

# Optimizing Counterinsurgency Requirements

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# Background

## Problem:

Given current frameworks of thought and historic data on counterinsurgencies, determine insights into the optimal number of forces required to reduce violence in an insurgency at the national level.

## Method:

Solving a math program to minimize the number of counterinsurgent forces required to reduce violence in an insurgency, using Afghanistan as a case study.

## Applicable Theories

- David Kilcullen: Multiple theories on micro and macro analysis
  - *Counterinsurgency*
  - *The Accidental Guerrilla*
- Thomas Barnett: Core-Gap Theory and the Ten Commandments for Globalization in *The Pentagon's New Map*
- Eli Berman: The Economic Club Theory in *Radical, Religious and Violent*
- Robert Pape: Effects of Suicide Terrorism in *Dying to Win* and *Cutting the Fuse*
- Bard O'Neill: Categorization of Insurgent Types and Strategies in *Insurgency & Terrorism*

## Previous Work

- Force-to-population ratios
  - James Quinlivan, *Force Requirements in Stability Operations*
  - John McGrath, *Boots on the Ground*
  - Steven Goode, *A Historical Basis for Force Requirements in Counterinsurgency*
- Logistic Regression on multiple factors: Justine Blaho, CAA. MORS Presentation 2009
- Analysis of individual factors in counterinsurgency: Jason Lyall, *Do Democracies Make Inferior Counterinsurgents?* and *Rage Against the Machines: Explaining Outcomes in Counterinsurgent Wars*
- Determine the percentage chance of winning a counterinsurgency based on forces and population, Enterline and Greig, *Against All Odds? Historical Trends in Imposed Democracy and the Future of Iraq and Afghanistan*
- Insurgent to counterinsurgent ratios, Christopher Lawrence, *The Analysis of the Historical Effectiveness of Different Counterinsurgency Tactics and Strategies*

# Data Sources and Definitions

- Data sources used in this study
  - Center For Army Analysis irregular warfare database
  - Penn World Tables
  - World Bank
  - Brookings Institute Publications: Iraq/Afghanistan Index
  - icasualties.org
- Definitions
  - Insurgency: The organized use of subversion and violence by a group or movement that seeks to overthrow or force change of a governing authority. (Joint Publication 1-02, 2011)
  - Host Nation: The country in which the insurgency is occurring.
  - Host Nation Forces: The national forces used to protect the population and conduct counterinsurgency in the host nation, including police and military.
  - Counterinsurgent Forces: All extra-national forces assisting the host nation forces in counterinsurgency.

# Methodology

## Step 1

Formulate a Math Program that determines the number of counterinsurgent and host nation forces required

### Theories

- Force-to-Population Ratio
- Historical Trends

### Data

- Forces
- Population
- Historical growth rates
- Modern limits on forces

## Step 2

Use historical data to determine the **number of counterinsurgents killed per year** based on the number of counterinsurgent forces present each year, the number of insurgents killed annually, and other economic, social, and geographic characteristics of the country

## Step 3

Add goals and constraints to the math program based on modern counterinsurgency frameworks of thought

### Theories

- Economic Clubs
- Core-Gap
- Pape Terrorism Theory
- O'Neill Classification

### Data

- Foreign Aid
- Foreign Investment
- Suicide Terrorism
- Other Causes of Instability

# Modeling Challenges

- Amount and frequency of data
- The problem of “No Universal Definitions”
  - Attacks and casualties are inconsistent measures within and among conflicts
  - Exceptions: “Data with a Constituency,” e.g., counterinsurgents killed in action and number of forces
- Nonlinearity in constraints
  - Expressions with multiple logged variables require nonlinear constraints, approximations, or formulating the optimization model in transformed data
  - For tractability purposes, we want a linear representation that solves quickly



## Description

- The math program determines the number of Counterinsurgent and Host Nation forces conducting counterinsurgency and population protection for each year of the conflict
- The objective of the math program is to minimize the deviation from the required force ratio
- Given the following parameters:
  - The limit on the size of counterinsurgent forces
  - The limit on the annual growth rate of counterinsurgent forces
  - The limit on the size of host nation forces
  - The limit on the annual growth rate of host nation forces

# Math Program Sets, Parameters, and Variables

## Sets

- $T$ : years of the insurgency, starting in the first year and ending in year ( $\bar{t}$ )

## Parameters

- $\mathcal{M}$ : A large number
- $\epsilon$ : A small number
- $pop_t$ : Population of the country in year  $t$
- $req$ : Required force level in forces per population
- $hn^{Max}$ : Maximum number of host nation forces
- $\bar{h}n^{Max}$ : Maximum increase per year of host nation forces
- $\bar{h}n^{Rate}$ : Maximum rate of increase of host nation forces(%)
- $\underline{h}n^{max}$ : Maximum number of counterinsurgent forces
- $\underline{h}n^{Rate}$ : Required rate of decrease of host nation forces(%)
- $in_t^D$ : Number of insurgent deaths in year  $t$
- $\beta_1, \delta_1, \gamma_1$ : Parameters used to determine the number of counterinsurgent deaths in year  $t$  when forces are above  $req$
- $\beta_2, \delta_2, \gamma_2$ : Parameters used to determine the number of counterinsurgent deaths in year  $t$  when forces are below  $req$

# Math Program Sets, Parameters, and Variables

## Variables

- $CI_t^N$ : Number of counterinsurgents in year  $t$
- $CI_t^D$ : Number of counterinsurgent deaths in year  $t$
- $HN_t^N$ : Number of host nation security forces in year  $t$
- $D_t$ : Deviation from desired force level in year  $t$
- $\alpha_t$ : Binary decision variable, 1 if forces are above the desired force level in year  $t$

# Math Program Description

Minimize Deviation from force level:

$$\sum_{t=1}^{\bar{t}} D_t \quad (1)$$

subject to:

$$CI_t^N / pop_t + HN_t^N / pop_t \geq req - D_t \quad \forall t \quad (2)$$

$$HN_{t+1}^N \leq HN_t^N + \bar{h}n^{Max} \quad \forall t \quad (3)$$

$$HN_{t+1}^N \leq HN_t^N \cdot \bar{h}n^{Rate} \quad \forall t \quad (4)$$

$$CI_{t+1}^N = CI_t^N \cdot \underline{c}i^{Rate} \quad \forall t \quad (5)$$

$$CI_t^N \leq \underline{c}i^{Max} \quad \forall t \quad (6)$$

# Math Program Description

$$HN_{t-1}^N + CI_{t-1}^N \geq req - \mathcal{M}(1 - \alpha_t) \quad \forall t \quad (7)$$

$$HN_{t-1}^N + CI_{t-1}^N \leq req - \epsilon + \mathcal{M}\alpha_t \quad \forall t \quad (8)$$

$$CI_{t+1}^D / pop_t \geq \beta_1 CI_t^N / pop_t + \delta_1 in_t^D / pop_t + \gamma_1 - \mathcal{M}(1 - \alpha_t) \quad \forall t \quad (9)$$

$$CI_{t+1}^D / pop_t \leq \beta_1 CI_t^N / pop_t + \delta_1 in_t^D / pop_t + \gamma_1 + \mathcal{M}(1 - \alpha_t) \quad \forall t \quad (10)$$

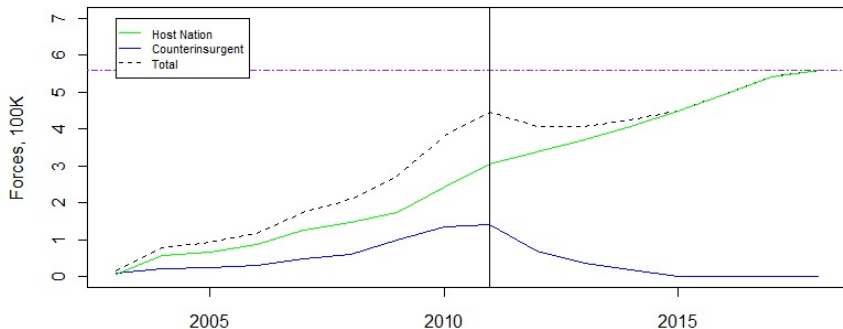
$$CI_{t+1}^D / pop_t \geq \beta_2 CI_t^N / pop_t + \delta_2 in_t^D / pop_t + \gamma_2 - \mathcal{M}\alpha_t \quad \forall t \quad (11)$$

$$CI_{t+1}^D / pop_t \leq \beta_2 CI_t^N / pop_t + \delta_2 in_t^D / pop_t + \gamma_2 + \mathcal{M}\alpha_t \quad \forall t \quad (12)$$

$$CI_t^N, CI_t^D, HN_t^N, D_t \geq 0 \quad \forall t \quad (13)$$

$$\alpha_t \in \{0, 1\} \quad (14)$$

# Application of the Math Program: Afghanistan force levels 2011-2018



## Analysis and Insights

- There is a log-linear relationship between the number of counterinsurgent forces and the number of counterinsurgent deaths and insurgent deaths (normalized by host nation population)
- Relationship of time-series data is complicated by autocorrelation
- Inclusion of outliers, especially of small insurgencies, must be carefully considered

## Further Study

- Determine the number of **counterinsurgent deaths** using fixed-effects regression on the number of counterinsurgent forces and the number of insurgents killed
- Use fixed-effects regression to determine the number of counterinsurgent deaths and examine the different coefficients on each country
- Determine the year of departure for counterinsurgent forces by examining historical patterns
- Add constraints using economic parameters
- Model remaining error to produce a confidence interval on our results
- Analyze results to produce recommendations on doctrine and policy



## Conflicts used in this study

Country	Start	end
Afghanistan	1979	1989
Afghanistan	2001	2011
Algeria	1954	1962
Angola	1961	1974
Angola	1975	1988
Cameroon	1955	1959
Chad	1969	1971
Chad	1978	1980
D.R. Congo	2000	2007
Cote d'Ivoire	2002	2009
Croatia	1991	1995
Cyprus	1955	1959

Country	Start	end
Guinea	1963	1974
Indonesia	1963	1966
Indonesia	1975	1999
Iraq	2003	2009
Kenya	1952	1956
Lebanon	1990	2008
Malaysia	1950	1960
Mozambique	1964	1974
Sierra Leone	1997	2004
Ukraine	2004	2006
Vietnam	1961	1964
Yemen	1963	1967