DEPLOYED ANALYST HANDBOOK

(DAHB)

JUNE 2016

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The Center for Army Analysis (CAA) has provided Operations Research /Systems Analysis (ORSA) support to forward deploying headquarters with both personnel and reachback project execution for over 14 years. Changes in the operational environment prompted this revision of the Deployed Analyst Handbook to prepare analysts for deployments in support of the warfighter. This handbook highlights ORSA methods and techniques that are expected to be used by ORSA analysts into the foreseeable future.

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DEPLOYED ANALYST HANDBOOK
(DAHB)
JUNE 2016

SUMMARY

THE PROJECT PURPOSE: This handbook is intended to be a quick reference guide for all deploying Operations Research/Systems Analysis (ORSA) analysts, whether military, civilian, or contractor.

THE PROJECT SPONSOR: Functional Area (FA) 49 Proponency Office.

THE PROJECT OBJECTIVES:

Present ORSA analysts with a wide range of topics from specific analytical products to ways to prepare and communicate analyses.

Present examples of analyses developed in theater and through reachback support.

Present examples of analyses that ORSA analysts can expect to execute in a combat theater.

Provide references for ORSA analysts who are interested in additional resources and examples.

THE SCOPE OF THE PROJECT: The information contained in this handbook was developed from the experiences of ORSA analysts who deployed to operational theaters in Iraq, Afghanistan, the Philippines, the Horn of Africa, the Middle East, and elsewhere over the past 14-plus years.

COMMENTS AND QUESTIONS may be sent to the Director, Center for Army Analysis, ATTN: CSCA-OA, 6001 Goethals Road, Suite 102, Fort Belvoir, VA 22060-5230

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PREFACE

Dedication. This Deployed Analyst Handbook (DAHB) is dedicated to the 142 ORSA analysts who deployed under Center for Army Analysis (CAA) auspices to Iraq, Afghanistan, the Horn of Africa, and the Philippines from 2002 through June of 2016.

The Center would also like to thank all Operations Research/Systems Analysis (ORSA) analysts who contributed to the development of the DAHB, as well as reviewing agencies, to include the U.S. Army Materiel Systems Analysis Activity (AMSAA), the Marine Corps Combat Development Command (MCCDC), the U.S. Army Training and Doctrine Command Analysis Center (TRAC), and the Functional Area (FA) 49 Proponency Office.

Intended Audience. Military FA 49s, civilian career program (CP) 36/1515s, and ORSA contractors who directly support the warfighter at brigade and higher levels of command.

Reference Guide. The DAHB is a quick reference guide for all deploying ORSA analysts and contains a wide range of techniques and analytical products that ORSA analysts have developed in theater and through reachback support, and have used in operational theaters. The lessons learned and best practices contained in the DAHB were consolidated from numerous ORSA analysts who have deployed in support of Operations Iraqi Freedom (OIF) and New Dawn (OND) in Iraq; Operations Enduring Freedom (OEF) and Freedom's Sentinel (OFS) in Afghanistan; Operation Inherent Resolve (OIR) in the Levant, and other Overseas Contingency Operations (OCOs) in the Philippines, the Horn of Africa, and elsewhere around the world over the past 14-plus years. The DAHB is informative, relevant, and full of information—not easily obtained elsewhere—that will prepare deploying ORSA analysts for their unique and highly critical assignments at the tactical, operational, and strategic levels of war.

Topic Selections. The information and examples presented in this handbook highlight the types of analyses that ORSA analysts can expect to conduct in the future. CAA thoughtfully chose these specific examples through working groups and advice received from experts throughout the analytical community.

Motivation for Using Handbook. This handbook complements the CAA Deploying Analyst Course (DAC) by providing a companion text that assists deploying ORSA analysts who are junior military officers, civilians, and contractors. This handbook helps prepare ORSA analysts to provide analytical support to their respective commands and staffs by exposing them to best practices and lessons learned, and informing them of the reachback processes.

Additional Deployed Analyst Information and Insights:

- CAA Deployed Analyst History Report Vol. I (Analytic Support to Combat Operations in Iraq (2002 – 2011)), March 2012, available at http://www.caa.army.mil/DAHR%20Volume%201%20-%20Iraq%20Final-March%202012.pdf.

- CAA Deployed Analyst History Report (DAHR) Vol. II (Analytic Support to Combat Operations in The Philippines (2011 - 2014)), December 2015, available at http://www.caa.army.mil/DAHR-Philippines(Final%20Report)20151203.pdf.

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CHAPTER 1 COMMUNICATING ORSA CAPABILITIES

1.1 What is Operations Research?

General. What is Operations Research/Systems Analysis? It is difficult to answer this question concisely without using words like stochastic, combinatorial, and heteroscedasticity. However, effectively communicating one's unique ORSA capabilities to the command is as critical to one's success as is the quality of one's work.

In a deployed environment, ORSA analysts often do not have the luxury of external resources to assist in communicating their skill set to the command and others who would benefit from their assistance. Many or most ORSA analysts are introverted by nature. More often than not, socializing one's skill set does not come naturally. However, it is a talent that can be developed with practice.

This chapter offers techniques for ORSA analysts to use (1) in explaining their profession concisely to others, (2) in applying their skills in a deployed environment, and (3) in effectively presenting their work. Much of the content of this chapter parallels information from the Institute for Operations Research and the Management Sciences (INFORMS) on communicating the ORSA profession.

1.2 Concisely Communicating the ORSA Profession to Others

ORSA Defined. ORSA is the acronym for the scientific field of "Operations Research/Systems Analysis," but ORSA is often used colloquially to mean an "ORSA analyst." Introducing oneself as an ORSA peaks the attention of others and leads to further inquiry. As senior leaders become familiar with the highly skilled, academic nature of an ORSA analyst's work, they gain a sober appreciation for the tremendous value ORSA analysts bring to the fight. In short order, senior leaders associate ORSA analysts with insight and solutions for solving complex problems at the tactical, operational, and strategic levels of war.

Responsibilities of a deployed ORSA:[1]

ORSAs use analytical methods and mathematically based procedures to enable leadership decisions in a constantly changing global environment. [ORSAs] introduce quantitative and qualitative analysis to the military's decision-making processes by developing and applying probability models, statistical inference, simulations, optimization, and economic models. [ORSAs work in] diverse disciplines that include personnel management, doctrine and force development, training management, system testing, system acquisition, decision analysis, and resource management, as well as tactical, operational and strategic planning from division through combatant command, and from Army Command (ACOM) through the highest levels of the [Department of Defense] DOD (Department of the Army Pamphlet [DA PAM] 600-3, 2014, p. 310).

ORSAs integrate military knowledge and experience with the scientific and managerial fields. They serve as subject matter experts in designing forces, allocating resources, analyzing effects,

[1] This discussion about the responsibilities of a deployed Army Officer ORSA taken from DA PAM 600-3, 2014 is substantially applicable to deployed Army, sister service, and partner nations' military, civilian, and contractor ORSAs.

performing course of action and trade-off analysis, and they effectively communicate potential solutions to complex problems to decision makers. The ORSA officer will typically serve in one of several general assignments:

(1) As a combat analyst on a division, corps, Army Service Component Command (ASCC), (or equivalent joint headquarters staff), or Combatant Command headquarters staff.

(2) As an analyst on an Army, joint, or defense agency staff, a field-operating agency (FOA) or a direct reporting unit, (e.g., CAA, Human Resources Command (HRC), or the Army Test and Evaluation Command).

(3) As an analyst in an ACOM, i.e., U.S. Army Training and Doctrine Command (TRADOC), U.S. Army Forces Command (FORSCOM), or U.S. Army Materiel Command (AMC), either in the command headquarters or in an organization whose principal mission is to provide analysis that supports the organizing, equipping, manning, training and operations of military forces. Such organizations include the TRADOC Army Capabilities Integration Center (ARCIC), TRADOC Analysis Center (TRAC), and Army Centers of Excellence (CoE).

(4) As an instructor teaching Operations Research/Systems Analysis and/or mathematics courses at the United States Military Academy (USMA), Naval Postgraduate School (NPS), Air Force Institute of Technology or a TRADOC School. (DA PAM) 600-3, 2014, p. 311).

The ORSA Skill Set. ORSA analysts (1) investigate essential factors that illuminate understanding; (2) communicate complex ideas to decision makers at brigade and higher levels of command; and (3) recommend solutions to complex problems.

ORSA analysts apply their skill set through (1) problem analysis, using various analytical techniques; (2) probability and statistics analysis to gain valuable insight; and (3) optimization analysis to quantify options and select the best option for a complex problem that has multiple solution sets.

Application examples include

- analyzing significant event data in order to identify spatial and temporal trends;
- developing strategies to effectively allocate or employ limited resources;
- improving supply chain and logistics operations;
- conducting qualitative and quantitative assessments of current operations;
- measuring risk and uncovering factors critical to managing and reducing risk; and
- evaluating the potential benefit of changes to tactics, techniques, and procedures (TTPs).

1.3 How to Recognize When Others Would Benefit from ORSA

An ORSA analyst can determine when others would benefit from their skill set through a variety of indicators including identifying staff

- with a large amount of data but do not know what is important or how to use it;
- who are responsible for inputting and storing their data in Excel but do not have the skills to do so;

- who do not know how to display their data to senior leaders;
- who are dealing with a complex problem with many decision points and need a method to analytically evaluate their options and choose the best one;
- who are risk-averse and do not have effective strategies for limiting, reducing, or managing risk; or
- who have variables they want to measure but do not know how to measure them.

1.4 Valuable Applications of the ORSA Skill Set in a Deployed Environment

Most ORSA analysts do not have the time required to use advanced ORSA techniques in a deployed environment; however, there are less complex applications that are highly valuable to theater commands. These include

- managing, analyzing, and displaying data;
- organizing large amounts of data;
- communicating technical information to commanders and senior leaders;
- thinking critically, i.e., "outside the box", and developing strategies to solve complex problems;
- advocating change and providing clear answers to problems others are reluctant to tackle;
- developing metrics to measure campaign progress;
- providing recommendations that are tactically, operationally, and strategically relevant; and
- teaching basic and advanced Excel and PowerPoint skills.

In the ORSA community, these tools are often taken for granted, e.g., pivot tables and charts; linking PowerPoint data to external statistical databases; or using Visual Basic for Applications (VBA) to automate tasks. The ORSA skill set is in high demand and pays huge dividends for theater commanders. For example, teaching staff members Excel technical shortcuts saves them a great deal of time (the most highly valued asset in theater). There is a saying, "If you give a man a fish, you feed him for a day. If you teach a man to fish, you feed him for a lifetime" (author unknown).

1.5 Ensuring One's Relevancy

ORSA analysts often must establish their role with other staff officers in the unit who may be confused as to the nature of their duties. This is essential in ensuring that ORSA analysts are used appropriately for the services they offer. Listed below are techniques incoming ORSA analysts should consider when establishing their role.

Keep others informed. ORSA analysts should strive to become extroverted collaborators, not "isolationists." They should be excited about their work and share it with others. Products improve when one collaborates with others and involves them in the process. No matter the level of expertise, others have opinions, unique histories and backgrounds, and "an extra set of eyes" to enhance the process. Others cannot help solve a problem or assist with a project unless they are aware of it.

Make time for face-to-face interaction with others. In today's digital world, staff work can keep professionals at their desks for hours on end. ORSA analysts should get out and mingle with their counterparts. This is the best way for everyone to get to know each other and share problems, issues, concerns, and ideas. Before one can influence others, one must gain their trust and respect. ORSA is a quiet profession. ORSA analysts have to get out and make a little noise if they want to be utilized. As a rule-of-thumb, one should spend more time interacting with others face-to-face than interacting with others over the computer.

Do not emphasize problems. Commanders and staff appreciate solutions. Problems are just challenges waiting to be met by determined ORSA analysts and their in and out of theater networks of associates. This does not mean the ORSA analyst is an expert in every staff issue. However, the ORSA analyst should talk to staff members to uncover solutions that can serve to solve problems.

Create the opportunity for follow-on interaction. When an ORSA analyst meets people face-to-face to discuss issues, he or she should set a time to meet again. This helps keep the momentum going so others do not lose interest or become sidetracked. One should say something like, "when we meet again at 1000 on Thursday, we will discuss progress on *x, y,* and *z*."

Actively seek out resources, e.g., colleagues, mentors, and "believers." There are people in the command who have ORSA backgrounds and/or are aware of the value ORSA analysts bring to the table. One should develop a strong rapport with these people, keep them informed of current work, and ask these people if they are willing to collaborate on projects. This is especially important if one is a "lone" deployed ORSA analyst. ORSA analysts should find others who appreciate groundbreaking ideas and support "out of the box" projects.

Familiarize others with ORSA work. The following technique can increase one's exposure: When briefing or describing one's work to others, say, "Do you think Colonel Smith would like to see this analysis?" When one receives an affirmative answer, one has a perfectly good reason to walk into Colonel Smith's office and present one's great work. When possible, an ORSA analyst should bring along his or her supervisor or counterpart in or near Colonel Smith's office or network. This builds relationships within an ORSA analyst's circle of influence.

Start with projects most applicable and important to the command. ORSA analysts could spend months simply mining through data sets. As a deployed ORSA analyst, one does not have the luxury of time. Deployed ORSA analysts need to produce results in days (or sometimes hours). Good work completed quickly is better than great work completed late. People need to receive answers while they still remember their questions. Conducting timely analysis that is most applicable and important to the command creates a healthy respect for the ORSA profession. Once senior leaders understand and appreciate the ORSA skill set, they will seek out ORSA analyst assistance on complex problems. By solving problems quickly and well, one becomes the go-to person in the command for advice and for solutions.

Answer *the* question. ORSA analysts should resist the temptation to over promise. When presented with a specific question, one should always answer that question first, especially prior to explaining to the senior leader that the question he asked is not the "real" question at hand. If time permits, one can conduct further analysis and provide alternative solutions and recommendations. Be humble when explaining new concepts to senior leaders; for example, introducing the concept of normalizing casualty statistics against the population of a security service, e.g., 52 killed in action/10k troops. Be prepared to explain what you mean in clear simple language and how normalizing casualties provides context not found in the raw numbers.

Prepare concise reports and clean presentations. Two or three pages or slides are usually sufficient. When possible, an ORSA analyst should present his or her results in one page or slide. One should write in Standard English so everyone can understand. Presentations should be brief and direct. One should highlight or **bold** the insights/results of the analysis.

Do not sell the algorithm; sell the results. Hardly anyone cares that one performed a Chi-Squared test with 41 degrees of freedom or a logistic regression with 12 independent variables with interactions. An ORSA analyst should present findings/results of the analysis and their significance to the mission. Too many ORSA analysts spend too much time writing and talking about *how* they did the analysis. Senior leaders do not need the process; they need the results. One should share his or her conclusions and make recommendations.

1.6 Summary

This chapter explained the role of the ORSA analyst. It was designed to teach a deploying ORSA analyst how to (1) communicate his or her profession to others; (2) apply his or her skill set in a deployed environment; and (3) become the *go-to* person in his or her command. Good communication skills are vital to one's success as a deployed ORSA analyst. Effective communication does not replace sound analytical work; both are required in a deployed environment.

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CHAPTER 2 DATA MANAGEMENT METHODS

2.1 Why Data Management?

Data Management is the process of planning, coordinating, and controlling an organization's data resources. Data management is generally a Chief Information Office (CIO)/ G-6 function; however, in a deployed environment, ORSA analysts play a significant role in data management. Key responsibilities associated with data management include data acquisition/collection, data indexing/cataloging/storage, and data verification/validation.

This chapter provides an overview of data management methods. It is not a cookbook of detailed procedures or an exploration of abstract, conceptual techniques. Rather, it provides an analytical approach that is responsive to the needs of decision makers at the highest levels of military command. It includes data management topics ranging from general data considerations to specific data requirements: data collection, data entry, data reporting, and data analysis.

2.2 Data Management Goals and Objectives

ORSA analysts seldom render advice based on perfect information. An ORSA analyst's task is to discern which data are pertinent and meaningful and then use these data in the problem solving process. Inappropriate, inaccurate, and invalid data are sources of fruitless analytical effort (sound study efforts based on sound analytical designs are of little value without valid data). It is a rookie mistake to base judgments on the unchallenged use of *official* figures. One must challenge his or her sources of information. One must examine the data that researchers used to reach their conclusions. One must determine how researchers derived their findings, and one must check data for accuracy. A key function of analysis is to reject bad data and inaccurate information. Ensuring and maintaining data integrity is fundamental to the military mission and requires a considerable investment of time and energy.

2.3 Data Management Process Overview

Data Flow Model. A simple data flow model provides a good starting point for understanding how to carry out data handling procedures. Figure 1 identifies five key steps in data flow: acquisition, verification, validation, analysis, and dissemination. These steps—plus additional procedural details—are described in the following pages. Additionally, storage, maintenance, and security issues apply at all stages of data flow.

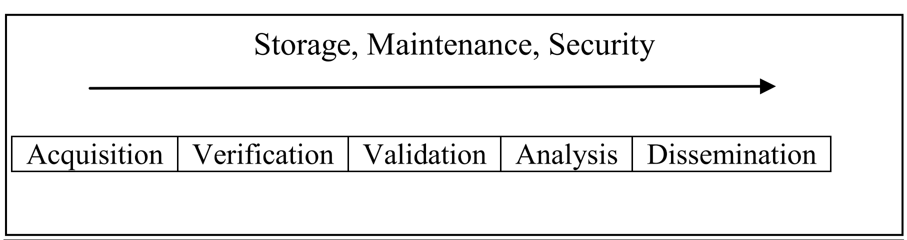

Figure 1. Steps in data flow model.

Data Acquisition. Acquiring and collecting data from many internal and external sources is critical and often complicated. Sometimes there is a need to collect raw data in the field, such as post blast details from an improvised explosive device (IED) event. Other times, there is a need to elicit data from other people, e.g., polling/survey data. Data may be acquired through data mining or field studies conducted personally or by other analysts. Regardless of one's method of collection, one must filter and validate the data to avoid garbage in, garbage out. Data quality is an extremely important issue.

2.4 Three Common Characteristics of Data Collection

Data Population for Measurement (Who?) In order to choose the most appropriate statistical methods of analysis, one must precisely define the population he or she wishes to measure. The specific segments of the general population one samples are called *sampling units*. Sampling units must be unique, easily identifiable, and selectable. For instance, if a poll involves Soldiers from multiple units, the researcher must capture certain criteria associated with each Soldier, e.g., rank, branch, duties, and responsibilities, so he or she can easily identify all measurements from this population. If the measured population includes Private Jones, an Infantry Soldier with the 101st Airborne Division who served in Afghanistan from May 2014 to May 2015, the researcher must identify measurements associated with this Soldier, i.e., personal characteristics and professional activities. *Sampling units* must be both discrete (countable) and measurable using standardized methodologies.

Items for Measurement (What?) After one defines the population and sampling units, one must define and select the *specific* data he or she wishes to measure. Measured data must have clear definitions, recognizable characteristics, a clearly defined set of observable measurement parameters (qualification standards), and a discrete name. For example, when a soldier submits an initial spot report, he or she describes enemy activity, gives a clear description of what the friendly forces were doing at the time of the incident (patrol, recon, etc.), pinpoints where the incident took place (grid location), how many soldiers were involved in the incident, what kind of incident occurred, e.g., IED explosion, and what the outcome of the incident was, i.e., battle damage assessment. One should treat each of these data points as discrete pieces of the event to facilitate further analysis and comparison with future or past events that are similar.

Methods of Performing the Measurement (How?) Data are generally classified as *objective* or *subjective*, depending on the amount of human judgment involved with measuring them. Objective data have physical/tangible properties, e.g., grid location, speed of a vehicle, number of vehicles in a convoy and require little or no human judgment. On the other hand, subjective data, e.g., lessons learned captured from surveys submitted by redeploying soldiers, require human judgment. For some aspects of data collection, objective data may ultimately give sensitive, reliable, and valid results. Other data, such as soldier feedback and assessments, require subjective measurements and interpretation. A researcher must evaluate, score, and assign a rating to each subjective measurement. He or she must assess and measure the validity of each. In every case—to the greatest extent possible—a researcher must minimize his or her personal biases in order to ensure valid and reliable data collection.

2.5 High Quality Data Attributes

Sensitivity. Sensitivity means the extent to which a small change in a parameter results in a relatively large change in the outcome. If a small change in a parameter results in a relatively large change in the outcome, the outcome is said to be *sensitive* to that parameter.

Reliability. Reliability means free from random error in the final measurement, usually indicated by consistency among items or stability in the measurements over time. Both sampling and non-sampling errors affect reliability. Sampling errors are the inevitable result of basing an inference on a random sample rather than on the entire population. Non-sampling errors occur from non-response, coding errors, computer processing errors, errors in the sampling frame, reporting errors, etc.

Validity. Validity means that the data accurately represent what they are intended to represent. Data validity depends partly on having adequate sensitivity and reliability of the measures; however, even with adequate sensitivity and reliability, the data may represent something other than what they appear to represent. For example, a poorly worded survey question may yield results that do not accurately answer the desired question (invalid results). Vague data definitions, insufficient interviewer training, casual data collection methods, and operator discretion weaken or reduce data validity.

Standardization. Standardization means ensuring uniformity in data collection procedures. Standardization ensures that data differences are not procedural differences. The standardization attribute is very sensitive to non-sampling errors associated with quality of data, collection techniques, and the stability of established data collection procedures.

Completeness. Completeness means that all the expected data elements, records, observations, etc. are present. Non-sampling errors affect completeness. Common causes of incomplete data include (a) failure to enforce data collection standards outlined in the standardized data entry report, (b) failure to report all of the required information, (c) failure to secure records from which the data are to be collected, (e) inability to read/scan the data collection form, and (f) corrupted files.

2.6 Data Entry

Data entry is the initial set of operations used to transcribe the raw source data (survey results, initial spot reports, etc.) into a computerized format, i.e., a database. Data entry begins when data collection is complete. Data entry forms and quality control features are extremely important in minimizing error. One should standardize data entry forms across all levels of command to ensure consistency in data collection. Standardized forms should contain logical formats that include discrete data entry choices e.g., drop down menus, to reduce transcription errors. Inevitably, the process of transcribing data from field forms to a digital format introduces error. To minimize errors, one must standardize data entry forms and quality control measures throughout the data management process. For example, data entry forms reduce transcription errors through pick lists, value limits, and controlled access to the database. Forms set for "data entry only" prevent accidental deletion or alteration of existing data. One can also set key fields to prevent duplicate entries such as variations of a unit's name. With standardized forms, one can also control the sequence of data entry. A well-developed data entry format enables users to search for and retrieve consistent results that are free from duplicate entries.

2.7 Data Verification

Irrespective of how one acquires the data, one must import the data into the database using a process that ensures verification. Data verification immediately follows data entry and involves checking the accuracy of source data. While one rarely achieves 100% error-free data entry, one can minimize transcription errors by using a layered approach to data verification. One should use quality control measures throughout the data management process, from the entry of an initial report, to the consolidation of massed reports into an official database, to retrieval at higher headquarters where one uses the data for analysis and decision making. A good *rule of thumb* is for one to verify 10% of all records for a specified period, focusing on key aspects of the report e.g., event location, event category, etc. One should compare these audited records with the existing record and include this information in the finalized report. If one finds reporting errors, he or she should review and re-verify the entire data set. Once one verifies that the computerized data accurately reflect the original field data, he or she can index and archive the reports for later retrieval.

2.8 Data Validation

Data validation ensures the accuracy of the original source field reports. Data should be accurate and logical. For example, a report stating the convoy speed was 150 mph is illogical and almost certainly incorrect, whether or not the original recorder properly transcribed the data from field reports. As another example of validated data, spatial data collected within a certain boundary should appear within that boundary when viewed in a geographic information system (GIS) environment. The process of reviewing computerized data for range and logic errors is the validation stage.

Database developers build certain components of data validation into their programs, e.g., range limits. ORSA analysts can perform additional data validation during verification if they are sufficiently knowledgeable about the data. During data validation, an ORSA analyst should identify generic errors, e.g., missing, mismatched, or duplicate records, as well as errors specific to particular items and types of activities. For example, validation of enemy threat data includes database queries and comparison of data over different years. One query may detect records of specific location identification (ID) and a certain type of enemy activity, e.g., IED attack. Another query may count the number of IED attack plots per sample site to ensure that personnel entered all plots correctly. Additionally, an ORSA analyst can compare current data with previous years to identify gross differences. One should ensure consistency between field forms and the database by noting how and why personnel made changes to the data on the original field forms. Once data validation is complete, the data can be archived for later retrieval.

2.9 Data Analysis

As described by Albright, Winston, and Zappe (2011), there are seven basic steps to data analysis: (1) define the problem, (2) collect and summarize the data, (3) formulate a model, (4) verify the model, (5) select one or more suitable decisions, (6) present results, and (7) update the model as new data become available. These steps aid in planning the proper course of data analysis. Simply put, there are a myriad of statistical tests, optimization methods, and simulation methods, and one must determine which technique is appropriate for a given situation. Analytical tools used to assist in the process include, but are not limited to, Excel, Access, ESRI Arc Geographical Information System (ArcGIS), SAS Institute Statistical Analysis System (SAS), and IBM's Statistical Package for the Social Sciences (SPSS).[2] All data analysis

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[2] Note: No endorsement is stated or implied by any references to commercial software applications in this handbook.

techniques should comport to scientific and professional standards. One should analyze results for statistical significant.

2.10 Data Dissemination

One should follow the appropriate review process and share results with all identified users. One should display data in a logical and consistent format and follow ownership protocol guidelines. To accomplish this goal, one should use standardized procedures to quality-check, analyze, document, catalogue, archive, and make data available for further analysis and decision making. It is especially important to provide well-documented data in a timely manner to those who depend on readily accessible, accurate, and complete data. One should consider the following advice:

- Data should be easily discoverable and obtainable.
- Data results should not be released until appropriate authorities have granted permissions.
- Complete metadata (characteristics of information-bearing entities) that clearly establish the source and content of the data should be included.
- Data should be properly identified and protected from unauthorized access and inappropriate use, e.g., sensitive data in reports, metadata, raw and manipulated spatial and non-spatial data, maps. One should clearly identify classified data and follow all rules of use and distribution.

At times, one may need to export data from one database to another, e.g., from Access to SPSS, ArcGIS, or FalconView for further analysis. Data integrity must be maintained when transferring data between software tools. One can most easily control the field order, i.e., order of variables in the resulting 'flat' file, while the data is still in the relational database. One should determine field types early on in the database development process. One should keep data type changes to a minimum in order to minimize risk to data loss. This handbook recommends using the American Standard Code for Information Interchange (ASCII) text for its nearly universal readability across applications. ASCII text typically delimits fields by commas, tabs, or spaces, and encloses text strings by single or double quotes. ASCII text requires extra steps to transfer data between applications and extra care regarding data formatting. The preferred alternatives are data exports directly from an Access .mdb file (such as ArcGIS) or link to an .mdb file by way of a database connection such as an Object Linking and Embedding Database (OLE DB) or an Open Database Connectivity (ODBC) data link.

2.11 Data Organization

The various databases, reports, GIS coverages, etc. create a large number of files and folders to manage. For example, databases are occasionally stored in two versions of Access in order to accommodate data users with different software versions. Additionally, GIS data are sometimes stored in two projections, one for navigation and another for use with existing base GIS data. Poor file management leads to confusion and data corruption.

2.12 Data Maintenance

Data sets are rarely static. They often change through additions, corrections, and improvements following the archival of a data set. There are three main caveats to this process:

- One should only make changes that improve or update the data and maintain data integrity.
- When archiving the data set, one should document change versions made to the data set.
- One should prepare backup files to recover from mistakes made during editing.

2.13 Version Control

Secure data archiving is essential for protecting data files from corruption. Version control of records is a critical piece of the data management process. Prior to making any major changes to the dataset, one should save the data set using a unique version number. This facilitates tracking changes over time. With proper controls and communication, versioning ensures that one uses only the most current version in analysis. One should use a logical numbering system and assign each additional version a sequentially higher number. When one makes new versions to the data set, one should provide all frequent users with the most recently archived version.

2.14 Operational Competence

ORSA analysts must remain operationally competent across the full spectrum of resident skills. One becomes operationally competent by integrating oneself into the staff process early in the planning process and by remaining engaged all the way through to the execution of operations. One's ability to access and utilize multiple data sources ensures that the commander has the most accurate, relevant, and timely information available. For example, ORSA analysts deployed with the International Security Assistance Force (ISAF), the Combined Joint Special Operations Task Force – Afghanistan (CJSOTF-A), the Joint Special Operations Task Force – Philippines (JSOTF-P), and the Combined Joint Task Force – Horn of Africa (CJTF-HOA) have utilized multiple data sources to

- analyze the projected size of the Afghan National Security Forces (ANSF);
- develop a process to locate, validate, store, and distribute polling data for analytical use to support strategic and operational issues in Operation Enduring Freedom (OEF);
- analyze poll results of counterinsurgency operations to gauge the success of efforts to win the hearts and minds of the local population;
- develop assessment frameworks to inform commanders and future campaign planners;
- consolidate and format unusable, individual unit reports into a single database using text extraction techniques;
- assess the effectiveness of combat and security operations on enemy activities; and
- establish robust database systems to better facilitate analysis of assessments.

2.15 Way Ahead

Data for decision making comes from a variety of sources, both internal and external. Because the database management system is one of the major components of most decision management support systems, it is important for ORSA analysts to be familiar with the latest developments in the field. Organizations are recognizing that their data contain a gold mine of information. Consequently, they are warehousing and mining data for users to obtain information on their own (through a variety of multidimensional analytical tools and new enterprise-wide system architectures) and establish relationships (through data extraction techniques) that were previously unknown. New emerging tools, such as Online Analytical Processing (OLAP), provide on-the-fly data analysis that is invaluable to analysts. Moreover, a wide variety of data formats are becoming available through innovative networked database management systems. One can use any or all of these methods to enhance data analysis and assist commanders at all levels of command in making highly informed decisions.

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CHAPTER 3 DATA ANALYSIS TECHNIQUES

3.1 Introduction

Definition. Data analysis is the act of transforming and modeling data to extract useful information and facilitate conclusions that support decision making.

Purpose. This chapter highlights several good data analysis techniques used by previously deployed ORSA analysts. As a deployed ORSA analyst, one makes inferences from data to recommend courses of action (COAs), assess specified activities, identify trends, etc.

Data analysis is an objective method for determining whether alternative COAs are significantly different from each other and for providing the commander with resource allocation recommendations. Data analysis underpins operational assessments, e.g., analysis of enemy and friendly activities that identify changes and trends in the operational environment. It is an ORSA analyst's responsibility to determine which data analysis technique will provide commanders with the most accurate findings to assist them in their decision making process. Commonly used analytical techniques include statistical analysis, simulation, optimization, network flow models, and geospatial analysis.

3.2 Data Cleaning

Prior to beginning analysis, one may need to mine and clean the dataset. Typically, datasets contain missing data, multiple entries of the same event, and duplicate events entered with different terminology, all of which one must identify and correct prior to analysis. Furthermore, the necessary data may be located in "text" fields that require one to mine the data and extract the information. In a deployed environment, "dirty data" are quite common. ORSA analysts must not use "dirty data" in their analyses. These analyses are not trivial; they often become part of larger studies. Data cleaning is a labor-intensive task.

3.3 Statistical Analysis

Accurate analyses necessitate selection of the most appropriate technique for a given complex problem. One should consider events that may have an impact on the graphed data, e.g., major operations, elections, battlespace transition, and/or significant changes in the political environment, such as ratification of a constitution/seating of a parliament. These events can explain spikes or dips in the data and place the data in context.

Descriptive Statistics. This handbook recommends visually inspecting the data set using a graph, e.g., scatter-plot, histogram, or time series chart prior to conducting the analysis. Statistics textbooks provide examples of descriptive statistics, e.g., Devore, 2012, and many on-line resources outline techniques for calculating numerical measures and developing graphs.

Statistical Techniques. One can find the most relevant trend-analysis examples by referencing the work of recently deployed ORSA analysts. Several statistical techniques used in recent projects conducted in theater and as part of the analytical reachback process include t-test; regression, e.g., linear, multiple, and logistic; and time series forecasting, e.g., moving average, weighted moving average, and Holt-Winters method. This handbook also recommends "Forecasting: Methods and Applications" by Makridakis, Wheelright, and Hyndman (1998).

3.4 Other Analytical Methods

Deployed ORSA analysts may find that the following analytical methods exceed combat-theater resources, i.e., time, skill, software; however, one can still use these methods through the reachback program.

Forecasting. Forecasting is the process of developing estimates for future outcomes that are likely to occur. Modern forecasting falls into one of two broad categories: causal forecasting or time series analysis. Causal forecasting predicts how an uncertain quantity relates to other quantities. Time series forecasting predicts future values of an uncertain quantity based on past values of a known quantity. Forecasting, i.e., predicting future events, is important as the United States continues the fight against terrorism. Senior leaders may ask ORSA analysts to develop tools and models to forecast enemy activity, both temporally and spatially.

One comprehensive forecasting resource is "Forecasting Principles: Evidence-based Forecasting" (2012), available from http://www.forecastingprinciples.com. Makridakis, Wheelwright, and Hyndman's "Forecasting: Methods and Applications" (1998) is also a good resource. Makridakis et al. provide descriptions and examples of basic forecasting tools, time series decomposition, simple regression, etc. Additionally, Sam L. Savage's "Decision Making with Insight" (2003) provides good explanations of causal and time series forecasting.

Simulation. Simulation is a mathematical model for recreating a situation repeatedly to more accurately estimate the likelihood of various outcomes. One can use simulation to show the eventual real effects of alternative conditions and COAs. Analysts widely use Monte Carlo computational algorithms for simulating the behavior of various physical and mathematical systems, and for other computations. One can use simulation in forecasting as well (for example, developing recommendations for resource allocation). Albright et al. (2011) include descriptions and examples of the simulation process. Additionally, Excel add-ins, such as @Risk, are designed to conduct simulations.

Optimization. One can use optimization, i.e., math programming, to minimize or maximize a real function by systematically choosing the values of real or integer variables from within an allowed set. One can use several different methods to conduct optimization, to include linear programming, network flow models, and critical path models. Over the past several years, commanders and senior leaders have asked ORSA analysts for optimal methods of employing technology, transporting technology and personnel to theater, optimizing coverage of specific assets, e.g., medical evacuation [MEDEVAC] and intelligence, surveillance, and reconnaissance [ISR] technology. One can conduct simple optimization problems using the built-in "Solver" of Excel. Additional Excel software tools are available for sensitivity analysis to determine how the optimal solution changes as one or more input variables change. Albright et al. (2011) include detailed descriptions of optimization models using linear programming.

Sensitivity Analysis. Sensitivity analysis is the procedure for determining the sensitivity of alternative outcomes to changes in one or more parameters. If a small change in a parameter results in a relatively large change in the outcome, the outcome is *sensitive* to that parameter. This may mean that one has to determine the parameter very accurately or redesign the outcome to be less sensitive. One should incorporate sensitivity analysis into the decision making process to determine how sensitive the recommended solution is to various parameters of the model. Albright et al. (2011) provide a good example using Excel to conduct sensitivity analysis.

Additionally, the Precision Tree add-in discussed below is a good tool for conducting this type of analysis.

Gap Analysis. ORSA analysts—more often than not—have only incomplete data to answer specific questions. Where there are incomplete data, there are potential gaps in the analysis. One should identify these gaps in the "limitations" section of one's final written report. There are several ways to approach missing data, to include (1) deleting incomplete entries, (2) filling in incomplete entries based upon the most similar complete entry ("hot deck imputation"), (3) simulation, (4) filling in complete entries with the sample mean ("mean substitution"), or (5) using a learning algorithm, e.g., maximum likelihood to infer a missing entry. In one's written reports, one should annotate the methods used to overcome the gaps in data. As additional data become available, one should conduct gap analysis to "fill in the blanks" or run another iteration of the analysis to determine how the additional data change the results.

3.5 Software Utilization

This section summarizes software packages available to assist in the execution of data analysis. Senior leaders do not expect ORSA analysts to be experts in all of them; however, they do expect ORSA analysts to know the differences between them.

Excel built-in Functions. Several built-in functions in Excel improve the efficiency of analysis. In particular, the following three features are very powerful: pivot tables, sort options, and filtering. These features allow one to manipulate and visualize data quickly. Moreover, Excel has "add-ins" such as Analysis ToolPak for statistical analysis.

Excel add-in Software.[3] The following Excel add-in software capabilities are available for purchase:

- **@Risk** for risk analysis. With this feature, one can define probability distributions and run simulations for input and output variables within Excel.
- **Precision Tree** is a decision analysis add-in. One may find it useful in optimization when one is dealing with a set of alternatives such as decisions on using new weapons or factoring in decisions at each stage of contracting and development.
- **Crystal Ball** performs Monte Carlo simulations in spreadsheets that automatically calculate thousands of different "what if" scenarios and save the inputs and results of each calculation as an individual scenario. Analysis of these scenarios reveals the range of possible outcomes, the probability of each occurring, which inputs have the greatest effect on the model, and where one should focus one's efforts.

Macros. One can create a Macro to automate repetitive actions, i.e., a series of recorded actions. One can write Macros using the built-in toolbar or Visual Basic for Applications (VBA) code in the VBA editor.

[3] Note: No endorsement is stated or implied by any references to commercial software applications in this handbook.

3.6 Examples of Available Software Packages[4]

- **SPSS** is used for statistical analysis, data management, and data documentation.
- **Stata** is used for data management, statistical analysis, graphics, simulations, and custom programming.
- **TRAC** creates and maintains visualization tools for DoD analysts.
- **DECMAT** is a well-known multi-criteria decision matrix, i.e., preference matrix used in the military decision making process (MDMP).
- **JMP** is visual software from SAS that sets itself apart by linking robust statistics with graphics on the desktop, producing visual representations of data that reveal context and insight impossible to see in a table of numbers. JMP allows one to be more efficient, tackle difficult statistical problems, and bring one's data analysis to a whole new level. Data and information visualization, design of experiments, and statistical modeling techniques from simple to advanced are all within one's grasp with this powerful platform. And when one makes JMP one's analytic hub, one can use other favorite tools: SAS, Excel, and R.[5]
- **MATLAB** is used for algorithm development, data analysis, visualization, and numerical computation.
- **Minitab** is used to analyze one's data and improve one's products and services with the leading statistical software used to implement Six Sigma worldwide.[6]
- **GAMS** is used for mathematical programming and optimization.
- **R** (free software) is used for statistical computing and graphics.
- **TABLEAU** helps people see and understand data. Tableau helps anyone quickly analyze, visualize, and share information.[7]

[4] Note: No endorsement is stated or implied by any references to commercial software applications in this handbook.
[5] JMP software is available from http://www.jmp.com/en_us/software.html
[6] Minitab software is available from http://www.minitab.com/en-US/Products
[7] Excerpt from the TABLEAU website: http://www.tableau.com/

3.7 Case Study: Time Series Analysis in a Theatre Strategic Headquarter[8]

Time Series Analysis in a Theatre Strategic Headquarter

Marcus Gaul and Eric Jesse

In: Williams, A., Bexfield, J., Fitzgerald Farina, F., and de Nijs, J., (Eds.). *Innovation in Operations Assessment: Recent Developments in Measuring Results in Conflict Environments*. Innovation in Capability Development Series, Vol. 1. Norfolk, VA: NATO Headquarters Supreme Allied Commander Transformation (2013).

Abstract

Time series analysis in its many facets and shapes, from data exploration to spatial analysis, and from qualitative to quantitative considerations offers a set of highly valuable tools for analysts in support of senior leader's decision making. Time series analysis can not only generate crucial insights by combining time and spatial domains, but it can help to identify unexpected relationships and opportunities that can be exploited by a command, and enable the assessment of operational effectiveness and developments in insurgent tactics. In this article we present the fundamentals of time series analysis and discuss some of its applications and uses stemming from our experiences of working in the Afghan Assessment Group (AAG) at the International Security Assistance Force's (ISAF) Headquarters in Kabul, Afghanistan.

Introduction

The AAG is the International Security Assistance Force's (ISAF) Headquarters' principal analysis and assessment organization. The AAG provides regular analysis and assessments of the campaign to the ISAF Commander, the Government of the Islamic Republic of Afghanistan (GIRoA), and the governments of troop contributing nations, the press, and the public. In assessing the campaign, AAG uses a variety of analytic methodologies, one of which is time series analysis, the focus of this discussion. Time series analysis, in particular, leverages the information advantage ISAF has achieved through its advanced theatre-wide data collection processes.

Our chapter begins with a general review of time series analysis and associated terminology. Then we will cover selected common analytical issues and challenges, to include

[8] Used by permission from Marcus Gaul and Eric Jesse In: Williams, A., Bexfield, J., Fitzgerald Farina, F., and de Nijs, J., (Eds.). *Innovation in Operations Assessment: Recent Developments in Measuring Results in Conflict Environments*. Innovation in Capability Development Series, Vol. 1. Norfolk, VA: NATO Headquarters Supreme Allied Commander Transformation (2013).

data collection and consistency, data aggregation, variable selection, seasonality, and non-constant variance. Aware of these problems that frame analytic approaches, we next discuss methods AAG employs to analyze insurgent activity in Afghanistan, covering year-over-year differencing, seasonal decomposition, and regression analysis. This carries into a discussion on the identification of statistically significant changes in insurgent behavior. Finally, we discuss the incorporation of geospatial considerations with temporal data. By adding spatial data, we can visualize, assess, and explain trends, which might otherwise go unobserved by analysts and decision makers. We conclude with a discussion of the challenges quantitative analysis encounters during the ISAF campaign, and the facilitating measures taken to remove them.

Time Series Analysis

A time series is a collection of observations obtained through repeated measurements over time. Time series are most often considered subsets of stochastic models or **stochastic processes**. Stochastic processes concern sequences of events governed by probabilistic laws. Stochastic models infer characteristics of a population using temporal or spatial data. Time series analysis utilizes the natural temporal order of the data to extract information about the underlying stochastic process.

The extent of assumptions about the underlying data in a statistical analysis defines two classes of statistics, parametric and non-parametric. The most common models utilize **parametric** statistics. Parametric statistics assume that the data have some underlying structure, most typically about the underlying distribution (often the normal distribution) and variance (often constant over time). Some widely known parametric models are ordinary least squares regression, generalized least squares, autoregressive and moving average models. **Non-parametric (or distribution free)** models do not assume an underlying distribution for the data; instead, they try to determine the underlying system structure within the data. As a result, larger datasets are required for non-parametric models to make similar conclusions as analogous parametric test. Non-parametric methods often rely on ranking or ordering of data for analysis. The Kolmogorov-Smirnov test is one such well known non-parametric method used to test whether a data set follows an assumed probability distribution, or whether two data sets come from the same generating process.

Our discussion of time series analysis focuses on parametric statistics, but we need to be aware that non-parametric analysis techniques exist when parametric assumptions are shown to be invalid.

Statistical analysis is further subdivided into linear and non-linear analysis. **Linear** analysis assumes the dependent variable (response variables) can be explained by a linear combination of independent variables (explanatory variables). Linear analysis assumes an additive relationship between variables that enables a closed form solution to estimation. While linear models are intuitively easier to interpret and understand, most real world systems do not follow strictly additive processes. In **non-linear** analysis, the dependent variable is explained by a non-linear combination of independent variables. Examples of non-linear functions include Lorenz curves, exponential functions, logarithmic functions, and Gaussian functions. Exponential and logarithmic functions can be transformed into linear forms enabling a closed form solution, but in general, non-linear functions use numerical techniques to estimate parameters.

Time series analysis can be used to answer two types of inquiries: descriptive and predictive. **Descriptive** inquiries seek to ascertain the existence of hypothesized relationships between the dependent and independent variables. For example, how do enemy-initiated attacks, the opportunities for leave, seasonality, or major Islamic holidays affect attrition, i.e., the planned and unplanned loss of personnel in the Afghan National Army? Descriptive analyses look for significance and direction of relationships between the dependent and independent variables. **Predictive** analysis projects potential future system states based on the historical relationship between a dependent variable and a set of independent variables. An example is predicting the level of enemy activity in 2013 using the historical relationship between the enemy activity level and independent variables such as the number of coalition forces[9].

Data Collection and Aggregation

ISAF collects vast amounts of data with most of the data being provided by military units using standard reporting procedures. These units are not focused primarily on data collection, so data quality, completeness, and accuracy can vary. Reported and collected data also tends to evolve with mission objectives, potentially adding further complexity to analysis. The collected data are refined with subsequent reports categorized and transmitted to an analytical database that also serves as a historical archive. A centralized data collation function provides an additional layer of quality assurance by enhancing data consistency, eliminating duplicate reports, and identifying and reconciling database anomalies.

[9] See (Gons, 2012) for an example of such a scenario.

ISAF tracks additional data sources beyond military operational reporting. These reports include open source, United Nations, and non-governmental organization (NGO) reporting. Military operational reporting is usually entered into the database within 24 hours of occurrence and data entry. This lag can mislead or bias near-term analysis. Understanding the data is the foremost task of the analysts, since quantity, quality, and reliability of the data is a primary factor shaping the analysis.

Data aggregation is the next major consideration for the analyst. Data should not be aggregated beyond the relevant level of inquiry. For example, looking at theater-wide improvised explosive device (IED) events would be an inappropriate means of assessing a new mine rolling system in Kandahar Province.

The aggregation of security-related data in Afghanistan is at least a three-dimensional issue, with data having spatial, temporal, and categorical aspects. Spatial disaggregation presents a particular challenge due to the number of ways Afghanistan can be divided. ISAF seeks to map data with an accuracy of a few meters to a specific military grid reference system (MGRS) coordinate, but this level of accuracy is not always achieved, especially for reports from the Afghan National Security Force (ANSF). Almost all data are identified at the district level. The approximately 400 districts are in 34 provinces, which in turn are part of 6 geographically distinct regions in Afghanistan: East, South, Southwest, West, North, and the Capital – the ISAF Regional Commands (RCs). Numerous further groupings are possible, for example defined by climate, terrain, and population demographics.

Aggregation can influence analytic results. Simpson's paradox is the phenomenon where a trend that appears in data subsets disappears or reverses when these subsets are combined. As a hypothetical example, we might find an improving security situation in 28 of Afghanistan's 34 provinces when analyzed separately, but when looking across the entire theater, the trend could be reversed and security would appear to be worsening. This trend could be driven by dominating negative conditions in just two provinces, for example Helmand and Kandahar.

Disaggregation can potentially obscure important trends due to the effect of specific events, operations, or simple random noise. Disaggregation can also limit the power of statistical analysis by reducing the number of observations. There is no "correct" level of aggregation to employ across all analysis. Aggregate models are very important to understanding general theater trends, while disaggregated models enable the understandings that are important at operational and tactical levels. Disaggregate models help with the analysis of local effects of actions such as clear/hold operations, cache finds, or weapon seizures. The appropriate level of aggregation is a judgment call by the operational analysts based on their understanding of the question and the tractability of the data.

Adjustments for Seasonality

Insurgent activity in Afghanistan follows a strong cyclical process. This type of recurring pattern in data is known as *seasonality*.[10] Nationwide insurgent activity in Afghanistan is closely tied to the rhythm of daily life, with the progression of the seasons strongly influencing engagement levels. Planting and harvesting crops demand the attention of individuals who might otherwise be fighting coalition or Government of the Islamic Republic of Afghanistan (GIRoA) forces, while the winter cold and snows close mountain passes limits movement that results in diminishing contact between insurgents and coalition forces.

As measures for insurgent activity, we consider, for example, *security incidents*[11] or *enemy-initiated attacks*[12] (EIAs). EIAs provide a perspective on the active, executed components of insurgent engagements against ISAF and the ANSF, while security incidents also include elements that failed to execute such as explosive devices that were found and cleared. For the purpose of this article, we consider enemy-initiated attacks as an approximation for insurgent activity.

Figure 2 shows the periodic pattern of insurgent activity over the period from 1 January 2007 through 31 December 2012. In July of 2011, EIAs averaged over 700 per week. Five months later, in December 2011, EIAs averaged just over 350 per week, a drop of approximately 50%. Interpreting this decrease as a sign of an improving security situation could be misleading for several reasons. First of all, this comparison fails to account for seasonality, i.e., fluctuations in the insurgent activity due to the seasonal temperature changes over the course of a year. We can see this by considering EIAs several months later. In July of 2012, EIAs again averaged over 700 per week.

[10] Many time series show cyclic variations that are known as seasonal fluctuations or seasonality. Insurgent activity in large parts of Afghanistan is correlated to the seasonal temperature fluctuations over the course of a year.

[11] Security incidents comprise enemy-initiated attacks (enemy-initiated direct fire, indirect fire, surface-to-air fire and executed IED attacks), as well as potential IED attacks such as IEDs and mines that were found and cleared.

[12] Enemy-initiated attacks is a term that is used for the total of enemy-initiated direct fire, indirect fire, and surface-to-air fire attacks, as well as executed IED attacks, namely IED explosions and mine strikes.

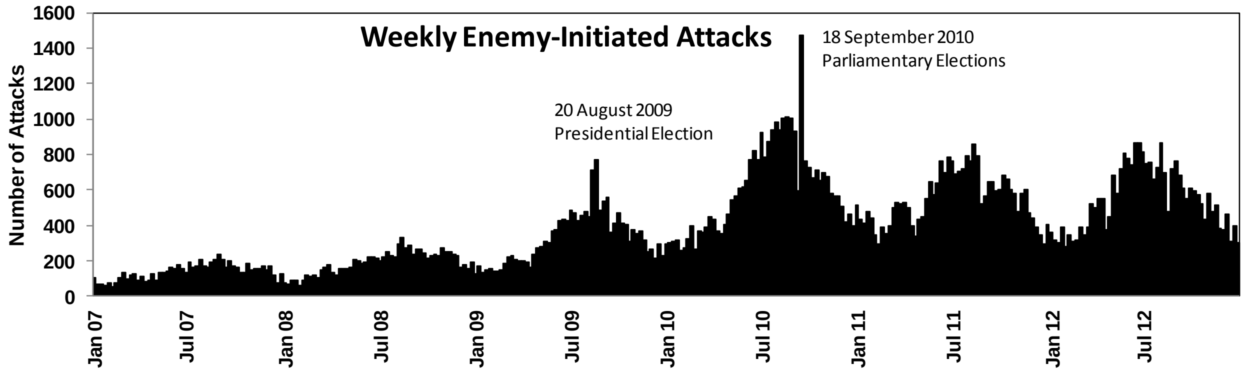


Figure 2. Weekly enemy-initiated attacks in Afghanistan (1 January 2007- 31 December 2012).

An assessment of the security situation should include not only insurgent activity, but also quantitative and qualitative metrics of population perceptions of development and governance, as well as interdependencies among the variables. A comprehensive analysis of this type extends beyond the scope of this chapter.

When analyzing the insurgency, it is useful to differentiate between **systemic changes** and those changes that are attributable to the cyclical pattern of the conflict. ISAF assessments regularly utilize three approaches to adjust for seasonality year-over-year differences, classical seasonal decomposition, and regression analysis.

Year-over-year (YoY) differences allow comparisons between seasonally analogous periods, e.g., comparing EIAs in January 2013 with January 2012. The comparison window is important, as periods that are too small risk confusing natural variance in the data with significant trends. HQ ISAF AAG found that a 1-week period was the shortest possible period to identify meaningful changes in insurgent activity from data noise. On the other hand, if YoY analysis spans too much time, operationally relevant factors may be obscured, giving the commander misleading information.

When seasonal trends evolve slowly, it is sometimes possible to compare the last period with that immediately preceding to search for changes, e.g., for data with an annual seasonal trend we can compare the last week with the preceding week. This is an analogous approach to more traditional YoY differencing in that the two periods should have very similar seasonal influences. When they differ considerably, it could be indications of an emerging trend.

A second approach commonly employed to seasonally adjust the data is **classical seasonal decomposition**. This method removes seasonal fluctuations from the data allowing the identification of long-term trends. The technique factors time series data (X_t) into two parts: a seasonal component (S_t) and a trend component (T_t). While both additive and multiplicative decompositions are available, multiplicative decompositions perform best when modeling insurgent activity in Afghanistan ($X_t = T_t * S_t$). Since we know *a priori* that the cycle affecting the time series of enemy-initiated attack data (X_t) is annual, we can calculate the two components of the seasonal decomposition using the following steps:

1) Compute a moving average for the series X_t, with the moving average window being of equal length to one season (i.e., 12 months, 52 weeks, 365 days). This step removes intra-seasonal variability from the data resulting in a smoothed time series (SM_t).
2) Compute the ratio of the observed (X_t) and smoothed (SM_t) series. This ratio is the raw seasonal component.
3) Next the average seasonal component (S_t) is computed by averaging the raw seasonal components for each point in the time series (i.e., each month, each week, and each day). Various forms of averaging the raw seasonal components to determine the average seasonal component are possible. We recommend normalized medial averaging. This approach excludes outliers from the average, preventing particularly abnormal observations from influencing the seasonal adjustment in the same period for other cycles.
4) The original time series (X_t) can now be seasonally adjusted by dividing it by the average seasonal component (S_t), producing the trend component (T_t).

A seasonal decomposition of weekly EIAs in Afghanistan is depicted in Figure 3 showing the usefulness of this approach.

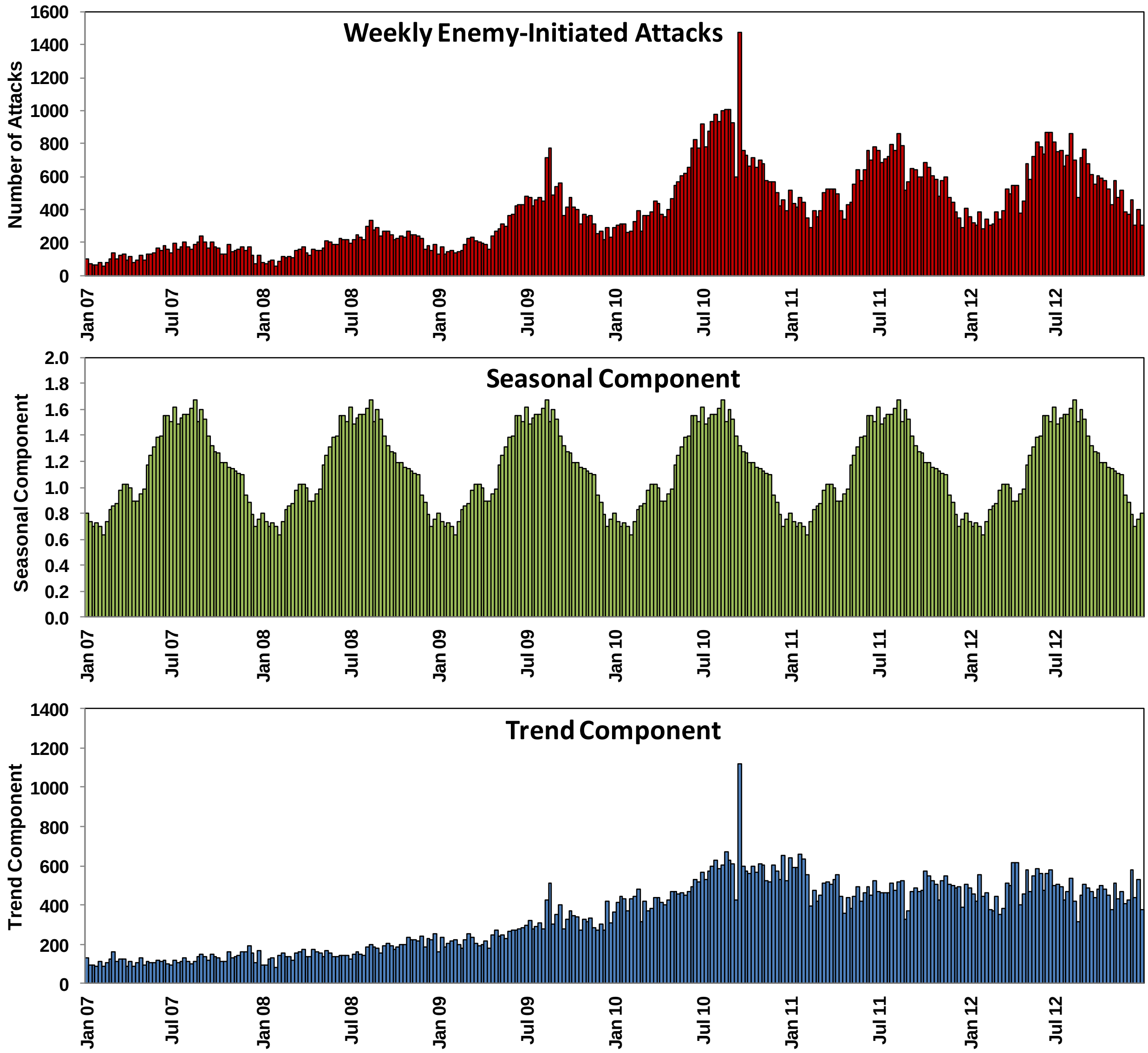


Figure 3. Seasonal decomposition of weekly enemy-initiated attacks in Afghanistan (1 January 2007- 31 December 2012).

Regression analysis is the third approach to seasonally adjust data and identify trends. Regression analysis is used to estimate relationships between a dependent variable and one or more independent variables. A major strength of regression analysis is that it assesses the relationships between multiple independent variables to the dependent variable. *Variable selection* is the process of identifying control variables in regression analysis. In Afghanistan, factors known to influence insurgent activity include coalition and ANSF force levels and significant events such as elections and Islamic holy days. The number of insurgent attacks on ISAF and ANSF patrols is related to the location and frequency of these patrols. In the case of elections and Islamic holy days, insurgent activity has two opposing characteristics. Prior to and during elections, insurgents attempting to intimidate the population accelerate attacks. Conversely, some Islamic holy days see lower levels of activity due to religious customs.

When selecting control variables for factors that influence insurgent activity, it is important to distinguish between regular periodicity and irregular periodicity, i.e., periods or events that recur at the same time each year and those periods or events that occur on different calendar dates. Events that occur at the same time annually are subsumed in the seasonal adjustment. For example, insurgent activity decreases during the poppy harvest season each year, but since the harvest occurs at approximately the same time each year it is captured by the seasonal adjustment. Islamic holy days, however, follow a lunar calendar in which a year is always 12 lunar months, making the months not linked to the seasons. Key dates shift each year 10 to 12 days. As a result, the effects of the annual Islamic observances of Eid al-Fitr (the "Festival of Fast-Breaking" marking the end of Ramadan) and Eid al-Adha (the "Festival of Sacrifice") will not be accounted for in a seasonal adjustment. Regression models, being the most powerful of the seasonal adjustment techniques will be explored in greater detail below.

Linear Regression Models

There are several types of regression models. In this section we discuss how simple linear regression models can be applied to estimating trends in enemy-initiated attacks. Other approaches will be addressed in later sections. Determining the best model structure, as measured by statistically accurate parameter estimates, can be challenging. Ordinary least squares (OLS) regression assumes the independent variables are additive (linear).

In Afghanistan, as discussed earlier, some of the major factors related to insurgent activity, in particular seasonality, have a multiplicative relationship. We use a log transformation converting an approximately multiplicative process into a linear model.[13] Techniques are available for treating seasonal adjustments simultaneously with other explanatory variables. If

[13] Coalition force levels strongly influence insurgent activity levels, but coalition force levels have varied significantly from less than 40,000 troops in 2006 to over 150,000 at the peak of the surge in 2011. As a result, the variance in insurgent activity has changed significantly over time. Uneven variance over time, heteroskedasticity, causes ordinary least squares estimation to be inefficient and overstates statistical confidence in measured estimates. A log transformation of the dependent variable makes a multiplicative model additive and in many cases significantly reduces or entirely removes the problem of heteroskedasticity. There are numerous methods to stabilize variance. A square root transformation is often also appropriate for count processes. Other variance stabilizations include the Anscombe transform (Anscombe, 1948), Freeman-Tukey transform (Freeman and Tukey, 1950), and Box-Cox transform (Box and Cox, 1964) amongst others.

treated separately, seasonal adjustments will include some of the effects of the explanatory variables. Treating the adjustment simultaneously with other explanatory factors ensures that the seasonal adjustment itself does not include effects that are more correctly attributed to the other explanatory factors in the model. In a regression model, the addition of "indicator" variables for each observation period in the seasonal cycle (which is 1 year for the Afghan insurgency) is equivalent to a classical seasonal decomposition. An indicator variable is assigned a value of one when a condition is present and zero otherwise. For example, the seasonal decomposition in a regression model using weekly data includes 51 additional indicator variables, one for each week. The 52nd week is captured in the intercept, as it is perfectly identified by the 51 other weekly indicator variables and therefore cannot be directly estimated.

A simple (multiple) linear regression model of weekly insurgent activity expressed by seasonality, coalition and Afghan Nation Army (ANA) force levels, and the holy days of Eid al-Fitr, and Eid al-Adha, can be written as follows (with each variable considered a vector of the data indexed by week):

$$Y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \beta_5 x_5 + \beta_6 x_6 \ldots + \beta_{57} x_{57} + \varepsilon$$

where

$Y =$ log (insurgent activity) ,

$x_1 =$ log (coalition forces) ,

$x_2 =$ log (ANA forces) ,

$x_3 = \Phi$(Eid al-Fitr), where Φ is a scalar function assigning the value of one to a week in which the days of Eid al-Fitr fall, and the value of zero otherwise,

$x_4 = \Phi$(Eid al-Adha), where Φ is a scalar function assigning the value of one to a week in which the days of Eid al-Adha fall, and the value of zero otherwise,

$x_5 = \Phi$(elections), where Φ is a scalar function assigning the value of one to a week in which an election falls, and the value zero otherwise,

$x_{6 \ldots 57} = \Phi$(week) is the indicator (or dummy) variables for each observation period, i.e., week, in the year, and

ε is the residual error.

The parameters β are computed using OLS, i.e., by minimizing the sum of squared deviations between the dependent variable (observations) and the estimate using the independent variables. Each parameter measures the observed historical relationship the independent variable has with the dependent variable.

The observed and predicted results of this model for the Afghan theater of operation are shown in Figure 4. The results of the OLS for nationwide and four Regional Command (RC) models are presented in Table 1.

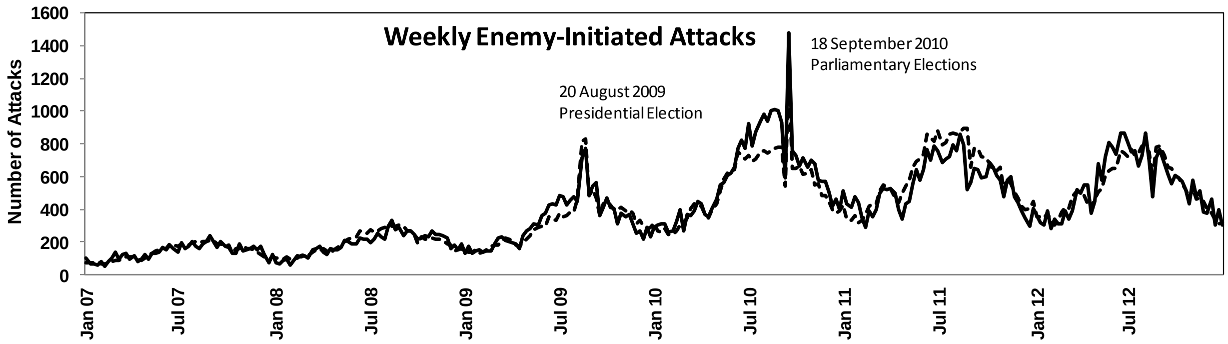


Figure 4. Observed versus predicted enemy-initiated attacks (EIAs).

Coefficient	**Theater**	**RC South**	**RC Southwest**	**RC East**	**RC North**
Intercept	-9.76 (0.26) ***	-9.31 (0.46) ***	-15.59 (0.54) ***	-8.75 (0.29) ***	-15.59 (0.54) ***
log(Coalition)	1.11 (0.07) ***	0.76 (0.13) ***	1.98 (0.15) ***	0.48 (0.08) ***	1.98 (0.15) ***
log(ANA)	0.21 (0.06) ***	0.38 (0.11) ***	-0.22 (0.12) *	0.63 (0.07) ***	-0.22 (0.12) *
Eid al-Fitr	-0.26 (0.07) ***	-0.30 (0.12) **	-0.33 (0.14) **	-0.21 (0.08) ***	-0.33 (0.14) **
Eid al-Adha	-0.10 (0.07)	-0.18 (0.12)	-0.04 (0.14)	-0.04 (0.08)	-0.04 (0.14)
Election Week	0.54 (0.11) ***	0.50 (0.19) ***	0.36 (0.22)	0.63 (0.12) ***	0.36 (0.22)
R^2	0.9525	0.8596	0.8736	0.9423	0.8736

Table Format: Coefficient (Standard Error) Significance
Significance: *** at 0.01, ** at 0.05, * at 0.1

Table 1. Results of the OLS model by region in Afghanistan.

We see in Table 1 that the parameters point in the hypothesized directions. Insurgent activity rises with increases in coalition and ANA force levels, Islamic holidays lead to decreases in insurgent activity, and elections result in increased insurgent activity. The only variable that does not point in its hypothesized direction is ANA troop level in RC North. This may have occurred because the ANA troop levels are modeled at the theater level, and this may be an inadequate measure of ANA forces in RC North. It could also have occurred by chance with the measured effect being only weakly significant at a confidence level of 0.1, i.e., with a 90% chance of being a significant relationship.

Looking at the nationwide model, assuming all else to be equal, the interpretation of the model results is as follows:

- A 10% decrease in the number of coalition forces is correlated with a 11% decrease in insurgent activity
- A 10% increase in ANA forces is correlated with a 2% increase in insurgent activity
- A week encompassing Eid al-Fitr has a 26% decrease in insurgent activity
- An election weeks results in a 54% increase in insurgent activity

Finally, it should be noted that each of the five regression results in Table 1 have an associated R^2. This is sometimes called the coefficient of determinations and it is a measure of the proportionate reduction of total variation associated with the use of the independent variables. It can take on values between zero and one, with higher numbers like those seen in the table implying that the regression model is a good fit to the data.

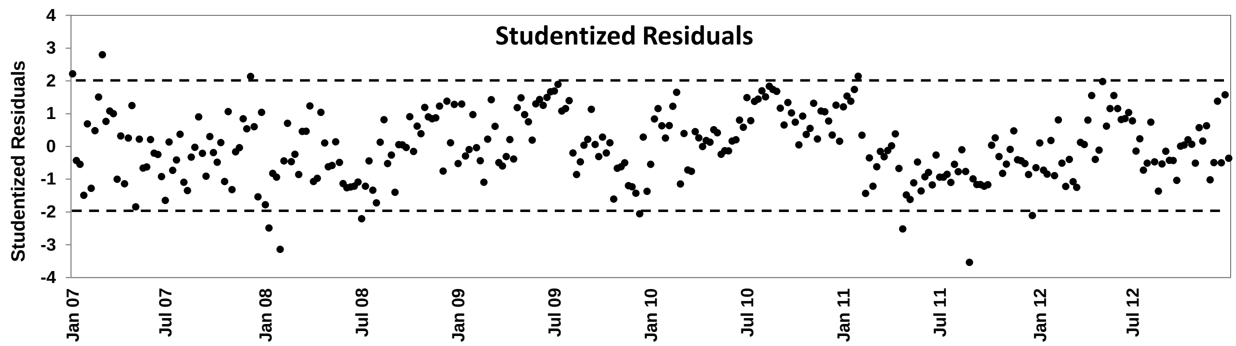
The levels of significance displayed in Table 1 are calculated assuming that the residuals are normally distributed, with constant variance, and are not correlated with each other. In general, it is necessary to test these implicit assumptions of parametric models and verify *model validity*. Violation of these assumptions can bias results and mislead conclusions.

Autocorrelation is one common issue in time series data. It occurs when the current observation is correlated with an observation at another time period, e.g., the immediately preceding one, violating the independence assumption of OLS.

Non-constant variance is a second potential issue. As coalition force levels have varied significantly, from less than 40,000 troops in 2006 to over 150,000 at the peak of the surge in 2011, the variance in reported insurgent activity has changed significantly over time. Uneven variance over time, heteroskedasticity, may result in overstated statistical confidence in parameter estimates.

We can test the OLS assumptions visually and with more formal tests. Figure 5 shows selected residual analysis for the nationwide model in Table 1. The top plot shows studentized residuals. Studentized residuals are normalized by their variance and thus should align with a standard normal curve with most observations falling between -2 and +2. The bottom plot compares a histogram of the residuals to a normal distribution. We can see that the residuals do not appear to violate the normality assumption.

The residuals show signs of autocorrelation, with insurgent activity in one period appearing strongly related to insurgent activity in adjacent periods, as visible in Figure 5. Having homoskedastic residuals (residuals with constant variance over time) that are reasonably balanced (centered about zero over time), our estimates are unbiased, but our confidence in these estimates is overstated. In order to correct the effects of autocorrelation (or heteroskedasticity if balanced) in the error terms from OLS regression, the autocorrelation-consistent Newey-West variance-covariance matrix estimator of the residuals is often used. Alternatively, we can utilize a generalized linear model and explicitly address the autocorrelation.



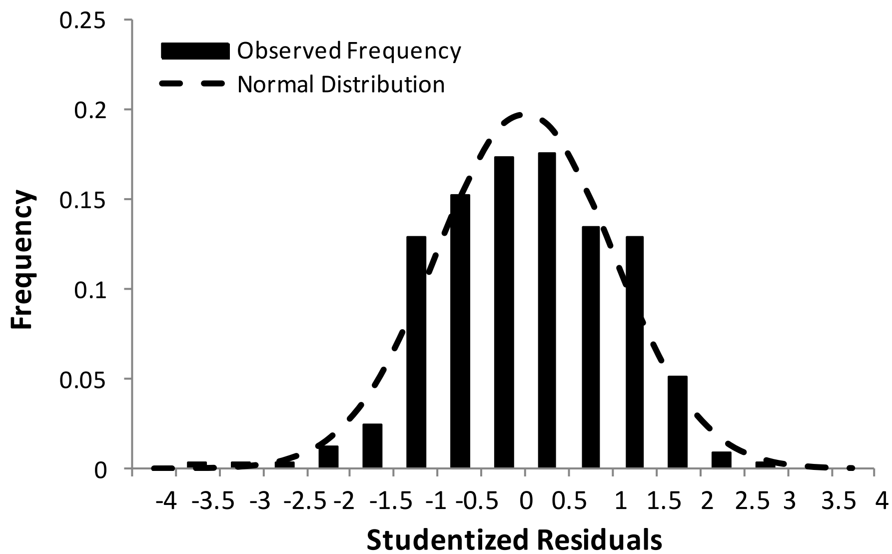


Figure 5. Selected residual analyses.

Autoregressive, Integrated Moving Average (ARIMA) Models

Ordinary least squares is one of many forms of regression analysis (Hamilton, 1994). As the event data are actually count data, Poisson or negative binomial models under certain conditions can yield much more accurate predictions. If data fidelity improved and limitations in computing power were removed, point process models like a Cox process result in even higher fidelity characterizations of the data over space and time (Cox 1955; Cox and Isham, 1980; Cook and Lawless, 2007; Allen et al., 2008).

A class of models that perform well in forecasting non-stationary time series data, like insurgent activity in Afghanistan, are autoregressive, integrated moving average (ARIMA) models (Box et al. 2008)[14]. ARIMA models consist of three parts, an autoregressive (AR) part, an integrated (I), and a moving average part (MA). The model is usually referred to as an ARIMA(*p, d, q*) model where the parameters *p, d,* and *q* are non-negative integers. The parameter *p* refers to the order of the autoregressive part, i.e., the number of autoregressive terms, *d* refers to the order of the involved differencing (note that a time series that needs to be differenced to be made stationary is said to be an "integrated" version of a stationary series), and *q* is the order of the moving average part of the model. An ARIMA model specification can be a subset of the autoregressive, integrated, and moving average components. None of the parts of the ARIMA is required be included in its final specification.

An *autoregressive model* seeks to define the current observation as a function of preceding observations. For example, an autoregressive model of order one is given by $y_t = \beta_0 + \beta_1 y_{t-1} + \varepsilon_t$, while the general autoregressive model of order *p* is given by $y_t = \beta_0 + \sum_{i=1}^{p} \beta_i y_{t-1} + \varepsilon_t$.

The *integrated part* of the model utilizes successive first differences. For example, for a difference of order 2, the relationship analyzed is with the variable defined by the difference between the current and previous periods minus the difference between the previous period and the period preceding, mathematically expressed as $z_t = (x_t - x_{t-1}) - (x_{t-1} - x_{t-2})$. The most common use of such an integrated term is to account for a quadratic trend in the data.

A *moving average model* defines the current observation as the mean μ of the series, and current and previous error terms ε_t. For example, a moving average model of order one is given by $y_t = \mu + \beta_0 \varepsilon_t + \beta_1 \varepsilon_{t-1}$, and a moving average model of order *q* is given by $y_t = \mu + \sum_{i=0}^{q} \beta_i \varepsilon_{t-i}$. Because the lagged error terms are not directly observable, iterative non-linear fitting procedures need to be used in place of linear least squares to estimate model parameters.

A seasonal ARIMA is an adaptation of the standard ARIMA that incorporates *a priori* information about the recurring seasonal pattern. In a seasonal ARIMA model with a recurrence period of time S, observation y_t is predicted by data values, differences, and errors with time lags that are multiples of S (the span of the complete seasonal cycle). For example, a seasonal autoregressive model of order two is given by $y_t = \beta_0 + \beta_1 y_{t-S} + \beta_1 y_{t-2S} + \varepsilon_t$.

[14] A stationary process is a stochastic process whose joint probability distribution does not change over time. This means parameters like the mean and variances are constant over time, i.e., time invariant. The data here exhibits cyclostationary properties - it varies annually. In order to perform time series analysis we transform the data to become stationary (Priestley 1988).

An ARIMA model as briefly discussed above has several benefits. It allows us to model seasonality using fewer terms than in the (multiple) linear regression model described earlier, increasing estimation power. It also allows simultaneous estimation of non-seasonal factors like force levels, or Islamic holy days Eid al-Adha and Eid al-Fitr. An ARIMA model will also identify, capture, and reflect unspecified underlying processes that might be eliminated as noise in other types of estimation models, thus making it a very powerful tool for forecasting and prediction.

At the theater strategic level we have used seasonal ARIMA models to forecast insurgent activity taking several factors into account, primarily the projected troop level changes. Figure 6 shows the model predictions of insurgent activity in 2012 based on historical data from 2007 to 2011. The troop level changes in 2012 that are factored in the prediction are shown, as well as the confidence bounds on the predicted EIA levels. The seasonal ARIMA has a non-seasonal part of (1, 0, 0) and a seasonal specification of (0, 2, 1); it also includes control variables for troop levels, Eid al-Fitr, and Eid al-Adha; however, no examination of the structural, systemic causes for insurgent activity, or the changes and dynamics are considered.

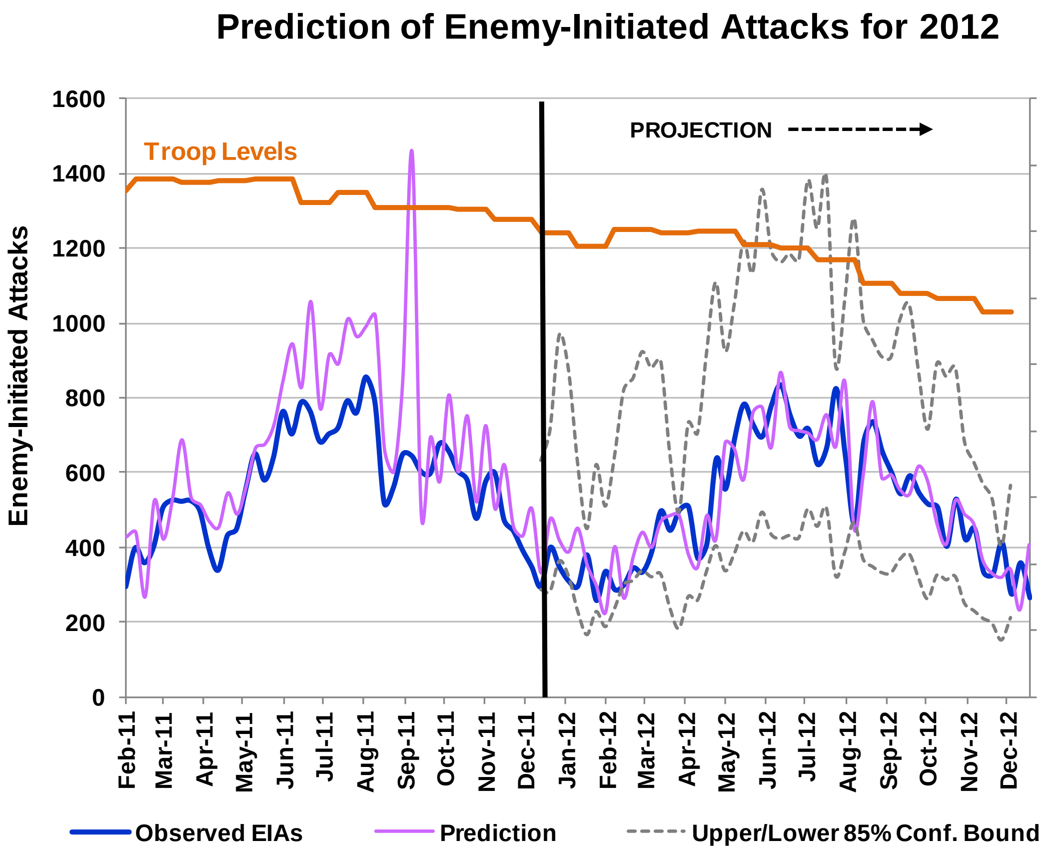


Figure 6. Seasonal ARIMA prediction model for insurgent activity.

Note that the model's overestimation of insurgent activity for 2011, as seen in Figure 6, is caused by not controlling for voter registration periods or the 18 September 2010 Parliamentary Election.

Identifying Operationally Relevant Changes

The identification of operationally relevant changes is one goal of analysis at a strategic headquarters. The ability to rapidly evaluate and assess changes, identify opportunities first, and provide the option to react faster, can provide a significant advantage over the opposition. ISAF developed a methodology that utilizes regression models to quickly identify measurable changes in insurgent activity and determine the statistical significance of this change (Jesse, 2013).

The procedure begins by defining a model to explain insurgent activity, and estimating it against a benchmark period of data. We next compute the residuals for this benchmark period, which are defined as the difference between model predictions and observed insurgent activity. The residuals, or fitting errors, to regression models often follow a distribution that is, in many cases, a normal distribution with mean zero. We can estimate the parameters of this residual distribution and design a statistical test to search for un-modeled changes in insurgent activity. With the model predictions over the benchmark period, we can forecast insurgent activity levels for new time periods and compare these with observed insurgent activity. From the sequence of errors obtained by this procedure, and the known information about the residuals' distribution, we can find the statistical likelihood for a significant change (Chandler and Scott, 2011).

One use of the above approach at ISAF is to monitor daily insurgent activity. We use a two-stage least-squares model[15] of daily enemy-initiated attacks baselined on the period from 1 January 2010 to 31 October 2012 to monitor changes in insurgent activity.

The advantage of a two-stage model is its separate accounting for additive and multiplicative relations. The first stage models enemy-initiated attacks using ISAF and ANSF troop levels, which explains much of the growth in insurgent activity. For the second stage, the observed enemy-initiated attack values are normalized by the predictions from the first stage. This procedure results in the dependent variable being normalized around one (seasonal fluctuations persist), and it should remove any heteroskedasticity. Fitting the second stage on the normalized dependent variable, independent variable coefficients estimate the relative change from the mean caused by the variables. In the example, fitting the second stage model, we get estimates of the effects of the Islamic holidays of Ramadan, Eid al-Adha, and Eid al-Fitr seasonality approximated by month.

In the next step, we compute the residuals of the two-stage model. The residuals of this model should closely approximate a normal distribution with a mean of zero and constant standard error. We then employ a *t*-test to calculate the likelihood that the observed insurgent activity deviates significantly from activity explained by modeled factors. Or stated differently, it tests the null hypothesis that the mean of a sample population, the residuals, is equal to a specified value μ_0.

The *t*-statistic is found by taking the mean of the sample population $\bar{x}$, minus the test value μ_0, and dividing this by the sample standard deviation $s/\sqrt{n}$, where n is the sample size.

[15] A two-stage model can allow implicit correction of heteroskedastic variance in a dependent variable. In the first modeling stage we control for additive independent variables and in the second stage multiplicative independent variables. This approach can outperform dependent variable transformations, as it incorporates a priori knowledge about modeled relationships. The approach yields unbiased results as long as the independent variables in the first stage are uncorrelated with the independent variables in the second stage.

For most regression models, to include those presented here, the test value μ_0 is zero, with the mean of the errors averaging to zero by construction. The *t*-statistic is:

$$t = \frac{\bar{x} - \mu_0}{s/\sqrt{n}}$$

The *t*-statistic comes from a Student's *t*-distribution, which maps directly to probability values allowing the determination of statistical significance. Rearranging the *t*-test equation, thresholds can be defined at the standard levels for statistical significance 0.10, 0.05, and 0.01, which corresponds to the identification of a change from the baseline with 90%, 95%, and 99% certainty[16]. The determination of the thresholds is accomplished by first finding the *t*-distribution value for the desired confidence level *p*, and degrees of freedom in the sample size $n - 1$. The *t* value, scaled by the sample standard deviation $s/\sqrt{n}$ provides upper and lower bounds for the sample mean minus the test value:

$$t_{n-1,p}\left(\frac{s}{\sqrt{n}}\right) < \bar{x} - \mu_0 < t_{n-1,p}\left(\frac{s}{\sqrt{n}}\right)$$

The exact likelihood of having observed a change can be found by solving explicitly for *t*; all the required sample characteristics are known (sample mean $\bar{x}$, number of events in the sample *n*, test value μ_0, and sample variance $s/\sqrt{n}$):

$$\bar{x} = \mu_0 \pm t_{n-1,p}\left(\frac{s}{\sqrt{n}}\right)$$

[16]Analyst selection of an appropriate significance level will be dictated by context. It must balance type 1 error, an incorrect rejection of the null hypothesis and type II error, falsely rejecting the null for the alternative hypothesis when in fact the null hypothesis is true (Pratt et al., 2001).

$$t_{n-1,p} = \frac{(\bar{x} - \mu_0)}{(\frac{s}{\sqrt{n}})}$$

Utilizing the detailed approach, Figure 7 shows one possible visualization of significant unexpected deviations in insurgent activity that occurred in 2012. Significant increases are denoted by shades of red, with darker reds indicating increased statistical confidence. Significant decreases are denoted by shades of green, with darker shades indicating increased statistical confidence. UB/LB means upper and lower confidence bounds, gray circles represent non-significant incidents. While the underlying analysis leverages daily residuals, Figure 7 plots moving 7-day averages of enemy-initiated attacks, smoothing the trend line for visual analysis.

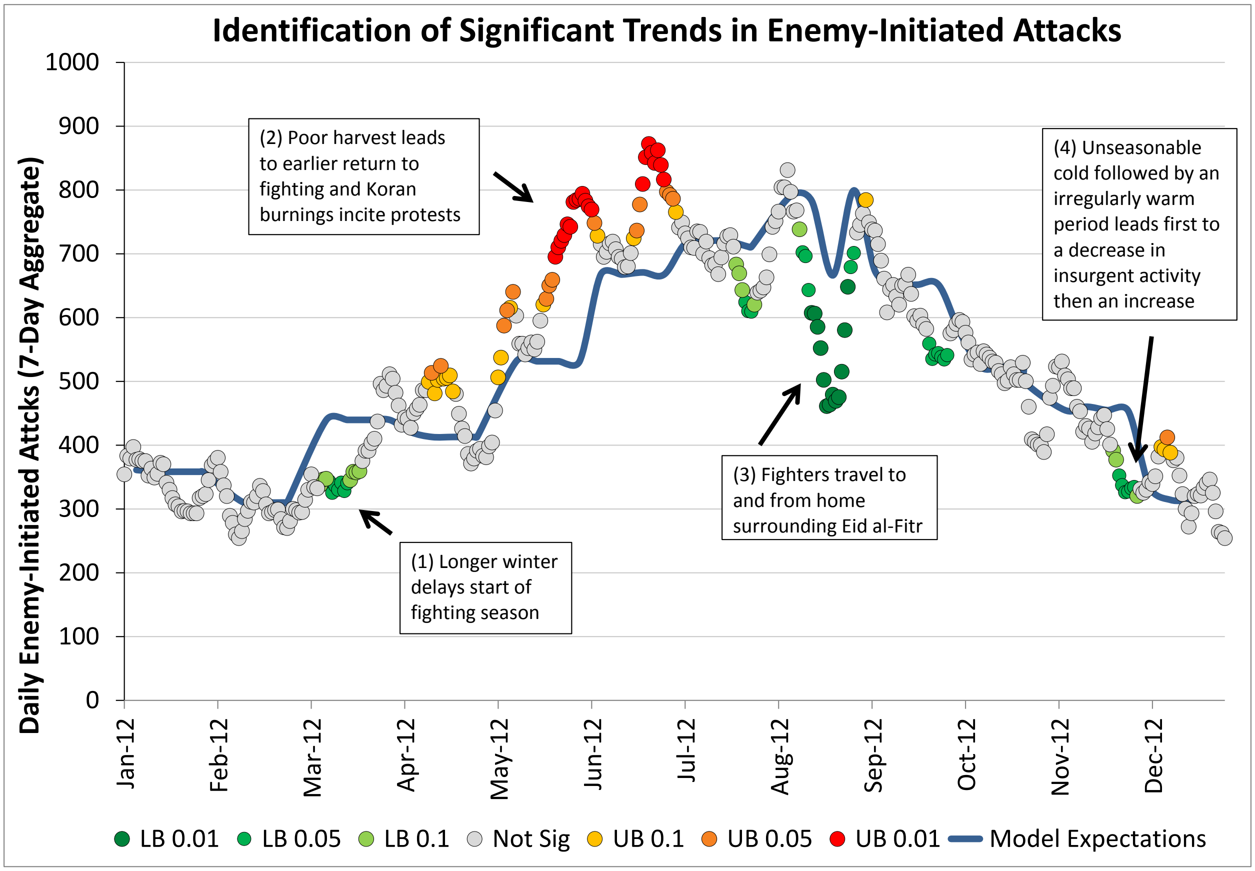


Figure 7. Results of a two-stage least squares model to identify unexpected trends.[17]

The strength of this process is that in recurring analysis it allows us to readily identify deviations from expected insurgent activity as they occur. With the identification of significant changes, possible explanations for these shifts are as follows:

1) An atypically severe winter might have caused a delay in the start of the fighting season.
2) A poorer harvest likely returned insurgent fighters to the fight earlier. At the same time, the burning of Korans at Bagram airbase reaches international and Afghan media outlets inciting protests.
3) EIAs decrease significantly surrounding Eid al-Fitr as insurgents travel to and from home for the observance.

[17] Results of a two-stage least squares model to identify significant unexpected trends in nationwide enemy-initiated attacks in Afghanistan in 2012. Significant increases/decreases are denoted by shades of red/green, with darker red/green indicating increased statistical confidence. UB/LB means upper and lower confidence bounds, gray circles represent non-significant incidents

4) Unseasonable cold temperatures likely led to lower than usual expected insurgent activities, but these were almost immediately followed by a period of unseasonable warm temperatures that probably led to an increase in activity levels.

Methods for Visualizing Time Series Data

Visualization is a very useful tool for showing changes in patterns or trends that might otherwise go unnoticed. Standard ways to display changes over time comprise among others line charts, bar charts, or scatter plots such as shown in Figure 7 with a supplementary color dimension to convey additional information, in this case statistical significance. Time series data can be categorized by considering their context or frame of reference – usually distinguished into abstract and spatial. An abstract frame of reference simply refers to data that has been collected in a non-spatial context, i.e., without connection to a spatial layout. A spatial frame of reference, on the other hand, implies the existence of a spatial layout for the data set - it allows viewing space as some kind of indexing system for events (Anselin, 1992; Cressie, 1993; Cressie and Wilke, 2011).

In the Afghanistan Theatre of Operations spatial information is collected - its geographic location for each event. Although it is important to know the insurgent activity changes over time, it is equally important to understand where insurgent actions occur, their spatial structures, spatial interactions, and the population that is impacted. The power for spatial data analysis lies in its geo-relational database structure, i.e., in the combination of value information and locational information. A geographical information system (GIS) is the natural tool to aid in the display and analysis of spatial data. The advanced display capabilities contained in a GIS can be useful for the visualization of processed, geo-referenced data, or the results of statistical analyses. These spatial visualizations can have a temporal dimension. In Figure 8a and Figure 8b we show examples for two static geospatial representations.[18] Figure 8a displays insurgent activity in Afghanistan's central Helmand Province relative to the population that is visualized as a background layer. The location of each individual insurgent attack is represented by a colored point, where the color represents one of the two time periods under consideration – June to September 2012 and, for comparability, the same period in 2011. This representation shows that insurgent activity moved from higher population densities in the central part (during the 2011 time period), to areas with lower population densities in 2012. Combined team operations and a high operational tempo appear to have had a considerable impact on the insurgent's campaign by

[18] Static representations visualize the data in still images (i.e., the representations do no changes automatically over time), while dynamic representations convey the time dependency of the data (i.e., representations over sequential time periods).

reducing attacks in key population centers in Helmand Province, namely in Marjeh District, as well as Lashkar Gah, Nad'Ali, and western Nahr-e Saraj Districts.

Figure 8a shows another static representation of the enemy activity for central Helmand Province. Figure 8b shows the difference between insurgent attach densities for 2011 and 2012 time periods for this same region. This representation reveals a relative *change* in insurgent activity from one year to another. Representations like those in Figure 8a and Figure 8b can greatly improve the situational and contextual understanding of both the analyst and more importantly the leadership and decision makers.

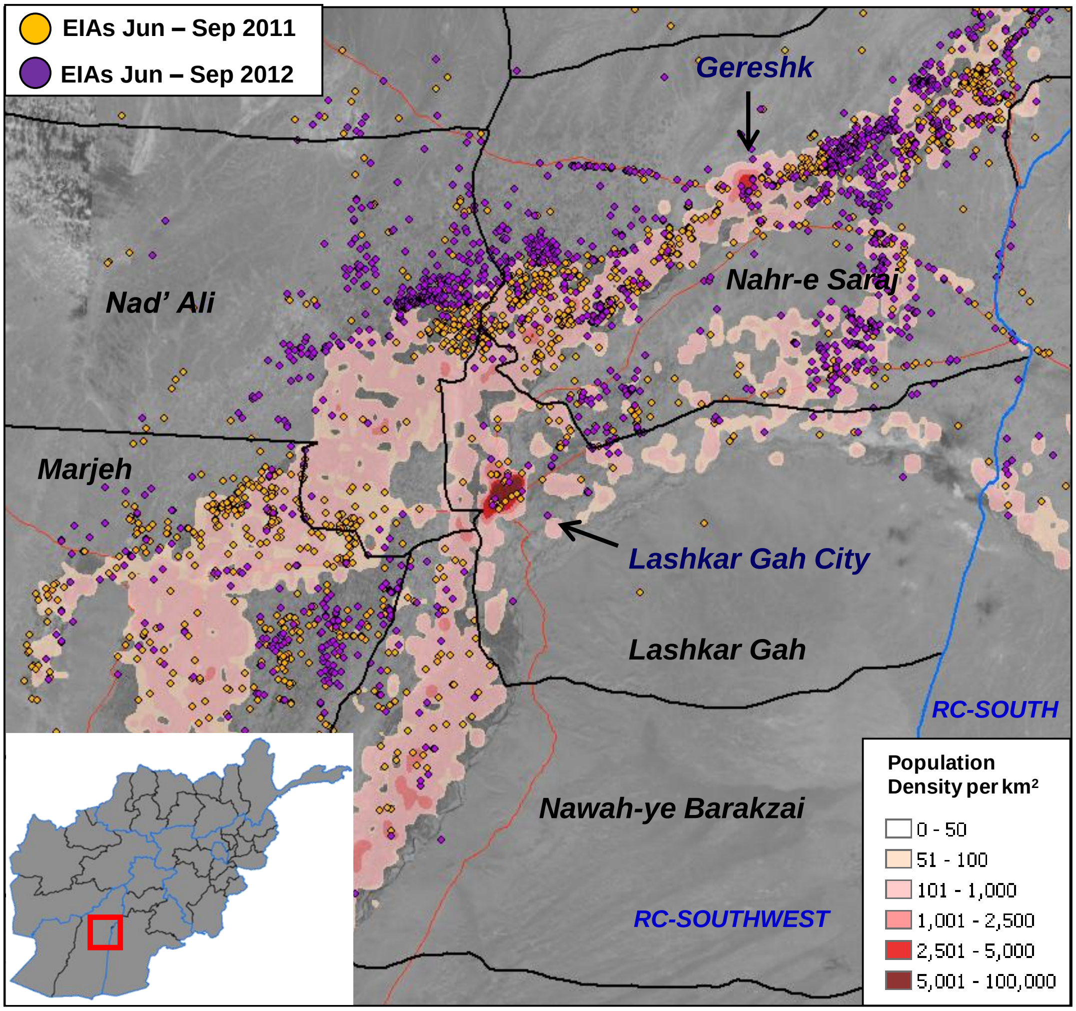


Figure 8a. Static, geospatial scatter plot visualizing individual enemy-initiated attacks.

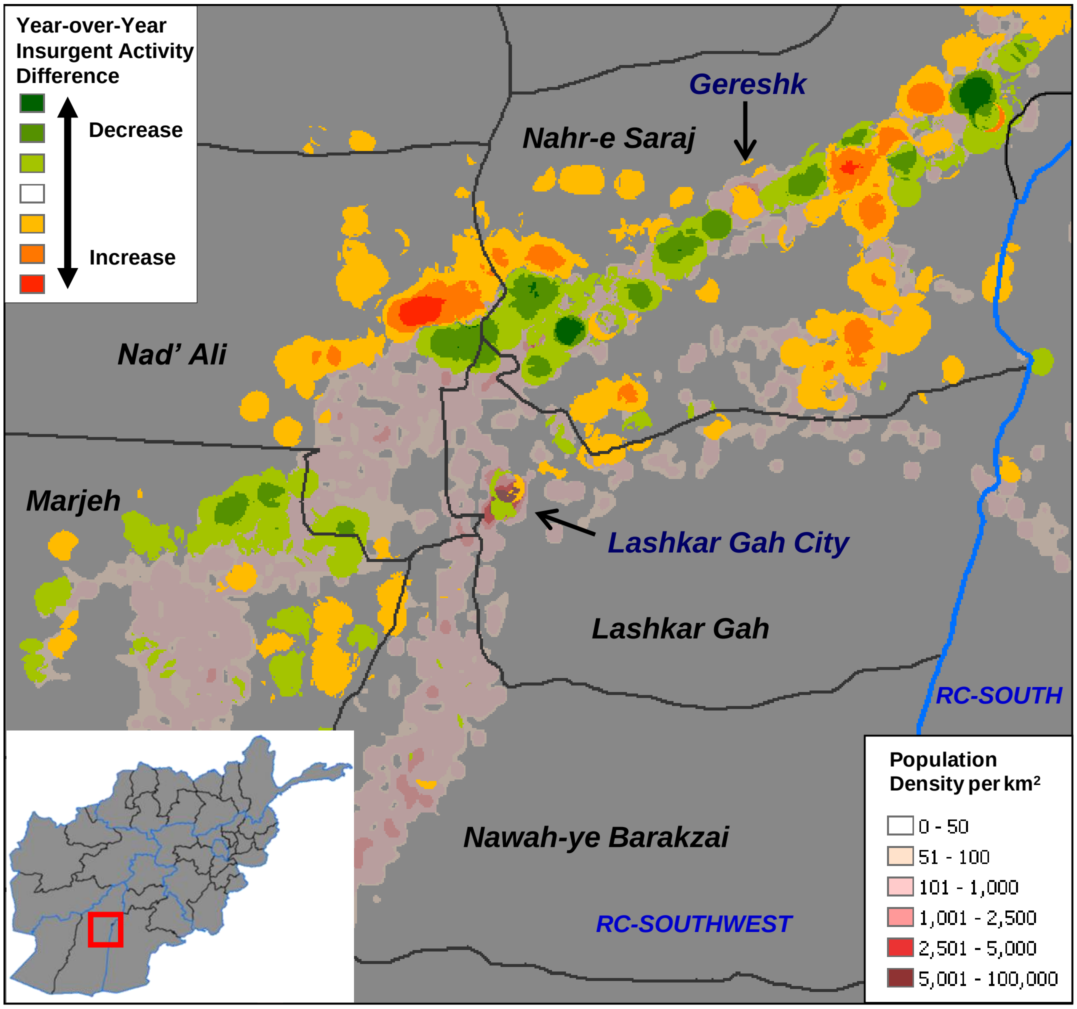


Figure 8b. Static geospatial density plot visualizing changes in enemy-initiated attacks

More robust spatial time series analysis can help to quantify these observed trends (Gaul, 2013). We achieve this by measuring the proximity of the population to insurgent activity, or more precisely by considering the average number of Afghans that live within 1 km of each enemy-initiated attack. A geographical information system is utilized to conduct the laborious spatial analysis.

Figure 9 shows the result, i.e., the average number of Afghans in proximity of an attack by month for all of Afghanistan since January 2010. We evidently see a continuing downward trend in this metric since 2010 when the average number of Afghans living within 1 km of an enemy-initiated attack was approximately 2,000, while in November 2012, around 1,300 Afghans were objectively affected on average. Each EIA affects (on average) fewer Afghans, or in other words, the insurgent attacks migrate to less densely populated areas where they are close to fewer and fewer Afghans. The visualized downwards trend is statistically significant.

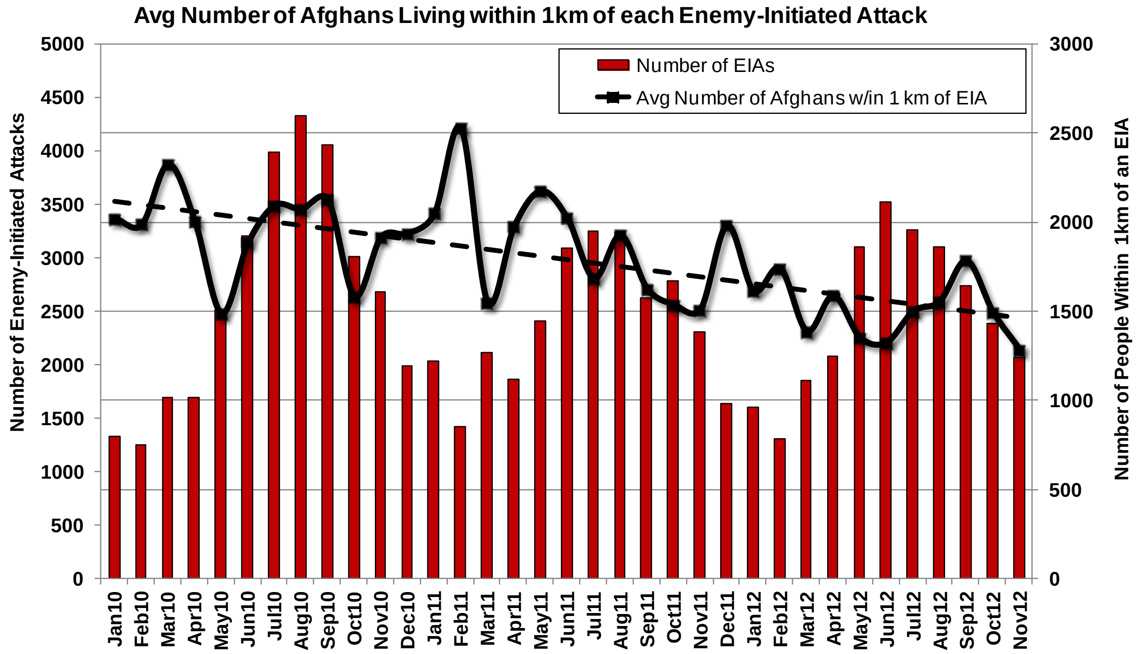


Figure 9. Average number of Afghans living within 1 km of each enemy-initiated attack (EIA).

Modern warfare is creating vast amounts of data. Leveraging this information across time and space can crucially advance operational and strategic goals. It is critical for analysts to be equipped with the right tools, skills, and opportunities to process and manipulate spatiotemporal data generated by a (military) campaign, thus facilitating expedient analysis of enemy actions and blue force operations.

Challenges

During our time at ISAF Headquarters we have encountered several challenges that have impeded our ability to perform effective analysis. They include the cost and time needed to establish an operational database, i.e., data collection, access to the data and data sharing; data quality control and quality assessment; the merging of data sets) and access to analytic software. Beyond these structural challenges, there often exists a gap between decision makers and analysts. The analysts need to understand the issues facing the top-level leadership in order to best focus their analysis.

In addition to the large upfront costs of establishing a database structure useable across a command, there is the time and manpower needed to maintain it, e.g., collate operational reports into the database, reconciling differences between inputs, manage lost or incomplete data, etc. This requires planning and a dedicated funding pool.

Across a theatre of operations different organizations often maintain databases or data repositories for various reasons, such as the collection of a specific type of information that is not collected elsewhere, or because of a lack of knowledge of existing databases. This can cause the analyst additional challenges, the primary ones being 1) lower standards concerning quality control or data consistency and data integrity compared to the authoritative "command databases," and 2) difficulties in assessing and accessing the data . The ability to access data is crucial to analysis and assessment – additional non-authoritative databases/repositories, although potentially well intended, can have counterproductive effects.

Understanding data quality and the constraints it places on subsequent analysis is an important prerequisite to formulating an assessment and making recommendations. The ability to control data quality by cleaning, processing, and organizing data is a necessary skill for analysts. In some cases analysis that could be done should be avoided because underlying data inconsistencies would lead to conclusions too unreliable to guide decision making.

The data necessary for an analysis may not exist in one repository. The ability to join large datasets is what enables many analyses. Combining datasets and looking across previously different lines of effort allows for the identification of formerly undetected interdependencies and interrelationships that can bring important campaign insights.

Access to analytic software is the final major constraint for the analyst. The tools to manage and manipulate large quantities of spatiotemporal data can be expensive. Funding such tools requires improved awareness of their operational benefits. Similarly, system protocols and security related constraints often hinder access to required software such as Microsoft Excel's VBA (Visual Basic for Applications) or tools publically available for statistical analysis such as R data analysis software.

Operational analysis can provide commanders critical information about the campaign. In this line, analysts need to link directly into the pulse of the campaign and understand current commander priorities, while leadership should seek to remove hurdles hindering analysis. A good analyst can often help transform commander's priorities and guide valuable research that informs future decisions.

Summary and Conclusion

Leveraging the vast amounts of data collected across time and space in modern military campaigns can crucially advance operational and strategic goals. It is critical for analysts to be equipped with the right tools, skills, and opportunities to process and manipulate these data. Time series analysis is one of these highly valuable tools and can generate crucial insights for a command, enabling the assessment of operational effectiveness and developments in insurgent tactics. By combining time and spatial domains it is possible to identify further relationships and opportunities that can be exploited. In this chapter we have presented the fundamentals of time series analysis and discussed some of its uses stemming from our experiences of working in the AAG at ISAF Headquarters in Kabul, Afghanistan. We concluded by presenting some of the assessment challenges encountered during the ISAF campaign; lessons that may help future analysts and commanders better structure their campaigns for success.

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3.8 Summary

There are numerous analytical techniques one can use to execute analysis. One does not have to be an expert in every technique, but one should know which technique is appropriate for a given problem. If a deployed ORSA analyst finds that a problem requires a specific technique where time, skill, or software availability is at issue, he or she can request analytical support from a reachback agency such as CAA or tap into his or her personal ORSA network.

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CHAPTER 4 COMMUNICATING CLEARLY

4.1 Purpose

The purpose of this chapter is to provide ORSA analysts with best practices for representing data and associated analyses in a clear, accurate, and understandable way.

4.2 Constraints, Limitations, and Assumptions (CLA)

CLA bound (scope) a study effort by identifying what must (or must not) and can (or cannot) be accomplished; they frame the study space and set the stage for the study team's methodology development; they serve as a "contract" between the study sponsor and the study team; and they provide a basis for the sponsor to reconcile the study results. CLA provide the framework for both the study team and the study sponsor to understand the conditions under which a study's results are applicable.

4.2.1 Constraints

Constraints are restrictions imposed by the study sponsor that limit the study team's options in conducting the analysis and/or study. The study tasker and sponsor's guidance may place bounds on the study by specifying the

- date by which the study must be completed;
- organizations to participate in the study;
- force structure(s) and force year(s) to consider;
- type(s) of combat operations to consider; and
- scenario(s), threats, and environments to consider.

These bounds may limit one's ability to conduct a full investigation and analysis of the issues at hand. One needs to discuss changes to any constraint with the study sponsor prior to removing or adjusting the constraint.

4.2.2 Limitations

Limitations are restrictions that limit one's ability to meet the study objectives or fully investigate/analyze the study issues within the bounds of the study's sponsor. Limitations may consist of the following

- concept immaturity;
- access to study information, e.g., information that requires special clearances;
- availability of data;
- number and type of available scenarios; and,
- available models and their capabilities.

One should not label something as a limitation that one imposes on oneself. If one can overcome a limitation by having the study sponsor change a constraint, one should recommend that change to the sponsor and identify how it benefits the analysis/study.

4.2.3 Assumptions

Assumptions are statements related to the analysis/study that are taken as true in the absence of facts, often to accommodate limitations.

Clearly define assumptions used in one's analysis. Assumptions are an integral part of any analysis. One needs to clearly define and state all assumptions associated with the analysis. Higher headquarters or written plans provide the assumptions associated with the analysis. One usually identifies these assumptions up-front to help shape the method of analysis. One may also discover other needed assumptions as the analysis progresses. When one discovers additional assumptions during the analysis, one needs to discuss these assumptions with the sponsor to determine their relevance or to obtain additional data that would eliminate them. Whether stated up-front or determined over the course of analysis, one needs to make all recipients of the final analytical product aware of all assumptions by incorporating them into the final presentation or report.

State how the assumptions will affect analysis results. It is important to state how each assumption will affect one's analysis and study results. One should only include those assumptions that have an impact on the analysis and results. If one cannot explain the effect—or there is no effect on the results—one should not include the assumption. One should explain all assumptions during one's presentation or in the notes section of the final product or report. The following are examples of relevant assumptions made in past analyses conducted in theater:

- Specific sensor system had line of sight to view significant activities.
- Attrition rate of 6.4%.
- International funds would continue at the same level for the next *x* number of years.

Based on the available data at the time of the analysis, one makes assumptions to allow analysis to continue. If additional data become available during the analysis, one should include them to provide greater fidelity and insight. Assumptions, such as those listed above, assist in the development of a data collection plan and enhance future iterations of the analysis.

4.3 Roles and Tenets of CLA

CLA are critical to a successful study. They

- bound (scope) a study effort by identifying what must (or must not) or can (or cannot) be accomplished;
- frame the study space and set the stage for the study team's method-development;
- serve as a contract between the study sponsor and the study team; and
- provide a basis for the sponsor to reconcile the study results.

CLA must be

- acceptable, i.e., generally agreed upon by all study participants;
- evolving, i.e., continually reviewed and adjusted as the study effort matures;
- necessary, i.e., enable the study effort; and

- valid, i.e., sound and supportable.

4.3.1 State All Caveats

One must clearly state all caveats associated with the data and analysis. Caveats are warnings or cautions that may include one's interpretation of data, interpretation of terminology, and one's graphical representation of results. One may address caveats in the form of limitations. One should address caveats up-front to give one's audience a greater perspective while they are reviewing the analysis and results. For example, one should include a caveat associated with a specific graphical representation of results as a text box or bullet on the same slide as the graphic to avoid misrepresentation and/or misunderstanding of the results.

The following are examples of caveats from OIF and OEF:

- Population data were extrapolated from the census conducted in 1975.
- All levels of armoring (1, 2, & 3) were included in the up-armored high mobility multipurpose wheeled vehicle (HMMWV) category.
- Only coalition forces (CF) casualty data were included.
- Responses for Afghan National Development Program (ANDP) opinion survey 4.0 were worded differently from previous surveys. Responses were binned to compare with ANDP surveys 1.0 - 3.0.

Caveats such as these inform the sponsor to begin collection on specific data requirements to enhance future iterations of ANDP analysis.

4.3.2 Presenting Results

Know the audience. Before one presents a brief on analytical results, he or she needs to know his or her audience. Knowing one's audience assists one in knowing what level of discussion to have on the analytical techniques used in the analysis.

Avoid becoming too technical. If one wants senior leaders to accept one's technical study results at the highest levels, one must communicate insights as simple statements, without becoming too technical. One should not assume that the decision maker will sift through briefing data to find the answers. The purpose of a briefing is *not* to show the decision maker all the data and expect him or her to find the answer. One must realize that most decision makers are not technical experts. If one displays too much technical data, one further complicates an already complex issue. One must *package* one's results to provide insight and recommendations to decision makers. Decision makers focus on decision making, not technical fascination.

Present *bottom line up front*. One should clearly state the purpose of one's brief/presentation at the beginning in the form of a purpose statement or problem statement. One should make these statements concise and develop them jointly with the study sponsor/study director.

Use a logical presentation methodology. One's presentation should have a logical flow to allow one's audience to understand the purpose, problem, analysis, and results. One should begin one's presentations with the purpose and/or problem statement, i.e., "bottom line up front." This technique enables one's audience to understand the end state and results while the discussion is unfolding. Any graphical representation of data or analysis should include a "take away" bullet. One should include a bullet comment on the most important reason for displaying the data/results in a given manner. This bullet should stand out using a color scheme, larger bold text, or some type of symbol to draw the audience's attention to this important fact.

If there is specific information that should remain displayed throughout the brief, e.g., a map of the operational area or a legend of a color scheme), one should create separate visual displays to make this possible.

The delivery of one's brief is just as important as the brief itself. One should rehearse one's brief to increase one's confidence, correct one's mistakes, and make changes to the flow of one's presentation. One should take the time to ensure all technology is operating properly (including replacing the batteries in the remote, the bulbs in the projector, the length of extension cords for the computer equipment, the volume on the sound, etc). If a remote is not available, one should arrange for someone else to work the slide show presentation (if one has time to rehearse, this is always a good idea because it limits one's distractions and keeps one's audience focused on the presentation). One can have the best analytical product in the world, but if one's delivery is poor, the decision maker may discount one's efforts.

After giving the presentation, one should re-assess the overall briefing and determine if one achieved one's stated goals. One should determine if follow-on presentations or meetings are necessary and appropriate.

Prepare slides to stand alone. One's slides should contain backup notes and potentially stand alone. Commanders and staffs at all levels may extract specific slides from one's presentation for other presentations/meetings/working groups, etc. Providing backup notes with one's slides limits misuse and misinterpretation.

Include the appropriate classification with each bullet. When incorporating classified information into one's presentation, one should use a Security Classification Guide or properly marked source document(s) to determine the classification of information incorporated into their presentation. Every portion in a classified presentation should be marked for classification, and every slide should contain a classification banner indicating the highest level of classification found on that slide. Reference the governing regulations or memorandums on marking of classified information that pertain to your working location.

Use the best method of presentation. Consider one's audience in determining the best method to display one's results. One should remember one is conducting the analysis *for* the customer. In some cases, this method is command-driven. If it is not, the following are helpful hints on best practices used in theater.

Present information in the clearest manner. One should not make slides so complex that the audience has difficulty understanding the main point of one's slides.

Use a combination of graphs or tables with accompanying bullets. One should highlight the "take away" of the slide. One should use colored text boxes and larger fonts to make important points stand out from other information on the slide. When one uses a common color scheme throughout the presentation, one's audience quickly recognizes the main point of each slide.

Properly label graphical representation of results. One should label all aspects of each graph, i.e., *x*-axis, *y*-axis, title, and legend. One should clearly define data table columns and rows. One should include the data source with all graphs and tables to enable one's audience to find the original data for follow-on analysis and/or validation.

Simplify mathematical concepts. One should know one's audience when explaining the mathematical concepts behind the analysis. As a rule, one should present concepts simply and have the mathematical computations available in one's back-up slides to present to senior leaders who request additional information.

Graphically display results and conclusions. Graphical displays are often more powerful than the technical analysis behind them. One should take extra time to display one's information in such a way that one's audience easily grasps the main points. When one incorporates tables, charts, or graphs into a PowerPoint presentation, one should paste them as pictures. One does this by using the Edit, Paste Special command in PowerPoint. This prevents anyone else from manipulating one's data and charts. It also reduces the size of one's presentation and makes it easier to send electronically. The following are some helpful hints for displaying results:

- Visuals are more powerful in color. One should use a specific color for the critical points or "take-a-ways" that require audience attention. One should limit the number of colors per graphic and keep colors consistent across one's entire presentation. Each graphic must contain a detailed legend that defines one's color-coding methodology. Ensure your primary audience member, e.g., the commander, is not colorblind, which could render your message ineffective.
- One should avoid confusing one's audience; one should keep scales constant across multiple charts on the same topic.
- After completing the analysis, one should determine the type of graphic that best communicates the results and main "take-a-way" points, e.g., text charts, tables, line charts, dual-axis charts, surface charts, vertical bar or column charts, and pie charts).
- Text charts are the easiest type of graphic to prepare. However, one should remember that words or bullets are not visuals. Pictures, clouds, and arrows used in conjunction with words create visual effects that communicate the information or results better. Text charts are effective for introducing topics, such as the methods one used in the analysis and important ideas or results. One should keep one's text charts as concise as possible; one should use bullet statements rather than entire sentences and paragraphs.

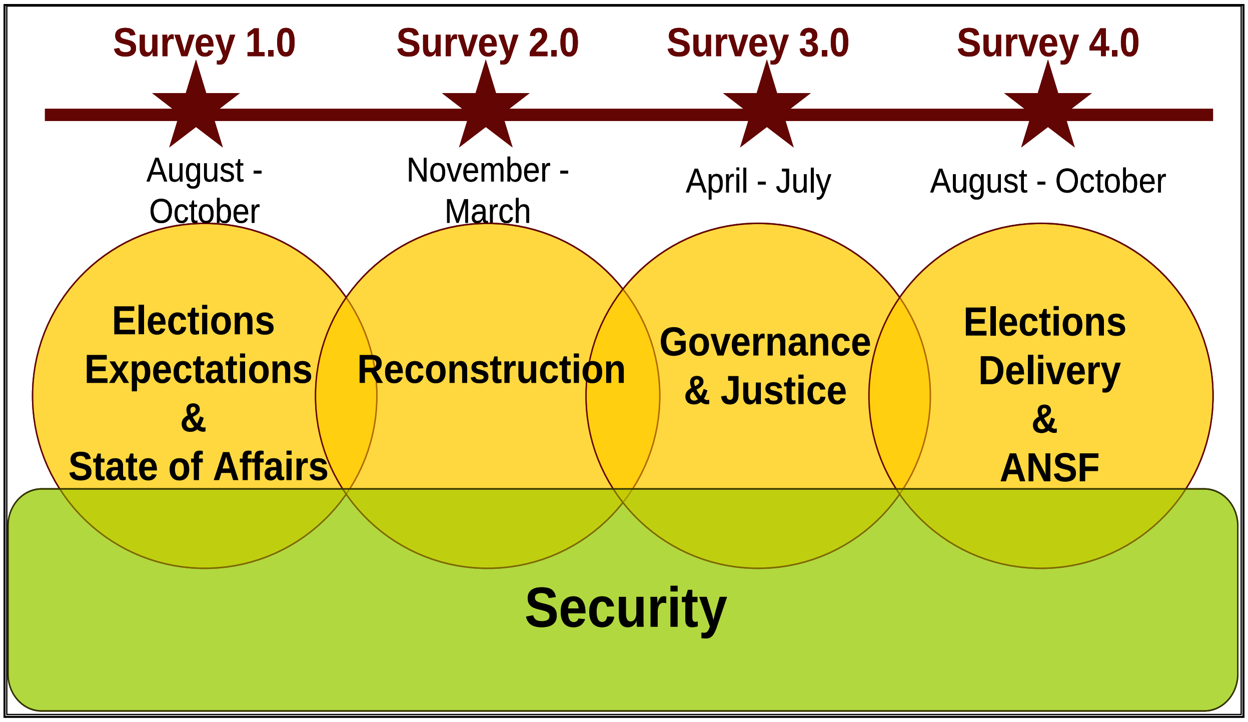


Figure 10. ANDP survey model

Figure 10 is a text chart displaying the survey model of the ANDP. One can use tables to display raw data or study results; however, there are better methods for displaying comparisons or trends. One can use a table in conjunction with other graphics if the exact numbers are relevant to the "take-a-way" one wants to achieve on a particular slide. When one uses tables, one should clearly label all columns and rows (see Figure 11).

Tables Show Specific Data					
Annual Spending ($B)					
Fiscal Year					
FY	1965	1970	1975	1980	1985
Procurement and RDTE	7.6	9.0	10.8	13.4	19.0
Personal Costs	9.1	11.3	13.8	19.5	26.5
Other	4.9	5.8	6.7	8.2	10.8

Figure 11. Annual ANDP spending per fiscal year

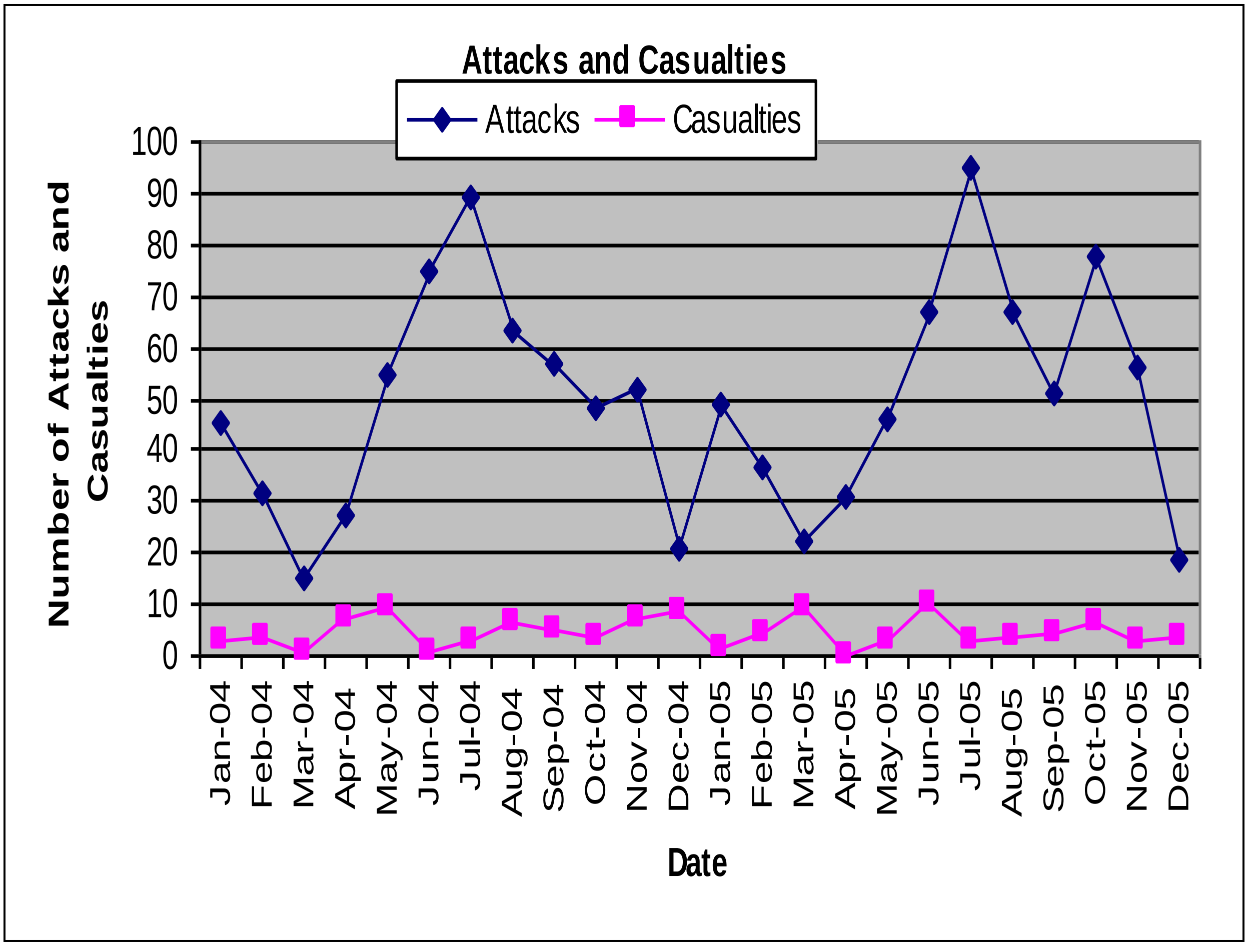


Figure 12. Numbers of attacks and casualties

Line or curve charts effectively show trends and time series data. Line charts display multiple lines on a single graph. One should clearly distinguish each line with differing colors or patterns (solid, dashed, etc). One should include a legend that defines colors and patterns.

Figure 12 is a sample line chart of *notional* attack and casualty data. The chart defines the *x*- and *y*-axes, and includes a legend to specify the representation of each line. The title specifies the exact category of the data, e.g., attacks and casualties.

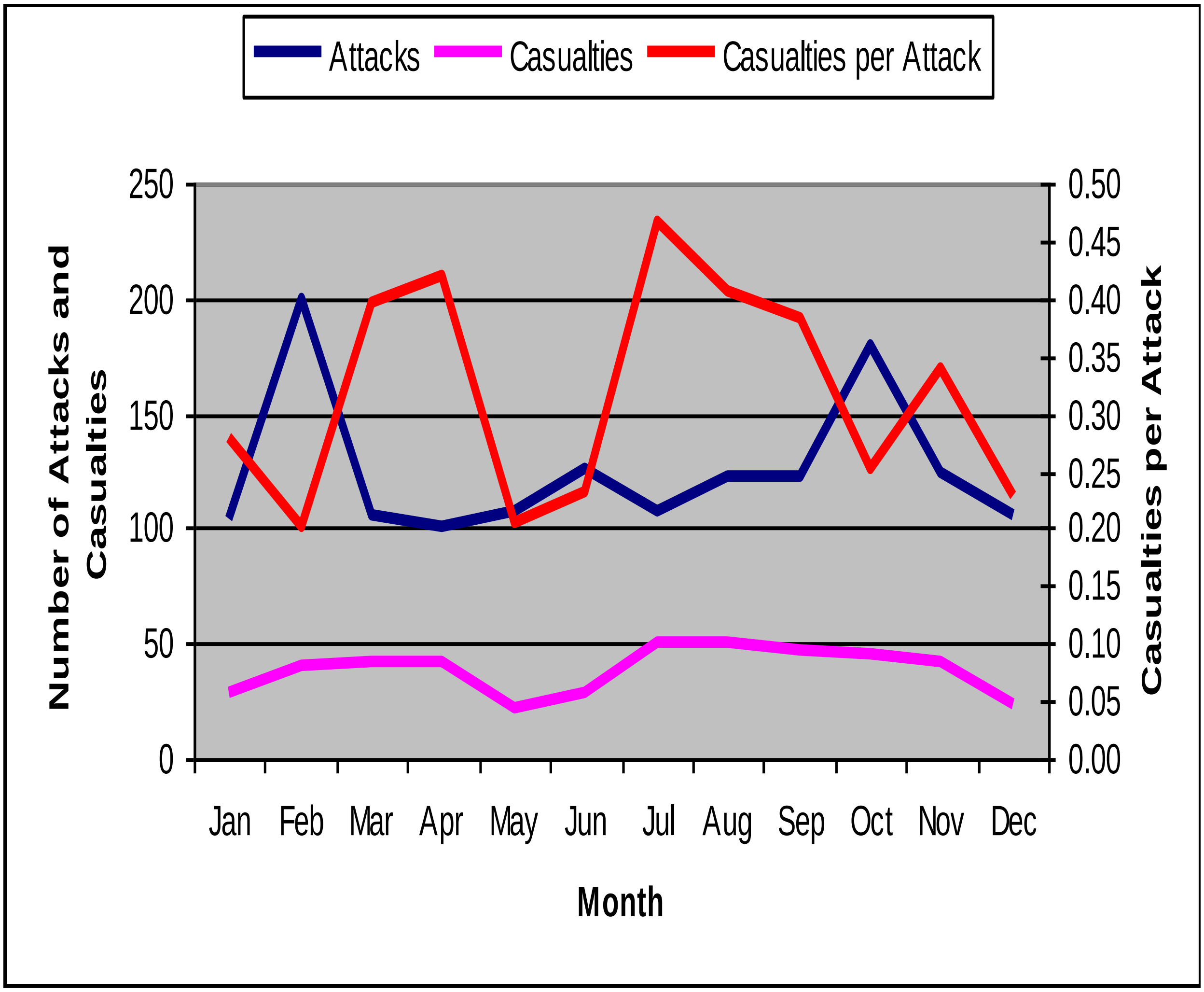


Figure 13. Casualties per attack

Dual axis charts show different data with a varying degree of magnitude between the data sets. In Figure 13, the ORSA analyst uses a red line to display *notional* casualties per attack. The dual-axis chart presents all pertinent information in a clear and understandable way.

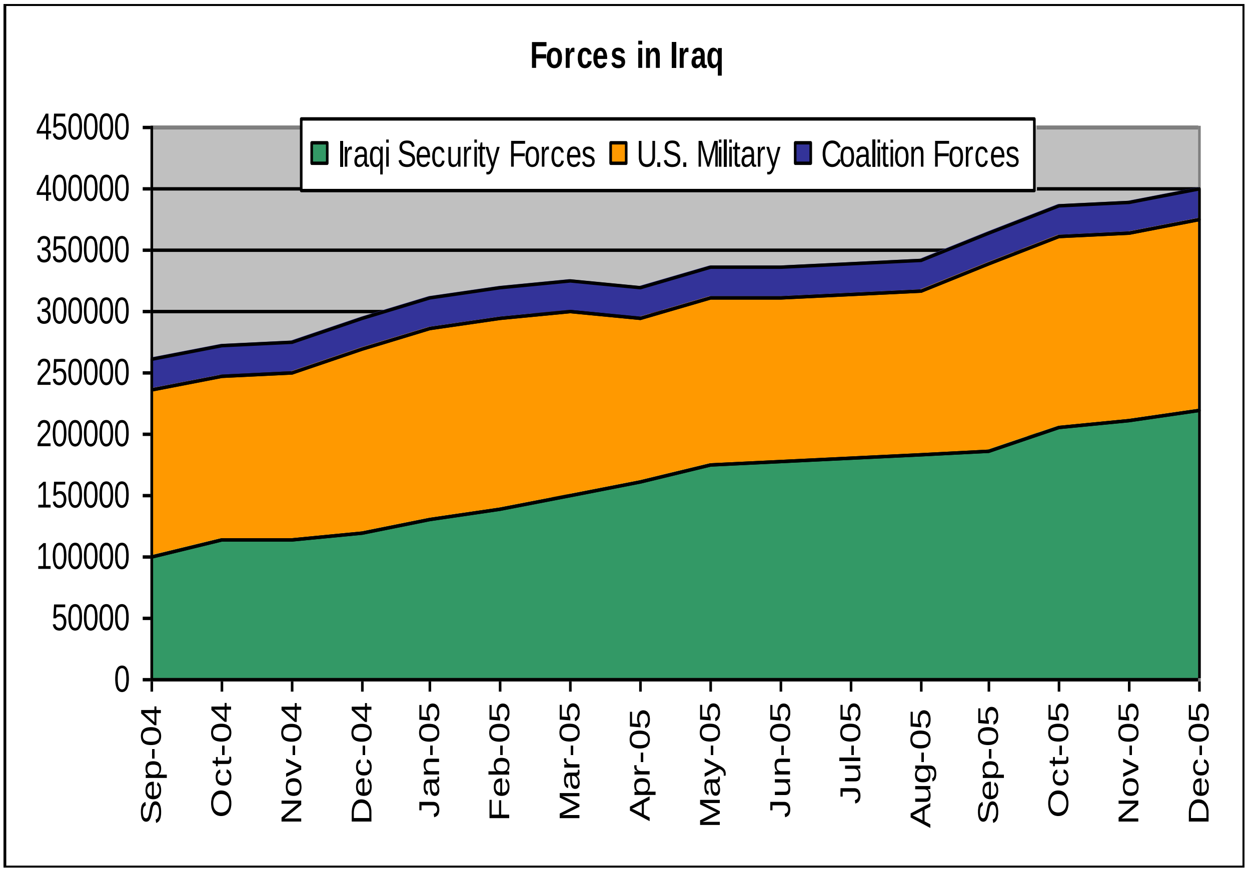


Figure 14. Numbers of participating ISF/US/CF security forces

In Figure 14, the ORSA analyst uses a surface chart to display data for the Iraqi Security Forces (ISF) Update conducted by Multi-National Forces-Iraq (MNF-I). A surface chart is a single line chart with the area shaded under the line. The shading emphasizes the size of the total amount rather than the differences or changes in the amounts.

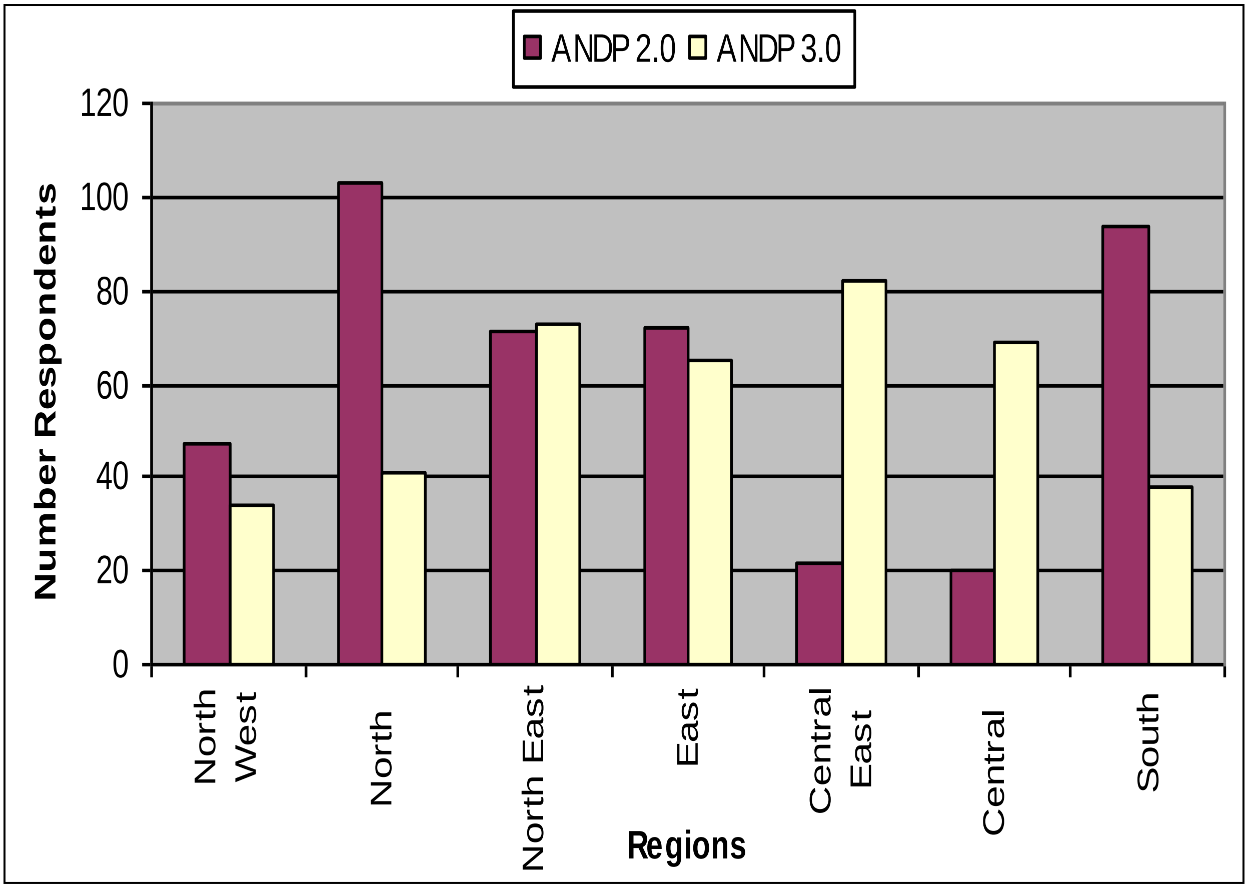


Figure 15. The answer "Road improvements would most improve our lives?"

Figure 15 is a column chart used to display the results of the answer "road improvements" to the question in the ANDP opinion surveys 2.0 and 3.0—"What is the one thing that would most improve your life?"

A vertical bar or column chart displays values and series groups as sets of vertical columns grouped by category. The height of each column represents each respective quantity and its variation across different categories, e.g., time intervals or geographic regions. Excel offers different variations of this type of chart, to include the stack column chart, the percentage column chart, and the option to graph multiple categories across the same intervals of time or geographic regions by displaying each as a different-colored column. Each graph should include a legend that defines the visual coding.

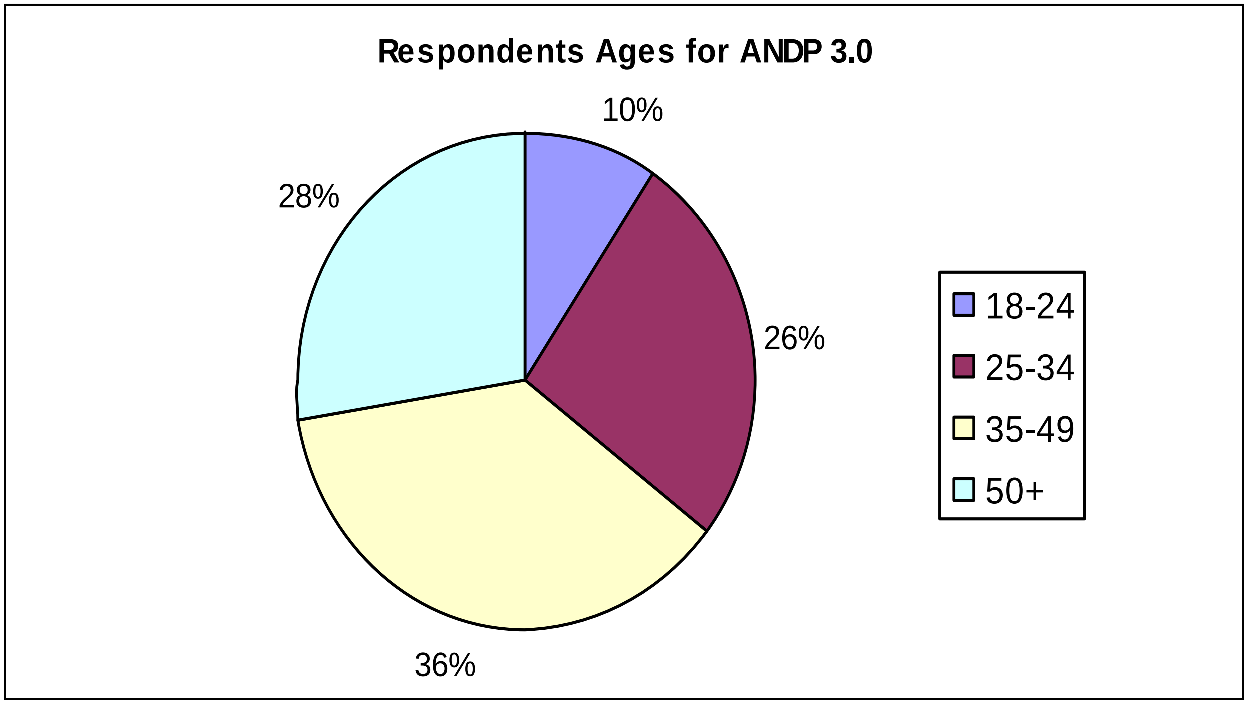


Figure 16. The age-percentages of ANDP 3.0 survey respondents

Figure 16 displays age category percentages for ANDP 3.0. A pie chart is used to show a composite whole and its proportions. Pie slices are compared with each other and with the whole. Each slice is represented with color and a legend is used to explain the color-coding methodology.

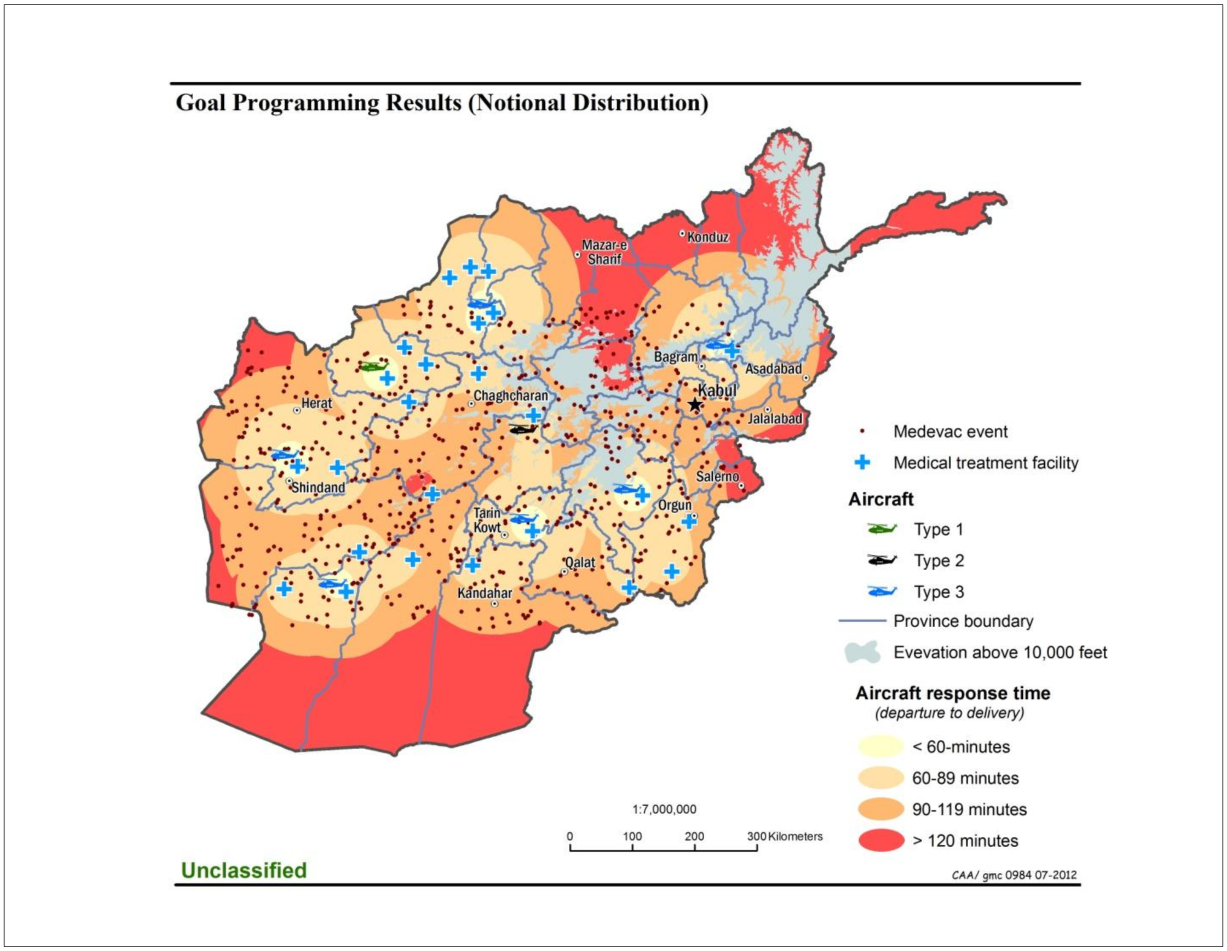


Figure 17. MEDEVAC helicopter response times and number of events

Figure 17 shows *notional* Afghanistan MEDEVAC data and helicopter response times created with ArcGIS. Shading represents the various response times and red dots represent MEDEVAC events.

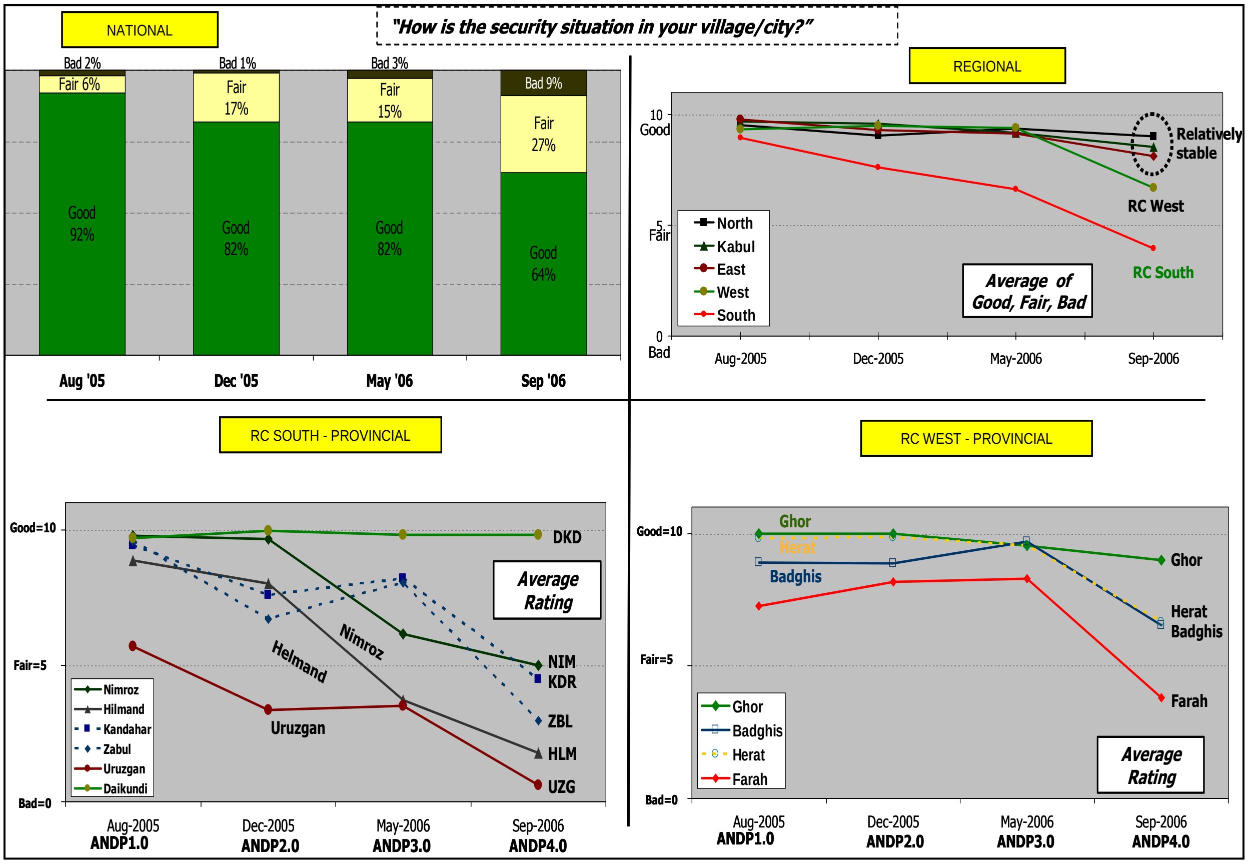


Figure 18. Security situation by province

Figure 18 is an example of a quad chart that summarizes and highlights trends on a specific question from the ANDP. Across all four iterations of the ANDP survey, pollsters asked, "How is the security situation in your village/city?" This information fed indicators and measures of effectiveness (MOEs) to determine if U.S./host nation (HN)/CF were meeting campaign plan objectives.

As a deployed ORSA analyst, one most commonly uses the "Quad" chart to summarize project status. The Quad chart divides a slide into four sections that usually consist of (1) the purpose/problem statement, (2) methods, (3) timeline, and (4) results/insights. One can adjust these sections to fit one's specific projects or quickly summarize one's current work effort. One can share these charts with agencies and other analysts who are interested in this work or collaborating on a reachback project. One can use Quad charts to show relationships. For example, in the assessment process, one may find this type of chart helpful in highlighting relationships between different indicators and MOEs, or increases/decreases in a specific MOE. One can amend the "Quad" chart, e.g., "Tri" or "Bi" chart) as the situation requires.

4.4 Summary

This chapter presented best practices for representing data and associated analyses in a clear, accurate, and understandable way. It presented the differences between constraints, limitations, and assumptions, and the importance of each. And finally, it highlighted the importance of using geospatial analysis as a powerful tool to complement other visual tools for displaying one's analysis.

CHAPTER 5 PUBLIC PERCEPTION SURVEY DEVELOPMENT AND ANALYSIS

5.1 Introduction

This chapter will discuss the value of public perception surveys, walk through the process to design and execute a survey, review analysis and presentation methods, and conclude with a discussion on the limitation of survey data and additional resources.

In operational environments where the indigenous population is the center of gravity, decision makers consider the population's perspective in their planning calculus. Commanders continually make decisions to address, persuade, and change public perceptions of key aspects and focus areas of the nation-building process, such as reconstruction, governance, security, etc. Surveys play an important role in understanding the population's perception, a unique data point to understanding the overall operational environment.

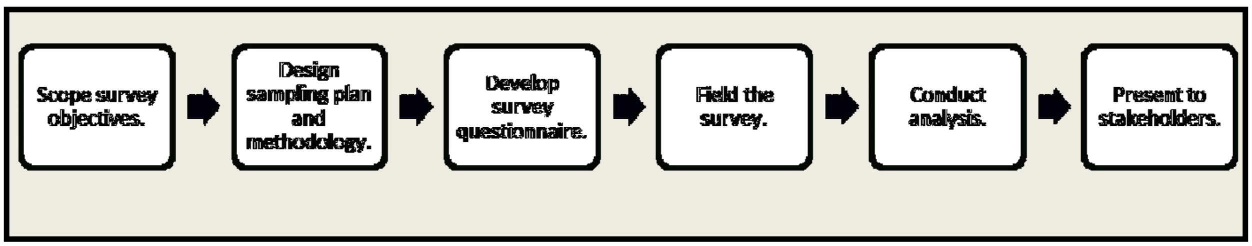


Figure 19. Survey process map

A broad overview of the entire process for designing, executing, and presenting public perception data is shown here.

5.2 Practical Applications and Examples

Public perception data can inform a broad range of decisions, spanning from the strategic level to more tactical decisions. This section lays out examples of the different ways in which survey data can be used.

Assessment Indicators

Commanders use assessments to determine whether progress has been made towards achieving stated objectives. Survey data are often used as a data source for indicators as part of the assessment framework. Data collected over time can show how a population's sentiment has changed over time, whether towards extremist groups, the U.S., a U.S-Coalition military presence, or the host nation government.

Example 1. International Security Assistance Force.

ISAF's Afghan National Quarterly Assessment Report (ANQAR), a nationally representative public perception survey, was used as one indicator to inform assessments of the ISAF mission by showing the trends of Afghans' perception of security over time.

Inform Planning Requirements

Survey data are also used to inform the development and adjustment of operations, particularly those related to civil affairs and military information support operations (MISO). Operators can identify target populations for potential operations, identifying areas of opportunity or need among the population. This includes identifying pockets of the population that are sympathetic towards violent extremists and understand why they are sympathetic. Then, using demographic and media usage information gleaned from the survey data, analysts can design a specific, targeted MISO series.

Example 2. Special Operations Command Africa

CAA used Department of State's nation-wide surveys in Niger to inform the planning decisions of Special Operations Command Africa, who was looking to build an airbase in the Agadez Region. The survey data provided insights on the public's sentiment towards the United States, as well as identified areas of opportunity, such as infrastructure improvement for the United States to build up good will.

Example 3. Joint Special Operations Task Force - Philippines

CAA's Southern Philippines Public Perception Survey identified pockets of the Mindanao population where the people were unfamiliar with the Bangsamoro Peace Process. This information was used to develop a MISO series to education the population where it was needed, conducted in coordination with Philippine counterparts.

Before Starting

Know the ultimate objective of the survey – what decision(s) is it informing? What are the data points stakeholders want from the survey? What information will it provide that other data sources cannot? Know who the primary stakeholders are, and what information they want from the survey. Ensure those expectations are realistic and fall within the scope of a public perception survey.

Process of Designing and Executing a Survey

The involvement of the ORSA analyst in the survey process will depend on the role of the supported command: it may range from designing, implementing, managing the entire survey process to simply analyzing data collected through an already-existing survey channel. This sections walks through that entire process.

If operating under a tight timeframe or with limited resources, there may not time to complete all these steps (pre-tests, back translations of the questionnaire, etc). Local contractors will almost always do the actual fieldwork; locals conducting surveys to local people in their own local dialect are much better received than if U.S. personnel were to conduct the surveys.

A note on working with contractors: Be certified as a Contracting Officer's Representative (COR). This provides the ability to communicate directly with the contractors, instead of going through the Contracting Officer (KO). The KO will almost certainly not be a subject matter expert (SME) in public perception surveys, so part of the COR role will be to work with the contractor in the development of the sampling plan and questionnaire, check in with them to ensure they are following the accepted processes and protocols, and follow up directly with the contractor if problems with the data are identified, e.g., incorrect coding, responses not translated to English, etc.,. Additionally, the COR will review the Statement of Work before it is finalized to be sure the details comport with the requirements. This includes sample size, questionnaire length, sampling plan, training of interviewers, format of data delivery, timeline for execution, data coding requirements, and any required final products from the contractor.

Sampling Plan and Methodology Development

Professional polling companies have the expertise to recommend the best polling methodology based on the survey's purpose. If one uses a contracting agency, inspect the sampling plan prior to fieldwork to ensure it comports to acceptable standards. Considerations include:

- Demographics. Typically, the survey sample should be representative of the population, as dictated by an authoritative source, such as a census. Depending on the purpose of the survey, the sample may need to focus on a particular portion of the population. For example, a survey looking at the influence of violent extremist organizations' messaging may focus on specific vulnerable populations as determined by the survey stakeholders.
- Random Sampling. In order to limit the bias associated with surveys, random sampling needs to occur at every level of the survey process, from the selection of towns and cities to the actual people one will interview. Standard selection methods usually suffice; however, there may be times when one needs to consider "non-standard" selection methods.
- Sample Size. Even when a survey controls for demographics and random sampling, there is a margin of error associated with any opinion poll. There are many methods for calculating this margin of error (each with underlying assumptions), the most common involves sample size and confidence level. The equation for the margin of error calculated at the 95% confidence level is:

$$\%\ \text{Error} = \frac{1.96}{2\sqrt{n}}$$, where n represents the sample size.

Much analysis is done with subsets of the sample – male/female, geographic, and religious breakdowns, etc. Keep in mind that each of these sub-groups will have larger margins of error as the sample size being analyzed shrinks. Make sure to account for statistical significance in the final analysis and presentation - do not highlight differences that are not meaningful.

Questionnaire Design

Designing a questionnaire should be a team effort, with involvement from all stakeholders to ensure their subject areas are covered, be it security, governance, development, etc. Typically, sections on demographics as well as media usage are standard. Whenever possible, one should take advantage of the contracted agency's expertise, both in polling as well as regional expertise, to assist with question wording and understand relevant cultural considerations.

When designing a questionnaire, there are several things to keep in mind:

- Length. Cost will limit the number of questions; consider interviewer and respondent fatigue when adding questions. Do not be unnecessarily redundant.
- Order. Ask about awareness of an issue before asking an opinion of that issue. Group questions thematically.
- Continuity. Keep as many questions from previous waves as possible to enable trend analysis.
- Language. Keep it simple. Plain language, clear, and direct. Consider what nuances may be lost in translation.

Example 4. Question Design

Bad Question: Do you think the government is doing a good job at fighting corruption and providing services for its people?

> This question combines multiple sentiments (fighting corruption and providing services) into one, which limits the respondent. The respondent may think the government is good at one thing and not the other – the data resulting from this question would not show this. Additionally, words should be specific enough that every respondent interprets the question the same way. What is meant by services? It could mean a broad range of things, and this question would not give meaningful data to act upon.

Better Question: Please tell me whether the government is doing a very good, somewhat good, neither good nor poor, somewhat poor, or very poor job for each of the following items:

i. Fighting corruption.
ii. Providing security services.
iii. Providing education services.
iv. Providing healthcare services.
v. Providing transportation services.
vi. Providing electricity services.

> This question asks about different tasks of the government, separately and specifically. The four answer choices offer more granularity for respondents.

There are several types of questions. These are some general categories:

- Closed-Ended Questions: Respondents are limited to the answer choices provided by the interviewer. The answer choices "Don't Know" is typically included for all closed-ended questions, however this selection is not provided to the respondent, only marked if that is what is said. Reading them aloud will skew results significantly.
- Attitudinal Questions – typically asked on a five-point scale to represent the range: very negative, somewhat negative, neutral, somewhat positive, very positive. Sometimes the neutral response is removed.

- Multiple Responses – Allow respondent to choose several (usually up to three) responses from a given set to answer a question.
- Agree/Disagree – Provide a statement, and ask respondents if they agree with it.
- Open-Ended Questions – Typically asked after an attitudinal question, to provide the "why." Respondents are free to answer however they want, and typically, contractors will bin common answers together to simplify analysis.

Example 5. Sample Question Series

Q1. Have you heard of the Abu Sayyaf Group?
(Yes, No)

Q2. How much of a threat does the Abu Sayyaf Group pose to your community?
(Great Deal, Fair Amount, Not Very Much, None)

Q3. Why do you say that?
(Open-ended)

The first question is used as a skip question, so that only people who have heard of ASG are asked questions about them.

The second question provides the Likert-scale spectrum to measure the public's sentiment towards the group.

The third question provides insights as to *why* the public feels a certain way. A respondent may say that ASG poses no threat to their community – that could be because ASG is simply not present in their community, or it could be because ASG is present and viewed favorably by the population. These two reasons have very different implications for the analysis, and are impossible to extrapolate from the survey data otherwise.

Focus Group Discussions

Analysts will sometimes have the contracting agency conduct focus group discussions with the population, typically 6 to 8 participants with a trained moderator. This can either be a stand-alone survey mechanism, or used to augment the typical quantitative survey. Focus groups offer deeper insights into why people feel a certain way on a topic. They are usually organized around one or two specific areas, such as upcoming elections or the local economy, and the moderator facilitates a fairly unstructured discussion with the participants. The composition of the focus groups will be particular to the region/subject matter; sometimes the groups are split along religious lines, sometimes divided into male and female groups. Focus groups are also a way to see whether certain topics make people more uncomfortable and less willing to be forthright about their opinion – something that can be used to inform the development of the quantitative questionnaire.

Pre-Test

Particularly for a new survey, or just new questions, one should initiate a field test with a small sample size (25) to see how the questions play before the actual fieldwork begins. Things to look for: Is the respondent comfortable talking about the subject being asked? Is the question understood or is it confusing? Is there a cultural issue that makes this question unsuitable? The field test will isolate these questions, and others that may provide non-significant insights, i.e., 100% of respondents answered "Don't Know" to a question, and allow the survey team to adjust, delete, or add questions based on field test results.

Oversee Fieldwork

When and where possible, one should observe and monitor the training of interviewers, and monitor the actual fieldwork to ensure field workers adhere to prescribed standards and methodologies. However, consider the sensitivity associated with training observation and fieldwork monitoring – will a survey agency's association with U.S. personnel place their employees at risk?

Example 6. Social Sensitivities in Questions

Do you own a gun?
vs.
Is it appropriate for someone in this neighborhood to own a gun to protect his family?

When asked in the Southern Philippine Public Perception Survey, the first question above yielded a very low positive response, which was universally agreed upon to be highly inaccurate. Filipinos did not want to admit to personally owning a gun. However, when asked in the third person, as in the second question above, the response rates were much more in line with what operational data had analysts expecting.

Quality Check the Data

When first receiving the raw data, run a basic quality control to check for inconsistencies and/or anomalies in the data that may point to incorrect coding or other instances of the contractor committing errors during the survey collection and processing period. The quality assurance (QA)/quality control (QC) will provide greater assurance that the data collected is valid, offering more legitimacy to the analysis that is based off of it. Listed below are some areas to focus on for a QC checklist.

Example 7. QA/QC Questions

- Do all SPSS variable labels and value labels in the data set match the final questionnaire?
- Are the marginal consistent with regional/cultural knowledge/previous trends?
- Are crosstabs logically consistent?
- Were filter questions properly executed and coded?
- Do the sampling variables match the pre-fieldwork sampling design?
- Does the weighted/unweighted sample match a known population distribution?
- Are lengths and timings of interviews consistent and within the realm of normal? (do interviews last 5 minutes, or happen in the middle of the night?)
- Are there overlapping interviews?
- Does one interviewer complete in excess of 10 interviews per day? (The standard is 10, but should be discussed with the contracting agency beforehand)
- Are there any instances of teleportation? (interviewer concludes one interview, begins another immediately after in a different province)
- Are there any duplicate cases in the dataset?

Future waves

If the command is planning on conducting subsequent waves to track trends, try to maintain as much consistency as possible. Keep the exact wording of the question and coding the same. Maintain a merge file to simplify analysis. Ensure the contractor complies with the exact specifications on how to code the data. Be mindful of the timing of the survey, as it relates to current events. Is there a desire to capture sentiment before and after a presidential election? After a major operation or other significant event? Keep these in mind while planning out the timeline of conducting a survey.

5.3 Data Analysis

There are several different types of analysis that can be used on survey data, ranging from basic to complex. This section walks through the basics of data analysis, and briefly discusses some of the more commonly used tools for survey analysis.

Common Tools[19]

- <u>SPSS</u>. The most common survey software is SPSS. SPSS is simple to learn and fairly intuitive, and has lots of capability for survey analysis. It allows the development and application of weights, conduct basic descriptive statistics and crosstabs, as well as more advanced analysis to include clustering, regression, the creation of new variables based on calculations of existing ones, etc. The data visualization for SPSS is not as flexible and intuitive as Microsoft's Excel and PowerPoint applications, and some analysts prefer use of Tableau software to visualize survey and other data.

[19] Note: No endorsement is stated or implied by any references to commercial software applications in this handbook.

- Excel. With basic Excel skills, one can do most survey analysis. There is no easy way to apply weights to data though, if necessary. Pivot tables will enable easy crosstabs, filtering, and frequencies of the data. Additionally, Microsoft Office is universal, so there is no need to request special software. Creating charts in Excel is simple, and they are easily manipulated to adjust, re-format, and combine into one PowerPoint presentation for stakeholders.

Basic Analysis

- Frequencies. Basic marginal information offers broad insights into the perceptions on a given topic for the population as a whole.
- Crosstabs. Understand relationships between variables, particularly demographics – sex, ethnicity, religion, and location are typical subsets that tend to have different attitudes towards subjects. Beyond demographics, crosstabs are important to understand relationships between different attitudinal questions.
- Trends. Longitudinal analysis provides stakeholders with the context of the survey findings – what was it before? How has it changed? What has been the general directionality over time?
- Correlations. Quantify the degree to which two or more factors show a tendency to vary together. It is useful to see how closely responses to one question follow responses to another. For example, respondents who have strong distrust for the government may also have strong distrust for security sector institutions.
- Cluster Analysis. Draw out groups of respondents whose response profiles are similar to one another, and identify what common characteristics the group has, and what makes it distinct from the rest.

In addition to various quantitative techniques for analyzing the data, the analyst should have regional expertise, or at least basic knowledge, to understand, recognize, and expect certain cleavages in the data. This supplementary contextual knowledge helps stakeholders better understand why the data are a certain way, and isolate the atypical data points from those that would be expected, given the population's composition and culture.

When compiling survey analysis to present to stakeholders, the analyst should try and incorporate other atmospheric information, analysis, and findings wherever possible to validate particular findings and/or determine areas of emphasis that need further analysis due to conflicting results.

5.4 Report Presentation and Delivery

Tailor the analysis to the stakeholders' needs and preferences. If they prefer less PowerPoint, draft a short narrative with minimal charts to capture the key findings from the data. Highlight the takeaways that are most relevant to their problem set. Minimize the use of statistical language, such as covariance, correlation, statistically significant.

Do not attribute causation for the way things are. Show correlation, overlay a timeline of current events over a trend of a particular sentiment, and offer potential explanations, but do not definitively state "why" something is the way it is.

Data Visualizations

Use color when it has a meaning, not just for the sake of using color. Do not use it too much to make it overwhelming to the audience. Do not choose a color for a category that would be counterintuitive; e.g., red should not mean support.

The figures below provide examples of different visualizations for survey data. There are no absolute rules for how to present survey analysis, but the figures below capture some examples that have worked for stakeholders. Know the stakeholder's preferences in order to create a presentation that fits their style best.

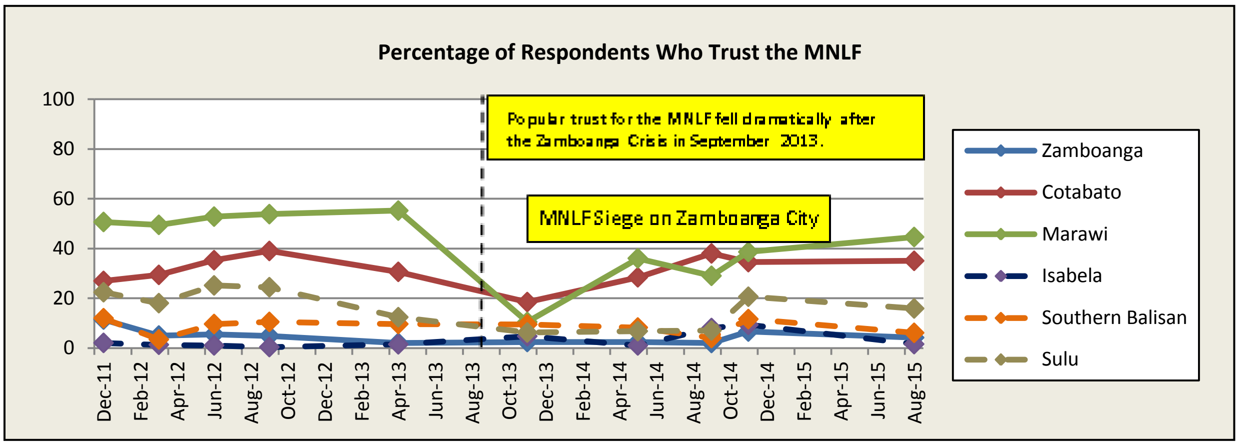


Figure 20. Line chart – depict changes in perception over time.

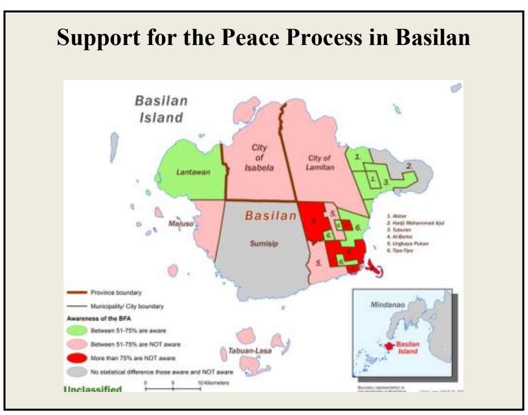


Figure 21. Geospatial Displays – Show the distribution across an area

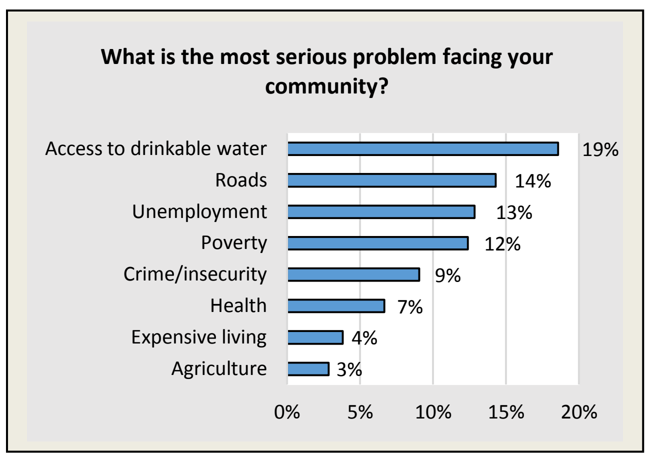
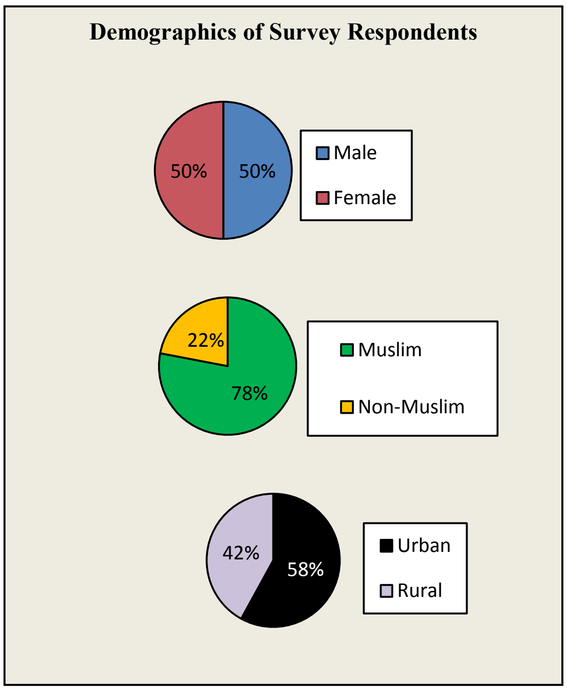


Figure 22. Clustered Bars – Illustrate a rank order among several choices



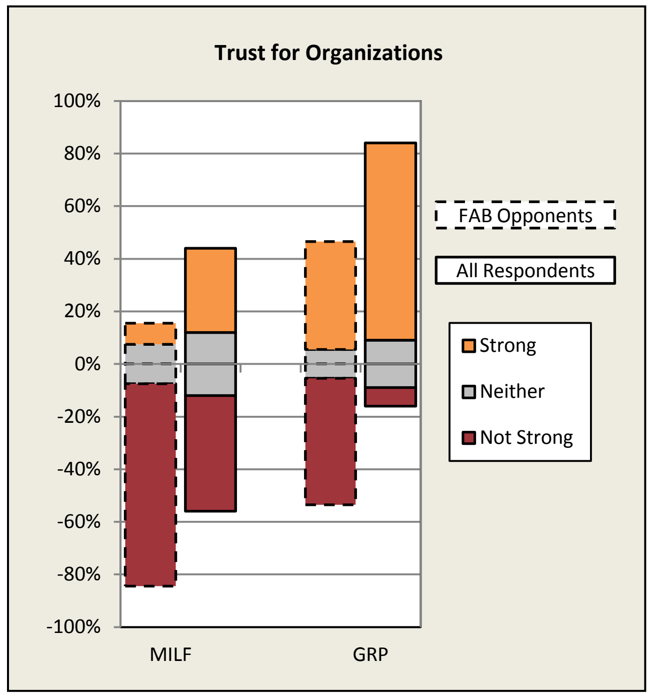


Figure 23. Pie Charts– Show demographic or categorical compositions

Figure 24. Stacked Charts - Display Likert-scale data across categories

5.5 Limitations of Surveys

When using survey data to inform analysis, there are several things to keep in mind. As with any data set, there are potential errors in the collection and cleaning processes to watch out for and mitigate as possible. Below are some of the more common errors, and how to limit the effects of them.

- Sampling Error. Were enough people asked the survey? Was the sample representative of the entire population?

  Use responsible sampling methodologies. Provide the margin of error when displaying analysis to stakeholders.

- Measurement Error. Did respondents respond honestly? Do the data accurately reflect the sentiment of the population?

  Vet the questions with focus groups. Have similar questions throughout the survey to check for consistency. Provide interviewer with questions on whether they felt the respondent was answering faithfully.

- Coverage Error. Did interviewers go where they were supposed to go?

  Particularly problematic with conflict areas. Conduct regular site visits during fieldwork, collect status reports from contractors, check data for instances of teleportation or other inconsistencies.

- Other Errors. Was there malfeasance? Incorrect coding? Failure to follow interview protocol? Compare data to other sources for consistency. Conduct thorough QA/QC checks on the data.

5.6 Existing Data Sources/Surveys

Several organizations, both governmental and non-governmental are already running surveys, most commonly at the national level. Before undertaking this process, do research. Department of State (DOS)'s Office of Opinion Research conducts surveys in almost every country, Center for Army Analysis has access to the Gallup World Poll dataset. Would either of these sources fulfill the requirements? What is the U.S. Embassy collecting? Are there other open source data available? The Asia Foundation and Social Weather Station conduct regular national and sub-national surveys in the Philippines. Surveys are expensive and time-consuming. Make sure the information is not already available through another avenue. If there are existing survey vehicles, can the analyst add questions to that survey questionnaire instead of beginning a new effort? If there are none, look around to see what other organizations would be interested in survey data of the specific areas. Can there be a combined effort? Look particularly to United States Agency for International Development (USAID) or DOS counterparts.

5.7 Summary

Surveys are just one data point in understanding the operational environment. Public perceptions represent what people think, not necessarily the reality on the ground. And given the complex nature of today's current operating environment, there is no way to attribute specific actions to changes in perception. In order to get a more complete picture of the situation, include all-source information, including operational data; atmospherics; Political, Military, Economic, Social, Information, and Infrastructure (PMESII) analysis; intelligence; etc.

5.8 Further Reading

This is a very basic primer on public perception surveys. See sources below for more detailed guidance. The internet is also a valuable resource.

Survey Research Methods. Fowler, Floyd J.

The American Association for Public Opinion Research Website (https://www.aapor.org) for educational resources, standard definitions, publications.

CHAPTER 6 OPERATIONS ASSESSMENTS

6.1 Introduction

A paradigm shift is underway in the operation assessment of complex environments. In the past, an assessment product was an attempt to determine progress over the preceding time period—in essence a history report—that organizations could share with higher authority. Today, an assessment process is becoming an increasingly robust attempt to improve our understanding of the operational environment (OE), which is informed by rigorously collected data given meaning by appropriate analyses, and the process is done explicitly for the purpose of making operations more effective. Therefore, assessment is now forward-looking to enable decision makers to take actions most appropriate to achieve their desired outcomes given the current state of the OE.

The definition of operation assessment proposed by the assessment community for the next revision of Joint Publication (JP) 5-0 makes this clear. Operation assessment is: **"An operational activity that supports decision making by determining progress toward accomplishing a task, creating an effect, or achieving an objective or end state for the purpose of making operations and campaigns more effective" (JP 5-0 proposal).**

In addition to the primary purpose of making operations more effective, assessment also has a secondary purpose of providing accountability to higher authority. Indeed, on many occasions, a formal assessment, summarized in a report, is required by law or regulation.

Assessors must also be aware that commanders may also use assessment data or products as messaging tools. This activity has implications for the veracity of assessment products used in this way (see Mushen and Schroden, (2014) "Are We Winning? A Brief History of Military Operations Assessment" available through Google). It is possible that a commander will want to "cherry-pick" data or results of analyses that support a particular message.

6.2 Assessment Framework

Assessment Framework

Joint Doctrine Note (JDN) 1-15, *Operation Assessment*, states that any assessment framework consists of three activities: organize and collect data, analyze data, and communicate results and recommendations.

Organizing and collecting data includes specifying what data require collection (information requirements), and details about who will collect it, how it will be collected, and how the data will be stored to support analysis.

Analyzing data consists of, in general, answering these questions:

- Where are we?
- What happened?
- Why do we think it happened? ("we think" is a hat tip to the idea that we are never sure "why")
- So what?
- What are the likely future opportunities and risks?

- What do we need to do?

Analyzing the data is largely an exercise in critical thinking. Mathematical techniques may **or may not** be useful depending upon the nature and quality of the data. Given the nature of the operational environment (OE) in complex operations and the quality of data collected, quantitative techniques should not be considered superior to critical reasoning. The appropriateness, usefulness, and likely validity of quantitative techniques require judgment from experienced assessors and others with appropriate expertise.

Analyzing the data is largely about trying to understand what has occurred and **why**, and therefore, what the joint force should do next in order to be most effective. Assessors cannot avoid discussions of causality. In practice, assessors will qualitatively examine sets of indicators that are related to each other. They will propose likely, possibly multiple, causal explanations (candidate hypotheses) for the movement of these indicators. Then they will pose additional analytic questions designed to eliminate some of these hypotheses and isolate the most likely cause. They do this by going back into the data in order to re-examine and exclude candidate hypotheses.

Much of this analysis is simple math and statistics or simple data visualization, enhanced by any more sophisticated quantitative techniques that are appropriate. **The overall process should be viewed as qualitative in nature**, simply because the complexity of the OE defies precise and complete measurement—that is, some important feature of the OE will not be precisely measureable.

Communicating results and recommendations includes packaging the pertinent information that was identified during the assessment process for sharing with decision makers and, if required, for reporting to higher authority. This information includes items, data, or results that the commander or other decision makers have asked to see; answers to specific questions that a decision maker has posed; and other things the staff has discovered during analysis that they think decision makers need to see.

It is **not necessary** to prepare slides that show the movement of every indicator. All indicators should be examined by functional area experts on the staff, but only a few are sufficiently important to occupy senior leaders' time. Moreover, it is usually counter-productive to attempt to aggregate several related indicators into some sort of index to reduce the amount of data assessors attempt to show senior leaders. Again, the report or brief should include only the things senior leaders have asked for and the things that the staff wants to bring to their attention.

It is important to remember that the packaging of information is designed to look forward, to inform decisions on future operations in order **to make these operations most effective**. The assessment product, whatever form it takes, is not merely a backward-looking history report.

It is also important to understand that the assessment product, whatever form it takes, is not the assessment itself, it is merely a communication of the pertinent portions of the assessment.

The assessment itself is the **improved understanding of the operational environment (OE), and our place in it, that we get from a systematic examination of the OE during the assessment process**. "The assessment" is a cognitive, not a physical or written product, that is analogous to a running staff estimate. The assessment product—a brief or a report—is essentially the executive summary of this improved understanding. (This is commonly misunderstood. Frequently, the words "the assessment" when heard about the headquarters are referring to the report. This is a conceptual problem. For more information, email adam.p.shilling.civ@mail.mil.)

JDN 1-15 contains an appendix (Appendix C) that discusses the advantages and disadvantages of various means of presentation of assessment results. It is relatively short, and the document is available through Google.

Outcomes

"Outcomes" is a single word that includes all of the following: end state, success criteria, termination criteria, objectives, sub-objectives, effects, conditions, tasks and purposes, or any other words that describe what we want some portion of the operating environment to look like in order for us to say that our operations are successful.

All operation assessment is contextual to the desired outcomes of the command performing the assessment. Its purpose is to provide the analysis to make operations more effective. Therefore, the questions (information requirements) and indicators that provide data for analysis are linked explicitly to the set of outcomes the command desires.

In addition to the data a command collects for its own use, higher authority may also require a command to report on various items that are of interest to the higher command.

The first duty of an assessor, when possible, is to help the planners write outcome statements that are specific. Failure to do this will make these outcomes very difficult to assess, but even more importantly, **unclear outcomes make it very difficult for subordinate commands to take effective action to achieve them**. Unclear outcome statements often do not focus or constrain subordinates' behavior, making the desired outcomes more difficult to achieve.

Linking Outcomes to Indicators

Once outcomes are as specific as possible, assessors should ask themselves, about each outcome statement, "What questions do we need to answer to know we are accomplishing this?" The resulting questions are information requirements (IRs). This list should be scrubbed and then prioritized to focus collection and reporting on the information that is most valuable. When any IR is sufficiently specific that it can be answered by empirical observation, the information that answers that question is an indicator.

Adam Shilling, PhD, developed a mental model for linking outcomes to indicators that can help assessors identify information requirements and indicators, understand the relationships between indicators, and organize indicators for collection and storage.

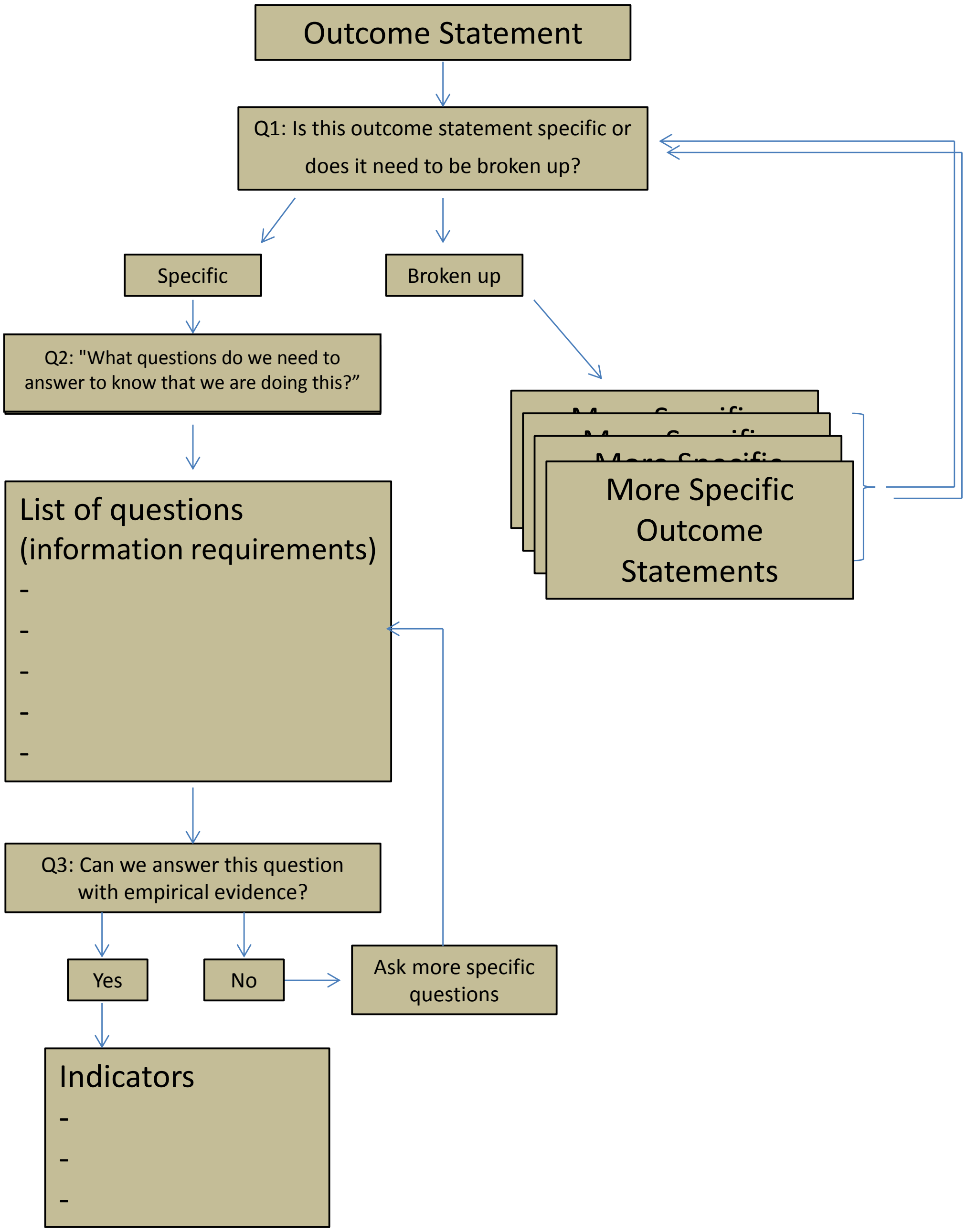


Figure 25. Mental model for linking outcomes to indicators.

The model is used by beginning at the top with any outcome statement and posing Q1. If the statement is judged to be specific enough, the assessor proceeds to Q2. If not, the assessor helps the planner break the original statement into more specific outcome statements that "add up" to the original outcome. Each of these is evaluated with Q1, and additional iterations through the "design loop," until all outcome statements are specific enough to proceed. At this point, assessors are helping the planners with "design."

For each specific outcome, assessors pose Q2. This generates a list of questions, also called information requirements (IRs), that the command needs to answer to determine whether they are progressing toward their desired outcomes. These questions need to be refined until they are specific enough to answer with empirical observation (or the judgment of a trusted observer), and prioritized in the face of limited collection resources. All of these answers are the set of indicators that are optimal. Again, in the real world, all of them may not be collectable, so assessors must prioritize the IRs and collect the most important indicators.

A word of caution: some assessors try to skip the list of questions (IRs) portion of the model. When they do, the typically develop a set of all possible indicators that have bearing on the desired outcomes. This creates a couple of problems: 1. the list of indicators is too long, lacks focus, and is hard to prioritize; 2. assessors do not understand the relationship of indicators to each other. The formal step of listing IRs (questions) and then identifying indicators that answer them helps assessors understand the relationship between several indicators that may answer a single question. Also, most people find the list of questions easier to prioritize than an exhaustive list of potential indicators. In essence, the formality of posing the questions focuses the identification of indicators.

Some observations from experience: Sometimes several questions (IRs) may be answered or informed by the same indicator or set of indicators. Some questions may be answered individually by one or more indicators; or several related questions may be answered collectively by a set of indicators. Some indicators are straight forward and observable, e.g., the number of recruits that qualified with their individual weapons in the current class of boot camp. Others will require a judgment, which will require an observer(s) trusted to make the judgment, e.g., a platoon is proficient in the task "react to ambush." Many more require observers to try to classify an empirical event according to set of criteria, e.g., was this attack simple or complex?

Some issues will require a set of IRs and indicators to give the command a thorough understanding of each issue. Others may require only enough information to determine that an issue is or is not a problem for the command. If a problem exists, the command can focus additional effort and resources on understanding and resolving the issue. If not, the command may be content with merely monitoring it.

Fully specifying indicators

Selected indicators must be sufficiently well-specified such that any one indicator can be collected consistently by multiple observers—at different places or over time. Each will need a definition, a plan for collecting the data (who, what, when, why, and how), and be sensitive to change within a relevant time frame. If it is calculated, it must have a formula; and it *may* have a target or threshold or a desired rate of change.

Among other pending changes in U.S. doctrine in 2015, the definitions of common terms associated with a regime of metrics or indicators are pending change. Joint Doctrine Note (JDN) 1-15, *Operation Assessment*, proposes the following new definitions to replace those currently in JP 3-0:

Measure of effectiveness (MOE): An indicator used to measure a current system state, with change indicated by comparing multiple observations over time.

Measure of performance (MOP): An indicator used to measure a friendly action that is tied to measuring task accomplishment.

Indicator: A specific piece of information that shows the condition, state, or existence of something, and provides a reliable means to measure performance or effectiveness.

Under previous definitions, a MOE was a criterion used to assess changes in systems, and a MOP was a criterion tied to measuring task accomplishment. An indicator provided insight into a MOE or MOP. These previous definitions created a hierarchy in which MOEs and MOPs were informed by indicators. This old metric regime, in practice, created a number of problems with the organization of information for collection and analysis, including that MOEs, as written, were rarely specific enough to measure anything. The new definitions destroy this hierarchy and provide that both MOEs and MOPs are types of indicator that, by definition, must be specific.

Sources for collecting indicators include routine reporting, intelligence and operations reporting, surveys, interagency or international partners, host nation reporting, or sometimes special data collection efforts for data not available elsewhere. Frequently, external organizations may collect data that are of higher quality on some topic than joint forces can collect themselves, e.g., civilian casualty data in Afghanistan are better collected by the United Nations than by ISAF. Also, assessors will want to check military data against data owned by external organizations, both to double check military collection and to be able to explain why military data may vary from other data published in international media.

6.3 More on Causality

Data scientists frequently shy away from talking about causality because the data, if they are of the right type, can only demonstrate a statistical correlation of a variable (indicator) to others. In assessment however, assessors cannot avoid the issue of causality because ultimately, assessors and subject matter experts on the staff must explain **why** indicators are moving as they are. **Any operational plan that orders a set of activities in pursuit of a set of outcomes is a set of causal hypotheses—that these activities will cause the changes in the OE that are specified as outcomes**. Assessment can be viewed as a testing of these hypotheses. Therefore, assessors must address issues of causality.

Assessors cannot assume, however, that since an outcome occurred, therefore friendly action caused it. The OE is full of other actors, some allied or sympathetic to US goals, some opposed or adversarial toward American goals, and many third party actors that are pursuing agendas of their own.

Assessors need to consider sets of related indicators together, determine possible causal relationships that would account for the movements in indicators, and then go back into the data in an attempt eliminate some possible causes, isolating the most likely.

6.4 Alternatives to MOE-MOP Constructs

Some assessment problems can be addressed through methods other than the formal monitoring of specific MOEs and MOPs. Some alternatives include:

The use of published standards, such as Training and Evaluation Outlines (T&EOs) and Soldiers' Manuals, provide "performance steps" that describe how to correctly perform collective and individual military tasks. These can be used as training references, as references for the evaluation of training, and as references for the assessment of operations. The correct performance of tasks will lead to more effective individuals and units. Moreover, if an outcome is not achieved, but we know from a task assessment that the task was performed correctly, then we know that performance of that task does not lead directly to that outcome. If the task were performed incorrectly, we might conclude the task should be performed again.

Inspection programs usually feature a qualified observer armed with a checklist. The observer answers those checklist questions about the performance or effectiveness of a unit, which is an assessment of the unit's capability. He may also mentor the unit on how to do better against the items on the checklist, and finally, the inspection itself is an incentive for the evaluated unit to periodically examine itself and ensure it is in compliance with standards.

Reports the headquarters receives are assessment documents. Ultimately, assessment data do not exist in a sterile database for assessors' analytic use. Observers in the field must witness and report the items that are of interest to assessors, and therefore, assessors must tell them what to report. Many items are reported routinely already, and gathering that data is a matter of gleaning them from existing reporting. For items not currently reported, assessors and staff members will need to construct a report format that enables disparate observers to consistently report the required information. For example, if a headquarters is tracking naval incursions of an adversarial navy into a friendly navy's waters, routine spot reports will provide size, activity, location, unit, time, and equipment information that, when analyzed, will answer many of the headquarters' questions about the adversary's activity trends and likely intentions.

Finally, when something out of the ordinary occurs, assessors might need to determine what happened and why to either ensure it never happens again (for a negative event) or to institute it as a best practice (for a positive event). For example, mission personnel returning from multi-day missions in the Horn of Africa reported during their after action reviews that they had difficulty contacting the Joint Operations Center (JOC) by phone for submitting evening accountability reports. The JOC's representative to the after action review panel investigated and determined the failure of the JOC watch to answer the phones was due to the fact that phone ringers were turned off during the daily afternoon brief and not consistently turned back on. He instituted corrective measures, and reports of the JOC's failure to answer the phones dropped to zero.

6.5 More on Assessment Products

Usually, the words, "the assessment," heard about the headquarters refer to the assessment product—usually a report or slideshow. In many staff actions, a focus on the "deliverable" is helpful to get work done. In operation assessment, this attitude is not as useful. Or more accurately, the "deliverable" for assessment is **an effective operation**, the "product," whatever it is, is merely a communication of the pertinent portions of the assessment—the unwritten cognitive product—for informing senior leaders or providing accountability.

Assessment products in the past (and often currently) have not reflected this sensibility. Often assessment briefs have consisted of many slides that each track an indicator. This is not a problem in itself and tracking indicators is critical, but only a few indicators are sufficiently important that a senior leader will need to see a slide of its trend. One important example was the end strength of the Afghan National Army (see below). Four-star leadership and higher authority wanted to see this trend because it was critical to U.S. perception of its success in building Afghan institutions. A less important example was the trend of the percentages of Afghan army recruits qualifying with their individual weapons. The latter metric is critical to the master sergeant who runs the rifle range and to the lieutenant colonel who commands basic training, but it is not something general officers need to see.

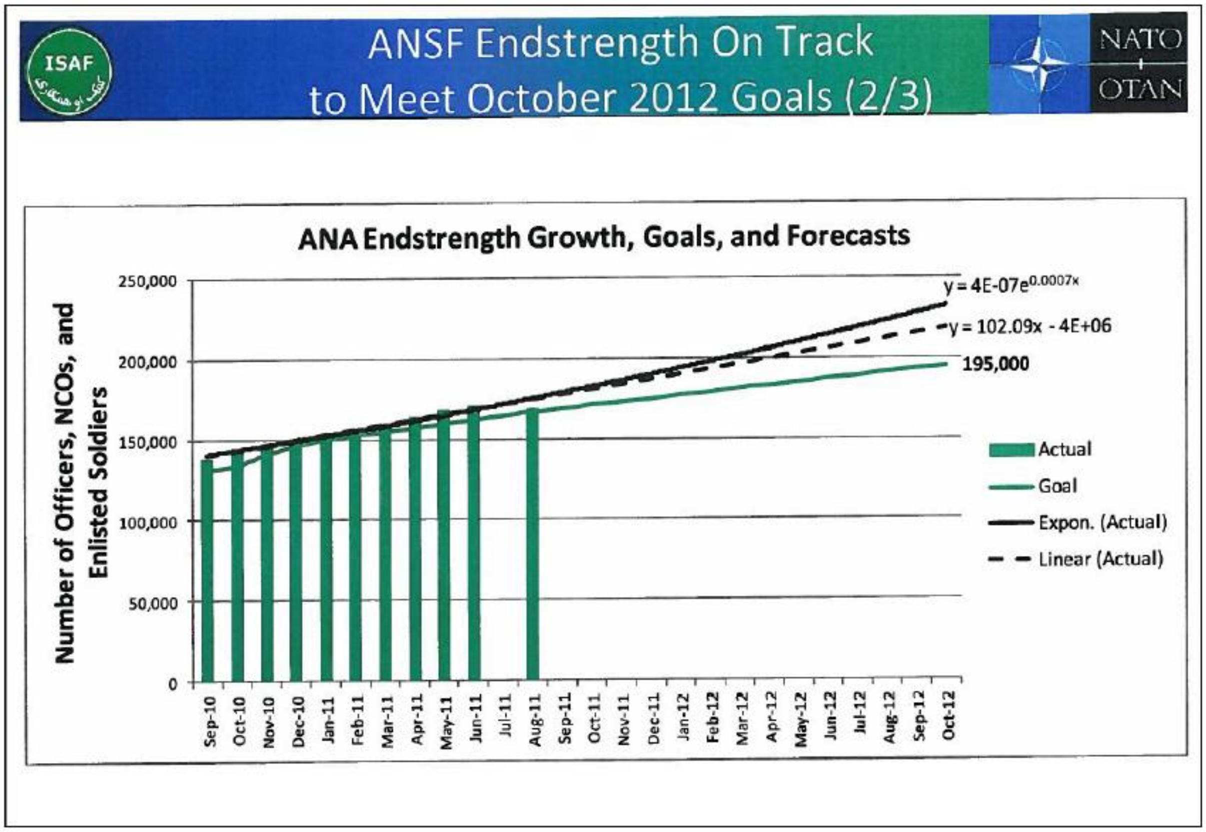


Figure 26. Assessment product example 1.

Many past products also consisted of a simple, often bulleted, summary of a "line of effort." Many of these have a stoplight depiction that communicates that the command is on track to achieve the outcomes of this line of effort and a depiction of the trend—are we moving in the right direction (see below)? These depictions are simplistic. They may be sufficient as communication tools provided they stimulate the right discussion among senior leaders, generate appropriate recommendations from the staff, and action is taken on them. However, this depiction cannot be mistaken for "the assessment" because the staff must still churn through the indicators, determine what they mean, posit causal relationships, and make recommendations for the command. The staff's mere production of this slide **does not constitute assessment**.

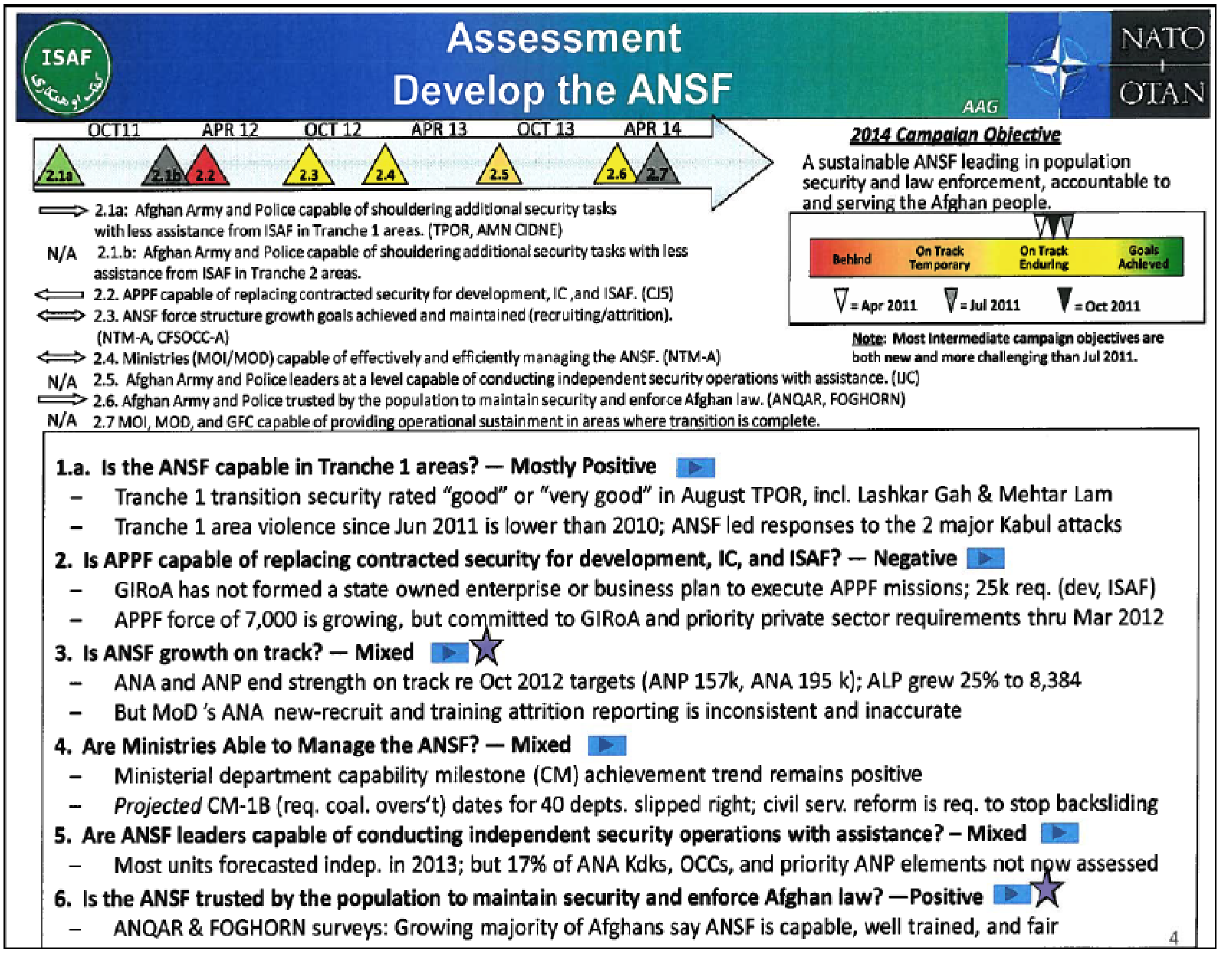


Figure 27. Assessment product example 2.

Assessment reports frequently feature narrative descriptions of happenings and their meaning that are illustrated by appropriate graphics. A major example is the "Report on Progress Toward Security and Stability in Afghanistan," also known as the "1230 report"[20] (available through Google). This report provides accountability to the U.S. Congress on military activities in Afghanistan. It is a large effort to describe the results of assessment analysis, but it is also a model of a narrative-based assessment communication tool that can be scaled down for use within a headquarters. Frequently, an effective depiction may be a chart or several charts that are captioned with a narrative explaining what they mean, what causal relationships exist, and what the command should do.

The bottom line of this discussion is that assessment products may take a variety of forms, some of which **may or may not be useful**, and so the product format must be evaluated according to this standard: Does the preparation of this depiction provoke the conversation among the staff that promotes nuanced understanding of our OE and help us select appropriate actions for our forces? Does this depiction allow the effective communication of our findings and

[20] In 2015 the 1230 Report was re-codified by Congress to section 1225 of the US National Defense Appropriation Act (NDAA) and now known as the 1225 Report, along with a classified annex.

recommendations, and their implications, to senior leaders? If so, the assessment product is probably successful.

One more thing: In general, CAA recommends showing senior leaders only what they ask to see and what the staff thinks they need to see. The former is highly correlated with the information that is really important, and the latter are the things the staff discovers during the assessment process that need to be brought to the attention of senior leaders.

6.6 To read more

Start with Joint Doctrine Note (JDN) 1-15, Operation Assessment (2015) (also available through Google). At the time of this writing, it is the most advanced published work on assessment doctrine. Older sources are useful for perspective, and there are number of people performing assessment in a manner consistent with older publications—you may work for one of these people soon—but JDN 1-15 is paradigm shift in why the joint force does operation assessment, and older publications reflect obsolete ways of thinking about assessment processes.

CAA also recommends several instructive critiques of the old ways of assessment. These are:

Jonathon Schroden, Why Operations Assessments Fail (Naval War College Review, Autumn 2011).

Stephen Downes-Martin, Operations Assessment in Afghanistan is Broken (Naval War College Review, Autumn 2011).

Ben Connable, Embracing the Fog of War: Assessment and Metrics in Counterinsurgency (RAND, 2012).

CHAPTER 7 GEOSPATIAL ANALYSIS

7.1 Introduction

Definition. Geospatial analysis seeks to find correlation between physical, cultural, or operational features, to answer a specific question. Typically, a Geographic Information System (GIS) or geospatial software is used to apply statistical and proximal techniques to geographically referenced data to determine if relationships exist within and/or between datasets (map layers) to provide insight to the study problem. Simply put, geospatial analysis is the use of geographic data to increase the understanding of a given phenomenon. The results can be presented in a map, graphic, or in tabular form depending on the nature of the analysis.

The Purpose of Geospatial Analysis. Geographic analysis is the "where" in the analyst query. 'Where" an event occurs is just as important as "when" and "how" in the context of discerning "why." Used appropriately, geospatial analysis can summarize large quantities of data clearly and concisely. The addition of a map to operational analysis will provide a reference framework to the analysis to enhance and accelerate its understanding. This chapter includes several examples to show the advantages of this technique.

7.2 Geospatial Software and Its Uses

Geospatial analysis is a powerful tool that complements other types of analyses. There are several geospatial software packages currently used by ORSA analysts, to include (1) ArcGIS, (2) FalconView, and (3) Web-Enabled Temporal Analysis System (WebTAS; commonly used with the Combined Information Data Network Exchange [CIDNE] database). These tools plot geo-referenced data to reveal geospatial relationships within and/or between the datasets, as well as other features such as populated places, administrative boundaries, roads, or operating areas. Each of the aforementioned software programs has different capabilities and strengths. One can use any combination of them to conduct geospatial analysis effectively. ArcGIS and WebTAS are able to plot densities, conduct clustering of specific incidents, determine distance/ direction, and display results. WebTAS is able to create a "video" of incidents; showing the incident pattern both spatially and over time.

7.3 Examples of Geospatial Analysis

Geospatial analysis has played an important role in analyses and assessments in Iraq, Afghanistan, Philippines, the Horn of Africa, and elsewhere. Common themes used in-theater include density of attacks, effectiveness of attacks, operating areas, area assessments (security, governance, development, and overall), MEDEVAC response times, and polling data representation. Geospatial analysis often compresses complex issues to enrich the commander's situational awareness. The following are examples of real-world geospatial analysis:

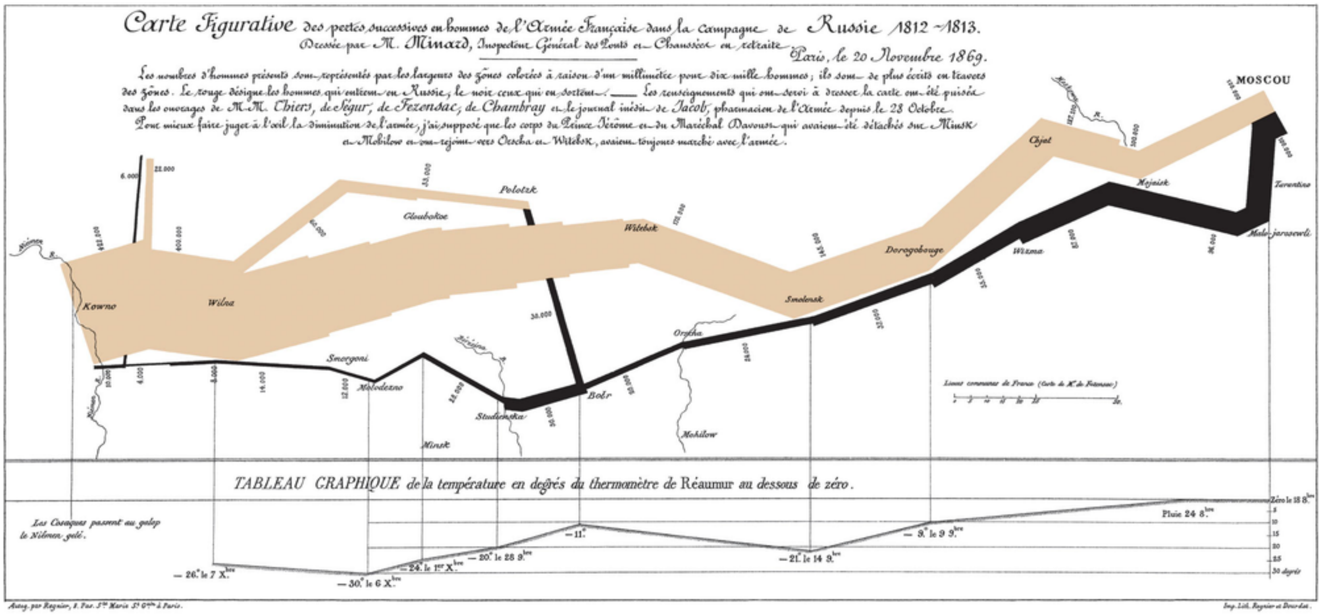


Figure 28. Napoleon's march to Moscow in 1812

Minard's use of geospatial analysis in 1869 to portray Napoleon's 1812 Russian campaign is generally referred to as the best statistical graphic ever drawn (see Figure 28 above). Minard uses six separate variables: (1) latitude and (2) longitude of the army as it moved; (3) line width continuously marks the size of the army; (4) lines showing the directions the army travels (5) temperatures on the return trip; and (6) dates (time). The variables were each instrumental in the force's failure. Together, Minard uses these variables to tell the story of Napoleon's force-attrition over the 6 months of the campaign.

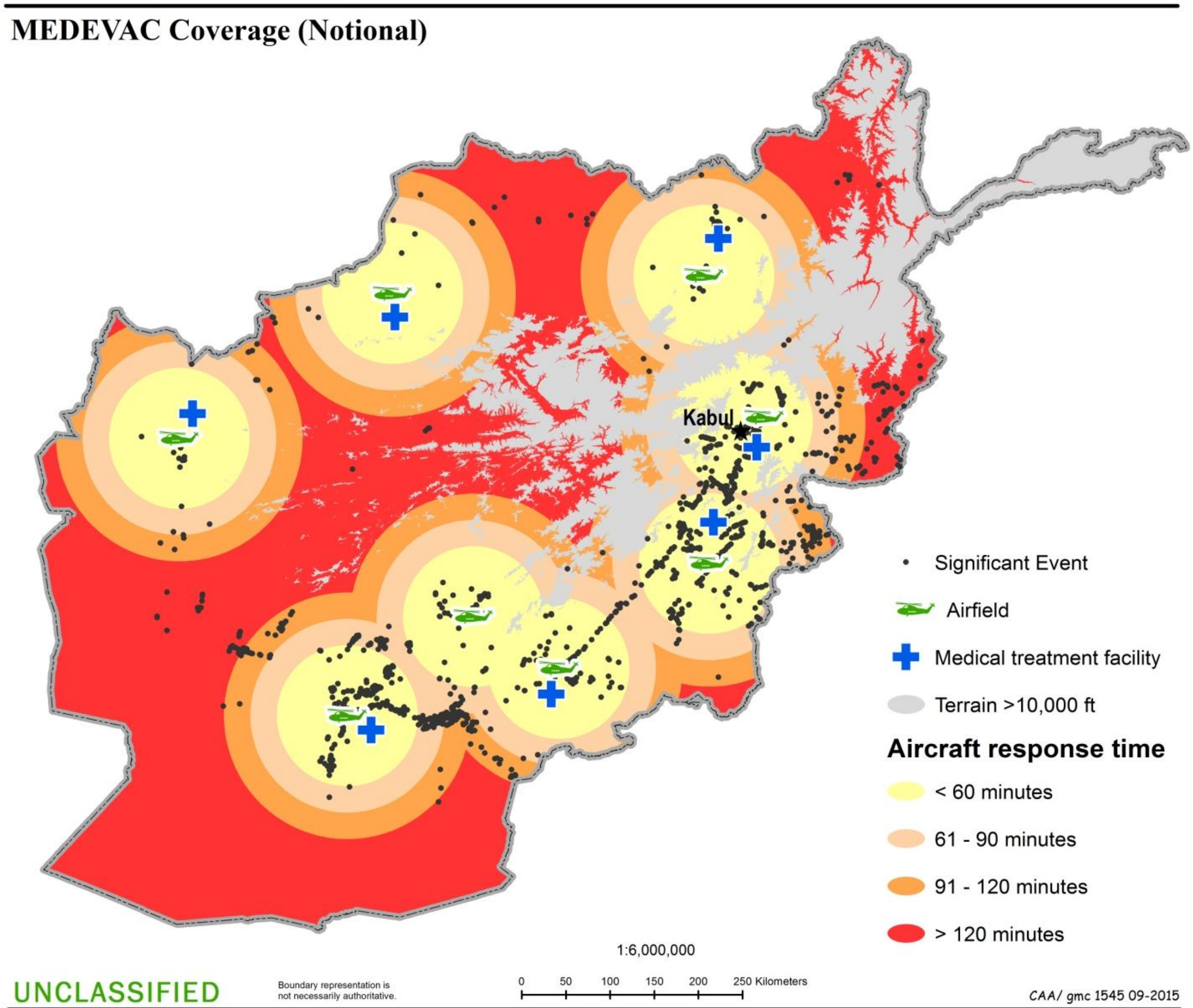


Figure 29. MEDEVAC coverage

Figure 29 depicts medical treatment facilities, aircraft bases, MEDEVAC events, and response bands. This illustration is especially useful to a planner who is considering a large operation requiring significant MEDEVAC capability. By identifying potential areas of inadequate coverage, the planner can work with MEDEVAC units to reposition assets for the operation in a way that ensures timely MEDEVAC.

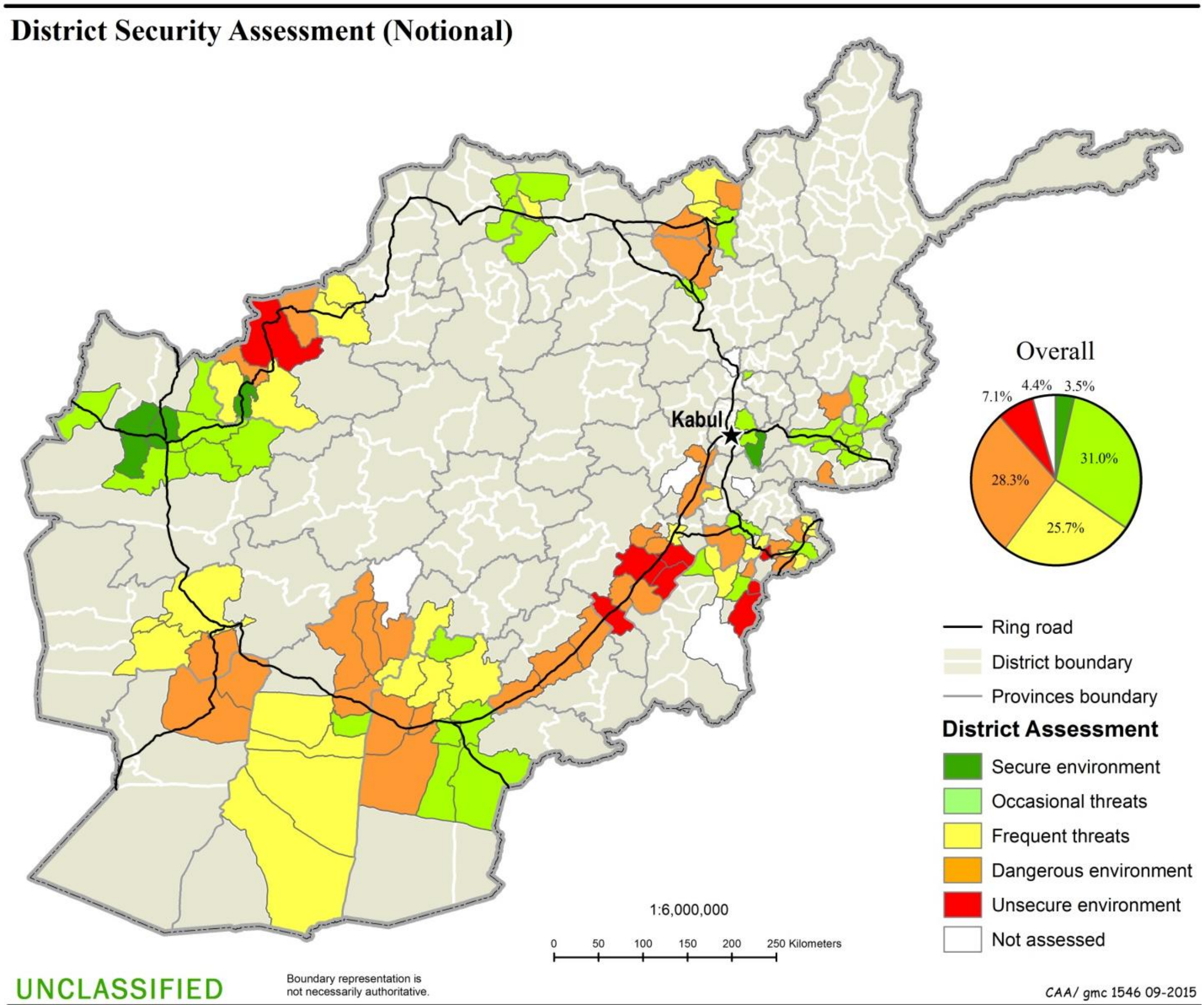


Figure 30. District assessments in Afghanistan

Figure 30 shows the overall district ratings on a country map. This type of map gives the commander a quick snapshot of the general situation to assist in identifying successes and areas of concern. While a map does not explain the entire situation, it does provide the commander with a clear picture of the current assessment in his or her area of responsibility (AOR). It is highly recommended that more detailed, narrative assessments are completed and briefed to the commander in addition to the map.

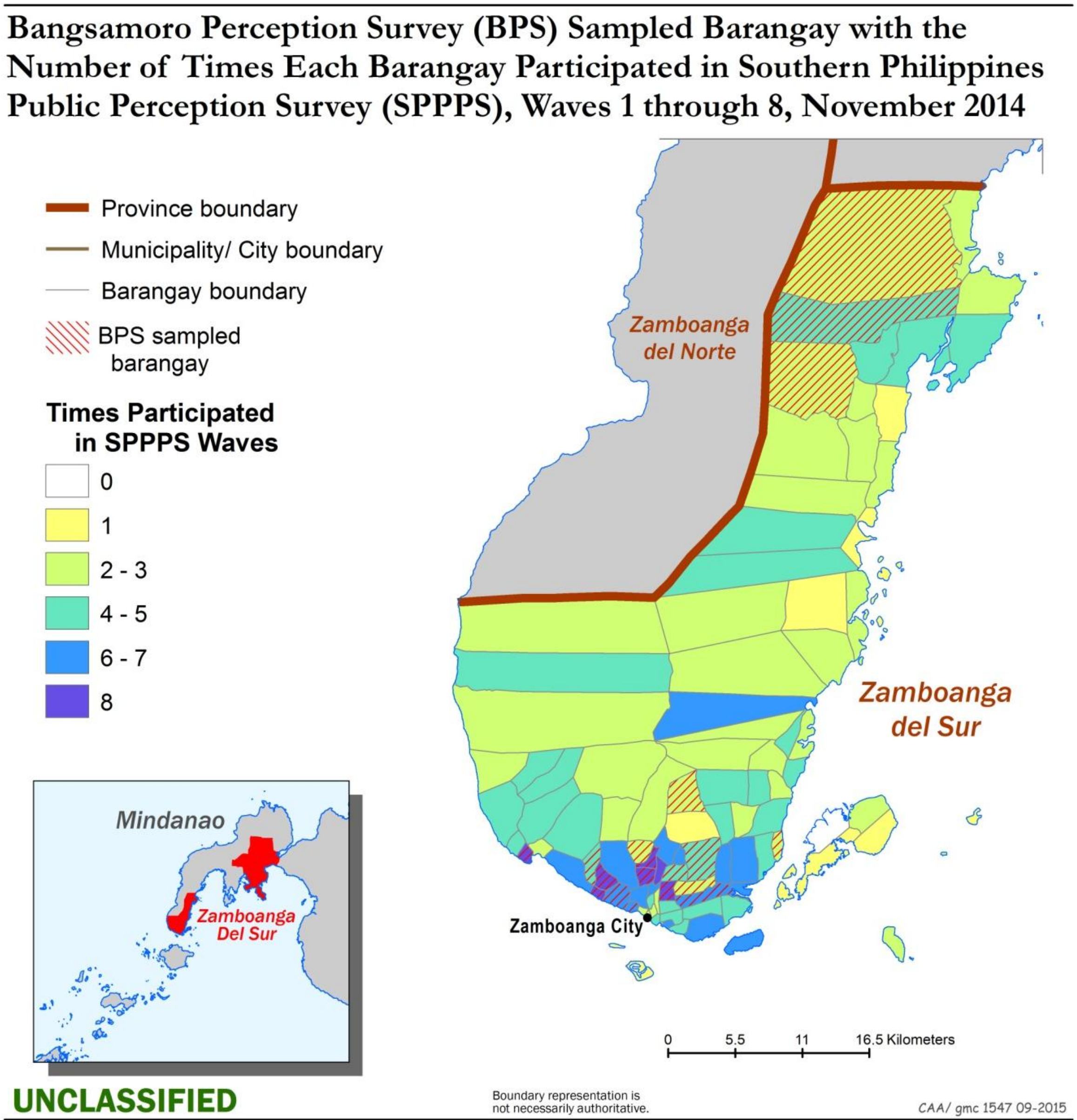


Figure 31. Map of areas polled in the Philippines

Figure 31 highlights the Zamboanga Peninsula that contractors polled for the BPS and relative participation in the SPPPS. This map highlights the Barangay suitable for further analysis, given the number of survey results available.

7.4 Summary

Geospatial analysis is a supplementary tool for the deployed ORSA analyst's toolkit. Geospatial software can summarize large quantities of geographically referenced data quickly, clearly, and concisely. Geospatial analysis opens a new area to explore and explain the relationships and correlations within and/or between multiple geographic datasets. The examples used here are only a subset of the range of applications.

For training reservations contact the National Geospatial Agency (NGA) College Registrar (571-588-2968) for the free 1-week courses "Fundamentals of Geographic Information Systems and Intermediate Geographic Information Systems (GIS) for Analysis." These courses are available in the St Louis, MO and Northern Virginia areas. For additional examples or further assistance, contact NGA's Geospatial Intelligence section or the CAA Operations Analysis (OA) reachback team POCs listed at http://www.caa.army.mil/Commanders_Trifold_Jan2016.pdf.

CHAPTER 8 REACHBACK CAPABILITIES

8.1 Why Reachback?

The Generating Force, i.e., institutional army analytical organizations, provide analyses through an integrated combination of embedded ORSA analysts—either assigned or attached to Army, Joint, and Multi-National headquarters—and through analytical reachback support (also known simply as "reachback"). Operations Research/Systems Analysis is vital in reducing commanders' uncertainty through sound reasoning and well-constructed analytical models. Reachback allows ORSA analysts serving at Division, Corps, ASCCs, and Multi-National Command headquarters in deployed environments to draw upon resources and capabilities of Generating Force organizations and institutions whose primary mission is to generate and sustain the Operational Army's capabilities for employment by Joint Force commanders.

As a deployed ORSA analyst, one applies logical reasoning and sound processes to solve highly complex problems at the operational and strategic levels when no readily apparent solutions exist. One applies analytical methods to perform trade-off analysis, compare courses of action, allocate critical resources, and assess operational effectiveness. These methods are an integral part of Army and Joint leadership decision-making processes to organize, staff, train, equip, sustain, and resource current and future forces. One conducts analyses using one's personal talents and skill set unless the complexity and scope of a given problem require additional resources.

8.2 Motivational Factors for Reachback

Integration of Analytical Effort. Reachback connects Operational Army analytical efforts to Generating Force organizations. This connectivity ensures analytical relevance along with greater capability within the operational headquarters. Specifically, reachback provides visibility of critical analytical requirements to Generating Force organizations. Additionally, this connectivity captures institutional knowledge for future deploying ORSA analysts.

Subject Matter Expertise. Generating Force organizations possess a wide array of expertise. Given the limited number of deployed ORSA analysts and the complexity of emerging issues, reachback provides a valuable mechanism for expanding one's expertise and analytical capabilities. Furthermore, organizations that provide reachback are frequently staffed with ORSA analysts who have or will deploy. This provides important continuity for analytical support to theater commanders.

Additional Data. Reachback expands available data and offers contextual reference for theater-specific analytical problems.

Analytical Review Process. Reachback provides a natural review process for analytical efforts. Through collaborative reachback and Generating Force organizational capabilities, multiple personnel and organizations review reachback analytical products. While the review process requires more time, it ensures high quality products.

Analytical Tools. Reachback provides one with access to sophisticated tools and additional expertise. Two examples of support provided to operational headquarters are provided below. Figure 32 is an example of an R script written to replace a manual process used downrange to download and index information from web pages on the internet, which saved hundreds of hours of manual processing time for a deployed headquarters.

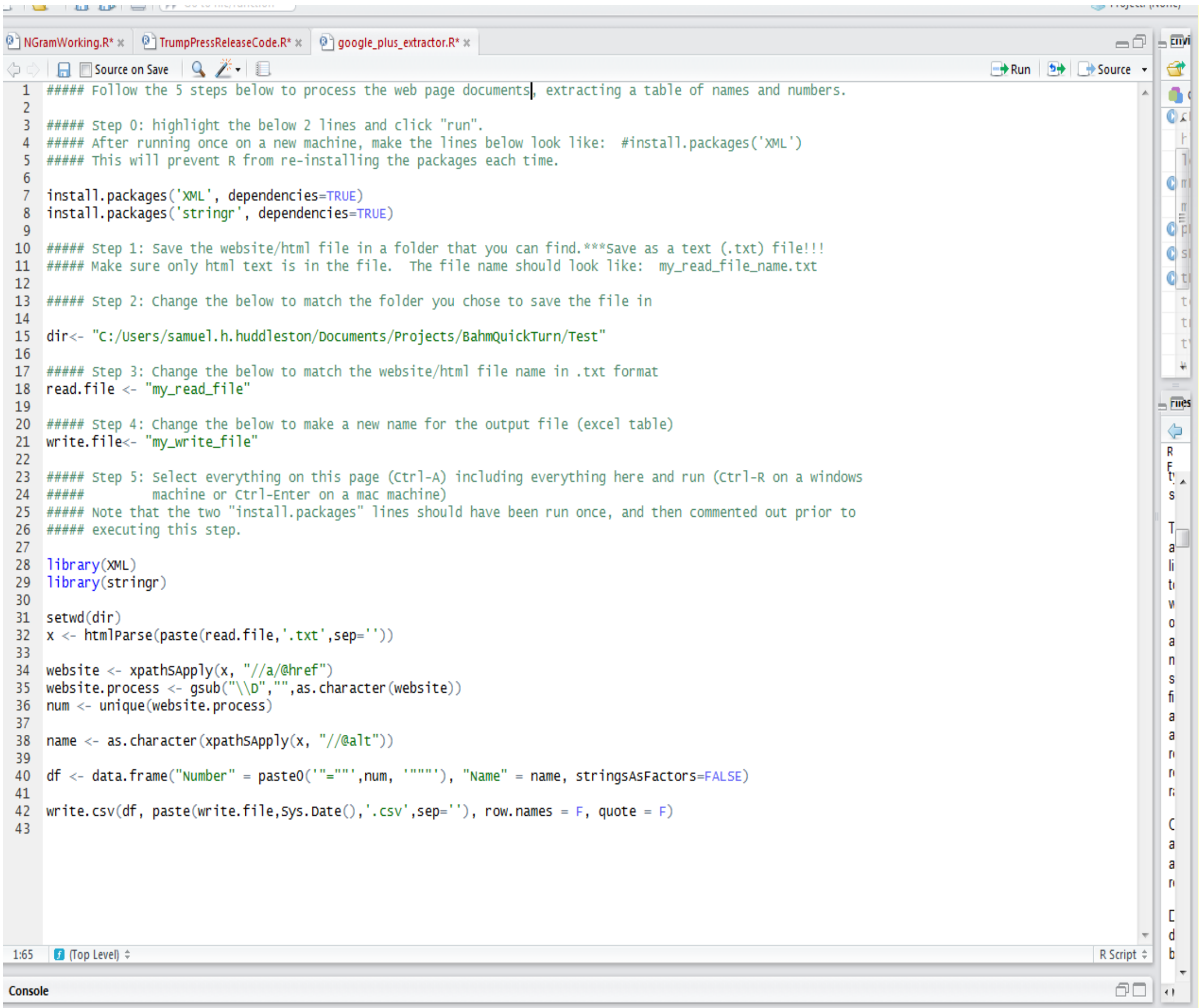


Figure 32. Example code (script) written to support reachback request

Figure 33 is an example of an interactive web-based analytic tool developed for an Army operational headquarters to provide time series analysis and visualization of enemy activity.

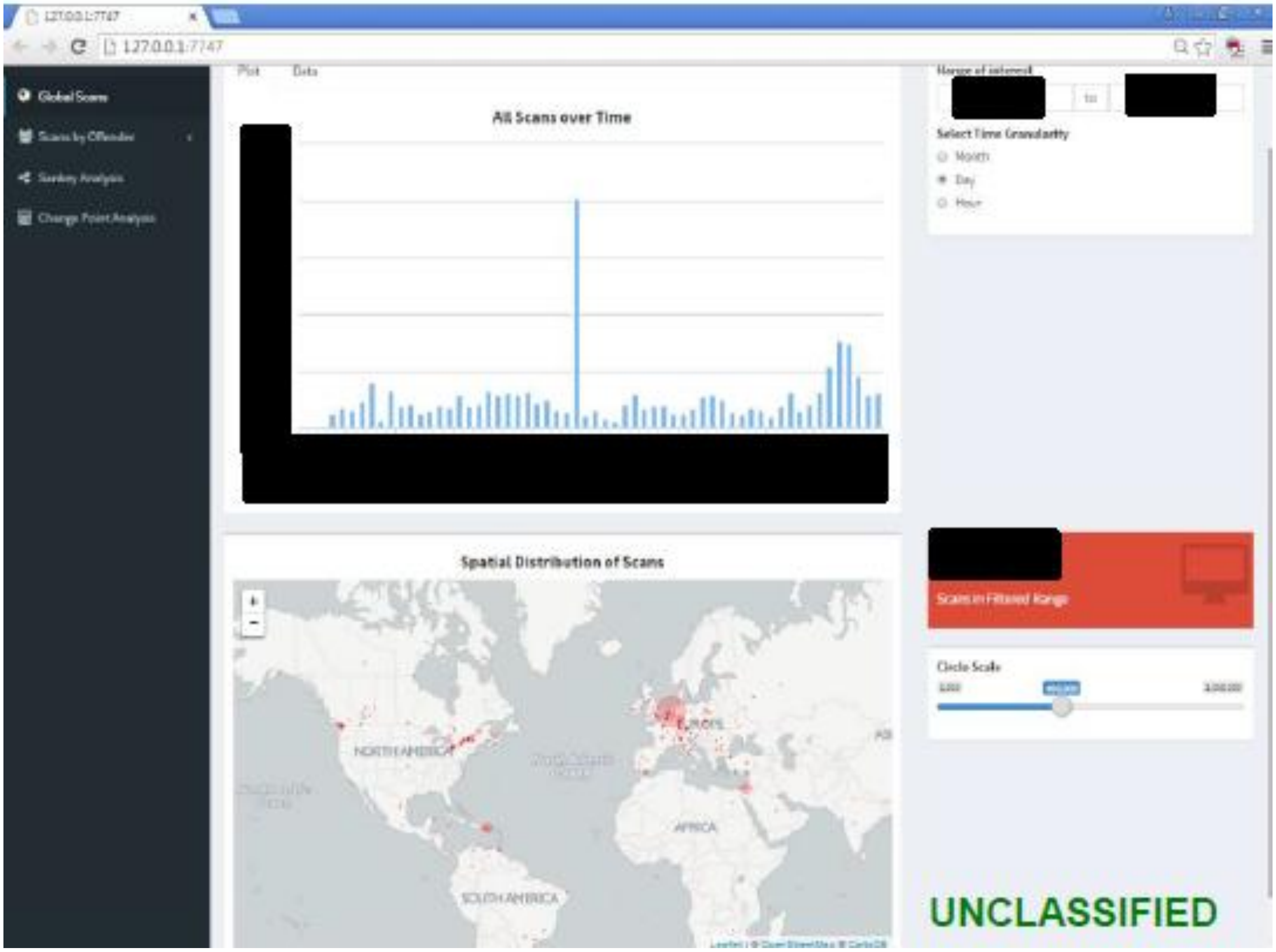


Figure 33. Example web application developed to support reachback request

Required Surge Capability. The connection between Operational Army commands and Generating Force organizations, enabled by reachback, allows for analytical surge capability as required. For example, from the onset of OIF and OEF, CAA, TRAC, Army Materiel Systems Analysis Activity (AMSAA), and the United States Military Academy (USMA) provided Deployed Analyst Support Teams (DASTs) to ASCCs in Iraq and Afghanistan. A recent change in U.S. military operational focus has resulted in these organizations expanding their analytical support to commands located in additional geographic locations, e.g., the Philippines and Africa.

8.3 Reachback Considerations

Timeliness. Deployed operational Army as well as Joint and Combined headquarters (HQs) generally operate 7 days a week/12-14 hours a day. An analytical request to/from these headquarters often has a quick-turn suspense that requires an answer within a few hours or days. generating force organizations performing reachback support must adapt to these "quick-turn" requirements. Deployed ORSA analysts must adapt to the environment within which generating force organizations operate. This environment requires a detailed, time-intensive, review process to ensure a high quality product.

Confidentiality of Derived Analysis. Generating Force organizations are customer-focused. They must obtain Operational Army Command release authority before disseminating derived analytical products. This release protocol ensures customer confidentiality in what often concerns contentious issues.

Organizational Capabilities. One should become familiar with the capabilities of Generating Force organizations. This familiarity enables one to incorporate current organizational efforts and understand where a problem solution may reside.

Contextual Reference. One must clearly articulate one's analytical requirements when requesting reachback support. A well-articulated request ensures that reachback personnel address the problem within the context of other competing issues such as time constraints, level of model sophistication, and the essential elements of analysis.

8.4 Reachback Support Topics

Generating Force analytical support to the current fight has thus far included campaign plan assessments, casualty analyses, theater campaign modeling and analyses, force-on-force analyses, stability and support operations analyses, and weapon systems analyses. ORSA topics span doctrine, organizations, training, materiel, leadership and education, personnel, and facilities (DOTMLPF). Examples of reachback support topics include:

- **Campaign plan assessments**. Campaign plan assessments include the development of appropriate MOEs and MOPs.
- **Casualty analyses**. Casualty analyses include efficacy of personal equipment and implications for operating force TTPs.
- **Theater campaign modeling and analysis**. Theater campaign modeling focuses on the Joint and Combined operational/strategic environment. These models incorporate weapons effectiveness data, unit formations, and current war plans in support of campaign analyses. Additionally, air and missile defenses, along with weapons of mass destruction (chemical, biological, radiological, and nuclear), are analyzed at the tactical, operational, and strategic levels of war. The Total Army Analysis (TAA) process uses analytical output to determine future force requirements for the Army.
- **Force-on-force modeling and simulation**. Generating Force ORSA analysts develop and maintain a class of warfighting force-on-force models and simulations (M&S) ranging from individual objects, e.g., Soldiers, weapons, terrain features to theater-level models that often aggregate objects, e.g., battalions at Corps level. AMSAA leads Army efforts in modeling platform performance parameters. TRAC focuses on Corps and below force-on-force combat models while CAA conducts theater-level campaign analysis. Collectively, these models are widely used by DOD, industry, and allied nations.
- **Stability and support operations**. Generating Force ORSA organizations contribute to stability operations with a variety of analytical products, e.g., campaign plan assessment methods development, convoy protection analysis, sensor placement recommendations, basing analysis, medical asset allocation recommendations, new materiel fielding and utilization analysis, Intelligence Preparation of the Battlespace (IPB) assistance, attack pattern analysis, economic forecasting, and force structure/size recommendations. The

foregoing ORSA capabilities assist in promoting a secure environment and aid in diplomatic and economic programs designed to eliminate root causes of instability. These contributions complement and reinforce overall Stability and Support Operations (SASO).

- **Weapon Systems analysis**. Weapons Systems analysis enables an understanding of the system, its functions, performance and effectiveness measures, and operational criteria. The ORSA community can provide a comprehensive assessment of the impact of a given friendly or enemy weapons system on the operational environment. The Army Test and Evaluation (ATEC) Command is one Generating Force organization with keen weapon systems insights.
- **Programmatic analysis**. The cost of campaigns and major operations strongly affects domestic support and helps determine success or failure of a given mission. ORSA analysts aid in decision making with analysis of logistics, force structure, and mobilization/deployment simulation modeling. These projects include force closure estimates, resources for mobilization/deployment data, lift asset requirements, pre-positioning recommendations, and high-level quick-turn COA analysis. ORSA analysts conduct analysis of support forces, i.e., combat support and combat service support requirements and casualty analysis, develop wartime Class V and Class VII requirements, and compare theater logistics requirements with capabilities.

8.5 The Reachback Process

General.

Each Generating Force organization manages its respective reachback mechanisms independently. CAA conducts an informal biweekly interagency meeting with deployed ORSA analysts in an effort to coordinate reachback efforts. While there is an effort to consolidate and formalize reachback contributions from Generating Force organizations, this chapter focuses on the overall reachback process.

Army Materiel System Analysis Agency (AMSAA). AMSAA conducts analyses across the Materiel Lifecycle to inform critical decisions for current and future Warfighter needs while valuing the unique knowledge, experiences, and backgrounds of its people.

Army Test and Evaluation Command (ATEC). ATEC plans, integrates, and conducts experiments, developmental testing, independent operational testing, and independent evaluations and assessments to provide essential information to acquisition decision makers and commanders.

Center for Army Analysis (CAA). CAA conducts analyses across the spectrum of conflict in a Joint, Interagency, Intergovernmental, and Multinational (JIIM) context to inform critical senior-level decisions for current and future national security issues. CAA supports DA and its major subordinate commands with analyses of Army forces and systems within the context of joint and combined warfighting. CAA analyzes strategic concepts and military options and estimates requirements to support Army input to the Planning, Programming, Budgeting, and Execution System (PPBES). CAA evaluates (1) the Army's ability to mobilize and deploy forces, (2) Army force capabilities, (3) force alternatives, and (4) theater force-level scenarios and resource analyses.

Marine Corps Combat Development Command (MCCDC). MCCDC fully integrates Marine Corps concepts and requirements based warfighting capabilities; including doctrine, organization, training, materiel, leadership and education, personnel and facilities in order to ensure the Marine Corps is properly organized, trained and equipped now and in the future.

U.S. Army Training and Doctrine Command Analysis Center (TRAC). TRAC serves as the principal analytical organization of TRADOC and provides centralized leadership and management of analysis for combat, training, and doctrinal developments, while unaligned with TRADOC proponents. TRAC conducts studies and analyses for TRADOC and Headquarters, Department of the Army (HQDA); conducts studies of the integrated battlefield related to doctrine, organization, training, materiel, personnel, and leadership; designs and develops models and simulations (M&S) for capabilities development; participates in technical exchange programs at the national and international levels; provides analytical support to Army Capabilities Integration Center (ARCIC), Centers of Excellence (CoEs), and schools; directs research related to methods, models, tools, and analysis; establishes, maintains, and manages the databases, scenarios, models, and wargaming tools required to support analyses and studies; and reviews and ensures, as directed, the quality of TRADOC studies before their approval.

Non-ORSA Generating Force organizations. The following Generating Force organizations also provide relevant information to many ORSA efforts:

- **National Ground Intelligence Center (NGIC)**. NGIC provides All Source and Geospatial Intelligence on foreign ground force capabilities and related military technologies and integrates with Mission Partners to ensure the U.S. Army, DoD, Joint, and National level decision makers maintain decision advantage to protect the U.S. and interests abroad.
- **Joint Improvised-Threat Defeat Agency (JIDA)**. JIDA enables Department of Defense actions to counter improvised threats with tactical responsiveness and through anticipatory, rapid acquisition in support of Combatant Commands' efforts to prepare for, and adapt to, battlefield surprise in support of counter-terrorism, counter-insurgency, and other related mission areas including counter-improvised explosive device.

Communication Methods. Deployed ORSA analysts and Generating Force organizations communicate using the **Defense Switched Network** (DSN), commercial telephone, Non-secure Internet Protocol Router Network (NIPRNET), Secret Internet Protocol Router Network (SIPRNET), Secure Video Telephone Conference (SVTC), Information Work Space (IWS), and other means beyond the scope of this chapter. Periodic communications ensure established relationships between deployed ORSA analysts and their respective organizations. Unclassified contact information for the most commonly requested reachback Generating Force organizations follows:

- **Army Logistics University (ALU) College of Professional and Continuing Education**. Available from http://www.alu.army.mil/; Commercial: (804)765-4710/4991/4553 or DSN (539) 4710.
- **Army Materiel Systems Analysis Activity (AMSAA)**. Available from http://www.amsaa.army.mil/home.html; Commercial (410) 278-6614 or DSN (298) 6614.

- **Army Test and Evaluation Command (ATEC).** Available from http://www.army.mil/ATEC; Commercial (443) 861-9999 or DSN (848) 9999.
- **Center for Army Analysis (CAA).** Available from http://www.caa.army.mil; Commercial (703) 806-5580/5680 or DSN (656) 5580.
- **Marine Corps Combat Development Command (MCCDC).** Available from http://www.mccdc.marines.mil; Operations Analysis Directorate; Commercial (703) 784-6293 or DSN (278) 6293.
- **National Ground Intelligence Center (NGIC).** Available from https://www.inscom.army.mil/msc/NGIC.aspx; Commercial (434) 980-7000.
- **U.S. Army Training and Doctrine Command Analysis Center (TRAC)**. Available from http://www.trac.army.mil; Commercial (913) 684-9150 or DSN (552) 9150.

8.6 Knowledge Management

Concept. The U.S. Army ORSA community provides a centralized reachback team, trained and equipped to coordinate effective and timely analytical contributions to U.S. Army ORSA analysts who are serving within deployed elements of an operational headquarters, e.g., Division/Corps/ASCC/Echelons above Corps [EAC]/Joint/Combined). CAA OA Division—with participating Generating Force organization assistance—maintains a SharePoint site (focused on current operations) on Non-secure Internet Protocol Router Network (NIPRNET) to facilitate deployed ORSA operations and analytical reachback support.

Vision. The CAA OA Division Current Operations Team SharePoint site identifies, creates, represents, and distributes knowledge for reuse, thereby enabling awareness and learning—with specific emphasis on current operations support—across the ORSA community. Key objectives of this site include shared intelligence, improved performance, competitive advantage over adversaries, and higher levels of innovation.

Structure. Figure 34 shows the general structure of the CAA Operations Analysis (OA) Division NIPRNET SharePoint site available from https://army/deps.mil/army/cmds/CAA/OA/SitePages/Home.aspx. CAA designed this SharePoint site to facilitate coordination between analytical agencies and deployed ORSA analysts regarding reachback and Irregular Warfare (IW) projects and data issues. Featured information includes organization points of contact (POCs), a request form for reachback support, and contact information for all known deployed ORSA analysts.

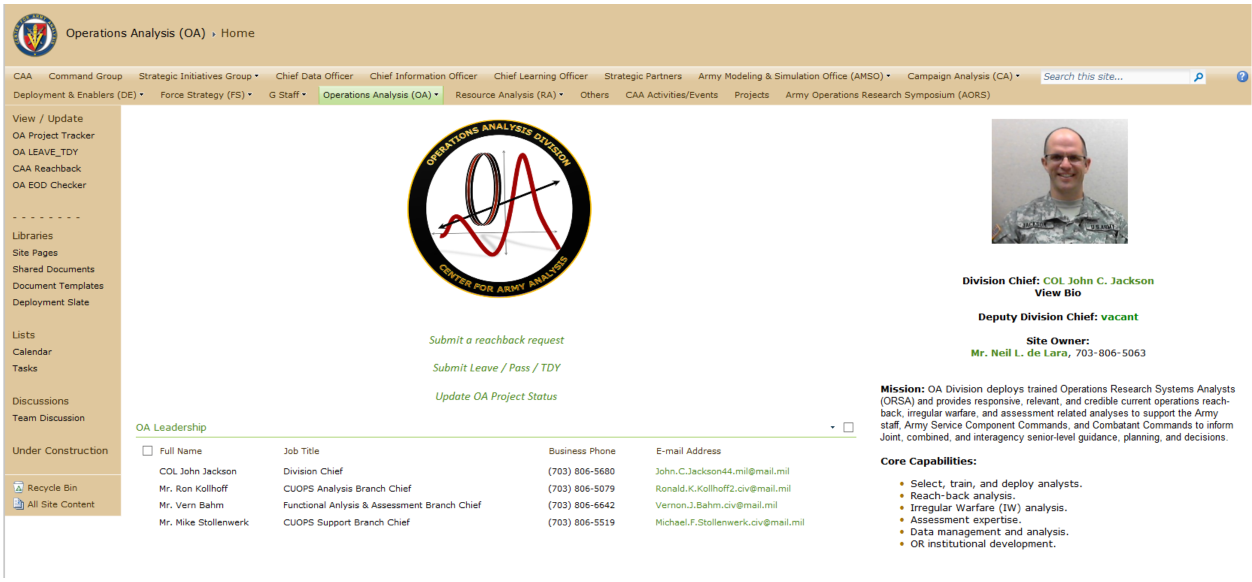


Figure 34. CAA Operations Analysis Division SharePoint Site

Reachback Request Form. Figure 35 shows the structure of the Request for Reachback Form that can be accessed through SharePoint site at http://www.caa.army.mil with U.S. CAC login.

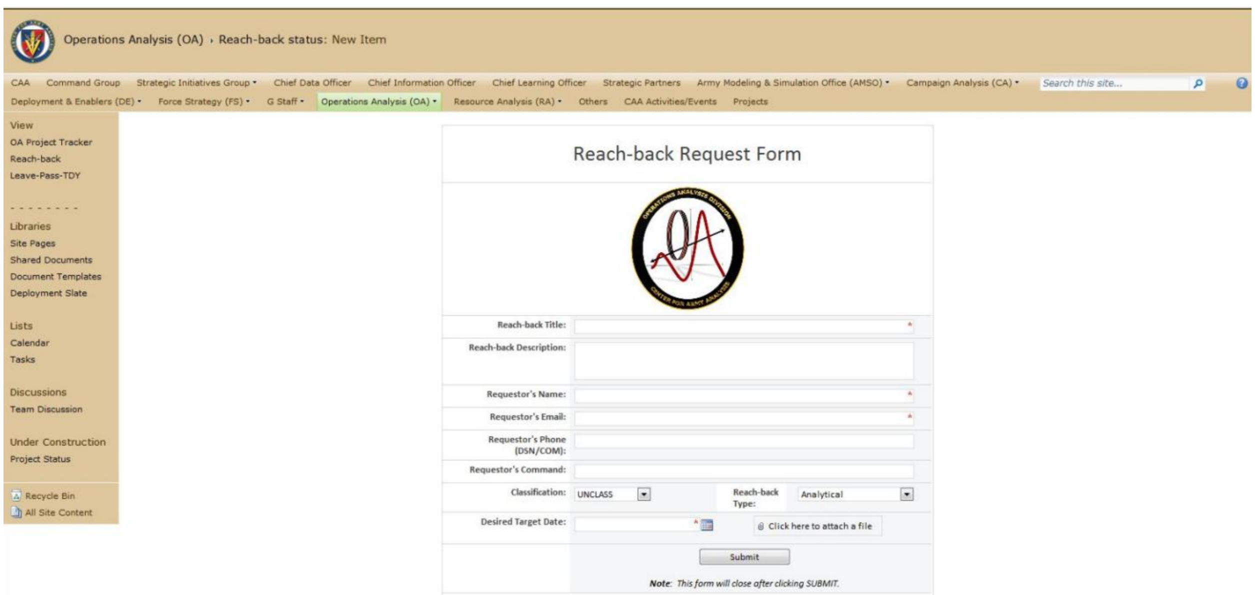


Figure 35. Reachback Request Form

8.7 Formulating Reachback Problems

In general, Generating Force organizations should adapt to the requirements of deployed ORSA analysts, especially in terms of the timeliness of derived products. To aid Generating Force organization endeavors, inquiries for reachback support should include the following information in as much detail as possible:

- **Problem Statement**. One should provide a clear definition of the problem along with essential elements of analysis. In particular, what question should reachback answer? One should provide a description of all assumptions related to the problem. If possible, one should describe potential modeling methods.
- **Problem Background**. One should explain factors/issues bearing on the problem. This guides one's literature review and provides insight to reachback personnel. One should describe the ultimate customers and how this reachback effort supports their decision making process and how it relates to other theater efforts, i.e., issues surrounding the analysis.
- **Data**. One should provide data or recommendations on how to generate/obtain the data necessary for the analysis.
- **Timeline and suspense.** One should specify desired completion dates and the impact of delayed analysis (details on intermediate milestones aid in project management and ensure customer satisfaction).
- **Communications**. One should establish recurrent communication with the supporting agency via the CAA Current Operations Team SharePoint site on NIPRNET and other communication tools, e.g., SIPRNET.
- **Classification**. The deployed analyst must be the expert as to the classification of (typically coalition derived) data and products, and be able to explain to others how the classification relates to the classifications of a home nation and other relevant international organizations, e.g., the North Atlantic Treaty Organization (NATO).
- **Releasability**. One should specify whether the customer has approved the release of derived analytical products developed for them. Analytical organizations must maintain customer confidentiality; however, release of analytical products of current issues and trends—where possible—furthers understanding within the ORSA community.

8.8 Coordinating Intra-/Inter-Theater Reachback Efforts

Documenting Analyses. Proper documentation of ongoing and completed analyses provides an initial start point for new analysis and reduces duplication of efforts. The CAA Current Operations Team asks deployed ORSA analysts to provide a concise briefing (normally one or two slides) on a biweekly basis to the CAA Current Operations meeting. This meeting focuses on current ORSA projects, ongoing reachback projects, and other miscellaneous activities that support the warfighter.

- **Sharing Data**. A mechanism for sharing very large unclassified data files is the U.S. Army Aviation and Missile Research Development and Engineering Center (AMRDEC) site that can be accessed at https://safe.amrdec.army.mil/safe. AMRDEC allows Common Access Card (CAC) holders to send files over AMRDEC SAFE (Safe Access File Exchange), and also allows non-CAC holders to send files to CAC holders. On the SIPRNET, large data files can be shared through the U.S. Air Forces Central Command (USAFCENT) Large File Distribution System (LFDS) at https://lfds.shaw.afcent.af.smil.mil/default.aspx. Headquarters Resolute Support (RS) command also uses a system called Centaur to allow specially designated and trained

U.S. staff officers and analysts to quickly move UP TO RESOLUTE SUPPORT[21] (RS) SECRET files from the RS Mission SECRET network to SIPRNET network, and from the SIPRNET network to the RS Mission SECRET network. Additionally, USCENTCOM provides a two-person review air gapping service to transfer files from SIPRNET and ISAF/SECRET or CENTRIXS to SIPRNET, NIPRNET, or ISAF/SECRET or CENTRIXS – the files must be marked with proper classifications on every page or sheet. The files must be emailable and it takes a couple days for USCENTCOM to send the files back to you – or – embarrassingly, tell you that your files are not marked properly or simply of the wrong classification to move to destination network you requested. Here are the links you need:

- Moving files from SIPRNET to NIPRNET, or RS SECRET or CENTRIXS: http://www.centrixs.centcom.smil.mil/CFTS.cfm
- Moving files from RS SECRET or CENTRIXS: http://22.11.80.14/cfts/cfm; use http://22.11.80.14/CFTS.cfm if the former link does not work.

Generating Force organizations alleviates many of the issues with data storage and analysis. Data management and analysis continue to be a source of reachback contributions.

Recurrent Coordination Meetings. Recurrent meetings provide coordination and collaboration between Generating Force organizations and deployed ORSA analysts. Continued support of formal and informal coordination meetings enables effective collaboration.

Knowledge Management. The CAA OA Division Current Operations SharePoint site provides a mechanism to manage creation, identification, accumulation, and application of knowledge for the Operations Research (OR) community. This effort brings together inherent intellectual capital.

8.9 Pre-Deployment Training Opportunities for Deploying Analysts

Deploying analysts as well as organizations deploying ORSA analysts to conflict areas should work in advance to identify and resource applicable tailored training opportunities for each deployer. The following known training opportunities provide ORSA analysts an initial menu of courses to consider:

- The CAA hosted no-fee Deploying Analyst Course (DAC), offered twice yearly (currently March and September) at Fort Belvoir, VA; POCs at http://www.caa.army.mil/Commanders_Trifold_Jan2016.pdf.
- The Individual Terrorism Awareness Course (INTAC), provided by the Army Corps of Engineers in Winchester, VA, POC Bill Bicking at Bill.Bicking@usace.army.mil.
- Combined Information Data Network Exchange (CIDNE) & Web-Enabled Temporal Analysis System (WebTas); POC Jason Thornton, ISS Corp., Alexandria, VA at Jason.Thornton@issinc.com.

[21] HQ Resolute Support (RS) is the successor coalition organization that replaced HQ International Security Force (ISAF) on 1 JAN 2015.

- Training offered by the deployers future deployed command hosted in the Continental United States.
- Geospatial analysis training hosted by the National Geospatial Agency (NGA); see course opportunity information at section 7.4, above.
- Contracting Officer's Representative (COR) training; see Defense Acquisition University (DAU) website at http://icatalog.dau.mil/onlinecatalog/courses.aspx?crs_id=1731.
- NATO related training opportunities at the NATO Joint Force Training Centre (JFTC) Bydgoszcz.
- The Operations Assessment Course at the NATO School in Oberammergau, Germany. See https://www.natoschool.nato.int/Academics/Resident-Courses/Course-Catelog; Enrollment POC is Boyd Forbes (Forbes.Boyd@natoschool.nato.int).
- For assistance identifying viable pre-deployment for deploying analysts, contact the CAA Operations Analysis (OA) reachback team POCs listed at http://www.caa.army.mil/Commanders_Trifold_Jan2016.pdf.

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APPENDIX A LIST OF ACRONYMS

AAG	Afghan Assessment Group
ACOM	Army Command
AMSAA	Army Materiel Systems Analysis Activity
ANA	Afghan National Army
ANDP	Afghan National Development Program
ANSF	Afghan National Security Forces
AOR	area of responsibility
ArcGIS	Arc Geographic Information System
ASCC	Army Service Component Commands
ASCII	American Standard Code for Information Interchange
ATEC	Army Testing and Evaluation Command
CAA	Center for Army Analysis
BPS	Bangsamoro Perception Survey
CENTRIX	Combined Enterprise Regional Information Exchange System
CF	coalition forces
CIDNE	Combined Information Data Network Exchange
CIO	Chief Information Office
CJSOTF-A	Combined Joint Special Operations Task Force - Afghanistan
CJTF-HOA	Combined Joint Task Force – Horn of Africa
CLA	Constraints, Limitations, and Assumptions
COA	course of action
CoEs	Centers of Excellence
COR	Contracting Officer's Representative
DA	Department of the Army
DA PAM	Department of the Army Pamphlet
DAC	Deploying Analyst Course
DAHB	Deployed Analyst Handbook

DAHR	Deployed Analyst History Report
DAST	Deployed Analyst Support Team
DAU	Defense Acquisition University
DOD	Department of Defense
DOTMLPF	Doctrine, Organizations, Training, Materiel, Leadership, Personnel, and Facilities
DSN	Defense Switched Network
EAC	Echelons Above Corps
FA	Functional Area
GIS	Geospatial Information System
HN	Host Nation
HOA	Horn of Africa
HQ	Headquarters
HQDA	Headquarters, Department of Army
ID	Identification
IED	Improvised Explosive Device
INTAC	Individual Terrorism Awareness Course
INFORMS	Institute for Operations Research and the Management Sciences
IPB	Intelligence Preparation of the Battlespace
IR	Information Requirement
ISAF	International Security Assistance Force
ISF	Iraqi Security Forces
ISR	Intelligence, Surveillance, and Reconnaissance
IW	Irregular Warfare
IWS	Information Work Space
JP	Joint Publication
JSOTF-P	Joint Special Operations Task Force – Philippines
M&S	Models and Simulations
MCCDC	Marine Corps Combat Development Command
MDMP	Military Decision Making Process

MEDEVAC	Medical Evacuation
MNF-I	Multi-National Forces – Iraq
MOE	Measure of Effectiveness
MOP	Measure of Performance
NATO	North Atlantic Treaty Organization
NGIC	National Ground Intelligence Center
NGA	National Geospatial Agency
NGO	Non-Governmental Organization
NIPRNET	Non-secure Internet Protocol Router Network
NPS	Naval Post Graduate School
OA	Operations Analysis
OCO	Overseas Contingency Operation
ODBC	Open Database Connectivity
OE	Operational Environment
OEF	Operation Enduring Freedom
OFS	Operation Freedom Sentinel
OIF	Operation Iraqi Freedom
OIR	Operation Inherent Resolve
OLAP	Online Analytical Processing
OLE DB	Object Linking and Embedded Database
OMB	Office of Management and Budget
OND	Operation New Dawn
OR	Operations Research
ORSA	Operations Research/Systems Analysis
PMESII	Political, Military, Economic, Social, Information, and Infrastructure
POC	Point of Contact
PPBES	Planning, Programming, Budgeting, and Execution System
P-Value	Probability Value
RS	Resolute Support

SAS	Statistical Analysis System
SASO	Stability and Support Operations
SIPRNET	Secret Internet Protocol Router Network
SPPPS	Southern Philippines Public Perception Survey
SPSS	Statistical Package for the Social Sciences
TAA	Total Army Analysis
TRAC	TRADOC Analysis Center
TRADOC	United States Army Training and Doctrine Command
TTPs	Tactics, Techniques, and Procedures
U.S.	United States
USAID	United States Agency for International Development
USMA	United States Military Academy
VBA	Visual Basic for Applications
VTC	Video Telephone Conference
WebTAS	Web-Enabled Temporal Analysis System

APPENDIX B REFERENCES

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