Baselining: Application of a Qualitative Methodology for Quantitative Assessment of Emergency Management Capabilities

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The Problem

Emergency management is an ever-evolving field that has multiple stakeholders, each of whom has ongoing efforts to improve existing capabilities—both technologies and activities—and introduce new ones. The utility, or value, of current response capabilities can be difficult to quantify, however, making subsequent metrics-based evaluation of new capabilities challenging.

The activities involved in developing the baseline have the potential to improve collaboration and promote response.

In emergency management, the benefits of new technologies can be immediately obvious (e.g., new firefighter gloves that are fire retardant at higher temperatures or a detector that has an improved ability to differentiate between biological/chemical agents in the environment). Sometimes, however, the benefits of technologies and activities are more difficult to assess. How can a new technology or activity be proven to change the response? Clear metrics become important and can result in reduced casualties, shortened response timelines, and more confidence to make decisions.

These metrics, though, present a challenge of their own. How can intangible improvements be demonstrated? The answer lies with understanding the current "as-is" and representing that baseline in a way that allows for quantification so that potential future improvements can also be quantified.

This article introduces a methodology for baselining and then provides an example of how this methodology might be used in conjunction with a quantifiable metric to assess the value of a new technology for multiple stakeholders.

What Is a Baseline?

A baseline is a benchmark that is used as a foundation for measuring or comparing current processes to potential changes, as shown in Figure 1. It is developed using data that are useful in constructing an accurate picture of the as-is state (Virtual Knowledge Centre to End Violence Against Women and Girls 2012), shown in blue. A baseline can be used on its own to evaluate current technologies, activities, capabilities, and gaps, or it can be used in conjunction with quantification tools to evaluate alternative actions and responses, shown in gray.

Baselines can take many forms including (but not limited to) timelines and frameworks. Timelines, built from the

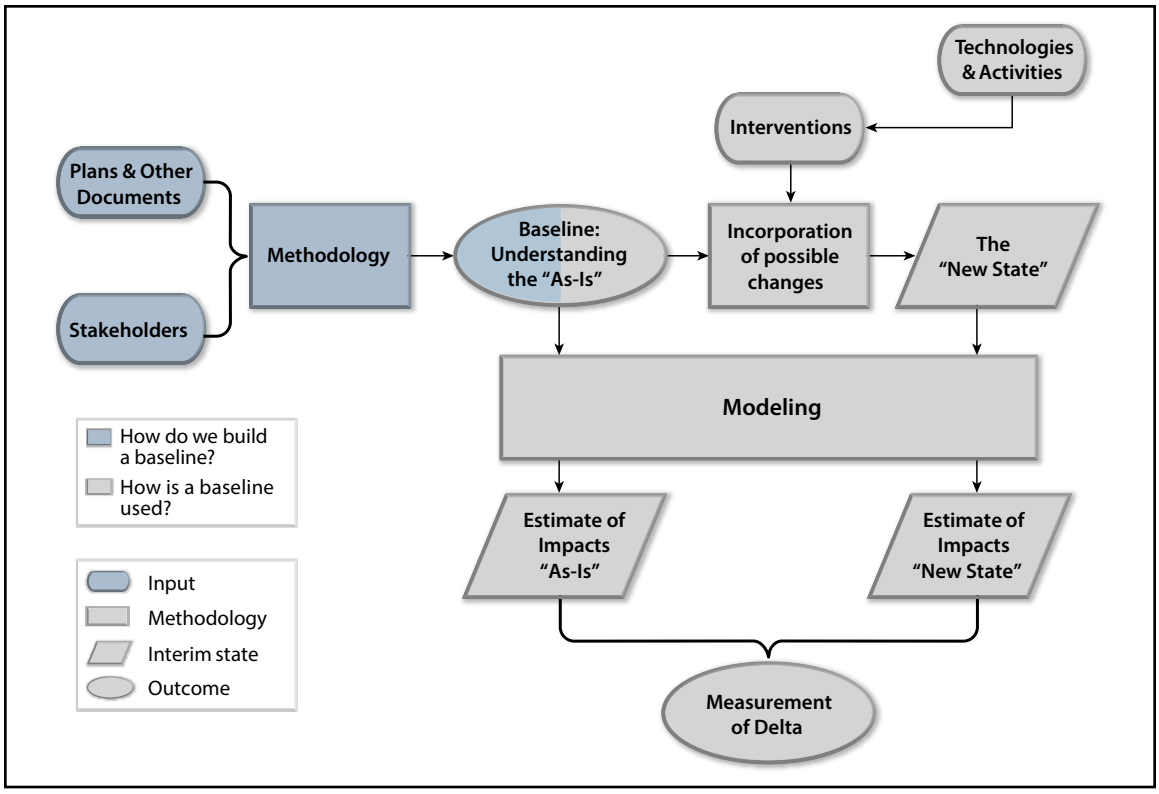


Figure 1. Building a Baseline for Use in Demonstrating the Potential of New Technologies and Activities

stakeholders up, illustrate the as-is by showing decisions, activities, information sharing, and high-impact events and using time as the principal metric for comparison. Frameworks use a top-down approach to gather a baseline of current guidance and "best practices," which can then be used in comparison with plans and protocols to identify divergences in practice and opportunities for guidance, activity, or technology improvements.

How Is a Baseline Developed?

Baselines can be developed using a number of techniques. While the exact methodologies employed to develop the baseline may vary, a number of fundamental steps build a baseline, as exemplified in Figure 2.

The first step, literature review, gathers inputs, or "unstructured data," from sources including plans, guidance, policies, and other documents. These documents provide an introduction to the decisions, actions, and information sharing that occur as part of any emergency response activity and serve as a foundation for follow-on baselining efforts. The literature review can also help the study team identify relevant stakeholders who have roles and responsibilities that should be captured in the baseline.

In addition, because the literature review aims to provide a comprehensive view of the mission and response space, it allows for an identification of potential gaps

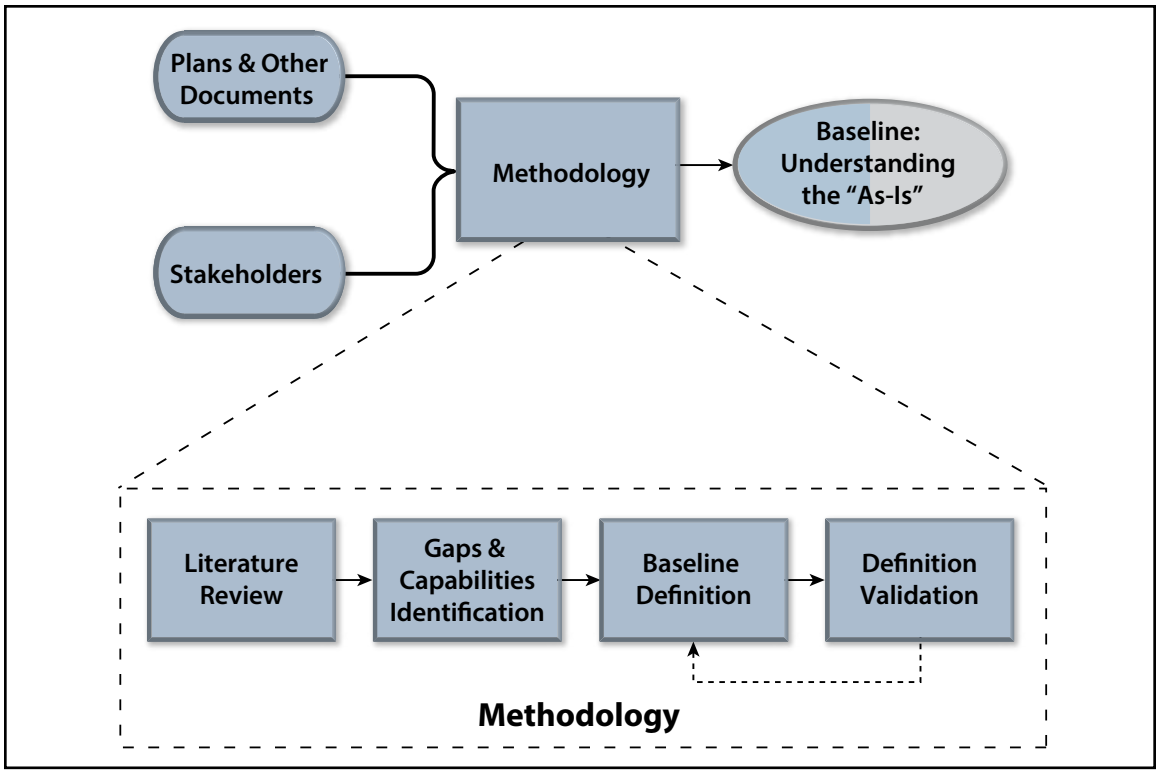


Figure 2. Fundamental Methodological Steps for Building a Baseline

in response and capabilities—technologies and activities—that are currently employed.

With a general understanding of response activities and decisions and current gaps and capabilities, the study team begins to define the baseline. While stakeholder input was useful in earlier steps, it now becomes invaluable. Plans and guidance can support the compilation of a list of events; these documents, however, rarely include information about the exact time—or the time relative to response initiation—that events occur during the response. In building a temporal baseline, the stakeholders provide the time information and identify any missing actions and decisions. For the case study presented later, the study team selected the Homeland Security Exercise and Evaluation Program (HSEEP) framework for workshops and table-top exercises (TTXs) (U.S. Department of Homeland Security 2013) to develop the baseline. Workshops enable open lines of communication among participants (Disraelly, Walsh, and Zirkle 2014) and facilitate collaboration to reach a common goal.

Once the baseline has been defined and documented, it should be validated. This step is accomplished in collaboration with stakeholders and gives key participants an opportunity to review the baseline and make revisions. This step also provides an opportunity to engage important stakeholders who were unable to participate in the development step. These stakeholders can

contribute through one-on-one or group interviews and add or clarify information to refine the baseline.

The final output of this process is the constructed baseline, the "critical output" of the baseline methodology, which provides the understanding of the "as-is" state.

How Is the Baseline Used?

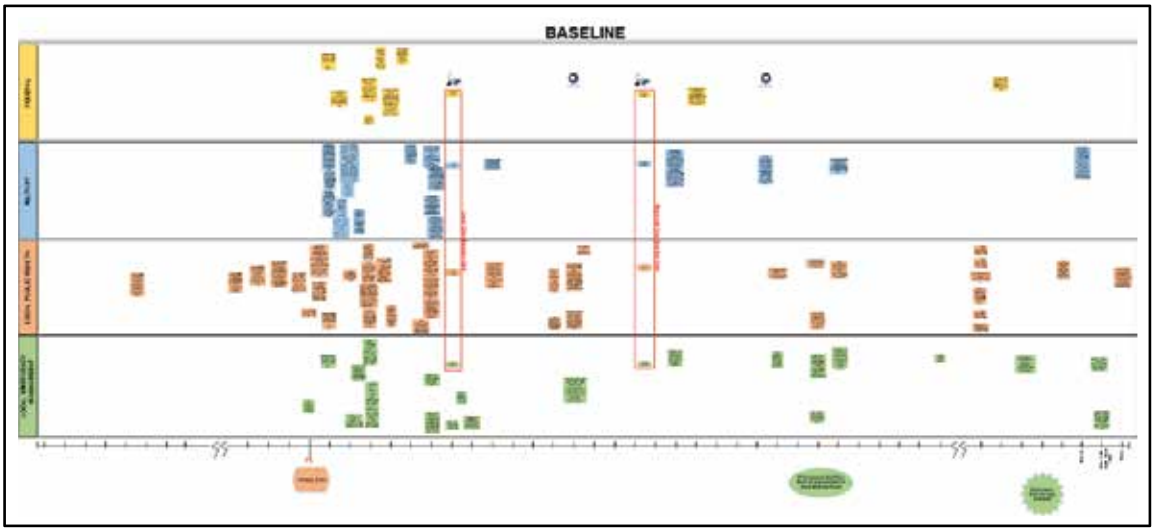
Baselines can be used with different quantitative and qualitative analytic tools to evaluate measures of effectiveness (MOEs) and assess program outcomes. The tools that are chosen depend on the type of baseline, the analytic methodologies, and the metrics appropriate for describing the as-is state. An excursion (an example of the injection of a new technology or activity into the baseline) may change the as-is state by changing the timing or types of decisions, activities, and other response actions. These changes can be assessed through modeling, as illustrated in Figure 1.

Why Baseline? A Case Study Assessing Rapid Diagnostics

Imagine a biological event—an intentional aerosolized release or a rapidly emerging epidemic. Imagine that the detected agent or the disease suddenly appearing in the population was contagious and posed a significant transmissibility risk. The goal of response to this event—and the MOE—is simple: minimize casualties and fatalities.

Response activities and technologies, including diagnostic technologies, directly affect these MOEs. Using a baseline as-is response, in conjunction with a casualty estimation methodology, could facilitate the evaluation of the utility of new capabilities in reducing casualties and fatalities.

The baseline for this case study was a biological response timeline, a notional example of which is presented in Figure 3. It illustrates the decisions,



Note: This timeline has been included for notional purposes only.

Figure 3. Baseline Timeline

actions, and communications taken by different stakeholder organizations during a biological event response. The timeline demonstrates a common operating picture in which actions are coordinated across different groups.

IDA developed the Human Response Injury Profile (HRIP) casualty estimation methodology to assess potential injury status over time, illness progression resolutions, and disease spread (Disraelly et al. 2010). The study team used HRIP to estimate the casualties and fatalities that might be expected given the biological event and the as-is response, displayed in Figure 4, assuming that post-exposure prophylaxis (PEP) is available and would be distributed on Day 5 after release.

The scenario, as presented, could result in tens of thousands of casualties. Could the introduction of a new technology or activity change this outcome? What if a proposed rapid diagnostic tool was "injected" into the baseline? How would this rapid diagnostic tool affect the number of casualties and fatalities? The technology aims to provide diagnostic information faster to allow for more rapid treatment of the ill and countermeasures to protect the susceptible populations. This scenario is not intended to imply that diagnostics can be done earlier in the course of the disease, since, for many diseases, effective diagnostics may not be possible during the incubation or even prodromal stages.

To evaluate the effect of the potential technology introduction, a "new response," or "excursion," was injected into the baseline. The injection of a notional rapid diagnostic tool could provide early indication of the emerging biological event and facilitate the implementation of intentional social distancing on Day 3 (vs. Day 5). With all other interventions and times remaining constant, the casualty and fatality estimates of this new response dropped as calculated

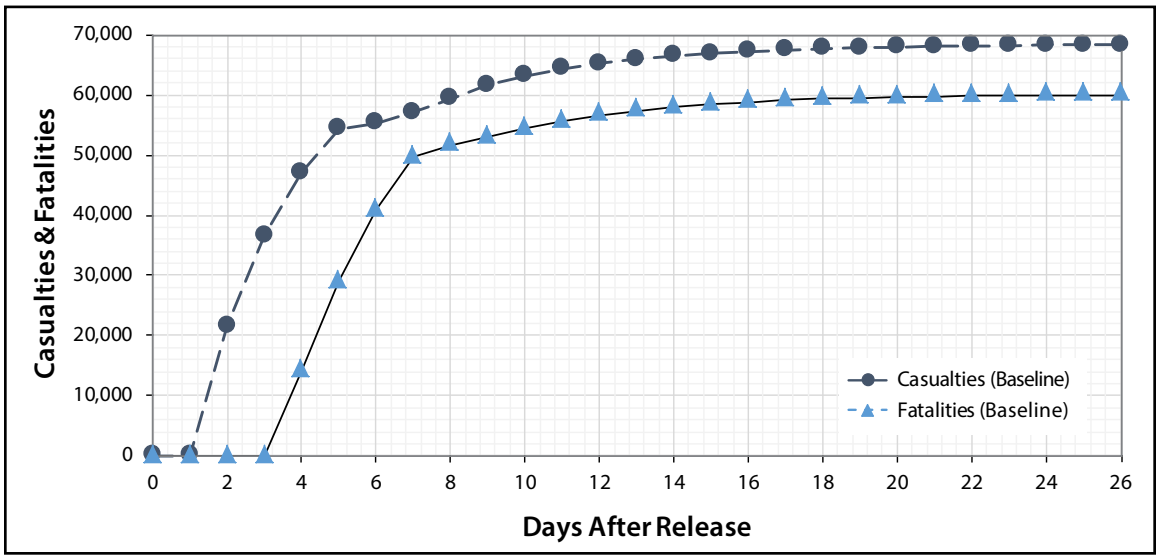


Figure 4. Baseline Daily Casualty and Fatality Estimations Resulting from an Emerging Contagious Biological Event

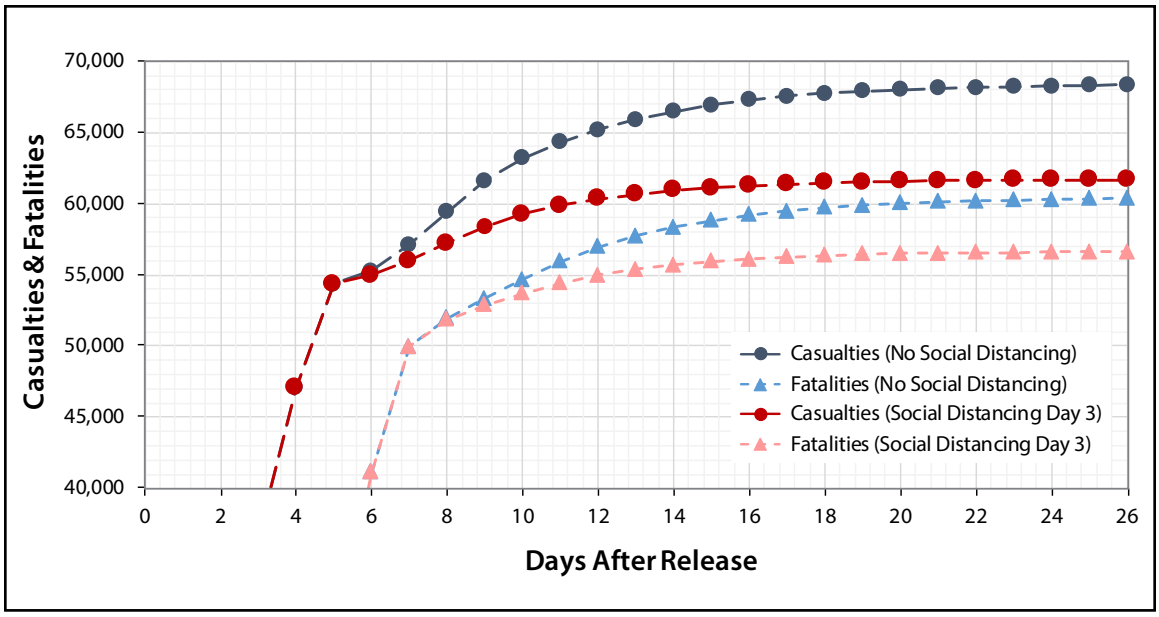


Figure 5. Daily Casualty and Fatality Estimations for the Baseline Response (Blue and Black) and with Early Social Distancing (Red and Pink)

with HRIP (see Figure 5). This result illustrates how the injection of a rapid diagnostic tool can directly affect casualties and fatalities, with a reduction in both. It also provides a quantifiable means of assessing system utility.

The case study illustrates how a baseline could be used in a complex problem space but does not cover all aspects of program evaluation. Different baselines allow researchers to measures changes to other types of MOEs, such as procurement costs, required training time, and so forth. Developing a clear and detailed baseline allows it to be used in conjunction with different types of quantitative tools, including those for casualty estimation, statistical comparison, and cost-benefit analyses to evaluate program effectiveness and provide insight into program outcomes.

What Is the Value Added?

Baselining is accepted as common practice in operations research. To realize improvements, the current practices, policies, and activities need to be understood. These as-is states are currently captured through discussions, literature reviews, and drills and exercises. Many of the existing methods, however, may not fully provide the detail needed to develop a baseline that shows the extent of coordination among multiple stakeholder groups or supporting quantifiable metrics. Without this common and coordinated baseline, measurement of improvement within these mission spaces may be nearly impossible.

Alternatively, baselining allows for the development of an as-is state with sufficient detail to support quantitative and qualitative assessments of

potential technology and activity changes. In addition, the activities involved in the baselining facilitate the coordination between stakeholders, the reviews and revisions of the as-is even without the introduction of new capabilities, and the identification of current capabilities and gaps that must be filled. So, while baselining facilitates capability utility assessment for emergency response, even as the assessments are ongoing, the activities involved in developing the baseline have the potential to improve collaboration and promote response.

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