

Looking Back to Move Forward: Hindcasting in Homeland Security and Emergency Management



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Abstract

While it may be tempting to quickly move on from our failings and shortcomings, given the seriousness of potential consequences within the fields of Homeland Security and Emergency Management, having a method of practice and process to efficiently and effectively review and dissect past incidents and events can be useful to formulating future planning and strategy. Hindcasting, which is also sometimes referred to as backtesting, may be the perfect vehicle for just such introspection.

“We should not look back unless it is to derive useful lessons from past errors, and for the purpose of profiting by dearly bought experience.”

~George Washington

Perhaps the first President of the United States was on to something in 1781 when he penned the words above in a letter to John Armstrong. (Washington, 1781) In its purest form, the hindcasting method (as illustrated below in Figure 1.1) usually refers to a process that tests a mathematical model or framework. (Everpedia, 2019) For instance, scientists might input historical climate data from a determined period and then see if the model accurately reflects the actual observed climate conditions. With enough data and observations that are correlated, then the use of hindcasting would serve to validate the model. An additional benefit of the hindcasting method is also in its ability not just to look backward, but also in the capability to use models validated by backtesting to forecast or predict future events.

For instance, Chen, Cane and colleagues (2004) using hindcasting, were not only able to validate the success of their model's ability to accurately predict the occurrence of El Niño events over the 146 years from the period 1857 to 2003, but they also discovered that their model provided the ability to accurately forecast the conditions leading up to El Niños up to two years prior to their beginning thereby providing valuable time for possible preparation and mitigation activities. (Chen, et.al., 2004)

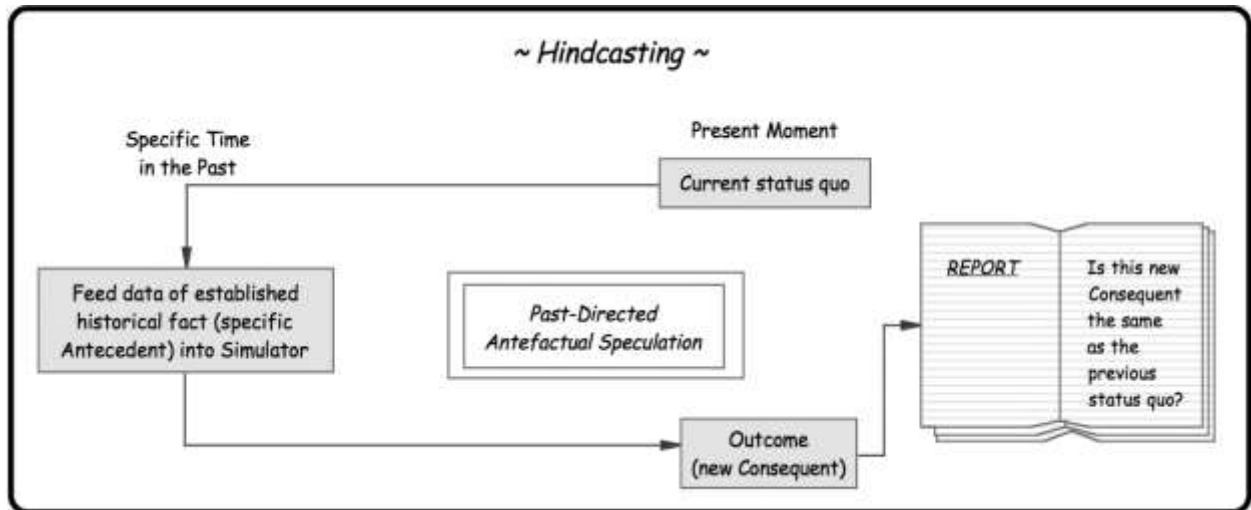


Figure 1.1 – The Hindcasting Process

Uses of Hindcasting

Traditionally, hindcasting has been most often used in the fields of Oceanography and Meteorology to provide validity to weather forecasts and ocean condition models. “Starting as early as the late 1960s and has progressed to be the de facto standard for the development of extreme and operability data” (Oceanweather, 2019) for weather forecasting particularly related to extreme weather events such as hurricanes and cyclones. It is also used extensively in Hydrology to model stream flows and hydro dynamics. Increasingly, the hindcasting method has also been found to be useful in climate change research and modeling, especially in its ability to use large amounts of historical data to assist in building valid climate models. “Hindcasting is fundamental to the development of computer climate models ... which will often contain hindcasting graphs which show how well the model curve “fits” actual temperature data since 1900.” (Webb, 2019) Additionally, when it comes to the changing environment, hindcasting can also provide critical insight into plant and animal habitat adaptation and provide valuable data for policy recommendations going forward. (Sanders, 2012)

Within the fields of epidemiology and medicine hindcasting is useful in improving diagnosis validity and verification and is also routinely used in morbidity and mortality (M&M) conference processes. More recently, it has also become quite valuable in mapping and analyzing disease outbreaks. For instance, the development of a “framework that combines response level data from multiple diagnostic tests and is able to ‘hindcast’ (infer the historical trend of) an infectious disease epidemic” (Rydevik, G. et. al., 2016) can be very useful in determining both treatment modalities as well as medical response options and resource deployment.

Hindcasting in Homeland Security and Emergency Management

While the traditional uses of hindcasting can be very useful within the Homeland Security and Emergency Management (HSEM) community, it is really in its adaptation to the fields that it becomes even more useful. The key question then is how is hindcasting in Homeland Security and Emergency Management different than in other fields of study and practice?

Likely the most important difference of hindcasting in HSEM is in its qualitative versus quantitative orientation. While it may be possible to use hindcasting for large historical data analysis in HSEM, the process being discussed here is primarily the use of hindcasting as a qualitative method for looking at incidents and events as a fact-finding discovery tool. It has significant potential implications in the security, emergency, and disaster management field.

Without requiring a lot of time or resources, a hindcasting event or exercise allows for a deep learning experience for practitioners at all levels of expertise and responsibility and encourages critical thinking and sharing between participants. It can serve as both a focusing event or exercise to begin emergency planning activities or also as an after-action or lessons learned tool. (Bergeron, 2020)

Uses of Hindcasting in Homeland Security and Emergency Management

When it comes to the use of hindcasting/backtesting in HSEM, the possibilities are virtually limitless and are only constrained by one's imagination and creativity. Obviously, some considerations such as the experience and training level of participants, the level of responsibility, and other factors can dictate which approach is likely to be the best fit for a certain situation. However, in most cases, the flexibility of the technique and process can allow for a wide variety of adaptations to suit just about any event or organization.

Given its historical nature, one of the most common uses for hindcasting is of course its use for lessons learned and after-action reviews of actual events or exercises that the participants have been involved in. However, it can also be just as useful using events, situations, or scenarios that are similar to those that may be encountered by a particular organization or jurisdiction but have not actually occurred but are part of the threat or hazard profile of the participants. This can be particularly useful as a planning driver for exercises and other planning activities.

In terms of exercises, the use of a hindcasting event can be a great way to enhance or in some cases even replace a tabletop exercise. In particular, the use of an actual event can provide for an excellent exercise scenario without the need for the creation of a lot of exercise materials and documents. In many cases, simply using the public media reporting on an event can provide just about all the scenario preparation that is needed. While using an actual event is a great way to create a hindcasting exercise, it can also be useful to modify or tailor a scenario to incorporate aspects that need to be stressed or exercised or to ensure that elements that may be unique to the participants/organization are covered as part of the event. Using an actual event's public media reporting as a base line scenario is a great way to ensure realism for the hindcasting event while also allowing for adaptation as necessary. It can also be useful to use these more generic "adapted events" versus actual events from a jurisdiction to help in eliminating the natural tendency for participants to want to assign blame or causation and can help in getting participants from mixed levels of responsibility to be comfortable in sharing honest and candid feedback.

When it comes to planning and plan development, the use of a hindcasting event can be a great way to focus planning efforts especially in terms of showing a worst case or "Black Swan" scenario. It can also help to orient individuals involved in the planning process especially in cases where they may come from a variety of disciplines or functional departments that may be outside of the HSEM discipline.

Possibly one of the most effective uses for hindcasting is its use as a "focusing event" especially in the case of senior leadership and administration officials who are usually very busy and do not have time for a longer duration tabletop type exercise. With a 15-20-minute time block, a hindcasting event can provide significant impact and help to focus senior leader attention on important HSEM topics in short order. This focus can then be leveraged to drive specific planning initiatives or to assist in resource allocation.



Figure 2.1 – The Hindcasting Process in HSEM

The Hindcasting Process in Homeland Security and Emergency Management

Similar to the normal hindcasting or backtesting process that begins with a hypothesis or a scientific model, hindcasting within HSEM should also begin similarly with a realization of the desired objective or purpose that is to be achieved by the process. While it may be simply to fulfill an exercise or a training requirement or to facilitate a post exercise evaluation process, in most cases the most effective use of the hindcasting process in HSEM will be to drive a specific result or objective from the participant audience. That objective could be to increase awareness of a hazard or threat, drive a planning effort, achieve a decision or outcome, or address a currently unmet need. Whatever that objective ultimately is can be a critical part of the form that a particular hindcast effort will take, but in all cases the HSEM hindcasting process (outlined above in figure 2.1) will be similar. (Bergeron, 2020) An example of a hindcast exercise brief used by the author can be found at: https://www.academia.edu/41669136/East_State_University_-_Hindcast_Exercise_Brief

Assembling the Team – The first necessary step in any hindcasting effort is to figure out who the target audience for participants will be. As discussed above, the particular goal or objective may be a driver of who ultimately becomes part of the effort. It is also important to note the experience, training, and responsibility level of participants since a mixed team may require more preparation and explanatory effort than a team that is of the same experience level and is well versed in HSEM.

Setting the Scene – Once the team is assembled (or at least its composition determined), then the next step is to prepare the materials necessary to properly frame the setting for the hindcasting event. This may be easy in terms of a post exercise hindcast used as an after action review event with the participants all having experienced the event, or it may require a more complex narrative to properly set the stage and convey the necessary information to the participants. As mentioned previously, the use of media reporting on emergency and disaster events can be a rich source of information for setting the scene for an actual event or as a starting point for adapting or tailoring a scenario to be used in the hindcast. An example of a hindcast scenario used by the author can be found at: https://www.academia.edu/41669138/East_State_University_-_News_Article

Asking the Questions – As with any scientific research effort, the hypothesis (goal or objective in this case), will drive the questions to be asked of the participants during the hindcast. Ideally, a short and focused list is usually best in terms orienting participants and can also help in managing time constraints for the hindcasting exercise. For instance, a hindcast dealing with a city’s response and recovery efforts after a tornado might include open ended questions centered on the top five things that went right and the top five things that went wrong. Similarly, one might ask “What are the top three key points of failure?” or “What are two things that could have been done differently?” Obviously, the nature and type of scenario or event will determine the best questions to ask.

Hindcasting Exercise - East State University

<p>What went wrong? What occurred that led to the perception of failure? What are the issues that impact continuity of operation for ESU?</p> <p>Stakeholders:</p>	
<p>Points of Failure - factors, errors, conditions</p> <ol style="list-style-type: none"> 1. 2. 3. 4. 	<p>Continuity - impacts, needs, capabilities</p> <ol style="list-style-type: none"> 1. 2. 3. 4.

Figure 3.1 – Hindcasting Response Form Example

Capturing the Data - In most cases, it is useful to have a common form (an example at figure 3.1) to collect participant responses which can also help in the later steps of analyzing the data and trend analysis. (Bergeron, 2020) The actual format will be largely determined by the purpose and scope of the hindcasting event. With larger groups it can be useful to use an online polling application to quickly capture responses that can be used both in real time trend analysis and for more detailed and in-depth analysis later.

Trend Analysis – Once the data is collected from the participants, it can be useful to take a break in the exercise and the facilitator can step away and quickly go through the responses to determine emergent themes or trends. The usefulness of limiting participants to their top responses is that it will help in rapid trend analysis. Usually, the top five trends will quickly emerge and then the facilitator can reconvene with the participants and discuss and review the trends and get concurrence on the trend ranking from the group. At this point, this is a good break point for the first session with participants returning for a second session or wrap up of the hindcasting results which the facilitator will develop in the final steps of the process.

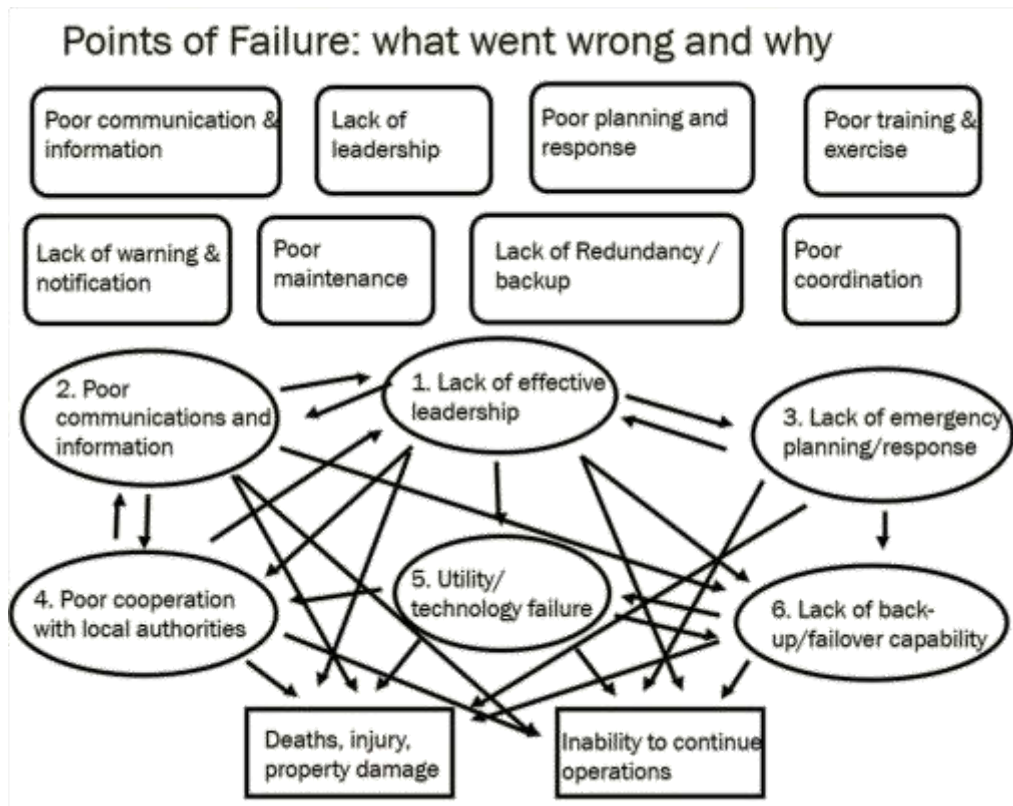


Figure 4.1 – Hindcasting Negative Link Analysis Example

Link Analysis – Once the trends are settled and agreed upon, then it is incumbent upon the facilitator to look at the items and to determine exactly how they are related to one another in a negative fashion. For instance, how does poor communication relate to a lack of leadership? These relationships are then portrayed in a critical factors slide or diagram (figure 4.1 shows an example from one of the author’s hindcasting exercises). The next step is to then reframe these negative factors and portray them in the positive – what must go right (as shown in the example in figure 4.2). (Bergeron, 2020)

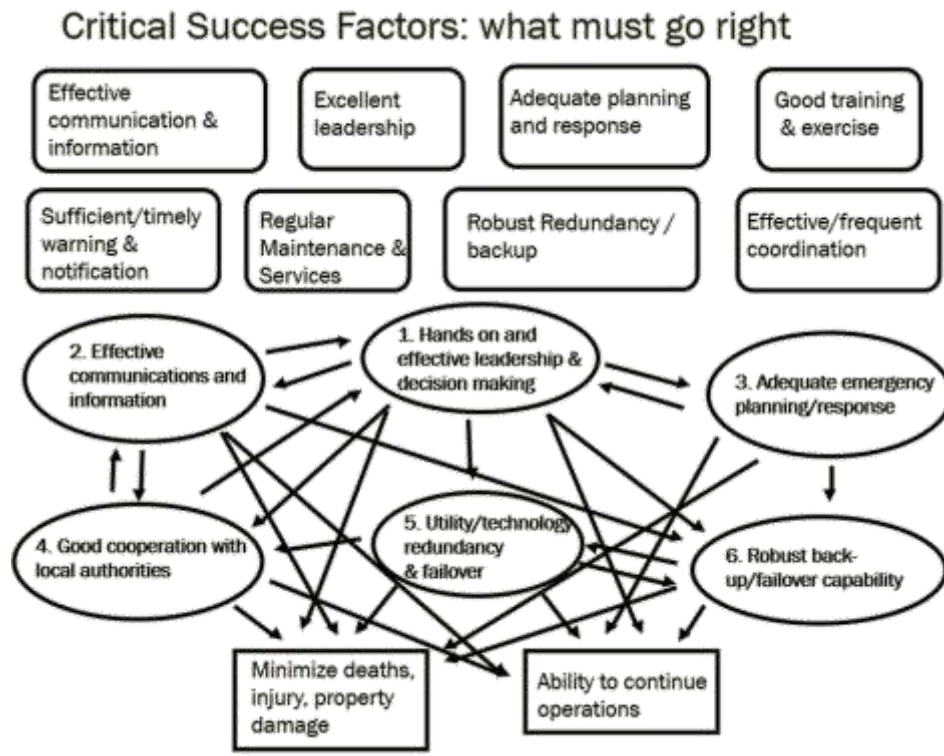


Figure 4.2 – Hindcasting Positive Link Analysis Example

Develop the Action Items – The final step in the analysis is to develop the specific action or focus items that are derived from the trend and link analysis. These can then form the basis for lessons learned, policy recommendations, training needs, regulatory frameworks, etc. Ideally, this step produces a set of items that participants and their decision makers can use as a roadmap to improved performance.

Recap the Results – This final step may be the most important one in the long-term impact of a hindcasting exercise where a facilitator presents the results and gets the buy-in of the participants on the path forward. Usually this will be done in a second or follow up session to allow for time for proper analysis and formal presentation of the results. The author has done this in a single session with smaller groups with the analysis being done in real time on a “whiteboard” as a collaborative activity with the participants, but even in those circumstances it is best to follow up with a formal product at the end of the process.

HSEM Hindcasting “Take Aways”

The use of hindcasting in HSEM provides for some unique opportunities as a performance improvement process and allows the leverage of expertise and the perspective of a large group in a short time. Unlike other methods, hindcasting does not take a lot of logistical preparation or resources to be effective and can be tailored to the time available. Hindcasting also has a huge advantage over some other methods of exercise and training in that it can be used with participants from different experience, training, and responsibility levels. In many ways this is a huge strength of the method in that you can take a whole team or even an entire organization and look at the same event or scenario. Another advantage is the ability to use actual events or to take tailored scenarios (based on actual events) to customize the learning objectives of the hindcast experience. Additionally, the hindcast method can be particularly useful in a wide variety of activities such as planning, training, exercises, after action reviews, etc. Finally, the use of hindcasting can provide for a shared experience and frame of reference and focusing event type impact that is sometimes difficult to achieve using other methods.

References

- Bergeron, W. (2020). "The Value of Hindcasting in Emergency and Disaster Management" Conference Presentation. *Manitoba Disaster Management Conference*. January 2020. <https://www.manitobadisastermanagementconference.org/>
- Chen, D., Cane, M.A., Kaplan, A., Zebiak, S.E. & Huang, D. (2004). "Predictability of El Niño Over the Past 148 Years". *Nature*, Vol.428, No.6984. pp.733-736. Retrieved from: https://www.researchgate.net/publication/8618461_Predictability_of_El_Nio_over_the_past_148_years
- Everpedia. *Backtesting*. (2019). Retrieved from: https://everipedia.org/wiki/lang_en/Backtesting
- Oceanweather Inc. (2019). *Hindcast Approach*. Retrieved from: <https://www.oceanweather.com/research/HindcastApproach.html>
- Rydevik, G. et. al. (2016). "Using Combined Diagnostic Test Results to Hindcast Trends of Infection from Cross-Sectional Data." *PLOS Computational Biology*. Retrieved from: <https://doi.org/10.1371/journal.pcbi.1004901>
- Sanders, R. (2012). "Hindcasting helps scientists improve forecasts for life on Earth". Berkley News. Retrieved from: <https://news.berkeley.edu/2012/06/12/hindcasting-helps-scientists-improve-forecasts-for-life-on-earth/>
- Washington, G. (March 26, 1781). *Letter to John Armstrong*. Retrieved from: <http://www.loc.gov/teachers/classroommaterials/presentationsandactivities/presentations/timeline/amrev/south/johnarm.html>
- Webb, P. *What is 'hindcasting' in the context of climate modelling?* Retrieved from: <https://www.quora.com/What-is-hindcasting-in-the-context-of-climate-modelling>

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Wayne is a native of Houma, Louisiana. He is an alumnus of Nicholls State University; Thibodaux Louisiana with a Bachelor's degree in Political Science and Criminal Justice earned in 1988 when he was commissioned into the Regular Army as a Military Police Officer. He was originally assigned to the 16th Military Police Brigade (Airborne) at Fort Bragg, North Carolina where he served the bulk of his 23-year career in Airborne and Special Operations Units.

In 1995 LTC Bergeron became qualified in both Civil Affairs and Psychological Operations and received a Master's Degree in International Relations from Troy State University in 1996. He has commanded units at every level from Platoon to Battalion, with his final assignment as the Chair and Professor of Military Science and Commander at the University of North Alabama ROTC program where he retired from active duty in May 2011. He currently serves as Chair of the Department of Geography and an Associate Professor, teaching Criminal Justice and Security and Emergency Management at UNA as well as serving as the faculty advisor for the UNA Military and Veterans Alliance. He completed his Doctor of Science in Emergency Management at Jacksonville State University in 2016.

Over the course of his career, LTC Bergeron has been assigned, deployed to, or worked in over thirty-five countries on four different continents and has served multiple combat tours in Panama, Iraq, Kuwait, Saudi Arabia, and Pakistan. He is a Master Parachutist, Jumpmaster, and is Air Assault qualified.

Additionally, he has served as an instructor and presenter at the Joint Special Operations University, the U.S. Army Special Warfare Center and School, The US Army and Marine War Colleges, the US Naval Post Graduate School, the National Defense University, the NATO School, the Koffi Annan Peace Training Center in Accra, Ghana and various other international defense academies. He has also worked extensively with the US Department of State, the U.S. Agency for International Development, and various International and Non-Governmental Organizations. He has also served as an associate faculty member with the US Naval Post Graduate School's Center for Civil Military Relations - Countering Terrorism Program.

Wayne is an Eagle Scout and serves as a volunteer leader with the Boy Scouts of America. He enjoys running, working out, scuba diving, boating, and the outdoors. His wife, Dr. Peggy Bergeron is an Associate Professor of Nursing at UNA and they have three children; Joshua (27) a graduate from LSU and a Newspaper Editor, Lauren (18), and Connor (16). They currently reside in Florence, Alabama with a house on the Tennessee River.