

# The Dynamics of ISIS – An Emerging State Actor.

## Appendix A – Model Structure Overview & Equations

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Note that a detailed sector-by-sector discussion of model structure, parameterization, validation and other matters is contained in Appendix B. Due to length and other considerations Appendix B is only available upon request.

Each model sector is represented first via a visual overview of the structure followed by the complete list of equations for that sector. Overall simulation control parameters are:

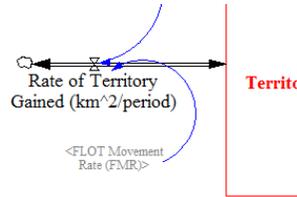
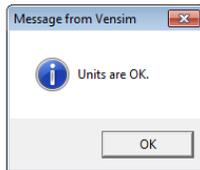
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.isis conference proceedings model
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### Simulation Control Parameters

- (415) FINAL TIME = 2020  
Units: Period  
The final time for the simulation.
- (416) INITIAL TIME = 2013  
Units: Period  
The initial time for the simulation.
- (417) SAVEPER = TIME STEP  
Units: Period [0,?]  
The frequency with which output is stored.
- (418) TIME STEP = 0.0055  
Units: Period [0,?]  
The time step for the simulation.

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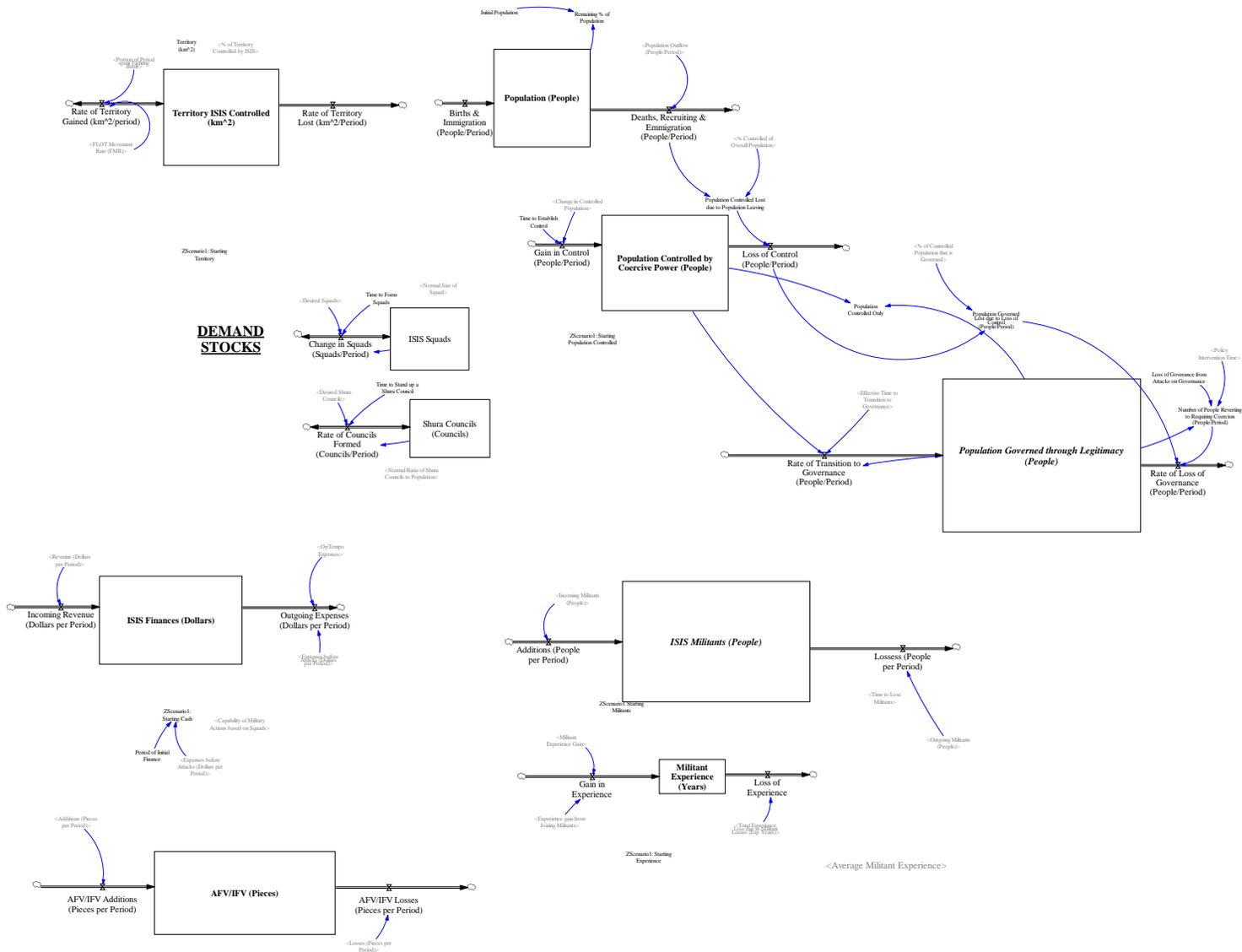
## Units Consistency Check for Model:



## SCENARIO CONTROLS

Baseline Switch  
(1 = On)

# Strategic Architecture Resource Stocks



### ***Resource Strategy Map Sector Equations***

(001) "% Controlled of Overall Population" = ZIDZ ( "Population Controlled by Coercive Power (People)" , "Population (People)" )  
Units: Fraction

(008) "% of Controlled Population that is Governed" = ZIDZ ( "Population Governed through Legitimacy (People)" , "Population Controlled by Coercive Power (People)" )  
Units: Fraction

(013) "% of Territory Controlled by ISIS" = "Territory ISIS Controlled (km<sup>2</sup>)" / "Territory (km<sup>2</sup>)"  
Units: Percentage

(017) "Additions (People per Period)" = "Incoming Militants (People)"  
Units: People/Period

(022) "AFV/IFV (Pieces)" = INTEG( "AFV/IFV Additions (Pieces per Period)" - "AFV/IFV Losses (Pieces per Period)" , 0)  
Units: Pieces

(023) "AFV/IFV Additions (Pieces per Period)" = "Additions (Pieces per Period)"  
Units: Pieces/Period

(024) "AFV/IFV Losses (Pieces per Period)" = MAX ( 0, "Losses (Pieces per Period)" )  
Units: Pieces/Period

(027) Average Militant Experience = ZIDZ ( "Militant Experience (Years)" , "ISIS Militants (People)" )  
Units: Exp Years/Person

(029) "Births & Immigration (People/Period)" = 0  
Units: People/Period

(031) "Additions (Pieces per Period)" = "AFV/IFV Looted"  
Units: Pieces/Period

(042) "Baseline Switch (1 = On) 1" = 1  
Units: Dmnl

(048) "Black Market Price per Barrel (Price per Barrel)" = 45  
Units: Dollars/Barrels

See Appendix B for parameterization method.

(071) Capability of Military Actions based on Squads = ISIS Squads \* Normal Military Capability of Squads  
Units: Military Actions/Period

- (073) Change in Controlled Population = ISIS Controlled Population - "Population Controlled by Coercive Power (People)"  
Units: People
- (074) "Change in Squads (Squads/Period)" = ( Desired Squads - ISIS Squads ) / Time to Form Squads  
Units: Squads/Period
- (096) "Deaths, Recruiting & Emmigration (People/Period)" = "Population Outflow (People/Period)"  
Units: People/Period
- (100) Desired Shura Councils = ( "Population Governed through Legitimacy (People)" + Ungoverned Population ) / Normal Ratio of Shura Councils to Population  
Units: Councils
- (101) Desired Squads = ( "ISIS Militants (People)" - Actual Garrison ) / Normal Size of Squad  
Units: Squads
- (107) "Gain in Control (People/Period)" = Change in Controlled Population / Time to Establish Control  
Units: People/Period
- (108) Gain in Experience = Experience gain from Joining Militants + Militant Experience Gain  
Units: Exp Years/Period
- (111) "ISIS Militants (People)" = INTEG( "Additions (People per Period)" - "Lossess (People per Period)" , ZScenario1 Starting Militants )  
Units: People
- (112) "Loss of Control (People/Period)" = Population Controlled Lost due to Population Leaving  
Units: People/Period
- (113) Loss of Experience = "Total Experience Loss due to Militant Losses (Exp Years)"  
Units: Exp Years/Period
- (114) "Lossess (People per Period)" = MAX ( 0, "Outgoing Militants (People)" )  
Units: People/Period  
Fix max function with different first order control. MAX(0,("ISIS Militants (People)"-"Outgoing Militants (People)"/Time to Lose Militants)
- (115) "Militant Experience (Years)" = INTEG( Gain in Experience - Loss of Experience , "ZScenario1: Starting Experience" )  
Units: Exp Years
- (126) Disable FLOT = 1  
Units: Dmnl

Used to test Proposition 1. Normal value =1 , disabled value = 0.

(128) Disable Local Recruiting = 1

Units: Dmnl

Normal value is 1, set to 0 to test Proposition 4.

(130) Disable Oil = 1

Units: Barrels/Period

Used for Proposition 2 - normal value =1, disabled value = 0

(145) Effective Time to Transition to Governance = Normal Time to Transition to Governance \* Effect of Shura Council Sufficiency on Transition to Governance

Units: Period

(146) "Embed US Advisors (Experience)" = 0

Units: Exp Years

0 is normal. 1 is the increase in average Exp Years due to having US troops embedded.

(147) "Embed US Advisors (Morale)" = 0

Units: Dmnl

0 is normal. .25 is nominal additional morale factor for US troops being embedded.

(155) "Expenses before Attacks (Dollars per Period)" = "Administration & Governance Expense (Dollars per Period)" + "Death Benefits (Dollars per Period)" + "Detention Benefits (Dollars per Period)" + "Media Border Security & Other Expenses (Dollars per Period)"

+ "Military Procurement (Dollars per Period)" + "Payroll (Dollars per Period)"

Units: Dollars/Period

(158) Experience gain from Joining Militants = ( Average Experience of Escaped Detainee \* "Escaped Detainees Joining ISIS (People)" ) + ( "Foreign Recruiting (People)" \* Average Experience of Foreign Recruit ) + ( "Local Recruiting (People)" \* Average Experience of Local Recruit

)  
Units: Exp Years/Period

(160) "FLOT Movement Rate (FMR)" = ( ( ( FMR Base1 + FMR Base2 ) \* "High Intensity FLOT Movement Rate (FMR) Multiplier" ) \* Disable FLOT ) \* Movement Direction

Units: "km^2"

(164) Foreign Recruiting Eliminated = 1

Units: Dmnl

Normal is 1. 0 means foreign recruiting is completely eliminated.

(172) "Incoming Militants (People)" = "Local Recruiting (People)" + "Foreign Recruiting (People)" + "Escaped Detainees Joining ISIS (People)"

Units: People/Period

(173) "Incoming Revenue (Dollars per Period)" = "Revenue (Dollars per Period)"

Units: Dollars/Period

(186) Initial Population = 3.99671e+007

Units: People

(191) "ISIS Finances (Dollars)" = INTEG( "Incoming Revenue (Dollars per Period)" - "Outgoing Expenses (Dollars per Period)" , "ZScenario1: Starting Cash" )

Units: Dollars

("Baseline Switch (1 = On)"\*(Capability of Military Actions based on Squads\*Cost per Attack))+("Scenario 1 Switch (1 = On)"\*"ZScenario1: Starting Cash")

(196) ISIS Squads = INTEG( "Change in Squads (Squads/Period)" , "ISIS Militants (People)" / Normal Size of Squad )

Units: Squads

Initialized at the starting Initial Number of Militants divided by the Normal Size of Squads

(205) Loss of Governance from Attacks on Governance = 0

Units: Dmnl/(Period\*Period)

Expressed as a Ramping percentage of the governing functions eliminated over time, 10% is minimal air campaign, 25% is significant air campaign and 50% is intensive air campaign.

(206) "Losses (Pieces per Period)" = "Lost in Battle (Pieces per Period)" + "Lost to Maintenance (Pieces per Period)"

Units: Pieces/Period

(215) Militant Experience Gain = "ISIS Militants (People)" \* Experience gained per Period

Units: Exp Years/Period

(229) Normal Ratio of Shura Councils to Population = 100000

Units: People/Council

TBD

(231) Normal Size of Squad = 11

Units: People/Squad

(232) Normal Time to Transition to Governance = 1 \* ( 1 + STEP ( Reduction in Time to Transition to Governance , Policy Intervention Time ) )

Units: Period

The Normal Time to transition from Controlled to Governance is 1 period, or 6 months. This is estimated based on the time it took ISIS to establish governance in Ar Raqqa city from March 2013 to June 2013. The Normal time to Transition to

Governance is modified by other factors to determine the Effective time to Transition.

(234) "Number of People Reverting to Requiring Coercion (People/Period)" = "Population Governed through Legitimacy (People)" \* ( 0 + ( RAMP ( Loss of Governance from Attacks on Governance , Policy Intervention Time , 2020) ) )  
Units: People/Period

(237) OpTempo Expenses = Actual Military Actions \* Cost per Military Action  
Units: Dollars/Period

(239) "Outgoing Expenses (Dollars per Period)" = MAX ( 0, ( "Expenses before Attacks (Dollars per Period)" + OpTempo Expenses ) )  
Units: Dollars/Period  
$$\text{MAX}(0, \text{"ISIS Finances (Dollars)" - ("Expenses before Attacks (Dollars per Period)" + OpTempo Expenses)})$$

(240) "Outgoing Militants (People)" = "Deaths (People/Period)" + "Defections (People)" + "Detentions (People)"  
Units: People/Period

(244) Period of Initial Finance = 1  
Units: Period

(246) Policy Intervention Time = 0  
Units: Period

(247) "Population (People)" = INTEG( "Births & Immigration (People/Period)" - "Deaths, Recruiting & Emmigration (People/Period)" , Initial Population )  
Units: People

Combined population of all Syrian and Iraqi Provinces.  
"Provinces of Syria", Administrative Divisions of Countries, Statoids, last modified September 22, 2004, accessed September 19th, 2014, <http://www.statoids.com/usy.html>.  
"Provinces of Iraq", Administrative Divisions of Countries, Statoids, last modified March 16, 2014, accessed September 19th, 2014, <http://www.statoids.com/uiq.html>.

(248) "Population Controlled by Coercive Power (People)" = INTEG( "Gain in Control (People/Period)" - "Loss of Control (People/Period)" , "ZScenario1: Starting Population Controlled" )  
Units: People

(249) Population Controlled Lost due to Population Leaving = "Deaths, Recruiting & Emmigration (People/Period)" \* "% Controlled of Overall Population"  
Units: People/Period

(250) Population Controlled Only = "Population Controlled by Coercive Power (People)" - "Population Governed through Legitimacy (People)"

Units: People

(251) "Population Governed Lost due to Loss of Control (People/Period)" = "Loss of Control (People/Period)" \* "% of Controlled Population that is Governed"

Units: People/Period

(252) "Population Governed through Legitimacy (People)" = INTEG( "Rate of Transition to Governance (People/Period)" - "Rate of Loss of Governance (People/Period)" , 0)

Units: People

(253) "Population Outflow (People/Period)" = "Civilian Deaths (People/Period)" + "Local Recruiting (People)" + "Refugees Leaving (People/Period)"

Units: People/Period

(254) Portion of Period spent Fighting Battle = 0.0055

Units: Period

(256) "Proposition Switch (1 = On) 0" = 1

Units: Dmnl

(258) Ransom Elimination = 0

Units: Dmnl

Normal value is 1. 0 means all ransom is eliminated.

(267) "Rate of Territory Gained (km<sup>2</sup>/period)" = "FLOT Movement Rate (FMR)" / Portion of Period spent Fighting Battle

Units: "km<sup>2</sup>"/Period

(268) "Rate of Territory Lost (km<sup>2</sup>/Period)" = 0

Units: "km<sup>2</sup>"/Period

(270) "Rate of Loss of Governance (People/Period)" = "Population Governed Lost due to Loss of Control (People/Period)" + "Number of People Reverting to Requiring Coercion (People/Period)"

Units: People/Period

(277) "Rate of Councils Formed (Councils/Period)" = ( Desired Shura Councils - "Shura Councils (Councils)" ) / Time to Stand up a Shura Council

Units: Councils/Period

(278) "Rate of Transition to Governance (People/Period)" = ( "Population Controlled by Coercive Power (People)" - "Population Governed through Legitimacy (People)" ) / Effective Time to Transition to Governance

Units: People/Period

(290) Reduction in Time to Transition to Governance = 0

Units: Period

0 is normal, 100 eliminates transition via airpower attacks

(295) "Remaining % of Population" = "Population (People)" / Initial Population  
Units: Percentage

(297) "Revenue (Dollars per Period)" = "Donations (Dollars per Period)" + "Pre Donations Revenue (Dollars per Period)"  
Units: Dollars/Period

(332) "Shura Councils (Councils)" = INTEG( "Rate of Councils Formed (Councils/Period)" ,  
"Population Governed through Legitimacy (People)" / Normal Ratio of Shura Councils to Population )  
Units: Councils  
Initialized at the Starting Governed Population / Normal ratio of Shura Councils

(339) Strikes per Day against Oil = 0  
Units: Strikes/Period  
Normal value is 0. Minimal is 10, Significant is 100 intensive is 500.

(374) "Territory (km<sup>2</sup>)" = 619308  
Units: "km<sup>2</sup>"

Includes all Provinces and Governates of Iraq and Syria.  
"Provinces of Syria", Administrative Divisions of Countries, Statoids, last modified September 22, 2004, accessed September 19th, 2014, <http://www.statoids.com/usy.html>.  
"Provinces of Iraq", Administrative Divisions of Countries, Statoids, last modified March 16, 2014, accessed September 19th, 2014, <http://www.statoids.com/uiq.html>.

(375) "Territory ISIS Controlled (km<sup>2</sup>)" = INTEG( "Rate of Territory Gained (km<sup>2</sup>/period)" - "Rate of Territory Lost (km<sup>2</sup>/Period)" , "ZScenario1: Starting Territory" )  
Units: "km<sup>2</sup>"

(382) Time to Establish Control = 1  
Units: Period

(383) Time to Form Squads = 0.16  
Units: Period

Ceylan Yeginsu, "ISIS Draws a Steady Stream of Recruits from Turkey,"  
[nytimes.com, http://www.nytimes.com/2014/09/16/world/europe/turkey-is-a-steady-source-of-isis-recruits.html](http://www.nytimes.com/2014/09/16/world/europe/turkey-is-a-steady-source-of-isis-recruits.html), accessed October 25, 2014. (CHECK LONGER TRAINING PERIOD)

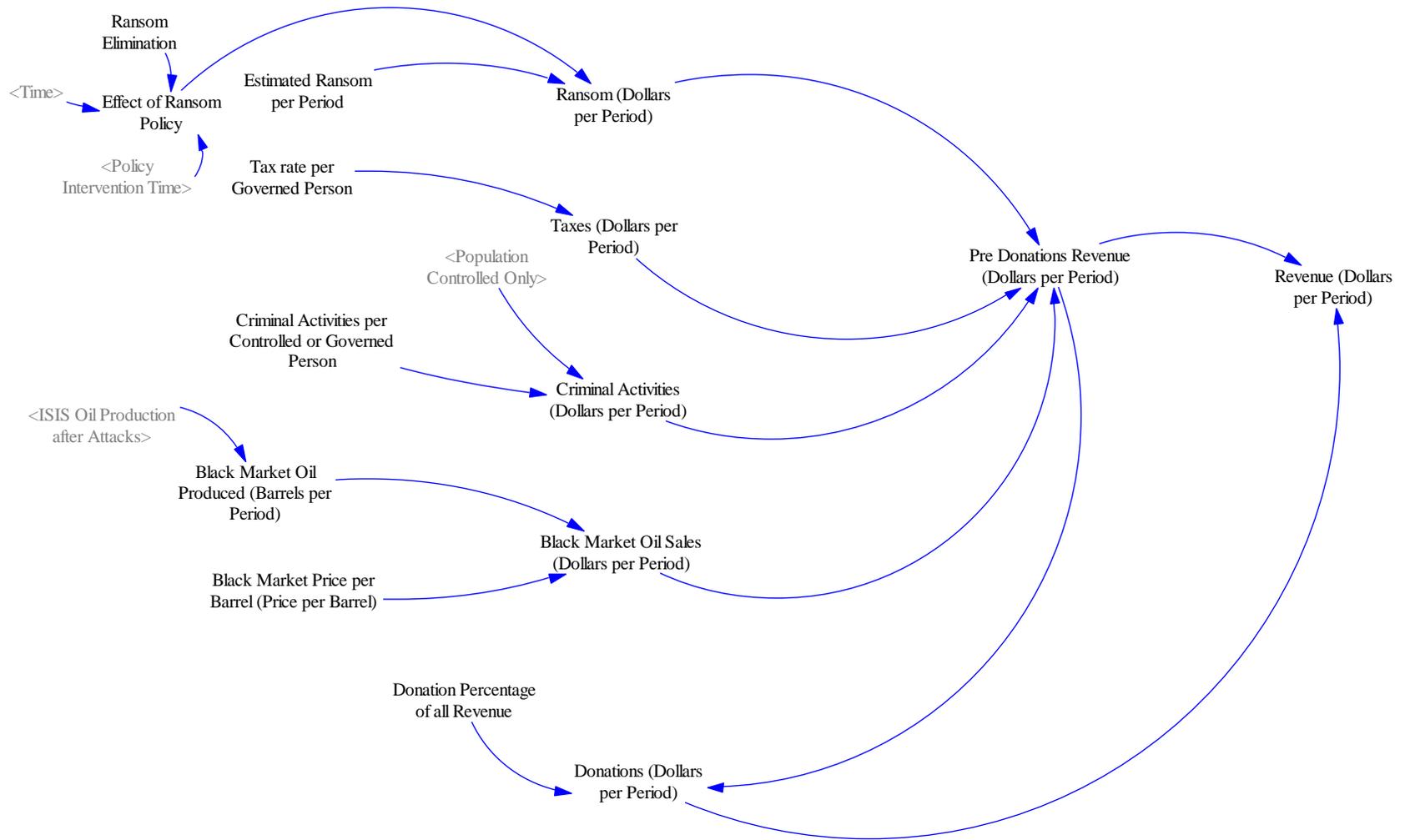
(384) Time to Lose Militants = 1  
Units: Period

(388) Time to Stand up a Shura Council = 0.5  
Units: Period

Estimated need source.

- (391) "Total Experience Loss due to Militant Losses (Exp Years)" = ( Average Militant Experience \* "Outgoing Militants (People)" )  
Units: Exp Years/Period
- (398) US Airpower Support Step Height = 0  
Units: Dmnl  
1 is normal. 1.01 is minimal, 1.10 is significant and 1.5 is intensive.
- (399) USEquipmentModifier = 0  
Units: Dmnl/Assets
- (402) ZScenario1 Starting Militants = 13200  
Units: People
- (403) "ZScenario1: Starting Cash" = Period of Initial Finance \* ( 5e+006 + ( "Expenses before Attacks (Dollars per Period)" \* 4) )  
Units: Dollars
- (404) "ZScenario1: Starting Experience" = 39928  
Units: Exp Years  
2824 Escaped Detainees @ 10 years experience (28,240), 2600 Local Fighters @ 3 Years Experience (7800), 7776 Foreign Fighters at .5 Experience (3888) = 39928
- (405) "ZScenario1: Starting Population Controlled" = 0  
Units: People
- (406) "ZScenario1: Starting Territory" = 0  
Units: "km^2"

# World Model: Revenue Structure



## ***World Model: Revenue Equations***

(046) "Black Market Oil Produced (Barrels per Period)" = ISIS Oil Production after Attacks

Units: Barrels/Period

Prior to US airstrikes ISIS was producing between 25,000-40,000 barrels of oil a day (BPD) across a dozen oil wells. See Appendix B for parameterization method.

(047) "Black Market Oil Sales (Dollars per Period)" = "Black Market Price per Barrel (Price per Barrel)" \* "Black Market Oil Produced (Barrels per Period)"

Units: Dollars/Period

(048) "Black Market Price per Barrel (Price per Barrel)" = 45

Units: Dollars/Barrels

See Appendix B for parameterization method.

(080) "Criminal Activities (Dollars per Period)" = Criminal Activities per Controlled or Governed Person \* ( Population Controlled Only + "Population Governed through Legitimacy (People)" )

Units: Dollars/Period

(081) Criminal Activities per Controlled or Governed Person = 2.76

Units: Dollars/(Period\*Person)

Converting these to \$/Person/Period works out from a range of \$1.62 to \$3.90/Person/Period for Population Controlled. Taken at midpoint. See Appendix B for parameterization method.

(132) Donation Percentage of all Revenue = 0.04

Units: Dmnl

See Appendix B for parameterization method.

(133) "Donations (Dollars per Period)" = "Pre Donations Revenue (Dollars per Period)" \* Donation Percentage of all Revenue

Units: Dollars/Period

(138) Effect of Ransom Policy = IF THEN ELSE ( Time > Policy Intervention Time , Ransom Elimination , 1)

Units: Dmnl

(150) Estimated Ransom per Period = 6e+006

Units: Dollars/Period

Assuming a simple \$2M/Month for ransoms results in \$6M/Period. See Appendix B for parameterization method.

(194) ISIS Oil Production after Attacks = ISIS Oil Production before Attacks - Effect of Attacks on Oil Production

Units: Barrels/Period

(246) Policy Intervention Time = 0

Units: Period

(250) Population Controlled Only = "Population Controlled by Coercive Power (People)" - "Population Governed through Legitimacy (People)"

Units: People

(252) "Population Governed through Legitimacy (People)" = INTEG( "Rate of Transition to Governance (People/Period)" - "Rate of Loss of Governance (People/Period)" , 0)

Units: People

(255) "Pre Donations Revenue (Dollars per Period)" = "Taxes (Dollars per Period)" + "Ransom (Dollars per Period)" + "Criminal Activities (Dollars per Period)" + "Black Market Oil Sales (Dollars per Period)"

Units: Dollars/Period

(257) "Ransom (Dollars per Period)" = Estimated Ransom per Period \* Effect of Ransom Policy

Units: Dollars/Period

(258) Ransom Elimination = 0

Units: Dmnl

Normal value is 1. 0 means all ransom is eliminated.

(297) "Revenue (Dollars per Period)" = "Donations (Dollars per Period)" + "Pre Donations Revenue (Dollars per Period)"

Units: Dollars/Period

(372) Tax rate per Governed Person = 15.995

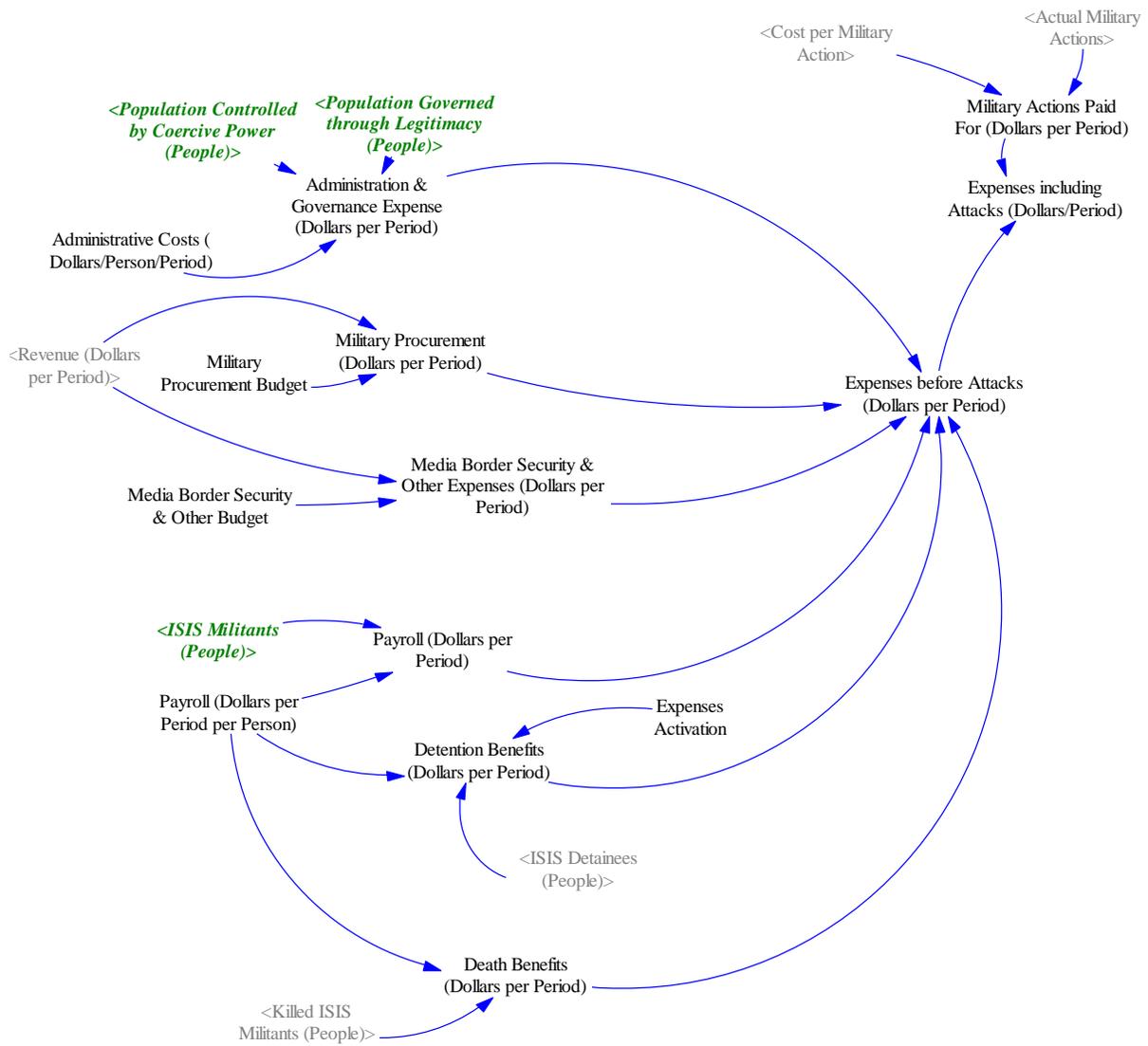
Units: Dollars/(Period\*Person)

Dividing this amount into the estimated Population governed for the 2014 Period results in a range from \$11.99-\$20 Person/Period for Population Governed. See Appendix B for parameterization method.

(373) "Taxes (Dollars per Period)" = Tax rate per Governed Person \* "Population Governed through Legitimacy (People)"

Units: Dollars/Period

# World Model: Expenses Structure



## ***World Model: Expense Equations***

(016) Actual Military Actions = IF THEN ELSE ( Capacity for Military Actions based on Budget > Capability of Military Actions based on Squads , Capability of Military Actions based on Squads , Capacity for Military Actions based on Budget )

Units: Military Actions/Period

(021) "Administrative Costs (Dollars/Person/Period)" = 0.185

Units: Dollars/(Period\*Person)

This implies a cost per ControlledPerson for overhead administration of \$.185 per ControlledPerson/Period. See Appendix B for parameterization method.

(032) "Administration & Governance Expense (Dollars per Period)" = ( "Population Governed through Legitimacy (People)" + "Population Controlled by Coercive Power (People)" ) \* "Administrative Costs (Dollars/Person/Period)"

Units: Dollars/Period

(079) Cost per Military Action = 2700

Units: Dollars/Military Action

Analysis showed that for each \$2700 transferred to a sector command, an AQI attack was launched. This cost includes not only direct costs of the attack, but indirect costs of all the other factors necessary for AQI to 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. RAND 57-69.

(093) "Death Benefits (Dollars per Period)" = "Killed ISIS Militants (People)" \* "Payroll (Dollars per Period per Person)"

Units: Dollars/Period

See Appendix B for parameterization method.

(102) "Detention Benefits (Dollars per Period)" = ( "ISIS Detainees (People)" \* "Payroll (Dollars per Period per Person)" ) \* ( 0 + Expenses Activation )

Units: Dollars/Period

See Appendix B for parameterization method.

(111) "ISIS Militants (People)" = INTEG( "Additions (People per Period)" - "Lossess (People per Period)" , ZScenario1 Starting Militants )

Units: People

(154) Expenses Activation = STEP ( 1, 2014)

Units: Dmnl

(155) "Expenses before Attacks (Dollars per Period)" = "Administration & Governance Expense (Dollars per Period)" + "Death Benefits (Dollars per Period)" + "Detention Benefits (Dollars per Period)" + "Media Border Security & Other Expenses (Dollars per Period)" + "Military Procurement (Dollars per Period)" + "Payroll (Dollars per Period)"  
Units: Dollars/Period

(156) "Expenses including Attacks (Dollars/Period)" = "Expenses before Attacks (Dollars per Period)" + "Military Actions Paid For (Dollars per Period)"  
Units: Dollars/Period

(190) "ISIS Detainees (People)" = INTEG( "Rate of Detentions (People/Period)" - "Rate of Escape or Release (People/Period)" , 2890)  
Units: People

Set as 0 update to final number at start

(199) "Killed ISIS Militants (People)" = INTEG( "Rate of Deaths (People/Period)" , 0)  
Units: People

Adjust initial level based on starting time of model.

(213) "Media Border Security & Other Budget" = 0.06  
Units: Dmnl

All other expenses were combined into a single bucket that amounts to 6% of all revenue. See Appendix B for parameterization method.

(214) "Media Border Security & Other Expenses (Dollars per Period)" = "Revenue (Dollars per Period)" \* "Media Border Security & Other Budget"  
Units: Dollars/Period

(217) "Military Actions Paid For (Dollars per Period)" = Cost per Military Action \* Actual Military Actions  
Units: Dollars/Period

(220) "Military Procurement (Dollars per Period)" = "Revenue (Dollars per Period)" \* Military Procurement Budget  
Units: Dollars/Period

(221) Military Procurement Budget = 0.1  
Units: Dmnl

According to the RAND analysis purchases related to military procurement – heavy weapons, ammunition, logistics and maintenance ran about 10% of all revenues. See Appendix B for parameterization method.

(241) "Payroll (Dollars per Period per Person)" = 366  
Units: Dollars/(Period\*Person)

Includes direct pay to militant of \$41/month and dependent (on average one) pay of \$20/month for \$61/month or \$366/period. See Appendix B for parameterization method.

(242) "Payroll (Dollars per Period)" = "ISIS Militants (People)" \* "Payroll (Dollars per Period per Person)"

Units: Dollars/Period

(248) "Population Controlled by Coercive Power (People)" = INTEG( "Gain in Control (People/Period)" - "Loss of Control (People/Period)" , "ZScenario1: Starting Population Controlled" )

Units: People

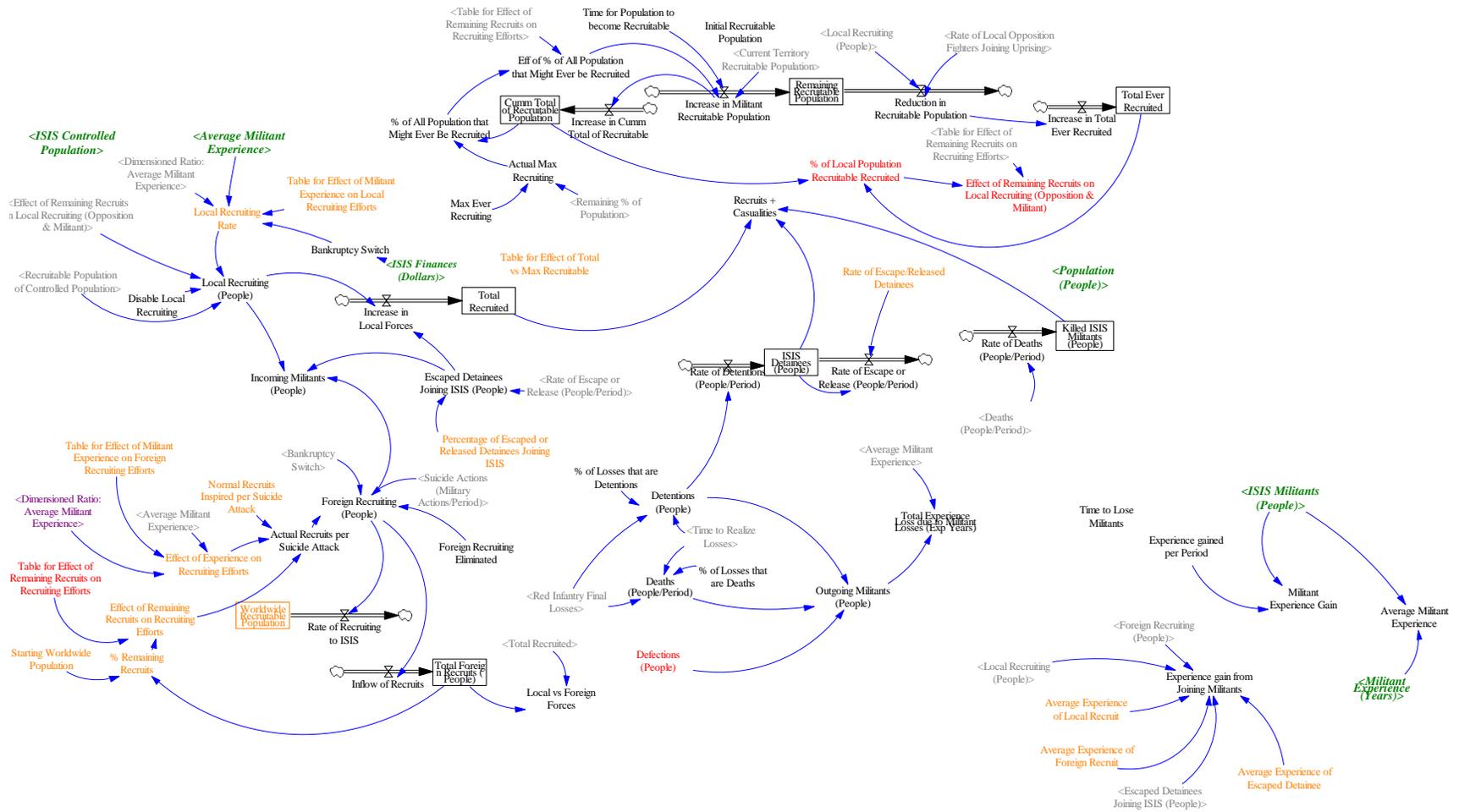
(252) "Population Governed through Legitimacy (People)" = INTEG( "Rate of Transition to Governance (People/Period)" - "Rate of Loss of Governance (People/Period)" , 0)

Units: People

(297) "Revenue (Dollars per Period)" = "Donations (Dollars per Period)" + "Pre Donations Revenue (Dollars per Period)"

Units: Dollars/Period

# World Model: Militant Recruiting & Loss



### ***World Model: Militant Recruiting & Loss Equations***

(006) "% of All Population that Might Ever Be Recruited" = Cumm Total of Recruitable Population / Actual Max Recruiting  
Units: Percentage

(010) "% of Local Population Recruitable Recruited" = ZIDZ ( Total Ever Recruited , Cumm Total of Recruitable Population )  
Units: Percentage

(011) "% of Losses that are Deaths" = 0.43  
Units: Fraction  
Derived from research need to finalize.

(012) "% of Losses that are Detentions" = 0.57  
Units: Fraction  
Derived from research. Need to confirm with causal factors.

(014) "% Remaining Recruits" = "Total Foreign Recruits (People)" / Starting Worldwide Population  
Units: Percentage  
Estimated parameter from data or nearby model structure see Appendix B for discussion.

(015) Actual Max Recruiting = Max Ever Recruiting \* "Remaining % of Population"  
Units: People

(020) Actual Recruits per Suicide Attack = Normal Recruits Inspired per Suicide Attack \* Effect of Experience on Recruiting Efforts \* Effect of Remaining Recruits on Recruiting Efforts  
Units: People/Military Action

(027) Average Militant Experience = ZIDZ ( "Militant Experience (Years)" , "ISIS Militants (People)" )  
Units: Exp Years/Person

(028) Bankruptcy Switch = IF THEN ELSE ( "ISIS Finances (Dollars)" < -100000, 0, 1 )  
Units: Dmnl

(039) Average Experience of Escaped Detainee = 10  
Units: Exp Years/Person  
Set at 10 need actual vaule to finish.

(040) Average Experience of Foreign Recruit = 1  
Units: Exp Years/Person  
Set at 1 update for final.

(041) Average Experience of Local Recruit = 3

Units: Exp Years/Person  
Set at 3 update for final.

- (085) Cumm Total of Recruitable Population = INTEG( Increase in Cumm Total of Recruitable , 0)  
Units: People
- (088) Current Territory Recruitable Population = "ZScenario1: Table for Cumm Total Recruitable Population based on Location of ISIS on Map" ( Current Location of ISIS on Territorial Map )  
Units: People
- (110) ISIS Controlled Population = "ZScenario1: Table for Percentage of Population Controlled Based on Location of ISIS on Territorial Map" ( Current Location of ISIS on Territorial Map ) \* Total Population  
Units: People
- (111) "ISIS Militants (People)" = INTEG( "Additions (People per Period)" - "Lossess (People per Period)", ZScenario1 Starting Militants )  
Units: People
- (115) "Militant Experience (Years)" = INTEG( Gain in Experience - Loss of Experience , "ZScenario1: Starting Experience" )  
Units: Exp Years
- (117) "Deaths (People/Period)" = ( Red Infantry Final Losses \* "% of Losses that are Deaths" ) / Time to Realize Losses  
Units: People/Period
- (118) "Defections (People)" = 0  
Units: People/Period  
Modeler assumption, not used in current version. See Appendix B for discussion.
- (120) "Detentions (People)" = ( Red Infantry Final Losses \* "% of Losses that are Detentions" ) / Time to Realize Losses  
Units: People/Period
- (121) "Dimensioned Ratio: Average Militant Experience" = 1  
Units: Person/Exp Years
- (128) Disable Local Recruiting = 1  
Units: Dmnl  
Normal value is 1, set to 0 to test Proposition 4.
- (129) "Eff of % of All Population that Might Ever be Recruited" = Table for Effect of Remaining Recruits on Recruiting Efforts ( "% of All Population that Might Ever Be Recruited" )  
Units: Percentage

(135) Effect of Experience on Recruiting Efforts = Table for Effect of Militant Experience on Foreign Recruiting Efforts ( Average Militant Experience \* "Dimensioned Ratio: Average Militant Experience" )  
Units: Dmnl

Estimated parameter from data or nearby model structure see Appendix B for discussion.

(139) "Effect of Remaining Recruits on Local Recruiting (Opposition & Militant)" = Table for Effect of Remaining Recruits on Recruiting Efforts ( "% of Local Population Recruitable Recruited" )  
Units: Dmnl

(140) Effect of Remaining Recruits on Recruiting Efforts = Table for Effect of Remaining Recruits on Recruiting Efforts ( "% Remaining Recruits" )  
Units: Dmnl

Estimated parameter from data or nearby model structure see Appendix B for discussion.

(149) "Escaped Detainees Joining ISIS (People)" = "Rate of Escape or Release (People/Period)" \* Percentage of Escaped or Released Detainees Joining ISIS  
Units: People/Period

(158) Experience gain from Joining Militants = ( Average Experience of Escaped Detainee \* "Escaped Detainees Joining ISIS (People)" ) + ( "Foreign Recruiting (People)" \* Average Experience of Foreign Recruit ) + ( "Local Recruiting (People)" \* Average Experience of Local Recruit )  
Units: Exp Years/Period

(159) Experience gained per Period = 0.5  
Units: Exp Years/(Period\*Person)

(163) "Foreign Recruiting (People)" = ( ( Actual Recruits per Suicide Attack \* "Suicide Actions (Military Actions/Period)" ) \* Foreign Recruiting Eliminated ) \* Bankruptcy Switch  
Units: People/Period

(164) Foreign Recruiting Eliminated = 1  
Units: Dmnl

Normal is 1. 0 means foreign recruiting is completely eliminated.

(172) "Incoming Militants (People)" = "Local Recruiting (People)" + "Foreign Recruiting (People)" + "Escaped Detainees Joining ISIS (People)"  
Units: People/Period

(178) Increase in Cumm Total of Recruitable = Increase in Militant Recruitable Population  
Units: People/Period

(180) Increase in Local Forces = ( "Local Recruiting (People)" + "Escaped Detainees Joining ISIS (People)" )

Units: People/Period

(181) Increase in Militant Recruitable Population = ( Current Territory Recruitable Population \* "Eff of % of All Population that Might Ever be Recruited" ) / Time for Population to become Recruitable

Units: People/Period

(182) Increase in Total Ever Recruited = Reduction in Recruitable Population

Units: People/Period

(185) Inflow of Recruits = "Foreign Recruiting (People)"

Units: People/Period

(187) Initial Recruitable Population = 50662

Units: People

Pull from the Scenario Builder Cumm Total of Recruitable Population.

(190) "ISIS Detainees (People)" = INTEG( "Rate of Detentions (People/Period)" - "Rate of Escape or Release (People/Period)" , 2890)

Units: People

Set as 0 update to final number at start

(191) "ISIS Finances (Dollars)" = INTEG( "Incoming Revenue (Dollars per Period)" - "Outgoing Expenses (Dollars per Period)" , "ZScenario1: Starting Cash" )

Units: Dollars

("Baseline Switch (1 = On)"\*(Capability of Military Actions based on Squads\*Cost per Attack))+("Scenario 1 Switch (1 = On)"\*"ZScenario1: Starting Cash")

(199) "Killed ISIS Militants (People)" = INTEG( "Rate of Deaths (People/Period)" , 0)

Units: People

Adjust initial level based on starting time of model.

(202) "Local Recruiting (People)" = ( Recruitable Population of Controlled Population \* Local Recruiting Rate \* "Effect of Remaining Recruits on Local Recruiting (Opposition & Militant)" ) \* Disable Local Recruiting

Units: People/Period

Must have territorial control to begin local recruiting.

(203) Local Recruiting Rate = Table for Effect of Militant Experience on Local Recruiting Efforts ( Average Militant Experience \* "Dimensioned Ratio: Average Militant Experience" ) \* Bankruptcy Switch

Units: Fraction

Derived from AQI implied local recruiting patterns. Estimated parameter from data or nearby model structure see Appendix B for discussion.

(204) Local vs Foreign Forces = ZIDZ ( Total Recruited , ( Total Recruited + "Total Foreign Recruits (People)" ) )

Units: Percentage

(209) Max Ever Recruiting = 3.39502e+006

Units: People

(215) Militant Experience Gain = "ISIS Militants (People)" \* Experience gained per Period

Units: Exp Years/Period

(230) Normal Recruits Inspired per Suicide Attack = 18

Units: People/Military Action

Estimated 26 recruits per suicide attack that is then propogandized. This may represent higher end of a nonlinear curve based on media proficiency. Estimated parameter from data or nearby model structure see Appendix B for discussion.

(240) "Outgoing Militants (People)" = "Deaths (People/Period)" + "Defections (People)" + "Detentions (People)"

Units: People/Period

(243) Percentage of Escaped or Released Detainees Joining ISIS = 1

Units: Fraction

Set at 1 check estiamte for final.

(247) "Population (People)" = INTEG( "Births & Immigration (People/Period)" - "Deaths, Recruiting & Emmigration (People/Period)" , Initial Population )

Units: People

Combined population of all Syrian and Iraqi Provinces.

“Provinces of Syria”, Administrative Divisions of Countries, Statoids, last modified September 22, 2004, accessed September 19th, 2014, <http://www.statoids.com/usy.html>.

“Provinces of Iraq”, Administrative Divisions of Countries, Statoids, last modified March 16, 2014, accessed September 19th, 2014, <http://www.statoids.com/uiq.html>.

(252) "Population Governed through Legitimacy (People)" = INTEG( "Rate of Transition to Governance (People/Period)" - "Rate of Loss of Governance (People/Period)" , 0)

Units: People

(262) "Rate of Deaths (People/Period)" = "Deaths (People/Period)"

Units: People/Period

(263) "Rate of Detentions (People/Period)" = "Detentions (People)"

Units: People/Period

(264) "Rate of Escape or Release (People/Period)" = "ISIS Detainees (People)" \* "Rate of Escape/Released Detainees"

Units: People/Period

(265) "Rate of Escape/Released Detainees" = 0.5

Units: 1/Period

Estimated parameter from data or nearby model structure see Appendix B for discussion.

(266) Rate of Local Opposition Fighters Joining Uprising = Diehards joining Uprising + ( Effect of Ungarrison Ratio on Recruiting Rate \* Current Territory Recruitable Population ) / Time for Uprising to Form

Units: People/Period

(271) Rate of Recruiting to ISIS = "Foreign Recruiting (People)"

Units: People/Period

(273) Recruitable Population of Controlled Population = "ZScenario1: Table for Recruitable Population based on Location of ISIS on Territorial Map" ( Current Location of ISIS on Territorial Map )

Units: People/Period

(274) "Recruits + Casualties" = "ISIS Detainees (People)" + "Killed ISIS Militants (People)" + Total Recruited

Units: People

(285) Red Infantry Final Losses = ( Red Infantry Initial Losses - ( Red Infantry Initial Losses \* "Infantry Recovery (People/Period)" ) )

Units: People

(289) Reduction in Recruitable Population = "Local Recruiting (People)" + Rate of Local Opposition Fighters Joining Uprising

Units: People/Period

(295) "Remaining % of Population" = "Population (People)" / Initial Population

Units: Percentage

(296) Remaining Recruitable Population = INTEG( Increase in Militant Recruitable Population - Reduction in Recruitable Population , Initial Recruitable Population )

Units: People

(337) Starting Worldwide Population = 100000

Units: People

Estimated parameter from data or nearby model structure see Appendix B for discussion.

(343) "Suicide Actions (Military Actions/Period)" = Actual Military Actions \* "% of Actions that are Suicide Attacks"

Units: Military Actions/Period

(351) Table for Effect of Militant Experience on Foreign Recruiting Efforts ( [(0,0)-(10,2)],(0,0.5),(1,0.75),(2,0.9),(3,1),(4,1.25),(5,1.5),(10,1.5) )

Units: Dmnl

Estimated parameter from data or nearby model structure see Appendix B for discussion.

(352) Table for Effect of Militant Experience on Local Recruiting Efforts ( [(0,0)-(10,0.3)],(0,0.01),(1,0.03),(2,0.06),(3,0.09),(4,0.11),(5,0.12),(10,0.12) )

Units: Fraction

Estimated parameter from data or nearby model structure see Appendix B for discussion.

(356) Table for Effect of Remaining Recruits on Recruiting Efforts ( [(0,0)-(10,1)],(0,1),(0.1,1),(0.2,1),(0.3,1),(0.4,1),(0.5,1),(0.6,0.95),(0.7,0.85),(0.8,0.65),(0.9,0.25),(0.95,0.15),(0.97,0.07),(0.99,0.01),(1,0),(1,0),(2,0),(10,0) )

Units: Dmnl

Parameter is based on modeler assumption, see Appendix B for discussion.

(361) Table for Effect of Total vs Max Recrutable ( [(0,0)-(1,1)],(0,1),(0.1,1),(0.2,1),(0.3,1),(0.4,1),(0.5,1),(0.6,0.95),(0.7,0.85),(0.8,0.65),(0.9,0.25),(0.95,0.15),(0.97,0.07),(0.99,0.01),(1,0),(1,0) )

Units: Dmnl

(378) Time for Population to become Recrutable = 1

Units: Period

(384) Time to Lose Militants = 1

Units: Period

(385) Time to Realize Losses = 1

Units: Period

(390) Total Ever Recruited = INTEG( Increase in Total Ever Recruited , 0)

Units: People

(391) "Total Experience Loss due to Militant Losses (Exp Years)" = ( Average Militant Experience \* "Outgoing Militants (People)" )

Units: Exp Years/Period

(392) "Total Foreign Recruits (People)" = INTEG( Inflow of Recruits , 0)

Units: People

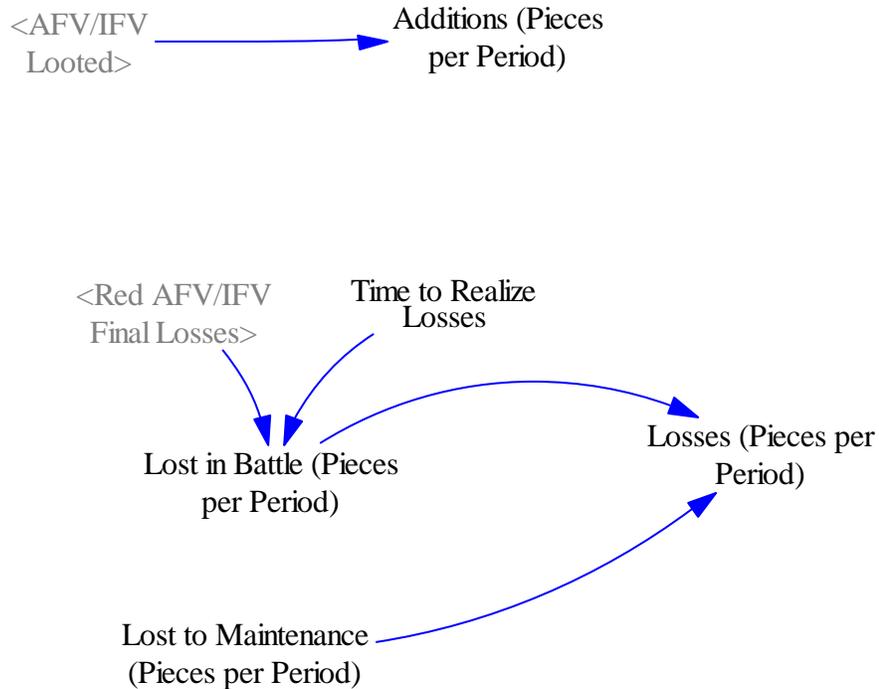
(394) Total Recruited = INTEG( Increase in Local Forces , 0)

Units: People

(400) Worldwide Recruitable Population = INTEG( - Rate of Recruiting to ISIS , Starting Worldwide Population )  
Units: People

## World Model: AFV/IFV Structure

AFV/IFV Purchased  
(Pieces per Period)



## World Model: AFV/IFV Equations

(018) "AFV/IFV Looted" = ( ( Blue HW Initial Losses \* Scavenging Rate of Heavy Weapons ) + ( Blue Artillery Initial Losses \* Scavenging Rate of Heavy Weapons ) ) / "Time to Repair & Operate"  
Units: Pieces/Period

(025) "AFV/IFV Purchased (Pieces per Period)" = 0  
Units: Pieces/Period

Not used in current model. In the current model ISIS can only scavenge AFV/IFV and cannot acquire heavy weapons.

(031) "Additions (Pieces per Period)" = "AFV/IFV Looted"  
Units: Pieces/Period

(206) "Losses (Pieces per Period)" = "Lost in Battle (Pieces per Period)" + "Lost to Maintenance (Pieces per Period)"  
Units: Pieces/Period

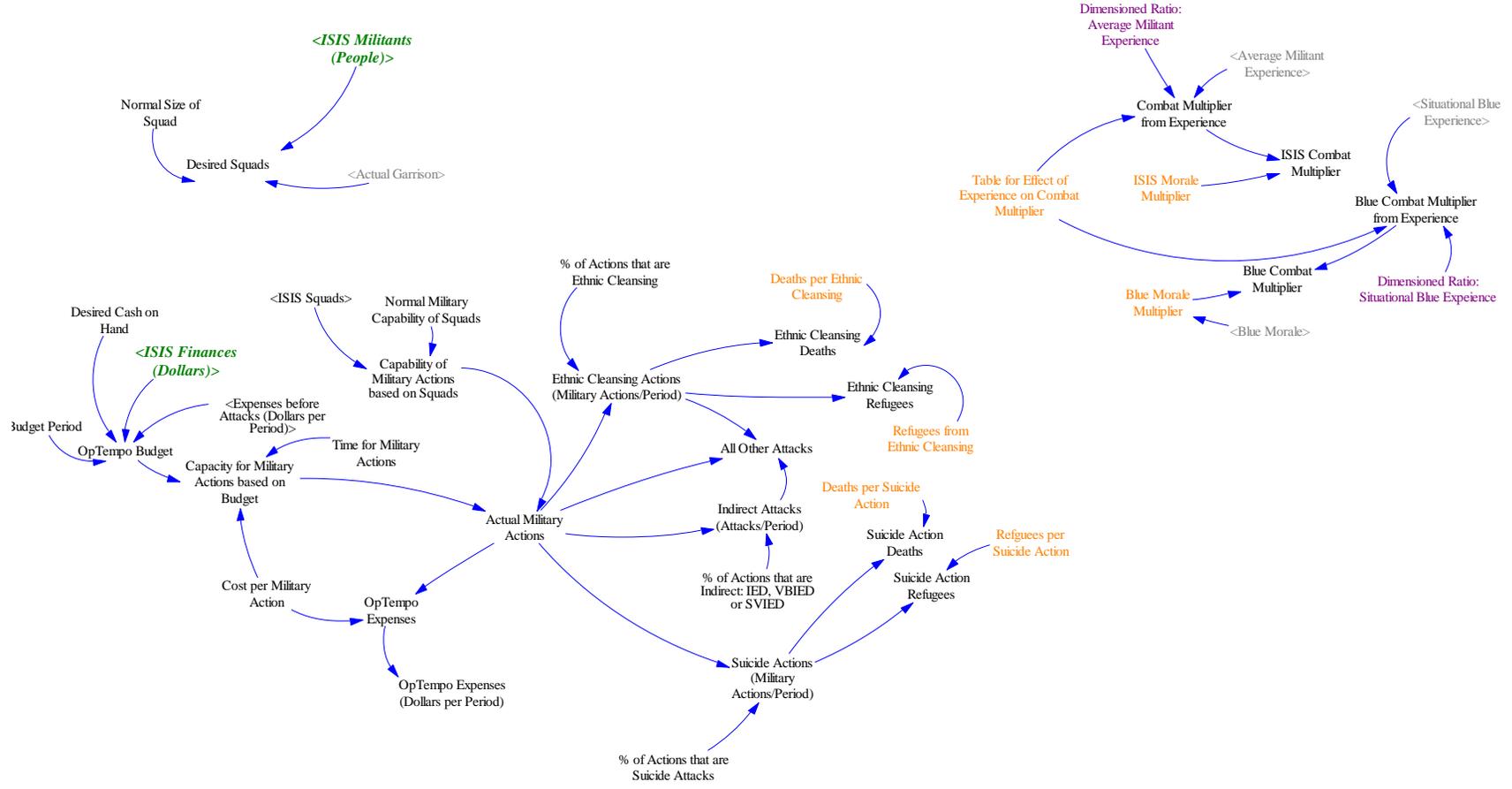
(207) "Lost in Battle (Pieces per Period)" = "Red AFV/IFV Final Losses" / Time to Realize Losses  
Units: Pieces/Period

(208) "Lost to Maintenance (Pieces per Period)" = 0  
Units: Pieces/Period

(275) "Red AFV/IFV Final Losses" = ( Red HW Initial Losses - ( Red HW Initial Losses \* HW Recovery ) )  
Units: Pieces

(385) Time to Realize Losses = 1  
Units: Period

# SubSystem: Military Action OpTempo



### ***OpTempo Attacks Sector Equations***

(003) "% of Actions that are Ethnic Cleansing" = 0.1  
Units: Percentage

(004) "% of Actions that are Indirect: IED, VBIED or SVIED" = 0.1  
Units: Percentage

(005) "% of Actions that are Suicide Attacks" = 0.1  
Units: Percentage

(016) Actual Military Actions = IF THEN ELSE ( Capacity for Military Actions based on Budget > Capability of Military Actions based on Squads , Capability of Military Actions based on Squads , Capacity for Military Actions based on Budget )  
Units: Military Actions/Period

(019) Actual Garrison = MIN ( "Desired Garrison & Police Forces" , Max Garrison Allocation )  
Units: People

(027) Average Militant Experience = ZIDZ ( "Militant Experience (Years)" , "ISIS Militants (People)" )  
Units: Exp Years/Person

(033) All Other Attacks = Actual Military Actions - "Ethnic Cleansing Actions (Military Actions/Period)" - "Indirect Attacks (Attacks/Period)"  
Units: Military Actions/Period

(053) Blue Combat Multiplier = 1 + ( Blue Morale Multiplier + Blue Combat Multiplier from Experience )  
Units: Dmnl

(054) Blue Combat Multiplier from Experience = Table for Effect of Experience on Combat Multiplier ( Situational Blue Experience \* "Dimensioned Ratio: Situational Blue Experience" )  
Units: Dmnl

Table for Effect of Experience on Combat Multiplier(Average Blue Experience)

(068) Blue Morale = "ZScenario1: Table of Blue Morale Based on ISIS Location on Territorial Map" ( Current Location of ISIS on Territorial Map ) + Morale Effect  
Units: Dmnl

(069) Blue Morale Multiplier = Blue Morale  
Units: Dmnl

(070) Budget Period = 1  
Units: Period

- (071) Capability of Military Actions based on Squads = ISIS Squads \* Normal Military Capability of Squads  
Units: Military Actions/Period
- (072) Capacity for Military Actions based on Budget = ( OpTempo Budget / Cost per Military Action ) / Time for Military Actions  
Units: Military Actions/Period
- (077) Combat Multiplier from Experience = Table for Effect of Experience on Combat Multiplier ( Average Militant Experience \* "Dimensioned Ratio: Average Militant Experience" )  
Units: Dmnl
- (079) Cost per Military Action = 2700  
Units: Dollars/Military Action  
Analysis showed that for each \$2700 transferred to a sector command, an AQI attack was launched. This cost includes not only direct costs of the attack, but indirect costs of all the other factors necessary for AQI to 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. RAND 57-69.
- (094) Deaths per Ethnic Cleansing = 25  
Units: People/Military Action  
Check source.
- (095) Deaths per Suicide Action = 10  
Units: People/Military Action
- (098) Desired Cash on Hand = 250000  
Units: Dollars
- (101) Desired Squads = ( "ISIS Militants (People)" - Actual Garrison ) / Normal Size of Squad  
Units: Squads
- (111) "ISIS Militants (People)" = INTEG( "Additions (People per Period)" - "Lossess (People per Period)", ZScenario1 Starting Militants )  
Units: People
- (121) "Dimensioned Ratio: Average Militant Experience" = 1  
Units: Person/Exp Years
- (125) "Dimensioned Ratio: Situational Blue Expeience" = 1  
Units: 1/Exp Years
- (151) "Ethnic Cleansing Actions (Military Actions/Period)" = Actual Military Actions \* "% of Actions that are Ethnic Cleansing"

Units: Military Actions/Period

(152) Ethnic Cleansing Deaths = "Ethnic Cleansing Actions (Military Actions/Period)" \* Deaths per Ethnic Cleansing  
Units: People/Period

(153) Ethnic Cleansing Refugees = "Ethnic Cleansing Actions (Military Actions/Period)" \* Refugees from Ethnic Cleansing  
Units: People/Period

(155) "Expenses before Attacks (Dollars per Period)" = "Administration & Governance Expense (Dollars per Period)" + "Death Benefits (Dollars per Period)" + "Detention Benefits (Dollars per Period)" + "Media Border Security & Other Expenses (Dollars per Period)" + "Military Procurement (Dollars per Period)" + "Payroll (Dollars per Period)"  
Units: Dollars/Period

(183) "Indirect Attacks (Attacks/Period)" = Actual Military Actions \* "% of Actions that are Indirect: IED, VBIED or SVIED"  
Units: Military Actions/Period

(189) ISIS Combat Multiplier = 1 + ( Combat Multiplier from Experience + ISIS Morale Multiplier )  
Units: Dmnl

(191) "ISIS Finances (Dollars)" = INTEG( "Incoming Revenue (Dollars per Period)" - "Outgoing Expenses (Dollars per Period)" , "ZScenario1: Starting Cash" )  
Units: Dollars

("Baseline Switch (1 = On))\* (Capability of Military Actions based on Squads\*Cost per Attack))+("Scenario 1 Switch (1 = On))\*("ZScenario1: Starting Cash")

(193) ISIS Morale Multiplier = 0.125  
Units: Dmnl

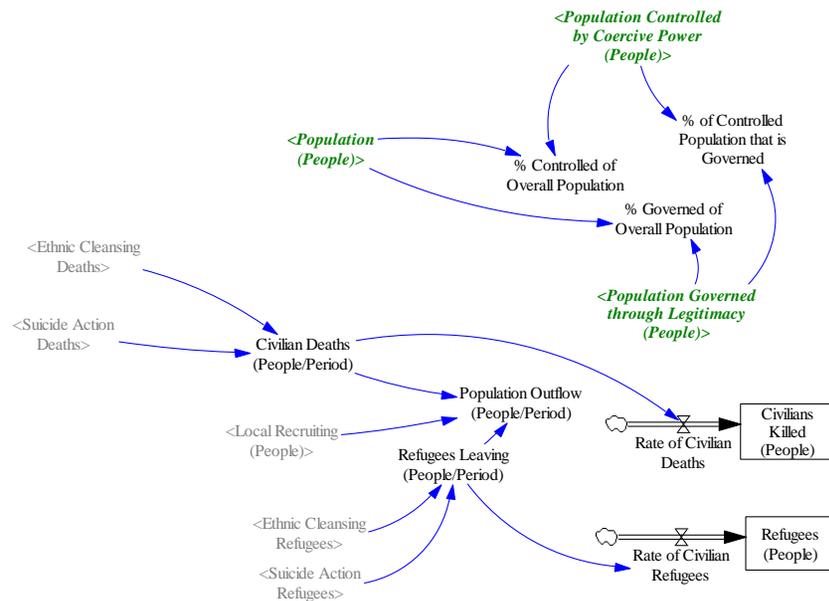
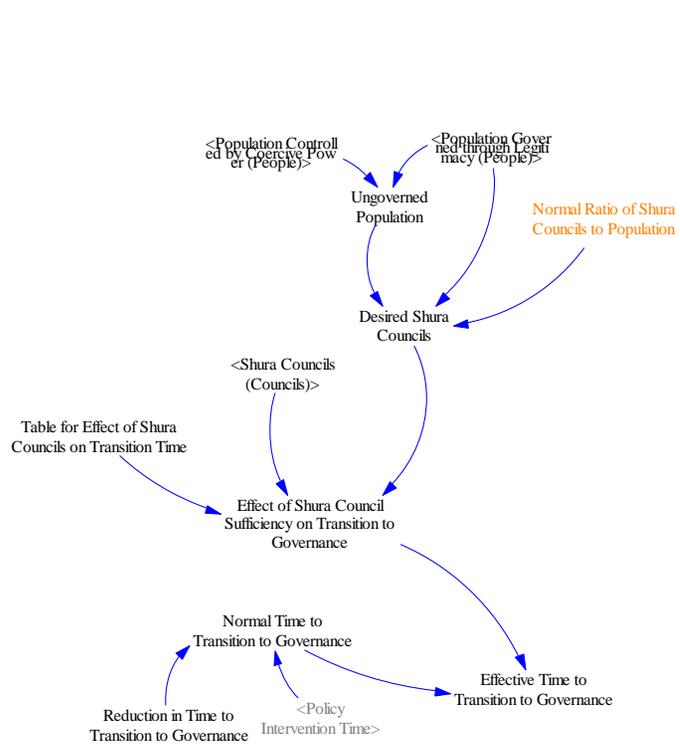
(196) ISIS Squads = INTEG( "Change in Squads (Squads/Period)" , "ISIS Militants (People)" / Normal Size of Squad )  
Units: Squads  
Initialized at the starting Initial Number of Militants divided by the Normal Size of Squads

(228) Normal Military Capability of Squads = 3  
Units: Military Actions/(Period\*Squad)  
1 every 2 months is normal

(231) Normal Size of Squad = 11  
Units: People/Squad

- (236) OpTempo Budget = MAX ( 0, ( "ISIS Finances (Dollars)" - Desired Cash on Hand ) - "Expenses before Attacks (Dollars per Period)" \* Budget Period )  
Units: Dollars
- (237) OpTempo Expenses = Actual Military Actions \* Cost per Military Action  
Units: Dollars/Period
- (238) "OpTempo Expenses (Dollars per Period)" = OpTempo Expenses  
Units: Dollars/Period
- (291) Refugees per Suicide Action = 25  
Units: People/Military Action
- (293) Refugees from Ethnic Cleansing = 250  
Units: People/Military Action
- (333) Situational Blue Experience = "ZScenario1: Table of Blue Experienced based on ISIS Location on Territorial Map" ( Current Location of ISIS on Territorial Map ) + Experience Effect  
Units: Exp Years
- (341) Suicide Action Deaths = "Suicide Actions (Military Actions/Period)" \* Deaths per Suicide Action  
Units: People/Period
- (342) Suicide Action Refugees = "Suicide Actions (Military Actions/Period)" \* Refugees per Suicide Action  
Units: People/Period
- (343) "Suicide Actions (Military Actions/Period)" = Actual Military Actions \* "% of Actions that are Suicide Attacks"  
Units: Military Actions/Period
- (350) Table for Effect of Experience on Combat Multiplier ( [(0,-0.3)-(10,1)],(0,-0.25),(0.5,-0.125),(1,0),(1.5,0.125),(2,0.25),(2.5,0.5),(3,0.75),(10,0.75) )  
Units: Dmnl
- (377) Time for Military Actions = 1  
Units: Periods

# World Model: Governance & Population Structure



## ***World Model: Governance & Population Equations***

- (001) "% Controlled of Overall Population" = ZIDZ ( "Population Controlled by Coercive Power (People)" , "Population (People)" )  
Units: Fraction
- (002) "% Governed of Overall Population" = ZIDZ ( "Population Governed through Legitimacy (People)" , "Population (People)" )  
Units: Fraction
- (008) "% of Controlled Population that is Governed" = ZIDZ ( "Population Governed through Legitimacy (People)" , "Population Controlled by Coercive Power (People)" )  
Units: Fraction
- (075) "Civilian Deaths (People/Period)" = Ethnic Cleansing Deaths + Suicide Action Deaths  
Units: People/Period
- (076) "Civilians Killed (People)" = INTEG( Rate of Civilian Deaths , 0)  
Units: People
- (100) Desired Shura Councils = ( "Population Governed through Legitimacy (People)" + Ungoverned Population ) / Normal Ratio of Shura Councils to Population  
Units: Councils
- (141) Effect of Shura Council Sufficiency on Transition to Governance = Table for Effect of Shura Councils on Transition Time ( ZIDZ ( "Shura Councils (Councils)" , Desired Shura Councils ) )  
Units: Dmnl
- (145) Effective Time to Transition to Governance = Normal Time to Transition to Governance \* Effect of Shura Council Sufficiency on Transition to Governance  
Units: Period
- (152) Ethnic Cleansing Deaths = "Ethnic Cleansing Actions (Military Actions/Period)" \* Deaths per Ethnic Cleansing  
Units: People/Period
- (153) Ethnic Cleansing Refugees = "Ethnic Cleansing Actions (Military Actions/Period)" \* Refugees from Ethnic Cleansing  
Units: People/Period
- (202) "Local Recruiting (People)" = ( Recruitable Population of Controlled Population \* Local Recruiting Rate \* "Effect of Remaining Recruits on Local Recruiting (Opposition & Militant)" ) \* Disable Local Recruiting  
Units: People/Period  
Must have territorial control to begin local recruiting.

(229) Normal Ratio of Shura Councils to Population = 100000

Units: People/Council

TBD

(232) Normal Time to Transition to Governance =  $1 * ( 1 + STEP ( Reduction in Time to Transition to Governance , Policy Intervention Time ) )$

Units: Period

The Normal Time to transition from Controlled to Governance is 1 period, or 6 months. This is estimated based on the time it took ISIS to establish governance in Ar Raqqa city from March 2013 to June 2013. The Normal time to Transition to

Transition. Governance is modified by other factors to determine the Effective time to

(246) Policy Intervention Time = 0

Units: Period

(247) "Population (People)" = INTEG( "Births & Immigration (People/Period)" - "Deaths, Recruiting & Emmigration (People/Period)" , Initial Population )

Units: People

Combined population of all Syrian and Iraqi Provinces.

“Provinces of Syria”, Administrative Divisions of Countries, Statoids, last modified September 22, 2004, accessed September 19th, 2014, <http://www.statoids.com/usy.html>.

“Provinces of Iraq”, Administrative Divisions of Countries, Statoids, last modified March 16, 2014, accessed September 19th, 2014, <http://www.statoids.com/uiq.html>.

(248) "Population Controlled by Coercive Power (People)" = INTEG( "Gain in Control (People/Period)" - "Loss of Control (People/Period)" , "ZScenario1: Starting Population Controlled" )

Units: People

(252) "Population Governed through Legitimacy (People)" = INTEG( "Rate of Transition to Governance (People/Period)" - "Rate of Loss of Governance (People/Period)" , 0)

Units: People

(253) "Population Outflow (People/Period)" = "Civilian Deaths (People/Period)" + "Local Recruiting (People)" + "Refugees Leaving (People/Period)"

Units: People/Period

(261) Rate of Civilian Refugees = "Refugees Leaving (People/Period)"

Units: People/Period

(276) Rate of Civilian Deaths = "Civilian Deaths (People/Period)"

Units: People/Period

(290) Reduction in Time to Transition to Governance = 0

Units: Period

0 is normal, 100 eliminates transition via airpower attacks

(292) "Refugees (People)" = INTEG( Rate of Civilian Refugees , 0)  
Units: People

(294) "Refugees Leaving (People/Period)" = Ethnic Cleansing Refugees + Suicide Action Refugees  
Units: People/Period

(332) "Shura Councils (Councils)" = INTEG( "Rate of Councils Formed (Councils/Period)" ,  
"Population Governed through Legitimacy (People)" / Normal Ratio of Shura Councils to Population )  
Units: Councils

Initialized at the Starting Governed Population / Normal ratio of Shura Councils

(341) Suicide Action Deaths = "Suicide Actions (Military Actions/Period)" \* Deaths per Suicide  
Action  
Units: People/Period

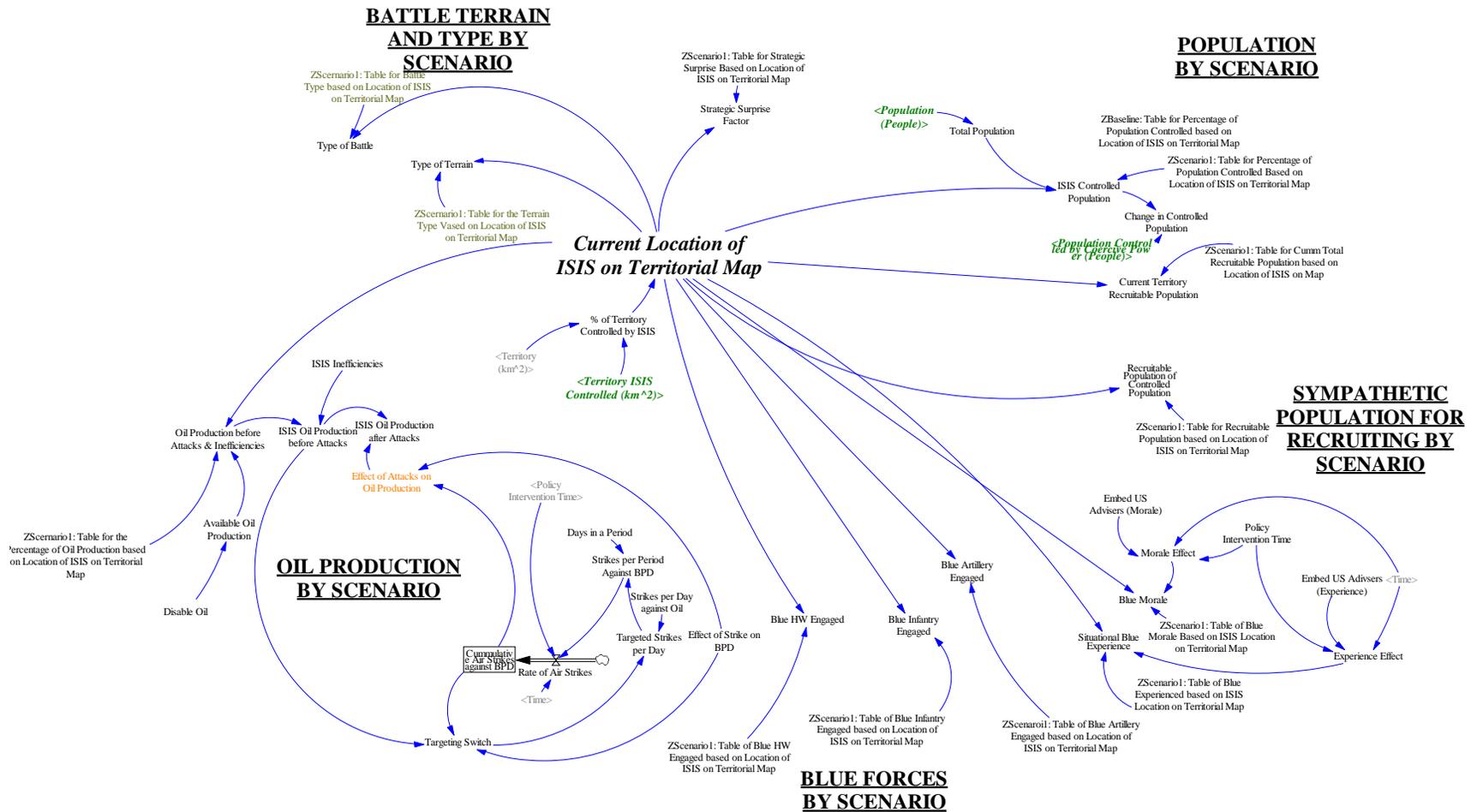
(342) Suicide Action Refugees = "Suicide Actions (Military Actions/Period)" \* Refugees per Suicide  
Action  
Units: People/Period

(357) Table for Effect of Shura Councils on Transition Time ( [(0,0)-(2,10)],(0,10),(1,1),(2,1) )  
Units: Dmnl

(397) Ungoverned Population = "Population Controlled by Coercive Power (People)" - "Population  
Governed through Legitimacy (People)"  
Units: People

Do we need a first order control here? IF THEN ELSE("Population Controlled  
(People)"-"People Governed (People)">0,"Population Controlled (People)"-"People Governed  
(People)",0)

# World Model: Territory & Scenario Sector Data



## ***World Model: Territory & Scenario Data Equations***

- (013) "% of Territory Controlled by ISIS" = "Territory ISIS Controlled (km<sup>2</sup>)" / "Territory (km<sup>2</sup>)"  
Units: Percentage
- (026) Available Oil Production = 5.013e+008 \* Disable Oil  
Units: Barrels/Period  
Total Syria & Iraq production pre-war and prior to ISIS inefficiencies or attacks.
- (050) Blue Artillery Engaged = "ZScenario1: Table of Blue Artillery Engaged based on Location of ISIS on Territorial Map" ( Current Location of ISIS on Territorial Map )  
Units: Pieces
- (058) Blue HW Engaged = "ZScenario1: Table of Blue HW Engaged based on Location of ISIS on Territorial Map" ( Current Location of ISIS on Territorial Map )  
Units: Pieces
- (064) Blue Infantry Engaged = "ZScenario1: Table of Blue Infantry Engaged based on Location of ISIS on Territorial Map" ( Current Location of ISIS on Territorial Map )  
Units: People
- (068) Blue Morale = "ZScenario1: Table of Blue Morale Based on ISIS Location on Territorial Map" ( Current Location of ISIS on Territorial Map ) + Morale Effect  
Units: Dmnl
- (073) Change in Controlled Population = ISIS Controlled Population - "Population Controlled by Coercive Power (People)"  
Units: People
- (086) Cummulative Air Strikes against BPD = INTEG( Rate of Air Strikes , 0)  
Units: Strikes
- (087) Current Location of ISIS on Territorial Map = "% of Territory Controlled by ISIS"  
Units: Percentage
- (088) Current Territory Recruitable Population = "ZScenario1: Table for Cumm Total Recruitable Population based on Location of ISIS on Map" ( Current Location of ISIS on Territorial Map )  
Units: People
- (090) Days in a Period = 180  
Units: Dmnl

(110) ISIS Controlled Population = "ZScenario1: Table for Percentage of Population Controlled Based on Location of ISIS on Territorial Map" ( Current Location of ISIS on Territorial Map ) \* Total Population

Units: People

(116) "Oil Production before Attacks & Inefficiencies" = "ZScenario1: Table for the Percentage of Oil Production based on Location of ISIS on Territorial Map" ( Current Location of ISIS on Territorial Map ) \* Available Oil Production

Units: Barrels/Period

(130) Disable Oil = 1

Units: Barrels/Period

Used for Proposition 2 - normal value =1, disabled value = 0

(134) Effect of Attacks on Oil Production = Cummulative Air Strikes against BPD \* Effect of Strike on BPD

Units: Barrels/Period

(142) Effect of Strike on BPD = 400

Units: Barrels/(Period\*Strike)

(146) "Embed US Adivsers (Experience)" = 0

Units: Exp Years

0 is normal. 1 is the increase in average Exp Years due to having US troops embedded.

(147) "Embed US Advisers (Morale)" = 0

Units: Dmnl

0 is normal. .25 is nominal additional morale factor for US troops being embedded.

(157) Experience Effect = IF THEN ELSE ( Time > Policy Intervention Time , "Embed US Adivsers (Experience)" , 0)

Units: Exp Years

(192) ISIS Inefficiencies = 0.5

Units: Fraction

(194) ISIS Oil Production after Attacks = ISIS Oil Production before Attacks - Effect of Attacks on Oil Production

Units: Barrels/Period

(195) ISIS Oil Production before Attacks = "Oil Production before Attacks & Inefficiencies" \* ISIS Inefficiencies

Units: Barrels/Period

- (224)  $\text{Morale Effect} = \text{IF THEN ELSE} ( \text{Time} > \text{Policy Intervention Time} , \text{"Embed US Advisers (Morale)"} , 0)$   
 Units: Dmnl
- (246)  $\text{Policy Intervention Time} = 0$   
 Units: Period
- (247)  $\text{"Population (People)"} = \text{INTEG} ( \text{"Births \& Immigration (People/Period)"} - \text{"Deaths, Recruiting \& Emmigration (People/Period)"} , \text{Initial Population} )$   
 Units: People  
 Combined population of all Syrian and Iraqi Provinces.  
 "Provinces of Syria", Administrative Divisions of Countries, Statoids, last modified September 22, 2004, accessed September 19th, 2014, <http://www.statoids.com/usy.html>.  
 "Provinces of Iraq", Administrative Divisions of Countries, Statoids, last modified March 16, 2014, accessed September 19th, 2014, <http://www.statoids.com/uiq.html>.
- (248)  $\text{"Population Controlled by Coercive Power (People)"} = \text{INTEG} ( \text{"Gain in Control (People/Period)"} - \text{"Loss of Control (People/Period)"} , \text{"ZScenario1: Starting Population Controlled"} )$   
 Units: People
- (259)  $\text{Rate of Air Strikes} = \text{IF THEN ELSE} ( \text{Time} > \text{Policy Intervention Time} , \text{Strikes per Period Against BPD} , 0)$   
 Units: Strikes/Period
- (273)  $\text{Recruitable Population of Controlled Population} = \text{"ZScenario1: Table for Recruitable Population based on Location of ISIS on Territorial Map"} ( \text{Current Location of ISIS on Territorial Map} )$   
 Units: People/Period
- (333)  $\text{Situational Blue Experience} = \text{"ZScenario1: Table of Blue Experienced based on ISIS Location on Territorial Map"} ( \text{Current Location of ISIS on Territorial Map} ) + \text{Experience Effect}$   
 Units: Exp Years
- (338)  $\text{Strategic Surprise Factor} = \text{"ZScenario1: Table for Strategic Surprise Based on Location of ISIS on Territorial Map"} ( \text{Current Location of ISIS on Territorial Map} )$   
 Units: Dmnl
- (339)  $\text{Strikes per Day against Oil} = 0$   
 Units: Strikes/Period  
 Normal value is 0. Minimal is 10, Significant is 100 intensive is 500.
- (340)  $\text{Strikes per Period Against BPD} = \text{Targeted Strikes per Day} * \text{Days in a Period}$   
 Units: Strikes/Period
- (370)  $\text{Targeted Strikes per Day} = \text{Strikes per Day against Oil} * \text{Targeting Switch}$   
 Units: Strikes/Period

(371) Targeting Switch = IF THEN ELSE ( Cumulative Air Strikes against BPD > ( ISIS Oil Production before Attacks / Effect of Strike on BPD ) , 0, 1)

Units: Dmnl

(374) "Territory (km^2)" = 619308

Units: "km^2"

Includes all Provinces and Governates of Iraq and Syria.

“Provinces of Syria”, Administrative Divisions of Countries, Statoids, last modified September 22, 2004, accessed September 19th, 2014, <http://www.statoids.com/usy.html>.

“Provinces of Iraq”, Administrative Divisions of Countries, Statoids, last modified March 16, 2014, accessed September 19th, 2014, <http://www.statoids.com/uiq.html>.

(375) "Territory ISIS Controlled (km^2)" = INTEG( "Rate of Territory Gained (km^2/period)" - "Rate of Territory Lost (km^2/Period)" , "ZScenario1: Starting Territory" )

Units: "km^2"

(393) Total Population = "Population (People)"

Units: People

(395) Type of Battle = "ZScenario1: Table for Battle Type based on Location of ISIS on Territorial Map" ( Current Location of ISIS on Territorial Map )

Units: Dmnl

(396) Type of Terrain = "ZScenario1: Table for the Terrain Type Vased on Location of ISIS on Territorial Map" ( Current Location of ISIS on Territorial Map )

Units: Dmnl

(401) "ZBaseline: Table for Percentage of Population Controlled based on Location of ISIS on Territorial Map" ( [(0,0)-(1,1)],(0,0),(1,1) )

Units: Percentage

(407) "ZScenario1: Table for Cumm Total Recruitable Population based on Location of ISIS on Map" ( [(0,0)-

(1,1e+007)],(0,0),(0.00317,50662),(0.00322,125750),(0.0566,356842),(0.08828,487942),(0.08844,599080),(0.08866,1.01308e+006),(0.31224,1.08208e+006)

,(0.3725,1.18374e+006),(0.41247,1.33232e+006),(0.41263,1.39212e+006),(0.41885,1.40175e+006),(0.45652,1.4655e+006),(0.45657,1.468e+006),(0.48642,1.858e+006),(0.48672,2.17782e+006),(0.50235,2.23182e+006),(0.50251,2.3169e+006),(0.51686,2.5611e+006)

,(0.51702,2.67367e+006),(0.5852,2.83867e+006),(0.61432,2.94867e+006),(0.61465,3.30947e+006),(0.61482,3.39502e+006) )

Units: People

(408) "ZScenario1: Table for Percentage of Population Controlled Based on Location of ISIS on Territorial Map" ( [(0,0)-

(1,1)],(0,0),(0.00317,0.006),(0.00322,0.014),(0.0566,0.039),(0.08828,0.053),(0.08844,0.065),(0.08866,0.11),(0.31224,0.118),(0.3725,0.129)  
,(0.41247,0.145),(0.41263,0.151),(0.41885,0.156),(0.45652,0.188),(0.45657,0.189),(0.48642,0.254),(0.48672,0.308),(0.50235,0.321),(0.50251,0.343),(0.51686,0.383),(0.51702,0.402),(0.5852,0.43),(0.61432,0.457),(0.61465,0.638),(0.61482,0.681)

)

Units: Percentage

(409) "ZScenario1: Table for Recruitable Population based on Location of ISIS on Territorial Map" ( [(0,0)-(1,400000)],(0,0),(0.00317,50662),(0.00322,75088),(0.0566,231092),(0.08828,131100),(0.08844,111138),(0.08866,414000),(0.31224,69000),(0.3725,101660)

,(0.41247,148580),(0.41263,59800),(0.41885,9626),(0.45652,63756),(0.45657,2500),(0.48642,390000),(0.48672,319815),(0.50235,54000),(0.50251,85079),(0.51686,244200),(0.51702,112575),(0.5852,165000),(0.61432,110000),(0.61465,360800),(0.61482,85550)

)

Units: People/(Period\*Percentage)

(410) "ZScenario1: Table for Strategic Surprise Based on Location of ISIS on Territorial Map" ( [(0,0)-(1,1)],(0,0.05),(0.00317,0.05),(0.00322,0.05),(0.0566,0.25),(0.08828,0.25),(0.08844,0.5),(0.08866,0.5),(0.31224,1),(0.41247,1),(0.41263,1),(0.41885,1)  
,(0.45652,1),(0.45657,1),(0.48642,1),(0.48672,1),(0.50235,1),(0.50251,1),(0.51686,1),(0.51702,1),(0.5852,1),(0.61432,1),(0.61465,1),(0.61482,1),(1,1) )

Units: Dmnl

(411) "ZScenario1: Table of Blue Experienced based on ISIS Location on Territorial Map" ( [(0,0)-(1,5)],(0,0.25),(0.00317,0.25),(0.00322,0.25),(0.0566,0.25),(0.08828,0.25),(0.08844,0.25),(0.08866,0.25),(0.31224,0.25),(0.3725,0.25),(0.41247,0.25),(0.41263,5)  
,(0.41885,5),(0.45652,5),(0.45657,3),(0.48642,3),(0.48672,3),(0.50235,5),(0.50251,5),(0.51686,3),(0.51702,3),(0.5852,3),(0.61432,3),(0.61465,3),(0.61482,3) )

Units: Exp Years

(412) "ZScenario1: Table of Blue HW Engaged based on Location of ISIS on Territorial Map" ( [(0,0)-(1,5000)],(0,80),(0.00317,80),(0.00322,119),(0.0566,365),(0.08828,207),(0.08844,176),(0.08866,654),(0.31224,109),(0.3725,161),(0.41247,235),(0.41263,95)  
,(0.41885,70),(0.45652,28),(0.45657,454),(0.48642,436),(0.48672,1218),(0.50235,51),(0.50251,455),(0.51686,301),(0.51702,126),(0.5852,799),(0.61432,400),(0.61465,4796),(0.61482,3197) )

Units: Pieces/Percentage

(413) "ZScenario1: Table of Blue Infantry Engaged based on Location of ISIS on Territorial Map" ( [(0,0)-(1,600000)],(0,8531),(0.00317,8531),(0.00322,12645),(0.0566,38916),(0.08828,22077),(0.08844,18716),(0.08866,69717),(0.31224,11620),(0.3725,17120)

,(0.41247,25021),(0.41263,10070),(0.41885,7456),(0.45652,2941),(0.45657,48375),(0.48642,46440),(0.48672,129753),(0.50235,5433),(0.50251,48437),(0.51686,32090),(0.51702,13468),(0.5852,85140),(0.61432,42605),(0.61465,510840),(0.61482,340560)

)  
Units: People/Percentage

(414) "ZScenario1: Table of Blue Morale Based on ISIS Location on Territorial Map" ( [(0,-0.3)-(1,0.15)],(0,-0.25),(0,-0.25),(0.00317,-0.25),(0.00322,-0.25),(0.0566,-0.25),(0.08828,-0.25),(0.08844,-0.25),(0.08866,-0.25),(0.31224,-0.25),(0.3725,-0.25)  
,(0.41247,0),(0.41263,0),(0.41885,0),(0.45652,0.125),(0.45657,0.125),(0.48642,0.125),(0.48672,0.05),(0.50235,0.05),(0.50251,0.05),(0.51686,0),(0.51702,0),(0.5852,0),(0.61432,0),(0.61465,0.125),(0.61482,0.125) )

Units: Dmnl

(415) "ZScenario1: Table of Blue Artillery Engaged based on Location of ISIS on Territorial Map" ( [(0,0)-(1,1600)],(0,26),(0.00317,26),(0.00322,39),(0.0566,121),(0.08828,68),(0.08844,58),(0.08866,216),(0.31224,36),(0.3725,53),(0.41247,78),(0.41263,31)  
,(0.41885,23),(0.45652,9),(0.45657,150),(0.48642,144),(0.48672,403),(0.50235,17),(0.50251,150),(0.51686,100),(0.51702,42),(0.5852,264),(0.61432,132),(0.61465,1585),(0.61482,1057) )

Units: Pieces/Percentage

(416) "ZScenario1: Table for Battle Type based on Location of ISIS on Territorial Map" ( [(0,0)-(0.7,6)],(0,1),(0.00317,1),(0.00322,1),(0.0566,3),(0.08828,3),(0.08844,4),(0.08866,2),(0.31224,1),(0.3725,1),(0.41247,1),(0.41263,3),(0.41885,1),(0.45652,6)  
,(0.45657,5),(0.48642,6),(0.48672,5),(0.50235,6),(0.50251,5),(0.51686,1),(0.51702,6),(0.5852,5)  
,(0.61432,2),(0.61465,5),(0.61482,5) )

Units: Dmnl

Scenario 1

(417) "ZScenario1: Table for the Percentage of Oil Production based on Location of ISIS on Territorial Map" ( [(0,0)-(1,0.2)],(0,0),(0.039,0.01307),(0.343,0.0382),(0.46467,0.11783),(1,0.11783) )

Units: Percentage

Scenario 1

(418) "ZScenario1: Table for the Terrain Type Vased on Location of ISIS on Territorial Map" ( [(0,0)-(0.7,5)],(0,4),(0.00317,4),(0.00322,4),(0.0566,1),(0.08828,1),(0.08844,4),(0.08866,4),(0.31224,1),(0.3725,1),(0.41247,1),(0.41263,4),(0.41885,2),(0.45652,5)  
,(0.45657,4),(0.48642,1),(0.48672,4),(0.50235,1),(0.50251,4),(0.51686,1),(0.51702,2),(0.5852,4)  
,(0.61432,2),(0.61465,4),(0.61482,4) )

Units: Dmnl

Scenario 1



## ***World Model: SFS Combat Simulator Equations***

(007) "% of Blue Infantry that are Local Opposition Fighters" = ZIDZ ( "Local Opposition Fighters (People)" , Blue Infantry Engaged )

Units: Percentage

(018) "AFV/IFV Looted" = ( ( Blue HW Initial Losses \* Scavenging Rate of Heavy Weapons ) + ( Blue Artillery Initial Losses \* Scavenging Rate of Heavy Weapons ) ) / "Time to Repair & Operate"

Units: Pieces/Period

(022) "AFV/IFV (Pieces)" = INTEG( "AFV/IFV Additions (Pieces per Period)" - "AFV/IFV Losses (Pieces per Period)" , 0)

Units: Pieces

(033) All Other Attacks = Actual Military Actions - "Ethnic Cleansing Actions (Military Actions/Period)" - "Indirect Attacks (Attacks/Period)"

Units: Military Actions/Period

(034) Assets per Artillery = 1

Units: Assets/Pieces

(035) Assets per Indirect Attack = 1

Units: Assets

(036) Assets per Person = 1

Units: Assets/Person

(037) Assets per Piece = 1

Units: Assets/Pieces

(038) Assets per Squad = Assets per Person \* Normal Size of Squad

Units: Assets/Squad

(043) BATTLE DECISION = ( IF THEN ELSE ( Days since Last Engagement > Days Prep Between Battles , 1, 0 ) )

Units: Days

(044) Battle Intensity = Table for Effect of Battle Type on Battle Intensity ( Type of Battle )

Units: Dmnl

(045) Battles per Decision = 1

Units: Battle/Day

(050) Blue Artillery Engaged = "ZScenaroi1: Table of Blue Artillery Engaged based on Location of ISIS on Territorial Map" ( Current Location of ISIS on Territorial Map )

Units: Pieces

(051) Blue Artillery Final Losses = ( Blue Artillery Initial Losses - ( Blue Artillery Initial Losses \* HW Recovery ) )

Units: Pieces

(052) Blue Artillery Initial Losses = Blue Artillery Engaged \* SFS Fraction of Blue Losses

Units: Pieces

(053) Blue Combat Multiplier = 1 + ( Blue Morale Multiplier + Blue Combat Multiplier from Experience )

Units: Dmnl

(055) Blue Force Fighters = INTEG( Increase in Blue Force Fighters - Rate of Blue Force Deaths , Starting Blue Force Fighters Actively Oposing ISIS )

Units: People

(056) Blue Force Strength = ( SFS Blue Heavy Weapons Situational Strength + SFS Blue Indirect Attack Situational Strength + SFS Blue Infantry Situational Strength ) + ( ( SFS Blue Heavy Weapons Situational Strength + SFS Blue Indirect Attack Situational Strength + SFS Blue Infantry Situational Strength ) \* Ground Support Campaign Start )

Units: Dmnl

(057) "Blue Heavy Weapons (Armor)" = Blue HW Engaged \* Assets per Piece \* Density Modifier for Heavy Weapons

Units: Assets

(058) Blue HW Engaged = "ZScenario1: Table of Blue HW Engaged based on Location of ISIS on Territorial Map" ( Current Location of ISIS on Territorial Map )

Units: Pieces

(059) Blue HW Final Losses = ( Blue HW Initial Losses - ( Blue HW Initial Losses \* HW Recovery ) )

Units: Pieces

(060) Blue HW Initial Losses = Blue HW Engaged \* SFS Fraction of Blue Losses

Units: Pieces

(061) "Blue Indirect Attacks (True Artillery)" = ( Blue Artillery Engaged ) \* Assets per Artillery \* Density Modifier for Blue Indirect Attacks

Units: Assets

Blue Indirect Attacks includes artillery, mortars and other traditional indirect means. It does not include suicide bombers, IEDs or VBIEDs.

(062) "Blue Infantry (Infantry & Light Mount Technicals)" = ( Blue Infantry Engaged + "Local Opposition Fighters (People)" ) \* Assets per Person \* "Density Modifier for Infantry & Red Indirect Attacks"

Units: Assets

(063) Blue Infantry Actual Losses = Blue Infantry Final Losses - Opposition Fighter Losses  
Units: People/Period

(064) Blue Infantry Engaged = "ZScenario1: Table of Blue Infantry Engaged based on Location of ISIS on Territorial Map" ( Current Location of ISIS on Territorial Map )  
Units: People

(065) Blue Infantry Final Losses = Blue Infantry Initial Losses \* Blue Infantry Recovery  
Units: People/Period

(066) Blue Infantry Initial Losses = Blue Infantry Engaged \* SFS Fraction of Blue Losses  
Units: People

(067) Blue Infantry Recovery = 0.25  
Units: Fraction/Period

(089) Days = 1  
Units: Days

(091) Days Prep Between Battles = RANDOM NORMAL ( Minimum Days Between Battles ,  
Maximum Days between Battles , Mean Days Between Battles , Standard Deviation between Battles ,  
NOISE SEED )  
Units: Days

(092) Days since Last Engagement = INTEG( Increase in Days Since Last Battle - Reduction in Days  
since Last Engagement , 5)  
Units: Days

(103) Density Modifier for Blue Indirect Attacks = Table for Effect of Terrain Type on Max Density of  
Indirect Attacks ( Type of Terrain )  
Units: Dmnl

(104) Density Modifier for Heavy Weapons = Table for Effect of Terrain Type on Max Density Heavy  
Weapons ( Type of Terrain )  
Units: Dmnl

(111) "ISIS Militants (People)" = INTEG( "Additions (People per Period)" - "Lossess (People per  
Period)" , ZScenario1 Starting Militants )  
Units: People

(119) "Density Modifier for Infantry & Red Indirect Attacks" = "Table for Effect of Terrain Type on  
Max Density Infantry & Indirect Attacks" ( Type of Terrain )  
Units: Dmnl

- (122) "Dimensioned Ratio: Days Prep" = 1  
Units: 1/Days
- (126) Disable FLOT = 1  
Units: Dmnl  
Used to test Proposition 1. Normal value =1 , disabled value = 0.
- (131) "DLR /ALR" = ZIDZ ( SFS Defender Loss Rate , "SFS Attacker Loss Rate (ALR)" )  
Units: Dmnl
- (136) Effect of Preparation of Attacker on Intensity Mult = Table for Effect of Preparation of Attacker on Intensity Mult ( Days Prep Between Battles \* "Dimensioned Ratio: Days Prep" )  
Units: Dmnl
- (137) Effect of Preparation on ER Adjustment = Table for Effect of Preparation of Attacker on ER Adjustment ( Days Prep Between Battles \* "Dimensioned Ratio: Days Prep" )  
Units: Dmnl
- (148) Engagements Conducted = ( BATTLE DECISION \* Battles per Decision ) / Portion of Period spent Fighting Battle  
Units: Battles/Period
- (160) "FLOT Movement Rate (FMR)" = ( ( ( FMR Base1 + FMR Base2 ) \* "High Intensity FLOT Movement Rate (FMR) Multiplier" ) \* Disable FLOT ) \* Movement Direction  
Units: "km^2"
- (161) FMR Base1 = Table for the Effect of Battle Type on FMR1 ( Type of Battle ) \* ZIDZ ( SFS Defender Loss Rate , "SFS Attacker Loss Rate (ALR)" )  
Units: Dmnl
- (162) FMR Base2 = "Table for Effect of Battle Type on FMR2 (ISIS Variant)" ( Type of Battle )  
Units: Dmnl
- (167) Ground Support Campaign Start = IF THEN ELSE ( Targeting Switch = 0, US Airpower Support Step Height , 0)  
Units: Dmnl
- (168) High Intensity Defender Loss Ratio Multiplier = 1.5  
Units: Dmnl
- (169) High Intensity Exchange Rate Multiplier = 1  
Units: Dmnl
- (170) "High Intensity FLOT Movement Rate (FMR) Multiplier" = 1.5  
Units: "km^2"

- (171) HW Recovery = 0.1  
Units: Fraction  
Placeholder rate at which initial losses are recovered after the battle.
- (179) Increase in Days Since Last Battle = Time Passing  
Units: Days/Period
- (183) "Indirect Attacks (Attacks/Period)" = Actual Military Actions \* "% of Actions that are Indirect: IED, VBIED or SVIED"  
Units: Military Actions/Period
- (184) "Infantry Recovery (People/Period)" = 0.25  
Units: Fraction
- (188) Intensity = High Intensity Defender Loss Ratio Multiplier \* Battle Intensity  
Units: Dmnl
- (189) ISIS Combat Multiplier = 1 + ( Combat Multiplier from Experience + ISIS Morale Multiplier )  
Units: Dmnl
- (201) "Local Opposition Fighters (People)" = INTEG( Rate of Local Opposition Fighters Joining Uprising - Rate of Local Fighter Deaths , 0)  
Units: People
- (211) Maximum Days between Battles = 20  
Units: Days
- (212) Mean Days Between Battles = 6  
Units: Days
- (218) Military Actions per Indirect Attack = 1  
Units: Military Actions/Period
- (219) Military Actions per Squad = 1  
Units: Military Actions/(Period\*Squad)
- (223) Minimum Days Between Battles = 0.5  
Units: Days
- (225) Movement Direction = IF THEN ELSE ( SFS Defender Loss Rate - "SFS Attacker Loss Rate (ALR)" >= 0, 1, -1)  
Units: Dmnl
- (226) NOISE SEED = 0  
Units: Dmnl  
Set to 0 noise seed. Can be varied.

- (231) Normal Size of Squad = 11  
Units: People/Squad
- (233) Number of Battles Fought = INTEG( Engagements Conducted , 0)  
Units: Battles
- (235) Opposition Fighter Losses = Blue Infantry Final Losses \* "% of Blue Infantry that are Local Opposition Fighters"  
Units: People/Period
- (246) Policy Intervention Time = 0  
Units: Period
- (254) Portion of Period spent Fighting Battle = 0.0055  
Units: Period
- (275) "Red AFV/IFV Final Losses" = ( Red HW Initial Losses - ( Red HW Initial Losses \* HW Recovery ) )  
Units: Pieces
- (279) Red Force Strength = ( SFS Red Heavy Weapons Situational Strength + SFS Red Indirect Attack Situational Strength + SFS Red Infantry Situational Strength )  
Units: Dmnl
- (280) "Red Heavy Weapons (Armor, Artillery & Heavy Mount Technicals)" = "AFV/IFV (Pieces)" \* Assets per Piece \* Density Modifier for Heavy Weapons  
Units: Assets
- (281) Red HW Initial Losses = MIN ( "AFV/IFV (Pieces)" , "AFV/IFV (Pieces)" \* SFS Fraction of Red Losses )  
Units: Pieces  
Added minimum function
- (282) Red Indirect Attack Multiplier based on Days Prep = IF THEN ELSE ( Days Prep Between Battles > 10, 1.1, 0.9 + ( 0.02 \* Days Prep Between Battles / Days ) )  
Units: Dmnl
- (283) "Red Indirect Attacks (Mortars, IED, VBIED & SvIED)" = ( "Indirect Attacks (Attacks/Period)" / Military Actions per Indirect Attack ) \* Assets per Indirect Attack \* "Density Modifier for Infantry & Red Indirect Attacks"  
Units: Assets
- (284) "Red Infantry (Infantry & Light Mount Technicals)" = ( All Other Attacks / Military Actions per Squad ) \* Assets per Squad \* "Density Modifier for Infantry & Red Indirect Attacks"  
Units: Assets

(285) Red Infantry Final Losses = ( Red Infantry Initial Losses - ( Red Infantry Initial Losses \* "Infantry Recovery (People/Period)" ) )

Units: People

(286) Red Infantry Initial Losses = MIN ( "ISIS Militants (People)" , "ISIS Militants (People)" \* SFS Fraction of Red Losses )

Units: People

Added minimum function

(288) Reduction in Days since Last Engagement = IF THEN ELSE ( BATTLE DECISION = 1, Days since Last Engagement / Time to Recognize Battle , 0)

Units: Days/Period

(299) Scavenging Rate of Heavy Weapons = 0.1

Units: Percentage

(300) "SFS Attacker Loss Rate (ALR)" = IF THEN ELSE ( SFS Modified Force Ratio > 0, ( SFS Defender Loss Rate \* SFS Exchange Rate ) / SFS Modified Force Ratio , 0)

Units: Dmnl

(301) "SFS Avg Blue Indirect Attack WEI/WUV" = 1 + Supply Better US Equipment

Units: Dmnl/Assets

(302) "SFS Avg Blue Inf WEI/WUV" = 1 + Supply Better US Equipment

Units: Dmnl/Assets

(303) "SFS Avg Red Indirec Attack WEI/WUV" = 1

Units: Dmnl/Assets

(304) "SFS Avg Red Inf WEI/WUV" = 1

Units: Dmnl/Assets

(305) "SFS Avg. Blue Heavy Weapon WEI/WUV" = 1 + Supply Better US Equipment

Units: Dmnl/Assets

(306) "SFS Avg. Red Heavy Weapon WEI/WUV" = 1 + Supply Better US Equipment

Units: Dmnl/Assets

(307) SFS Blue Heavy Weapon Base Strength = SFS Blue Heavy Weapons Raw Strength \* Blue Combat Multiplier

Units: Dmnl

(308) SFS Blue Heavy Weapons Raw Strength = "SFS Avg. Blue Heavy Weapon WEI/WUV" \* "Blue Heavy Weapons (Armor)"

Units: Dmnl

- (309) SFS Blue Heavy Weapons Situational Strength = Table for Effect of Type of Battle on Heavy Weapons DEFENDER ( Type of Battle ) \* SFS Blue Heavy Weapon Base Strength  
Units: Dmnl
- (310) SFS Blue Indirect Attack Base Strength = ISIS Combat Multiplier \* SFS Blue Indirect Attack Raw Strength \* Blue Combat Multiplier  
Units: Dmnl
- (311) SFS Blue Indirect Attack Raw Strength = "SFS Avg Blue Indirect Attack WEI/WUV" \* "Blue Indirect Attacks (True Artillery)"  
Units: Dmnl
- (312) SFS Blue Indirect Attack Situational Strength = Table for Effect of Type of Battle on Indirect Attack DEFENDER ( Type of Battle ) \* SFS Blue Indirect Attack Base Strength  
Units: Dmnl
- (313) SFS Blue Infantry Base Strength = SFS Blue Infantry Raw Strength \* Blue Combat Multiplier  
Units: Dmnl
- (314) SFS Blue Infantry Raw Strength = "Blue Infantry (Infantry & Light Mount Technicals)" \* "SFS Avg Blue Inf WEI/WUV"  
Units: Dmnl
- (315) SFS Blue Infantry Situational Strength = Table for Effect of Type of Battle on Infantry DEFENDER ( Type of Battle ) \* SFS Blue Infantry Base Strength  
Units: Dmnl
- (316) SFS Blue Losses = Blue Force Strength \* SFS Defender Loss Rate  
Units: Dmnl
- (317) SFS Defender Loss Rate = IF THEN ELSE ( SFS Modified Force Ratio > 0, Intensity \* ( 0.03 \* SFS Modified Force Ratio ^ 0.64 ) , 0)  
Units: Dmnl
- (318) SFS Exchange Rate = MIN ( 5, IF THEN ELSE ( SFS Modified Force Ratio > 0, High Intensity Exchange Rate Multiplier \* ( 4.5 \* ( SFS Modified Force Ratio ^ ( -0.57 ) ) ) , 0 ) )  
Units: Dmnl  
Added minimum function for now to capp exchange rate losses.  
MIN(5,IF THEN ELSE(SFS Modified Force Ratio>0,High Intensity Exchange Rate Multiplier\*(4.5\*(SFS Modified Force Ratio^(-0.57))),0))
- (319) SFS Fraction of Blue Losses = ZIDZ ( SFS Blue Losses , Blue Force Strength )  
Units: Dmnl

- (320) SFS Fraction of Red Losses = ZIDZ ( SFS Red Losses , Red Force Strength )  
Units: Dmnl
- (321) SFS Modified Force Ratio = ZIDZ ( Red Force Strength , ( Strategic Surprise Factor \* Blue Force Strength ) )  
Units: Dmnl
- (322) SFS Red Heavy Weapon Base Strength = SFS Red Heavy Weapons Raw Strength \* ISIS Combat Multiplier  
Units: Dmnl
- (323) SFS Red Heavy Weapons Raw Strength = "SFS Avg. Red Heavy Weapon WEI/WUV" \* "Red Heavy Weapons (Armor, Artillery & Heavy Mount Technicals)"  
Units: Dmnl
- (324) SFS Red Heavy Weapons Situational Strength = Table for Effect of Type of Battle on Heavy Weapons ATTACKER ( Type of Battle ) \* SFS Red Heavy Weapon Base Strength  
Units: Dmnl
- (325) SFS Red Indirec Attack Raw Strength = "SFS Avg Red Indirec Attack WEI/WUV" \* "Red Indirect Attacks (Mortars, IED, VBIED & SvIED)"  
Units: Dmnl
- (326) SFS Red Indirect Attack Base Strength = ( ISIS Combat Multiplier \* SFS Red Indirec Attack Raw Strength ) \* Red Indirect Attack Multiplier based on Days Prep  
Units: Dmnl
- (327) SFS Red Indirect Attack Situational Strength = Table for Effect of Type of Battle on Indirect Attacks ATTACKER ( Type of Battle ) \* SFS Red Indirect Attack Base Strength  
Units: Dmnl
- (328) SFS Red Infantry Raw Strength = "Red Infantry (Infantry & Light Mount Technicals)" \* "SFS Avg Red Inf WEI/WUV"  
Units: Dmnl
- (329) SFS Red Infantry Base Strength = SFS Red Infantry Raw Strength \* ISIS Combat Multiplier  
Units: Dmnl
- (330) SFS Red Infantry Situational Strength = Table for Effect of Type of Battle on Infantry ATTACKER ( Type of Battle ) \* SFS Red Infantry Base Strength  
Units: Dmnl
- (331) SFS Red Losses = SFS Blue Losses \* SFS Exchange Rate  
Units: Dmnl
- (335) Standard Deviation between Battles = 1

Units: Days

(338) Strategic Surprise Factor = "ZScenario1: Table for Strategic Surprise Based on Location of ISIS on Territorial Map" ( Current Location of ISIS on Territorial Map )

Units: Dmnl

(344) Supply Better US Equipment = IF THEN ELSE ( Time > Policy Intervention Time , USEquipmentModifier , 0)

Units: Dmnl/Assets

0 is normal value. .25 indicates a 25% increase in Weapon Value/Weapon Effectiveness by supplying US Arms. Note, the increase in Weapon Value/Weapon Effectiveness translates over to ISIS HW as well.

(347) Table for Effect of Battle Type on Battle Intensity ( [(0,0)-(7,1.2)],(1,1.05),(2,1.05),(3,1),(4,0.95),(5,0.8),(6,0.85) )

Units: Dmnl

(348) Table for Effect of Battle Type on FMR2 ( [(0,-0.5)-(7,30)],(1,30),(2,0),(3,0),(4,0),(5,-0.5),(6,0) )

Units: Dmnl

(349) "Table for Effect of Battle Type on FMR2 (ISIS Variant)" ( [(0,-300)-(7,1250)],(1,1000),(2,25),(3,25),(4,25),(5,10),(6,500) )

Units: Dmnl

(353) Table for Effect of Preparation of Attacker on ER Adjustment ( [(0,0)-(20,1.25)],(0,1.15),(1,1.1),(3,1.05),(5,1),(7,0.95),(20,0.95) )

Units: Dmnl

(354) Table for Effect of Preparation of Attacker on Intensity Mult ( [(0,0)-(20,1.25)],(0,0.65),(1,0.75),(3,0.85),(5,0.95),(7,1),(20,1) )

Units: Dmnl

(358) Table for Effect of Terrain Type on Max Density Heavy Weapons ( [(0,0)-(5,1.5)],(1,0.8),(2,1),(3,0.5),(4,0.4),(5,0.2) )

Units: Dmnl

(359) "Table for Effect of Terrain Type on Max Density Infantry & Indirect Attacks" ( [(0,0)-(10,10)],(1,0.8),(2,1),(3,0.8),(4,1.2),(5,0.6) )

Units: Dmnl

(360) Table for Effect of Terrain Type on Max Density of Indirect Attacks ( [(0,0)-(6,1.1)],(1,1),(2,1),(3,0.8),(4,0.7),(5,0.4) )

Units: Dmnl

(362) Table for Effect of Type of Battle on Heavy Weapons ATTACKER ( [(0,0)-(6,1.5)],(1,1.4),(2,1.2),(3,1),(4,0.95),(5,0.9),(6,0.8) )

Units: Dmnl

(363) Table for Effect of Type of Battle on Heavy Weapons DEFENDER ( [(0,0)-(6,1.3)],(1,0.8),(2,0.8),(3,1),(4,1.1),(5,1.2),(6,0.8) )

Units: Dmnl

(364) Table for Effect of Type of Battle on Indirect Attack DEFENDER ( [(0,0)-(6,1.5)],(1,0.5),(2,0.8),(3,1),(4,1.1),(5,1.2),(6,0.5) )

Units: Dmnl

(365) Table for Effect of Type of Battle on Indirect Attacks ATTACKER ( [(0,0)-(6,1.3)],(1,0.4),(2,1.2),(3,1),(4,0.95),(5,0.9),(6,0.8) )

Units: Dmnl

(366) Table for Effect of Type of Battle on Infantry ATTACKER ( [(0,0)-(6,1.3)],(1,0.4),(2,1.2),(3,1),(4,0.95),(5,0.95),(6,1) )

Units: Dmnl

(367) Table for Effect of Type of Battle on Infantry ATTACKER 0 ( [(0,0)-(6,1.3)],(1,0.4),(2,1.2),(3,1),(4,0.95),(5,0.95),(6,1) )

Units: Dmnl

(368) Table for Effect of Type of Battle on Infantry DEFENDER ( [(0,0)-(7,1.5)],(1,0.5),(2,0.7),(3,1),(4,1.3),(5,1.4),(6,0.7) )

Units: Dmnl

(369) Table for the Effect of Battle Type on FMR1 ( [(0,0)-(7,15)],(1,5),(2,9),(3,12.5),(4,12),(5,10),(6,5) )

Units: Dmnl

Multiplier to multiply against (DLR/ALR)

(371) Targeting Switch = IF THEN ELSE ( Cummulative Air Strikes against BPD > ( ISIS Oil Production before Attacks / Effect of Strike on BPD ) , 0, 1)

Units: Dmnl

(380) Time Passing = 1

Units: Days/Period

(381) TIME STEP = 0.0055

Units: Period [0,?]

The time step for the simulation.

(386) Time to Recognize Battle = 1

Units: Period

(387) "Time to Repair & Operate" = 1

Units: Period

(395) Type of Battle = "ZScenario1: Table for Battle Type based on Location of ISIS on Territorial Map" ( Current Location of ISIS on Territorial Map )

Units: Dmnl

(396) Type of Terrain = "ZScenario1: Table for the Terrain Type Vased on Location of ISIS on Territorial Map" ( Current Location of ISIS on Territorial Map )

Units: Dmnl

(398) US Airpower Support Step Height = 0

Units: Dmnl

1 is normal. 1.01 is minimal, 1.10 is significant and 1.5 is intensive.

(399) USEquipmentModifier = 0

Units: Dmnl/Assets



### ***World Model: Resistance & Uprising Equations***

(009) "% of Controlled that will Join Opposition Forces" = 0.001

Units: Percentage/Period

Diehard opposition will fight against ISIS regardless of state of Garrison. This may also account for tribal rivalries. Should be approximately 1,000 per 1m controlled pop.

(019) Actual Garrison = MIN ( "Desired Garrison & Police Forces" , Max Garrison Allocation )

Units: People

(030) Actual Garrison per Cohort = Normal Garrison Requirement per Cohort \* Local Forces Density Force Multiplier \* KIA perM Force Multiplier

Units: People/Cohort

(055) Blue Force Fighters = INTEG( Increase in Blue Force Fighters - Rate of Blue Force Deaths , Starting Blue Force Fighters Actively Oposing ISIS )

Units: People

(063) Blue Infantry Actual Losses = Blue Infantry Final Losses - Opposition Fighter Losses

Units: People/Period

(064) Blue Infantry Engaged = "ZScenario1: Table of Blue Infantry Engaged based on Location of ISIS on Territorial Map" ( Current Location of ISIS on Territorial Map )

Units: People

(065) Blue Infantry Final Losses = Blue Infantry Initial Losses \* Blue Infantry Recovery

Units: People/Period

(078) Controlled Cohorts = Population Controlled Only / Size of Cohort

Units: Cohort

(082) Cumm Blue Force Deaths = INTEG( Increase in Cumm Blue Force Deaths , 0)

Units: People

(083) Cumm Blue Force Fighters = INTEG( Increase in Cumm Blue Force Fighters , Starting Blue Force Fighters Actively Oposing ISIS )

Units: People

(084) Cumulative Opposition Deaths = INTEG( Increase in Cumulative Opposition Deaths , 0)

Units: People

(088) Current Territory Recruitable Population = "ZScenario1: Table for Cumulative Total Recruitable Population based on Location of ISIS on Map" ( Current Location of ISIS on Territorial Map )

Units: People

(097) "Delta between Desired & Actual Garrison" = "Desired Garrison & Police Forces" - Actual Garrison

Units: People

(099) "Desired Garrison & Police Forces" = ( Garrison Troops Required + Police Forces Required ) \* Disable Garrison Troops

Units: People

(105) Diehards joining Uprising = "Population Controlled by Coercive Power (People)" \* "% of Controlled that will Join Opposition Forces"

Units: People/Period

(111) "ISIS Militants (People)" = INTEG( "Additions (People per Period)" - "Losses (People per Period)" , ZScenario1 Starting Militants )

Units: People

(123) "Dimensioned Ratio: ISIS Militants" = 1

Units: 1/People

(124) "Dimensioned Ratio: People/Period" = 1

Units: Period/People

(127) Disable Garrison Troops = 1

Units: Dmnl

(143) Effect of Ungarrison Ratio on Recruiting Rate = Table for Effect of Ratio on Uprising ( Ratio of Delta to Militants )

Units: Fraction

This determines the what % of the population will join the die-hard opposition as ISIS is unable to garrison effectively.

- (144) Effect of Uprising Militants on Max Garrison Allocation ( [(0,0)-(50000,2)],(0,0.5),(10000,0.75),(20000,0.8),(30000,0.9),(40000,0.95),(50000,1) )  
Units: Dmnl
- (165) Garrison Troops Required = Controlled Cohorts \* Actual Garrison per Cohort  
Units: People
- (166) Governed Cohorts = "Population Governed through Legitimacy (People)" / Size of Cohort  
Units: Cohort
- (174) Increase in Blue Force Fighters = Blue Infantry Engaged / Time for Fighters to Activate  
Units: People/Period
- (175) Increase in Cumm Blue Force Deaths = Rate of Blue Force Deaths  
Units: People/Period
- (176) Increase in Cumm Blue Force Fighters = Increase in Blue Force Fighters  
Units: People/Period
- (177) Increase in Cumm Opposition Deaths = Rate of Local Fighter Deaths  
Units: People/Period
- (197) KIA Per Million Population = "Rate of Deaths (People/Period)" / ( "Population (People)" / Million Population )  
Units: People/Period
- (198) KIA perM Force Multiplier = "Table f/ KIA perM on Force Multiplier" ( KIA Per Million Population \* "Dimensioned Ratio: People/Period" )  
Units: Dmnl
- (200) Local Forces Density Force Multiplier = "Table f/ Local vs Foreign Forces on Force Multiplier" ( Local vs Foreign Forces )  
Units: Dmnl
- (201) "Local Opposition Fighters (People)" = INTEG( Rate of Local Opposition Fighters Joining Uprising - Rate of Local Fighter Deaths , 0)  
Units: People

- (204) Local vs Foreign Forces = ZIDZ ( Total Recruited , ( Total Recruited + "Total Foreign Recruits (People)" ) )  
Units: Percentage
- (210) Max Garrison Allocation = "ISIS Militants (People)" \* Effect of Uprising Militants on Max Garrison Allocation ( "Local Opposition Fighters (People)" \* "Dimensioned Ratio: ISIS Militants" )  
Units: People
- (216) Militant Police per Cohort = 2.8  
Units: People/Cohort
- (222) Million Population = 1e+006  
Units: People
- (227) Normal Garrison Requirement per Cohort = 8  
Units: People/Cohort
- (235) Opposition Fighter Losses = Blue Infantry Final Losses \* "% of Blue Infantry that are Local Opposition Fighters"  
Units: People/Period
- (245) Police Forces Required = Governed Cohorts \* Militant Police per Cohort  
Units: People
- (247) "Population (People)" = INTEG( "Births & Immigration (People/Period)" - "Deaths, Recruiting & Emmigration (People/Period)" , Initial Population )  
Units: People  
Combined population of all Syrian and Iraqi Provinces.  
"Provinces of Syria", Administrative Divisions of Countries, Statoids, last modified September 22, 2004, accessed September 19th, 2014, <http://www.statoids.com/usy.html>.  
"Provinces of Iraq", Administrative Divisions of Countries, Statoids, last modified March 16, 2014, accessed September 19th, 2014, <http://www.statoids.com/uiq.html>.
- (248) "Population Controlled by Coercive Power (People)" = INTEG( "Gain in Control (People/Period)" - "Loss of Control (People/Period)" , "ZScenario1: Starting Population Controlled" )  
Units: People

- (250) Population Controlled Only = "Population Controlled by Coercive Power (People)" - "Population Governed through Legitimacy (People)"  
Units: People
- (252) "Population Governed through Legitimacy (People)" = INTEG( "Rate of Transition to Governance (People/Period)" - "Rate of Loss of Governance (People/Period)" , 0)  
Units: People
- (260) Rate of Blue Force Deaths = Blue Infantry Actual Losses  
Units: People/Period
- (262) "Rate of Deaths (People/Period)" = "Deaths (People/Period)"  
Units: People/Period
- (266) Rate of Local Opposition Fighters Joining Uprising = Diehards joining Uprising + ( Effect of Ungarrison Ratio on Recruiting Rate \* Current Territory Recruitable Population ) / Time for Uprising to Form  
Units: People/Period
- (269) Rate of Local Fighter Deaths = Opposition Fighter Losses  
Units: People/Period
- (272) Ratio of Delta to Militants = "Delta between Desired & Actual Garrison" / "ISIS Militants (People)"  
Units: Fraction
- (334) Size of Cohort = 1000  
Units: People/Cohort
- (336) Starting Blue Force Fighters Actively Oposing ISIS = 10000  
Units: People
- (345) "Table f/ KIA perM on Force Multiplier" ( [(0,0)-(460,3)],(0,1),(28,1),(50,1.23),(67,1.36),(120,1.67),(298,2.36),(460,2.8) )  
Units: Dmnl
- (346) "Table f/ Local vs Foreign Forces on Force Multiplier" ( [(0,0)-(1,3)],(0,2.38),(0.1,2.38),(0.65,1.14),(1,1) )  
Units: Dmnl

- (355) Table for Effect of Ratio on Uprising ( [(0,0)-(1.5,0.15)],(0,0),(0.5,0.01),(0.75,0.02),(0.8,0.03),(1,0.05),(1.2,0.1) )  
Units: Fraction
- (376) Time for Fighters to Activate = 1  
Units: Period
- (379) Time for Uprising to Form = 1  
Units: Period