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HOW TO UNDERSTAND EXTREME RISK - BEYOND HAZARD, VULNERABILITY ASSESSMENTS

Carl Taylor JD[1]

[1]*Executive Director, Fraser Institute for Health and Risk Analytics And XCH, LLC*
Email: cwtaylor1@gmail.com

ABSTRACT:

A far too common phrase heard after a naturally occurring disaster or man---caused catastrophic event is "we never imagined". That phrase is followed closely by "we never thought something like this could happen here". Time and again poor preparedness or ineffective response was preceded by a failure to imagine, or perhaps more appropriately a failure to anticipate. We write these occurrences off to being "Black Swan" events, taken from a book of the same name by Nicholas Taleb. However to be fair, Black Swans always existed and were imaginable, they were just not imagined, until after their discovery. This paper will begin with why I believe our current use of hazard vulnerability assessments is flawed. More importantly the paper will focus on the tools, I call the Four Pillars and the approach to imagining or anticipating disasters more effectively before they occur. More effective imagination or anticipation will contribute greatly to improvement in our steps towards mitigation, preparedness, response and recovery.

KEYWORDS:
Hazard, Vulnerability Assessments, systems of systems, modeling, decision support, situational awareness.

1. INTRODUCTION

I would respectfully suggest one of the causes of our disaster "imagination/anticipation" deficit, lies in the over reliance of highly linear forms for conducting hazard vulnerability analysis. The process we use in many parts of the world attempts to create a formulaic approach to defining future events. This approach erodes collaborative discussion. It attempts to reduce disasters to ordinal numbers. It silos events into isolated actions, and contributes little to actual preparedness. Even worse these forms are rarely reviewed after an event to determine whether or not this approach contributed in any positive way to an effective response. The result seems to be we observe lessons more than we learn from them.

This linear, analog system to identification of vulnerabilities ignores the fact that events do not occur in silos, but can indeed cascade as we saw in Japan in which an earthquake caused a tsunami, which triggered a nuclear plant meltdown. This approach ignores the unimaginable extreme risk events such as - coronal mass ejections, collapse of governments leading to mass migration, rapidly spreading outbreaks of highly infectious diseases, slow developing crisis such as climate change, or cyber attacks causing the collapse of a large financial institution or company. Further, this approach ignores the fact that disasters cannot be reduced to ordinal numbers because disasters do not regress to a mean.

We can and should approach hazard vulnerability analysis differently. My suggestion is a structure of Four Pillars. The first pillar of this design moves away from a formulaic and static approach of hazard vulnerability analysis. Rather the starting point for imagining and/or anticipating more effectively must begin with a system of systems approach to surveillance and sensing. This gives the opportunity to "sense" events on a global basis, which may impact us as close to the moment of occurrence as possible. While this ambitious goal may have been difficult to achieve in the past, we can move towards an approach more thoughtfully now in the era of "big data" (note the authors - disclaimer that big data is actually a great deal of small data). Using a system of

systems approach allows us to focus on a domain or to collect data across domains (using animal data to predict human disease spillover as an example). It also allows for multi-dimensional (spatial and temporal) data collection and analysis, in real time.

The second pillar is to use the big (small) data to drive a more robust suite of models. Models should be used to project emerging ranges of events and probabilities. Models allow for "sense making", severity prediction, understanding causality, understanding complexity, and "imagining/anticipating" through what if scenarios.

The third pillar is decision support. How do we optimize our decisions? How would we respond- particularly to emerging events in which all of the facts are not known? Decision optimization allows for "imagining/anticipating" a range of responses (courses of action) and the impact therefrom. In highly visible outbreaks of infectious diseases, or significant natural disasters for instance critical economic decisions must be considered in order to protect citizens, businesses and government. Focusing on decision support creates the opportunity to identify critical success factors and levers of importance. It drives a thorough review of capabilities and intents exposing the need to ask more questions about the complex interactions of agencies, the private sector and others.

Finally the last pillar is acting. Here again, because of the nature of our current linear and analog approach we fail to imagine or anticipate (or perhaps wrongly imagine) what might happen as a result of an event. Hazard vulnerability assessments create a series of myths, each regretfully exposed during disasters. They create the myth that there is a limit to the risks we are exposed to. They create a myth that the magnitude of the events is known. They create the myth that we can manage with our current systems anything nature or man can bring our way. Unfortunately the underlying premise is our public and responders will act rationally and that aspects of our society will respond to events as we as "professionals" believe they should.

Calculating, anticipating, measuring, modeling, monitoring and imagining actions form a key part of enhancing our response-ability.

2. THE CHALLENGE

We should not underestimate the difficulty of changing or modifying any approach to hazard, vulnerability awareness. In fact a fair question is-can we move away from the "way we have always done it"? There are a number of forces at work, which, serve as barriers to imagining and thinking differently about response.

They include:

First, dangers often remain hypothetical until they occur. That is why we hear the phrase: "we just never imagined". This is not true when applied to known and frequently experienced events such as coastal storms as long as they stay within a mean range of severity. But beyond that our imagination suffers or in fact is not rewarded in planning activities. Those who imagine may be singled out as worrying too much or "imagining things". Because of this adverse imagination bias we deal poorly with extreme risks and Black Swans.

The second barrier against change is the psychological bias to maintain the status quo. An appropriate phrase here is "we have always done it this way". Flaws in risk recognition may be difficult to overcome if the status quo is embedded in training, hard coded in planning, institutionalized in process or memorialized as part of regulatory requirements.

The third barrier arises when the status quo is challenged. When it is suggested that alternative approaches be considered. At that moment both dominant leaders and organizational behavior close ranks to protect the existing bureaucracy and risk planning structure.

Finally in many cases there is no easily identifiable incentive for disruption and change in existing processes. Disruption may require new training, new staff, new software, new budgets, new processes against which the existing culture will not see a benefit. After all don't disasters simply happen anyway? For the rare Black Swan event is there even a cost benefit to spending time thinking about the unthinkable. How, if at all, would the outcome be any different, than the more or less random walk we take today?

To respond to the four barriers, my suggestion is to build a thoughtful case for change.

3. IN THE BEGINNING

Our journey towards preparedness and response with a greater imagination and/or anticipation begins often with a process to identify hazards. For our purposes I would define hazards as:

> "An event, which impacts your ability to continue to operate and provide essential services"

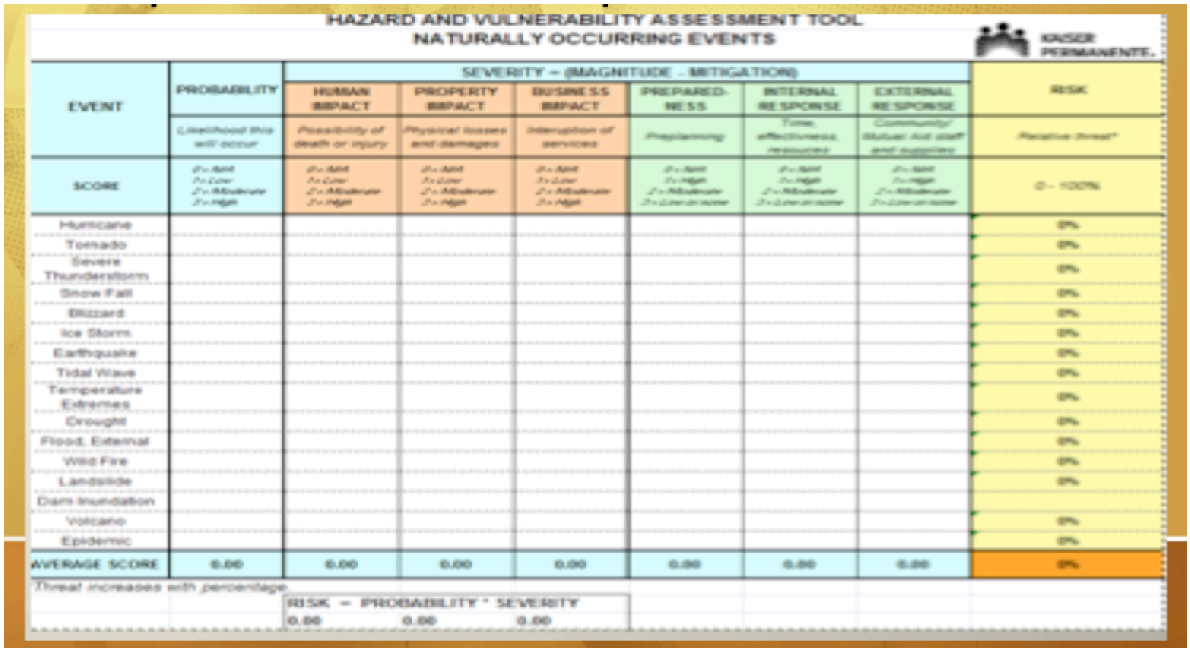
Hazards are found in four places:

a. Internal Threats - Such as the loss of power, water line break, cyber attack (if internally generated)
b. External Threats - Mass casualties in a healthcare setting, cyber attacks (malware, DNS, hacking from external government or non government actors)
c. Internal/External - Sandstorms, floods, hurricanes, earthquakes, civil disturbances or economic collapse
d. Local/Global- Infectious diseases including pandemics, large numbers of involuntarily displaced persons fleeing fighting and/or economic collapse.

Vulnerability may be defined as a risk of loss to a hazard. Vulnerability arises from a number of factors. These may include natural selection - geographic threats due to the proximity of fault lines producing earthquakes, or coastal regions exposed to storms or climate changes. Vulnerability may also arise from poor choices, or poor planning, such as a lack of building codes or a strong public health system. The adage there are no natural disasters only natural events, which meet poor planning may apply here. Finally, vulnerability may arise as a consequence of decisions outside of your control. These would include fighting or civil disruption in neighboring countries as well as poor disease recognition, which in turn leads to a spread of infectious diseases beyond the borders of any one country.

To be sure our goals today are to reduce or avoid loss, provide prompt response to victims and achieve an effective recovery from an event.

Today in many jurisdictions in the world the journey towards hazards vulnerability assessment begins with answering questions in a form that frequently looks like:



HAZARD AND VULNERABILITY ASSESSMENT TOOL
NATURALLY OCCURRING EVENTS

KAISER PERMANENTE

EVENT	PROBABILITY	SEVERITY = (MAGNITUDE - MITIGATION)						RISK
		HUMAN IMPACT	PROPERTY IMPACT	BUSINESS IMPACT	PREPAREDNESS	INTERNAL RESPONSE	EXTERNAL RESPONSE	
	Likelihood this will occur	Possibility of death or injury	Physical losses and damages	Interruption of services	Preplanning	Time, effectiveness, resources	Community/ Mutual Aid staff and supplies	Relative threat*
SCORE	0 = N/A 1 = Low 2 = Moderate 3 = High	0 = N/A 1 = Low 2 = Moderate 3 = High	0 = N/A 1 = Low 2 = Moderate 3 = High	0 = N/A 1 = Low 2 = Moderate 3 = High	0 = N/A 1 = High 2 = Moderate 3 = Low or none	0 = N/A 1 = High 2 = Moderate 3 = Low or none	0 = N/A 1 = High 2 = Moderate 3 = Low or none	0 - 100%
Hurricane								0%
Tornado								0%
Severe Thunderstorm								0%
Snow Fall								0%
Blizzard								0%
Ice Storm								0%
Earthquake								0%
Tidal Wave								0%
Temperature Extremes								0%
Drought								0%
Flood, External								0%
Wild Fire								0%
Landslide								0%
Dam Inundation								
Volcano								0%
Epidemic								0%
AVERAGE SCORE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0%

Threat increases with percentage

RISK = PROBABILITY * SEVERITY		
0.00	0.00	0.00

The key discussion points involved in filling out the above form include the probability of an event, the magnitude of the event, the exposure and consequences and preparedness.

Simply stated: Vulnerability = Hazard Probability + Severity – Preparedness and Mitigation.

Well used an HVA features the following attributes:

- Exposure of known (experienced) vulnerabilities
- Highlights of planning requirements/opportunities
- Exercise opportunities to test preparedness
- Pre-event mitigation
- Potentially a dialog amongst planners and responders
- In theory a more effective response.

The outcome of a hazard vulnerability analysis frequently reduces disasters to ordinal numbers in a form similar to that shown below:

It is my suggestion that hazard vulnerability analysis may work tolerably well for known and recognized events, which occur within ranges of previously experienced events. If a coastal area experiences storms or flooding the HVA will deal with these events adequately, until a Katrina occurs. If a plains area experiences frequent tornados the HVA will provide guidance until a category F 5 tornado destroys the community. But not only do HVAs in their current form, poorly deal with severity, they are wholly challenged to provide guidance for events not previously experienced such as cyber or terrorist attacks. Nor do they do well with cascade events. Cascade events are those, which flow one from the other. An offshore earthquake, triggering a tsunami, which in turns creates a nuclear catastrophe being an ideal example of a failure in the current HVA approaches.

4. WHY

I think it is worth spending a few paragraphs on where our current HVA process falls short. First, I would argue it is very difficult to reduce disasters to ordinal numbers. Our experience shows that disasters do not regress to the mean. Yet in practice more than one community has experienced flooding when its levee system was designed to protect against an "average" event. It is the extremes not the means that get us in

trouble. Second, is the challenge of the 4 Ms'. The first M is myth. Myth is a story we construct mentally before engaging in a discussion of a hazard vulnerability analysis. A myth can be summarized by "nothing like this has ever happened here". The inference of course is since it has not happened within our recorded memories it is not capable of happening. On a small scale I remember the conventional wisdom in the Deep South of the United States to never spend time worrying about snowfall and blizzards. Yet one cold January a light snowstorm fell and paralyzed our community. It wasn't the amount of snow but the inexperience of thousands of people experiencing it for the first time, which caused workers to flee their offices, run to the stores and head for home. I have no doubt anyone who lives in a colder climate would have been laughing hysterically as I have done in reverse when a weak hurricane threatens areas with no hurricane experience. Myths are not our best guides to recognizing vulnerabilities.

The second M is Motive. For many people engaged in the vulnerability process, the motive is to simply get the form done. New or emerging threats may mean new work in planning or exercising. It may mean challenging decisions and processes. It may mean having to engage in a dialog about how we protect our information perimeter from hackers for instance. It may in the case of British Petroleum have meant that imagining threats from the Deep Water Horizon during the drilling application process would have meant being turned down for a permit to take oil from the Gulf of Mexico.

The third M is magnitude. This is our regression to the mean problem or our intentional downgrading the threat. Again going to BP, the statement often made pre- spill was even if there was a leak it would be a small one, hardly noticeable and no doubt incapable of causing environmental harm. We do the same thing with even recognized events. Where the magnitude of harm or risk of harm may be pronounced in one geographical area, but would never impact "us". Wherever in the world "us" lives. SARS would stay confined as an Asian problem and never become a significant threat in Toronto. Fighting and religious conflicts in the Middle East would never reach New York, nor ever impact public sporting events such as the Boston Marathon or trains in Madrid, or the sidewalks of London. Where the myth would state: "nothing like that could happen here", magnitude chimes in to say - even if it did, it would not have much of an impact. Yes there is a risk, but the harm arising from that risk would be minimal.

The final M is management. Management follows closely with magnitude. If the impact is small then our ability to manage the risk is great. We believe we have the right resources, the right training, and the right response plan. We are prepared for "it". If we have not stretched our imagination to an extreme event, if we have not stretched our imagination to events with which we have no familiarity, if we have not imagined that events occurring in other parts of the world can and will reach us. Then we feel prepared and quite capable of managing.

We defend the 4 M's vigorously. We have a biased advocacy towards the status quo as I outlined earlier. We feel comfortable in our current knowledge and expertise and feel constrained to push beyond those boundaries to the "knowable unknowns". Sometimes even worse we treat HVAs as a: done once a year form to put on the bookshelf or as an addenda to our plans. We believe at the moment of their construction HVAs represent all we need to know and that nothing will change or evolve over the coming months.

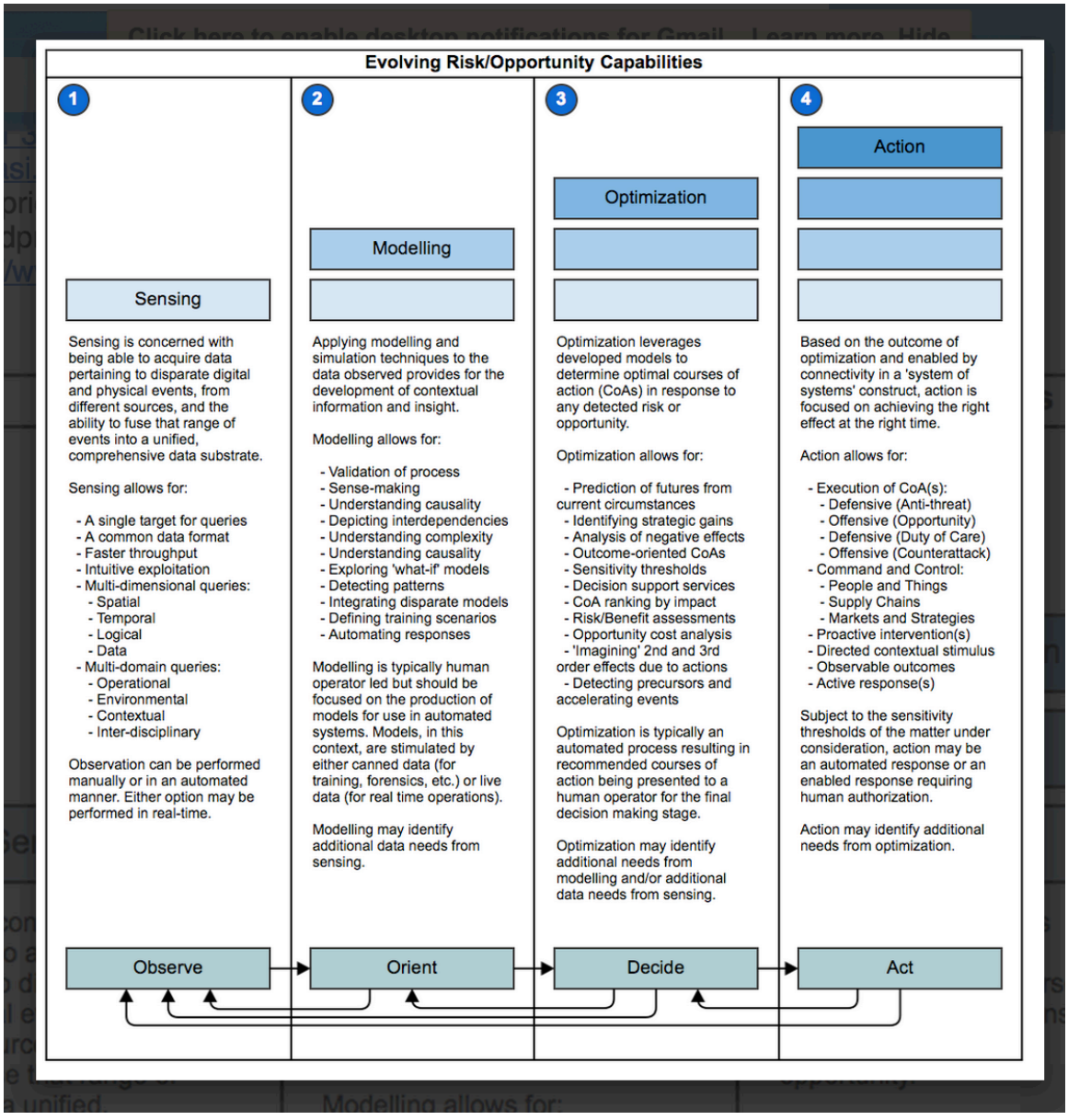
5. THE PATH TO BETTER

The purpose of this paper is to suggest another approach to performing hazard vulnerability assessments. At the outset I would suggest our real goals in dealing with hazards and vulnerabilities is to imagine/anticipate events before they occur even to the point of identifying threats before we are fully aware of them.

I want to be very clear at this juncture by my use of the phrase improving "imagination". My goal is not as much to expand our concerns to every imaginable threat some of which come straight from science fiction. Rather it is to move us away from fixed tools, which only point in one direction. At the outset my goals listed in the above paragraph can be met through a system, which (much like our own immune system) has an

ability to detect and respond to changes in our environment. Hence we can recognize that the role of the hazard vulnerability analysis is not a static process but instead is a dynamic one. The dynamic process envisioned seeks to fuse semiautonomous specialized data gatherers, with planners and responders. We seek simply to anticipate either new, previously un-experienced risks or to imagine known risks but at a greater severity than previously occasioned.

I have suggested one approach fits into what I refer to as four pillars. A good chart of those four pillars would look like the chart below:

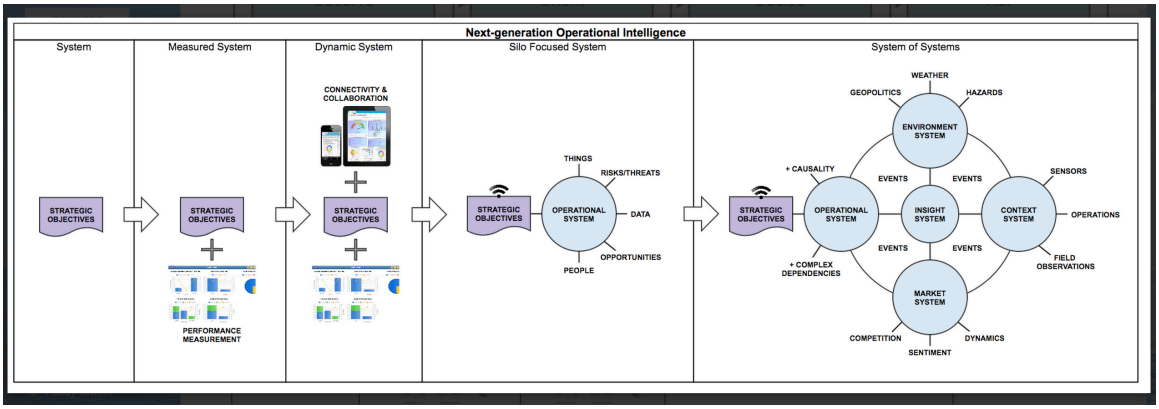


Breaking down the four pillars further I would suggest:

Pillar One: Systems Matter In Improving Our Imagination/Anticipation

Pandemics, infectious diseases, illness and injuries like cyber threats are systems issues, not just a virus. In order to model impacts, build economic models and contribute to robust hazard vulnerability awareness, one

must move away from silos of excellence to aware systems. What must occur is recognition that events are often the result of poor decisions made long before a disaster occurred. Sergio Mora, a World Bank Consultant based in Costa Rica uses a wonderful phrase that "there are no natural disasters only natural events which have come in contact with poor planning". By bringing government, the private sector and academia together before and during risk events, you can create an opportunity to understand "created risks". Greater awareness of the impact of our decisions is the key to mitigation and risk reduction. The figure below suggests the migration to an end state of system of systems awareness.

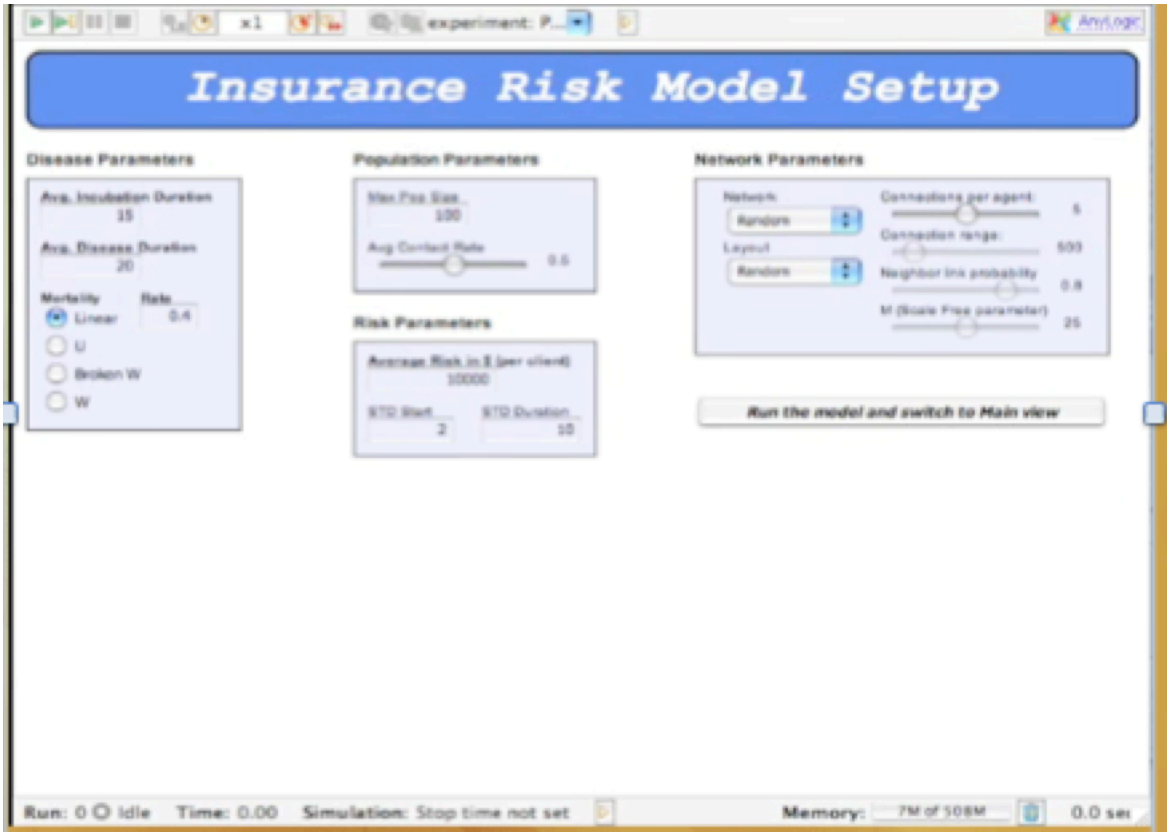


Systems of Systems Migration-Developed with Xuvasi, LLC

The output of creating a systems approach is to be inclusive in data in order to anticipate and respond to the known and unknown challenges of natural and man-made threats. The challenges include- the difficulty of predicting outbreaks, the recognition of financial risk, the unpredictable changes in the threats themselves, overly focusing surveillance or the wrong threats, determining the right answers when even experts will be wrong, developing an effective response with strong decision support and finally communicating to your public, who in the absence of convincing advice will develop their own response behavior. Systems of systems response reduce the knowable unknowns and highlight hidden challenges. The concept of Pillar One therefore is the creation of a dynamic system of hazard vulnerability recognition.

Pillar Two: Recognizing and Modeling Signals and Eliminating Noise

If the goal is to maximize the numbers of lives saved and demonstrate a resilient community, then early awareness of the severity of the threat of an event matters. Tools in the form of models, must be created which harness for instance: the epidemiological and population factors, which will influence disease spread. While models are often wrong, the point is to begin to understand the ranges of concerns emanating from the signals. The goal is really to gain a picture of the emerging risk of a country at any point in time and to search for data which may evidence threat severity. Bio-surveillance and situational awareness contribute to models. In fact key models recognize that weather, animal health, tourism, school attendance, food safety, research facilities, environmental conditions, and healthcare are all key contributing factors as we attempt to answer the fundamental question of event severity. An approaching sandstorm, an outbreak among poultry, a drop in school attendance or spikes in visits to the accident and emergency rooms are all early warning signs which can be modeled in an organized fashion. An example is represented here:



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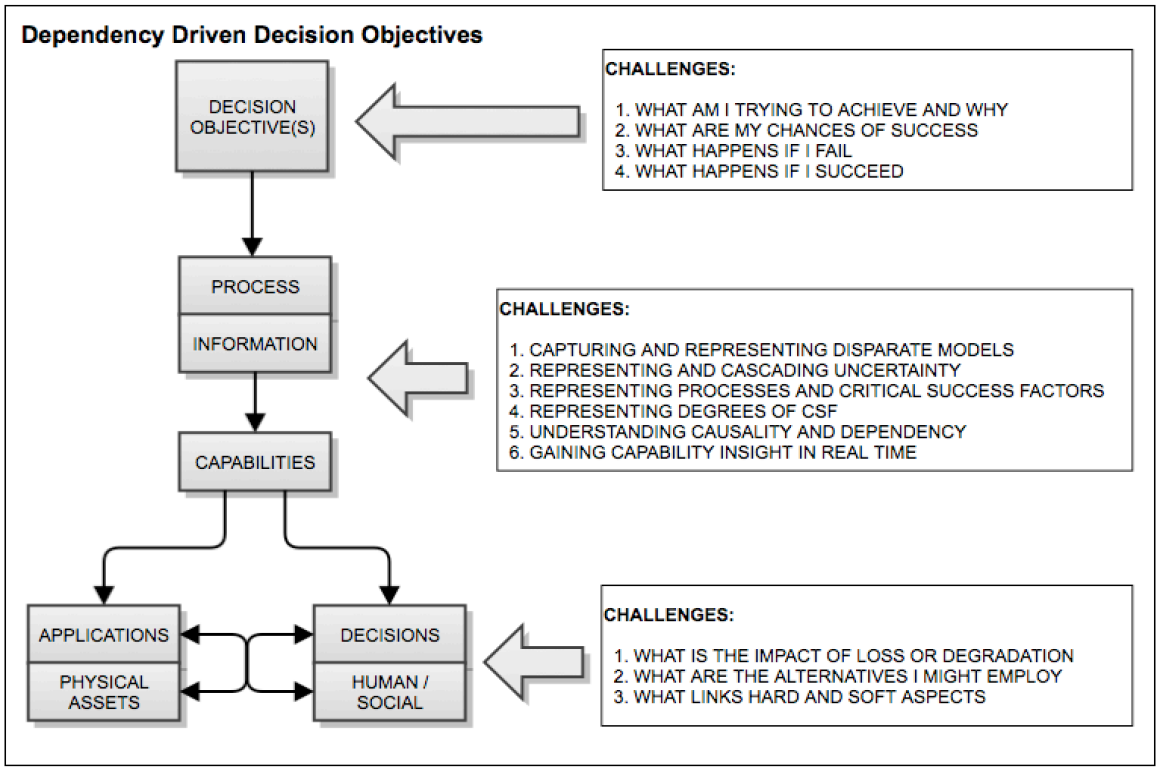
Pillar Three: Decision Support For Better Decision Making

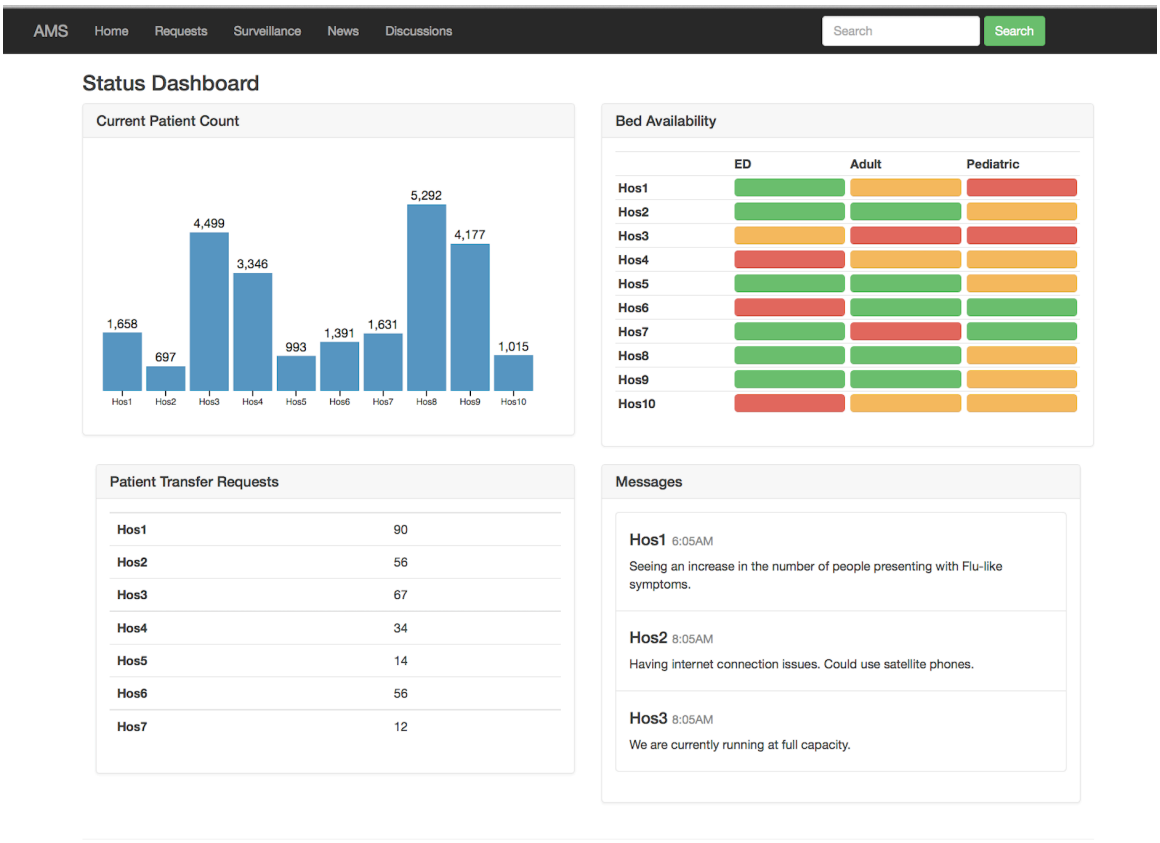
Ultimately the goal, once an event is identified is to engage in right action. For pandemics and other infectious diseases this is more difficult than one might imagine. As stated above, information will be late in arriving, diagnosis will be wrong, your community will rely on traditional ways even in the face of a non-traditional threat, counter-balancing voices will appear and the news reports and media will chart their own course. Decision support also relies on a multi-disciplinary approach. Because events are fluid, right action is often based on the best available information. Even when the science is uncertain a trusted voice must emerge. Figure 6 below captures the factors, which weigh into taking action.



Pillar Four: Situational Awareness of the Actions of Our Responders and Public

It is likely that despite the best efforts of any nation, individuals will become sick and perhaps die. The need for healthcare is the one common denominator of any disaster regardless of how caused. Any nation no matter how rich in health resources must be prepared for surge capacity events. A surge capacity event is one in which the numbers of persons seeking care overwhelm the ability of a hospital or clinic to respond to their needs. Under that circumstance an ability to manage surge capacity must exist. However, during disasters there are many events, which impede or erode the ability of responders and caregivers from adequately providing the assistance we believed should occur based on our planning and exercises. Roads may be blocked, responders may have been impacted by events, traditional facilities and places of care and assistance may have been destroyed. Fear, fuel, communications, civil disturbances and other factors all require us to imagine/anticipate during an emergency how best to manage our available human and physical resources.

Assistance in our short-term imagination and anticipation should come from well-developed and implemented situational awareness tools similar to that exhibited below.



Screen Shot from AMS an XCH, LLC situational awareness and event management tool

6. SUMMARY

At the core of preparedness lies anticipation/imagination. I worry little about known and frequently experienced events, which occur routinely with limited impacted. Where I believe there is room for improvement is in developing a process to anticipate those events, which may be infrequent in occurrence or infrequent and extreme in severity. It is those events, which test our response-ability and expose the outer limits of our imagination.

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