THINKING THE UNTHINKABLE
Bio-terrorism in the UK

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Keywords: Hazard Modelling, Terrorism, Biological Weapons, Risk, Response

Abstract
There is a growing realisation of the threats posed by weapons of mass destruction (House of Commons, Defence Select Committee, 2002). In particular biological warfare has become a focus of international terrorists and dictators who have been seen to be making continued efforts to obtain and produce such weapons (Hoge & Rose, 2001). The affects of such attacks on an unprotected civilian population could be devastating as is noted by many researchers (Simon, 1997 and Fischer, 1999) who have investigated the use and impacts of biological agents as weapons of mass destruction.

Realising the United Kingdom's vulnerability to such attacks, planning for such an unprecedented threat has become necessary for those authorities that do not wish to be caught unprepared (Granot, 2000). To assist in the planning and response to such incidents a number of organisations including The Civil Contingencies Secretariat (CCS) and the Defence Threat Reduction Agency have developed intricate modelling environments (e.g. HAZMOD, HPAC) in an attempt to predict the impacts that deliberate as well as non-deliberate biological releases may have on an unprotected population.

This paper presents preliminary results from current research which is seeking to evaluate these models and identify how they may be utilised to assess the risks and impacts of a biological attack on an unprotected civilian population. Discussion will then be focussed upon how these models may improve the effectiveness and safety of response should such a threat become reality within the United Kingdom.

Introduction
Globally and for the UK in particular, the threat of terrorism has changed since the attacks of September 11 in New York and Washington, and this requires a complete reappraisal of our plans in order to meet these new threats. Whilst there has been a reduction in the quantity of incidents of terrorism in the last half a century, the quality and lethality of the remaining has dramatically increased (Karmon, 2002). Conventional weapons such as car bombs (and those used by the terrorist groups in Northern Ireland for instance) are considered, to no longer achieve the intended impact of the terrorist i.e. publicity, reaction and chaos, so terrorists are exploring more extravagant means, such as weapons of mass destruction. The first real non-conventional terrorist attack is considered to have been the Sarin Attack on the Tokyo subway by the Aum Shinrikyo cult in March 1995, and is considered to have "broken the taboo in the use of weapons of mass destruction" (*ibid.* 2002:122).

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In particular biological weapons (defined as "any organism or toxin found in nature that can be used to incapacitate, kill, or otherwise impede an adversary" (Richards CF et al, 1999:184)) have become a focus of international terrorist and dictators who have been seen to be making continued efforts to obtain and produce such weapons (Hoge, Rose, 2001). The reasons for their appeal being that biological weapons are low cost, take little scientific knowledge to produce, are the hardest to detect and trace, can cause widespread panic and disruption without killing many or any people, and are the most complex to mitigate against (Simon, 1997, Karmon, 2002, Granot, 2000). Some suggest (Richards, et al, 1999) that there are however disadvantages to the terrorist from the use of biological weapons including the dangers in producing and handling the agents, but in this new age of terror it seems many are willing to die for their cause as illustrated by the attacks of September 11.

The threat posed to the UK from such weapons can be illustrated by the recent events of January 2003 during which arrests where made of Algerian extremists who where attempting to produce ricin, a deadly toxin, which police suspected was intended for a bio-terror attack in the UK. This clearly indicates an ongoing interest among terrorists in the development of improvised biological weapons and re-enforces the fact that biological weapons are no longer a hypothetical concern confined to fictional thrillers and rare policy discussions (Brusstar, 2002).

The most likely tactic to be taken by the terrorists utilising biological weapons is the release of agents into the air as a biological aerosol ("a stable cloud of suspended microscopic droplets of bacteria or virus particles", Simon, 1997:429). Distribution via explosive processes is undesirable because of the likelihood that the organisms will be destroyed during the explosion, and distribution via water supplies is seen to be a less appealing due to the large amount of biological agent which is required mainly because of dilution factors and water purification procedures which extract bacteria (*ibid.*1997).

Dissemination of biological agents using aerosols is an effective means of widespread dispersal, and depending on the atmospheric conditions and the agent's properties, could result in clouds of infectious materials carried over hundreds of kilometres.

Such hazardous areas can be defined using a concept of Crisis Prediction (hazard modelling), which has gained appreciable momentum in recent years and which enables the identification of hazardous areas such as those created following a biological release (Swiatek & Kaul, 1999).

Hazard models are tools which enable probabilistic prediction of hazards, represented on a rectangular grid (X, Y) (Hunting Engineering, 2000). In order to create such models input files are required which describe the circumstances of the hazard i.e. what, where and when. Through the use of complex particulate transport equations it is then possible to produce hazard files which define the hazard 'footprint' or 'template' (Hunting Engineering, 2000, & Science Applications International Corporation, 2002a/b). This output can then be manipulated in conjunction with other grid format files (databases) to analyse the hazard further.

Hazard modelling is predominantly used as a decision aid for consequence management following the immediate onset of disasters. It also has the capacity however, to be used in other practical applications in emergency management including contingency planning, validation of emergency response plans, training, exercising, and post incident evaluation.

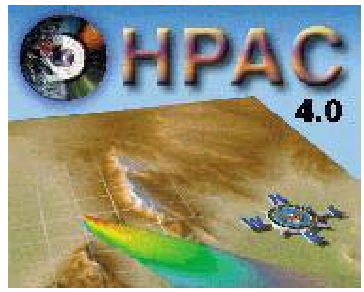
This paper is aiming to present initial results from research which is seeking to evaluate these models and to identify how they may be utilised to assess the risks and the impacts of a biological attack on an unprotected civilian population. Preliminary conclusions will then be drawn on how these models may improve the effectiveness and safety of response should such a threat become reality within the United Kingdom.

Theory and Method

Research began with an extensive literature search being conducted during the early stages to identify the vast arsenal of biological weapons, which are obtainable, their most probable forms of dissemination and their impacts on unprotected populations. This literature search also sought to review existing hazard modelling environments which are being developed or which are in current use, and any studies relating to their offered improvements to disasters involving biological weapons.

Using the information gathered during the literature search it was then possible to generate a number of probable scenarios which could be run using the hazard modelling environments identified as suitable to model bio-terrorist incidents. Two models were chosen for this experimental phase:

- HPAC (Hazard Prediction and Assessment Capability)



HPAC is a forward deployable, Nuclear Biological and Chemical (NBC) hazard prediction capability, which accurately predicts the effects of a hazardous material release into the atmosphere and evaluates the subsequent collateral impacts on the civilian and military populations.

The software uses integrated source terms, and an array of terrain, land-use and meteorological data (i.e. climatology, high resolution weather forecasts and real-time observations), and particulate transport algorithms to model hazard areas and human collateral effects in minutes. Its use is designed for both operational users (i.e. those users responding to actual or expected events) and analytical users (i.e. those involved in research and development). (Science Applications International Corporation, 2002a).

- CATS (Consequences Assessment Tool Set)

CATS computes the spatial extent of natural and technological hazards, using models having a broad range of sophistication, and displays the hazards as objects in a Geographical Information System (GIS). The model then interprets hazard intensity using multiple layers of information into damage and consequence probabilities including mortality and morbidity (Science Applications International Corporation, 2002b).

CATS also incorporates a 'response resource sustainability' utility which provides a means to query databases of mobility sites, services, commodities and medical resources to identify and locate resources for an effective, sustained response. This utility also recommends the most effective roadblock distribution to prevent unauthorised access to the affected area (Science Applications International Corporation, 2002b).

A programme of research has been identified to further evaluate the effectiveness of hazard modelling including questionnaires and interviews. A pilot questionnaire is currently being reviewed by five individuals, who have been chosen to be representative of those who will be involved in the final study. This pilot study is being conducted in order to ascertain the relevance and understanding of the questions, so alterations may be made where necessary to improve the effectiveness of the questionnaire before the final study. The final study will then seek to ascertain the current use and demand for hazard modelling capabilities, the functionality, which they would be expected to present, and the improvements, which are offered or anticipated.

Data from the questionnaire responses will be analysed using graphs, charts and tally sheets for quantitative data regarding hazard modelling usage, and a list of key words will be generated to identify frequency of responses for qualitative data collected such as views regarding functionality and improvements.

Finally a series of semi-structured interviews will be conducted with both the hazard modelling environment developers and a selection of representative users in order to gain a deeper understanding of the benefits gained through the use of hazard modelling, as well as to identify improvements which are required with regard to hazard modelling in order to greater increase its usefulness and further adoption when dealing with bio-terrorism.

Results

Research so far has identified the different uses of hazard modelling which are likely to provide improvements throughout the disaster cycle, from planning to post incident evaluations.

<u>Preparedness Planning</u>
Hazard modelling provides planners with a means of conducting vulnerability assessments of critical buildings and environments which are considered credible targets for a bio-terrorist attack. Such modelling data can provide the means to create site specific plans to deal with incidents should they arise.

<u>Training and Exercising</u>
Hazard modelling provides trainers and those preparing exercises with a platform on which they have the ability to create realistic and illustrative scenarios.

Response:

- hazard modelling provides operational controllers and responders with a means of checking their manual plots and reports for accuracy.
- quickly evaluating the scene and a means of predicting / forecasting the impacts that an incident has created including casualty estimations based on integrated population databases.
- identify where treatment is needed, and the types of treatment required in different areas.
- conduct damage / consequence assessments.
- determine roadblock locations and exclusion zones for safe routing of responders and victims.
- determine quarantine areas.
- logistics planning i.e. estimating capacity required in local rest centres, morgues, hospitals etc
- ability to identify & evaluate possible secondary hazards. For instance if the bio-plume crosses a freshwater reservoir which serves the local population with drinking water then it may be necessary to restrict this source.

<u>Mitigation and Cleanup</u>
Through the integration of GIS and user defined resource databases it is possible to use hazard-modelling environments to assess needs and locate resources for a sustained response.
Use following an incident enables responders to obtain accurate information for reporting purposes (damage assessment) including insurance. Hazard modelling can also be used to establish lessons which need to be learnt from the incident and response.

However, despite the many uses which have been identified through out the experimental phase there are also a number of problems concerning hazard modelling and its use.

Experimentation using HPAC found that model computation can be timely if the plume crosses spatial domains set by the computer or if there are complexities in the terrain and weather files. This extra time taken to model the hazard could prove detrimental to a rapid response.

One barrier to the effective use of hazard modelling is the availability of intelligence. If there is a lack of intelligence concerning the specifics of the release, hazard modelling is unable to operate. In order to ensure quick identification of a bio-terror incident surveillance systems are needed which evaluate data from laboratories, clinics, pharmacies and hospitals for clusters of unusual symptoms which may signal a bio-terrorist attack. Thus ensuring that at the earliest opportunity data is available to compute impacts using hazard modelling (McGee, 2002).

McFee (2002) noted that following a bio-attack it is unlikely there will be a bang, plume, cloud or other announcement that an attack has occurred as Bio-weapons are stealth weapons. This causes complications for hazard modelling because without this intelligence victims are likely to become ill or die before the hazard area can be identified. Victims may even serve as weapons themselves if the bacterium used is contagious, such as smallpox, and before diagnosis is made they come into contact with previously unexposed individuals (Granot 2000). This so called person-to-person contamination is not presently an aspect that the identified hazard models are able to evaluate.

Since no massive bio-terrorist attack has ever been launched on the civilian population in the UK all attempts to plan for such a contingency remain speculative as do hazard modelling capabilities, despite some assurances regarding the impacts of meteorological and terrain factors on the behaviour of atmospheric releases which have been tested and verified.

Discussion

Hazard modelling continues to gain momentum particularly in the United States where its use is recommended and becoming more widespread during all stages of a disaster, from planning to mitigation and post incident evaluation. In the UK it has been identified as an area which requires further research and development by the newly formed Health Protection Agency (HPA). However, it would seem it still requires further recognition for its worth among other units which have a role in planning or responding to a bio-terrorist attack in the UK. (HPA, 2003)

Again McFee (2002) has noted that “It is a significant challenge to prepare for an unknown event”. As identified, hazard modelling has many uses within the disaster cycle and it is considered that its adoption will prove greatly beneficial. The perceived benefits are discussed here in relation to the stages of the disaster cycle.

<u>Preparedness Planning</u>
Disease outbreaks following a bio-terrorist attack can develop rapidly, therefore being prepared is essential in order to minimise the impact on the public. It is a daunting task to plan logistics with an uncertain number of victims, however the ability to plan for such eventualities based on simulations of likely / feasible attacks, ensures that adequate equipment for such procedures as decontamination and ample stockpiles of vaccinations and antibiotics for treatment are achieved before the incident occurs (McFee, 2002).

<u>Training and Exercising</u>
The ability to create realism in training and exercising for bio-terrorist incidents through the use of hazard modelling increases the likelihood that those involved will gain a greater understanding of the challenges which they face and will almost certainly treat such exercises with greater seriousness. By creating such realism it is also likely to better prepare responders psychologically (Holloway, et al 1997).

Response

In order to achieve a return to normality and minimise the impacts of a bio-terror attack it is vital that emergency responders have available to them the information required to initiate a rapid and efficient response. Hazard modelling as shown by the preliminary results of this research, provide valuable information which will assist many aspects of response from securing the area of the outbreak to identification of resource needs and their location.

Once a biological attack is suspected it is important that steps are taken to determine "exposure risk, assess the potential effect[s] … and define the needs from local and national resources" (Richards, et al, 1999:187). Early assessment of the impact will allow specific, targeted and prompt treatment, and provide a greater window of opportunity during which prophylaxis by response agencies and the public will be more effective and thus save lives (Simon, 1997). Identification of the affected population and their levels of exposure will also prove vital information for hospitals to prepare in advance of casualty arrivals, with regards to treatment needs etc.

Mitigation and Cleanup

The response resource sustainability utility aspect of the hazard models provide marked benefits to speedy mitigation and a return to normality. The ability of response workers to conduct searches to identify the closest location of tools and equipment required for mitigation and cleanup will prevent long arduous searches of paper directories.

Hazard modelling provides a unique capability to evaluate response procedures following an incident, and thus learn from the experiences should an incident of a similar nature occur again.

Finally an overarching benefit of hazard modelling to all stages within the disaster cycle concerns consistency and compatibility. Creating a model, which is recommended for use by all emergency responders in such incidents of bio-terrorism, will enable consistency of approach at both a local and central government level, and will promote the sharing of information due to systems compatibility's. This will almost certainly help improve and promote a more co-ordinated response.

Previous study undertaken by the CCS confirmed a favourable interest in hazard modelling, by the UK emergency planning community (Amat & Athwal, 2001) however this project lost momentum for many reasons not least the restructuring of emergency planning in the UK. Therefore it is vital that we maintain the momentum created following the Anthrax events of 2001, if we are to tackle this issue and develop a suitable level of preparedness.

Events particularly since September 11 2001 have demonstrated the possibility of a bio-terrorist attack on the civilian population in the UK, and this probability of mass destruction cannot be ignored. Taking this into account it is clear that there is a need for "a utility that can reliably simulate a disaster itself as well as assess its consequences" (Swiatek & Kaul, 1999:2).

Acknowledgements

I would like to express my thanks to Mrs Eve Coles and Mr Robin Tasker for their support and assistance in the preparation of this paper. I would also like to thank the Defence Threat Reduction Agency and their staff for providing me with the software to conduct this research and their ongoing support.

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Previous Employment has included the UK Home Office Emergency Planning Division (EPD), working as part of the research group responsible for a wide range of topics, both internally and externally in support of EPD objectives. The findings of which are ultimately disseminated and used in the development of effective national arrangements for integrated emergency management.

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