APPENDIX B Discussion of Model Structure & Parameter Values

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

## 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.

## 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 Appendix C-8 on “Behavior Reproduction” for examples.)

## 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 appendix – but not necessarily indicative of precise timing down to the day.

## Structure of the Appendices and this Document

The four Appendices are the supporting materials to E-SAM.

***Appendix A Model Documentation***

This appendix 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.

***Appendix B: Discussion of Structure & Parameterization***

This appendix 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.

***Appendix C: Validation & Confidence Building Tests***

This appendix 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.

***Appendix D: User Manual for E-SAM***

This appendix 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.

The structure of Appendix B is:

***B-1 Emerging-State Actor Model Overview:*** Overview of E-SAM, key concepts and capabilities.

***B-2 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.

***B-3 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 Appendix A for full model equations.)

***B-4 Sector by Sector Review of the 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.

***B-5 Bibliography of Appendix B:*** A bibliography of the sources referenced in this document.

The Appendix 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 Appendix is intended to allow further development, testing, reproduction and replication testing as well as ongoing refinement of the E-SAM.

# B-1 Emerging-State Actor Model Overview

## 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.

## 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 Figures 1-4 below to illustrate that the models roughly replicate realistic behavior.

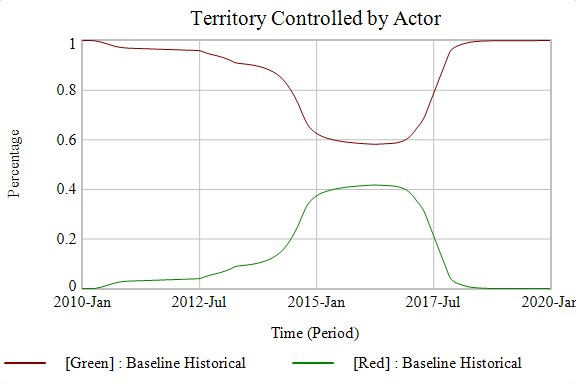


Figure 1: Historical Baseline – Territory Controlled

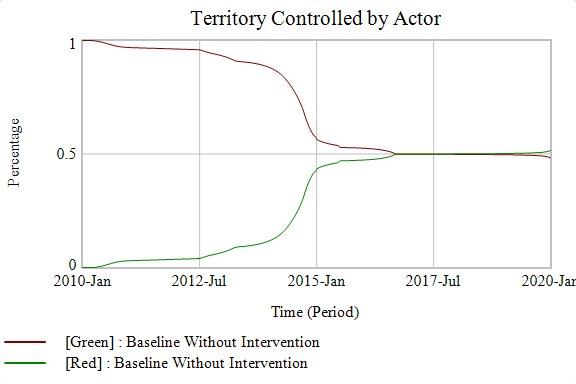


Figure 2: Baseline without Intervention - Territory Controlled

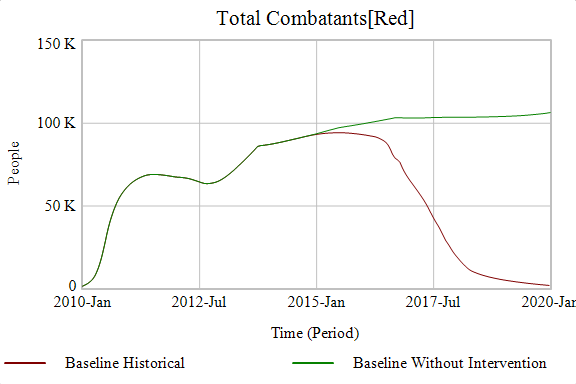


Figure 3: Baseline Scenarios - Total Combatants for Red (ISIS)

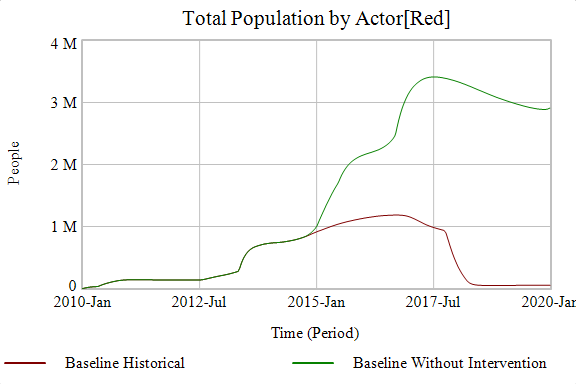


Figure 4: Baseline Scenarios - Total Population Controlled by Red (ISIS)

## 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.

### 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 1.

Table 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 2.

Table 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. |
| 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. |

## 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 3.

Table 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.” |

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

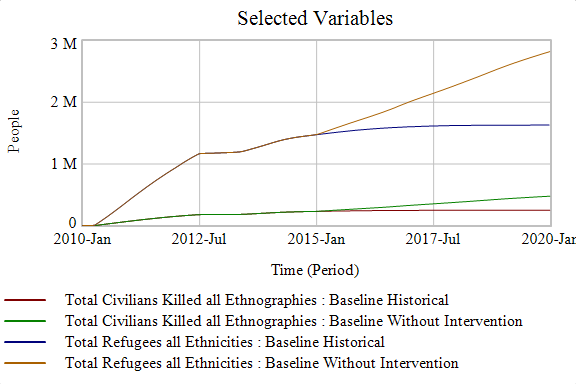


Figure 5: Baseline Scenarios – Civilian Deaths & Total Refugee Comparison

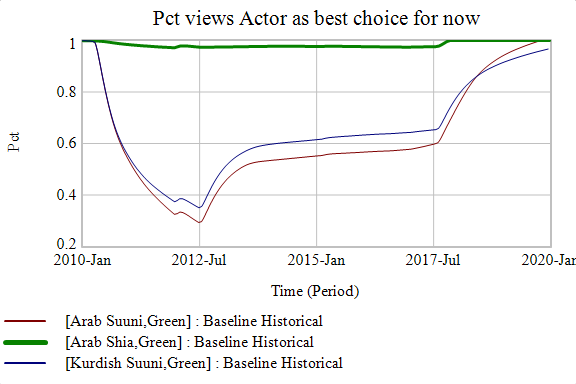


Figure 6: Baseline Historical - Calculated Legitimacy of Green Actor by Ethnography

## 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.

## Sector Overview

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

Table 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 7.



Figure 7: Overview of Sectors and Interactions

Note that Figure 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 Appendix A. The focus however is not on equations – but review and discussion of key subsystems, notes on parameters and highlighting key dynamics where appropriate. As Appendix A already includes the equations they are not repeated here. Neither B-3 nor B-4 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.

## 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

## 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 Appendix C.)

# B-2 Review of Causal Loop Structures

## 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 Appendix C) 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 8.



Figure 8: Emerging-State Actor Causal Loop Structure

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]](#footnote-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.

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

Table 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” |

# B-3 Sector by Sector Review of Strategic Architecture

## 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 9.

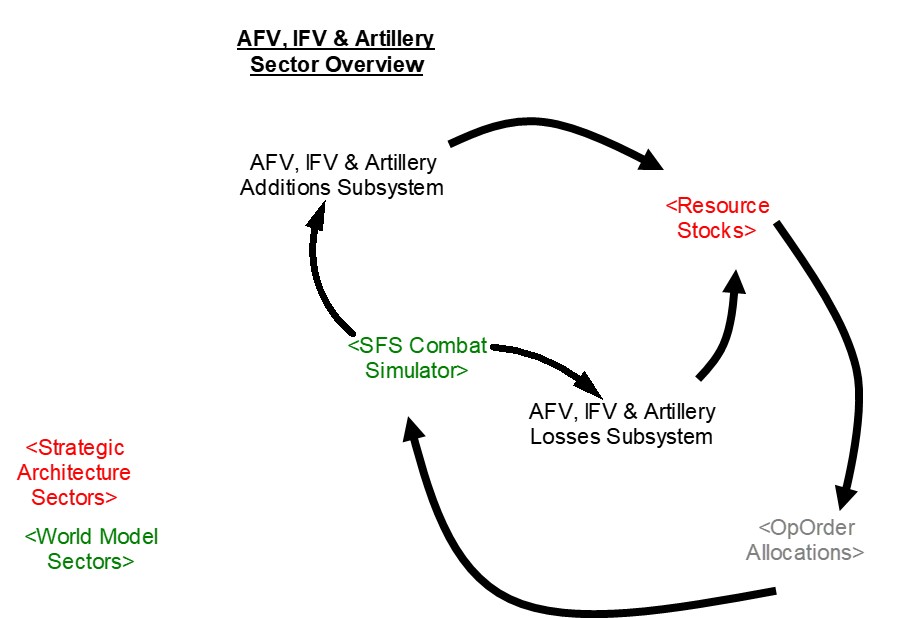


Figure 9: AFV, IFV & Artillery Sector

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 10 shows that as the losses of Green occur, the gains in Red match closely.

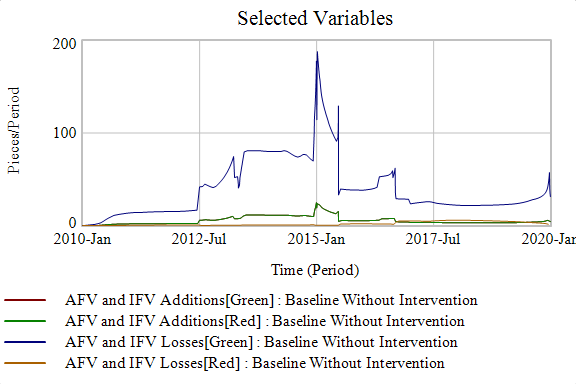


Figure 10: Losses & Gains of AFV for Green and Red

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 11.

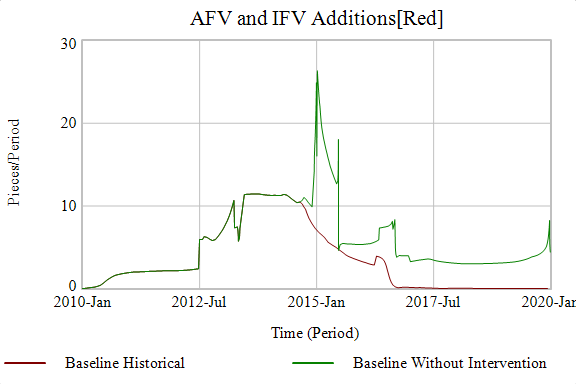


Figure 11: AFV Gains by Red Actor Both Scenarios

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.



Figure 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.

## 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.

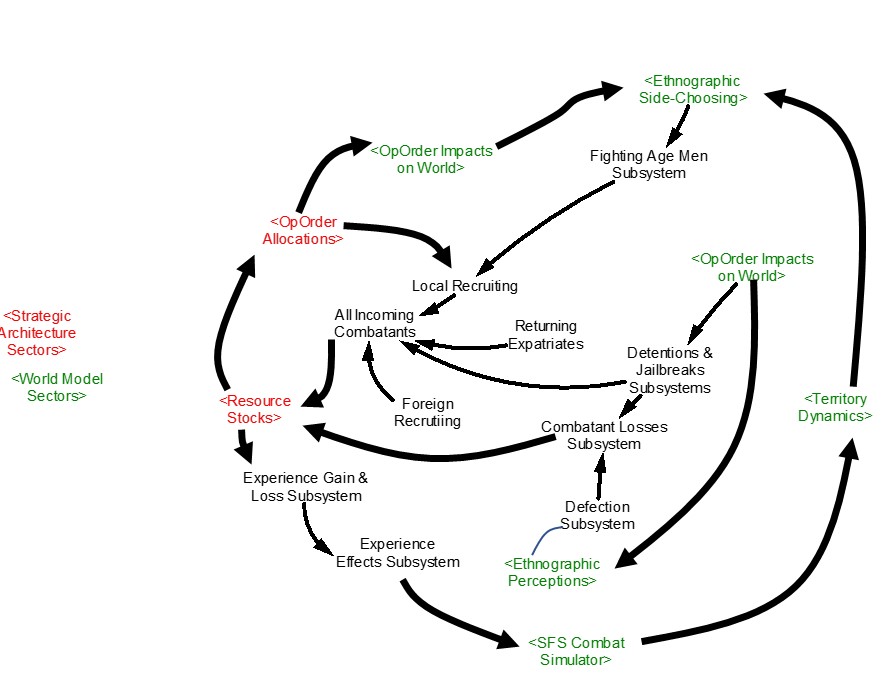


Figure 13: Combatant Recruiting & Losses Sector

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 14.



Figure 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 15 from the Baseline Historical for Sunni Arab [Red Actor] only.



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

As is demonstrated in Figure 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 16.

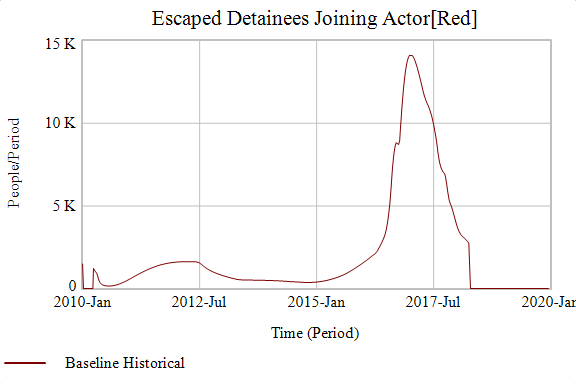
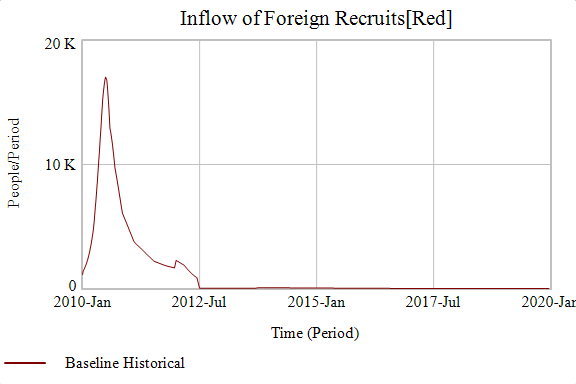


Figure 16: Foreign Recruits & Escaped Detainees [Red]

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]](#footnote-2) The following table 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]](#footnote-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]](#footnote-4) and that ISIS specifically tracks “Prison Escapes” as a strategic metric in its 2013 Annual Report.[[5]](#footnote-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 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 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]](#footnote-6) |
| Kandahar, Afghanistan | 6/14/2008 | Sarposa Prison Break | 300 (25%) | ~1200 combatants[[7]](#footnote-7) |
| Baghdad, Iraq | 7/20/2010 | Camp Croppe Prison Escape | 4 (100% | 4 senior AQ leaders[[8]](#footnote-8) |
| Kandahar, Afghanistan | 4/25/2011 | Sarposa Prison Break | 122 (25%) | ~488 combatants freed[[9]](#footnote-9) |
| Sedanya Prison, Syria[[10]](#footnote-10) | 6/20/2011 | Syrian Amnesty Orders #53 & #61 | 700 (50%) | ~700 combatants released[[11]](#footnote-11) |
| Al-Mukalla, Yemen | 6/22/2011 | Al-Munawara Prison Break | 31 (50%) | 62 combatants freed[[12]](#footnote-12) |
| Tikrit, Iraq | 9/28/2011 | Tasfirat Prison Break | 90 (100%) | ~90 combatants freed[[13]](#footnote-13) |
| Aden, Yemen | 12/12/2011 | Aden Prison Break | 14 (100%) | 14 combatants freed[[14]](#footnote-14) |
| Abu Graib, Iraq | 7/21/2013 | Abu Ghraib Prison Break | 500 (100%) | ~500 combatants freed[[15]](#footnote-15) |
| Benghazi, Libya | 7/27/2013 | Kuafiya Prison Break | 1117 (100%) | 1,117 combatants freed[[16]](#footnote-16) |
| Dera Ismail Khan, Pakistan | 7/29/2013 | Dera Ismail Prison Break | 250 (100%) | ~250 combatants freed[[17]](#footnote-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 17: Detention & Jail Break Subsystems

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 18.



Figure 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 below.



Figure 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 20.



Figure 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 21 below.



Figure 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 7 are the historical estimated manpower of ISIS and its predecessor incarnations, as well as the implied inflow to maintain the estimated size.

Table 7: Historical Demographic Estimates of ISIS & AQI

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Year** | **ISIS Estimated Size[[18]](#footnote-18)** | **Size – Losses** | **Implied Inflow to Maintain Size** | **Deaths** | **Detentions** | **Total Losses** |
| 2004 | 300[[19]](#footnote-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]](#footnote-20) | 6290 | 5710 | 2595 | 3115 | **5710** |
| 2006.5 | 10000 | 4312 | 5688 | 2682 | 3006 | **5688** |
| 2007 | 7500[[21]](#footnote-21)[[22]](#footnote-22) | 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]](#footnote-23) | 9648 | 3552 | 1507 | 2045 | **3552** |
| 2013.5 | 13200 | 8675 | 4525 | 1964 | 2561 | **4525** |
| 2014 | 30000[[24]](#footnote-24) | 18758 | 11242 | 4931 | 6311 | **11242** |
| **2014.5** | **80000[[25]](#footnote-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.*

***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]](#footnote-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 combatants of 173 per 1,000 combatants/year or .173%.[[27]](#footnote-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]](#footnote-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 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 Appendix-C)

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 22.

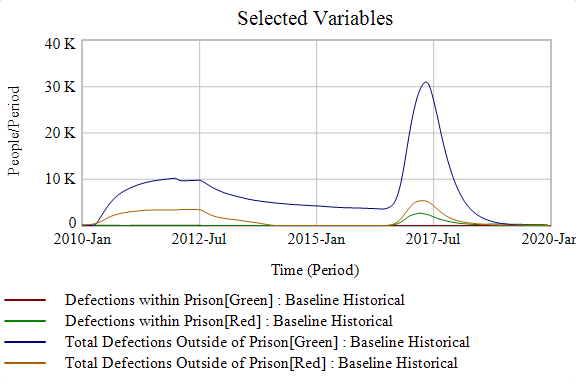


Figure 22: Defection rates of Combatants & Detainees [Green, Red]

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 23.

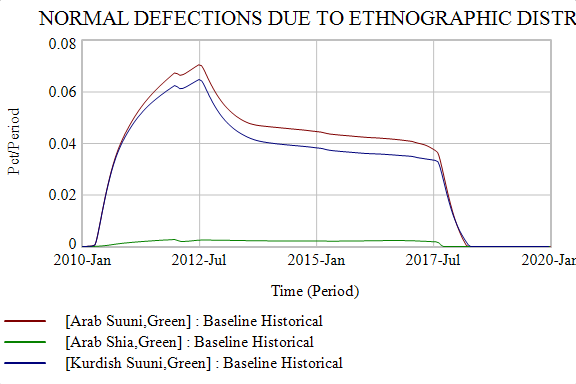


Figure 23: Ethnographic Distrust driving Green Defections

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.

## 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.

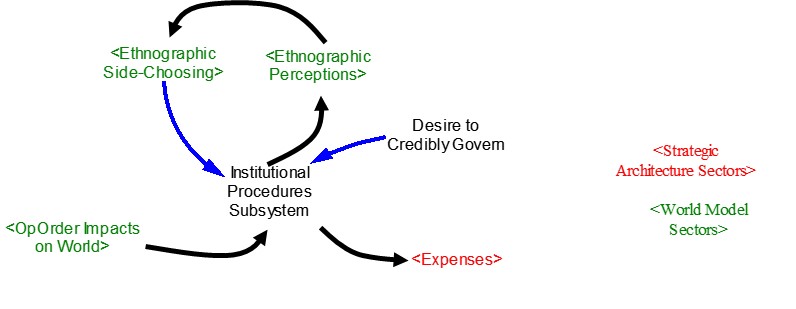


Figure 24: Governance Sector Overview

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 25.



Figure 25: Structure of Institutional Procedures Subsystem

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

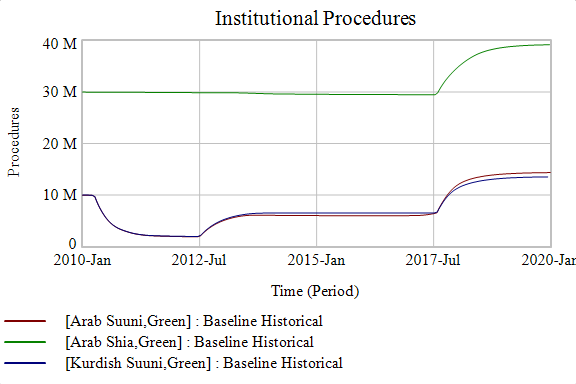


Figure 26: Credible Institutional Procedures by Ethnography [Green]

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 27, represents a common challenge confronting counter-insurgency operation.



Figure 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 28 which depicts the lifecycle of Arab Sunni relations to the Green government.

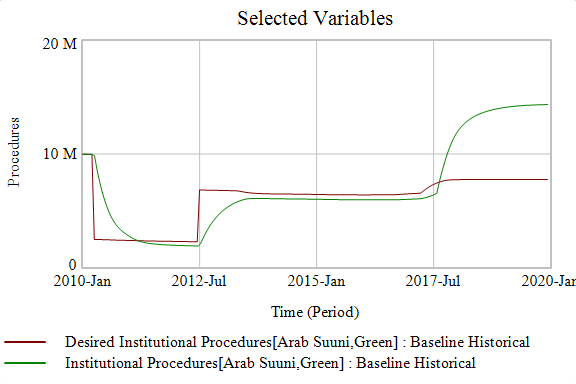


Figure 28: Demonstration of Losing the War by Winning the Battle Archetype Dynamics

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]](#footnote-29)

## 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 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 Appendix A section A-16 for more details.) Below in Figure 29 is the structure of OpOrder Allocations for the Green and Red Actors.



Figure 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 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 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 31.

## 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.

***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. In the table below the historical finances on hand of AQI and ISIS are displayed.

***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***

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]](#footnote-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]](#footnote-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]](#footnote-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.

## 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 other capabilities of the strategic architecture. These in turn impact the “world” as represented in Figure 32 below.

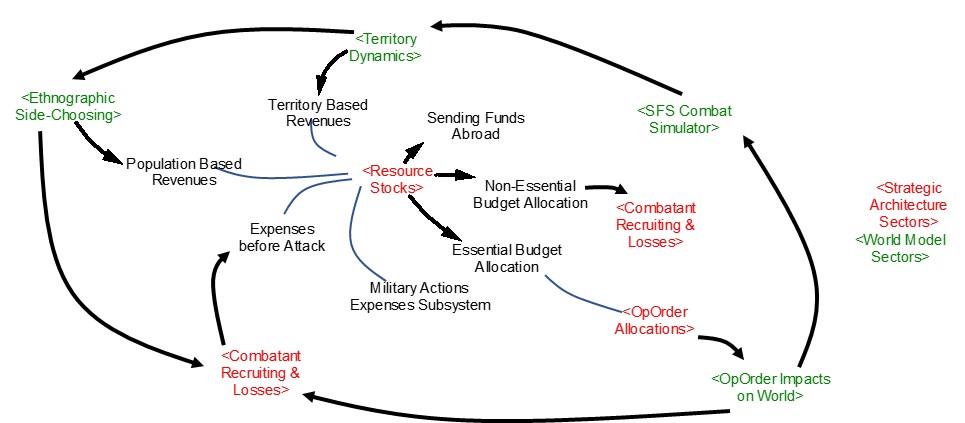


Figure 32: Revenue & Expenses Sector Overview

### 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 33 with a single in-flow of revenue (Dollars per Period) and outflow of expenses (Dollars per Period).

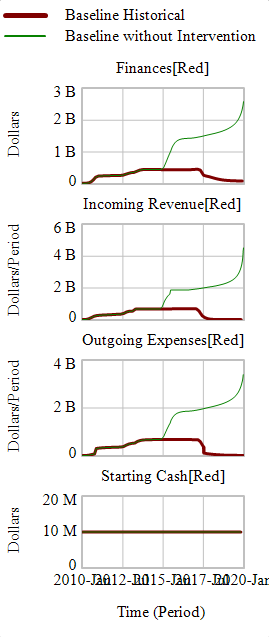


Figure 33: Incoming Revenue & Outgoing Expenses [Red]

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

subsystems that feed them. Pictured in Figure 34 are the actual components of Revenue that are explained in more detail below. Expenses are handled after Revenue.



Figure 34: 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.

### 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]](#footnote-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]](#footnote-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]](#footnote-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]](#footnote-36)

RAND depicted the financial flows of revenue and expenses in Figure 35 below:[[37]](#footnote-37)

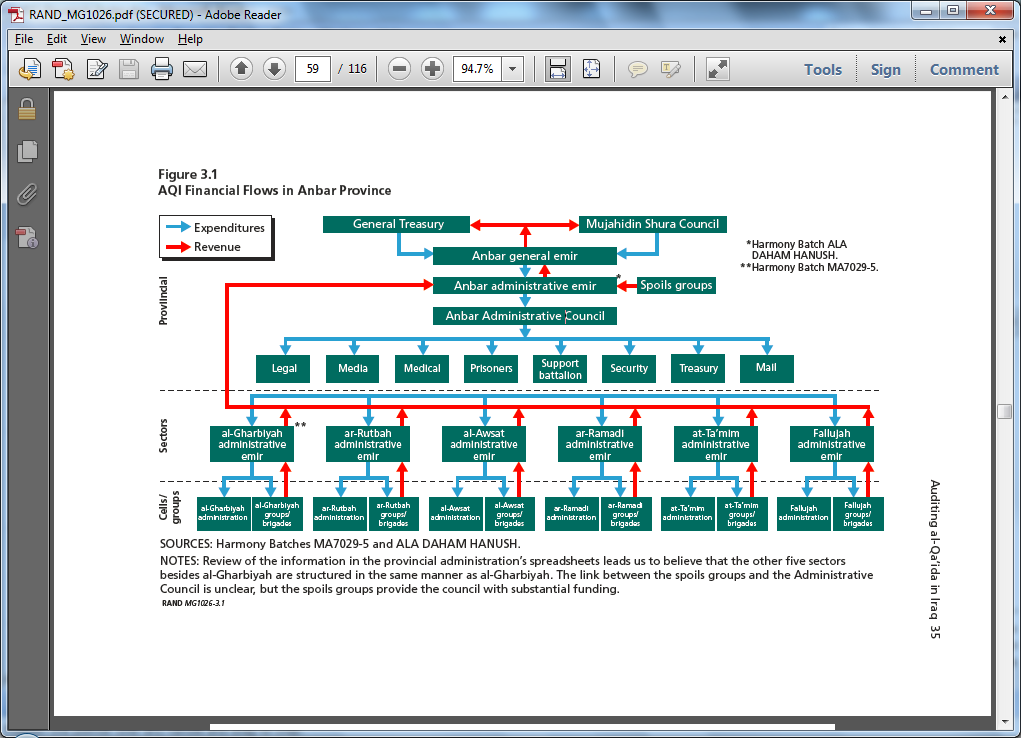


Figure 35: AQI Financial Flows as Reported by RAND

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]](#footnote-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 territory fully occupied by the government. This taxation amount is currently estimated at $1m/day or approximately $90m/Period.[[39]](#footnote-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]](#footnote-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]](#footnote-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]](#footnote-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.

***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]](#footnote-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 36 for the Baseline Historical Case of Red.



Figure 36: Sources of Expenses [Red]

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 37: 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 38.

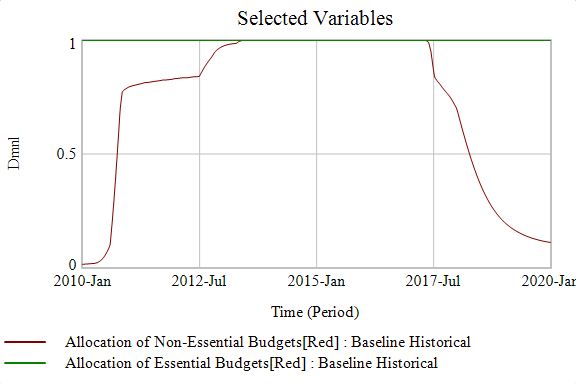


Figure 38: Allocation of Essential & Non-Essential Budgets [Red]

As demonstrated in the figure, 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]](#footnote-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 Baseline Historical and Baseline without Intervention are compared below, showing how this measure can be used for policy analysis.

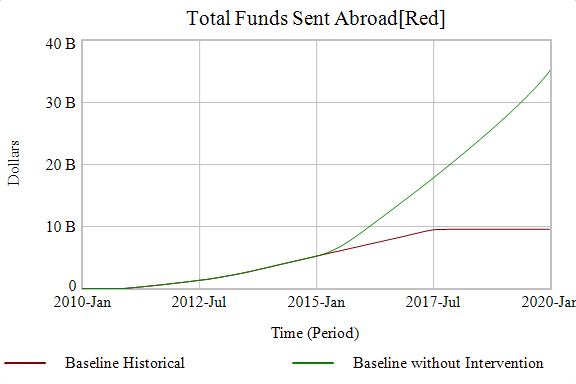


Figure 39: Total Funds Sent Abroad both Scenarios [Red]

***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]](#footnote-45)

Table 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***

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

## 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 faster, and the ability to recruit locally stronger in these areas. This is shown in Figure 40 of Fighting Age Men in the *Calculated Legitimacy* population.

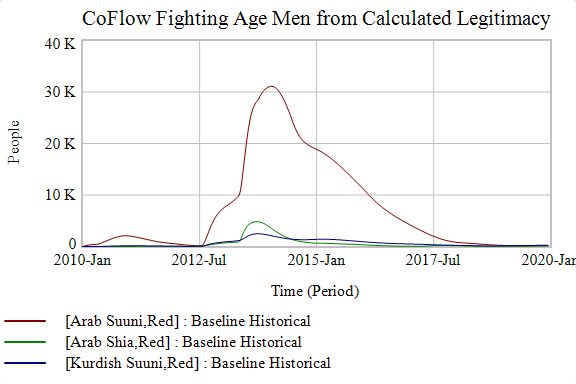


Figure 40: Fighting Age Men in Calculated Legitimacy by Ethnography [Red]

*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.

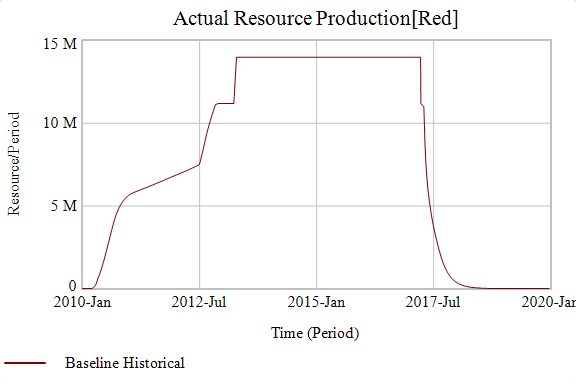


Figure 41: Oil Production before Air Strikes [Red]

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.

# B-4 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.

## 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 42.



Figure 42: 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 43.



Figure 43: Anchored Ethnographic Perception of Actor

The short-term perception adjusts in reaction to the perception of presence or absence of “credible institutional procedures”[[50]](#footnote-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.

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 44.



Figure 44: 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.

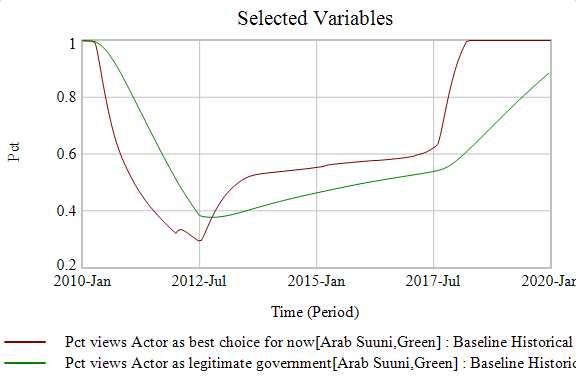


Figure 45: Sentiments of Legitimacy of Green [Sunni Arab]

It is this structure which allows the Red Actor to further its own advances often by targeting its own aligned ethnographic group. In the Baseline Historical 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 Baseline Historical.

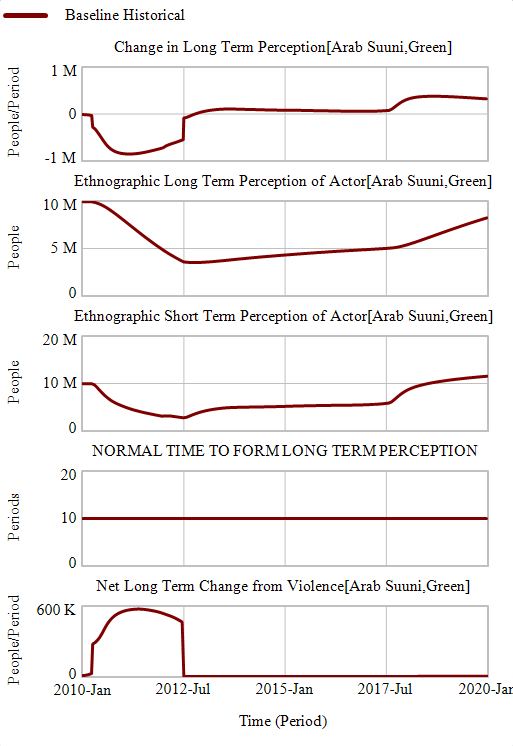


Figure 46: Change in Long Term Perception [Arab Sunni, Green]

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 47 show the influencers to *Change in Short Term Perception.*



Figure 47: 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.

((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 48.



Figure 48: 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.

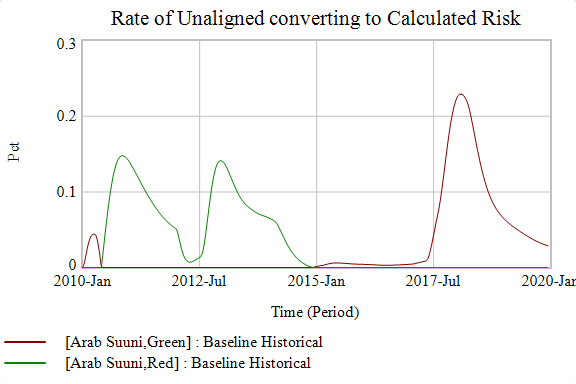


Figure 49: Rate of Unaligned Converting to Calculated Risk [Sunni Arab]

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.

## 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.

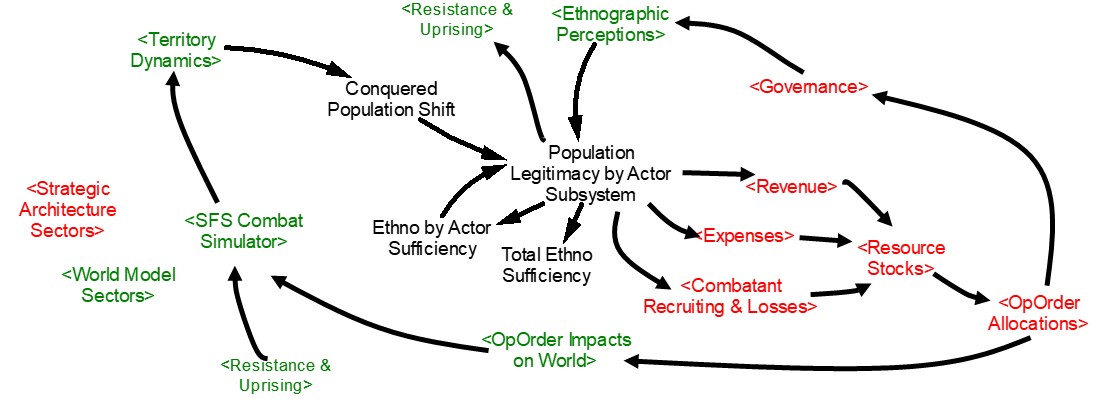


Figure 50: Ethnographic Side-Choosing & Legitimacy Structure

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 51: 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. The table below

Table 10: Inflows & Outflows of Population Legitimacy Subsystem

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Type of Flow | Unaligned | Coerced | Calculated | Governed |
| Inflow | * Defections to Unaligned * Coerced to Unaligned | * Unaligned Conquered to Coerced * Conquest * Calculated to Coerced | * Coerced to Calculated * Governed to Calculated | * Calculated to Governed |
| 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 52 charts the Arab Sunni Ethnographic group within Green as they shift from *Governed* stock through the material chain of stocks in this subsystem.

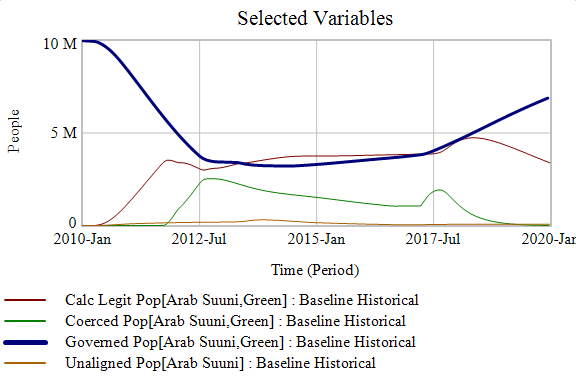


Figure 52: Distribution of Arab Sunnis Across Legitimacy Subsystem [Green]

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 53.

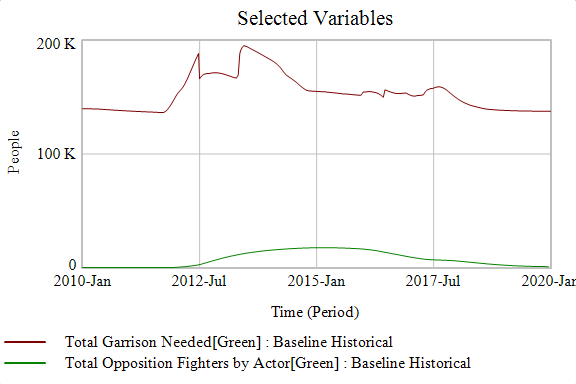


Figure 53: Breakdown in Stability [Green]

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 54 the population stocks are again shown but this time for Sunni Arab ethnographic groups that are part of Red.

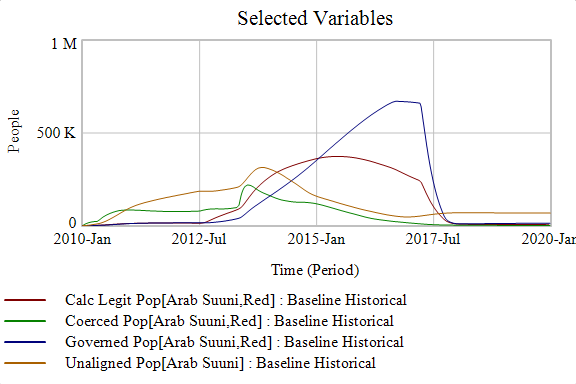


Figure 54: Rise and Fall of Red Legitimacy

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 Appendix C section C-12 for more information on sensitivity analysis of these time delays.

## 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 55.

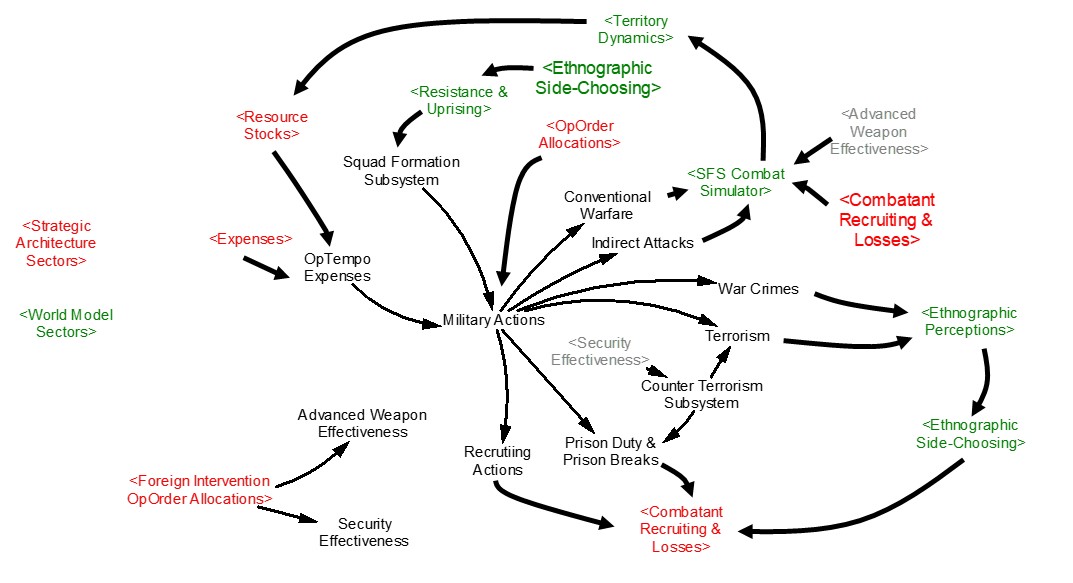


Figure 55: OpOrder Impacts in World Sector Overview

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 56.



Figure 56: 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 56. 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 57.



Figure 57: 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.

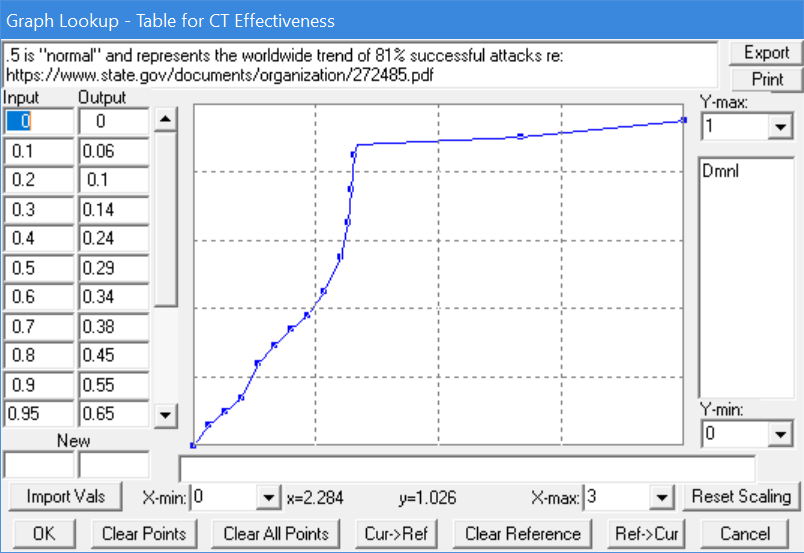


Figure 58: Graphical Lookup Function for Counter Terrorism

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]](#footnote-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) between the rate of fund flows increasing or decreasing and corresponding changes in the pace of attacks.[[52]](#footnote-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.

## 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 59.

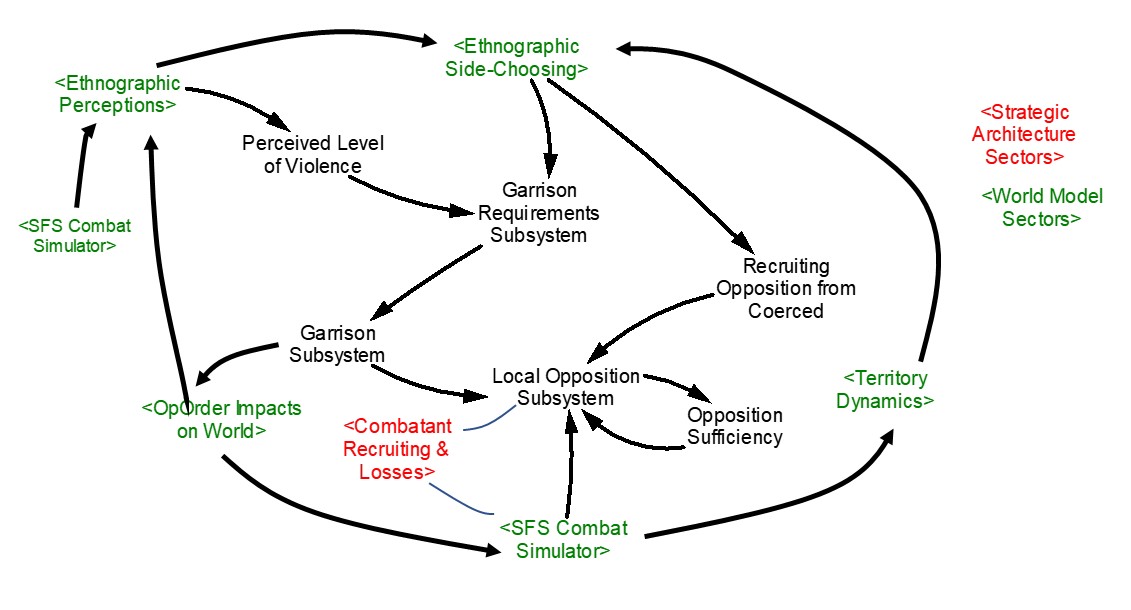


Figure 59: Sector Overview of Resistance & Uprising

### 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 60: 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]](#footnote-53)

Table 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]](#footnote-54)

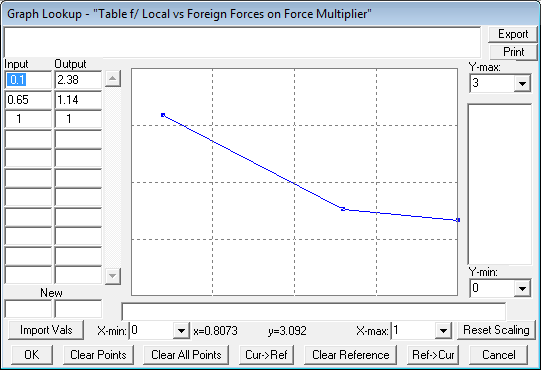
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Figure 61: Lookup Table for Local Troop Density effect on Garrison

***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]](#footnote-55)

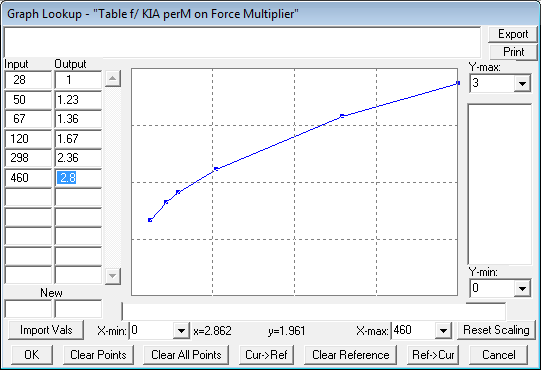


Figure 62: Table for the Effect of Conflict Severity on Garrison Force Ratio

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 Historical Baseline and Baseline without Intervention 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]](#footnote-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 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 63 for both the Historical Baseline and Baseline without Intervention.

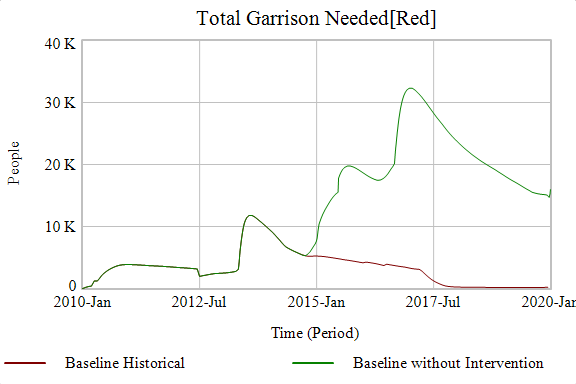


Figure 63: Garrison & Police Forces Baseline Scenarios

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 64.

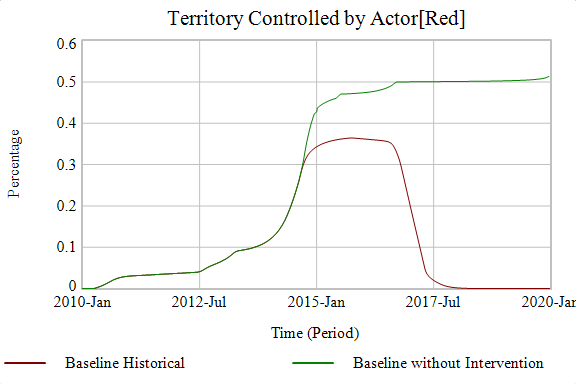


Figure 64: Territorial Boundary Endogenously Created by Limits to Growth

## 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]](#footnote-57) The key subsystems and interacting sectors are depicted in Figure 65.

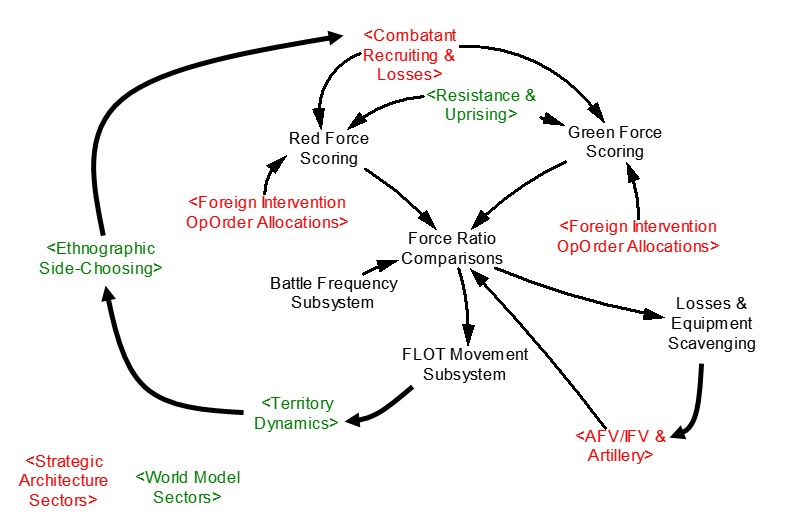


Figure 65: Overview of SFS Combat Simulator Sector

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.”

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]](#footnote-58), Combat Power Density by Zanella[[59]](#footnote-59), Joint Integrated Contingency Model (JCIM) developed by RAND[[60]](#footnote-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.

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.

## 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 66.

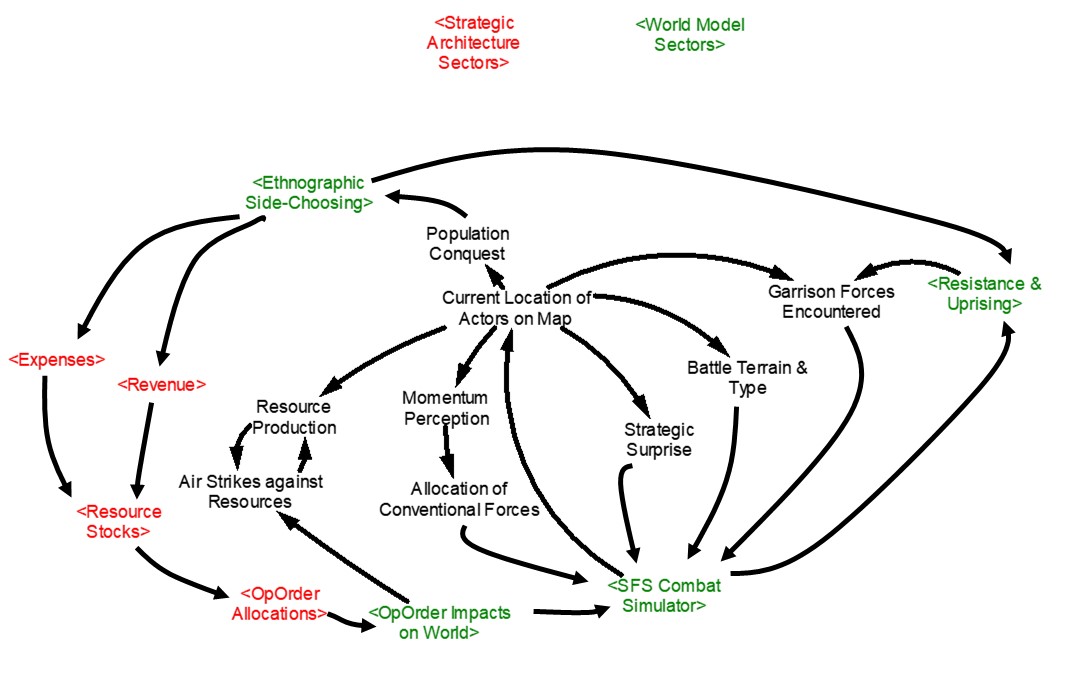


Figure 66: Overview of Territory Dynamics Sector

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 Family Member Tests in Appendix C section C-10); 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 Appendix D 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 67 demonstrates how this structure results in determining Green garrison forces Red encounters in the Baseline Historical compared to the Baseline without Intervention.

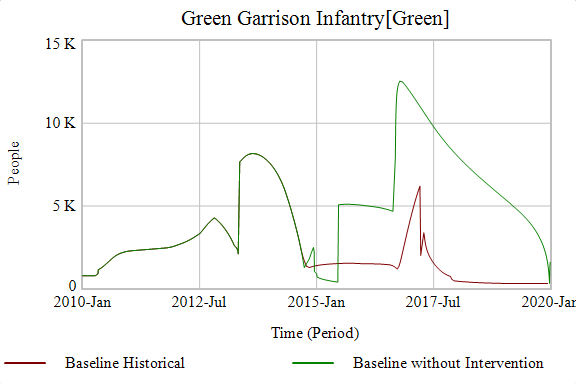


Figure 67: Green Garrison Encountered in Baseline Scenarios

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 Baseline Without Intervention. 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 Baseline Historical Scenario 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.*



Figure 68: 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 69, the *Actor Perception of Momentum* is charted for both Green and Red in the Historical Baseline.

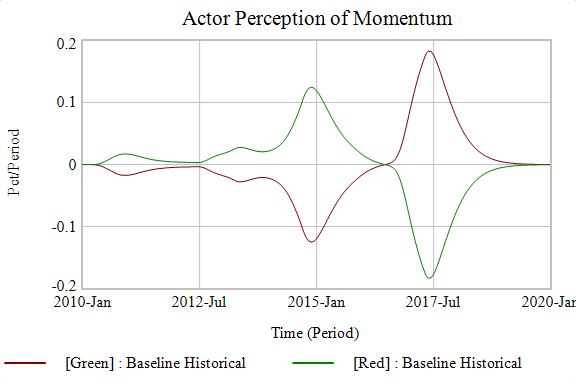


Figure 69: Actor Perception of Momentum in Baseline Historical

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 70 which looks at the same value for the Baseline without Intervention.

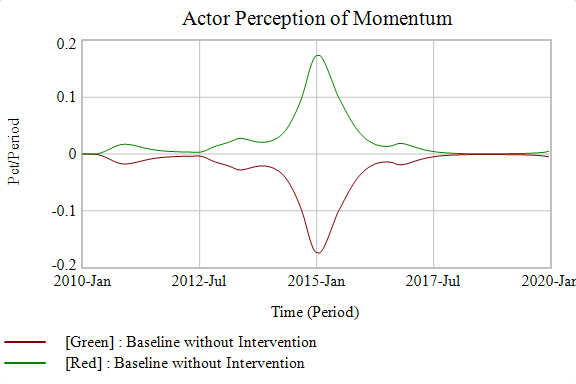


Figure 70: Actor Perception of Momentum in Baseline without Intervention

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 71 shows this *Allocation* dynamic as a function of *Perception* in the Baseline Historical scenario.

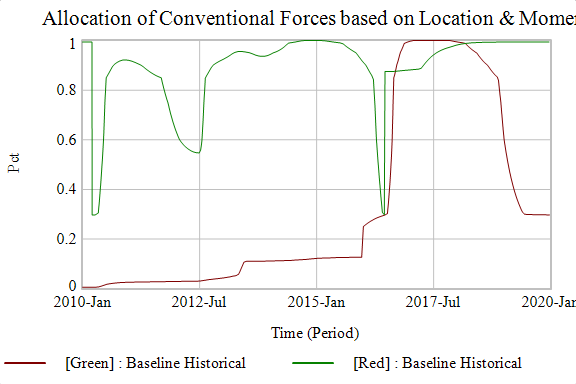


Figure 71: Allocation of Forces Baseline Historical

In Figure 71 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 72 however, this existential threat to Red never materializes. Both sides perceive a relative stalemate and adjust their forces accordingly.

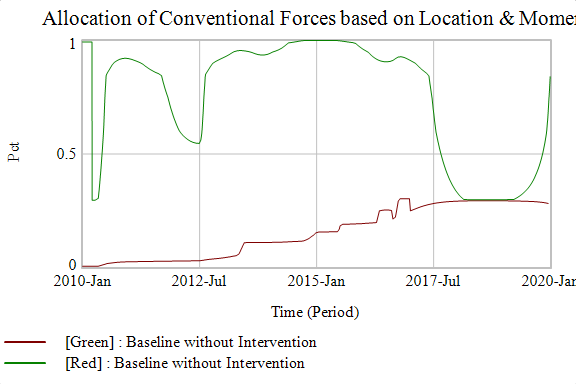


Figure 72: Allocation of Conventional Forces Baseline without Intervention

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 are tables 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]](#footnote-61)

Table 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 |

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

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