Innovative and increased risks from *CBR* disasters and effective, economical, adaptive countermeasures

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Ten years after 9-11 we are at a crucial junction point in our preparedness and defenses for chemical, biological, radiological and nuclear (CBRN) events initiated by terrorists, accidents or natural causes. Despite a decade of intensified work and significant expenditure aimed at providing more effective prevention as well as response to a variety of WMD-type incidents, society (USA and worldwide) is facing a higher probability for disruptive events, particularly "CBR" (chem.-bio-rad) that can cripple nations and their economies. This statement is in contradiction to common public opinions expressed on the subject. Why are CBRN risks in fact higher than before, and why are some of the types of countermeasures, particular those focused strongly upon terrorist-origin CBR threats, insufficient for preparing and responding in ways required for maintaining social resilience and sustainability? Included in our assessment are non-terrorist events that can be potentially of greater damage and consequence than terrorist acts. We also examine the diversity and unpredictability by which principally CBR threats can be brought into a large and mobile population and how such events can be amplified and made more destructive, not only by physical measures, but by psychological impact and caused by mass-panic.

Assessing New Risks

Does the emphasis upon unforeseen and multiple new risks imply that we must remain in a situation of diminished ability to protect and to respond in disaster settings? On the contrary, there are other countermeasures and protection procedures that can be developed; some are appropriate to large, civilian population and appropriate for present-era global economic conditions that demand austerity and cost-cutting. The defense and protection emphasis for nearly a generation has been upon advancing "newer, smaller, smarter" technologies, such as sensors, measurements, simulations, and intelligent information systems. All of these, if accurate and if appropriately deployed, are important and valuable, but only if we can effectively use the information within the ranks of our population. There are resources and tools that need to be considered for addressing a broader scope of CBR threats, in which cases knowledge and training by a highly diversified population is needed, beyond specialized technology and the availability of specialized technicians. Having the information is one ingredient to addressing the threat, but there must be a translation into responsible and timely action by people. In brief, we need to employ more resources but not necessarily more unique systems and tools.

Can we afford to be moving in new directions and expanding our CBR readiness, especially in difficult economic times? Yes, because we can be utilizing better the resources already in place within the general civilian population, especially if we put greater emphasis on training, awareness and participation. If we are to avoid catastrophes that could make many terrorist actions seem small in comparison, we cannot avoid enabling and involving the population. This is not only about detection and measurement. Many hazmat and mass-casualty simulations and practice-runs, along with true emergency responses to hurricanes, tornadoes and other disasters, have shown problems in communications and logistics for such basic procedures as setting up shelters, triage checkpoints, clinics, and decontamination zones. Delays and confusion here can be life-takers in a real emergency involving thousands and with potential unknowns. Consider the early months of the SARS epidemic in southern China and the consequences of having information but no pathways for mass dissemination and warnings.

What are the growing, even accelerated, risks of CBR incidents? The prospects of an event or attack resulting in high casualty numbers and massive environmental damage, with tens or hundreds of thousands of deaths and severe injuries, appear to be decreasing. There are clearly many new barriers to intentional, deliberate WMD terrorism. These barriers include not only the traditional ones at airport, shipping and border security, but massively increased activities within electronic and human counterterrorism. We have built wide-area surveillance networks and deployed sensors and information

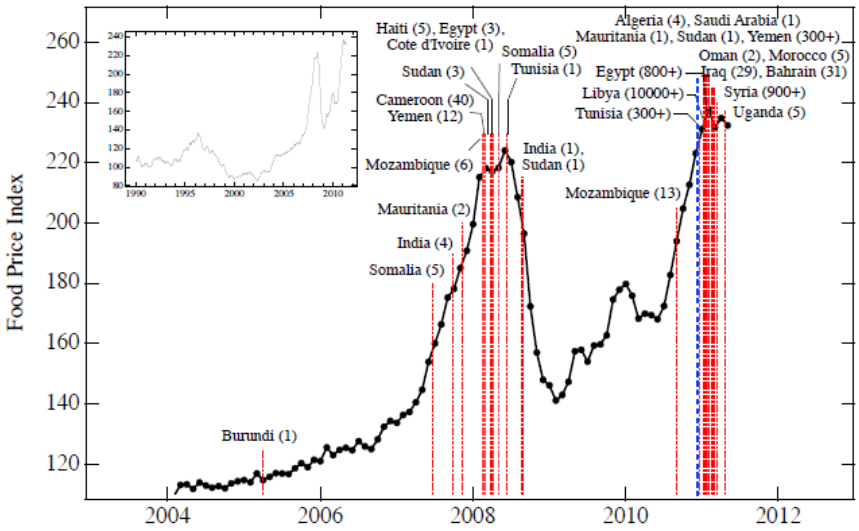
gathering systems that appear to provide a strong defense. But are these sufficient for threats that can emerge from "behind the lines" and also without a traditional terrorist origin? Or have we created a type of CBR(N) "Maginot Line?"

Risk Basis

Today, in 2011, the view that risks of CBR events are reduced and that we live in a safer world is a view that rests upon insecure foundations. Two primary factors influence this view. First, the absence of major CBR-disaster occurrences (affecting ~1000 people or more) over a relatively short period of time (even if we look back to the 1990's or even 1980's). Second, the *perceived* reduction in the threat from organized terrorist groups, particular those associated with radical Islamic extremist organizations such as al Qaeda. Attention has been primarily upon deliberate, terrorist-driven, agent-performed attack threats. These threats still exist, but they are not necessarily the major concern "on our doorstep." New risks with increasing probabilities stem from different causes, as well as from a weakened capability to respond effectively on a large scale (e.g., multiple incidents, or encompassing a large region/nation). Looking forward, we need to examine our current mode of conducting "life as usual" within a changing environment of increased and mobile populations, how we deal with tenuous and delicate balances in climate and environment, the transitions and dispersion of natural biothreats, and dangerous at-the-edge conditions within our power, transportation and communication infrastructures. Can we use protection methods and management systems that we have built for handling one hazard (e.g., toxic chemicals) for others (e.g., biological or nuclear materials)? Can we build-in fault-tolerance approaching fail-safe for our ability to Respond?

Mobility and Global Connections

Most of the new causal risks concern the increased mixing, travel, transport and proximity of human and animal populations as well as the supplies of food and energy for both. More people, movement, and density in all of our human traffic. More foods coming from distant sources, greater intermingling and handling along the supply chain. More basic life-sustenance supplies requiring high dependency upon complex technologies for production including harvesting, for processing, for transportation. A breakdown caused by a CBR event or series of such can rapidly create a sudden and widespread drop in food availability. Consider the figure below from a recent paper [Lagi, M., Bertrand, K.Z., & Bar-Yam, Y., "The Food Crises and Political Instability in North Africa and the Middle East," New England Complex Systems Institute, 2011 - http://arxiv.org/PS_cache/arxiv/pdf/1108/1108.2455v1.pdf]. Although referring to widely differing locations and causal factors, the models have been very accurate, almost to the week, with respect to events that from different causes (e.g., CBR attacks, pandemics, natural disasters) can affect any society. (We can also reflect upon Hurricane Katrina and the Superdome as a concrete example from within the USA.)



Even the simple matter of basic food acquisition is today, for most Americans, a dependence upon acquiring goods at a large supermarket, itself a process dependent upon the electric power grid being

functional and upon the convergence of shoppers and employees in each market or mall. This in itself brings up a requirement of local transit by automobile or some form of mass transit. We cannot abruptly shut down the transit of people and goods without causing socioeconomic problems that conceivably could cost more in lives, injuries and costs than the consequences of dispersed bioweapon agents or radioactive substances. Moreover, the collective impact of all of the high mobility and the dependence upon long-distance distribution of good and their assembly or processing is that there are more situations where a chemical, biological or radioactive incident will likely affect and disrupt more people, more communities, and whole economies.

If we examine as a reference point the evolution of the SARS epidemic step-by-step on its path from China to other countries worldwide, we see the foundations for how a transmissible outbreak can spread with ease [Greenfeld, Karl T., "China Syndrome," Harper Collins (2006)]. Information was present, even in the earliest stages, but there was a virtual lock-down on disseminating the facts of the threat, originating in China. This could be compared to the slow action in releasing information by Soviet authorities after the Chernobyl incident. The H1N1 pandemic of 2009 is a similar illustration from real history. Even though many advanced modeling and forecasting tools exist and are used, by which regions of next or imminent impact or infection can be reasonably predicted, the practical implementations of preventive measures are *met with resistance by an economy that abhors restraint or limitation*, the most extreme form being quarantines and shutdowns of transit routes and major business, manufacturing and commerce centers. There were means to address known potential groups of potential and likely carriers, especially in the case of SARS, such as quarantining or even basic interviewing, sampling and testing of deplaning passengers, but at the critical early stages, none of this took place. During the H1N1 pandemic, such measures met strong resistance from some of the US public.

Furthermore, physical transit is only one of the new risk-enhancers. We are now in a globally-connected social-network world, in which traditional media is in many cases superseded by the message of the internet – the web and dominant exchanges of "viral information" such as FaceBook and Twitter. Rumors spread fast, confusion sets in, and panic can be an enhancer of the spread of any biological pandemic or the disorder of a radiation-exposure incident. The "panic and pandemic" relationship has been increasingly a subject of study (e.g., Joshua Epstein's work at Brookings Institute and Johns Hopkins). [Epstein, J. M., Parker, J., Cummings, D., Hammond, R. A., "Coupled Contagion Dynamics of Fear and Disease: Mathematical and Computational Explorations," Plos One, Dec. 2008, Number 3, Issue 12, e3955]. Public panic can become an "accelerant" for dispersion of a biological agent throughout a region. The "panic factor" can also have a drastically negative effect upon such basics as food supply and distribution. Computer models by Ekici et al at Georgia Tech's Stewart School of Industrial and Systems Engineering have illustrated some of the consequences for a region of Georgia based upon 2009 H1N1 infection projections [Ekici, A., Keskinocak, P., Shi, P. & Swann, J. L., "Modeling Infuenza Pandemic and Strategies for Food Distribution," http://www.scl.gatech.edu/research/humanitarian/files/ModelingInfluenzaPandemicandStrategiesforFoodDistributionpresentation.pdf].

Our CBR strategies and the protective systems that have been designed and implemented for avoidance of a high mass casualty episode have done well to address "classical terrorism." By this is meant, terrorism as it has generally been practiced by organized groups or cells, including individual "solo" operators but with training or minimally a philosophical disposition that is in keeping with groups such as al Qaeda, Hezbollah, or state-supported terrorism such as can be attributed or linked with factions in Iran, Afghanistan, or rogue states such as North Korea. What our defenses do not cover well, at present, are the growing numbers of non-aligned domestic terrorists, including organized hate groups, or the non-terrorist threats from purely accidental or natural causes.

The recent (March, 2011) disaster at the Fukushima Daiichi power plants is one example. No act of terrorism here, the environmental catastrophe has been enormous for not only the immediate zone of highest contamination but also for the agricultural and seafood economies of a much larger region. There has been a substantive and plausible evidence of risk due to similar placement and construction of nuclear facilities at other locations, including San Onofre (California) and Indian Head (New York), where an event comparable to Fukushima could create minimally a very localized danger zone but that would clearly, from all indications, give rise to panic and major social disruption because of fear and panic reactions in the general population. Despite the availability of a vast array of radiation sensing devices – small, handheld,

inexpensive – and software to acquire and compile collected data, there were political and organizational barriers put up that prevented, just for one instance, the deployment of volunteer teams to do early-stage surveys of agricultural areas and inland water tables. This was not due to any lack of technologies, equipment, or persons who could be part of an ensemble-team to address information gathering as well as wide-scale medical response.

Shifting back to the domain of deliberate terrorism, there is the undeniable fact that large numbers of small quantities of radionuclides, particularly associated with medical and industrial uses, enable the prospects for one or more groups, particularly operating in concert as part of a strike-plan, to accumulate sufficient quantities for not necessarily an explosive "dirty bomb" but a large-enough number of passive radiation-exposure devices ("PRED"). The impact value for the terrorist, in this case, is social and economic disruption, with or without any significant harm to the health of any individuals. Consider the social impact of "Fukushima-fright" upon some of the population in the USA and consequent rushes, at some health risk, to ingest iodine tablets. Consider the general public reaction to the Litvinenko poisoning by Po-210, a situation that would be extremely difficult to replicate on a large scale with any isotope but which, given public sensitivities, fears and the ever-present threat of "panic pandemics," could result in all manner of disruptions to basic services and especially to the food industry. One non-explosive "dusting" of a major shipping port could have expensive consequences. Today, the threat of multiple PRED deployments, using a fraction of radionuclide quantities needed to build an explosive "dirty bomb" (much less a true fission bomb), is greater and easier than ever. The damaging impact on any society is certain, particularly if the general population is lacks sufficient knowledge of the actual risks from different radiation exposures.

Preventing a Recession in Protection

We cannot avoid the fact that even prior to the economic recession and downturns beginning in 2008, there is a crisis of physical infrastructure systems in several countries including the USA. This is not in one geographical area nor one class of system. The list is a long roster but certainly includes aging water and sewer systems, reservoirs, all aspects of the transportation network, and the electric power grid. As only one illustration of how a major biological disaster of WMD-proportions, and potentially greater than any planned, intentional act of terrorism, consider the potential failure due to storms or engineering system breakdowns in the water supply for any major metropolitan area with several million inhabitants or more. The ability to prevent epidemic-proportion spread of infectious diseases (ghirardia, e.coli, cholera, salmonella, listeria, and more) will be near-impossible; this would be without giving consideration to any simultaneous actions by domestic or foreign terrorists or by a major weather condition.

We are more "on the edge" of potentially catastrophic instabilities than ever before. A CBR event or sequence of such events, even with low fatalities as an immediate consequence from any precipitating cause, will invariably lead to rapid social and economic breakdowns and grave consequences of additional injury and loss of life plus economic costs. Regardless of debates, the simple fact is that we have presently more people densely packed together in urban areas, more sources of toxic substances that could potentially be released into the environment. Add to this, whether for the long-term or only episodically, a high incidence of extreme weather effects including tornados, floods, forest fires and other means by which chemical and biological toxins especially can be released into the atmosphere and into waterways.

Looking at the responses and the deployments of resources that have gone into CBR early-warning, intelligence, counterterrorism and medical responses, a first reaction might be to conclude that we have made great steps forward. Is not our society in a much better position now compared to five or ten years ago? We have more and newer technology, some of it very advanced for forecasting, detection, containment, and removal for most high-risk toxic substances. We appear to be better positioned for preventing chemical, biological and radioactive/nuclear incidents, especially those that may be originating from a specific intentional source and occurring in a specific target location. No one can dispute that efforts have been ramped up, awareness increased, technology improved. These are clearly valuable for the non-terrorist and "nouveau-terrorist" CBR threats of today and looking forward into the next decades.

Conclusions and a New "Forward": Reallocating Resources to Enable and Train

We must recognize that in 2011 and looking forward, we need to re-examine how we can best use the tools that we have, how we can address a broader range of possible threat-events, and how to do so in a

economically and socially practical manner. One of the best measures is “sitting in our pocket” - or jacket, or purse, or right in our hand (and not only figuratively so). We are in an era that, unlike ten or twenty years ago, is intensively, massively enabled by mobile wireless communications. This is the era of the iPhone and Android. Smartphones and apps are part of the general culture, as is the use of the web for almost every imaginable function in daily life. We have a capability “in our hands” to make better use of the ways that have become “routine” for millions of people going about their personal lives. There is no big barrier to cross with public education and familiarity if we use what people consider to be part of everyday living.

We need nothing radically new in the way of hardware, and only trivially so in terms of software; e.g., some few new apps. Mostly it is a task of engaging an increasingly larger segment of the population to become comfortable and to have confidence in a bi-directional flow of information about potential threats and actual events, if and when they are occurring. This can be accomplished more easily than might at first seem possible, given the innate disposition of people to respond to things, to information, that is associated with something of personal interest and attraction. It becomes more a question of how to weave and embed the kind of information exchange that is desirable, with respect to a probable or actual CBR event, into the world of commerce, music, and personal activities that on the surface might seem to have nothing to do with health, safety, and security, much less chem.-bio-rad hazards and threats.

People will may more attention and will take an interest in something if it is coupled, associated, emotionally and in a touch-feel-use way, with something that is commonplace, everyday, and accepted.

This may seem to be an unusual suggestion, namely, that improvements to our CBR defensive and responsive capabilities, for our world of unpredictable natural and human-linked situations (that can be the trigger for a CBR disaster), can rest in greater part upon more involvement by the wide-open civilian population “as is” and without a huge and expensive outlay of more specialized technologies and operatives. It is not so unusual considering that the most critical factor to mitigate such disasters is getting the right information to the maximum number of people in ways that get those people out of a danger zone and into a safe area. That is the most basic response and relief, and it is “in our hands” today with mobile maps, GIS, GPS, and what to many is “standard play.” Of course, there will be casualties in some instances - unavoidable. But the number and the gravity of casualties may be significantly reduced if more people have a “heads up” that derives either locally, ad hoc, on the spot, or through massive and situation-appropriate dissemination of information to those people.

Consider all the ways in which a large crowd, or a neighborhood, or a city, can react to news of a biological or radiation-based incident. What does it take to get their attention? Consider the probabilities of how many people will become exposed, and carriers of a life-threatening agent or substance, by reliance upon a centralized system which itself may be rendered inoperative or significantly disabled by the event. What type of education-through-use will enable a decentralized system of communication, one that actually enables gathering information as well as distributing such, to be more resilient, more fault-tolerant, and also a more powerful tool for mitigating fear and panic?

We have the “bells and whistles” of sensors, GIS, GPS, wireless, and expert systems. Organizing people to respond quickly and coherently will reduce not only casualties in the first place but it will improve preparations and response tactics after an attack or accident. This does not require a new breakthrough in technology but a committed effort in civilian engagement and participation. Therein lies also the economical feasibility – this part does not demand any budget increase and can even help to reduce outlays and expenditures on hardware and specialized systems we don’t really need. People can be taught and brought “onboard” even by making use of the popular media of YouTube, web gaming, and all forms of entertainment media. We may be able to learn more from studying Apple and Amazon than from pursuing the old style ways of complicated and expensive custom systems. This is a revolutionary approach to what has often been done only “behind closed doors”, but it is a revolutionary approach that is necessary in order to deal with a world full of CBR volatilities in our midst.