BIOTERRORISM AND RISK ASSESSMENT

***Alan Watson and Fiona McAllister[1]**
Division of Risk
Glasgow Caledonian University
Scotland, UK

Introduction

Recent events such as the discovery of the toxin ricin in a North London flat and the mail anthrax attacks in the USA have heightened awareness of the risks of bioterrorism, and have been detailed in an article by Charles N. Hass (2002). The process of risk analysis has developed over the past twenty years to include the risk from micro-organisms. Hass (2002), believes that the use of a formal risk assessment process could contribute greatly to understanding the risks generated by a bio terrorist attack. Roman, defined bioterrorism as:

"*The intentional or threatened use of viruses, bacteria, fungi or toxins from living organisms to produce death or disease in humans, animals or plants.*"[1]

There are many potential bio terrorist agents, and the Centres for Disease Control (CDC)[2] has developed a prioritised list based on several criteria such as mortality, infectivity, person to person transmission, and dread. Prior to the events of 2001 in the USA several actual and threatened attacks occurred throughout the world, and these attacks provide useful pointers to areas of vulnerability. The use of a Risk Assessment Framework offers a convenient approach to assessing, prioritising and quantifying the impacts of these vulnerabilities. The problem can be analysed using the Risk Triplet described by Kaplan and Garrick, *(1981)*

1. *What can happen (go wrong)?*
2. *How likely is it?*
3. *What are the consequences?*[3]

---

*Dr. Watson, PhD, Mphil, FCII, MIRM, ILTM, Chartered Insurance Practitioner, is an Undergraduate Programme Manager and Senior Lecturer in the Division of Risk. Ms. MacAllister is a student at the university, in the Business Information Management Programme.

[1]Roman, R. (undated). Bio-terrorism, an overview. http://www.bt.cdc.gov/documents/laboratoryOverview2slides.

[2]Rotz, L. D., *et al.* (2002). Public Health assessment of potential biological terrorism agents. *Emerging Infectious Diseases, 8* (2)

[3]Kaplan, S, & Garrick, B.J. (1981) On the quantitative definition of risk. *Risk Analysis, 1*(1)

Vulnerability-situation formulation can be undertaken at several levels, globally, nationally or for an individual system or facility. To understand the myriad of situations which could occur, it is vital that experts are consulted and previous bio terrorist techniques identified and analysed. For an attack to be successful a series of necessary events must occur. Flow charts and fault trees can depict these events and assist in the development of quantitative assessments in the likelihood of the event occurring. Existing microbial risk assessment frameworks are used to evaluate the effects of microorganisms on food, water and dermal exposure, and can be adapted to evaluate the consequences of a particular bioterrorist attack.

In addition to the medical issues, there are issues of decontamination of facilities and equipment. Difficulties arise in estimating the risks involved, as information on acceptable risk levels is limited. Studies are required to estimate the degree of contamination considered as "safe" after such an attack. Eleven cases of inhalation anthrax were reported after 2001, compared to 5,000 deaths per year from food poisoning and 20,000 deaths from influenza. Aspects of risk perception may explain the attention given to this incident. Slovik (1987) describes two factors; dread and unknown risk, which act to magnify public awareness and risk perception[4]. The degree to which the public condemns regulatory agencies and the government for hazard events may increase public perception of risk. Current risks which may emanate from normal exposure to microorgnisms far exceed those from bio terrorism, and an increase in the public knowledge and awareness, through effective communication, of the risks involved may dispel many fears.

The mail anthrax events in the United States of America in September of 2001 heightened the public's awareness of the potential risks of bioterrorism. The attacks in the USA received worldwide attention with the media presenting the unfolding events on a daily basis in a series of sensationalist headlines. The following headlines appeared in the days after the events first unfolded.

"Anthrax, Fear is sweeping the western world following reports that deadly anthrax spores have been mailed to media offices in America, as part of an insidious new terror campaign."[5]

"A Nation challenged: killing anthrax; Post Office to Install Devices to Destroy Deadly Organisms at Mail – Processing Centres".[6]

---

[4]Slovik, P. (1987) Perception of Risk. Science, 236, 280-285
[5]Brown, D. (2001), www.guardian.co.uk/anthrax/story
[6]Feder,B.J. & Revkin, A.C. (2001) www.nytimes.com.

Prior to the events in Florida in 2001 a few bioterrorist attacks had been recorded throughout the world. The most serious of these occurred in Tokyo in 1995, when a religious /political group dispersed nerve gas in Tokyo's underground system. As a result of this event 12 individuals died and hundreds were injured.[7] The media coverage of this event was less than the events in Florida although a greater number of individuals were killed and injured in Tokyo. There are over 5,00 deaths per year in the USA from air-borne infections and 20,000 from influenza, which receive little or limited media attention, so why did the anthrax threats in Florida receive media attention disproportionate to the actual threat?

Terrorist attacks around the world have received considerable media coverage since the tragic terrorist attacks on the New York Twin Towers on September 11th 2001. The bioterrorist threats in Florida occurred almost immediately after these events when fears regarding the risk of terrorism were already at a heightened level. Did psychological and emotional factors play a part in increasing the public's perception of the risks? Traditional risk assessment focuses on losses usually defined in term of probability: *"Risk is often thought of in terms of chance (or probability) of loss"*[8] Whereas Risk Perception can be defined as: *" Involving people's beliefs, attitudes, judgements and feelings as well as the wider social or cultural values and dispositions that people adopt, towards hazards and their benefits."*[9]

Risk Perception: Objective / Subjective

Individuals normally rely on past experience, knowledge, observation of a situation and data from a variety of sources, friends, colleagues, experts and specialists to assist in their analysis of a given situation. In attempting to assess the risks from an extreme event they may not be in a position to analyse the situation objectively, as they have limited information or experience of previous events on which to base their analysis. Is the perceived increase in risks from bioterrorism based on psychological and emotional factors alone? Since the 1970's it has been accepted that psychological and emotional factors must play a role in the risk assessment process.

Risk Perception is multidimensional, with hazard and risk presenting varied interpretations in differing situations, often dependant on underlying belief systems. There is general agreement that the physical consequences of hazards such as death, injuries, and environmental harm are objective facts. Risk assessment if based on individual attitudes,

---

[7]Roffy, R. et al (2002) Clinical Microbial Infection 8: 552-528 .
[8]Carter, R.L. et al, (1981). Risk Management. Chartered Institute of Insurance, London. 1/3.
[9]Pidgeon. N. et al. (1999). Risk: Analysis, perception & management. Royal Society. London 89.

cultural beliefs or on the mathematical models of risk assessment, such as cost/benefit analysis or flow charts, necessarily depend upon human judgement, and it can be argued that the assessment of risk may involve a degree of subjectivity to a greater or lesser extent. When extreme events occur, individuals and society estimate the likelihood of an event by the ease with which they can recall past events. When extreme events such a the Mail Anthrax event and the tragic terrorist attack on the New York Twin Towers occur, the public tend to overestimate the possibility of the event happening.

"After the events of September 11th many people refused to fly because they perceived the risks of highjacking to be very high even though it could be argued that the likelihood of such events happening in the future was extremely low given the increased vigilance and protection at airports etc."[10]

The Mail Anthrax events caused panic-purchasing of protective breathing apparatus and prophylactic antibiotics even though the probability of infection was minimal. There are usually two extreme reactions to such extreme events, *"either, it won't happen to me or it will happen to me"*[11]. Media analysis of the situation and the assessment of the available expert information can unduly influence the form of reaction on society.

Dread Risk and Unknown Risk

Research undertaken in the 1970's and 1980's by Slovik,[12] identified two factors "Dread Risk" and "Unknown Risk" which act to magnify the public's perception of risk. Dread risk factors include: uncontrollability, fatality of consequences, and unequitable distribution of risk. Risks which rate high in this factor, are Nuclear Weapons, Crime and Terrorism. Unknown Risk Factors include observability of risk, familiarity of risk, delayed risk, and whether the risk can be viewed as scientific.Risks which rate high in this factor, are space exploration, DNA research, and Food Irradiation. Both forms of risk appear to be present in the Mail Anthrax events, which may explain the public reaction to the events.

In developing risk management strategies to tackle extreme events such as Terrorism there is a need to incorporate the data from risk assessment studies and the factors which have been shown to influence risk perception if the strategies are to be successfully implemented. Risk management strategies have been developed to control a wide range

---

[10]Kunreuther, H. (2002). Risk Analysis & Risk Management in an Uncertain World. Risk Analysis, Vol. 22, No. 4 658.
[11]Kunreuther, H. (2002). Risk Analysis & Risk Management in an Uncertain World. Risk Analysis, Vol. 22, No. 4 658.
[12]Slovik, P. (1987). Facts & Fears: Understanding perceived risk. New York. Plenum Press

of risks which affect both individuals and organisations. However there are inherent difficulties in developing strategies to reduce the likelihood of further terrorist attacks.

There is considerable debate regarding information communicated to the public to reassure them that the risks of a given extreme event are tolerable. Risk Perception research has indicated that there are considerable variances regarding information the general public wish to be made aware of, depending upon factors such as culture, psychological disposition risk awareness, risk aversion, and personal preferences.

There is also an increasing requirement both morally and legally for governments and private industry to inform the public of any environmental, technological and health hazard to which they may become exposed. How this information is communicated may influence the public's reaction to it. There is historical evidence of the mistrust by the public of experts based on previous experience.

"the public for its part did not believe the experts' figures because they were not communicated very well, the assumptions on which they were based were not well stated, and there was little understanding as to why the experts disagreed with each other" [13]

Information and Evaluation of Risks

Gathering information from a variety of sources such as reports, site visits, questionnaires, surveys and interviews, and observation of practice, are common techniques when analysing risks that may affect an organisation. When developing strategies to reduce the risk of future terrorist attacks there are difficulties in collating information regarding specific risks.

"We do not know who the perpetrators are, what their motivations are, the nature of the next attack and where it will be delivered."[14]

Risk Assessment tools such as flow diagrams and event trees could be utilised to analyse risks. These techniques will assist in reducing future catastrophic events. Flow charts have the advantage of reducing practical situations / circumstances / problems / concerns into manageable divisions, and also they have the advantage of presenting the process in a pictorial format for interpretation and analysis. The disadvantages of a flow chart, are

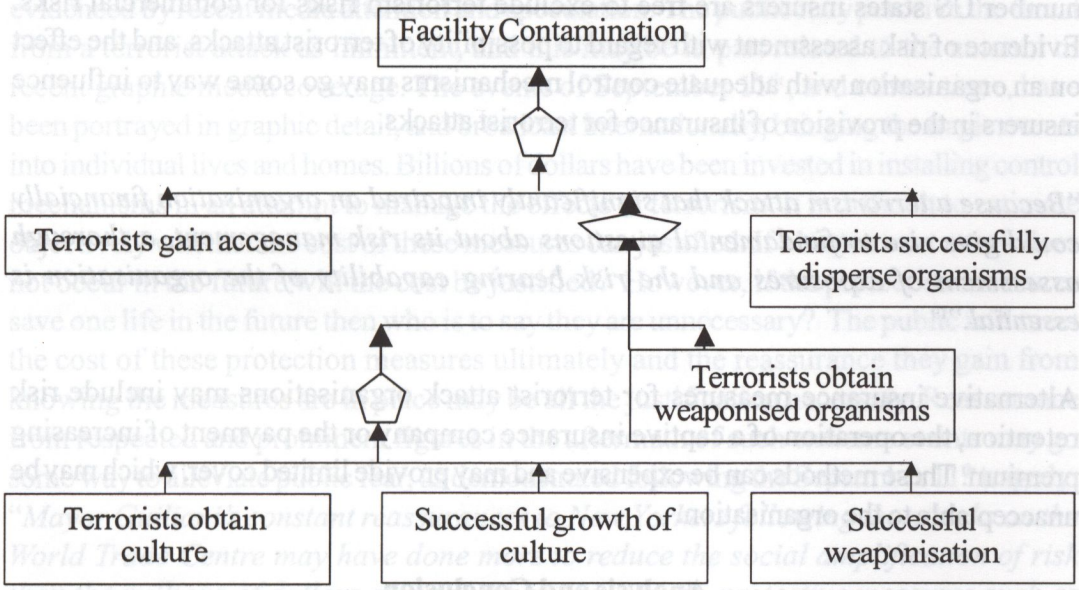
[13]Kunreuther, H. (2002). Risk Analysis & Risk Management in an Uncertain World. Risk Analysis, Vol. 22, No.4 657

[14]Kunreuther, H. (2002). Risk Analysis & Risk Management in an Uncertain World. Risk Analysis, Vol. 22, No.4 662

the time required for preparation and construction. They can also appear as too complex, and to that extent they may obscure the identifiable risks. They may also be generalised in nature and be of no practical value.

The final disadvantage of the flow chart is that it may not comment on the likelihood of an event happening.[15] In order for a successful attack to occur, certain barriers must be overcome and these can be presented in the form of a fault tree, which can be used to develop quantitative assessments of the likelihood of particular risk situations occurring. "*A fault tree works back from a particular event (known as the top event) through all the chains of events that are precursors of the top event.*" [16] The detail of any fault tree will depend on the particular scenario. Figure 2 details a fault tree for the contamination of a large public enclosed space.

Figure 1 Fault Tree for Bioterrorist Event



Schematic Fault Tree for Bioterrorist Event[17]

Fault trees can provide quantitative data but can also be used as a qualitative tool. The bioterrorist attack is located at the apex of the fault tree and the events, which must precede this event, are presented as branches of the tree. The events linked by the AND gate (the pentagon symbol in Figure 1) must all occur if the attack is to take place.

---

[15]Dickson, G.C.A et al.(1991) Risk Management. The Chartered Insurance Institute
[16]Dickson, G, C, A et al.(1991) Ibid
[17]Hass, C, N. (2002) The Role of Risk Analysis in Understanding Bio Terrorism. Risk Analysis, Vol. 22, No. 4 page

Costs Associated With Risks

There are many costs incurred in risk assessment and control. It is important that the costs of any control mechanisms are financially realistic in relation to probability of the risk occurring in the future and to the cost of any consequences of the risk. Since the Mail Anthrax events, several US government agencies have investigated the benefits of installing equipment designed to kill anthrax spores and other deadly organisms. The US Postal service is to install such equipment in all 300 regional mail centres at a cost of billions of dollars. The total cost of installing this equipment into several or indeed all US government Agencies will cost the US government and ultimately the US tax payer many billions of dollars.[18] Companies and organisations normally possess some form of insurance (for example, property, liability and business interruption insurance) to protect against insurable risks. Since the events of September 2001 there has been a dramatic increase in the cost of insurance programmes which provide cover against acts of terrorism. In a number US states insurers are free to exclude terrorism risks for commercial risks. Evidence of risk assessment with regard to possibility of terrorist attacks, and the effect on an organisation with adequate control mechanisms may go some way to influence insurers in the provision of insurance for terrorist attacks.

"*Because a terrorism attack that significantly impaired an organisation financially could give rise to fundamental questions about its risk management, a thorough assessment of exposures and the risk bearing capability of the organisation is essential.*"[19]

Alternative insurance measures for terrorist attack organisations may include risk retention, the operation of a captive insurance company or the payment of increasing premium. These methods can be expensive and may provide limited cover, which may be unacceptable to the organisation.

Analysis and Conclusion

With the apparent increase in global risks from extreme threats such as terrorism, a Risk Assessment Framework may provide a useful tool when conducting risk analysis, evaluating the effect and providing control mechanisms for identifying risks. The terrorist attacks of 2001/2 created a feeling of fear and uncertainty throughout the world. Considerable research has already been conducted by government agencies throughout the world, gathering information on the most dangerous biohazard agents and their associated risks, and also detailing previous criminally and politically motivated

[18]Feder, B.J. & Revkin, A.C. (2001) www.nytimes.com

[19]Risk Directions (2002) AIRMIC, Spring 2002, London

bioterrorist attacks. Analysis of this information is vital if an effective risk assessment of terrorism is to be undertaken. Despite terrorism being seen as a global problem many governments are reluctant to share their counter-terrorist information, which will only hinder the process. Who will take responsibility for gathering the relevant information and undertaking such a detailed analysis?

"In order to counter threats of biological warfare or terrorism, there is a need for more intensive international cooperation for threat assessment and planning, and also to enhance society's awareness." [20]

The reaction of the general public to recent threats has been one of fear and uncertainty, with fears exaggerated in relation to the low probability of the events occurring in the future. The public is not concerned with probabilities whether high or low and is only concerned that these events may be repeated and that they themselves may be at risk, as evidenced by recent media attention and speculation. The public may perceive the threat from a terrorist attack as imminent, and this may be in part related to the amount of recent graphic media coverage. The events of September 11th, and others since, have been portrayed in graphic detail, and broadcast internationally, bringing the tragic events into individual lives and homes. Billions of dollars have been invested in installing control mechanisms in an attempt to manage the effects of terrorism. It is difficult to estimate objectively whether the cost of these measures can justified. If a bioterrorist attack does not occur in the future will the cost be justified? However, if the protection measures save one life in the future then who is to say they are unnecessary? The public will meet the cost of these protection measures ultimately and the reassurance they gain from knowing the measures are in place may be all the justification necessary. Reassurance from respected and prominent figures in the aftermath of such extreme events may go some way to alleviate public fear; as demonstrated following the September 11th tragedy: "*Mayor Guiliani's constant reassurances to New Yorkers following the attacks on the World Trade Centre may have done more to reduce the social amplification of risk than the millions of dollars of expenditures on pseudo-protective measures such as stationing the National Guard at airports and train stations*"[21]

The public were reassured by Mayor Guiliani's words but there is evidence that reassurances from so-called experts within the science community are not always well received or appreciated. The public does not always trust the experts, as their previous

---

[20]Roffey, R. et al (2002). Biological weapons & bio terrorism preparedness: importance of public health awareness and international cooperation. Clinical Microbial Infectious Diseases, 8, page

[21]Kunreuther, H. (2002). Risk Analysis & Risk Management in an Uncertain World. Risk Analysis, Vol. 22, No. 4 page

experience has seen conflicting reports from various specialists. There would appear to be a conflict between public ignorance and awareness through appropriate' disseminated material and propaganda from governments and security agencies. The terrorist attacks of 2001 and since have raised worldwide awareness of the risks associated with terrorism. The use of risk assessment tools and risk management techniques may prove useful in the analysis of these risks by:

- Identifying the risks by collating and reviewing current reports and research documents gathered from several sources.
- Improving the understanding of the social and psychological effects which extreme events such as terrorism have on the general public.
- Evaluating the effect of the risks on individuals, organisations and nations by the use of cost/benefit analysis, event trees and fault trees, HAZOP studies etc.
- Detailing Risk control and protection mechanisms which if installed may assist in the control of the effect of the risk of terrorist attack.

Problems may be encountered in gathering information required to undertake an assessment of this magnitude and which needs governments to work together and permit their information to be shared globally. The general public is often confronted with a barrage of politically biased information and misinformation, which may or may not be of value. This increased knowledge base appears to be tainted by past experience of world leaders attempting to further their own agendas and play on the political and technical naivety of the general public.

BIBLIOGRAPHY

Carter, R.L. et al, (1981). Risk Management. Chartered Institute of Insurance, London.

Dickson, G.C.A. et al,(1991) Risk Management. The Chartered Insurance Institute

Hass, C, N. (2002) The Role of Risk Analysis in Understanding Bio Terrorism. Risk Analysis, Vol.22, No.4 pp671-677.

Kaplan, S. & Garrick, B.J. (1981) On the quantitative definition of risk. *Risk Analysis, 1*(1)

Kunreuther, H. (2002). Risk Analysis & Risk Management in an Uncertain World. Risk Analysis, Vol. 22, No. 4

Pidgeon. N. et al. (1999). Risk: Analysis, perception & management. Royal Society. London

Roffey, R. et al (2002). Biological weapons & bio terrorism preparedness: importance of public health awareness and international cooperation. Clinical Microbial Infectious Diseases, 8

Roffy, R. et al (2002) Clinical Microbial Infection 8

Roman, R. (undated). Bio-terrorism, an overview.

Rotz, L. D., *et al.* (2002). Public Health assessment of potential biological terrorism agents. *Emerging Infectious Diseases, 8*(2)

Slovik, P. (1987) Perception of Risk. Science, 236

Web Sites

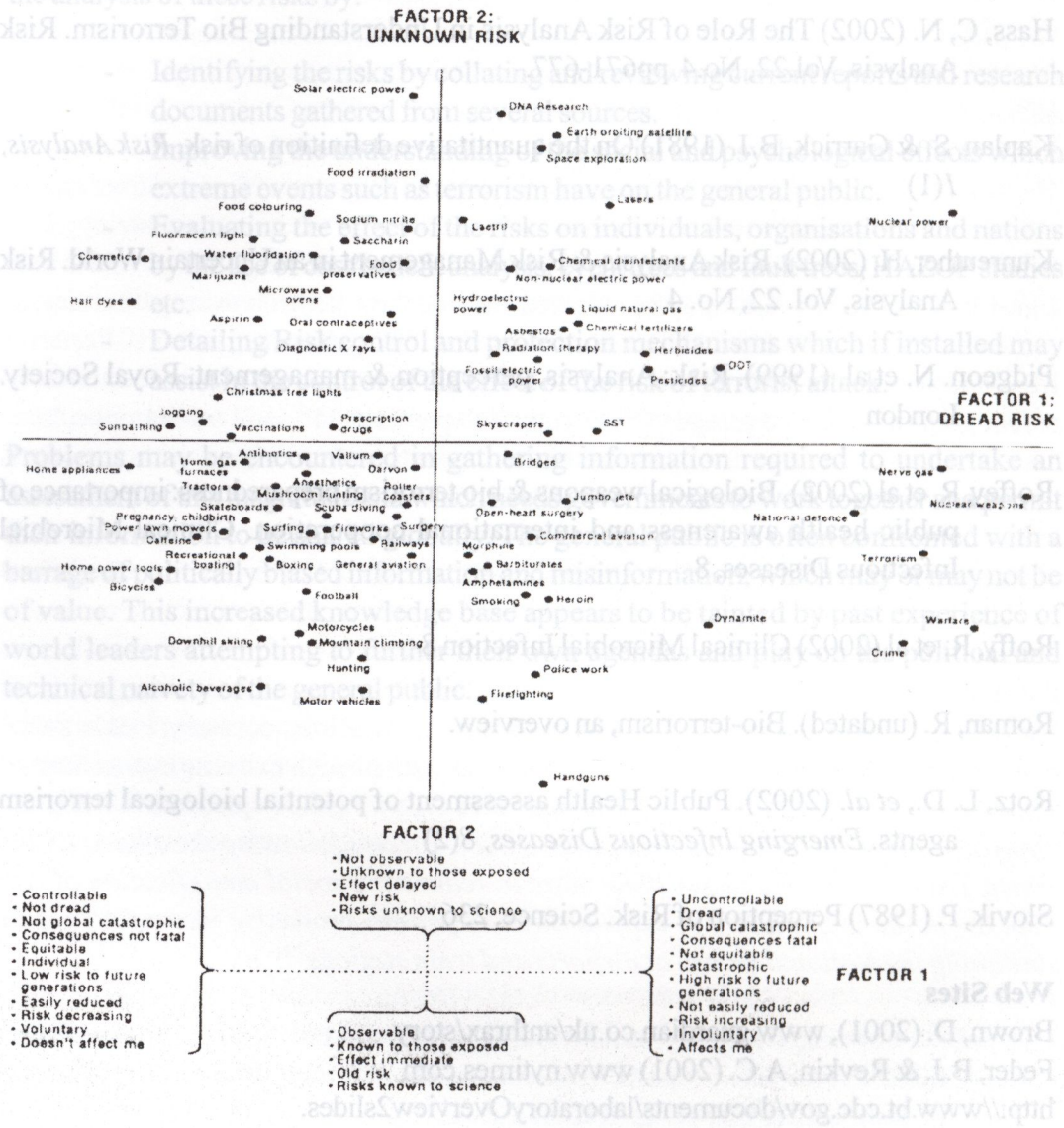
Brown, D. (2001), www.guardian.co.uk/anthrax/story

Feder, B.J. & Revkin, A.C. (2001) www.nytimes.com

http://www.bt.cdc.gov/documents/laboratoryOverview2slides.

APPENDIX

Source: Pidgeon. N. et al. (1999). Risk: Analysis, perception & management. Royal Society. London



Locations of 90 hazards on factor 1 (dread risk) and factor 2 (unknown risk) of the three-dimensional factor space derived from the interrelationships among 18 risk characteristics. Factor 3 (not shown) reflects the number of people exposed to the hazard and the degree of one's personal exposure. (Source: Slovic, Fischhoff & Lichtenstein 1980).