-87 is higher.
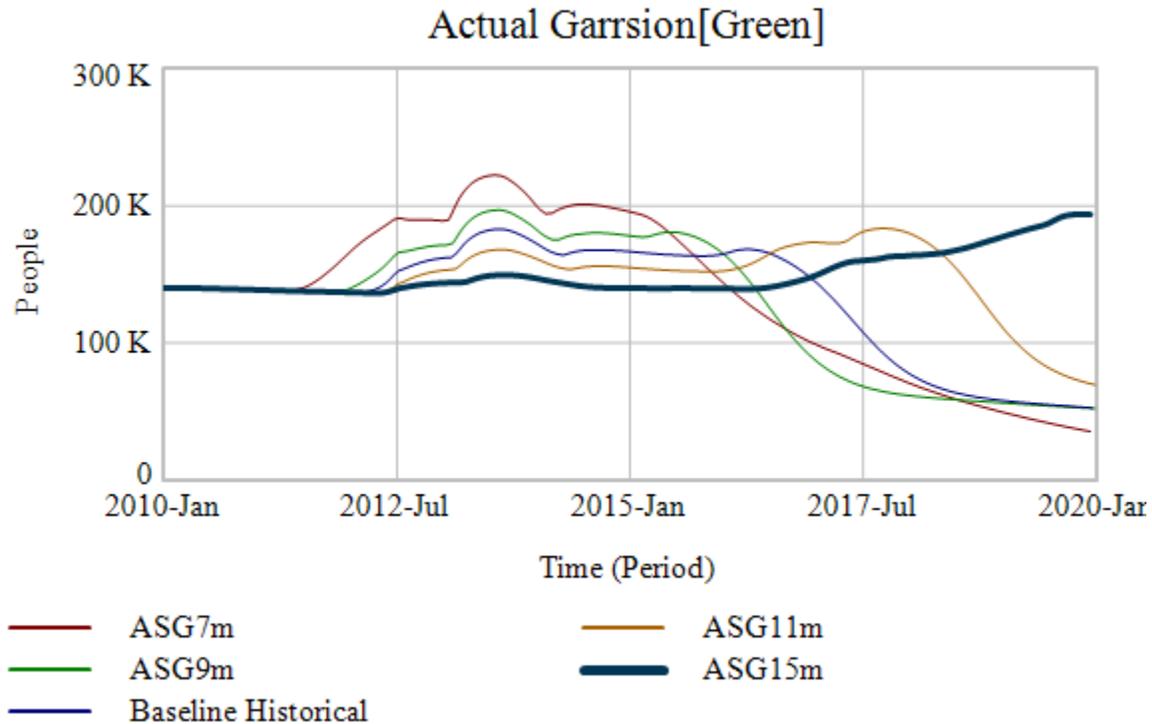
Figure B-86: Threshold Effects of Ethnographic Perception on Actual Garrison
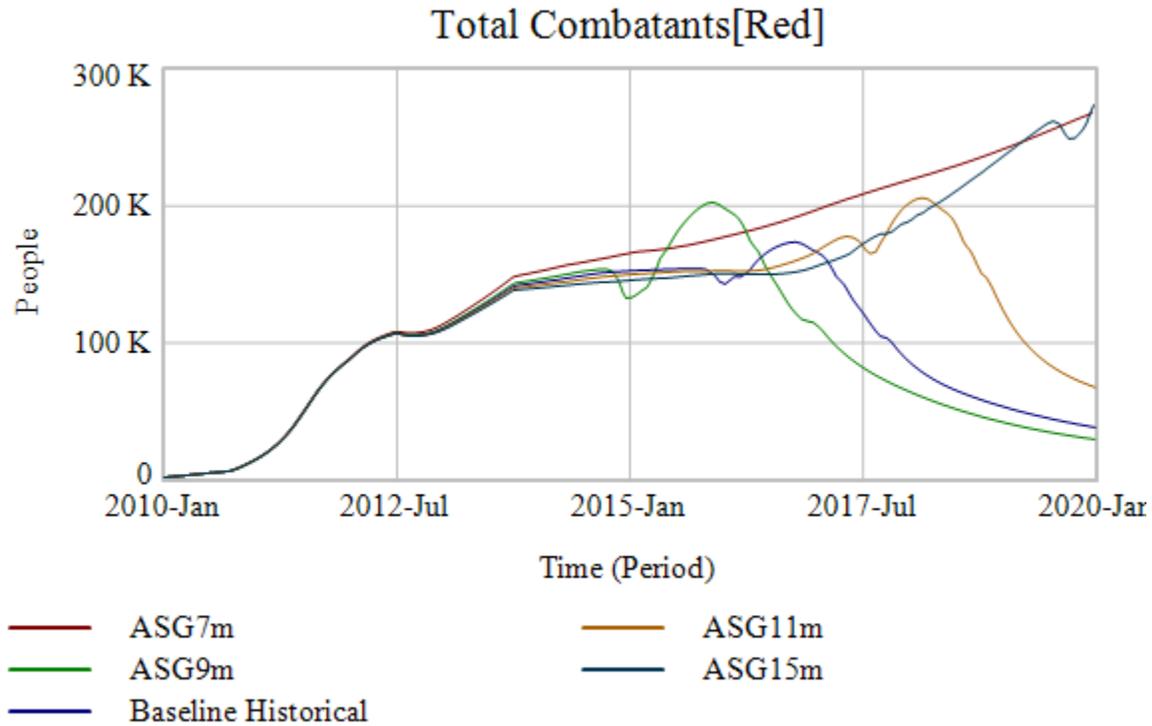
Figure B-87: Select Threshold Points of Starting Ethnographic Perception

At ASG7m despite having a higher garrison the higher grievances of the population for *Arab Sunni* results in more *Total Combatants[Red]* and Red can achieve a breakout.

ASG8m-ASG10m (Baseline Historical) however enter an 'ethnographic-valley'. Arab Sunni's grievances are supporting Red, but there is also a higher garrison and the tipping point is reached where the garrison is sufficiently large to slow Red's expansion. Containing it to the point where the later foreign intervention can reverse the gains. The exit of that valley however pushes further to the right at ASG11m and ASG15m. A relatively calm population, with comparatively low garrisons stationed there, do not have the defenses in place to as quickly halt Red's expansion.

It's important to note that this second threshold is not a point of ultimate failure for Green as the first threshold point is. Looking at *Territory Controlled by Actor[Red]* in Figure B-88 below, any run with an *Starting Ethnographic Generational Perception* at 8m or greater for *Arab Sunnis* ultimately prevail against Red.

179
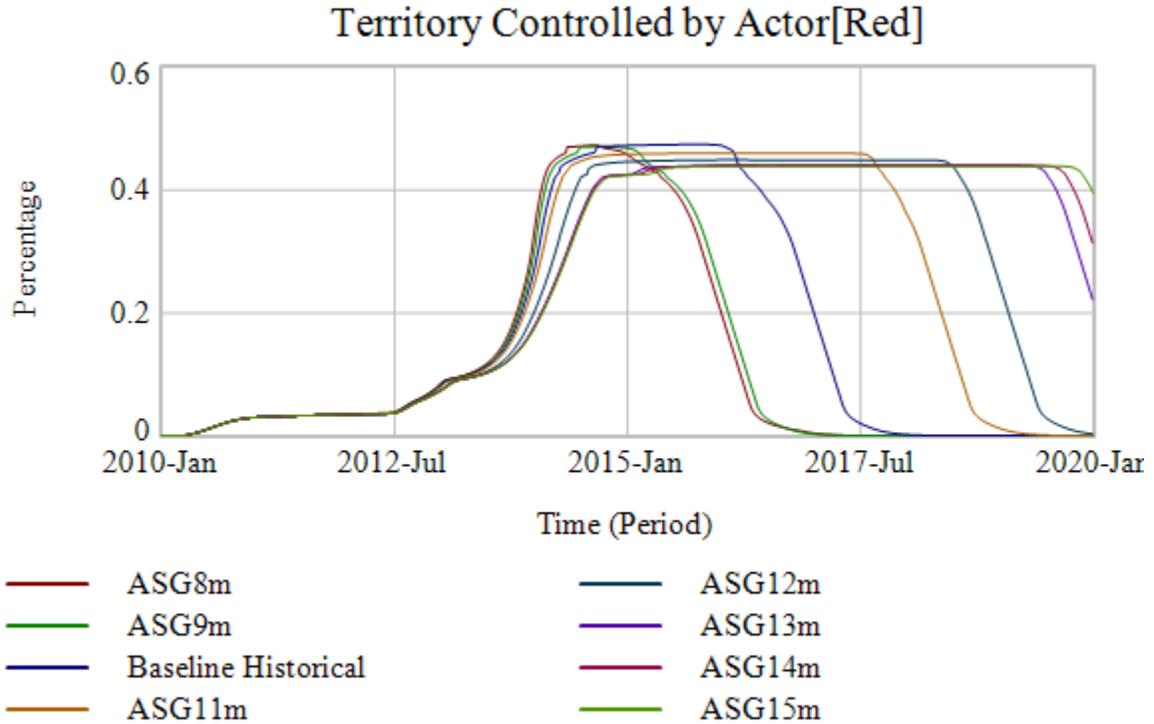
Figure B-88: Territory Controlled under Several Values of Starting Ethnographic Perception

What changes is how long it takes to recover from the initial

The policy take-away from this sensitivity analysis is nuanced. It requires understanding whether there is an ethnographic population structurally opposed to the state power and then secondly understanding how their current beliefs can aid or hinder Red progress. Very low support leads to a Red success, while medium support combined with an adequate garrison leads to Red defeat. However, higher support with an *inadequate* garrison may represent a false-sense of security that doesn't have the forces in place when Red attempts to break out.

B-12.2 Constants Sensitivity

Table B-8: Overview of Sensitivity Results for Select Constants

Constants	Units	Normal	Minimum Value	Maximum Value	Behavior Sensitivity	Policy Sensitivity
T3R [Red]	Pct	0.05	0.025	0.25	High	High
T3R [Green]	Pct	0.3	0.15	0.45	High	Significant

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B-12 Sensitivity Analysis

Normal Experience Gain [Red]	Exp Years	0.5	0.25	0.75	High	Minimal
Normal Experience Gain [Green]	Exp Years	0	0	0.5	High	Negligible
Deaths per War Crime [Arab Sunni, Green]	People/ Military Action	25	12.5	25	Significant	Minimal
Advanced Equipment Modifier[Green]	Pct	0.25	0.125	0.375	Minimal	Minimal
Deployment Time[Green]	Period	2	1	6	Minimal	Negligible
Normal Recruiting [Red]	People/ Military Action	10	5	15	Minimal	Negligible
Average Experience of Local Recruit [Green]	Exp Years	3	1.5	4.5	Negligible	Negligible
Average Experience of Local Recruit [Red]	Exp Years	3	1.5	4.5	Negligible	Negligible
Blue or Purple T3R [Green]	Pct	0.67	0.52	0.82	Negligible	Negligible
Deaths per War Crime [Arab Shia, Red]	People/ Military Action	25	12.5	25	Negligible	Negligible

The highest sensitivity in Actor Constants has to do with the T3R rating for both Green and Red. This logistic ratio is a percentage that reduces *Total Combatants* down to an actual fighting force separate from logistics, administration, headquarters and other non-combat functions.

The three charts below demonstrate the high degree of sensitivity for primary measures of effectiveness for Green when controlling T3R as shown in Figure B-89.

B-12 Sensitivity Analysis
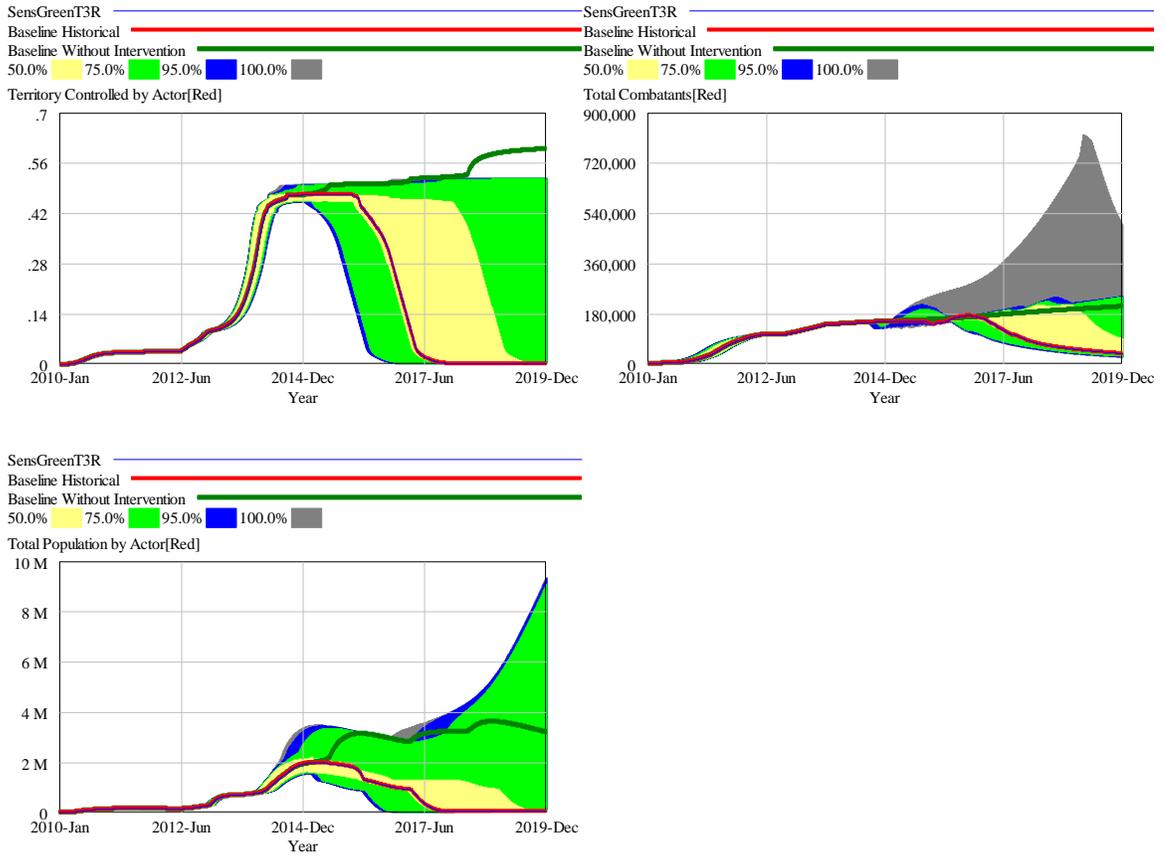
Figure B-89: Sensitivity Analysis of T3R[Green]

Likewise, sensitivity is very high when T3R is modified for Red Actor as shown in Figure B-90.

B-12 Sensitivity Analysis
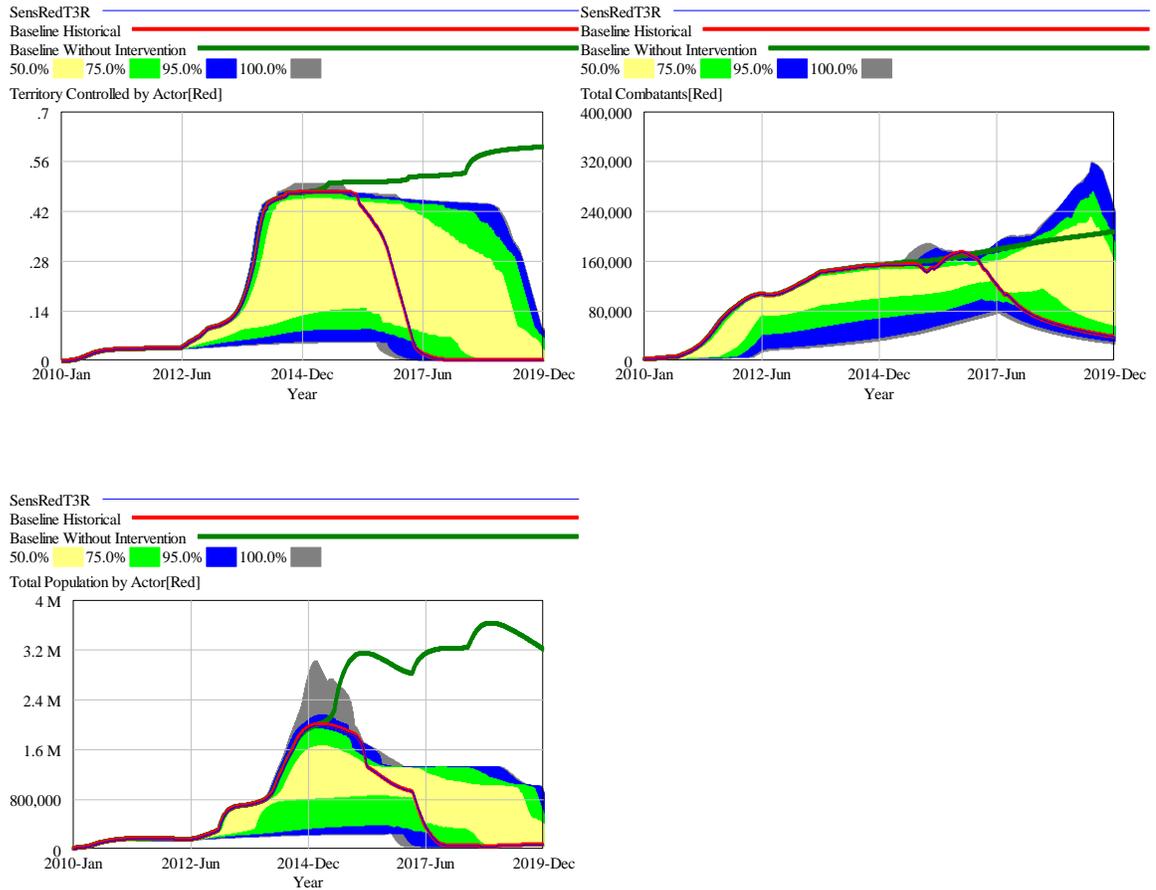
Figure B-90: Sensitivity Analysis T3R[Red]

What's occurring here is not just an absolute, but a relative measure between the T3R's of the competing actors. The closer the ratio between Green and Red is to 1:1, or equal T3R, the more *Total Combatants[Red]* there must be relative to Green. But the more lopsided a ratio, the more asymmetric Red becomes versus Green. Interestingly the T3R ratio of Blue Deployments in support of Green have far less sensitivity.

B-12 Sensitivity Analysis

This policy implications of this sensitivity to the local actor's T3R illustrates Kilcullen's Article #22 "Local forces should mirror the enemy, not ourselves."[74] It represents a potential "fixes that fail" system archetype shown below.
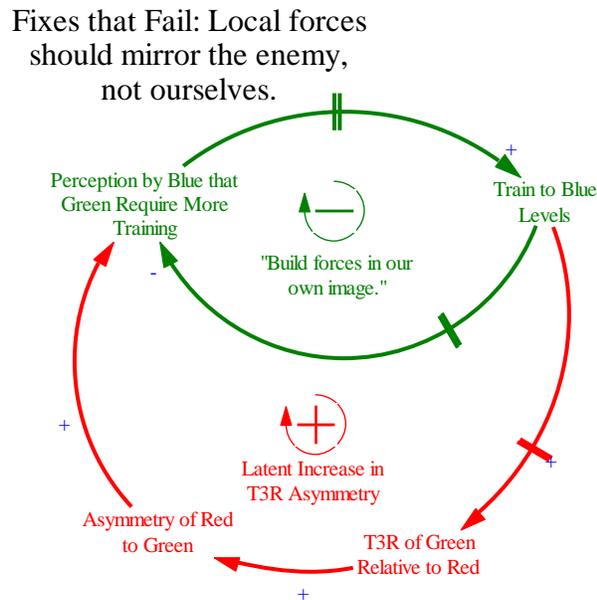
Figure B-91: Conflict Archetype Local Forces Should Mirror the Enemy Not Ourselves

The green balancing loop is the perception by Blue that the training level of Green is insufficient to halt Red. But the training goal is to make Green "look more like Blue." But this time-delayed fix activates a vicious cycle, the red reinforcing loop, with an even longer time delay. Training Green in the image of Blue results in an increase in Green's own T3R as the logistical, administrative, and headquarters operations begin to mimic Blue's. This increase in T3R of Green relative to Red, increases the asymmetry of Red relative to Green. The asymmetry can be thought of the ratio of every 100 *Total Combatants* that each Actor possess: how many are conducting actual military actions?

In the <u>Baseline Historical</u> for every 100 *Total Combatants* Red can use 95 of them to perform military actions. Green only can convert 70 of them into military actions. The resulting asymmetry is ~1.3:1 and, when combined with the unequal distribution of forces by Green relative to where Red is attacking, accounts for a large difference of the ability of Red to 'punch above its weight.' In the sensitivity analysis, the largest theoretical asymmetry is a ratio that occurs when Green is at the Maximum T3R of 45% and Red is at the Minimum of 2.5%.

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[74] Kilcullen, "Twenty-Eight Articles: Fundamentals of Company-Level Counterinsurgency," 8.

At this point the asymmetry in Military Actions per 100 Combatants will be ~1.77:1 in favor of Red. Although this doesn't seem like much of an increase, it is sufficient to cause Red's performance to exceed that of even the Baseline Without Intervention.

From a policy perspective this identifies two leverage points: minimizing the increase of asymmetry in T3R by following Kilcullen's 22nd Article. A second leverage point is introducing an increase in T3R burden into a Red actor. This isn't easy, as Red isn't being trained by Blue – and may be an inadvertent 2nd order effect of some other action. But efforts designed to increase the logistical burden of Red, taking *Total Combatants* away from military actions and into supporting T3R, can help shift the asymmetry more favorably to Green.

B-12.3 Time Delay Sensitivity Tests

An overview of the sensitivity test results for time delays in E-SAM can be seen in Table B-9.

Table B-9: Overview of Time Delay Sensitivity Test Results

Time Delays	Units	Normal	Minimum Value	Maximum Value	Behavior Sensitivity	Policy Sensitivity
Normal Time to Transition Population [Arab Sunni, Green]	Period	0.25	0.125	0.375	High	High
Normal Time to form Current Perception	Period	0.5	0.25	4	High	High
Normal Period	Period	1	0.33	4	High	High
Normal Time for Generational Perception to Form	Period	10	5	15	High	Significant
Normal Time to Transition Population [Arab Sunni, Red]	Period	0.25	0.125	4	High	Minimal
Normal Procedural Decay Fraction[Green]	Period	5	2.5	10	Significant	Negligible
Normal Procedural Development Time[Green]	Period	2	1	4	Significant	Negligible
Deployment Time	Period	1.5	0.5	6	Minimal	Negligible
Average Time to Absorb Training[Green]	Period	2	1	4	Minimal	Negligible

B-12 Sensitivity Analysis

Normal Procedural Development Time[Red]	Period	2	1	4	Minimal	Negligible
Time to Form Perception on Foreign Troops[Arab Sunni]	Period	0.5	1	1.5	Minimal	Negligible
Time to Form Perception on Foreign Troops[Arab Shia]	Period	0.5	1	4	Minimal	Negligible
Average Time for Anchor Security Effectiveness to Change[Green]	Period	5	10	15	Negligible	Negligible
Normal Time to Transition Population [Arab Shia, Green]	Period	0.25	0.125	0.375	Negligible	Negligible
Normal Time to Transition Population [Arab Shia, Red]		0.25	0.125	0.375	Negligible	Negligible
Normal Time for Unaligned to Choose Sides	Period	10	5	15	Negligible	Negligible
Organic Procedural Development Time[Red]	Period	0.25	0.125	4	Negligible	Negligible

For most adjustments to Time Delay parameters the results are either a high degree of behavioral sensitivity, with no policy sensitivity, or negligible amounts of both. The overall shape of the behavior remains consistent, but the timing points of inflection, the specific magnitude and ending levels vary. This can represent an ambiguity in the knowledge about time delay affects that aren't well studied. It may also be an area of modeler choice in adjusting these time delays to reflect different circumstances. Historical conflicts, or those in areas of low technological access might have longer time delays in perception formation because of how information travels more slowly. It may also reflect another kind of perception formulation difference where elites may still have access to more recent information, but the general population simply doesn't have much more than word of mouth. In recreating historical scenarios adjusting these time delays can be used to represent such historical or circumstance specific conditions.

B-12 Sensitivity Analysis

Side-Choosing

Aside from this general observation there is a specific category of sensitive parameters which are the three time delays that deal with ethnographic perception and transitioning of legitimacy between the two actors. *Normal Time for Generational Perception to Form*, *Normal time for Current Perception to Form* and *Normal Time to Transition Population* fall in this category. Taken together these three parameters are the cumulative time-delays of an information-flow that drives ethnographic side-choosing between the Green and Red Actor. However, the sensitivity does not hold true across all ethnographic groups. Table B-10, like Table B-6 previously, maps the supporting and opposing ethnographic support to show how these relationships relate to sensitivity.

Table B-10: Ethnographic to Actor Relationship Matrix for Ethnographic Side-Choosing

Actor // Ethnographic Stance	Supported By	Opposed To
Green	*Arab Shia* Negligible Behavioral Sensitivity Negligible Policy Sensitivity	*Arab Sunni* High Behavioral Sensitivity High Policy Sensitivity
Red	*Arab Sunni* High behavioral sensitivity Minimal policy sensitivity	*Arab Shia* Negligible Behavioral Sensitivity Negligible Policy Sensitivity

The nature of the relationship between ethnographic group and actor as it relates to side-choosing plays a large role. Only Arab Sunnis, who oppose and are opposed by the Green Actor and are favored by the Red Actor demonstrate this side-choosing time specific sensitivity. Arab Shia, when subjected to the same sensitivity on both Green and Red Actors shows negligible sensitivity.

This behavior is intuitively plausible. In the Baseline Historical scenario, it is the Arab Sunni that Green targets for reduction in services and extra-legal violence that provokes the conditions of instability. From a Green perspective the information-flow the total time it takes the ethnographic group to perceive this mistreatment, adjusting both current and long-term perceptions, then act on transitioning from *Governed,* to *Calculated Legitimacy* and then finally to a *Coerced* state as they exit the sphere of influence of the state government. Along the way revenues and recruiting for Green will drop while the *Total Garrison Required* will rise, and if Green cannot meet that number *Local Opposition Fighters* will begin appearing. It is from these amorphous *Local Opposition Fighters* that Red gains some of its first recruits. And it is from the *Unaligned* population that side-choosing begins as local networks select Red over Green as being more aligned with their interests. From the Red perspective it is the speed with which Arab Sunni switch sides and grant legitimacy to Red as an alternative government that fuels many dynamics in the model such as recruiting, taxation and garrisoning levels.

B-12 Sensitivity Analysis

Among the three parameters *Normal Time to Form Current Perception* has the most sensitivity, followed by *Normal time to Form Long Term Perception* and *Normal Time to Transition Population[Green]* with *Normal Time to Transition Population[Red]* creating the least sensitivity within this group. This is can be demonstrated by comparing sensitivity strips of *Total Combatants[Red]* across all three parameters in Figure B-92.
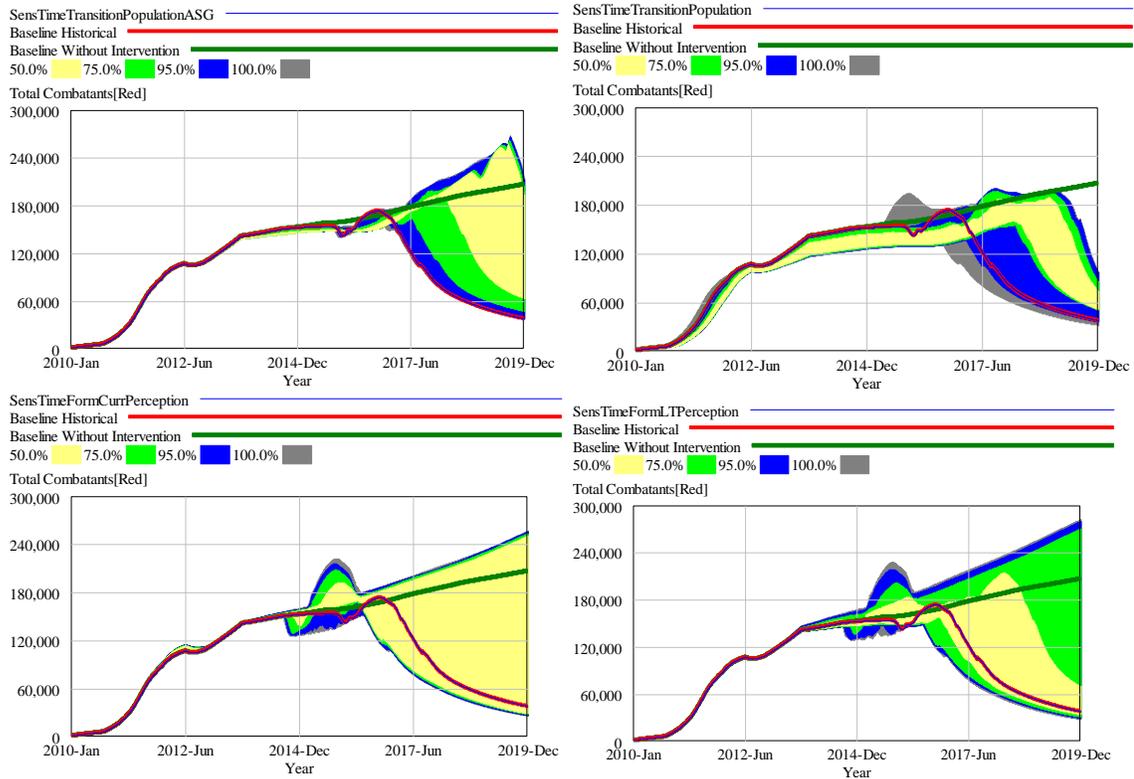
Figure B-92: Sensitivity Analysis of Total Combatants across Select Time Delays

In summary the sensitivity analysis served two purposes. It identified those parameters that could benefit from additional rigor in parameterization that may suggest future research opportunities. The second purpose was to identify areas of policy leverage that might not be immediately apparent. This most important aspect involves the side-choosing dynamics of ethnographic groups in relation to Green and Red. These side-choosing dynamics require a sophisticated understanding of an ethnography's relationship with an actor (supporting or opposing) and how that relationship shapes simulation results. Side-choosing policies have implications not only for how to react to a conflict, but in shaping the conflict as well ahead of time and perhaps staving off a conflict in the first place. Another point of leverage is the logistical footprint, expressed in T3R ratios, of the Green Actor relative to Red.

Additional work still remains in creating multivariate sensitivity tests that could help understand E-SAM's behavior in different environments. Numerical statistical analysis would also help understanding the relative strength of sensitivity. These remain for future efforts.

B-13 System Improvement

System improvement is demonstrated when evidence can be collected and shown that an intervention proposed by a model resulted in the expected change. As the E-SAM has not yet been used in this manner – no such data can be collected and this remains an area for continued application and research. Such efforts should not just focus on whether the model behavior was realistic to the result of a policy – but also whether users increased their understanding before and after the use of E-SAM.

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Section C Draft user Manual Emerging-State Actor Model (E-SAM) Iteration 1.0 2/28/2018

C-1 Introduction

The Emerging-State Actor Model (E-SAM) enables policy makers, researchers and military operational planners to understand conflicts involving non-state actors. This includes insurgencies, terrorism, emerging-state actors as well as non-lethal conflicts such as propaganda. Policy makers can use E-SAM to educate themselves on the unanticipated consequences of policy choices. Researchers can instantiate specific iterations of E-SAM to a time and location to study a specific conflict, or more broadly study these conflicts in general. Military operational planners can instantiate a model for a specific theatre or region of interest and analyze courses of action, testing them against baseline scenarios and assess the merits prior to adopting, as well as using the tool to monitor ongoing conflicts.

E-SAM is a simulation that can run to cover up to a 20-year period of conflict between a state-actor government ("Green") and a non-state actor ("Red.") E-SAM can simulate the potential path of progression from initial assumptions, understand the impact of changing conditions or entrance of third party state-sponsors backing either side, or evaluate courses of action for intervention.

 E-SAM is a Systems Dynamics simulation designed primarily to support military operational planning and research into violence and instability. E-SAM is constructed to evaluate and understand medium-to-long term effects (several years to decades) of choices made by state and non-state actors. Within one structure E-SAM integrates territorial data of the region of interest, ethnographic demographics and perception to actors including reaction to grievances, the actors themselves (including governance, financial performance, military activities).

The E-SAM has been designed to support operational planning and research around policy design, testing and monitoring in conflict zones. E-SAM can be used individually or in a game context by multiple users each taking the role of an actor (to educate and inform stakeholders) or run by AI players competing against one another. In any of these configurations E-SAM can be used to test national strategies, forecast the impact on current and future operations of new intelligence, validate existing counter-insurgency theories and uncover new insights into how to conduct conflict in these arenas. Exercises in any of these often involve creating a baseline scenario where performance can be modeled absent significant change. Then intervention portfolios, enemy strategies, and changes in the environment can be simulated along-side the baseline. Significant gaps between strategic goals and simulation results indicate potential changes required in allocations as well as possibly adding or removing intervention options.

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This section proposes a DRAFT user-manual that is focused to a user of E-SAM who is not in the field of system dynamics or a research scientist. It provides clearer descriptions of the use of Operational Orders as they are aligned to military doctrine and contains a glossary.

C-1.1 Structure of this Section

C-2 Emerging State Actor Simulator Overview

C-3 Running the Simulation

C-4 Green/Red Operation Orders

C-5 Foreign Actor Operation Orders

C-6 Starting Conditions

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C-2 Emerging State Actor Simulator Overview

The Emerging-State Actor (ESA) Simulator is designed to be used by both human and computer operational planners to evaluate the dynamics and potential progress of unconventional conflict, test different policies, and evaluate courses of action to select paths forward.

C-2.1 Local Actors

The Simulator models the development of conflict between two actors: Green and Red. Green represents the status-quo government, ostensibly allied with the United States. Red is the local competing actor – be it a guerilla group, insurgency or emerging-state actor.   However, Green is simply the designation of the state actor, and Red the non-state actor – in a scenario.

Nearly any form of less-than-full-spectrum conflict can be modeled using the simulator. The Red Actor may represent terrorist networks operating clandestinely with little or no support of the population. To guerilla movements or insurgencies that have conventional military forces but can't control the territory sovereignly or seek to govern openly. To emerging-state actors who openly seize, and govern as a sovereign, territory. Although these can be influenced by the Theatre Strategy settings (see below) in some cases the Red Actor may endogenously move through these different states. Likewise, the Green actor responses can wildly vary from a counter-terrorism centric approach, population centric, political (address ethnographic grievances) to conventional warfare against the Red Actor.

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C-2.2 Ethnographies

The model can depict any number of different Ethnographies that the Green and Red actor are influencing and being influenced by. These ethnographic populations drive many important dynamics as they select which side, Green or Red, they will support and to what extent. An ethnographic population may be split between three states of support with any Actor, and their support may cross different actors:

- Governed is a state where the population views the Actor as the legitimate government.
- Calculated is a state where the population views the Actor as the "best-choice" government for now but is open to switching.
- Coerced is a state where that population would switch sides or leave the government but is prevented by force of arms from doing so.
- Unaligned is a state where the population supports no Actor currently and evaluates the two Actors on where they appear to be heading in terms of support for the Ethnography.

Additionally, under certain conditions members of an Ethnographic population will rise as local-opposition fighters within the Actor. They may not formally be aligned with Green or Red but represent additional indigenous sources of conflict.

C-2.3 Foreign Actors

External state-sponsored support to the Green or Red actor is depicted by Blue or Purple actors. Blue actors support through intervention with accompanying training, equipment provision, combat training etc. the Green actor, while Purple supports the Red actor.

C-3 Running the Simulation

Every simulation is played by one or more "planners", which may be human participant or a machine learning algorithm. These planners then compete against one another, or against the simulation itself. Note that the simulation in this context is **_not_** a learning environment, it creates dynamic conditions upon which a machine learning algorithm can learn.

The progress of simulation activities in each game is the same, regardless of who is portraying a planner.

C-3.1 Selecting Theater Strategies

First, each planner reviews available Theater Strategies and picks one for their side. A Theater Strategy represents parameter values for numerous starting conditions for either Actor, the Ethnographies, the Territories they are conflicting over or the limitations of external help from Blue or Purple.

Technically, the selection of each Theater Strategy identifies a Scenario file in the database to pull and merge into one unified "scenario" which is then loaded. This unified scenario determines the boundaries of the model, geospatial data of troops, resources, ethnographic population and perceptions and other simulation data. If deterministic strategies are needed, for example what path the Red Actor will seek to conquer cities, this is loaded in as well.

For both actors the Theater Strategies represent decision making by leaders dictating the constraints within which they can create a campaign plan. For the Red Actor this might be fatwa's, the beliefs or grand strategies of key leaders or tribal realities. For the Blue Actor this represents national security objectives, policy constraints, SOFA agreements etc. Once selected each Theater Strategy is fixed for the length of the game. This means there is a bit of game-theory between each planner when picking a Theater Strategy to determine what the other side is picking. However, picking the 'wrong' Theater Strategy versus an opponent selection doesn't guarantee a loss, it just makes the operational campaign much harder.

C-3.2 Operational Orders

The bulk of the game is played within the simulation as each planner issues operation orders (OPORDs) at regular intervals within the game. These are issued every six months. Because the perspective is operational, the focus is on orders at the campaign plan level and not the tactical. These are choices of allocations of available resources to various tasks. For example, the Red Actor may allocate 20% of their personnel to Recruiting and 5% to Propaganda, but there is no tactical decision making in how recruiting and propaganda are conducted. Constants can be set to mimic general effectiveness of the known tactics of the Actor, but this is part of Theatre Strategy selection and not something the player will be able to modify.

The Operational Orders available to Green and Red Actor are:

Table C-1: Local Actor Operational Order Overview

Local Actor Operational Orders	Description
AFV/IFV Purchases	Per Period Purchase Rate of Armored or Improvised Fighting Vehicles
Artillery Purchases	Per Period Purchase Rate of Artillery Pieces

OpOrder Armed Civil Affairs	Pct of Military Actions allocated to Armed Civil Affairs. This creates government capacity via military force.
OpOrder Combatting Terrorism	Pct of Military Actions allocated to Combatting Terrorism (AT & CT) activities. CT effectiveness is useful for exposing and thwarting Terrorism and Prison Breaks (though Prison Breaks also require Prison Duty.)
OpOrder Conventional Warfare	Pct of Military Actions allocated to Conventional Warfare - either capturing or reclaiming Territory.
OpOrder Indirect IED VBIED or SVIED	Pct of Military Actions allocated to Indirect attacks using IED - these attacks influence conventional combat and are not targeting the civilian population (see Terrorism.)
OpOrder Prison Breaks	Pct of Military Actions allocated to attempting to break Actor Detainees out of Prison.
OpOrder Prison Duty	Pct of Military Actions allocated to attempting to prevent Prison Breaks.
OpOrder Propaganda	Pct of Military Actions allocated to Propaganda efforts.
OpOrder Recruiting	Pct of Military Actions allocated to Recruiting, by Ethnography.
OpOrder Terrorism	Pct of Military Actions allocated to conducting terrorism, of all forms, against a civilian population by Ethnography.
OpOrder War Crimes	Pct of Military Actions allocated to War Crimes, by Ethnography. War Crimes are ethnic cleansing, massacres, forced eviction etc.

Table C-2: Foreign Actor Operational Orders Overview

Foreign Actor Operational Orders	Description
Blue or Purple Airpower Targeting Combatants	Pct of state-sponsor airpower sorties per day that are used in close-combat supports to attack conventional fighters of the opponent.
Blue or Purple Airpower Targeting Government Capacity	Pct of state-sponsor airpower sorties per day that target the opponents governing capacity.
Blue or Purple Airpower Targeting Resources	Pct of state-sponsor airpower sorties per day that target resources and resource production.
Blue or Purple OpOrder Advanced Equipment Provision	Pct of state-sponsor military actions allocated to the provision and training of advanced equipment use by front-line conventional troops.
Blue or Purple OpOrder Airpower	Pct of state-sponsor military actions allocated to sustaining airpower operations. The number of troops sustaining airpower determine the number of sorties per day available.
Blue or Purple OpOrder Armed Civil Affairs	Pct of state-sponsor military actions allocated to increasing government capacity through military units.
Blue or Purple OpOrder Embedded Combat Advisers	Pct of state-sponsor military actions allocated to embedding troops into local actor units as combat advisers. This will risk these troops to death or detention.
Blue or Purple OpOrder Information Operations	Pct of state-sponsor military actions engaging in Information Operations, which functions similarly to Propaganda.
Blue or Purple OpOrder Training Local Actor	Pct of state-sponsor military actions allocated to training local actor in security issues, this improves CT effectiveness.
Intervention Size	The number of people that Blue/Purple desire to have in Theatre supporting the Green or Red Actors respectively.

C-3.3 Scoring & Victory Conditions

Scoring for both sides is based on the allocation of ethnographic populations within the three possible perceptions to an Actor:

1. That the population supports them only when coercively forced to do so.
2. That a population supports them from the standpoint of calculated-legitimacy.
3. Or the population supports them as fully legitimate.

Each "person" in one of these perceptions is a weighted score for the Actor. And the total score determines victory based on the victory conditions of the Theater Strategy. This allows complex victory conditions such as a "victory" for the Red Actor, even if they are defeated militarily, if their Theater Strategy was to create a Failed State in the operational area.

C-3.4 Primary Measures of Effectiveness

In addition to scoring and victory conditions the following primary measures of effectiveness can be tracked.

Table C-3: Sample Primary Measures of Effect

Sample Primary Measures of Effect	Description
Actor Combatants that are Local	The percentage of combatants within an actor who are locally recruited vs. the total which includes foreign fighters and Blue/Purple support.
Actual Garrison	The actual number of allocated military personnel assigned to garrison and/or policing duty from the Actor.
Civilian Deaths	All civilian deaths in total, can be segmented by Ethnography.
Finances	The cash reserves, by Actor. A high surplus indicates available funds to send abroad to sponsor foreign actions by the Actor.
Foreign Combatants	The number of foreign fighters who have traveled to the theatre and joined Green or Red side.
Local Opposition Fighters to Actor	The unaligned or loosely organized local combatants who oppose the Actor, but are not formally part of Green or Red.
Territory Controlled by Actor	The percentage of the overall territory that an Emerging-State Actor has seized control of.
Total Combatants	The total number of combatants or combatants within an Actor.
Total Conflict Deaths	The aggregate number of Green, Red, Blue, Purple combatant deaths, deaths of the local opposition and civilian deaths.
Total Ethno by Actor	The total number of ethnographic civilian population who are in the Green or Red Control.
Total Garrison Needed	The number of combatants who are required to adequately garrison & police the population. Garrisoning at less than this amount will result in the rise of Local Opposition Actors.
Total Population by Actor	The total number of civilian population, across all ethnographies, who are in the Green or Red control.
Total Refugees all Ethnicities	The total number of refugees, either IDP or having exited the country, that have been produced across all ethnographies over the course of the conflict.
Total Terrorist Attacks	The total number of Terrorist attacks by an Actor, regardless of Ethnography targeted or success of an attack.
View Actor as Best Choice for Now	The population wide view of an Actor, across all ethnographies. Represents the percentage of the population who at least view the Actor from a standpoint of calculated legitimacy. When combined with *View Actor as Legitimate*

	Government this primary measure is referred to as the "conflict narrative."
View Actor as Legitimate Government	The population wide view of an Actor, across all ethnographies. Represents the percentage of the population who view the Actor as the legitimate government. When combined with *View Actor as Best Choice for Now* this primary measure is referred to as the "conflict narrative."

C-3.5 Secondary Measures of Effectiveness

Depending on the Theatre Strategy selected virtually any parameter in the model might become a secondary measure of effectiveness. For example if a counter-terrorism strategy is envisioned, then the number of terrorist attacks attempted, completed, thwarted and the deaths/refugees specifically from terrorism may be important as a secondary measure of effectiveness.

C-4 Green/Red Operation Orders

Operation orders allocate Green/Red personnel who are not otherwise assigned to garrison/policy duty to undertake a variety of different types of military actions.

C-4.1 AFV/IFV Purchases

This is manually set to represent how many Armored or Improvised Fighting vehicles an Actor acquires every Period.

C-4.2 Artillery Purchases

This is manually set to represent how many Artillery Pieces an Actor acquires every Period.

C-4.3 Armed Civil Affairs

Armed Civil Affairs is the use of military units to support or bolster governing capacity. Each military action of Armed Civil Affairs will add to the credible governing capacity across all Ethnographies. This can either bolster a weak governing system, or help jump-start governing capacity for Red Actor with no previous experience in governing.

C-4.4 Garrison

Garrison is a special type of operational order that occurs by default. The model automatically calculates how many troops are needed to garrison the population under control based on their disposition between Coerced, Calculated and Governed. The *Total Garrison* is then compared to a maximum garrison amount as a percentage of all forces based on the size of any current Uprising. The model will use the lesser of the two values (*Total Garrison* and *Max Garrison Allocation)* to determine the *Actual Garrison.* This prevents newly established insurgencies from allocating 100% of their troops to garrison the population, even if there isn't any uprising against

their actions yet. In many situations *Total Garrison* and *Max Garrison Allocation* will be the same number. Often when this occurs it represents a natural limit to growth. The Actor has as much population as it can handle and 100% of Combatants are being allocated to garrison and police duty. The Actor must either shift more population to Governed, recruit more troops, or reduce through combat the opposition number before they can territorially expand again.

This Garrison calculation is carried out prior to allocating combatants between squads for other military actions. Thus if 100% of the combatants are in a Garrison mode, then none will be available for any other OpOrder.

C-4.5 Conventional Warfare

This action seeks to use the military force represented by the squads in this OpOrder to attack the other combatant and seize territory, or take it back. Conventional Warfare leverages the Situational Force Scoring (SFS) combat simulator to determine who wins in conflict, and how much territory exchanges hands.

C-4.6 Indirect Attacks

Description: Indirect Attack OpOrders are how Actors can use IED, VBIED, and SVIED for military purposes. This can shape the battlefield by denying access or maneuver, or directly harming the enemy. The mechanical effect of this in the simulation is that squads assigned to Indirect Attacks add to the Indirect Attack pool in the combat simulator as if they were a poor-man's artillery. The actual suicide bombers who might die in such attacks are not accounted for – assuming to be recruited, trained and deployed as part of the squads actions.

Intended Use: Traditional artillery is inaccessible to the Red Actor through most simulations. Using Indirect Attacks via IED is a way to access at least part of the military benefits of this kind of equipment, which are quiet effective in urban areas, that they might not otherwise have.

C-4.7 Local Recruiting

Description: Local Recruiting Actions are the basic building block of Actor forces. Squads assigned to this OpOrder will seek to recruit more combatants from the fighting-age men of each ethnographic group. Recruiting only can be accomplished from populations within Calculated Legitimacy or Governed. Each Actor has a target recruiting number per action, by ethnographic group, for the two types of population. Total recruiting is limited by the adequacy of fighting age men, which is set demographically as a percentage of the whole by ethnographic group in the scenario. Higher levels of militant experience will increase the pool of fighting-age men from which to draw from, thereby increasing recruiting even under difficult conditions and could represent recruiting child-soldiers, women, those who might not normally fight etc.

Intended Use: Recruiting Actions are the only way to grow the size of a militant force or replace losses. Since all Op Orders require combatants who can be formed into squads, recruiting is an essential function of both actors to manage.

C-4.8 Terrorist Attacks

Description: Suicide bombings, VBIED, IED's, vehicular ramming – all attacks conducted with an aim of inflicting mass causalities at a target ethnographic group residing under the control of an opposing Actor.

Intended Use: Terrorism produces civilian deaths and refugees within the population controlled by an opposing Actor. This hurts the ethnographic perception of the controlling actor as being unable to protect the population. In this way for example the Red Actor could target Terrorist attacks on the Green Actor's Sunni population, driving them into the arms of the Red Actor. Also because Terrorism adds to the overall rate of violence, they will have an effect of increasing the need for garrisoning troops, leading to destabilization if garrison needs cannot be met. Terrorism also serves as the most powerful propaganda tool for Red to recruit foreign fighters. It will cause negative perceptions to form within the Ethnographic group to the Red Actor. If a Theater Strategy is to destabilize a country with a large flow of IDP's, or a neighboring countries capacity to manage that many, then increasing the number of Terrorist acts is one way to accomplish that.   At the operational level Terrorist acts are assumed to "succeed" unless opposed by Counter-terrorism OpOrders carried out by the other actor.

C-4.9 Combatting Terrorism

Description: An order covering the full spectrum of operations necessary to disrupt terrorist and other clandestine activities. This includes antiterrorism defensive protection of high value targets, ethnographic populations and facilities; as well as counterterrorism efforts to gather intelligence, identify and attack the network of terrorists and their supporters.

Intended Use: This OpOrder assigns Actor Squads to CT duties. Their effectiveness depends on their experience, and any benefit derived from Blue/Purple Training operations. The higher effectiveness, the greater percentage of acts that will be stopped from commission and "thwarted." CT Effectiveness is a multiplier that determines how many Terrorist Attempts are Thwarted, and how many Prison Duty Squads are successful in stopping Prison Breaks. However it is impossible to stop all acts, as some small percent will always get through.   Effectiveness degrades over time, at a rate that declines the more experienced the Actor is. This means an Actor with career professionals will experience far less, even zero, degradation of effectiveness than one that relies mainly on untrained conscripts.

C-4.10 Propaganda

Description: An Actor can manipulate Ethnographic support for themselves and an opposing actor by assigning OpOrders for Propaganda. The effect impacts negatively the short term Ethnographic Perception of opposing Actors, and positively impacts the perception of the Actor conducting the act.

Intended Use: Propaganda allows an Actor to reduce ethnographic support without necessarily killing the targets, such as in Terrorist or War Crime OpOrders. For example, the Red Actor might use Armed Propaganda on Sunni Arabs within the Green Actor's control, lowering the perception to encourage more Sunni's to defect to Red Actor's control.

C-4.11 Armed Civil Affairs

Description: These OpOrders assign Squads to conduct civil affairs, building credible institutional procedures within the target Ethnography.

Intended Use: An Actor's Institutional Procedures requires population to begin being built, and is limited by finances. Assigning militant squads to Armed Civil Affairs allows the creation of governmental structure without having to have a controlled population first. This will benefit the Actor when they do gain control of population by already having an infrastructure in place.

C-4.12 Prison Breaks

Description: Prison Breaks are OpOrders for squads to seek out opposing actor detention facilities and free militant detainees. Based on the scenario, a certain percentage of the militant detainees will return to the Actor which freed them.

The number of Squads assigned to this OpOrder is compared with the number of prisons holding detainees. The ratio between the two determines how many detainees will be freed from detention. This means that all Prison Break actions are assumed to be successful unless the opposing Actor assigns squads to Prison Duty. (Its assumed militant squads will overcome local or municipal jail guards.)

Intended Use: The Green Actor captures Red Actor and detainees them. This represents a reserve pool of combatants to 'reobtain' without having to recruit. Also militant detainees have the highest starting value of experience, at 10 years, reflecting how many prisons serve as insurgent graduate school providing training and networking with other captured insurgents. Under most scenarios the Red Actor does not hold Green combatants as detainees, killing them on the battlefield. This can be changed by scenario and then the Blue Actor Prison Breaks represent efforts to free these captured combatants and return them to Blue Actor control.

C-4.13 Prison Duty

Description: This allocates Squads of the Actor to protect its prison camps, prisons and municipal jails. Prison Duty Squads reduce the effective number of Prison Break actions, reducing the ratio at which detainees will be freed, possibly to zero. These actions are wasted if the Opposing Actor is not allocating squads to prison breaks.

C-4.14 War Crimes

Description: War crimes include the intentional targeting of civilians, ethnic cleansing, crimes against humanity and other mass casualty attack by conventional or unconventional forces against a target ethnographic group. These are distinguished from terrorism however within the model. War Crimes can be either an act of deliberate policy, or reflect the inexperience of troops or provocation by opposing Actors. Ethnic Cleansings cause fatalities in the targeted ethnographic population controlled by Actor who commits the War Crime. This means Green Actor atrocities will impact Green Actor populations. Unlike Terrorism the ethnographic perception penalty applies to the Actor committing the War Crime. Actors take a significant ethnographic penalty for committing War Atrocities, and because they add to the overall rate of violence, they will have an effect of increasing the need for garrisoning troops, leading to destabilization. War Atrocities also create refugees fleeing the violence. These refugees begin as IDP and then leave the country – potentially depopulating it.

Intended Use: War Atrocities are a way for an actor to "cleanse" its controlled population of undesired ethnographic groups. Because War Atrocities are only targeted against a population the Actor physically controls – the deaths and refugees have the effect of 'clearing out' the target population. The simulation effect of this is that an Actor can reduce its Garrison requirements over time by committing War Atrocities against an Ethnographic group that already views it poorly, thus reducing the number of Coerced Population that need to be Garrison. Even though this will cause an Ethnographic hit, if there are less people of that ethnography within the Actor's control it won't matter as much. Also if a Theater Strategy is to destabilize a country with a large flow of IDP's, or a neighboring countries capacity to manage that many, then increasing the number of War Atrocities is one way to accomplish that, though at a cost of increasing the difficulty of governing the targeted population at anything other than Coercive levels.

C-5 Foreign Actor Operation Orders

Foreign intervention is possible in E-SAM on behalf of either the Green or Red Actor. These can be by state or non-state actors. Foreign intervention on behalf of Green is designated as the Blue Actor, while foreign intervention on behalf of Red is designated as the Purple Actor.

C-5.1 Blue/Purple Armed Civil Affairs

Same as Green/Red Armed Civil Affairs, but executed by Blue/Purple personnel.

C-5.2 Blue/Purple Information Operations

Same as Green/Red Propaganda, but executed by Blue/Purple personnel.

C-5.3 Blue/Purple Training Actor Security Forces

Description: Conduct activities like those described under "Framework of Development: Train" to include developing training standards, training HNF soldiers, officers, civilians and friendly networks.[75] Assumes the Required Assessment & Organize activities are complete.[76] In the *Ideal Case* these shaping activities take negligible time. In the *Operationally Constrained Case* these activities represent the ramp-up time before Training formulations take effect.

Includes all efforts – from personnel training, physical infrastructure and technology improvements and direct support in CT operations to improve the Actor Security Forces ability to thwart terrorism and other clandestine acts such as prison breaks.

Intended Use: This training is provided by Blue/Purple personnel to Green/Red personnel conducting Combatting Terrorism OpOrders. The number of Green/Red personnel assigned to CT is compared to Blue/Purple. Unlike Combat Training or Advanced Equipment Provision, there is no multiplier training effect. This is based on the assumption that the ongoing mentorship of Counter Terrorism is more intensive than one-off training for a new piece of equipment or tactic. The percentage of Blue/Purple training forces to Green/Red CT forces is the additional % that will be added every Period to the Current Security Effectiveness. This makes CT training either very personnel intensive or time intensive, or both, to make a difference.

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[75] David Howell Petraeus and James F Amos, *Counterinsurgency: FM 3-24 (2006)* (Boulder, Colo.; Newbury: Paladin ; Casemate [distributor, 2009). 6-12 thru 6-16.
[76] Ibid. 6-6 thru 6-12

C-5.4 Blue/Purple Airpower

Description: Fixed wing, rotary, drones and all forms of aviation are covered under this OpOrder. Airpower is designated by an overall rate, which determines the number of aircraft and sorties per day available, and then a secondary allocation is made to determine the targeting priorities of those aircraft: ground support, attacking an Actor's resource production or attacking an Actor's governing capabilities.

Intended Use: Assigned personnel represent the maintenance, sustainment and piloting requirements to field a certain amount of aircraft. In other words the number of aircraft, or sorties per day, are not determined arbitrarily, but as a function of how many personnel are assigned. It currently is set at 27 Squads necessary to support a Squadron of Aircraft, each of which consists of 12 planes, each of which can on average support 2 Sorties per day.

Airpower Target Combatants

All close ground-support and stand-off attacks are covered under this. A percentage benefit is provided within the SFS Combat Simulator to represent proper air-support. This increases the exchange ratio which helps cause losses to the other side. However airpower targeting combatants does not eliminate Actor forces outside of battle itself.

Airpower Target Resource Production

Drone strikes, cruise missiles and traditional airpower strikes are covered under this OpOrder. These strikes target the Resource Production of the Actor, and each strike eliminates a certain number of producing units, thus degrading the ability of the Actor to obtain resources. Note that in the ESA Simulator, Resource Production refers to a specific valuable resource that it takes control of the land to access and exploit: e.g. oil, opium, cocaine etc. Airpower strikes target this particular resource, and are not targeting more general or broad economic activity.

Airpower Target Government Capability

Includes attacked against fixed or mobile infrastructure, command and control, communication or other instruments of state power. Airpower strikes against government capability reduce by block-amounts the 'credible institutional procedures' an Actor is able to provide, across all ethnographies. This has a second-order effect of reducing Ethnographic support for that actor. These strikes will either have a limited effect, or must be continued for a long duration, to degrade an largely legitimate government. However a failed-state or emerging-state actor governance, strikes such as this can make the difference between Coercion and Calculated Legitimacy perceptions of the government, or make it more difficult for the Actor to function as a state.

C-5.5 Blue/Purple Providing Advanced Equipment

Description: The provision of advanced weaponry, communications or other materiel equipment including the necessary training to be able to use the equipment effectively.

Intended Use: Advanced Equipment provides a % increase in overall combat effectiveness in the SFS Simulator. The amount of that benefit actually obtained is based on the ratio between Blue/Purple squads assigned to provisioning and the conventional forces of the Actor. There is a multiplier effect, one Squad of trainers can train 10 Squads of Trainees per military action. Like CT Effectiveness, the ability to use advanced weapons degrades over time – mitigated by the Actors overall experience level. (e.g. a highly experienced military will not lose the training benefit, while a less experienced on will lose it rapidly.)

C-5.6 Blue/Purple Combat Advising

Description: Covers all the aspects of military training including embedding in combat troops, establishing training regimes, academies etc.

Intended Use: These Blue/Purple squads assigned to embed as combat advisors join the Actor's conventional forces, providing benefits to Morale and a faster increase in Experience.   They also count to the Actor's Infantry, adding additional direct combat capability. However, as they are directly engaged in combat, they suffer losses at a percentage rate equal to their overall percentage within the force they are advising.

C-5.7 Intervention Size

This OpOrder sets the in-country level of military personnel a Blue or Purple actor is willing to commit. It takes time for troops to deploy and reach effective operating status – so if an Intervention Size is increased dramatically in one period, not all of those troops will be available that, or even the next period. Additionally, the Tooth-to-Tail ratio for Blue and/or Purple determines what % of the intervention size is available for actual military actions. The remainder are considered to be allocated to logistics, administration and other functions that don't add capability directly – but are necessary for the ongoing maintenance of the force.

C-5.8 War Crimes

This is a special action that doesn't represent an intentional operational order for Blue/Purple military actions. Instead a set percentage of all Blue/Purple airpower sorties and Embedded Combat Advising will instead be diverted and result in War Crimes, similar to a war crime by a

Green/Red Actor. This percentage is usually very low, 1/10th of 1%. But represents inadvertent missile strikes, fog-of-war and actual intentional war crimes by rogue troops.

C-6 Starting Conditions

E-SAM has over 100 customizable starting parameters that can be adjusted to fit a regional or historical context. However, not all of these need to be set for each scenario as many represent core dynamics that will be common across conflicts. The current values in E-SAM are set to a scenario of Iraq & Syria corresponding with the rise of ISIS in 2010 but they can be modified.

C-6.1 Ethnography Starting Conditions

Ethnography starting conditions represent the starting attributes, size and distribution of ethnographic groups. Note the Territory Conditions Table for Distribution of Population are designed to be cut and paste directly into Vensim Lookup Functions if required.

Table C-4: Ethnographic Starting Conditions

Parameter	Arab Sunni	Arab Shia	Kurdish Sunni	Notes
Normal Pct of Fighting Age Men in Population	0.23	0.23	0.23	The % of fighting age men (16-44yrs) in a population who can be drawn to recruits, become local opposition etc. As this depletes recruiting and joining opposition becomes more difficult.
Starting Level of Ethnographic Population	10000000	30000000	10000000	Raw number of people in total at the start of the scenario for each ethnographic population.
Territory Conditions Table for Distribution of Population by Ethnography on Territorial Map	[(0,0)-(1,1)],(0,0.00496),(0.00317,0.00496),(0.00367,0.01231),(0.05867,0.03494),(0.09117,0.04777),(0.09167,0.05865),(0.09217,0.09468),(0.32217,0.10144),(0.38243,0.11139),(0.4224,0.12594),(0.4229,0.13179),(0.42912,0.13204),(0.46912,0.13363),(0.46962,0.13369),(0.49962,0.15349),(0.500	[(0,0)-(1,1)],(0.00317,0.00028),(0.00367,0.00068),(0.05867,0.00194),(0.09117,0.00265),(0.09167,0.00326),(0.09217,0.01001),(0.32217,0.01039),(0.38243,0.01094),(0.4224,0.01175),(0.4229,0.01208),(0.42912,0.01641),(0.46912,0.04512),(0.46962,0.04625),(0.49962,0.06605),(0.50012,0.08365	[(0,0)-(1,1)],(0.00317,0.00028),(0.00367,0.00068),(0.05867,0.00194),(0.09117,0.00265),(0.09167,0.00326),(0.09217,0.00551),(0.32217,0.00589),(0.38243,0.00644),(0.4224,0.00725),(0.4229,0.00757),(0.42912,0.00781),(0.46912,0.00941),(0.46962,0.00947),(0.49962,0.02927),(0.50012,0.04688	Lookup function that determines a % of the overall population, by ethnography, that occupies each section of the map. As these sections are conquered (or lost) the population is removed from the other Actor via Conquest functions.

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	12,0.1711),(0.515 74,0.17245),(0.51 624,0.17445),(0.5 3124,0.18805),(0. 53174,0.19409),(0 .60174,0.20311),(0.63174,0.20576), (0.63224,0.21479) ,(0.63274,0.21693),(0.64257,0.2405 5),(0.64915,0.255 32),(0.64965,0.26 032),(0.66965,0.2 695),(0.67992,0.2 7326),(0.68042,0. 28826),(0.71116,0 .29326),(0.74116, 0.29417),(0.74166 ,0.29736),(0.7716 6,0.29736),(0.821 66,0.29736),(0.82 216,0.29736),(0.8 4716,0.29824),(0. 84766,0.30039),(0 .87356,0.30039),(0.95856,0.30039), (0.99356,0.30039) ,(0.99406,0.30039)	),(0.51574,0.0951 4),(0.51624,0.112 14),(0.53124,0.12 534),(0.53174,0.1 3121),(0.60174,0. 13996),(0.63174,0 .14128),(0.63224, 0.15031),(0.63274 ,0.15245),(0.6425 7,0.15245),(0.649 15,0.15245),(0.64 965,0.15245),(0.6 6965,0.15857),(0. 67992,0.15857),(0 .68042,0.15857),(0.71116,0.17357), (0.74116,0.17878) ,(0.74166,0.19686),(0.77166,0.1968 6),(0.82166,0.196 86),(0.82216,0.19 686),(0.84716,0.1 9686),(0.84766,0. 19686),(0.87356,0 .19686),(0.95856, 0.19686),(0.99356 ,0.19686),(0.9940 6,0.19686)	),(0.51574,0.0475 5),(0.51624,0.048 55),(0.53124,0.06 175),(0.53174,0.0 6762),(0.60174,0. 07637),(0.63174,0 .09891),(0.63224, 0.26141),(0.63274 ,0.29994),(0.6425 7,0.30781),(0.649 15,0.32258),(0.64 965,0.32758),(0.6 6965,0.34289),(0. 67992,0.34664),(0 .68042,0.36164),(0.71116,0.36164), (0.74116,0.36164) ,(0.74166,0.36164),(0.77166,0.3812 5),(0.82166,0.382) ,(0.82216,0.402),(0.84716,0.40988), (0.84766,0.42924) ,(0.87356,0.44519),(0.95856,0.4560 9),(0.99356,0.461 09),(0.99406,0.50 109)	
Normal Procedures Required for Credibility per Pop	1	1	1	The number of credible institutional procedures needed for every person to reach "Governed" consensus.
Normal Time for Population to Transition	0.25	0.25	0.25	The amount of time for population to complete the transition between Coerced, Calculated Legitimacy and Governed at each stage. Population only shifts when there is sufficient credible institutional procedures in place. Nominally set at .25 or ~3weeks.

Time for Unaligned to Choose a Side	10	10	10	Currently set at 2.5 years for all of Unaligned to pick a side.
Time to be Conquered	1	1	1	This is the period of time it takes a "conquered" population to shift out of the previous and into the new Actors Coerced population. (All conquests enter Coerced). .035 represents a week, though various ethnographies may have longer or slower times.
Time to form Long Term Perception	10	10	10	The perception formation time of the Ethnographies "Deep Anchor." nominally set at 10 period, 2.5 years, or 5 times the short term value in order to see all dynamics without an extended duration model.
Time to form Perception	0.5	0.5	0.5	The perception formation time of an Ethnographies Perception of an Actor, this is nominally set at .5, or 1.5 months, which means that if there are sufficient governing credibility conquered people will move from Coerced to Calculated in 1.5months, and from Calculated to Governed in 1.5months.

C-6.2 Actor Starting Conditions

Actor starting conditions represent initial values of key resources, capabilities, and skill sets.

Table C-5: Actor Starting Conditions

Parameter	Green #	Red #	Notes
Blue or Purple Intervention Time	0.00E+00	0	The number of periods after which Blue or Purple will intervene at the set Desired Intervention Size.
Minimum Force Size to Engage	0.00E+00	20,000	The number of combatants Red Actor must have before it begins waging conventional military attacks
Normal Combatting Terrorism	8%	0%	
Normal Desire to Credibly Govern	1,1,1	1,1,1	The "level of concern" an actor has with credibly governing an Ethnographic Group. When value is 1, then full procedures will be developed. At .25, then only 25% of needed procedures will be developed, limiting the ability to influence an Ethnographic group into moving to Calculated or Governed status.
Scenario Morale Effect	0	0.13	Exogenous addition to morale established by scenario.
Starting Actor Advanced Weapon Effectiveness	0	0	The Pct of Equipment Modifier benefit they will get from weapons provided by Blue or Purple.
Starting Actor Conditions Expatriate Fighters	0.00E+00	0	
Starting Actor Security Effectiveness	0.50	0.5	Starting security effectiveness.
Starting AFV/IFV	2137	0	The starting armored or improvised vehicles by actor.
Starting Artillery	594	0	The starting artillery pieces by actor.
Starting Blue or Purple Personnel	0	0	The number of state-sponsored foreign

			troops supporting Green or Red respectively.
Starting Cash	5.00E+09	10,000,000	The starting value of Finances
Starting Combatants	87200,261600, 87200	1500,0,0	The number of combatants by ethnography that each actor begins with.
Starting Detainees by Actor	0.00E+00	1,500	The number of Combatants held by the other side at start.
Starting Ethno Distribution Unaligned	0,0,0	0,0,0	% of all Ethnographies that start in the Unaligned position
Starting Ethno Distribution Calculated by Actor	0,0,0	0,0,0	% of all Ethnographies controlled by Actor that start in Calculated Legitimacy Stage
Starting Ethno Distribution Coerced by Actor	0,0,0	0,0,0	% of Ethnographies controlled by Actor that are in Coerced Stage
Starting Ethno Distribution Governed	1,1,1	0,0,0	% of all Ethnographies controlled by Actor that start in Governed Stage
Starting Ethno Distribution Unaligned by Actor	0,0	0,0	% of Ethnographies that are in Unaligned.
Starting Ethnographic Deep Anchor Perception	Computed	3500000, 1300000, 825000	The perception of the ethnography to the actor at start.
Starting Ethnographic Perception	Same as Starting Generational	Same as Starting Generational	The short term perception of the ethnography to the actor at start.
Starting Experience	0.00E+00	3	
Starting Foreign Combatants	0.00E+00	0	Number of foreign fighters fighting within Green or Red.
STARTING WORLDWIDE POPULATION OF FOREIGN RECRUITS	0.00E+00	100,000	The number of potential foreign fighters who might join Green or Red.
Territory Conditions Pct Territory Controlled by Actor Start	1	-	Total territory controlled at simulation start. Note Green Actor is assumed to control anything not controlled by Red Actor

C-6.3 Actor Attributes

These are inherent attributes of an Actor that may be individually modified to reflect more realistic conditions. However – many of these represent somewhat generic values that could be easily used for a variety of irregular conflicts in the early part of the 21st Century.

Table C-6: Actor Attributes

Parameter	Green #	Red #	Notes
Advanced Equipment Modifier	0.25	0	The % value of Advanced Weapons that Blue or Purple can provision to Green or Red. Modified by the effectiveness of local troops to use them.
AFV/IFV Lost due to Maintenance	0	0	Per Period Losses due to bad Maintenance
Artillery Lost due to Maintenance	0	0	Per Period Losses due to bad Maintenance
Average Blue/Purple War Atrocities Rate	0.01%	0	The rate at which Blue/Purple Military Actions assigned to Airpower (Sorties) or Embedded Combat Advisors will produce a War Atrocity instead of the intended outcome. These War Atrocities feed into the respective Actor's (Green or Red) total.
Average Experience of Escaped Detainee	10	10	
Average Experience of Foreign Recruit	1	1	
Average Experience of Local Recruit	3	3	
Average Squadron Sorties per Period	4320	4320	Number of Sorties over a 6month period. Currently stands at # of planes per squadron (average 12) * 2/day * 180 days.
Averaging Time Reserves	4	4	The number of periods on which an Actor will average its financial reserves - relative to making a decision to cease funding new procedures or maintaining them.
Blue Deployment Time	2	2	The number of months for Blue personnel to form into Squads. This represents the time from order to deployment.
Blue/Purple Squads to Support a Squadron	27	27	How many full time (all actions) Squads are

			necessary to support each flying Squadron.
Cost per Military Action	2700	2700	required financing to conduct a military action prior to activating one
Death per Terrorist Attack	10	10	
Death per War Crime	25	25	
Desired Cash on Hand	250,000	250,000	What is the floor above which actors will spend as much as they can to drive military actions.
Desired Reserve	1000000	1000000	The reserve of $$ the Actor desires to have. Continued performance beneath this reserve will lead to the reduction in creating new or replacement procedures.
Initial Worldwide Population of Foreign Recruits	0	50,000	Represents the global recruiting base to draw from. The theoretical ceiling of foreign recruits who can be inspired and arrive. Assumes anything above this doesn't exist, is intercepted, captured etc.
Local T3R Ratio	0.67	0.67	The Ratio of squads in a local actor between logistics and combat. Only combat squads will conduct Military Actions.
New Procedure Cost	10	10	Number of $ per new credible institutional procedure created.
Normal # of Detainees per Prison	100	100	Number of militants held as detainees at each prison (makeshift or permanent.)
Normal CT Impact	1	1	This is the multiplier applied to Squads assigned to Combatting Terrorism. An Actor more effective at CT would have a higher multiplier. Blue Actor advising teams can improve the impact amount.

Normal Deaths per Thwarted Terrorist Attack	11	6	Reflects the likelihood of that actor being killed in a thwarted attack. An 11 indicates that either all terrorists thwarted would fight to the death, or the opposing actor may not take prisoners alive.
Normal Defection Rate	0	0	FIX
Normal Degradation Fraction of Effectiveness	0.12	0.12	The % of Security Effectiveness lost each year until Effectiveness reaches 0. This is offset by the benefit of military experience, which at high levels of experience can take the Effectiveness degradation to zero.
Normal Detainees per Thwarted Terrorist Attack	0	5	Reflects the likelihood of that actor being caught alive and detained for a thwarted attack. A 0 may indicate the opposing actor will kill anyone they catch attempting terrorism.
Normal Effect of Kinetic Attack on Governing Capacity	10000	100000	Number of Institutional Procedures eliminated per kinetic strike (which may be airborne or a ground terrorist attack) made against the actor.
Normal Effect of Strike on Resource Production	400	400	Number of resource units/production/period destroyed on average per airstrike by Blue/Purple state support.
Normal Experience Gained per Period	0	0.5	How much experience per 6month period is gained. A 1:1 gain of experience would be .5, a 0 might be used for Conscripts who receive little to no opportunity for training.
Normal Foreign Recruits inspired per Terrorist Attack	0	26	Critical number that correlates terrorist activity with foreign recruiting, only helps if Foreign Recruiting is

			activated. Serves as tangible proxy for social media propaganda and effectiveness
Normal Military Capability of Squads	0	1	1 every 3 months is normal
Normal Recruits per Military Action	10,10,10	10,10,10	How many recruits can a squad obtain in 6 months for 1 action?
Normal Size per Squad	11	11	Squads commit actions so the size of squad divided by the militants determines the number of squads available for military actions
Normal Training Reach	10	10	The number of Squads each Blue/Purple embedded squads can impact.
Organic Procedural Development Time	0.25	0.25	The fraction of time it takes for normal bureaucracy to develop or devolve procedures relative to need.
Pct of Losses that are Deaths	1	0	This and Pct of Losses that are Detainees should equal 1.
Pct of Losses that are Detentions	0	57%	Determines how many of "losses" are killed vs. being detained. Detained are transferred to prisoner camps/jails and held until freed. Note because the % is applied to Actor's losses, the % of detention for the *opposing* actor should be entered as a value. For example: [Green, Red] entered as [0,57%] means that Red militants will be detained at 57% of the loss rate by the Green Actor, while the Red actor takes no prisoners.
Procedure Maintenance Cost	1	1	Number of $ per procedure an actor needs to spend to maintain the bureaucratic

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			infrastructure of the procedures.
Refugees per Terrorist Attack	25	25	
Refugees per War Crime	250	250	
Squads Needed per Prison Break Attempt	5	5	The number of squads that form into a Prison-break team.
T3R Ratio	0.67	0.67	The ratio of Blue personnel between logistics and combat. Only combat personnel will form into Squads and conduct Military Actions. Note that in all cases of "Blue", the Blue is supporting its associated actor. So if Iran and the US are both supporting opposing sides of a conflict, the US would be Blue Personnel [Green] and Iran would be Blue Personnel [Red]. This allows state actor intervention on the opposing side.
Table f/ Effect of Procedural Adequacy	[(-2,-2)-(2,10)],(0,2),(1,0.1),(1.25,0.05),(1.5,0),(1.75,0)	[(-2,-2)-(2,10)],(0,2),(1,0.1),(1.25,0.05),(1.5,0),(1.75,0)	Lookup that graphically plots an Actor's concern over procedural inadequacy and acts as a multiplier on Organic Development.

C-6.4 Territory Starting Conditions

Territory starting conditions instantiate the geospatial terrain the conflict will occur over, including identifying terrain type, battle type, location of resources etc. Note lookup functions such as Territory Conditions for Battle Type, Terrain Type, Strategic Surprise etc. are designed to be cut and paste directly into a Vensim Lookup function.

Table C-7: Territory Starting Conditions

Parameter	Value	Notes
Territory Conditions Price per Resource Unit	$80,$45	The estimated black-market price per unit of resource production Red Actor can obtain once it has seized control of resource production by seizing territory. In Iraq/Syria this was $/bbl. oil, in Afghanistan this might be $/pound of heroin, or $/pound of Cocaine in Columbia. Not all territories have valuable resources that can be exploited by insurgents by seizing land.
Territory Conditions Starting Total Territory	619308	The km^2 of the entire bounded territory represented in the model. As Red Actor controls parts of this, it's % of Controlled Territory will be used on lookup functions to determine what they find.
Territory Conditions Table for Battle Type Based on Red Actor Location on Map	[(0,0)-(0.7,6)],(0.0032,1),(0.0037,1),(0.0587,3),(0.0912,3),(0.0917,4),(0.0922,2),(0.3222,1),(0.3824,1),(0.4224,1),(0.4229,3),(0.4291,1),(0.4691,6),(0.4696,5),(0.4996,6),(0.5001,5),(0.5157,6),(0.5162,5),(0.5312,1),(0.5317,6),(0.6017,5),(0.6317,4),(0.6322,5),(0.6327,5),(0.6426,4),(0.6492,4),(0.6497,5),(0.6697,3),(0.6799,1),(0.6804,5),(0.7112,4),(0.7412,4),(0.7417,5),(0.7717,4),(0.8217,1),(0.8222,5),(0.8472,1),(0.8477,5),(0.8736,4),(0.9586,1),(0.9936,1),(0.9941,5)	Provides a Battle Type, 1-6. The exact battle type is determined by the scenario data loaded in and exogenous assumptions of the analyst.
Territory Conditions Table for Percentage of Unaligned Population Controlled based on Location of Red Actor on Territorial Map	[(0,0)-(1,1)],(0,0),(1,1)	This lookup determines how many Unaligned are Conquered, moved into Coerced, based on Red Actor advancement. Currently this is a proportional representation.
Territory Conditions Table for Strategic Surprise Based on	[(0,0)-(1,1)],(0,0.05),(0.00317,0.05),(0.00322,0.05),(0.0566,0.25),(0.08	Determines a strategic surprise variable based on where the Red

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Location of Red Actor on Territorial Map	828,0.25),(0.08844,0.5),(0.08866,0.5),(0.31224,1),(0.41247,1),(0.41263,1),(0.41885,1),(0.45652,1),(0.45657,1),(0.48642,1),(0.48672,1),(0.50235,1),(0.50251,1),(0.51686,1),(0.51702,1),(0.5852,1),(0.61432,1),(0.61465,1),(0.61482,1),(1,1)	Actor is located. This is based on Analyst Assumptions.
Territory Conditions Table for the Percentage of Resource Production based on Red Actor Location on Territorial Map	[(0,0)-(1,1)],(0,0),(0,0),(0.06,0.04),(0.09,0.04),(0.09,0.04),(0.09,0.05),(0.32,0.05),(0.38,0.05),(0.42,0.06),(0.42,0.06),(0.43,0.06),(0.47,0.14),(0.47,0.14),(0.5,0.14),(0.5,0.14),(0.52,0.39),(0.52,0.39),(0.53,0.39),(0.53,0.39),(0.6,0.39),(0.63,0.39),(0.63,0.4),(0.63,0.4),(0.64,0.4),(0.65,0.4),(0.65,0.4),(0.67,0.4),(0.68,0.4),(0.68,0.4),(0.71,0.4),(0.74,0.41),(0.74,0.41),(0.77,0.41),(0.82,0.41),(0.82,0.41),(0.85,0.41),(0.85,0.41),(0.87,0.42),(0.96,0.42),(0.99,1),(0.99,1)	Determines the percentage of all resource production Red Actor will gain as they gain territory. Path of conquest is based on analyst assumptions.
Territory Conditions Table for the Terrain Type Based on Location of Red Actor on Territorial Map	[(0,0)-(0.7,5)],(0.00317,4),(0.00367,4),(0.05867,1),(0.09117,1),(0.09167,4),(0.09217,4),(0.32217,1),(0.38243,1),(0.4224,1),(0.4229,4),(0.42912,2),(0.46912,5),(0.46962,4),(0.49962,1),(0.50012,4),(0.51574,1),(0.51624,4),(0.53124,1),(0.53174,2),(0.60174,4),(0.63174,2),(0.63224,4),(0.63274,4),(0.64257,5),(0.64915,1),(0.64965,5),(0.66965,2),(0.67992,1),(0.68042,4),(0.71116,1),(0.74116,5),(0.74166,4),(0.77166,2),(0.82166,1),(0.82216,4),(0.84716,1),(0.84766,4),(0.87356,2),(0.95856,1),(0.99356,1),(0.99406,4)	This lookup "represents" the geographical fixtures of the territory based on the progression of the Red Actor. Requires exogenous analyst assessment of where Red Actor will go and in what order.
Territory Conditions Table of Cumulative Green Forces Engaged based on Location of Red Actor on Map	[(0,0)-(1,1)],(0.00317,0.00551),(0.00367,0.01368),(0.05867,0.03882),(0.09117,0.05308),(0.09167,0.06517),(0.09217,0.11021),(0.32217,0.11771),(0.38243,0.12877),(0.4224,0.14494),(0.4229,0.15144),(0.42912,0.15626),(0.46912,0.15816),(0.46962,0.18941),(0.49962,0.21941),(0.50012,0.30323),(0.51574,0.30674),(0.51624,0.33803),(0.53124,0.35876),(0.53174,0.36746),(0.60174,0.42246),(0.63174,0.44998),(0.63224,0.59998),(0.63274,0.69998),(0.64257,0.72998),(0.64915,0.73998),(0.64	Lookup of the total % of Green Conventional Forces that will be engaged based on location of Red Actor.

	965,0.75998),(0.66965,0.76498), (0.67992,0.76998),(0.68042,0.79 498),(0.71116,0.81998),(0.7411 6,0.82498),(0.74166,0.85498),(0 .77166,0.85648),(0.82166,0.857 98),(0.82216,0.90798),(0.84716, 0.90998),(0.84766,0.95998),(0.8 7356,0.96098),(0.95856,0.96198),(0.99356,0.96298),(0.99406,1. 01298)		
Territory Conditions Total Available Resource Production	5.013E+13		The total value of all Available Resource Production in the entire territory. In this case Bbl./Day of oil production.
Territory Conditions Table of Local Garrison Green Forces Engaged	[(0,0)- (0.7,0.3)],(0.00317,0.00551),(0.0 0367,0.00817),(0.05867,0.02514),(0.09117,0.01426),(0.09167,0. 01209),(0.09217,0.04504),(0.32 217,0.00751),(0.38243,0.01106), (0.4224,0.01616),(0.4229,0.0065 1),(0.42912,0.00482),(0.46912,0 .0019),(0.46962,0.03125),(0.499 62,0.03),(0.50012,0.08382),(0.5 1574,0.00351),(0.51624,0.03129),(0.53124,0.02073),(0.53174,0. 0087),(0.60174,0.055),(0.63174, 0.02752),(0.63224,0.15),(0.6327 4,0.1),(0.64257,0.03),(0.64915,0 .01),(0.64965,0.02),(0.66965,0.0 05),(0.67992,0.005),(0.68042,0. 025),(0.71116,0.025),(0.74116,0 .005),(0.74166,0.03),(0.77166,0. 0015),(0.82166,0.0015),(0.8221 6,0.05),(0.84716,0.002),(0.8476 6,0.05),(0.87356,0.001),(0.9585 6,0.001),(0.99356,0.001),(0.994 06,0.05)		This allocates the location of Green Garrison forces across the map.
Theatre Plan of Attack	Ar Raqqah City	0.00317	This represents the Theatre Plan of attack or sequence to be pursued. The available territory is divided into % and a network map is constructed wherein the % of km^2 advanced in the FLOT by the Red Actor corresponds to the outer limit of its boundary (which can advance as a blob or in discrete unconnected spheres.) So if Baghdad is the first target, it might be at 1% of territory in one scenario but if it's the last conquered it might be 99% in another. It is this sequence that is
	Fallujah	0.00367	
	Derie e Zor Province	0.05867	
	Ar Raqqah province	0.09117	
	Ramadi	0.09167	
	Mosul City	0.09217	
	Anbar Province, Ninawa & Salah ad-Din	0.32217	
	Remainder Ninawa Province	0.38243	

	Salah ad-Din Province except Tirkrit	0.42240	used to assign terrain type, battle type and population in other settings.
	Tikrit	0.42290	
	Ayn al Arab SubDistrict	0.42912	
	Al Hasakah Governate	0.46912	
	Kobani	0.46962	
	Alleppo Governate but Aleppo	0.49962	
	Aleppo	0.50012	
	Kirku Province	0.51574	
	Kirkuk City	0.51624	
	Hama Province	0.53124	
	Homs Province but Homs	0.53174	
	Take Homs	0.60174	
	Rif-Damascus but Damascus	0.63174	
	Baghdad	0.63224	
	Damascus	0.63274	
	Idlib	0.64257	
	Latakia & Tartous	0.64915	
	Latakia Capital	0.64965	
	"As-Suwayda, Quneitra, Daraa		
	"	0.66965	
	Remainder of Babil	0.67992	
	Hillah	0.68042	
	Diyala	0.71116	
	Erbil	0.74116	
	Erbil Capital	0.74166	
	Wasit	0.77166	
	Remainder of Najaf	0.82166	
	Najaf Capital	0.82216	
	Remainder Dhi Qar	0.84716	
	Nasiriyah Capital	0.84766	
	Misan	0.87356	
	Muthana	0.95856	
	Basra	0.99356	

C-6.5 Glossary

measure of effectiveness — An indicator used to measure a current system state, with change indicated by comparing multiple observations over time. Also called MOE.

See also combat assessment; mission. (JP 5-0)

advise - Advisors are the most prominent group of U.S. personnel that serve with HN units. Advisors live, work, and (when authorized) fight with their HN units. Segregation is kept at an absolute minimum. The relationship between advisors and HN forces is vital. U.S. commanders must remember that advisors are not liaison officers, nor do they command HN units.[77]

friendly networks — Friendly networks are networks that are sympathetic to or assisting

directly or indirectly with our mission. They include the military and civil components and non-governmental organizations associated with allied coalition forces and host nation forces. They are characterized as green or blue.[78]

green networks — Green networks are military and government civilian host-nation forces.[79]

operation order — A directive issued by a commander to subordinate commanders for the purpose of effecting the coordinated execution of an operation. Also called OPORD.

(JP 5-0)[80]

campaign plan — A joint operation plan for a series of related major operations aimed at

achieving strategic or operational objectives within a given time and space. See also

campaign. (JP 5-0)[81]

counterterrorism — Activities and operations taken to neutralize terrorists and their

---

[77] Ibid., 6–17.

[78] *Attack the Network Commanders Guide* (Suffolk, VA: Joint Warfighting Center, Joint Doctrine Division, 2011), GL-19.

[79] *Attack the Network Commanders Guide*. GL-19

[80] "Joint Publication 1-02: Dictionary of Military and Associated Terms" (United States Department of Defense, n.d.), 176.

[81] Ibid., 31.

organizations and networks in order to render them incapable of using violence to instill

fear and coerce governments or societies to achieve their goals. Also called CT. See

also antiterrorism; combating terrorism; terrorism. (JP 3-26)[82]

combating terrorism — Actions, including antiterrorism and counterterrorism, taken to

oppose terrorism throughout the entire threat spectrum. Also called CbT. See also

antiterrorism; counterterrorism. (JP 3-26)[83]

antiterrorism — Defensive measures used to reduce the vulnerability of individuals and

property to terrorist acts, to include rapid containment by local military and civilian

forces. Also called AT. See also counterterrorism; terrorism. (JP 3-07.2)[84]

theater strategy - An overarching construct outlining a combatant commander's vision for
integrating and synchronizing military activities and operations with the other

instruments of national power in order to achieve national strategic objectives. See also

national military strategy; national security strategy; strategy. (JP 3-0)[85]

counterinsurgency — Comprehensive civilian and military efforts designed to

simultaneously defeat and contain insurgency and address its root causes. Also called

COIN. (JP 3-24)[86]

occupied territory — Territory under the authority and effective control of a belligerent armed
force and not being administered pursuant to peace terms, treaty, or other agreement, express
or implied, with the civil authority of the territory. (JP 4-02)[87]

white network - Neutral networks are networks that are not hostile to, or in any way

---

[82] Ibid., 57.
[83] Ibid., 42.
[84] Ibid., 18.
[85] Ibid., 236.
[86] Ibid., 56.
[87] Ibid., 172.

supportive of any one of the forces in a hostile environment. Sometimes characterized as

White networks.[88]

blue network — Blue networks are military and government civilian US, allied and coalition forces.[89]

black network — Black networks are formal and /or informal grouping of criminals that are not necessarily adversarial to the friendly networks, but thwart attempts to create stability so that they can further the aims of their criminal enterprises.[90]

red networks — Red networks are formal and/or informal grouping of adversarial actors that are in opposition to the friendly networks. Red networks are the adversary network(s)

identified in the commander's intent.[91]

T3R – TBD

Purple Network - TBD (see if other but this is a state-actor sponsor of a Red Actor, similar of how Blue supports Green, Purple supports Red)

C-7 Bibliography for Section C

Attack the Network Commanders Guide. Suffolk, VA: Joint Warfighting Center, Joint Doctrine Division, 2011.

"Joint Publication 1-02: Dictionary of Military and Associated Terms." United States Department of Defense, n.d.

Petraeus, David Howell, and James F Amos. *Counterinsurgency: FM 3-24 (2006)*. Boulder, Colo.; Newbury: Paladin ; Casemate [distributor, 2009.

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[88] *Attack the Network Commanders Guide*, 172.
[89] Ibid., 159.
[90] Ibid.
[91] Ibid., 174.

Section D Model Documentation & Experiment Results

D-1 Introduction

E-SAM contains fifteen sectors, split between the strategic architecture and world model. The sectors are listed in Table D-1.

Table D-1: Sector list of E-SAM

Strategic Architecture Sector	World Model Sector
AFV, IFV & Artillery	Ethnographic Perceptions
Combatant Recruiting & Losses	Ethnographic Side-Choosing & Actor Legitimacy
Expenses	Expenses
Foreign Intervention OpOrder Allocations	OpOrder Impacts on World
Govrenance	Resistance & Uprising
OpOrder Allocations	Revenue
Resource Stocks	SFS Combat Simulator
Revenue	Territory Dynamics

Each Sector of this section is covered first by an overview diagram of the subsystem structure and interactions with other sectors. Then all the equations for that sector are presented. After all sectors are covered a section will provide the two command scripts necessary to replicate Baseline Historical and Baseline without Intervention. A final section will include the starting values of all variables. This should be sufficient to replicate the information found in the articles.

D-2 Model Control Settings

```
*******************************

   .Control

*******************************
```

Simulation Control Parameters

FINAL TIME = 40

     Units: Period

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The final time for the simulation.

INITIAL TIME = 0

      Units: Period

      The initial time for the simulation.

SAVEPER = TIME STEP

      Units: Period [0,?]

      The frequency with which output is stored.

TIME STEP = 0.01111

      Units: Period [0,?]

      The time step for the simulation.

****

.esa model for publication final

****

D-3 Strategic Architecture Sectors & Equations

D-3.1 AFV, IFV & Artillery

Sector Overview

AFV, IFV & Artillery
Sector Overview
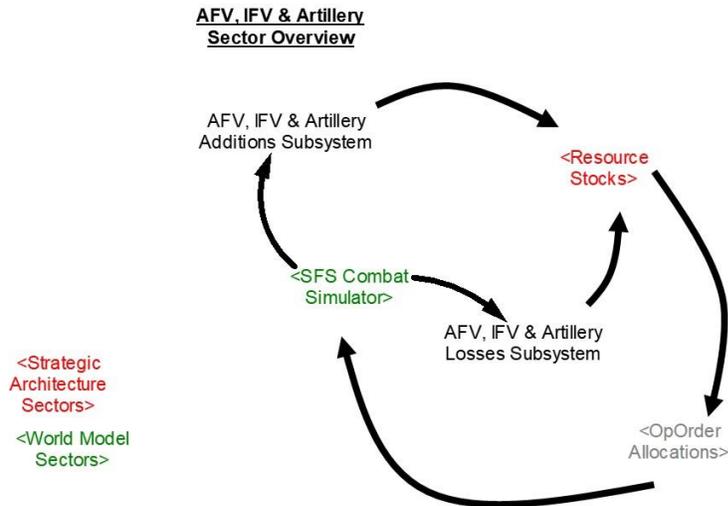
Figure D-1: AFV, IFV & Artillery Sector

Equations

AFV and IFV Additions[Actors] = (AFV and IFV Scavenged[Red] / Time to Repair and Operate[

Actors]) + AFV and IFV Purchases[Actors]

Units: Pieces/Period

AFV and IFV Losses[Actors] = AFV and IFV Lossses in Battle[Actors] + AFV and IFV Lost due to Maintenance[

Actors]

Units: Pieces/Period

AFV and IFV Lossses in Battle[Red] = Red AFV and IFV Final Losses[Red] / NORMAL PERIOD

AFV and IFV Lossses in Battle[Green] = Green AFV Final Losses[Green] / NORMAL PERIOD

Units: Pieces/Period

AFV and IFV Lost due to Maintenance[Actors] = 0, 0

Units: Pieces/Period

AFV and IFV Purchases[Green] = GAME(0)

AFV and IFV Purchases[Red] = 0

Units: Pieces/Period

Not used in current model. In the current model ISIS can only

scavenge AFV/IFV and cannot acquire heavy weapons.

AFV and IFV Scavenged[Red] = (((Green HW Initial Losses[Green]) * Scavenging Rate of Heavy Weapons

) + ((Green Artillery Initial Losses[Green]) * Scavenging Rate of Heavy Weapons

))

Units: Pieces

Artillery Additions[Actors] = Artillery Purchases[Actors]

Units: Pieces/Period

Artillery Losses[Actors] = Artillery Losses in Battle[Actors] + Artillery Lost due to Maintenance[

Actors]

Units: Pieces/Period

Artillery Losses in Battle[Green] = Green Artillery Final Losses[Green] / NORMAL PERIOD

Artillery Losses in Battle[Red] = 0

Units: Pieces/Period

Artillery Lost due to Maintenance[Actors] = 0, 0

Units: Pieces/Period

Artillery Purchases[Green] = GAME(0)

Artillery Purchases[Red] = 0

Units: Pieces/Period

Green AFV Final Losses[Actors] = (Green HW Initial Losses[Actors] - (Green HW Initial Losses[

Actors] * HW Recovery))

Units: Pieces

Green Artillery Final Losses[Actors] = (Green Artillery Initial Losses[Actors]

- (Green Artillery Initial Losses[Actors] * HW Recovery))

Units: Pieces

NORMAL PERIOD = 1

Units: Period

Red AFV and IFV Final Losses[Actors] = (Red HW Initial Losses[Actors] - (Red HW Initial Losses[

Actors] * HW Recovery))

Units: Pieces

Time to Repair and Operate[Actors] = 1

Units: Period

D-3.2 Combatant Recruiting & Losses

Overview
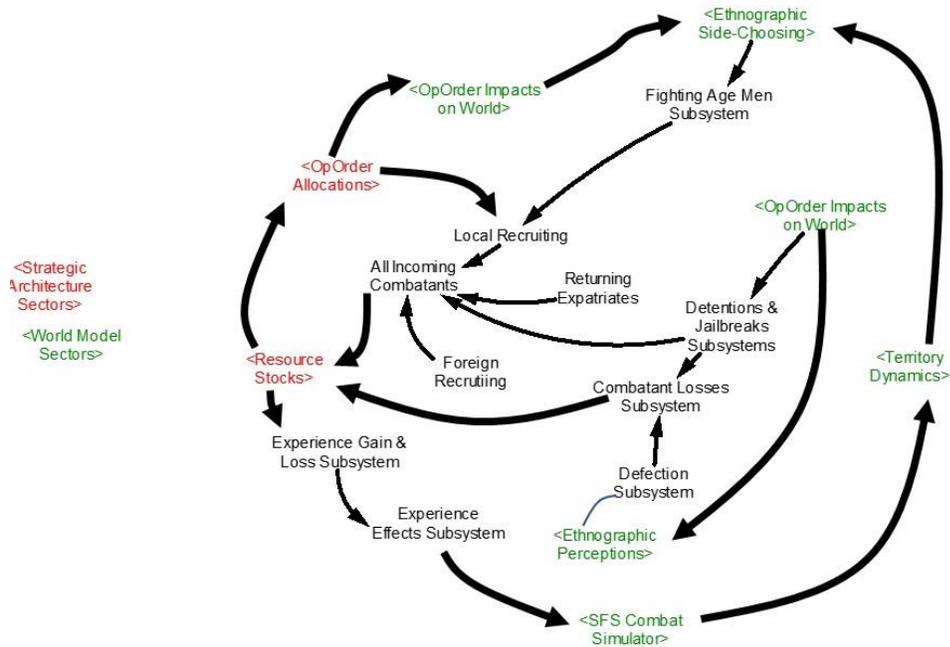
Figure D-2: Combatant Recruiting & Losses Sector

Equations

Actor Combatants that are Foreign[Ethnographies,Actors] = INTEG(Chng in Troop Composition[

Ethnographies,Actors] , Local vs Foreign Forces[Ethnographies,Actors]

)

    Units: Pct

Actor Infantry Actual Losses[Green] = Green Infantry Final Losses[Green] - (Opposition Combatant Losses[

Green]) - Blue or Purple Combatant Losses[Green]

Actor Infantry Actual Losses[Red] = Red Infantry Final Losses[Red] - (Opposition Combatant Losses[

Red]) - Blue or Purple Combatant Losses[Red]

Units: People/Period

Actor Perception of Momentum[Green] = Perception of Momentum[Green] - Perception of Momentum[

Red]

Actor Perception of Momentum[Red] = Perception of Momentum[Red] - Perception of Momentum[

Green]

Units: Pct/Period

Actual Governed Local Recruiting[Ethnographies,Actors] = (Target Recruitment Governed[

Ethnographies,Actors]) * FAM Modifier for Governed[Ethnographies,Actors]

Units: People/Period

Actual Local Calculated Recruiting[Ethnographies,Actors] = Target Recruitment Calculated Legit[

Ethnographies,Actors] * FAM Modifier for Calc Legit[Ethnographies,Actors]

Units: People/Period

Actual Recruiting Fighting Age Men in Population[Ethnographies,Actors] = (STARTING NORMAL PCT OF FIGHTING AGE MEN IN POPULATION[

Ethnographies] * (1 + Experience Effect on Actions[Actors]))

Units: Pct

The ethnographic norm +capability of the actor based on experience.

Actual Recruits per Suicide Attack[Actors] = GAME(NORMAL FOREIGN RECRUITS INSPIRED PER TERRORIST ATTACK[

Actors] * Effect of Experience on Recruiting Efforts[Actors] * Effect of Remaining Recruits on Recruiting Efforts[

Actors])

Units: People/Military Action

D-3 Strategic Architecture Sectors & Equations

Adequacy of Calc Legit FAM[Ethnographies,Actors] = ZIDZ (CoFlow Fighting Age Men from Calculated Legitimacy[

Ethnographies,Actors] / NORMAL PERIOD , Target Recruitment Calculated Legit[

Ethnographies,Actors])

Units: Dmnl

Adequacy of Governed FAM[Ethnographies,Actors] = ZIDZ (CoFlow Fighting Age Men from Governed[

Ethnographies,Actors] / NORMAL PERIOD , Target Recruitment Governed[Ethnographies

,Actors])

Units: Pct

ZIDZ(Target Recruitment Governed[Ethnographies,Actors],CoFlow

Fighting Age Men from Governed[Ethnographies,Actors])

All Decreases in Calc FAM[Ethnographies,Actors] = Cal Legit Pop Dying[Ethnographies

,Actors] + Calc Legit Refugees Leaving[Ethnographies,Actors] + Calculated Lost to Conquest[

Ethnographies,Actors] + Calculated to Governed[Ethnographies,Actors]

+ Calculated to Governed[Ethnographies,Actors]

Units: People/Period

All Decreases in Governed Fam[Ethnographies,Actors] = (Governed Dying[Ethnographies

,Actors] + Governed Lost to Conquest[Ethnographies,Actors] + Governed Refugees Leaving[

Ethnographies,Actors] + Governed to Calculated[Ethnographies,Actors]

) * Actual Recruiting Fighting Age Men in Population[Ethnographies,Actors]

Units: People/Period

All Increases in Calc FAM[Ethnographies,Actors] = Coerced to Calculated[Ethnographies

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,Actors] + Governed to Calculated[Ethnographies,Actors] + Local Opposition Joining Opposing Actor Militants[

Ethnographies,Actors] + Unaligned Choosing Sides[Ethnographies,Actors

]

Units: People/Period

All Increases in Governed FAM[Ethnographies,Actors] = Calculated to Governed[Ethnographies

,Actors] * Actual Recruiting Fighting Age Men in Population[Ethnographies,

Actors]

Units: People/Period

Allocation of Essential Budgets[Actors] = Table for Effect of Sufficiency of Reserves on Essentials Bankruptcy Policy[

Actors] (ZIDZ (Finances[Actors] , Normal Actor Desired Local Reserves[Actors

]))

Units: Dmnl

Average Combatant Experience[Actors] = ZIDZ (Combatant Experience[Actors] , Total Combatants[

Actors])

Units: Exp Years/Person

Average Time to Defect[Actors] = 10

Units: Periods

AVG EXPERIENCE OF ESCAPED DETAINEE[Actors] = 0, 10

Units: Exp Years/Person

Set at 10 need actual vaule to finish.

AVG EXPERIENCE OF FOREIGN RECRUIT[Actors] = 1

> Units: Exp Years/Person

> Set at 1 update for final.

AVG EXPERIENCE OF LOCAL RECRUIT[Actors] = 3

> Units: Exp Years/Person

> Set at 3 update for final.

Blue or Purple Combat Training Effect[Actors] = MIN (1, ZIDZ (Normal Training Reach[

> Actors] * Blue or Purple Embedded Combat Advisers[Actors] , Conventional Warfare[

> Actors]))

> Units: Pct

Blue or Purple Personnel[Actors] = INTEG(Increase in Blue Personnel[Actors] - Decrease in Blue Personnel[

> Actors] , Starting Blue or Purple Personnel[Actors])

> Units: People

Cal Legit Pop Dying[Ethnographies,Actors] = Calc Legit Pop Deaths[Ethnographies,

Actors]

> Units: People/Period

Calc Legit Pop[Ethnographies,Actors] = INTEG(Coerced to Calculated[Ethnographies

> ,Actors] + Governed to Calculated[Ethnographies,Actors] + Unaligned Choosing Sides[

> Ethnographies,Actors] - Cal Legit Pop Dying[Ethnographies,Actors

>] - Calc Legit Pop Recruited or Joining Uprising[Ethnographies,Actors

>] - Calc Legit Refugees Leaving[Ethnographies,Actors] - Calculated Lost to Conquest[

> Ethnographies,Actors] - Calculated to Coerced[Ethnographies,Actors

] - Calculated to Governed[Ethnographies,Actors] , STARTING LEVEL OF ETHNOGRAPHIC POPULATION[

Ethnographies] * STARTING ETHNO DISTRIBUTION CALCULATED[Ethnographies

,Actors])

Units: People

Calc Legit Pop Recruited or Joining Uprising[Ethnographies,Actors] = Calc Legit Recruited[

Ethnographies,Actors]

Units: People/Period

Calc Legit Recruited[Ethnographies,Actors] = Actual Local Calculated Recruiting[

Ethnographies,Actors]

Units: People/Period

Actual Governed Local Recruiting[Ethnographies,Actors]*"Pct Calc

Legit Fighting Age Men (Red)"[Ethnographies,Actors]

Calc Legit Refugees Leaving[Ethnographies,Actors] = Calc Legit Pop Refugees[Ethnographies

,Actors]

Units: People/Period

Calculated Lost to Conquest[Ethnographies,Actors] = Loss of CalcLegit due to Conquest[

Ethnographies,Actors] * Ethno by Actor Sufficiency[Ethnographies,Actors]

Units: People/Period

Calculated to Coerced[Ethnographies,Actors] = MAX (0, (Calc Legit Pop[Ethnographies

,Actors] * Fr Transition to Coerced[Ethnographies,Actors]) / NORMAL TIME FOR POPULATION TRANSITION[

Ethnographies,Actors])

Units: People/Period

Calculated to Governed[Ethnographies,Actors] = MAX (0, (Calc Legit Pop[Ethnographies

,Actors] * Fr Transition to Legitimacy[Ethnographies,Actors]) / NORMAL TIME FOR POPULATION TRANSITION[

Ethnographies,Actors])

Units: People/Period

Chng in Troop Composition[Ethnographies,Actors] = (Local vs Foreign Forces[Ethnographies

,Actors] - Actor Combatants that are Foreign[Ethnographies,Actors]) / Perception Formation Time[

Ethnographies]

Units: Pct/Period

Coerced to Calculated[Ethnographies,Actors] = MAX (0, (Coerced Pop[Ethnographies

,Actors] * Fr Transition to Calculated Legitimatcy[Ethnographies,Actors

]) / NORMAL TIME FOR POPULATION TRANSITION[Ethnographies,Actors

])

Units: People/Period

CoFlow Fighting Age Men from Calculated Legitimacy[Ethnographies,Actors] = INTEG(

Increase in FA Calc Legit[Ethnographies,Actors] - Decrease in FA Calc Legit[

Ethnographies,Actors] , Calc Legit Pop[Ethnographies,Actors] * Actual Recruiting Fighting Age Men in Population[

Ethnographies,Actors])

Units: People

CoFlow Fighting Age Men from Governed[Ethnographies,Actors] = INTEG(Increase in FAM Governed[

Ethnographies,Actors] - Decrease in FAM Governed[Ethnographies,Actors

] , Governed Pop[Ethnographies,Actors] * Actual Recruiting Fighting Age Men in Population[

Ethnographies,Actors])

Units: People

Combat Multiplier[Actors] = 1 + (Combat Multiplier from Experience[Actors] + SCENARIO MORALE EFFECT[

Red] + Blue or Purple Combat Training Effect[Actors])

Units: Dmnl

Combat Multiplier from Experience[Actors] = Table for Effect of Experience on Combat Multiplier[

Actors] (Average Combatant Experience[Actors] * Dimensioned Ratio Average Militant Experience[

Actors])

Units: Dmnl

Combatant Experience[Actors] = INTEG(Gain in Experience[Actors] - Loss of Experience[

Actors] , Starting Experience[Actors])

Units: Exp Years

Combatant Experience Gain[Actors] = (Total Combatants[Actors] * (NORMAL EXPERIENCE GAINED PER PERSON[

Actors] + Experience Gained from Blue or Purple Training[Actors]))

/ NORMAL PERIOD

Units: Exp Years/Period

Combatants[Ethnographies,Actors] = INTEG(Combatant Additions[Ethnographies,Actors

] - Combatant Losses[Ethnographies,Actors] , Starting Combatants[Ethnographies

,Actors])

Units: People

D-3 Strategic Architecture Sectors & Equations

Completed Terrorist Attacks by Ethnography[Ethnographies,Red] = Terrorist Attempts[

Ethnographies,Red] * (1 - CT Effectiveness[Green])

Completed Terrorist Attacks by Ethnography[Ethnographies,Green] = Terrorist Attempts[

Ethnographies,Green] * (1 - CT Effectiveness[Red])

Units: Military Actions/Period

CT Effectiveness[Green] = Table for CT Effectiveness (Effective CounterTerrorism Efforts[

Green])

CT Effectiveness[Red] = Table for CT Effectiveness (Effective CounterTerrorism Efforts[

Red])

Units: Dmnl

Table for CT Effectiveness(1-ZIDZ (SUM(Terrorist

Attempts[Ethnographies!,Red]),Effective CounterTerrorism

Efforts[Green]))

Cumm Combatant Deaths by Actor[Actors] = INTEG(Increase in Cumm Combatant Deaths by Actor[

Actors] , 0)

Units: People

Deaths[Actors] = (Actor Infantry Actual Losses[Actors] * PCT OF LOSSES THAT ARE DEATH[

Actors]) + Deaths from CT Operations[Actors] + Deaths from Thwarted Prison Breaks[

Actors]

Units: People/Period

(Red Infantry Final Losses[Red]*PCT OF LOSSES THAT ARE

DEATH[Red])/Time to Realize Losses+ Deaths from CT

Operations[Red]+Deaths from Thwarted Prison Breaks[Red]

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Deaths from CT Operations[Actors] = Normal Deaths per Thwarted Action[Actors] *

Thwarted Terrorist Attacks[Actors]

Units: People/Period

Deaths from Thwarted Prison Breaks[Actors] = Normal Deaths per Thwarted Action[Actors

] * Thwarted Prison Break Actions[Actors]

Units: People/Period

Decrease in FA Calc Legit[Ethnographies,Actors] = MIN (FAM Calc Decrease[Ethnographies

,Actors] , CoFlow Fighting Age Men from Calculated Legitimacy[Ethnographies

,Actors] / NORMAL PERIOD)

Units: People/Period

Decrease in FAM Governed[Ethnographies,Actors] = MIN (FAM Gov Decrease[Ethnographies

,Actors] , CoFlow Fighting Age Men from Governed[Ethnographies,Actors

] / NORMAL PERIOD)

Units: People/Period

Defections by Ethnography[Ethnographies,Actors] = (NORMAL DEFECTIONS DUE TO ETHNOGRAPHIC DISTRUST[

Ethnographies,Actors] + NORMAL DEFECTIONS DUE TO PAY INSUFFICIENCY[Actors]

+ Normal Defections from Momentum[Ethnographies,Red]) * Combatants[Ethnographies

,Actors]

Units: People/Period

Defections within Prison[Actors] = (((1 - Detention Benefits Gap[Actors]) /

Average Time to Defect[Actors]) * Detainees in Prison[Actors]) + Detainees in Prison[

Actors] * Prison Defections Based on Momentum[Actors]

    Units: People/Period

Detainees from CT Operations[Actors] = Normal Detainees per Thwarted Action[Actors

    ] * Thwarted Terrorist Attacks[Actors]

        Units: People/Period

Detainees from Thwarted Prison Breaks[Actors] = Normal Detainees per Thwarted Action[

    Actors] * Thwarted Prison Break Actions[Actors]

        Units: People/Period

Detainees in Prison[Actors] = INTEG(Increase in Detentions[Actors] - Defections within Prison[

        Actors] - Detainees Released[Actors] - Defections within Prison[

        Actors] , STARTING DETAINEES BY ACTOR[Actors])

        Units: People

Detainees Released[Actors] = (Ratio of Prisons Targeted versus Prisons[Actors]

      * Detainees in Prison[Actors]) / NORMAL PERIOD

        Units: People/Period

Detention Benefits Gap[Actors] = ZIDZ (Detention Benefits[Actors] , (Detainees in Prison[

    Actors] * Wages[Actors]))

        Units: Pct

Detentions[Actors] = (Actor Infantry Actual Losses[Actors] * PCT OF LOSSES THAT ARE DETENTIONS[

    Actors]) + Detainees from CT Operations[Actors] + Detainees from Thwarted Prison Breaks[

    Actors]

D-3 Strategic Architecture Sectors & Equations

Units: People/Period

(Red Infantry Final Losses[Red]*PCT OF LOSSES THAT ARE

DETENTIONS[Red])/Time to Realize Losses+ Detainees from CT

Operations[Red]+Detainees from Thwarted Prison Breaks[Red]

Dimensioned Ratio Average Militant Experience[Actors] = 1, 1

Units: Person/Exp Years

Effect of Experience on Recruiting Efforts[Actors] = Table for Effect of Militant Experience on Foreign Recruiting Efforts

(Average Combatant Experience[Actors] * Dimensioned Ratio Average Militant Experience[

Actors])

Units: Dmnl

Estimated parameter from data or nearby model structure see Section A for discussion.

Effect of Remaining Recruits on Recruiting Efforts[Actors] = Table for Effect of Remaining Recruits on Recruiting Efforts

(Pct Remaining Recruits[Actors])

Units: Dmnl

Estimated parameter from data or nearby model structure see Section A for discussion.

EFfective Prison Break Actions[Green] = MAX (0, Prison Break Actions[Green] - (

Prison Duty Actions[Red] * CT Effectiveness[Red]))

EFfective Prison Break Actions[Red] = MAX (0, Prison Break Actions[Red] - (Prison Duty Actions[

Green] * CT Effectiveness[Green]))

Units: Military Actions/Period

Escaped Detainees by Ethnography[Ethnographies,Actors] = Pct Combatants by Ethnography[

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Ethnographies,Actors] * Escaped Detainees Joining Actor[Actors]

     Units: People/Period

Escaped Detainees Joining Actor[Actors] = Detainees Released[Actors] * Percentage of Escaped or Released Detainees Joining ISIS[

     Actors]

      Units: People/Period

Exp Years per Pct Training[Actors] = 1

      Units: Exp Years/(Pct*Person)

Expatriate Fighters[Actors] = INTEG(- Expatriate Fighters Returning[Actors] , Starting Actor Conditions Expatriate Fighters[

     Actors])

      Units: People

Expatriate Fighters by Ethnography[Ethnographies,Actors] = Expatriate Fighters Returning[

    Actors] * Pct Combatants by Ethnography[Ethnographies,Actors]

      Units: People/Period

Expatriate Fighters Returning[Actors] = Expatriate Fighters[Actors] * Fraction Returning per Period[

    Actors]

      Units: People/Period

Experience Effect on Actions[Actors] = Table for Effect of Militant Experience on Military Actions

    (Average Combatant Experience[Actors] * Dimensioned Ratio Average Militant Experience[

     Actors]) * Allocation of Essential Budgets[Actors]

      Units: Pct

D-3 Strategic Architecture Sectors & Equations
Derived from AQI implied local recruiting patterns. Estimated

parameter from data or nearby model structure see Section A for

discussion.

Experience Gain from Foreign Fighters[Actors] = AVG EXPERIENCE OF FOREIGN RECRUIT[

   Actors] * Foreign Fighter Increase[Actors]

      Units: Exp Years/Period

Experience gain from Joining Combatants[Actors] = (AVG EXPERIENCE OF ESCAPED DETAINEE[

   Actors] * Escaped Detainees Joining Actor[Actors]) + (Experience Gain from Foreign Fighters[

      Actors]) + ((SUM (Actual Governed Local Recruiting[Ethnographies!

        ,Actors])) * AVG EXPERIENCE OF LOCAL RECRUIT[Actors])

      Units: Exp Years/Period

Experience Gained from Blue or Purple Training[Actors] = Blue or Purple Combat Training Effect[

   Actors] * Exp Years per Pct Training[Actors]

      Units: Exp Years/Person

FAM Calc Decrease[Ethnographies,Actors] = MAX (0, (All Decreases in Calc FAM[Ethnographies

      ,Actors] * Actual Recruiting Fighting Age Men in Population[Ethnographies

        ,Actors]) + Actual Local Calculated Recruiting[Ethnographies,Actors

        ])

      Units: People/Period

FAM Calc Increase[Ethnographies,Actors] = MAX (0, All Increases in Calc FAM[Ethnographies

      ,Actors] * Actual Recruiting Fighting Age Men in Population[Ethnographies

        ,Actors])

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Units: People/Period

FAM Gov Decrease[Ethnographies,Actors] = Actual Governed Local Recruiting[Ethnographies

,Actors] + All Decreases in Governed Fam[Ethnographies,Actors]

Units: People/Period

FAM Gov Increase[Ethnographies,Actors] = All Increases in Governed FAM[Ethnographies

,Actors]

Units: People/Period

FAM Modifier for Calc Legit[Ethnographies,Actors] = Table for Effect of Remaining Recruits on Recruiting Efforts

(Adequacy of Calc Legit FAM[Ethnographies,Actors])

Units: Dmnl

FAM Modifier for Governed[Ethnographies,Actors] = Table for Effect of Remaining Recruits on Recruiting Efforts

(Adequacy of Governed FAM[Ethnographies,Actors])

Units: Pct

Foreign Fighter Increase[Actors] = Foreign Recruiting[Actors]

Units: People/Period

Foreign Recruiting[Actors] = ((Actual Recruits per Suicide Attack[Actors] * (

SUM (Completed Terrorist Attacks by Ethnography[Ethnographies!,Actors

]))) * Foreign Recruiting Eliminated[Actors]) * Allocation of Essential Budgets[

Actors]

Units: People/Period

Foreign Recruiting Eliminated[Actors] = 0, 1

    Units: Dmnl

    Normal is 1. 0 means foreign recruiting is completely eliminated.

Fraction Returning per Period[Actors] = 0, 0.55

    Units: Pct/Period

Governed Dying[Ethnographies,Actors] = Goverened Deaths[Ethnographies,Actors]

    Units: People/Period

Governed Lost to Conquest[Ethnographies,Actors] = Loss of Governed due to Conquest[
   Ethnographies,Actors] * Ethno by Actor Sufficiency[Ethnographies,Actors]

    Units: People/Period

Governed Pop[Ethnographies,Actors] = INTEG(Calculated to Governed[Ethnographies
    ,Actors] - Governed Dying[Ethnographies,Actors] - Governed Lost to Conquest[
        Ethnographies,Actors] - Governed Pop Recruited[Ethnographies,Actors
        ] - Governed Refugees Leaving[Ethnographies,Actors] - Governed to Calculated[
        Ethnographies,Actors] , STARTING LEVEL OF ETHNOGRAPHIC POPULATION[
    Ethnographies] * STARTING ETHNO DISTRIBUTION GOVERNED[Ethnographies,Actors
        ])

    Units: People

Governed Recruited[Ethnographies,Actors] = Actual Governed Local Recruiting[Ethnographies
    ,Actors]

    Units: People/Period

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Governed Refugees Leaving[Ethnographies,Actors] = Governed Refugees[Ethnographies

,Actors]

Units: People/Period

Governed to Calculated[Ethnographies,Actors] = MAX (0, (Governed Pop[Ethnographies

,Actors] * Fr Transition Back to Calculated[Ethnographies,Actors]) /

NORMAL TIME FOR POPULATION TRANSITION[Ethnographies,Actors])

Units: People/Period

"Governance Gap (Red)"[Ethnographies,Actors]/NORMAL TIME FOR

POPULATION TRANSITION[Ethnographies,Actors]

Green Infantry Final Losses[Green] = (Green Infantry Initial Losses[Green] - (

Green Infantry Initial Losses[Green] * Infantry Recovery[Green])) /

NORMAL PERIOD

Units: People/Period

Incoming Combatants[Ethnographies,Actors] = INTEG(Rate of Incoming Combatants[Ethnographies

,Actors] , 0)

Units: People

Increase in Cumm Combatant Deaths by Actor[Actors] = Deaths[Actors]

Units: People/Period

Increase in Detentions[Actors] = Detentions[Actors]

Units: People/Period

Increase in FA Calc Legit[Ethnographies,Actors] = FAM Calc Increase[Ethnographies

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,Actors]

Units: People/Period

Increase in FAM Governed[Ethnographies,Actors] = FAM Gov Increase[Ethnographies,

Actors]

Units: People/Period

Inflow of Foreign Recruits[Actors] = Foreign Recruiting[Actors]

Units: People/Period

Inflow of Foreign Recruits by Ethnography[Ethnographies,Actors] = Inflow of Foreign Recruits[

Actors] * Pct Combatants by Ethnography[Ethnographies,Actors]

Units: People/Period

Killed Militants Total = INTEG(Rate of Militant Deaths Total , 0)

Units: People

Adjust initial level based on starting time of model.

Local Opposition Joining Opposing Actor Militants[Ethnographies,Actors] = MAX (

0, (Local Opposition Fighters to Actor[Ethnographies,Actors] * Normal Fraction Joining Opposing Actor or Militias[

Ethnographies])) / NORMAL PERIOD

Units: People/Period

Local Recrutiing[Ethnographies,Actors] = Calc Legit Recruited[Ethnographies,Actors

] + Governed Recruited[Ethnographies,Actors]

Units: People/Period

D-3 Strategic Architecture Sectors & Equations

Local vs Foreign Forces[Ethnographies,Actors] = 1 - ZIDZ (Combatants[Ethnographies

,Actors] , Blue or Purple Personnel[Actors] + Total Combatants[Actors

])

Units: Percentage

"Loss of all Combatants from Deaths, Detentions and Defections"[Actors] = Deaths[

Actors] + Total Defections[Actors] + Detentions[Actors]

Units: People/Period

"Loss of Foreign Combatants by Deaths, Detentions and Defections"[Actors] = Pct of Combatants that are Foreign[

Actors] * "Loss of all Combatants from Deaths, Detentions and Defections"[

Actors]

Units: People/Period

Loss of Local Combatants by Ethnography[Ethnographies,Actors] = "Loss of Local Combatants from Deaths, Detentions and Defections"[

Actors] * Pct Combatants by Ethnography[Ethnographies,Actors]

Units: People/Period

"Loss of Local Combatants from Deaths, Detentions and Defections"[Actors] = "Loss of all Combatants from Deaths, Detentions and Defections"[

Actors] - "Loss of Foreign Combatants by Deaths, Detentions and Defections"[

Actors]

Units: People/Period

MILITARY ACTIONS NEEDED PER PRISON BREAK ATTEMPT = 1

Units: Military Actions/(Period*Prison)

1

Normal Deaths per Thwarted Action[Actors] = 11, 2

Units: People/Military Action

NORMAL DEFECTIONS DUE TO ETHNOGRAPHIC DISTRUST[Ethnographies,Actors] = (1 - Pct views Actor as best choice for now[

Ethnographies,Actors]) / Average Time to Defect[Actors]

Units: Pct/Period

See Section A for discussion.

NORMAL DEFECTIONS DUE TO PAY INSUFFICIENCY[Actors] = (1 - Payroll Gap[Actors])

/ Average Time to Defect[Actors]

Units: Pct/Period

Normal Defections from Momentum[Ethnographies,Red] = IF THEN ELSE (Actor Perception of Momentum[

Red] < 0, - (Actor Perception of Momentum[Red]) , 0)

Units: Pct/Period

Normal Detainees per Thwarted Action[Actors] = 0, 2

Units: People/Military Action

NORMAL EXPERIENCE GAINED PER PERSON[Actors] = 0, 0.5

Units: Exp Years/Person

Represents training effect. 1 = an effective year of professional

training. Conscripts with effectively no training gain 0 per period

where as partly trained troops may earn .5.

NORMAL FOREIGN RECRUITS INSPIRED PER TERRORIST ATTACK[Actors] = 0, 26

      Units: People/Military Action

      Estimated 18-26 recruits per suicide attack that is then

            propogandized. This may represent higher end of a nonlinear curve

            based on media proficiency. Estimated parameter from data or nearby

            model structure see Section A for discussion.

NORMAL NUMBER OF DETAINEES PER PRISON = 50

      Units: People/Prison

NORMAL PERIOD = 1

      Units: Period

NORMAL RECRUITS PER MILITARY ACTION FOR CALCULATED[Ethnographies,Red] = 15, 15,

   15

NORMAL RECRUITS PER MILITARY ACTION FOR CALCULATED[Ethnographies,Green] = 10, 10

  , 10

      Units: People/Military Action

NORMAL RECRUITS PER MILITARY ACTION FOR GOVERNED[Ethnographies,Red] = 20, 2, 2

NORMAL RECRUITS PER MILITARY ACTION FOR GOVERNED[Ethnographies,Green] = 5, 25, 5

      Units: People/Military Action

      Estimate needs verification.

Normal Starting Worldwide Population[Actors] = 0, 50000

Units: People

Number of Prisons Targeted[Actors] = EFfective Prison Break Actions[Actors] / MILITARY ACTIONS NEEDED PER PRISON BREAK ATTEMPT

Units: Prisons

Payroll Gap[Actors] = ZIDZ (Payroll[Actors] , (Total Combatants[Actors] * Wages[

Actors]))

Units: Pct

Pct Combatants by Ethnography[Ethnographies,Actors] = ZIDZ (Combatants[Ethnographies

,Actors] , Total Local Combatants[Actors])

Units: Pct

Pct of Combatants that are Foreign[Actors] = ZIDZ (Foreign Combatants[Actors] ,

Total Combatants[Actors])

Units: Pct

PCT OF LOSSES THAT ARE DEATH[Actors] = 1, 0.43

Units: Fraction

Derived from research need to finalize.

PCT OF LOSSES THAT ARE DETENTIONS[Actors] = 0, 0.57

Units: Pct

Derived from research. Need to confirm with causal factors.

Pct Remaining Recruits[Actors] = 1 - ZIDZ (Total Foreign Recruits[Actors] , STARTING WORLDWIDE POPULATION OF FOREIGN RECRUITS[

Actors])

Units: Percentage

Estimated parameter from data or nearby model structure see Section A for discussion.

Pct views Actor as best choice for now[Ethnographies,Actors] = IF THEN ELSE (Ethnographic Short Term Perception of Actor[

Ethnographies,Actors] < 0, 0, MAX (0, MIN (1, ZIDZ (Ethnographic Short Term Perception of Actor[

Ethnographies,Actors] , Total Ethno Population[Ethnographies

]))))

Units: Pct

Percentage of Escaped or Released Detainees Joining ISIS[Actors] = 1

Units: Fraction

Set at 1 check estiamte for final.

Perception Formation Time[Ethnographies] = 1

Units: Period

Prison Break Actions[Actors] = Actual Military Actions[Actors] * OpOrder Prison Breaks[

Actors]

Units: Military Actions/Period

Prison Defections Based on Momentum[Actors] = IF THEN ELSE (Actor Perception of Momentum[

Actors] < 0, - (Actor Perception of Momentum[Actors]) * 2, 0)

Units: Pct/Period

Prison Duty Actions[Actors] = Actual Military Actions[Actors] * OpOrder Prison Duty[

Actors]

Units: Military Actions/Period

Prisons to Target[Actors] = Detainees in Prison[Actors] / NORMAL NUMBER OF DETAINEES PER PRISON

Units: Prisons

Rate of Incoming Combatants[Ethnographies,Red] = (Actual Local Calculated Recruiting[

Ethnographies,Red] + Actual Governed Local Recruiting[Ethnographies,Red] +

Escaped Detainees by Ethnography[Ethnographies,Red] + Local Opposition Joining Opposing Actor Militants[

Ethnographies,Green] + Inflow of Foreign Recruits by Ethnography[Ethnographies

,Red] + Expatriate Fighters by Ethnography[Ethnographies,Red] + Test Extreme Conditions Combatants[

Ethnographies,Red])

Rate of Incoming Combatants[Ethnographies,Green] = (Actual Local Calculated Recruiting[

Ethnographies,Green] + Actual Governed Local Recruiting[Ethnographies,Green

] + Escaped Detainees by Ethnography[Ethnographies,Green] + Local Opposition Joining Opposing Actor Militants[

Ethnographies,Red] + Expatriate Fighters by Ethnography[Ethnographies

,Green] + Inflow of Foreign Recruits by Ethnography[Ethnographies,Green

] + Test Extreme Conditions Combatants[Ethnographies,Green])

Units: People/Period

Rate of Militant Deaths Total = SUM (Deaths[Actors!])

Units: People/Period

Rate of Recruiting to Actor[Actors] = Foreign Recruiting[Actors]

Units: People/Period

Ratio of Prisons Targeted versus Prisons[Actors] = MIN (ZIDZ (Prisons to Target[

Actors] , Prisons to Target[Actors]) , MAX (0, ZIDZ (Prisons to Target[

Actors] , Number of Prisons Targeted[Actors])))

Units: Pct

MIN(ZIDZ(Prisons to Target[Actors],Prisons to

Target[Actors]),MAX(0,ZIDZ(Prisons to Target[Actors],Number of

Prisons Targeted[Actors])))

Recruiting Actions[Ethnographies,Actors] = Actual Military Actions[Actors] * OpOrder Recruiting[

Ethnographies,Actors]

Units: Military Actions/Period

Red Infantry Final Losses[Red] = (Red Infantry Initial Losses[Red] - (Red Infantry Initial Losses[

Red] * Infantry Recovery[Red])) / NORMAL PERIOD

Units: People/Period

SCENARIO MORALE EFFECT[Actors] = 0, 0.125

Units: Dmnl

Starting Actor Conditions Expatriate Fighters[Actors] = 0, 0

Units: People

STARTING DETAINEES BY ACTOR[Actors] = 0, 1500

Units: People

Determines starting value of detainees by actor.

D-3 Strategic Architecture Sectors & Equations

STARTING WORLDWIDE POPULATION OF FOREIGN RECRUITS[Actors] = GAME(Normal Starting Worldwide Population[

    Actors])

    Units: People

    Estimated parameter from data or nearby model structure see Section A for discussion.

Table for Effect of Experience on Combat Multiplier[Actors] ([(0,-0.3)-(10,1)],

    (0,-0.25),(0.5,-0.125),(1,0),(1.5,0.125),(2,0.25),(2.5,0.5),(3,0.75)

    ,(10,0.75))

    Units: Dmnl

Table for Effect of Militant Experience on Foreign Recruiting Efforts ([(0,0)-(10,2)

    ],(0,0.5),(1,0.75),(2,0.9),(3,1),(4,1.25),(5,1.5),(10,1.5))

    Units: Dmnl

    Estimated parameter from data or nearby model structure see Section A

 for discussion.

Table for Effect of Militant Experience on Military Actions ([(0,0)-(10,0.3)],(0,0.01)

    ,(1,0.03),(2,0.06),(3,0.09),(4,0.11),(5,0.12),(10,0.12))

    Units: Dmnl

    Estimated parameter from data or nearby model structure see Section A for discussion.

Table for Effect of Remaining Recruits on Recruiting Efforts ([(0,0)-(1,1)],(0,0)

    ,(0.01,0),(0.03,0),(0.05,0),(0.1,0.0125),(0.2,0.025),(0.3,0.05),(0.4,0.1)

    ,(0.5,0.2),(0.6,0.35),(0.7,0.65),(0.8,0.85),(0.9,0.95),(0.95,0.975),

    (0.97,0.985),(0.99,0.99),(1,1))

Units: Dmnl

Parameter is based on modeler assumption, see Section A for

discussion.

[(0,0)-(1,1)],(0,1),(0.1,0.95),(0.2,0.85),(0.3,0.65),(0.4,0.35),(0.5,0

.2),(0.6,0.1),(0.7,0.05),(0.8,0.025),(0.9,0.0125),(0.95,0),(0.97,0),(0

.99,0),(1,0),(1,0),(2,0),(10,0)

Target Recruitment Calculated Legit[Ethnographies,Actors] = (NORMAL RECRUITS PER MILITARY ACTION FOR CALCULATED[

    Ethnographies,Actors] * Recruiting Actions[Ethnographies,Actors])

        Units: People/Period

Target Recruitment Governed[Ethnographies,Actors] = (NORMAL RECRUITS PER MILITARY ACTION FOR GOVERNED[

    Ethnographies,Actors] * Recruiting Actions[Ethnographies,Actors])

        Units: People/Period

Test Extreme Conditions Combatants[Ethnographies,Actors] = GAME(0)

        Units: People/Period

Thwarted Prison Break Actions[Actors] = Prison Break Actions[Actors] - EFfective Prison Break Actions[

    Actors]

        Units: Military Actions/Period

Total Combatants[Actors] = Total Local Combatants[Actors] + Foreign Combatants[Actors

    ]

        Units: People

Total Defections[Actors] = SUM (Defections by Ethnography[Ethnographies!,Actors

])

Units: People/Period

Total Experience Loss due to Militant Losses[Actors] = (Average Combatant Experience[

Actors] * "Loss of all Combatants from Deaths, Detentions and Defections"[

Actors])

Units: Exp Years/Period

Total Foreign Recruits[Actors] = INTEG(Inflow of Foreign Recruits[Actors] , 0)

Units: People

Total Local Recruiting[Ethnographies,Actors] = INTEG(Local Recrutiing[Ethnographies

,Actors] , 0)

Units: People

Unaligned Choosing Sides[Ethnographies,Green] = Unaligned to Calculated[Ethnographies

,Red]

Unaligned Choosing Sides[Ethnographies,Red] = Unaligned to Calculated[Ethnographies

,Green]

Units: People/Period

Worldwide Recruitable Population[Actors] = INTEG(- Rate of Recruiting to Actor[

Actors] , STARTING WORLDWIDE POPULATION OF FOREIGN RECRUITS[Actors])

Units: People

D-3.3 Governance

Overview
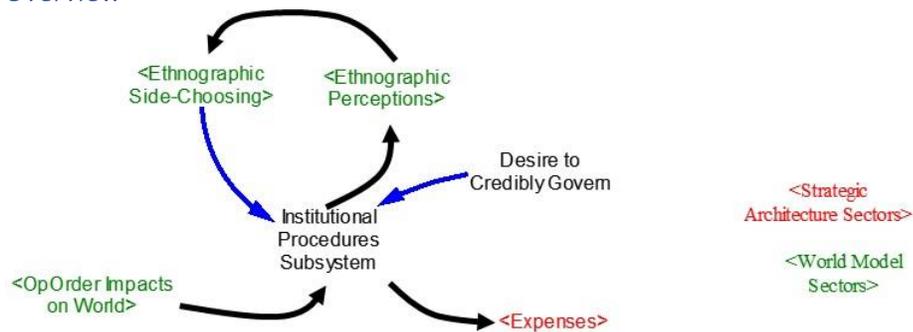
Figure D-3: Governance Sector Overview

Equations

Increase in Institutional Procedures[Ethnographies,Actors] = MAX (0, (Organic Procedures[

Ethnographies,Actors] + Procedural Development[Ethnographies,Actors]

+ Replacing Obsolete Procedures[Ethnographies,Actors] + Impact of Armed Civil Affairs[

Actors]))

Units: Procedures/Period

MAX(0,(Adj to Procedural Spend[Actors]*Organic

Procedures[Ethnographies,Actors])+ (Adj to Procedural

Spend[Actors]*Procedural Development[Ethnographies,Actors])+ (Adj to

Procedural Spend[Actors]*Replacing Obsolete

Procedures[Ethnographies,Actors]))

Institutional Procedures[Ethnographies,Actors] = INTEG(Increase in Institutional Procedures[

Ethnographies,Actors] - Procedural Decay[Ethnographies,Actors] - Reduction in Institutional Procedures[

Ethnographies,Actors] , Desired Institutional Procedures[Ethnographies

,Actors] + Legacy Procedures Step Test[Ethnographies,Red])

Units: Procedures

Organic Procedural Development[Ethnographies,Actors] = Table for Effect of Procedural Adequacy[

Actors] (Procedural Adequacy[Ethnographies,Actors])

Units: Pct

Organic Procedures[Ethnographies,Actors] = MAX (0, (((Institutional Procedures[

Ethnographies,Actors] / 100) * Organic Procedural Development[Ethnographies

,Actors]) * "Allocation of Non-Essential Budgets"[Actors]) / ORGANIC PROCEDURAL DEVELOPMENT TIME[

Actors])

Units: Procedures/Period

Procedural Adequacy[Ethnographies,Actors] = ZIDZ (Institutional Procedures[Ethnographies

,Actors] , Desired Institutional Procedures[Ethnographies,Actors])

Units: Pct

Procedural Decay[Ethnographies,Actors] = MAX (0, (Institutional Procedures[Ethnographies

,Actors] / Normal Procedural Decay Fraction))

Units: Procedures/Period

Procedural Development[Ethnographies,Actors] = ((Desired Institutional Procedures[

Ethnographies,Actors] / Normal Procedural Development Time[Actors]) - (Institutional Procedures[

Ethnographies,Actors] / Normal Procedural Development Time[Actors])

) * "Allocation of Non-Essential Budgets"[Actors]

Units: Procedures/Period

Actual Desire to Credibly Govern[Ethnographies,Actors] = GAME(Normal Desire to Credibly Govern[

Ethnographies,Actors])

Units: Pct

D-3 Strategic Architecture Sectors & Equations

Actual Effect of Kinetic Attacks on Governing Capacity[Actors] = Effect of Kinetic Attacks on Governing Capacity[

Actors]

Units: Procedures/Period

IF THEN ELSE(Effect of Kinetic Attacks on Governing

Capacity[Actors]>SUM(Institutional

Procedures[Ethnographies!,Actors]), 0 , Effect of Kinetic Attacks on

Governing Capacity[Actors])

"Allocation of Non-Essential Budgets"[Actors] = Table for Effect of Sufficiency of Reserves on Essentials Bankruptcy Policy[

Actors] (ZIDZ (Finances[Actors] * Level of Reserves at Which NonEssentials Begin to Be Cut[

Actors] , (Normal Actor Desired Local Reserves[Actors] * Reserves Multiplier to Determine NonEssentials Cut Off Level

)))

Units: Dmnl

Armed Civil Affairs[Actors] = Actual Military Actions[Actors] * OpOrder Armed Civil Affairs[

Actors]

Units: Military Actions/Period

Blue or Purple Armed Civil Affairs[Actors] = Actual Blue or Purple Military Actions[

Actors] * Blue or Purple OpOrder Armed Civil Affairs[Actors]

Units: Military Actions/Period

Blue or Purple Sorties Targeting Government Capacity[Actors] = Blue or Purple Sorties Per Period[

Actors] * Blue or Purple Airpower Targeting Government Capacity[Actors]

Units: Sorties/Period

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Calc Legit Pop[Ethnographies,Actors] = INTEG(Coerced to Calculated[Ethnographies

,Actors] + Governed to Calculated[Ethnographies,Actors] + Unaligned Choosing Sides[

Ethnographies,Actors] - Cal Legit Pop Dying[Ethnographies,Actors

] - Calc Legit Pop Recruited or Joining Uprising[Ethnographies,Actors

] - Calc Legit Refugees Leaving[Ethnographies,Actors] - Calculated Lost to Conquest[

Ethnographies,Actors] - Calculated to Coerced[Ethnographies,Actors

] - Calculated to Governed[Ethnographies,Actors] , STARTING LEVEL OF ETHNOGRAPHIC POPULATION[

Ethnographies] * STARTING ETHNO DISTRIBUTION CALCULATED[Ethnographies

,Actors])

Units: People

Calc Legit Pop Deaths[Ethnographies,Actors] = Rate of Civilian Deaths[Ethnographies

,Actors] * Pct Calc Legit Pop[Ethnographies,Actors]

Units: People/Period

Calc Legit Pop Refugees[Ethnographies,Actors] = (Rate of Civilian Refugees[Ethnographies

,Actors] * Pct Calc Legit Pop[Ethnographies,Actors])

Units: People/Period

Coerced Pop[Ethnographies,Actors] = INTEG((Unaligned to Coerced[Ethnographies,

Actors] + Calculated to Coerced[Ethnographies,Actors] - Coerced Dying[

Ethnographies,Actors]) - Coerced Refugees Leaving[Ethnographies

,Actors] - Coerced to Calculated[Ethnographies,Actors] - Coerced to Unaligned[

Ethnographies,Actors] - Coerced Opposition Recruitment[Ethnographies

,Actors] + Conquest[Ethnographies,Actors] , STARTING LEVEL OF ETHNOGRAPHIC POPULATION[

Ethnographies] * STARTING ETHNO DISTRIBUTION COERCED[Ethnographies,Actors

])

Units: People

Coerced Pop Deaths[Ethnographies,Actors] = (Rate of Civilian Deaths[Ethnographies

,Actors] * Pct Coerced Pop[Ethnographies,Actors])

Units: People/Period

Coerced Pop Refugees[Ethnographies,Actors] = (Rate of Civilian Refugees[Ethnographies

,Actors] * Pct Coerced Pop[Ethnographies,Actors])

Units: People/Period

COMPUTED INSTITUTIONAL PROCEDURES[Ethnographies,Green] = ((Calc Legit Pop[Ethnographies

,Green] + Governed Pop[Ethnographies,Green] + Coerced Pop[Ethnographies,Green

]) * NORMAL PROCEDURES REQUIRED FOR CREDIBILITY PER POP[Ethnographies

]) * Desire to Credibly Govern Ethnography[Ethnographies,Green]

COMPUTED INSTITUTIONAL PROCEDURES[Ethnographies,Red] = 2e+006, 0, 2e+006

Units: Procedures

Current Location of Red Actor on Territorial Map[Red] = Territory Controlled by Actor[

Red]

Units: Percentage

Days in a Period = 90

Units: Days/Period

Desire to Credibly Govern Ethnography[Ethnographies,Green] = Actual Desire to Credibly Govern[

Ethnographies,Green]

Desire to Credibly Govern Ethnography[Ethnographies,Red] = Actual Desire to Credibly Govern[

Ethnographies,Red]

Units: Pct

Desired Institutional Procedures[Ethnographies,Actors] = (Required Institutional Procedures[

Ethnographies,Actors] * Desire to Credibly Govern Ethnography[Ethnographies

,Actors])

Units: Procedures

Effect of Kinetic Attacks on Governing Capacity[Green] = (Blue or Purple Sorties Targeting Government Capacity[

Red] * Normal Effect of Kinetic Attack on Governing Capacity[Red])

Effect of Kinetic Attacks on Governing Capacity[Red] = Blue or Purple Sorties Targeting Government Capacity[

Green] * Normal Effect of Kinetic Attack on Governing Capacity[Green]

Units: Procedures/Period

Ethno Sufficiency Modifier[Ethnographies] = Table for Effect of Remaining Population on Sufficiency

(Remaining Ethnographic Population[Ethnographies])

Units: Dmnl

Finances[Actors] = INTEG(Incoming Revenue[Actors] - Outgoing Expenses[Actors] ,

Starting Cash[Actors])

Units: Dollars

("Baseline Switch (1 = On)"*(Capability of Military Actions based on

Squads*Cost per Attack))+("Scenario 1 Switch (1 = On)"*"ZScenario1:

Starting Cash")

Goverened Deaths[Ethnographies,Actors] = (Rate of Civilian Deaths[Ethnographies

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,Actors] * Pct Governed Pop[Ethnographies,Actors])

    Units: People/Period

Governed Pop[Ethnographies,Actors] = INTEG(Calculated to Governed[Ethnographies

    ,Actors] - Governed Dying[Ethnographies,Actors] - Governed Lost to Conquest[

    Ethnographies,Actors] - Governed Pop Recruited[Ethnographies,Actors

    ] - Governed Refugees Leaving[Ethnographies,Actors] - Governed to Calculated[

    Ethnographies,Actors] , STARTING LEVEL OF ETHNOGRAPHIC POPULATION[

    Ethnographies] * STARTING ETHNO DISTRIBUTION GOVERNED[Ethnographies,Actors

    ])

    Units: People

Governed Refugees[Ethnographies,Actors] = (Rate of Civilian Refugees[Ethnographies

    ,Actors] * Pct Governed Pop[Ethnographies,Actors])

    Units: People/Period

Impact of Armed Civil Affairs[Actors] = (Armed Civil Affairs[Actors] + Blue or Purple Armed Civil Affairs[

    Actors]) * Normal Effect of Armed Civil Affairs[Actors]

    Units: Procedures/Period

Legacy Procedures Step Test[Ethnographies,Red] = 0, 0, 0

    Units: Procedures

Loss of CalcLegit due to Conquest[Ethnographies,Green] = Pct Calc Legit Pop[Ethnographies

    ,Green] * IF THEN ELSE (Rate of Conquering Red[Ethnographies,Red] > 0, Rate of Conquering Red[

    Ethnographies,Red] , 0)

Loss of CalcLegit due to Conquest[Ethnographies,Red] = IF THEN ELSE (Rate of Conquering Red[

Ethnographies,Red] < 0, - Rate of Conquering Red[Ethnographies,Red] *

Pct Calc Legit Pop[Ethnographies,Red] , 0)

Units: People/Period

Loss of Coerced due to Conquest[Ethnographies,Green] = Pct Coerced Pop[Ethnographies

,Green] * IF THEN ELSE (Rate of Conquering Red[Ethnographies,Red] > 0, Rate of Conquering Red[

Ethnographies,Red] , 0)

Loss of Coerced due to Conquest[Ethnographies,Red] = IF THEN ELSE (Rate of Conquering Red[

Ethnographies,Red] < 0, - Rate of Conquering Red[Ethnographies,Red] ,

0)

Units: People/Period

Loss of Governed due to Conquest[Ethnographies,Green] = IF THEN ELSE (Rate of Conquering Red[

Ethnographies,Red] > 0, Rate of Conquering Red[Ethnographies,Red] , 0

) * Pct Governed Pop[Ethnographies,Green]

Loss of Governed due to Conquest[Ethnographies,Red] = IF THEN ELSE (Rate of Conquering Red[

Ethnographies,Red] < 0, - Rate of Conquering Red[Ethnographies,Red] ,

0)

Units: People/Period

Normal Desire to Credibly Govern[Ethnographies,Green] = 1, 1, 1

Normal Desire to Credibly Govern[Ethnographies,Red] = 1, 1, 1

Units: Pct

Normal Effect of Armed Civil Affairs[Actors] = 10000, 10000

Units: Procedures/Military Actions

Normal Effect of Kinetic Attack on Governing Capacity[Actors] = 10000, 10000

Units: Procedures/Sortie

NORMAL PERIOD = 1

Units: Period

Normal Procedural Decay Fraction = 5

Units: Period

Assumes 10yr for a 100% of government institutional procedures to

naturally decay given no input.

Normal Procedural Development Time[Actors] = 2

Units: Period

NORMAL PROCEDURES REQUIRED FOR CREDIBILITY PER POP[Ethnographies] = 1

Units: Procedures/People

Normal Time to be Conquered[Ethnographies] = 1

Units: Period

ORGANIC PROCEDURAL DEVELOPMENT TIME[Actors] = 0.25

Units: Period

0.25

Pct Calc Legit Pop[Ethnographies,Actors] = MIN (1, MAX (0, ZIDZ (Calc Legit Pop[

Ethnographies,Actors] , Total Ethno by Actor[Ethnographies,

Actors])))

Units: Percentage

Pct Coerced Pop[Ethnographies,Actors] = MIN (1, MAX (0, ZIDZ (Coerced Pop[Ethnographies

,Actors] , Total Ethno by Actor[Ethnographies,Actors])))

Units: Percentage

Pct Governed Pop[Ethnographies,Actors] = MIN (1, MAX (0, ZIDZ (Governed Pop[Ethnographies

,Actors] , Total Ethno by Actor[Ethnographies,Actors])))

Units: Percentage

Procedural Excess[Ethnographies,Actors] = MAX (0, (1 - ZIDZ (Desired Institutional Procedures[

Ethnographies,Actors] , Institutional Procedures[Ethnographies

,Actors])))

Units: Pct

Rate of Civilian Deaths[Ethnographies,Actors] = (Civilian Deaths[Ethnographies,

Actors]) * Ethno Sufficiency Modifier[Ethnographies]

Units: People/Period

Rate of Civilian Refugees[Ethnographies,Actors] = Refugees Leaving[Ethnographies

,Actors] * Ethno Sufficiency Modifier[Ethnographies]

Units: People/Period

Rate of Conquering Red[Ethnographies,Red] = (Target Ethno Population by Most Recent Conquest[

Ethnographies,Red] - Ethno by Actor Conquer Reference[Ethnographies,Red])

/ Normal Time to be Conquered[Ethnographies]

Units: People/Period

Reduction in Institutional Procedures[Ethnographies,Actors] = MAX (0, ((Table for Reduction in Institutional Procedures[

    Ethnographies,Actors] (Procedural Excess[Ethnographies,Actors]) * Institutional Procedures[

     Ethnographies,Actors]) / NORMAL PERIOD) + Actual Effect of Kinetic Attacks on Governing Capacity[

     Actors])

     Units: Procedures/Period

Replacing Obsolete Procedures[Ethnographies,Actors] = ZIDZ ((Procedural Decay[

    Ethnographies,Actors] * Desire to Credibly Govern Ethnography[Ethnographies

     ,Actors]) * "Allocation of Non-Essential Budgets"[Actors] , 1)

     Units: Procedures/Period

Required Institutional Procedures[Ethnographies,Actors] = MAX (0, NORMAL PROCEDURES REQUIRED FOR CREDIBILITY PER POP[

    Ethnographies] * Total Ethno by Actor[Ethnographies,Actors])

     Units: Procedures

Sorties Targeting Government per Day[Actors] = Blue or Purple Sorties Targeting Government Capacity[

   Actors] / Days in a Period

     Units: Sorties/Day

Table for Effect of Procedural Adequacy[Actors] ([(-2,-2)-(2,10)],(0,2),(0.9,1)

    ,(0.95,0),(1,0),(1.25,0),(1.5,0),(1.75,0))

     Units: Pct

Table for Reduction in Institutional Procedures[Ethnographies,Actors] ([(0,0)-(1,1)

    ],(0,0),(0.1,0.03),(0.2,0.05),(0.3,0.1),(0.4,0.2),(0.5,0.3),(0.6,0.35)

,(0.7,0.4),(0.8,0.45),(0.9,0.475),(1,0.5))

    Units: Dmnl

Territory Conditions Table for Percentage of Unaligned Population Controlled based on Location of Red Actor on Territorial Map

        ([(0,0)-(1,1)],(0,0),(1,1))

    Units: Percentage

Total Ethno by Actor[Ethnographies,Actors] = Calc Legit Pop[Ethnographies,Actors

   ] + Coerced Pop[Ethnographies,Actors] + Governed Pop[Ethnographies,Actors]

     Units: People

Total Population by Actor[Actors] = (SUM (Total Ethno by Actor[Ethnographies!,

    Actors]))

     Units: People

Unaligned Conquered to Coerced[Ethnographies,Red] = (Unaligned Pop[Ethnographies

   ] * Territory Conditions Table for Percentage of Unaligned Population Controlled based on Location of Red Actor on Territorial Map

    (Current Location of Red Actor on Territorial Map[Red])) / Normal Time to be Conquered[

    Ethnographies]

Unaligned Conquered to Coerced[Ethnographies,Green] = 0

    Units: People/Period

Unaligned Pop[Ethnographies] = INTEG(Defections to Unaligned[Ethnographies] + (

    SUM (Coerced to Unaligned[Ethnographies,Actors!])) - (SUM (

     Unaligned to Coerced[Ethnographies,Actors!])) - (SUM (Unaligned to Calculated[

    Ethnographies,Actors!])) , 0)

Units: People

Normal is: STARTING LEVEL OF ETHNOGRAPHIC

POPULATION[Ethnographies]-((SUM(Coerced

Pop[Ethnographies,Actors!]))+(SUM(Calc Legit Pop [Ethnographies,Acto

[Ethnographies,Actors!]))+(SUM(Governed

Pop[Ethnographies,Actors!]))), Indonesia is 0

War Crime Refugees[Ethnographies,Actors] = MAX (0, (War Crimes[Ethnographies,Actors

] * REFUGEES PER WAR CRIME[Ethnographies,Actors]) * Ethno by Actor Sufficiency[

Ethnographies,Actors])

Units: People/Period

D-3.4 OpOrder Allocations

Overview
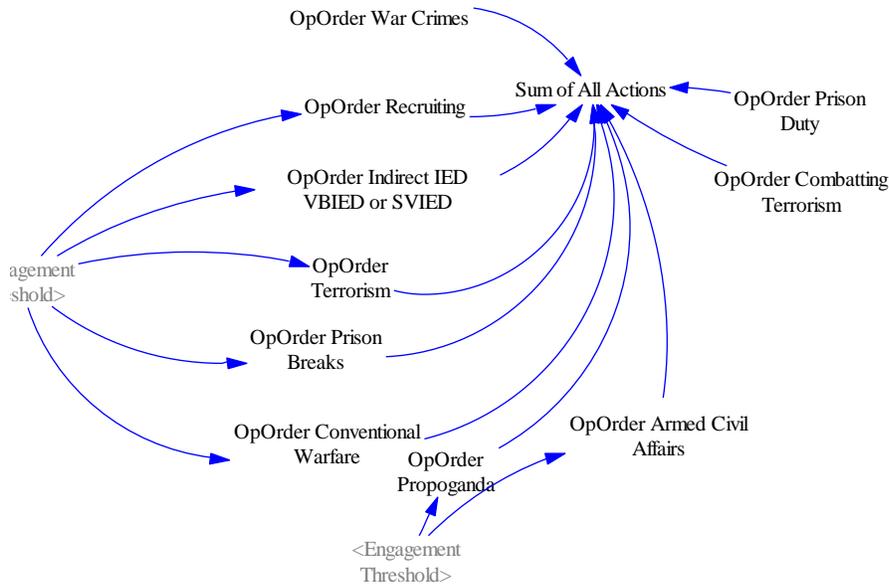
Figure D-4: Allocation of Operational Orders Structure
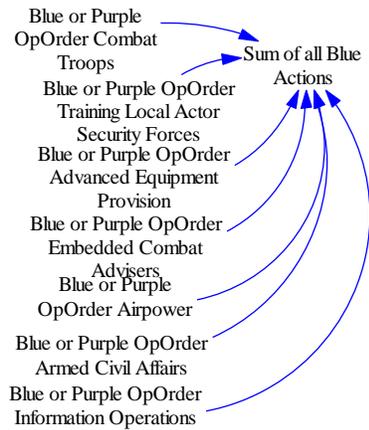
Figure D-5: Structure of Foreign OpOrder Allocation

Equations

Blue or Purple Airpower Targeting Combatants[Green] = GAME(1)

Blue or Purple Airpower Targeting Combatants[Red] = 0

> Units: Pct

Blue or Purple Airpower Targeting Government Capacity[Green] = GAME(0)

Blue or Purple Airpower Targeting Government Capacity[Red] = GAME(0)

> Units: Pct

Blue or Purple Airpower Targeting Resources[Green] = GAME(0)

Blue or Purple Airpower Targeting Resources[Red] = 0

> Units: Pct

Blue or Purple OpOrder Advanced Equipment Provision[Green] = GAME(0.25)

Blue or Purple OpOrder Advanced Equipment Provision[Red] = 0

> Units: Pct

Blue or Purple OpOrder Airpower[Green] = GAME(0)

Blue or Purple OpOrder Airpower[Red] = 0

       Units: Pct

Blue or Purple OpOrder Armed Civil Affairs[Green] = GAME(0)

Blue or Purple OpOrder Armed Civil Affairs[Red] = 0

       Units: Pct

Blue or Purple OpOrder Combat Troops[Green] = GAME(0)

Blue or Purple OpOrder Combat Troops[Red] = GAME(0)

       Units: Pct

Blue or Purple OpOrder Embedded Combat Advisers[Actors] = GAME(0)

       Units: Pct

Blue or Purple OpOrder Information Operations[Green] = GAME(0.25)

Blue or Purple OpOrder Information Operations[Red] = 0

       Units: Pct

Blue or Purple OpOrder Training Local Actor Security Forces[Green] = GAME(0.25)

Blue or Purple OpOrder Training Local Actor Security Forces[Red] = 0

       Units: Pct

Calc Legit Pop[Ethnographies,Actors] = INTEG(Coerced to Calculated[Ethnographies

    ,Actors] + Governed to Calculated[Ethnographies,Actors] + Unaligned Choosing Sides[

      Ethnographies,Actors] - Cal Legit Pop Dying[Ethnographies,Actors

      ] - Calc Legit Pop Recruited or Joining Uprising[Ethnographies,Actors

      ] - Calc Legit Refugees Leaving[Ethnographies,Actors] - Calculated Lost to Conquest[

Ethnographies,Actors] - Calculated to Coerced[Ethnographies,Actors

] - Calculated to Governed[Ethnographies,Actors] , STARTING LEVEL OF ETHNOGRAPHIC POPULATION[

Ethnographies] * STARTING ETHNO DISTRIBUTION CALCULATED[Ethnographies

,Actors])

Units: People

Combatants[Ethnographies,Actors] = INTEG(Combatant Additions[Ethnographies,Actors

] - Combatant Losses[Ethnographies,Actors] , Starting Combatants[Ethnographies

,Actors])

Units: People

Engagement Threshold[Actors] = IF THEN ELSE (Total Combatants[Red] > Minimum Force Size to Engage[

Red] , 1, 0)

Units: Dmnl

Green and Red OpOrder Pct Indirect[Actors] = 0, 0.03

Units: Pct

Green and Red OpOrder Pct Recruiting[Ethnographies,Red] = 0.15, 0, 0.075

Green and Red OpOrder Pct Recruiting[Ethnographies,Green] = 0, 0, 0

Units: Pct

Green and Red Pct OpOrder Armed Civil Affairs[Actors] = 0, 0.2

Units: Pct

Green and Red Pct OpOrder Prison Breaks[Actors] = 0, 0.05

Units: Pct

Green and Red Pct OpOrder Propoganda[Actors] = 0, 0.01

    Units: Pct

Green and Red Pct OpOrder Terrorism[Ethnographies,Red] = 0, 0.1, 0.1

Green and Red Pct OpOrder Terrorism[Ethnographies,Green] = 0, 0, 0

    Units: Pct

Green and Red PE Pct Armed Civil Affairs[Actors] = 0, 0.01

    Units: Pct

Green and Red PE Pct Conventional Warfare[Actors] = 0, 0

    Units: Pct

Green and Red PE PCT Prison Breaks[Actors] = 0, 0.05

    Units: Pct

Green and Red PE Pct Propoganda[Actors] = 0, 0.25

    Units: Pct

Green and Red PE Pct Terrorism[Ethnographies,Red] = 0.2, 0.1, 0.1

Green and Red PE Pct Terrorism[Ethnographies,Green] = 0, 0, 0

    Units: Pct

Green and Red PE Recruiting[Ethnographies,Red] = 0.1, 0, 0.05

Green and Red PE Recruiting[Ethnographies,Green] = 0, 0, 0

    Units: Pct

Normal Combatting Terrorism[Actors] = 0.075, 0

Units: Pct

Normal Conventional Warfare[Actors] = 0.2, 0.475

Units: Pct

Normal Prison Duty[Actors] = 0.05, 0

Units: Pct

OpOrder Armed Civil Affairs[Actors] = GAME(IF THEN ELSE (Engagement Threshold[

Actors] = 1, Green and Red Pct OpOrder Armed Civil Affairs[Actors

] , Green and Red PE Pct Armed Civil Affairs[Actors]))

Units: Pct

OpOrder Combatting Terrorism[Actors] = GAME(Normal Combatting Terrorism[Actors]

)

Units: Pct

OpOrder Conventional Warfare[Actors] = GAME(IF THEN ELSE (Engagement Threshold[

Red] = 1, Normal Conventional Warfare[Actors] , Green and Red PE Pct Conventional Warfare[

Actors]))

Units: Pct

OpOrder Indirect IED VBIED or SVIED[Actors] = GAME(IF THEN ELSE (Engagement Threshold[

Actors] = 1, Green and Red OpOrder Pct Indirect[Actors] , PreThreshold Indirect[

Actors]))

Units: Pct

OpOrder Prison Breaks[Actors] = GAME(IF THEN ELSE (Engagement Threshold[Actors

] = 1, Green and Red Pct OpOrder Prison Breaks[Actors] , Green and Red PE PCT Prison Breaks[

Actors]))

Units: Pct

OpOrder Prison Duty[Actors] = GAME(Normal Prison Duty[Actors])

Units: Pct

OpOrder Propoganda[Actors] = GAME(IF THEN ELSE (Engagement Threshold[Actors] =

1, Green and Red Pct OpOrder Propoganda[Actors] , Green and Red PE Pct Propoganda[

Actors]))

Units: Pct

OpOrder Recruiting[Ethnographies,Actors] = GAME(IF THEN ELSE (Engagement Threshold[

Actors] = 1, Green and Red OpOrder Pct Recruiting[Ethnographies,

Actors] , Green and Red PE Recruiting[Ethnographies,Actors]))

Units: Pct

OpOrder Terrorism[Ethnographies,Red] = GAME(IF THEN ELSE (Engagement Threshold[

Red] = 1, Green and Red Pct OpOrder Terrorism[Ethnographies,Red]

, Green and Red PE Pct Terrorism[Ethnographies,Red]))

OpOrder Terrorism[Ethnographies,Green] = IF THEN ELSE (Engagement Threshold[Green

] = 1, Green and Red Pct OpOrder Terrorism[Ethnographies,Green] , Green and Red PE Pct Terrorism[

Ethnographies,Green])

Units: Pct

D-3 Strategic Architecture Sectors & Equations

OpOrder War Crimes[Ethnographies,Actors] = GAME(0)

> Units: Pct

> War atrocities include ethnic cleansing by Red actor and

>> massacares/war crimes by Blue Actors.

PreThreshold Indirect[Actors] = 0, 0

> Units: Pct

Sum of All Actions[Actors] = OpOrder Indirect IED VBIED or SVIED[Actors] + (SUM (

> OpOrder Recruiting[Ethnographies!,Actors])) + (SUM (OpOrder Terrorism[

> Ethnographies!,Actors])) + (SUM (OpOrder War Crimes[Ethnographies!

> ,Actors])) + OpOrder Prison Breaks[Actors] + OpOrder Prison Duty[

> Actors] + OpOrder Combatting Terrorism[Actors] + OpOrder Propoganda[Actors

>] + OpOrder Armed Civil Affairs[Actors] + OpOrder Conventional Warfare[

> Actors]

>> Units: Pct

Sum of all Blue Actions[Actors] = Blue or Purple OpOrder Airpower[Actors] + Blue or Purple OpOrder Armed Civil Affairs[

> Actors] + Blue or Purple OpOrder Embedded Combat Advisers[Actors] + Blue or Purple OpOrder Information Operations[

> Actors] + Blue or Purple OpOrder Advanced Equipment Provision[Actors]

> + Blue or Purple OpOrder Training Local Actor Security Forces[Actors]

> + Blue or Purple OpOrder Combat Troops[Actors]

>> Units: Pct

SUM Total of Airpower Allocations[Actors] = Blue or Purple Airpower Targeting Combatants[

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Actors] + Blue or Purple Airpower Targeting Government Capacity[Actors] +

Blue or Purple Airpower Targeting Resources[Actors]

Units: Pct

D-3.5 Resource Stocks

Equations

Actual Territory Decline[Actors] = MAX (0, Peak Territory[Actors] - Territory Actor Controls[

Actors])

Units: "km^2"

AFV and IFV[Actors] = INTEG(Increase in AFV and IFV[Actors] - Decrease in AFV and IFV[

Actors] , Starting AFV and IFV[Actors])

Units: Pieces

AFV and IFV Additions[Actors] = (AFV and IFV Scavenged[Red] / Time to Repair and Operate[

Actors]) + AFV and IFV Purchases[Actors]

Units: Pieces/Period

AFV and IFV Losses[Actors] = AFV and IFV Lossses in Battle[Actors] + AFV and IFV Lost due to Maintenance[

Actors]

Units: Pieces/Period

ARTILLERY[Actors] = INTEG(Increase in Artillery[Actors] - Decrease in Artillery[

Actors] , Starting Artillery[Actors])

Units: Pieces

Artillery Additions[Actors] = Artillery Purchases[Actors]

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Units: Pieces/Period

Artillery Losses[Actors] = Artillery Losses in Battle[Actors] + Artillery Lost due to Maintenance[

Actors]

Units: Pieces/Period

Average Combatant Experience[Actors] = ZIDZ (Combatant Experience[Actors] , Total Combatants[

Actors])

Units: Exp Years/Person

Baseline Switch where 1 equals On = 1

Units: Dmnl

Blue Desired Personnel[Actors] = Blue or Purple Intervention Size[Actors] * Deployment Activation[

Actors]

Units: People

Blue or Purple Intervention Size[Actors] = GAME(Normal Blue or Purple Intervention Size[

Actors])

Units: People

Blue or Purple Intervention Time[Actors] = 0, 0

Units: Period

Blue or Purple Personnel[Actors] = INTEG(Increase in Blue Personnel[Actors] - Decrease in Blue Personnel[

Actors] , Starting Blue or Purple Personnel[Actors])

Units: People

D-3 Strategic Architecture Sectors & Equations

Blue or Purple Squads[Actors] = INTEG(Change in Blue Squads[Actors] , 0)

    Units: Squads

Blue or Purple T3R Average[Actors] = 0.67

    Units: Pct

    Average % of non-combat troops to combat. Source

        http://usacac.army.mil/cac2/cgsc/carl/download/csipubs/mcgrath_op23.pd

        f p80

Capability of Military Actions based on Squads[Actors] = (Squads[Actors]) * NORMAL MILITARY CAPABILITY OF SQUADS[

    Actors]

    Units: Military Actions/Period

Change in Blue Squads[Actors] = (Desired Blue Squads[Actors] - Blue or Purple Squads[

    Actors]) / NORMAL PERIOD

    Units: Squads/Period

Change in Squads[Actors] = (Desired Squads[Actors] - Squads[Actors]) / Time to Form Squads

    Units: Squads/Period

Combatant Additions[Ethnographies,Actors] = Rate of Incoming Combatants[Ethnographies

   ,Actors]

    Units: People/Period

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Combatant Experience[Actors] = INTEG(Gain in Experience[Actors] - Loss of Experience[

    Actors] , Starting Experience[Actors])

    Units: Exp Years

Combatant Experience Gain[Actors] = (Total Combatants[Actors] * (NORMAL EXPERIENCE GAINED PER PERSON[

    Actors] + Experience Gained from Blue or Purple Training[Actors]))

    / NORMAL PERIOD

    Units: Exp Years/Period

Combatant Losses[Ethnographies,Actors] = MAX (0, Loss of Local Combatants by Ethnography[

    Ethnographies,Actors])

    Units: People/Period

    Fix max function with different first order control. MAX(0,("ISIS

            Militants (People)"-"Outgoing Militants (People)")/Time to Lose

            Militants)

Combatants[Ethnographies,Actors] = INTEG(Combatant Additions[Ethnographies,Actors

    ] - Combatant Losses[Ethnographies,Actors] , Starting Combatants[Ethnographies

    ,Actors])

    Units: People

Decrease in AFV and IFV[Actors] = MAX (0, AFV and IFV Losses[Actors])

    Units: Pieces/Period

Decrease in Artillery[Actors] = Artillery Losses[Actors]

    Units: Pieces/Period

D-3 Strategic Architecture Sectors & Equations

Decrease in Blue Personnel[Actors] = 0

      Units: People/Period

Decrease in Peak[Actors] = (Peak Condition[Actors] * Peak Territory[Actors]) /

    NORMAL PERIOD

      Units: "km^2"/Period

Deployment Activation[Actors] = IF THEN ELSE (Time > Blue or Purple Intervention Time[

     Actors] , 1, 0)

      Units: Dmnl

Deployment Time[Actors] = 2, 2

      Units: Period

Desired Blue Squads[Actors] = (Blue or Purple Personnel[Actors] - Number of Blue Logistics[

    Actors]) / NORMAL SIZE PER SQUAD[Actors]

      Units: Squads

Desired Squads[Actors] = MAX (0, ((Total Combatants[Actors] - Actual Garrsion[

     Actors]) - Number of Green or Red Logistics[Actors]) / NORMAL SIZE PER SQUAD[

     Actors])

      Units: Squads

Expenses before Attacks[Actors] = Death Benefits[Actors] + Detention Benefits[Actors

    ] + "Media Border Security & Other Expenses"[Actors] + Military Procurement[

    Actors] + Payroll[Actors] + Governance Expenses[Actors]

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D-3 Strategic Architecture Sectors & Equations

Units: Dollars/Period

Experience gain from Joining Combatants[Actors] = (AVG EXPERIENCE OF ESCAPED DETAINEE[

Actors] * Escaped Detainees Joining Actor[Actors]) + (Experience Gain from Foreign Fighters[

Actors]) + ((SUM (Actual Governed Local Recruiting[Ethnographies!

,Actors])) * AVG EXPERIENCE OF LOCAL RECRUIT[Actors])

Units: Exp Years/Period

Finances[Actors] = INTEG(Incoming Revenue[Actors] - Outgoing Expenses[Actors] ,

Starting Cash[Actors])

Units: Dollars

("Baseline Switch (1 = On)"*(Capability of Military Actions based on

Squads*Cost per Attack))+("Scenario 1 Switch (1 = On)"*"ZScenario1:

Starting Cash")

First Conquest = IF THEN ELSE (SFS Modified Force Ratio > 0, (IF THEN ELSE ((

FMR Base1 + FMR Base2) = 0, Initial Territory Conquered , 0))

, 0) * First Conquest Disable[Red]

Units: "km^2"

First Conquest Territory Gain = First Conquest

Units: "km^2"

FLOT Movement Rate = GAME((((FMR Base1 + FMR Base2) * High Intensity FLOT Movement Rate Multiplier

) * Disable FLOT) * Movement Direction)

Units: "km^2"

D-3 Strategic Architecture Sectors & Equations

Foreign Combatants[Actors] = INTEG(Foreign Fighter Increase[Actors] - Foreign Fighter Decrease[

Actors] , Starting Foreign Combatants[Actors])

Units: People

Foreign Fighter Decrease[Actors] = "Loss of Foreign Combatants by Deaths, Detentions and Defections"[

Actors]

Units: People/Period

Foreign Fighter Increase[Actors] = Foreign Recruiting[Actors]

Units: People/Period

Foreign Recruiting[Actors] = ((Actual Recruits per Suicide Attack[Actors] * (

SUM (Completed Terrorist Attacks by Ethnography[Ethnographies!,Actors

]))) * Foreign Recruiting Eliminated[Actors]) * Allocation of Essential Budgets[

Actors]

Units: People/Period

Gain in Experience[Actors] = Experience gain from Joining Combatants[Actors] + Combatant Experience Gain[

Actors]

Units: Exp Years/Period

Governed Cohorts[Ethnographies,Actors] = (Calc Legit Pop[Ethnographies,Actors]

+ Governed Pop[Ethnographies,Actors]) / SIZE OF COHORT

Units: Cohort

Green Actor Territory Gain[Green] = IF THEN ELSE (FLOT Movement Rate < 0, - FLOT Movement Rate

, 0)

Units: "km^2"

Green Actor Territory Lost[Green] = IF THEN ELSE (FLOT Movement Rate > 0, FLOT Movement Rate

, 0)

Units: "km^2"

Incoming Revenue[Actors] = Revenue[Actors] + Test Extreme Conditions Revenue[Actors

]

Units: Dollars/Period

Increase in AFV and IFV[Actors] = AFV and IFV Additions[Actors]

Units: Pieces/Period

Increase in Artillery[Actors] = Artillery Additions[Actors]

Units: Pieces/Period

Increase in Blue Personnel[Actors] = (Blue Desired Personnel[Actors] - Blue or Purple Personnel[

Actors]) / Deployment Time[Actors]

Units: People/Period

Increase in Peak[Actors] = (Territory Actor Controls[Actors] * Peak Condition[Actors

]) / NORMAL PERIOD

Units: "km^2"/Period

Loss of Experience[Actors] = Total Experience Loss due to Militant Losses[Actors

]

Units: Exp Years/Period

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"Loss of Foreign Combatants by Deaths, Detentions and Defections"[Actors] = Pct of Combatants that are Foreign[

    Actors] * "Loss of all Combatants from Deaths, Detentions and Defections"[

      Actors]

        Units: People/Period

Loss of Local Combatants by Ethnography[Ethnographies,Actors] = "Loss of Local Combatants from Deaths, Detentions and Defections"[

    Actors] * Pct Combatants by Ethnography[Ethnographies,Actors]

        Units: People/Period

Militant Police per Cohort = 2.8

        Units: People/Cohort

Money Sent Abroad[Actors] = (Surplus for Sending Money Abroad[Actors] * Allocation of Essential Budgets[

    Actors]) / Time to Spend Money Abroad[Actors]

        Units: Dollars/Period

Normal Blue or Purple Intervention Size[Actors] = 0, 0

        Units: People

NORMAL PERIOD = 1

        Units: Period

NORMAL SIZE PER SQUAD[Actors] = 10

        Units: People/Squad

        Normal value for ISIS is set at an average of 11. Value for

equilibrium is set at 10.

Number of Blue Logistics[Actors] = Blue or Purple Personnel[Actors] * Blue or Purple T3R Average[

Actors]

Units: People

OpTempo Expenses[Actors] = Actual Military Actions[Actors] * Cost per Military Action[

Actors]

Units: Dollars/Period

Outgoing Expenses[Actors] = MAX (0, (Expenses before Attacks[Actors] + OpTempo Expenses[

Actors] + Money Sent Abroad[Actors]))

Units: Dollars/Period

MAX(0,"ISIS Finances (Dollars)"-("Expenses before Attacks (Dollars

per Period)"+OpTempo Expenses))

Pct Combatants by Ethnography[Ethnographies,Actors] = ZIDZ (Combatants[Ethnographies

,Actors] , Total Local Combatants[Actors])

Units: Pct

Pct Decline from Peak[Actors] = ZIDZ (Actual Territory Decline[Actors] , Peak Territory[

Actors])

Units: Pct

Pct of Combatants that are Foreign[Actors] = ZIDZ (Foreign Combatants[Actors] ,

Total Combatants[Actors])

Units: Pct

Pct of Total Combatants by Ethnography[Ethnographies,Actors] = Combatants[Ethnographies

,Actors] / Total Local Combatants[Actors]

   Units: Pct

Peak Condition[Actors] = IF THEN ELSE (Territory Actor Controls[Actors] > Peak Territory[

   Actors] , 1, 0)

   Units: Dmnl

Peak Territory[Actors] = INTEG(Increase in Peak[Actors] - Decrease in Peak[Actors

   ] , 0)

   Units: "km^2"

Period of Initial Finance = 1

   Units: Period

Proposition Switch where 1 equals on = 1

   Units: Dmnl

Rate of Incoming Combatants[Ethnographies,Red] = (Actual Local Calculated Recruiting[

   Ethnographies,Red] + Actual Governed Local Recruiting[Ethnographies,Red] +

   Escaped Detainees by Ethnography[Ethnographies,Red] + Local Opposition Joining Opposing Actor Militants[

   Ethnographies,Green] + Inflow of Foreign Recruits by Ethnography[Ethnographies

   ,Red] + Expatriate Fighters by Ethnography[Ethnographies,Red] + Test Extreme Conditions Combatants[

   Ethnographies,Red])

Rate of Incoming Combatants[Ethnographies,Green] = (Actual Local Calculated Recruiting[

Ethnographies,Green] + Actual Governed Local Recruiting[Ethnographies,Green

] + Escaped Detainees by Ethnography[Ethnographies,Green] + Local Opposition Joining Opposing Actor Militants[

Ethnographies,Red] + Expatriate Fighters by Ethnography[Ethnographies

,Green] + Inflow of Foreign Recruits by Ethnography[Ethnographies,Green

] + Test Extreme Conditions Combatants[Ethnographies,Green])

   Units: People/Period

Rate of Territory Gained[Green] = (Green Actor Territory Gain[Green] / Time to Secure Territory

) * Territorial Limits Modifier on Gaining[Green]

Rate of Territory Gained[Red] = (Red Actor Territory Gain[Red] / Time to Secure Territory

) * Territorial Limits Modifier on Gaining[Red]

   Units: "km^2"/Period

Rate of Territory Lost[Green] = (Green Actor Territory Lost[Green] / Time to Secure Territory

) * Territorial Limits Modifier on Losing[Green]

Rate of Territory Lost[Red] = (Red Actor Territory Lost[Red] / Time to Secure Territory

) * Territorial Limits Modifier on Losing[Red]

   Units: "km^2"/Period

Red Actor Territory Gain[Red] = First Conquest Territory Gain + (IF THEN ELSE (

   FLOT Movement Rate > 0, FLOT Movement Rate , 0))

   Units: "km^2"

Red Actor Territory Lost[Red] = IF THEN ELSE (FLOT Movement Rate < 0, - FLOT Movement Rate

, 0)

   Units: "km^2"

D-3 Strategic Architecture Sectors & Equations

Revenue[Actors] = Donations[Actors] + Pre Donations Revenue[Actors]

      Units: Dollars/Period

Squads[Actors] = INTEG(Change in Squads[Actors] , (SUM (Starting Combatants[Ethnographies!

      ,Actors])) - (SUM (Governed Cohorts[Ethnographies!,Actors])) *

        Militant Police per Cohort)) / NORMAL SIZE PER SQUAD[Actors

  ])

      Units: Squads

      Initialized at same formula as Desired Squads. (Militants - Garrison

              Needs)

Starting AFV and IFV[Actors] = 2137, 0

      Units: Pieces

Starting Artillery[Actors] = 594, 0

      Units: Pieces

Starting Blue or Purple Personnel[Actors] = 0, 0

      Units: People

Starting Cash[Red] = 1e+007

Starting Cash[Green] = 5e+009

      Units: Dollars

      Period of Initial Finance*(5e+006+(Expenses before Attacks[Red]*4))

Starting Combatants[Ethnographies,Green] = 87200, 261600, 87200

Starting Combatants[Ethnographies,Red] = 1500, 0, 0

  Units: People

  check: https://www.state.gov/documents/organization/170479.pdf

Starting Experience[Actors] = 0, 3

  Units: Exp Years

Starting Foreign Combatants[Actors] = 0, 0

  Units: People

Table for Effect of Territorial Limits on Gaining[Actors] ([(0,0)-(1,1)],(0,1),

  (0,1),(0,1),(0,1),(0,1),(0,1),(0.95,1),(0.96,0.5),(0.97,0.25),(0.98,0.15)

  ,(0.99,0.1),(1,0))

  Units: Dmnl

Table for Effect of Territorial Limits on Losing[Actors] ([(0,0)-(1,1)],(0,0),(0.01,0.1)

  ,(0.02,0.15),(0.03,0.25),(0.04,0.5),(0.05,1),(0.95,1),(0.96,1),(0.97,1)

  ,(0.98,1),(0.99,1),(1,1))

  Units: Dmnl

Territorial Limits Modifier on Gaining[Actors] = Table for Effect of Territorial Limits on Gaining[

  Red] (ZIDZ (Territory Actor Controls[Actors] , Territory Conditions Starting Total Territory

))

  Units: Dmnl

Territorial Limits Modifier on Losing[Actors] = Table for Effect of Territorial Limits on Losing[

  Actors] (ZIDZ (Territory Actor Controls[Actors] , Territory Conditions Starting Total Territory

))

Units: Dmnl

Territory Actor Controls[Actors] = INTEG(Rate of Territory Gained[Actors] - Rate of Territory Lost[

Actors] , Territory Conditions Starting Total Territory * Territory Conditions Pct Territory Controlled by Actor at Start[

Actors])

Units: "km^2"

Territory Conditions Pct Territory Controlled by Actor at Start[Actors] = 1, 0

Units: Pct

Territory Conditions Starting Total Territory = 619308

Units: "km^2"

Includes all Provinces and Governates of Iraq and Syria. "Provinces

of Syria", Administrative Divisions of Countries, Statoids, last

modified September 22, 2004, accessed September 19th, 2014,

http://www.statoids.com/usy.html. "Provinces of Iraq",

Administrative Divisions of Countries, Statoids, last modified March

16, 2014, accessed September 19th, 2014,

http://www.statoids.com/uiq.html.

Territory Controlled by Actor[Actors] = ZIDZ (Territory Actor Controls[Actors]

, Territory Conditions Starting Total Territory)

Units: Percentage

Test Extreme Conditions Revenue[Actors] = GAME(0)

Units: Dollars/Period

Time to Form Squads = 0.16

Units: Period

Ceylan Yeginsu, "ISIS Draws a Steady Stream of Recruits from

Turkey," nytimes.com,

http://www.nytimes.com/2014/09/16/world/europe/turkey-is-a-steady-sour

ce-of-isis-recruits.html, accessed October 25, 2014.

Time to Secure Territory = 1

Units: Period

0.0385

Total Combatants[Actors] = Total Local Combatants[Actors] + Foreign Combatants[Actors

]

Units: People

Total Experience Loss due to Militant Losses[Actors] = (Average Combatant Experience[

Actors] * "Loss of all Combatants from Deaths, Detentions and Defections"[

Actors])

Units: Exp Years/Period

Total Local Combatants[Actors] = SUM (Combatants[Ethnographies!,Actors])

Units: People

D-3.6 Revenue & Expenses
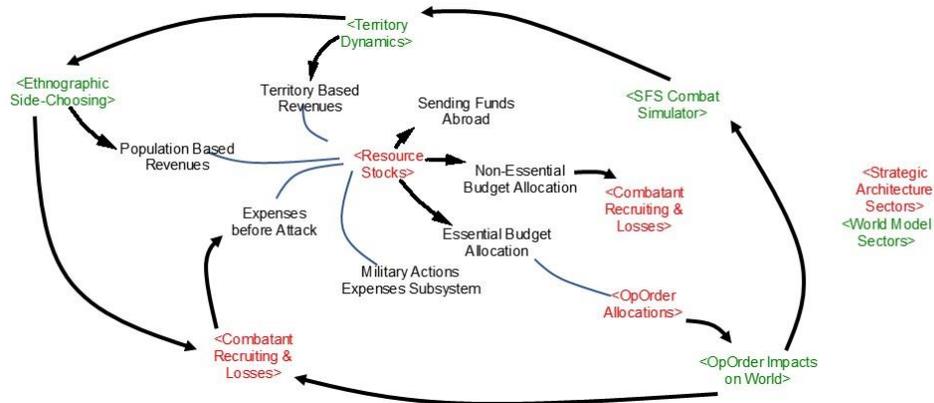
Overview

Figure D-6: Revenue & Expenses Sector Overview

Equations

Actual Resource Production[Actors] = Resource Production before Strikes[Actors]

- Effect of Attacks on Actual Production[Actors]

Units: Resource/Period

Blue or Purple Intervention Time[Actors] = 0, 0

Units: Period

Calc Legit Pop[Ethnographies,Actors] = INTEG(Coerced to Calculated[Ethnographies

,Actors] + Governed to Calculated[Ethnographies,Actors] + Unaligned Choosing Sides[

Ethnographies,Actors] - Cal Legit Pop Dying[Ethnographies,Actors

] - Calc Legit Pop Recruited or Joining Uprising[Ethnographies,Actors

] - Calc Legit Refugees Leaving[Ethnographies,Actors] - Calculated Lost to Conquest[

Ethnographies,Actors] - Calculated to Coerced[Ethnographies,Actors

] - Calculated to Governed[Ethnographies,Actors] , STARTING LEVEL OF ETHNOGRAPHIC POPULATION[

Ethnographies] * STARTING ETHNO DISTRIBUTION CALCULATED[Ethnographies

,Actors])

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Units: People

Coerced Pop[Ethnographies,Actors] = INTEG((Unaligned to Coerced[Ethnographies,

Actors] + Calculated to Coerced[Ethnographies,Actors] - Coerced Dying[

Ethnographies,Actors]) - Coerced Refugees Leaving[Ethnographies

,Actors] - Coerced to Calculated[Ethnographies,Actors] - Coerced to Unaligned[

Ethnographies,Actors] - Coerced Opposition Recruitment[Ethnographies

,Actors] + Conquest[Ethnographies,Actors] , STARTING LEVEL OF ETHNOGRAPHIC POPULATION[

Ethnographies] * STARTING ETHNO DISTRIBUTION COERCED[Ethnographies,Actors

])

Units: People

Criminal Activities[Ethnographies,Actors] = Criminal Activities per Person[Actors

] * (Coerced Pop[Ethnographies,Actors] + Calc Legit Pop[Ethnographies,Actors

] + Governed Pop[Ethnographies,Actors])

Units: Dollars/Period

Criminal Activities per Person[Actors] = 0, 2.76

Units: Dollars/(Period*Person)

Converting these to $/Person/Period works out from a range of $1.62

to $3.90/Person/Period for Population Controlled. Taken at midpoint.

See Section A for parameterization method.

Donation Percentage of all Revenue[Actors] = 0, 0.04

Units: Dmnl

See Section A for parameterization method.

Donations[Actors] = MAX (0, Pre Donations Revenue[Actors] * Donation Percentage of all Revenue[

   Actors])

   Units: Dollars/Period

Effect of Ransom Policy[Actors] = IF THEN ELSE (Time > Blue or Purple Intervention Time[

   Actors] , Ransom Elimination[Actors] , 1)

   Units: Dmnl

Estimated Ransom per Period[Actors] = 0, 6e+006

   Units: Dollars/Period

   Assuming a simple $2M/Month for ransoms results in $6M/Period.See

      Section A for parameterization method.

Governed Pop[Ethnographies,Actors] = INTEG(Calculated to Governed[Ethnographies

   ,Actors] - Governed Dying[Ethnographies,Actors] - Governed Lost to Conquest[

      Ethnographies,Actors] - Governed Pop Recruited[Ethnographies,Actors

      ] - Governed Refugees Leaving[Ethnographies,Actors] - Governed to Calculated[

      Ethnographies,Actors] , STARTING LEVEL OF ETHNOGRAPHIC POPULATION[

   Ethnographies] * STARTING ETHNO DISTRIBUTION GOVERNED[Ethnographies,Actors

      ])

   Units: People

Normal Territory Conditions Price per Resource Unit[Actors] = 80, 45

   Units: Dollars/Resource

Pre Donations Revenue[Actors] = Taxes[Actors] + Ransom[Actors] + (SUM (Criminal Activities[

   Ethnographies!,Actors])) + Resource Sales[Actors]

Units: Dollars/Period

Ransom[Actors] = Estimated Ransom per Period[Actors] * Effect of Ransom Policy[Actors
]

Units: Dollars/Period

Ransom Elimination[Actors] = 1

Units: Dmnl

Normal value is 1. 0 means all ransom is eliminated.

Resource Sales[Actors] = Territory Conditions Price per Resource Unit[Actors] *

Resources Produced[Actors]

Units: Dollars/Period

Resources Produced[Actors] = Actual Resource Production[Actors]

Units: Resources/Period

Prior to US airstrikes ISIS was producing between 25,000-40,000

barrels of oil a day (BPD) across a dozen oil wells.See Section A

for parameterization method.

Revenue[Actors] = Donations[Actors] + Pre Donations Revenue[Actors]

Units: Dollars/Period

Tax Rates[Actors] = 33.1279, 15.995

Units: Dollars/(Period*Person)

Dividing this amount into the estimated Population governed for the

2014 Period results in a range from $11.99-$20 Person/Period for

Population Governed. See Section A for parameterization method. For

equilbiurm the tax rate should start at the total revenue needed

divided by the population, unless equilibrium with natural resource

production, foreign donations etc. is desired.

Taxes[Actors] = (Tax Rates[Actors] * ((SUM (Calc Legit Pop[Ethnographies!,Actors

])) + (SUM (Governed Pop[Ethnographies!,Actors]))))

Units: Dollars/Period

Territory Conditions Price per Resource Unit[Actors] = GAME(Normal Territory Conditions Price per Resource Unit[

Actors])

Units: Dollars/Resource

See Section A for parameterization method.

Increase in Institutional Procedures[Ethnographies,Actors] = MAX (0, (Organic Procedures[

Ethnographies,Actors] + Procedural Development[Ethnographies,Actors]

+ Replacing Obsolete Procedures[Ethnographies,Actors] + Impact of Armed Civil Affairs[

Actors]))

Units: Procedures/Period

MAX(0,(Adj to Procedural Spend[Actors]*Organic

Procedures[Ethnographies,Actors])+ (Adj to Procedural

Spend[Actors]*Procedural Development[Ethnographies,Actors])+ (Adj to

Procedural Spend[Actors]*Replacing Obsolete

Procedures[Ethnographies,Actors]))

Institutional Procedures[Ethnographies,Actors] = INTEG(Increase in Institutional Procedures[

Ethnographies,Actors] - Procedural Decay[Ethnographies,Actors] - Reduction in Institutional Procedures[

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Ethnographies,Actors] , Desired Institutional Procedures[Ethnographies

,Actors] + Legacy Procedures Step Test[Ethnographies,Red])

   Units: Procedures

Organic Procedures[Ethnographies,Actors] = MAX (0, (((Institutional Procedures[

   Ethnographies,Actors] / 100) * Organic Procedural Development[Ethnographies

      ,Actors]) * "Allocation of Non-Essential Budgets"[Actors]) / ORGANIC PROCEDURAL DEVELOPMENT
TIME[

      Actors])

   Units: Procedures/Period

Procedural Development[Ethnographies,Actors] = ((Desired Institutional Procedures[

   Ethnographies,Actors] / Normal Procedural Development Time[Actors]) - (Institutional Procedures[

      Ethnographies,Actors] / Normal Procedural Development Time[Actors])

) * "Allocation of Non-Essential Budgets"[Actors]

      Units: Procedures/Period

Actual Military Actions[Actors] = IF THEN ELSE (Capacity for Military Actions based on Budget[

      Actors] > Capability of Military Actions based on Squads[Actors] , Capability of Military Actions based on
Squads[

      Actors] , Capacity for Military Actions based on Budget[Actors])

      Units: Military Actions/Period

Allocation of Essential Budgets[Actors] = Table for Effect of Sufficiency of Reserves on Essentials Bankruptcy
Policy[

   Actors] (ZIDZ (Finances[Actors] , Normal Actor Desired Local Reserves[Actors

      ]))

      Units: Dmnl

D-3 Strategic Architecture Sectors & Equations

"Allocation of Non-Essential Budgets"[Actors] = Table for Effect of Sufficiency of Reserves on Essentials Bankruptcy Policy[

    Actors] (ZIDZ (Finances[Actors] * Level of Reserves at Which NonEssentials Begin to Be Cut[

        Actors] , (Normal Actor Desired Local Reserves[Actors] * Reserves Multiplier to Determine NonEssentials Cut Off Level

)))

      Units: Dmnl

Combatants[Ethnographies,Actors] = INTEG(Combatant Additions[Ethnographies,Actors

    ] - Combatant Losses[Ethnographies,Actors] , Starting Combatants[Ethnographies

    ,Actors])

      Units: People

Cost per Military Action[Actors] = 3000

      Units: Dollars/Military Action

      Analysis showed that for each $2700 transferred to a sector command,

                an AQI attack was launched. This cost includes not only direct costs

                of the attack, but indirect costs of all the other factors necessary

                for AQI to peform in that sector outside Media, Courts,

                Administration. Furthermore, there was a strong correlation (.66)

                between the rate of fund flows increasing or decreasing and

                corresponding changes in the pace of attacks. RAND 57-69. Equilibrium

                value set to 3000.

Death Benefits[Actors] = (Killed Militants Total * Wages[Actors]) * "Allocation of Non-Essential Budgets"[

    Actors]

      Units: Dollars/Period

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See Section A for parameterization method.

Detainees in Prison[Actors] = INTEG(Increase in Detentions[Actors] - Defections within Prison[

Actors] - Detainees Released[Actors] - Defections within Prison[

Actors] , STARTING DETAINEES BY ACTOR[Actors])

Units: People

Detention Benefits[Actors] = (Detainees in Prison[Actors] * Wages[Actors]) * "Allocation of Non-Essential Budgets"[

Actors]

Units: Dollars/Period

See Section A for parameterization method.

Detention Benefits Gap[Actors] = ZIDZ (Detention Benefits[Actors] , (Detainees in Prison[

Actors] * Wages[Actors]))

Units: Pct

Expenses before Attacks[Actors] = Death Benefits[Actors] + Detention Benefits[Actors

] + "Media Border Security & Other Expenses"[Actors] + Military Procurement[

Actors] + Payroll[Actors] + Governance Expenses[Actors]

Units: Dollars/Period

Expenses including Attacks[Actors] = Expenses before Attacks[Actors] + Military Actions Paid For[

Actors]

Units: Dollars/Period

Finances[Actors] = INTEG(Incoming Revenue[Actors] - Outgoing Expenses[Actors] ,

Starting Cash[Actors])

Units: Dollars

("Baseline Switch (1 = On)"*(Capability of Military Actions based on

Squads*Cost per Attack))+("Scenario 1 Switch (1 = On)"*"ZScenario1:

Starting Cash")

Gap between Desired Reserves and Current Finances[Actors] = Finances[Actors] - Normal Actor Desired Local Reserves[

Actors]

Units: Dollars

Governance Expenses[Actors] = MAX (0, Total New Procedure Costs[Actors] + Total Procedure Maintenance Costs[

Actors])

Units: Dollars/Period

Killed Militants Total = INTEG(Rate of Militant Deaths Total , 0)

Units: People

Adjust initial level based on starting time of model.

Level of Reserves at Which NonEssentials Begin to Be Cut[Actors] = 0.25

Units: Dmnl

"Media Border Security & Other Budget"[Actors] = 0.06

Units: Pct

All other expenses were combined into a single bucket that amounts to

6% of all revenue. See Section A for parameterization method.

"Media Border Security & Other Expenses"[Actors] = MAX (0, (Revenue[Actors] *

"Media Border Security & Other Budget"[Actors]) * Allocation of Essential Budgets[

Actors])

Units: Dollars/Period

Military Actions Paid For[Actors] = Cost per Military Action[Actors] * Actual Military Actions[

Actors]

Units: Dollars/Period

Military Procurement[Actors] = MAX (0, (Revenue[Actors] * Military Procurement Budget[

Actors]) * Allocation of Essential Budgets[Actors])

Units: Dollars/Period

Military Procurement Budget[Actors] = 0.1

Units: Pct

According to the RAND analysis purchases related to military

procurement – heavy weapons, ammunition, logistics and maintenance

ran about 10% of all revenues. See Section A for parameterization

method.

Money Sent Abroad[Actors] = (Surplus for Sending Money Abroad[Actors] * Allocation of Essential Budgets[

Actors]) / Time to Spend Money Abroad[Actors]

Units: Dollars/Period

NEW PROCEDURE COST[Actors] = 10

Units: Dollars/Procedures

Normal Actor Desired Local Reserves[Actors] = 1e+007

    Units: Dollars

NORMAL PERIOD = 1

    Units: Period

Payroll[Actors] = (Total Combatants[Actors] * Wages[Actors]) * Allocation of Essential Budgets[

    Actors]

    Units: Dollars/Period

Payroll Gap[Actors] = ZIDZ (Payroll[Actors] , (Total Combatants[Actors] * Wages[

    Actors]))

    Units: Pct

PROCEDURE MAINTENANCE COST[Actors] = 1

    Units: Dollars/(Period*Procedure)

    $1/Period Nominal

Replacing Obsolete Procedures[Ethnographies,Actors] = ZIDZ ((Procedural Decay[

    Ethnographies,Actors] * Desire to Credibly Govern Ethnography[Ethnographies

    ,Actors]) * "Allocation of Non-Essential Budgets"[Actors] , 1)

    Units: Procedures/Period

Reserves Multiplier before Sending Money Abroad[Actors] = 15

    Units: Dmnl

Reserves Multiplier to Determine NonEssentials Cut Off Level = 10

Units: Dmnl

Revenue[Actors] = Donations[Actors] + Pre Donations Revenue[Actors]

Units: Dollars/Period

Surplus for Sending Money Abroad[Red] = IF THEN ELSE (Finances[Red] / NORMAL PERIOD

- Expenses including Attacks[Red] > Normal Actor Desired Local Reserves[

Red] / NORMAL PERIOD * Reserves Multiplier before Sending Money Abroad[

Red] , Finances[Red] - Normal Actor Desired Local Reserves[

Red] , 0)

Surplus for Sending Money Abroad[Green] = 0

Units: Dollars

Table for Effect of Sufficiency of Reserves on Essentials Bankruptcy Policy[Actors

] ([(0,0)-(1,1)],(0,0),(0,0),(0,0),(0.0025,0),(0.005,0.005),(0.1,0.05),(0.2,0.1)

,(0.3,0.3),(0.4,0.5),(0.5,0.7),(0.6,0.8),(0.7,0.875),(0.8,0.95),(0.9,0.99)

,(0.97,1),(0.99,1),(1,1))

Units: Dmnl

[(0,0)-(1,1)],(0,0),(0,0),(0,0),(0.0025,0),(0.005,0.005),(0.1,0.01),(0

.2,0.05),(0.3,0.2),(0.4,0.35),(0.5,0.5),(0.6,0.6),(0.75,0.8),(0.8,0.85

),(0.9,0.95),(0.97,0.99),(0.99,0.99),(1,1)

Time to Spend Money Abroad[Actors] = 1

Units: Periods

Total Combatants[Actors] = Total Local Combatants[Actors] + Foreign Combatants[Actors

]

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Units: People

Total Ethno by Actor[Ethnographies,Actors] = Calc Legit Pop[Ethnographies,Actors

] + Coerced Pop[Ethnographies,Actors] + Governed Pop[Ethnographies,Actors]

Units: People

Total Funds Sent Abroad[Actors] = INTEG(Money Sent Abroad[Actors] , 0)

Units: Dollars

Total New Procedure Costs[Actors] = MAX (0, Total New Procedures[Actors] * NEW PROCEDURE COST[

Actors])

Units: Dollars/Period

Total New Procedures[Actors] = SUM (Organic Procedures[Ethnographies!,Actors])

+ SUM (Procedural Development[Ethnographies!,Actors]) + SUM (Replacing Obsolete Procedures[

Ethnographies!,Actors])

Units: Procedures/Period

Total Procedure Maintenance Costs[Actors] = PROCEDURE MAINTENANCE COST[Actors] *

(SUM (Institutional Procedures[Ethnographies!,Actors]))

Units: Dollars/Period

Wages[Actors] = 366, 366

Units: Dollars/(Period*Person)

Includes direct pay to militant of $41/month and dependent (on

averaqge one) pay of $20/month for $61/month or $366/period. See

Section A for parameterization method.

D-4 World Model Sectors

D-4.1 Ethnographic Perceptions
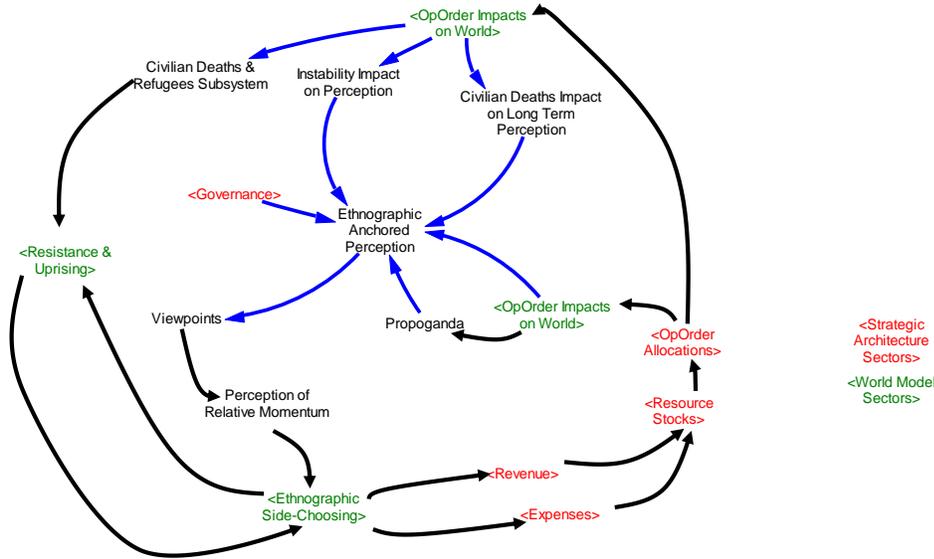
Overview

Figure D-7: Ethnographic Perceptions Sector Overview

Equations

Change in Long Term Perception[Ethnographies,Actors] = ((Ethnographic Short Term Perception of Actor[

Ethnographies,Actors] - Ethnographic Long Term Perception of Actor[Ethnographies

,Actors]) / NORMAL TIME TO FORM LONG TERM PERCEPTION) - Net Long Term Change from Violence[

Ethnographies,Actors]

Units: People/Period

Change in Short Term Perception[Ethnographies,Actors] = ((Perception Adjst Amnt[

Ethnographies,Actors] + (Ethnographic Long Term Perception of Actor[Ethnographies

,Actors] - Ethnographic Short Term Perception of Actor[Ethnographies,

Actors])) / TIME TO FORM SHORT TERM PERCEPTION) + Net Propoganda Impact[

Ethnographies,Actors] - (Net Perception Change from Violence[Ethnographies

,Actors] + Net Instability Change[Actors])

> Units: People/Period

Ethnographic Long Term Perception of Actor[Ethnographies,Actors] = INTEG(Change in Long Term Perception[

> Ethnographies,Actors] , Initial Ethnographic Generational Perception[

> Ethnographies,Actors])

> Units: People

Ethnographic Short Term Perception of Actor[Ethnographies,Actors] = INTEG(Change in Short Term Perception[

> Ethnographies,Actors] , Initial Ethnographic Perception[Ethnographies

> ,Actors])

> Units: People

Institutional Procedures[Ethnographies,Actors] = INTEG(Increase in Institutional Procedures[

> Ethnographies,Actors] - Procedural Decay[Ethnographies,Actors] - Reduction in Institutional Procedures[

> Ethnographies,Actors] , Desired Institutional Procedures[Ethnographies

> ,Actors] + Legacy Procedures Step Test[Ethnographies,Red])

> Units: Procedures

Perception Adjst Amnt[Ethnographies,Actors] = ((Institutional Procedures[Ethnographies

> ,Actors] * Peoples Adjusted Perception per Procedure) - Ethnographic Short Term Perception of Actor[

> Ethnographies,Actors])

> Units: People

Actual Governed Local Recruiting[Ethnographies,Actors] = (Target Recruitment Governed[

> Ethnographies,Actors]) * FAM Modifier for Governed[Ethnographies,Actors]

> Units: People/Period

D-4 World Model Sectors

All Conflict Deaths = INTEG(Rate of All Conflict Deaths , 0)

     Units: People

Average Perception Period[Ethnographies,Actors] = INTEG(Change of Average[Ethnographies

    ,Actors] , Pct views Actor as best choice for now[Ethnographies,Actors

    ])

     Units: Pct

Average Rate of Change of Perception[Ethnographies,Actors] = INTEG(Rate of Change of the Average Perception[

    Ethnographies,Actors] , 0)

     Units: Pct/Period

Blue or Purple Information Operations[Actors] = Actual Blue or Purple Military Actions[

    Actors] * Blue or Purple OpOrder Information Operations[Actors]

     Units: Military Actions/Period

Change of Average[Ethnographies,Actors] = (Pct views Actor as best choice for now[

    Ethnographies,Actors] - Average Perception Period[Ethnographies,Actors])

     / NORMAL PERIOD

     Units: Pct/Period

Civilian Deaths[Ethnographies,Actors] = War Crime Deaths[Ethnographies,Actors]

     Units: People/Period

Civilians Killed[Ethnographies,Actors] = INTEG(Rate of Civilian Deaths[Ethnographies

,Actors] , 0)

Units: People

COMPUTED INSTITUTIONAL PROCEDURES[Ethnographies,Green] = ((Calc Legit Pop[Ethnographies

,Green] + Governed Pop[Ethnographies,Green] + Coerced Pop[Ethnographies,Green

]) * NORMAL PROCEDURES REQUIRED FOR CREDIBILITY PER POP[Ethnographies

]) * Desire to Credibly Govern Ethnography[Ethnographies,Green]

COMPUTED INSTITUTIONAL PROCEDURES[Ethnographies,Red] = 2e+006, 0, 2e+006

Units: Procedures

Death Generational Perception Multiplier = 20

Units: Dmnl

Thisis the number of periods that the violence will be "remembered"

and cause an impact. This impact is delivered up front and must be

earned back over time. Currently set from 20 = 10 yrs.

Deaths[Actors] = (Actor Infantry Actual Losses[Actors] * PCT OF LOSSES THAT ARE DEATH[

Actors]) + Deaths from CT Operations[Actors] + Deaths from Thwarted Prison Breaks[

Actors]

Units: People/Period

(Red Infantry Final Losses[Red]*PCT OF LOSSES THAT ARE

DEATH[Red])/Time to Realize Losses+ Deaths from CT

Operations[Red]+Deaths from Thwarted Prison Breaks[Red]

Ethno Sufficiency Modifier[Ethnographies] = Table for Effect of Remaining Population on Sufficiency

(Remaining Ethnographic Population[Ethnographies])

Units: Dmnl

D-4 World Model Sectors

Ethnographic Relative Momentum in Perception[Ethnographies,Actors] = Average Rate of Change of Perception[

　　Ethnographies,Green] - Average Rate of Change of Perception[Ethnographies,

　　　Red]

　　　　Units: Pct/Period

　　　　Rate of Change of the Average Perception[Ethnographies,Red]-Rate of

　　　　　　　Change of the Average Perception[Ethnographies,Green]

Initial Ethnographic Generational Perception[Ethnographies,Green] = IF THEN ELSE (

　　　STARTING ETHNOGRAPHIC GENERATIONAL PERCEPTION OF ACTOR[Ethnographies,

　　　Green] = 0, COMPUTED INSTITUTIONAL PROCEDURES[Ethnographies,Green] /

　　　　NORMAL PROCEDURES REQUIRED FOR CREDIBILITY PER POP[Ethnographies

　　　　] , STARTING ETHNOGRAPHIC GENERATIONAL PERCEPTION OF ACTOR[Ethnographies

　　　,Green])

Initial Ethnographic Generational Perception[Ethnographies,Red] = IF THEN ELSE (

　　　STARTING ETHNOGRAPHIC GENERATIONAL PERCEPTION OF ACTOR[Ethnographies,

　　　Red] = 0, COMPUTED INSTITUTIONAL PROCEDURES[Ethnographies,Red] / NORMAL PROCEDURES

REQUIRED FOR CREDIBILITY PER POP[

　　　　Ethnographies] , STARTING ETHNOGRAPHIC GENERATIONAL PERCEPTION OF ACTOR[

　　　Ethnographies,Red])

　　　　Units: People

Initial Ethnographic Perception[Ethnographies,Actors] = IF THEN ELSE (STARTING ETHNOGRAPHIC PERCEPTION[

　　　Ethnographies,Actors] = 0, Initial Ethnographic Generational Perception[

　　　Ethnographies,Actors] , STARTING ETHNOGRAPHIC PERCEPTION[Ethnographies

　　　,Actors])

　　　　Units: People

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D-4 World Model Sectors

KIA Per Million Population[Ethnographies,Actors] = Rate of All Conflict Deaths /

    (SUM (Total Ethno Population[Ethnographies!]) / Million Population

)

     Units: People/Period

Negative Propoganda Impact[Ethnographies,Green] = (Propoganda Squads[Red] + Blue or Purple Information Operations[

    Red]) * NORMAL NEGATIVE PROPOGANDA IMPACT[Ethnographies,Red]

Negative Propoganda Impact[Ethnographies,Red] = (Blue or Purple Information Operations[

   Green] + Propoganda Squads[Green]) * NORMAL NEGATIVE PROPOGANDA IMPACT[Ethnographies

   ,Red]

    Units: People/Period

    -(Propoganda Squads[Green]*Normal Propoganda

        Impact[Ethnographies,Green])

Net Instability Change[Actors] = Rate of All Conflict Deaths

    Units: People/Period

Net Long Term Change from Violence[Ethnographies,Actors] = (War Crime Deaths[Ethnographies

   ,Actors] + Terrorism Deaths[Ethnographies,Actors]) * Death Generational Perception Multiplier

    Units: People/Period

Net Perception Change from Violence[Ethnographies,Actors] = (KIA Per Million Population[

   Ethnographies,Actors] + Terrorism Refugees[Ethnographies,Actors] + War Crime Refugees[

    Ethnographies,Actors]) * Violence Perception Multiplier[Actors]

D-4 World Model Sectors
Units: People/Period

Net Propoganda Impact[Ethnographies,Actors] = Positive Propoganda Impact[Ethnographies

,Actors] - Negative Propoganda Impact[Ethnographies,Actors]

Units: People/Period

NORMAL NEGATIVE PROPOGANDA IMPACT[Ethnographies,Green] = 1000, 1000, 1000

NORMAL NEGATIVE PROPOGANDA IMPACT[Ethnographies,Red] = 1000, 1000, 1000

Units: People/Military Action

NORMAL PERIOD = 1

Units: Period

NORMAL POSITIVE PROPOGANDA IMPACT[Ethnographies,Green] = 1000, 1000, 1000

NORMAL POSITIVE PROPOGANDA IMPACT[Ethnographies,Red] = 1000, 0, 500

Units: People/Military Action

NORMAL PROCEDURES REQUIRED FOR CREDIBILITY PER POP[Ethnographies] = 1

Units: Procedures/People

NORMAL TIME TO FORM LONG TERM PERCEPTION = 10

Units: Periods

nominally set at 10 period or 5 times the short term value in order

to see all dynamics without an extended duration model.

Outflow of Population Under Control[Ethnographies] = (SUM (Civilian Deaths[Ethnographies

,Actors!])) + (SUM (Actual Governed Local Recruiting[Ethnographies

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,Actors!])) + (SUM (Refugees Leaving[Ethnographies,Actors!]

))

Units: People/Period

Pct views Actor as best choice for now[Ethnographies,Actors] = IF THEN ELSE (Ethnographic Short Term Perception of Actor[

Ethnographies,Actors] < 0, 0, MAX (0, MIN (1, ZIDZ (Ethnographic Short Term Perception of Actor[

Ethnographies,Actors] , Total Ethno Population[Ethnographies

]))))

Units: Pct

Pct views Actor as legitimate government[Ethnographies,Actors] = IF THEN ELSE (

Ethnographic Long Term Perception of Actor[Ethnographies,Actors] < 0,

0, MAX (0, MIN (1, ZIDZ (Ethnographic Long Term Perception of Actor[

Ethnographies,Actors] , Total Ethno Population[Ethnographies

]))))

Units: Pct

Peoples Adjusted Perception per Procedure = 1

Units: People/Procedure

Positive Propoganda Impact[Ethnographies,Green] = NORMAL POSITIVE PROPOGANDA IMPACT[

Ethnographies,Green] * (Propoganda Squads[Green] + Blue or Purple Information Operations[

Green])

Positive Propoganda Impact[Ethnographies,Red] = (Propoganda Squads[Red] + Blue or Purple Information Operations[

Red]) * NORMAL POSITIVE PROPOGANDA IMPACT[Ethnographies,Red]

Units: People/Period

Propoganda Squads[Actors] = Actual Military Actions[Actors] * OpOrder Propoganda[

Actors]

Units: Military Actions/Period

Rate of All Conflict Deaths = Rate of Total Civilian Death all Ethnographies + (

SUM (Deaths[Actors!]))

Units: People/Period

Rate of Change of the Average Perception[Ethnographies,Actors] = (Change of Average[

Ethnographies,Actors] - Average Rate of Change of Perception[Ethnographies

,Actors]) / NORMAL PERIOD * 2

Units: Pct/(Period*Period)

Rate of Civilian Deaths[Ethnographies,Actors] = (Civilian Deaths[Ethnographies,

Actors]) * Ethno Sufficiency Modifier[Ethnographies]

Units: People/Period

Rate of Civilian Refugees[Ethnographies,Actors] = Refugees Leaving[Ethnographies

,Actors] * Ethno Sufficiency Modifier[Ethnographies]

Units: People/Period

Rate of Civilian Refugees all Ethnographies = SUM (Rate of Civilian Refugees[Ethnographies!

,Actors!])

Units: People/Period

Rate of Total Civilian Death all Ethnographies = SUM (Rate of Civilian Deaths[Ethnographies!

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,Actors!])

   Units: People/Period

Rate of Unaligned converting to Calculated Risk[Ethnographies,Green] = IF THEN ELSE (

   Ethnographic Relative Momentum in Perception[Ethnographies,Green] > 0

   , Ethnographic Relative Momentum in Perception[Ethnographies,Green] *

      NORMAL PERIOD , 0)

Rate of Unaligned converting to Calculated Risk[Ethnographies,Red] = IF THEN ELSE (

   Ethnographic Relative Momentum in Perception[Ethnographies,Green] < 0

   , - (Ethnographic Relative Momentum in Perception[Ethnographies,Red]

      * NORMAL PERIOD) , 0)

   Units: Pct

Refugees[Ethnographies,Actors] = INTEG(Rate of Civilian Refugees[Ethnographies,

   Actors] , 0)

   Units: People

Refugees Leaving[Ethnographies,Actors] = War Crime Refugees[Ethnographies,Actors

   ] + Terrorism Refugees[Ethnographies,Actors]

   Units: People/Period

STARTING ETHNOGRAPHIC GENERATIONAL PERCEPTION OF ACTOR[Ethnographies,Green] = 1e+007

   , 3e+007, 1e+007

STARTING ETHNOGRAPHIC GENERATIONAL PERCEPTION OF ACTOR[Ethnographies,Red] = 0, 0

   , 0

   Units: People

STARTING ETHNOGRAPHIC PERCEPTION[Ethnographies,Green] = 1e+007, 3e+007, 1e+007

STARTING ETHNOGRAPHIC PERCEPTION[Ethnographies,Red] = 0, 0, 0

    Units: People

Terrorism Deaths[Ethnographies,Red] = (Completed Terrorist Attacks by Ethnography[

    Ethnographies,Green] * DEATHS PER TERRORIST ATTACK[Green]) * Ethno by Actor Sufficiency[

    Ethnographies,Red]

Terrorism Deaths[Ethnographies,Green] = (Completed Terrorist Attacks by Ethnography[

    Ethnographies,Red] * DEATHS PER TERRORIST ATTACK[Red]) * Ethno by Actor Sufficiency[

    Ethnographies,Green]

    Units: People/Period

Terrorism Refugees[Ethnographies,Green] = (Completed Terrorist Attacks by Ethnography[

    Ethnographies,Red] * REFUGEES PER TERRORIST ATTACK[Red]) * Ethno by Actor Sufficiency[

    Ethnographies,Green]

Terrorism Refugees[Ethnographies,Red] = (Completed Terrorist Attacks by Ethnography[

    Ethnographies,Green] * REFUGEES PER TERRORIST ATTACK[Green]) * Ethno by Actor Sufficiency[

    Ethnographies,Red]

    Units: People/Period

TIME TO FORM SHORT TERM PERCEPTION = 0.5

    Units: Periods

    nominally set at .5 Period, or 3months of credible processes for

        short term formation.

Total Civilians Killed all Ethnographies = INTEG(Rate of Total Civilian Death all Ethnographies

    , 0)

Units: People

Total Ethno Population[Ethnographies] = INTEG(Increase in Pop[Ethnographies] -

Decrease in Pop[Ethnographies] , STARTING LEVEL OF ETHNOGRAPHIC POPULATION[

Ethnographies])

Units: People

Total Refugees all Ethnicities = INTEG(Rate of Civilian Refugees all Ethnographies

, 0)

Units: People

Violence Perception Multiplier[Actors] = 6, 1

Units: Dmnl

Multiplier indicating the length of time the violence will be

remembered. This impact is delivered up front and fades over time.

War Crime Deaths[Ethnographies,Actors] = MAX (0, (War Crimes[Ethnographies,Actors

] * DEATHS PER WAR CRIME[Ethnographies,Actors]) * Ethno by Actor Sufficiency[

Ethnographies,Actors])

Units: People/Period

War Crime Refugees[Ethnographies,Actors] = MAX (0, (War Crimes[Ethnographies,Actors

] * REFUGEES PER WAR CRIME[Ethnographies,Actors]) * Ethno by Actor Sufficiency[

Ethnographies,Actors])

Units: People/Period

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D-4.2 Ethnographic Side-Choosing & Actor Legitimacy

Overview
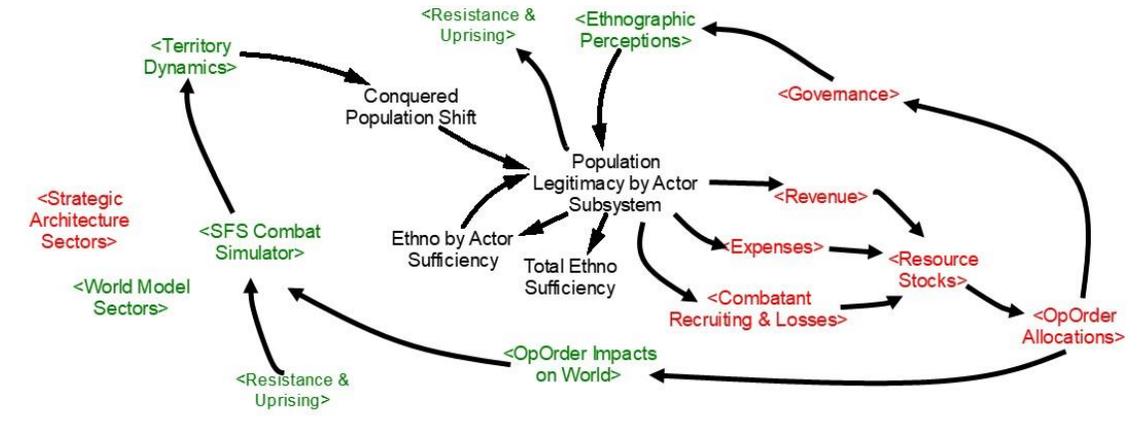
Figure D-8: Ethnographic Side-Choosing & Legitimacy Structure

Equations

Ethnographic Short Term Perception of Actor[Ethnographies,Actors] = INTEG(Change in Short Term Perception[

Ethnographies,Actors] , Initial Ethnographic Perception[Ethnographies

,Actors])

Units: People

Institutional Procedures[Ethnographies,Actors] = INTEG(Increase in Institutional Procedures[

Ethnographies,Actors] - Procedural Decay[Ethnographies,Actors] - Reduction in Institutional Procedures[

Ethnographies,Actors] , Desired Institutional Procedures[Ethnographies

,Actors] + Legacy Procedures Step Test[Ethnographies,Red])

Units: Procedures

Actual Governed Local Recruiting[Ethnographies,Actors] = (Target Recruitment Governed[

Ethnographies,Actors]) * FAM Modifier for Governed[Ethnographies,Actors]

Units: People/Period

Actual Opposition Recruited[Ethnographies,Actors] = Adequacy of Fighting Age Men for Opposition[

Ethnographies,Actors] * Target Recruited Opposition[Ethnographies,Actors]

>Units: People/Period

Actual Recruiting Fighting Age Men in Population[Ethnographies,Actors] = (STARTING NORMAL PCT OF FIGHTING AGE MEN IN POPULATION[

>Ethnographies] * (1 + Experience Effect on Actions[Actors]))

>>Units: Pct

>>The ethnographic norm +capability of the actor based on experience.

Cal Legit Pop Dying[Ethnographies,Actors] = Calc Legit Pop Deaths[Ethnographies,

>Actors]

>>Units: People/Period

Calc Legit Pop[Ethnographies,Actors] = INTEG(Coerced to Calculated[Ethnographies

>,Actors] + Governed to Calculated[Ethnographies,Actors] + Unaligned Choosing Sides[

>>Ethnographies,Actors] - Cal Legit Pop Dying[Ethnographies,Actors

>>] - Calc Legit Pop Recruited or Joining Uprising[Ethnographies,Actors

>>] - Calc Legit Refugees Leaving[Ethnographies,Actors] - Calculated Lost to Conquest[

>>Ethnographies,Actors] - Calculated to Coerced[Ethnographies,Actors

>>] - Calculated to Governed[Ethnographies,Actors] , STARTING LEVEL OF ETHNOGRAPHIC POPULATION[

>Ethnographies] * STARTING ETHNO DISTRIBUTION CALCULATED[Ethnographies

>>,Actors])

>>Units: People

Calc Legit Pop Deaths[Ethnographies,Actors] = Rate of Civilian Deaths[Ethnographies

>,Actors] * Pct Calc Legit Pop[Ethnographies,Actors]

>>Units: People/Period

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Calc Legit Pop Recruited or Joining Uprising[Ethnographies,Actors] = Calc Legit Recruited[

Ethnographies,Actors]

Units: People/Period

Calc Legit Pop Refugees[Ethnographies,Actors] = (Rate of Civilian Refugees[Ethnographies

,Actors] * Pct Calc Legit Pop[Ethnographies,Actors])

Units: People/Period

Calc Legit Recruited[Ethnographies,Actors] = Actual Local Calculated Recruiting[

Ethnographies,Actors]

Units: People/Period

Actual Governed Local Recruiting[Ethnographies,Actors]*"Pct Calc

Legit Fighting Age Men (Red)"[Ethnographies,Actors]

Calc Legit Refugees Leaving[Ethnographies,Actors] = Calc Legit Pop Refugees[Ethnographies

,Actors]

Units: People/Period

Calculated Legitimacy Gap[Ethnographies,Actors] = MAX (0, 1 - XIDZ (Pct views Actor as best choice for now[

Ethnographies,Actors] , Pct Calc Legit Pop[Ethnographies,Actors

] , 1))

Units: Pct

MAX(0,1-XIDZ(Pct views Actor as best choice for

now[Ethnographies,Actors],"Pct Calc Legit Pop

(Red)"[Ethnographies,Actors],1))

Calculated Lost to Conquest[Ethnographies,Actors] = Loss of CalcLegit due to Conquest[

Ethnographies,Actors] * Ethno by Actor Sufficiency[Ethnographies,Actors]

Units: People/Period

Calculated to Coerced[Ethnographies,Actors] = MAX (0, (Calc Legit Pop[Ethnographies

,Actors] * Fr Transition to Coerced[Ethnographies,Actors]) / NORMAL TIME FOR POPULATION
TRANSITION[

Ethnographies,Actors])

Units: People/Period

Calculated to Governed[Ethnographies,Actors] = MAX (0, (Calc Legit Pop[Ethnographies

,Actors] * Fr Transition to Legitimacy[Ethnographies,Actors]) / NORMAL TIME FOR POPULATION
TRANSITION[

Ethnographies,Actors])

Units: People/Period

Civilian Deaths[Ethnographies,Actors] = War Crime Deaths[Ethnographies,Actors]

Units: People/Period

Coerced Dying[Ethnographies,Actors] = MAX (0, Coerced Pop Deaths[Ethnographies,

Actors])

Units: People/Period

Coerced Lost to Conquest[Ethnographies,Actors] = Loss of Coerced due to Conquest[

Ethnographies,Actors] * Ethno by Actor Sufficiency[Ethnographies,Actors]

Units: People/Period

Coerced Opposition Recruitment[Ethnographies,Actors] = MAX (0, Actual Opposition Recruited[

Ethnographies,Actors])

Units: People/Period

Coerced Pop[Ethnographies,Actors] = INTEG((Unaligned to Coerced[Ethnographies,

Actors] + Calculated to Coerced[Ethnographies,Actors] - Coerced Dying[

Ethnographies,Actors]) - Coerced Refugees Leaving[Ethnographies

,Actors] - Coerced to Calculated[Ethnographies,Actors] - Coerced to Unaligned[

Ethnographies,Actors] - Coerced Opposition Recruitment[Ethnographies

,Actors] + Conquest[Ethnographies,Actors] , STARTING LEVEL OF ETHNOGRAPHIC POPULATION[

Ethnographies] * STARTING ETHNO DISTRIBUTION COERCED[Ethnographies,Actors

])

Units: People

Coerced Pop Deaths[Ethnographies,Actors] = (Rate of Civilian Deaths[Ethnographies

,Actors] * Pct Coerced Pop[Ethnographies,Actors])

Units: People/Period

Coerced Pop Refugees[Ethnographies,Actors] = (Rate of Civilian Refugees[Ethnographies

,Actors] * Pct Coerced Pop[Ethnographies,Actors])

Units: People/Period

Coerced Refugees Leaving[Ethnographies,Actors] = MAX (0, Coerced Pop Refugees[Ethnographies

,Actors])

Units: People/Period

Coerced to Calculated[Ethnographies,Actors] = MAX (0, (Coerced Pop[Ethnographies

,Actors] * Fr Transition to Calculated Legitimatcy[Ethnographies,Actors

]) / NORMAL TIME FOR POPULATION TRANSITION[Ethnographies,Actors

])

Units: People/Period

Coerced to Unaligned[Ethnographies,Actors] = Leaving from Coerced to Unaligned[Ethnographies

,Actors] / NORMAL TIME FOR POPULATION TRANSITION[Ethnographies,Actors]

Units: People/Period

MAX(0,(Coerced Pop[Ethnographies,Actors]*("% of Garrison Gap to

Coerced"[Ethnographies,Actors]*0.75))/NORMAL TIME FOR POPULATION

TRANSITION [Ethnographies,Actors])

Conquest[Ethnographies,Red] = Green Conquered to Coerced[Ethnographies,Green]

Conquest[Ethnographies,Green] = Red Conquered to Coerced[Ethnographies,Red]

Units: People/Period

Decrease in Pop[Ethnographies] = Decrease in Total Ethno Pop All Sources[Ethnographies

]

Units: People/Period

Decrease in Total Ethno Pop All Sources[Ethnographies] = (SUM (Cal Legit Pop Dying[

Ethnographies,Actors!]) + (SUM (Calc Legit Pop Recruited or Joining Uprising[

Ethnographies,Actors!])) + (SUM (Calc Legit Refugees Leaving[

Ethnographies,Actors!])) + (SUM (Governed Dying[Ethnographies

,Actors!])) + (SUM (Governed Pop Recruited[Ethnographies,Actors!

])) + (SUM (Governed Refugees Leaving[Ethnographies,Actors!]

)) + (SUM (Coerced Dying[Ethnographies,Actors!])) + (SUM (

Coerced Refugees Leaving[Ethnographies,Actors!])))

Units: People/Period

(SUM(Cal Legit Pop Dying[Ethnographies,Actors!])+ (SUM(Calculated

Lost to Conquest[Ethnographies,Actors!]))+ (SUM(Calc Legit Pop

Recruited or Joining Uprising[Ethnographies,Actors!]))+ (SUM(Calc

Legit Refugees Leaving[Ethnographies,Actors!]))+ (SUM(Governed

Dying[Ethnographies,Actors!]))+ (SUM(Governed Lost to

Conquest[Ethnographies,Actors!]))+ (SUM(Governed Pop

Recruited[Ethnographies,Actors!]))+ (SUM(Governed Refugees

Leaving[Ethnographies,Actors!]))+ (SUM(Coerced

Dying[Ethnographies,Actors!]))+ (SUM(Coerced Refugees

Leaving[Ethnographies,Actors!])))

Defections by Ethnography[Ethnographies,Actors] = (NORMAL DEFECTIONS DUE TO ETHNOGRAPHIC DISTRUST[

Ethnographies,Actors] + NORMAL DEFECTIONS DUE TO PAY INSUFFICIENCY[Actors]

+ Normal Defections from Momentum[Ethnographies,Red]) * Combatants[Ethnographies

,Actors]

Units: People/Period

Defections to Unaligned[Ethnographies] = SUM (Defections by Ethnography[Ethnographies

,Actors!])

Units: People/Period

Demographic Growth[Ethnographies] = 0

Units: Pct

Effect of Garrison Ratio on Leaving to Unaligned[Ethnographies,Actors] = Table for Effect of Ratio on Leaving to Unaligned

(Pct of Desired Garrison Actual Represents[Ethnographies,Actors])

      Units: Pct

Ethno by Actor Sufficiency[Ethnographies,Actors] = Table for Effect of Remaining Ethno Population by Actor

    (MAX (0, Total Ethno by Actor[Ethnographies,Actors] / Reference Population for Sufficiency[

        Ethnographies,Actors]))

      Units: Pct

Ethno Sufficiency Modifier[Ethnographies] = Table for Effect of Remaining Population on Sufficiency

    (Remaining Ethnographic Population[Ethnographies])

      Units: Dmnl

Experience Effect on Actions[Actors] = Table for Effect of Militant Experience on Military Actions

    (Average Combatant Experience[Actors] * Dimensioned Ratio Average Militant Experience[

     Actors]) * Allocation of Essential Budgets[Actors]

      Units: Pct

      Derived from AQI implied local recruiting patterns. Estimated

            parameter from data or nearby model structure see Section A for

            discussion.

Fr Transition Back to Calculated[Ethnographies,Actors] = Table for Effect of Abandoning Actor

    (Legitimacy Gap Fraction[Ethnographies,Actors])

      Units: Pct

Fr Transition to Calculated Legitimatcy[Ethnographies,Actors] = Table for Effect of Gap on Transition

    (Gap for Calc[Ethnographies,Actors])

      Units: Pct

Fr Transition to Coerced[Ethnographies,Actors] = Table for Effect of Abandoning Actor

   (Calculated Legitimacy Gap[Ethnographies,Actors])

       Units: Pct

Fr Transition to Legitimacy[Ethnographies,Actors] = Table for Effect of Gap on Transition

   (Gap for Legitimacy[Ethnographies,Actors])

       Units: Dmnl

Gap for Calc[Ethnographies,Actors] = MAX (0, 1 - ZIDZ (Pct Calc Legit Pop[Ethnographies

       ,Actors] , Pct views Actor as best choice for now[Ethnographies

       ,Actors]))

       Units: Pct

Gap for Legitimacy[Ethnographies,Actors] = MAX (0, 1 - XIDZ (Pct Governed Pop[

       Ethnographies,Actors] , Pct views Actor as legitimate government[

       Ethnographies,Actors] , 1))

       Units: Pct

Goverened Deaths[Ethnographies,Actors] = (Rate of Civilian Deaths[Ethnographies

   ,Actors] * Pct Governed Pop[Ethnographies,Actors])

       Units: People/Period

Governed Dying[Ethnographies,Actors] = Goverened Deaths[Ethnographies,Actors]

       Units: People/Period

Governed Lost to Conquest[Ethnographies,Actors] = Loss of Governed due to Conquest[

Ethnographies,Actors] * Ethno by Actor Sufficiency[Ethnographies,Actors]

    Units: People/Period

Governed Pop[Ethnographies,Actors] = INTEG(Calculated to Governed[Ethnographies

    ,Actors] - Governed Dying[Ethnographies,Actors] - Governed Lost to Conquest[

    Ethnographies,Actors] - Governed Pop Recruited[Ethnographies,Actors

    ] - Governed Refugees Leaving[Ethnographies,Actors] - Governed to Calculated[

    Ethnographies,Actors] , STARTING LEVEL OF ETHNOGRAPHIC POPULATION[

    Ethnographies] * STARTING ETHNO DISTRIBUTION GOVERNED[Ethnographies,Actors

    ])

    Units: People

Governed Pop Recruited[Ethnographies,Actors] = MAX (0, Governed Recruited[Ethnographies

    ,Actors])

    Units: People/Period

Governed Recruited[Ethnographies,Actors] = Actual Governed Local Recruiting[Ethnographies

    ,Actors]

    Units: People/Period

Governed Refugees[Ethnographies,Actors] = (Rate of Civilian Refugees[Ethnographies

    ,Actors] * Pct Governed Pop[Ethnographies,Actors])

    Units: People/Period

Governed Refugees Leaving[Ethnographies,Actors] = Governed Refugees[Ethnographies

    ,Actors]

    Units: People/Period

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Governed to Calculated[Ethnographies,Actors] = MAX (0, (Governed Pop[Ethnographies

,Actors] * Fr Transition Back to Calculated[Ethnographies,Actors]) /

NORMAL TIME FOR POPULATION TRANSITION[Ethnographies,Actors])

Units: People/Period

"Governance Gap (Red)"[Ethnographies,Actors]/NORMAL TIME FOR

POPULATION TRANSITION[Ethnographies,Actors]

Green Conquered[Ethnographies] = (SUM (Red Conquered to Green[Ethnographies,Actors!

]))

Units: People/Period

Green Conquered to Coerced[Ethnographies,Green] = Red Conquered[Ethnographies]

Units: People/Period

Green Conquered to Red[Ethnographies,Red] = Total Conquered[Ethnographies,Green]

Green Conquered to Red[Ethnographies,Green] = 0

Units: People/Period

Increase in Pop[Ethnographies] = (Demographic Growth[Ethnographies] * Total Ethno Population[

Ethnographies]) / NORMAL PERIOD

Units: People/Period

Held constant for 10yr model.

Leaving from Coerced to Unaligned[Ethnographies,Actors] = Coerced Pop[Ethnographies

,Actors] * Effect of Garrison Ratio on Leaving to Unaligned[Ethnographies,

Actors]

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Units: People

Legitimacy Gap[Ethnographies,Actors] = MAX (0, 1 - ZIDZ (Pct views Actor as legitimate government[

Ethnographies,Actors] , Pct Governed Pop[Ethnographies,Actors

]))

Units: Pct

Legitimacy Gap Fraction[Ethnographies,Actors] = Legitimacy Gap[Ethnographies,Actors

]

Units: Pct

Loss of CalcLegit due to Conquest[Ethnographies,Green] = Pct Calc Legit Pop[Ethnographies

,Green] * IF THEN ELSE (Rate of Conquering Red[Ethnographies,Red] > 0, Rate of Conquering Red[

Ethnographies,Red] , 0)

Loss of CalcLegit due to Conquest[Ethnographies,Red] = IF THEN ELSE (Rate of Conquering Red[

Ethnographies,Red] < 0, - Rate of Conquering Red[Ethnographies,Red] *

Pct Calc Legit Pop[Ethnographies,Red] , 0)

Units: People/Period

Loss of Coerced due to Conquest[Ethnographies,Green] = Pct Coerced Pop[Ethnographies

,Green] * IF THEN ELSE (Rate of Conquering Red[Ethnographies,Red] > 0, Rate of Conquering Red[

Ethnographies,Red] , 0)

Loss of Coerced due to Conquest[Ethnographies,Red] = IF THEN ELSE (Rate of Conquering Red[

Ethnographies,Red] < 0, - Rate of Conquering Red[Ethnographies,Red] ,

0)

Units: People/Period

Loss of Governed due to Conquest[Ethnographies,Green] = IF THEN ELSE (Rate of Conquering Red[

Ethnographies,Red] > 0, Rate of Conquering Red[Ethnographies,Red] , 0

) * Pct Governed Pop[Ethnographies,Green]

Loss of Governed due to Conquest[Ethnographies,Red] = IF THEN ELSE (Rate of Conquering Red[

Ethnographies,Red] < 0, - Rate of Conquering Red[Ethnographies,Red] ,

0)

Units: People/Period

NORMAL PERIOD = 1

Units: Period

NORMAL TIME FOR POPULATION TRANSITION[Ethnographies,Actors] = GAME(0.25)

Units: Period

NORMAL TIME FOR UNALIGNED TO CHOSE A SIDE = 10

Units: Period

setat10 assumes 5 years

Pct Calc Legit Pop[Ethnographies,Actors] = MIN (1, MAX (0, ZIDZ (Calc Legit Pop[

Ethnographies,Actors] , Total Ethno by Actor[Ethnographies,

Actors])))

Units: Percentage

Pct Governed Pop[Ethnographies,Actors] = MIN (1, MAX (0, ZIDZ (Governed Pop[Ethnographies

,Actors] , Total Ethno by Actor[Ethnographies,Actors])))

Units: Percentage

Pct of Desired Garrison Actual Represents[Ethnographies,Actors] = ZIDZ ("Desired Garrison & Police Forces"[

Ethnographies,Actors] , Actual Garrsion[Actors])

Units: Pct

Pct views Actor as best choice for now[Ethnographies,Actors] = IF THEN ELSE (Ethnographic Short Term Perception of Actor[

Ethnographies,Actors] < 0, 0, MAX (0, MIN (1, ZIDZ (Ethnographic Short Term Perception of Actor[

Ethnographies,Actors] , Total Ethno Population[Ethnographies

]))))

Units: Pct

Pct views Actor as legitimate government[Ethnographies,Actors] = IF THEN ELSE (

Ethnographic Long Term Perception of Actor[Ethnographies,Actors] < 0,

0, MAX (0, MIN (1, ZIDZ (Ethnographic Long Term Perception of Actor[

Ethnographies,Actors] , Total Ethno Population[Ethnographies

]))))

Units: Pct

Peoples Adjusted Perception per Procedure = 1

Units: People/Procedure

Rate of Conquered Population Green[Ethnographies,Green] = MAX (0, Territory Conditions Table for Distribution of Population by Ethnography on Territorial Map[

Ethnographies] (Current Location of Red Actor on Territorial Map[Red

]) * Total Ethno Population[Ethnographies])

Rate of Conquered Population Green[Ethnographies,Red] = MAX (0, Total Ethno by Actor[

Ethnographies,Red] * Pct Decline from Peak[Red])

Units: People

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Rate of Conquering Red[Ethnographies,Red] = (Target Ethno Population by Most Recent Conquest[

    Ethnographies,Red] - Ethno by Actor Conquer Reference[Ethnographies,Red])

      / Normal Time to be Conquered[Ethnographies]

        Units: People/Period

Rate of Local Opposition Fighters Joining Uprising[Ethnographies,Actors] = Diehards joining Uprising[

    Ethnographies,Actors] + Actual Opposition Recruited[Ethnographies,Actors]

        Units: People/Period

Rate of Unaligned converting to Calculated Risk[Ethnographies,Green] = IF THEN ELSE (

      Ethnographic Relative Momentum in Perception[Ethnographies,Green] > 0

      , Ethnographic Relative Momentum in Perception[Ethnographies,Green] *

        NORMAL PERIOD , 0)

Rate of Unaligned converting to Calculated Risk[Ethnographies,Red] = IF THEN ELSE (

      Ethnographic Relative Momentum in Perception[Ethnographies,Green] < 0

      , - (Ethnographic Relative Momentum in Perception[Ethnographies,Red]

        * NORMAL PERIOD) , 0)

        Units: Pct

Red Conquered[Ethnographies] = (SUM (Green Conquered to Red[Ethnographies,Actors!

    ]))

        Units: People/Period

Red Conquered to Coerced[Ethnographies,Red] = Green Conquered[Ethnographies]

        Units: People/Period

Red Conquered to Green[Ethnographies,Green] = Total Conquered[Ethnographies,Red]

Red Conquered to Green[Ethnographies,Red] = 0

      Units: People/Period

Reference Population for Sufficiency[Ethnographies,Actors] = 100000

      Units: People

Refugees[Ethnographies,Actors] = INTEG(Rate of Civilian Refugees[Ethnographies,

     Actors] , 0)

      Units: People

Remaining Ethnographic Population[Ethnographies] = ZIDZ (Total Ethno Population[

     Ethnographies] , STARTING LEVEL OF ETHNOGRAPHIC POPULATION[Ethnographies

     ])

      Units: Pct

STARTING ETHNO DISTRIBUTION CALCULATED[Ethnographies,Green] = 0, 0, 0

STARTING ETHNO DISTRIBUTION CALCULATED[Ethnographies,Red] = 0, 0, 0

      Units: Dmnl

STARTING ETHNO DISTRIBUTION COERCED[Ethnographies,Green] = 0, 0, 0

STARTING ETHNO DISTRIBUTION COERCED[Ethnographies,Red] = 0, 0, 0

      Units: Dmnl

STARTING ETHNO DISTRIBUTION GOVERNED[Ethnographies,Green] = 1, 1, 1

STARTING ETHNO DISTRIBUTION GOVERNED[Ethnographies,Red] = 0, 0, 0

      Units: Dmnl

D-4 World Model Sectors

STARTING ETHNO DISTRIBUTION UNALIGNED[Ethnographies,Green] = 0, 0, 0

STARTING ETHNO DISTRIBUTION UNALIGNED[Ethnographies,Red] = 0, 0, 0

    Units: Pct

STARTING LEVEL OF ETHNOGRAPHIC POPULATION[Ethnographies] = 1e+007, 3e+007, 1e+007

    Units: People

STARTING NORMAL PCT OF FIGHTING AGE MEN IN POPULATION[Ethnographies] = 0.23

    Units: Pct

    The normal demographic pct of the population that can fight.

Sum of Distributions[Ethnographies,Actors] = STARTING ETHNO DISTRIBUTION CALCULATED[

    Ethnographies,Actors] + STARTING ETHNO DISTRIBUTION COERCED[Ethnographies,

      Actors] + STARTING ETHNO DISTRIBUTION GOVERNED[Ethnographies,Actors]

      + STARTING ETHNO DISTRIBUTION UNALIGNED[Ethnographies,Actors]

    Units: Dmnl

Table for Effect of Abandoning Actor ([(0,0)-(1,1)],(0,0),(0.1,0.05),(0.2,0.1),

    (0.3,0.175),(0.4,0.325),(0.5,0.425),(0.6,0.5),(0.7,0.55),(0.8,0.575)

    ,(0.9,0.595),(1,0.6))

    Units: Dmnl

Table for Effect of Gap on Transition ([(0,0)-(1.1,0.25)],(1,0.25),(0.9,0.24),(0.8,0.22)

    ,(0.7,0.2),(0.6,0.16),(0.5,0.12),(0.4,0.06),(0.35,0.04),(0.25,0.02),

    (0.2,0.01),(0.15,0),(0,0))

    Units: Pct

Table for Effect of Remaining Ethno Population by Actor ([(0,0)-(1,1)],(0,0),(0,0)

,(0,0),(0.0025,0),(0.005,0.005),(0.1,0.01),(0.2,0.05),(0.3,0.2),(0.4,0.35)

,(0.5,0.5),(0.6,0.6),(0.75,0.8),(0.8,0.85),(0.9,0.95),(0.97,0.99),(0.99,0.99)

,(1,1))

Units: Dmnl

Table for Effect of Remaining Population on Sufficiency ([(0,0)-(1,1)],(0,0),(0,0)

,(0.025,0.005),(0.05,0.01),(0.1,0.05),(0.2,0.1),(0.3,0.25),(0.4,0.4)

,(0.5,0.55),(0.6,0.65),(0.7,0.75),(0.8,0.8),(0.9,0.85),(0.95,0.9),(1,1)

)

Units: Dmnl

Territory Actor Controls[Actors] = INTEG(Rate of Territory Gained[Actors] - Rate of Territory Lost[

Actors] , Territory Conditions Starting Total Territory * Territory Conditions Pct Territory Controlled by Actor at Start[

Actors])

Units: "km^2"

Total Conquered[Ethnographies,Actors] = Calculated Lost to Conquest[Ethnographies

,Actors] + Coerced Lost to Conquest[Ethnographies,Actors] + Governed Lost to Conquest[

Ethnographies,Actors]

Units: People/Period

Total Ethno by Actor[Ethnographies,Actors] = Calc Legit Pop[Ethnographies,Actors

] + Coerced Pop[Ethnographies,Actors] + Governed Pop[Ethnographies,Actors]

Units: People

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Total Ethno Population[Ethnographies] = INTEG(Increase in Pop[Ethnographies] -

Decrease in Pop[Ethnographies] , STARTING LEVEL OF ETHNOGRAPHIC POPULATION[

Ethnographies])

Units: People

Unaligned Choosing Sides[Ethnographies,Green] = Unaligned to Calculated[Ethnographies

,Red]

Unaligned Choosing Sides[Ethnographies,Red] = Unaligned to Calculated[Ethnographies

,Green]

Units: People/Period

Unaligned Conquered to Coerced[Ethnographies,Red] = (Unaligned Pop[Ethnographies

] * Territory Conditions Table for Percentage of Unaligned Population Controlled based on Location of Red
Actor on Territorial Map

(Current Location of Red Actor on Territorial Map[Red])) / Normal Time to be Conquered[

Ethnographies]

Unaligned Conquered to Coerced[Ethnographies,Green] = 0

Units: People/Period

Unaligned Pop[Ethnographies] = INTEG(Defections to Unaligned[Ethnographies] + (

SUM (Coerced to Unaligned[Ethnographies,Actors!])) - (SUM (

Unaligned to Coerced[Ethnographies,Actors!])) - (SUM (Unaligned to Calculated[

Ethnographies,Actors!])) , 0)

Units: People

Normal is: STARTING LEVEL OF ETHNOGRAPHIC

POPULATION[Ethnographies]-((SUM(Coerced

Pop[Ethnographies,Actors!]))+(SUM(Calc Legit Pop [Ethnographies,Acto

[Ethnographies,Actors!]))+(SUM(Governed

Pop[Ethnographies,Actors!]))), Indonesia is 0

Unaligned to Calculated[Ethnographies,Actors] = (Rate of Unaligned converting to Calculated Risk[

Ethnographies,Actors] * Unaligned Pop[Ethnographies]) / NORMAL TIME FOR UNALIGNED TO CHOSE A SIDE

Units: People/Period

Unaligned to Coerced[Ethnographies,Actors] = Unaligned Conquered to Coerced[Ethnographies

,Actors]

Units: People/Period

D-4.3 Foreign OpOrder Impacts on World

Equations

Actual Blue or Purple Military Actions[Actors] = Capability of Blue or Purple Military Actions based on Squads[

Actors]

Units: Military Actions/Period

AVERAGE BLUE or PURPLE WAR CRIMES RATE[Actors] = 0.0001, 0

Units: Pct

Blue Airpower[Actors] = Actual Blue or Purple Military Actions[Actors] * Blue or Purple OpOrder Airpower[

Actors]

Units: Military Actions/Period

Blue or Purple Advanced Weaponry Provision and Training Effect[Actors] = MAX (1

, ZIDZ (Blue or Purple Advanced Weaponry Provisions[Actors] * Normal Training Reach[

Actors] , Conventional Warfare[Actors]))

Units: Pct

Blue or Purple Advanced Weaponry Provisions[Actors] = Actual Blue or Purple Military Actions[

Actors] * Blue or Purple OpOrder Advanced Equipment Provision[Actors]

Units: Military Actions/Period

Blue or Purple Airpower Targeting Combatants[Green] = GAME(1)

Blue or Purple Airpower Targeting Combatants[Red] = 0

Units: Pct

Blue or Purple Airpower Targeting Government Capacity[Green] = GAME(0)

Blue or Purple Airpower Targeting Government Capacity[Red] = GAME(0)

Units: Pct

Blue or Purple Airpower Targeting Resources[Green] = GAME(0)

Blue or Purple Airpower Targeting Resources[Red] = 0

Units: Pct

Blue or Purple Armed Civil Affairs[Actors] = Actual Blue or Purple Military Actions[

Actors] * Blue or Purple OpOrder Armed Civil Affairs[Actors]

Units: Military Actions/Period

BLUE or PURPLE AVERAGE SQUADRON SORTIES PER PERIOD[Actors] = 2160, 2160

Units: Sorties/(Period*Squadron)

D-4 World Model Sectors

2160 = 2 sorties per day per plane at an average of 12 planes per

squadron * 90 days in a period =

Blue or Purple Combat Training Effect[Actors] = MIN (1, ZIDZ (Normal Training Reach[

Actors] * Blue or Purple Embedded Combat Advisers[Actors] , Conventional Warfare[

Actors]))

Units: Pct

Blue or Purple Embedded Combat Advisers[Actors] = (Actual Blue or Purple Military Actions[

Actors] * Blue or Purple OpOrder Embedded Combat Advisers[Actors]) - ((

Actual Blue or Purple Military Actions[Actors] * Blue or Purple OpOrder Embedded Combat Advisers[

Actors]) * AVERAGE BLUE or PURPLE WAR CRIMES RATE[Actors])

Units: Military Actions/Period

Blue or Purple Embedded Combat Troops[Actors] = Actual Blue or Purple Military Actions[

Actors] * Blue or Purple OpOrder Combat Troops[Actors]

Units: Military Actions/Period

Blue or Purple Information Operations[Actors] = Actual Blue or Purple Military Actions[

Actors] * Blue or Purple OpOrder Information Operations[Actors]

Units: Military Actions/Period

Blue or Purple OpOrder Advanced Equipment Provision[Green] = GAME(0.25)

Blue or Purple OpOrder Advanced Equipment Provision[Red] = 0

Units: Pct

Blue or Purple OpOrder Airpower[Green] = GAME(0)

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Blue or Purple OpOrder Airpower[Red] = 0

Units: Pct

Blue or Purple OpOrder Armed Civil Affairs[Green] = GAME(0)

Blue or Purple OpOrder Armed Civil Affairs[Red] = 0

Units: Pct

Blue or Purple OpOrder Combat Troops[Green] = GAME(0)

Blue or Purple OpOrder Combat Troops[Red] = GAME(0)

Units: Pct

Blue or Purple OpOrder Embedded Combat Advisers[Actors] = GAME(0)

Units: Pct

Blue or Purple OpOrder Information Operations[Green] = GAME(0.25)

Blue or Purple OpOrder Information Operations[Red] = 0

Units: Pct

Blue or Purple OpOrder Training Local Actor Security Forces[Green] = GAME(0.25)

Blue or Purple OpOrder Training Local Actor Security Forces[Red] = 0

Units: Pct

Blue or Purple Security Forces Training Effect[Actors] = ZIDZ (Blue or Purple Training Actor Security Forces[

Actors] , Combatting Terrorism[Actors]) * Diminishing Returns on Security Force Training[

Actors]

Units: Pct

Security Forces Training does not benefit from the same reach

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D-4 World Model Sectors

multiplier as advanced weaponry provisions or combat training. This

indicates it's more intensive 1:1 and continuous mentorship aspect

rather than "training."

Blue or Purple Sorties Per Period[Actors] = (BLUE or PURPLE AVERAGE SQUADRON SORTIES PER PERIOD[

Actors] * Blue or Purple Squadrons[Actors]) - ((BLUE or PURPLE AVERAGE SQUADRON SORTIES PER PERIOD[

Actors] * Blue or Purple Squadrons[Actors]) * AVERAGE BLUE or PURPLE WAR CRIMES RATE[

Actors])

Units: Sorties/Period

Blue or Purple Sorties Targeting Combatants[Actors] = Blue or Purple Sorties Per Period[

Actors] * Blue or Purple Airpower Targeting Combatants[Actors]

Units: Sorties/Period

Blue or Purple Sorties Targeting Government Capacity[Actors] = Blue or Purple Sorties Per Period[

Actors] * Blue or Purple Airpower Targeting Government Capacity[Actors]

Units: Sorties/Period

Blue or Purple Sorties Targeting Resources[Actors] = Blue or Purple Sorties Per Period[

Actors] * Blue or Purple Airpower Targeting Resources[Actors]

Units: Sorties/Period

Blue or Purple Squadrons[Actors] = Blue Airpower[Actors] / Military Actions to Support Each Squadron[

Actors]

Units: Squadrons

Blue or Purple Squads[Actors] = INTEG(Change in Blue Squads[Actors] , 0)

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Units: Squads

Blue or Purple Squads to Support a Squadron[Actors] = 27, 27

Units: Squads/Squadron

Blue or Purple Training Actor Security Forces[Actors] = Actual Blue or Purple Military Actions[

Actors] * Blue or Purple OpOrder Training Local Actor Security Forces[Actors

]

Units: Military Actions/Period

Blue or Purple War Crimes[Actors] = (Blue or Purple Embedded Combat Advisers[Actors

] + (Blue or Purple Sorties Per Period[Actors] * War Crimes per Sortie[Actors

])) * AVERAGE BLUE or PURPLE WAR CRIMES RATE[Actors]

Units: Military Actions/Period

Capability of Blue or Purple Military Actions based on Squads[Actors] = (Blue or Purple Squads[

Actors]) * NORMAL MILITARY CAPABILITY OF SQUADS[Actors]

Units: Military Actions/Period

Combatting Terrorism[Actors] = Actual Military Actions[Actors] * OpOrder Combatting Terrorism[

Actors]

Units: Military Actions/Period

Conventional Warfare[Actors] = (Actual Military Actions[Actors] * OpOrder Conventional Warfare[

Actors] * Engagement Threshold[Actors])

Units: Military Actions/Period

D-4 World Model Sectors

Current Security Effectiveness[Actors] = INTEG(Change in Current Security Effectivneess[

Actors] - Decay in Security Effectiveness[Actors] , Anchor Security Effectiveness[

Actors])

Units: Pct

Days = 1

Units: Days

Days in a Period = 90

Units: Days/Period

Diminshing Returns on Security Force Training[Actors] = Table for Effect of Current Security Effectiveness on Training Effect

(Current Security Effectiveness[Actors])

Units: Pct

Effect of Ground Support Campaign[Actors] = Table for Effect of Ground Support Air Campaign[

Actors] (Sorties Supporting Ground Campaign[Actors] / Maximum Daily Sorties

)

Units: Dmnl

Local Actor Combatants Engaged in Conventional Warfare[Ethnographies,Actors] = (

Conventional Warfare[Actors] / NORMAL MILITARY CAPABILITY OF SQUADS[Actors

]) * NORMAL SIZE PER SQUAD[Actors]

Units: People

Maximum Daily Sorties = 600

Units: Sorties/Day

Military Actions to Support Each Squadron[Actors] = NORMAL MILITARY CAPABILITY OF SQUADS[

Actors] * Blue or Purple Squads to Support a Squadron[Actors]

Units: Military Actions/(Period*Squadron)

NORMAL MILITARY CAPABILITY OF SQUADS[Actors] = 1, 1

Units: Military Actions/(Period*Squad)

1 every 2 months is normal

NORMAL SIZE PER SQUAD[Actors] = 10

Units: People/Squad

Normal value for ISIS is set at an average of 11. Value for

equilibrium is set at 10.

Normal Training Reach[Actors] = 10, 10

Units: Dmnl

How many Squads each Blue/Purple Squad help via being embedded.

Sorties Supporting Ground Campaign[Actors] = Blue or Purple Sorties Targeting Combatants[

Actors] / Days in a Period

Units: Sorties/Day

Sorties Targeting Government per Day[Actors] = Blue or Purple Sorties Targeting Government Capacity[

Actors] / Days in a Period

Units: Sorties/Day

Table for Effect of Current Security Effectiveness on Training Effect ([(0,0)-(1,1)

],(0,1),(0.1,0.99),(0.2,0.95),(0.3,0.85),(0.4,0.65),(0.5,0.45),(0.6,0.25)

,(0.7,0.125),(0.8,0.075),(0.9,0.025),(0.95,0.0125),(0.99,0.001),(1,0)

)

Units: Dmnl

Table for Effect of Ground Support Air Campaign[Actors] ([(0,0)-(1,1)],(0,0),(0.016,0.01)

,(0.16,0.1),(0.83,0.5),(1,0.5))

Units: Dmnl

Lookup for ground campaign support effectiveness based on intensity

per day of air campaign.

War Crimes per Sortie[Actors] = 1

Units: Military Actions/Sorties

D-4.4 OpOrder Impacts on World

D-4.5 Overview
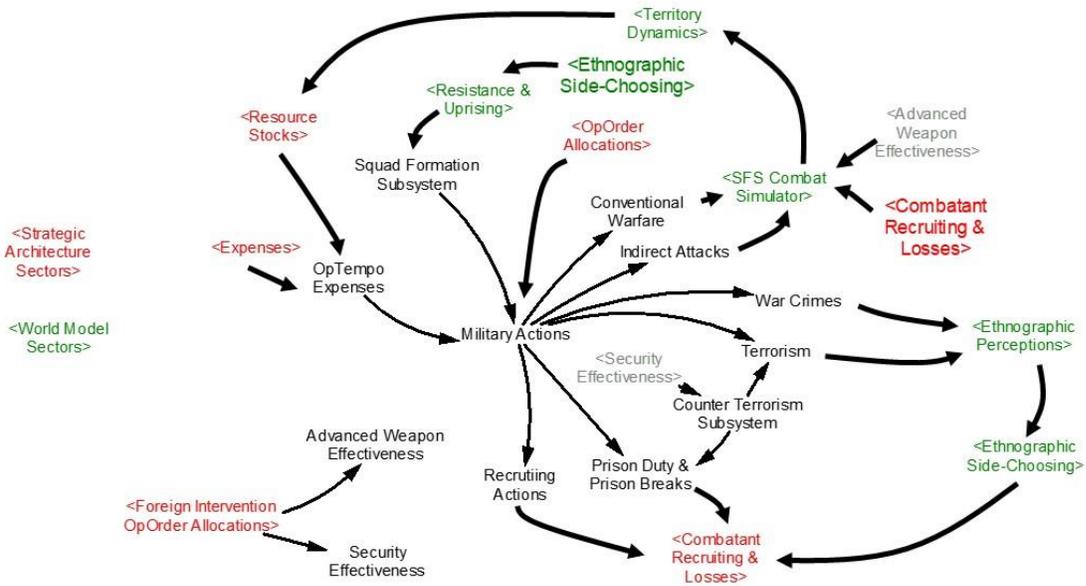
Figure D-9: OpOrder Impacts in World Sector Overview

Equations

Actual Effectiveness Degradation Fraction[Actors] = NORMAL DEGRADATION FRACTION OF EFFECTIVENESS[

Actors] - Experience Effect on Actions[Actors]

Units: Pct

Every period 25% of the skills willd egrade until 0 effectivenes is

reached. This is mitigated by more skilled militants.

Actual Garrsion[Actors] = INTEG(Change in Actual Garrison[Actors] , Actor Starting Conditions Initial Garrison[

Actors])

Units: People

Actual Military Actions[Actors] = IF THEN ELSE (Capacity for Military Actions based on Budget[

Actors] > Capability of Military Actions based on Squads[Actors] , Capability of Military Actions based on Squads[

Actors] , Capacity for Military Actions based on Budget[Actors])

Units: Military Actions/Period

Anchor Advanced Weapon Effectiveness[Actors] = INTEG(Change in Anchor Advanced Weapon Effectiveness[

Actors] , Starting Actor Advanced Weapon Effectiveness[Actors])

Units: Pct

Anchor Security Effectiveness[Actors] = INTEG(Change in Anchor Security Effectiveness[

Actors] , Starting Actor Security Effectiveness[Actors])

Units: Pct

Armed Civil Affairs[Actors] = Actual Military Actions[Actors] * OpOrder Armed Civil Affairs[

Actors]

Units: Military Actions/Period

Average Time for Anchor Effectiveness to Change[Actors] = 10

Units: Period

Number of periods for the anchor of security effectiveness to

improve, 10 = 5 years.

Average Time for Anchor Security Effectiveness to Change[Actors] = 10

Units: Period

Number of periods for the anchor of security effectiveness to

improve, 10 = 5 years.

Average Time to Absorb Security Training[Actors] = 2

Units: Period

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Average Time to Absorb Training[Actors] = 2

> Units: Period

Blue or Purple Advanced Weaponry Provision and Training Effect[Actors] = MAX (1

, ZIDZ (Blue or Purple Advanced Weaponry Provisions[Actors] * Normal Training Reach[

Actors] , Conventional Warfare[Actors]))

> Units: Pct

Blue or Purple OpOrder Training Local Actor Security Forces[Green] = GAME(0.25)
Blue or Purple OpOrder Training Local Actor Security Forces[Red] = 0

> Units: Pct

Blue or Purple Security Forces Training Effect[Actors] = ZIDZ (Blue or Purple Training Actor Security Forces[

Actors] , Combatting Terrorism[Actors]) * Diminshing Returns on Security Force Training[

Actors]

> Units: Pct

> Security Forces Training does not benefit from the same reach

> multiplier as advanced weaponry provisions or combat training. This
> indicates it's more intensive 1:1 and continuous mentorship aspect
> rather than "training."

Blue or Purple War Crimes[Actors] = (Blue or Purple Embedded Combat Advisers[Actors

] + (Blue or Purple Sorties Per Period[Actors] * War Crimes per Sortie[Actors

])) * AVERAGE BLUE or PURPLE WAR CRIMES RATE[Actors]

> Units: Military Actions/Period

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Budget Period[Actors] = 1

Units: Period

Capability of Military Actions based on Squads[Actors] = (Squads[Actors]) * NORMAL MILITARY CAPABILITY OF SQUADS[

Actors]

Units: Military Actions/Period

Capacity for Military Actions based on Budget[Actors] = (OpTempo Budget[Actors]

/ Cost per Military Action[Actors]) / NORMAL PERIOD

Units: Military Actions/Period

Change in Anchor Advanced Weapon Effectiveness[Actors] = (Current Advanced Weapon Effectivenes[

Actors] - Anchor Advanced Weapon Effectiveness[Actors]) / Average Time for Anchor Effectiveness to Change[

Actors]

Units: Pct/Period

Change in Anchor Security Effectiveness[Actors] = (Current Security Effectiveness[

Actors] - Anchor Security Effectiveness[Actors]) / Average Time for Anchor Security Effectiveness to Change[

Actors]

Units: Pct/Period

Change in Current Advanced Weapon Effectivneess[Actors] = ((Anchor Advanced Weapon Effectiveness[

Actors] - Current Advanced Weapon Effectivenes[Actors]) + Blue or Purple Advanced Weaponry Provision and Training Effect[

Actors]) / Average Time to Absorb Training[Actors]

Units: Pct/Period

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Change in Current Security Effectivneess[Actors] = ((Anchor Security Effectiveness[

　　Actors] - Current Security Effectiveness[Actors]) + Blue or Purple Security Forces Training Effect[

　　Actors]) / Average Time to Absorb Security Training[Actors]

　　　　Units: Pct/Period

Civilians Killed[Ethnographies,Actors] = INTEG(Rate of Civilian Deaths[Ethnographies

　　,Actors] , 0)

　　　　Units: People

Combatants[Ethnographies,Actors] = INTEG(Combatant Additions[Ethnographies,Actors

　　] - Combatant Losses[Ethnographies,Actors] , Starting Combatants[Ethnographies

　　,Actors])

　　　　Units: People

Combatting Terrorism[Actors] = Actual Military Actions[Actors] * OpOrder Combatting Terrorism[

　　Actors]

　　　　Units: Military Actions/Period

Completed Terrorist Attacks by Ethnography[Ethnographies,Red] = Terrorist Attempts[

　　Ethnographies,Red] * (1 - CT Effectiveness[Green])

Completed Terrorist Attacks by Ethnography[Ethnographies,Green] = Terrorist Attempts[

　　Ethnographies,Green] * (1 - CT Effectiveness[Red])

　　　　Units: Military Actions/Period

Conventional Warfare[Actors] = (Actual Military Actions[Actors] * OpOrder Conventional Warfare[

　　Actors] * Engagement Threshold[Actors])

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Units: Military Actions/Period

Cost per Military Action[Actors] = 3000

Units: Dollars/Military Action

Analysis showed that for each $2700 transferred to a sector command,

an AQI attack was launched. This cost includes not only direct costs

of the attack, but indirect costs of all the other factors necessary

for AQI to peform in that sector outside Media, Courts,

Administration. Furthermore, there was a strong correlation (.66)

between the rate of fund flows increasing or decreasing and

corresponding changes in the pace of attacks. RAND 57-69. Equilibrium

value set to 3000.

CT Effectiveness[Green] = Table for CT Effectiveness (Effective CounterTerrorism Efforts[

Green])

CT Effectiveness[Red] = Table for CT Effectiveness (Effective CounterTerrorism Efforts[

Red])

Units: Dmnl

Table for CT Effectiveness(1-ZIDZ (SUM(Terrorist

Attempts[Ethnographies!,Red]),Effective CounterTerrorism

Efforts[Green]))

CT Force Ratio[Actors] = ZIDZ (Combatting Terrorism[Actors] , FP Force Size[Actors

])

Units: Pct

ZIDZ((Combatting Terrorism[Green]*NORMAL MILITARY CAPABILITY OF

SQUADS[Actors]),Total Combatants[Red])

D-4 World Model Sectors

CT Force Ratio Modifier[Actors] = Table for Effect of CT Force Ratio Adequacy (

      CT Force Ratio[Actors])

        Units: Dmnl

Cumm Opposition Deaths = INTEG(Increase in Cumm Opposition Deaths , 0)

        Units: People

Current Advanced Weapon Effectivenes[Actors] = INTEG(Change in Current Advanced Weapon Effectivneess[

      Actors] - Decay in Advanced Weapon Effectiveness[Actors] , Anchor Advanced Weapon Effectiveness[

      Actors])

        Units: Pct

Current Security Effectiveness[Actors] = INTEG(Change in Current Security Effectivneess[

      Actors] - Decay in Security Effectiveness[Actors] , Anchor Security Effectiveness[

      Actors])

        Units: Pct

Deaths from CT Operations[Actors] = Normal Deaths per Thwarted Action[Actors] *

      Thwarted Terrorist Attacks[Actors]

        Units: People/Period

DEATHS PER TERRORIST ATTACK[Actors] = 10

        Units: People/Military Action

DEATHS PER WAR CRIME[Ethnographies,Actors] = 25

        Units: People/Military Action

D-4 World Model Sectors

Decay in Advanced Weapon Effectiveness[Actors] = (Current Advanced Weapon Effectivenes[

Actors] * Actual Effectiveness Degredation Fraction[Actors]) / NORMAL PERIOD

Units: Pct/Period

Decay in Security Effectiveness[Actors] = (Current Security Effectiveness[Actors

] * Actual Effectiveness Degredation Fraction[Actors]) / NORMAL PERIOD

Units: Pct/Period

DESIRED CASH ON HAND[Actors] = 250000

Units: Dollars

Desired Squads[Actors] = MAX (0, ((Total Combatants[Actors] - Actual Garrsion[

Actors]) - Number of Green or Red Logistics[Actors]) / NORMAL SIZE PER SQUAD[

Actors])

Units: Squads

Detainees from CT Operations[Actors] = Normal Detainees per Thwarted Action[Actors

] * Thwarted Terrorist Attacks[Actors]

Units: People/Period

Effective CounterTerrorism Efforts[Actors] = CT Force Ratio Modifier[Actors] * Current Security Effectiveness[

Actors]

Units: Pct

Engagement Threshold[Actors] = IF THEN ELSE (Total Combatants[Red] > Minimum Force Size to Engage[

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Red] , 1, 0)

Units: Dmnl

Ethno by Actor Sufficiency[Ethnographies,Actors] = Table for Effect of Remaining Ethno Population by Actor

(MAX (0, Total Ethno by Actor[Ethnographies,Actors] / Reference Population for Sufficiency[

Ethnographies,Actors]))

Units: Pct

Expenses before Attacks[Actors] = Death Benefits[Actors] + Detention Benefits[Actors

] + "Media Border Security & Other Expenses"[Actors] + Military Procurement[

Actors] + Payroll[Actors] + Governance Expenses[Actors]

Units: Dollars/Period

Experience Effect on Actions[Actors] = Table for Effect of Militant Experience on Military Actions

(Average Combatant Experience[Actors] * Dimensioned Ratio Average Militant Experience[

Actors]) * Allocation of Essential Budgets[Actors]

Units: Pct

Derived from AQI implied local recruiting patterns. Estimated

parameter from data or nearby model structure see Section A for

discussion.

Finances[Actors] = INTEG(Incoming Revenue[Actors] - Outgoing Expenses[Actors] ,

Starting Cash[Actors])

Units: Dollars

("Baseline Switch (1 = On)"*(Capability of Military Actions based on

Squads*Cost per Attack))+("Scenario 1 Switch (1 = On)"*"ZScenario1:

Starting Cash")

D-4 World Model Sectors

Force Protection per Military Action[Actors] = 1

       Units: Military Actions/(Period*People)

Foreign Combatants[Actors] = INTEG(Foreign Fighter Increase[Actors] - Foreign Fighter Decrease[

       Actors] , Starting Foreign Combatants[Actors])

       Units: People

FP Force Size[Actors] = Total Combatants[Actors] * Force Protection per Military Action[

       Actors]

       Units: Military Actions/Period

Green or Red T3R Average[Actors] = 0.3, 0.05

       Units: Pct

       Average % of non-combat troops to combat. Source

                http://usacac.army.mil/cac2/cgsc/carl/download/csipubs/mcgrath_op23.pd

                f p80 Normal of 67%

Indirect Attacks[Actors] = Actual Military Actions[Actors] * OpOrder Indirect IED VBIED or SVIED[

       Actors]

       Units: Military Actions/Period

Killed Militants Total = INTEG(Rate of Militant Deaths Total , 0)

       Units: People

       Adjust initial level based on starting time of model.

Normal Deaths per Thwarted Action[Actors] = 11, 2

Units: People/Military Action

NORMAL DEGRADATION FRACTION OF EFFECTIVENESS[Actors] = 0.25, 0.12

Units: Pct

Normal Detainees per Thwarted Action[Actors] = 0, 2

Units: People/Military Action

NORMAL MILITARY CAPABILITY OF SQUADS[Actors] = 1, 1

Units: Military Actions/(Period*Squad)

1 every 2 months is normal

NORMAL PERIOD = 1

Units: Period

NORMAL SIZE PER SQUAD[Actors] = 10

Units: People/Squad

Normal value for ISIS is set at an average of 11. Value for

equilibrium is set at 10.

Number of Green or Red Logistics[Actors] = Total Combatants[Actors] * Green or Red T3R Average[

Actors]

Units: People

OpOrder Armed Civil Affairs[Actors] = GAME(IF THEN ELSE (Engagement Threshold[

Actors] = 1, Green and Red Pct OpOrder Armed Civil Affairs[Actors

] , Green and Red PE Pct Armed Civil Affairs[Actors]))

Units: Pct

OpOrder Combatting Terrorism[Actors] = GAME(Normal Combatting Terrorism[Actors]

)

Units: Pct

OpOrder Conventional Warfare[Actors] = GAME(IF THEN ELSE (Engagement Threshold[

Red] = 1, Normal Conventional Warfare[Actors] , Green and Red PE Pct Conventional Warfare[

Actors]))

Units: Pct

OpOrder Indirect IED VBIED or SVIED[Actors] = GAME(IF THEN ELSE (Engagement Threshold[

Actors] = 1, Green and Red OpOrder Pct Indirect[Actors] , PreThreshold Indirect[

Actors]))

Units: Pct

OpOrder Prison Breaks[Actors] = GAME(IF THEN ELSE (Engagement Threshold[Actors

] = 1, Green and Red Pct OpOrder Prison Breaks[Actors] , Green and Red PE PCT Prison Breaks[

Actors]))

Units: Pct

OpOrder Prison Duty[Actors] = GAME(Normal Prison Duty[Actors])

Units: Pct

OpOrder Propoganda[Actors] = GAME(IF THEN ELSE (Engagement Threshold[Actors] =

1, Green and Red Pct OpOrder Propoganda[Actors] , Green and Red PE Pct Propoganda[

Actors]))

Units: Pct

OpOrder Recruiting[Ethnographies,Actors] = GAME(IF THEN ELSE (Engagement Threshold[

Actors] = 1, Green and Red OpOrder Pct Recruiting[Ethnographies,

Actors] , Green and Red PE Recruiting[Ethnographies,Actors]))

Units: Pct

OpOrder Terrorism[Ethnographies,Red] = GAME(IF THEN ELSE (Engagement Threshold[

Red] = 1, Green and Red Pct OpOrder Terrorism[Ethnographies,Red]

, Green and Red PE Pct Terrorism[Ethnographies,Red]))

OpOrder Terrorism[Ethnographies,Green] = IF THEN ELSE (Engagement Threshold[Green

] = 1, Green and Red Pct OpOrder Terrorism[Ethnographies,Green] , Green and Red PE Pct Terrorism[

Ethnographies,Green])

Units: Pct

OpOrder War Crimes[Ethnographies,Actors] = GAME(0)

Units: Pct

War atrocities include ethnic cleansing by Red actor and

massacares/war crimes by Blue Actors.

OpTempo Budget[Actors] = MAX (0, (Finances[Actors] - DESIRED CASH ON HAND[Actors

]) - Expenses before Attacks[Actors] * Budget Period[Actors])

Units: Dollars

OpTempo Expenses[Actors] = Actual Military Actions[Actors] * Cost per Military Action[

Actors]

Units: Dollars/Period

D-4 World Model Sectors

Prison Break Actions[Actors] = Actual Military Actions[Actors] * OpOrder Prison Breaks[

    Actors]

      Units: Military Actions/Period

Prison Duty Actions[Actors] = Actual Military Actions[Actors] * OpOrder Prison Duty[

    Actors]

      Units: Military Actions/Period

Propoganda Squads[Actors] = Actual Military Actions[Actors] * OpOrder Propoganda[

    Actors]

      Units: Military Actions/Period

Rate of OpTempo Expenses[Actors] = OpTempo Expenses[Actors]

      Units: Dollars/Period

Recruiting Actions[Ethnographies,Actors] = Actual Military Actions[Actors] * OpOrder Recruiting[

    Ethnographies,Actors]

      Units: Military Actions/Period

REFUGEES PER TERRORIST ATTACK[Actors] = 10

      Units: People/Military Action

      25

REFUGEES PER WAR CRIME[Ethnographies,Actors] = 125

      Units: People/Military Action

      250

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Squads[Actors] = INTEG(Change in Squads[Actors] , (SUM (Starting Combatants[Ethnographies!

,Actors]) - (SUM (Governed Cohorts[Ethnographies!,Actors]) *

Militant Police per Cohort)) / NORMAL SIZE PER SQUAD[Actors

])

Units: Squads

Initialized at same formula as Desired Squads. (Militants - Garrison

Needs)

Starting Actor Advanced Weapon Effectiveness[Actors] = 0

Units: Dmnl

Starting Actor Security Effectiveness[Actors] = 0.5, 0.5

Units: Dmnl

Table for CT Effectiveness ([(0,0)-(3,1)],(0,0),(0.1,0.06),(0.2,0.1),(0.3,0.14)

,(0.4,0.24),(0.5,0.29),(0.6,0.34),(0.7,0.38),(0.8,0.45),(0.9,0.55),(0.95,0.65)

,(0.97,0.75),(0.99,0.85),(1,0.88),(1,0.88),(2,0.9),(3,0.95))

Units: Dmnl

.5 is "normal" and represents the worldwide trend of 81% successful

attacks re: https://www.state.gov/documents/organization/272485.pdf

[(0,0)-(2,1)],(0,1),(0.1,1),(0.2,0.95),(0.3,0.75),(0.4,0.45),(0.5,0.3)

,(0.6,0.225),(0.7,0.175),(0.8,0.12),(0.9,0.07),(0.95,0.03),(0.97,0.02)

,(0.99,0.01),(1,0.01),(1,0.01),(2,0.01),(10,0.01)

Table for Effect of CT Force Ratio Adequacy ([(0,0)-(1,2)],(0,0),(0.005,0.05),(0.01,0.15)

,(0.05,0.5),(0.1,0.75),(0.2,0.9),(0.36,1),(0.4,1.025),(0.5,1.05),(0.6,1.1)

,(1,1.2))

    Units: Dmnl

Terrorism Deaths[Ethnographies,Red] = (Completed Terrorist Attacks by Ethnography[

    Ethnographies,Green] * DEATHS PER TERRORIST ATTACK[Green]) * Ethno by Actor Sufficiency[

    Ethnographies,Red]

Terrorism Deaths[Ethnographies,Green] = (Completed Terrorist Attacks by Ethnography[

    Ethnographies,Red] * DEATHS PER TERRORIST ATTACK[Red]) * Ethno by Actor Sufficiency[

    Ethnographies,Green]

      Units: People/Period

Terrorism Refugees[Ethnographies,Green] = (Completed Terrorist Attacks by Ethnography[

    Ethnographies,Red] * REFUGEES PER TERRORIST ATTACK[Red]) * Ethno by Actor Sufficiency[

    Ethnographies,Green]

Terrorism Refugees[Ethnographies,Red] = (Completed Terrorist Attacks by Ethnography[

    Ethnographies,Green] * REFUGEES PER TERRORIST ATTACK[Green]) * Ethno by Actor Sufficiency[

    Ethnographies,Red]

      Units: People/Period

Terrorist Attempts[Ethnographies,Actors] = Actual Military Actions[Actors] * OpOrder Terrorism[

    Ethnographies,Actors]

      Units: Military Actions/Period

Thwarted Terrorist Attacks[Actors] = SUM (Terrorist Attempts[Ethnographies!,Actors

    ]) - SUM (Completed Terrorist Attacks by Ethnography[Ethnographies!

     ,Actors])

      Units: Military Actions/Period

D-4 World Model Sectors

Total Combatants[Actors] = Total Local Combatants[Actors] + Foreign Combatants[Actors
]
Units: People

Total Conflict Deaths[Actors] = SUM (Civilians Killed[Ethnographies!,Actors!])
+ Cumm Opposition Deaths + Killed Militants Total
Units: People

Total Terrorism Deaths[Actors] = SUM (Terrorism Deaths[Ethnographies!,Actors])
Units: People/Period

Total Terrorism IDP[Actors] = SUM (Terrorism Refugees[Ethnographies!,Actors])
Units: People/Period

Total Terrorist Attacks[Actors] = SUM (Completed Terrorist Attacks by Ethnography[
Ethnographies!,Actors])
Units: Military Actions/Period

War Crime Deaths[Ethnographies,Actors] = MAX (0, (War Crimes[Ethnographies,Actors
] * DEATHS PER WAR CRIME[Ethnographies,Actors]) * Ethno by Actor Sufficiency[
Ethnographies,Actors])
Units: People/Period

War Crime Refugees[Ethnographies,Actors] = MAX (0, (War Crimes[Ethnographies,Actors
] * REFUGEES PER WAR CRIME[Ethnographies,Actors]) * Ethno by Actor Sufficiency[
Ethnographies,Actors])

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Units: People/Period

War Crimes[Ethnographies,Actors] = (Actual Military Actions[Actors] * OpOrder War Crimes[

Ethnographies,Actors]) + Blue or Purple War Crimes[Actors]

Units: Military Actions/Period

D-4.6 Resistance & Uprising
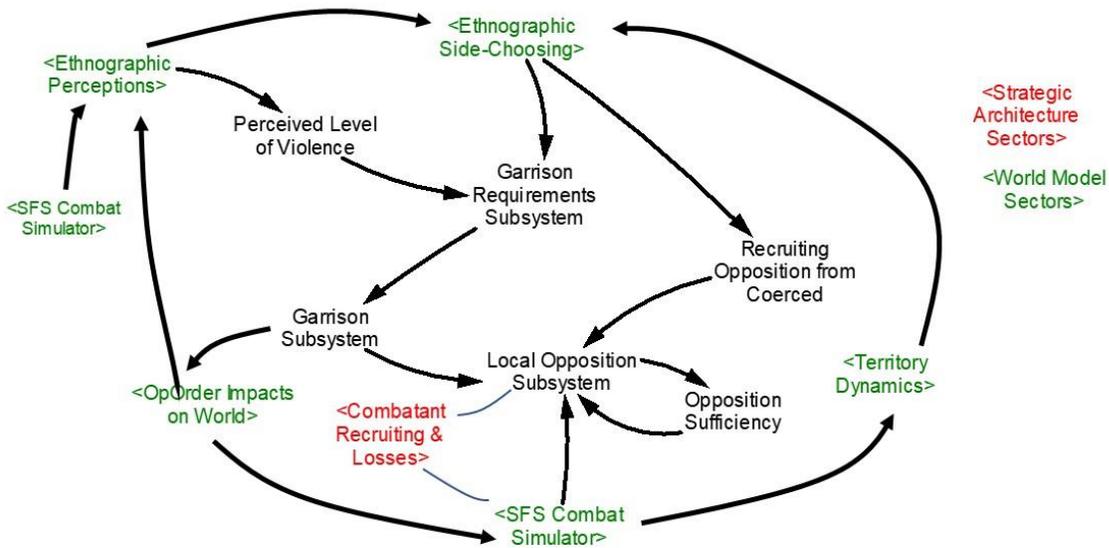
Overview

Figure D-10: Sector Overview of Resistance & Uprising

Equations

Actor Combatants that are Foreign[Ethnographies,Actors] = INTEG(Chng in Troop Composition[

Ethnographies,Actors] , Local vs Foreign Forces[Ethnographies,Actors]

)

Units: Pct

Actor Infantry Actual Losses[Green] = Green Infantry Final Losses[Green] - (Opposition Combatant Losses[

Green]) - Blue or Purple Combatant Losses[Green]

Actor Infantry Actual Losses[Red] = Red Infantry Final Losses[Red] - (Opposition Combatant Losses[

Red]) - Blue or Purple Combatant Losses[Red]

Units: People/Period

Actor Starting Conditions Initial Garrison[Actors] = 140000, 0

Units: People

Actual Effect on Uprising Militant on Max Garrison Allocation[Actors] = Effect of Uprising Militants on Max Garrison Allocation[

Actors] (SUM (Local Opposition Fighters to Actor[Ethnographies!,Actors]

) / Reference for Maximum Tolerated Uprising[Actors])

Units: Pct

Effect of Uprising Militants on Max Garrison

Allocation[Actors]((SUM(Local Opposition Fighters to

Actor[Ethnographies!,Actors]))*Dimensioned Ratio ISIS

Militants[Actors])

Actual Garrison per Cohort[Ethnographies,Actors] = Normal Garrison Requirement per Cohort[

Ethnographies,Actors] * Local Forces Density Force Multiplier[Ethnographies

,Actors] * KIA perM Force Multiplier[Ethnographies,Actors]

Units: People/Cohort

Actual Garrsion[Actors] = INTEG(Change in Actual Garrison[Actors] , Actor Starting Conditions Initial Garrison[

Actors])

Units: People

Actual Opposition Recruited[Ethnographies,Actors] = Adequacy of Fighting Age Men for Opposition[

    Ethnographies,Actors] * Target Recruited Opposition[Ethnographies,Actors]

        Units: People/Period

Actual Recruiting Fighting Age Men in Population[Ethnographies,Actors] = (STARTING NORMAL PCT OF FIGHTING AGE MEN IN POPULATION[

    Ethnographies] * (1 + Experience Effect on Actions[Actors]))

        Units: Pct

        The ethnographic norm +capability of the actor based on experience.

Adequacy of Fighting Age Men for Opposition[Ethnographies,Actors] = Table for Effect of Remaining Recruits on Recruiting Efforts

    (1 - (ZIDZ (Remaining Coerced Fighting Age Men[Ethnographies,Actors] /

            NORMAL PERIOD , Target Recruited Opposition[Ethnographies

        ,Actors])))

        Units: Dmnl

Calc Legit Pop[Ethnographies,Actors] = INTEG(Coerced to Calculated[Ethnographies

    ,Actors] + Governed to Calculated[Ethnographies,Actors] + Unaligned Choosing Sides[

        Ethnographies,Actors] - Cal Legit Pop Dying[Ethnographies,Actors

        ] - Calc Legit Pop Recruited or Joining Uprising[Ethnographies,Actors

        ] - Calc Legit Refugees Leaving[Ethnographies,Actors] - Calculated Lost to Conquest[

        Ethnographies,Actors] - Calculated to Coerced[Ethnographies,Actors

        ] - Calculated to Governed[Ethnographies,Actors] , STARTING LEVEL OF ETHNOGRAPHIC POPULATION[

    Ethnographies] * STARTING ETHNO DISTRIBUTION CALCULATED[Ethnographies

        ,Actors])

        Units: People

Calculated to Coerced[Ethnographies,Actors] = MAX (0, (Calc Legit Pop[Ethnographies

,Actors] * Fr Transition to Coerced[Ethnographies,Actors]) / NORMAL TIME FOR POPULATION
TRANSITION[

Ethnographies,Actors])

Units: People/Period

Calculated to Governed[Ethnographies,Actors] = MAX (0, (Calc Legit Pop[Ethnographies

,Actors] * Fr Transition to Legitimacy[Ethnographies,Actors]) / NORMAL TIME FOR POPULATION
TRANSITION[

Ethnographies,Actors])

Units: People/Period

Change in Actual Garrison[Actors] = (MIN (Total Garrison Needed[Actors] , Max Garrison Allocation[

Actors]) - Actual Garrsion[Actors]) / NORMAL PERIOD

Units: People/Period

Coerced Cohorts[Ethnographies,Actors] = Coerced Pop[Ethnographies,Actors] / SIZE OF COHORT

Units: Cohort

Coerced Dying[Ethnographies,Actors] = MAX (0, Coerced Pop Deaths[Ethnographies,

Actors])

Units: People/Period

Coerced Opposition Recruitment[Ethnographies,Actors] = MAX (0, Actual Opposition Recruited[

Ethnographies,Actors])

Units: People/Period

Coerced Pop[Ethnographies,Actors] = INTEG((Unaligned to Coerced[Ethnographies,

    Actors] + Calculated to Coerced[Ethnographies,Actors] - Coerced Dying[

    Ethnographies,Actors]) - Coerced Refugees Leaving[Ethnographies

    ,Actors] - Coerced to Calculated[Ethnographies,Actors] - Coerced to Unaligned[

    Ethnographies,Actors] - Coerced Opposition Recruitment[Ethnographies

    ,Actors] + Conquest[Ethnographies,Actors] , STARTING LEVEL OF ETHNOGRAPHIC POPULATION[

    Ethnographies] * STARTING ETHNO DISTRIBUTION COERCED[Ethnographies,Actors

    ])

    Units: People

Coerced Refugees Leaving[Ethnographies,Actors] = MAX (0, Coerced Pop Refugees[Ethnographies

    ,Actors])

    Units: People/Period

Coerced to Calculated[Ethnographies,Actors] = MAX (0, (Coerced Pop[Ethnographies

    ,Actors] * Fr Transition to Calculated Legitimatcy[Ethnographies,Actors

    ]) / NORMAL TIME FOR POPULATION TRANSITION[Ethnographies,Actors

    ])

    Units: People/Period

Coerced to Unaligned[Ethnographies,Actors] = Leaving from Coerced to Unaligned[Ethnographies

    ,Actors] / NORMAL TIME FOR POPULATION TRANSITION[Ethnographies,Actors]

    Units: People/Period

    MAX(0,(Coerced Pop[Ethnographies,Actors]*("% of Garrison Gap to

        Coerced"[Ethnographies,Actors]*0.75))/NORMAL TIME FOR POPULATION

        TRANSITION [Ethnographies,Actors])

Conquest[Ethnographies,Red] = Green Conquered to Coerced[Ethnographies,Green]

Conquest[Ethnographies,Green] = Red Conquered to Coerced[Ethnographies,Red]

      Units: People/Period

Cumm Opposition Deaths = INTEG(Increase in Cumm Opposition Deaths , 0)

      Units: People

Deaths[Actors] = (Actor Infantry Actual Losses[Actors] * PCT OF LOSSES THAT ARE DEATH[

      Actors]) + Deaths from CT Operations[Actors] + Deaths from Thwarted Prison Breaks[

      Actors]

      Units: People/Period

      (Red Infantry Final Losses[Red]*PCT OF LOSSES THAT ARE

                  DEATH[Red])/Time to Realize Losses+ Deaths from CT

                  Operations[Red]+Deaths from Thwarted Prison Breaks[Red]

Decrease in Coerced Fighting Age Men[Ethnographies,Actors] = Diehards joining Uprising[

    Ethnographies,Actors] + Coerced Opposition Recruitment[Ethnographies,Actors

      ] + (Coerced Dying[Ethnographies,Actors] + Coerced Refugees Leaving[

        Ethnographies,Actors] + Coerced to Unaligned[Ethnographies,Actors

        ]) * Actual Recruiting Fighting Age Men in Population[Ethnographies

        ,Actors]

      Units: People/Period

"Desired Garrison & Police Forces"[Ethnographies,Actors] = (Garrison Troops Required[

    Ethnographies,Actors] + Police Forces Required[Ethnographies,Actors]) * Disable Garrison Troops

      Units: People

D-4 World Model Sectors

Diehards joining Uprising[Ethnographies,Actors] = Coerced Pop[Ethnographies,Actors

] * Pct of Coerced Pop that will Join Opposition Forces[Ethnographies]

Units: People/Period

Dimensioned Ratio ISIS Militants[Actors] = 1

Units: 1/People

Dimensioned Ratio People per Period = 1

Units: Period/People

Disable Garrison Troops = 1

Units: Dmnl

Effect of Garrison Ratio on Leaving to Unaligned[Ethnographies,Actors] = Table for Effect of Ratio on Leaving to Unaligned

(Pct of Desired Garrison Actual Represents[Ethnographies,Actors])

Units: Pct

Effect of Ungarrision Ratio on Recruiting Rate[Ethnographies,Actors] = Table for Effect of Ratio on Uprising

(Pct of Desired Garrison Actual Represents[Ethnographies,Actors])

Units: Pct

This determines the what % of the population will join the die-hard

opposition as ISIS is unable to garrison effectively.

Effect of Uprising Militants on Max Garrison Allocation[Actors] ([(0,0)-(1,1)],

(0,0.5),(0.2,0.75),(0.4,0.8),(0.6,0.9),(0.8,0.95),(1,1))

Units: Dmnl

Ethno Sufficiency Modifier[Ethnographies] = Table for Effect of Remaining Population on Sufficiency

   (Remaining Ethnographic Population[Ethnographies])

      Units: Dmnl

Garrison Troops Required[Ethnographies,Actors] = Coerced Cohorts[Ethnographies,Actors

   ] * Actual Garrison per Cohort[Ethnographies,Actors]

      Units: People

Governed Cohorts[Ethnographies,Actors] = (Calc Legit Pop[Ethnographies,Actors]

    + Governed Pop[Ethnographies,Actors]) / SIZE OF COHORT

      Units: Cohort

Governed Pop[Ethnographies,Actors] = INTEG(Calculated to Governed[Ethnographies

    ,Actors] - Governed Dying[Ethnographies,Actors] - Governed Lost to Conquest[

      Ethnographies,Actors] - Governed Pop Recruited[Ethnographies,Actors

      ] - Governed Refugees Leaving[Ethnographies,Actors] - Governed to Calculated[

      Ethnographies,Actors] , STARTING LEVEL OF ETHNOGRAPHIC POPULATION[

    Ethnographies] * STARTING ETHNO DISTRIBUTION GOVERNED[Ethnographies,Actors

      ])

      Units: People

Green Infantry Final Losses[Green] = (Green Infantry Initial Losses[Green] - (

    Green Infantry Initial Losses[Green] * Infantry Recovery[Green])) /

    NORMAL PERIOD

      Units: People/Period

D-4 World Model Sectors

Increase in Coerced Fighting Age Men[Ethnographies,Actors] = (Unaligned to Coerced[

Ethnographies,Actors] + Calculated to Coerced[Ethnographies,Actors] + Conquest[

Ethnographies,Actors]) * Actual Recruiting Fighting Age Men in Population[

Ethnographies,Actors]

Units: People/Period

Increase in Cumm Opposition Deaths = SUM (Rate of Local Fighter Deaths[Ethnographies!

,Actors!])

Units: People/Period

KIA Per Million Population[Ethnographies,Actors] = Rate of All Conflict Deaths /

(SUM (Total Ethno Population[Ethnographies!]) / Million Population

)

Units: People/Period

KIA perM Force Multiplier[Ethnographies,Actors] = Table For KIA perM on Force Multiplier

(KIA Per Million Population[Ethnographies,Actors] * Dimensioned Ratio People per Period

)

Units: Dmnl

Local Forces Density Force Multiplier[Ethnographies,Actors] = Table for Local vs Foreign Forces on Force
Multiplier

(Actor Combatants that are Foreign[Ethnographies,Actors])

Units: Dmnl

Local Opposition Fighters this Period[Ethnographies,Actors] = Local Opposition Fighters to Actor[

Ethnographies,Actors] / NORMAL PERIOD

Units: People/Period

Local Opposition Fighters to Actor[Ethnographies,Actors] = INTEG(Rate of Local Opposition Fighters Joining Uprising[

Ethnographies,Actors] - Local Opposition Joining Opposing Actor Militants[

Ethnographies,Actors] - Rate of Local Fighter Deaths[Ethnographies

,Actors] , 0)

Units: People

Local Opposition Joining Opposing Actor Militants[Ethnographies,Actors] = MAX (

0, (Local Opposition Fighters to Actor[Ethnographies,Actors] * Normal Fraction Joining Opposing Actor or Militias[

Ethnographies])) / NORMAL PERIOD

Units: People/Period

Max Garrison Allocation[Actors] = Total Combatants[Actors] * Actual Effect on Uprising Militant on Max Garrison Allocation[

Actors]

Units: People

Militant Police per Cohort = 2.8

Units: People/Cohort

Million Population = 1e+006

Units: People

Normal Fraction Joining Opposing Actor or Militias[Ethnographies] = 0.1

Units: Pct

10% will join an opposing actor's miltirary forces

Normal Garrison Requirement per Cohort[Ethnographies,Actors] = 8

Units: People/Cohort

NORMAL PERIOD = 1

Units: Period

Opposition Combatant Losses[Green] = MIN (Green Infantry Final Losses[Green] *

Pct of Actor Infantry that are Local Opposition Fighters[Green]

, Total Opposition Fighters by Actor[Red] / NORMAL PERIOD)

Opposition Combatant Losses[Red] = MIN (Red Infantry Final Losses[Red] * Pct of Actor Infantry that are Local Opposition Fighters[

Red] , Total Opposition Fighters by Actor[Green] / NORMAL PERIOD

)

Units: People/Period

Opposition Fighter Sufficiency[Ethnographies,Actors] = ZIDZ (Total Decrease of Opposition Fighters[

Ethnographies,Actors] , Local Opposition Fighters this Period[Ethnographies

,Actors] * 0.9)

Units: Pct

the sufficiency implies that at 10% or less of original strength

opposition fighters go into hiding

Opposition Fighter Sufficiency Modifier[Ethnographies,Actors] = Table for Effect of Remaining Population on Sufficiency

(Pct of Current Oppositon Fighters[Ethnographies,Actors])

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Units: Dmnl

Opposition Fighter Sufficiency Smooth[Ethnographies,Actors] = SMOOTH (Opposition Fighter Sufficiency[

Ethnographies,Actors] , NORMAL PERIOD)

Units: Pct

smoothed over a week

Opposition Losses by Ethno[Ethnographies,Green] = Pct by Ethno Opposition Fighters by Actor[

Ethnographies,Red] * Opposition Combatant Losses[Red]

Opposition Losses by Ethno[Ethnographies,Red] = Pct by Ethno Opposition Fighters by Actor[

Ethnographies,Green] * Opposition Combatant Losses[Green]

Units: People/Period

Pct by Ethno Opposition Fighters by Actor[Ethnographies,Actors] = ZIDZ (Local Opposition Fighters to Actor[

Ethnographies,Actors] , Total Opposition Fighters by Actor[Actors])

Units: Pct

Pct of Coerced Pop that will Join Opposition Forces[Ethnographies] = 0.001

Units: Percentage/Period

Diehard opposition will fight against ISIS regardless of state of

Garrison. This may also account for tribal rivalries. Should be

approximately 1,000 per 1m controlled pop.

Pct of Current Oppositon Fighters[Ethnographies,Actors] = ZIDZ (Local Opposition Fighters to Actor[

Ethnographies,Actors] / NORMAL PERIOD , Opposition Losses by Ethno[Ethnographies

,Actors])

Units: Pct

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D-4 World Model Sectors

Pct of Desired Garrison Actual Represents[Ethnographies,Actors] = ZIDZ ("Desired Garrison & Police Forces"[

Ethnographies,Actors] , Actual Garrsion[Actors])

Units: Pct

Police Forces Required[Ethnographies,Actors] = Governed Cohorts[Ethnographies,Actors

] * Militant Police per Cohort

Units: People

Rate of All Conflict Deaths = Rate of Total Civilian Death all Ethnographies + (

SUM (Deaths[Actors!]))

Units: People/Period

Rate of Local Fighter Deaths[Ethnographies,Actors] = MAX (0, Opposition Losses by Ethno[

Ethnographies,Actors] * Opposition Fighter Sufficiency Modifier[Ethnographies

,Actors])

Units: People/Period

Rate of Local Opposition Fighters Joining Uprising[Ethnographies,Actors] = Diehards joining Uprising[

Ethnographies,Actors] + Actual Opposition Recruited[Ethnographies,Actors]

Units: People/Period

Reference for Maximum Tolerated Uprising[Actors] = 50000

Units: People

Remaining Coerced Fighting Age Men[Ethnographies,Actors] = INTEG(Increase in Coerced Fighting Age Men[

Ethnographies,Actors] - Decrease in Coerced Fighting Age Men[Ethnographies

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,Actors] , 0)

    Units: People

SIZE OF COHORT = 1000

    Units: People/Cohort

Table for Effect of Ratio on Leaving to Unaligned ([(0,0)-(1.5,0.2)],(0.69,0),(0.7,0.01)

    ,(0.75,0.02),(0.8,0.04),(0.9,0.08),(1,0.1),(1.2,0.11),(1.5,0.115))

    Units: Dmnl

Table for Effect of Ratio on Uprising ([(0,0)-(1.5,0.1)],(0.69,0),(0.7,0.005),(0.75,0.01)

    ,(0.8,0.02),(0.9,0.04),(1,0.05),(1.2,0.055),(1.5,0.055))

    Units: Dmnl

Table for Effect of Remaining Population on Sufficiency ([(0,0)-(1,1)],(0,0),(0,0)

    ,(0.025,0.005),(0.05,0.01),(0.1,0.05),(0.2,0.1),(0.3,0.25),(0.4,0.4)

    ,(0.5,0.55),(0.6,0.65),(0.7,0.75),(0.8,0.8),(0.9,0.85),(0.95,0.9),(1,1)

)

    Units: Dmnl

Table for Effect of Remaining Recruits on Recruiting Efforts ([(0,0)-(1,1)],(0,0)

    ,(0.01,0),(0.03,0),(0.05,0),(0.1,0.0125),(0.2,0.025),(0.3,0.05),(0.4,0.1)

    ,(0.5,0.2),(0.6,0.35),(0.7,0.65),(0.8,0.85),(0.9,0.95),(0.95,0.975),

    (0.97,0.985),(0.99,0.99),(1,1))

    Units: Dmnl

    Parameter is based on modeler assumption, see Section A for

        discussion.

D-4 World Model Sectors

[(0,0)-(1,1)],(0,1),(0.1,0.95),(0.2,0.85),(0.3,0.65),(0.4,0.35),(0.5,0

.2),(0.6,0.1),(0.7,0.05),(0.8,0.025),(0.9,0.0125),(0.95,0),(0.97,0),(0

.99,0),(1,0),(1,0),(2,0),(10,0)

Table For KIA perM on Force Multiplier ([(0,0)-(460,3)],(0,1),(28,1),(50,1.23),

(67,1.36),(120,1.67),(298,2.36),(460,2.8))

   Units: Dmnl

Table for Local vs Foreign Forces on Force Multiplier ([(0,0)-(1,3)],(0,2.38),(0.1,2.38)

,(0.65,1.14),(1,1))

   Units: Dmnl

Target Recruited Opposition[Ethnographies,Actors] = Effect of Ungarrision Ratio on Recruiting Rate[

   Ethnographies,Actors] * Remaining Coerced Fighting Age Men[Ethnographies,Actors

   ] / NORMAL PERIOD

   Units: People/Period

Total Combatants[Actors] = Total Local Combatants[Actors] + Foreign Combatants[Actors

   ]

   Units: People

Total Decrease of Opposition Fighters[Ethnographies,Actors] = Local Opposition Joining Opposing Actor Militants[

   Ethnographies,Actors] + Opposition Losses by Ethno[Ethnographies,Actors]

   Units: People/Period

Total Ethno Population[Ethnographies] = INTEG(Increase in Pop[Ethnographies] -

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Decrease in Pop[Ethnographies] , STARTING LEVEL OF ETHNOGRAPHIC POPULATION[

Ethnographies])

Units: People

Total Garrison Needed[Actors] = (SUM ("Desired Garrison & Police Forces"[Ethnographies!

,Actors]))

Units: People

Total KIA per Million Population = SUM (KIA Per Million Population[Ethnographies!

,Actors!])

Units: People/Period

Total Opposition Fighters by Actor[Actors] = SUM (Local Opposition Fighters to Actor[
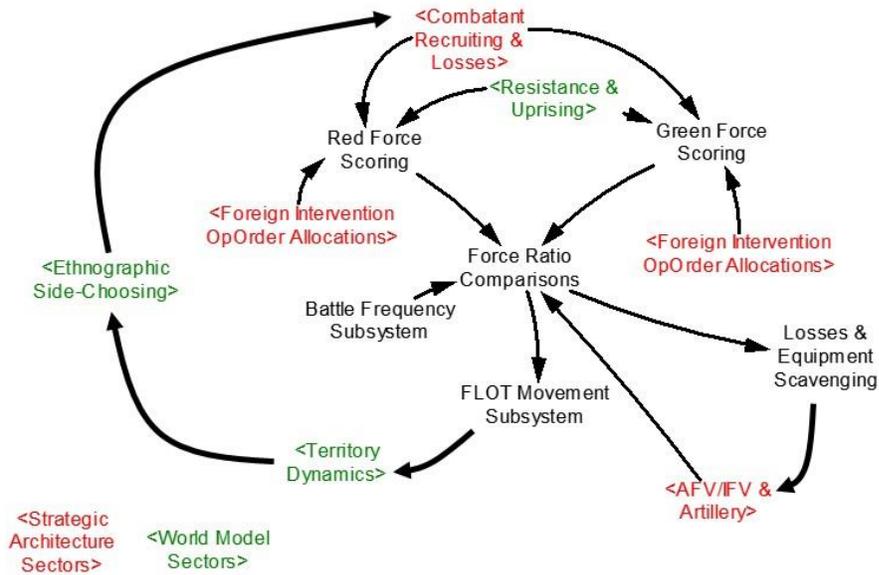
Ethnographies!,Actors])

Units: People

Unaligned to Coerced[Ethnographies,Actors] = Unaligned Conquered to Coerced[Ethnographies

,Actors]

Units: People/Period

D-4.7 SFS Combat Simulator

D-4 World Model Sectors

Figure D-11: Overview of SFS Combat Simulator Sector

Equations

Actual Blue or Purple Military Actions[Actors] = Capability of Blue or Purple Military Actions based on Squads[

Actors]

Units: Military Actions/Period

AVERAGE BLUE or PURPLE WAR CRIMES RATE[Actors] = 0.0001, 0

Units: Pct

Blue Airpower[Actors] = Actual Blue or Purple Military Actions[Actors] * Blue or Purple OpOrder Airpower[

Actors]

Units: Military Actions/Period

Blue or Purple Advanced Weaponry Provision and Training Effect[Actors] = MAX (1

, ZIDZ (Blue or Purple Advanced Weaponry Provisions[Actors] * Normal Training Reach[

Actors] , Conventional Warfare[Actors]))

Units: Pct

D-4 World Model Sectors

Blue or Purple Advanced Weaponry Provisions[Actors] = Actual Blue or Purple Military Actions[

Actors] * Blue or Purple OpOrder Advanced Equipment Provision[Actors]

Units: Military Actions/Period

Blue or Purple Airpower Targeting Combatants[Green] = GAME(1)

Blue or Purple Airpower Targeting Combatants[Red] = 0

Units: Pct

Blue or Purple Airpower Targeting Government Capacity[Green] = GAME(0)

Blue or Purple Airpower Targeting Government Capacity[Red] = GAME(0)

Units: Pct

Blue or Purple Airpower Targeting Resources[Green] = GAME(0)

Blue or Purple Airpower Targeting Resources[Red] = 0

Units: Pct

Blue or Purple Armed Civil Affairs[Actors] = Actual Blue or Purple Military Actions[

Actors] * Blue or Purple OpOrder Armed Civil Affairs[Actors]

Units: Military Actions/Period

BLUE or PURPLE AVERAGE SQUADRON SORTIES PER PERIOD[Actors] = 2160, 2160

Units: Sorties/(Period*Squadron)

2160 = 2 sorties per day per plane at an average of 12 planes per

squadron * 90 days in a period =

Blue or Purple Combat Training Effect[Actors] = MIN (1, ZIDZ (Normal Training Reach[

Actors] * Blue or Purple Embedded Combat Advisers[Actors] , Conventional Warfare[

Actors]))

Units: Pct

Blue or Purple Embedded Combat Advisers[Actors] = (Actual Blue or Purple Military Actions[

Actors] * Blue or Purple OpOrder Embedded Combat Advisers[Actors]) - ((

Actual Blue or Purple Military Actions[Actors] * Blue or Purple OpOrder Embedded Combat Advisers[

Actors]) * AVERAGE BLUE or PURPLE WAR CRIMES RATE[Actors])

Units: Military Actions/Period

Blue or Purple Embedded Combat Troops[Actors] = Actual Blue or Purple Military Actions[

Actors] * Blue or Purple OpOrder Combat Troops[Actors]

Units: Military Actions/Period

Blue or Purple Information Operations[Actors] = Actual Blue or Purple Military Actions[

Actors] * Blue or Purple OpOrder Information Operations[Actors]

Units: Military Actions/Period

Blue or Purple OpOrder Advanced Equipment Provision[Green] = GAME(0.25)

Blue or Purple OpOrder Advanced Equipment Provision[Red] = 0

Units: Pct

Blue or Purple OpOrder Airpower[Green] = GAME(0)

Blue or Purple OpOrder Airpower[Red] = 0

Units: Pct

Blue or Purple OpOrder Armed Civil Affairs[Green] = GAME(0)

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Blue or Purple OpOrder Armed Civil Affairs[Red] = 0

> Units: Pct

Blue or Purple OpOrder Combat Troops[Green] = GAME(0)

Blue or Purple OpOrder Combat Troops[Red] = GAME(0)

> Units: Pct

Blue or Purple OpOrder Embedded Combat Advisers[Actors] = GAME(0)

> Units: Pct

Blue or Purple OpOrder Information Operations[Green] = GAME(0.25)

Blue or Purple OpOrder Information Operations[Red] = 0

> Units: Pct

Blue or Purple OpOrder Training Local Actor Security Forces[Green] = GAME(0.25)

Blue or Purple OpOrder Training Local Actor Security Forces[Red] = 0

> Units: Pct

Blue or Purple Security Forces Training Effect[Actors] = ZIDZ (Blue or Purple Training Actor Security Forces[
Actors] , Combatting Terrorism[Actors]) * Diminshing Returns on Security Force Training[
Actors]

> Units: Pct

> Security Forces Training does not benefit from the same reach
>
> > multiplier as advanced weaponry provisions or combat training. This
> >
> > indicates it's more intensive 1:1 and continuous mentorship aspect
> >
> > rather than "training."

Blue or Purple Sorties Per Period[Actors] = (BLUE or PURPLE AVERAGE SQUADRON SORTIES PER PERIOD[

    Actors] * Blue or Purple Squadrons[Actors]) - ((BLUE or PURPLE AVERAGE SQUADRON SORTIES PER PERIOD[

      Actors] * Blue or Purple Squadrons[Actors]) * AVERAGE BLUE or PURPLE WAR CRIMES RATE[

       Actors])

      Units: Sorties/Period

Blue or Purple Sorties Targeting Combatants[Actors] = Blue or Purple Sorties Per Period[

    Actors] * Blue or Purple Airpower Targeting Combatants[Actors]

      Units: Sorties/Period

Blue or Purple Sorties Targeting Government Capacity[Actors] = Blue or Purple Sorties Per Period[

    Actors] * Blue or Purple Airpower Targeting Government Capacity[Actors]

      Units: Sorties/Period

Blue or Purple Sorties Targeting Resources[Actors] = Blue or Purple Sorties Per Period[

    Actors] * Blue or Purple Airpower Targeting Resources[Actors]

      Units: Sorties/Period

Blue or Purple Squadrons[Actors] = Blue Airpower[Actors] / Military Actions to Support Each Squadron[

    Actors]

      Units: Squadrons

Blue or Purple Squads[Actors] = INTEG(Change in Blue Squads[Actors] , 0)

      Units: Squads

Blue or Purple Squads to Support a Squadron[Actors] = 27, 27

      Units: Squads/Squadron

D-4 World Model Sectors

Blue or Purple Training Actor Security Forces[Actors] = Actual Blue or Purple Military Actions[

Actors] * Blue or Purple OpOrder Training Local Actor Security Forces[Actors

]

Units: Military Actions/Period

Blue or Purple War Crimes[Actors] = (Blue or Purple Embedded Combat Advisers[Actors

] + (Blue or Purple Sorties Per Period[Actors] * War Crimes per Sortie[Actors

])) * AVERAGE BLUE or PURPLE WAR CRIMES RATE[Actors]

Units: Military Actions/Period

Capability of Blue or Purple Military Actions based on Squads[Actors] = (Blue or Purple Squads[

Actors]) * NORMAL MILITARY CAPABILITY OF SQUADS[Actors]

Units: Military Actions/Period

Combatting Terrorism[Actors] = Actual Military Actions[Actors] * OpOrder Combatting Terrorism[

Actors]

Units: Military Actions/Period

Conventional Warfare[Actors] = (Actual Military Actions[Actors] * OpOrder Conventional Warfare[

Actors] * Engagement Threshold[Actors])

Units: Military Actions/Period

Current Security Effectiveness[Actors] = INTEG(Change in Current Security Effectivneess[

Actors] - Decay in Security Effectiveness[Actors] , Anchor Security Effectiveness[

Actors])

Units: Pct

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D-4 World Model Sectors

Days = 1

      Units: Days

Days in a Period = 90

      Units: Days/Period

Diminshing Returns on Security Force Training[Actors] = Table for Effect of Current Security Effectiveness on Training Effect

    (Current Security Effectiveness[Actors])

      Units: Pct

Effect of Ground Support Campaign[Actors] = Table for Effect of Ground Support Air Campaign[

    Actors] (Sorties Supporting Ground Campaign[Actors] / Maximum Daily Sorties

)

      Units: Dmnl

Local Actor Combatants Engaged in Conventional Warfare[Ethnographies,Actors] = (

    Conventional Warfare[Actors] / NORMAL MILITARY CAPABILITY OF SQUADS[Actors

     ]) * NORMAL SIZE PER SQUAD[Actors]

      Units: People

Maximum Daily Sorties = 600

      Units: Sorties/Day

Military Actions to Support Each Squadron[Actors] = NORMAL MILITARY CAPABILITY OF SQUADS[

    Actors] * Blue or Purple Squads to Support a Squadron[Actors]

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Units: Military Actions/(Period*Squadron)

NORMAL MILITARY CAPABILITY OF SQUADS[Actors] = 1, 1

Units: Military Actions/(Period*Squad)

1 every 2 months is normal

NORMAL SIZE PER SQUAD[Actors] = 10

Units: People/Squad

Normal value for ISIS is set at an average of 11. Value for

equilibrium is set at 10.

Normal Training Reach[Actors] = 10, 10

Units: Dmnl

How many Squads each Blue/Purple Squad help via being embedded.

Sorties Supporting Ground Campaign[Actors] = Blue or Purple Sorties Targeting Combatants[

Actors] / Days in a Period

Units: Sorties/Day

Sorties Targeting Government per Day[Actors] = Blue or Purple Sorties Targeting Government Capacity[

Actors] / Days in a Period

Units: Sorties/Day

Table for Effect of Current Security Effectiveness on Training Effect ([(0,0)-(1,1)

],(0,1),(0.1,0.99),(0.2,0.95),(0.3,0.85),(0.4,0.65),(0.5,0.45),(0.6,0.25)

,(0.7,0.125),(0.8,0.075),(0.9,0.025),(0.95,0.0125),(0.99,0.001),(1,0)

)

Units: Dmnl

Table for Effect of Ground Support Air Campaign[Actors] ([(0,0)-(1,1)],(0,0),(0.016,0.01)

,(0.16,0.1),(0.83,0.5),(1,0.5))

Units: Dmnl

Lookup for ground campaign support effectiveness based on intensity

per day of air campaign.

War Crimes per Sortie[Actors] = 1

Units: Military Actions/Sorties

D-4.8 Territory Dynamics
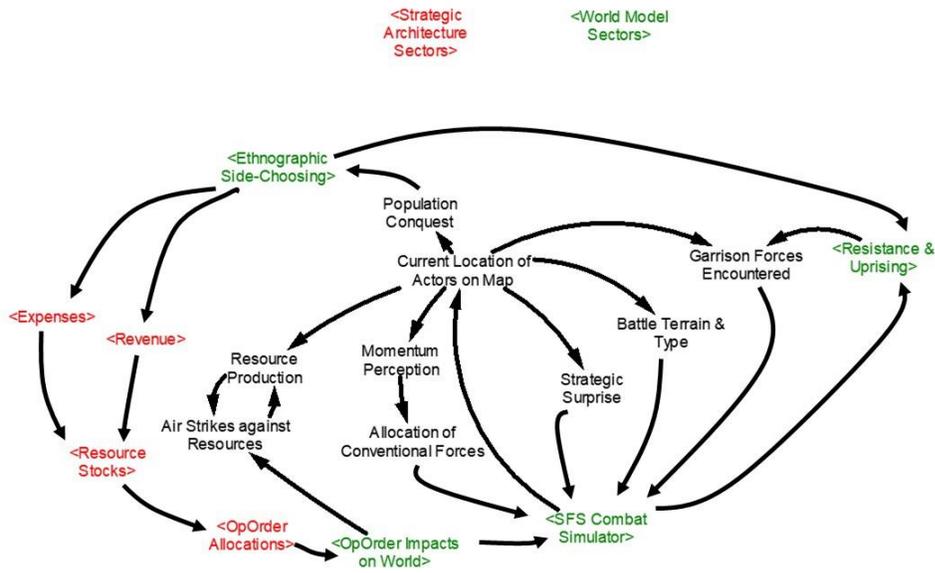
Figure D-12: Overview of Territory Dynamics Sector

Equations

Actor Inefficiencies = 0.5

Units: Pct

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D-4 World Model Sectors

Actor Perception of Momentum[Green] = Perception of Momentum[Green] - Perception of Momentum[

Red]

Actor Perception of Momentum[Red] = Perception of Momentum[Red] - Perception of Momentum[

Green]

Units: Pct/Period

Actual Resource Production[Actors] = Resource Production before Strikes[Actors]

- Effect of Attacks on Actual Production[Actors]

Units: Resource/Period

"Allocation of Conventional Forces based on Location & Momentum"[Green] = IF THEN ELSE (

Offensive Stance based on Actor Perception of Momentum[Green] > 0, Offensive Stance based on Actor
Perception of Momentum[

Green] , Pct of Actor Forces Engaged Cummulative[Green])

"Allocation of Conventional Forces based on Location & Momentum"[Red] = IF THEN ELSE (

Offensive Stance based on Actor Perception of Momentum[Red] > 0, Offensive Stance based on Actor
Perception of Momentum[

Red] , Pct of Actor Forces Engaged Cummulative[Red])

Units: Pct

Blue or Purple Sorties Targeting Resources[Actors] = Blue or Purple Sorties Per Period[

Actors] * Blue or Purple Airpower Targeting Resources[Actors]

Units: Sorties/Period

Calc Legit Pop[Ethnographies,Actors] = INTEG(Coerced to Calculated[Ethnographies

,Actors] + Governed to Calculated[Ethnographies,Actors] + Unaligned Choosing Sides[

Ethnographies,Actors] - Cal Legit Pop Dying[Ethnographies,Actors

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] - Calc Legit Pop Recruited or Joining Uprising[Ethnographies,Actors

] - Calc Legit Refugees Leaving[Ethnographies,Actors] - Calculated Lost to Conquest[

Ethnographies,Actors] - Calculated to Coerced[Ethnographies,Actors

] - Calculated to Governed[Ethnographies,Actors] , STARTING LEVEL OF ETHNOGRAPHIC POPULATION[

Ethnographies] * STARTING ETHNO DISTRIBUTION CALCULATED[Ethnographies

,Actors])

Units: People

Change of Perception of Territorial Momentum[Actors] = (Territory Controlled by Actor[

Actors] - Perception of Territorial Progress[Actors]) / NORMAL PERIOD

Units: Pct/Period

Cummulative Air Strikes against Resource Production[Actors] = INTEG(Rate of Air Strikes[

Actors] , 0)

Units: Sorties

Current Location of Red Actor on Territorial Map[Red] = Territory Controlled by Actor[

Red]

Units: Percentage

Disable Oil = 1

Units: Resources/Period

Used for Proposition 2 - normal value =1, disabled value = 0

Effect of Attacks on Actual Production[Green] = Cummulative Air Strikes against Resource Production[

Red] * Normal Effect of Strike on Resource Production[Green]

Effect of Attacks on Actual Production[Red] = Cummulative Air Strikes against Resource Production[

Green] * Normal Effect of Strike on Resource Production[Red]

     Units: Resources/Period

Engagement Threshold[Actors] = IF THEN ELSE (Total Combatants[Red] > Minimum Force Size to Engage[

     Red] , 1, 0)

     Units: Dmnl

Ethno by Actor Conquer Reference[Ethnographies,Red] = INTEG(Rate of Conquering Red[

     Ethnographies,Red] , Total Ethno by Actor[Ethnographies,Red])

     Units: People

Increase in Cumm Pct of Actor Forces Engaged[Green] = ((Pct Actor Forces Engaged based on Location of Red on Territorial Map[

    Green] * Peak Actor Forces Engaged Condition[Green]) / NORMAL PERIOD)

Increase in Cumm Pct of Actor Forces Engaged[Red] = (Pct Actor Forces Engaged based on Location of Red on Territorial Map[

    Red] - Pct of Actor Forces Engaged Cummulative[Red]) / NORMAL PERIOD

     Units: Pct/Period

     ("Territory Red Actor Controls (km^2)"*Peak Condition)/1

Loss of Strategic Surprise = (Strategic Surprise / Time to Recover from Strategic Surprise

) * Strategic Surprise Countdown Engaged

     Units: Dmnl/Period

Minimum Force Size to Engage[Red] = 1000

     Units: People

Normal Effect of Strike on Resource Production[Actors] = 400

D-4 World Model Sectors

Units: Resources/(Period*Sortie)

Units production destroyed per air strike.

NORMAL PERIOD = 1

Units: Period

Normal Time to be Conquered[Ethnographies] = 1

Units: Period

Offensive Stance based on Actor Perception of Momentum[Green] = IF THEN ELSE (Strategic Surprise

> 0.25, 0, IF THEN ELSE (Actor Perception of Momentum[Green] * NORMAL PERIOD

> -0.015, Table for Effect of Actor Perception of Momentum on Offensive Stance[

Green] (Actor Perception of Momentum[Green] * NORMAL PERIOD) ,

0))

Offensive Stance based on Actor Perception of Momentum[Red] = IF THEN ELSE (Actor Perception of Momentum[

Red] * NORMAL PERIOD > 0, Table for Effect of Actor Perception of Momentum on Offensive Stance[

Red] (Actor Perception of Momentum[Red] * NORMAL PERIOD) , 0)

Units: Pct

Pct Actor Forces Engaged based on Location of Red on Territorial Map[Green] = Territory Conditions Table of Cummulative Green Forces Engaged based on Location of Red Actor on Map

(Current Location of Red Actor on Territorial Map[Red])

Pct Actor Forces Engaged based on Location of Red on Territorial Map[Red] = 1 -

Pct Actor Forces Engaged based on Location of Red on Territorial Map[

Green]

Units: Pct

"ZScenario1: Table of Green Infantry % Engaged based on Location of

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ISIS on Territorial Map"(Current Location of Red Actor on Territorial

Map)

Pct Decline from Peak[Actors] = ZIDZ (Actual Territory Decline[Actors] , Peak Territory[

Actors])

Units: Pct

Pct Ethno Control Reference[Ethnographies,Red] = ZIDZ (Total Ethno by Actor[Ethnographies

,Red] , Total Ethno Population[Ethnographies])

Units: Pct

the current control of an ethnographic population prior to any

adjustment due to recent conquests.

Pct of Actor Forces Engaged Cummulative[Actors] = INTEG(Increase in Cumm Pct of Actor Forces Engaged[

Actors] , Starting Actor Conditions Pct of Forces Engaged[Actors])

Units: Pct

Pct of Ethno Population by Current Location of Red Actor on Map[Ethnographies,Red

] = Territory Conditions Table for Distribution of Population by Ethnography on Territorial Map[

Ethnographies] (Current Location of Red Actor on Territorial Map[Red])

Units: Pct

Pct of Green Garrison Forces Engaged based on Location of Red Actor on Territorial Map[

Red] = 1 - Pct of Green Garrison Forces Engaged based on Location of Red Actor on Territorial
Map[

Green]

Pct of Green Garrison Forces Engaged based on Location of Red Actor on Territorial Map[

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Green] = Territory Conditions Table of Local Garrison Green Forces Engaged based on Location of Red Actor on Map

   (Current Location of Red Actor on Territorial Map[Red])

      Units: Dmnl

Pct Total Population Controlled[Actors] = SUM (Total Ethno by Actor[Ethnographies!

   ,Actors]) / SUM (Total Ethno Population[Ethnographies!])

      Units: Pct

Peak Actor Forces Engaged Condition[Green] = IF THEN ELSE (Pct Actor Forces Engaged based on Location of Red on Territorial Map[

   Green] > Pct of Actor Forces Engaged Cummulative[Green] , 1, 0)

Peak Actor Forces Engaged Condition[Red] = IF THEN ELSE (Pct Actor Forces Engaged based on Location of Red on Territorial Map[

   Red] < Pct of Actor Forces Engaged Cummulative[Red] , 1, 0)

      Units: Dmnl

      Activates a multiplier to accept a higher peak increase.

Perception of Momentum[Actors] = INTEG(Rate of Change of the Perception of Momentum[

   Actors] , 0)

      Units: Pct/Period

Perception of Territorial Progress[Actors] = INTEG(Change of Perception of Territorial Momentum[

   Actors] , Territory Conditions Pct Territory Controlled by Actor at Start[

   Actors])

      Units: Pct

Rate of Air Strikes[Actors] = Targeted Strikes per Period[Actors]

Units: Sorties/Period

Rate of Change of the Perception of Momentum[Actors] = (Change of Perception of Territorial Momentum[

Actors] - Perception of Momentum[Actors]) / NORMAL PERIOD

Units: Pct/(Period*Period)

Rate of Conquered Population Green[Ethnographies,Green] = MAX (0, Territory Conditions Table for Distribution of Population by Ethnography on Territorial Map[

Ethnographies] (Current Location of Red Actor on Territorial Map[Red

]) * Total Ethno Population[Ethnographies])

Rate of Conquered Population Green[Ethnographies,Red] = MAX (0, Total Ethno by Actor[

Ethnographies,Red] * Pct Decline from Peak[Red])

Units: People

Rate of Conquering Red[Ethnographies,Red] = (Target Ethno Population by Most Recent Conquest[

Ethnographies,Red] - Ethno by Actor Conquer Reference[Ethnographies,Red])

/ Normal Time to be Conquered[Ethnographies]

Units: People/Period

Red Actor Resource Production[Red] = Territory Conditions Table for the Percentage of Resource Production based on Red Actor Location on Territorial Map

(Current Location of Red Actor on Territorial Map[Red]) * Territory Conditions Total Available Resource Production

Units: Resources/Period

Resource Production before Strikes[Red] = Red Actor Resource Production[Red] * Actor Inefficiencies

Resource Production before Strikes[Green] = Territory Conditions Total Available Resource Production

- Red Actor Resource Production[Red]

Units: Resources/Period

Starting Actor Conditions Pct of Forces Engaged[Actors] = 0.006, 0.994

Units: Pct

Strategic Surprise = INTEG(- Loss of Strategic Surprise , 0.95)

Units: Dmnl

Strategic Surprise Countdown Engaged = IF THEN ELSE (Current Location of Red Actor on Territorial Map[

Red] > 0.092, 1, 0)

Units: Dmnl

Strategic Surprise Factor = Territory Conditions Table for Strategic Surprise Based on Location of Red Actor on Territorial Map

(Current Location of Red Actor on Territorial Map[Red])

Units: Dmnl

Table for Effect of Actor Perception of Momentum on Offensive Stance[Actors] ([(-0.02,0)-(0.15,1)

],(-0.015,0.25),(0.001,0.3),(0.002,0.4),(0.003,0.5),(0.004,0.6),(0.005,0.75)

,(0.006,0.85),(0.012,0.9),(0.024,0.95),(0.048,0.99),(0.1,1))

Units: Pct

[(0,0)-(0.25,1)],(0.001,0.25),(0.02,0.25),(0.04,0.4),(0.06,0.6),(0.08,

0.75),(0.1,0.85),(0.12,0.9),(0.14,0.95),(0.16,0.99),(0.18,1)

Table for Effect of Remaining Ethno Population by Actor ([(0,0)-(1,1)],(0,0),(0,0)

,(0,0),(0.0025,0),(0.005,0.005),(0.1,0.01),(0.2,0.05),(0.3,0.2),(0.4,0.35)

,(0.5,0.5),(0.6,0.6),(0.75,0.8),(0.8,0.85),(0.9,0.95),(0.97,0.99),(0.99,0.99)

,(1,1))

    Units: Dmnl

Target Ethno Population by Most Recent Conquest[Ethnographies,Red] = Total Ethno Population[

    Ethnographies] * Pct of Ethno Population by Current Location of Red Actor on Map[

    Ethnographies,Red]

      Units: People

Targeted Strikes per Period[Actors] = Blue or Purple Sorties Targeting Resources[

    Actors] * Targeting Switch[Actors]

      Units: Sorties/Period

Targeting Switch[Green] = IF THEN ELSE (Cummulative Air Strikes against Resource Production[

      Green] > (Resource Production before Strikes[Red] / Normal Effect of Strike on Resource Production[

        Green]) , 0, 1)

Targeting Switch[Red] = IF THEN ELSE (Cummulative Air Strikes against Resource Production[

    Red] > (Resource Production before Strikes[Green] / Normal Effect of Strike on Resource Production[

      Red]) , 0, 1)

      Units: Dmnl

Territory Actor Controls[Actors] = INTEG(Rate of Territory Gained[Actors] - Rate of Territory Lost[

      Actors] , Territory Conditions Starting Total Territory * Territory Conditions Pct Territory Controlled by
Actor at Start[

      Actors])

      Units: "km^2"

D-4 World Model Sectors

Territory Conditions Pct Territory Controlled by Actor at Start[Actors] = 1, 0

> Units: Pct

Territory Conditions Starting Total Territory = 619308

> Units: "km^2"

> Includes all Provinces and Governates of Iraq and Syria. "Provinces
>
> > of Syria", Administrative Divisions of Countries, Statoids, last
> >
> > modified September 22, 2004, accessed September 19th, 2014,
> >
> > http://www.statoids.com/usy.html. "Provinces of Iraq",
> >
> > Administrative Divisions of Countries, Statoids, last modified March
> >
> > 16, 2014, accessed September 19th, 2014,
> >
> > http://www.statoids.com/uiq.html.

Territory Conditions Table for Battle Type based on Location of Red Actor on Territorial Map

> ([(0,0)-(0.7,6)],(0.0032,1),(0.0037,1),(0.0587,3),(0.0912,3),(0.0917,4),(0.0922,2)

,(0.3222,1),(0.3824,1),(0.4224,1),(0.4229,3),(0.4291,1),(0.4691,6),(0.4696,5)

,(0.4996,6),(0.5001,5),(0.5157,6),(0.5162,5),(0.5312,1),(0.5317,6),(0.6017,5)

,(0.6317,4),(0.6322,5),(0.6327,5),(0.6426,4),(0.6492,4),(0.6497,5),(0.6697,3)

,(0.6799,1),(0.6804,5),(0.7112,4),(0.7412,4),(0.7417,5),(0.7717,4),(0.8217,1)

,(0.8222,5),(0.8472,1),(0.8477,5),(0.8736,4),(0.9586,1),(0.9936,1),(0.9941,5)

)

> Units: Dmnl

> Scenario 1

Territory Conditions Table for Distribution of Population by Ethnography on Territorial Map[

> Arab Suuni] ([(0,0)-(1,1)],(0,0.00496),(0.00317,0.00496),(0.00367,0.01231),(0.05867,0.03494)

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,(0.09117,0.04777),(0.09167,0.05865),(0.09217,0.09468),(0.32217,0.10144)

,(0.38243,0.11139),(0.4224,0.12594),(0.4229,0.13179),(0.42912,0.13204)

,(0.46912,0.13363),(0.46962,0.13369),(0.49962,0.15349),(0.50012,0.1711)

,(0.51574,0.17245),(0.51624,0.17445),(0.53124,0.18805),(0.53174,0.19409)

,(0.60174,0.20311),(0.63174,0.20576),(0.63224,0.21479),(0.63274,0.21693)

,(0.64257,0.24055),(0.64915,0.25532),(0.64965,0.26032),(0.66965,0.2695)

,(0.67992,0.27326),(0.68042,0.28826),(0.71116,0.29326),(0.74116,0.29417)

,(0.74166,0.29736),(0.77166,0.29736),(0.82166,0.29736),(0.82216,0.29736)

,(0.84716,0.29824),(0.84766,0.30039),(0.87356,0.30039),(0.95856,0.30039)

,(0.99356,0.30039),(0.99406,0.30039))

Territory Conditions Table for Distribution of Population by Ethnography on Territorial Map[

Arab Shia] ([(0,0)-(1,1)],(0.00317,0.00028),(0.00367,0.00068),(0.05867,0.00194)

,(0.09117,0.00265),(0.09167,0.00326),(0.09217,0.01001),(0.32217,0.01039)

,(0.38243,0.01094),(0.4224,0.01175),(0.4229,0.01208),(0.42912,0.01641)

,(0.46912,0.04512),(0.46962,0.04625),(0.49962,0.06605),(0.50012,0.08365)

,(0.51574,0.09514),(0.51624,0.11214),(0.53124,0.12534),(0.53174,0.13121)

,(0.60174,0.13996),(0.63174,0.14128),(0.63224,0.15031),(0.63274,0.15245)

,(0.64257,0.15245),(0.64915,0.15245),(0.64965,0.15245),(0.66965,0.15857)

,(0.67992,0.15857),(0.68042,0.15857),(0.71116,0.17357),(0.74116,0.17878)

,(0.74166,0.19686),(0.77166,0.19686),(0.82166,0.19686),(0.82216,0.19686)

,(0.84716,0.19686),(0.84766,0.19686),(0.87356,0.19686),(0.95856,0.19686)

,(0.99356,0.19686),(0.99406,0.19686))

Territory Conditions Table for Distribution of Population by Ethnography on Territorial Map[

Kurdish Suuni] ([(0,0)-(1,1)],(0.00317,0.00028),(0.00367,0.00068),(0.05867,0.00194)

,(0.09117,0.00265),(0.09167,0.00326),(0.09217,0.00551),(0.32217,0.00589)

,(0.38243,0.00644),(0.4224,0.00725),(0.4229,0.00757),(0.42912,0.00781)

,(0.46912,0.00941),(0.46962,0.00947),(0.49962,0.02927),(0.50012,0.04688)

,(0.51574,0.04755),(0.51624,0.04855),(0.53124,0.06175),(0.53174,0.06762)

,(0.60174,0.07637),(0.63174,0.09891),(0.63224,0.26141),(0.63274,0.29994)

,(0.64257,0.30781),(0.64915,0.32258),(0.64965,0.32758),(0.66965,0.34289)

,(0.67992,0.34664),(0.68042,0.36164),(0.71116,0.36164),(0.74116,0.36164)

,(0.74166,0.36164),(0.77166,0.38125),(0.82166,0.382),(0.82216,0.402)

,(0.84716,0.40988),(0.84766,0.42924),(0.87356,0.44519),(0.95856,0.45609)

,(0.99356,0.46109),(0.99406,0.50109))

  Units: Percentage

Territory Conditions Table for Strategic Surprise Based on Location of Red Actor on Territorial Map

([(0,0)-(1,1)],(0,0.05),(0.00317,0.05),(0.00322,0.05),(0.0566,0.25),(0.08828,0.25)

,(0.08844,0.5),(0.08866,0.5),(0.31224,1),(0.41247,1),(0.41263,1),(0.41885,1)

,(0.45652,1),(0.45657,1),(0.48642,1),(0.48672,1),(0.50235,1),(0.50251,1)

,(0.51686,1),(0.51702,1),(0.5852,1),(0.61432,1),(0.61465,1),(0.61482,1)

,(1,1))

  Units: Dmnl

Territory Conditions Table for the Percentage of Resource Production based on Red Actor Location on Territorial Map

([(0,0)-(1,1)],(0,0),(0,0),(0.06,0.04),(0.09,0.04),(0.09,0.04),(0.09,0.05),(0.32,0.05)

,(0.38,0.05),(0.42,0.06),(0.42,0.06),(0.43,0.06),(0.47,0.14),(0.47,0.14)

,(0.5,0.14),(0.5,0.14),(0.52,0.39),(0.52,0.39),(0.53,0.39),(0.53,0.39)

,(0.6,0.39),(0.63,0.39),(0.63,0.4),(0.63,0.4),(0.64,0.4),(0.65,0.4),

(0.65,0.4),(0.67,0.4),(0.68,0.4),(0.68,0.4),(0.71,0.4),(0.74,0.41),(0.74,0.41)

,(0.77,0.41),(0.82,0.41),(0.82,0.41),(0.85,0.41),(0.85,0.41),(0.87,0.42)

,(0.96,0.42),(0.99,1),(0.99,1))

  Units: Percentage

Scenario 1

Territory Conditions Table for the Terrain Type Based on Location of Red Actor on Territorial Map

([(0,0)-(0.7,5)],(0.00317,4),(0.00367,4),(0.05867,1),(0.09117,1),(0.09167,4)

,(0.09217,4),(0.32217,1),(0.38243,1),(0.4224,1),(0.4229,4),(0.42912,2)

,(0.46912,5),(0.46962,4),(0.49962,1),(0.50012,4),(0.51574,1),(0.51624,4)

,(0.53124,1),(0.53174,2),(0.60174,4),(0.63174,2),(0.63224,4),(0.63274,4)

,(0.64257,5),(0.64915,1),(0.64965,5),(0.66965,2),(0.67992,1),(0.68042,4)

,(0.71116,1),(0.74116,5),(0.74166,4),(0.77166,2),(0.82166,1),(0.82216,4)

,(0.84716,1),(0.84766,4),(0.87356,2),(0.95856,1),(0.99356,1),(0.99406,4)

)

Units: Dmnl

Scenario 1

Territory Conditions Table of Cummulative Green Forces Engaged based on Location of Red Actor on Map

([(0,0)-(1,1)],(0.00317,0.00551),(0.00367,0.01368),(0.05867,0.03882),(0.09117,0.05308)

,(0.09167,0.06517),(0.09217,0.11021),(0.32217,0.11771),(0.38243,0.12877)

,(0.4224,0.14494),(0.4229,0.15144),(0.42912,0.15626),(0.46912,0.15816)

,(0.46962,0.18941),(0.49962,0.21941),(0.50012,0.30323),(0.51574,0.30674)

,(0.51624,0.33803),(0.53124,0.35876),(0.53174,0.36746),(0.60174,0.42246)

,(0.63174,0.44998),(0.63224,0.59998),(0.63274,0.69998),(0.64257,0.72998)

,(0.64915,0.73998),(0.64965,0.75998),(0.66965,0.76498),(0.67992,0.76998)

,(0.68042,0.79498),(0.71116,0.81998),(0.74116,0.82498),(0.74166,0.85498)

,(0.77166,0.85648),(0.82166,0.85798),(0.82216,0.90798),(0.84716,0.90998)

,(0.84766,0.95998),(0.87356,0.96098),(0.95856,0.96198),(0.99356,0.96298)

,(0.99406,1.01298))

Units: Dmnl

D-4 World Model Sectors

Territory Conditions Table of Local Garrison Green Forces Engaged based on Location of Red Actor on Map

([(0,0)-(0.7,0.3)],(0.00317,0.00551),(0.00367,0.00817),(0.05867,0.02514),(0.09117,0.01426)
,(0.09167,0.01209),(0.09217,0.04504),(0.32217,0.00751),(0.38243,0.01106)
,(0.4224,0.01616),(0.4229,0.00651),(0.42912,0.00482),(0.46912,0.0019)
,(0.46962,0.03125),(0.49962,0.03),(0.50012,0.08382),(0.51574,0.00351)
,(0.51624,0.03129),(0.53124,0.02073),(0.53174,0.0087),(0.60174,0.055)
,(0.63174,0.02752),(0.63224,0.15),(0.63274,0.1),(0.64257,0.03),(0.64915,0.01)
,(0.64965,0.02),(0.66965,0.005),(0.67992,0.005),(0.68042,0.025),(0.71116,0.025)
,(0.74116,0.005),(0.74166,0.03),(0.77166,0.0015),(0.82166,0.0015),(0.82216,0.05)
,(0.84716,0.002),(0.84766,0.05),(0.87356,0.001),(0.95856,0.001),(0.99356,0.001)
,(0.99406,0.05))

Units: Dmnl

Territory Conditions Total Available Resource Production = 5.6e+008 * Disable Oil

Units: Resources/Period

Total Syria & Iraq production pre-war and prior to ISIS inefficiences

or attacks.

Territory Controlled by Actor[Actors] = ZIDZ (Territory Actor Controls[Actors]

, Territory Conditions Starting Total Territory)

Units: Percentage

Time to Recover from Strategic Surprise = 4

Units: Periods

Total Ethno by Actor[Ethnographies,Actors] = Calc Legit Pop[Ethnographies,Actors

] + Coerced Pop[Ethnographies,Actors] + Governed Pop[Ethnographies,Actors]

Units: People

Total Ethno Population[Ethnographies] = INTEG(Increase in Pop[Ethnographies] -

Decrease in Pop[Ethnographies] , STARTING LEVEL OF ETHNOGRAPHIC POPULATION[

Ethnographies])

Units: People

Type of Battle = Territory Conditions Table for Battle Type based on Location of Red Actor on Territorial Map

(Current Location of Red Actor on Territorial Map[Red])

Units: Dmnl

Type of Terrain[Actors] = Territory Conditions Table for the Terrain Type Based on Location of Red Actor on Territorial Map

(Current Location of Red Actor on Territorial Map[Red])

Units: Dmnl

D-5 Scenario Scripts

D-5.1 Scenario Scripts

Both scenarios begin the same, representing a decline in relative stability in Syria and Iraq as the US began major withdrawals. A period of crisis emerges indicative of the response of Syria to the Arab Spring and crackdown in Iraq of Arab Suuni minorities by the Arab Shia governing majority. Both baseline scenarios include a period of increasing violence and terrorism accompanying the rise of ISIS leading to breakout of ISIS as it begins waging conventional military attacks and acquiring territory leading to the fall of Fallujah, Ramadi, Mosul and even the entire Anbar Province which historically took place largely during the first half of 2014.

The fork in the scenarios occurs at the point when ISIS has expaned to the point of threatening Kobani. For the Baseline without Intervention scenario – Red and Green will continue fighting without any assistance from

external forces. In the "Historical Baseline", historically realistic interventions of foreign state-actors foreign-supported local non-state actors occur.

The baselines are identical in how the Green Actor allocates its own forces with operational orders. Where the baselines split is as ISIS expansion approaches what historically would've been Kobani in Syria. This is when interventions are added for the Historical Baseline or not for the Baseline Without Intervention.

Baseline Historical Script

:Time=0

Actual Desire to Credibly Govern[Arab Suuni,Green]=1

Actual Desire to Credibly Govern[Arab Suuni,Red]=1

Actual Desire to Credibly Govern[Arab Shia,Green]=1

Actual Desire to Credibly Govern[Arab Shia,Red]=1

Actual Desire to Credibly Govern[Kurdish Suuni,Green]=1

Actual Desire to Credibly Govern[Kurdish Suuni,Red]=1

Blue or Purple Intervention Size[Green]=0

Blue or Purple Intervention Size[Red]=0

Blue or Purple OpOrder Embedded Combat Advisers[Green]=0

Blue or Purple OpOrder Embedded Combat Advisers[Red]=0

Blue or Purple T3R Average[Green]=.3

OpOrder Armed Civil Affairs[Green]=0.0

OpOrder Armed Civil Affairs[Red]=0.01

OpOrder Combatting Terrorism[Green]=0.075

OpOrder Combatting Terrorism[Red]=0

OpOrder Conventional Warfare[Green]=0.15

OpOrder Conventional Warfare[Red]=0.0

OpOrder Indirect IED VBIED or SVIED[Green]=0

OpOrder Indirect IED VBIED or SVIED[Red]=0

OpOrder Prison Breaks[Green]=0

OpOrder Prison Breaks[Red]=0.05

OpOrder Prison Duty[Green]=0.2

OpOrder Prison Duty[Red]=0

OpOrder Propoganda[Green]=0.0

OpOrder Propoganda[Red]=0.24

OpOrder Recruiting[Arab Suuni,Green]=0

OpOrder Recruiting[Arab Suuni,Red]=0.023

OpOrder Recruiting[Arab Shia,Green]=0

OpOrder Recruiting[Arab Shia,Red]=0

OpOrder Recruiting[Kurdish Suuni,Green]=0

OpOrder Recruiting[Kurdish Suuni,Red]=0.0125

OpOrder Terrorism[Arab Suuni,Red]=0.3

OpOrder Terrorism[Arab Shia,Red]=0.14

OpOrder Terrorism[Kurdish Suuni,Red]=0.14

OpOrder War Crimes[Arab Suuni,Green]=0

OpOrder War Crimes[Arab Suuni,Red]=0

OpOrder War Crimes[Arab Shia,Green]=0

OpOrder War Crimes[Arab Shia,Red]=0.05

OpOrder War Crimes[Kurdish Suuni,Green]=.00

OpOrder War Crimes[Kurdish Suuni,Red]=0.03

:Time=1.0

Actual Desire to Credibly Govern[Arab Suuni,Green]=0.25

Actual Desire to Credibly Govern[Kurdish Suuni,Green]=0.25

OpOrder War Crimes[Arab Suuni,Green]=0.03

OpOrder War Crimes[Kurdish Suuni,Green]=0.03

:Time=8.0024

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D-5 Scenario Scripts

OpOrder Propoganda[Red]=0.01

OpOrder Terrorism[Arab Suuni,Red]=0.3

OpOrder Terrorism[Arab Shia,Red]=0.3

OpOrder Terrorism[Kurdish Suuni,Red]=0.21

:Time=10.0043

Actual Desire to Credibly Govern[Arab Suuni,Green]=0.75

Actual Desire to Credibly Govern[Kurdish Suuni,Green]=0.75

OpOrder War Crimes[Arab Suuni,Green]=0

OpOrder War Crimes[Kurdish Suuni,Green]=0

OpOrder Armed Civil Affairs[Red]=0.2

OpOrder Conventional Warfare[Red]=0.56

OpOrder Indirect IED VBIED or SVIED[Red]=0.03

OpOrder Terrorism[Arab Suuni,Red]=0.00

OpOrder Terrorism[Arab Shia,Red]=0.03

OpOrder Terrorism[Kurdish Suuni,Red]=0.01

:Time=15.0092

OpOrder Terrorism[Arab Shia,Red]=0.07

OpOrder Recruiting[Arab Suuni,Red]=0.00

OpOrder Recruiting[Kurdish Suuni,Red]=0.0

:Time=18.557

AFV and IFV Purchases[Green]=300

Blue or Purple Intervention Size[Green]=43082

Blue or Purple OpOrder Embedded Combat Advisers[Green]=.06352

Blue or Purple OpOrder Combat Troops[Green]=.44

Blue or Purple OpOrder Training Local Actor Security Forces[Green]=.23

Blue or Purple OpOrder Information Operations[Green]=.1020

Blue or Purple OpOrder Advanced Equipment Provision[Green]=.09835

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Blue or Purple OpOrder Airpower[Green]=.02

Blue or Purple Airpower Targeting Combatants[Green]=.8830

Blue or Purple Airpower Targeting Resources[Green]=0

Blue or Purple Airpower Targeting Government Capacity[Green]=.1169

OpOrder Combatting Terrorism[Green]=0.24

OpOrder Conventional Warfare[Green]=0.37

OpOrder Recruiting[Arab Shia,Green]=.19

:Time=20.5538

AFV and IFV Purchases[Green]=0

OpOrder Recruiting[Arab Shia,Green]=0

OpOrder Conventional Warfare[Green]=0.39

OpOrder Propoganda[Green]=0.11

:Time=22.4495

Blue or Purple Intervention Size[Green]=44082

Blue or Purple OpOrder Embedded Combat Advisers[Green]=.062384

Blue or Purple OpOrder Combat Troops[Green]=.4537

Blue or Purple OpOrder Training Local Actor Security Forces[Green]=.261808

Blue or Purple OpOrder Information Operations[Green]=.0997

Blue or Purple OpOrder Advanced Equipment Provision[Green]=.1118

Blue or Purple OpOrder Airpower[Green]=.04

Blue or Purple Airpower Targeting Combatants[Green]=.5777

Blue or Purple Airpower Targeting Resources[Green]=.36166

Blue or Purple Airpower Targeting Government Capacity[Green]=.06055

OpOrder Combatting Terrorism[Green]=0.09

OpOrder Recruiting[Kurdish Suuni,Green]=.14

OpOrder Recruiting[Arab Shia,Green]=.04

:Time=24.4484

OpOrder Combatting Terrorism[Green]=0.06

OpOrder Conventional Warfare[Green]=0.56

OpOrder Recruiting[Kurdish Suuni,Green]=.00

:Time=28.26

Blue or Purple Intervention Size[Green]=92082

Blue or Purple OpOrder Embedded Combat Advisers[Green]=.186247

Blue or Purple OpOrder Combat Troops[Green]=.265

Blue or Purple OpOrder Training Local Actor Security Forces[Green]=.281716

Blue or Purple OpOrder Information Operations[Green]=.1519

Blue or Purple OpOrder Armed Civil Affairs[Green]=0

Blue or Purple OpOrder Advanced Equipment Provision[Green]=.053564

Blue or Purple OpOrder Airpower[Green]=.06

Blue or Purple Airpower Targeting Combatants[Green]=.832522

Blue or Purple Airpower Targeting Resources[Green]=.143457

Blue or Purple Airpower Targeting Government Capacity[Green]=.024021

AFV and IFV Purchases[Green]=30

Artillery Purchases[Green]=30

:Time=30.2627

Blue or Purple Intervention Size[Green]=108082

Blue or Purple OpOrder Embedded Combat Advisers[Green]=.158676

Blue or Purple OpOrder Combat Troops[Green]=.296072

Blue or Purple OpOrder Training Local Actor Security Forces[Green]=.262218

Blue or Purple OpOrder Information Operations[Green]=.12949

Blue or Purple OpOrder Armed Civil Affairs[Green]=.103625

Blue or Purple OpOrder Advanced Equipment Provision[Green]=.045634

Blue or Purple OpOrder Airpower[Green]=.08

Blue or Purple Airpower Targeting Combatants[Green]=.81197

Blue or Purple Airpower Targeting Resources[Green]=.161061

Blue or Purple Airpower Targeting Government Capacity[Green]=.026969

AFV and IFV Purchases[Green]=50

Artillery Purchases[Green]=50

:Time=32.265

AFV and IFV Purchases[Green]=0

Artillery Purchases[Green]=0

:Time=39.9991

Baseline Without Intervention Script
:Time=0

Actual Desire to Credibly Govern[Arab Suuni,Green]=1

Actual Desire to Credibly Govern[Arab Suuni,Red]=1

Actual Desire to Credibly Govern[Arab Shia,Green]=1

Actual Desire to Credibly Govern[Arab Shia,Red]=1

Actual Desire to Credibly Govern[Kurdish Suuni,Green]=1

Actual Desire to Credibly Govern[Kurdish Suuni,Red]=1

Blue or Purple Intervention Size[Green]=0

Blue or Purple Intervention Size[Red]=0

Blue or Purple OpOrder Embedded Combat Advisers[Green]=0

Blue or Purple OpOrder Embedded Combat Advisers[Red]=0

OpOrder Armed Civil Affairs[Green]=0.0

OpOrder Armed Civil Affairs[Red]=0.01

OpOrder Combatting Terrorism[Green]=0.075

OpOrder Combatting Terrorism[Red]=0

OpOrder Conventional Warfare[Green]=0.15

OpOrder Conventional Warfare[Red]=0.0

OpOrder Indirect IED VBIED or SVIED[Green]=0

OpOrder Indirect IED VBIED or SVIED[Red]=0

OpOrder Prison Breaks[Green]=0

OpOrder Prison Breaks[Red]=0.05

OpOrder Prison Duty[Green]=0.2

OpOrder Prison Duty[Red]=0

OpOrder Propoganda[Green]=0.0

OpOrder Propoganda[Red]=0.24

OpOrder Recruiting[Arab Suuni,Green]=0

OpOrder Recruiting[Arab Suuni,Red]=0.023

OpOrder Recruiting[Arab Shia,Green]=0

OpOrder Recruiting[Arab Shia,Red]=0

OpOrder Recruiting[Kurdish Suuni,Green]=0

OpOrder Recruiting[Kurdish Suuni,Red]=0.0125

OpOrder Terrorism[Arab Suuni,Red]=0.3

OpOrder Terrorism[Arab Shia,Red]=0.14

OpOrder Terrorism[Kurdish Suuni,Red]=0.14

OpOrder War Crimes[Arab Suuni,Green]=0

OpOrder War Crimes[Arab Suuni,Red]=0

OpOrder War Crimes[Arab Shia,Green]=0

OpOrder War Crimes[Arab Shia,Red]=0.05

OpOrder War Crimes[Kurdish Suuni,Green]=.00

OpOrder War Crimes[Kurdish Suuni,Red]=0.03

:Time=1.0

Actual Desire to Credibly Govern[Arab Suuni,Green]=0.25

Actual Desire to Credibly Govern[Kurdish Suuni,Green]=0.25

OpOrder War Crimes[Arab Suuni,Green]=0.03

OpOrder War Crimes[Kurdish Suuni,Green]=0.03

:Time=8.0024

OpOrder Propoganda[Red]=0.01

OpOrder Terrorism[Arab Suuni,Red]=0.3

OpOrder Terrorism[Arab Shia,Red]=0.3

OpOrder Terrorism[Kurdish Suuni,Red]=0.21

:Time=10.0043

Actual Desire to Credibly Govern[Arab Suuni,Green]=0.75

Actual Desire to Credibly Govern[Kurdish Suuni,Green]=0.75

OpOrder War Crimes[Arab Suuni,Green]=0

OpOrder War Crimes[Kurdish Suuni,Green]=0

OpOrder Armed Civil Affairs[Red]=0.2

OpOrder Conventional Warfare[Red]=0.56

OpOrder Indirect IED VBIED or SVIED[Red]=0.03

OpOrder Terrorism[Arab Suuni,Red]=0.00

OpOrder Terrorism[Arab Shia,Red]=0.03

OpOrder Terrorism[Kurdish Suuni,Red]=0.01

:Time=15.0092

OpOrder Terrorism[Arab Shia,Red]=0.07

OpOrder Recruiting[Arab Suuni,Red]=0.00

OpOrder Recruiting[Kurdish Suuni,Red]=0.0

:Time=18.557

OpOrder Combatting Terrorism[Green]=0.24

OpOrder Conventional Warfare[Green]=0.37

:Time=20.5538

OpOrder Conventional Warfare[Green]=0.39

OpOrder Propoganda[Green]=0.11

:Time=24.4484

OpOrder Combatting Terrorism[Green]=0.06

OpOrder Conventional Warfare[Green]=0.56

:Time=39.99

D-6 Scenario Data

D-6.1 Scenario Data

The tables below summarizes an pre-war estimated population, territorial size, capital and nominal controlling faction of Syria[92] and Iraq Provinces.[93] These are then translated into scenario data that will be used to instantiate the model in both the <u>Baseline Historical</u> and <u>Baseline without Intervention</u> scenarios.

Table D-2: Syria Demographic Parameters in Scenario

Country	Province	Population	Area(km.²)	Area(mi.²)	Capital	Nominal Control
Syria	Aleppo	4,045,166	18,498	7,142		ISIS Target
Syria	Al Ḥasakah	1,275,118	23,334	9,009		Kurdish
Syria	Ar Raqqah	793,514	19,618	7,575		ISIS
Syria	As Suwaydā'	313,231	5,550	2,143		
Syria	Damascus	1,552,161	118	46		
Syria	Dar`ā	843,478	3,730	1,440		
Syria	Dayr az Zawr	1,004,747	33,060	12,765		ISIS
Syria	Hama	1,384,953	10,163	3,924		
Syria	Ḥimṣ	1,529,402	40,940	15,807		ISIS Target
Syria	Idlib	1,258,427	6,097	2,354		

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[92] "Provinces of Syria", Administrative Divisions of Countries, Statoids, last modified September 22, 2004, accessed September 19th, 2014, http://www.statoids.com/usy.html.

[93] "Provinces of Iraq", Administrative Divisions of Countries, Statoids, last modified March 16, 2014, accessed September 19th, 2014, http://www.statoids.com/uiq.html.

Syria	Latakia	879,551	2,297	887		
Syria	Quneitra	66,593	1,861	719		
Syria	Rif Dimashq	2,273,074	18,018	6,957		
Syria	Ţarţūs	701,395	1,896	732		
TOTAL	14 Provinces	17,920,810	185,180	71,498		

Table D-3: Iraq Demographic Parameters in the Scenario

Country	Province	Population	Area(km.²)	Area(mi.²)	Capital	% ISIS Control
Iraq	Al-Anbar	1,023,776	138,501	53,476	Ar-Ramadi	ISIS
Iraq	Al-Basrah	1,556,445	19,070	7,363	Al-Basrah	
Iraq	Al-Muthanna	436,825	51,740	19,977	As-Samawah	
Iraq	Al-Qadisiyah	751,331	8,153	3,148	Ad-Diwaniyah	
Iraq	An-Najaf	775,042	28,824	11,129	An-Najaf	
Iraq	Arbil	1,095,992	14,471	5,587	Arbil	
Iraq	As-Sulaymaniyah	1,362,739	17,023	6,573	As-Sulaymaniyah	
Iraq	Babil	1,181,751	6,468	2,497	Al-Hillah	

D-6.2 Starting Conditions

E-SAM has over 100 customizable starting parameters that can be adjusted to fit a regional or historical context. However, not all of these need to be set for each scenario as many represent core dynamics that will be common across conflicts. The current values in E-SAM are set to a scenario of Iraq & Syria corresponding with the rise of ISIS in 2010 but they can be modified.

Ethnography Starting Conditions

Ethnography starting conditions represent the starting attributes, size and distribution of ethnographic groups. Note the Territory Conditions Table for Distribution of Population are designed to be cut and paste directly into Vensim Lookup Functions if required.

Table D-4: Ethnographic Starting Conditions

Parameter	Arab Sunni	Arab Shia	Kurdish Sunni	Notes
Normal Pct of Fighting Age Men in Population	0.23	0.23	0.23	The % of fighting age men (16-44yrs) in a population who can be drawn to recruits, become local opposition etc. As this depletes recruiting and joining opposition becomes more difficult.
Starting Level of Ethnographic Population	10000000	30000000	10000000	Raw number of people in total at the start of the scenario for each ethnographic population.
Territory Conditions Table for Distribution of Population by Ethnography on Territorial Map	[(0,0)-(1,1)],(0,0.00496),(0.00317,0.00496),(0.00367,0.01231),(0.05867,0.03494),(0.09117,0.04777),(0.09167,0.05865),(0.09217,0.09468),(0.32217,0.10144),(0.38243,0.11139),(0.4224,0.12594),(0.4229,0.13179),(0.42912,0.13204),(0.46912,	[(0,0)-(1,1)],(0.00317,0.00028),(0.00367,0.00068),(0.05867,0.00194),(0.09117,0.00265),(0.09167,0.00326),(0.09217,0.01001),(0.32217,0.01039),(0.38243,0.01094),(0.4224,0.01175),(0.4229,0.01208),(0.42912,0.01641),(0.46912,0.04512),(	[(0,0)-(1,1)],(0.00317,0.00028),(0.00367,0.00068),(0.05867,0.00194),(0.09117,0.00265),(0.09167,0.00326),(0.09217,0.00551),(0.32217,0.00589),(0.38243,0.00644),(0.4224,0.00725),(0.4229,0.00757),(0.42912,0.00781),(0.46912,0.00941),(	Lookup function that determines a % of the overall population, by ethnography, that occupies each section of the map. As these sections are conquered (or lost) the population is removed from the other Actor via

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	0.13363),(0.46962,0.13369),(0.49962,0.15349),(0.50012,0.1711),(0.51574,0.17245),(0.51624,0.17445),(0.53124,0.18805),(0.53174,0.19409),(0.60174,0.20311),(0.63174,0.20576),(0.63224,0.21479),(0.63274,0.21693),(0.64257,0.24055),(0.64915,0.25532),(0.64965,0.26032),(0.66965,0.2695),(0.67992,0.27326),(0.68042,0.28826),(0.71116,0.29326),(0.74116,0.29417),(0.74166,0.29736),(0.77166,0.29736),(0.82166,0.29736),(0.82216,0.29736),(0.84716,0.29824),(0.84766,0.30039),(0.87356,0.30039),(0.95856,0.30039),(0.99356,0.30039),(0.99406,0.30039)	0.46962,0.04625),(0.49962,0.06605),(0.50012,0.08365),(0.51574,0.09514),(0.51624,0.11214),(0.53124,0.12534),(0.53174,0.13121),(0.60174,0.13996),(0.63174,0.14128),(0.63224,0.15031),(0.63274,0.15245),(0.64257,0.15245),(0.64915,0.15245),(0.64965,0.15245),(0.66965,0.15857),(0.67992,0.15857),(0.68042,0.15857),(0.71116,0.17357),(0.74116,0.17878),(0.74166,0.19686),(0.77166,0.19686),(0.82166,0.19686),(0.82216,0.19686),(0.84716,0.19686),(0.84766,0.19686),(0.87356,0.19686),(0.95856,0.19686),(0.99356,0.19686),(0.99406,0.19686)	0.46962,0.00947),(0.49962,0.02927),(0.50012,0.04688),(0.51574,0.04755),(0.51624,0.04855),(0.53124,0.06175),(0.53174,0.06762),(0.60174,0.07637),(0.63174,0.09891),(0.63224,0.26141),(0.63274,0.29994),(0.64257,0.30781),(0.64915,0.32258),(0.64965,0.32758),(0.66965,0.34289),(0.67992,0.34664),(0.68042,0.36164),(0.71116,0.36164),(0.74116,0.36164),(0.74166,0.36164),(0.77166,0.38125),(0.82166,0.382),(0.82216,0.402),(0.84716,0.40988),(0.84766,0.42924),(0.87356,0.44519),(0.95856,0.45609),(0.99356,0.46109),(0.99406,0.50109)	Conquest functions.
Normal Procedures Required for Credibility per Pop	1	1	1	The number of credible institutional procedures needed for every person to reach "Governed" consensus.
Normal Time for Population to Transition	0.25	0.25	0.25	The amount of time for population to complete the transition between Coerced, Calculated Legitimacy and Governed at each stage. Population only shifts when there is sufficient

				credible institutional procedures in place. Nominally set at .25 or ~3weeks.
Time for Unaligned to Choose a Side	10	10	10	Currently set at 2.5 years for all of Unaligned to pick a side.
Time to be Conquered	1	1	1	This is the period of time it takes a "conquered" population to shift out of the previous and into the new Actors Coerced population. (All conquests enter Coerced). .035 represents a week, though various ethnographies may have longer or slower times.
Time to form Long Term Perception	10	10	10	The perception formation time of the Ethnographies "Deep Anchor." nominally set at 10 period, 2.5 years, or 5 times the short term value in order to see all dynamics without an extended duration model.
Time to form Perception	0.5	0.5	0.5	The perception formation time of an Ethnographies Perception of an Actor, this is nominally set at .5, or 1.5 months, which means that if there are sufficient governing credibility conquered people will move from

				Coerced to Calculated in 1.5months, and from Calculated to Governed in 1.5months.

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D-6 Scenario Data

Actor Starting Conditions

Actor starting conditions represent initial values of key resources, capabilities, and skill sets.

Table D-5: Actor Starting Conditions

Parameter	Green #	Red #	Notes
Blue or Purple Intervention Time	0.00E+00	0	The number of periods after which Blue or Purple will intervene at the set Desired Intervention Size.
Minimum Force Size to Engage	0.00E+00	20,000	The number of combatants Red Actor must have before it begins waging conventional military attacks
Normal Combatting Terrorism	8%	0%	
Normal Desire to Credibly Govern	1,1,1	1,1,1	The "level of concern" an actor has with credibly governing an Ethnographic Group. When value is 1, then full procedures will be developed. At .25, then only 25% of needed procedures will be developed, limiting the ability to influence an Ethnographic group into moving to Calculated or Governed status.
Scenario Morale Effect	0	0.13	Exogenous addition to morale established by scenario.
Starting Actor Advanced Weapon Effectiveness	0	0	The Pct of Equipment Modifier benefit they will get from weapons provided by Blue or Purple.
Starting Actor Conditions Expatriate Fighters	0.00E+00	0	
Starting Actor Security Effectiveness	0.50	0.5	Starting security effectiveness.
Starting AFV/IFV	2137	0	The starting armored or improvised vehicles by actor.

Starting Artillery	594	0	The starting artillery pieces by actor.
Starting Blue or Purple Personnel	0	0	The number of state-sponsored foreign troops supporting Green or Red respectively.
Starting Cash	5.00E+09	10,000,000	The starting value of Finances
Starting Combatants	87200,261600, 87200	1500,0,0	The number of combatants by ethnography that each actor begins with.
Starting Detainees by Actor	0.00E+00	1,500	The number of Combatants held by the other side at start.
Starting Ethno Distribution Unaligned	0,0,0	0,0,0	% of all Ethnographies that start in the Unaligned position
Starting Ethno Distribution Calculated by Actor	0,0,0	0,0,0	% of all Ethnographies controlled by Actor that start in Calculated Legitimacy Stage
Starting Ethno Distribution Coerced by Actor	0,0,0	0,0,0	% of Ethnographies controlled by Actor that are in Coerced Stage
Starting Ethno Distribution Governed	1,1,1	0,0,0	% of all Ethnographies controlled by Actor that start in Governed Stage
Starting Ethno Distribution Unaligned by Actor	0,0	0,0	% of Ethnographies that are in Unaligned.
Starting Ethnographic Deep Anchor Perception	Computed	3500000, 1300000, 825000	The perception of the ethnography to the actor at start.
Starting Ethnographic Perception	Same as Starting Generational	Same as Starting Generational	The short term perception of the ethnography to the actor at start.
Starting Experience	0.00E+00	3	
Starting Foreign Combatants	0.00E+00	0	Number of foreign fighters fighting within Green or Red.
STARTING WORLDWIDE POPULATION OF FOREIGN RECRUITS	0.00E+00	100,000	The number of potential foreign fighters who might join Green or Red.
Territory Conditions Pct Territory Controlled by Actor Start	1	-	Total territory controlled at simulation start. Note Green Actor is assumed to control

			anything not controlled by Red Actor

Actor Attributes

These are inherent attributes of an Actor that may be individually modified to reflect more realistic conditions. However – many of these represent somewhat generic values that could be easily used for a variety of irregular conflicts in the early part of the 21st Century.

Table D-6: Actor Attributes

Parameter	Green #	Red #	Notes
Advanced Equipment Modifier	0.25	0	The % value of Advanced Weapons that Blue or Purple can provision to Green or Red. Modified by the effectiveness of local troops to use them.
AFV/IFV Lost due to Maintenance	0	0	Per Period Losses due to bad Maintenance
Artillery Lost due to Maintenance	0	0	Per Period Losses due to bad Maintenance
Average Blue/Purple War Atrocities Rate	0.01%	0	The rate at which Blue/Purple Military Actions assigned to Airpower (Sorties) or Embedded Combat Advisors will produce a War Atrocity instead of the intended outcome. These War Atrocities feed into the respective Actor's (Green or Red) total.
Average Experience of Escaped Detainee	10	10	
Average Experience of Foreign Recruit	1	1	
Average Experience of Local Recruit	3	3	
Average Squadron Sorties per Period	4320	4320	Number of Sorties over a 6month period. Currently stands at # of planes per squadron (average 12) * 2/day * 180 days.
Averaging Time Reserves	4	4	The number of periods on which an Actor will average its financial reserves - relative to making a decision to

			cease funding new procedures or maintaining them.
Blue Deployment Time	2	2	The number of months for Blue personnel to form into Squads. This represents the time from order to deployment.
Blue/Purple Squads to Support a Squadron	27	27	How many full time (all actions) Squads are necessary to support each flying Squadron.
Cost per Military Action	2700	2700	required financing to conduct a military action prior to activating one
Death per Terrorist Attack	10	10	
Death per War Crime	25	25	
Desired Cash on Hand	250,000	250,000	What is the floor above which actors will spend as much as they can to drive military actions.
Desired Reserve	1000000	1000000	The reserve of $$ the Actor desires to have. Continued performance beneath this reserve will lead to the reduction in creating new or replacement procedures.
Initial Worldwide Population of Foreign Recruits	0	50,000	Represents the global recruiting base to draw from. The theoretical ceiling of foreign recruits who can be inspired and arrive. Assumes anything above this doesn't exist, is intercepted, captured etc.
Local T3R Ratio	0.67	0.67	The Ratio of squads in a local actor between logistics and combat. Only combat squads will conduct Military Actions.
New Procedure Cost	10	10	Number of $ per new credible institutional procedure created.

Normal # of Detainees per Prison	100	100	Number of militants held as detainees at each prison (makeshift or permanent.)
Normal CT Impact	1	1	This is the multiplier applied to Squads assigned to Combatting Terrorism. An Actor more effective at CT would have a higher multiplier. Blue Actor advising teams can improve the impact amount.
Normal Deaths per Thwarted Terrorist Attack	11	6	Reflects the likelihood of that actor being killed in a thwarted attack. An 11 indicates that either all terrorists thwarted would fight to the death, or the opposing actor may not take prisoners alive.
Normal Defection Rate	0	0	FIX
Normal Degradation Fraction of Effectiveness	0.12	0.12	The % of Security Effectiveness lost each year until Effectiveness reaches 0. This is offset by the benefit of military experience, which at high levels of experience can take the Effectiveness degradation to zero.
Normal Detainees per Thwarted Terrorist Attack	0	5	Reflects the likelihood of that actor being caught alive and detained for a thwarted attack. A 0 may indicate the opposing actor will kill anyone they catch attempting terrorism.
Normal Effect of Kinetic Attack on Governing Capacity	10000	100000	Number of Institutional Procedures eliminated per kinetic strike (which may be airborne or a ground terrorist attack) made against the actor.

Normal Effect of Strike on Resource Production	400	400	Number of resource units/production/period destroyed on average per airstrike by Blue/Purple state support.
Normal Experience Gained per Period	0	0.5	How much experience per 6month period is gained. A 1:1 gain of experience would be .5, a 0 might be used for Conscripts who receive little to no opportunity for training.
Normal Foreign Recruits inspired per Terrorist Attack	0	26	Critical number that correlates terrorist activity with foreign recruiting, only helps if Foreign Recruiting is activated. Serves as tangible proxy for social media propaganda and effectiveness
Normal Military Capability of Squads	0	1	1 every 3 months is normal
Normal Recruits per Military Action	10,10,10	10,10,10	How many recruits can a squad obtain in 6 months for 1 action?
Normal Size per Squad	11	11	Squads commit actions so the size of squad divided by the militants determines the number of squads available for military actions
Normal Training Reach	10	10	The number of Squads each Blue/Purple embedded squads can impact.
Organic Procedural Development Time	0.25	0.25	The fraction of time it takes for normal bureaucracy to develop or devolve procedures relative to need.
Pct of Losses that are Deaths	1	0	This and Pct of Losses that are Detainees should equal 1.
Pct of Losses that are Detentions	0	57%	Determines how many of "losses" are killed vs. being detained. Detained are transferred to prisoner camps/jails

			and held until freed. Note because the % is applied to Actor's losses, the % of detention for the *opposing* actor should be entered as a value. For example: [Green, Red] entered as [0,57%] means that Red militants will be detained at 57% of the loss rate by the Green Actor, while the Red actor takes no prisoners.
Procedure Maintenance Cost	1	1	Number of $ per procedure an actor needs to spend to maintain the bureaucratic infrastructure of the procedures.
Refugees per Terrorist Attack	25	25	
Refugees per War Crime	250	250	
Squads Needed per Prison Break Attempt	5	5	The number of squads that form into a Prison-break team.
T3R Ratio	0.67	0.67	The ratio of Blue personnel between logistics and combat. Only combat personnel will form into Squads and conduct Military Actions. Note that in all cases of "Blue", the Blue is supporting its associated actor. So if Iran and the US are both supporting opposing sides of a conflict, the US would be Blue Personnel [Green] and Iran would be Blue Personnel [Red]. This allows state actor intervention on the opposing side.

Table f/ Effect of Procedural Adequacy	[(-2,-2)-(2,10)],(0,2),(1,0.1),(1.25,0.05),(1.5,0),(1.75,0)	[(-2,-2)-(2,10)],(0,2),(1,0.1),(1.25,0.05),(1.5,0),(1.75,0)	Lookup that graphically plots an Actor's concern over procedural inadequacy and acts as a multiplier on Organic Development.

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D-6 Scenario Data

Territory starting conditions instantiate the geospatial terrain the conflict will occur over, including identifying terrain type, battle type, location of resources etc. Note lookup functions such as Territory Conditions for Battle Type, Terrain Type, Strategic Surprise etc. are designed to be cut and paste directly into a Vensim Lookup function.

Table D-7: Territory Starting Conditions

Parameter	Value	Notes
Territory Conditions Price per Resource Unit	$80,$45	The estimated black-market price per unit of resource production Red Actor can obtain once it has seized control of resource production by seizing territory. In Iraq/Syria this was $/bbl. oil, in Afghanistan this might be $/pound of heroin, or $/pound of Cocaine in Columbia. Not all territories have valuable resources that can be exploited by insurgents by seizing land.
Territory Conditions Starting Total Territory	619308	The km^2 of the entire bounded territory represented in the model. As Red Actor controls parts of this, it's % of Controlled Territory will be used on lookup functions to determine what they find.
Territory Conditions Table for Battle Type Based on Red Actor Location on Map	[(0,0)-(0.7,6)],(0.0032,1),(0.0037,1),(0.0587,3),(0.0912,3),(0.0917,4),(0.0922,2),(0.3222,1),(0.3824,1),(0.4224,1),(0.4229,3),(0.4291,1),(0.4691,6),(0.4696,5),(0.4996,6),(0.5001,5),(0.5157,6),(0.5162,5),(0.5312,1),(0.5317,6),(0.6017,5),(0.6317,4),(0.6322,5),(0.6327,5),(0.6426,4),(0.6492,4),(0.6497,5),(0.6697,3),(0.6799,1),(0.6804,5),(0.7112,4),(0.7412,4),(0.7417,5),(0.7717,4),(0.8217,1),(0.8222,5),(0.8472,1),(0.8477,5),(0.8736,4),(0.9586,1),(0.9936,1),(0.9941,5)	Provides a Battle Type, 1-6. The exact battle type is determined by the scenario data loaded in and exogenous assumptions of the analyst.
Territory Conditions Table for Percentage of Unaligned Population Controlled based on Location of Red Actor on Territorial Map	[(0,0)-(1,1)],(0,0),(1,1)	This lookup determines how many Unaligned are Conquered, moved into Coerced, based on Red Actor advancement. Currently this is a proportional representation.

Territory Conditions Table for Strategic Surprise Based on Location of Red Actor on Territorial Map	[(0,0)-(1,1)],(0,0.05),(0.00317,0.05),(0.00322,0.05),(0.0566,0.25),(0.08828,0.25),(0.08844,0.5),(0.08866,0.5),(0.31224,1),(0.41247,1),(0.41263,1),(0.41885,1),(0.45652,1),(0.45657,1),(0.48642,1),(0.48672,1),(0.50235,1),(0.50251,1),(0.51686,1),(0.51702,1),(0.5852,1),(0.61432,1),(0.61465,1),(0.61482,1),(1,1)	Determines a strategic surprise variable based on where the Red Actor is located. This is based on Analyst Assumptions.
Territory Conditions Table for the Percentage of Resource Production based on Red Actor Location on Territorial Map	[(0,0)-(1,1)],(0,0),(0,0),(0.06,0.04),(0.09,0.04),(0.09,0.04),(0.09,0.05),(0.32,0.05),(0.38,0.05),(0.42,0.06),(0.42,0.06),(0.43,0.06),(0.47,0.14),(0.47,0.14),(0.5,0.14),(0.5,0.14),(0.52,0.39),(0.52,0.39),(0.53,0.39),(0.53,0.39),(0.6,0.39),(0.63,0.39),(0.63,0.4),(0.63,0.4),(0.64,0.4),(0.65,0.4),(0.65,0.4),(0.67,0.4),(0.68,0.4),(0.68,0.4),(0.71,0.4),(0.74,0.41),(0.74,0.41),(0.77,0.41),(0.82,0.41),(0.82,0.41),(0.85,0.41),(0.85,0.41),(0.87,0.42),(0.96,0.42),(0.99,1),(0.99,1)	Determines the percentage of all resource production Red Actor will gain as they gain territory. Path of conquest is based on analyst assumptions.
Territory Conditions Table for the Terrain Type Based on Location of Red Actor on Territorial Map	[(0,0)-(0.7,5)],(0.00317,4),(0.00367,4),(0.05867,1),(0.09117,1),(0.09167,4),(0.09217,4),(0.32217,1),(0.38243,1),(0.4224,1),(0.4229,4),(0.42912,2),(0.46912,5),(0.46962,4),(0.49962,1),(0.50012,4),(0.51574,1),(0.51624,4),(0.53124,1),(0.53174,2),(0.60174,4),(0.63174,2),(0.63224,4),(0.63274,4),(0.64257,5),(0.64915,1),(0.64965,5),(0.66965,2),(0.67992,1),(0.68042,4),(0.71116,1),(0.74116,5),(0.74166,4),(0.77166,2),(0.82166,1),(0.82216,4),(0.84716,1),(0.84766,4),(0.87356,2),(0.95856,1),(0.99356,1),(0.99406,4)	This lookup "represents" the geographical fixtures of the territory based on the progression of the Red Actor. Requires exogenous analyst assessment of where Red Actor will go and in what order.
Territory Conditions Table of Cumulative Green Forces Engaged based on Location of Red Actor on Map	[(0,0)-(1,1)],(0.00317,0.00551),(0.00367,0.01368),(0.05867,0.03882),(0.09117,0.05308),(0.09167,0.06517),(0.09217,0.11021),(0.32217,0.11771),(0.38243,0.12877),(0.4224,0.14494),(0.4229,0.15144),(0.42912,0.15626),(0.46912,0.15816),(0.46962,0.18941),(0.4996	Lookup of the total % of Green Conventional Forces that will be engaged based on location of Red Actor.

	2,0.21941),(0.50012,0.30323),(0.51574,0.30674),(0.51624,0.33803),(0.53124,0.35876),(0.53174,0.36746),(0.60174,0.42246),(0.63174,0.44998),(0.63224,0.59998),(0.63274,0.69998),(0.64257,0.72998),(0.64915,0.73998),(0.64965,0.75998),(0.66965,0.76498),(0.67992,0.76998),(0.68042,0.79498),(0.71116,0.81998),(0.74116,0.82498),(0.74166,0.85498),(0.77166,0.85648),(0.82166,0.85798),(0.82216,0.90798),(0.84716,0.90998),(0.84766,0.95998),(0.87356,0.96098),(0.95856,0.96198),(0.99356,0.96298),(0.99406,1.01298)		
Territory Conditions Total Available Resource Production	5.013E+13		The total value of all Available Resource Production in the entire territory. In this case Bbl./Day of oil production.
Territory Conditions Table of Local Garrison Green Forces Engaged	[(0,0)-(0.7,0.3)],(0.00317,0.00551),(0.00367,0.00817),(0.05867,0.02514),(0.09117,0.01426),(0.09167,0.01209),(0.09217,0.04504),(0.32217,0.00751),(0.38243,0.01106),(0.4224,0.01616),(0.4229,0.00651),(0.42912,0.00482),(0.46912,0.0019),(0.46962,0.03125),(0.49962,0.03),(0.50012,0.08382),(0.51574,0.00351),(0.51624,0.03129),(0.53124,0.02073),(0.53174,0.0087),(0.60174,0.055),(0.63174,0.02752),(0.63224,0.15),(0.63274,0.1),(0.64257,0.03),(0.64915,0.01),(0.64965,0.02),(0.66965,0.005),(0.67992,0.005),(0.68042,0.025),(0.71116,0.025),(0.74116,0.005),(0.74166,0.03),(0.77166,0.0015),(0.82166,0.0015),(0.82216,0.05),(0.84716,0.002),(0.84766,0.05),(0.87356,0.001),(0.95856,0.001),(0.99356,0.001),(0.99406,0.05)		This allocates the location of Green Garrison forces across the map.
Theatre Plan of Attack	Ar Raqqah City	0.00317	This represents the Theatre Plan of attack or sequence to be pursued. The available territory is divided into % and a network map is constructed wherein the % of km^2 advanced in the FLOT by the Red Actor
	Fallujah	0.00367	
	Derie e Zor Province	0.05867	
	Ar Raqqah province	0.09117	

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	Ramadi	0.09167	corresponds to the outer limit of its boundary (which can advance as a blob or in discrete unconnected spheres.) So if Baghdad is the first target, it might be at 1% of territory in one scenario but if it's the last conquered it might be 99% in another. It is this sequence that is used to assign terrain type, battle type and population in other settings.
	Mosul City	0.09217	
	Anbar Province, Ninawa & Salah ad-Din	0.32217	
	Remainder Ninawa Province	0.38243	
	Salah ad-Din Province except Tirkrit	0.42240	
	Tikrit	0.42290	
	Ayn al Arab SubDistrict	0.42912	
	Al Hasakah Governate	0.46912	
	Kobani	0.46962	
	Alleppo Governate but Aleppo	0.49962	
	Aleppo	0.50012	
	Kirku Province	0.51574	
	Kirkuk City	0.51624	
	Hama Province	0.53124	
	Homs Province but Homs	0.53174	
	Take Homs	0.60174	
	Rif-Damascus but Damascus	0.63174	
	Baghdad	0.63224	
	Damascus	0.63274	
	Idlib	0.64257	
	Latakia & Tartous	0.64915	
	Latakia Capital	0.64965	
	"As-Suwayda, Quneitra, Daraa		
	"	0.66965	
	Remainder of Babil	0.67992	
	Hillah	0.68042	
	Diyala	0.71116	
	Erbil	0.74116	
	Erbil Capital	0.74166	
	Wasit	0.77166	

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Remainder of Najaf	0.82166	
Najaf Capital	0.82216	
Remainder Dhi Qar	0.84716	
Nasiriyah Capital	0.84766	
Misan	0.87356	
Muthana	0.95856	
Basra	0.99356	

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D-7 Experiment Test Parameters & Results

D-7.1 Theory of an Emerging State Actor Experiments

Proposition Test Parameters

Table D-8: Proposition Test Parameters for Theory of an Emerging-State Actor Article

Propositions Tested as Experiments	Change Summary	Command Script Formulation
Experiment 1: ISIS must take and control territory.	Remove ability to gain territory because of combat.	Set "FLOT Movement" in Command Script to 0
Experiment 2a: The territory must have valuable resources.		
2b: Black market price of oil is $22/bbl		
2c: Black market price of oil drops to $11/bbl.	Sever link to oil production from captured territory or adjust price per bbl.	2a: Set command script "Territory Conditions Price per Resource Unit" from $45/bbl to $0/bbl.
2b: Set command script "Price per Barrel of Oil" from $45/bbl to $22/bbl		
2c: Set command script "Price per Barrel of Oil" from $45/bbl to $11/bbl		
Experiment 3: The transition from coercively controlled to legitimately governed population cannot be too slow.		
		Desire to Credibly Govern[Red]=1 is changed to:
3a = .75 & Armed Civil Affairs [Red] reduced to 75%	Increase Normal Time to Transition by 200%, 300% and 400%.	
3b = .5 & Armed Civil Affairs[Red] reduced to 50%		
3c = .25 & Armed Civil Affairs[Red] reduced to 25%		
3d= 0 & Armed Civil Affairs[Red] reduced to 0%		
Experiment 4: Local grievances are required for local recruiting.	Disable local recruiting only.	Set "Local Recruiting Actions"[Red] to 0 across all ethnographies.
Experiment 5: Foreign recruits are required.	Disable foreign recruiting in the model.	Set command script "Actual Recruits per Suicide Attack"[Red] to 0.
Experiment 6: A "classical" insurgency is modeled with no transition to governance or seizing of territory. significant foreign recruiting.	Combine Experiments 1 & 3D.	Set "FLOT Movement" in Command Script to 0
Experiment 7: The existence or lack of a certain terrain benefits or harms emerging-state actors.	Replace all instances of "Open" terrain in the model with one of three types.	In "Terrain Type" lookup function replace "Open" (1) values with: 7a: "Mixed" (2) 7b: "Rough" (3)

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		7c: "Mountain" (5)

Proposition Test Results

Table D-9: Test Results for Theory of an Emerging-State Actor Article

Scenario	Experiment	% Territory MAX	Total Pop[Red] MAX	Total Combatants [Red] MAX	% Territory Controlled at End [Red]	Total Population by Actor at End [Red]	Total Combatants at End [Red]
Historical	Baseline Historical	36%	1.993M	93k	0%	53k	532
Historical	EXP1	0	35k	23k	0%	25k	30
Historical	EXP2A	5%	220k	23k	3%	33k	4
Historical	EXP2B	41%	1.18M	94k	0%	53k	1,719
Historical	EXP2C	39%	1.10M	91k	0%	52k	3,520
Historical	EXP3A	26%	850K	79k	0%	16k	130
Historical	EXP3B	18%	681k	71k	0%	14k	102
Historical	EXP3C	17%	1.10M	60k	0%	27k	100
Historical	EXP3D	13%	614k	68k	0%	-	75
Historical	EXP4	14%	824k	60k	0%	12k	89
Historical	EXP5	2%	101k	1.6k	0%	3k	-
Historical	EXP6	2%	104k	1.6k	0%	3k	-
Historical	EXP7A	33%	966k	93k	0%	53k	539
Historical	EXP7B	26%	888k	92k	0%	41k	139
Historical	EXP7C	43%	1.3M	96k	0%	51k	550

D-7.2 Application of Emerging-State Actor Theory Experiments

Hypothetical Best-Case Policy Tests Summary

Table D-10: Best Case Policy Formulations for Application Article

Proposition Tested	Hypothetical Best Case	Subsystem & Formulation
Policy 1. BCP Oil	At 2013 sever link to oil production from captured territory.	Add to command script: :Time=12

D-7 Experiment Test Parameters & Results

Use airpower to attack ISIS's oil production (BPD) to decrease revenue to ISIS Finances.		Territory Conditions Price per Resource Unit[Red]=0
Policy 2. BCP Ransom Convince allies not to pay ransom for ISIS hostages to decrease revenue to ISIS Finances.	At 2010 sever link to Ransom Revenue creation.	Set variables as follow: "Estimated Ransom per Period" to $0
Policy 3. BCP Embedded Advisers Embed military trainers to improve the fighting quality of forces opposing ISIS in combat-roles. **Embedded Advisers - A= 10,000** **Embedded Advisers - B = 25,000** **Embedded Advisers - C = 50,000**	Increase Green Force Morale from .875 to 2.875 (1 = Normal) Increase Green Force Average Experience: Embedded Advisers - A 2.75 yrs Embedded Advisers - B 3.5 yrs Embedded Advisers - C 4.25 yrs	Set variables: Normal Time to Deploy [Green]=.33 Blue or Purple T3R Average=0 Add to command script: :Time=12.01 Blue or Purple Intervention Size[Green]= 10000(A) 25000(B) 50000(C) Blue or Purple OpOrder Embedded Combat Advisers[Green]=1 :Time=13.01 Blue or Purple Intervention Size[Green]=0
Policy 4. BCP Counter Terrorism Return military advisers to Iraq to train and oversee counter-terrorism operations against ISIS in non-combat roles. **Counter Terrorism - A = 5,000** **Counter Terrorism - B = 10,000** **Counter Terrorism - C = 15,000**		Set variables: Deployment Time[Green]=.33 Blue or Purple T3R Average=0 Add to command script: :Time=12.01 Blue or Purple Intervention Size[Green]= 5000(A) 10000(B) 15000(C) Blue or Purple OpOrder Training Local Actor Security Forces [Green]=1 :Time=13.01 Blue or Purple Intervention Size[Green]=0
Policy 5. BCP Foreign Recruiting Reduce the effectiveness of foreign recruiting for ISIS.	Foreign Recruiting - A: Foreign Recruiting reduced by 50% Foreign Recruiting - B: Foreign Recruiting Reduced by 100%	Set Variable to: NORMAL FOREIGN RECRUITS INSPIRED PER TERRORIST ATTACK[Red] =26 (Normal) 5A = 13 5B = 0
Policy 6. Air Campaign Leverage close air support missions to aid opposing forces engaged in combat with ISIS.	Target Effect of Ground Support Campaign[Green] Air Campaign - A= 10% Air Campaign - B = 50%	Set variables: Deployment Time[Green]=.33 Blue or Purple T3R Average=0 Add to command script: :Time=12.01

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		Blue or Purple Intervention Size[Green]= 1080 (6a) 5670(6b) Blue or Purple OpOrder Airpower[Green]=1 Blue or Purple Airpower Targeting Combatants[Green]=1 :Time=13.01 Blue or Purple Intervention Size[Green]=0

In the above tests "non-combat roles" are deployments that by structure of the model will not result in fatalities from conflict for Blue Personnel. "Combat roles" however are included in the combat simulation and will suffer casualties proportionate to their relative proportion in the overall force, and the allocation of that force by the Green Actor at a given time. The results of these tests are summarized in Table D-11 across nine factors. The maximum and ending values of three Primary Measures of Effectiveness: Total Territory[Red], Total Combatants[Red], and Total Population[Red] as well as Total Intervention Size, Blue Combatant Losses, and Total Conflict Deaths are compared inTable D-11.

Hypothetical Best Case Test Results

Table D-11: Best Case Policy Results for Application Article

Experiment	% Territory MAX	Total Pop[Red] MAX	Total Combatants [Red] MAX	% Territory Controlled at End [Red]	Total Population by Actor at End [Red]	Total Combatants at End [Red]	Total Intervention Size	Blue Combatant Losses[Green]	Total Conflict Deaths
Baseline Historical	36%	1.04M	93k	0%	49k	220	108,100	9,861	436k
Baseline without Intervention	52%	3.415M	107k	52%	2.94M	107k	-	-	692k
BCP1	40%	1.28M	80k	40%	1.28M	21k	-	-	363k
BCP2	36%	1.04M	93k	0%	49k	275	108,100	12,060	440k
BCP3A	42%	1.11M	95k	42%	1.11M	95k	10,000	6,463	451k
BCP3B	12%	901K	88k	12%	901k	84k	25,000	16,140	458k
BCP3C	10%	879K	86k	10%	879k	76k	50,000	29,860	441k
BCP4A	52%	3.42M	107k	52%	2.97M	107k	5,000	-	692k
BCP4B	52%	3.58M	106k	52%	3.36M	106k	10,000	-	691k
BCP4C	51%	3.34M	107k	51%	2.84M	107k	15,000	-	694k
BCP5A	16%	842K	68k	13%	513k	786	108,100	39,180	502k
BCP5B	2%	101K	1.5k	0%	1.7k	-	108,100	3132	230k
BCP6A	52%	3.54M	106k	52%	3.30M	106k	1,080	0	693k
BCP6B	51%	3.30M	107k	51%	2.82M	107k	5,670	0	700k

COA1 Elements

The three courses of action labeled COA1A-C consist of three elements all beginning in June of 2014:

1. Deploy ~10,000 embedded combat advisers to improve the fighting quality of forces opposing ISIS in combat-roles.
2. Deploy 5,000 military advisers to train and oversee counter-terrorism operations against ISIS in non-combat roles.

3. In addition to the above conduct an air-campaign which will be tested at three levels The levels of air-campaign are the only differences between COA1 and are labeled COA1-Minimal, COA1-Significant, and COA1-Intensive:
    a. COA1-Minimal: ~12/sorties/day
    b. COA1-Significant: ~120/sorties/day
    c. COA1-Intensive: ~500/sorties/day

COA1 Operational Constraints

The operational constraints for this COA are that will take ~6months for US forces to deploy and arrive to full strength in the theatre. Likewise, normal tooth-to-tail ratios for logistics, administration and headquarters will be 'taxed' upon the deployed force. This means that to achieve 15,000 troops able to perform missions, 45,000 overall troops are deployed. Many of this total force will be in support roles related to the deployment itself, and not directly advancing the mission of embedding combat advisors, training host nation security capability or supporting the air campaign. Furthermore, troops will be replaced if they become casualties. The overall troop levels necessary to reach the COA targets are:

1. COA1-Minimal: ~45,000
2. COA2-Signfiicant: ~49,000
3. COA1-Intensive: ~62,000

The intervention date is set at June of 2014 – the actual point in which US military intervention began with an air campaign against ISIS. An air campaign can range in its intensity. The historic actual rate for the campaign against ISIS was originally 10 sorties/day with occasional ten-fold increases up to nearly 100 sorties/day at time. The height of US airpower operational tempo in recent history is 500 sorties/day which will be used a theoretical maximum sustained operational tempo for extended operations.   In this COA airstrikes will focus 100% on destroying ISIS's oil, and only then switch to ground support missions. An air strike targeting a modular oil refinery removes only 300-500 BPD of production. How many air strikes are needed to significantly impact ISIS's oil production? And would that level of airpower detract from the ability to provide close ground support? Table D-12 lists the airpower options for COA1 now established and the personnel required will be added to each scenario.

Air strikes will target ISIS oil production 100% until it is destroyed, and then shift into a Ground Support role. This is based off the knowledge that eliminating ISIS's oil revenue was a key factor in reducing its growth under the hypothetical best-case scenario. We can now compare COA1-A, B & C against both the Historical Baseline intervention and the counterfactual Baseline without Intervention across a dashboard of primary measures of effectiveness. First, the three COA's will be compared against the same factors as in Table D-11 in Table D-13.

COA1 Test Inputs

To formalize this COA into a testable policy requires making the following changes.

D-7 Experiment Test Parameters & Results

Table D-12: COA1 Test Elements

COA Version	Subsystem Formulation
COA1-Minimal: **10,000 Embedded Combat Advisors** **5,000 Security Advisors** **~12/sorties/day**	Add to command script: :Time=18 Blue or Purple Intervention Size[Green]=45,405 Blue or Purple OpOrder Embedded Combat Advisers[Green]=.7 Blue or Purple OpOrder Training Local Actor Security Forces[Green]=.23 Blue or Purple OpOrder Airpower[Green]=.07 Blue or Purple Airpower Targeting Resources[Green]=1
COA1-Significant: **10,000 Embedded Combat Advisors** **5,000 Security Advisors** **~120/sorties/day**	Add to command script: :Time=18 Blue or Purple Intervention Size[Green]=49050 Blue or Purple OpOrder Embedded Combat Advisers[Green]=.62 Blue or Purple OpOrder Training Local Actor Security Forces[Green]=.31 Blue or Purple OpOrder Airpower[Green]=.07 Blue or Purple Airpower Targeting Resources[Green]=1
COA1-Intensive **10,000 Embedded Combat Advisors** **5,000 Security Advisors** **~500/sorties/day**	Add to command script: :Time=18 Blue or Purple Intervention Size[Green]=62010 Blue or Purple OpOrder Embedded Combat Advisers[Green]=.5 Blue or Purple OpOrder Training Local Actor Security Forces[Green]=.25 Blue or Purple OpOrder Airpower[Green]=.25 Blue or Purple Airpower Targeting Resources[Green]=1

COA1 Results

Table D-13: COA1 Results

Experiment	% Territory MAX	Total Pop[Red] MAX	Total Combatants [Red] MAX	% Territory Controlled at End [Red]	Total Population by Actor at End [Red]	Total Combatants at End [Red]	Total Intervention Size	Blue Combatant Losses[Green]	Total Conflict Deaths
Baseline Historical	36%	1.04M	93k	0%	49k	220	108,100	9,861	436k
COA1 Minimal	34%	1.09M	98k	31%	1.09M	32k	43,260	29,570	403k
COA1 Significant	34%	1.08M	97k	30%	1.08M	20k	46,870	29,120	405k

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COA1 Intensive	28%	1.03M	93k	25%	1.0M	10k	60,790	25,800	435k
COA1 Minimal Early	9%	941k	86k	9%	378k	14k	41,000	43,460	452k

COA2

The same operational constraints are in effect in this COA as in COA1.

Table D-14: Emerging-State Actor COA and Falsification COA Components

COA Element	Subsystem & Formulation
COA2 Emerging-State Phase I: Blue deploys 5,000 personnel with a focus on security training, helping Green lower its logistical burden, bolstering legitimacy of Green and using airpower to target governance of Red. Require Green to make token effort to increase credible governance to Arab Sunni and Kurdish Sunni, increase security of prisons holding detained ISIS, and bolster Green legitimacy.	:Time=12 Blue or Purple Intervention Size[Green]=5000 Blue or Purple OpOrder Training Local Actor Security Forces[Green]=.6 Blue or Purple Airpower Targeting Government Capacity[Green]=.2 Blue or Purple OpOrder Information Operations[Green]=.2 OpOrder Combatting Terrorism[Green]=0.25 OpOrder Prison Duty[Green]=.3 OpOrder Armed Civil Affairs[Green]=.2 OpOrder Propaganda[Green]=.1 Actual Desire to Credibly Govern[Arab Sunni,Green]=.8 Actual Desire to Credibly Govern[Kurdish Sunni,Green]=.8
COA2 Emerging-State Phase II: Blue deploys 10,000 additional personnel and shifts to providing embed combat advisers, additional airpower. Green & Blue to work together to raise indigenous local forces from within the ethnographic groups that have a lower logistical footprint than Green. Green shifts to taking more direct lead in conventional military activities and Blue picks up legitimacy building activities through Armed Civil Affairs.	:Time=18.557 OpOrder Armed Civil Affairs[Green]=0 OpOrder Propaganda[Green]=0 OpOrder Prison Duty[Green]=.2 Blue or Purple T3R Average[Green]=.55 Blue or Purple Intervention Size[Green]=15000 Blue or Purple OpOrder Embedded Combat Advisers[Green]=.1 Blue or Purple Armed Civil Affairs[Green]=.1 Blue or Purple OpOrder Training Local Actor Security Forces[Green]=.27 Blue or Purple OpOrder Airpower[Green]=.43 Blue or Purple Airpower Targeting Government Capacity[Green]=1 OpOrder Recruiting[Arab Sunni,Green]=.05 OpOrder Recruiting[Kurdish Sunni,Green]=.05 OpOrder Recruiting[Arab Shia,Green]=.1 OpOrder Conventional Warfare[Green]=0.3 Green or Red T3R Average[Green]=.25
COA2 Military Only: Blue deploys 15,000 split between improving host-nation security forces, embedded combat advisers and airpower.	:Time=12 OpOrder Propaganda[Green]=0 OpOrder Prison Duty[Green]=.2 Blue or Purple Intervention Size[Green]=15000 Blue or Purple OpOrder Embedded Combat Advisers[Green]=.3 Blue or Purple OpOrder Training Local Actor Security Forces[Green]=.27

	Blue or Purple OpOrder Airpower[Green]=.43
	Blue or Purple Airpower Targeting Combatants [Green]=1
COA2 Political Only: Blue deploys 15,000 personnel split between conducting Armed Civil Affairs in support of Green and Information Operations against Red.	:Time=12
	Blue or Purple Intervention Size[Green]=15000
	Blue or Purple OpOrder Information Operations[Green]=.5
	Blue or Purple OpOrder Armed Civil Affairs[Green]=.5
	Actual Desire to Credibly Govern[Arab Sunni,Green]=.8
	Actual Desire to Credibly Govern[Kurdish Sunni,Green]=.8