Public Health England

Chemical Hazards and Poisons Report

From the Centre for Radiation, Chemical and Environmental Hazards

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Contents

Editorial

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Centre for Radiation, Chemical and Environmental Hazards, Public Health England

Public Health England has now been operational for over a year*. Articles in this edition demonstrate how PHE is collaborating with national and international partners to further develop the environmental public health evidence base while continuing to deliver its core business functions. This issue of the Chemical Hazards and Poisons Report focuses on our work within Europe and on the preparedness and response to international chemical incidents.

The mechanisms for identifying, reporting and responding to cross-border public health threats in Europe are explored. The article 'Le Pong' shows how a release from an industrial plant in France in 2013 had a significant impact upon many of our emergency services in England and how having agreed mechanisms for liaising with our counterparts in Europe greatly improves our ability to respond to such events. A stricken ship off the coast of England required international collaboration to assess and mitigate the potential public health risk. Another recent 'toxic' import is the oak processionary moth and public health staff from the Netherlands share their approach to dealing with the caterpillars.

Improving air quality is one of the biggest environmental public health challenges in Europe. PHE describes its work to estimate the mortality burden associated with long-term exposure to particulate air pollution. Assessing the air quality impact of a large waste fire is the subject of two articles by the Met Office and PHE.

The Control of Major Accident Hazard (COMAH) Regulations implement the requirements of the European Seveso Directives. Articles describe the role of public health in the planning, preparedness and response to incidents at COMAH-regulated sites. If a significant accident involving hazardous materials were to occur, PHE has developed guidance tools and the Government Decontamination Service maintains a framework of contractors available to assist with recovery and restoration. This is discussed in a series of articles.

Finally, the World Health Organization states that flooding is the most common natural hazard in Europe and England experienced significant floods last winter. Lessons from previous floods in Gloucestershire and the impact on a NHS blood manufacturing centre are presented.

The next issue of the report is planned for spring 2015; please contact us if you would like to contribute to this edition. Guidelines for authors and a permission to publish form can be found on the website at www.hpa.org.uk/chemicals/reports. Please do not hesitate to contact us about any papers you may wish to submit on chapreport@phe.gov.uk, or call us on 020 7811 7141.

We are very grateful to Andrew Tristem and Matthew Pardo for their support in preparing this issue.

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Front cover images: flooded NHS Blood and Transport manufacturing centre, GDS framework supplier removing contaminated waste, Seal Sands refineries and Happy Lady

Happy Lady (reproduced by courtesy of the Environment Agency)

* On 1 April 2013 the Health Protection Agency was abolished and its functions transferred to Public Health England.

Incident Response

Smethwick recycling plant fire – a Met Office perspective

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Introduction

In the event of a large fire the Met Office provides information on how the plume of smoke and other contaminants will spread in the atmosphere using the Numerical Atmospheric-dispersion Modelling Environment (NAME) dispersion model. NAME uses weather data from the Met Office's weather prediction models together with a description of the fire to forecast the spread of the plume. An estimate of the height to which the plume rises close to the source is a useful part of the description of the fire as the efficiency with which the plume is dispersed in the atmosphere can depend on its initial height. On 30 June 2013 a large fire broke out at a recycling depot in Smethwick (near Birmingham). The fire was extremely hot, meaning that the plume rose above the height of the atmospheric boundary layer (estimated to be 300–1300 m above ground) and remained above it for the duration of the fire. This report demonstrates that the height of the boundary layer is a key factor to consider when determining whether a plume is likely to be of significant public health concern to those on the ground.

Incident summary

At approximately 11.00pm on 30 June 2013 a fire broke out at a recycling depot. The fire involved approximately 10,000 tonnes of paper and plastic material. At the peak of the incident more than 35 fire engines and 200 fire fighters from across the West Midlands were in attendance[1] and the plume could be seen for some distance. It took West Midlands Fire and Rescue Service (FRS) approximately 24 hours to bring the fire under control and reduce the material to a smouldering state.

The Met Office's Environmental Monitoring and Response Centre (EMARC) was notified of the fire at approximately 7:30am on 1 July by Public Health England (PHE). EMARC immediately produced and issued a chemical meteorology (CHEMET) report[2] (Figure 1). At this time winds were blowing from the west, pushing material to the east towards Birmingham. Conditions were dry and only light showers were predicted for later in the day, indicating that there would be no significant removal of material from the atmosphere by rain. Satellite images of the UK (Figure 2a) provided further evidence of the plume location. However, it quickly became clear from photographs that the plume was not grounding (no significant amount of material was reaching the ground). A police helicopter estimated that the plume was reaching heights of up to 2 km and that the base of the plume was estimated to be around 700 m. This was confirmed by people on the ground who reported an elevated plume passing at altitude over Birmingham. Figure 2b shows NAME predictions of the plume location based on the helicopter estimated plume height.

Dispersion and the boundary layer

The impact of a plume on human health is dependent on a number of factors including the location of the plume in the atmosphere, the chemical species (eg particulate matter or other products of combustion) contained in the plume and the quantity of the species to which an individual is exposed. Here the focus is on the location of the plume in the atmosphere. Most (smaller) fires release material into a part of the atmosphere called the boundary layer. This is the lowest part of the atmosphere, typically extending upwards to between 100 and 1500 m above the ground. The boundary layer is the part of the atmosphere which is most directly influenced by the Earth's surface through friction, heat and moisture transfer and is typically, though not always, characterised as an area of the atmosphere in which pollutants are mixed relatively rapidly. Movement of contaminates between the boundary layer and the rest of the atmosphere can be significantly more limited. Thus material which is released within the boundary layer often remains 'trapped' within it and material released above the boundary layer often remains above it with only a slow exchange of contaminants.

The plume from a fire is generally hotter than the surrounding air and therefore has a lower density and positive buoyancy, and so it rises. As it rises it entrains (mixes with) the cooler surrounding air. This cools the plume until it reaches the same temperature as the surrounding air. At this point the plume stops rising due to its buoyancy (it is now neutrally buoyant) and spreads due to atmospheric mixing and advection. If the plume is sufficiently buoyant it may rise above the boundary layer, plume behaviour known as 'lofting'. The amount of mixing is much reduced above the boundary layer so the downward spread of the plume is restricted. This means that particulate and/or other pollutant concentrations close to the ground are not generally elevated. This can be confirmed with results from monitoring sites.

The height of the top of the boundary layer and other boundary layer characteristics do not remain constant. The

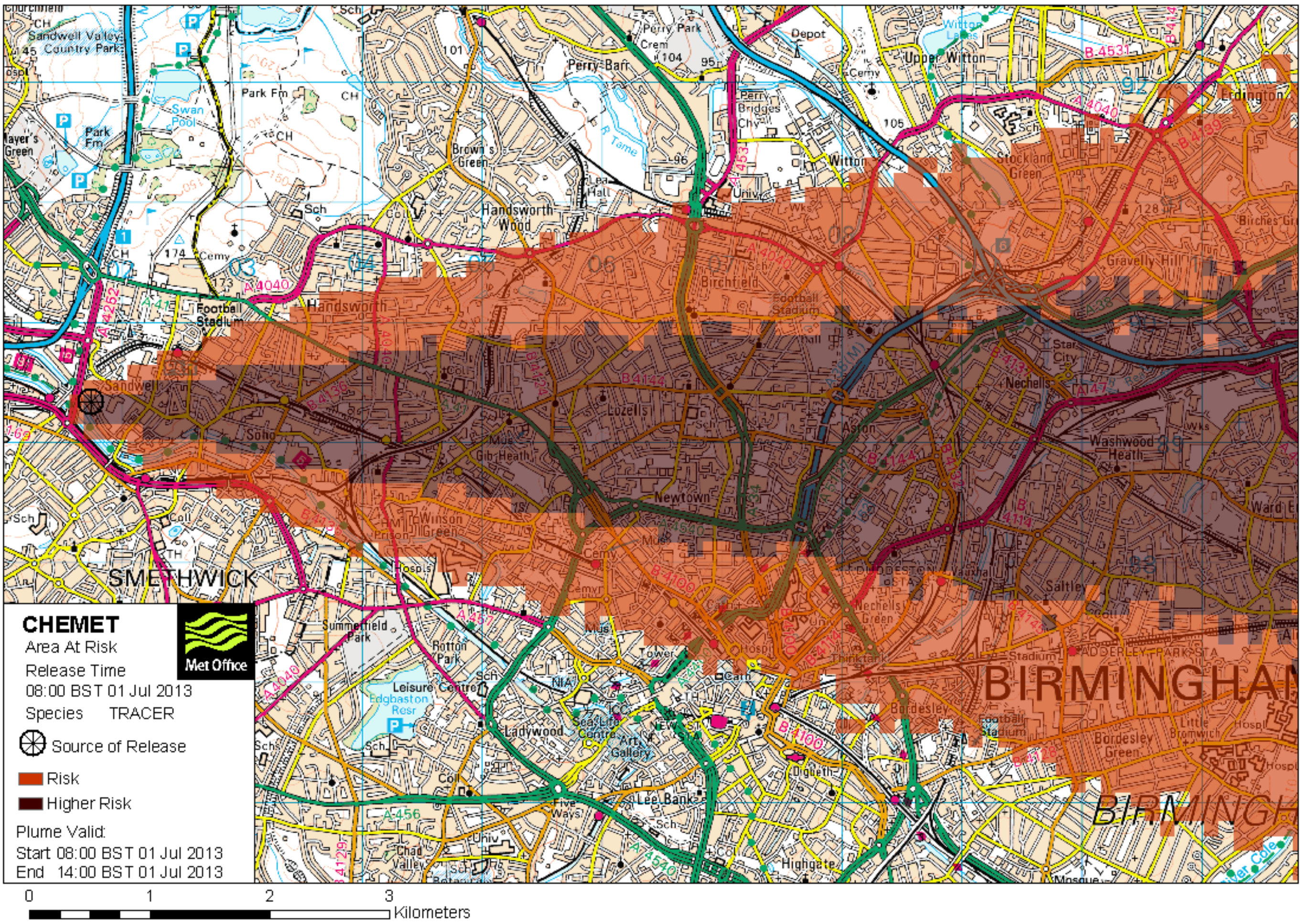
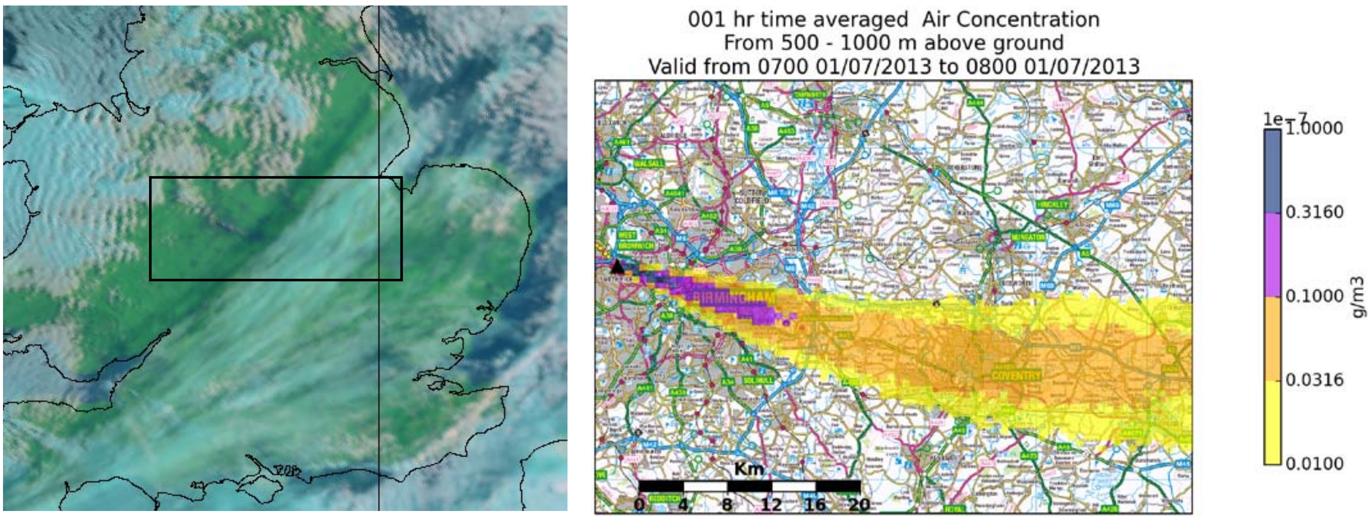


Figure 1: CHEMET area at risk plot issued at 8am on 1 July 2013. Note that this CHEMET assumed that the material was being released at ground level



(Met Office/NOAA © Crown copyright)

(a) **(b)**

Figure 2: (a) a visible composite satellite image from the NOAA-15 satellite showing the plume from the fire at 07:25 BST on 1 July 2013 – the plume is the dark thin streak heading to the southeast in the area highlighted by the black box, (b) NAME dispersion model prediction of the smoke plume location between 07:00 and 08:00 BST on 1 July 2013

height varies due to variations in heating from the sun and wind speed[3]. Thus during a prolonged release of pollutants the boundary layer will change and the behaviour of the plume will be affected as a result of the change. For example, if the boundary layer height grows to a depth which is greater than the base of the smoke plume the material will be mixed into the boundary layer in a process known as 'fumigation'. The greater turbulence in the boundary layer will then result in the plume becoming well mixed throughout the boundary layer including down to the surface (plume grounding). The plume may then become a concern for human health. Evidence for plume grounding would, for example, include an increase in particulate measurements at local air quality monitoring stations.

Meteorological conditions during the fire

The fire started at approximately 11.00pm and continued into the following day. At the time when the fire started, the boundary layer height was around 600 m and it decreased to around 300 m during the coldest part of the night. Heating from the sun resulted in the boundary layer increasing in depth to about 1300 m by midday on 1 July (Figure 3). Initial estimates of the height of plume suggest that the plume was above the boundary layer in the morning but that there was a possibility of fumigation later in the day. This information, together with visual observations, confirmed that the plume did not ground and remained above the boundary layer throughout the day.

Some peaks in particulate matter were observed in data from mobile monitoring locations deployed during the fire (see page 7) . This was likely to be due to local turbulence and mixing of the periphery of the plume as the mobile monitoring sites were all within a kilometre of the fire. One possible cause of this turbulence is the difference in the temperature

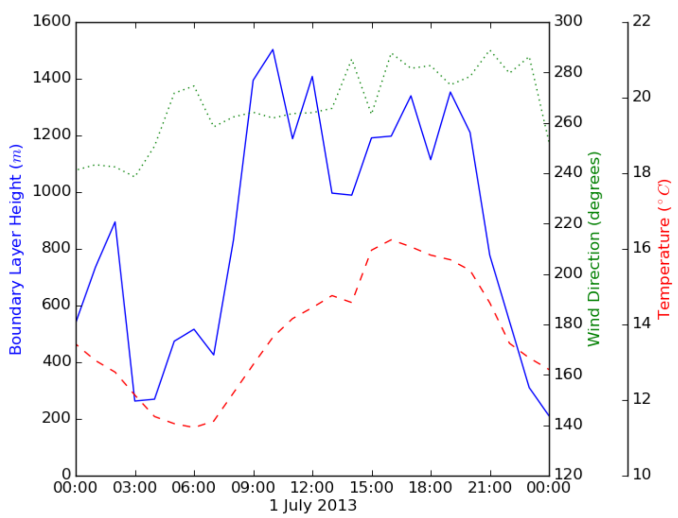


Figure 3: Time evolution of boundary layer height, wind direction and temperature during 1 July 2013 at the location of the fire. The meteorological data was extracted from the Met Office's high resolution UK meteorological model

of the fire and the surrounding air, which would have created some local turbulence. Particulate matter remained close to previously reported background concentrations at the closest Defra Automatic Urban and Rural Network (AURN) air quality monitor[4] (Birmingham Tyburn), which was approximately 11 km from the fire.

Key points

- the boundary layer is the part of the atmosphere closest to the Earth's surface. It can act as a semi-impermeable barrier to air pollution. Thus, plumes of pollutants which are injected (for example, due to buoyancy) above the boundary layer generally remain above the boundary layer
- the height of the boundary layer is not constant. If the plume is above the boundary layer, an increase in its height can result in a plume being drawn down in to the boundary layer, a process known as fumigation. This did not occur during the fire at the Smethwick recycling plant
- knowledge of the height of the plume in relation to the boundary layer is important. This information may be passed to the Met Office by the requestor of the CHEMET (as was the case for this fire), or may be determined from photographs of the fire. If the wind direction changes a lot with height the direction in which the plume is travelling may also provide an indication of the height of the plume. It is usually difficult to accurately determine the height of the plume
- CHEMET plots only provide information about the spread of material within the boundary layer, although the simulations used to produce them take the full atmosphere into account

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3 Stull RB. An Introduction to Boundary Layer Meteorology. Kluwer Academic Publishers, 1988, ISBN 90-277-2769.

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Smethwick recycling plant fire – PHE response

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Introduction

In recent years, Public Health England (PHE) and one of its predecessor organisations, the Health Protection Agency, has been involved in responding to an increasing number of fires associated with waste processing and recycling facilities. These sites can store and process a variety of wastes, including combustible material, typically household and commercial waste comprising paper and cardboards, plastics, and general waste. Fighting such fires can present many challenges for the fire and rescue services. Often waste is tightly packed on to the site with limited space between stockpiles, or stored within buildings making access, and aggressive fire fighting, difficult. These difficulties are often exacerbated due to water availability for fire fighting, and the need to contain and manage potentially large volumes of fire-water run off to minimise impact on the local environment. Consequently these fires have the potential to burn for a prolonged period of time, potentially leading to anxiety in the local community and attracting significant media attention.

Overview of the incident

A large fire, reputedly the largest ever seen in the West Midlands, broke out at a recycling and waste management centre at Smethwick, at approximately 11.00pm on 30 June 2013. The fire was declared a major incident on the morning of 1 July by West Midlands Fire and Rescue Service (FRS), and involved approximately 10,000 tonnes of baled plastic (polyethylene) and paper waste materials. At the fire's greatest intensity, a plume of thick black smoke was visible across Birmingham city centre, with reports that it was visible as far away as Coventry, over 25 km away.

A mobile incident command centre was established by West Midlands FRS at the scene at an early stage in the response, which allowed the vital exchange of information between multiagency partners.

The waste facility was located in a predominately industrial area; however, sensitive receptors including residential properties and a number of schools were identified within 500 m to the east and south. Following experience with previous fires from waste facilities and owing to concerns associated with the potential for the fire to be protracted in nature due to the waste types and volume, and for its potential to impact on air quality in the local area, PHE and the Environment Agency (EA) agreed the need for activation of an air quality cell (AQC). The AQC is a virtual collaboration between the EA, PHE and the Met Office, alongside other invited partners, to agree a common interpretation of the air pollution climate in the vicinity of major incidents. It can request detailed dispersion modelling and/or the deployment of air quality monitoring to collect real-time air quality data during major fires or chemical releases. The AQC enables informed multiagency public health decisions to be made on the effects of air pollution on the local population throughout the incident response. Attendees of the AQC were the EA, PHE, Met Office, Food Standards Agency and the local authority.

The virtual AQC officially ran from 10:30am on 1 July 2013 to 3:30pm on 2 July (29 hours) and deployed monitoring teams at four monitoring locations (Figure 1) at different times during the incident. In addition, the Met Office undertook modelling predictions to support the risk assessment and decisions regarding the deployment locations of the monitoring teams (see page 4). There were initial difficulties in identifying accessible monitoring locations due to road and school closures in the local area resulting from the fire; the monitoring equipment requirements include a secure location with a continuous power supply.

Potential public health implications

Fires involving waste materials have the potential to release products of combustion including particulate matter (PM_{10} and $PM_{2.5}$), and organic and inorganic irritant gases depending on the type of waste involved and the temperature at which the fire burns[1]. Smoke from any source is an irritant, affecting the eyes and throat of individuals exposed to the plume, and may worsen existing breathing and heart conditions. Individuals with asthma and other respiratory conditions can be particularly susceptible to smoke.

Messages to shelter had been provided by West Midlands FRS early in the incident and these messages were reinforced throughout the incident. Visual observations from the scene (FRS and EA) were used throughout the incident to support the risk assessment. Additionally, modelling predictions undertaken by the Met Office indicated that, because the fire was extremely hot, the plume would rise above the height of the atmospheric boundary layer, minimising the impact on public health at ground level (see page 4).

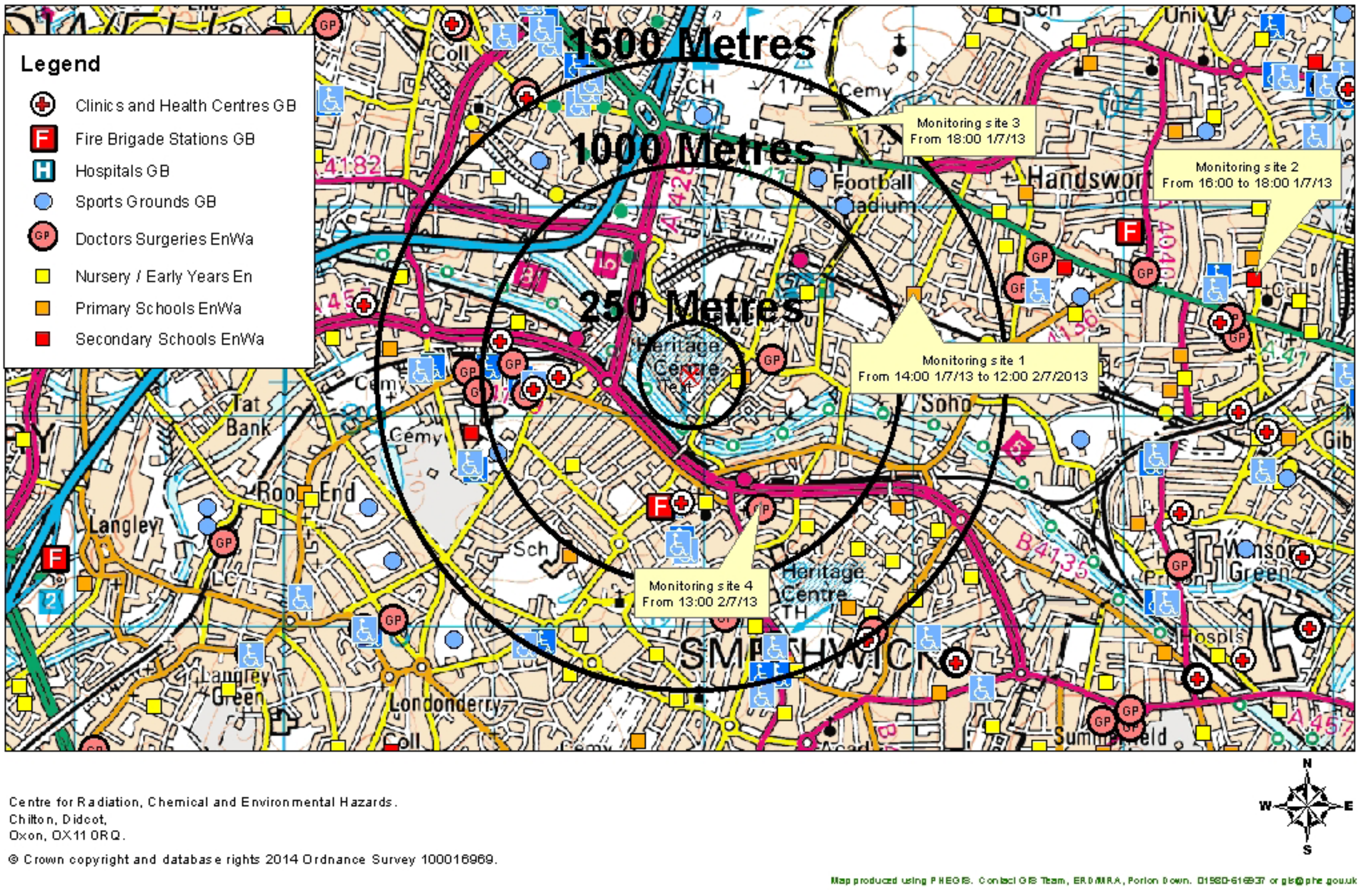

Figure 1: Location map of sensitive receptors, showing 250 m, 1000 m and 1500 m buffers and AQC monitoring locations

Periods of elevated particulate matter were recorded at monitoring sites 1, 2 and 3 during day 1 of the incident. Data was not collected from any single location for a 24-hour period; however, PM_{10} concentrations at monitoring site 1 (22-hour average) were recorded at 67 µg/m^3 (Defra index band medium 24-hour average)[2]. Monitoring only took place at monitoring site 2 for 2 hours, but the average PM_{10} concentration during this period was 88 µg/m^3 (Defra index band high 24-hour average). At the 'high' air pollution banding Defra recommends

> '... adults and children with lung problems, and adults with heart problems, should reduce strenuous physical exertion, particularly outdoors, and particularly if they experience symptoms. People with asthma may find they need to use their reliever inhaler more often. Older people should also reduce physical exertion.'

While data was not collected continuously for 24 hours at any of the monitoring locations, these levels were considered reassuring as shelter-in-place messages had been issued throughout, minimising public exposure to high levels of particulate matter. Additionally, while monitoring and modelling results showed elevated PM_{10} concentrations, updates from the Met Office indicated that any potential exposure would be short lived due to a change in wind direction. Precautionary advice was provided for anyone affected by the smoke or concerned about its impact on their health to contact NHS Direct/NHS 111 for advice.

Key points

- long running waste fires can generate media and public concern associated with their potential to impact on public health. The response to such fires can be very resource intensive for all agencies involved
- due to the incident location and visibility of the plume, much media attention was awarded to the fire. Therefore while any health impact on the local population was expected to be minimal, there was significant concern generated within the local community regarding the potential impact on public health
- given the increasing number of fires at waste processing and recycling facilities, agencies including PHE, the EA, local authorities and fire and rescue services are increasingly undertaking joint risk assessments of these facilities through local resilience forums. The aim of the risk assessment is to develop emergency response plans for existing facilities to ensure all agencies are prepared and there are appropriate notification procedures in place if a significant fire occurs at such a site (see page 24)
- modelling predictions undertaken by the Met Office (see page 4), and feedback from on-site partners regarding the impact of the plume on local air quality were invaluable in terms of supporting the ongoing public health risk assessment throughout the incident

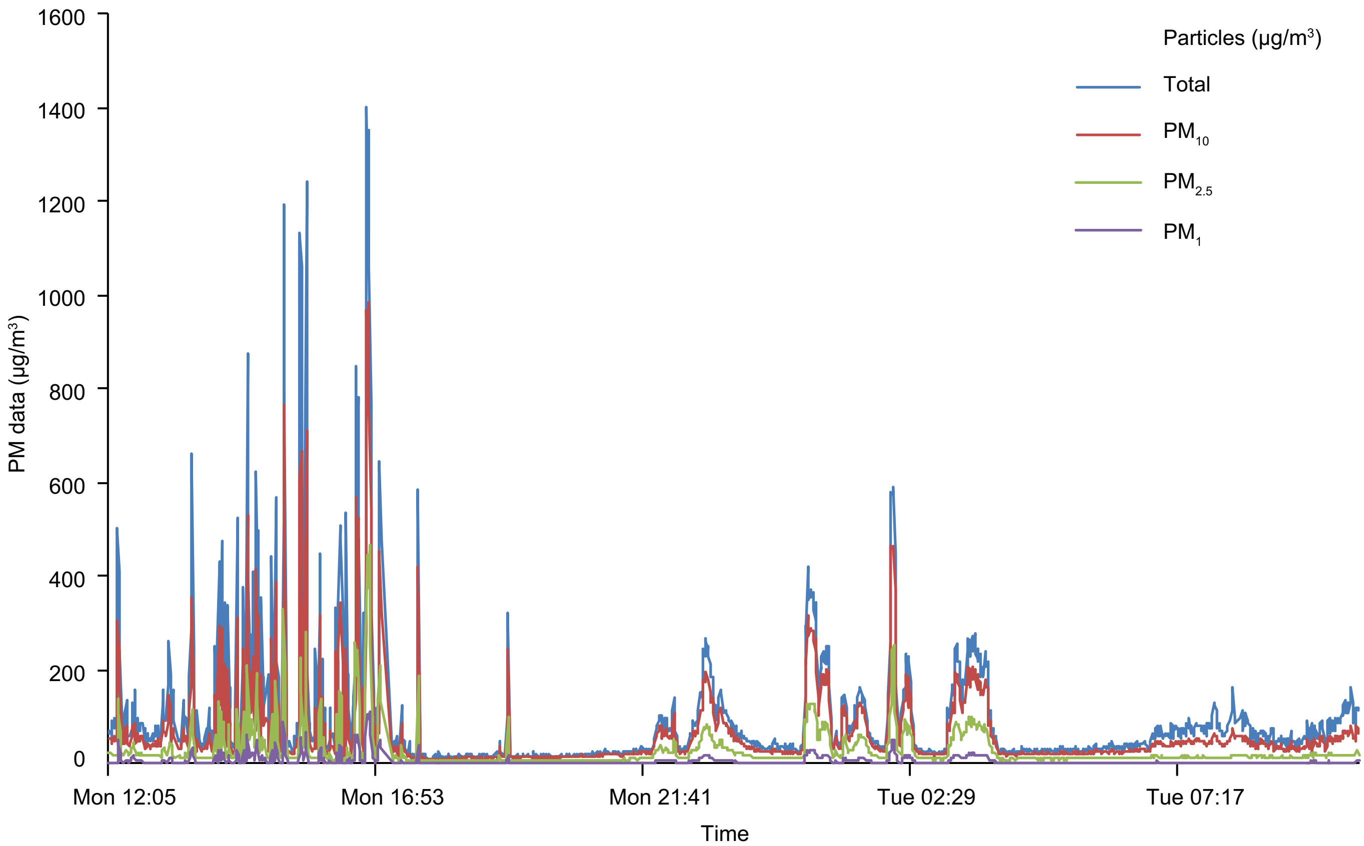

Figure 2: Particulate concentrations from 1 July 2013 to 2 July 2013 at monitoring site 1

- attendance at the mobile incident command centre at scene at an early stage by multiagency partners allowed a vital exchange of information
- the potential impact of road closures should be considered in terms of access, and potential impact on monitoring team locations during an AQC. Incidents such as these allow all agencies to improve their emergency plans and working together arrangements during future multiagency incidents and exercises
- declaration of a major incident by West Midlands Fire and Rescue Service allowed the production of coordinated multiagency messages for the public, through a number of different routes including the media and social media throughout the incident

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'Le pong' – a public health incident?

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Introduction

The human nose is very sensitive to odours, allowing us to detect the presence of some substances which are dangerous to health. Odours are caused by compounds in the atmosphere which have the potential to trigger our sense of smell.

The ability to perceive an odour can therefore be very useful in protecting our health. Natural gas, for example, is odourised to allow us to identify its presence in air and thus detect leaks, lowering the potential risk of gas explosions. However, because something has an odour does not automatically mean that it is harmful, as our sense of smell is very sensitive and is often stimulated at very low levels which we would not expect to be harmful.

Nonetheless, the presence of a detectable odour can, however, cause annoyance among the population, possibly leading to stress and anxiety. Some people may experience symptoms such as nausea, headaches or dizziness, as a reaction to an odour even when the substance that causes the smell is itself not harmful to health.

This article describes a multiagency, multiregional response to an international incident where a low toxicity, yet highly malodorous substance was accidentally released into the atmosphere.

Incident

At approximately 8:45am on Tuesday 22 January 2013 the out-of-hours chemical on-call team for the then HPA Centre for Radiation, Chemical and Environmental Hazards (CRCE) received a call from the HPA emergency planning manager for the Kent area. He wished to report that there had been a number of enquiries in the local area regarding a chemical odour present over a large area of south Kent. The initial understanding was that the source of the odour was a chemical release following an incident at a chemical manufacturing plant in France. This was based on media reports but further details were not known. Shortly before 9:00am a second call was received by CRCE. This call was from a consultant at the emergency department of William Harvey Hospital in Ashford, Kent. Three members of a family had presented at the hospital reportedly feeling mildly unwell after being exposed to the noticeable odour.

At this stage the source of the odour was not confirmed and little was known about the potential risks to health. The odour was described in a number of terms, including sulphurous and similar to diesel fuel. There had been no reports from the UK emergency services or other resilience partners of any chemical release and thus it was inferred that a cross-border release was a likely cause.

The nature of the release made it difficult to establish the risk to health. The usual approach to investigation of public health risks in acute incidents is to liaise with specialists from the emergency services at the scene of an incident to establish the nature of the chemical hazards. In this case the approach would not be possible as the scene of the incident was thought to be outside the UK.

Public health risk assessment

Initial assessment of the risk to health focused on the identification of the substances that may have been released from the incident in France and confirmation that the French incident was the cause of the odour in Kent.

Identification of the source was achieved in two ways. A search was undertaken of media and internet resources that contained reports of the incident in France. Internet resources included statements from the French emergency services about the incident and a press release from the operator of the site where the release occurred. The data located indicated that there had been a release from the Lubrizol plant near Rouen in France. Information released by the company indicated that the released chemical was a mercaptan (predominantly methyl mercaptan). Methyl mercaptan (see Figure 1) has a very low odour threshold and smells sulphurous, which matched the odour profile reported in Kent.

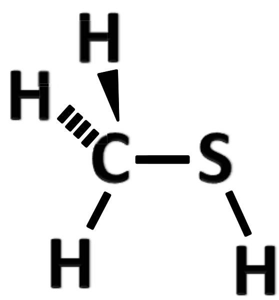

Figure 1: Structure of methyl mercaptan

In order to confirm that the methyl mercaptan release was responsible for the odour in Kent, CRCE contacted the Met Office for assistance in ascertaining the source of the air currently present over Kent. If it could be shown that the air had originated from Rouen, it could be inferred that the chemical released at Lubrizol was the cause of the odour and thus provide the basis of a public health risk assessment.

The Met Office was able to model a release in the Rouen area 12 hours prior to the initial reports of odour in Kent. This showed that the air in position over Kent had originated from the area of release in France (see Figures 2–7). This confirmed the mercaptan release as the reason for the odour complaints.

Mercaptans are commonly used as stenching agents in odourless natural gas due to their very low odour threshold to provide a warning of gas leaks. The very low odour threshold allows it to be detected at levels far below those required to cause ill-health effects, in the case of methyl and ethyl mercaptan the odour threshold is reported as two parts per billion (ppb)[1], while the UK safe workplace exposure limit[2] (as an 8-hour average) is 500 ppb and health effects such as headache and nausea would only be expected above 4000 ppb [1]. The level of methyl mercaptan likely to present an acute risk of life-threatening health effects or death following an 8-hour exposure was reported[3] as 22 ppm (22,000 ppb).

Any public health risk assessment requires an estimation of public exposure to the levels of contaminants involved in the incident. This may involve many sources of information such as modelling and monitoring data.

In the initial stages of the incident no data was available on the amounts being emitted from the Lubrizol site despite attempts to gather information via links with French authorities and the National Chemical Emergency Centre. However, inferences about the potential risks from exposure could be drawn from the reported impacts on the health on the local population close to the incident and the distance between the release and the UK population.

Media reports quoted French local government officials stating that the levels of mercaptan that were released were 'not-toxic'[4] and there had been no reports of health effects beyond odour-associated nausea. Some disruption to local events had been caused due to the odour, including the cancellation of a local football game[5]. However, this disruption was due to the nuisance caused by the odour rather than a risk to public health.

Geographic information systems (GIS) were used by CRCE scientists to measure the distance from the point of release to the nearest point on the English coast. The distance measured in a straight line was approximately 100 miles (160 km). Given that the concentrations in the local area in France were not causing severe acute health effects and the vast dilution effects expected when a gas disperses over such long distances, it could be concluded that the exposure to the public in Kent and across the south coast of England would not be significant to health, notwithstanding the presence of an unpleasant odour.

Multiagency response

The rapid public health risk assessment was completed by 9:30am and the Kent, Surrey and Sussex health protection units (HPUs) were briefed by CRCE regarding the potential risk to health. The HPUs briefed the regional communications as the level of media interest in the incident was very high.

By 10:00am there had been a number of calls to the Kent, Surrey and Sussex HPUs from various stakeholders including the emergency services, environmental health departments and members of the public. These indicated that many civil contingency partners were concerned about the odour including the fire and rescue services and the National Grid (NG), who were receiving an extraordinary number of calls from members of the public wanting to notify of potential gas leaks[6].

These calls were due to the nature of the odour. As mercaptan is used to odourise natural gas the population logically assumed that the recognisable odour was due to a local gas leak. These 'false alarms' highlighted a public health issue from the incident: the loss of the ability of the public to identify actual natural gas leaks, raising the likelihood of fire or explosion.

The modelling from the Met Office also indicated that the wind direction was likely to spread the contaminated air from the south coastal region across central and western England and Wales over the next 12 hours.

The key issues in the management of the incident were identified as the need to communicate about the risk to health to stakeholders in areas likely to be affected by the odour and management of the increased number of calls from the members of the public regarding the odour and/or suspected gas leaks.

Shortly before 11:00am the HPA was contacted by the Environment Agency (EA) to discuss the setting up of an air quality cell (AQC) due to local concerns. An AQC is a multiagency cell that is triggered in the event of an incident expected to significantly affect air quality. The capability of the AQC teams to detect mercaptans at very low levels was discussed and it was established that the teams did not hold equipment capable of detecting the substance of concern. As such, an AQC would not have been helpful in the management of the incident. The ability of fire and rescue service detection, identification and monitoring (DIM) equipment to detect mercaptan was also discussed, but was not expected to be capable of detecting the contaminant. As

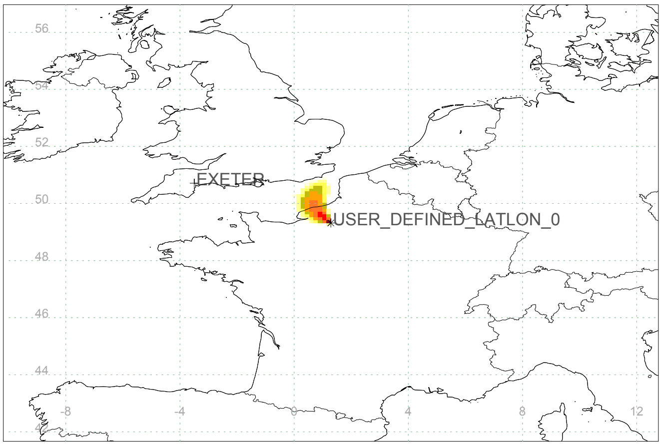

Figure 2: NAME plume modelling 12:00 21/01/13 (coloured for illustration purposes, not representative of atmospheric concentration) (Met Office © Crown copyright 2013)

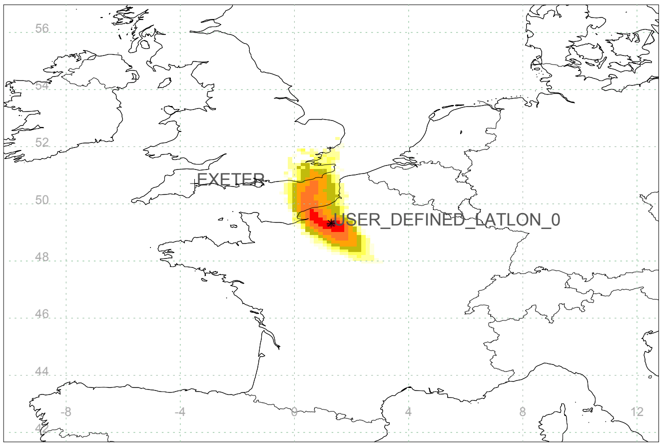

Figure 3: NAME plume modelling 00:00 22/01/13 (coloured for illustration purposes, not representative of atmospheric concentration) (Met Office © Crown copyright 2013)

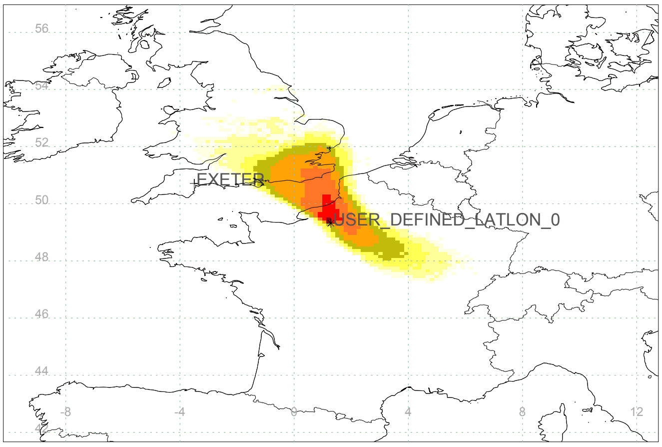

Figure 4: NAME plume modelling 12:00 22/01/13 (coloured for illustration purposes, not representative of atmospheric concentration) (Met Office © Crown copyright 2013)

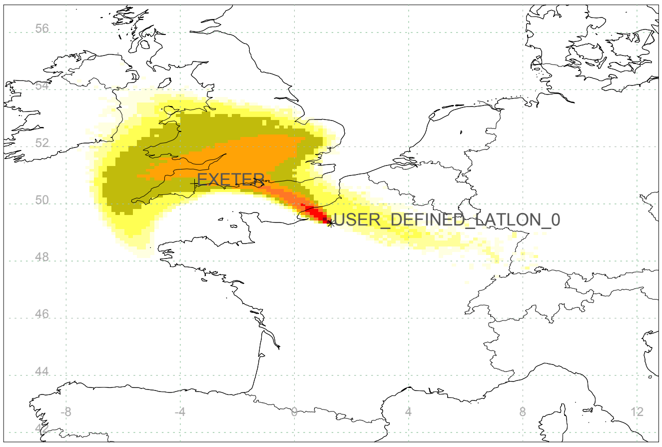

Figure 5: NAME plume modelling 00:00 23/01/13 (coloured for illustration purposes, not representative of atmospheric concentration) (Met Office © Crown copyright 2013)

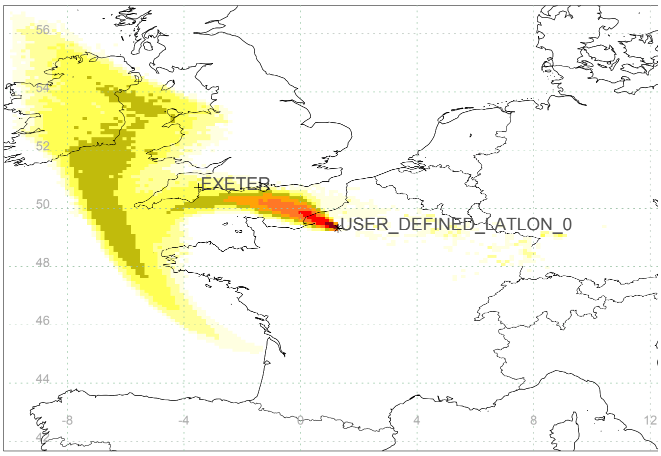

Figure 6: NAME plume modelling 12:00 23/01/13 (coloured for illustration purposes, not representative of atmospheric concentration) (Met Office © Crown copyright 2013)

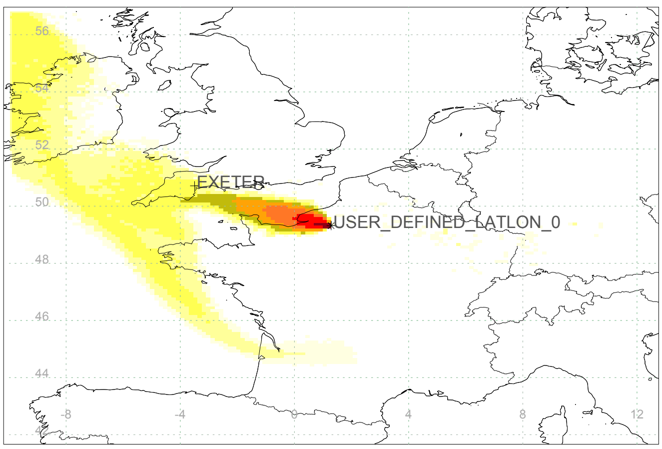

Figure 7: NAME plume modelling 00:00 24/01/13 (coloured for illustration purposes, not representative of atmospheric concentration) (Met Office © Crown copyright 2013)

it was not possible to detect and monitor methyl mercaptan using equipment that was readily available, the exposure assessment could not be based on local monitoring data.

An internal HPA teleconference was held at 11:00am. The incident was discussed and actions identified to notify our multiagency partners of our risk assessment. Actions were taken to brief CRCE supra-regional units, HPUs, HPA communications teams and HPA emergency planning managers across southern England on the potential issues due to the odour. The local teams were asked to cascade the briefing to their local resilience partners. Public Health Wales was also notified due to the potential for Wales to be affected by the odour.

CRCE worked with HPA communications staff to draft a public message to provide reassurance to the population affected by the odour. The public was not advised to shelter but was warned that the odour had the potential to make some feel nauseous:

> 'The smell drifting over Southern England today poses no risk to public health. The odour, which is similar to rotten eggs, has been noticed by people mainly in Kent, East and West Sussex and some parts of Surrey. It is caused by a particularly smelly chemical that is added to odourless natural gas to give that its characteristic smell.
>
> 'The chemical leaked from a factory in Rouen, France, yesterday and has blown across the Channel overnight. It is not toxic and has also been diluted before entering the air over England, so people should be reassured it will cause no harm. It is an unpleasant odour which may cause some people to feel slightly nauseous but it will dispel naturally.'

The public health message was issued as a press release, via social media and promulgated by resilience partners. The incident generated considerable media interest at a local and national level.

At 1:00pm Kent Police hosted a strategic coordinating group (SCG) to discuss the impact of the incident. A STAC (science and technical advice cell) was not requested or set up to support the SCG. The SCG was attended by representatives from Kent HPU and CRCE. From discussion of the incident it became apparent that the first call to the UK emergency services regarding the odour was made at 6:36 that morning. Kent Police had spoken with their French counterparts who advised that they were not treating it as a danger to health as it was a low level of concentration and advised the public there to refrain from using the emergency number to report the odour. It was agreed that the risk to the public remained very low and that the greatest risk to public health was due to the potential for non-detection of natural gas leaks.

Discussion at the SCG was based around the assessment of risk to the public, the ability to monitor for the contaminant and who should lead on communications to stakeholders and the public. The main outcome from the SCG was to ensure that resilience organisations in other areas would be informed of the odour, and the low risk to health, before their populations were affected.

Over the next 12–24 hours there were numerous reports of the odour across southern England and Wales; however, there were few reports of ill health and none that could be linked to toxic effect of exposure to mercaptans.

Discussion

This incident was unusual for a number of factors:

- it is rare that the UK is acutely affected by chemical releases from other countries
- few chemicals have such an extremely low odour threshold as mercaptans
- the agencies responding to the incident did not have access to monitoring capability that could accurately quantify the low levels of chemical present in the environment
- there are few acute chemical incidents that impact on such a large geographical area

The circumstances of the incident led to a very low risk event, with very high levels of public and stakeholder concern, over a large part of the country. As such, the response to the incident does not easily fit into civil contingencies planning, which is based around local resilience forum (LRF) areas for locally managed incidents and central government for major incidents affecting multiple LRFs[7].

In this case the incident affected multiple LRFs and a devolved administration but as the impacts were not significant central government did not take an incident management role. This led to much debate about the appointment of a lead civil contingencies responder for the event and an ad-hoc approach to the dissemination of communications to the affected regions of scientific advice.

The lack of a national multiagency organisational lead for the incident prevented the development of a commonly recognised information picture among contingency responders. This in turn led to the potential for different areas of the UK to draw different conclusions regarding the release and issue contradictory advice, which could have led to public confusion.

A similar organisational issue could be identified within the HPA. The incident was not considered to be a major incident under the HPA integrated emergency response plan and therefore a national incident lead was not appointed. However, the incident affected many HPUs in more than one region. This led to debate on who should lead for the HPA and provide direction for the response.

During the incident some stakeholders felt that the health community should take the lead in the response as the primary concern was in relation to public health effects of exposure to the odour. However, it may be argued that this event was not a health incident at all as the only effect seen in the UK was of widespread odour nuisance. What is without question is that the incident showed the need for scientific advice to be available to the civil contingencies community to assess potential impacts and ensure that the public health response to an incident is proportional to the risk.

The incident highlights a need for discussion of leadership in acute incidents that have high public health concern despite low risks to the population. It would be sensible for responders to consider how they would react to a similar event and establish who should lead both the overall response and public communications in such an event.

Finally the incident highlights the need for responders to understand the links available with European partners in the event of cross-border incidents. At the time of the incident the HPA liaised with colleagues in France from L'Institut de Veille Sanitaire and the Lille Poison Centre, who did not consider the incident to be a serious threat to public health. The Lille Poison Centre, which is responsible for the affected area, received less than 50 calls in relation to the odours and none of the enquirers suffered any ill health effects[8]. It is suggested that responders consider the relevant frameworks that are in place through the EU and the HPA's international partners to ensure they know who to contact for information in future incidents. 'EU Ddecision for serious cross-border threats to health' (see page 39) further discusses the need for coordinated notification and response to cross-border incidents with the potential to impact on health.

Acknowledgements

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Sewers, culverts and other underground pipes – an under recognised pathway for chemical exposures in acute incidents: case series

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Introduction

Urban areas have an extensive network of subsurface utilities, such as underground sewers and other water pipes, which connect to houses. These utilities vary in size, water carried and purpose. Drains are pipes that take foul sewage (waste from toilets, bathrooms and kitchens) and surface water (rain water) away from a single property, and lie within that property's boundary. Culverts are closed conduits used to convey water from one area to another and vary from short culverts to carry streams under roads to more extensive culverted watercourses often created to enable building on a site. There are also trenches which carry utilities such as gas or electricity that are surrounded by porous backfill material[1].

While this extensive network of subsurface utilities is critical to sanitation and public health, it can also act as a preferential pathway for odours and chemical vapours to enter the home[2]. The problem of these underground utilities acting as a preferential pathway is not unique. There have been a number of cases of volatile contaminants entering homes through various utility penetration points due to underlying contaminated soil or groundwater containing volatile contaminants[3,4,5]. However, these cases are typically chronic exposure scenarios and while they are important to be considered during any investigation of land potentially affected by contamination, they rarely require an immediate public health response.

A series of acute incidents in north west England in which members of the public complained of strong chemical odours in their homes highlighted the problem of contaminants/odours entering homes through preferential pathways. Underground utilities as the route of entry for volatile chemicals or odours into the home in an acute incident are often overlooked, especially as the origin of the contamination source can be a considerable distance from the affected houses.

This paper describes a series of acute incidents in north west England where this pathway has resulted in members of the public being exposed to chemical vapours.

Case study 1: disposal of solvent into a mains sewer

In February 2011, an abandoned stolen tanker leaked 13,500 litres of para-xylene into a drainage system storm overflow. At the time of the incident the fire and rescue service (FRS) carried out a clean-up of the immediate area; however, the quantity of para-xylene which had entered the sewer was unknown. Initially it was not thought to be a concern and only one complaint about odours was received from a nearby public house.

Xylene is a colourless, flammable liquid with a sweet odour that exists in three forms: meta-xylene (m-xylene), ortho-xylene (o-xylene) and para-xylene (p-xylene). The three different forms are known as isomers[6]. Below 13°C para-xylene solidifies; between 13 and 27°C it is a colourless liquid that is insoluble in water; and above 27°C it is a pungent gas. Inhalation of xylene at levels above 100 ppm (435 mg/m^3) can result in dizziness, drowsiness, headache and nausea. Ingestion can result in nausea, vomiting and aspiration.

Five days later, the water company discovered p-xylene solidified in a sewer due to the cold weather at the time of the incident, requiring urgent clearance work due to the public health implications of a vital sewer network being out of action. Additional complaints regarding odours were received in the vicinity of the section of sewer with the solidified p-xylene. The odour threshold for p-xylene is low – it can be less than 1 ppm (1.88 mg/m^3) – and it has a sweet odour. Xylene odours can be detected at concentrations well below levels at which health symptoms would expect to be reported.

Seven days after the spill, an odour complaint was received from a basement car park adjacent to the river. P-xylene was identified floating on the surface of the river, presumed to have entered from a nearby storm overflow. A boom was used to prevent further migration of the p-xylene. Monitoring was undertaken in the car park using a photoionisation detector (PID), which is a portable device that detects total volatile organic compounds (VOCs). The PID detected VOC concentrations of 23–30 ppm (100–130 mg/m^3) in the car park.

A multiagency group was set up to discuss the public health advice required and steps to remediate the sewer. The multiagency group comprised representatives from the local authority, the water company, Environment Agency (EA) and the then Health Protection Agency (HPA). The group concluded that the current levels of p-xylene, while odorous, were unlikely to pose a risk to health. Specialist contractors were engaged to remove p-xylene from the sewers. In order to remove the solidified p-xylene from the sewer system hot water was required to be pumped into the sewer to liquefy the p-xylene and then a vapour extraction system was used. The nature of the remediation works meant that there was the potential for further odours to be produced, so the multiagency group prepared advice for nearby residents that odour may be noticed during the remediation works but that the health risk was low.

In early May 2011, the removal of p-xylene was confirmed, the sewer returned to normal activity and the boom on the river was removed. The costs of this clean-up were significant, estimated to be in excess of £600,000.

Case study 2: solvent groundwater plume ingress into sewer system

In mid-2011, a fire and rescue service (FRS) responded to a call from a member of the public reporting a strong chemical smell and two children feeling unwell. The FRS used its monitoring equipment and detected VOCs, particularly within the basement and first floor of a property. The HPA was informed and enquiries began to determine the source of the chemical and potential public health impacts. Initial information suggested a link with a chemical works in the area; however, this was located approximately 800 m from the incident and no reports from the company had been received of a leak or any other members of the public being unwell.

A multiagency response was established and it became apparent that this was an acute exacerbation of a chronic incident. Approximately 25 years ago there was a leak of toluene and xylene into the ground from the chemical works. Toluene, like xylene, is a clear, colourless flammable liquid with a sweet, pungent odour[7].

The leak of solvents was not detected for some years, which led to the underlying shallow groundwater becoming contaminated and the migration of a plume of solvents off-site. The chemical works had been undertaking remediation work on the groundwater through boreholes on-site for a number of years. It had received very occasional odour complaints (typically one a year) from nearby residents. However, early in 2011, the number of complaints increased to around one or two per month. Investigations by the water company tracked vapours along sewers, indicating that the contaminated groundwater plume had managed to enter the sewer system.

The solvents in the groundwater plume were thought to have entered the sewer system because they are non-aqueous and less dense than water so float on the groundwater table. As the water table rose or fell past the old Victorian brick built and unlined sewer, solvent could enter the sewer system and thus vapours could migrate into homes. The sewer system was also in poor condition with a collapsed section (approximately 5 m in length). Jetting of the sewer system by the water company to remove silt sediment was thought to have facilitated the migration of groundwater into the system and thereby lead to the resultant increase in vapours and increased complaints from nearby residential properties.

The multiagency response group provided advice to local residents to ventilate their properties. Indoor air monitoring was also carried out in domestic properties in response to complaints. The collapsed section of the sewer was repaired and the remainder relined to prevent the contaminated groundwater entering the sewer. The repair measures resolved the complaints and no further odour issues were identified. Long-term remediation of the groundwater plume is still ongoing.

Case study 3: resin repair to culvert

In March 2012, the Environment Agency undertook repair works on a culverted brook that was located in the rear gardens of a group of residential properties. The culvert was around 100 years old and in poor condition, with a high probability of collapse occurring, which would result in a flooding risk. The culvert was around 2 m deep and approximately 1.5–2 m in diameter. The preferred option for the remediation was a method known as cured in place pipe lining (CIPP) using steam inversion. CIPP is a common, cost-effective method for repairing underground pipes and does not require excavation works, which would disturb the gardens. This technique uses a thermoplastic tube, saturated with thermosetting resin, usually styrene based, to create a new lining around the inside of an existing pipe. The tube is inserted into the culvert and then filled either with steam, water or ultraviolet light. This causes the resin to polymerise and harden against the culvert wall. The process is complete once the new pipe has fully hardened.

The thermosetting resin contains a number of odorous compounds including styrene which can be detected at very low levels, typically well below 1 ppm (4.2 mg/m^3). This means it can be smelt at levels well below those which can cause health effects. Styrene also has the potential to linger in groundfloor/basement/cellar areas as it is heavier than air at room temperature. Short-term exposure to low concentrations of styrene can typically cause symptoms such as discomfort of the eye, nose and throat irritation[8].

In the case of this culvert, a 200 m stretch was lined by contractors and filled with compressed air and steam. The reaction with resin is exothermic (releases heat) so contractors are able to monitor the temperature and establish when the 'curing' process is complete and the resin has hardened. In this case sufficient temperature of the liner could not be maintained to achieve the curing. The contractors used an additional compressor to try to achieve this; however, the final cure was not achieved until 3 days later. The extended curing period in close proximity to residential properties generated a number of complaints concerning odour, and health effects such as headaches and nausea were reported. A number of households were relocated to stay with relatives or in hotels.

Subsequent investigations indicated that a small breach occurred in the liner during the early curing process. This caused steam containing styrene to escape and enter nearby properties, most likely through connections to the culvert.

Discussion

These case studies demonstrate that sewers and culverts can be a preferential pathway for vapours in acute as well as chronic incidents. Vapours can travel long distances through the sewer network and thus the household(s) affected are not easily predicted, especially if the sewer network is not considered as a pathway by the above-ground responders. In the response to such an incident, understanding of the underground utilities helps to identify properties and people at risk of exposure, and those to be targeted for information and control measures. This can only be achieved by effective multiagency working combining knowledge of toxicology, physical chemistry, environmental science, engineering processes, sewer networks and public health among others. This knowledge is not the domain of any one agency or organisation.

The public health messages are challenging in such incidents as the risks and the uncertainties have to be communicated. Initial control measures, such as ventilating homes, are not always practical in the medium- to long-term. Ventilation of houses is effective for volatile chemicals but reduces temperatures within the home, potentially making the house uninhabitable. Equally, ventilated and/or evacuated homes are often insecure as doors and windows are open. Public health messages need to consider the practical challenges in implementing such messages.

Debriefings from these incidents highlighted the need for an early multiagency response, and in some cases proactive communication between agencies prior to remedial works commencing where there may be public concerns. This enables a clear action plan to be developed prior to work commencing. The plan should consider acceptable concentrations of chemicals at receptors, actions to be taken if raised concentrations are detected, possible health effects and criteria for evacuation and subsequent return.

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Acute risks from contaminated land

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Introduction

Within the UK there is a legacy of land contamination due to past industrial activity and historical waste operations. This land may have since been redeveloped or acquired new uses such as housing, resulting in the need to assess the potential risks from residual contamination in the ground. In assessing land contamination, the primary concern is usually the chronic (ie long-term) risk to health. This is because most contaminants would be present at low levels and would take a number of years of exposure to potentially affect health. However, there are a few exceptions: where there are particularly high concentrations of contaminants, it may be necessary to consider whether an immediate effect could occur or if the particular contaminant present could be toxic even at low concentrations (eg cyanide).

Currently within the UK there are only published guidelines for assessing chronic exposure from land contamination[1] and very limited information on assessing risks from acute exposure to contaminants in soil. This can make it very challenging to assess potential acute risk to health when looking at land affected by contamination. This article presents an example of a site where acute risks from land contamination were a concern and the advice that the then Health Protection Agency (HPA) provided.

Case study

The site is situated in north west England and is used as an informal open space and short cut by dog walkers and pedestrians. Historically the site was used as a tip for wastes from the nearby gas manufacturing plant. The waste material was deposited against the natural slope of a major river corridor to form a plateau approximately 70 m by 30 m (Figure 1).

The tip area consists of bare soil/waste materials and is mainly devoid of vegetation. The surrounding areas consist of partly wooded areas and an informal network of footpaths, including the one across the main tip area.

Figure 1: The plateau area of the tipped waste

The waste at the tip arose from the process used to remove impurities from manufactured gas. Initially lime and later 'bog iron-ore' was used to precipitate out the hydrogen sulphide and hydrogen cyanide impurities as iron sulphide and various cyanide compounds[2]. These resultant waste compounds are often referred to as 'blue billy' owing to their distinctive 'blue-green' colouration[3].

Historically there had been several site investigations at the tip, starting in the late 1970s. The most recent was an investigation by the local authority environmental health department in 2011 to determine if it met the definition of 'contaminated land' as set out in the Environmental Protection Act 1990. During the site investigation it was noted that recent disturbance of the tip surface had occurred due to informal bike scrambling. In addition, within the areas of bare soil there was observed to be small, but visible deposits of 'blue-green' material at the surface (Figure 2). This prompted the local authority to be concerned about potential acute risks to the public from exposure to contaminants in the tip material. In particular, there was a concern that children accessing the site, with their inquisitive nature, may preferentially seek out the blue coloured materials, which potentially contained high concentrations of free cyanide.

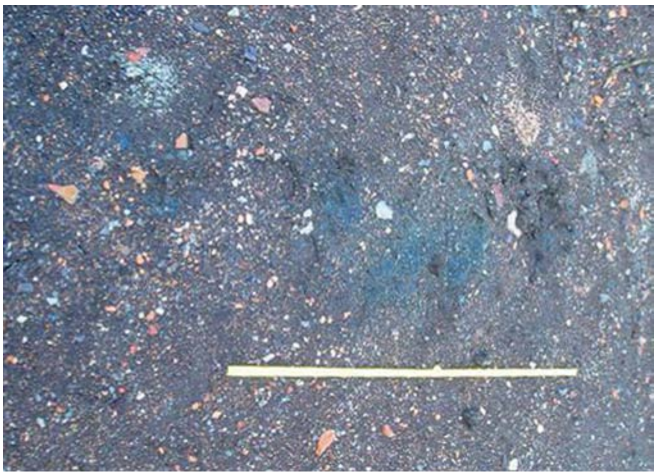

Figure 2: View of coloured deposits (1 m ruler alongside for scale)

Why is free cyanide a concern?

The most toxic form of cyanide (CN) is free cyanide (fCN). Not all cyanide at land affected by contamination may be in the form of free cyanide. Other forms of cyanide include complex cyanide, such as ferric ferrocyanide, which is relatively non-toxic[4].

Cyanide compounds are acutely toxic to humans and death can occur rapidly after ingestion of relatively small amounts, ie a few grams[5]. The acute dose-response curve for cyanide rises steeply from a no-effect level to a lethal level (ie there is a small margin between these two exposure levels). Cyanide toxicity results from inhibition of cytochrome oxidase, thereby limiting the absorption of oxygen at the cellular level. Acute toxic effects of cyanide include loss of consciousness and breathing difficulties[5].

Risk assessment

A specialist consultancy undertook the site investigation and risk assessment for the local authority including obtaining 12 samples of the blue deposits at the site. These samples were sent for analysis to a laboratory to determine the concentration of free cyanide. In order to assess the health risk posed by these deposits the concentrations of free cyanide needed to be compared to a health-based assessment criteria. The initial assessment undertaken by the consultants was based on the tolerable daily intake (TDI) of 12 µg CN per kg bodyweight (bw), published within the Environment Agency TOX 5 report for inorganic cyanide[6], which is designed to be used as a health criteria value (HCV) for long-term oral exposure arising from cyanide-contaminated land.

There are no published assessment criteria (eg soil guideline values) for free cyanide, therefore in order for the consultant to assess the health risk it was necessary to derive a suitable assessment criteria value. The consultant derived an assessment criteria of 41 mg/kg, which was designed to be protective against acute risks should a small amount of soil containing free cyanide be ingested. The assessment criteria were derived using the calculation in the box.

Box: Consultant approach to deriving assessment criteria for free cyanide

Soil assessment criteria (mg/kg) = TDI x bw/dose

where

tolerable daily intake (TDI) = 0.012 mg/kg bw/day
(EA TOX 5 report[5])

bodyweight (bw) = 17.2 kg (average bodyweight for a 3–6 year old)

dose = 5 g (one-off bolus dose, equivalent to a teaspoon of soil)

Note Difference in units: conversion required before calculation

The maximum concentration of free cyanide detected within the samples taken by the consultant was 1384 mg/kg, therefore when compared to the derived assessment criteria of 41 mg/kg it was clear that there was a potential risk to health. The TOX 5 report specifically states:

> 'The TDIs derived here are appropriate for chronic exposure. When assessing the risks from contaminated soils, it will also be necessary to take account of the risks from short-term exposure to inorganic cyanide, which may be important given its acute toxicity. The lowest reported fatal oral dose for humans is 0.56 mg CN kg^{-1} bw, which is nearly 50 times greater than the recommended TDI oral of 12 µg CN kg^{-1} bw. Given the steepness of the dose-response curve for acute exposure, and the speed and efficiency of detoxification … **ingestion of a bolus dose of cyanide equivalent to the TDI would not be expected to cause any acute toxicity.**'[5]

The risk assessment undertaken by the consultant provided a suitable approach for an initial indication of the potential level of risk. However, it is not possible to establish whether an acute risk is definitely occurring as the assessment criteria is based on a TDI which is in effect a conservative safe level of acute exposure, based on long-term exposure rather than acute exposure. However, exceeding the TDI on a single day does not indicate that a health effect will arise. The more a TDI is exceeded, the more chance there is that a health effect could arise. The precise level of exceedance of the TDI that would result in an acute health effect was unknown. Therefore the local authority asked the HPA for advice as to the whether the concentrations at the site were an acute risk to the health of the public.

Toxicology of free cyanide

While it is well known that cyanide compounds are acutely toxic, the dose-response profile of the acute toxicity of cyanide is not particularly well characterised[6]. There is data available on single oral intakes that have resulted in death (eg obtained from suicide events), but there is a paucity of characterised information to identify a threshold dose of cyanide for the onset of acute toxic effects, such as loss of consciousness and breathing difficulties.

To assist in informing the acute risk assessment the HPA undertook a preliminary review of the available toxicological information for free cyanide to try to establish how high above the TDI a single bolus exposure would need to be to give rise to acute toxicity. It was not possible to define an acute oral no observed adverse effect level (NOAEL) which could be used for risk assessment purposes of accidental or deliberate soil ingestion. However, the review did identify an acute lowest observed adverse effect level (LOAEL) of 400 µg CN per kg bw that would provide a suitable value for the acute risk assessment. This acute LOAEL was based on a clinical study of cyanide exposure in some cancer patients given as a single oral dose of 0.5 g of amygdalin, estimated to be equivalent to an oral dose of 0.4 mg of hydrogen cyanide per kg bw[7].

Further risk assessment

The local authority undertook further sampling to increase the understanding of the free cyanide concentrations present at the site. A number of the blue coloured deposits were taken and combined to provide a sufficient sample for analysis. Three final sample masses were obtained in this way, crudely representing deposits with different colour intensity. The results are shown in the table.

Table: Cyanide content of coloured deposits

Sample colour intensity (subjective)	Total cyanide (mg CN per kg)	Free cyanide (mg fCN per kg)	Percentage of free cyanide to total cyanide
Light	4803	1545	32
Medium	2741	702	26
Dark	8904	1044	11

The results indicated no obvious association between the subjective assessment of colouration and free cyanide content. However, the ratio of free to total cyanide in the tip area was identified to be much higher than in other areas of the wider site.

The risk assessment was repeated using the LOAEL derived from HPA's review and assuming a 5 g worst-case value for a one-off ingestion mass and 10 kg bodyweight for a child. The 5 g ingestion mass was considered to be equivalent to the amount that could be ingested by an inquisitive child, either accidentally (eg by licking contaminated hands after handling blue deposits) and/or deliberately tasting or swallowing fragments of the deposits (ie pica type activity)[8]. A bodyweight of 10 kg was used in the risk assessment, this being a commonly used default value for young children in environmental risk assessments. From this a reasonable worst-case assessment could be made using the maximum concentration of free cyanide detected at the site, ie 1545 mg/kg. Therefore a 5 g deposit with 1545 mg/kg is equal to a dose of 750 µg/kg bw/day for a 10 kg child. This exceeded the acute LOAEL of 400 µg CN per kg bw, indicating there is a potential for an acute toxic dose to occur at the site.

Based on the results of the risk assessment and other evidence, the local authority determined the site as 'contaminated land' under Part 2A, Environmental Protection Act 1990. While long-term remediation options were being reviewed, the local authority implemented immediate control measures to prevent members of the public coming into contact with tip materials, including:

- signage to warn the public to avoid undertaking high risk activities (Figure 3)
- fencing off areas of the site
- re-seeding the bare soil to minimise potential contact with deposits

Figure 3: Signage put in place to warn members of public to avoid high risk exposure activities in the area of the waste tip

Discussion

Undertaking acute risk assessments are uncommon in land contamination because the hazards encountered usually present chronic risks to health from long-term exposure to contaminants. However, this case study demonstrates the potential for acute public health risks at some sites affected by contamination. There are currently no published UK guidelines on assessing acute risks from land contamination. Establishing suitable toxicological data for acute risk assessments can be challenging as there is often a paucity of available published data.

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Kowalczyk G, Brown M, Twigg R et al (2013). Contaminated land: can acute exposure be a significant health risk? Two case studies and associated risk assessment methods. Environmental Science Processes and Impacts, 15, 1859–1865.

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MSC Flaminia – public health assessment and contribution to the places of refuge assessment

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Background and incident overview

On 14 July 2012 the cargo vessel MSC Flaminia was mid-Atlantic on its way from the US to Antwerp, Belgium, when an explosion and fire occurred on board. The crew attempted to tackle the blaze but were forced to evacuate. The incident resulted in three injured crew and two fatalities. A Dutch salvage team was appointed to deal with the vessel, which brought the fire under control by 24 July, and proceeded to tow the casualty towards Germany, which would involve passage through the English Channel.

The vessel, nearly 300 m long and 40 m wide, was almost fully laden at the time of the accident, including 149 containers of dangerous goods. The EU Directive 2009/17/EC[1] requires the Secretary of State's representative (SOSREP) to nominate possible places of refuge (PoR) for vessels in need of assistance along the English coast when necessary. Due to the nature of the cargo on board, the process of identifying PoR required assessments of the risks not only to the marine environment, but also to public health, should the vessel come near the shore. This article describes the multiagency work that was undertaken with respect to nomination of PoR and assessing the risks from the passage of the vessel through the English Channel.

Command and control structure

The national contingencies plan for marine pollution from shipping and offshore installation (NCP)[2] is the response plan for dealing with maritime incidents and is maintained by the Maritime and Coastguard Agency (MCA). The NCP describes various emergency response cells which would be stood up in the event of an incident, each dealing with a specific aspect of the response. One of the cells, the environment group (EG)[3], assesses the risk to the environment and public health. It has an advisory role to SOSREP, MCA and the other response cells accordingly.

Standing environment groups (SEG) are multiagency bodies responsible for particular areas of coastline. A SEG is responsible for planning for marine incidents and will be activated to provide advice during a marine pollution incident. Agencies represented on these groups include the Environment Agency (EA), Natural England (NE), Public Health England (PHE), Natural Resources Wales (NRW) and Public Health Wales (PHW).

Place of refuge (PoR) process

The International Maritime Organization has produced guidelines for the provision of a PoR, the legal requirements of which are formally described in EU Directive 2009/17/EC. These guidelines place a requirement on a national competent authority to identify suitable ports or places where a vessel can take refuge in order to be repaired and prevent further environmental damage. In the UK the responsibility for nominating PoR falls to the SOSREP, who relies on EGs to provide material to aid decision making.

Immediately after the explosion on MSC Flaminia the crew was evacuated and given medical treatment and shelter on the UK mainland. Initially the EG focused on the threat to the natural environment as the vessel was over 250 miles offshore and it was feared that there could be a complete loss of the ship and cargo. However, as time progressed this scenario became unlikely and a PoR request was made (August 2012) to bring the ship closer to the shoreline due to inclement weather. This request required EGs around the coast from South Wales to Brighton to provide SOSREP with options for suitable PoR. As part of this process, maps were produced by the then Health Protection Agency showing the proximity of the locations to sensitive human receptors.

In addition to the EG's response, Cornwall Council held daily SCGs to plan possible responses to the risks posed to Cornwall's shorelines and associated population centres (see below).

Human health implications

Once the ship was stabilised the greatest concern was to the shoreline's human population due to emissions to air of hazardous and noxious substances (HNS* from damaged containers on board.

MSC Flaminia was originally laden with 149 containers of dangerous goods. The initial explosion at sea destroyed some of the cargo, therefore details of the remaining hazardous

* A hazardous and noxious substance is a substance other than oil which, if introduced to the marine environment, is likely to create hazards to human health, to harm living resources and marine life, to damage amenities or to interfere with other legitimate uses of the sea.

goods on board and their containment were uncertain. The manifest listed some generic groups of materials which did not allow specific hazardous properties of a substance to be considered. Some containers only held residues rather than being full of toxic substances, further complicating establishing a reliable estimate of the potential emissions. Where individual substances were listed it was immediately obvious that there were potentially large quantities of highly toxic gases. The cargo included up to 20 tonnes of methyl bromide, 10 tonnes of phosphorus trichloride and 5 tonnes of carbon tetrachloride.

A rapid risk assessment was performed using the cargo manifest, by initially sorting substances by quantity and considering air quality thresholds of effects (such as acute exposure guideline levels, AEGLs), where available. This process identified phosphorus trichloride as the individual substance of greatest concern. However, the manifest also contained a large quantity of materials classified in broad generic groupings that could not be screened in this manner (eg environmentally hazardous substances).

Worst-case risk assessment

The EA undertook dispersion modelling of hazardous emissions from a theoretical worst-case release. This was evaluated for the potential public health impact by identifying situations where predicted air concentrations exceeded toxicity thresholds. The theoretical worst-case scenario involved the entire release in pure form of the inventory of the known chemicals on board, and dictated that the vessel should not be brought closer than 8 nautical miles from the shore to ensure that chemical concentrations in the air did not exceed toxicity thresholds for the population on land.

Following the production of the worst-case evaluation, the SOSREP requested that a more realistic release scenario be considered to assist with ongoing decisions regarding the salvage operation. The SOSREP asked for the revised scenario to include an assessment of the likelihood of release. It was also agreed that the worst-case scenario was so unlikely that it was only of limited value in making decisions about viable PoR.

This additional requirement to assess the likelihood of release proved difficult at the time due to the uncertainty over the exact quantity and physical state of hazardous material left on board. A chemistry report was produced by the salvors (who had been employed to salvage the vessel and take it to its final destination), but it was not shared with the EG until 5 days after it was produced.

The salvors were best placed to undertake sampling to support the risk assessment during their recovery of the vessel. When deemed safe they boarded the vessel and undertook ‘one-off’ short-term air sampling using Tedlar bag and adsorption tubes. The sampling results were sent to the HPA which provided advice on the potential public health risks associated with the potential chemical exposures. The results provided some reassurance that there were no significant emissions at that time, but the assessment was severely limited due to the short sampling times and limited number of samples taken.

Final actions

In early September 2012 the MCA received information from the salvors which suggested that the vessel condition was stable and that the vessel could be moved through the English Channel and on to its destination without damaging the marine environment, and on this basis the go-ahead was given for the ship to navigate the channel and a PoR was not required.

Learning points

- the response to this incident demonstrated excellent communication between the EG and Cornwall Council response groups, and showed how emergency response plans are sufficiently flexible to optimise efficiency. In this case a formal STAC was not convened, as the EG was best placed to fulfil this role as the incident evolved
- the SOSREP is refining the PoR template for the UK and the material that was produced for this event can be used to update the template for future requests. This should facilitate a rapid and comprehensive response. The focus must be on environment and health risks as required by the SOSREP, with optional separate sections for other local impacts
- due to the uncertainty about the situation on board a vessel at a time of a major incident, it is unlikely that there will be sufficient detail upon which to assess the probability of toxic materials being released. This results in a large number of possible scenarios, ranging from a small release to a release of large quantities of toxic materials. Ongoing projects such as Arcopol (see page 92) are looking at how best to gather information and make these assessments
- some air quality monitoring was performed on board the vessel, but this was of limited value. It would be useful to consider how to refine the sampling protocol for on-board measurement to support the risk assessment for future incidents, and agree sampling procedures in cases where salvors are unable to board the ship
- the chemistry report from the salvage company was not shared with the EG in a timely manner, highlighting that, for future events, the salvage company could be an important source of intelligence for the EG
- the results of the dispersion modelling based on the worse-case scenario indicated that the ship should remain 8 nautical miles from the UK coast. Details of the assumptions used to derive this distance will be provided in future publications. It is, however, worth noting that this

was a highly conservative assessment which could be applicable for similar situations in the future

Conclusion

This incident highlighted the importance of flexible, multiagency emergency plans which facilitated an effective response to a major incident. It also highlighted aspects that could improve how information is analysed and interpreted for future PoR decisions. In addition, it is important to stress that the SOSREP's main priority is the protection of human health and the natural environment.

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Emergency Preparedness and Response

Collaborative working with local resilience forums to prevent an environmental major incident

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Background

The Centre for Radiation, Chemical and Environmental Hazards (CRCE) has been asked on a number of occasions to support local resilience forums (LRFs) in assessing the potential public health risks associated with identified environmental hazards. On all occasions, a gross accumulation of uncontrolled waste was the catalyst to urgently convene a meeting of Category 1 and 2 responders under the Civil Contingencies Act 2004[1]. A major incident had not been declared for any of these situations; specific sites were identified where the uncontrolled accumulation of waste presented a potential public health risk due the fire risk.

Multiagency response to a waste tyre site

In December 2010, the then Health Protection Agency was notified about a substantial accumulation of waste tyres located in a small holding on the perimeter of a town with a population of approximately 20,000. Due to concerns associated with the potential impact on public health and the environment, a strategic coordinating group (SCG) was convened to discuss response mechanisms should a fire occur.

The number of tyres was estimated to be between 800,000 and 1 million, reported to be stored in an unsafe manner. Following previous incidents at the location, the Environment Agency (EA), police and fire and rescue service (FRS) had identified the waste to be at high risk of arson. Due to the quantity, haphazard storage of the tyres and the poor access to the site via a country lane, fears were that a tyre fire could be substantial and protracted. It was estimated the fire could burn for weeks, if not months, with the potential to impact severely on local air quality[2].

The tyres were located above a groundwater aquifer and within 200 m of a river drinking water abstraction point supplying potable water to an estimated 500,000 properties. In the event of a fire, fire-water run-off had the potential to pollute the nearby river and impact on public water supplies through contamination of the groundwater beneath the site. There were also concerns regarding the potential for run-off to impact on the local water treatment works. The water company advised this could result in the local population being without their public water supply for a number of days, requiring bottled water to be provided the affected properties. In addition, overhead electricity power lines which supplied power to hundreds of local properties arched over the tyre piles. If a fire took hold beneath, the local population could be without electricity for days until power was re-routed.

The SCG tasked a tactical coordination group (TCG) to carry out a risk assessment, identifying the potential impact on health and the environment of an incident at the site (Box 1). An off-site preparedness plan was also produced, detailing roles and responsibilities of partners and a notification cascade to ensure timely notification of all responding agencies. Membership of the TCG included the EA, FRS, police, primary care trust (PCT), HPA, local authority and water company (see Box 2).

Health risk assessment

A health sub-group of the TCG was formed to focus on the public health consequences of a fire at the site. Membership of this sub-group comprised the local consultant in communicable disease control (CCDC) from the HPA Health Protection Unit, environmental public health scientists from CRCE, a consultant in public health from the PCT and the PCT health emergency planner. The health sub-group undertook a health risk assessment detailing the potential hazards associated with the site, the likelihood of an incident associated with these hazards and the potential impact on public health, and mitigating actions to be implemented to minimise offsite implications. The group also confirmed there were appropriate notification procedures in place in case of an incident at the site, in and out of hours (see Box 2, notification cascade).

Outcome

After unsuccessful attempts to contact the operator of the business, the EA made the decision to access the site, seize the tyres and undertake emergency works using its powers under Section 109 of the Environment Act 1995[3]. As a result of the health risk assessment and multiagency concern about the site, this action was brought forward, resulting in the site being made safe over a period of days, rather than the initially intended months. In the meantime, 24-hour security was brought to the site. The sub-group met often and regularly reviewed the risk assessment until the risks associated with the presence of the tyres on the site were adequately controlled.

Box 1: Health risk assessment template produced to support multiagency response to waste tyre site (amended to reflect recent command and control changes in public health) (based on LRF risk assessment template[4])

Health risk assessment

Hazard/threat category

Industrial incident: major fire

Hazard description

Overview of hazard:

- details of waste involved: waste tyres
- site location; identification of sensitive receptors (details redacted)
- concerns associated with incident at site: impact of smoke on local air quality, impact of water run-off on local water supplies

Historical evidence	Details of previous similar incidents nationally
Likelihood	Predicted likelihood of incident: • tyres being stored catching fire and resulting in major air quality from the resulting smoke and/or water quality pollution problems
Impact	Potential impact on the environment and health: • predicted estimation of fire duration • predicted impact of plume on local community: evacuation/sheltering considerations; modelling predictions • predicted impact of run-off on private water supplies, rivers
Overall assessment	**Outcome*** **Impact*** **Likelihood*** **Risk***
Actions to minimise off-site implications of an incident on site	Controls to reduce potential risk to the environment and human health of the tyre storage: • 24-hour site security • mitigating measures, eg fire breaks and reduction in size of piles on site • drainage assessment to identify pathways and receptors of any site run-off; insertion of bunds to minimise off-site run-off • off-site preparedness plan detailing roles and responsibilities of partners and notification procedures (see Box 2) • arrangements for national air quality monitoring • development of communications plan • notification plan for water companies in case of incident with the potential to impact on waste supplies in local area • mitigating measures to minimise run-off from site

* Impact, likelihood and risk updated throughout response

Box 2: Off-site plan for (xxxx)

Section 1: Notification cascade

Incident occurs, eg fire

Security guards on site

Emergency services required?

Fire control alerted via 999 call

Fire control to call police, LA emergency planning, Environment Agency and ambulance service

Police control room will:
dependent on emergency situation call any further assistance if required

Environment Agency incident control service will:
contact environment management duty officer
EMDO will contact area base controller

County council duty emergency planning officer will:
contact county council on-call silver and gold officers
district councils
crisis support (on standby)

Ambulance control room will:
trigger HazMed protocols (if available)
PHE health protection team

Section 2: Activation of off-site response and key procedures

Police off-site commander roles and responsibilities, including:
- initial traffic management
- evacuation procedures
- security of unoccupied properties

Fire and rescue service roles and responsibilities, including:
- determine FRS marshalling areas (RVPs)
- request CHEMETS

Public Health England roles and responsibilities, including:
- undertake risk assessment within PHE major incident support pack
- contact CRCE for specialist chemicals advice
- work with public health to provide an assessment of the incident's potential impact on the local population's health
- (CRCE) consider the need to establish an AQC
- consider the need to enhance local surveillance systems

District council roles and responsibilities, including:
- establish rest centres
- enable homelessness services
- provide environmental health support

NHS England roles and responsibilities, including:
- liaise with PHE to ensure that specialist advice is available from the CRCE
- work with PHE to provide an assessment of the incident's potential impact on the local population's health
- consider the effects on vulnerable premises in the area
- work with PHE to provide advice on public health issues to the general public, responding organisations and NHS organisations
- work with PHE to consider the need to enhance local surveillance systems

Ambulance roles and responsibilities, including:
- deploy HART team
- EOC to report the incident to the designated casualty receiving hospital switchboard operator, using priority numbers held, detailing full details of the incident
- report incident to PHE
- liaise with on-site fire incident commander to determine requirements on site
- assess need to deploy mobile decontamination unit and casualty clearing station vehicles to scene

County council emergency planning duty officer roles and responsibilities, including:
- facilitate strategic coordination of off-site plan and local resilience forum joint emergency response arrangements (JERA)
- inform HSE, EA and additional utility companies as required
- consider deploying key operational officer(s) to site incident control point
- contact scientific services support if required
- consider activation of emergency helpline

Environment Agency roles and responsibilities, including:
open area incident room
- contact national air quality technical advisor (NAQTA)
- NAQTA to liaise with PHE CRCE to feedback from the scene and discuss AQC
- notify water companies
- provide antipollution/containment advice to FRS
- undertake water sampling and arrange emergency sampling as required

Section 3: Road closures
Details of road closure requirements

Section 4: Rest centres
Details of rest centre requirements

Section 5: Public health interventions (initial)
Details of public health intervention (eg consideration of shelter advice and contamination of potable water supplies)

Section 6: GIS map

Section 7: Emergency contact numbers
Details of emergency contact numbers for all agencies involved

Subsequent use of the health risk assessment template – chemical waste processing site

The health risk assessment template has been subsequently tailored for use on a number of occasions to support the multiagency response to sites identified to be of potential public health concern due to environmental hazards. In 2012, CRCE was approached by the EA due to concerns associated with an abandoned chemical waste processing site in a poor state of repair where intermediate bulk containers (IBCs) containing a mixture of unknown substances were unsafely stored.

Following the provision of immediate initial advice, the HPA suggested the need to activate multiagency partners via the LRF. Following discussion between the EA and the local authority, a TCG was convened within days of the initial notification to CRCE. The TCG included representatives from the local authority (emergency planners and environmental health), EA, police, FRS, ambulance service, HPA, PCT, water company and the Highways Agency.

The IBCs were reported to be leaking and stacked four high. There was concern they could collapse and their unknown contents would enter the surface or foul sewers. There was also a risk of fire. Due to safety concerns, access to the site was difficult. This complicated the risk assessment as a very small number of IBCs could be safely accessed and sampled for analysis. The results from the IBCs indicated the presence of mixed organics compounds including pesticides and phenolic compounds.

Local sensitive receptors were identified using GIS mapping, and the health risk assessment template was used to identify potential hazards associated with the site and the potential impact on health. These included:

- smoke from a fire involving unknown substances; a fire at the site had the potential to impact on local air quality. Difficulties accessing the site could impede FRS's ability to tackle the fire, leading to a protracted incident
- pollution risk to air, land or water resulting from spill or release from IBC's contents; previous release of unknown chemical substances past the site boundary had been reported leading to concerns associated with potential inhalation or skin exposures due to the close proximity to a footpath and neighbouring properties
- threat of pollution of controlled waters resulting from poor surface drainage and containment; previous high rainfall had resulted in surface run-off entering a nearby foul sewer via the main road. Previous incidents involving discharge of contaminated waste to a foul sewer resulted in vapour intrusion and odour complaints in residential properties (see page 15). There were also concerns such a release could impact on the local waste water treatment work, disrupting operations, resulting in untreated sewage entering the waterways, causing fish mortalities, and wider public health implications relating to the release of untreated sewage
- intruder access; due to the site being in a poor state of repair, there was concern that intruders could become contaminated and self-present at the hospital emergency department, or be overcome by fumes requiring attendance of emergency services on the site

Sensitive receptors within the local area included a nursery, schools, general practitioner surgeries and medical centre, residential properties and a sports ground. There was also concern that an incident at the site could cause major disruption for all transport routes in and out of the city (road and rail), which could impact on the ability for the emergency services to respond quickly to an incident at the site.

Following the production of the risk assessment a number of controls were agreed at the multiagency TCG to reduce the potential risk to the environment and human health from the site. These included:

- site security to prevent intruder access and increased police surveillance
- mitigating measures, eg bunds to prevent off-site release of spills
- drainage assessment to identify pathways with the potential to impact off-site receptors
- production of an off-site preparedness plan detailing roles and responsibilities of partners and notification procedures
- development of a communications plan, including details of the communication lead for the incident and agencies involved

Discussion

In both of the cases detailed above, no major incident occurred. Activation of multiagency partners through the LRFs proved to be a successful mechanism to convene partners, ensure the relevant agencies were made aware of hazards associated with a site, and through proactive risk assessment, identify appropriate control measures to be instigated.

Feedback following the response highlighted that stakeholders felt there are many benefits in using the health risk assessment template to identify potential hazards which could be associated with sites posing major concerns such as these. This process allowed the agencies to share multiagency concerns and ensure appropriate mitigation measures were put in place to minimise the potential impact of an incident at the site. It also ensured appropriate notification procedures were in place in case of an incident, in and out of hours. Currently the health risk assessment template is being used through a number of LRFs to ensure there are appropriate risk assessments and notification procedures in place following a number of fires at waste processing and recycling installations.

In all of the cases, the local resilience forum risk assessment template was used in a shared multiagency risk assessment found on the Cabinet Office website: https://www.gov.uk/government/publications/emergency-preparedness[4].

Key learning points

- activation of partners through the LRF to undertake a multiagency risk assessment was shown to be a timely and effective way to ensure control measures were put in place to mitigate any identified risk. However, consideration of the appropriateness of activating the LRF is paramount and identifying which multiagency partners should be involved is key to its success. The appropriateness of all incident management options should be considered prior to activation (see the figure)
- Civil Contingencies Act guidance exists on when activation is appropriate[4]
- only limited information may be available to support the health risk assessment process, leading to discussions about possible scenarios and 'what ifs'

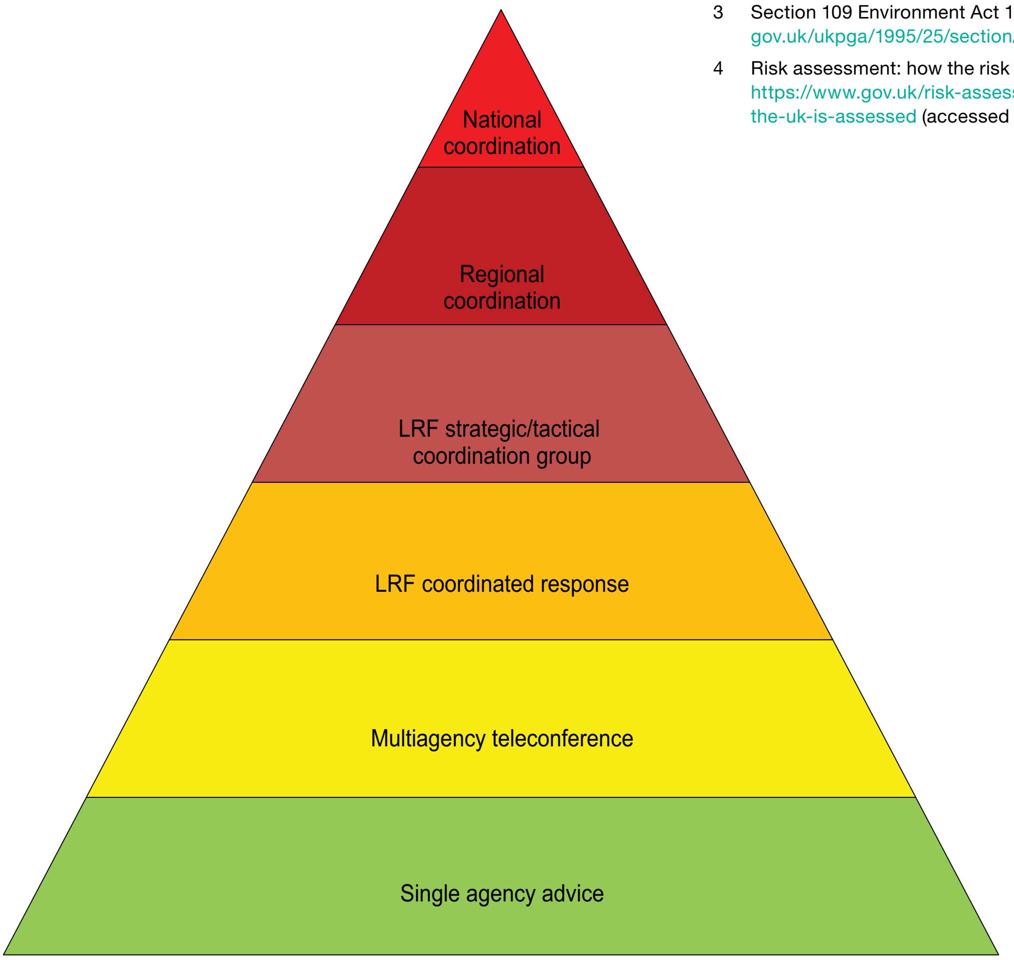

Figure: Hierarchy of incident management options

- given the complexities of public health roles and responsibilities, a health sub-group was formed outside the SCG and TCG meetings to focus discussions. Attendees of a heath sub-group may include public health and environmental health from the local authority, PHE, ambulance service, NHS England and clinical commissioning groups who may need to be consulted. Not all these organisations have representation at the LRFs but their attendance should be considered
- the health risk assessment template should be treated as an evolving document. It is important to reassess the risks associated with the site as mitigation actions are undertaken and control mechanisms put in place
- identification of key contacts and attendees for each agency involved early on was key to the success of the LRF multiagency response due to the dynamic nature of the risk assessment

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Transition to new health arrangements: Public Health England's exercise assurance programme

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The Department of Health's Emergency Preparedness, Resilience and Response (EPRR) Partnership Group commissioned Public Health England (PHE) to develop and deliver a series of exercises to test the effectiveness of the new health arrangements, which were introduced by the Health and Social Care Act 2012 in April 2013. This work was undertaken by PHE's Emergency Response Department (ERD).

Over 2000 health professionals from the NHS, PHE and multiagency partners including local authorities have contributed to and participated in this extensive 18-month programme. There have been eight regional level workshops and ten tabletop command post exercises to test incident coordination centres at a regional and national level. The programme culminated in a test of the EPRR Partnership, NHS England and PHE national level incident coordination centres providing information to a simulated Cabinet Office Briefing Rooms (COBR) against the scenario of a deliberate anthrax release.

Exercise Paladin: health system pressures with a chemical incident

The programme included Exercise Paladin that was designed to assess the local and regional health response to a major incident. The exercise scenario included a toxic plume and this component was developed with specialist advice from the Centre for Radiation, Chemical and Environmental Hazards (CRCE) of PHE.

Delegates participated in three sessions during the exercise. In the first two sessions, delegates responded to a developing major incident scenario with a background of severe winter pressures. A breaking news bulletin in session one introduced a serious rail crash involving a freight train carrying epichlorohydrin, in which the collision breached the chemical containment. The resulting fire combusted the epichlorohydrin and, for the purposes of the exercise scenario, no liquid form of the chemical escaped.

The chemical release was a serious public health hazard and stimulated the formation of a science and technical advice cell (STAC). Due to the release to air, a multiagency air quality cell (AQC) chaired by the Environment Agency was also convened. The exercise suggested there is some uncertainty about roles within the AQC and its liaison with the STAC: the Environment Agency shares monitoring data with CRCE, which interprets the information and provide recommendations to the STAC. This process was captured as a lesson identified and requires incorporation into relevant response plans.

Lessons identified

In addition to developing and delivering the programme, the ERD exercises team has produced 18 exercise reports to capture the lessons identified (such as the point above regarding the role of the AQC during a major chemical incident) and best practice identified in each event. There were many region-specific lessons, but three areas of concern were consistently identified across the exercises:

- lack of clarity on the role of the local authority director of public health in incident response
- lack of clarity on the role of the NHS clinical commissioning groups in incident response
- importance of achieving a coordinated health message to warn and inform the public during a major incident

Many of the tactical and operational lessons identified have been addressed and the national-level issues have helped to inform guidance and strategy on roles and responsibilities during major incidents. This should help to improve the coordination between PHE and the NHS.

This ERD exercise programme was included in the external audit, by Price Waterhouse Coopers, of the EPRR Partnership and PHE's EPRR capabilities, and was highlighted as an example of good practice.

Participants attending a regional health EPRR workshop in the north of England

The Control of Major Accident Hazards (COMAH) Regulations – forthcoming legislative changes and the role of Public Health England

These PHE articles provide an overview of the role of Public Health England in the planning, preparedness and response to chemical incidents under the Control of Major Accident Hazard (COMAH) Regulations. The articles specifically address potential public health aspects, and collate and present good practice in public health. They are aimed at public health professionals and those responsible for the preparation and exercising of off-site emergency plans in England and Wales.

This first article introduces the COMAH Regulations and the role of PHE. It explains the relevance of the legislation to public health in England, although equivalent measures apply to Scotland, Wales and Northern Ireland. Public health organisations in England are discussed in general terms and the specific role of PHE is discussed in more detail. The second article provides an overview of the public health information within off-site emergency plans.

Part 1: COMAH and the role of Public Health England

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Introduction

The Control of Major Accident Hazards (COMAH) Regulations 1999[1] (as amended in 2005[2], 2008[3] and 2009[4]) bring into force the requirements of the Seveso II Directive (96/82/EC)[5] within Great Britain (Northern Ireland produces its own regulations). Referred to in this article as the 'COMAH Regulations' or 'the Regulations', they implement the Seveso Directive's aim of preventing major accidents involving dangerous substances and limiting the consequences to people and the environment of any accidents that do occur. The Regulations are supported by guidance for operators and stakeholders[6]: this includes recognition and discussion of public health impacts and the need to recognise the role of health organisations[7].

Major accidents have the potential to cause adverse impacts on public health. Public health organisations have a role in the multiagency response to such incidents, and they also have a role in the planning and preparedness mandated by the Regulations. Sites subject to the Regulations are required to prepare emergency plans, requiring consultation with the 'health authority' and other agencies.

Understanding public health

Overview of the response to incidents at COMAH sites

The COMAH Regulations require that every operator shall take all measures necessary to prevent major accidents and limit their consequences to persons and the environment. Enforcement is by the 'Competent Authority' which in England is the joint duty of the Health and Safety Executive (HSE) and Environment Agency (EA). Similar arrangements are in place between the HSE and the relevant environmental agencies in the devolved administrations.

Sites coming under the jurisdiction of the Regulations are designated as either 'top-tier' or 'lower-tier' sites when dangerous chemicals in the quantity prescribed in the legislation are stored or used on site, with top-tier sites being those with a larger amount of dangerous chemicals. Top-tier sites are more tightly regulated under COMAH. There are currently around 345 top-tier sites and around 575 lower-tier sites in the UK. These include oil refineries, steelworks, natural gas storage facilities and chemical manufacturers.

Operators of top-tier sites are required to produce a 'safety report' – a very detailed and voluminous technical dossier, within which are contained detailed descriptions of safety and mitigation measures, assessments of possible accident scenarios and potential consequences, both on-site and off-site. From the safety report, operators are obliged to provide sufficient and relevant information to 'local authorities'* which have duties in connection with the preparation, review, revision and testing of off-site emergency plans for top-tier COMAH sites in their area. Top-tier site operators are required to review, revise and test both the on-site and off-site emergency plans.

* 'Local authority' is defined by 'A guide to the Control of Major Accident Hazards Regulations 1999 (as amended)' as: (i) London, the London Fire and Emergency Planning Authority; (ii) an area where there is a fire and civil defence authority, that authority; (iii) the Isles of Scilly, the Council of the Isles of Scilly; (iv) an area in the rest of England, the county council for that area, or where there is no county council for that area, the district council for that area; (v) an area in Scotland, the council for the local government area; (vi) an area in Wales, the county council or the county borough council for that area.

The off-site emergency plan should include adequate arrangements for dealing with the consequences of possible major accidents and the response, in terms of off-site mitigatory action. One of the objectives is to contain and control incidents so as to minimise effects and limit damage to people, the environment and property. A major incident at a COMAH site, or an uncontrolled event which could reasonably be expected to lead to a major accident, should trigger the off-site emergency plan without delay, and result in the appropriate multiagency response. This would normally lead to establishing a strategic coordinating group (SCG – commonly referred to as 'gold command') with possibly a science and technical advice cell (STAC) and an air quality cell (AQC) being formed to provide advice, depending on the nature of the incident.

The preparation of off-site emergency plans is part of a multiagency contingency planning process that involves the 'local authority' and other key Category 1 and 2 responders under the Civil Contingencies Act[8] such as the emergency services, local authorities, health bodies, EA and HSE. These arrangements reflect those in place for other civil contingencies[9]. With changes in the organisation of the NHS and local authority public health responsibilities, the definition of the term 'health authority' used in the COMAH Regulations themselves is no longer up-to-date, but is taken to refer to the bodies responsible for public health and health protection in England (namely Public Health England, public health teams led by directors of public health (DsPH) embedded within local authorities, and NHS emergency planners).

The various health authorities can make a significant contribution, and have interest in all stages of COMAH preparedness and response. In practice, these organisations usually provide health input into the preparation and exercising of off-site emergency plans, and are part of the multiagency response to acute and chronic incidents.

Public health roles and responsibilities

Major accidents have the potential to give rise to a wide range of health consequences and may have far-reaching effects, both on populations local to COMAH sites themselves and on those located further afield.

Health bodies, including those responsible for public health and health protection, play a key role in managing the response to incidents that affect off-site populations. They have specialist knowledge of environmental, chemical and toxicological impacts on human health at both the individual and the population level. During incidents public health organisations provide a range of advice and support to the public, emergency responders and other agencies covering areas such as:

- health risk assessment
- public health risk assessment
- incident management, eg actions to avoid or mitigate risk
- communication

Public health organisations hold information related to the health profiles of the communities that they serve. The information that they collect and access as part of their routine surveillance of population health can inform the health response and follow-up to incidents (such as the rate of presentation to primary and secondary care). They may also undertake health investigations in response to incidents with the potential to significantly impact on public health: for example, where members of the public are exposed to unacceptable levels of pollution.

The different stages in incident response are summarised in Table 1, with additional information on the health care organisations that would also be involved. These health organisations would support the multiagency response, which is likely to be chaired by the police during the emergency phase of an incident.

As well as their response during acute incidents, health organisations can have a role in informing proactive risk assessment and the planning of exercise scenarios. Health bodies have a key role in ensuring that the health aspects are fully considered in the preparation and exercising of emergency plans. For example, local health bodies hold information about local population health and health care facilities (such as their capacity and likely incident impacts on infrastructure and services). Additionally, local councils and health organisations already have established day-to-day working relationships and cooperative networks that are a vital part of communications and incident management.

Future developments – major revision of COMAH Regulations in 2015

In December 2010, the European Commission announced plans for a major revision of the Seveso II Directive, and the final text of a new Seveso III Directive was agreed in the summer of 2012[10]. New UK COMAH Regulations, enacting the new Directive, will come into force on 1 June 2015 (see http://www.hse.gov.uk/seveso/introduction.htm) and will be consulted upon in 2014.

Seveso III addresses changes to EU legislation on the classification, packaging and labelling of chemical substances and mixtures. The Directive also strengthens a number of areas relevant to public health, including many new duties, such as enhanced requirements to provide information to the public for all COMAH sites (both top and lower tier). This includes information on:

- chemicals on-site and their hazards
- risks from possible accidents
- public health mitigation measures

Table 1: Health responses in a major incident at a COMAH site

Incident response	Includes	Timescale	Responsible health organisations
Initial health risk assessment (eg toxicological assessment)	• impact of environmental, chemical and toxicological threats to health of individuals • impact of these threats on health care facilities and other resources	Immediate and recurring	Immediate Ambulance service PHE (health protection teams and chemical units) Followed by STAC (multiagency including health bodies) if set up
Public health risk assessment	Integration of: • initial health risk assessment • local knowledge and relevant situations • needs of agencies and communities • impacts of incident response on health	Immediate, recurring, long-term projections and assessments	PHE (health protection teams and chemical units) STAC AQC (if formed) Local authority public health teams
Public health risk Management	Advice on actions required to avoid or mitigate immediate and long-term risk	Immediate and long-term	Through STAC if set up (lead) PHE (health protection teams and chemical units) Local NHS Local authority public health teams
Public health risk communication	Ongoing communication through the incident with stakeholders including: • incident commander • partner responders • local/affected community • wider community • local politicians and others with community responsibility • senior management of agencies • site operator	Immediate to long-term, depending on content and focus of communication	All (lead – incident commander)

Table 2: Items of information to be provided to the public[10]

Part 1: All COMAH sites	
1	Name or trade name of the operator and the full address of the establishment concerned
2	Confirmation that the establishment is subject to the regulations and/or administrative provisions implementing this Directive and that the notification referred to in Article 6(1) or the safety report referred to in Article 9(1) has been submitted to the competent authority
3	An explanation in simple terms of the activity or activities undertaken at the establishment
4	The common names or, in the case of dangerous substances covered by Part 1 of Annex I of the Directive, the generic names or the hazard classification of the relevant dangerous substances involved at the establishment which could give rise to a major accident, with an indication of their principal dangerous characteristics in simple terms
5	General information about how the public concerned will be warned, if necessary; adequate information about the appropriate behaviour in the event of a major accident or indication of where that information can be accessed electronically
6	The date of the last site visit in accordance with Article 19(4), or reference to where that information can be accessed electronically; information on where more detailed information about the inspection and the related inspection plan can be obtained upon request, subject to the requirements of Article 21 (ie confidentiality and security considerations)
7	Details of where further relevant information can be obtained, subject to the requirements of Article 21 (ie confidentiality and security considerations)
Part 2: For upper-tier (top-tier) sites (in addition to the information referred to in Part 1 above)	
1	General information relating to the nature of the major-accident hazards, including their potential effects on human health and the environment and summary details of the main types of major-accident scenarios and the control measures to address them
2	Confirmation that the operator is required to make adequate arrangements on site, in particular liaison with the emergency services, to deal with major accidents and to minimise their effects
3	Appropriate information from the off-site plan drawn up to cope with any off-site effects from an accident. This should include advice to cooperate with any instructions or requests from the emergency services at the time of an accident
4	Where applicable, indication whether the establishment is close to the territory of another member state with the possibility of a major accident with transboundary effects under the Convention of the United Nations Economic Commission for Europe on the Transboundary Effects of Industrial Accidents

Details of the new public information requirements are provided in Table 2. This new requirement for the provision of information will raise awareness of the existence of sites and their accident potential among a wider population than is currently informed under the present COMAH Regulations. The level of detail of information to be provided to the public has been extended, and it must now be made permanently available electronically. This contrasts with the current Regulations, under which the public near to top-tier sites must be made aware of what actions they need to take in the event of an incident. This is commonly by way of an information leaflet sent once every three years or so.

Additionally, top-tier site operators will need to provide, on request, either the full safety report or a non-technical summary (NTS) of that information, and the 'public concerned' will need to be consulted on off-site emergency plans.

The competent authorities are expected to engage with PHE for assistance in the drafting of guidance and advice to support the public health aspects of the Regulations, and will have an important role in supporting the provision of public-facing information on chemical hazards, risks and consequences. PHE will be working with the HSE and EA to develop guidance to assist operators and other with the discharge of these new duties.

Further information on the introduction of the new COMAH Regulations can be found on dedicated HSE webpages, http://www.hse.gov.uk/seveso/introduction.htm.

Contact information

To engage PHE locally in matters related to COMAH, Public Health England centres are the first point of contact. Contact details for the PHE centres and the supporting PHE Centre for Radiation, Chemical and Environmental Hazards (CRCE), Environmental Hazards and Emergencies Departments (also called chemical units), are available on the PHE pages of the gov.uk website, www.gov.uk/phe.

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Part 2: Public health information in COMAH off-site emergency plans

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COMAH site (© Cygnor Sir Penfro 2013)

Introduction

The Control of Major Accident Hazard (COMAH) Regulations 1999[1] (as amended in 2005[2], 2008[3] and 2009[4]) (the Regulations) apply to any site that holds dangerous chemicals at or above quantities specified by the Regulations. There are two thresholds defined in the Regulations (Schedule 1). Sites are categorised as either lower-or upper-tier (top-tier) sites depending on the maximum quantities of dangerous chemicals stored on site at any one time. Accidents at top-tier establishments have the potential for more serious public health and/or environmental consequences and therefore the Regulations impose additional requirements on them.

The 'local authority' must prepare an off-site emergency plan for each top-tier establishment in its area as defined by Regulation 2(1). Local authorities vary according to location and administrative arrangements, but in England they are either councils or fire and civil defence authorities.

The objectives of off-site plans, as specified in Part 1 of Schedule 5 of the Regulations, are:

- containing and controlling incidents so as to minimise the effects, and to limit damage to persons, the environment and property
- implementing the measures necessary to protect persons and the environment from the effects of major accidents
- communicating the necessary information to the public and to the emergency services and authorities concerned in the area
- providing for the restoration and clean-up of the environment following a major accident

Off-site plans must contain information specified in Part 3 of Schedule 5. This includes arrangements for alerting responders, providing advice to the public and off-site mitigatory action. COMAH establishments are regulated by the COMAH Competent Authority (CA), comprising the Health and Safety Executive (HSE), the Environment Agency, Natural Resources Wales (NRW) and the Scottish Environment Protection Agency (SEPA). The HSE has published detailed advice and guidance on the Regulations for operators and local authorities[5,6,7].

The Regulations require local authorities to consult 'health authorities' when preparing off-site plans (a term that is also defined in the Regulations). The legislation predates the formation of Public Health England (PHE) (and one of its predecessor bodies, the Health Protection Agency). However, in practice, PHE is usually consulted. This article explores the incorporation of public health information in COMAH off-site plans, by providing a summary of the legal framework for off-site plans, reporting on a study of 15 off-site plans in Wales, and recommends a guidance note for local authorities on what could be included in off-site plans to support the initial public health risk assessment.

Public health risk assessment

Public health risk assessment is not an exact science. In the context of a major incident, decisions often need to be taken by strategic or tactical coordinating groups without necessarily being in possession all the desirable information. A number of risk assessment models exist but most contain four common elements:

- hazard identification
- dose-response assessment
- exposure assessment
- risk characterisation[8]

An understanding of this process provides the background as to why more comprehensive off-site plans would be of public health value in such incidents. The inclusion of more detailed information on hazardous substances within off-site plans would increase the effectiveness of the initial risk assessment.

Findings from a study – top-tier COMAH sites in Wales

Although the Regulations impose certain requirements regarding the information that off-site plans must provide, the exact format and content of off-site emergency plans varies between local authorities. With regard to Wales, the significant difference for the public health content of off-site plans is the inclusion of Public Health Wales (PHW) in the reporting and responding structures, in all other respects the requirements are the same. A recent review of 15 Welsh off-site plans, carried out by the Centre for Radiation, Chemical and Environmental Hazards – Wales (CRCE Wales) and PHW examined the usefulness of information contained within off-site plans to public health responders. Plans were scored based on the presence or absence of certain information, the findings of the review are summarised below.

Site information

- information about the site such as the nature of the process, hours of operation and on-site resources was complete for the majority of sites
- the need for improvements was identified regarding details of transport arrangements for materials and products (47% of plans made no mention of transport arrangements)
- when reviewing the provision of information to the public via company websites (where available) on actions to take in the event of an incident, only 20% of sites referred to their websites as a source of information

**COMAH site
(© Cyngor Sir Penfro 2013)**

Location

- determination of the site location, using site address, postcode, easting and northing (geographic, Cartesian coordinates for a point) references and plans to support this were available for the majority of sites (80%). The remainder of the sites were typically missing the easting and northing information
- the location of vulnerable populations and local receptors was identified in 87% of plans, with 67% of plans additionally identifying areas subject to special consideration (it was not possible to discern if the remainder of the plans had no areas subject to special consideration or had not included the areas in the plan)

Chemical information

- Chemical Abstract Service (CAS) numbers were only detailed in 27% of the plans
- 47% of off-site plans listed products of decomposition/combustion. The need to include details of decomposition/combustion products and their fate was identified as an area for plan improvement
- the majority of the plans (66%) lacked detailed information relating to site/operator capability to undertake monitoring and sampling of emissions. This could reflect a failure to address this in the plans or deficiencies in capability (including equipment and expertise) of the operator to undertake monitoring and sampling

Accident scenarios

- accident scenarios (resulting from prior risk assessment and analysis of critical control points) were generally well described
- additional information pertaining to the estimated likelihood of a particular accident scenario occurring together with an estimation of the possible duration of incidents would be useful

Communications with the public

- copies of information provided to the public were not included in 20% of the plans. There was an absence of an agreed initial public message for use in the event of an incident message at 34% of the sites

Command and control

- locations of command centres were described in 93% of the plans
- definitions of the role of multiagency groups, such as the science and technical advice cell (STAC) and air quality cell (AQC) were found to be inconsistent or absent

Public health roles and responsibilities

- the roles and responsibilities of public health agencies were described well within the plans; however, PHW and PHE CRCE Wales input to the incident response (including STAC) was not well defined

Box 1: Information to be included in off-site plan to assist the public health response

Site information

- nature of process
- number of employees and contractors on-site (including day/night split)
- hours of operation
- on-site responses resources available (containment/fire fighting/monitoring)
- transport arrangements (including unloading/loading)
- if response information is available on a website during an incident (including link to website)

Location (maps should be provided to detail site and critical plant locations)

- site address, post codes and easting and northing
- nearest off-site receptors
- identification of other hazardous sites in vicinity
- key infrastructure (utilities etc)
- vulnerable populations (including schools, healthcare facilities)
- areas subject to special consideration/areas of congregation
- environmental receptors (including water supplies, land etc)
- location and plans of on-site drainage, sewerage systems and discharge locations

Chemical information

- chemicals that exceed COMAH thresholds
- other hazardous chemicals
- chemical names and categories (including Chemical Abstract number)
- quantities of chemicals stored (maximum and typical inventories)
- descriptions of storage arrangements
- form of chemicals stored (gas, liquid, solid) and physical properties
- decomposition products and products of combustion
- health effects associated with exposure
- sources of further information (site/company contacts/MSDS)
- site capability to undertake monitoring/modelling of releases

Accident scenarios

- chemicals involved in scenario (focus on off-site impacts)
- types of accident (chemical releases/fires/explosions)
- predicted impacts on people (including mechanism of harm)
- other potential impacts (neighbouring sites, utilities, environmental receptors, sensitive receptors)
- indication of likelihood of accident scenario
- duration of accident scenarios

Communicating with the public

- copies of public information (released to premises in PIZ, public information zone)
- agreed initial public message (including when and how to issue)
- how ongoing public messages will be communicated
- when and how warning and all-clear will be sounded

Command and control

- trigger criteria for activation of command and control structure
- likely location(s) of silver command/SCG/STAC

Roles and responsibilities

- defined roles of emergency services
- defined roles of local authorities
- defined roles of other external organisations
- PHE-specific roles and responsibilities
- when to contact (including alerts and notifications)
- communication mechanisms (including hotlines, email, fax etc)
- role in STAC and AQC described

Reviews, exercises and recovery

- mechanism for document control
- date plan published and date of next scheduled review
- recovery arrangements
- recovery resources
- recovery following chronic incident

- the role of the emergency services, local authorities and other external organisations and their relationship with public health organisations in the event of an incident were well described within the plans
- the use and description of AQCs and the joint role of PHW and PHE CRCE Wales together with Natural Resources Wales in convening AQCs was identified to be a key point which needs to be addressed

Recovery

- 80% of plans referred to recovery arrangements, most referring to local authority resilience plans
- where resources to aid recovery were mentioned, this focused on recovery within the acute phase; however, 60% of the plans did refer to recovery following chronic incidents

Guidance for the inclusion of information to support the public health risk assessment within off-site plans

Summarising the content of the off-site plans against broad criteria has identified where plans are supportive of the public health role in incident management; however, it has also identified important areas where additional information would be useful. The absence of this information has the potential to impact on the ability of multiagency groups to undertake a timely public health risk assessment in the acute phase of a major accident.

The roles and responsibilities of public health agencies were described well within the plans; however, detail regarding the work undertaken by the multiagency groups, such as the role of STAC and AQC, was inconsistent or absent. The findings of the study have contributed to the development of a better informed set of criteria to be included in off-site plans. These are set out in Box 1.

The review identified variation and the absence of key information within COMAH off-site plans in Wales; however, the expectation is that similar variation is likely for COMAH plans within England. To address the formation of PHE and its role in STAC and AQC groups it is appropriate to reaffirm the roles and PHE's supporting actions (Boxes 2 and 3). The decision as to what level of detail to provide within plans ultimately rests with local authorities; however, early discussions with off-site plan authors has welcomed support for the publication of further content guidance.

Conclusion

Public health risk assessment is a critical element of determining the effective response to an incident at a COMAH site, particularly if there are off-site implications for local populations. In the early stages of responding to a major incident, risk assessments often have to be made without having all the information available. The risk assessment process could be supported by having more detailed information available in off-site emergency plans. The majority of this is not unique to the Regulations; it reflects what is sought by public health responders during the response to any chemical incident. The compilation of off-site plans should be undertaken in an integrated manner with all multiagency partners working with local authorities to ensure adequate and suitable content. Through early engagement with local authorities, scientists within PHE local centres can influence off-site plan content to aid multiagency decision making during incident response.

Box 2

Science and technical advice

A science and technical advice cell (STAC) may be formed in the event of an emergency where there is a requirement for coordinated scientific or technical advice at multiagency strategic coordinating group (SCG or 'Gold') level. If a STAC is required, it will be convened according to the arrangements laid out in a local STAC plan

STAC membership will vary depending on the nature of the incident, but it is likely to include technical advisers from public health and environmental bodies. For incidents that have implications for public health, the STAC is likely to be chaired by a senior public health professional and will lead on the formulation of public health advice. The STAC will agree with the SCG commander the advice to be given to the public regarding health aspects and actions to protect the public, including the consequences of any evacuation or containment policies

Further detail regarding STAC arrangements is provided in published Cabinet Office guidance[9]

Air quality cell

The air quality cell (AQC) is a multiagency advisory group, chaired by the Environment Agency (EA), which can be convened within two hours during a major incident to coordinate air monitoring and modelling. The AQC is a virtual group and meets by teleconference. Partners include the EA, PHE, Met Office, Health and Safety Laboratory, Food Standards Agency and other organisations providing specific expertise as required

The AQC aims to provide timely, interpreted air quality and air modelling information to the STAC (if formed), or to a multiagency group if a STAC is not formed. The AQC will also respond to questions from the STAC or multiagency group. AQC outputs may help to inform on-site fire-fighting strategies as well as shelter/evacuation decisions. However, the AQC should be seen as only one of several decision-making tools available to inform the public health risk assessment. While AQC outputs may not always change public health actions they inform risk assessment

Monitoring and modelling are undertaken under the auspices of the AQC. An AQC may also be informed by outputs provided by operators. If a site has the capability to undertake or arrange monitoring or modelling of releases, then it is helpful to describe this within the off-site plan together with an explanation of how the operator will communicate this information to responding organisations

Further detail regarding AQC arrangements is available from the EA website[10]

Box 3: Public health roles and responsibilities

Public Health England

COMAH PLAN ACTION CARD

1 PHE role

Public Health England is an executive agency of the Department of Health. PHE provides an integrated health protection service to ensure that the public are protected from threats to their health from infectious disease and environmental hazards such as radiation, chemicals and poisons

PHE centres (PHEC) provide a 24 hour nationwide integrated public health service delivering expertise, information and intelligence to public health teams based in local authorities and the NHS tailored to local needs. PHE's Centre for Radiation, Chemical and Environmental Hazards (CRCE) is a source of specialist advice and operational support through PHECs, providing expert advice on the public health risks of chemicals in the environment as part of PHE's emergency preparedness and response

2 PHE notification process

Upon receipt of a notification of an off-site release from a COMAH site via the local PHEC or CRCE, PHE will notify staff through an internal emergency response cascade and activate the relevant PHE response as appropriate. PHE may also alert partners (as appropriate) to the incident, in compliance with the existing science and technical advice cell (STAC) plan. A STAC is likely to be established if the incident has significant health and environmental consequences. The STAC is formed to provide advice to the strategic coordinating group (SCG) by providing scientific and technical advice when required

3 Summary of actions

The local PHE centre, supported by CRCE, will work with emergency responders and the wider NHS in responding to incidents. PHE actions may comprise:

- contacting emergency responders to ascertain details of the incident
- undertaking public health risk assessments
- undertaking exposure assessments
- when appropriate, convening a science and technical advice cell (STAC)
- when appropriate, the Environment Agency and PHE will convene an air quality cell (AQC)
- providing information and public health advice direct to emergency responders and multiagency groups (eg about the toxic effects of released chemicals, protective actions to be taken to protect health, health surveillance, and the need for a major incident health register)
- providing public health advice to the fire and rescue service's incident commander regarding the use of a 'controlled burn'
- advising emergency responders on the health considerations of response decisions (eg evacuation versus sheltering decisions)
- providing health messages for multiagency media statements
- providing information to GPs, hospital staff and public health staff based in local authorities via DsPH and CCGs
- providing public health advice in the recovery phase of an incident

Contact information

To engage PHE locally in matters related to COMAH, Public Health England centres are the first point of contact. Contact details for the PHE centres and the supporting PHE Centre for Radiation, Chemical and Environmental Hazards (CRCE), Environmental Hazards and Emergencies Departments (also called chemical units), are available on the PHE pages of the gov.uk website, www.gov.uk/phe.

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EU Decision for serious cross-border threats to health

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Introduction

The European Parliament and the Council of the European Union (EU Council) have adopted a Decision (legal instrument) on serious cross-border threats to health, which came into force on 5 November 2013[1]. The Decision sets provisions on notification, ad-hoc monitoring and coordination of public health measures following serious cross-border threats to health from biological, chemical, environmental events as well as events that have an unknown origin; it does not cover radiation. The legal instrument applies to all the 28 European Union (EU) member states (MSs) and is comparable to the new International Health Regulations[2] (IHR) in its content and requirements, adopting the all-hazards approach. In this report we discuss the content of the Decision with an emphasis on interpreting the requirements for cross-border incidents involving chemicals and what this means for the EU MSs, including the UK.

This paper describes key concepts of the Decision with respect to chemicals and the gaps that this legal instrument was designed to meet. The following two articles describe collaborative research and development projects part funded under the second EU Health Programme that was specifically designed to address these gaps.

Background

Past cross-border public health threats in the EU, such as pandemic flu in 2009[3] or the *E. coli* outbreak in 2011[4], showed that there are gaps in the resilience and response to events that affect more than one country and that a shared and coordinated approach to the response is of crucial added value. The European Commission (EC) identified a need to improve risk assessment, preparedness and response planning and crisis management, with improved coordination and shared common approaches identified to be central to improving the way that these events are addressed. Regarding chemicals and biotoxins, a need to introduce a formal instrument to cover the management of such hazards was clearly indicated due to the discrepancy with communicable disease legislation (eg reporting chemical events of cross-border relevance with a serious impact on public health was not part of the EU legislation). The need to improve the resilience and response to health threats for the EU is consistent with the Lisbon Treaty in ensuring that all EU policies and activities afford a high level of health protection (Article 168)[5].

What are the gaps and how will the Decision address them?

Rapid alerting and reporting

A gap analysis was undertaken by the EC to assess how far existing European alerting systems cover the monitoring of threats to health, notification procedures, risk assessment and crisis management capacities and structures from the public health perspective[6]. This gap analysis revealed that the existing structures and mechanisms at EU level did not address these threats sufficiently as far as public health is concerned. For example, there are a variety of monitoring and alert systems for different threats at EU level, but these are not systematically linked to EU public health institutions. To address this, an 'all-hazards' alerting approach has been adopted in the Decision whereby all events that constitute a public health emergency of international concern are communicated via one channel, the Early Warning and Response System (EWRS) – see Box 1. The system will also serve to link other sectors in the EC (eg Food and Feed), as well as other EU agencies and international bodies such as the World Health Organization (WHO) via co-notification features. Linkage of other relevant European alert systems such as the Epidemic Information System, Rapid Alert System for Food and Feed and the Rapid Alert System for Chemicals will be explored to facilitate the information sharing between the assessment and management interface.

Box 1: Early Warning and Response System (EWRS) alerting criteria (Article 9 of the Decision)

If an event fulfils the following three criteria then it should be notified via EWRS:

1a It is unusual or unexpected for the given place and time, or it causes or may cause significant morbidity or mortality in humans, or it grows rapidly or may grow rapidly in scale, or it exceeds or may exceed national response capacity

2 It affects or may affect more than one member state

3 It requires or may require a coordinated response at EU level

Inter-sectoral planning and response

The requirement for greater inter-sectoral coordination was demonstrated by the Icelandic volcanic ash cloud and Hungarian toxic red sludge in 2010. Both events had a serious cross-border impact with significant effects on society and demonstrated that these emergencies are not limited to only one sector such as transport, environment or food safety[6,7]. Therefore, inter-sectoral and international collaboration has been recognised as requiring improvement. Under the Decision's provisions MSs have to produce and share national plans (in the first year and three yearly thereafter) on the interoperability between health and other sectors, business continuity plans in case of an emergency, and preparedness and response plans required under IHR. At a European level, enhanced interaction between the EC and the WHO will serve to ensure that the European response is consistent with global requirements[2,8].

Rapid risk assessment

Before the adoption of the Decision, risk assessment of threats due to chemical events of cross-border relevance were undertaken in an informal way by the chemical, biological, radiological and nuclear (CBRN) section of the Health Security Committee (HSC) (eg rapid risk assessments of the potential impact on public health of deliberate release of toxic substances). However, shortfalls in past assessments demonstrated the need for a sustainable and coordinated approach to allow the preparation of a rapid, robust and transparent assessment during a serious chemical event of cross-border relevance[6,9]. This task will be regulated under the current Decision, taking stock of existing mechanisms already available to optimise the EU expertise and avoid redundancy and duplications of efforts: for example, the scientific committees of the EC.

Formalisation and coordination of risk management

To ensure the provision of consistent and coordinated communication and information should an event arise, the Decision sets out requirements for the coordination of response. The HSC, now formally recognised following adoption of the Decision, will be composed of high level officials from each MS and will be responsible for risk management. MSs will consult each other within the HSC, in liaison with the EC, so that all stakeholders are aware of and satisfied with the nature, purpose and scope of measures to combat a serious cross-border threat to health. The Decision takes fully into account the subsidiary and proportionality principles of the EU and MSs – see Box 2.

Awareness of cross-border events

Awareness of emerging events through surveillance has also been recognised as a requirement. Until now MSs have only had to provide operational procedures for epidemiological surveillance of communicable diseases to the EC. The Decision sets out the need for ad-hoc monitoring of other health threats should the need arise. Recent examples of chemical events where European toxicosurveillance would have improved the awareness and public health response include the Czech methanol outbreak (2012) and poisoning from toy beads in several countries (2007)[10,11]. While there is research in this area (see pages 42 and 46 on the ASHTIII and ECHEMNET projects) and activity at the EC level in regard to hazardous chemicals (classification, labelling and packaging regulations) there is no mandated methodology to rapidly capture and collate chemical exposures data in Europe[12].

Box 2: Principles of subsidiary and proportionality (Article 5 of the Treaty on the European Union)

1. The limits of EU competences are governed by the principle of conferral. The use of EU competences is governed by the principles of subsidiarity and proportionality
2. Under the principle of conferral, the EU shall act only within the limits of the competences conferred upon it by the member states in the treaties to attain the objectives set out therein. Competences not conferred upon the EU in the treaties remain with the member states
3. Under the principle of subsidiarity, in areas which do not fall within its exclusive competence, the EU shall act only if and in so far as the objectives of the proposed action cannot be sufficiently achieved by the member states, either at central level or at regional and local level, but can rather, by reason of the scale or effects of the proposed action, be better achieved at EU level

   The institutions of the EU shall apply the principle of subsidiarity as laid down in the protocol on the application of the principles of subsidiarity and proportionality
4. Under the principle of proportionality, the content and form of EU action shall not exceed what is necessary to achieve the objectives of the treaties

What does this mean for the UK?

From 7 March 2014 the UK, as well as the other MSs, will be expected to have a process in place for dealing with cross-border health threats in a timely manner and for notifying and informing the EU through EWRS. It is anticipated this will require an EWRS contact point to be nominated as well as a national representative in the HSC. In the UK this is fulfilled by PHE's Centre for Infections Disease Surveillance and Control (CIDSC) in Colindale, London. A nominated member of PHE's Centre for Radiation, Chemical and Environmental Hazards (CRCE) Directorate will liaise with the EWRS contact point and with the UK HSC members on chemical and environmental events to ensure information is correct and in line with UK views. To ensure consistency of approaches for chemicals and environmental hazards, CRCE Directorate (with relevant technical risk assessment support within CRCE) will also liaise with UK HSC members at the Department of Health.

By 7 November 2014, and every three years thereafter, MSs will have to report to the EC, via the HSC, on their national preparedness and response planning. To facilitate this process for the UK the nominated member of CRCE Directorate will liaise with the UK EWRS contact point to discuss requirements.

The Decision may require information from UK monitoring systems related to chemical and environmental hazard events following a cross-border event. This will be realised by formalising links with UK regulatory agencies, monitoring networks and governmental departments to gather information at a national level of chemical and environmental events (such as exposures and intoxications, volcanic ash and gases, climate change and extreme weather events).

Conclusion

The Decision on serious cross-border threats to health seeks to improve the coordinated response to serious public health events that affect more than one MS. Gaps identified in the current response will be strengthened by the Decision in the areas of risk assessment, preparedness and response planning and crisis management. The Decision will also complement existing IHR approaches and seeks to improve the inter-sectoral response and preparedness to such events. Two other papers in this edition by Orford et al describe collaborative research projects that were part funded under the second EU Health Programme (ASHTIII and ECHEMNET), which aim to support implementation of the Decision and the response to cross-border chemical health threats. Plans in the UK to implement the Decision are well underway. PHE is well placed to ensure that the new regime is adopted efficiently and robustly.

Glossary

The European Parliament and the Council of the European Union	EU Council
European Union Member States	MS
International Health Regulations	IHR
Early Warning and Response System	EWRS
World Health Organisation	WHO
Chemical, Biological, Radiological and Nuclear	CBRN
Health Security Committee	HSC
Classification, Labelling and Packaging	CLP
Centre for Infections Disease Surveillance and Control	CIDSC
Centre for Radiation, Chemical and Environmental Hazards	CRCE
Alerting, Reporting and Surveillance System for Chemical Health Threats Phase III	ASHTIII
European Chemical Emergency Network	ECHEMNET

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Alerting, Reporting and Surveillance System for Chemical Health Threats, Phase III (ASHTIII) – update report

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Introduction

The Alerting, Reporting and Surveillance System for Chemical Health Threats Phase III (ASHTIII) is a collaborative research and development project part funded under the second European Union (EU) Health Programme and is designed to aid the coordinated response to cross-border chemical incidents and poisonings, to reduce their impact on the public. As described by Orford et al in this edition (see page 39), the Decision of the European Parliament and of the Council of the European Union on serious cross-border threats to health (Decision 1082/2013/EU)[1] seeks to address gaps within the response to cross-border chemical health threats. The ASHTIII project seeks to support both the European Commission (EC) and EU member states (MSs) in implementing the Decision for chemical health threats.

Background

Many chemicals are used in the manufacturing of products, production of food and other agricultural and industrial processes. Some of these chemicals have toxic properties which can cause harm if they are not safely managed. New global and European laws have helped to ensure that these processes are now very safe and, as the impact of a chemical incident is usually local, the vast majority of the population are very rarely affected by such events. However, history dictates that chemical incidents such as those listed in the table can have a major impact on society in terms of health, well-being, living conditions, travel, trade, economics and politics across boundaries. These effects can be amplified when the event affects more than one country.

Table: Examples of chemical incidents

Industrial accident	Seveso industrial accident, Italy (1975) Bhopal methyl isocyanate release, India (1984) Buncefield oil depot fire, UK (2005)
Incidents involving foodstuff	Dioxins in pork, Ireland (2008) Melamine in milk, China (2009) Gastroenteritis outbreaks, Germany (2011, 2012) Methanol-contaminated alcohol, Czech Republic (2012)
Incidents involving consumer products	Magic nano-spray, Germany (2006) Aquabeads, Australia (2007)
Deliberate releases	Chemical release in subway, Tokyo (1995) Use of chemicals against civilians in Syria (2013)

Chemical incidents involving more than one country can arise from diverse scenarios ranging from international trade (eg internet purchases) of tainted products, to a toxic cloud (eg chemical fire) travelling over a country's border. Although rare, when more than one country is affected it is important that there is coordination between the countries impacted to ensure that the right actions are taken. All 28 European MSs have recently agreed to work together in ensuring that there are better plans and a coordinated response to such events[1].

The ASHTIII project is a joint effort by medical and scientific experts from the UK, Germany, France, Italy, Czech Republic, Lithuania and other countries to address gaps in the response to cross-border chemical health threats. Experts in the project group work in European poisons centres (which provide advice on chemical exposures and treat poisoned patients) and public health authorities.

A number of tools and workstreams have been developed to address identified weaknesses in the current response to cross-border chemical health threats as identified through stakeholder consultations and past research projects in this area[2,3].

Figure: ASHTIII Group at an interim meeting in Vilnius: (left to right) Sergey Zakharov, Herbert Desel, Laura Settimi, Daniela Pelclova, Erik Andrew, Martin Ebbecke, Fabrizio Sesanna, Charlotte Hague, Gabija Dragelyte, Rob Orford, Franca Davanzo, Robertas Badaras, Al Bronstein, Laima Gruzdyte and Monique Mathieu-Nolf

RASCHEM platform

The need for rapid and harmonised communication of emerging event information has been addressed by the development of an IT platform that allows 'health risk assessors' from different countries to alert each other and assess the risks of new chemical events. This platform, the Rapid Alerting System for Chemicals (RASCHEM), went live on 19 June 2014 and helps to ensure that countries are aware of events and the same information is shared between them[2]. RASCHEM is hosted by the EC and acts as a risk assessment platform for poisons centres and public health authorities. Should an event discussed via the RASCHEM platform be deemed to meet the necessary notification criteria under Article 9 of the Decision, it will be notified by the national health authorities through the Early Warning and Response System (EWRS), which is the alerting system for serious cross-border threats to health. The EWRS links the national public health authorities in the EU MSs who will coordinate, with the EC, the risk management and response to the event under the current EU legislation.

Chemical emergency risk management monographs

During a cross-border incident there is a need for consistent authoritative information on chemical hazards. Information sheets, termed chemical emergency risk management monographs (CERM), have been developed for chemical agents of interest to public health authorities and poisons centres. This resource is aimed at providing a common suite of authoritative, timely and practical information on specific chemical hazards that can be used at the European level and shared between MSs. CERM sheets contain 11 different sections on public health and medical management information related to the hazard including: physicochemical properties, personal protective equipment, first aid, emergency medical management, environmental monitoring, clinical effects and public health measures. They are intended to help decision makers and those responding to chemical incidents (eg paramedics) and are not primarily written for clinicians responsible for acute treatment. There are many thousands of toxic chemicals and many sources of information, and these sheets help to ensure that a common set of authoritative resources is available in the event of a serious event. These documents do not seek to replace national risk management resources developed by individual MSs, but merely provide a common focal point for discussions and give authoritative information if required. A core stock of CERMs is being developed in ASHTIII, but it would be expensive and beyond current budgets to derive 'off the shelf' CERMs for all chemicals that may potentially be involved in a cross-border health threat. To fill this gap, the EU co-funded European Chemical Emergency Network

(ECHEMNET) project (see page 46) is developing and testing an emergency drafting protocol so that CERMs can be provided on request, at short notice (24–30 hours). It is essential to ensure the information provided is authoritative, appropriate and peer reviewed. This process will be tested through exercises in ECHEMNET and in 'pilot mode' in response to emerging chemical threats.

Ad-hoc monitoring of emerging chemical events: toxicosurveillance

There is a need for ad-hoc surveillance of emerging health threats. The ability of MSs to rapidly exchange and compare information on chemical exposures in the same manner in order to look for emerging trends and signals is an important concept; great care has been taken to develop and test ways of doing this. The ASHTIII group has recently developed a system to enable different countries to compare information about exposures and poisonings to toxic products, such as pesticides. In addition, the group has developed a pilot classification system for hazardous chemicals (biocides and plant protection agents) that will enable data of exposures from different countries to be easily compared. Previously this would have been extremely arduous due to different product names and ways of recording this type of data in each country. Earlier work led to an agreed set of terms that describe how an exposure occurred and also the symptoms of poisoning[4]. A related workstream in the second half of the project aims to automate the process of capturing and analysing poisons centre exposures case data (from Lille, Gottingen, Prague, Lithuania and Milan), as well as documenting the technical and logistical challenges in doing this.

Identifying unknown toxic chemicals

Sometimes identifying toxic chemical agents involved in an incident is difficult. An IT tool is under development to help those who respond to incidents (eg poisons centres) to identify hazardous substances by using the symptoms of poisoning of those exposed (eg skin blisters)[5]. The tool is designed to work in multiple languages and allow for differences in the way injuries are described (eg eye irritation, eye redness and painful eyes). Improving the identification of hazards from signs and symptoms will ensure that relevant medical and public health management options are put in place. The group is using a hierarchical medical terminology system (MedDRA) which codes, groups and orders symptoms by organ systems to help establish links between groups of associated symptoms of a particular exposure (toxidrome – see the box) and the identity of the chemical.

Network of toxicological risk assessors

Independent, authoritative and timely expert advice is central to a coordinated and effective European level response to chemical incidents that affect more than one MS. A project workstream is ongoing to determine whether a network of toxicological experts can be created in order to provide toxicological information to EU MSs and the EC. In the event of a serious cross-border chemical health threat within the EU, this information will be essential for a coordinated EU response. The types of activities that such a network could provide include the following:

- provision of information to support timely independent and impartial risk assessment, including hazard characterisation, exposure assessment, technical and scientific information usable for risk communication purposes, or medical treatment of exposed persons and contacts (eg antidotes and triage)
- ad-hoc monitoring – developing toxicosurveillance strategies and providing situational awareness
- moderation of material posted into the RASCHEM platform
- development of standard terms, codes and tools to describe chemical products, features of poisoning and support identification of chemical hazards
- further development, maintenance, training and testing of a network of expert public health risk assessors

The proposed activities of such a network will be discussed with key stakeholders to better understand the scope, merits and impact (cost benefit) of providing such a service to the EU MSs and the EC.

Box: Toxidrome definition

The term **toxidrome** (toxic/syndrome) describes a set of features of intoxication or poisoning that might be indicative of exposure to a certain type of chemical

For example, carbamates and organophosphate exposure can be associated with the following symptoms: vomiting, diarrhoea, abdominal cramping, bronchospasm (constricted airways), bradycardia (slow heart rate), miosis (pin point pupils), salivation respiratory hyper-secretion (drooling) and diaphoresis (sweating), tremor, muscle weakness, agitation, seizures and coma. This toxidrome is termed cholinergic syndrome

Examples of use of project outputs

Following a series of fatal intoxications (42) in the Czech Republic in mid-September 2012, caused by alcohol tainted with methanol, the project group drafted a CERM for the substance at the request of the EC[6]. Information from six different public health authorities and poisons centres was provided and supported the production of the CERM. The process involved peer review by expert toxicologists. Once the response was initiated, an agreed monograph was sent to the EC within two working days. Producing the monograph demonstrated the value of developing and maintaining a network of expert toxicologists from European poisons centres and public health authorities that is able to assist the EC. The completed monograph was sent to the EC and disseminated through the Health Security Committee to the

MSs to aid discussions. The CERM production process will be further developed and improved upon in the ASHT and ECHEMNET projects, with a greater number of 'off the shelf' sheets available to the EC.

What next?

Stakeholder discussions are key to the successful development and use of the project outputs. The next phase includes consultations, workshops and exercises to test project outputs. For example, there was a joint ASHT and ECHEMNET workshop, in parallel with the 50th European Association of Poisons Centres and Clinical Toxicologists Annual Congress, to discuss the EU level response to cross-border chemical health threats with external stakeholders and project partners in Brussels at the end of May 2014. If you would like more information or would like to join the project as a collaborating partner please contact ASHT@phe.gov.uk or visit our website, www.ASHT.eu.

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Helsedirektoratet
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European Chemical Emergency Network (ECHEMNET) – update report

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Introduction

The European Chemical Emergency Network (ECHEMNET) is a collaborative research and development project part funded under the second European Union (EU) Health Programme. Like ASHTIII, this project is designed to help EU member states (MSs) and the European Commission (EC) to alert and respond to chemical incidents in order to reduce their impact on public health. Thus it also supports the implementation of the Decision of the European Parliament and of the Council of the European Union on serious cross-border threats to health (Decision 1082/2013/EU)[1,2] (see page 39).

Background

Chemical incidents can impact on society in a number of ways; these effects can be further confounded if the incident involves more than one country. Improvements in preparing and responding to such events are required and this has been recognised by the publication of the Decision on serious cross-border threats to health (see page 39)[1,2,3,4,5].

ECHEMNET brings together results from a number of research projects and workstreams which have been part funded by the first and second EU Health Programme in the area of health security – in particular, chemical hazards[6,7,8,9,10]. Figure 1 shows how the different project outputs link together, heading toward a common endpoint. ECHEMNET will refine, further develop and deliver technical documents and mechanisms aimed at supporting the EU response to cross-border chemical health threats. Within the project there will be stakeholder engagement and exercises to consult upon and improve these documents in an objective manner. A network of public health risk assessors will also be recruited to assist the technical response and assessment of emerging events.

Since the Decision was published in November 2013[1], the ECHEMNET project is acting in 'pilot mode' to support the EC in the event of a cross-border chemical health threat. The end goal of the project is that a permanent mechanism for the coordinated and cohesive response to public health threats involving chemicals is put in place. Recommendations will be made to the EC based on the findings of the group, with the aim that best practice approaches developed in past projects, refined and brought together by ECHEMNET, are used by the EC and MSs to agree such a mechanism.

ECHEMNET is a joint effort by medical and scientific experts from the UK, Germany, Netherlands, Sweden, Spain and other countries. As the project matures, more partners will be bought into the project as official collaborators. Experts in the project group work for public health authorities and European poisons centres.

Project objectives and outcomes

A number of tools and workstreams have been developed to address identified weaknesses in the current response to cross-border chemical events (see page 39). These include:

- the need for an improved inter-sectoral response
- development of an authoritative and transparent risk assessment process
- improved reporting and alerting for chemical events
- development of a network of expert public health risk assessors to aid the risk assessment process

A brief description of how these shortfalls will be addressed during the project will be expanded upon in the following sections.

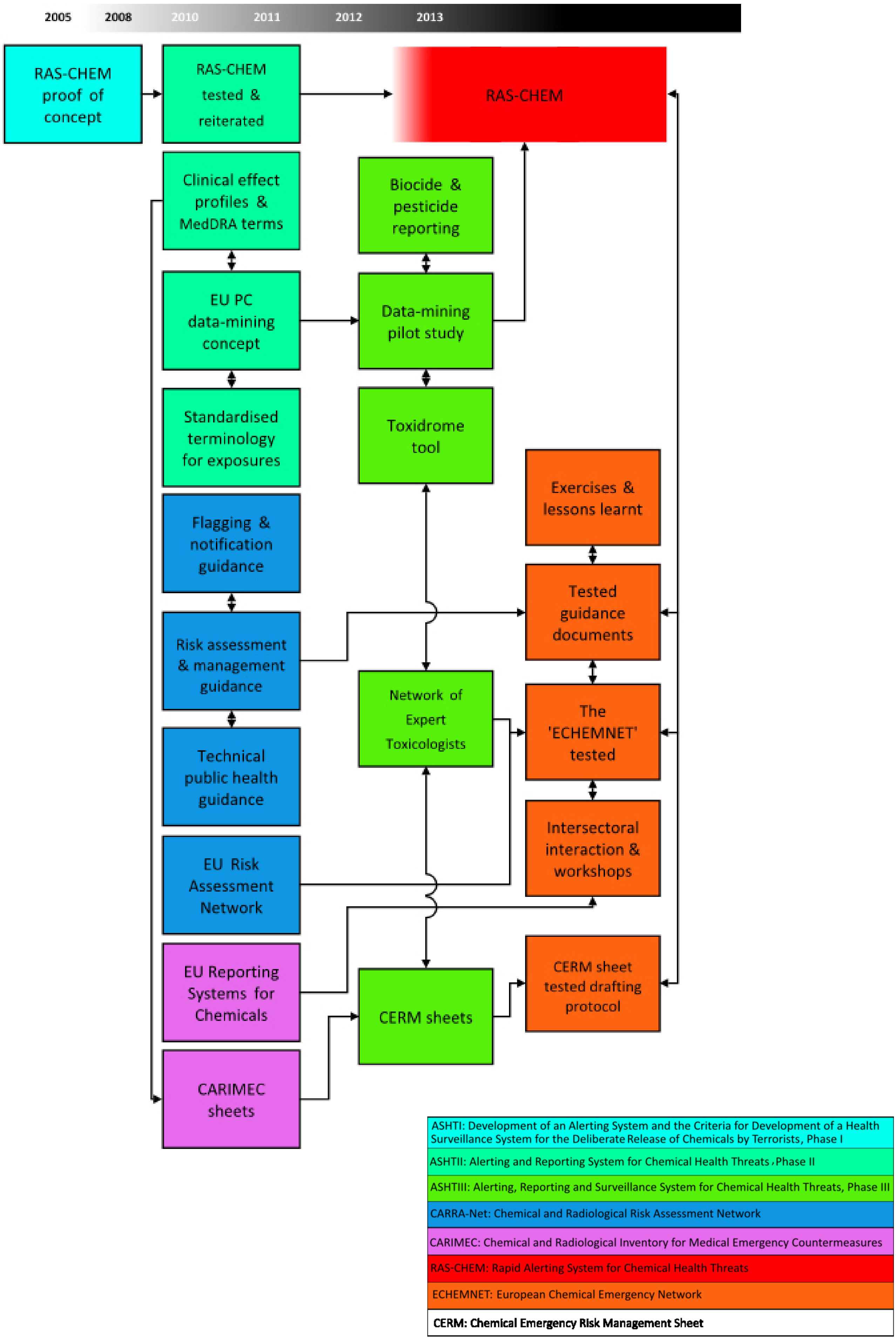

Figure 1: Project and workstreams in EU projects part funded by the EU Health Programme in the area of chemical health security

Figure 2: ECHEMNET group: (left to right) Jim Stewart-Evans, Jesús Ocaña García-Donas, Rob Orford, María del Carmen García Cazalilla, Kerry Foxall, Mark Griffiths, Elisabeth Wigenstam, Jiri Trnka, Rebecca Gay, Charles Turner, Lisbeth Hall, Barbara Fothergill, Andreas Schaper, Marjolein Groot, Charlotte Hague, Herbert Desel and Raquel Duarte-Davidson

Reporting guidance and assessment

Two IT platforms have been developed to support the risk assessment and risk management of cross-border chemical health threats within Europe. A lower level risk assessment tier (Rapid Alerting System for Chemicals, RASCHEM) has been developed for use by poisons centres and public health authorities to communicate technical information on emerging hazards. A higher level risk management platform (Early Warning and Response System, EWRS) has been developed for all threats (excluding radiation), which meet a specified threshold[4].

Protocols and guidance documents were developed in 2010 which focused on supporting the use of RASCHEM and the role of national risk assessors and risk managers in a cross-border chemical emergency[6]. These documents will be reiterated in accordance with the published Decision and circulated for comment among the European chemical health protection and poisons centre community.

Work is also underway to ensure that the alerting criteria (see Table 1) established in the Decision and related legislation (eg the WHO International Health Regulations, IHR)[11] can easily be interpreted for chemical events. This will take account of the alerting criteria that defines an event as 'serious'. A subcriterion of seriousness is the direct human consequences of exposure (italicised in Table 1). Other subcriteria could include geographical scope, loss of containment or epidemiological linkage with similar events. Seveso reporting requirements, which apply to industrial accidents, employ a different approach to the Decision (and IHR) for defining the specific alerting criteria for health impacts. This quantitative approach was developed in earlier work[6] which sought to provide a clearer indication on the definition of 'significant morbidity and mortality' when applied to cross-border chemical health threats.

While the health criteria highlighted in Table 1 for Seveso reporting requirements are useful for Seveso site* industrial accidents, it is not suitable for all potential chemical threats that might present a cross-border risk due to their varying nature. For example, there are many deaths each year in the EU resulting from tainted recreational drugs in each MS; if all of these were reported to the EC through the EWRS IT reporting platform (as required for Seveso), the system would soon become unworkable, due to the number reported. Therefore a more dynamic objective approach is required to define 'significant' events' to aid decision making for chemical events. The French Ministry of the Environment has led the

* SEVESO site definition: whole area under the control of an operator where dangerous substances are present in one or more installations, including common or related infrastructures or activities[12].

Table 1: Health-related reporting and alerting criteria (italicised)

EWRS alerting criteria (Article 9)[4]	Seveso reporting requirements (Annexe VI)[12,13,14]	CARRANET[5]
If an event fulfils the following three criteria then it should be notified through the EWRS: 1a It is unusual or unexpected for the given place and time, *or it causes or may cause significant morbidity or mortality in humans*, or it grows rapidly or may grow rapidly in scale, or it exceeds or may exceed national response capacity 2 It affects or may affect more than one member state 3 It requires or may require a coordinated response at EU level	1 *A death* 2 *Six persons injured within the establishment and hospitalised for at least 24 hours* 3 *One person outside the establishment hospitalized for at least 24 hours*	1 *Two or more fatalities among members of the public* 2 *Six members of the public hospitalised for 24 hours*

development of a 'European scale of industrial accidents' which was adopted for assessment of the severity of Seveso site accidents (IMPEL). The scale contains four uniform groups to enable the quantification of dangerous goods involved, health and social impacts, environmental consequences and financial impacts[15,16]. Work will be undertaken to assess if the IMPEL scale could be used to aid risk assessors in deciding if different types of chemical events should be notified to the EC.

Rapid risk assessment of chemical events that fall outside the remit of other organisations

The Decision identifies the need to undertake authoritative, transparent and independent risk assessments. Where an event falls outside the remit of other regulatory authorities (eg events involving food or foodstuff fall under European Food Standards Agency), the rapid risk assessment process will be led by a European scientific committee.

ECHEMNET is supporting the development of this mechanism by producing a rapid risk assessment protocol that could be used by the Committee and EC to support the decision making process (eg risk mitigation measures). A number of risk assessment protocols for cross-border health threats have been developed by international organisations (eg the WHO and ECDC, the European Centre for Disease Prevention and Control); however, communicable disease scenarios are the primary focus of these. ECHEMNET is developing a methodology that is more focused towards chemicals as the risk of chemical events (the hazard and threat) is diverse and presents its own set of unique challenges. The hazard can arise from one chemical or a combination of thousands of chemicals used in society; threats can impact upon humans through numerous different routes and exposure scenarios. An important component of the work involves ensuring that, where possible, the terminology and methodological principles applied to the rapid risk assessment (RRA) for chemicals are consistent with those used to assess and manage other risks (eg communicable disease). This ensures that risk managers are able to make balanced and consistent decisions on such risks, particularly when those involved in decision making may not be experts in chemical incidents.

The RRA will be tested and improved as necessary taking into account feedback from end users (eg feedback from exercises); it will include a number of sections (see Table 2) and will require a dynamic, flexible and objective approach, while maintaining quality assurance, transparency and process control.

Table 2: Rapid risk assessment sections

Event control information	When, where, what and how
Hazard assessment	Type of hazard, seriousness of the event
Exposure assessment	Evidence of harm and public health impact
Context assessment	Nature of the incident (eg at risk populations)
Risk characterisation	Based upon hazard, exposure and context assessment
Recommended actions	Suggested actions based upon the hazard, exposure and context assessment and risk characterisation

Inter-sectoral preparedness

A review of 11 different alerting and reporting systems that exist within the EU and internationally, which are used to notify authorities of emerging chemical health risks, has been undertaken[8]. The purpose of undertaking a review of these systems was to aid national risk assessors in understanding if incidents should be notified cross-sectorally (eg to other organisations within the health sector) and inter-sectorally (from the health sector to environment, transport or trading standards sectors, etc) as required by the Decision. The systems described in the review cover public health emergencies, food and feedstuff, consumer products, illicit drugs, medicines and industrial accidents.

Short monographs have been produced describing each system including information on legal reporting requirements and contact points; these are available from the ECHEMNET website (www.ECHEMNET.eu).

European network of expert public health risk assessors

The EC will use expert European scientific committees to undertake independent risk assessments on emerging cross-border public health events, where the nature of the threat falls outside the remit of other organisations (eg the European Food Standards Agency for events involving food). To support the role of these committees in providing rapid assessments to such threats, ECHEMNET is developing a network of expert health risk assessors. A key difference between the existing activities of the European health risk assessment committees and those for dealing with acute chemical incidents of cross-border significance is that the existing committees work on developing authoritative position statements for health issues over longer periods (eg mercury in dental amalgam), rather than undertaking rapid risk assessments during the acute response phase to a incident. The project will develop and objectively test a mechanism to aid this process. The following questions will need to be addressed by the group prior to developing a mechanism:

1 Should the network provide authoritative, dynamic and rapid advice, if necessary on a rolling 24/7 basis?

2 Can the activities of the network be sustained for the duration of a serious incident (eg Bhopal or Seveso scale)?

3 Can the network provide the multidisciplinary requirements that may be presented by a chemical incident (eg access to proprietary toxicological databases or meteorological modelling services)?

4 What is the cost of establishing and maintaining such a network and who should fund it?

5 Are the legal requirements for operating the network in an emergency covered by the existing regulations?

Due to the complexity of advice required and the need for the provision of very rapid information on specific chemicals it may be necessary to have an extended network of experts able to provide timely advice on specific areas relevant to the public health response.

What next? Exercises and engagement

The technical working documents which have been further developed by ECHEMNET[6,8,9,10] will be discussed and agreed to form a common set of working documents. To facilitate this, a workshop was held in March 2014 in Oxford. This workshop was followed by detailed stakeholder discussions on the proposed guidance documents and mechanisms at the end of May 2014 in Brussels in parallel with an ASHT workshop at the 50th European Association of Poisons Centres and Clinical Toxicologist Annual Congress. Additionally, exercises to test the working documents will be developed and run in 2014.

Feedback consultations and exercises will be used to reiterate the technical working documents. In addition, the ECHEMNET project group may be requested to act upon an event following a request from the EC; this will involve the project group acting in pilot mode to deliver the appropriate technical support using the draft project outputs. At the end of the project, recommendations will be made on a permanent mechanism that can be deployed to aid the EU level response to an acute phase cross-border chemical incident.

If you would like more information or would like to join the project as a collaborating partner please contact ECHEMNET@phe.gov.uk or visit our website, www.ECHEMNET.eu.

Acknowledgements

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Developing tools to assist with evaluating a recovery strategy

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Following the implementation of the Civil Contingencies Act (2004), there has been a national focus on improving resilience and response to managing chemical, biological, radiological and nuclear (CBRN) incidents (accidental, intentional or malicious intent). Until recently, there was limited practical guidance or advice on how to remediate contaminated environments (eg inhabited areas) and develop a recovery and remediation strategy, following a chemical, radiation or biological incident. The Centre for Radiation, Chemical and Environmental Hazards (CRCE) of Public Health England (PHE) has led on the development of the Chemical and Radiation Recovery Handbooks[1,2] and it is committed to continue to maintain and update guidance and advice for recovery and remediation to ensure that it builds the evidence base for recovery strategies. This includes developing a Recovery Handbook for Biological Incidents, for which CRCE provides steer and support.

As part of this commitment, a Chemical and Radiation Recovery Navigation Tool (C&R RNT)[3] is being developed in close collaboration with the Department for Environment, Food and Rural Affairs (Defra), the Food Standards Agency (FSA), Department for Transport (DfT) and the UK Government Decontamination Service (GDS)[4]. The purpose of the project is to develop an interactive support tool, to facilitate and guide recovery decision makers through the process of tailoring a recovery strategy when responding to any given chemical or radiation incident.

A pilot version of the C&R RNT for chemical incidents (inhabited areas, food production systems and water environments) is now available for testing on the legacy Health Protection Agency website, and can be accessed at http://www.hpa.org.uk/ProductsServices/ChemicalsPoisons/RemediationAndEnvironmentalDecontamination/chemChemicalrecoverydecisionsupporttoolproject/ and at http://legacyassets.phe.org.uk/tools/CRT_elearning/index.html.

The project team will be working closely with scientists across CRCE, local authorities and other stakeholders to refine the C&R RNT during the course of the project and would like to invite readers to review the developing tool.

The developing tool also includes a recovery record form, as a method of capturing information on the handover from the acute response phase to the recovery phase, and assisting with recording decisions made during the evaluation of a recovery strategy (ie why recovery options were selected, based on the scientific evidence base and any constraints associated with them).

What's next

A final version of the Chemical RNT and recovery record forms will be published on PHE's recovery web pages in the next few weeks. Other recovery resources developed by the project team such as posters and articles will also be uploaded on to provide the user with a global vision in the use of these recovery tools.

Phase three of the project will begin in September 2014, and consist of the extension of the developing Chemical RNT to incorporate the new version of the Radiation Handbook that will be published by the beginning of autumn 2014 as an interim version. The expected completion date of the C&R RNT is June 2015.

Other aspects of the project include an evaluation of the evidence base for recovery options recommended in the UK Recovery Handbook for Radiation Incidents, which is expected to be updated and published in autumn 2014, and the development of an e-Learning module.

If you are interested or would like collaborate with us on the project then please contact the project team at chemical.recovery@phe.gov.uk.

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Practically assessing the GDS framework against CBRN scenarios – can it really do what it says on the tin?

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Introduction

The UK Government Decontamination Service (GDS) manages a framework of specialist suppliers from the private sector who are capable of assisting with the recovery from a CBRN (chemical, biological, radiological and nuclear) or major HazMat incident.

The framework is procured through an Official Journal of the European Union (OJEU) call for companies that can provide sampling and analysis, decontamination and waste management capabilities. The procurement assessment is based on written responses to a chemical, biological or radiological/nuclear scenario. Prospective applicants are expected to complete a pre-qualification questionnaire (PQQ) before (if successful at the PQQ) the invitation to tender (ITT). If all criteria including financial stability are shown to be met following review by a panel of experts from academia, government and related bodies, an award is made for a 4-year framework contract.

Figure 1: GDS framework supplier sampling contaminated area (K Halls © Crown copyright 2013 GDS)

The EU procurement process rules stipulate that submissions are made as a written proposal. This presented several challenges during the framework procurement process, not least that most CBRN agents do not tend to be encountered on a regular basis in the commercial world. This meant very few of the supplier bids could demonstrate practical experience of working in a CBRN environment during the procurement process. As a result the companies on the framework were unable to demonstrate experience of dealing with the CBRN-specific substances GDS is concerned with.

In order for GDS to be confident in the ability of its suppliers to operate safely and carry out sampling and analysis, decontamination and waste management effectively in a CBRN environment, a process of framework assurance has been launched. Framework assurance has the goal of gathering as much information about each supplier as possible. This information can then be used to inform judgements as to the capability of suppliers to respond to a particular scenario.

Since the framework was launched in March 2012 a huge amount of information on the capability of the suppliers has been collected. This came initially from the submitted procurement documents, but has been added to by meetings with suppliers to discuss particular issues.

Assessment of environmental sampling capacity and capability

The GDS work programme throughout 2013 had a strong focus on increasing understanding of the capability and capacity for environmental sampling on the framework. Firstly a questionnaire was sent to suppliers to establish their view of their sampling capability. This requested information such as how many sampling teams a supplier could deploy and an estimate of the number of samples they could collect in line with their capability. This initial assessment was followed by a meeting with the suppliers in September 2013 to discuss techniques and procedures for sampling.

The final stage of the assurance process was a practical exercise which took place in October 2013 at MOD Stafford. The aim of the exercise was to test environmental sampling; however, due to the notorious British weather and its potential to impact on the exercise GDS occupied (with the kind permission of MOD Stafford) a disused hanger and generated

Figure 2: GDS framework supplier undertaking decontamination (J Webster © Crown copyright 2013 GDS)

a simulated outdoor environment. This made use of a variety of surfaces including grass, gravel, concrete, small wooden structures and various pieces of debris.

The Health and Safety Laboratory (HSL) dosed the area with a simulant* which was then sampled to confirm that it had been dispersed satisfactorily across the hanger. At this point the hanger was presumed to be 'hot' and was treated as such. Two days later, GDS framework suppliers with expertise in sampling arrived on site and prepared to enter the hot zone. They were briefed on the theoretical response to the incident by a representative from the Police National CBRN Centre, before receiving their tasking brief from GDS, which was acting as the contracting authority. The scenario was discussed and, with the suppliers ready to go, HSL briefed the sampling teams on the best way to collect samples based on their prior laboratory experiments. The suppliers were asked to collect samples in the manner detailed in this briefing to ensure the operative could adopt a consistent approach to ensure that the samples could be analysed. This procedure ensured that whatever the background of the operative supplied by the framework company, they would be able to take samples correctly.

* Spores of *Bacillus atrophaeus* subspecies globigii were aerosolised to provide an even coverage of an organism (which is highly resistant to decontamination) in the scenario area. This system is useful for being able to test both fumigation and mechanical/chemical decontamination processes.

Three injects were used to direct the scenario, requesting collection of both biological and chemical samples by the supplier's operative. Sample locations were determined using VSP (Visual Sample Plan) software to ensure that the results could be considered statistically valid. The samples were handed over to HSL which took them away for analysis to assess whether the suppliers had managed to successfully sample the contaminated area. The results have shown that this was possible. This information, along with observations of how the suppliers performed on site will allow GDS to better understand the suppliers' capability to sample in a CBRN environment.

Assessment of decontamination capability

The following week, the decontamination suppliers arrived on site and were again briefed by the Police CBRN Centre, GDS and HSL as to the scenario. Theoretical sampling results were also included in the brief, representing the fact that sampling had taken place (the actual results were not available due to time restrictions of the exercise). The suppliers then undertook their preferred decontamination method to remediate the scene. The majority of suppliers used a manual, chemical approach as can be seen in Figure 2 where the supplier is using handheld sprayers to apply a chemical solution. One supplier opted for a novel fumigation approach which involved the supplier tenting areas of the scene before applying the fumigant to the area. This process has not been tested in the

Figure 3: GDS framework supplier removing waste (J Webster © Crown copyright 2013 GDS)

outdoor environment before. Following the decontamination work, HSL returned to the scenario to collect samples to assess the effectiveness of the decontamination. The results of this sampling indicated that the decontamination by all suppliers had been successful and reduced the contamination significantly.

Conclusions

The evaluation demonstrated that the suppliers tested were able to successfully deploy to an environment contaminated with a simulant of a CBRN agent. They were able to successfully collect samples within the hot zone following a procedure briefed to them by an independent laboratory. In a real incident this will be essential to ensure samples are taken consistently and can be analysed to show where contamination has fallen in an area. For the decontamination evaluation, different suppliers were able to successfully deploy into the contaminated environment. Several decontamination methods were used which have been shown to successfully reduce contamination. Two of the suppliers used methods they had not trialled before and so their successful testing has enhanced the capability available on the GDS framework.

These practical evaluations demonstrate the ability of GDS suppliers to enter, sample and decontaminate a contaminated environment such as they might be required to deal with in the recovery from a CBRN incident. This information adds to the understanding GDS has of the commercial companies on its framework and this information can be used to inform CBRN recovery in the UK.

Impact of response actions on recovery – the importance of a consolidated approach to UK resilience

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Introduction

The release of a hazardous material (HazMat) or chemical, biological or radiological/nuclear (CBRN) material in a public facility would potentially result in multiple casualties, loss of national confidence and significant economic and political impacts, particularly if the facility was a critical asset or formed part of local or national infrastructure.

The restoration of facilities, such as major transport nodes, distribution centres, data storage facilities and large public amenities, following a HazMat or CBRN release is an extremely complex business. In order to hasten the restoration process and return to (new?) normality, it is vital that we understand how the various decisions and activities within the response (acute) and recovery phases, influence the overall recovery.

The Government Decontamination Service (GDS) has found that the majority of response and recovery workshops and exercises tend to take place as separate events in isolation from each other. While each workshop may involve a wide variety of players, the transition from response to recovery is rarely played through. As response players can be different to recovery, eg response is generally police led, whereas recovery will be led by the responsible (local) authority, each side may have little understanding of the drivers and pressures the other faces and the implications that early decisions can have on recovery options. This in turn can greatly complicate and impact costs and time to remediate.

Workshop (G Knight © Crown copyright 2012 GDS)

It was for this key reason that GDS organised CBRN joint response and recovery workshops, aimed at improving awareness of response considerations with recovery bodies while simultaneously bringing forward recovery considerations in to the response phase.

Key considerations during the response and recovery phases

Decisions made and actions undertaken during the response phase of an incident can impact on the overall recovery timeline. For example, through early communication with the recovery organisations decontamination strategies can be initiated at the earliest opportunity, speeding recovery. The figure illustrates the components which need to be considered during the response and recovery phases of the incident and the overlap between the two.

Figure: Illustration of the components involved in response and recovery

To test the impact of response actions on recovery, GDS produced a CBRN table-top exercise to be played in near real time. Scenarios were developed to test the chemical, biological and radiological aspects of deliberate release, with the workshops crafted as separate events to independently exercise joint response and joint recovery. The scenario itself was designed to be an overt targeting of two critical areas of the chosen asset. This was discussed in advance with the asset owner and agreement was reached regarding the areas chosen to cause maximum disruption to normal operations.

The two individual locations were also chosen to be separate and independent from each other, the first targeting a critical function that would involve the public directly, while the second targeted a critical function on which the business depended but which had low public contact. This tested the impact economic considerations, such as prioritisation of business-critical areas over public areas, could have on decisions required during the recovery phase. In this way it was hoped to examine the emergency response direction and drivers in more detail. For example, would significant efforts be focused at one location to the detriment of the other? If one area was prioritised, then what were the reasons and what additional factors would require consideration, such as actions to minimise spread of contaminant or the potential for ingress into surfaces, that would complicate decontamination and remediation?

The response workshop included key players from government departments, appropriate agencies and subject matter experts along with local authorities and the GDS framework of specialist suppliers (see page 53). All players were tasked with fulfilling their normal roles and gaining an understanding of the decision making process and the impacts these would have on the recovery timeline using current UK protocols and guidance. A review of the workshop can be found in the previous CHAP report article: 'How the UK Government Decontamination Service is aiding preparedness in the event of a CBRN or major HazMat incident'[1]. The workshops also enabled GDS to promote the UK Recovery Handbook for Chemical Incidents (UKRHCI[2]), which had recently been published.

Actions made during the response can impact on the recovery phase of such an incident, and it is important for organisations in the response phase to consider this during their actions/discussions. The following early recovery considerations (within 4 hours of an incident) are key (see the table).

Table: Key early recovery considerations (within four hours of an incident)

Nature and extent of contamination	Actions or containment measures implemented during the response phase: for example, shutting down of HVAC (heating, ventilation, and air conditioning) systems to minimise the spread of contamination, may influence remediation methods and the overall recovery timeline Detail of the contaminated area, including any monitoring data collected during response, will support recovery decisions
Communication, flow of information and handover	Information gathered during the response should be shared with the recovery coordination group to allow decontamination strategies to be initiated at the earliest opportunity Communication routes between response and recovery should be clarified and maintained throughout the response in order to keep all relevant authorities, government agencies, departments and relevant experts informed A clear definition of the transition between response and recovery phases should be made Appropriate handover during transition from response to recovery , including clarification of who decides when the response has been completed
Recovery considerations	Arrangements for the coordination of recovery operations Correct attendance and relevant expertise at the recovery coordination group is essential Consideration of time constraints affecting the urgency with which recovery measures should be implemented Technical detail regarding the scope and the objective of the recovery work and clearance goals, required in advance of sampling, decontamination and monitoring activities Funding considerations should form part of planning Regulatory requirements or implications including known health and safety implications or issues Site management and security issues Consideration of how recovery decisions can impact on businesses affected economically, in particular identification of business-critical functions Extent to which site amenities/utilities are available for use Public perception and implications when responding to media queries Procedures and instructions for managing sensitive information
Suggested recommendations for future developments and recovery to CBRN incidents	Effective planning and exercising of critical facilities by contracting authorities is of key importance before an incident occurs roles, function and influence of the science and technical advisory cell (STAC), Strategic coordinating group (SCG), scientific advisory group for emergencies (SAGE) and Cabinet Office Briefing Rooms (COBR) should be more clearly defined in national guidance Roles and responsibilities of government agencies and departments during the recovery phase of a CBRN incident should be clarified National guidance should be collated in one place (ie the National Resilience Gateway) Robust training, familiarisation and exercising in recovery and remediation following a CBRN incident is required for all organisations, including the development of remediation strategies Clarity is required regarding the process of sharing information between responders and other government departments (ie access to information from senior investigating officers GDS suppliers should be engaged at an early stage of an incident to enable mobilisation and allow early action to support containment Consideration of preventive measures and investment in more resilient infrastructure as long-term planning options, to reduce political and financial pressures Business-continuity plans and timelines should include recovery and restoration to 'new' normality

Conclusions

There is a need to improve knowledge of the way key decisions and activities made in the response phase can impact on recovery. First responders should be aware of the impact their decisions could have on recovery and how they can assist the recovery process as part of the acute response.

Future workshops along with the application of UK guidance will enable GDS and partners to work towards compressing the overall remediation timeline and better support UK resilience. The exercise also demonstrated the additional value brought to recovery with the publication of the Strategic National Guidance (SNG[3]) and Public Health England's UK Recovery Handbook for Chemical Incidents (UKRHCI[1]).

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A quick tour of social media and emergency preparedness, resilience and response (EPRR)

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Introduction

In the not too distant past, the internet was a collection of information to view or download, with web developers being the only contributors. The arrival of 'Web 2.0' technologies changed the internet from a static resource, providing functionality which enabled the public to post information themselves, opening new opportunities for information sharing. This interaction using the new technology has been labelled 'social media'.

Information sharing through social media

Social media has changed the internet into a collaborative environment where a contributor no longer requires technical expertise. Information can be shared in various formats including text, image, audio, map location and video. It is often added in 'chunks' by various contributors, dynamically, responsively and collaboratively, resulting in a new type of evolving information. This new type of information is often generated collectively by online 'communities of interest' or 'communities of practice', groups of individuals with common interest in a topic or area. A community of practice may include a group of scientists with a shared interest, which often becomes a resource for specialist advice for the public. However, it should be remembered that information provided by these communities is often not evidence based or peer reviewed, and can be a source of misinformation, raising unjustified concern within the general public.

Social media provides a platform for people across the world to work collaboratively, share information and ideas in real time, and gain support from others with similar experiences. It can help to reunite displaced people, be a mechanism to report crime and allocate resources, and can be used to provide situational awareness. For example, those working in flood-prone communities in one location can share their experiences with those facing similar issues in a different part of the world[1]. Communities such as the Facebook page 'Incidents on Teesside' can help the public to make sense of a situation. Currently this Facebook page has over 88,000 followers, providing updates from traffic alerts to police incidents.

The advances in web technologies are coupled with the rapid development of mobile technology, most likely a response to the ever-increasing demand for faster and more reliable information sharing. An increasing number of people now carry a phone or device which is capable of capturing images and connecting to the internet. The technology is affordable and therefore accessible to a larger proportion of the population. Anybody carrying such a device is now a potential 'citizen reporter', a member of the public who reports news and information via the internet. Citizen reporters are powerful, often at the scene of an incident before the responders and traditional media[2], with actual experience of the event. These citizen reporters are also greater in number and able to represent a larger geographical area than traditional media reporters[3].

These new reporters can have a far-reaching internet audience. This power to capture information and share it in real time has been demonstrated on many occasions in recent times, during disasters such as Haiti[3] and Fukushima[4], and during social and political change such as the Arab uprisings 'all played an important role in communicating, coordinating and channelling this rising tide of opposition and variously managed to bypass state controlled national media as they propelled images and ideas of resistance and mass defiance across the Middle East and North Africa'[5].

Social media and emergency preparedness, resilience and response (EPRR)

Responders can also use social media to engage with the public, allowing them to provide a better understanding of a developing situation– for example, through regular updates on Facebook or Twitter, enabling the public to make faster, more informed decisions. Communications teams are recognising the need to include social media communication as part of their strategy during planning, response and recovery stages of an incident.

One method or harnessing the power of social media is 'crowdsourcing'. This is to use the power of the crowd to collect information or complete a specific task. The US Federal Emergency Management Agency (FEMA) has developed a mobile application called 'Disaster Reporter' to 'crowdsource and share disaster-related information for events occurring within the United States, allowing citizens, first responders, emergency managers, community response and recovery teams, and others to view and contribute information on a publicly accessible map'[6]. Research has shown that individuals respond quickly and massively to emergencies, and that they try to help with the situation[7].

Geographically representing crowdsourced information is known as 'crowdmapping'. The use of crowdmapping by authorities to improve situational awareness during an incident is illustrated by an explosion in Oregon where people reported hearing a loud 'boom' or 'explosion' and within minutes numerous reports emerged online[2] . A web developer, one of those to hear the 'boom', quickly created a Google Map™[8] and asked people to plot what the explosion had sounded like from their location. Within an hour 100 people had placed a pin on the map, colour coded depending on the intensity of the noise heard, red being loudest. The police attended the scene concentrating on the area containing the highest concentration of red pins and found the remnants of an exploded pipe bomb.

Ushahidi is a platform that enables crowdmapping, through SMS, email, Twitter and the internet. Ushahidi, which means 'testimony' in Swahili, was a website initially developed to map reports of violence in Kenya after the post-election fallout at the beginning of 2008[9]. It has since been used on many occasions around the world in various scenarios. Crowdmapping can be used to support incident response. For example, one week after the Fukushima disaster the Safecast project was launched. Safecast loaned volunteers cheap Geiger counters to measure local levels of radioactivity (or volunteers purchased their own device). This data was mapped and made publicly available through the Safecast website[10]. This data was used alongside official information. Using the crowd in such a way provided a greater depth of information without the allocation of financial and physical resources. Crowdmapping is also useful in 'peacetime'. The public can be asked to plot information of any type to identify problem areas such as river pollution, a number of examples can be seen at Crowdmap.com*.

Along with considering how information can be gathered from the public using social media, these devices also make the user a potential audience who can be targeted directly. The public is increasingly seeking information through existing social media channels and there is often an expectation that someone is monitoring the information posted. This was demonstrated in Australia when two young girls were trapped in a storm drain near Adelaide. Rather than calling the emergency services, they updated their Facebook status – luckily for them a friend viewed the status and alerted the fire service who then rescued the girls. However, monitoring social media, particularly during an incident, is resource intensive. For example, there is a need for regular updates of information as a situation changes and responders are required to continuously monitor feeds associated with their communications. Initiatives such as VOST UK (UK Virtual Operations Support Team) are trying to address this issue. A VOST is a team of trusted volunteers which monitors online traffic in an emergency and provides reports to the emergency services. This project aims to develop a model of VOST for the UK that Category 1 responders can feel confident in and that is able to add value to the emergency response[11].

Targeting the public through social media has so far relied on users signing up or seeking information in the first instance. The Cabinet Office has recognised the opportunities presented by the increased number of mobile phone users and the need to change the way it communicates with the public. Cell broadcasting allows messages to be sent out simultaneously to every active handset near a chosen mobile mast without the need for individual phone numbers. The potential of this technology is obvious during incident response. For example, all mobile phone users within a specific area could be targeted with a message informing them of the issue, and advising them of appropriate actions if required. Social media can clearly be used to gather and share information with the public in support of the Category 1 duty to 'warn and inform'. There is also an opportunity for the EPRR community to use the technology to support its duty to 'cooperate and collaborate'. Partner organisations could use social media as a common platform for sharing non-sensitive information in real time. As Barbier et al point out, during the response to the Haiti crisis, governmental and non-governmental organisations worked together but difficulties arose in coordinating the response due to the lack of a common information system[12]. Social media could be a solution, providing a common platform to facilitate information sharing.

Additionally, social media can be used to support emergency preparedness through training and exercising. An online virtual world called 'Second Life' has been used to facilitate learning through interaction in a virtual environment. Examples include professionals attending a virtual talk on H1N1 and simulation of a multiagency response to an anthrax attack, an exercise which included establishment of mass prophylaxis sites and distribution of materials.

Conclusions

While communications teams are enthusiastically exploring how social media can be used to support their work, there is less evidence of EPRR teams or local resilience forums developing social media strategies beyond broadcasting messages and monitoring their organisation's own social media presence. There are examples of how social media has been used to support response to incidents, and EPRR teams and local resilience forums need to identify opportunities to develop social media strategies to support their emergency preparedness, resilience and response. Key examples include the use of crowdmapping to improve situational awareness of an incident location, the use of social media to deliver timely communications to a local community impacted by an incident, and the use of technology such as Second Life to complement existing training and exercising programmes. Additionally, in the current financial climate one important

* Crowdmap.com is the hosted version of the USHAHIDI platform.

factor that should not be ignored is the fact that social media technology is usually free, and can be used to access a large proportion of the population, some of whom can be difficult to reach by conventional mechanisms.

The lack of exploration of social media strategies to support EPRR may be for a number of reasons, including a lack of physical resources and understanding of the technology at the strategic level. While organisations may develop strategies internally, for maximum effectiveness they should be developed collaboratively with partner organisations to support a consistent multiagency response.

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Environmental and Toxicological Research

Estimating local mortality burdens associated with long-term exposure to particulate air pollution

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Introduction

In April 2014, Public Health England (PHE) published estimates of the mortality burden associated with long-term exposure to particulate air pollution in all local authority areas in the UK. The estimates were presented as attributable fractions, attributable deaths and associated years of life lost[1]. The figures were calculated by approaches used, or recommended, by the Committee on the Medical Effects of Air Pollutants (COMEAP) and built upon the attributable fractions reported as an indicator in the public health outcomes framework for England[2]. This article presents a short summary of the report. Further details of the methods and results are available in the report itself.

Background

Both epidemiological studies and studies on volunteers have shown that air pollution causes a range of adverse health effects. Effects of short-term exposure to high levels of various pollutants include exacerbation of asthma, effects on lung function, increases in hospital admissions for respiratory and cardiovascular conditions, and increases in mortality. Long-term exposure to air pollution reduces life expectancy, and this effect on mortality is greater than that associated with short-term variations in air pollution concentrations. COMEAP recommended the associations with fine particulate matter ($PM_{2.5}$) reported in cohort studies as the most appropriate basis for quantifying the effect of long-term exposure to air pollution on mortality[3].

Using a coefficient linking concentrations of fine particulate matter ($PM_{2.5}$) to all-cause mortality (a relative risk (RR) of 1.06 for all-cause mortality per 10 μg/m^3 increase in $PM_{2.5}$), COMEAP estimated the mortality burden of existing levels of anthropogenic air pollution in UK in 2008 as being an effect equivalent to 29,000 deaths and an associated loss to the population of 340,000 life-years[4]. Discussion sessions run by the Health Protection Agency* at workshops organised by Environmental Protection UK and the London Air Quality Network in 2011 suggested that similar estimates, produced at the local level, would be useful in communicating with the public and with local elected representatives and professionals. COMEAP was, therefore, asked to comment on technical considerations particularly relevant to local assessments and advise on possible approaches to such calculations[5].

COMEAP's opinion that mortality burden estimates could be calculated at the local authority level informed the Department of Health's decision to include the mortality effect associated with particulate air pollution as an indicator in its public health outcomes framework (PHOF) for England (indicator 3.1). The indicator adopted is the 'fraction of all-cause adult mortality attributable to long-term exposure to current levels of anthropogenic particulate air pollution'[6].

Methods and metrics

Pollution estimates

The estimates of mortality burden published by PHE in April 2014 are based on modelled annual average concentrations of fine particulate matter ($PM_{2.5}$) at background locations in each local authority area in 2010 originating from human activities. The modelling used methods developed by the Department for Environment, Food and Rural Affairs (Defra) to assess compliance with (and reporting under) EU directives. An additional step was included to apportion various sources/components of particulate air pollution as being either the result of human activity or naturally occurring.

The Pollution Climate Mapping (PCM) model uses dispersion modelling based on emissions data from the National Atmospheric Emissions Inventory (NAEI), chemical transport modelling and measurement data for specific components of particulate matter to estimate the concentration of $PM_{2.5}$ at background locations in each 1 km x 1 km grid square† . These modelled concentrations are then calibrated against monitoring data. Population statistics were applied to the modelled concentrations to calculate the population-weighted annual average modelled anthropogenic $PM_{2.5}$ concentrations for each local authority area.

* In April 2013, the Health Protection Agency was abolished and its functions transferred to Public Health England (PHE).

† EU Directive 2008/50/EC on ambient air quality defines 'background' locations as those representative of the exposure of the general population, ie they (a) are not within a steep concentration gradient influenced by a single source such as a road or an industrial installation and (b) integrate all local sources.

Attributable fraction

The local annual mean concentration (x) of $PM_{2.5}$ was used to estimate a relative risk (RR) for each local area, from a base relative risk of 1.06 per 10 μg/m³ of $PM_{2.5}$. The formula used for this logarithmic (multiplicative) scaling was $RR(x) = 1.06^{x/10}$.

In this context, the attributable fraction (AF) is the proportion of local deaths attributable to long-term exposure to anthropogenic particulate air pollution. The attributable fraction, expressed as a percentage, is calculated as $AF = 100 \times (RR - 1)/RR$.

Attributable deaths

Estimates of deaths attributable to long-term exposure to air pollution were made by multiplying the attributable fraction by the total number of deaths annually in the local area.

Data on the adult population and adult mortality rates for each local authority for the years 2008, 2009 and 2010 published by the Office for National Statistics, General Register Office for Scotland and Northern Ireland Statistics and Research Agency was used in the calculations. The figures of population and deaths were averaged over 3 years, to provide a less variable set of rates for calculations than annual figures. Mortality rates in 10-year age groups were used.

A calculated figure of 'attributable deaths' does not represent the number of individuals whose length of life has been shortened by air pollution. Long-term exposure to air pollution is understood to be a contributory factor to deaths from respiratory and, particularly, cardiovascular disease, ie it is unlikely to be the sole cause of deaths of individuals. This means that it is likely that air pollution contributes a small amount to the deaths of a larger number of exposed individuals rather than being solely responsible for a number of deaths equivalent to the calculated figure of 'attributable deaths', although the distribution of the mortality effect within the population is unknown. COMEAP therefore recommended expressing the results of these calculations of attributable deaths as 'an effect on mortality equivalent to 'X' deaths at typical ages'[4].

Years of life lost by the local population

Years of life lost to the population were calculated by multiplying the numbers of attributable deaths at each age by estimates of their age-specific remaining life expectancies, which were calculated using actuarial life-tables.

Combinations of local areas

As well as figures for individual local authority areas, results were required for a number of combinations of these areas. For these combined areas, the total attributable deaths and years of life lost were calculated by summing over the relevant local authorities.

Results

Central estimates of the fraction of mortality attributable to long-term exposure to current levels of anthropogenic (human-made) particulate air pollution ranged from around 2.5% in some local authorities in rural areas of Scotland and Northern Ireland and between 3 and 5% in Wales, to over 8% in some London boroughs. The mortality burden in England was estimated as equivalent to 25,000 deaths at typical ages, with an associated loss of life of more than 250,000 life-years. Because of uncertainty in the increase in mortality risk associated with ambient $PM_{2.5}$, the actual burdens associated with these modelled concentrations could range from approximately one-sixth to about double these figures, based on the 75% plausibility interval recommended by COMEAP[3].

Discussion

The aim of the work was to estimate the scale of the public health problem associated with air pollution. The estimates within the report are most appropriately used within a local authority area for comparison with health burdens from other risk factors. Comparisons of mortality burdens between local authorities are not an appropriate basis to assess good or poor practice in managing local air quality. This is because concentrations of anthropogenic fine particulate matter ($PM_{2.5}$) are dependent upon characteristics of the area, such as the proportion of the population living in urban and rural areas, and the extent to which concentrations are influenced by pollution from sources elsewhere.

Because the assumptions about emissions from some sources (eg roads) which underpin the modelling are based on a national inventory, very local initiatives affecting these sources (for example, local measures affecting vehicle age or technology) will not be reflected in the local modelled $PM_{2.5}$ concentrations. Thus, local mortality burden estimates based on this modelling approach are rather insensitive to local conditions affecting emissions from traffic sources, even though reductions in the actual mortality burden would be expected from such measures.

Also, contributions from local sources (those within about 15 km) typically account for only about 20–40% of urban background concentrations. This is another reason why both actual and estimated burdens of mortality attributable to long-term exposure to air pollution are relatively insensitive to individual local air pollution control measures; larger gains will be achieved when measures are implemented on a wider scale.

Another relevant consideration is that differences in the personal exposure of members of the local population to existing levels of pollution are not reflected in the burden estimates. Therefore, although initiatives to reduce personal exposure to $PM_{2.5}$ (eg by encouraging the use of low pollution walking routes or providing cycling lanes away from roads carrying large volumes of traffic) would be anticipated to be beneficial to public health, they would not be directly reflected in the estimates of local mortality burden attributable to air pollution.

Application of research to health protection

The published figures confirm that current levels of particulate air pollution have a considerable impact on public health in the UK. Measures to reduce levels of particulate air pollution, or to reduce exposure of the population to such pollution, are regarded as an important public health initiative.

The figures in the report are intended to be helpful to public health professionals and air quality specialists, particularly those within local authorities, in raising awareness of the local mortality burden of air pollution. By raising awareness of the effect of air pollution on public health, the figures should also encourage advocacy of the need for local – and also regional, national and international – actions to reduce air pollution. Individual authorities can implement measures to encourage and achieve reductions in local emissions and population exposure to air pollutants. However, more significant reductions in pollution will require action at all these levels.

Air pollution affects mortality from cardiovascular and respiratory conditions, including lung cancer. Measures implemented to reduce exposure to air pollution will, therefore, also deliver benefits for other indicators within the PHOF, including those reflecting premature mortality from these causes (indicators 4.4, 4.5 and 4.7). As well as reducing polluting emissions, encouragement of active travel – ie walking or cycling on journeys for which a car would previously have been used – will also have wider public health benefits associated with increased physical fitness. These benefits will contribute towards progress on other PHOF indicators: for example, indicators related to excess weight at various ages (indicators 2.6 and 2.12), as well as indicator 2.13, which reflects the proportion of physically active adults[6].

In addition to measures specifically targeted at improving air quality by reducing emissions, such as vehicle low emission strategies, a number of options to improve air quality and mitigate the effects of climate change on health, while also addressing other public health priorities such as increasing physical activity and addressing community severance and road safety, are available to local authorities. These include active travel policies, intelligent traffic control, and approaches to local planning which reduce the need for motorised travel and improve the design of green spaces.

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The Environment and Health Atlas for England and Wales: a printed and online tool

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The Environment and Health Atlas – what is it?

The Environment and Health Atlas provides maps showing the distribution of 14 health conditions and five environmental agents at small area scale together with interpretive text. Produced by the Small Area Health Statistics Unit (SAHSU) at Imperial College London, it is available in two formats: a hardback book, published in April 2014 by Oxford University Press, and an interactive online platform (www.envhealthatlas.co.uk). The aim of the atlas is to help in the development of hypotheses and research to better understand and explain variability in disease risk, particularly potential causal relationships between environmental agents and health. It should be noted that the publication cannot be used to directly infer causal links between an environmental agent and a health outcome.

The free open-access interactive version of the atlas shows maps with some summary information about the health or environmental agent displayed. The user can look at census ward level risks for health conditions or levels of environmental agents either by clicking through or by entering a postcode; census wards have an average population of around 6000 people.

The book presents the maps together with an overview of the current knowledge on risk factors for each health condition, potential health effects for each environmental agent and statistical summary tables. Contextual maps (including topography, urban/rural classification and population density of England and Wales) are also provided to aid interpretation. A technical appendix provides detail on the statistical methods used.

Methods

Long-term average risks were mapped for 14 health conditions using data from the Office for National Statistics (ONS) and the Welsh Cancer Intelligence and Surveillance Unit (WCISU):

- nine cancer diagnoses (lung, breast, prostate, malignant melanoma, bladder, leukaemia, brain, liver and mesothelioma)
- three common causes of mortality (coronary heart disease, chronic obstructive pulmonary disorder (COPD) and kidney disease)
- two reproductive outcomes (stillbirths and low birth weight)

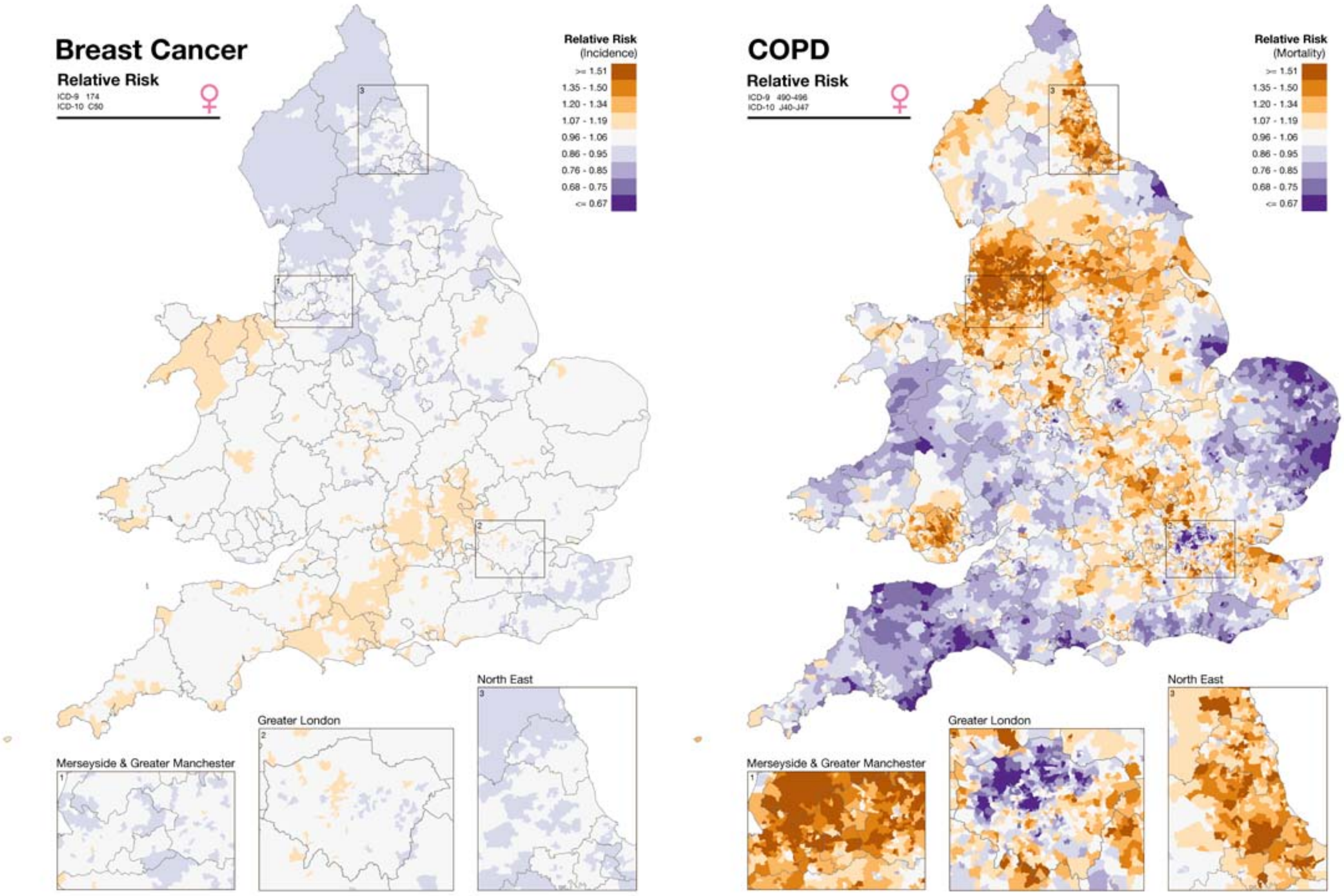
A 25-year averaging period was used (1985–2009) to calculate the risk of an area relative to the average risk in England and Wales. The health conditions are presented separately for men and women and the relative risks are adjusted for both age and deprivation. Even over 25 years, counts for some diseases were low, therefore statistical smoothing (using a Bayesian hierarchical model) was used to minimise chance variations related to small numbers so patterns could be more readily recognised. To provide a measure of the statistical uncertainty associated with the relative risk, maps for posterior probabilities are presented in the print version of the atlas (see the atlas for full details). The interactive version displays 95% uncertainty intervals around the relative risk estimate for each ward in a graphic below the main map.

The environmental agents mapped are agricultural pesticide usages, air pollution, chlorination disinfection byproducts in public water supplies, radon potential (the print version only) and sunshine duration. Other good quality environmental data at small area scale with national coverage was not readily available. The environmental maps came from a variety of sources but the majority of the environmental agent maps required at least some geographical modelling by SAHSU.

SAHSU worked closely with Sense About Science, a charitable trust with a remit to equip people to make sense of scientific and medical claims (www.senseaboutscience.org) during the development of the atlas to help make it more accessible to a range of audiences, including researchers and health professionals, policy makers and the public. Workshops with user representatives helped determine best ways to present information and key concepts – for example, that direct comparison of environmental and health maps could not be used to demonstrate a causal relationship.

Example maps from the atlas

Some health conditions produced 'flat maps', showing little geographical variation across England and Wales such as breast cancer (Figure 1a), but others showed much more geographical variation, such as COPD mortality (Figure 1b).



(a) (b)

Figure 1 (a) smoothed relative risk of breast cancer in England and Wales, 1985–2009 and (b) smoothed relative risk of female COPD mortality in England and Wales, 1985–2009

(In The Environment and Health Atlas for England and Wales by Hansell, Beale, Ghosh, Fortunato, Jarup and Elliott (2014), Figures 5.2.4 and 5.11.5 pp 76 and 174. By permission of Oxford University Press, www.oup.com)

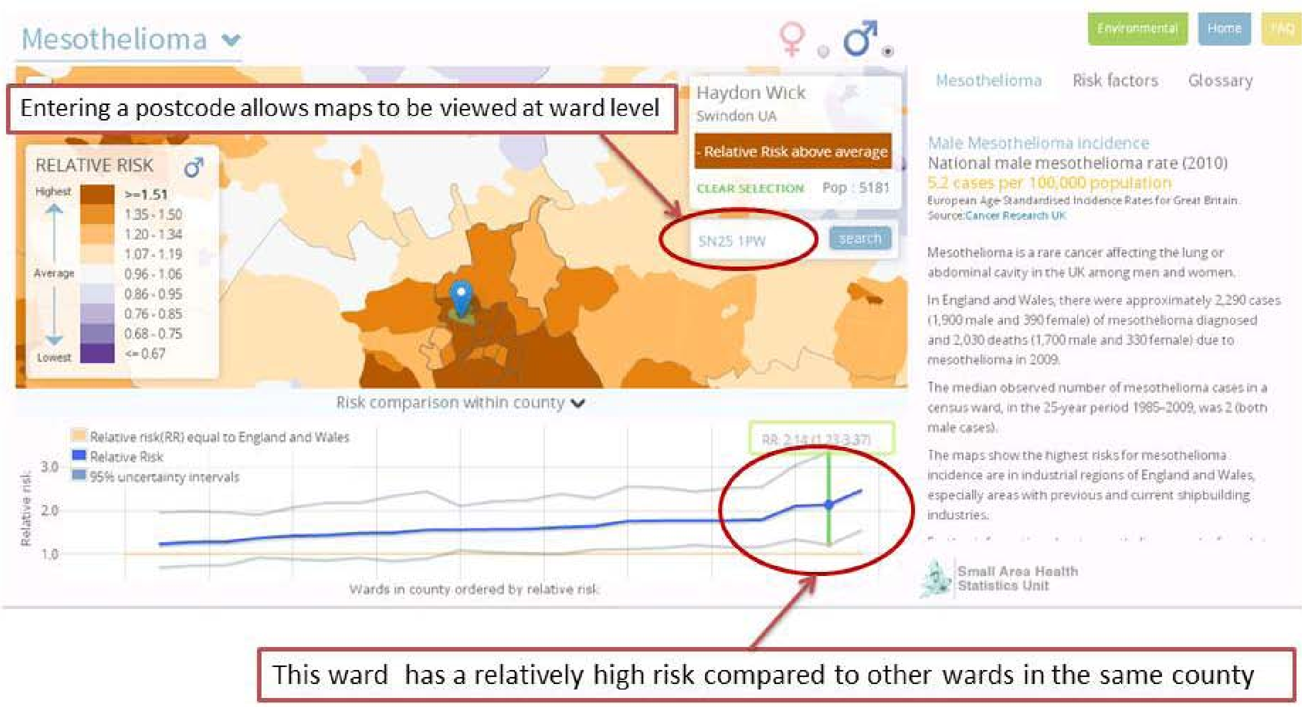


Figure 2: Screenshot of online atlas

Visitors to the online atlas can access relative risks for the census ward selected compared with England and Wales, these are displayed within a chart showing where the neighbourhood is ranked compared to the relative risks of other neighbourhoods in that county (Figure 2).

Maps of environmental agents such as air pollution are available in the print version and in a postcode searchable format in the online interactive version (Figure 3).

Media and public reception of atlas

Careful planning and responsible media coverage contributed to the overall positive feedback of the atlas. Public Health England (PHE) led on stakeholder briefing plans, establishing a working group with members from PHE, Public Health Wales, the Department of Health, Welsh Government, the Department for Environment, Food and Rural Affairs and the Health and Safety Executive. Key messages of the atlas were circulated along with briefing materials and the group provided input into the press release.

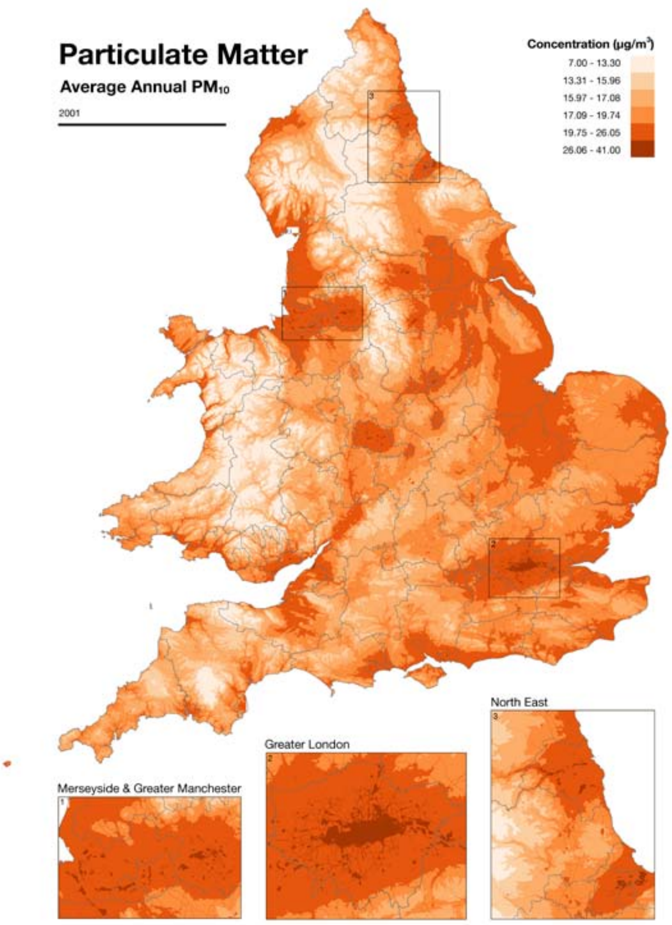


Figure 3: Average annual particulate matter (PM_{10}) concentration in 2001 in England and Wales

(In The Environment and Health Atlas for England and Wales by Hansell, Beale, Ghosh, Fortunato, Jarup and Elliott (2014), Figure 4.2.2 p 42. By permission of Oxford University Press, www.oup.com**)**

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On the day before publication and website launch, SAHSU held a press conference at the Science and Media Centre, London. As a result, the atlas received substantial coverage in the local and national media, including a feature on the Radio 4 Today programme. Over 205,000 visitors have used the online atlas since the launch (as of 21 May 2014), with an average of 575 unique visits per day.

The atlas has promoted discussion of health inequalities, research and policy at local and national levels. SAHSU hopes that the atlas will also contribute to future development of non-communicable disease surveillance and of environmental public health tracking.

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Asbestos: review of toxicology and epidemiology and an approach for human health risk assessment of low level environmental exposures

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Introduction

Asbestos is a trade name for a group of mineral silicates which exist in an 'asbestiform' habit, that is to say that they occur in polyfilamentous bundles composed of flexible fibres. The two main types are:

- the amphiboles, which include amosite (brown asbestos), crocidolite (blue asbestos) and tremolite
- serpentine asbestos, also known as chrysotile or white asbestos

Asbestos-containing materials (ACMs) are found commonly in buildings constructed up to the year 2000 as floor and ceiling tiles, pipe lagging, insulation board, roofing materials, protective coatings, textured decorations, etc, as well as being widely used as brake linings. This has inevitably led to asbestos fibres being liberated into the air, eg from damaged and/or weathered surfaces and there is generally a small amount of airborne asbestos present in the urban environment (see Table 1). Background ambient levels of respirable asbestos fibres may range in rural areas from below 0.0001 fibres per millilitre (f/ml) to 0.000001 f/ml. Assuming a respiratory rate of 8 litres (l)/minute, the Medical Research Council (MRC) Institute for Environmental Health estimated that this level of exposure would result in a lifetime exposure to asbestos fibres in the range of 0.29 million to 29.5 million fibres[1].

Table 1: Airborne levels of asbestos

Air concentration (f/m^3)	Equivalent air concentration (f/ml)	Meaning
100,000	0.1	HSE 4-hour control limit (Control of Asbestos Regulations 2012)
10,000	0.01	HSE 'clearance indicator' level
1,000	0.001	WHO air quality guideline*
100–1,000	0.001– 0.0001	Background levels in typical urban environment[1]

* Measured by electron microscopy

Review of toxicology and epidemiology

Health effects

The main non-carcinogenic health effects in humans associated with exposure to asbestos are diffuse pleural thickening (DPT), pleural plaques, asbestosis (fibrosis) and decrease in lung function[2].

In respect of carcinogenic effects, a recent International Agency for Research on Cancer (IARC) review has concluded that 'all forms of asbestos (chrysotile, crocidolite, amosite, tremolite, actinolite and anthophyllite) are carcinogenic to humans (Group 1)' and that 'asbestos causes mesothelioma and cancer of the lung, larynx, and ovary'. In addition, IARC concluded that 'positive associations have been observed between exposure to all forms of asbestos and cancer of the pharynx, stomach, and colorectum'[3].

The main factors determining the health effects of asbestos fibres are its form, type, size, surface chemistry, biopersistence and solubility in body fluids. Fibres need to be 'sufficiently long, thin and durable' to exert pathogenic effects and this means meeting the World Health Organization (WHO) fibre definition, ie:

- an aspect ratio ≥ 3 : 1
- length ≥ 5 μm
- diameter ≤ 3 μm

Generally, the pathogenic potency increases with fibre length, but the smaller fibres still have a role to play in determining health effects. Other factors also play a part and these includes trace contaminants, solubility in body fluids and ability to translocate through body tissues.

Differing physical structures result in amphiboles and serpentine asbestos behaving differently within human tissues. Chrysotile asbestos is formed as rolled concentric cylindrical sheets which can be readily degraded into smaller fibrils which can be easily removed from the body. The amphiboles exist as twin sheets formed into solid cylinders which are much more resistant to degradation in the body than chrysotile. The amphiboles tend to break along the crystal planes forming smaller, thinner fibres, which still retain pathological properties.

Possible mechanisms of action

Asbestos fibres when inhaled can be deposited in the lung with the site of deposition dependent upon the aerodynamic diameter of the fibres, their geometry and density. Fibres meeting the WHO criteria are more likely to reach the alveoli. From there the fibres can be translocated to pleural mesothelium (membrane of the thoracic cavity). The translocation pathway is unknown, but movement through the lymphatic system has been shown to occur in studies of amosite in rats.

Normally particulate matter is cleared from the deeper areas of the lung by being engulfed by macrophages and then removed from the respiratory tract by mucocilliary clearance. However, some asbestos fibres are longer than the diameter of macrophages (14–25 μm) and are not readily engulfed by them. This leads to a process named as 'frustrated phagocytosis' which can result in macrophage death. Fibres (in particular the amphiboles) can subsequently persist longer in the lung, allowing translocation to other tissues.

The recent IARC review has postulated mechanisms for the induction of cancer by asbestos. These originate from frustrated phagocytosis, resulting in either:

- impaired clearance and translocation of fibres, and/or
- 'inflammasome activation' caused by oxidants resulting in the release of the cytokine IL-1β followed by inflammatory cell recruitment and activation[3]

Subsequently the following series of events is postulated:

- release of reactive oxygen species (ROS), reactive nitrogen species (RNS), cytokines, chemokines and growth factors
- DNA damage and apoptosis
- effects on cellular signalling pathways, leading to cell proliferation, and resulting in fibrosis
- impaired DNA repair, chromosomal and epigenetic alterations, oncogene activation, etc, resulting eventually in cancer

Health evidence – epidemiological studies

Human health risk assessment for asbestos is derived from epidemiological assessment of cohorts of occupationally exposed workers in a variety of activities, but mainly either during the mining of asbestos or through involvement in its processing into useable materials. There are many scientific shortcomings in the quality of the evidence upon which dose-response relationships for the different forms of asbestos have been derived. Among these are:

- fibre measurement methods: was the right thing being measured? (ie were asbestos fibres of the correct dimensions detected)
- exposure estimates: accuracy of assumptions about which types of asbestos were present in the working environment, work exposure levels and exposure durations
- insufficient information on smoking habits and other confounders
- cancer ascertainment: this comes mainly from death certificate information, and there could be under-reporting for the existence of mesothelioma

Some of the key models and risk estimates are listed below:

- Hodgson and Darnton (2000) on behalf of the Health and Safety Executive (HSE)[4]
- Berman and Crump (2008) on behalf of the USEPA[5]
- Health Council of Netherlands (2010) on behalf of the Dutch Ministry of Health[6]
- WHO Air Quality Guidelines for Europe (2000)[7]
- US Environmental Protection Agency (USEPA) Integrated Risk Information System (IRIS) Database Reference Concentration (RfC) and Slope Factors (2000)[8]

The Hodgson and Darnton model (2000) is the model favoured in the UK. The authors undertook separate analyses for lung and mesothelial cancer risk and associated these with cumulative fibre exposure estimates. The exposure metric used is the average fibre concentration in air multiplied by the number of years of exposure, and is effectively an indicator of cumulative asbestos exposure:

$$\text{Exposure metric} = \underset{\text{(fibre/ml)}}{\text{Concentration}} \times \underset{\text{(years)}}{\text{Duration}} = \text{f/ml.y}$$

This metric is an indicator of the total number of fibres inhaled at work over the relevant exposure period. Non-linear models were used to get the best fit between cancer risk and the exposure metric. For mesothelioma, these models identified a greater slope at very low exposure levels f/ml.y than at higher levels. In the risk model, exposures were assumed to commence at age 30 years, continue for 5 years and the risk was assessed to age 80.

A key finding from this analysis was the relative potencies for mesothelioma for the different forms of asbestos. These were found to be in the ratio 1 : 100 : 500 for chrysotile versus amosite versus crocidolite. However, the risk estimates were derived from a small number of studies. The datasets were as follows: crocidolite – three cohorts; amosite – two cohorts; chrysotile – three selected cohorts.

The Health Council of Netherlands study concluded that the available data only allowed analysis of exposures to (a) chrysotile alone and (b) mixed fibres of chrysotile and amosite. Of the 30 epidemiological studies reviewed, only six studies (two for mesothelioma and four for lung cancer) met the quality criteria standards set by the authors. The newer risk estimates were 40 times greater than those calculated previously in the Netherlands and were also greater than those estimated by Hodgson and Darnton and by Berman and Crump, particularly in respect of chrysotile risk. The potency estimate was 1 : 50 for chrysotile versus amphibole.

A comparison of risk estimates from these various evaluations, expressed as an air concentrations of chrysotile resulting in a

1 in 100,000 excess lifetime mesothelioma risk, is presented in Table 2. A wide range of risk estimates is apparent. These differences are due to different estimates of the potency of chrysotile, depending on which epidemiological studies were included in the evaluation, and the models used to calculate the risk.

Table 2: Comparison of risk estimates (1 in 100,000 excess lifetime mesothelioma risk) for air concentrations of chrysotile

Organisation	Concentration (f/ml)	Comments
USEPA IRIS (1993)	0.00004	Derived from inhalation unit risk of 0.23 per f/ml for all fibre types
Health Council of Netherlands (2010)	0.0003	Midway between the published values for maximum tolerable risk (MTR) level (a 10^{-4} risk) and the virtually safe risk level (VR) (a 10^{-6} risk)
WHO Air Quality Guidelines (2000)	0.001	10^{-5} to 10^{-4} risk for mesothelioma in adults (30% smokers) for all fibre types
Hodgson and Darnton (2000)	0.001	Calculated from a cumulative exposure of 0.1 f/ml.y (Hodgson and Darnton 1 in 100,000 risk estimate) by assuming 70 years' exposure at 0.001 f/ml adjusted for early life exposures
Berman and Crump (2008)	0.01	Calculated from a cumulative exposure of 1.0 f/ml.y (Berman and Crump 1 in 100,000 risk estimate) by assuming 70 years' exposure at 0.01 f/ml and adjusted for early life exposures

Approach for human health risk assessment of low level environmental exposures

Low level asbestos exposure

Background cumulative public exposure to asbestos is likely to be less than 0.01 f/ml.y. This could arise from exposure to urban background levels of 0.0001 f/ml, experienced for several decades. Short-term exposure to a low level of asbestos, for instance a contamination incident where the public might experience a concentration of 0.1 f/ml for several hours over possibly one or a few days (this would be equivalent to less than 0.01 working year), could result in an even smaller cumulative load (ie 0.001 f/ml.y in this example) than is experienced from background exposure.

Due to the absence of a threshold for the carcinogenic effects of all forms of asbestos, a small risk to public health may be present at these low level environmental asbestos exposures. The risk model published by Hodgson and Darnton allows an estimate of cancer risk to be made at exposure levels which are much lower than those experienced in the epidemiological studies, where exposures were in the range of 100–1000 f/ml.y. The Hodgson and Darnton risk estimates, extrapolated down to 0.1 f/ml.y, are presented in Table 3[9]. There is considerable uncertainty in the risk estimates as can be seen in the wide ranges given in brackets at the lower exposure levels in the table. It should be born in mind that these lower estimates are highly uncertain as these cumulative exposures are up to 100,000 times lower than the observable data range from which dose-response relationships were obtained. Consequently, numbers should not be used as an absolute risk estimate, but rather as an 'indicator' of relative risks.

Table 3: Hodgson and Darnton risk estimates – excess lifetime asbestos-related lung cancer and mesothelioma (the two tumour types combined) per 100,000

Exposure (f/ml.y) (best max–min*)	Crocidolite	Amosite	Chrysotile
10	5600 (3200–8400)	2300 (960–4000)	56 (23–340)
1	750 (250–1600)	180 (35–570)	6 (1–45)
0.1	120 (24–360)	21 (2–100)	1 (0.1–7)

* Best estimate from the Hodgson and Darnton 2000 best-slope model with maximum and minimum estimates based on the range of predictions consistent with the Hodgson and Darnton 2000 high-slope and low-slope models. All models give cumulative risk up to age 80. Risks calculated for 5 years' exposure from age 30 years, calculated to age 80. These numbers should not be taken to be reliable absolute risk values

Some national authorities consider an excess lifetime cancer risk of 1 in 100,000 to be broadly acceptable. This level of risk would equate to a cumulative exposure of 0.1 f/ml.y for chrysotile. Risks from the amphiboles at this exposure level may be substantially higher.

The HSE's advisory body, the Working Group on Action to Control Chemicals (WATCH)[9], reviewed the applicability of using Hodgson and Darnton risk estimates at lower levels than published in Table 3, and concluded:

> '… the scientific judgement of WATCH is that there are risks of asbestos-induced cancer arising from work-related cumulative exposures below 0.1 fibres/ml.years. …
>
> 'The risk will be lower, the lower the exposure, but 'safe' thresholds are not identifiable. …
>
> 'Where potential exposures to amphiboles, particularly crocidolite, are below 0.1 fibres/ml.years (for example, 0.01 fibres/ml.years), the available scientific evidence suggests no basis for complacency, but rather a basis for active risk management …'

Exposures in childhood

The risk model for mesothelioma (but not for lung cancer) is not simply based on cumulative exposure (f/ml.y) but is also dependent on time elapsed since first exposure. The risk calculations in Table 3 assume a 50-year period since first exposure for adults. Children exposed to asbestos have potentially a longer time since first exposure, compared to adults, and so are at greater risk for the same level of fibre exposure.

The important aspect of possible increased vulnerability of children has been considered by the UK Government's Advisory Committee on Carcinogenicity (CoC)[10] which concluded:

> 'From the available data, it is not possible to say that children are intrinsically more susceptible to asbestos-related injury.
>
> 'However, it is well recognised by this Committee that, due to the increased life expectancy of children compared to adults, there is an increased lifetime risk of mesothelioma as a result of the long latency period of the disease.
>
> 'In reaching our conclusion and taking into consideration that there are a number of uncertainties and data gaps, we conclude that exposure of children to asbestos is likely to render them more vulnerable to developing mesothelioma than exposure of adults to an equivalent asbestos dose.'[10]

Table 4 provides a relative risk calculation for children compared to adults based on an increased duration of exposure. Compared to an adult first exposed at age 30 years, a child with the same cumulative exposure of 0.1 f/ml.y, with exposure beginning age 5, carries a 5.3 times greater risk of mesothelioma. Risk estimates which involve early life exposures need to be multiplied by adjustment factors such as those given in Table 4 (abstracted from data provided in CoC 2012)[11].

Table 4: Age adjustment factors for mesothelioma risk dependent on the age at which exposure commences[11]

Age at start of exposure	Risk persisting until age 80
0	7.0
5	5.3
10	4.0
15	3.0
20	2.1
25	1.5
30	1
40	0.4

NB these factors make no adjustment for possible greater susceptibility of the young

In addition to the greater risk due to early life exposures, children might also be more susceptible to early age exposures to asbestos, potentially because of impaired clearance mechanisms, underdeveloped immune systems, greater exposures relative to body weight, presence of actively growing tissues, etc. This is an important factor that needs to be considered in public health risk assessments of environmental asbestos exposure.

A risk assessment approach to low level environmental exposures

The Hodgson and Darnton risk model and the caveats described by WATCH and CoC provide an approach which might be useful for evaluating low level asbestos exposures (eg prolonged low exposure from asbestos-contaminated soils, short-term public exposure resulting from demolition work, or the discovery of asbestos in air at school premises). Placing these exposures into some context using the risk estimates can aid the public communication, prioritisation and management in these incidents.

The approach first requires an assessment of cumulative exposure in terms of f/ml.y. In this context a year is taken to be 1920 hours, the duration of a working year on which the epidemiological evidence is based, not 8760 hours which is the number of hours in a year (365 days x 24 hours/day). Once a cumulative exposure in terms of f/ml.y has been calculated, an adjustment may need to be made for early life exposures if relevant. The HSE WATCH table (Table 3) can be consulted to give an indication of risk if the type of fibre involved in the exposure is known. If exposures are to chrysotile and are well below 0.1 f/ml.y, risks are possibly so small that they are not significant. However, exposures to other types of asbestos greater than 0.1 f/ml.y may indicate that a more detailed risk assessment and/or mitigation measures may be required. A hypothetical case study using this risk assessment approach is presented in the box.

The following caveats must always be considered and expressed in any risk assessment using this approach:

- be aware of the large uncertainties in the risk estimates at very low cumulative exposures (in f/ml.y)
- WATCH risk estimates are useful for prioritisation and risk management; however, they should not be taken as absolute risk values as there is no threshold established for asbestos exposures, even if the risks are considered to be very low, action may still need to be taken to ensure that any exposure is reduced to 'as low as reasonably practicable'

Box: Hypothetical case study

Damaged asbestos ceiling tiles are detected in a bedroom of a council owned property, currently occupied by a 5-year-old girl. Monitoring has been undertaken, and indoor air concentrations of chrysotile asbestos have been measured to be 0.005 fibres/ml. The parents are concerned because their daughter has occupied that room since she was born. The parents have estimated she has spent on average 10 hours a day in her room, over the 5-year period.

Calculation of cumulative exposure (f/ml.y)

Exposure time (h)	10 h/day x 365 days/year x 5 years	18,250 h
'Exposure years'*	18,250 h/1,920	9.5 years
Risk metric (f/ml x years)	0.005 f/ml x 9.5 years	0.048 f/ml.y
Adjustment factor for childhood exposure†	Age at first exposure = 0	Factor of 7.0 appropriate
Effective exposure	0.048 f/ml.y x 7.0 (adjustment factor for childhood exposure)	0.333 f/ml.y

* Assume an 'exposure year' to be equivalent to 1,920 hours exposure

† To account for mesothelioma risk being greater for children than adults as they have longer to develop illness

Conclusions

Although the measured air concentrations are not too different to background levels in some urban environments, a comparison with the risk estimate from the WATCH table (see Table 3), allowing for the additional risks which can be experienced by children (Table 4), indicates that the cumulative exposure for the child exceeds the 0.1 f/ml.y risk metric, and adds weight to the view that remedial action should be carried out.

Conclusions

- the health effect of asbestos are well known and factors influencing the health effects are reasonably well understood though the mechanism by which these effects arise is largely unknown
- risk estimates and dose-response relationships have been established from studies of highly exposed workers for induction of both lung cancer and mesothelioma. There is generally considered to be no threshold for the carcinogenic effects of all forms of asbestos
- public health risks may be present from low level environmental asbestos exposures because of the absence of a threshold
- models indicate the level of cancer risk to be directly linked to the cumulative fibre exposure
- for mesothelioma risk, the level of cancer risk is thought to be influenced both by cumulative exposure and by the age at first exposure
- extrapolations from the Hodgson and Darnton risk estimates can allow an estimate of risk to be made for the environmental exposure in question; however, the uncertainties underlying these risk estimates always need to be clearly identified

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Use of fumigants in the transport of goods by sea – health impact

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Background

Maritime law and regulation is complex; in the UK, the Maritime and Coastguard Agency (MCA) (an executive agency of the Department for Transport) is responsible for the enforcement of merchant shipping regulations, including the carriage of cargoes. It follows recommendations produced by the International Maritime Organisation (IMO) (an agency of the United Nations).

Approximately 95% (by volume) of the UK's international trade is transported by sea[1]. The world trading fleet is over 55,000 vessels, totalling 983 million gross tons and global shipping tonnage has grown by over 90% since 1999[1]. In 2011, the total UK shipping fleet which includes directly owned, parent owned or those managed by UK companies was 1602 ships, representing over 61 million gross tons. This is an increase of six fold from 1999 and, as an example of cargo volume, the UK's largest container port (Felixstowe) handled 2 million cargo containers in 2011[2].

There is a need when transporting cargo to ensure that the contents of containers are protected from pests and insects as well as from degradation due to the transport process. While there are a number of methods available, fumigants are often used to control pests. In order to control rodents, lice and vermin it may be necessary to fumigate the vessel and cargo hold. Additionally, the cargo may itself require fumigation in order to prevent spoilage or damage by insects. Typical pests that are controlled by fumigation include booklice, grain beetles, grain weevils, rice weevil and mites.

The type of fumigant used will depend on the cargo being shipped, but a range of products may be fumigated – for example, foods and medicines, textiles, mattresses, shoes, wood and furniture. In a study conducted in the port of Hamburg, the most common items found to have been fumigated were shoes, furniture, foods and electrical appliances. Textiles and clothes were the most frequently transported items, representing one in every four containers arriving at the port[3].

There has been a global increase in the use of fumigant gases since 2005[4]. This has been attributed to the International Standards for Phytosanitary Measures 15 (ISPM 15), which aim to reduce the distribution of wood-damaging insects in wood-packaging materials[5].

The fumigation process within cargo containers is a potential hazard to both the health of those handling them and conducting the fumigation process, but also to the environment of the importing country should fumigant gases be released. However, the control of pests is an important public health measure, as there are also risks to public health through vectors (which transmit disease) being released where they are not controlled in transit. An example would be the Asian tiger mosquito which is a vector for the spread of dengue and chikungunya infections and lays eggs in containers and tyres[6].

There is an international maritime dangerous goods code, developed as a uniform international code for the transport of dangerous materials which includes fumigation gases and this became a mandatory code of practice in 2004. Under this code there is a requirement to clearly label containers under fumigation[7].

Methodology

A literature search was undertaken using both conventional medical databases (Medline, Embase, CinHal and PubMed) and general internet searches to identify information related to incidents where exposure to fumigants has occurred from shipping cargo containers. No restrictions were placed on type of fumigant chemical or location of the incident; however, only reports in English were able to be included.

Types of fumigants

The table described the most common types of fumigant gases used, their main purpose and the exposure effects. It is worth noting that fumigants may also be used in combination so exposure may not be to a single chemical. Methyl bromide

Table: Commonly used fumigation chemicals and their health effects[8]

Chemical	Main use	Exposure effects
Methyl bromide (bromomethane)	To reduce wood-damaging insects on a number of products	Inhalation causes dizziness, headache, nausea and irritation of the airway. It also affects the central nervous system and in high concentrations can cause respiratory failure
Chloropicrin	Used as a pesticide to kill pests found in soils	Causes rapid irritation of the eye, nose and throat with nausea and vomiting, death can be caused from lung oedema after damage to the bronchial tubes
Phosphine (including phosphine generating substances such as magnesium phosphide and aluminium phosphide)	Commonly used to protect dry plant products from insects	Affects the respiratory tract and can lead to lung damage and oedema, it also in higher doses causes a drop in blood pressure and circulatory collapse
1,2-dichloroethane (ethylene dichloride)	Insecticide	Suppresses the central nervous system, nausea, vomiting, damage to the liver and kidneys. In higher doses heart rhythm dysfunction, genotoxic and carcinogenic
1-3 dichloropropene	Used to protect crops and foods, mainly in the US	Potential carcinogen

is an ozone-depleting substance which is being phased out by most countries under the terms of the Montreal protocol. However, it can still be used under critical-use exemptions. Less common chemicals used in fumigation include volatile organic compounds such as benzene and toluene and other chemicals such as sulphuryl fluoride, carbon dioxide, methyl iso-thiocyanate generating substances and formaldehyde.

Possible exposure to fumigants

The risk of exposure to fumigants comes from either direct contact with the fumigated container for workers and bystanders at ports, or onward exposure to people handling the goods and to consumers who purchase the products[3, 9,10].

A prospective study of 2113 containers passing through Hamburg, one of Europe's largest container terminals, found that 70% were contaminated with fumigant chemicals above the chronic reference exposure level, indicating a risk to workers handling them[3]. In addition, a study in Rotterdam reported that only 2% of containers which were not yet free of pesticide were actually carrying appropriate warning labels[11]. Five per cent of those had gaseous pesticide concentrations above occupational exposure limit values for the Netherlands[4,10].

Exposure incidents

There are few published reports of incidents involving fumigants occurring at sea or during the unloading of cargo containers in the conventional medical literature[12,13]. There are other reports from industrial events such as where a number of people were exposed or where a loss of life has occurred[14,15,16] and reports of incidents in specialist publications[17,18].

There is likely to be publication bias in the published literature as only more extreme events or incidents are likely to be written up and therefore unlikely to be representative of the range of exposures that may be occurring. More reliable information to address this comes from systematic data collection systems usually held by organisations involved in the response to such incidents.

In the UK, the National Poisons Information Service (NPIS) reported in 2010 on pesticide fumigant exposures occurring between 2004 and 2009[19]. Fumigants were only 1.2% of the total pesticide incidents, with aluminium phosphide (68%) and methyl bromide (29%) being the most common chemicals. Just over half (55%) were occupational exposures and 42% of these were exposures occurring after the application of the fumigant had taken place (ie not while using the product). The most common symptoms were bronchospasm, mouth/throat irritation, nausea/vomiting, lachrymation, dizziness, headache, eye irritation, lethargy, tachycardia and anxiety[19].

In Germany, a database of fumigation-related health incidents is kept by a network of port health authorities based on direct reports and regular reviews for any incidents reported in the literature[20]. The database was initiated in 2007 and was last updated at the end of 2012. There are a total of 64 reports which would equate to over one per month. These incidents are also likely to be an underestimate due to the passive nature of data collection and reliance on self-reporting by clinicians seeing patients exposed to chemicals. A review of the database contents was published in 2011[13], representing cases reported to 2010 and reports exposures to methyl bromide, ethylene dichloride and phosphine from contact with shipping containers and packaging materials. Patients were commonly diagnosed with reactive airways dysfunction syndrome as a result of exposure.

Looking at the current data within the database (January 2013) the most common exposure chemicals reported are now methyl bromide (35.2%) followed by phosphine (16.6%). These were also the two most common chemicals in the

NPIS study and a review of pesticide-related illness from Washington State Department of Health from 1992–1996[21]. Exposures are mainly reported during the opening or handling of shipping containers at ports (37%) or directly occurring at sea during transport (16%).

The maritime insurer Gard reports on incidents it has investigated and has produced a newsletter specifically focusing on issues related to the safe use of fumigant gases as part of a series of reports on fumigation on cargo ships[18]. The majority of reports are of phosphine gas exposures including two reports of crew members being overcome by phosphine gas during the transit of soya bean meal, both of which were due to deficiencies in the ventilation system or ship maintenance, and the death of a stowaway who was among six people found on a ship carrying fumigated coca beans.

Consumers and long-term exposure

Exposure may also occur directly from products such as rice and dried fruits, seeds and nuts as fumigant gases are absorbed[22]. In addition, chemicals may be found on the coverings of furniture, textiles and on the surfaces of some items. Incidents from these types of exposures are rarely reported in the literature, although a study of products from cargo containers clearly demonstrated that fumigants are detectable on products which would have the potential to be received by consumers; these included mattresses, shoes and other textiles[22]. This study was not, however, designed to calculate the actual risk from such potential exposure.

While further work is needed to determine the risk, if any, to health from the potential exposure from products at these levels, there have been events where acute exposure to chemicals absorbed in products has occurred. These have the potential to affect a larger number of people. In the UK, exposure to dimethyl fumarate (DMF), which was used as an anti-fungal treatment to protect furniture during storage, occurred from sofas which had been stored in a warehouse and treated with DMF to avoid fungal growth. Unexplained chemical reactions including skin burns and respiratory problems emerged and after a delay in identifying the source of the problem, the contamination of the sofas was discovered and significant media coverage followed. This resulted in a £20 million compensation settlement from the distributers of the sofas[23]. Even after the exposure sources were removed, people exposed reported a loss of muscle strength, mood variations and unusual exhaustion and fatigue[24].

There is currently very limited data on the potential effects of long-term exposure to fumigation chemicals, particularly from exposure from cargo containers.

A cohort study assessing risk factors for the development of Alzheimer's disease reported an adjusted increased relative risk (4.35 times) associated with occupational exposure to fumigants and defoliants compared to those without such exposure, although the confidence interval around the estimate is wide (95% CI 1.05 to 17.90) due to the low number of people developing the disease in the cohort over the 5-year follow-up period[25].

A recent systematic review of the literature of methyl bromide exposure risk for cancer found a non-significant but increased risk of prostate cancer[26] suggesting further investigations are warranted, although none of the identified studies looked at exposure from shipping cargo containers. Barry et al[27] analysed outcomes from an agricultural health study cohort across a number of cancer sites and found inconclusive evidence of an increased prostate cancer risk (non-significant increased risk in those with a family history) but did report an increased relative risk of stomach cancer (increased risk 3.13 times 95% CI 1.25 to 7.80) in those using high and low levels of methyl bromide compared to no use[26].

Discussion

Exposure to fumigants in this context occurs either at the time of fumigating, at sea during transportation or when handling and unloading cargo containers. There are very few reports of subsequent exposure in consumers or of risks to people in the surrounding environment.

The most common exposure leading to health effects is likely to be from methyl bromide or phosphine. The effects of exposure to fumigants may cause both acute and chronic effects (see the table). Most chemicals used in fumigation processes do not have a smell so there is no warning that exposure is occurring until symptoms develop. Symptoms may present as non-specific and it is important to consider occupation as a risk factor. Symptoms of acute exposure include bronchospasm, mouth/throat irritation, nausea/vomiting, lachrymation, dizziness, headache, eye irritation, lethargy, tachycardia, and anxiety[12,18].

In the event of a suspected exposure incident in the UK, as much information as possible should be collected to identify the chemical involved and expert information on the clinical management of people exposed to fumigant gases is available from the NPIS. The public health risk assessment algorithm for chemical incidents at sea reported in 2009 in the CHaP Report[28] could be used. Some Public Health England health protection teams have reported a series of incidents over time including the experiences reported from West Yorkshire with phosphine in a range of settings including the unpacking of storage containers and shipments of wooden garden furniture in a DIY store[17].

In the UK, those conducting the fumigation process must follow appropriate health and safety guidance, such as the Health and Safety Executive (HSE) guidance for employers and technicians carrying out fumigation operations (produced in 2005)[29], but there is a need to ensure workers both handling containers and in contact with containers, and those at sea during the transportation of cargo that has been fumigated, are aware of the risks.

International agencies and regulators must ensure the labelling of cargo containers is sufficiently clear to provide warnings of the risk from their contents. Labelling has been shown to be inconsistent and poor with many unlabelled containers containing high levels of fumigant gases[3,4] and there is potential for accumulation of concentrations of fumigant gases in containers[30], so it is important that methods for storage and transport, including aeration and ventilation, are regularly reviewed.

Public Health England is developing a short statement to assist incident response involving fumigants and the work will also be considered for inclusion in the SHIPSAN project which deals with impacts on maritime transport of health threats including chemicals[31].

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Role of risk communication in non-infectious disease cluster investigations: a summary of the literature

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Background

It is not uncommon for people to notice what they believe to be an abnormal number of cases of disease in people they know – be it patients, family, friends or members of their community. Non-infectious disease clusters can be defined as 'an unusual aggregation, real or perceived, of health events that are grouped together in time and space'[1] . For example, non-infectious disease clusters may involve cancers, chronic diseases, congenital anomalies or other cases of unusual illnesses.

Investigation of clusters can require complex epidemiological and statistical analysis and environmental exposure assessment. The majority of clusters occur by chance and cannot be attributed to any local environmental sources. Investigations of possible disease clusters therefore require effective risk communication and engagement with the public in order to provide a satisfactory resolution for the communities concerned.

Aims

This review aims to identify key factors affecting risk communication in non-infectious disease cluster investigations. By examining potential obstacles and facilitators to effective risk communication, this review aims to establish a set of basic guidelines for communicating about risk to the public during disease clusters. The findings of this review will be considered in the development of Public Health England's new guidelines on disease cluster investigations.

The findings of this report were informed by an extensive literature review of academic studies of risk communication, as well as analysis of a variety of international government reports and guidelines on the management of disease cluster investigations.

Why is effective communication important?

Effective communication in disease cluster investigations is crucial for maintaining a positive, well-informed relationship with the public. The health practitioner/public relationship is especially important in light of the fact that no environmental source is found for the majority of disease cluster investigations. Public expectations of investigators' capabilities often outstrip the reality of the processes, procedures and scientific solutions, meaning an inconclusive result is seen as a failure[2].

Obstacles to risk communication

Risk communication messages must be timely and framed in terms that are accurate, understandable and relevant to the individuals and communities involved in disease cluster outbreaks. There are several factors that can damage the effectiveness of risk communication messages. These include, but are not limited to:

- differences between public and expert understandings of risk (see the table)
- confusing use of technical 'jargon'[3]
- failure to elaborate on standard scientific uncertainty[4]

First, technical/expert assessments of risk tend to be built upon quantitative assessments of the likelihood and impact of specific risks. Members of the public are interested in the quantitative findings, but their perceptions of risk are more likely to be informed by qualitative assessments based on whether or not they perceive the risk(s) as having the ability to impact the quality of their day-to-day life and long-term health. The table illustrates some of the ways in which members of the public perceive risks differently from experts.

Second, it can be tempting for experts to provide information in terms that are normal to their profession in order to ensure accuracy and clarity among health care responders. Unfortunately, the use of technical 'jargon' can make the message difficult for the public to understand. Risk

Table: Variations in public and expert perceptions of risk[5]

Expert risk perception factors	Public risk perception factors
Can I identify a clear cause and effect relationship?	Is the risk voluntary or involuntary?
Can I quantify the amount of harm?	Is the risk familiar or unfamiliar?
Do I suspect a hazard based on past experience?	Do I have control over the risk or do I trust the organizations who are supposed to be responsible for the risk?
Is there a possibility of an accident?	Is the risk fair or unfair?
Is there a possibility of exposure to the risk?	Is the risk natural or technological?
Is there evidence of damage?	Does the risk cause dread?

communication messages must be adapted in order to ensure that they are clear and relevant to members of the public. North Carolina's cluster investigation protocol since 1990 is a good example of a strategy that establishes a useful relationship with the affected individuals during the initial stage of an investigation. By advocating a meeting between a public health official and the community, that protocol allows for some early engagement with the specifics of a scenario and an opportunity to educate the public in a more personal setting. It also provides investigators with important information that can inform their risk communication methods as an investigation progresses[4].

Third, the use of messages stating the standard scientific acceptance of uncertainty can be perceived by members of the public as avoiding responsibility or a lack of commitment[4]. Failing to account for language and trust barriers in disease cluster risk communication can increase the likelihood of an investigation losing credibility with the public. Understanding and acknowledging the social context in which an investigation is taking place allows investigators to communicate about risk more effectively by adapting messages to specific scenarios and audiences[6]. Communication about scientific uncertainty in particular must be adapted to each situation in order to ensure that the information is useful and relevant to members of the public. For example, in one case following a fire in New York that contaminated an office building with dioxin, public health officials were able to effectively communicate information and uncertainty to the public by involving specialists and laypeople unaffiliated with the State Department of Health in their response committee. That committee deliberated its decisions publicly, allowing the affected community to see and understand the processes through which decisions were being made. The transparency allowed the public an excellent degree of understanding of the government response and made the process of risk communication far easier[7].

Overcoming obstacles to risk communication

Investigators and risk communicators have a number of tools and strategies that they can use in order to help them overcome the obstacles listed above.

First, and foremost, health care responders and investigators must consider the tone of the messages they communicate to the public. Specifically, individuals tasked with communicating about risk during a disease cluster outbreak must ensure that they avoid making absolute statements.

The danger of making absolute statements is linked to public expectations outstripping the investigations' capabilities. For example, the statement 'This investigation will identify a source for this cluster' is an absolute that gives the public expectations beyond what can realistically be provided. Acknowledging a degree of uncertainty early in the process allows public expectations to be adjusted to a more realistic level[8].

Individuals tasked with communicating risk during disease cluster outbreaks must also ensure that they avoid trivialising the issue through risk comparisons. The danger of comparisons (such as 'it is less risky than smoking') is also linked to public understandings of risk (see the table); comparisons that place voluntary risks against perceived cluster scenarios are often received poorly[9].

In addition to tone, risk communicators must consider the content of their messages. In terms of content, there is a broad consensus that messages should be kept simple, clear and strong. Glik[10] highlights the following as key strengths that communicators should consider:

- message consistency
- message certainty
- source credibility
- source familiarity

Maintaining a strong, clear and understandable message is considered important by academics and professionals, and does not require the denial of scientific uncertainty. Sandman stresses that uncertainty is not in itself a problem, provided it is presented to the public appropriately[8].

Last but not least, one of the most important elements of risk communication involves the development of trust. Trust can explain up to 50% of cooperation, indicating that a healthy relationship between investigators and the affected community in a disease cluster investigation is crucial to effective risk communication[11]. Establishing a good relationship rests upon involving the local community in the investigation from an early stage. Academic and professional sources advise transparency and openness throughout the investigation[7]. Investigators are also advised to respond to public mistrust and demands sympathetically, and without hostility[6]. This review found that the following tools were suggested to facilitate this process:

- telephone hotlines
- public forums
- personal meetings between public health professionals and the public[4]

These tools allow the public avenues through which to voice their concerns. They can also serve as sources of information for the public. Most importantly they facilitate dialogue and familiarity between the public and the investigation.

Conclusion

Effective risk communication in disease clusters can be extremely challenging. Examining the literature surrounding the topic shows a strong consensus underlining the importance of the following key points:

- clear and coherent messages
- understanding of public perception of risk
- early and direct engagement with the concerns of the public
- transparent investigative procedures

From this review's findings, protocols that ensure these are considered in disease cluster investigations should find the process of risk communication significantly easier.

Agencies and organisations responsible for investigating and communicating about disease cluster outbreaks must be proactive. The authors acknowledge that disease cluster outbreak incidents vary greatly in respect to symptoms, communities, timing and trusted communicators. Fresh messages will need to be created, communicated and adapted throughout the process of investigation. In spite of this, communication about disease outbreaks or suspected disease cluster outbreaks share a number of common elements and messages (ie symptoms, assessment, uncertainty, etc). Investigators and communicators can prepare for this by developing and pre-testing standard expert statements with non-expert members of the public prior to an incident. These messages can include issues of framing around uncertainty, information about exposure assessment procedures, and more. These messages will need to be adapted to suit each event, but the act of pre-testing messages can uncover previously unidentified public information needs and move investigators and communicators closer to building trust through accurate, timely and effective communication with affected communities[12].

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Natural Hazards, Extreme Events and Climate Change

The oak processionary caterpillar and public health: the Dutch approach

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Background

The caterpillar of the oak processionary moth can pose a nuisance to communities who live in the vicinity of infested oak trees or those passing through these areas. Exposure to the hairs of the caterpillar can lead to health effects, such as skin rashes and eye irritation. In the Netherlands, members of the public have been seeking advice from the Municipal Public Health Services on this issue for the last 20 years.

Inexorable march of the oak processionary caterpillar

The first recorded outbreak of caterpillars of the oak processionary moth (*Thaumetopoea processionea*) in the Netherlands was in 1878, in an area near Nijmegen in the south of the country[1]. The area was cordoned off after cows grazing there developed tongue lesions. There were no reports of caterpillars the following year and it took more than a century for them to return. Since 1988, when the caterpillars returned to the south of the Netherlands near Eindhoven[2], there has been an increase in their number and spread (see Figure 1[3]). There have been some notable outbreaks, such as in 1996, when the explosive growth of the population led to a veritable plague of caterpillars in the southern provinces of Limburg and Noord Brabant, with more than 20,000 people consulting their GPs concerning symptoms[4]. Since 2010, nests of the *T. processionea* caterpillars have been identified in all provinces of the Netherlands[3] and *T. processionea* is also expanding its territory in other countries.

Since 2006, infestations have been identified in London, causing one outbreak of itchy rash in 2006[5], and since 2010, *T. processionea* has been found in West Berkshire[6]. Despite the presence of the oak processionary moth in these parts of England, the evidence suggests human health problems in

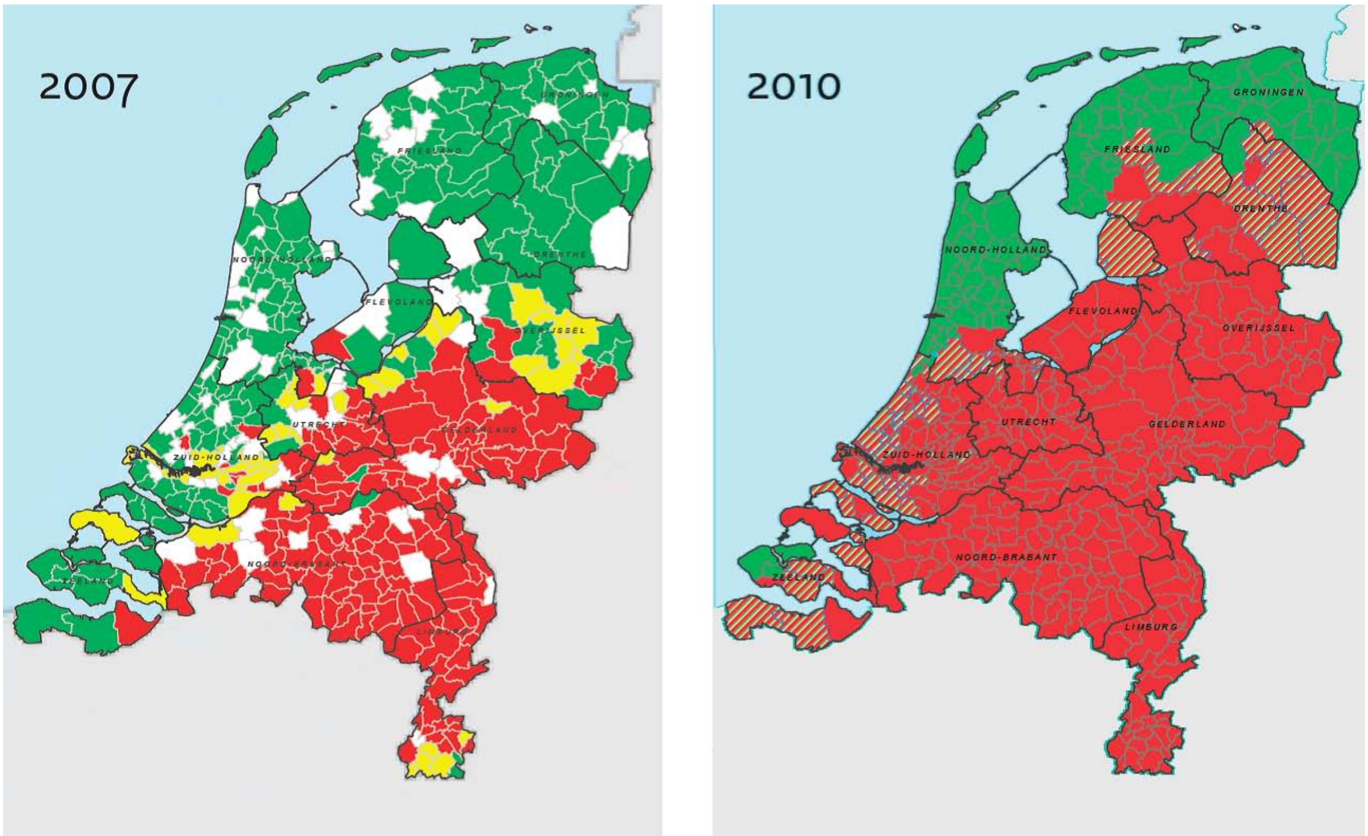

Figure 1: Example of the spread of the oak processionary caterpillar in the Netherlands (NVWA[3]):
red indicates areas where the caterpillar is present
yellow indicates areas where the caterpillar was first identified in 2007
red stripes indicate areas where the caterpillar was suspected to be present in 2010
green indicates areas where the caterpillar was not identified

the UK have been consistently very low over the past seven years apart from sensitisation of some arboricultural workers.

Lifecycle of the oak processionary moth

The oak processionary caterpillar is the larva of the *T. processionea* moth, which lays its eggs in the tops of oak trees in the summer, where they remain throughout the autumn and winter. The caterpillars hatch in late April to early May. After passing through several moulting stages, the caterpillars are fully grown in July. The caterpillars acquire their urticating (irritant) hairs after the third moult. This is between mid-May and late June. In July, the caterpillars pupate into a grey moth. The female moths then lay their eggs in the tops of oak trees from which the caterpillars will hatch the following year.

Oak trees infested with caterpillars

In May, June and July, hairy *T. processionea* caterpillars can be found on many oak trees throughout the Netherlands (see Figure 2). Oak trees infested with caterpillars can be identified by the characteristic nests on the trunk or thick branches (see Figure 3). These nests are built of dense webs of shed skins, irritant hairs and excrement. The caterpillars leave their nests at night to move head to tail in procession (hence the name) to the tops of trees in search of food (predominantly oak leaves). Groups of caterpillars can completely defoliate a tree.

Figure 2: Oak processionary caterpillars on a branch 'in procession' (Leon van den Heuvel, Foto-effect)

In 2010, underground nests were discovered for the first time in the Netherlands[7]. It is suspected that this occurs when daytime temperatures are high (30°C or higher) and the caterpillars seek a cool place to shelter. The caterpillars bury themselves in the ground at the base of the trunk of an oak tree and stay there in a huddle during the day. At night time, they return to the trees to eat the leaves. If high temperatures persist, pupation can even occur underground.

Figure 3: Oak processionary caterpillar nest on a tree trunk (Maarten Crezée, Plagen Preventie Dienst)

Health complaints caused by the urticating hairs

Contact with the microscopic arrow-shaped urticating hairs (setae) can lead to symptoms, such as an itchy rash and irritation of the eyes or respiratory tract[8]. There is a particular risk of health complaints in the period that the oak processionary caterpillars have these setae (mid-May to late June) and during the further spread of these hairs from the remains of the nests (July to September) (see the table). Direct contact is not a requirement for the manifestation of symptoms. The setae (600,000–700,000 per caterpillar) can be spread by the wind and end up on skin or on clothing. The setae have barbs that can easily penetrate the skin, eyes and respiratory tract. They can elicit a pseudo-allergic reaction, which may vary strongly from person to person. After frequent contact, the reactions may become more intense. The skin irritation (which occurs within eight hours of contact) results in a painful, red, intensely itchy rash that can last up to 2 weeks. If setae get into the eyes, a red, painful, irritating and itchy swelling occurs within hours. Inhalation of setae can cause irritation (problems with swallowing) and inflammation of the lining of the nose, throat and respiratory tract. Sometimes, a true allergic reaction is elicited.

Table: Periods when health complaints can occur

Period	Development stage caterpillar	Degree of discomfort
September to mid-April	Egg stage	Limited discomfort
Mid-April to Mid-May	Young caterpillars	Limited discomfort
Mid-May to late June	Mature caterpillars (urticating hairs from 3rd to 6th larval stage)	Much discomfort
Mid-June to late August	Pupation stage (nests and hairs)	Discomfort
July to September	Moth (nests and hairs)	Discomfort

Advising and informing the public

In the Netherlands, the Dutch Municipal Public Health Services (GGDs) advise the public and local governments on environmental health issues, including *T. processionea*. The caterpillar generates complaints and enquiries that are registered in the online database used by the GGDs to register environmental health complaints. Since the oak processionary caterpillar was added as a category to the system in 2008, 7–8% of the complaints each year pertaining to the outdoor environment (around 2400 in total in the period 2011–2012) have been due to this issue[9]. On average, about half the registered complaints are health complaints (predominantly itchy rash) and the others are either nuisance or worry complaints, or this category was not filled in (missing data). Of the complaints related to the outdoor environment between 2009 and 2012, the *T. processionea* caterpillar generated the most complaints after asbestos. The spread of the caterpillar through the Netherlands can also be traced by these complaints. In 2009 and 2010, hardly any complaints were registered by the GGDs in the three northern provinces of the Netherlands. However, from 2011–2012, more than a quarter of the complaints pertaining to the outdoor environment registered by these GGDs were related to the caterpillar[9].

The Netherlands National Institute for Public Health and the Environment (RIVM) has collaborated with the GGDs to develop several products to help them provide sound advice and information on *T. processionea* and associated health effects to local authorities and the public. A guidance document developed in 2008 gives an overview of the available knowledge on the *T. processionea* caterpillar, its spread, associated health complaints and control measures[10]. Also included is a chapter on when and how to advise and inform the local authorities and the public. Furthermore, the RIVM published an update of the scientific literature on the potential health effects of the *T. processionea* caterpillar in 2013[11].

A downloadable 'communication toolkit' is available on the RIVM website with free, ready-to-use information for GGDs to use in their public communication[12]. The resources in the toolkit include a folder, frequently asked questions, photographs, posters, examples of press releases, and a presentation. The GGDs can tailor these resources to their needs. In 2012, the toolkit was accessed from around 1500 unique browsers, making it the most frequently accessed toolkit on an environmental health issue produced by the RIVM.

How to protect against health effects

The public are warned to avoid all contact with *T. processionea* caterpillars and their remains, such as urticating hairs, skin and empty nests. People should cover their neck, arms and legs and not sit on the ground when visiting an area suspected of being infested with the caterpillar and children should be warned about the dangers of the caterpillar. The urticating hairs of the caterpillar can affect an area for many years after an infestation.

Management of oak processionary caterpillar

In the Netherlands, landowners, local authorities, county councils and national government are responsible for the management and mitigation of the *T. processionea* caterpillar on trees in areas under their management. Since *T. processionea* has become a chronic problem in the Netherlands, local authorities now often have structural management plans in place rather than taking ad hoc management actions.

The Netherlands Food and Consumer Product Safety Authority (NVWA) has produced guidelines on management of the *T. processionea* caterpillar, which were updated in 2013[7]. These guidelines were set up by the national expert group on the *T. processionea* caterpillar, in which the RIVM participates. Management is based on a three-step process whereby the onus is on responsible management to achieve a sustainable ecological balance with as little nuisance to humans and fauna as possible. First, a risk assessment should be done of the area concerned, taking into account the presence of sensitive plants (eg oak monocultures), people and livestock. Second, monitoring of *T. processionea* moths, eggs, caterpillars and nests should be carried out to build up a picture of the extent of the problem. Third, an appropriate management option should be chosen. This can range from warning the public to eliminating the caterpillars using environmentally friendly measures. These include spraying the trees with biological agents (eg formulas with the bacterium *Bacillus thuringiensis* or the nematode *Steinernema feltiae*) in the second and third larval stage and vacuuming the caterpillars and nests from the trees in a later stage of the lifecycle.

Conclusion

The spread of *T. processionea* throughout the Netherlands has led to a greater need among GGDs for information and advice on dealing with complaints and enquiries from the public and local authorities on this issue. RIVM has collaborated with the GGDs to produce various products which, judging by their uptake, are helping the GGDs in their task of providing information and advice. What the effects have been on awareness raising, and avoidance and mitigation of symptoms in the public, has not yet been evaluated, however. Anecdotal evidence suggests that the number of patients presenting health effects associated with the *T. processionea* caterpillar to their GP is now lower than predicted from earlier studies. This could be the result of various factors, such as raised awareness in the public resulting in avoidance of areas where outbreaks have occurred or recognition and self-management of symptoms. More studies are needed to elucidate this further. Nevertheless, through the increase in available information and evidence, we now regard the oak processionary caterpillar as a manageable public health issue in the Netherlands.

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Improving the response to flooding: changes implemented in Gloucestershire since the summer 2007 floods

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Background

Following the wettest May to July period on record since 1766, additional excessively heavy rainfall on 19–20 July 2007 on already saturated ground led to severe flooding in Gloucestershire[1]. Across England, 13 people died and 55,000 properties were flooded, resulting in 180,000 insurance claims and damage estimates at £3 billion[1]. Gloucestershire was particularly badly affected: three people died – two from carbon monoxide poisoning and one from drowning, 825 homes were evacuated resulting in approximately 1,950 people (including 490 children) seeking temporary accommodation[2], and 350,000 people were left without mains water for more than 2 weeks[1]. Effective collaboration between governmental agencies prevented an electricity substation from flooding but 42,000 residents had to be disconnected for 24 hours to construct substation flood defences, causing communication disruption into and out of homes[1]. Transport networks suffered as tens of thousands of Gloucestershire commuters were stranded on roads and local rail network stations due to flooding[2].

This paper discusses the issues experienced by Gloucester County Council (GCC) and its multiagency partners during and after the 2007 flooding, the steps taken to improve the resilience of responders and the community to future flooding, and their implications for public health.

Identifying the problems and solutions

The extent of the flooding in Gloucestershire in 2007 and the speed at which it occurred was unprecedented, meaning individuals were largely unprepared and service providers' resources were stretched. In the aftermath of the floods, GCC set up an inquiry to look at how the emergency services, local authorities and utility companies dealt with the event.

Insufficient council funds to meet the cost of priority flood resilience work led to a decision to add a 1.1% 'flood levy' to the 2008/2009 council tax. By using the £2.3 million generated from the flood levy alongside governmental funding, priority work programmes were established. A GCC-chaired multiagency flood risk management group brought together GCC, district councils, the Environment Agency (EA), water companies and the Inland Drainage Board to share information, responsibility and facilitate effective flood resilience projects. A dedicated flood risk management team within GCC was established to coordinate the work. The table describes the issues identified by GCC and its multiagency partners and charts the progress made against them in the years since 2007.

Floodwaters in England

Discussion

The Gloucestershire flooding of 2007 was caused by a combination of river and surface water flooding. Recommendations from the Pitt Review[1] and EA enabled GCC to analyse its practice and develop an action plan to initiate internal and multiagency improvements. Gloucestershire Local Resilience Forum's multiagency flood plan was independently assessed and approved by the EA as an inclusive plan for all flood response agencies and its 'flood guide' for residents won awards from the Chartered Institute of Public Relations. GCC continues to work with other partners on flood risk management projects, raising awareness and improving resilience in flood risk communities. Ongoing work is taking place in Gloucestershire, learning lessons from more recent flooding, to continue to improve multiagency flood response and flood data collection arrangements.

In 2007, flooding was a key priority for GCC with resources and planning paramount. Due to county council pressures, when major flooding is not imminent, other council issues take precedence and funding can be diverted until flooding occurs again, bringing it back to the top of the agenda. The efforts of GCC and partners to plan and prepare in mitigation of future flooding are an investment in the community, and performing robust evaluations of these interventions is an integral part of this process. During the latter part of 2012, large amounts of rainfall and a high water table led to a combination of river, surface water and sewer flooding in localised areas of the county. According to the EA, a total of 200 properties were flooded across Gloucestershire. However, it is estimated that a further 500 properties in these areas would have been affected by flooding if it had not been for the flood alleviation schemes installed since 2007[3].

The risks to public health from flooding can be extensive and significant, and occur before, during and after the event. Mortality can be caused by drowning[4] or carbon monoxide poisoning from indoor generator use[5], and morbidity can be caused from injury or contact with contaminated water[4]. Mental health and wellbeing are significantly adversely affected by to flooding; property damage, household disruption and displacement cause depression, anxiety and stress[4]. Population vulnerability to the public health risks from flooding result from a variety of factors. The severity and speed of flooding and how response measures are put in place will determine the extent to which the population is affected. Research suggests that properties are flooded three or more times before the majority of owners take preventive rather than purely reactive measures[6]. The flood risk management changes implemented by GCC such as coordinated multiagency flood plans, improved response arrangements, infrastructure protection, and increasing resources, enhances Gloucestershire's resilience to future flooding events, meaning that ultimately the health of the community is better protected.

Acknowledgements

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Table: Key changes made to flood preparedness, resilience and response in Gloucestershire

	Issue identified from 2007 flooding	Change made	Expected outcome
Flood risk management and infrastructure protection	**Highway drainage and flood alleviation** Road and property flooding was exacerbated or caused by flooding from highways drainage systems	In partnership, Gloucestershire Highways, GCC, the district councils and the Environment Agency (EA) identified 100 highway locations where drainage system improvements would reduce the risk of property flooding. Flood alleviation programmes were prioritised against criteria for properties in danger of flooding	Over 160 partnership flood alleviation schemes, drainage and resilience projects have been initiated, including high pressure jetting and regular gully cleaning and maintenance schedules Flood alleviation work has reduced the risk of flooding to over 1,500 homes
	Schools 25 schools were flooded causing varying degrees of damage	Flood resilience work was conducted at the 9 schools most affected with funding from the then Department for Children, Schools and Families A council scheme provided guidance for schools and children's services vulnerable to flood damage Guidance for developing individual school emergency plans was updated	Schools at greatest risk of flooding are more resilient and their awareness of planning for emergencies is reinforced
	Utilities A water treatment works and an electricity substation were flooded, leading to loss of supply to thousands; a huge multiagency effort was initiated to prevent another substation from flooding	Utility companies contributed to an inquiry by GCC Utility companies were requested to engage more with the local resilience forum (LRF) and put resilience measures in place	Improved engagement of utility companies and LRFs Severn Trent Water has undertaken considerable flood resilience work at significant cost to protect water treatment works and installed a new pipeline to a backup water supply Permanent flood defences have been installed at the electricity substation

table continues

	Issue identified from 2007 flooding	Change made	Expected outcome
Emergency planning and response	**Rest centre equipment** All equipment intended for use in rest centres was stored centrally but this building was evacuated in 2007 due to the flooding risk. Extracting equipment for distribution to rest centres therefore proved problematic due to flooded access and egress routes	Flood resilience project funding by Severn Trent Water enabled a GCC-approved project to purchase additional rest centre equipment to be held by each district council	There is greater resilience in rest centre equipment being held in a number of locations rather than at a single vulnerable point
	Vulnerable people plan Special arrangements were considered for vulnerable people affected by the loss of mains water supply for up to 12 days. However, identifying vulnerable people proved challenging	GCC led a multiagency plan for identifying vulnerable people whereby organisations formed one contact register shared across relevant agencies	The challenge of identifying every vulnerable person is mitigated by known vulnerable people being easily identified and effectively supported in adverse incidents within and outside the scope of flooding
	Emergency Control Centre resilience The Emergency Control Centre was evacuated during the flooding as it was located in the basement and council response staff worked from the Gloucestershire Fire and Rescue Service (FRS) offices The main basement IT server room had a controlled power down due to the flooding risk The loss of GCC offices for a week highlighted the need for additional business continuity management (BCM) plans	The Emergency Control Centre has been re-located on the second floor. Back-up emergency control centre provision is located outside the flood risk area Relocating the IT server room was not feasible or cost-effective so flood gates were installed and IT disaster recovery arrangements made All services (including those less critical) were asked to produce a BCM plan	The Emergency Control Centre is more resilient with formalised back-up arrangements if required Key responders can continue to communicate in the event that IT systems are down The majority of services now have BCM plans and arrangements in place
	Staff shift changes and handover During the 2007 flood response, local authority staff worked an unfamiliar shift-style pattern and consequently shift changes and handover were not as effective as they could have been. The two 'gold officers' assigned to represent GCC at multiagency strategic coordinating groups (SCG) were stretched as SCG ran for over 2 weeks	A proposed overlap between staff shifts during a response incident to allow a complete handover to take place 'Change of shift' exercises are included in new staff training All 10 of GCC's senior officers agreed to become gold officers. Training and a formalised rota were established	Staff rotas for emergencies are developed by managers who are more aware of taking a sufficient handover period into account. Gold officer availability is more resilient and sustainable for long-running emergencies
	Water distribution plan The scale and duration of the water supply outage as a result of the 2007 Gloucestershire flooding exceeded contingency plans and initiated a multiagency distribution scheme	The good practice and lessons learnt from the water distribution scheme were developed into a plan with relevant water companies	Enhanced flood resilience mitigation measures by Severn Trent Water should minimise the need for activation of a water distribution plan but, if necessary, an effective and coordinated water distribution response is available

table continues

	Issue identified from 2007 flooding	Change made	Expected outcome
Emergency planning and response	**Multiagency flood plan** Following the Pitt Review, local authority flood plans were reviewed and adapted in accordance with EA and government guidance	A multiagency working group assisted in generating a flood plan with the GCC Civil Protection Team who then supported district councils to review existing flood plans Updated plans incorporating lessons learnt were used in desktop exercises with district councils and local resilience forums	One inclusive plan for all flood response agencies is expanding the awareness of information available that may help in a flooding emergency
	Dedicated GCC flood team Flood risk management was not a dedicated resource or staffing assignment within the council prior to 2007 **Offers of help team** The huge volume of offers of help from outside agencies during the flood were not recorded or as effectively used as they could have been	A dedicated Flood Risk Management Team was established by GCC in 2008, with two full-time staff The GCC Civil Protection Team developed a team of volunteer staff trained to take calls, collate information and signpost to other agencies. An online system for the public to offer assistance was also devised	**Dedicated GCC flood team** The Flood Risk Management Team coordinates GCC's flood resilience work and undertakes work to meet the requirements of the Flood and Water Management Act 2010 The team also liaises closely with the Civil Protection Team to coordinate flood risk awareness and resilience work and flood data collection **Offers of help team** A dedicated system and trained staff effectively deals with callers offering help
	Joint training with voluntary agencies The 2007 flooding demonstrated the value of working together and highlighted the need for increased joint training	A GCC steering group leads on training recognised partner agency staff Gloucestershire FRS and the police have undertaken more joint training with voluntary search and rescue organisations The Department for Environment, Food and Rural Affairs (Defra) and Severn Trent Water have funded two hovercrafts and a boat for water rescue	Joint training is increasing the awareness of the capability and resources of voluntary search and rescue organisations enabling a more effective joined-up response Gloucestershire FRS is involved in the Defra Flood Rescue Concept of Operations[7], and has a trained water rescue team and equipment nationally and internationally deployable in support of flood response
Community resilience	**Raising public awareness** Lack of flood awareness from the public	The council tax 'flood levy' necessitated public transparency on flood spending. Every Gloucestershire property received a 'flood guide' with information and advice A media campaign highlighted GCC and partnership flood projects Parish councillors received flood information packs Gloucestershire Highways used 'Flood Relief Project' signs when conducting relevant work	The flood guide was reviewed in 2012 and aims to raise awareness of the risks of flooding in Gloucestershire. It includes: • risk reduction action by authorities • help available for flood affected households • preventive measures in preparation for future flooding The media are reporting positive messages about GCC's flood resilience A multiagency flood risk management group has developed a joint leaflet for riparian owners (anyone who owns property alongside a natural watercourse)
	Community emergency plans The scale and impact of the 2007 floods stretched responder's resources and cut off some access and egress routes, leaving many communities to be self-reliant	GCC developed a community emergency plan template District councils encouraged communities through parish councils or flood action groups to develop their own plans Gloucestershire Rural Community Council (a community focused organisation) developed a CD Rom toolkit for community resilience	30–40 communities in Gloucestershire have community emergency plans to increase their resilience to future flooding and other extreme weather events

Effective flood resilience in health providers: flooding at a major NHS Blood and Transplant facility

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Background

The flooding of health infrastructure can result in the loss of facilities, loss of operational capacity and subsequent interruption of business, introducing difficulty in providing routine medical and nursing care for patients with chronic diseases (eg diabetes) or who have complex healthcare needs[1].

Formed in 2005, NHS Blood and Transplant (NHSBT) is a special health authority and arm's length body of the Department of Health that provides blood and blood components for England and North Wales. The service oversees organ donation and transplantation by matching and allocating donated organs across the UK. Furthermore, NHSBT provides many specialist products and services including tissues, diagnostics, therapeutics, haemopoietic stem cells and clinical advice.

NHSBT collects, manufactures and distributes approximately 2 million units of red blood cells annually to 330 hospitals across England and North Wales (80% of the UK's daily blood requirements). Once collected, the blood undergoes extensive manufacturing and testing and is kept under strict environmentally controlled conditions.

At 9,000 m^2, NHSBT Filton in Bristol, which opened in 2008, is one of the largest and most advanced blood manufacturing centres in the world and, as such, is NHSBT's flagship manufacturing centre in the UK. The centre represents almost 50% of NHSBT's manufacturing capabilities and houses a number of specialised departments including cellular and molecular therapy and organ donation; its scientists carry out both nationally and internationally recognised research. The strategic and operational importance of the Filton centre to the NHSBT UK operations means that any disruption to its manufacturing capacity could have an immediate and significant impact upon UK blood and transplant services, potentially putting lives at risk.

Overview of the incident

Following the wettest UK summer in 100 years[2], a significant low pressure system moved across South West England in the early hours of Monday 24 September 2012. With reported cloud heights 7 miles high, exceptionally high rainfall fell on to already saturated ground, leading to widespread surface water flooding. By 7:40am on 24 September, a drainage culvert at the rear of the building – not owned by NHSBT, but which was known to be damaged – was unable to drain the accumulating surface water. Avon Fire and Rescue Service was called to pump the considerable volume of surface water away from the building; however, high volume pumps could not be used as there was nowhere to pump the water to. By 8:45am it became apparent that NHSBT Filton was at imminent danger of flooding and at 9:00am there was a sudden and significant ingress of floodwater into the building (up to 4 inches deep in places) (Figures 1 and 2). As a result, all power to the building was isolated and shutdown. This resulted in the loss of refrigeration, air handling and building management systems; so the building was evacuated.

NHSBT protocols for a major incident stipulate that 100% of the Filton core blood supply operations and commitments are to be picked up by the other NHSBT blood centres across the UK (Colindale, Manchester, Newcastle and Sheffield) within 24 hours of an incident. This led to immediate measures being put into place to secure and evacuate blood stocks from Filton for re-distribution across the NHSBT network. Using a transport and logistics plan, steps were taken to divert collections within the Filton catchment to other centres for manufacturing on the evening of 24 September.

Potential public health implications

NHSBT is the sole provider of blood and blood components to hospitals across England and North Wales. The strategic importance of NHSBT Filton in ensuring the stability and security of the UK's largest blood and organ distribution system, means that any disruption to the site's operational capabilities has the potential to cause significant and widespread health impacts. The public health impacts of the closure of NHSBT Filton include patients not receiving lifesaving treatments and the undermining and interruption of patient care across the wider health community.

Discussion

Despite the significant disruption caused by the flood, by the evening of 24 September the command and control plan, national reprovisioning plan for the manufacturing and distribution of blood products and the national coldroom failure plan were in operation to minimise the impact to health services. A recovery group was established by day 2 of the incident to coordinate the restoration efforts and two senior

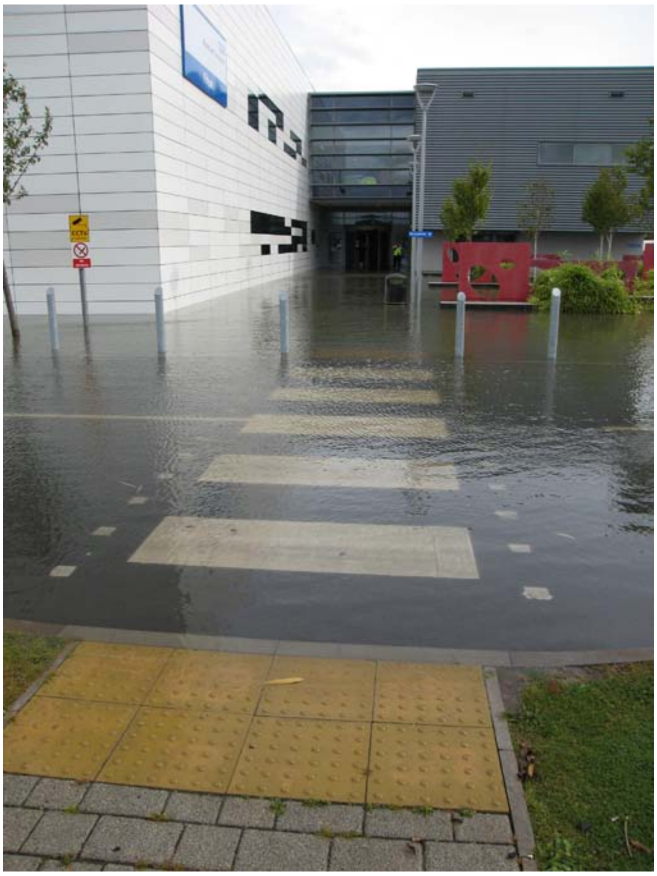

Figure 1: Floodwater reaches the entrance to NHSBT Filton

Figure 2: Floodwater inside NHSBT Filton was up to 4 inches deep in places

operations managers were delegated responsibility for response and recovery.

Despite initial concerns that NHSBT Filton would not be operational for several months, the recovery phase of the incident commenced just 9 hours after the water had closed the service. A recovery plan was devised by NHSBT which called for the core functions of the blood supply chain (manufacturing, testing and distribution) to be re-established within 1 week of the incident. With all electricity power lines coming from the ceiling to feed the lights and power sockets, there was no damage to essential infrastructure and this design permitted the power to be restored safely and expediently. Blue paper towels were used to catch and filter out floodwater debris (Figure 3) including waste from a nearby waste recovery facility to lessen the effects of dirty floodwater. Once power had been restored to the centre, residual flood water was removed from the building, with the assistance of the fire service and a large number of de-humidifiers. This permitted a four-stage cleaning plan to be implemented. During the first few days, this cleaning of the manufacturing hall and laboratories (3,000 m^2 of floor space) included a sanitising clean, chlorine bleach clean, freshwater rinse and finally a second sanitising clean.

While the cleaning of the manufacturing areas of the centre was underway, the stem cell immunotherapy department engaged specialist cleaners to sanitise its clean rooms due to the specific requirements for cleanliness at these locations. Sterile conditions were not required for the manufacturing areas as the blood remains within a closed system. The whole power system underwent full electrical testing and the pre-existing pest control regime, which had been wiped out by the incident, was reinstalled. On day 4 a successful environmental health inspection of the kitchen enabled the canteen to be reopened and staff to begin moving back into the centre. Throughout the stages of cleaning, the quality assurance manager was tasked with inspecting and signing off each process at each locality. On day 6 of the incident, the quality assurance department started contact and air sampling of the manufacturing area in preparation for re-opening. Other specialist companies were used to deal with the large volume of sensitive and confidential documents contained within the administrative offices which required clearing and the removal of flood-damaged carpets, which were replaced on day 7. Finally on day 8, following a visit by the Medicines and Healthcare Products Regulatory Agency (MHRA), NHSBT confirmed that blood supply operations at Filton could recommence.

This series of actions, coupled with the concerted effort of all staff involved and their previous exercise experience of scenarios focusing on the loss of the Filton centre, helped ensure that all customer orders to hospitals were fulfilled by the NHSBT service. The unprecedented event and the success of this example of business continuity has led to

Figure 3: Blue paper towels were used to filter out floodwater debris

the NHSBT Filton story attracting great interest from as far afield as Australia and Canada. Moreover, the event of September 2012 led to NHSBT being awarded the 'Most Effective Recovery of the Year' category at the 2013 Business Continuity Institute's European awards.

Key learning points

Although the successful management of this flood incident is indicative of the experience and commitment of staff at NHSBT and the robust emergency management and business continuity planning, there are always lessons that can be learned to improve and enhance resilience. For this reason NHSBT tasked the acting head of resilience and risk to undertake a review of the incident and NHSBT's response. The review highlighted the key lessons learned from the incident and made 34 recommendations to enhance resilience at NHSBT facilities (see the table), centred upon the broad themes of:

- emergency and business continuity planning
- incident management and crisis scene control
- internal and external communications
- risk assessment

These recommendations have been accepted by the NHSBT Board and are supported by a robust action plan to ensure their implementation and testing.

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Table: Summary of lessons learnt and considerations

Emergency and business continuity plans	The review recommends the creation of a whole-site approach to contingency planning at Filton, rather than a concentration of core operations (eg blood testing and supply). The incident identified the need for up-to-date emergency contact details for staff along with the need for a protocol for incident managers to follow. A list of customer hospitals serviced by each National Blood Service Centre, reprovisioning centre and temporary delivery unit requires ongoing review and updating, across the whole NHSBT service Flooding should be included with other evacuation scenarios in emergency exercises and training of fire wardens and marshals to ensure that processes are effective. Moreover, fire and rescue services along with other local agencies should continue to be invited to, and participate in, NHSBT exercises wherever possible The review highlights the need for greater clarity with regard to accessing NHSBT IT and customer service expertise outside office hours. Moreover, to help ensure the continuity of service, a register of those staff members able and willing to be relocated in an emergency should be created across the organisation. This register should be supported by an integrated plan on the staff redeployment human resources policy
Incident management and crisis scene control	The review recommends a consolidation in the number of documents used to log incidents and suggests that better guidance and training are required for incident managers in their use and application. The reviewers recommend the creation and maintenance of a pool of NHSBT personnel trained to log incidents To ensure effective incident management, the reviewers recommend a review of the existing command and control structure and national reprovisioning plans that include both national and local teams and incorporate a national recovery group. These plans should include guidance on when and how to escalate incidents and stipulate specific roles and responsibilities. Those staff within the new plans should undergo mandatory training that entails an assessment of competency in terms of incident management. The review also recommends the creation of command suites that would act as the focus for an emergency and would be used to coordinate strategic response. At times of quiescence, these facilities would form part of the normal day-to-day NHSBT activities
Internal and external communications	To enable the development of guidance and protocols for incident managers, an evaluation of issues raised around the use of social media, internal/external risk communication and the establishment of a critical incident helpline should be undertaken. NHSBT should explore the development of a mass messaging platform to aid stakeholder engagement/communication and formalise the importance of debriefing sessions into critical incidents
Risk assessment	The review recommends an assessment and standardisation of local reprovisioning arrangements across the NHSBT service. Consideration should be given to the unification of the risk management and emergency preparedness committees A programme for on-site business continuity risk assessments should be undertaken for relevant parts of the NHSBT infrastructure. These risk assessments should use both internal (estates) and external (community and national registers) risks. Furthermore, the description of impact and the escalation levels for risk should be considered to ensure they are tailored to NHSBT

Conferences and Workshop Updates

Atlantic Regions' COastal POLlution (ARCOPOL) Response Plus conference Creating a toolkit for effective maritime incident response – communications, resources and planning

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Introduction

A two-day conference, held in Cardiff 11–12 September 2013, was organised as part of the Atlantic Regions' COastal POLlution (ARCOPOL) Plus project, which is funded by the European Regional Development Fund and framed in the Atlantic Area Transnational Programme. The project aims to improve the preparedness, response and mitigation capabilities of local responders against maritime shoreline pollution incidents. The event was organised jointly by Public Health Wales, Pembrokeshire County Council and the World Health Organization, with assistance from Cardiff Metropolitan University.

The conference was divided into five themed sessions and had a variety of speakers from UK and international organisations. The sessions included presentations and the opportunity for discussion, demonstrations and audience participation.

Planning and preparedness to maritime incidents

The first session included presentations from Kevin Colcomb from the Maritime and Coastguard Agency (MCA), John Mouat from Bonn Agreement and Nicky Cariglia from the International Tanker Owner Pollution Federation (ITOPF).

Kevin Colcomb introduced and discussed the mechanisms within the current and future national contingency plans (NCP), noting that the areas that cause most frustration during an incident are:

- waste management
- activation, interaction and the potential for overlapping advice between the science and technical advice cell (STAC) and the standing environment group (SEGs)
- activation of the shoreline response centres (SRC) and/or strategic command groups (SCGs)
- oil spill countermeasures
- cost recovery

The alert phase was described to the audience noting that when there are cross-border impacts communications between organisations need to be clarified and detailed, in particular when discussing the roles and responsibilities of cross-border agencies. This can be key when discussing and agreeing a place of refuge.

It was agreed that the above issues need to be resolved to prevent further confusion. The NCP is currently out for UK consultation.

John Mouat presented 'Be Aware' a European funded project for cooperation in dealing with pollution of the North Sea by oil and other harmful substances. The greater North Sea currently has no overall risk assessment for marine pollution; however, there is an increase in both traffic and the size of vessels operating, as well as increasing transport of oil and hazardous and noxious substances (HNS), and a greater number of offshore installations. Therefore the development of a risk assessment is required and a project is intending to undertake the first area wide risk assessment that will allow the risks to be mapped and compared. Results of the project, due to be completed in December 2013, will include identification of high risk locations for collisions and grounding based on traffic data and risk assessment. The subsequent project 'Be Aware II' aims to expand on the data collected in Be Aware and will develop, through modelling, a range of scenarios, joint sensitivity mapping and detailed analysis of impact to enhance preparedness and risk management conclusions. Additional information on this project can be found at http://beaware.bonnagreement.org/.

The International Tanker Owners Pollution Federation Limited (ITOPF) was established after the Torrey Canyon incident which occurred on the southwest coast in 1968, and involved the release of 32 million gallons of crude oil, the effects of which are still evident today. ITOPF represents 98% of the world's bulk oil, chemical and gas carriers. It has responded to and attended over 700 incidents in 100 countries and can mobilise 24/7 to provide on-site technical advice to government, responders and victims. ITOPF's roles during an incident will vary depending on the country's experience in dealing with maritime incidents. For example, some countries will have contingency plans in place and ITOPF may be asked to provide support to the responders dealing with the incident; however, on other occasions ITOPF may be asked to take over the incident with financial backing from the country's government. ITOPF has developed quick-reference country profiles for 160 nations on their response arrangements,

The ARCOPOL Project Team

capabilities and policies for maritime response, if they exist. It has also produced 17 downloadable booklets (technical information papers) to assist responders, from operational to strategic levels. Additional information on this organisation can be found at www.itopf.co.uk.

Communication during a maritime incident

This session included presentations from Huw Brunt from Public Health Wales, Ann Hayward Walker from SEA Consulting and Rhion Jones from Consultation Institute.

Huw Brunt discussed the role of public health bodies during a maritime incident and highlighted the importance of clear communication, and effective ways to communicate about the public health risks during an incident. A strategy document has been developed as part of ARCOPOL Plus, which is available at http://www.arcopol.eu/buscaDocu.aspx?soc=PHE.

Ann Hayward Walker discussed the community engagement guidance for oil and HNS incidents document released in June 2013, which has been produced for Pembrokeshire County Council. This document highlights the need for community engagement during the response to maritime incidents to improve understanding of, and address, community concerns and share relevant information. Ann Hayward Walker was involved in community engagement during Deep Water Horizon, the BP oil spill in the Gulf of Mexico, and relayed her experiences of community engagement in practice, including the use of social media, noting the importance of ongoing communication with the public throughout the response and recovery phases of the incident. This document is available on the ARCOPOL website, www.arcopol.eu. Rhion Jones from Consultation Institute discussed community engagement in practice, outlining the processes required and issues encountered when communicating and engaging with stakeholders in respect of maritime incidents.

Response and recovery to a maritime incident

The final session on the first day focused on issues such as waste management and associated with accreditation, skills and expertise of companies which could be required to support clean-up strategies in the recovery phase.

Natalie Beau from Centre of Documentation, Research and Experimentation on Accidental Water Pollution (CEDRE) discussed waste management best practice, highlighting the content of the guidance on waste management during a shoreline pollution incident*, which it has produced. This document contains operational guidelines to assist decision makers and operation responders in the initial stages of

* Kremer X. Guidance on Waste Management during a Shoreline Pollution Incident. Operational Guidelines. Brest: Cedre, 2011, 83pp.

Table: Key workshops from the public health perspective

HNS risk prioritisation database Andrew Kibble, Public Health England	Database of 350 HNS incidents which can be used to help assess public health impacts associated with a marine incident involving these materials. The database focuses on the potential acute human health impacts based on toxicology, reactivity and the potential to reach the public. Database currently can be accessed at http://www.arcopol.eu/arcopol/fichaDocumento.aspx?id=27
Filling gaps in knowledge in marine species and implementation at operational levels CIMAR Portuguese Marine Sciences Associate Laboratory	CIMAR update on ongoing work to revise the fate and weathering data of HNS from a previous spill incident and its shoreline impact. Assessment of acute and chronic toxicology, carcinogenicity, behaviour in water (eg sink or reach coast), involvement in previous incidents and traffic ranking of 23 priority HNS incidents. Further information available at www.ciimar.up.pt/hns
Dynamic risk analysis and modelling Marine Environment and Technology Centre (MARETEC)	Use of numerical modelling applied to water environmental problems, monitoring and data management. HNS spill module is being implemented under ARCOPOL, which aims to model the behaviour of HNS involved in a spill, considering factors including ship location, quantity involved, coastal and weather conditions. Modelling capabilities will estimate, in real time, the trajectory and behaviour of oil spills using metocean forecasting data sources. The model outputs can be updated using satellite images, modelled or monitored data, and will support forecasting and risk analysis
Spills and forecast tools for local authorities (INTECMAR)	Tools available to support the response to maritime incidents include detection and monitoring of the spill using photography from a helicopter followed by insertion into GIS. Information can be disseminated through the ARCOPOL viewer tool, which can gather and organise all information of the spill episode (geographical information, model outputs and observations). It is solely for use by local authorities and maritime organisations. Future development could include a tool for public reporting and observations
E-Learning Paul Harold, Public Health England Antonio Santiago, Junta De Andalusia	There was a parallel workshop session running as well, which featured talks on e-learning from PHE – http://moodle.uwic.ac.uk/login/index.php –developing a series of units covering planning, preparedness and response to maritime incidents involving HNS . Also e-learning work is being undertaken by the region of Andalusia focusing on oil pollution and environmental clean-up
Community Engagement Daniel John, Pembrokeshire County Council	The final workshop presented by Pembrokeshire County Council covered works undertaken around engagement of shoreline communities in respect of maritime pollution planning and preparedness

the emergency response by providing concise information on all aspects and phases of waste management following a maritime pollution incident. Although the guidance concentrates on oil waste, the principles can be applied to HNS and non-polluting waste originating from the incident. Additional information on the organisation can be found at www.cedre.fr/en/cedre/.

ARCOPOL projects – tools and resources

The second day consisted of smaller workshops, aimed at demonstrating the tools which have been developing through ARCOPOL, and can be used to support the response to maritime incidents. Sessions focused on contingency planning, HNS, modelling and decision support software, environmental modelling and training, and awareness raising. Details of key workshops from the public health perspective included those detailed in the table.

The conference concluded with presentations from Public Health England on other EU projects and Centro Tecnologico del Mar (CETMAR) which discussed the future of ARCOPOL project.

Dr Stacey Wyke, Public Health England, presented the UK Recovery Handbook for Chemical Incidents and used incidents to demonstrate how the document can be used to aid stakeholder group decisions in managing the recovery phase of a chemical incident where contamination has affected food production systems, inhabited areas and water environments. The document can be accessed at http://www.hpa.org.uk/webc/HPAwebFile/HPAweb_C/1317134402459.

Dr Ehi Idahosa-Taylor, Public Health England, presented the SHIPSAN project which is preparing guidelines (eg for port officers) to support the response to chemical and radiation incidents on ships that result in occupational and public exposure. Updates are through a bimonthly e-newsletter and 10 pilot training courses. Additional information on SHIPSAN is available at www.shipsan.eu/keyresources.aspx.

The final presentation was on the future of the project with ARCOPOL+, which concluded in February 2014; however, an application to continue the work was been submitted and ARCOPOL Platform will run from January 2014 to June 2015, further enhancing the work on contingency planning, HNS, modelling and decision support software, environmental monitoring and training, and awareness. Further details and all of the presentations are available at http://www.arcopol.eu/network/home.aspx.

Conclusions

The conference was well attended and it was a great opportunity to meet colleagues in organisations involved in responding to maritime incidents both in the UK and around the world. It also highlighted the importance of responding organisations being aware of the public health implications of a maritime spill. ARCOPOL continues to strengthen the preparedness and response to maritime incidents from both the tools that have been, and are continuing to be, developed and work to build on the underlying evidence base. However, issues associated with the current command structures during incidents do need to be resolved to ensure consistency and that effective action is taken during the response and recovery phases of a maritime incident. We hope that the upcoming NCP consultation will assist in discussions and a conclusion to this matter.

Acknowledgement

One of the partners in the ARCOPOL project is CRCE Wales and for further information on the project please visit www.arcopol.eu or contact paul.harold@phe.gov.uk.

About Public Health England

Public Health England exists to protect and improve the nation's health and wellbeing, and reduce health inequalities. It does this through advocacy, partnerships, world-class science, knowledge and intelligence, and the delivery of specialist public health services. PHE is an operationally autonomous executive agency of the Department of Health.

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